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Marine genetic resources beyond national jurisdiction: an integrated approach to benefit-sharing, conservation and sustainable use

Harriet Harden-Davies

University of Wollongong

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Marine genetic resources beyond national jurisdiction: an integrated approach to benefit-sharing, conservation and sustainable use

Harriet Harden-Davies

Supervisors:
Professor Robin Warner
Professor Alistair McIlgorm

This thesis is presented as part of the requirement for the conferral of the degree:
Doctor of Philosophy

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The University of Wollongong
Australian National Centre for Ocean Resources and Security (ANCORS)

June 2018
Abstract

The genetic diversity of marine life can be harnessed through scientific research and technological development to provide a range of benefits to society and the ocean. However, due to gaps and ambiguities in the international legal framework, existing access and benefit-sharing regimes are not applicable to marine genetic resources in the 60 percent of the ocean that lies in areas beyond national jurisdiction (ABNJ). Equity concerns have arisen from disparities in scientific and technical capacity that prevent many countries from acquiring and utilising marine genetic resources in ABNJ. Consequently, benefit-sharing presents a challenging issue for historic intergovernmental negotiations that are poised to commence to develop a new international legally-binding instrument (ILBI) under the 1982 United Nations Convention on the Law of the Sea (LOSC) for the conservation and sustainable use of marine biological diversity in ABNJ. Pragmatic and science-based solutions are urgently needed to navigate the divergent views on the nature of marine genetic resources, the benefits to be shared, and the options for capacity building and technology transfer if an agreement is to be reached in the forthcoming Intergovernmental Conference.

This thesis investigates practical options to achieve the objective of benefit-sharing identified by States: to serve the dual interests of building the capacity of developing countries to access and use marine genetic resources of ABNJ and the conservation and sustainable use of marine biodiversity. The analysis demonstrates that international science collaboration, technology transfer and scientific capacity building are key ingredients for benefit-sharing. A conceptual model for a holistic approach to the acquisition, sharing and utilisation of benefits from marine genetic resources in ABNJ is developed. The study provides the first illustration of the linkages between benefit sharing and the development and transfer of marine technology under the law of the sea, identifying a new paradigm of technology transfer based on international collaboration and inclusivity in innovation. The study reveals that the LOSC framework provisions for marine scientific research (Part XIII) and the development and transfer of technology (Part XIV) provide a basis for an integrated approach to benefit-sharing. Thus, this thesis provides the first comprehensive analysis of the potential to enable benefit-sharing from marine genetic resources of ABNJ by strengthening the implementation
of existing LOSC framework provisions in Part XIII and XIV relevant to scientific and technological capacity through the ILBI.

Drawing on an examination of existing scientific practices and legal frameworks for benefit-sharing, a suite of measures elaborating existing LOSC provisions are proposed for inclusion in the ILBI, that are grounded in international law and scientifically practicable. The measures are targeted to enable benefit-sharing by producing four outcomes: first to enhance international scientific research cooperation and facilitate marine scientific research in ABNJ; second, to support access to data and knowledge; third, to empower scientific capacity building at global, regional, national, institutional and individual levels; and fourth, to create an enabling framework for implementation by specifying institutional responsibilities and implementation mechanisms. Thus, this thesis presents suggestions an integrated approach to sharing benefits from marine genetic resources of ABNJ that supports the conservation and sustainable use of marine biodiversity in ABNJ.

The adoption of the proposed integrated approach could transform benefit-sharing from a polarising challenge into a unifying opportunity for the international community by providing a framework to enhance global, regional and national scientific and technological capacity to study, conserve and sustainably use marine biodiversity. Against this backdrop, this thesis proposes tangible measures that could be adopted to serve as a means to both incentivise and enable the conservation and sustainable use of biodiversity in the vast expanse of the global ocean that lies in ABNJ.
Acknowledgments

This thesis would not have been possible without the generous support of several individuals and the many incredible experiences that have been open to me. I am deeply grateful to my supervisor Robin Warner for patiently providing me with such expert guidance over the course of my PhD research, to my co-supervisor Alistair McIlgorm for always helping me gain perspective, and to Mary-Ann Palma for starting me on this incredible journey at ANCORS. I am deeply grateful to Kristina Gjerde for inspiring me and for encouraging me every step of the way.

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Certification

I, Harriet Harden-Davies, declare that this thesis submitted in fulfilment of the requirements for the conferral of the degree Doctor of Philosophy, from the University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. This document has not been submitted for qualifications at any other academic institution.

Harriet Harden-Davies

12th June 2018
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<td>Areas beyond national jurisdiction</td>
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<tr>
<td>AOSIS</td>
<td>Alliance of Small Island States</td>
</tr>
<tr>
<td>AUV</td>
<td>Automated underwater vehicle</td>
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<tr>
<td>BBNJ</td>
<td>Biodiversity beyond national jurisdiction</td>
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<tr>
<td>CARICOM</td>
<td>Caribbean Community</td>
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<tr>
<td>CBD</td>
<td>Convention on Biological Diversity</td>
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<tr>
<td>CCAMLR</td>
<td>Convention on the Conservation of Antarctic Marine Living Resources</td>
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<tr>
<td>CGIAR</td>
<td>Consultative Group on International Agricultural Research</td>
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<td>CGTMT</td>
<td>Criteria and Guidelines on the Transfer of Marine Technology</td>
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<td>DNA</td>
<td>Deoxyribonucleic acid</td>
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<td>DOOS</td>
<td>Deep Ocean Observing Strategy</td>
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<td>EU</td>
<td>European Union</td>
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<td>FAO</td>
<td>Food and Agriculture Organisation</td>
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<td>G7</td>
<td>Group of Seven</td>
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<td>G77</td>
<td>Group of 77</td>
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<tr>
<td>GEF</td>
<td>Global Environment Facility</td>
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<tr>
<td>GISRS</td>
<td>Global Influenza Surveillance and Response System</td>
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<tr>
<td>GOOS</td>
<td>Global Ocean Observing System</td>
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<tr>
<td>IARC</td>
<td>International Agricultural Research Centre</td>
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<tr>
<td>IIOE</td>
<td>International Indian Ocean Expedition</td>
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<td>ILBI</td>
<td>International legally binding instrument, under the 1982 United Nations Convention on the Law of the Sea, for the conservation and sustainable use of marine biological diversity in areas beyond national jurisdiction</td>
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<td>IOC</td>
<td>Intergovernmental Oceanographic Commission of UNESCO</td>
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<td>IOC-WESTPAC</td>
<td>IOC regional Sub-Commission for the Western Pacific</td>
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<td>IODE</td>
<td>International Oceanographic Data and Information Exchange</td>
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<td>ISA</td>
<td>International Seabed Authority</td>
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<td>ITPGRFA</td>
<td>International Treaty on Plant Genetic Resources for Food and Agriculture</td>
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<tr>
<td>MARPOL</td>
<td>International Convention for the Prevention of Pollution from Ships</td>
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<td>MGR</td>
<td>Marine genetic resources</td>
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<td>NP</td>
<td>Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilization to the CBD</td>
</tr>
<tr>
<td>OBIS</td>
<td>Ocean Biogeographic Information System</td>
</tr>
<tr>
<td>ODAS</td>
<td>Ocean Data Acquisition Systems</td>
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<tr>
<td>OECD</td>
<td>Organisation for Economic Cooperation and Development</td>
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<tr>
<td>PIP</td>
<td>Pandemic Influenza Preparedness</td>
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<tr>
<td>Acronym</td>
<td>Full Form</td>
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<td>PrepCom</td>
<td>Preparatory Committee, established by UNGA Res 69/292, for the conservation and sustainable use of marine biological diversity in ABNJ</td>
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<td>PSIDS</td>
<td>Pacific Small Island Developing States</td>
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<td>RFMO</td>
<td>Regional Fisheries Management Organisation</td>
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<td>RNA</td>
<td>Ribonucleic acid</td>
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<td>ROV</td>
<td>Remotely operated vehicle</td>
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<tr>
<td>SBSTTA</td>
<td>Subsidiary Body on Scientific, Technical and Technological Advice (to the CBD)</td>
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<td>SCOR</td>
<td>Scientific Committee on Oceanic Research</td>
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<tr>
<td>SDG</td>
<td>Sustainable Development Goal</td>
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<tr>
<td>SIDS</td>
<td>Small Island Development States</td>
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<tr>
<td>UN</td>
<td>United Nations</td>
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<tr>
<td>UNCLOS</td>
<td>United Nations Conference on the Law of the Sea</td>
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<tr>
<td>UNESCO</td>
<td>United Nations Educational, Scientific and Cultural Organisation</td>
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<tr>
<td>UNFCCC</td>
<td>United Nations Framework Convention on Climate Change</td>
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<tr>
<td>UNGA</td>
<td>United Nations General Assembly</td>
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<tr>
<td>USA</td>
<td>United States of America</td>
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<tr>
<td>USP</td>
<td>University of the South Pacific</td>
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<td>UWI</td>
<td>University of the West Indies</td>
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Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, opened for signature on 18 December 1979, 1363 UNTS 3 (entered into force on 11 July 1984)


Convention for the conservation of Southern Bluefin Tuna, opened for signature 10 May 1993, 1819 UNTS (entered into force 20 May 1994)

Convention on the High Seas, opened for signature 29 April 1958, 450 UNTS 11 (entered into force 30 September 1962)

International Convention for the Regulation of Whaling opened for signature 2 December 1946, 161 UNTS 74 (entered into force 10 November 1948)


Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilization to the Convention on Biological Diversity, opened for signature 29 October 2010 (entered into force 12 October 2014)


Thesis Publications

Some parts of this thesis appear in modified form in the following publications:

Chapter 1
Introduction

1.1. Introduction

The vast, deep area of the ocean that lies in areas beyond national jurisdiction (ABNJ) is largely unexplored, yet scientific research has already revealed a rich diversity and abundance of life. The variety of ocean life at genetic, species and ecosystem levels can be broadly considered as marine biological diversity (biodiversity), and plays a critical role supporting life on Earth. Marine biodiversity is a rich source of natural innovation offering various potential benefits — from increasing scientific knowledge of ocean ecosystems, to meeting societal needs through developments for health, food security and upholding healthy ocean ecosystems. However, disparities in scientific and technical capacity worldwide mean that not all countries have the capacity to acquire and use so-called “marine genetic resources” in ABNJ, and there is currently no applicable international regime for access and benefit-sharing. Meanwhile, growing pressures from human activities are causing the loss of

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2 See Section 2.2.2 of Chapter 2 for a discussion on the definition of biodiversity and legal and scientific perspectives.


4 See Section 1.2.1 of this Chapter.

5 “Genetic resources” are defined as “genetic material of actual or potential value” in Article 2 of the Convention on Biological Diversity, opened for signature 5 June 1992, 1760 UNTS 79 (entered into force 29 December 1993). See Section 2.2.2.2 of Chapter 2 for a discussion of legal and scientific perspectives on definitions of genetic material and genetic resources, see Section 2.2.2.3 of Chapter 2 and Section 3.2.3.5 of Chapter 3 for a discussion of legal and scientific definitions of value.

Recognising a need to address gaps and fragmentation in the legal framework for ABNJ, States are poised to commence the development of a new international legally-binding instrument (ILBI), under the 1982 United Nations Convention on the Law of the Sea (LOSC), for the conservation and sustainable use of marine biological diversity in ABNJ. One of the four key issues that the instrument will address, together and as a whole, is “marine genetic resources, including questions on the sharing of benefits.”

Definitional gaps in the LOSC and deeply rooted ideological divides regarding the application of the principles of common heritage of mankind and freedom of the high seas have dominated much of the international deliberations relating to marine genetic resources and, to date, proved intractable. Consequently, States have resorted to searching for a new, pragmatic approach to share benefits from marine genetic resources in ABNJ. Uncertainty shrouding expectations of monetary benefits poses a major challenge to the development of the ILBI. However, a growing body of literature demonstrating the significance of so-called “non-monetary” benefits is paving the way for a pragmatic solution to benefit-sharing.

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10 Ibid para 2.

11 See Section 1.2.2 of this Chapter.


LOSCE regimes for marine scientific research and the development and transfer of marine technology have been identified as a possible basis for sharing benefits from marine genetic resources of ABNJ.14 However, many questions remain as to how benefit-sharing could be achieved through measures associated with marine scientific research and technology transfer.

This thesis offers a unique contribution to the scholarly literature addressing those questions. It does so by investigating if the sharing of benefits from marine genetic resources in ABNJ could be achieved by strengthening the implementation of the existing LOSC framework for marine scientific research and the development and transfer of technology, through the ILBI. In this Chapter, the background to the challenge of sharing benefits from marine genetic resources of ABNJ is introduced in Section 1.2. Following an explanation of the need for a pragmatic solution to benefit-sharing, the significance of the thesis is then presented in Section 1.3 and the area of focus is identified. The thesis objectives, research questions, structure, scope and methodology are then established in Section 1.4.

1.2. Background: marine genetic resources beyond national jurisdiction as a global challenge

This section introduces the issue of sharing benefits from marine genetic resources of ABNJ. The current significance of this issue in the context of the conservation and sustainable use of biodiversity beyond national jurisdiction is explained in Section 1.2.1. The key legal gaps are identified in Section 1.2.2.

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14 Glowka, above n 6; Broggiato et al, above n 6; Thomas Greiber, Access and benefit sharing in relation to marine genetic resources from areas beyond national jurisdiction: A possible way forward, (IUCN and German Federal Agency for Nature Conservation, 2011).
1.2.1. Biodiversity beyond national jurisdiction: a historic development in the international law of the sea

The global ocean covers approximately 70 per cent of Earth. Approximately 60 per cent of the ocean surface and 95 per cent of the ocean volume lie in ABNJ (Figure 1.1).\textsuperscript{15} Marine ABNJ comprise two distinct maritime zones established by the LOSC: the high seas, i.e. the water column beyond national jurisdiction;\textsuperscript{16} and the Area, i.e. the seabed, ocean floor and subsoil thereof beyond the limits of national jurisdiction\textsuperscript{17} (Figure 1.2).

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{Figure1_1.png}
\caption{Marine areas beyond national jurisdiction (high seas only)}
\end{figure}  
\textsuperscript{18}

\begin{itemize}
\item[(15)] FAO, Common Oceans: Global Sustainable Fisheries Management and Biodiversity Conservation in Areas Beyond National Jurisdiction (FAO, 2014).
\item[(16)] The high seas incorporate the water column beyond national jurisdiction of States, measured as 200 nautical miles from a State’s territorial sea baseline i.e. beyond the exclusive economic zone (EEZ), LOSC art 57; Convention on the High Seas opened for signature 29 April 1958, 450 UNTS 11 (entered into force 30 September 1962). For a discussion of other areas beyond national jurisdiction, including outer space and Antarctica, see Paul A Berkman, 'Biodiversity stewardship in international spaces' (2010) 8(3) Systematics & Biodiversity 311-320.
\item[(17)] LOSC art 1 (1).
\item[(18)] AD Rogers et al, The High Seas and Us: Understanding the Value of High Seas Ecosystems (Global Ocean Commission, 2014) 5.
\end{itemize}
Figure 1.2: Maritime zones established by the LOSC (top) and applicable international legal instruments for marine scientific research, and access and benefit-sharing of genetic resources in areas within, and beyond, national jurisdiction (bottom). Legend: Nautical miles (NM); United Nations Convention on the Law of the Sea (LOSC); Convention on Biological Diversity (CBD); Commission on the Limits of the Continental Shelf (CLCS).
(Source: modified from Harden-Davies, 2017).19

The myriad ecosystems that characterise the vast, remote and deep ocean spaces of ABNJ support a rich diversity of life.20 Genetic resources are one of the many goods and services provided by marine ecosystems.21 The genetic and biochemical properties arising from the adaptations of marine life to the various natural environments of ABNJ have a range of

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20 See above n 1.

21 Genetic resources have been characterised as a ‘provisioning service’. Ecosystem goods and services include: provisioning services (marine living resources, mineral resources, genetic resources); supporting services (habitats, nutrient cycling, chemosynthetic primary production, resilience); regulating services (atmospheric and climate regulation, waste absorption and detoxification and biological regulation) and cultural services. C W Armstrong et al, 'Services from the Deep: Steps Towards Valuation of Deep Sea Goods and Services' (2012) 2 Ecosystem Services 2. Rogers et al, above n 3.
potential applications, including in agriculture, biotechnology, bioremediation, cosmetics, food, nutraceuticals, industrial processes, scientific research and pharmaceuticals.\textsuperscript{22}

However, the full potential of marine genetic resources remains unknown. Deep ocean areas beyond national jurisdiction represent the final exploration frontier on Earth. Although discoveries of marine species have outpaced those of terrestrial origin, significant scientific knowledge gaps remain.\textsuperscript{23} Emphasising how little we know of the ocean, especially the deep ocean, estimates of the total number of marine species yet to be described by science range from 50 per cent to more than 90 per cent.\textsuperscript{24} The investigation of marine life in ABNJ, particularly microbial and deep-sea species, are anticipated to yield many new genetic and biochemical discoveries, including natural products.\textsuperscript{25} As a result, the full extent of potential benefits from marine genetic resources of ABNJ remains unknown.

Potential benefits from marine genetic resources range from advances in scientific knowledge to developing new products and services. For example, benefits could include:\textsuperscript{26}

- access to samples, data, information and knowledge;
- collaboration and international cooperation in scientific research;
- capacity building and technology transfer including scientific training and access to resources, research infrastructure and technology;


\textsuperscript{23} See Section 2.3 and Section 2.5.2 of Chapter 2.


\textsuperscript{25} Natural products are biochemical compounds produced by living organisms; for definitions and a discussion of marine natural products, see Section 2.2.2 of Chapter 2; Skropeta and Wei, above n 22; Danielle Skropeta, 'Deep-sea natural products' (2008) 25(6) Natural Product Reports 1131-1166.

\textsuperscript{26} Benefits are often considered as “monetary” or “non-monetary”. Nagoya Protocol (2010): monetary benefits include: payments (up-front, milestone or royalties); fees (access, license or special); research funding; and joint intellectual property rights ownership. See Section 3.2.3 of Chapter 3.
• societal benefits, including research directed to priority needs such as health and food security; and
• monetary or economic benefits, including intellectual property or financial gain.

Discrepancies in scientific and technical capacity worldwide have fuelled equity concerns and discussions on benefit-sharing.27 In 2011, Arnaud-Haond et al., reported that patent claims associated with marine genes originated from just 31 countries worldwide, with 70 per cent belonging to USA, Germany and Japan.28 While few countries have the financial, technological and other means necessary to access and use marine genetic resources in ABNJ; concerns among developing countries grew about “fair and equitable” sharing of benefits, heightened by reports of biopiracy and technological advances that accelerated genetic research capabilities such as DNA sequencing.29 According to Snelgrove (2016):

“…many opportunities remain for the discovery of marine bioproducts, but the spatial mismatch between science capacity, hotspots for biodiversity and bioproducts, and resource access and development adds a great challenge”.

Scientific and technological capacity is therefore a significant factor in accessing and utilising marine genetic resources. Capacity requirements range from addressing scientific knowledge gaps, to driving research, technology and innovation for sustainable development.

30 Snelgrove, above n 24.
Numerous and growing pressures from human activities threaten marine biodiversity.\textsuperscript{31} Some threats are linked to greenhouse gas emissions and global climate change, in particular, ocean warming, acidification and deoxygenation.\textsuperscript{32} Other threats to ocean life result from: extractive ocean industries such as fishing, sea-bed mining and offshore oil and gas extraction;\textsuperscript{33} shipping;\textsuperscript{34} and pollution.\textsuperscript{35} The need to protect biodiversity in ABNJ has been increasingly highlighted in the literature.\textsuperscript{36} Overall, the potential for biodiversity loss to diminish opportunities to utilise genetic resources is one driver for biodiversity conservation.\textsuperscript{37} In turn, the development of international legal instruments regarding access and benefit-sharing of genetic resources,\textsuperscript{38} is one way to incentivise biodiversity conservation.\textsuperscript{39} Against this backdrop, the development of the ILBI can be seen as a means to both incentivise and enable biodiversity conservation.


\textsuperscript{33} Mcauley et al, Merrie et al, Halpern et al, above n 7.


\textsuperscript{35} Ibid; Glover and Smith, Benn et al, Robison, Ramirez-Llodra et al, Van Dover et al, Gjerde et al, above n 31.


\textsuperscript{38} See, eg: CBD above n 5; International Treaty on Plant Genetic Resources for Food and Agriculture, opened for signature 3 November 2001, 2400 UNTS 303 (entered into force 29 June 2004).

\textsuperscript{39} See, eg: Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity, opened for signature 29 October 2010 (entered into force 12 October 2014), Preamble [6]. For a discussion on the linkages between access and benefit sharing of genetic resources, and the conservation and sustainable use of biodiversity, see Section 2.6.2 of Chapter 2; for a discussion on possible perceptions of the economic, environmental, social and scientific value of genetic resources see Section 2.2.2.3 of Chapter 2 and Section 3.2.3.5 of Chapter 3.
Fragmentation and gaps in the international legal framework prevent effective governance of marine biodiversity in ABNJ.\(^{40}\) Recognising this problem, international momentum has been building for more than a decade to develop an international legally-binding instrument on the conservation and sustainable use of marine biological diversity beyond national jurisdiction under the LOSC.\(^{41}\) The United Nations Ad Hoc Open-Ended Informal Working Group to study issues relating to the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction (BBNJ Working Group) was established by the United Nations General Assembly (UNGA) in 2004.\(^{42}\) Consequently, on 19 June 2015, as recommended by the BBNJ Working Group, the UNGA decided to develop an international legally binding instrument under the LOSC on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction.\(^{43}\) States deliberated on this through four sessions of the Preparatory Committee (PrepCom) established by UNGA Resolution 69/292.\(^{44}\) In its final report, adopted on 21 July 2017, the PrepCom recommended to the General Assembly that:

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\(^{44}\) Ibid, [1]. The Preparatory Committee was established by the UNGA to make substantive recommendations to the UNGA on the elements of a draft text of an international legally binding instrument under UNCLOS, taking
“…the General Assembly take a decision, as soon as possible, on the convening of an intergovernmental conference, under the auspices of the United Nations, to consider the recommendations of the Preparatory Committee on the elements and to elaborate the text of an international legally binding instrument under the Convention.”

Building on the PrepCom discussions, on 24 December 2017, in its resolution 72/249, the UNGA decided to convene an Intergovernmental Conference under the auspices of the United Nations to:

“…consider the recommendations of the Preparatory Committee on the elements and to elaborate the text of an international legally binding instrument under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction, with a view to developing the instrument as soon as possible…”

The international community now stands on the cusp of a historic development in the international law of the sea. Marine genetic resources are one of the four issues that will be addressed “in particular, together, and as a whole”.

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46 UNGA, above n 9.

47 The UNGA decided, in resolution 72/249, that the negotiations of the Intergovernmental Conference shall “address the topics identified in the package agreed in 2011, namely, the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction, in particular, together and as a whole, marine genetic resources, including questions on the sharing of benefits, measures such as area-based management tools, including marine protected areas environmental impact assessments and capacity-building and the transfer of marine technology”, UNGA, ibid, [2].
1) Marine genetic resources, including questions on the sharing of benefits;
2) Measures such as area-based management tools, including marine protected areas;
3) Environmental impact assessments; and
4) Capacity building and the transfer of marine technology.

With formal negotiations poised to commence in 2018, it is at this unique moment in time that this thesis seeks to make a substantive contribution by addressing key legal gaps, constraints and ambiguities concerning marine genetic resources in ABNJ.

1.2.2. The legal gaps concerning marine genetic resources in ABNJ

Marine genetic resources in ABNJ occupy what has been described as a “legal lacuna”, with two key legal uncertainties giving rise to international debate on the issue of benefit-sharing. Firstly, the LOSC does not mention marine genetic resources, nor provide a specific regime for access and benefit-sharing. At the time of the LOSC negotiations, human knowledge of deep sea life was limited and work on marine natural products was at an embryonic stage. Secondly, existing access and benefit regimes are limited applicability to ABNJ. In particular, those established under the 1992 Convention on Biological Diversity and the 2010 Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilization to the Convention on Biological Diversity, (Nagoya Protocol) are largely restricted to areas within national jurisdiction and based on bilateral arrangements that are unsuitable for ABNJ. Similarly, the scope of other multilateral access and benefit-sharing instruments, such as the 2001 International Treaty on Plant Genetic Resources for Food and Agriculture, and the Pandemic Influenza

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48 Arico and Salpin, above n 6, 35.
50 For example, the first marine derived product reached the market in the 1970s, and deep-sea marine natural product research was almost non-existent, see Section 2.5.1 of Chapter 2.
51 CBD, above n 5; Nagoya Protocol, above n 39.
Preparedness Framework for the sharing of influenza viruses and access to vaccines and other benefits (PIP Framework) are narrow in focus and do not include marine genetic resources in ABNJ. Therefore, there is presently no applicable access and benefit-sharing regime for marine genetic resources in ABNJ.

A further definitional challenge relates to the interconnections between marine scientific research and activities relating to the acquisition, sharing and utilisation of benefits from marine genetic resources. Marine scientific research, undertaken for non-commercial purposes, is widely recognised as the primary activity currently accessing marine genetic resources in ABNJ. The LOSC establishes a regime for “marine scientific research” under Part XIII, but does not define this term. Previous attempts to distinguish “commercial” (i.e. industrial or applied) from “non-commercial” (i.e. pure or basic) research in the law of the sea have not been conclusive. Differentiating non-commercial “marine scientific research” from commercial “bioprospecting” could be similarly challenging, given that the distinction between pure and applied scientific research is increasingly blurred with the advent of new technologies driving transformative change in where, how and by whom marine scientific research can be conducted. Recognising this, there have been repeated calls from States and scientists to ensure that the development of a benefit-sharing regime does not hinder marine scientific research.

The gaps in the legal framework have given rise to a polarised international debate regarding the potential application of the principles of freedom of the high seas or common heritage of

53 See Section 3.4.1.1 of Chapter 3.
55 See Section 4.2.2.1 of Chapter 4.
57 See Section 5.2.2.2 of Chapter 5.
mankind to marine genetic resources. While a detailed a discussion of these complex issues is beyond the scope of this Chapter, it is necessary to provide a brief summary, as follows. The high seas are open to all States, including for scientific research, under the principle of conditional ‘freedom of the high seas’. The governance regime for the Area is more stringent and subject to the principle of ‘common heritage of mankind’. Given the apparent dichotomy between these regimes, international opinion on this question has been starkly divided. The G77 and China have argued that marine genetic resources of the Area should be treated as part of the ‘common heritage of mankind’, and that a benefit-sharing regime should be established. Other States propose that the principle of ‘freedom of the high seas’ should apply. This question has been debated at length. Thus far, the issue has proved intractable – the final report of the PrepCom indicated that further discussion was needed on

58 For a rigorous analysis of the applicability of the common heritage of mankind principle to marine genetic resources see Marciniak, above n 12. The report of the PrepCom identified that further discussions were required on common heritage of mankind and the freedom of the high seas, with respect to marine genetic resources, see Report of the Preparatory Committee established by General Assembly resolution 69/292, above n 45, 17.


61 Ardron et al, above n 40; Co-chairs’ summary of discussions at the Ad hoc Open-ended Informal Working Group to study issues relating to the conservation and sustainable use of marine biological diversity beyond national jurisdiction UN Doc A/69/177 (July 2014) [47] and [48].


64 See, eg: Leary, above n 13; Tullio Scovazzi, ‘Bioprospecting on the Deep-Seabed: a Legal Gap Requiring to be Filled’ in Francesco Francioni and Tullio Scovazzi (eds), Biotechnology and International Law (Hart, 2006) 81-99; Marciniak, above n 12; Tladi, above n 12.
common heritage and freedom of the high seas. As commented by Iceland (2017) “Given that neither of the aforementioned principles [common heritage of mankind or freedom of the high seas] seem to be directly applicable, a practical, possibly hybrid, definition and solution needs to be found”. It is increasingly recognised that there is a need to find common ground between the principles of common heritage of mankind and freedom of the high seas. This thesis explores the role of science and technology as pivotal issues for the development of a pragmatic solution to benefit-sharing, as discussed in the following section.

1.3. Significance of the thesis: the role of science, technology transfer and capacity building in developing a pragmatic solution for benefit-sharing

The benefit-sharing debate has been clouded by uncertainty over the economic potential of marine genetic resources. This uncertainty is due in part to gaps in knowledge about the extent of genetic and biochemical diversity in ABNJ, a lack of awareness about the long complex and costly research and development processes required to access and commercialise biotechnology, and a lack of clarity concerning financial benefits to be derived. Regarding the latter issue, it is vital to be aware that less than 1 per cent of novel marine genetic resources will make it to market, and the biodiscovery process could take 15 years and cost up to US$ 1 billion. There are very few reported examples of commercial

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65 Report of the Preparatory Committee established by General Assembly resolution 69/292, above n 45, 17. Note: The following issues were also identified for further discussion: whether to address intellectual property rights in relation to marine genetic resources; whether the instrument should regulate access to marine genetic resources; and whether to provide for the monitoring of the utilization of marine genetic resources of areas beyond national jurisdiction.

66 Chair’s non-paper on elements of a draft text of an international legally-binding instrument under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction 28/02/17. Distributed prior Third session of the PrepCom (to 27 March-7 April 2017), citing Iceland submission, p24.


68 Leary et al, above n 13; Oldham et al, above n 13.

69 See, eg: Martins et al, above n 22.

70 Royal Society, Future ocean resources: Metal-rich minerals and genetics - evidence pack (Royal Society, 2017) 44.

products derived from ABNJ.\textsuperscript{72} The high and variable estimates for the value of marine genetic resources reflect the economic uncertainty, for example, the value of undiscovered anti-cancer drugs from marine origin was estimated to be US$ 563 billion-5.69 trillion in 2010.\textsuperscript{73} Such lucrative estimates are based on potential economic value and do not take into account the externalities and potential barriers in the biodiscovery process.\textsuperscript{74} Recognising the commercial uncertainties, there is a growing recognition that monetary benefits should not form the central focus of the development of a new governance regime for marine genetic resources of ABNJ.\textsuperscript{75}

In contrast to the uncertain financial outcomes from marine genetic resources, benefits relating to science, technology and capacity building (so-called “non-monetary benefits”) are more immediate and guaranteed outcomes of research and development.\textsuperscript{76} These benefits have an intrinsic value in and of themselves, for example marine genetic resources in ABNJ could enable the advancement of knowledge through research but not have a realised or realisable commercial value.\textsuperscript{77} Technology and scientific research capacity (including human, institutional and technical) strongly influence the ability of States to acquire, utilise and share benefits from marine genetic resources.\textsuperscript{78}

International, cross-sectoral and multidisciplinary collaborations are often critical to develop and deploy new technologies and overcome obstacles to deep-sea research. This is illustrated by several examples, from the discovery of hydrothermal vents in the 1970s to the Census of

\textsuperscript{72} There are two products derived from ABNJ (one cosmetic product and one enzyme used in the biofuels sector) that are reported in the literature, see Section 3.2.2 of Chapter 3.


\textsuperscript{74} Oldham et al, above n 13, 35.

\textsuperscript{75} See, eg: Leary and Juniper, above n 49.

\textsuperscript{76} See, eg: Broggiato et al, above n 6; Oldham et al, above n 13; Thomas Greiber, An international instrument on conservation and sustainable use of biodiversity in marine areas beyond national jurisdiction: exploring different elements to consider, \textit{Options and approaches for access and benefit-sharing}, (IUCN and German Federal Agency for Nature Conservation, 2014); Laura E. Lallier et al, 'Access to and use of marine genetic resources: understanding the legal framework' (2014) 31(5) Natural Product Reports 612-616.

\textsuperscript{77} Ibid.

Marine Life 2000-2010, as will be discussed in Chapter 2 of this thesis. The development of new technologies offers unprecedented possibilities for new discoveries. However, scientific research capacity remains a major limiting factor to deriving and sharing benefits from marine genetic resources – for developing and developed nations alike. Thus, international science collaboration, technology transfer and scientific capacity building are key ingredients for sharing benefits from marine genetic resources in ABNJ.

The potential for the LOSC provisions relating to marine scientific research and technology transfer to form the basis of a benefit-sharing solution was first identified by Glowka in his seminal 1996 paper “The Deepest of Ironies”. Since then, the need to improve the implementation of the LOSC provisions for technology transfer in order to share benefits from marine genetic resources in ABNJ has been highlighted in the literature, including by Arico and Salpin (2005), Tvedt and Jorem (2013), Broggiato et al. (2014), Vierros et al. (2016), and Arico (2015). The importance of cooperation in scientific research and development, capacity building and technology transfer for benefit-sharing has also been identified. However, the foundation for benefit-sharing provided by the LOSC regimes for marine scientific research and the development and transfer of marine technology has not yet been examined in depth – this is a central contribution of this thesis.

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81 Glowka, above n 6; See also Lyle Glowka, 'Evolving Perspectives on the International Seabed Area's Genetic Resources: Fifteen Years after the Deepest of Ironies' in David Vidas (ed), *Law, Technology and Science for Oceans in Globalisation: IUU Fishing, Oil Pollution, Bioprospecting, Outer Continental Shelf* (Martinus Nijhoff, 2010) 397-423.
82 Arico and Salpin, above n 6.
84 Broggiato et al, above n 6.
85 Vierros et al, above n 6.
The LOSC establishes several responsibilities for the conduct of marine scientific research. These include obligations to: protect the marine environment; cooperate internationally; publish and share knowledge and data; conduct research with appropriate scientific methods and means; and conduct scientific research in the Area for the benefit of mankind. However, capacity gaps and weaknesses in the international institutional framework are widely considered to hinder the implementation of the LOSC Parts XIII and XIV and thus of the broader principles of international cooperation and benefit-sharing enshrined in the LOSC, as noted by Long (2007). LOSC Parts XIII and XIV have not been extensively studied, and the implementation of these Parts, including the role of the scientific community in this regard, is identified by Glowka (1996) as an area requiring study to address the question of marine genetic resources of ABNJ. A critical examination of the LOSC framework under Part XIII and XIV as a basis for the sharing of benefits, the current level of implementation, and the possible options to strengthen the international framework, is therefore needed.

Furthermore, existing instruments such as the ITPGRFA, the Nagoya Protocol, and the PIP Framework have been identified as potential role models for the development of an access and benefit-sharing regime for marine genetic resources in ABNJ, partly on account of their prominent focus on research capacity building. Possible benefit-sharing obligations for marine genetic resources in ABNJ could include: 1) facilitating access to ex situ resources, in silico analysis, and technology; 2) collaboration and cooperation in R&D programs; and 3) different types of capacity building. However, the link between benefit-

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88 LOSC art 240(d).
89 LOSC arts 242 and 243.
90 LOSC art 244.
91 LOSC art 240(b).
92 LOSC art 143.
95 Glowka, above n 81.
96 See, eg ITPGRFA art 13.
97 See, eg Nagoya Protocol art 10.
98 Greiber, above n 14.
99 Greiber, above n 76; Druel and Gjerde, above n 87.
sharing, technology transfer and capacity building in relation to marine genetic resources in ABNJ remains poorly studied and understood.

At the conclusion of the PrepCom (July 2017), there was convergence among most delegations that benefit-sharing should meet dual objectives of capacity building and the conservation and sustainable use of biodiversity.100

“The text would set out that the objectives of benefit-sharing are:

- Contributing to the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction
- Building capacity of developing countries to access and use marine genetic resources of areas beyond national jurisdiction.”101

This indicates that States recognise the role of marine scientific research, technology transfer and capacity building in sharing benefits from marine genetic resources in ABNJ.102 However, a persistent divergence of views among delegations on the question of marine genetic resources is evident from the Chair’s non-paper prior to the fourth session of the PrepCom,103 and the final report of the PrepCom.104 The areas for further discussion that were identified in the final report of the PrepCom include:105

100 This text appeared in section A of the Report of the Preparatory Committee established by General Assembly resolution 69/292, above n 45. These elements are not indicative of consensus.
101 Report of the Preparatory Committee established by General Assembly resolution 69/292, above n 45, 10 [38] subsection 3.2.2(i).
104 Report of the Preparatory Committee established by General Assembly resolution 69/292, above n 45.
105 Ibid, 17. Note: The following issues were also identified for further discussion: whether to address intellectual property rights in relation to marine genetic resources; whether the instrument should regulate access
• the nature of marine genetic resources;
• what benefits of marine genetic resources should be shared; and
• terms and conditions, institutional arrangements and funding for capacity building and transfer of marine technology.

This indicates that there are several areas requiring further investigation. This thesis seeks to examine and address these uncertainties associated with marine genetic resources and formulate approaches that contribute to the conservation and sustainable use of biodiversity in ABNJ. The following section describes how this thesis contributes to addressing these questions.

1.4. The thesis

In this section, the thesis objectives and research questions are provided in Section 1.4.1. The scope and methodology is described in Section 1.4.2, and the thesis structure is outlined in Section 1.4.3.

1.4.1. Thesis objectives

The central research question addressed by this thesis is: could the implementation of existing provisions of the LOSC relating to marine scientific research and the development and transfer of marine technology be strengthened through the development of a new international legally binding instrument under the LOSC in order to enable the sharing of benefits from marine genetic resources of ABNJ? There are three objectives of the study:

The first objective is to examine the benefits from marine genetic resources of ABNJ with particular reference to the role of scientific and technological capacity building. The nature of
marine genetic resources of ABNJ is examined in Chapter 2 and the potential benefits from marine genetic resources of ABNJ are investigated in Chapter 3.

The second objective is to critically analyse the relevance of the existing international legal framework to sharing benefits from marine genetic resources of ABNJ and identify implementation gaps. The role of science and technology is examined in the context of advancing scientific knowledge of marine life in ABNJ (Chapter 2) and in deriving, sharing and utilising benefits from marine genetic resources in ABNJ (Chapter 3).

The third objective is to develop options to strengthen the implementation of the existing LOSC framework provisions relating to scientific and technological capacity through the development of an ILBI to enable the sharing of benefits from marine genetic resources of ABNJ. The existing LOSC framework for marine scientific research and the development and transfer of marine technology is examined in the LOSC, including unclear institutional responsibilities and lack of implementation mechanisms, inhibit the implementation of the LOSC framework provisions under Parts XIII and XIV (Chapters 4, 5 and 6).

1.4.2. Approach: scope and methodology

In the previous section, it was demonstrated that a critical examination of the LOSC framework under Part XIII and XIV as a basis for the sharing of benefits is still required in order to develop pragmatic options for benefit-sharing under an ILBI. To date, the role of scientific and technological cooperation and capacity building in sharing benefits from marine genetic resources of ABNJ has not been the topic of in-depth study. This thesis investigates the role of marine scientific research, technology transfer and capacity building in sharing benefits from marine genetic resources in ABNJ. It provides the first investigation of how sharing benefits from marine genetic resources in ABNJ could be achieved by strengthening the implementation of the LOSC framework provisions in Part XIII and XIV through the development of an ILBI.
Three contributions to the literature are provided by this thesis. First, the study establishes the nature, significance, value and potential benefits of marine genetic resources in ABNJ. Second, the existing international legal framework for the sharing of benefits is critically analysed and the precedent for benefit-sharing to occur at the nexus of science cooperation, technology transfer and capacity building is investigated. Third, options to strengthen the implementation of the existing LOSC framework provisions in Parts XIII and XIV are proposed, in order to share benefits from marine genetic resources in ABNJ and contribute to the study, conservation and sustainable use of marine biodiversity. With the development of the ILBI poised to commence, this is the central focus of this thesis.

Given that the subject matter of this thesis sits at the interface of science and law; a multidisciplinary approach drawing on legal and scientific sources was adopted to determine the potential benefits from marine genetic resources of ABNJ. The need to engage the scientific community to bridge the gap between science and policy to ensure that legal and policy developments are based on a clear understanding of basic and applied scientific research processes, has been identified in the context of marine genetic resources in ABNJ, including by Glowka in 1996. This study sought to engage scientists to enable a thorough investigation of the research questions.

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106 The need for an interdisciplinary approach in the international law of the sea to address the growing interaction between law and marine science has been identified by, eg: Yoshifumi Tanaka, *A Dual Approach to Ocean Governance: The Cases of Zonal and Integrated Management in International Law of the Sea* (Ashgate, 2008) 237.


108 Twenty two unstructured interviews with scientists were conducted to gather qualitative information on non-monetary benefit-sharing practices. The information obtained was used to shape and inform the analysis of current practices provided in Chapter 6. Scientists were selected based on their reputation in peer-reviewed published scientific literature. The purpose of the interviews was to ascertain the current state of practice and to analyse the extent to which existing provisions of the LOSC relating to the sharing of non-monetary benefits are implemented. This approach recognised that the need to involve the scientific community in deliberations regarding the interplay between Part XIII of the LOSC has been recognised by several scholars, including Broggiato et al, above n 6, Soons above n 97 and Glowka, above n 81. The interviews were conducted in line with the approval of the University of Wollongong Human Research Ethics Committee. Fontana, Andrea and James H Frey, 'The Interview: From Structured Questions to Negotiated Text' in N K Denzin and Y S Lincoln (eds), *Handbook of Qualitative Research* (Sage, 2000) 645.
In delineating the scope of this thesis, there are some topics that are not included. The geographic scope of this thesis is focused on ABNJ, although some legal instruments applicable to areas within national jurisdiction are included in the analysis. The area of focus is on the role of scientific cooperation, technology transfer and capacity building in deriving and sharing benefits from marine genetic resources of ABNJ. Economic and monetary benefits are not a central concern in this thesis and considered beyond the scope. While it is acknowledged that capacity building is large topic, the focus of this thesis is on scientific and technological aspects of capacity building. Furthermore, rather than provide a detailed discussion on the application of the principles of ‘common heritage of mankind’ and ‘freedom of the high seas’, this thesis seeks to develop practical options for benefit-sharing that are consistent with the application of both principles. This is pursued by focusing the analysis on the provisions of Part XIII and XIV of the LOSC. Institutional issues are touched upon, however, a detailed examination of institutions is not within the scope of this thesis. Rather than undertake a quantitative evaluation of implementation of Part XIII and XIV, Chapter 6 offers a qualitative assessment of current practices in international scientific cooperation, technology transfer and capacity building. This draws on an analysis of illustrative examples, a literature review, and informal unstructured interviews conducted with key scientists, as described above.

The research was undertaken as a desktop study. Addressing the research questions entailed collecting, synthesising and critically analysing information from a range of sources, including all sources of international law, in particular: international legal instruments; legal principles; UNGA resolutions; reports and decisions from intergovernmental

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109 For rigorous analyses of the application of the common heritage of mankind principle to the marine genetic resources in ABNJ, see: Tladi, above n 12; and Marciniak, above n 12.
111 Sources of international law include: principles; treaties; customary international law; judicial decisions; and the writings of publicists. For a discussion on sources of international environmental law see: Patricia W Birnie, Alan E Boyle and Catherine Redgwell, International law and the environment (Oxford University Press, 3rd ed, 2009) 111; and James Harrison, Saving the Oceans Through Law: The International Legal Framework for the Protection of the Marine Environment (Oxford University Press, 2017) 6-7.
112 Legal principles, are a source of international law and have a dual nature as both constitutive elements of law and management tools. As per the 1970 General Assembly Declaration on Principles of International Law, “every State has the duty to fulfil in good faith its obligations under the generally recognised principles and
organisations, including the Intergovernmental Oceanographic Commission of UNESCO; guidelines and codes of conducts; soft law instruments such as the PIP framework and global plans of action for genetic resources; in addition to material contained in reports, books, and peer reviewed academic journals. The research also involved fieldwork in the form of: participating in several workshops and conferences relating to scientific and legal aspects of the research topic; visiting scientific research institutions; and attending the second, third and fourth sessions of the PrepCom. A systematic analysis utilising traditional legal textual research techniques enabled the identification of potential measures that could be adopted under an ILBI to enable benefit-sharing. The data contained in this thesis is current as of 31 January 2018.

1.4.3. Thesis structure

The thesis comprises eight Chapters (Table 1.1).

The present Chapter introduces the problem of sharing benefits from marine genetic resources in ABNJ. The rationale for the research focus area is set out, noting the uncertainty relating to the economic potential of marine genetic resources and the growing body of literature concerning the potential for the LOSC science and technology transfer regimes to form a basis for benefit-sharing. It is suggested that, in the context of the conservation and sustainable use of biodiversity in ABNJ and the development of an ILBI, this is a timely and significant area of research. The research objectives, questions, methodology, limitations and contribution are established and the thesis structure is presented.

In Chapter 2, the nature and significance of marine genetic resources in ABNJ is examined. Legal and scientific definitions of marine genetic resources and associated terms are reviewed to ascertain the material scope of marine genetic resources in ABNJ. Potential applications of

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113 Visits included the Natural History Museum, London; Queensland Museum, Brisbane; Museum Victoria, Melbourne; Museum of Tropical Queensland, Townsville; and UK National Oceanography Centre, Southampton. The visits were made possible by the funding support from the University of Wollongong Global Challenges Program.
marine genetic resources are examined, highlighting the role of marine scientific research and technology in discovering marine genetic resources in ABNJ.

In Chapter 3, the potential benefits from marine genetic resources of ABNJ are outlined and appraised. The processes through which benefits from marine genetic resources of ABNJ could be acquired, shared and utilised are examined. The possible benefits and value of marine genetic resources of ABNJ are critically analysed. A conceptual framework for benefit-sharing based on science, technology transfer and capacity building is established.

In Chapter 4, the precedent for an integrated approach to benefit-sharing and the role of scientific and technological capacity building is investigated. The principles and rationale behind the concept of sharing benefits from marine genetic resources of ABNJ are considered, with a focus on the role of an integrated approach to science cooperation, technology transfer and capacity building in sustainable development. The ways in which elements of benefit-sharing have been elaborated through international legal instruments relevant to genetic resources and ABNJ are examined. Based on this analysis, key elements to foster an integrated approach to benefit-sharing through science cooperation, technology transfer and capacity building are identified.

In Chapter 5, the international legal framework under the LOSC for sharing benefits through science, technology transfer and capacity building is critically analysed. The framework for marine scientific research, the development and transfer of marine technology and the development of human, institutional and technical scientific capacity is examined. The strengths and weaknesses of the LOSC framework for the sharing benefits from marine genetic resources of ABNJ are analysed.

In Chapter 6, current practice in sharing benefits from marine genetic resources of areas beyond national jurisdiction is examined. The acquisition and sharing of benefits through international marine scientific research cooperation is reviewed. The sharing of data and samples relating to marine genetic resources of ABNJ is examined. Human, technical and institutional aspects of scientific capacity building are then considered. A cross cutting
analysis of the preceding three sections enables common factors influencing the implementation of science cooperation, technology transfer and capacity building in practice to be identified.

In Chapter 7, synthesising the foregoing research, potential measures that could be adopted through the development of an ILBI under the LOSC to enable the sharing of benefits from marine genetic resources of ABNJ are proposed. An array of legal and policy measures are proposed to facilitate: international cooperation in marine scientific research; sharing outcomes of scientific research through access to scientific data and knowledge; and enhancing scientific capacity building. Cross-cutting measures to create an international enabling framework for benefit-sharing through scientific and technological capacity building are identified.

In concluding, Chapter 8 summarises how existing LOSC framework provisions for marine science, technology transfer and capacity building could be further elaborated and implemented through the development of an ILBI in order to support benefit-sharing from marine genetic resources in ABNJ. It is suggested that the proposed integrated approach would support the acquisition, sharing and application of scientific knowledge. It is further proposed that this would thus enable the sharing of benefits from marine genetic resources of ABNJ as well as the conservation and sustainable use of biodiversity in ABNJ. The progression of the argument through the thesis is summarised in Table 1.1.
Table 1.1: Thesis argument

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Line of Argument</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Introduction</td>
<td>The sharing of benefits from marine genetic resources of ABNJ is a contemporary challenge for international law that requires an investigation of the role of scientific cooperation, the development and transfer of technology and capacity building in formulating practical governance solutions for the ILBI.</td>
</tr>
<tr>
<td>2  Oceans of opportunity: investigating marine genetic resources in ABNJ</td>
<td>Science collaboration and technological innovation are key to discoveries in ABNJ. Due to definitional ambiguities, marine genetic resources and marine biodiversity should be considered holistically in developing benefit-sharing measures.</td>
</tr>
<tr>
<td>3  Benefits: science, sharing and serendipity</td>
<td>Benefits of marine genetic resources are linked to scientific research and technology, as illustrated by the acquisition, sharing and application of scientific knowledge for biodiversity conservation. Benefit-sharing can be considered as a nexus between science cooperation, technology development and transfer, and capacity building.</td>
</tr>
<tr>
<td>4  Benefit-sharing: the precedent for an integrated approach</td>
<td>Benefit-sharing can enable sustainable development through equitable access to science, technology and innovation. There is a precedent for an integrated approach to sharing benefits through science cooperation, technology development and transfer, and capacity building.</td>
</tr>
<tr>
<td>5  The law of the sea: framework for marine scientific research, technology transfer and capacity building</td>
<td>The LOSC provides a basis for an integrated approach to scientific research cooperation, the development and transfer of technology and the scientific capacity building. However, gaps and ambiguities weaken the legal and institutional framework.</td>
</tr>
<tr>
<td>6  Current practice: sharing benefits through scientific and technological capacity building</td>
<td>Marine scientific research cooperation, technology transfer and scientific capacity building are interlinked in practice, providing a basis for an integrated approach to benefit-sharing. There is a need for legal and policy measures to strengthen the implementation of the LOSC Parts XIII and XIV.</td>
</tr>
<tr>
<td>7  Towards an integrated approach: elements of a benefit-sharing system</td>
<td>A suite of measures could be adopted through the development of the ILBI in order to foster an integrated approach to benefit-sharing based on scientific and technological capacity building.</td>
</tr>
<tr>
<td>8  Conclusion</td>
<td>The international legal framework for scientific and technological capacity building could be strengthened through the ILBI by fostering an integrated approach to share benefits from marine genetic resources and conserve and sustainably use biodiversity of ABNJ.</td>
</tr>
</tbody>
</table>


Chapter 2

Oceans of opportunity: investigating marine genetic resources in areas beyond national jurisdiction

2.1. Introduction

Determining the nature of marine genetic resources is a complex challenge facing States in the negotiations for an international legally-binding instrument (ILBI), under the *1982 United Nations Convention on the Law of the Sea* (LOSC),\(^1\) for the conservation and sustainable use of marine biological diversity in areas beyond national jurisdiction (ABNJ).\(^2\) This Chapter examines the nature and significance of marine genetic resources of ABNJ. The purpose of this analysis is to determine the material scope of the resource for which the question of benefit-sharing is to be considered in this thesis. Relevant legal definitions are critically examined in Section 2.2 to ascertain the meaning of “marine genetic resources of ABNJ”. Scientific knowledge relating to marine life in ABNJ is reviewed and the nature and significance of marine genetic resources of ABNJ is discussed in Section 2.3. Potential uses of marine genetic resources of ABNJ are then identified in Section 2.4. The role of science collaboration and technological innovation in acquiring scientific knowledge by investigating marine life in ABNJ is examined in Section 2.5, and the scope for future discoveries is considered. The implications for benefit-sharing are discussed in Section 2.6 and the potential for integration is introduced.

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2.2. Defining “marine genetic resources of areas beyond national jurisdiction”

The first step in addressing the thesis problem is to clarify the meaning of “marine genetic resources of areas beyond national jurisdiction (ABNJ)”, in order to determine the nature and scope of the resource to which benefit-sharing measures would apply under an ILBI. Determining “ABNJ” is straightforward, as the LOSC provides a legal definition of the water column (high seas) and the sea-bed (Area) of ABNJ. Understanding “marine genetic resources” is more complex, however, because the LOSC does not make any reference to this term and there is no internationally agreed definition of the term. The nature of marine genetic resources requires further discussion. It is necessary to consider the relevance of various definitions in order to determine the meaning of “marine genetic resources” and begin to establish the material scope. Definitions provided in the LOSC are considered in Section 2.2.1, those provided in other legal instruments are considered in Section 2.2.2.

2.2.1. LOSC definitions relating to “resources”

Although the LOSC does not mention “marine genetic resources”, it does refer to “resources”, “marine living resources” and “sedentary species”. According to LOSC Article 133, the term “resources”, in the context of the Area refers to “all solid, liquid or gaseous mineral resources in situ in the Area at or beneath the seabed, including polymetallic nodules” which are termed “minerals” when recovered from the Area. This definition does not clearly include genetic resources.

The term “marine living resources” is used repeatedly in the LOSC, but not defined. As such, the meaning of this term, and whether it might be interpreted to encompass genetic resources, is ambiguous. Regardless, the LOSC provisions for “marine living resources” are of little relevance in addressing the question of sharing benefits. For example, the LOSC regime for the conservation and management of the living resources of the high seas pertain almost

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3 See Section 1.2.1 of Chapter 1.
4 PrepCom report, above n 2, 17.
5 The discussion of the material scope of marine genetic resources of ABNJ is continued in Section 2.3 and Section 3.2.1 of Chapter 3.
6 LOSC art 133.
exclusively to fisheries related activities, however, the use of genetic resources differs in many ways from fisheries activities. Pursuing this line of enquiry would therefore be inconclusive and fail to fully address the ambiguity stemming from the absence of a definition of marine genetic resources in the LOSC.

The term “sedentary species” is defined in LOSC Article 77(1) as “organisms which at the harvestable stage, either are immobile on or under the seabed or are unable to move except in constant physical contact with the seabed and subsoil”. The narrow geographic and biological scope of this definition is not sufficiently expansive to include all marine genetic resources of ABNJ. Furthermore, the sedentary species definition is challenging to apply in practice and open to interpretation, due to the complex and varied ecology and life-cycles of deep-sea organisms. This highlights the difficulties that could be encountered in elaborating and applying a legal definition of marine genetic resources in ABNJ. Such difficulties were discussed during the Preparatory Committee for the development of a new international legally binding instrument for the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (PrepCom). For example, several delegations suggested that a distinction should be made between fish used for research on their genetic properties and fish used as a commodity. One suggestion was that a scientific threshold

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7 LOSC arts 116, 118, 119. In contrast, LOSC art 117 does not relate solely to fisheries activities.
8 For example, in the case of fisheries, the raw mass of the natural resource is used as a commodity whereas in the case of genetic resources it is the genetic information contained in the organism that is used, see: Section 3.4.1.1 of Chapter 3; A Deplazes-Zemp, ‘Genetic resources’ an analysis of a multifaceted concept' (2018) 222 Biological Conservation 86-94.
9 For example, it is not always clear if an organism conforms to the definition “at the harvestable stage”: species of Cnidaria (e.g. corals) and Porifera (e.g. sponges), for example, may be planktonic as larvae (i.e. in the water column) and sessile as adults (i.e. on the sea-bed); some organisms that may appear sessile as adults (e.g. scallops) are able to move through the water column.
could be established whereby if a resource was extracted in excess of a certain amount it would be considered as a commodity.\textsuperscript{13} This issue was not resolved during the PrepCom, and the “nature of marine genetic resources” remains unclear. This indicates that existing definitions in the LOSC either do not include genetic resources, or are of limited usefulness in addressing questions on the sharing of benefits. It is therefore necessary to look outside the LOSC to understand the term “marine genetic resources”.

\textit{2.2.2. Conceptualising the material scope of marine genetic resources of ABNJ}

The \textit{1992 Convention on Biological Diversity} (CBD) defined genetic resources as “genetic material of actual or potential value”.\textsuperscript{14} The CBD definition has been adopted widely, is echoed in definitions adopted by other international legal instruments (Table 2.1), and has shaped attempts to define marine genetic resources of ABNJ. For example, Vierros \textit{et al.} (2016) define genetic resources as “material from deep-sea animals, microbes or other organisms, and parts thereof containing functional units of heredity of actual or potential value”.\textsuperscript{15} The deliberations of the PrepCom followed a similar definition to the CBD, as shown in Section 2.2.2.1. However, the CBD definition is fraught with ambiguities,\textsuperscript{16} as discussed in Section 2.2.2.2.

\textsuperscript{14} \textit{Convention on Biological Diversity}, opened for signature 5 June 1992, 1760 UNTS 79 (entered into force 29 December 1993); \textit{CBD} art 2.
\textsuperscript{16} Deplazes-Zemp, above n 8.
Table 2.1: Definitions of genetic resources and related terms in international law.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Biological resources</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biological diversity</td>
<td>“variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems”</td>
<td>CBD art. 2</td>
</tr>
<tr>
<td>Biological resources</td>
<td>“includes genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity”</td>
<td>CBD art. 2</td>
</tr>
<tr>
<td>Biological materials</td>
<td>“includes human clinical specimens, virus isolates of wild type human H5N1 and other influenza viruses with human pandemic potential; and modified viruses prepared from H5N1 and/or other influenza viruses with human pandemic potential developed by WHO GISRS laboratories, these being candidate vaccine viruses generated by reverse genetics and/or high growth re-assortment […] RNA extracted from wild-type H5N1 and other human influenza viruses with human pandemic potential and cDNA that encompass the entire coding region of one or more viral genes”</td>
<td>PIP [5.1]</td>
</tr>
<tr>
<td><strong>Genetic material</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Genetic material</td>
<td>“any material of plant, animal, microbial, or other origin containing functional units of heredity”</td>
<td>CBD art. 2</td>
</tr>
<tr>
<td>Genetic material</td>
<td>“any material of plant origin, including reproductive and vegetative propagating material, containing functional units of heredity”</td>
<td>ITPGRFA art. 2</td>
</tr>
<tr>
<td><strong>Genetic resources</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Genetic resources</td>
<td>“genetic material of actual or potential value”</td>
<td>CBD art. 2</td>
</tr>
<tr>
<td>Plant genetic resources for food and agriculture</td>
<td>“any genetic material of plant origin of actual or potential value for food and agriculture”</td>
<td>ITPGRFA art. 2</td>
</tr>
<tr>
<td>Forest genetic resources</td>
<td>“the heritable materials maintained within and among tree and other woody plant species that are of actual or potential economic, environmental, scientific or societal value”</td>
<td>Global Plan of Action for the Conservation, Sustainable Use and Development of</td>
</tr>
</tbody>
</table>
2.2.2.1. Defining “marine genetic resources of ABNJ”

A lack of clarity relating to the geographic and material scope of marine genetic resources is evident from the broad options proposed during the PrepCom (Table 2.2 and Table 2.3). Ahead of the fourth and final session of the PrepCom, the Chair’s non-paper noted that a definition of marine genetic resources should take into account the distinction between organisms used for genetic properties and organisms used as a commodity, and include four elements: 1) animal, plant, microbe or other origin in the oceans and seas; 2) genetic materials containing functional units of heredity; 3) the actual or potential value; 4) the resources derived from areas beyond national jurisdiction. Possible options for a definition were proposed, based on the CBD definition, with the principal variation between options being whether the geographic scope would include all ABNJ or solely the Area (Table 2.2). An equally fraught and related matter of scope is whether the definition of genetic material extends to include derivatives. A further issue is whether information and data are included

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19 See, eg: Chair’s non-paper above n 13, 5, 7.
20 Ibid, 7.
21 See Table 2.3; Chair’s non-paper above n 12, 23.
in the definition of genetic resources and whether these should form part of a benefit-sharing regime.22

Table 2.2: Summarised definitions of genetic resources proposed during the PrepCom.23

<table>
<thead>
<tr>
<th>Option</th>
<th>Definition</th>
<th>Geographic specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>“genetic material of actual or potential value”</td>
<td>None</td>
</tr>
<tr>
<td>2</td>
<td>“any marine genetic material of plant, animal, or microbial origin of actual or potential value collected from the Area”</td>
<td>Area only</td>
</tr>
<tr>
<td>3</td>
<td>“any marine genetic material of plant, animal, microbial or other origin, containing functional units of heredity, being of actual or potential value”</td>
<td>Area and high seas</td>
</tr>
</tbody>
</table>

Table 2.3: Summarised definitions of genetic material proposed during the PrepCom.24

<table>
<thead>
<tr>
<th>Option</th>
<th>Definition</th>
<th>Biological specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>“ any material of plant, animal, microbial or other origin containing functional units of heredity”</td>
<td>Broad</td>
</tr>
<tr>
<td>2</td>
<td>“ any material of plant origin, including reproductive and vegetative propagating material, containing functional units of heredity”</td>
<td>Plant only</td>
</tr>
<tr>
<td>3</td>
<td>“ any material of plant, animal, or microbial origin containing functional units of heredity collected from the Area; it does not include materials made from material, such as derivatives, or information describing material, such as genetic sequence data”</td>
<td>Explicit exclusion of derivatives</td>
</tr>
</tbody>
</table>

A persistent divergence of views among States relating to the term “genetic resources” is evident from the report of the PrepCom. The report stated that the ILBI would set out the geographical and material scope, and that further discussions will be required on the nature of marine genetic resources;25 this indicates the absence of a common understanding about the

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22 See Section 3.3.1 of Chapter 3.  
23 Chair’s streamlined non-paper, above n 20, 7.  
24 Ibid.  
scope of marine genetic resources of ABNJ among State delegations at the conclusion of the PrepCom. If the CBD definition is adopted for the purposes of the ILBI, there are still challenges in clearly defining the scope of marine genetic resources of ABNJ, due to ambiguities in the CBD definition. The CBD definition is examined in two parts in the following Sections: the meaning of “genetic material” is discussed in Section 2.2.2.2, and the meaning of “actual or potential value” is considered in Section 2.2.2.3.

2.2.2.2. “Genetic material”

Genetic material is defined by the CBD as “any material of plant, animal, microbial, or other origin containing functional units of heredity”.26 This definition is reflected in the 2001 International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA).27 The term “functional units of heredity” refers to genes, which are composed of deoxyribonucleic acid (DNA). A literal interpretation of the CBD definition would therefore imply that the material scope of genetic resources is restricted to genes. However, the application of this definition in practice becomes more complex. For example, the 2010 Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity (Nagoya Protocol) included “derivatives” (Table 2.1).28 Derivatives are included in the CBD definition of “biotechnology” which in turn is included in the Nagoya Protocol definition of “utilization of genetic resources”.29 This allows a broad interpretation of the scope of components to be included under a regime for genetic resources, potentially including both genes and derivatives. In scientific terms, this could include a range of primary and secondary metabolites (Table 2.4; Figure 2.1).30 However, the divergent views among State delegations

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26 CBD art 2.
27 International Treaty on Plant Genetic Resources for Food and Agriculture, opened for signature 3 November 2001, 2400 UNTS 303 (entered into force 29 June 2004); ITPGRFA art 2; Table 2.1.
29 Definitions of “biotechnology” (CBD art 2) and “utilization of genetic resources” (Nagoya Protocol art 2c) are provided in Table 3.5 and discussed in Section 3.4.1.1 of Chapter 3.
30 Primary metabolites, such as proteins, play a role in the growth and reproduction of an organism. Secondary metabolites (such as natural products) are small organic biochemical compounds resulting from the genetic expression or metabolism of living creatures and play a role in an organism’s ecological function, such as in chemical communication, predation, defence, and competition for space and food. For a discussion on natural products see, eg: Ana Martins et al, 'Marketed Marine Natural Products in the Pharmaceutical and
as to whether derivatives should form part of the scope of marine genetic resources under an ILBI is evident from Table 2.3.

Table 2.4. Scientific and legal meaning of terms relating to genetic resources.

<table>
<thead>
<tr>
<th>Defined term</th>
<th>Source</th>
<th>Legal terminology</th>
<th>Scientific meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genetic resources</td>
<td>CBD art. 2</td>
<td>genetic material of actual or potential value</td>
<td>Unclear</td>
</tr>
<tr>
<td>Genetic material</td>
<td>CBD art. 2</td>
<td>functional units of heredity</td>
<td>Genes (DNA)</td>
</tr>
<tr>
<td>Derivatives</td>
<td>Nagoya Protocol art. 2(e)</td>
<td>biochemical compound resulting from the genetic expression or metabolism of biological or genetic resources</td>
<td>Secondary metabolites</td>
</tr>
</tbody>
</table>

To further examine the potential scope of a benefit-sharing regime for marine genetic resources of ABNJ, it is necessary to consider the difference between “genetic resources” and “biological resources”. Genes are the essence of life and a fundamental part of biology; genetic diversity is a key underpinning of biological diversity. Genetic resources are part of biological resources, as recognised in CBD Article 2 (Table 2.1). Biological resources contain genetic material that could be of actual or potential value and could thus potentially be considered as genetic resources. This illustrates the blurred distinction, in scientific terms, between “genetic resources” and “biological resources”, and the interconnections with both genetic material and derivatives as components of life (Figure 2.1). Figure 2.1 also shows that these legal terms correspond to a range of potential elements, from primary and secondary metabolites to a whole organism, a group of organisms or an entire ecosystem.

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Figure 2.1: Illustration of potential legal and scientific perspectives of “genetic resources”. Elements corresponding to different scientific discipline areas are indicated as an illustrative example to show that use of terms varies between scientific disciplines.

Emphasising the informational and non-material nature of genetic resources, Deplazes-Zemp (2018) argues that the CBD definition does not reflect the real value, biological function, or use of genetic resources because they are “utilised as natural resources, as something derived from nature, which becomes instrumentally valuable for humans to generate profits and other benefits including scientific knowledge”.32 The result of the broad and vague nature of existing definitions of genetic resources is that the term “marine genetic resources in ABNJ” could arguably be interpreted to encompass all marine life in ABNJ.33 To further explore this,
it is necessary to consider the second part of the CBD definition of genetic resources: that which concerns “actual or potential value” of genetic material.

2.2.2.3. “Actual or potential value”

The preceding discussion suggested that the first source of ambiguity is whether a benefit-sharing regime for marine genetic resources of ABNJ would apply to genes alone, or whether a wide range of primary and secondary metabolites could also be included in the scope. To examine this further, it is necessary to consider a second source of ambiguity: the meaning of “actual or potential value” of genetic material. This is a key distinguishing feature genetic resources is the definition provided by CBD Article 2. However, being of “actual or potential use or value for humanity” is also part of the CBD definition for “biological resources”. This further illustrates the overlap between genetic resources and biological resources, and highlights the need to examine the concept of value.

A number of references to the value and importance of genetic resources are made in international legal instruments relating to genetic resources. The “intrinsic value of biological diversity and of the ecological, social, economic, scientific, educational, cultural, recreational and aesthetic values of biological diversity and its components” is recognised in the CBD.\textsuperscript{34} The “social, scientific or economic importance” of genomes and genes; the “social, economic, cultural or scientific importance” of ecosystems, habitats, species and communities, as well as the “medicinal, agricultural or other economic value” of species and communities are also referred to in the CBD in the context of identifying and monitoring components of biodiversity.\textsuperscript{35} The importance of genetic resources to “food security, public health, biodiversity conservation, and the mitigation of and adaptation to climate change” is recognised in the Nagoya Protocol.\textsuperscript{36} The Global Plan of Action for Conservation, Sustainable Use and Development of Forest Genetic Resources (Forest Genetic Resources Plan),\textsuperscript{37} considers genetic resources to be genetic material of “actual or potential economic,

\textsuperscript{34} CBD Preamble [1]; see also CBD art 7 (a) and Annex I.
\textsuperscript{35} CBD Annex I [2].
\textsuperscript{36} Nagoya Protocol Preamble [14]. For a discussion on the implied values of genetic resources under the Nagoya Protocol, see Section 3.2.2 of Chapter 3.
\textsuperscript{37} FAO Commission on Genetic Resources for Food and Agriculture, above n 17.
environmental, scientific or societal value” and crucial to the adaptation and protection of ecosystems.\textsuperscript{38} The Forest Genetic Resources Plan also recognises the intrinsic value of genetic diversity as the “mainstay of biological stability”.\textsuperscript{39} This illustrates that genetic resources are considered under international law to have a range of values, including cultural, economic, environmental, scientific and social values.\textsuperscript{40}

However, the emphasis varies between international legal instruments. For example, the only specific reference to value in the Nagoya Protocol is the “economic value of ecosystems and biodiversity”.\textsuperscript{41} This suggests that greater priority is afforded to economic value under the access and benefit-sharing regime established by the Nagoya Protocol, an observation that is supported by the categorisation of benefits as either “monetary” or “non-monetary”, which correspond as economic and non-economic value.\textsuperscript{42} This also further highlights the link between genetic resources and biodiversity, whereby the value is identified as residing in “ecosystems and biodiversity”.\textsuperscript{43}

In contrast, the ITPGRFA could be interpreted as encompassing a broader set of values than the Nagoya Protocol, given that it does not refer to benefits in “monetary and non-monetary” terms.\textsuperscript{44} One reason for this difference could be that the Nagoya Protocol is primarily concerned with bilateral arrangements to protect sovereign rights over genetic resources within national jurisdiction, whereas the ITPGRFA is a multilateral system for a globally agreed goal of food security. The Pandemic Influenza Preparedness Framework (PIP Framework), which is also a multilateral system, has a similarly strong focus on international cooperation in science, technology transfer and capacity building, for a globally agreed goal.

\begin{footnotesize}
\begin{itemize}
\item \textsuperscript{38} Ibid Foreword [1].
\item \textsuperscript{39} Ibid Foreword [1].
\item \textsuperscript{40} For a discussion on the value of biodiversity, see: Giles Atkinson, Ian Bateman and Susana Mourato, 'Valuing Ecosystem Services and Biodiversity' in Dieter Helm and Cameron Hepburn (eds), \textit{Nature in the Balance: The Economics of Biodiversity} (Oxford University Press, 2014) 101-150, 105.
\item \textsuperscript{41} Nagoya Protocol Preamble [6].
\item \textsuperscript{42} The potential benefits from genetic resources are discussed in Section 3.2.1 and 3.2.3 of Chapter 3.
\item \textsuperscript{43} For a discussion of the link between biodiversity and genetic resources, and of biodiversity as a source of asset unidentified instrumental value, see: Deplazes-Zemp, above n 8.
\item \textsuperscript{44} In the ITPGRFA the ratio of “non-monetary” to “monetary” could be considered as 3:1, in the Nagoya Protocol it could be considered as 1:1. Acknowledging that this is a fairly literal interpretation of the conventions, this issue is explored in detail in Section 3.2.3 of Chapter 3, and Chapter 5.
\end{itemize}
\end{footnotesize}
of health security.\textsuperscript{45} The Forest Genetic Resources Plan is also concerned with multilateral cooperation for a global goal. As noted above, this soft law instrument portrays a wide interpretation of the value of genetic resources including economic, environmental, scientific value, social value. These examples further illustrate that marine genetic resources of ABNJ could be considered as an inextricable part of ocean ecosystems and with economic, environmental, scientific and social value.

Economic value, for example, could be financial gain derived through the commercialisation of products or business growth.\textsuperscript{46} In terms of environmental value, genetic resources are part of the fabric of biodiversity, which in turn is a crucial part of healthy ecosystems, enabling adaptation and resilience to change. For example, Armstrong \textit{et al.} (2012) and Rogers \textit{et al.} (2014) observe that marine genetic resources are one of the ecosystem services provided by the deep sea.\textsuperscript{47} The scientific value of genetic resources is evident from the many advancements in scientific knowledge relating to marine life and natural products of ABNJ.\textsuperscript{48} The societal value of marine genetic resources can be considered in terms of their potential role in addressing key societal challenges such as, nutrition, energy and health, as well as the potential capacity building opportunities relating to scientific advances.\textsuperscript{49} The cultural value of marine life of ABNJ is illustrated by the identification of potential World Heritage sites.\textsuperscript{50} These examples suggest that marine genetic material in ABNJ arguably has innate potential environmental, scientific, social and economic value. Hence, the issue of benefit-sharing is of

\textsuperscript{45} \textit{Pandemic Influenza Preparedness Framework for the sharing of influenza viruses and access to vaccines and other benefits} (PIP Framework). World Health Assembly, ‘Pandemic Influenza Preparedness Framework’, WHA64.5, 64\textsuperscript{th} sess, Agenda Item 13.1 (24 May 2011).

\textsuperscript{46} See Section 3.2.3 of Chapter 3.


\textsuperscript{48} Section 2.4.


wide potential significance for environmental, economic, scientific and social reasons. This is summarised in the following Section.

2.2.2.4. Towards a definition of marine genetic resources: life and its derivatives?

The preceding discussion has demonstrated that there are complex scientific issues and ambiguities relating to the potential legal definitions of genetic resources of ABNJ, as shown by the expansion of the concept of benefit-sharing to include derivatives as well as genetic material, the overlaps between genetic and biological resources, the broad range of potential interpretations of value, and the consequential lack of clarity at the PrepCom regarding definitions of genetic resources. It can be concluded that genetic resources is a concept pertaining to the value of the biological, genetic and biochemical diversity of life—rather than a definitive scientific term. It is not clear at this stage if or how the scope of marine genetic resources of ABNJ will be narrowed to a particular set of species or categories for the purposes of benefit-sharing under an ILBI. Based on the preceding discussion, it is conceivable that the potential scope of marine genetic resources could potentially span the breadth of ocean life in ABNJ, ranging from a bacteria living in sediment, to an invertebrate on the seabed, to a microorganism, to a large animal in the water column (Figure 2.2). Accordingly, the potential material scope of marine genetic resources of ABNJ is considered in this thesis to be very broad and potentially to encompass all marine life in ABNJ.

Marciniak, above n 33, observes that the question of sharing benefits from marine genetic resources in ABNJ matters from economic, scientific and environmental perspectives.
Figure 2.2: Illustrative examples of the potential range of components that could be considered in the scope of a regime for sharing benefits from marine genetic resources of ABNJ: a) Examples of marine organisms that could be found in ABNJ; b) Example of DNA, a primary metabolite; c) Example of a secondary metabolites e.g. natural products.

(Sources: a) various, as specified; b) creative commons; c) Skropeta 2014\textsuperscript{53}).


\textsuperscript{53} Danielle Skropeta and Liangqian Wei, ’Recent advances in deep-sea natural products’ (2014) 31(8) Natural Product Reports 999-1025.
2.3. The nature of marine genetic resources of ABNJ: life in the deep

This Section aims to examine the nature of marine genetic resources of ABNJ. The marine environments and habitats in ABNJ are considered in Section 2.3.1, the current state of knowledge about ocean life in ABNJ is examined in Section 2.3.2.

2.3.1. Marine environments in ABNJ

Stretched between maritime boundaries more than 200 nautical miles from land, the vast area of the global ocean that constitutes ABNJ is deep. With more than 95 per cent of the ocean exceeding depths of 1,000m (Figure 2.3), the deep ocean is the largest biosphere on Earth and hosts a number of different environments.54 From the water column to the sea-floor, more than 28 different habitat types have been described since 1840.55 The various habitats provided by deep sea ABNJ support some of the richest and most unique ecosystems on Earth.

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54 The deep ocean is widely considered to be the area of ocean that lies below 200m, however, some scientists consider it to be the area of ocean that lies below 2,000m. See Section 2.3.1.1.
**Figure 2.3: Global bathymetric map.** The depth profile of the global ocean is shown. (Source: GEBCO).\(^{56}\)

2.3.1.1. *The water column*

The water column is known, in general terms, as the pelagic zone (Figure 2.4). More than 30 different pelagic provinces have been identified. The average depth of the global ocean is approximately 4,000m,\(^{57}\) and the deep ocean (beneath 200m) encompasses more than one billion km\(^3\).\(^{58}\)

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\(^{57}\) Ibid.

Figure 2.4: Pelagic zones. The water column can be considered in five different pelagic zones (left). The scale of the bathypelagic and abyssopelagic zones graphic representation of ocean volume relative to bottom depth (right).
(Sources: Oldham et al., 2014 (left); Robison, 2009 (right)).

2.3.1.2. The sea-bed

The deep sea-floor spans more than 300 million km² and accounts for more than 60 per cent of the Earth’s surface. It contains a variety of habitats, including more than 25 different types of deep sea geological features such as continental shelves and slopes, basins, abyssal plains, deep ocean trenches, mid-ocean ridges, seamounts and canyons. More than 38 benthic provinces and 10 hydrothermal vent provinces have been identified. Hydrothermal vents release super-heated sea-water at temperatures reaching more than 350°C, and are found at some sea-floor spreading centres in the Atlantic, Pacific, Indian and Southern Oceans.

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60 The deep-sea floor is typically defined as the area of ocean floor underneath at least 1000 m of water column.
61 Ibid
seep ecosystems, found at active and passive margins (Figure 2.5), are fuelled by substances such as methane that seep out of the sea floor.\textsuperscript{62}

\subsection*{2.3.2. Ocean life}

The global ocean is home to a rich diversity of life that far exceeds that of land.\textsuperscript{64} The ocean contains 28 phyla (i.e. groups) of animals, 13 of which are endemic; whereas terrestrial

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure2.5.png}
\caption{Examples of sea-bed features. Plate tectonic movement direction indicated by arrows. Hydrothermal vents and cold seeps, formed by plate tectonics and gravitational and hydrological forces, highlighted in yellow. Not to scale. Chemosynthetic ecosystems (hot vent and cold seep) have been highlighted. (Source: Jørgensen and Boetius, 2007).\textsuperscript{63}}
\end{figure}

\footnotesize
\begin{itemize}
\item \textsuperscript{64} Jesse H Ausubel, Darlene T Crist and Paul E Waggoner (eds), \textit{First Census of Marine Life 2010: Highlights of a Decade of Discovery} (Census of Marine Life, 2010).
\end{itemize}
ecosystems contain 11 phyla of animals, one of which is endemic.\textsuperscript{65} The Census of Marine Life 2000-2010 discovered more than 6,000 previously undescribed species, bringing the total number of described marine species to 250,000.\textsuperscript{66} However, it is estimated that there are at least 750,000 marine species yet to be described. For the deep sea alone, estimates of the total number of species vary from 500,000 to over 10 million species, with estimates that the deep pelagic could contain one million undescribed species.\textsuperscript{67} The range in these estimates reflect the knowledge gaps relating to marine species.\textsuperscript{68} Marine microbes are a principal source of the uncertainty, as the most diverse and abundant form of ocean life and they are present in all marine ecosystems.\textsuperscript{69} In one litre of seawater, for example, there can be up to one billion bacterial cells, and viruses can be an order of magnitude more abundant.\textsuperscript{70} Life—from microbes to mega-fauna—thrives in the deep ocean. Deep-ocean environments are characterised by darkness, high pressure, reduced oxygen levels, weak currents, slow sediment accumulation rates and temperatures as low -2°C, or as high as 150°C at hydrothermal vents.\textsuperscript{71} Without the sunlight that fuels primary photosynthetic productivity in shallow water, the deep-ocean is food limited. The deep-sea floor, for example, is almost exclusively reliant on organic matter sinking from overlying shallower sunlit waters.\textsuperscript{72} Hydrothermal vents and cold seeps are the only source of \textit{in situ} primary production in deep-sea ecosystems. They are fuelled by chemical energy sources, such as methane or hydrogen sulphide, feeding bacterial chemosynthetic production and supporting communities high in

\textsuperscript{65} Angel, above n 58; Sara Maxwell et al, \textit{Medicines from the Deep - the Importance of Protecting the High Seas from Bottom Trawling} (Natural Resources Defense Council, 2005).
\textsuperscript{66} Ausubel et al, above n 64.
\textsuperscript{67} Robison, above n 58.
\textsuperscript{68} See Section 2.4.
\textsuperscript{69} Microbes include uni-cellular and multi-cellular life forms from eukarya (phytoplankton and zooplankton), prokarya (i.e. bacteria e.g. cyanobacteria), archaea, viruses and protists. See, eg: Abida et al, above n 49; Beth N Orcutt et al, 'Microbial Ecology of the Dark Ocean above, at, and Below the Seafloor' (2011) 75(2) Microbiology and Molecular Biology Reviews 361; Jørgensen and Boetius, above n 63; David M Karl, 'Microbial Oceanography: Paradigms, Processes and Promise' (2007) 5(10) Nature Reviews: Microbiology 759.
Deep-ocean life has adapted through years of evolution to survive the harsh environmental conditions that are so characteristic of ABNJ. For example, organisms can have lower metabolic rates to conserve energy, physiological adaptations to withstand pressure and predation strategies to cope with natural low light levels through advanced chemosensory capabilities or bioluminescence (light production). At least 90 per cent of organisms inhabiting deep pelagic zones use bioluminescence for purposes of attracting prey, avoiding predators and communication.

Life in the deep-ocean is not uniformly dispersed. Diversity (the number of different species) and abundance (the total number of organisms) varies greatly between deep-sea habitats. For example, vents and seeps are often characterised by high abundance but relatively low biodiversity. Deep sea-bed abyssal plains, on the other hand, are characterised by high biodiversity but low abundance. Some species feed on material that has fallen onto the sea-

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73 Since their discovery, more than 700 hydrothermal vent species have been discovered and described at vents around the globe. Seeps also show high levels of biomass and productivity and there are more than 600 species described. C R German et al, 'Deep-Water Chemosynthetic Ecosystem Research During the Census of Marine Life Decade and Beyond: A Proposed Deep-Ocean Road Map' (2011) 6(8) PLoS ONE 1; Michael A Rex and Ron J Etter, Deep Sea Biodiversity: Pattern and Scale (Harvard University Press, 2010); Ramirez-Llodra et al, above n 55.

74 These include including species of crustaceans (e.g. crabs), molluscs (e.g. mussels), cnidarians (e.g. sea anemones), polychaetes (e.g. annelid worms) and echinoderms (e.g. starfish). See for example: Alex D Rogers et al, 'The Discovery of New Deep-Sea Hydrothermal Vent Communities in the Southern Ocean and Implications for Biogeography' (2012) 10(1) PLoS Biol e1001234; German et al, above n 73.

75 For example, deep ocean organisms often have low biological rates, such as slow growth rates, this also makes them vulnerable to human disturbance. For a discussion on the adaptations of deep-ocean life, see Rex and Etter, above n 73.

76 Robison, above n 58.

77 Vents and seeps have higher productivity than the surrounding environments, but few organisms are adapted to survive there. See, eg: Ramirez-Llodra et al, above n 55; German et al, above n 73; M Turnipseed et al, 'Diversity in Mussel Beds at Deep-Sea Hydrothermal Vents and Cold Seeps' (2003) 6(6) Ecology Letters 518.

78 Ramirez-Llodra et al, above n 55.
floor from the overlying water-column, other forms ‘biodiversity hotspots’, often where physical or other processes enhance the availability of food.

As a consequence of unique adaptations and long evolutionary history, the deep-ocean harbours the richest collection of genetic and biochemical diversity in nature. Marine species are 500 times more likely to yield previously undescribed chemicals than terrestrial species. Marine microbes are already a significant source of natural products, described by Sogin (2006) as a “nearly inexhaustible source of genomic innovation”. Viruses alone are thought to account for many newly discovered protein families. Ocean life is described as a “unique reservoir for a broad range and diversity of molecules of interest to further scientific knowledge and develop new products that improve human well-being” by Broggiato et al. (2014). Given the vast scale of ABNJ and the expectations for new discoveries for new discovery, ABNJ is a potentially attractive source of genetic resources. The following Section examines the potential applications of genetic resources.

2.4. Potential applications of marine genetic resources of ABNJ

Humans have a long history of seeking inspiration from the ingenuity and innovations of nature to improve prosperity and wellbeing. From combatting disease to acquiring food, the

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80 Examples include seamounts, canyons, cold water corals and whale falls. These features are often ‘oases’ of life hosting greater abundance than surrounding areas. Rex and Etter, above n 73; Glover and Smith, above n 72.
81 Robison, above n 52.
85 Arrieta et al, above n 82; Abida et al, above n 49.
genetic and biochemical properties of marine organisms have various potential applications, including:

- Bioremediation
- Cosmetics and cosmeceuticals
- Food and nutraceuticals
- Industrial processes and commodity chemicals
- Scientific research
- Pharmaceuticals

This Section examines the potential applications of marine genetic resources of ABNJ.

2.4.1. Bioremediation

Bioremediation measures address pollution or environmental contamination. Cold adapted (psychrophilic) bacteria derived from sea-ice have been used in the development of bioremediation measures to address environmental contamination ranging from hydrocarbon contamination of soil to water pollution.87

2.4.2. Cosmetics and cosmeceuticals88

Bioactive compounds, vitamins and minerals found in marine life, including microalgae, are used in anti-oxidant, anti-ageing, anti-wrinkle and anti-acne products. For example, Abyssine contains an anti-inflammatory polysaccharide deepsane that was derived from a deep-sea bacteria isolated from the polychaete Alvinella pompejana (the ‘Pompeii worm’, so named for its ability to thrive the extreme heat of its habitat) from a hydrothermal vent in

87 David Leary, Bioprospecting in the Arctic (UNU-IAS, 2008).
88 The term ‘cosmeceuticals’ refers to the inclusion of bioactive ingredients in cosmetics products.
89 Microalgae (phytoplankton) produce a range of bioactive compounds (e.g. proteins, lipids, carbohydrates, carotenoids or vitamins) many of which are used in skin and hair cosmetic products and sunscreens. Martins et al, above n 30.
90 Martins et al, above n 30.
ABNJ. Other examples include a product for skin protection containing proteins derived from bacteria collected in Antarctica, a hydration and anti-wrinkle product marketed for its muscle contraction inhibition properties including an extract from a species of bacteria collected at a deep-sea hydrothermal vent, and a face-cream marketed for anti-inflammatory properties including an extract from a sea whip.

2.4.3. Food and nutraceuticals

Carrageenans are derived from red algae (Rhodophyceae) and have gelling, thickening and stabilising properties that can be applied in the food industry. An anti-freeze protein derived from the ocean pout, Macrozoacres americanus, found in the Arctic Ocean, has been used in ice-creams marketed by Unilever. Genes encoding nitrogen transporters, isolated from marine phytoplankton, could be transferred to crop plants in order to improve nitrogen use efficiency and hence reduce fertiliser need. The production of dietary supplements high in polyunsaturated (omega 3) fatty acids is another area where marine genetic resources have been used. These are often referred to as nutraceuticals, including algae as a source.

Microbial species or strains (that are ‘fast biomass producers’) could also be used to produce bioactive compounds and other value-added compounds that are already known but difficult to produce due to cost or technological barriers, e.g. proteins, polyunsaturated fatty acids,

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92 See, eg: SeaCode, which is marketed as a bioactive ingredient that can support skin protection and reconstruction, contains glycoproteins derived from the fermentation of a species of bacteria of the genus Pseudoalteromonas collected in Antarctica. Martins et al, above n 30.
93 See, eg: RefirMAR is marketed as a hydration and anti-wrinkle product for its muscle contraction inhibition properties contains an extract from a bacterial strain of Pseudoalteromonas sp collected from a depth of 2,300m near a hydrothermal vent in Portuguese waters. Ibid.
95 Martins et al, above n 30.
96 Abida et al, above n 49.
carotenoids, phycobiliproteins, polysaccharides, vitamins and sterols. Nutraceuticals derived from the deep pelagic ocean is an emerging area of interest.

2.4.4. Industrial processes and commodity chemicals

Advances in science, reductions in cost of research and interest from industry are fuelling a growing interest in the potential of industrial biotechnology to accelerate the advanced manufacturing of chemicals for applications ranging from human health to agriculture.

Adaptations of marine organisms to tolerate extreme heat of hydrothermal vent ecosystems, the cold of polar conditions, the pressure of deep ocean environments, or the pH (e.g. acidity or alkalinity) of some marine ecosystems are of high interest for scientific and industrial applications that require stability and are conducted at high temperature, pressure and pH levels. Fuelzyme, an alpha-amylase enzyme for starch liquefication, is a rare example of a commercial product derived from ABNJ. It was derived from a sample collected by the deep-sea crewed submersible Alvin. Although Fuelzyme is one of the few known examples of a commercially successful product derived from ABNJ, comparatively little is known about its origins and applications.

There are several substances that can be derived from marine origins with potential uses in commercial products. Examples include potassium alginate and fucoidan (brown algae), aluminium silicate (sea-mud) and chitin (crustaceans). Other examples include a shark repellent (pavonine) from the Pacific sole; fish-feeding deterrents (limatulone) from a limpet.

98 Abida et al, above n 49.
100 Section 2.4.2.
102 Ibid.
104 Martins et al, above n 30.
species; antibacterials (bromoindoles) from various sponge species; and antifungals (squalamine) from a species of shark.  

2.4.5. Scientific research

The microbe *Pyrococcus furiosus* (‘rushing fireball’), so named for its ability to rapidly move at temperatures as high as 100°C, is used to create DNA Polymerase – a reagent for genetic research.  
Green fluorescent protein, derived from the bioluminescent jellyfish *Aequorea Victoria*, absorbs UV light and emits it as green light and can be used for a range of scientific research purposes, from tracking the spread of viruses to genetic engineering. The researchers that discovered the protein were awarded the Nobel Prize in Chemistry in 2008.  
Enzymes known as luciferases derived from deep ocean organisms are used to measure cytotoxicity in order to enable the selection and optimisation of tumor associated antigens. These illustrate potential uses of enzymes and proteins of marine origin in scientific research processes.

Compounds from marine origin have been the focus of long-term scientific investigations. For example, palytoxin was derived from an anemone of the genus *Palythoa* that was historically used to coat hunting spears in Hawaii. It was identified and named in 1971 but it took a further ten years to solve the chemical structure and another thirteen years to prepare the first synthetic version. Palytoxin is one of the most poisonous and complex chemicals known.

2.4.6. Pharmaceuticals

Plants and microbes have long been an important source of natural products for pharmaceuticals, among the most notable examples is the use of morphine for pain relief, the

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106 Munro et al, above n 94.
109 Skropeta, above n 30, 212-213.
introduction of aspirin, and the discovery of the anti-biotic, penicillin by Alexander Fleming in 1929. Today, half of drugs used to treat cancer and 75 per cent of drugs used to treat infectious diseases derive from natural products.

Marine organisms, particularly invertebrates, have a high incidence of biological activity (‘bioactivity’). Bioactive compounds have functions such as anti-tumour, anti-microtubule, anti-proliferative, anti-biotic or anti-infective. Marine natural products, although often lethal to other organisms, can be used to stimulate or impede biological processes in humans, and are valued as drug leads. More than half of the 30,000 marine natural products reported in the scientific literature have shown pharmacological activity. Seventy five per cent of the novel deep-sea natural products described between 2009 and 2013 were

111 Skropeta and Wei, above n 53. For example, natural products are used in: paclitaxel (anti-cancer) from the Pacific Yew Tree; quinine (anti-malarial) from the bark of Cinchona; and salicylic acid (used in aspirin) from the bark of the willow tree. Skropeta, above n 30, 214.
112 Marine invertebrates are a source of leads for anti-cancer drug discovery and marine natural products for pharmaceutical purposes have been derived from a range of marine organisms including sponges, nudibranchs, tunicates and bryozoans. In the early days of marine natural product research, Porifera (sponges) were the most studied phylum, followed by Cnidaria (e.g. corals and anemones), Chromophycota and Rhodophycota (algae), Mollusca (e.g. sea snails), Chordata (e.g. fish, tunicates) and Echinodermata (e.g. sea stars and sea cucumbers). Munro et al, above n 94; Concetta Imperatore et al, 'Alkaloids from Marine Invertebrates as Important Leads for Anticancer Drugs Discovery and Development' (2014) 19(12) Molecules 20391; Alejandro M S Mayer et al, 'Marine pharmacology in 2007–8: Marine compounds with antibacterial, anticoagulant, antifungal, anti-inflammatory, antimalarial, antiprotozoal, antituberculosis, and antiviral activities; affecting the immune and nervous system, and other miscellaneous mechanisms of action' (2011) 153(2) Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology 191-222; Alejandro M S Mayer et al, 'The odyssey of marine pharmaceuticals: a current pipeline perspective' (2010) 31(6) Trends in Pharmacological Sciences 255-265; Keith B Glaser and Alejandro M S Mayer, 'A renaissance in marine pharmacology: From preclinical curiosity to clinical reality' (2009) 78 Biochemical Pharmacology 440-448; Bob Hunt and Amanda C J Vincent, 'Scale and Sustainability of Marine Bioprospecting for Pharmaceuticals' (2006) 35(2) Ambio 57-64.
113 Skropeta et al, above n 30.
114 Skropeta, above n 30.
116 Skropeta, above n 30.
found to be biologically active with almost half showing anti-cancer potential.\textsuperscript{117} Invertebrates are a focus for anti-cancer drug discovery.\textsuperscript{118}

One of the earliest examples of marine-based drug discovery began in the mid twentieth century, when two molecules (spongothymidine and spongouridine) were derived from a species of sponge, \textit{Tethya crypta}, in the Caribbean.\textsuperscript{119} This triggered research on the potential applications of these products as anti-cancer agents, the development of three compounds used in pharmaceuticals followed soon after: cytarabine to treat leukaemia,\textsuperscript{120} vidarabine to treat viruses such as herpes,\textsuperscript{121} and zidovudine to combat HIV.\textsuperscript{122}

The development of pharmaceuticals derived from marine natural products began in the 1970s.\textsuperscript{123} Marine derived products can be used to develop pharmaceutical products such as:\textsuperscript{124} neuroprotective drugs, treatments for central nervous system injuries and disorders,\textsuperscript{125} cancer, inflammation, pain relief, HIV and Alzheimers disease.\textsuperscript{126} The first marine-based drugs emerged in the late 1990s, for pain relief and cancer treatment.\textsuperscript{127} There are seven marine derived drugs on the market, none are derived are ABNJ.\textsuperscript{128} Although, the number of

\textsuperscript{117} Skropeta and Wei, above n 53.
\textsuperscript{118} Imperatore et al, above n 112.
\textsuperscript{120} Cystosar-U, containing cytarabine, has been used for more than 40 years for the treatment of leukaemia.
\textsuperscript{121} Vira-A, containing vidarabine, is used to treat viruses such as herpes. Martins et al, above n 31.
\textsuperscript{122} In 1986, Zidovudine became the first drug used to treat HIV-AIDS. Skropeta, above n 53, 213; Martins et al, above n 31. See also: Munro et al, above n 94, report that more than 130 marine natural products were tested in lab trials for HIV 2002-2011, these were derived from organisms that were accessed in the exclusive economic zones of almost 30 countries only one access was undertaken in ABNJ.
\textsuperscript{123} Skropeta, above n 53, 214.
\textsuperscript{124} Newman and Cragg, above n 115.
\textsuperscript{125} Clara Grosso et al, 'Bioactive Marine Drugs and Marine Biomaterials for Brain Diseases' (2014) 12(5) Marine Drugs 2539.
\textsuperscript{127} Munro et al, above n 94.
\textsuperscript{128} Mayer, A ‘Marine Pharmaceuticals: The Clinical Pipeline’ available at http://marinepharmacology.midwestern.edu/ accessed 15 June 2015; Martins et al, above n 30; See also Section 3.2.2 of Chapter 3 for a brief discussion of the challenges to drug discovery.
approved marine-derived drugs has doubled since 2004.\textsuperscript{129} Half of the drugs currently on the market are for cancer treatment (Cystosar-U, Halaven,\textsuperscript{130} Yondelis,\textsuperscript{131} and Adcetris\textsuperscript{132}), one for pain management (Prialt),\textsuperscript{133} one to tackle viruses (Vira-A)\textsuperscript{134} and one for the treatment of hypertriglyceridemia (Lovaza).\textsuperscript{135} Many compounds remain in clinical trials.\textsuperscript{136} Most research effort to date has been focused on areas within national jurisdiction.\textsuperscript{137}

2.4.7. Summary

This Section has highlighted that marine genetic resources can have a range of potential applications, it has also pointed to some of the challenges to the development of commercial products, as will be discussed in Chapter 3. The different types of products mentioned here will require different research and development processes and have different timelines and costs and meet markets of different sizes and structures. Furthermore, much remains to be discovered and understood about the genetic and biochemical libraries of marine life; the


\textsuperscript{130} Halaven can be used to treat breast cancer, it contains eribulin mesylate which is derived from natural product halichondrin-B from the sponge \textit{Halichondria okadai}, found in Japan prior to 1986. Halaven is the only drug on the market that is derived from a deep-sea marine organism.

\textsuperscript{131} Yondelis can be used to treat soft tissue sarcoma, it contains trabectedin derived from the tunicate \textit{Ecteinascidia turbinata} found off the coast of Central America in 1978 and Florida US in 1986. It was commercialised by PharmaMar and co-developed by Johnson and Johnson. Martins et al, above n 30.

\textsuperscript{132} Adcetris is used for the treatment of lymphoma and marketed by Seattle Genetics (USA). It contains brentuximab vedotin 63 (FDA approved in 2011), a synthetic analog of dolastatin 10 which was originally isolated from the sea hare \textit{Dolabella auricularia} in 1972 but in such small quantities that it was not until 1987 that the structure was elucidated, and a further two decades for the drug to be marketed. Martins et al, above n 30.

\textsuperscript{133} Prialt can be used to treat chronic severe pain, it contains ziconotide derived from mollusc \textit{Conus magnus} the 'magician’s cone snail'. See, eg: BM Olivera, et al. ‘Peptide Neurotoxins from Fish Hunting Cone Snails’ (1985) 230 Science 1338; Hartmut Meyer, Lena Fey and Wilma Brinkmeyer, 'Relevance of Marine Bioprospecting for Abs Frameworks' (Fact Sheet: Access and Benefit-sharing (ABS) Report for the ABS Capacity building Initiative, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), 2014); ‘Prialt - see the person through the pain’, print ad by Saatchi & Saatchi, London 2011 http://www.coloribus.com/adsarchive/prints/prialt-prialt-see-the-person-through-the-pain-14706155/.

\textsuperscript{134} Another example of an anti-viral is Carregelose, which contains iota-carrageenan derived from red algae (\textit{Rhodophyceae}) used in an anti-viral nasal spray used for the treatment of the symptoms of the common cold. Martins et al, above n 30, above n 121.

\textsuperscript{135} Lovaza is a drug used to treat hypertriglyceridemia, comprising several omega-3 fatty acids sourced from fish oil. Martins et al, above n 30.

\textsuperscript{136} For a discussion on the process of drug development see Section 3.2.2 of Chapter 3.

\textsuperscript{137} Munro et al, above n 94.
following Section examines the role of scientific research and development in accessing and investigating marine genetic resources of ABNJ.

2.5. Investigating marine genetic resources of ABNJ

“We now face a new golden age for deep sea research, more challenging than ever, rich with new tools and technologies, offering unprecedented opportunities for new discoveries…”138

This Section describes the historical development of marine investigation of deep sea ecosystems in Section 2.4.1. Possible areas for future scientific research are considered in Section 2.4.2. The role of scientific collaboration and technological innovation in advancing knowledge of marine life in ABNJ and creating opportunities to benefit from genetic resources are discussed in Section 2.4.3.

2.5.1. Historical development of marine investigation of deep-ocean ecosystems

Deep-sea scientific investigation was advocated for as early as the 17th century ‘Age of Enlightenment’ by renowned scientist Robert Hooke FRS, but it was not until the 19th century that deep sea investigation began in earnest.139 This was a time for giant leaps in scientific endeavour, including Charles Darwin’s voyages on the HMS Beagle 1831-36. The voyages of Wyville Thompson and William Carpenter aboard the HMS Challenger 1872-76, provided irrefutable evidence of deep-ocean life,140 refuting the ‘azoic theory’ posited by Forbes.141

138 Danovaro, Snelgrove and Tyler, above n 71.
140 Anthony J Koslow, Silent Deep: the discovery, ecology and conservation of the deep sea (University of New South Wales Press, 2007) 19, 23. It is relevant to note that the Challenger expedition also discovered the polymetallic nodules on the deep-sea bed that would later be referred to by Arvid Pardo as a vast untapped wealth, see, eg: Intervention delivered by Arvid Pardo on behalf of Malta During: ‘Examination of the question of the reservation exclusively for peaceful purposes of the sea-bed and the ocean floor, and the subsoil thereof, underlying the high seas beyond the limits of present national jurisdiction, and the use of their resources in the interests of mankind’ United Nations General Assembly (1967), 22nd sess. Item 92. First Committee, 1515th meeting, 1 November 1967, UN doc. A/C.1/PV.1515 [27].
141 The azoic theory posited that the deep ocean was barren and largely devoid of life theory, it was proposed by Edward Forbes during a dredging voyage in the Aegean Sea aboard the HMS Beacon 1841-42. Koslow, Ibid, 13, 14, 15.
Some years later, the *Galathea* expedition 1950-1952 confirmed that there was life in the ocean trenches deeper than 10,000m. The *Challenger* voyages are widely regarded as the beginning of modern oceanography, and deep-sea science in particular.

In the 1930s, William Beebe (a biologist) and Otis Barton (an engineer) designed and built the bathysphere to undertake a series of exploratory deep-sea dives, culminating in a dive to 3,028ft (923m) in 1934. The ensuing three decades saw the emergence of bathyscaphes such as the *Trieste*, aboard which Jacques Piccard and Don Walsh became the first humans to reach the deepest point of the ocean – the bottom of Challenger Deep in the Mariana Trench – at a depth of 35,797ft (10,911m) on 23 January 1960. It was more than fifty years later that a human re-visited this place, when James Cameron in *Deep Sea Challenge* achieved a new record solo dive to 35,787ft (10,908m) on 26 March 2012. Despite some attempts to open up the deep ocean to tourism, there are still very few people that have journeyed into the depths.

Scientific curiosity has been a feature of deep ocean investigation throughout history, but it was in many ways a by-product of exploration until the beginning of the 20th century. As noted by Ballard (2000), after the 1960s “with the race to the bottom finished, both nations [USA and France] used their bathyscaphs to embark on long and illustrious research programs.” By the 1960s and 1970s, deep-sea research had moved from a largely descriptive activity to an ecological and experimental approach. Collaborations and competitiveness between different actors and countries have driven technological innovations...

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142 Ramirez-Llodra et al, above n 55; Snelgrove and Smith, above n 79.
147 Ballard, above n 143, 59.
148 Ramirez-Llodra et al, above n 55.
to enable deep ocean discoveries, ranging from hydrothermal vents to the wreck of the Titanic.149

Advances in underwater technologies drove a step-change in human understanding of the deep-sea floor in the mid-late twentieth century. Since the early pioneers of deep ocean exploration in human occupied submersibles, remotely operated vehicles (ROVs) and automated underwater vehicles (AUVs) are now increasingly used to study the global ocean by private and public sector organisations.150 Communications technology continues to open up opportunities to raise public awareness about deep ocean life.151 Technology is increasingly important to advance scientific knowledge. The following Sections describe the potential future significance of science and technology to investigate and harness marine genetic resources.

2.5.2. Future scientific research focus areas

Given the knowledge gaps relating to marine life of ABNJ, it is necessary to consider the future opportunities and challenges facing marine scientific research and technology to advance knowledge of marine genetic resources. This Section considers the need to advance knowledge of marine life of ABNJ, in Section 2.5.2.1. The potential applications of genetic research for biodiversity conservation are briefly explored in Section 2.5.2.2. Possible future pathways to develop goods and services through marine natural products research are examined in Section 2.5.2.3.

149 Including collaborations between research organisations and the navy. For example, the Challenger expedition was supported by the Royal Society and the Admiralty and is credited as the dawn of public funding for ‘big science’. Koslow, above n 140, 19, 23; for a discussion of the role of the US Navy (Office of Naval Research) in the development of the bathyscaphe Trieste (1950s), submersible Alvin (1960s), and later in the Argo/Jason system (1970s) see Ballard above n 143, 234; see also Section 6.1 of Chapter 6.
151 See, eg: Oceanos expedition https://oceanexplorer.noaa.gov/oceanos/ accessed 1/12/2017; Ballard, above n 143, 310.
2.5.2.1. Marine life of ABNJ

The oceans are widely recognised as the planet’s least explored and least well known realm and that research on genetic resources is being extended into the deep-ocean - “the last great frontier on the planet”.\textsuperscript{152} Indeed, more is known about the surface of Mars than of Earth’s deep-sea floor;\textsuperscript{153} less than one per cent of the seabed has been sampled spatially and less than one per cent of the water column has been explored.\textsuperscript{154} Most of what is known about deep ocean biodiversity is based on studies of the sea-floor, the deep pelagic ocean is considered largely under-sampled, poorly understood, and under-represented in biodiversity databases.\textsuperscript{155} Investigating the extent of deep-sea biodiversity has been the focus of various international scientific collaborations,\textsuperscript{156} but much remains to be discovered and scientific investigations continue to unearth new levels of diversity and complexity in marine life.\textsuperscript{157}

As a consequence of the challenges in investigating such a vast area, deep sea research predominantly focuses on particular locations or regions, or specific taxonomic groups or charismatic habitats (e.g. hydrothermal vents, whale falls and cold seeps).\textsuperscript{158} Many priority areas for the investigation of deep-sea chemosynthetic ecosystems lie in ABNJ—excluding

\textsuperscript{153} See eg: David T Sandwell et al, ‘New global marine gravity model from CryoSat-2 and Jason-1 reveals buried tectonic structure’ (2014) 346(65) Science; Harris et al, above n 60. Although the entire sea-bed of the global ocean has been mapped using satellites, the resolution in general only enables the main geological features and less than 20 per cent of mid-ocean ridges have been explored for hydrothermal activity, German et al, above n 73.
\textsuperscript{154} P Cochonat et al, The Deep-Sea Frontier: Science Challenges for a Sustainable Future (European Communities, 2007).
\textsuperscript{155} Whereas traditional sampling methods such as nets, trawls and sonar allowed only indirect observation of the mid-water realm, technological advances (such as underwater vehicles) have enabled new ‘direct’ techniques for better understanding the diversity, physiology and ecology of life in the deep pelagic ocean (e.g. the significant role of gelatinous fauna, under-sampled by previous conventional methods, which may account for as much as one quarter of biomass of the deep pelagic) and suggest that abundance may be higher than once thought. As a result, there are estimates that there are one million undescribed species in the deep pelagic. Robison, above n 58; see also Thomas J. Webb, Edward Vanden Berghe and Ron O’Dor, 'Biodiversity's Big Wet Secret: The Global Distribution of Marine Biological Records Reveals Chronic under-Exploration of the Deep Pelagic Ocean' (2010) 5(8) PLoS ONE e10223.
\textsuperscript{156} See Section 6.3 of Chapter 6.
\textsuperscript{157} For example, the diversity, composition abundance and distribution of marine microbes remains unknown. Thornburg et al, above n 110; Glover and Smith, above n 72; See Section 6.3 of Chapter 6 for a discussion of international scientific collaborations.
\textsuperscript{158} See, eg: Webb, above n 155; Ramirez-Llodra et al, above n 55; Oldham et al, above n 59.
areas of the East Pacific Rise, the mid-Atlantic Ridge, South-west Indian Ridge and South-east Indian Ridge—and the deep-sea observatory at the Porcupine Abyssal Plain in the North Atlantic.

2.5.3.2. Genetic research for conservation

Genetic research can increase knowledge of biodiversity by enabling species identification and offer a monitoring tool to support the development and implementation of legal and policy measures for the conservation and sustainable use of biodiversity. For example, gene sequences support understanding of the amount, distribution and functional significance of genetic variation. Metagenomics can provide information on ecosystem processes such as nutrient and energy flux, or assessing physiological condition. Genomic and transcriptomic data enable assessment of population to adapt to challenges; even low-quality DNA from fossilised remains can be incorporated into analyses. Genetic research highlights the importance of genetic diversity for avoiding species extinction, preserving adaptive potential to stressors such as climate change.

Genetic research techniques can support biodiversity conservation. For example, by providing data on species connectivity and population dynamics, genetic research enables: designing and monitoring area-based management measures such as protected areas, assessing fish stock delineation and restoration, detecting potentially harmful or invasive

159 German et al, above n 73.
162 Corlett, ibid.
165 von der Heyden et al, above n 164; see also ICES Working Group on the Application of Genetics in Fisheries and Aquaculture, which provides advice on methods to describe, conserve and manage intra-specific
species, and detecting illegal practices such as illegal unreported or unregulated fishing or trade practices, through ‘wildlife forensics’. This is sometimes referred to as conservation genetics and conservation genomics.

A more contentious use of genetic research could be used to address or potentially reverse conservation challenges through the development and application of biotechnology. Corlett (2017) suggests that gene editing could help endangered species to cope with change, gene drives help control invasive species, or even enable de-extinction. Piaggio et al. (2017) discuss the potential to conduct genome editing using synthetic biology to address issues such as invasive species or pathogens. However, such approaches would raise a number of scientific, ethical and regulatory considerations.

Genetics is poorly integrated into national, regional or global policy frameworks for the conservation and sustainable use of biodiversity, as reported by Taylor et al. (2017) and von der Heyden et al. (2014). The need to bridge the gap between conservation policy and conservation genomics research has been identified. Understanding and addressing these barriers could be a useful outcome of the ILBI. For example, genetic tools such as metabarcoding can offer a fast and cost-effective option for biodiversity assessment.

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biodiversity, focusing on genetic and genomic analysis
http://www.ices.dk/community/groups/Pages/WGAGFA.aspx accessed 20 February 2018.

166 For example, to monitor harmful aquatic organisms and pathogens.
167 Taylor et al, above n 161.
168 According to Schafer et al, above n 161: conservation genetics uses genetic markers (e.g. gene sequences and microsatellite) to help conserve biodiversity and manage species and populations, conservation genomics “uses genome-wide information (including data derived from high-throughput sequencing technology) to help conserve biodiversity and manage species and populations.
169 Corlett, above n 161.
172 Taylor et al, above n 161.
however, morphological and taxonomic analyses.\textsuperscript{175} Therefore, multiple forms of research, are necessary to complete the inventory of marine species before the full potential of genetic research technologies can be realised. This highlights the need for a diverse portfolio of research approaches and technologies for the ILBI.\textsuperscript{176}

2.5.3.3. Marine natural products research

According to one estimate, more than 1 million novel natural products have been described (from terrestrial and marine sources),\textsuperscript{177} of which 30,000 are of marine origin including approximately 600 of deep-water marine organisms.\textsuperscript{178} Work on marine natural products began in earnest in the late 1940s, at the dawn of the self-contained underwater breathing apparatus (SCUBA). SCUBA enabled up-close encounters with marine life and the isolation of a novel compound from a shallow water Caribbean sponge species followed shortly after.\textsuperscript{179} Today, marine natural product research is on the rise. A gradual increase in research effort into products derived from marine genetic resources is reflected by the rise in the number of articles describing “marine natural products” over the past 50 years. In 2000, there were already more than 10,000 scientific publications relating to marine natural products, by 2015 there were more than 27,500 publications.\textsuperscript{180} A growing emphasis on the discovery of novel bioactive natural products, particularly for applications in the pharmaceutical field, has been observed in the scientific literature.\textsuperscript{181} There were 185 bioactive compounds reported in the years prior to 1986 and that number had risen by 400 in 1993.\textsuperscript{182} In 2012 alone, more than 1200 new marine natural products were described.\textsuperscript{183}

\textsuperscript{175} Metabarcoding is a technique that sequences all DNA in a sample (of water or sediment) and uses fast automated techniques called high-throughput sequencing to determine what organisms are (or were) present in a sample by comparison against DNA libraries, however, there is at present a lack of a comprehensive and taxonomically reliable barcode database, Corlett, above n 161.

\textsuperscript{176} See Section 2.6.2.

\textsuperscript{177} Martins et al, above n 30.

\textsuperscript{178} Defined by the researchers as 50 to more than 5000m depth in order to include fauna beyond the depths of scuba, Skropeta, above n 52.

\textsuperscript{179} See for example Bergmann and Feeney, above n 119; Bergmann and Stempień, above n 119.

\textsuperscript{180} Ibid; MarinLit \url{http://pubs.rsc.org/marinlit/} accessed 13/04/2015.

\textsuperscript{181} Ibid.

\textsuperscript{182} Munro et al, above n 94.

\textsuperscript{183} J W Blunt, B R Copp, R A Keyzers, M H Munro, M R Prinsep, ‘Marine natural products’ (2014) 31(1) \textit{Natural Product Reports} 160-258.
Research into marine natural products from ABNJ origin is at a relatively early stage. It is, however, increasing. For example, although little more than two per cent of all marine natural products reported originate from the deep-sea, deep-sea natural products are increasingly reported in the literature indicating a growing research effort on these compounds. By 2008, 400 deep-sea natural products had been described.\textsuperscript{184} Between 2009 and 2013, a further 188 novel deep-sea natural products were described. The number of deep-sea natural products derived from depths greater than 1000m that were reported in the period 2009-2013 was more than three times greater than all those reported prior to 2008.\textsuperscript{185} Furthermore, this period also saw the emergence of deep sea natural products derived from depths greater than 5000m (Figure 2.6). The geographical origins of deep-sea natural products described to date appear to be predominantly within areas of national jurisdiction.\textsuperscript{186} There are potentially many more natural products to be discovered from ABNJ.

\textsuperscript{184} Skropeta, above n 52.
\textsuperscript{185} Ibid.
\textsuperscript{186} Ibid.
Figure 2.6: Number and depth profile of novel natural products isolated from deep-sea sources.
(Source: Harden-Davies, 2017).\textsuperscript{187}

The number of deep-sea natural products derived from marine microbes, in particular, is increasing. Prior to 2008, microbes accounted for 12 per cent of deep-sea natural products, however, by 2013 this had risen to 42 per cent. It has been suggested that this could be due to the relative ease of sampling deep-sea sediment vs deep-sea macro-invertebrates. Furthermore, many compounds isolated from marine macro-organisms (e.g. sponges) have later been found to have derived from associated microorganisms.\textsuperscript{188} Deep-sea bacteria account for more than 25 per cent of deep-sea natural products described and deep-sea fungi


\textsuperscript{188} Martins et al, above n 30.
account for more than 17 per cent of deep-sea natural products described. The microbial realm is, however, still widely considered to be poorly understood and underexploited.

Porifera, including sponges, are the largest source of natural products described to date, however, microbes are increasingly recognised as a source. Deep-sea natural product research effort to date has been focused on the adaptations of sessile deep-sea organisms on the abyssal plain and of ‘extremophiles’ inhabiting hydrothermal vents and cold seeps. Invertebrates inhabiting the deep pelagic ocean are thought to be a rich and untapped source of novel compounds. In particular, microbes are an area for further marine drug discovery research. However, gaps in knowledge of marine biodiversity mean that the full potential of marine biodiversity for use in drug discovery of other commercial products remains unclear.

2.5.3. Harnessing scientific collaboration and technological innovation to overcome barriers to knowledge

Investigating marine life, and the biological, genetic and biochemical diversity that underpins interest in ABNJ faces a number of challenges. The sheer size and inaccessibility of deep sea ABNJ limits research effort. The costs and challenges of collecting marine samples and isolating and purifying marine natural products, are particularly high from deep sea areas. As scientific collaboration and technological innovation have been key tools to overcome these challenges throughout history, they are likely to be crucial in future. This is illustrated by considering the role of technology in conducting research at sea and on shore in Section 2.5.3.1, and the role of collaboration in Section 2.5.3.2.

189 Skropeta and Wei, above n 53.
190 Abida et al, above n 49.
191 Skropeta, above n 52.
192 Martins et al, above n 30.
193 For example, soft-bodied gelatinous invertebrate organisms of the deep pelagic, lacking physical defences, have already yielded biologically active (‘bioactive’) compounds based on their chemical defences. Munro et al, above n 94; Robison, above n 58.
194 Newman and Cragg, above n 115; see also Gerwick and Fenner, above n 115.
195 Thornburg et al, above n 110.
196 Munro et al, above n 94.
197 Danovaro, Snelgrove and Tyler, above n 71.
2.5.3.1. Research at sea and on shore

There is a growing array of tools that could be used to access deep sea organisms in ABNJ. Advances in marine technology in the past two decades have enabled direct scientific observation in situ through the use of underwater vehicles. Underwater vehicles enable visual observations to better understand deep-sea ecology, collection of environmental data and selective sampling - and have improved opportunities for discovery of new species and associated bioactive compounds. Specially equipped research vessels are usually required to conduct deep sea research and operate research infrastructure. These vessels incur high operating costs, and just a few countries worldwide have publicly funded vessels capable of undertaking deep-sea research. There are also research vessels funded by philanthropic and private sources. Less technical means of sampling, can also be used, such as trawls, nets, sediment scoops, or simple water sampling equipment can also be used, but encounter limitations.

Marine biodiversity research is in many ways lagging behind terrestrial biodiversity research. To enhance knowledge of biodiversity of ABNJ, there is a need for broader geographical coverage of deep-sea habitats to develop a more complete understanding—including the deep pelagic ocean, chemosynthetic ecosystems, deep-sea bed sediments, and the oxygen minimum zone. For example, time-series studies are required to understand natural patterns of variability and changes over time, deep-ocean observations could be increased, and modelling techniques support future predictions. Future technological progress could

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199 Deep sea research vessels need a number of features, such as spacious deck areas, berths for scientific and technical crew, adequate crane- and winch-based operability for deploying research equipment, multi-purpose laboratories and research facilities. Cochonat et al, above n 154.

200 Including the USA, Europe, Japan, South Korea see http://www.researchvessels.org/ accessed 27 December 2017.

201 See, eg: RV Falkor an 83m vessel operated by the Schmidt Ocean Institute, https://www.nature.com/news/private-research-ship-makes-waves-1.12680 accessed 29 December 2017.


203 See for example Shirley A Pomponi, 'Roger Revelle Commemorative Lecture—The oceans and human health: The discovery and development of marine-derived drugs' (2001) 14(1) Oceanography 78-87; Glover and Smith, above n 72; Robison, above n 58; Cochonat et al, above n 154.
enhance research capabilities for ABNJ through advances in sampling equipment and instrumentation such as:

- Ecological information from automated underwater vehicles (AUVs) fitted with cameras and target acquisition systems, acoustic tools for habitat discovery and image recognition and analysis software could enable automated processing of image data;\(^ {204}\)
- Genetic, biochemical or other information from molecular tools potentially enabling *in situ* DNA sequencing;
- Monitoring species and assessing populations using environmental DNA (eDNA);\(^ {205}\)
- Environmental information from sensors (increasingly miniaturised and stable) that can be used on sampling platforms from gliders, floats, AUVs and observatories;
- Monitoring biodiversity conservation using satellite technology;\(^ {206}\) and
- Ocean observing systems (including imaging, sample collection).\(^ {207}\)

In addition to at-sea research, the study of marine genetic resources of ABNJ would also require molecular technologies conducted in laboratories, for example DNA sequencing,\(^ {208}\) and high-throughput rapid screening techniques to identify chemical compounds. This could accelerate natural product discoveries.\(^ {209}\) Examples of technologies that support biological, genetic and biochemical research include:

- Genome mining and metagenomics, genetic engineering;\(^ {210}\)

\(^{204}\) See for example Robison, above n 58; Cochonat et al, above n 154.

\(^{205}\) eDNA is the sequencing and analysis of all DNA in a sample – water or sediment- including parts of an organism (such as skin cell or blood) and hence can provide information about an organism that was present in a water sample at a former time. This can be used to observe threatened species. See, eg: Danovaro, Snellgrove and Tyler, above n 71; Paul V R Snellgrove, 'An Ocean of Discovery: Biodiversity Beyond the Census of Marine Life' (2016) 82(09/10) *Planta Med* 790-799; Germain Boussarie et al, 'Environmental DNA illuminates the dark diversity of sharks' (2018) 4(5) *Science Advances*.


\(^{207}\) See Section 6.2 of Chapter 6 for a discussion on ocean observing systems.


\(^{209}\) Including from microbial diversity hot spots see Thornburg et al, above n 110.

- Proteomics and metabolomics;
- Informatics, bioinformatics;
- Analytical spectroscopy to discover new chemical compounds;\(^{211}\) and
- High throughput or high content screening.\(^{212}\)

The emergence of such technologies is, in some cases, associated with faster rates and lower costs. According to the US National Academy of Sciences (2015) since 2005, there has been an “explosion in the technologies to compose, read, write, and debug DNA … rapidly increasing the scale and sophistication of genetic engineering projects … and lead[ing] to more complex chemical structures…”.\(^{213}\) For example, in 1995 it took more than a year to sequence the genome of *Haemophilus influenza*, costing US$0.5 per base pair but by 2009 a bacterial genome could be sequenced in less than a day for just a few US cents per base pair.\(^{214}\) Advances in molecular research technologies could make screening for marine bioactives faster and cheaper.\(^{215}\)

Molecular research techniques need to be complemented by ecological and biological data and observations of marine genetic resources research to be meaningful.\(^{216}\) ‘Shotgun sequencing’, for example, enables the identification of genetic information from water samples,\(^{217}\) however, this does not provide information on the role of a particular bioactive compound in the biochemistry or physiology of an organism. This can be a significant gap in

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\(^{211}\) Ibid; Martins et al, above n 30.


\(^{213}\) “Synthetic biologists pursue the creation of important tools to solve this problem [i.e. that the ability to compose, or decide the sequence of, DNA has lagged behind our ability to read and write it], including genetic circuits, precision gene regulation parts, and computer-aided design to systematically recode multigene systems.” National Academy of Sciences, ‘Industrialization of Biology: A Roadmap to Accelerate the Advanced Manufacturing of Chemicals’ (National Academies Press, 2015), 3.

\(^{214}\) Ibid; The cost of sequencing human genomes has diminished substantially in the past ten plus years, in 2001 the cost of sequencing the first human genome was US$2.7 billion while in 2014 a company released a product offering a sequenced human genome for US$1,000. Ibid; ‘The Human Genome Project Completion: Frequently Asked Questions’ [http://www.genome.gov/11006943](http://www.genome.gov/11006943) accessed 23/12/2017.

\(^{215}\) Martins et al, above n 30.

\(^{216}\) Pomponi, above n 203.

\(^{217}\) Shotgun sequencing has yielded estimates that current protein databases contain less than half of the total number of proteins that exist in the marine microbial realm. Shibu Yooseph et al, ‘The Sorcerer II Global Ocean Sampling Expedition: Expanding the Universe of Protein Families’ (2007) 5(3) *PLoS Biology* e16. Viruses are thought to account for much of these newly discovered protein families. See, eg: Abida et al, above n 69.
understanding the possible applications of a marine natural product, because some bioactive compounds will only be produced by an organism in response to a particular stimulus or condition. The need to better integrate biological sampling for natural products research with ongoing deep-sea exploration has been identified as a future priority.218 Furthermore, bioinformatics is only useful if there are known gene functions, however, the function of many genes is unknown function as yet.

There are several potential methods to produce chemical compounds derived from marine organisms, including harvesting, aquaculture, synthesis. Culturing deep-ocean organisms ex situ has been identified as a possible priority for future research.219 Deep-sea bacteria and deep-sea fungi have been cultured from sediment obtained from depths greater than 5,000 m and 10,000 m respectively.220 However, there are numerous technical challenges, especially for organisms from deep-sea areas in ABNJ.221 First, the organism must be obtained from the deep-sea habitat and kept alive through the change in pressure and temperature. This might be relatively feasible for microbes using only simple sampling equipment, but it is far more difficult for larger and more complex organisms. Second, there may be technical difficulties in recreating the ambient conditions of deep-sea organisms, such as extremes of pressure, temperature, salinity, pH and habitat conditions. There are few facilities worldwide with this technical capacity. Third, there could be challenges in providing adequate nutrition and waste removal for the cultured organism.222 One reason for undertaking this research would be to study the functions of marine organisms, including the primary and secondary metabolites (such as natural products) that they produce.

Synthesis is one possibility to secure the supply of molecules required for some genetic resources related research. For example, the cancer drug Yondelis contains a bioactive compound trabectedin, present in very small quantities in a shallow-water species of tunicate

218 Thornburg et al, above n 110.
219 Professor Nobuhiro Fusetani quoted in: Glaser and Mayer, above n 112; Munro et al, above n 94.
220 Skropeita and Wei, above n 53.
221 Molinski et al, above n 210.
Ecteinascidia turbinate.\textsuperscript{223} Although it proved possible to culture the animal to secure a supply of the bioactive compound for clinical development, the cost of aquaculture and deep freezing facilities proved too high, and the extraction and isolation yield too low, for the process to be economically feasible to scale up for commercialisation. Finally, trabectidin was successfully produced by a semi-synthetic mechanism that was industrially viable.\textsuperscript{224} This illustrates that synthesis techniques have the potential to significantly impact how marine natural products can be produced and supplied. However, technological and other challenges remain.\textsuperscript{225} Synthetic biology is another research area relevant to genetic resources.\textsuperscript{226} However, this remains an emerging and complex area of research,\textsuperscript{227} which has already raised a number of legal, policy and regulatory questions relating to the conservation and sustainable use of biodiversity.\textsuperscript{228} It has been suggested that the potential to synthesise bioactive compounds will significantly reduce the need to access genetic resources \textit{in situ}, negating large scale harvest.\textsuperscript{229} However, biodiscovery (the discovery of novel bioactive products from nature) has seen a renaissance in recent years.\textsuperscript{230}

Harnessing scientific research and development involving marine genetic resources requires a range of technical infrastructure.\textsuperscript{231} On-shore infrastructure is needed to facilitate the processing of data and knowledge transfer at regional and global scales, including: sample storage and curation; data storage; and analysis and modelling capacities. The following

\textsuperscript{223} Resulting in a yield of just 0.0001 per cent, and would require one ton of the animal to isolate one gram of trabectidin (5 grams are needed for a clinical trial so that would require 5 tons of animal). Martins et al, above n 30.

\textsuperscript{224} As a result, research efforts attempted to synthesise trabectidin, but this was not successful. Martins et al, above n 30.

\textsuperscript{225} Glaser and Mayer, above n 112.

\textsuperscript{226} Molinski et al, above n 210; National Academy of Sciences, above n 213.


\textsuperscript{228} Paul Oldham, Stephen Hall and Geoff Burton, 'Synthetic Biology: Mapping the Scientific Landscape' (2012) 7(4) \textit{PLoS ONE} e34368; Glaser and Mayer, above n 112.

\textsuperscript{229} See, eg: Leary and Juniper, above n 103.

\textsuperscript{230} Techniques using high throughput screening and combinatorial chemistry (that make screening for bio-active compounds faster and cheaper) partly resulted in a period of reduced interest in natural product discovery. However, these techniques did not deliver successful development of bioactive compounds, partly due to disadvantages and gaps (e.g. chemical compounds with low purity, solubility or diversity) in many of the ‘libraries’; Martins et al, above n 30; Molinski et al, above n 210; Glaser and Mayer, above n 112.

\textsuperscript{231} Rogers et al, above n 126.
Section discusses the role of collaboration in developing and utilising science, technology and innovation for marine genetic resources of ABNJ.

2.5.3.2. Harnessing science, technology and innovation: the role of collaboration

International, interdisciplinary and cross-sectoral research and development collaborations play important roles in advancing knowledge of marine genetic resources from ABNJ, including to overcome financial and technical barriers to research and development. For instance, the SERPENT project enabled biodiversity and natural product research through collaborations between research organisations and the oil and gas sector. In another example, Halchondrin B was the most complex natural product based drug ever to be synthesised – its success hinged on a collaboration between academics from the US, New Zealand and Japan, industry and the US government.

A variety of scientific disciplines could be considered as relevant to marine genetic resources of ABNJ. The importance of cross-disciplinary collaborations for marine biotechnology has been described by OECD (2013). Marine natural products research is characterised by cross-disciplinary research; marine drug discovery, for example, involves molecular biologists, pharmacologists and chemical ecologists. Interdisciplinary research could drive improvements in marine natural product research, applying technological advances from sectors such as space science and medical diagnostics to deep sea marine genetic resources. However, this would require multi-phase approaches harnessing a number of disciplines.

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236 Pomponi, above n 203. For example: Space technology could support the development of specialised equipment such as ‘bioreactors’ to enable deep-sea organisms to be collected and maintained under ambient conditions (e.g. high pressure, low temperature, low oxygen) for the study of bioactive compounds; Medical diagnostics could inspire the development of miniaturised biosensors to enable collecting tools and bioreactors to perform rapid in situ analysis of marine organisms for bioactive molecules, supporting non-destructive analyses of target organisms.
(genomics, chemo-informatics, molecular, genetics and chemical ecology) as well as linking with taxonomy, biology, ecology research to enhance knowledge of marine organisms. This would also require a holistic approach to accelerate deep-sea sampling technology development (including material sciences, robotics, energy, communication and navigation technology, chemical sensing, nano- and bio-technology). Integration between deep-ocean exploration, biological sampling and natural products research has been identified as a future priority.

Cross-sectoral collaboration is also characteristic of marine scientific research, as recognised in the LOSC. The need to build greater integration of the private sector and scientific communities in the law and policy debate surrounding access and benefit-sharing of marine genetic resources in ABNJ is increasingly recognised. The renaissance in marine natural product research from 1990-2010 was driven in part by collaborations between research and industry, technological developments. Research to business collaborations offer different benefits to different parties, however, they can be complex and challenging to develop and sustain due to barriers such as conflicting performance metrics and time-frames. These examples illustrate the importance of cross-sectoral and multidisciplinary collaboration in developing and utilising scientific research and technological innovation for the study of marine genetic resources of ABNJ. The following Section discusses the implications of this for benefit-sharing.

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237 Prof Marcel Jaspars and Prof Nobuhiro Fusetani quoted in: Glaser and Mayer, above n 112.
238 Cochonat et al, above n 154.
239 Thornburg et al, above n 110.
240 The importance of cross-disciplinary collaboration is recognised in LOSC art 277(a), which refers to training and educational programmes across a number of disciplines relating to marine scientific and technological research, including marine biology, conservation and management of living resources, oceanography, hydrography, engineering, geological exploration of the seabed, mining and desalination technologies.
241 See, eg: Broggiato et al, above n 86; Leary and Juniper, above n 103, 769.
242 Glaser and Mayer, above n 112; Molinski et al, above n 210.
243 Research and business partnerships will deliver different benefits to different parties. In drug discovery and development, for example, research organisations can benefit from access to research tools and infrastructure (such as screening, pharmacological evaluation and advancement of leads to in vivo models) while business/industry can benefit from access to high-value leads (while avoiding the high risks and costs associated with access to deep-sea organisms and subsequent biodiscovery processes). See for example Tadeusz F Molinski et al, above n 210; Glaser and Mayer, above n 112.
244 See, eg: Capon, above n 235; Martins et al, above n 30.
2.6. Discussion: implications for benefit-sharing and the potential role of integration

This Section summarises the implications of the analysis presented in this Chapter for the sharing of benefits from marine genetic resources of ABNJ. It is suggested that there are three key elements of integration that should be considered in the development of the ILBI:

- Marine genetic resources can be considered in conjunction with marine biodiversity as part of marine life (Section 2.6.1);
- Benefit-sharing can be considered together with conservation and sustainable use of biodiversity (Section 2.6.2); and
- Science, technology and innovation have a dual function as drivers and enablers of marine genetic resources investigation (Section 2.6.3).

2.6.1. Scope: marine biodiversity and marine genetic resources are linked

Given the ambiguities in the definitions relating to genetic resources, as discussed in Section 2.2.2, the material scope of “marine genetic resources” remains open to interpretation.²⁴⁵ However, formulating a narrower definition of marine genetic resources risks creating artificial boundaries around components of life, being difficult to apply in practice, and becoming obsolete as scientific and technical advances reveal new discoveries. Furthermore, the addition of new definitions of terms could complicate the implementation of the ILBI in harmony with the CBD and Nagoya Protocol.²⁴⁶ Disconnects between legal and scientific terminology would need to be identified and bridged to avoid creating legal loopholes that necessitate the development of add-on instruments to clarify or expand the scope of the definition of marine genetic resources.²⁴⁷

²⁴⁵ Section 2.2.1.
²⁴⁶ Particularly in areas where access to genetic resources transects areas within and beyond national jurisdiction (such as a research cruise). This is discussed in Section 3.4.1 of Chapter 3.
²⁴⁷ As illustrated by the Nagoya Protocol adding a definition for ‘derivatives’. Synthetic biology is one example of how future scientific advances could go beyond existing legal definitions of terms that determine the scope of sharing benefits from genetic resources. See, eg: Deplazes-Zemp, above n 8; K Kariyawasam and M Tsai, ‘Access to genetic resources and benefit-sharing: Implications of Nagoya Protocol on providers and users’ (2018) Journal of World Intellectual Property 1-17; D Neumann et al, ‘Global biodiversity research tied up by juridical interpretations of access and benefit-sharing’ (2018) 18(1) Organisms Diversity and Evolution,
Therefore, adopting the CBD definition, whereby marine genetic resources in ABNJ are "genetic material of actual or potential value", appears to be the most pragmatic option. Marine genetic resources are, in general terms, an integral part of marine biological resources and are inextricably linked to biodiversity. The term potentially encapsulates the genetic properties of marine organisms and the derivatives therefrom. In this interpretation, the material scope of benefit-sharing measures under an ILBI should potentially apply to all marine life in ABNJ, including its genetic and biochemical properties.

There are advantages to a large and inclusive scope. An inclusive scope of genetic resources that was equally applicable to the high seas (i.e. water column beyond national jurisdiction) and Area (i.e. seabed and subsoil beyond national jurisdiction) would avoid the risk of creating an artificial distinction, as some marine organisms can move between these two zones.248 Considering a large material scope of marine genetic resources would also capture the wide range of scientific research activities that are relevant to the investigation of marine life.249 A broad interpretation that incorporates all marine life ensures that as-yet undiscovered species are included; this is significant given that all marine life could arguably be considered as having some form of value.250 However, this large scope would also raise issues, particularly for marine living resources that are considered for purposes of fisheries. During the PrepCom, several delegations suggested the need to distinguish between fish as genetic resources, and fish used as commodity.251 One possibility would be to specify exclusions for regulatory purposes; for example, utilisation for direct consumption of marine organisms (as would relate to most fisheries) could be excluded,252 whereas uses dependent on research and development processes could be included in benefit-sharing, this is further

248 Section 2.2.2, Table 2.2.
249 Section 2.4.2, Section 2.6.3.
250 Section 2.2.2 and Section 3.2.3.5 of Chapter 3.
discussed in Section 3.4.1.1 of Chapter 3. The interpretation that marine genetic resources should be considered as an integral part of biodiversity has implications for the focus of benefit-sharing, as discussed in the following Section.

2.6.2. Conservation, sustainable use and benefit-sharing are linked

The analysis of the CBD definition of “genetic resources” given above suggests that the difference between the terms “biological resources” and “genetic resources” hinges on perceptions of value. It was suggested in Section 2.2.2.3 that marine genetic resources of ABNJ could be considered to have cultural, economic, environmental, scientific and social value. This supports a broad scope of marine genetic resources to potentially include all marine life.

It is the variability among living organisms (i.e. the biological resources that contain genetic resources) that underpin the value of marine genetic resources. Therefore, the capture of value from marine genetic resources depends on the conservation and sustainable use of marine biodiversity (Figure 2.7).

253 Section 2.2.2.1.
254 This is further explored in Section 3.3 of Chapter 3.
255 See also for a discussion of the inextricable link between the conservation of marine biological resources in ABNJ and the sustainable use of marine genetic resources: Tullio Scovazzi, ‘Bioprospecting on the Deep- Seabed: a Legal Gap Requiring to be Filled’ in Francesco Francioni and Tullio Scovazzi (eds), Biotechnology and International Law (Hart, 2006) 81-99.
Figure 2.7: Illustration of the links between benefit-sharing and the conservation and sustainable use of biodiversity.

This is particularly critical given the threat of marine biodiversity loss in ABNJ. Value can be captured in different ways, as discussed in Section 3.2.3.5 of Chapter 3. For example, the environmental value of genetic resources can be captured through conservation, by preserving the ecological function of organisms. The CBD recognised that access to and sharing of genetic resources and technologies is essential for the conservation and sustainable use of biodiversity, which in turn is of critical importance for meeting food, health and other needs of the growing world population. The important contribution to sustainable development made by technology transfer and cooperation, to build research and innovation capacities for adding value to genetic resources, including for poverty eradication and environmental sustainability, is recognised in the Nagoya Protocol. The potential role of scientific research, technology transfer, and capacity building in benefit-sharing and in

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256 Section 1.4 of Chapter 1.
257 For a discussion on the link between molecular genetics and conservation, see M van Zonneveld et al, 'Bridging molecular genetics and participatory research: how access and benefit-sharing stimulate interdisciplinary research for tropical biology and conservation' (2018) 50(1) Biotropica 178-186.
258 CBD Preamble [20].
259 Nagoya Protocol, Preamble [5], [7] and art 22. See also Section 3.2.3 of Chapter 3.
capturing the value of marine genetic resources of ABNJ is discussed further in Section 2.6.3 and in Chapter 3.

2.6.3. Scientific collaboration and technological innovation are linked as drivers and enablers of benefit-sharing, conservation and sustainable use

For hundreds of years, collaboration has been a key driver of technological innovation to advance knowledge of deep-ocean life in ABNJ. In the future, it appears likely that technology will continue to unveil new pathways to open up avenues to understand and potentially exploit the genetic and biochemical properties of deep-ocean life.

Scientific and technical capacity has been a driver of the development of access and benefit-sharing instruments and a key reason behind the inclusion of marine genetic resources in the package of elements developed by States for the future ILBI. The level of access to research vessels equipped with underwater research vehicles (particularly submersibles and ROVs) and other deep-sea sampling equipment is a key factor influencing the capacity of a state to undertake research relating to marine genetic resources. On-shore laboratory based technologies are also needed to research and develop marine genetic resources of ABNJ. The fact that not all countries have access to the technologies required to undertake research involving marine genetic resources of ABNJ is a challenge to be overcome in the development of the ILBI. However, it also presents an opportunity for the development of the ILBI to boost scientific and technological capacity building by facilitating access to scientific research technologies. The importance of international collaboration to promote science and economic growth based on genetic resources is recognised.

260 Section 2.4.1.
261 Section 2.4.2.
262 Section 2.3.3.1.
263 Section 2.5.
Both developed and developing States could benefit from enhanced investigation of marine life of ABNJ. According to Oldham et al (2014), possible opportunities for research could include: advanced human knowledge and understanding of deep-sea biodiversity; a roadmap of research efforts for ABNJ; improved coordination and communication between funding agencies and incentives for funding deep-sea research in understudied and new locations. Furthermore, given the need to enhance knowledge of biodiversity, increased collaboration and investment in deep-sea research could also be a desirable outcome, including to develop research capacity to investigate below depths of 2,000m. Thus, developed countries could also stand to benefit from enhance research cooperation. Furthermore, the potential benefits for biodiversity conservation and sustainable use arising from genetics research further highlight the need for a holistic approach to the role of science and technology in ABNJ.

A further opportunity could lie in enhancing scientific research collaboration through promoting integration across disciplines, sectors and countries. Interdisciplinary collaboration could consider the development and integration of skills across multiple disciplines (including, for example, deep-sea ecologists, taxonomists, conservation genetics, synthetic biology, and natural product chemists) in order to shape measures for human capacity building. Cross-sectoral collaboration could consider research and business partnerships to develop and deploy new technologies to investigate marine life of ABNJ and promote innovative financing mechanisms. International collaboration could inform funding of large scale programs and help to build national and regional scientific research institutional capacity, and support the integration of genetic research approaches for ocean management. Standardisation for genetic research approaches, including the use of metabarcoding tools, could support the use of genetic research to support the conservation and sustainable use of biodiversity. Technological advances likely to drive growing convergence between genetic resources for developing new products for commercial

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265 This is further explored in chapter 3.4 and 6.3.
266 Oldham et al, above n 59.
267 Rogers et al, above n 126.
268 Section 2.4.3.1.
269 Section 7.5.1 of Chapter 7.
270 Section 6.2.1 and 6.4.1 of Chapter 6.
271 See, eg: Taylor, Dussex and van Heezik, above n 161.
272 See, eg: van Zonneveld et al, above n 257; Neumann et al, above n 247.
applications. Meanwhile, genetics research could also support conservation and sustainable use.

The development and deployment of new technologies to investigate marine life of ABNJ would also benefit from enhanced science collaboration and innovation. However, to realise any of these potential opportunities, a number of regulatory and legal questions must be answered, including data ownership, technology access and funding for international approaches to develop capacity. Enabling measures would also need to be identified to enable technologies to have a wider scope of application through enhanced uptake of technology and technology transfer to developing nations coupled with capacity building programs. Collaboration is likely to be required to meet the logistical, financial and technical challenges of improving understanding of marine biodiversity in ABNJ and accessing marine genetic resources. These issues are further explored in Chapter 3.

2.7. Conclusion

This Chapter has examined the nature and significance of marine genetic resources of ABNJ. The deep ocean areas beyond national jurisdiction could be considered to be the largest but least well explored biosphere on Earth. A rich diversity of life has already been identified in ABNJ, but significant knowledge gaps remain. The biological, genetic and biochemical properties of marine organisms offer fertile ground for scientific discovery that could be harnessed for a range of applications. Marine genetic resources as a concept is about value of marine life. Marine genetic resources of ABNJ can be considered to have innate actual environmental, scientific and social and potential economic value.

Because legal gaps and ambiguities complicate attempts to define marine genetic resources, marine genetic resources should be considered to be an intrinsic part of marine life and inextricably linked to biodiversity. Therefore, the possibility that the material scope for benefit-sharing under ILBI could be considered to incorporate all marine life of ABNJ, including its genetic properties and biochemical derivatives, must be considered. Including this large material scope under an ILBI would be the most ambitious attempt by the
international community to develop a regime for benefit-sharing. This poses a challenge as well as an opportunity.

A combination of scientific curiosity, technological innovation and international and interdisciplinary collaboration continues to open up new avenues to explore the deep ocean and advance knowledge about the biological, genetic and biochemical properties of ocean life. The fact that not all States have the scientific and technical capacity to access ABNJ is one of the challenges which can be tackled through the development of the ILBI. The pivotal role of science and technology lays the foundation for considering tangible measures for benefit-sharing. Therefore, the development of the ILBI could be an opportunity to enhance scientific collaboration across disciplines, sectors and countries and to boost technological innovation through international cooperation in marine scientific research.

In summary, it is suggested that there are three aspects of integration that must be considered at the outset of addressing the question of sharing benefits from marine genetic resources of ABNJ. Firstly, marine genetic resources should be considered holistically as part of marine biodiversity. Secondly, the conservation and sustainable use of biodiversity is linked to the sharing of benefits from genetic resources. Thirdly, scientific collaboration and technological innovation are key drivers of research, and the resulting knowledge advancements could generate and share benefits from genetic resources, capture and share value including through conservation and sustainable use of biodiversity. In Chapter 3, the potential benefits from marine genetic resources of ABNJ are examined, and the role of science and technology in acquiring, sharing and utilising benefits is examined in detail.
Chapter 3
Benefits from marine genetic resources of ABNJ: science, serendipity and sharing

3.1. Introduction

This Chapter examines the potential benefits that could be derived from marine genetic resources of areas beyond national jurisdiction (ABNJ). The meaning of “benefits” from genetic resources is discussed in Section 3.2. The processes through which benefits from marine genetic resources of ABNJ could be acquired, shared and utilised are examined, highlighting the significance of scientific and technological capacity. In Section 3.3, the terminology relating to benefits from genetic resources is critically analysed. Key concepts, including technology, data and information, are examined. In Section 3.4, related challenges and opportunities for the development of a new international legally binding instrument (ILBI), under the 1982 United Nations Convention on the Law of the Sea (LOSC), for the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (ABNJ) are discussed. Thus, a conceptual framework for benefit-sharing based on science cooperation, technology transfer and capacity building is established.

3.2. Establishing a framework to consider benefits from marine genetic resources of ABNJ

The aim of this Section is to establish a framework for considering benefits from marine genetic resources of ABNJ. The meaning of “benefits of genetic resources” is examined in Section 3.2.1. The process through which benefits from marine genetic resources can be

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accessed and used is analysed in Section 3.2.2. A framework for considering benefits from genetic resources is then established.

3.2.1. Introducing benefits from genetic resources

There is no single definition of “benefit” in the context of genetic resources; no definition is provided in any international legal instrument relating to genetic resources. In broad terms, a benefit could be considered to be an advantage gained from something. The Merriam-Webster dictionary defines a benefit as “something that produces good or helpful results or effects or that promotes wellbeing”. The following analysis of hard and soft law instruments aims to provide an interpretation of the meaning of benefits, in the context of genetic resources.

The 2010 Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilization to the Convention on Biological Diversity (Nagoya Protocol) refers to “monetary” and “non-monetary” benefits; examples are provided in an Annex. Monetary benefits include payments (up-front, milestone or royalties); fees (access, license or special); research funding; joint intellectual property rights ownership and patents. The 17 examples of non-monetary benefits that are provided in the Nagoya Protocol Annex (Table 3.1) can be summarised as:

- Collaboration and international cooperation in scientific research;

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5 Nagoya Protocol, above n 3.

6 Nagoya Protocol, art 5(4); Annex.
• Access to samples, data and knowledge, including the publication and sharing of scientific knowledge;
• Capacity building and technology transfer, including scientific training and access to resources, research infrastructure and technology; and
• Scientific, social and economic outcomes of research involving genetic resources, including actions oriented to the conservation and sustainable use of biodiversity.

The examples of “monetary and non-monetary” benefits provided in the 2002 Bonn Guidelines on Access to Genetic Resources and Fair and Equitable Sharing of the Benefits Arising Out of Their Utilization (Bonn Guidelines) are identical to those that were subsequently included in the Nagoya Protocol.\(^7\) There is one exception relating to the capacity of local communities to conserve and sustainably use genetic resources, that was included in the Bonn Guidelines but not in the Nagoya Protocol.\(^8\) Another unique aspect of the Bonn Guidelines is the consideration of benefits in three time categories: near-, medium- and long-term.\(^9\) These categories, though not referred in the Nagoya Protocol, provide a useful frame that reflects the fact that different benefits can be derived at different points in time, as discussed in Section 3.2.2.

Conversely, the 2001 International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA)\(^10\) does not adopt the terms monetary and non-monetary benefits; nor does it provide an indicative list of benefits. Instead, the focus is on mechanisms to share benefits in support of the conservation and sustainable use of plant genetic resources for food and agriculture. Four ways through which benefits shall be shared fairly and equitably are identified in ITPGRFA Article 13.2: a) exchange of information, b) access to and transfer of technology, c) capacity building, and d) sharing of benefits arising from commercialisation.\(^11\)

\(^7\) Secretariat of the Convention on Biological Diversity, ‘Bonn Guidelines on Access to Genetic Resources and Fair and Equitable Sharing of the Benefits Arising Out of Their Utilization’ (Secretariat of the Convention on Biological Diversity, 2002). This soft law instrument preceded the Nagoya Protocol.
\(^8\) Ibid Appendix II (g).
\(^9\) Ibid [47].
\(^10\) ITPGRFA, above n 3.
\(^11\) ITPGRFA art 13.2 applies to benefits arising from the use, including commercial, of plant genetic resources for food and agriculture under the Multilateral System established under the ITPGRFA. For further discussion see Section 4.3.1. of Chapter 4.
Although the terminology used in the ITPGRFA is different, the key elements are aligned with the benefits enshrined in the Nagoya Protocol. In essence, the first three forms of benefit-sharing under the ITPGRFA (a, b and c) correspond to what is termed non-monetary benefit-sharing under the Nagoya Protocol; while the fourth form of benefit-sharing under the ITPGRFA (d) could be considered as monetary benefit-sharing under the Nagoya Protocol.

A comparison between the benefits referred to in both the Nagoya Protocol and the ITPGRFA (Table 3.1) reveal a broad alignment that can be summarised into the following four themes:

- Collaboration in scientific research;
- Technology transfer, including access to research results/samples/data/knowledge;
- Capacity building: scientific and technical, human and institutional; and
- Capturing economic, environmental, scientific and social outcomes.

In order to identify the benefits that could be derived from marine genetic resources of ABNJ, it is necessary to examine the process by which benefits can be accessed and used. This is provided in the following Section.

**Table 3.1: Summary of potential benefits from genetic resources.**

<table>
<thead>
<tr>
<th>Summary</th>
<th>Nagoya Protocol</th>
<th>ITPGRFA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaboration in scientific</td>
<td>(b) Collaboration, cooperation and contribution in scientific research and</td>
<td>(a) exchange of information</td>
</tr>
<tr>
<td>research</td>
<td>development programmes, particularly biotechnological research</td>
<td>(c) capacity building</td>
</tr>
<tr>
<td>(a) Sharing of research and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>development results</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sources: Nagoya Protocol Annex and ITPGRFA art. 13.2, corresponding pinpoint references are shown as letters in brackets.
<table>
<thead>
<tr>
<th>Technology transfer, and access to research results/samples/data/knowledge</th>
<th>catalogues, inventories</th>
</tr>
</thead>
<tbody>
<tr>
<td>(e) Admittance to <em>ex situ</em> facilities of genetic resources and to databases</td>
<td>(a) exchange of information on results of technical, scientific and socio-economic research</td>
</tr>
<tr>
<td>(f) Transfer to the provider of the genetic resources of knowledge and technology that make use of genetic resources or that are relevant to the conservation and sustainable use of biodiversity</td>
<td>(a) exchange of information on technologies</td>
</tr>
<tr>
<td>(k) Access to scientific information relevant to conservation and sustainable use of biological diversity, including biological inventories and taxonomic studies</td>
<td>(b) access to and transfer of technology</td>
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<tr>
<th>Scientific and technical, human and institutional capacity building</th>
<th></th>
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<tbody>
<tr>
<td>(b) Collaboration, cooperation and contribution in scientific research and development programmes, particularly biotechnological research</td>
<td>(c(iii)) capacity building for carrying out scientific research</td>
</tr>
<tr>
<td>(d) Collaboration, cooperation and contribution in education and training</td>
<td>(c(i)) scientific and technical education and training</td>
</tr>
<tr>
<td>(n) Institutional and professional relationships</td>
<td>(c(ii)) developing and strengthening facilities</td>
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</tbody>
</table>

<table>
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<tr>
<th>Capturing social and economic outcomes</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>(m) Research directed towards priority needs, such as health and food security</td>
<td>(d) sharing of benefits arising from commercialisation</td>
</tr>
<tr>
<td>(l) Contributions to the local economy</td>
<td>(c) capacity building for the</td>
</tr>
</tbody>
</table>
3.2.2. Process to potential: the role of science and technology in capturing benefits from marine genetic resources of ABNJ

In this Section, the processes required to acquire, share and utilise benefits from genetic resources are examined. Pathways to access marine genetic resource of ABNJ are reviewed in Section 3.2.2.1. The scientific research and development processes involved in deriving benefits are examined in Section 3.2.2.2. The likelihood of capturing different types of benefits is considered and the example of marine drug discovery is used to illustrate the challenges in deriving financial benefits.

3.2.2.1 Access

The first step to deriving benefits from marine genetic resources of ABNJ is access. There are four main access options to obtaining genetic and biochemical substances from marine genetic resources:\(^{13}\)

1. *In situ* (e.g. collecting/harvesting a marine organism from its natural habitat);
2. *Ex situ* (e.g. accessing a sample of marine organism that has been removed from its natural habitat or breeding/culturing of organisms from which genetic and biochemical substances could be extracted);
3. *In vitro* (e.g. synthesising a gene or small chemical molecule in a laboratory); and

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4. *In silico* (e.g. accessing information or data relating to a marine genetic resource).

Each access option entails a different research pathway. Access to marine genetic resources in *situ* in ABNJ is dependent upon marine scientific research infrastructure, such as research vessels, underwater vehicles and sampling equipment, which incur high cost and logistical challenges. If a promising bioactive sample is identified, it could be necessary to harvest large quantities of the target organism *in situ* in order to isolate sufficient volumes of the compound for subsequent research and development processes, or commercial product development. In addition to logistical challenges and high costs of accessing ABNJ, harvesting could also raise concerns of over-exploitation and adverse impacts. The environmental impact of harvesting organisms for marine genetic resource research and development will depend on a number of factors, including: the quantity required, the organism itself, and the habitat and ecosystem. Another option is to culture target organisms to secure a viable source of genetic or biochemical material *ex situ*, or to synthesise a target molecule *in vitro*. However, these techniques face a number of barriers. Therefore, although scientific and technological advances such as synthesis will continue to revolutionise access options, *in situ* access remains critical for researching marine genetic resources from ABNJ.

It is also important to note that *in vitro* and *in silico* access are not well defined concepts, in

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14 As discussed in Section 2.5.2 and 2.5.3 of Chapter 2, future technological advances (such as floats or gliders equipped with DNA sensors) could enable faster and lower-cost access to marine organisms, without the use of ships.

15 However, development stages could require tons of target organism. For example, as reported by Skropeta (2011), the anti-cancer agent Halichondrin-B is naturally present in such small quantities in the sponge from which it is derived (just 0.0004 per cent wet weight of sponge) that 7,000 tonnes of sponge would be needed to produce 2.8 kg of drug. Danielle Skropeta, 'Exploring Marine Resources for New Pharmaceutical Applications' in Warwick Gullett, Clive Schofield and Joanna Vince (eds), *Marine Resources Management* (LexisNexis Butterworths, 2011) 211, 219.

16 At early stages of screening for a bioactive compound, the material requirements would be small, with environmental impacts likely to be minimal and similar to marine scientific research involving sampling. For a discussion on the environmental impacts of marine scientific research see: Angela R Benn et al, 'Human Activities on the Deep Seafloor in the North East Atlantic: An Assessment of Spatial Extent' (2010) 5(9) PLoS ONE e12730; Cindy Lee Van Dover, 'Impacts of Anthropogenic Disturbances at Deep-Sea Hydrothermal Vent Ecosystems: A Review' (2014) 102 Marine Environmental Research 59; Bob Hunt and Amanda C J Vincent, 'Scale and Sustainability of Marine Bioprospecting for Pharmaceuticals' (2006) 35(2) Ambio 57.

17 See Section 2.5.3.1 of Chapter 2.

18 Another reason why *in situ* access is likely to remain an important pre-requisite for biodiscovery is to identify promising compounds and inspire research, because genetic and biochemical libraries and computing power are not presently capable of capturing the diversity and complexity of nature. For a related discussion of opportunities and challenges for deep-ocean scientific discoveries see Section 2.5.2 of Chapter 2. For a discussion of supply issues for drug development, see: D Newman, 'Screening and identification of novel biologically active natural compounds' (2017) 6 *F1000Research*; and D J Newman, 'Developing natural product drugs: Supply problems and how they have been overcome' (2016) 162 *Pharmacology and Therapeutics* 1-9.
particular, questions remain relating to what would constitute genetic resources data. The following Section examines the process of research and development.

3.2.2.2. Research and development: deriving benefits from genetic resources

The development and commercialisation of a product derived from a marine genetic resource requires a long-term, high-cost and high-risk series of activities. There are substantial requirements for laboratory facilities, research infrastructure and associated analytical skills. Depending on the nature of the activity, this could include disciplines such as taxonomy, ecology, genetics, molecular biology, microbiology, chemistry, oceanography and bioinformatics.

First, following an in situ collection of a marine genetic resource of ABNJ, taxonomic identification is required. This is not always straightforward, given that many samples obtained from in situ ABNJ are new to science. The identification of new species takes time, and could occur even after a product has been isolated. Reconciling the high rate of collection of new species with the slower rate of taxonomic description is a challenge; coordinating deep-sea taxonomic work on a global scale, although a formidable task, is widely considered to be an essential gap to be filled. Therefore, building and coordinating research capacity in deep-sea taxonomy could be a focus area for science collaboration and capacity building measures under an ILBI.

Samples, data and information are outcomes from scientific research and can be considered to be a type of benefit from genetic resources. Databases are crucial tools to enable

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19 See Section 3.4.3.1.
20 See Section 2.5 and 2.6.2 of Chapter 2.
21 Ibid.
23 It is relevant to note that the Nagoya Protocol explicitly recognises the need to build capacity to undertake taxonomic studies in relation to bioprospecting, see Nagoya Protocol art 22 (5)(f).
24 For a discussion on the difference between data and information see Section 3.4.3.
understanding of marine biodiversity,\textsuperscript{25} identify new species, analyse taxonomic data, confirm discoveries of novel marine natural products and synthesise chemical compounds.\textsuperscript{26} Given the breadth of research phases involved in marine genetic resources, there are a range of different databases that could be relevant to marine genetic resources in ABNJ, spanning marine biodiversity databases to marine natural products registries.\textsuperscript{27}

To further examine the process through which benefits can be derived from genetic resources, the example of the development of a pharmaceutical product can be considered. This can be simplified into a conceptual four-phase research and development process, including collection of a marine organism, biodiscovery, biomedical research and development and commercialisation (Figure 3.1). These phases form a dynamic, non-linear value chain, potentially involving a number of stages and a diverse range of actors, spanning different sectors and states. The first three phases are research driven and thus reliant upon a range of technical and scientific research infrastructure, requiring different skills across a number of disciplines. The fourth phase relates to commercialisation and is often a complicated, long-term, capital-intensive and high-risk business process.

As illustrated by Figure 3.1, so-called non-monetary benefits can be derived throughout the research and development process, commencing from the process of accessing a genetic resource. However, monetary benefits can only be derived at the end of successful commercialisation and hence are not guaranteed. The challenges to deriving benefits are discussed in the remainder of this Section, and a conceptual illustration of the potential benefits from marine genetic resources of ABNJ is then provided.


\textsuperscript{26}For a comprehensive review of natural product databases see: John W Blunt, Murray H G Munro and Meg Upjohn, 'The Role of Databases in Marine Natural Products Research' in E Fattorusso, W H Gerwick and O Tagliatela-Scafati (eds), Handbook of Marine Natural Products (Springer, 2012) 389.

\textsuperscript{27}See Section 6.3 of Chapter 6 for a discussion of data sharing practices and options for an ILBI.
Due to the long time-frames involved in biodiscovery research and the fact that marine natural products are relatively recent phenomena,\textsuperscript{29} the evolution and emergence of products from marine genetic resources could be considered as early-stage and untapped. However, there are a number of potential challenges including (Table 3.2):\textsuperscript{30}


\textsuperscript{29} See Section 2.3 of Chapter 2 for a summary of the history of marine natural product research.

\textsuperscript{30} For a comprehensive discussion of market, biodiversity, supply and technical barriers to marine natural product development in pharmaceutical and cosmeceutical sectors, see, eg: Ana Martins et al, 'Marketed Marine Natural Products in the Pharmaceutical and Cosmeceutical Industries: Tips for Success' (2014) 12 Marine Drugs
• Technical and scientific;
• Financial;
• Time;
• Skills;
• Legal/policy/regulatory; and
• Industry interest.

For example, not all bioactive marine natural products that appear promising in early stages of drug-discovery research will be suitable candidates. Factors include a lack of efficacy, drug toxicity, lack of natural product supply and challenges in optimisation.\(^{31}\) Less than one per cent of marine natural products that are described make it through to market.\(^{32}\) Estimates of the success rate vary, but it is broadly considered to be one in a few thousand.\(^{33}\) The cost of drug discovery is high, estimates for the cost of a drug discovery program vary, ranging from US$50-800million.\(^{34}\) The development and eventual commercialisation of a product can take decades. For example, it took fifteen years from the first isolation of the marine natural product dolastatin from the sea hare *Dolabella auricularia* until the chemical structure was determined, 40 years in total from extract of the bioactive compound to the marketing of the approved drug.\(^{35}\) It took 24 years to develop the drug Halaven after the publication of the

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31 Martins et al, ibid.


35 Dolastatin was present in such small quantities that it took 1 ton of the animal to isolate 29 mg of the natural product. Two years later, in 1989, a total synthesis of dolastatin was achieved, removing any potential supply issues. It was later discovered that dolastatins are produced by cyanobacteria, which are part of the diet of the sea hare. Martins et al, above n 30. See also Section 2.4.6 of Chapter 2.
compound halichondrin-B from a deep-sea sponge.\textsuperscript{36} Alternative applications could offer simpler pathways. For example, a marine-derived novel bioactive compound could be commercialised as a cosmeceutical, even though it had potential applications in the pharmaceutical sector, because the trial and commercialisation process for a cosmeceutical is less time-consuming and lower-risk than for a pharmaceutical.\textsuperscript{37}

\textbf{Table 3.2. Examples of potential barriers to developing a commercial product using genetic resources}

<table>
<thead>
<tr>
<th>Type</th>
<th>Example of potential barriers</th>
</tr>
</thead>
</table>
| Technical/scientific      | • isolating novel marine natural products  
                           | • identifying molecular composition  
                           | • understanding natural function (chemical ecology) and bioactive mechanisms  
                           | • securing sustainable supply of target compound in sufficient quantities |
| Financial                 | • cost of deep-sea research  
                           | • cost of drug discovery  
                           | • cost of drug development |
| Time                      | • time of drug development programs |
| Skills                    | • skilled researchers in a range of disciplines, from taxonomy to chemistry  
                           | • commercialisation  
                           | • policy/regulatory development |
| Legal/policy/regulatory    | • limitations on collection and transport of biodiversity  
                           | • different regulations for different actors  
                           | • cross the boundaries of different disciplines, sectors and States adding further layers of complexity and possible barriers such as intellectual property ownership, compliance with regulation, fair and equitable sharing of technology and other benefits arising from the use of genetic resources |

Despite the promising potential of marine genetic resources to yield commercially valuable products,\textsuperscript{38} there is no guarantee of commercial success and financial returns on the

\textsuperscript{36} Newman, above n 18, Section 2.4.6 of Chapter 2.
\textsuperscript{37} Martins et al, above n 30.
\textsuperscript{38} See Section 2.4 of Chapter 2.
investment. The logistical challenges and cost requirements for accessing marine genetic resources of ABNJ are especially high. A number of factors, including investment, will influence the conversion of potential value into actual value in relation to marine genetic resources of ABNJ.\(^{39}\) As discussed in Chapter 2, there are few commercialised products from marine compounds derived from organisms in ABNJ.\(^{40}\) There are various reasons for this. Firstly, most marine natural products research to date has been focused on shallow-water (e.g. coral reefs) sessile marine organisms (e.g. sponges) which are located within national jurisdiction where the logistical challenges and cost of access is lower than in deep water locations beyond national jurisdiction. Secondly, the significant financial, skill and technical requirements throughout the process from the collection of a marine sample to the development and marketing of a derivative product are compounded when dealing with organisms from remote, deep-water locations in ABNJ. For example, the cost of research vessels and equipment for access is high, challenges for culturing organisms to secure a sustainable supply of target organism are great.\(^{41}\) These challenges create risk, and challenge optimistic expectations for wealth generation from genetic resources.\(^{42}\)

The actual economic potential of marine genetic resources in ABNJ remains unclear.\(^{43}\) Attempts to ascertain the potential economic value of marine genetic resources of ABNJ have been inconclusive and estimates vary widely. In 2010, the value of undiscovered anti-cancer drugs of marine origin was estimated to be between US$563 billion and 5.69 trillion, with estimates that more than 90 per cent of marine natural products remained undiscovered and


\(^{40}\) See Section 2.4.6 of Chapter 2.

\(^{41}\) See Section 2.2.3 of Chapter 2.


\(^{43}\) Ibid, see especially: Leary et al; Leary and Juniper; and Paul Oldham et al.
55-214 new anti-cancer drugs were yet to enter the market.44 The global market value for marine natural product derived drugs was estimated to reach US$8.6 billion by 2016.45 The variations in these estimates reflects uncertainty relating to knowledge gaps of the full extent of marine life, and the process by which marine genetic resources are accessed and used. For example, of the marine derived compounds used in drugs that are currently on the market, less than half were used in the original form (those in Prialt, Yondelis and Carregelose) – the others underwent some form of optimisation or alteration.46 Furthermore, these estimates do not include other uses of marine genetic resources.47 Options to share non-economic benefits are therefore critically important.

3.2.3. Discussion: what are the benefits?

The analysis of the activities and processes involved in accessing and using marine genetic resources of ABNJ, presented in Section 3.2.2, reveals that science and technology are critical to acquire, share and apply benefits. This Section discusses the significance of non-monetary benefits in Section 3.2.3.1, and suggests in Section 3.2.3.2 that a broad interpretation of the value of marine genetic material of ABNJ is necessary.

3.2.3.1. Advantages of “non-monetary benefits”

One difference between monetary and non-monetary benefits relates to time. As shown in Section 3.2.2.2, non-monetary benefits could occur throughout a research and development process, beginning with the immediate moment at which there is initial access to a marine organism in ABNJ, and continuing through the iterations of subsequent knowledge generation. Monetary benefits, on the other hand, occur towards the end of a long research
and development process that could take decades (Figure 3.1). A related distinction is likelihood. Non-monetary benefits are possible throughout all stages of accessing and using marine genetic resources from ABNJ, being largely dependent on scientific and technological capacity and cooperation (Figure 3.1, Figure 3.2). Monetary benefits are far more dependent on factors relating to commercial interests and the successful transition of a product through a long, complex and costly research and development process (Table 3.2). Consequently, deriving non-monetary benefits is increasingly recognised as being more feasible than monetary benefits in the context of marine genetic resources in ABNJ. Before further examining the benefits that could be derived from marine genetic resources of ABNJ, the question of terminology relating to benefits must be addressed.

3.2.3.2. Disadvantages of the “non-monetary and monetary” benefit concept

There are two disadvantages of adopting the terminology of “monetary and non-monetary benefits” in the context of marine genetic resources of ABNJ. Categorising benefits as “monetary” and “non-monetary” can be misleading, for the following reasons:

- Non-monetary benefits are not cost-free;
- Monetary and non-monetary benefits are not mutually exclusive, they are interlinked i.e. non-monetary benefits could lead to monetary benefits (e.g. subsequent research and development processes using data obtained from accessing a genetic resource) and monetary benefits can also produce non-monetary benefits (e.g. funding for capacity building or intellectual property arrangements that are conducive to open access and innovation);
- The term “non-monetary benefit” is vague and does not capture the breadth of the various elements that are encompassed (from international research programs to

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48 Benefit-sharing is discussed in Chapter 4.
49 See, eg: Broggiato et al, above n 13.
technology transfer) or communicate the overlaps with elements of scientific and technological capacity building; and

- The term “non-monetary” creates a negative connotation (i.e. ‘not money’) which potentially diminishes perceived value and does not accurately reflect the breadth of elements that could be included and potential values to be captured.

For the reasons listed above, the terminology of “monetary” and “non-monetary” benefits is of limited use in the context of marine genetic resources of ABNJ. As a possible reflection of this, throughout the PrepCom, the use of the terms monetary and non-monetary in interventions by States diminished, whereas the more general reference “benefits” was favoured by some. On the other hand, retaining the terminology for the purpose of alignment with the CBD and Nagoya Protocol to support harmony between benefit-sharing approaches between areas within national jurisdiction and ABNJ. Such alignment could be desirable for efficient implementation of an ILBI, including for the facilitation of marine scientific research given that a single scientific sampling expedition could span areas within and beyond national jurisdiction. Regardless of the terminology to be used—whether the ILBI refers to “benefits” or “monetary and non-monetary benefits”—the critical issue is to ensure clarity about what the benefits from marine genetic resources of ABNJ are, if they are to be shared in a meaningful way. This is examined in the following Section.

3.2.3.3. “Non-monetary benefit-sharing” and technology transfer overlap

The importance of clarity in terminology relating to “benefits” is further illustrated by a comparison between the meaning of “non-monetary benefits” and “technology”. The analysis in Section 3.2 indicates that benefits from marine genetic resources of ABNJ are related to science and technology, either directly or indirectly. A comparison between the examples of “non-monetary benefits” provided by the Nagoya Protocol and the examples of “technology” provided by the IOC Criteria and Guidelines on Transfer of Marine

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51 As discussed in section 1.3.2 of Chapter 1, monetary (i.e. economic or commercial) benefits are not part of the scope of this thesis.
52 See section 2.5 of Chapter 2.
53 See section 3.3. for a detailed discussion of technology, the purpose of this analysis is to demonstrate the limitations of the terminology of “non-monetary benefits”.

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Technology\textsuperscript{54} reveals close similarities that can be summarised in five common themes (Figure 3.2):

1. Access to data, samples and information (e.g. open-access to data, publication of knowledge);
2. Capacity building (e.g. marine scientific training, research equipment, regional centres of excellence);
3. International cooperation (e.g. research in ABNJ, training);
4. Scientific and socioeconomic benefits (e.g. advanced knowledge of ABNJ, research directed to priority needs, enhanced reputation of scientific institutions); and
5. Standards, guidelines and methodologies (e.g. criteria for scientific research, technology transfer and capacity-building).\textsuperscript{55}


\textsuperscript{55} For example, standards facilitate and guide international cooperation in scientific research and can thus be considered as an enabling element for a benefit-sharing framework.
Figure 3.2: Comparison between examples of technology (IOC, 2005) and non-monetary benefits (Nagoya Protocol, 2010), including five common science and technology themes.
(Source: Harden-Davies, 2016).

These five themes collectively provide a scaffold of science and technology elements that could be considered as ‘common interests’, supporting both the sharing of benefits of marine genetic resources and the transfer of marine technology. Specifying the categories of benefits and recognising the synergies between benefits of genetic resources and other cross-cutting

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56 IOC, above n 54.
marine science and technology themes could enable these elements to be considered “together and as a whole” in accordance with UNGA Resolution 72/249.\textsuperscript{59}

A further issue that must be considered is that the range of elements that could be considered to be “non-monetary” benefits (Table 3.1) are also interlinked. Taking scientific knowledge as an example, the interlinkages between the acquisition, sharing and application of benefits through scientific research cooperation, technology transfer (including sharing of data and knowledge) and capacity building can be visualised (Figure 3.3). International scientific collaboration to access marine life \textit{in situ} enables scientific knowledge to be generated, which underpins the sharing of benefits through access to data and information, and the utilisation of benefits through scientific capacity building. In turn, enhanced national, regional and global scientific capacity enables the conduct of ocean science. An alternative way of considering non-monetary benefits could therefore be in the context of an enabling environment for scientific and technological capacity building. Key considerations and components of an enabling environment are set out in the remainder of this Chapter. The concept of an enabling environment is further discussed in Section 4.4.3 of Chapter 4, and suggestions for creating an enabling environment for benefit-sharing relating to marine genetic resources of ABNJ are provided in Chapter 7.

\textsuperscript{59} UNGA, above n 2, [2].
Figure 3.3: The interdependency between the acquisition, sharing and application of scientific knowledge. Scientific knowledge, as a benefit from marine genetic resources of ABNJ, illustrates the interdependence between science cooperation, technology transfer and capacity building.
(Source: Harden-Davies 2017).

3.2.3.4. Breaking benefits down

As shown in Section 3.2.1, the concept of non-monetary benefits includes a range of elements according to the Nagoya Protocol. For marine genetic resources of ABNJ, this could include:

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1. **Access to samples, data and knowledge**: This could include sharing research results, data, samples, and knowledge relating to marine genetic resources in ABNJ across the full spectrum of relevant scientific disciplines (e.g. from marine ecology to natural products chemistry);

2. **Collaboration and international cooperation**: This might include international scientific cooperation in deep-sea research to develop and deploy technology to enhance knowledge of deep-sea biodiversity in ABNJ and access marine genetic resources *in situ* whilst sharing costs of deep-sea research expeditions. Particular areas for further work could include enhanced research effort in the deep pelagic, abyssal plain and further work on microbes. It might also include international cooperation to develop scientific research techniques and accelerate technology development to improve and enable *ex situ* and *in vitro* access to marine genetic resources, for example, by enhancing efforts to culture and synthesise marine organisms. This could also include collaboration with private or philanthropic sectors;

3. **Human, institutional and technical capacity building**: This could include opportunities to develop research capacity in deep-sea research and research relating to the use of genetic resources, including (but not limited to) natural products chemistry in developing countries and opportunities to train scientific researchers (e.g. scholarships, exchanges) in methods required to develop natural products as well as access to technology and research infrastructure needed to access deep-sea marine genetic resources in ABNJ; and

4. **Social and scientific benefits**: This could include the conduct of research directed towards priority needs, such as new approaches to address health and food security, as part of the development of marine natural products from ABNJ. Funding options would be required, although this would be facilitated by research funders and priority setting exercises. There could also be other downstream non-monetary benefits from building research capacity and access to technology in developing countries, for example, enabling developing countries to develop genetic resources from areas within national jurisdiction.\(^61\)

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\(^{61}\) This echoes the reference to the role of science, research and technology transfer in improving ocean health and enhancing the contribution of marine biodiversity to the development of developing countries in Sustainable...
Section 3.2.1 also demonstrates that there are alternative options for terminology that could be followed, rather than “monetary and non-monetary benefits”. Drawing on the analysis presented in Section 3.2.1 (of ITPGRFA Article 13.2 and the Nagoya Protocol) benefits from marine genetic resources of ABNJ could be considered in four broad categories:

A. Collaboration in scientific research;
B. Technology transfer, including access to research outcomes (e.g. samples, data and knowledge);
C. Capacity building, including scientific and technical forms of capacity building at human, institutional, national, regional and even global scales; and
D. Commercial or monetary benefits.

The significance of science, technology and capacity building as potential benefits from marine genetic resources of ABNJ can be seen in the depiction at Figure 3.4. As illustrated in Figure 3.1 and 3.4, the very process of research and development generates knowledge, data and opportunities to derive and share benefits. The outcomes of scientific research (such as knowledge, data, information and samples) are benefits that could be shared, including through technology transfer and capacity building. Benefits A, B and C (which could be considered as “non-monetary”) are possible from the beginning of the research and development process, beginning to accrue from the point at which a marine organism is accessed in ABNJ (Figure 3.4). 

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Figure 3.4: Benefits from marine genetic resources of ABNJ. Benefits could include knowledge, data, information and samples (A), technology development and transfer (B), and capacity building (C). Commercial benefits (D) could only be derived following iterative research and development processes. For a depiction of value, see Figure 3.5.

3.2.3.5. Before economic value: environmental, social and scientific values

In Section 3.2.2.2, it was demonstrated that the economic potential of marine genetic resources of ABNJ is unclear, and that there are various barriers to deriving economic value, or monetary benefits. As such, marine genetic resources in ABNJ represent potential rather than actual economic value.  

62 In Chapter 2, it was suggested that marine genetic resources of ABNJ could be considered as marine genetic material with actual or potential environmental, economic, scientific or social value.  

63 This reinforces the need to consider the broader

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62 For a discussion on actual and potential economic value, see Oldham et al, above n 42.

63 See Section 2.2.2.3 of Chapter 2.
environmental, scientific and social value of marine genetic resources, and the way in which that value can be captured.

The different potential values of marine genetic resources can be captured in different ways. Some actual value is inherent; by their very existence and role in ecosystem function, marine genetic resources deliver actual environmental value. On the other hand, deriving actual economic value requires the successful execution of a series of targeted activities to investigate, utilise and exploit genetic resources. As noted by Oldham et al. (2014), marine genetic resources in ABNJ could be of actual value for the advancement of knowledge by research, but not have a realised or realisable commercial value. Scientific value depends on the existence of healthy marine ecosystems, or dependent on capacity building opportunities. In other words, all marine life arguably has innate potential economic, environmental, scientific and social value; and actual environmental, scientific and social value given their role in the ecological fabric of nature.

It could be considered that potential value becomes actual value through scientific research and development processes, at which point benefits can also be acquired (Figure 3.5). The benefits arising from the capture of this value are also interlinked and could accrue in different ways, to different actors, and at different times. For example, immediate benefits relating to scientific value could also lead to subsequent benefits linked to social and economic value through the development of a new product or service. The different possible outcomes from a single scientific activity was also recognised by Arvid Pardo in his historic speech of 1967 to the United Nations General Assembly.

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64 See Section 2.2.2.3 of Chapter 2.
65 Section 3.3.
66 Oldham et al, above n 42.
68 Pardo noted the Meteor expedition had the initial purpose to seek to extract gold from seawater but generated an amount of scientific information and technological advancements that could be used to improve water security: Intervention delivered by Arvid Pardo on behalf of Malta During: ‘Examination of the question of the reservation exclusively for peaceful purposes of the sea-bed and the ocean floor, and the subsoil thereof, underlying the high seas beyond the limits of present national jurisdiction, and the use of their resources in the
Considering value in this way has two implications for considering the issue of benefit-sharing of marine genetic resources of ABNJ. Firstly, capturing inherent value is dependent on healthy marine ecosystems, and this reinforces the link between benefit-sharing and the conservation and sustainable use of biodiversity. Secondly, the development of biotechnology or other commercial products is not the only way that value of marine genetic resources can be realised. The capture of the value of genetic resources through scientific research and development could lead to a range of different benefits accruing in different ways, to different actors, and at different times.

**Figure 3.5: Actual or potential value of marine genetic resources of ABNJ.** Marine genetic resources of ABNJ could be considered as having potential scientific, social, environmental and economic value.

The value of marine genetic material and the potential benefits from marine genetic resources of ABNJ are interlinked; benefits could be considered as partially captured value of marine

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genetic material. The Chair’s non-paper ahead of the third session of the PrepCom, recognised that the ILBI could consider the particular types of benefits that can be shared at particular points in the process:

“For example, an access and benefit-sharing regime under the implementing agreement may require marine genetic resources research to be published within a specified reasonable timeframe, ensuring that findings are shared with the international community. This could provide value, even in instances where commercialisation is delayed, or does not eventuate”. 69

This indicates at least some recognition within the international community that sharing the outcomes of scientific research would constitute a benefit, and that the genetic resources of ABNJ have a broader value than purely economic value derived after commercialisation. Therefore, options to capture the potential scientific, social, environmental as well as economic value through scientific research and technological innovation are needed. The way in which this thesis attempts to develop such options is established in the following Section.

3.2.4. The framework for investigating benefits from marine genetic resources of ABNJ used in this thesis

In Section 3.2.3.1, it was suggested that various so-called non-monetary benefits can be derived throughout a research and development process, however, financial monetary benefits could only occur after the successful commercialisation of a product (Figure 3.4). In Section 3.2.3.5, it was suggested that the actual and potential economic, environmental, scientific and social value of marine genetic resources will also vary throughout the research and development process (Figure 3.5).

69 Australia, cited in: Chair’s non-paper on elements of a draft text of an international legally-binding instrument under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction 28/02/1. Distributed prior to the third session of the PrepCom (27 March - 7 April 2017), 30.
Given the demonstrated significance of so-called non-monetary benefits, and the crucial role of the scientific research and development process in capturing value from genetic resources, this thesis considers the problem of benefit-sharing through the lens of the following three key elements (Figure 3.6):

1. Cooperation in marine scientific research and technology transfer,\(^{70}\)
2. Technology transfer, including for the sharing of data, knowledge and outcomes of scientific research; and
3. Human, institutional and technical scientific capacity building.

Figure 3.6: The framework for considering benefits from marine genetic resources of ABNJ used in this thesis.

\(^{70}\) It is recognised that science cooperation is not necessarily a pre-requisite for acquiring benefits from genetic resources. The reasons for emphasising cooperation are: most scientific research in ABNJ is internationally collaborative, as shown in Section 2.5.3.2 of Chapter 2 and section 6.2 of Chapter 6; cooperation is a necessity under the LOSC, as discussed in Section 5.2 of Chapter 5; and cooperation is required for most benefit-sharing activities, as discussed in Section 6.2 of Chapter 6.
As shown in Figure 3.6, the three elements are interlinked. This can be summarised by considering the example of knowledge as a benefit from genetic resources. Knowledge can be acquired through marine scientific research, which is often internationally cooperative. The production of this knowledge is dependent upon the use of technology, including research infrastructure. This knowledge can be shared, and utilised through the sharing of information and data, as well as skills and methods to interpret and apply knowledge. These activities create opportunities for capacity building, including in human, technical and institutional terms. In turn, this capacity building supports international cooperation in scientific research, and the development and transfer of technology. This suggests that benefit-sharing occurs at the nexus between the three elements. This framework for considering benefits is further elaborated in Section 3.3.

3.3. Elaborating the benefits framework: data, samples and technology sub-categories

In this Section, the framework for considering benefits in this thesis is further developed and potential definitions for subcategories of benefits are examined. Having highlighted the significance of “non-monetary” or “scientific and technological capacity building” benefits, and identified three broad sub-categories of benefits in Section 3.4.2, the meaning of these categories must then be determined. The meaning of 1) international cooperation in science, and 3) scientific capacity building in the context of the law of the sea can be interpreted in the context of the LOSC and will be discussed in detail in Chapter 5. The technical definitions and characteristics of 2) ‘data, information and knowledge’, as well as samples and technology, are examined in this Section.

3.3.1. Data, information, knowledge

Data, information and knowledge are differentiated and defined by the Royal Society (2012) as follows:71

- Data: “numbers, characters or images that designate an attribute of a phenomenon”;

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• Information: “data become information when they are combined together in ways that have the potential to reveal patterns in the phenomenon”; and
• Knowledge: “information yields knowledge when it supports non-trivial, true claims about a phenomenon”.

According to this formulation, knowledge and information can be considered as benefits from marine genetic resources arising from research and development activities occurring after a sample has been acquired. Hence, providing access to that information is a form of sharing benefits. Another type of information relates to how benefit-sharing activities could or should occur, such as research activities, capacity building opportunities, relevant policies and guidelines.

Defining the scope of data is a complicated issue for genetic resources, from access and benefit-sharing perspectives. The various potential elements that could be considered as being included in the definition leave it open to wide interpretation. For example, data relevant to genetic resources could include:

• Species (i.e. biological diversity);
• Genetic sequences (i.e. genetic material); and
• Molecular composition and chemical structures of biochemical compounds/marine natural products (i.e. derivatives).

Genetic sequences are defined under the Pandemic Influenza Preparedness Framework for the sharing of influenza viruses and access to vaccines and other benefits (PIP Framework) as “the order of nucleotides found in a molecule of DNA or RNA. They contain the genetic information that determines the biological characteristics of an organism or a virus”.

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72 See section 3.2.2.1 of Chapter 3 for a discussion of discussion of in silico access.
73 See Section 2.2 of Chapter 2 for definitions of biological diversity, genetic material and derivatives.
74 PIP Framework, above n 3.
75 PIP Framework 4.2.
The issue of “genetic sequence data” is, however, contentious. The PIP Framework explicitly addresses genetic sequence data, but it also indicates that the handling of genetic sequence data remains an unresolved issue. Genetic sequence information, or digital sequence information, is also an issue of discussion under the auspices of the *Convention on Biological Diversity* (CBD), where it has been recognised as a cross-cutting issue for conservation and sustainable use of biodiversity and the fair and equitable sharing of benefits from genetic resources. An Ad Hoc Technical Expert Group (AHTEG) on Digital Sequence Information on Genetic Resources has been established by the CBD and will also serve the Nagoya Protocol. According to the terms of reference, the AHTEG is tasked to consider the technical scope and legal and scientific implications of existing terminology related to digital sequence information on genetic resources. This highlights that international deliberations on the issue of genetic sequence information are ongoing. It appears that further work is required to reach a common understanding among States on the interpretation and implementation of international law in relation to the role of genetic sequence data, and other forms of data, in sharing benefits from genetic resources.

For the development of the ILBI, this complicates the question of what could be considered to be part of the scope of benefit-sharing of marine genetic resources. The uncertainty was reflected in the PrepCom. The scope of what data, including genetic sequence data, could be included in benefit-sharing of marine genetic resources of ABNJ is a complex issue for the development of the ILBI. Given that there are existing examples of access to data and

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76 PIP Framework 5.2.
77 Member States request the Director-General to consult the Advisory Group on the best process for further discussion and resolution of issues relating to the handling of genetic sequence data from H5N1 and other influenza viruses with pandemic potential as part of the PIP Framework. PIP Framework 5.2.4 and 5.2.3.
information forming part of benefit-sharing from genetic resources,\textsuperscript{82} this thesis considers a wide range of data sources in the analysis of benefit-sharing options. There are different types of data that could be included (Table 3.3).

Table 3.3: Definitions of data (Source: Royal Society, 2012).\textsuperscript{83}

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big data</td>
<td>Data that requires massive computing power to process</td>
</tr>
<tr>
<td>Broad data</td>
<td>Structured big data, so that it is freely available through the web to everyone</td>
</tr>
<tr>
<td>Data</td>
<td>Qualitative or quantitative statements or numbers that are (or assumed to be) factual. Data may be raw or primary data (e.g. direct from measurement), or derivative of primary data, but are not yet the products of analysis or interpretation other than calculation</td>
</tr>
<tr>
<td>Linked data</td>
<td>Described by a unique identifier naming and locating it in order to facilitate access. Contains identifiers for other relevant data, allowing links to be made between data that would not otherwise be connected, increasing discoverability of related data</td>
</tr>
<tr>
<td>Metadata</td>
<td>Data about data, contains information about a dataset, may state why and how it was generated, who created it and when; may be technical describing its structure, licensing terms, and standards it conforms to</td>
</tr>
<tr>
<td>Open data</td>
<td>Open data is data that meets the criteria of intelligent openness: accessible, useable, assessable and intelligible</td>
</tr>
</tbody>
</table>

3.3.2. Samples

Access to whole or part of marine organisms is a pre-requisite for any research and development to generate benefits from marine genetic resources. As such, access to samples or specimens is one of the potential benefits that could be considered under benefit-sharing. The PIP framework defines “clinical specimens” as “materials taken from humans or animals, in as far as the samples taken from animals are shared by originating countries/laboratories with the WHO GISRS.”\textsuperscript{84} The PIP definition specifies the purposes of the research and development, the type of material included and the application of the

\textsuperscript{82} See section 3.2.1.
\textsuperscript{83} Royal Society, above n 71, 12.
\textsuperscript{84} PIP Framework [4.2].
definition to a specified set of institutions. This definition could provide an example for the development of a definition of marine genetic resources samples under an ILBI.

3.3.3. Technology

Technology can be broadly considered as the application of information to undertake an activity. The OECD (2012) defines “technology” as the creation and use of technical means and their relation to life, society and the environment. The importance of access to genetic resources and technologies is reiterated in Article 1 of the CBD. Technology is not defined in the Nagoya Protocol, CBD, ITPGRFA, or PIP Framework. In the context of genetic resources, Bohm and Collen (2015) note that technology is often thought of as hardware in the context of the CBD or biodiversity, but also includes soft technologies such as knowledge.

Marine technology, as defined by the Intergovernmental Oceanographic Commission of UNESCO (IOC) in the CGTMT includes:

- Information and data (marine sciences, operations and services);
- Expertise, knowledge, skills, methods (technical/scientific/legal);
- Equipment (in situ sampling and observation, laboratory analysis and experimentation);
- Computer software, models and modelling techniques; and

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85 PIP Framework [4.2] “…These include specimens collected from the respiratory tract (for example, swabs and aspirated fluid), and also blood, serum, plasma, faeces, and tissues, for diagnostic purposes, detection of pathogens and further characterization, study or analysis.”
87 CBD art 1 provides that “The objectives of this Convention, to be pursued in accordance with its relevant provisions, are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding.” The Bonn Guidelines also stipulate that benefits should be directed in such a way as to promote conservation and sustainable use of biological diversity. Bonn Guidelines, above n 7 [48].
89 IOC, above n 54.
• Manuals, guidelines, criteria, standards, reference materials.

In the context of the ILBI, the usefulness of the IOC CGTMT has been recognised by various delegations at the PrepCom. However, the G77 group of countries remarked at the second session of the PrepCom that it might be timely to revise and update the guidelines, in relation to technology transfer and capacity building for biodiversity in ABNJ. Examples of technology that could be relevant to sharing benefits from marine genetic resources of ABNJ is provided in Table 3.4.

The PrepCom reflected a range of views concerning the meaning of technology. The Chair’s non-paper ahead of PrepCom 2 reflected that technology—in the context of biodiversity beyond national jurisdiction—includes soft and hard technologies. However, the Chair’s non-Paper ahead of PrepCom 4 included the following definition of “technology”:

“Technology means hard technology as well as all of its associated aspects, such as specialized equipment and technical know-how, including manuals, designs, operating instructions, training and technical advice and assistance, necessary to assemble, maintain and operate a viable system and the legal right to use these items for that purpose on a non-exclusive basis. It also refers to infrastructure and enhancing technical capacity to make such transfer sustainable.”

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91 Chair’s non-paper to the third session of the PrepCom, above n 69, 82; LOSC Annex III art 5(8); Nagoya Protocol art 22 (5)(g).

From this definition, it seems that there is a focus on hard technology and it is therefore open to interpretation whether technology also includes scientific knowledge, equipment, data, samples and related human, institutional and technical capacity building. To investigate this further it is necessary to examine the context of the use of these terms in the LOSC – this is provided in Chapter 5. Before this can be completed, the implications of this analysis of benefits for the development of the ILBI are examined in Section 3.4.

Table 3.4: Examples of marine technology transfer for marine genetic resources of ABNJ
(Source: modified from Harden-Davies 2017).93

<table>
<thead>
<tr>
<th>Technology category (IOC, 2005)</th>
<th>Indicative list of technology transfer activities that could be relevant to the ILBI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information and Data</td>
<td>Access to scientific research results, including:</td>
</tr>
<tr>
<td></td>
<td>- Academic peer-reviewed literature</td>
</tr>
<tr>
<td></td>
<td>- Research reports</td>
</tr>
<tr>
<td></td>
<td>- Biodiversity data</td>
</tr>
<tr>
<td></td>
<td>- Marine environmental data</td>
</tr>
<tr>
<td></td>
<td>- Molecular data</td>
</tr>
<tr>
<td></td>
<td>- Genetics data</td>
</tr>
<tr>
<td></td>
<td>Access to information about research activities, capacity building activities, including eg: research cruises</td>
</tr>
<tr>
<td>Expertise, knowledge,</td>
<td>Training courses, information products, workshops, in areas such as: taxonomy,</td>
</tr>
<tr>
<td>skills and methods</td>
<td>genetics, chemistry, oceanography, informatics, data management, ecology, biology,</td>
</tr>
<tr>
<td></td>
<td>sampling, research and development</td>
</tr>
<tr>
<td>Equipment</td>
<td>Observation and sampling in situ (remote sensors, observing systems, AUVs, ROVs)</td>
</tr>
<tr>
<td></td>
<td>Molecular tools (e.g. genomics, proteomics)</td>
</tr>
<tr>
<td></td>
<td>Analysis (e.g. data management, bioinformatics)</td>
</tr>
<tr>
<td></td>
<td>IT infrastructure</td>
</tr>
<tr>
<td>Computer software,</td>
<td>Biodiversity mapping</td>
</tr>
<tr>
<td>models and modelling techniques</td>
<td>Climate change modelling</td>
</tr>
<tr>
<td></td>
<td>Ocean circulation, pollution</td>
</tr>
<tr>
<td>Manuals, guidelines,</td>
<td>Sampling, storage and curation standards for biological samples</td>
</tr>
<tr>
<td>criteria, standards,</td>
<td>Biodiversity data management and interpretation</td>
</tr>
<tr>
<td>reference materials</td>
<td>Genetics and natural products chemistry research techniques</td>
</tr>
</tbody>
</table>

3.4. Discussion: implications for a new international legally binding instrument for ABNJ

The preceding analysis has demonstrated that science and technology are critical to deriving benefits from genetic resources. This Section examines the implications for the development of the ILBI. Challenges to identify a particular sector involved in sharing benefits from genetic resources of ABNJ are discussed in Section 3.4.1, and opportunities to support the conservation and sustainable use of marine biodiversity of ABNJ through an integrated approach are identified in Section 3.4.2.

3.4.1. Challenges

One of the first challenges facing the development of the ILBI is that, in a similar way that it is difficult to clearly define the material scope of genetic resources, it is difficult to define a particular activity or sector that would be regulated by new legislation.

3.4.1.1. Is there an activity to regulate?

The utilisation of marine genetic resources of ABNJ is often referred to as “bioprospecting”. However, the term is not defined in the LOSC, CBD, ITPGRFA or Nagoya Protocol. The Subsidiary Body on Scientific, Technical and Technological Advice (2003) for the CBD, described bioprospecting as: “the exploration of biodiversity for commercially valuable genetic and biochemical resources” and further “the process of gathering information from the biosphere on the molecular composition of genetic resources

94 See Section 2.2 of Chapter 2.
for the development of new commercial products”. According to this description, the development of commercial products is a characteristic of bioprospecting.

Ascertaining the current level of bioprospecting in ABNJ is complicated by a number of factors. As noted in Section 3.2.2, there are many challenges to developing a commercial product sourced from marine genetic resources of ABNJ. Furthermore, marine scientific research (specifically deep-sea scientific research) is at present the primary option for accessing marine genetic resources in ABNJ. More generally, the EU regulation No. 511/2014 recognises that the collection of genetic resources in situ is mostly undertaken for non-commercial purposes by academic, university and non-commercial researchers.

In the absence of a definition of marine scientific research under the LOSC, it is unclear how bioprospecting could be distinguished from scientific research. As observed by Scovazzi (2006), it is difficult–bordering on impossible–to distinguish bioprospecting from marine scientific research. The examination of the process of accessing and using marine genetic resources supports the argument that it is difficult to draw a line between bioprospecting and scientific research. Furthermore, science rarely operates in isolation and it is therefore difficult to regulate as isolated activity. The increasingly blurred line between pure/basic and applied/commercial research means that a commercial application could arise from research without it being the primary objective. This is a challenge for regulation in the context of marine genetic resources of ABNJ where a diverse range of actors and activities could be involved, and unforeseen commercial applications could result from serendipitous scientific discovery. Concerns that access and benefit-sharing regimes can negatively impact negatively

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97 Oldham et al, above n 42, 19.


99 See Section 5.2.2 of Chapter 5.


101 SBSTTA, above n 96, [50].
impact biodiversity research have been raised, for example, due to administrative burden on collections.\textsuperscript{102} The potential for blurred lines between public and private funding of research involving marine genetic resources of ABNJ and the legal and regulatory issues that could arise was noted by Glowka (1995, 1999 and 2010).\textsuperscript{103} The long-standing issues relating to the distinction between pure and applied research, and the potential negative impacts of such a legal distinction for scientific research, pose a challenge for the development of the ILBI.

One way of addressing this issue is to define and elaborate the activities (Table 3.5) and actors (Table 3.6) that are referred to or involved, based on existing definitions in international law. The merits of using existing definitions is reflected in the Chair’s non-Paper ahead of the fourth session of the PrepCom.\textsuperscript{104} However, a clear definition of terms and the formulation of legal provisions is a crucial influencing factor for subsequent implementation. Furthermore, other definitions of terms may be needed. For example, in addition to “technology”,\textsuperscript{105} the terms “science” and “innovation” are also relevant terms that are not defined in international law. Including some form of description of these terms in the ILBI could be useful to illustrate the nature of activities relevant to benefit-sharing of genetic resources of ABNJ. For example, highlighting the broad range of activities that could be considered as innovation, OECD (2012) defines “science” and “innovation” as follows:\textsuperscript{106}

- Science: “research, the main purpose of which is to generate knowledge to help to explain or understand natural or social phenomena and/or can assist human endeavor”.


\textsuperscript{103} See Glowka, above n 42.

\textsuperscript{104} Chair’s streamlined non-paper above n 92, 8.

\textsuperscript{105} Section 3.2.2.2.

\textsuperscript{106} OECD, above n 86, 39.
• Innovation: “the implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations”.

Table 3.5: Definitions of activities relating to genetic resources

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biotechnology</td>
<td>“(...) any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use...”</td>
<td>CBD art 2</td>
</tr>
<tr>
<td>Ex situ conservation</td>
<td>“the conservation of plant genetic resources for food and agriculture outside their natural habitat”</td>
<td>ITPGRFA art 2</td>
</tr>
<tr>
<td>Utilization of genetic</td>
<td>“(...) to conduct research and development on the genetic and/or biochemical composition of genetic resources, including through the application of biotechnology as defined in Article 2 of the Convention [on Biological Diversity]...”</td>
<td>Nagoya Protocol art 2(c)</td>
</tr>
</tbody>
</table>

Table 3.6: Definitions of actors relevant to genetic resources

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collection</td>
<td>“(...) a set of collected samples of genetic resources and related information that is accumulated and stored, whether held by public or private entities...”</td>
<td>EU Regulation 511/2014 article 3(9)</td>
</tr>
<tr>
<td>User</td>
<td>“(...) a natural or legal person that utilises genetic resources or traditional knowledge associated with genetic resources...”</td>
<td>EU Regulation 511/2014 article 3(4)</td>
</tr>
<tr>
<td>Essential regulatory laboratory</td>
<td>“...influenza laboratories designated by WHO located in, or associated with, national regulatory agencies and which have a critical role at the global level for developing, regulating and standardizing human influenza vaccines...”</td>
<td>PIP [4.3]</td>
</tr>
</tbody>
</table>

107 Note, the PIP framework [4.3] also defines “national influenza centres”, “other authorized laboratories”, “public health researchers” and “WHO GISRS”.

118
3.4.1.2. Is there a sector to regulate?

As discussed in Section 3.2, a number of different interlinked scientific research and development processes are involved in acquiring, sharing and utilising benefits. This further complicates attempts to identify a marine genetic resources sector. For example, it is difficult to define marine biotechnology as a sector. This is reflected in the following quote from the OECD (2013): 108

“Marine biotechnology is unlike other areas of biotechnology in that it is defined in terms of its source material, rather than the market it serves. It is best described as the use of marine organisms, at the whole, cell, or molecular level, to provide solutions, thereby benefiting society.”

Biotechnology is defined by the CBD as an application (Table 3.5). This highlights that biotechnology can be considered in the context of the conservation and sustainable use of biodiversity, as well as the sharing of benefits arising from the utilisation of genetic resources. However, caution is required. The need to take a realistic approach to considering the potential of biotechnology was recognised in the Rio Declaration on Environment and Development: “by itself, biotechnology cannot resolve all the fundamental problems of environment and development, so expectations need to be tempered by realism”. 109 Given this challenge it could be argued that biotechnology is useful as a framing concept that could inform the use of genetic resources, in order to support the conservation and sustainable use of biodiversity; however, the concept of a biotechnology sector is not useful in narrowing down the scope of benefit-sharing.

Marine bioprospecting, as an iterative, long and convoluted research and development process, 110 is different to other sectors involving the extraction and exploitation of living and

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108 OECD, above n 39.
110 Section 3.2.2.
non-living resources, such as minerals or fisheries.\textsuperscript{111} For example, although the word ‘resources’ is used in association with ‘marine genetic resources’ and ‘mineral resources’,\textsuperscript{112} they differ in terms of:

- Nature of the resource and the possible applications;
- Time required to produce an output of actual economic value;
- Cost of the activities;
- Breadth of different activities involved in production;
- Diversity of key players involved;
- Number and type of benefits that can be derived; and
- Scale of the benefits.

The activities involved in exploiting marine genetic resources in ABNJ usually begin with a by-product of serendipitous scientific discovery, the often accidental consequence of pure research in exploring the deep-sea.\textsuperscript{113} While there are some commercial activities involving marine genetic resources, these are usually small to medium sized enterprises focusing on a niche market exploiting genetic resources from within national jurisdiction.\textsuperscript{114} Whether there will be companies in future with specific expressed interest in marine genetic resources from ABNJ, remains unclear at this stage. Because marine genetic resources could have a range of different applications across a number of industries, and deliver various benefits to various actors at different stages of the process,\textsuperscript{115} defining a single sector or industry would be challenging. Instead, it is more accurately described as a complex series of research and development activities that could deliver a range of different benefits along the way.

\textsuperscript{111} Given the complexities inherent in adding value to a marine genetic resource, as described in Section 3.2.2, terms such as ‘biomining’ and ‘bioprospecting’ are in many ways misleading as they do not capture the research and development processes that are involved in utilising marine genetic resources.
\textsuperscript{112} LOSC art. 133 defines “resources” as all solid, liquid or gaseous mineral resources \textit{in situ} in the Area at or beneath the seabed, including polymetallic nodules. All resources recovered from the Area are referred to as ‘minerals’.
\textsuperscript{113} Section 2.5 of Chapter 2.
\textsuperscript{114} Section 2.4 of Chapter 2. One example of a company is PharmaMar, which is advertised as a leader in developing anticancer drugs of marine origin \url{http://www.pharmamar.com/} accessed 20/09/2014.
\textsuperscript{115} Section 3.2.2.
3.4.1.3. Further regulatory issues - traceability

From a research and development perspective, traceability is important to enable re-collection. From a legal and regulatory perspective, traceability is important to ascertain applicable legislation. However, in practice, tracing the origin of a biological sample, genetic sequence, or chemical compound is not straightforward,\(^{116}\) with gaps reported in both scientific papers relating to initial collection and in patent documents relating to subsequent inventions. The development of new sampling technologies could further complicate the issue of traceability. This in turn could pose a challenge to capturing and sharing benefits from marine genetic resources of ABNJ.

3.4.2. Opportunities: an integrated approach

It was suggested in Section 3.3.2 that marine genetic resources of ABNJ could be considered as having a number of overlapping potential and actual economic, environmental, scientific and social values. In this Section, three key areas where the development of the ILBI could foster an integrated approach to support the sharing of benefits are discussed:

- Sustaining value through conservation and capturing value through innovation (Section 3.4.2.1);
- Capturing value through capacity building and sharing benefits through science (Section 3.4.2.2); and
- Supporting benefit-sharing through science and technology by separating serendipitous scientific discoveries from strategic bi-\(^{116}\)

\(^{116}\) For example, some research papers relating to the collection and identification of deep sea organisms from which a natural product was derived lack depth information: Danielle Skropeta and Liangqian Wei, 'Recent Advances in Deep-Sea Natural Products' (2014) 31(8) Natural Product Reports 999. For a discussion on the need for better documentation on patent origins see for example Leary et al, above n 42.
3.4.2.1. Sustaining value through conservation and capturing value through technological innovation

Biodiversity conservation embodies the overlapping values of genetic resources. Capturing value from genetic resources depends on the continued existence of biological diversity, of which genetic resources are part. The conservation and sustainable use of genetic resources offers a multitude of potential benefits to society by preserving the economic, environmental, scientific and social value of genetic resources and enabling that value to be captured.

For example, the CBD acknowledges that “conservation and sustainable use of biological diversity is of critical importance for meeting the food, health and other needs of the growing world population, for which purpose access to and sharing of both genetic resources and technologies are essential” (emphasis added). The link between genetic resources and conservation is explicitly reflected through the concept of ecopharmacognosy. Natural products could have various societal roles that support sustainable development, such as healthcare or agricultural development, and require a series of sustainable actions to be put into practice. For example, Cordell (2017) highlights that 9000 medicinal plants are on the IUCN CITES threatened or endangered lists and advances a concept of “sustainable medicine” as a healthcare security issue. This supports the notion that an integrated approach linking conservation and sustainable use to the sharing of benefits from marine genetic resources of ABNJ is required.

3.4.2.2. Capturing value and sharing benefits through an integrated approach to scientific and technological capacity building

The examination in Section 3.2.2 of the process through which genetic resources can be accessed and used highlights the importance of scientific and technological capacity building.

117 See Section 2.2.2.3 of Chapter 2.
118 CBD Preamble.
119 This is defined by Cordell (2014) as “the study of sustainable natural product resources” in: G A Cordell, ‘Cognate and cognitive ecopharmacognosy — in an anthropogenic era’ (2017) 20 Phytochemistry Letters 540-549.
120 Ibid.
to capture the value of genetic resources. It has also been suggested that marine scientific research is currently the main activity involved in generating non-monetary benefits by publishing and sharing knowledge and data, enabling access to deep-sea samples of marine genetic resources through collections, and promoting international scientific cooperation.\footnote{See, eg: Oldham et al, above n 42, 19.}

The issue of ‘openness’ illustrates how scientific research and technology could be considered as an opportunity to share benefits from marine genetic resources and deliver various advantages for science and society.\footnote{Royal Society above n 71, 9.} According to the G7 (2013), openness accelerates the progress of scientific discovery, drives innovation, supports transparency and public engagement in science, and enables better international collaboration and coordination of research.\footnote{G8 Science Ministers Statement, 13 June 2013, \url{https://www.gov.uk/government/news/g8-science-ministers-statement}.} The G7 further acknowledged that the benefits of science, technology and innovation should be shared by society as a whole, and that the advancement of enabling technologies empower scientists and help bring prosperity to all.\footnote{Enabling technologies include information communication technologies (ICT). This echoes the G8 science ministers statement, which recognised that “open enquiry is at the heart of scientific endeavour” and that rapid technological change has profound implications for the conduct of science and transmission of results. Ibid.} The G7 have called for “Inclusive Innovation” and “Open Science”\footnote{G7 Science and Technology Ministers Meeting, 15-17 May 2016, Tsukuba, Communique, (Science and Technology Ministers of Canada, France, Germany, Italy, Japan, the United Kingdom, the United States, and the European Commissioner for Research, Science and Innovation, 2016).} to be reflected in all science, technology and innovation priorities including the future of seas and oceans, in order to address key challenges.\footnote{Ibid.} This statement reiterated the 2013 commitment to openness and transparency in science and public participation and to expanded access to research results.\footnote{See, eg: Oldham et al, above n 42, 19.} Open access also supports ‘responsible innovation’, whereby the outcomes of publicly funded science support the wellbeing and prosperity of the public.\footnote{G8 Science Ministers Statement, above n 123.}

For example open access to data and samples, brings a number of technology transfer advantages for both ‘pure’ and ‘applied’ research. Open science is fast becoming a prevalent,\footnote{Jack Stilgoe, Richard Owen, Phil Macnaghten, ‘Developing a framework for responsible innovation’, 42(9) Research Policy 1568-1580; Geetha Sugumaran, ‘Open Source Drug Discovery - redefining IPR through open source innovations’ (2012) 102(12) Current Science 1637-1639.}
and in some cases preferred, method in research and development for plant genetic resources,\(^{129}\) neglected tropical diseases,\(^{130}\) and synthetic biology.\(^{131}\) As noted by Todd (2007), “the iterative improvement of the route to a drug that is of great importance to underdeveloped countries is of little interest to for-profit companies, but neither is it a priority for academia - we see open source collaboration as the only way to make research challenges like this tractable”.\(^{132}\)

Open access can be considered as a modality for sharing benefits from marine genetic resources of ABNJ. The role of knowledge networks in benefit-sharing is, according to Bohm and Collen (2015), important to achieve technology transfer and benefit-sharing of genetic resources through equality of biodiversity knowledge, as well as for sustainable development more generally.\(^{133}\) Publishing data enables reproducibility of results, underpinning scientific excellence,\(^{134}\) and widening the available pool of scientific effort on particular data-sets – a growing necessity as volumes of genetic and open ocean data grow. Similarly, sharing samples of marine genetic resources of ABNJ is crucial to keep the pipeline of scientific knowledge flowing and support research integration.\(^{135}\) Technology development and transfer can drive sustainable development, including by spreading new capabilities and developing capacity.\(^{136}\) For example, according to Cordell (2017), open access and international collaboration relating to genetic resources supports global healthcare and there four broad requirements for science to benefit society:\(^{137}\)

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\(^{130}\) See, eg: Sugumaran, above n 128; Wesley C Van Voorhis et al, 'Open Source Drug Discovery with the Malaria Box Compound Collection for Neglected Diseases and Beyond' (2016) 12(7) PLoS Pathogens.

\(^{131}\) Denisa Kera, 'Innovation regimes based on collaborative and global tinkering: Synthetic biology and nanotechnology in the hackerspaces' (2014) 37 Technology in Society 28-37.


\(^{133}\) Böhm and Collen, above n 88.

\(^{134}\) See, eg: Woelfe et al, above n 132.


\(^{137}\) Cordell, above n 119.
• Strategy based on information resources and societal objectives;
• Analytical tools to process the available resource data for optimal decision-making;
• Cognitive, secure computing with global access; and
• Effective mechanisms to translate beneficial results into finished products [for global healthcare].

These examples are relevant to the issue of benefit-sharing of ABNJ. A further consideration, however, is that capacity building, technology transfer, and international science collaboration should be considered holistically. This summarised by Martin Rees, the then President of the UK Royal Society, (2008):

“Many of the challenges that science faces today (…) are global in nature and require a global response. These factors make international collaboration in science more important than ever. Yet, successful collaboration depends on all parties having a certain level of scientific and technological capacity. (…) International projects in science must address both local needs and global concerns. Institutions in the North that are hoping to help their colleagues in the South should focus their efforts on training, international exchange and infrastructure development.”\textsuperscript{138}

Drawing on the aforementioned examples, it could be suggested that access to technology (e.g. analytical tools, laboratory equipment, or computing tools), data, information, and knowledge (e.g. sample collection, storage, and curation) could be considered as a form of technology transfer and an enabler of benefit-sharing from marine genetic resources of ABNJ. These issues will be discussed in detail in Chapter 6. However, while open access could be a benefit, it can only be captured if there is corresponding capacity to harness it. If there is insufficient capacity, then international cooperation will be required to build the needed human, technical or institutional capacity to utilise the technology and truly benefit

\textsuperscript{138} Martin Rees, ‘International collaboration is part of science's DNA’ (2008) 465 Nature 31 doi:10.1038/twas08.31b.
from genetic resources. As such, an integrated approach considering international science cooperation, technology transfer and capacity building together is needed.

3.4.2.3. Serendipity and strategy

There are a very wide range of scientific activities and actors that could be considered as involved in marine genetic resources research.\textsuperscript{139} Discoveries of commercially valuable elements relating to genetic resources can arise serendipitously from scientific research that did not include biodiscovery as a key aim. An example of this is the 1970s discovery of hydrothermal vents and “black smokers” by researchers in the submersible \textit{Alvin},\textsuperscript{140} which opened up new opportunities to understand the origins of life,\textsuperscript{141} and paved the way for isolation of a compound, abyssine, that is now used in a cosmetic product.\textsuperscript{142} Conversely, research with a specific commercial aim could generate scientific knowledge. There could be a need to differentiate between serendipitous scientific discoveries and strategic biodiscovery in a future regime for the sharing of benefits from marine genetic resources. However, as discussed in Section 3.4.1 of this Chapter and Section 5.2 of Chapter 5, drawing this distinction could be challenging, given the reality of scientific investigation whereby different applications could arguably be as likely to result from serendipitous scientific research or strategic commercial exploitation.

One approach to support the capture of value from genetic resources through both serendipitous scientific discovery and strategic biodiscovery could be through separate incentives for marine scientific research and research-business partnerships. According to OECD (2013), given that marine biotechnology can be used in different industries (from pharmaceuticals to food), “different types of industry incentives and partnership strategies to foster the effective development and diffusion of technology” will be required.\textsuperscript{143} Other

\textsuperscript{139} Section 3.3.2.
\textsuperscript{141} Alex D Rogers et al, 'The Discovery of New Deep-Sea Hydrothermal Vent Communities in the Southern Ocean and Implications for Biogeography' (2012) 10(1) \textit{PLoS Biol} e1001234. See also Ballard, ibid.
\textsuperscript{142} See Section 2.6.2 of Chapter 2.
incentives could support interdisciplinary research, including for linking deep-sea research and natural products research. The importance of involving a range of stakeholders to harness scientific research for the conservation and sustainable use of genetic resources is also recognised by the Forest Genetic Resources Plan. This suggests that engaging the full breadth of actors involved in the use of marine genetic resources in the development of the ILBI could promote measures and incentives relating to basic scientific research as well as applied biodiscovery activities that are fit for the purposes of benefit-sharing and the conservation and sustainable use of marine biodiversity of ABNJ.

3.5. Conclusion

This Chapter has examined the potential benefits from marine genetic resources of ABNJ, highlighting the pivotal role of science and technology in the processes through which benefits can be derived, shared and utilised. The analysis has been demonstrated that the process of capturing value by accessing and using marine genetic resources of ABNJ is dependent on scientific research and technology. Various different benefits could accrue to different actors at different stages of scientific research and development; financial benefits are not guaranteed and face many barriers. Many benefits are by-products of the scientific research endeavour, such as scientific knowledge of marine life, biological samples, data, and research methodologies, tools and techniques. The analysis has also illustrated that benefits are indirectly or directly linked to science cooperation, the development and transfer of technology, and capacity building. Therefore, there are synergies between benefit-sharing and, more broadly, technology transfer and capacity building for the conservation and sustainable use of biodiversity of ABNJ.

Based on an analysis of international legal instruments relating to genetic resources, a conceptual framework for considering benefits from marine genetic resources of ABNJ has been established in this Chapter. The framework rests on three elements: 1) scientific

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144 Snelgrove, above n 22. See also Section 2.5.2 of Chapter 2.
research cooperation; 2) technology transfer, including the sharing of research outcomes such as data and knowledge; and 3) capacity building. This framework is inspired by the benefit-sharing system established by the ITPGRFA. It has been suggested that these elements are interlinked, and need to be considered as connected.

It is suggested that the development of the ILBI could recognise the synergies between benefit-sharing and science cooperation, technology transfer and capacity building, by fostering integration in three ways. Firstly, by sustaining and capturing the value of genetic resources through the conservation and sustainable use of marine biodiversity of ABNJ. Secondly, by enabling the capture of value through capacity building and sharing benefits through science cooperation, the development and transfer of technology, and capacity building. Thirdly, by recognising the need for different incentives and enabling measures for both serendipitous scientific discoveries and for strategic bioprospecting activities in order to maximise benefit-sharing opportunities. However, to avoid potential regulatory challenges arising from the lack of distinction between ‘pure’ and ‘applied research’, clarity and specificity of terminology could be necessary. In Chapter 4, the issue of benefit-sharing is examined.
Chapter 4
An integrated approach to benefit-sharing: principles, precedent and pragmatism

4.1. Introduction

In this Chapter, principles and approaches for sharing benefits from marine genetic resources of areas beyond national jurisdiction (ABNJ) are examined. In Chapter 3, the potential benefits from marine genetic resources of ABNJ were analysed, highlighting that scientific and technological capacity is critical for acquiring, sharing and utilising benefits. A framework comprised of three interlinked elements was established for the purposes of considering benefits in this thesis: 1) scientific research cooperation; 2) technology transfer, including the sharing of research outcomes such as data and knowledge; and 3) scientific and technological capacity building. To establish whether this is a viable framework for addressing the question of benefit-sharing from marine genetic resources of ABNJ, it is necessary to investigate the role of these elements in the international legal and policy framework.

Therefore, the concept of benefit-sharing is introduced in Section 4.2, and some guiding principles and approaches are considered. Following the conclusion of Chapter 3, the focus of this analysis is on the role of an integrated approach to science cooperation, technology transfer and capacity building in achieving benefit-sharing of marine genetic resources of ABNJ. The ways in the three benefit-sharing elements have been elaborated through international legal instruments relevant to genetic resources and ABNJ are then examined in Section 4.3.\(^1\) By comparing and contrasting the measures adopted in international legal

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instruments, potential features of an integrated approach to benefit-sharing through science cooperation, technology transfer and capacity building are identified in Section 4.4.

4.2. The benefit-sharing concept: from principles to pragmatism

This Section examines the meaning and potential interpretations of the “term” benefit-sharing in Section 4.2.1, highlighting science cooperation, technology transfer and capacity building as components of benefit-sharing. Guiding principles and approaches for benefit-sharing are then discussed in Section 4.2.2, including equity, equitability and sustainable development. Considering the links between science, technology transfer and capacity building, the potential for an integrated approach to benefit-sharing is further examined in Section 4.2.3.

4.2.1. Defining benefit-sharing

Benefit-sharing is not clearly defined in international law.² According to Schroeder (2007), “benefit-sharing” can be defined as the action of giving a portion of advantages and profits to others.³ The notion of the ‘action of giving’ implies a one-way donation. One dictionary definition of “share” is “to divide and distribute”. This supports an interpretation that benefit-sharing is a ‘one-way’ activity to assign or apportion benefits to an identified beneficiary.⁴

Another dictionary definition of “share” is “to partake of, use, experience, occupy or enjoy with others”⁵ or to “have a portion of part of something with another or others”.⁶ This suggests that the meaning of “benefit-sharing” could also be considered to be a collective,

² The terms ‘benefit-sharing’ or ‘sharing of benefits’ are not defined in the LOSC, or in the following international legal instruments that are concerned with benefit-sharing: International Treaty on Plant Genetic Resources for Food and Agriculture, opened for signature 3 November 2001, 2400 UNTS 303 (entered into force 29 June 2004); Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity, opened for signature 29 October 2010 (entered into force 12 October 2014); Convention on Biological Diversity, opened for signature 5 June 1992, 1760 UNTS 79 (entered into force 29 December 1993); and Pandemic Influenza Preparedness Framework for the sharing of influenza viruses and access to vaccines and other benefits (PIP Framework) adopted by World Health Assembly, ‘Pandemic Influenza Preparedness Framework’, WHA64.5, 64th sess, Agenda Item 13.1 (24 May 2011).
⁵ Ibid.
active, continuous and cooperative activity. For example, the multi-way knowledge exchange relating to marine life is collective and cooperative because it involves multiple actors engaging to produce and share scientific knowledge.\(^7\) Scientific knowledge exchange is also often continuous by forming an iterative process which delivers potential flow-on benefits through research and development feedback mechanisms. Following this interpretation, benefit-sharing could be considered as a ‘multi-way’ activity. The synergies between marine technology and benefits from genetic resources, as demonstrated in Chapter 3,\(^8\) illustrate the potential iterative feedback mechanisms from benefit-sharing.

Considering the cooperation and collaboration that is required to derive, share and use benefits from marine genetic resources of ABNJ,\(^9\) the ‘one-way’ notion of benefit-sharing is arguably too simplistic. The ‘multi-way’ notion is more accurate and has the advantage of capturing the interlinkages between various overlapping benefits, for example scientific benefits such as knowledge could lead to societal and economic benefits through biotechnology development.\(^10\) The following Section explores this further.

4.2.2. Principles behind benefit-sharing: equity, equitability and sustainable development

The Report of the Preparatory Committee established by United Nations General Assembly resolution 69/292 (PrepCom report) identified two guiding principles and approaches for benefit-sharing of marine genetic resources of ABNJ that could be included in the ILBI:\(^11\)

- “Being beneficial to current and future generations”; and

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\(^7\) See Section 2.5.3 of Chapter 2 and Section 3.2 of Chapter 3 for a discussion of the role of marine scientific research in accessing marine genetic resources of ABNJ, and of the role of knowledge exchange as a form of benefit-sharing.

\(^8\) See Section 3.3.3 of Chapter 3.

\(^9\) Ibid.

\(^10\) Ibid.

“Promoting marine scientific research and development”.

The first point echoes the closing paragraph in the Preamble of the 1992 Convention on Biological Diversity (CBD) that refers to the conservation and sustainable use of biological diversity “for the benefit of present and future generations”. Although the PrepCom report does not explicitly refer to equity or equitability, the notion of “being beneficial to current and future generations” has connotations of equity, equitability and sustainable development: being beneficial to future generations could be considered as inter-generational equity, being beneficial to present generations could be considered as intra-generational equity and equitability. These are discussed in the remainder of this sub-Section, in order to explore possible principles and approaches behind benefit-sharing.

Inter-generational equity captures the concept that humankind has a duty to safeguard and preserve natural resources for the benefit of future generations; it enshrines the notion that future generations have rights, and that present generations have responsibilities. According to Brunee (2008) “As members of the present generation, we are both trustees, responsible for the robustness and integrity of our planet, and beneficiaries, with the right to use and benefit from it for ourselves.” Science can also be considered as inter-generational, as observed by Brown Weiss (1992).

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12 CBD, above n 2, Preamble [25].
13 See, eg: Elisa Morgera, Conceptualizing Benefit-Sharing as the Pursuit of Equity in Addressing Global Environmental Challenges (Edinburgh School of Law, 2014).
17 Brown-Weiss, above n 15, observed that “long-term scientific research and development is part of an intergenerational strategy”. 

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The importance of integrating science cooperation, data access and capacity building to achieve equity is reflected in the International Council for Science (ICSU) Principle of Universality of Science. The ICSU Principle of Universality of Science promotes “a truly global scientific community on the basis of equity and non-discrimination” and reflects the need for access to data to be coupled with capacity building. Furthermore, the ICSU World Data System aims to “promote universal and equitable access to quality-assured scientific data, data services, products and information, with a view towards long term data stewardship”. This suggests that scientific actors consider there is a role for scientific cooperation in achieving equity through the development of common, globally interoperable distributed data systems.

The equitable use of resources is one way to achieve sharing of benefits within the current generation, and is a critical ingredient for intra-generational equity. Equitability is enshrined in all international legal instruments concerning genetic resources. For example, the objectives of the CBD include the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources. The significance of equitability in benefit-sharing is reflected in the 2010 Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilization to the Convention on Biological Diversity (Nagoya Protocol). The 2001 International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) recognises the right of farmers to equitably participate in sharing benefits arising from the utilisation of [genetic resources].

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20 Second Polar Data Forum “International Collaboration for Advancing Polar Data Access and Preservation” – Communique. 27-29 October 2015, Waterloo, Ontario, Canada, available at https://6ec11f60-a-62cb3a1a-sites.googlegroups.com/site/polardataforum/programme/PDFII_Communique_FINAL.pdf?attachauth=ANoY7c_psmVOr61Q8xoYfWDaCDM53Tve6A1yw7Q_DOTo_qqY_gNMA820eAO8K7ihpZjAgeUpC12w8sm3zh3W78W0UTGIdhAYhCbsK2Cu2TuLVX3ShIKGAZ28xAXNklSLk2YfTDVNLEn9AJTldhlEs8f66Mloq4YGiSMpWHx1w5xPi5-pqEeidOUZv69u7mE8w15Zh3KZxElOEFZ6YbPwct1FGFOfZh_nWExJRNA4Q6JriIRmeuUdYWwS7O6fY35S1eVB&attredirects=0 accessed 12/05/2016.
21 Sands, above n 15, 263.
22 CBD, art 1.
23 Nagoya Protocol, above n 2.
24 ITPGRFA, ibid.
25 ITPGRFA, art 9.2(b).
objectives of the Pandemic Influenza Preparedness Framework for the sharing of influenza viruses and access to vaccines and other benefits (PIP framework)\textsuperscript{26} include the strengthening of a “fair, transparent, equitable, efficient, effective system” for sharing influenza viruses with human pandemic potential and access to vaccines and sharing of other benefits.\textsuperscript{27}

Equitability is also enshrined in the international law of the sea. For example, references to equitability can be found in Part XIV of the 1982 United Nations Convention on the Law of the Sea (LOSC),\textsuperscript{28} in relation to the rights and responsibilities associated with technology and technology transfer.\textsuperscript{29} The equitable sharing of benefits arising from the use of marine resources was a key motivation behind the concept of common heritage of mankind.\textsuperscript{30} For example, LOSC Article 140 refers to the equitable sharing of financial and other economic benefits.\textsuperscript{31}

The role of science and technology in achieving equitability is broadly referred to in the LOSC Preamble, which recognises that the “study, protection and preservation of the marine environment”\textsuperscript{32} will contribute to a “just and equitable international economic order which takes into account the interests and needs of mankind as a whole and, in particular, the special interests and needs of developing countries, whether coastal or landlocked.”\textsuperscript{33} International

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\textsuperscript{26} PIP Framework, above n 2.
\textsuperscript{27} PIP Framework, [2].
\textsuperscript{28} LOSC, above n 1.
\textsuperscript{29} See, eg: LOSC art 266(3) calls on States to “foster favourable economic and legal conditions for the transfer of marine technology for the benefit of all parties concerned on an equitable basis” (emphasis added). This is echoed in Article 269(b), which identifies the promotion of “favourable conditions for the conclusion of agreements, contracts and other similar arrangements, under equitable and reasonable conditions” (emphasis added) as a measure to achieve the objectives of Part XIV. See Section 5.3 of Chapter 5 for a critical analysis of the framework for the development and transfer of marine technology established by Part XIV of the LOSC.
\textsuperscript{31} Ibid.
\textsuperscript{32} LOSC Preamble [3].
\textsuperscript{33} LOSC Preamble [4]. Note that the new international economic order is linked to the notion of sharing benefits and transferring technology in the context of Part XI and was one of the issues of contention leading to the adoption of the 1994 Implementing Agreement. See Section 5.3.1 of Chapter 5.
cooperation, access to research outcomes and capacity building are framed as benefits from science and technology in the LOSC.\(^34\)

The role of science, technology and capacity building in achieving equity and equitability through benefit-sharing will be examined in Section 4.2.3. The following discussion considers the broader concept of sustainable development. The PrepCom report recognised sustainable development as a guiding principle or approach for the conservation and sustainable use of biodiversity that that could be included in the ILBI.\(^35\) According to Sands (2012), sustainable development comprises four interrelated legal principles, including equity:\(^36\)

- Intergenerational equity;
- Intra-generational equity or equitable use;
- Sustainable use; and
- Integration.

Sustainable development has been recognised since the late nineteenth century.\(^37\) According to Brown Weiss (1992) sustainable development can be considered as an ethical and philosophical commitment to equity with future generations.\(^38\) The relevance of the principle of sustainable development for ABNJ is discussed by Freestone (2009) and Oude-Elferink (2012).\(^39\) Sustainable development is defined in the 1987 report of the World Commission on Environment and Development (Brundtland report), as:

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\(^34\) *LOSC* art 143 recognises three broad requirements for international cooperation in marine scientific research programmes to be for “the benefit of developing States and technologically less developed States”: i) strengthening their research capabilities; ii) training their personnel and the personnel of the Authority in the techniques and applications of research; iii) fostering the employment of their qualified personnel in research in the Area. For a discussion see See Section 5.2.1 and 5.3 of Chapter 5.

\(^35\) PrepCom report, above n 11, 9 [III(1)].

\(^36\) Sands, above n 15, 253

\(^37\) See, eg: Ibid, 252.

\(^38\) Weiss, above n 15.

“Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.”

This definition highlights the role of technology and also points to the significance of technological needs and limitations. The role of science and technology in sustainable development is further examined in Section 4.2.3. First, the concept of integration is introduced.

The PrepCom report recognised the integrated approach as a guiding principle or approach for the conservation and sustainable use of marine biodiversity of ABNJ that could be included in the ILBI. According to Sands (2012), integration is about achieving a balance between competing needs, as reflected in the term “conservation and sustainable use”. For example: the integration of environmental considerations into economic and other plans; and the integration of social and economic development needs into the implementation of environmental obligations.

There could be many aspects of integration.

One concept of integration is that benefit-sharing can be achieved through a holistic approach linking science cooperation, technology transfer, and capacity building. This notion of integration, is explicitly articulated in the ITPGRFA Article 5.1, which calls on Parties to cooperate to “promote an integrated approach to exploration, conservation and sustainable use of [genetic resources]” including through surveys, collection of samples and associated information and metadata. A second reference to an integrated approach can be found in ITPGRFA Article 7.1, which concerns national commitments for integrating activities

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41 PrepCom report, above n 11, 9, [III(1)].
42 Sands, above n 15, 266.
43 ITPGRFA art 5.1.
relating to Conservation, Exploration, Collection, Characterization, Evaluation and Documentation and sustainable use of genetic resources in national policies and programmes.

This interpretation of integration captures the links between the elements of benefit-sharing considered in this thesis; sharing benefits from marine genetic resources can be progressed through scientific investigation, technology transfer and capacity building. This also suggests that integrating a suite of complementary benefit-sharing measures, such as the advancement of knowledge and the development of scientific and technological capacity, can support a common goal of the conservation and sustainable use of biodiversity. For example, the importance of technology transfer and international cooperation to build research and innovation capacity for adding value to genetic resources for developing countries is recognised in the Preamble to the Nagoya Protocol. This suggests that an integrated approach to the investigation, conservation and sustainable use of genetic resources could foster potential spill-over benefits whereby technology could be applied for broader purposes relating to the conservation and sustainable use of biodiversity.

An integrated approach to benefit-sharing through science cooperation, technology transfer and capacity building could promote sustainable development through equity, equitability, conservation and sustainable use of marine genetic resources of ABNJ. For example, conserving and sustainably using marine genetic resources, as part of biodiversity, of ABNJ would support the application of inter-generational equity, by preserving the resource for future generations. The implementation of benefit-sharing measures, including through science, technology transfer and capacity building, would support intra-generational equity by enabling current generations to participate in the conservation and sustainable use of the resource. The concept of an integrated approach to benefit-sharing is explored further in the following Section.

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44 i.e. *ITPRFRA* art 5.
45 i.e. *ITPRFRA* art 6.
46 See Section 2.2 of Chapter 2.
47 For a discussion of the link between equity and benefit-sharing, see: Bourrel et al, above n 30.
4.2.3. Science, technology and capacity building: the basis for an integrated approach?

Science, technology and international research cooperation is a requirement for sustainable development. The importance of technology transfer and scientific capacity building to implement the LOSC and benefit from sustainable development has been recognised in several UNGA resolutions. The importance of research cooperation and scientific and technological capacity building, including the creation of research and technological infrastructure, to accumulate biological knowledge and preserve genetic diversity in sustainable development was recognised in the Brundtland report.49 The general duty to cooperate is recognised in the 1970 General Assembly Declaration on Principles of International Law,50 which states that “all States have the duty to cooperate with one another…to maintain international peace and security and to promote international economic stability and progress…”. The same declaration explicitly recognised the duty of states to cooperate in the field of science and technology and also specifies the importance of promoting economic growth in developing countries.51

The need to apply science and technology for “economic and social development” to address environmental problems and for “the common good of mankind” was recognised in Principle 18 of the 1972 Declaration of the United Nations Conference on the Human Environment (Stockholm Declaration).52 Principle 20 recognised the importance of promoting scientific research and development, however, there was no explicit mention of international cooperation in science and technology. Twenty years later, the 1992 Rio Declaration on Environment and Development (Rio Declaration) recognised the need for international cooperation in science and technology, with Principle 9 referring to the need for international

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49 Brundtland report, above n 40, 78 [71]. The report also states that the “equitable sharing and widespread diffusion of the technologies” can be facilitated through cooperative research ventures.
51 Ibid.
cooperation to improve scientific understanding as a mode of capacity building. A further two decades on, following the 2012 United Nations Conference on Sustainable Development, the importance of cooperation in marine scientific research to implement the provisions of the LOSC was recognised in “The future we want”. These declarations illustrate a long-held recognition of the role of international cooperation in scientific research, technology transfer and capacity building into the global sustainable development agenda. Soft law declarations such as these, are potentially significant sources of international law that could guide, influence and shape State practice. However, these declarations are solely aspirational and are not legally binding.

The importance of these elements is summarised in United Nations Sustainable Development Goal 14 *Conserve and sustainably use the oceans, seas and marine resources for sustainable development*; Target 14a of this goal highlights the need to increase scientific knowledge, develop research capacity and transfer marine technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to sustainable development. Similarly, an outcome of benefit-sharing could be to enhance the contribution of marine biodiversity of ABNJ to sustainable development.

Research capacity is a critical issue for achieving equitability in ABNJ. As noted by Brunnee (2008) “While open access, in legal terms, means equal access of all states, in practical terms, access tends to correspond to states’ technological and financial resources”. This highlights the importance of technological capacity to enjoy rights such as freedom of the high seas in

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55 For a discussion on international cooperation as customary international law, see Sands, above n 15, 250.
56 For a discussion on the implementation of international scientific cooperation, the sharing of data and information, and capacity building in practice, see Chapter 6.
58 Brunnee, above n 16. See also, for a discussion on the principle of sustainable development in the law of the sea, Oude Elferink, above n 235.
The importance of scientific collaboration, sharing data and knowledge for benefit-sharing to support the conservation and sustainable use of biodiversity and satisfy the obligation for scientific research in the Area to be for the benefit of mankind is discussed by Ridings (2018). These issues are highly applicable to marine genetic resources in ABNJ, as illustrated in Chapter 3. Scientific research cooperation, sharing of the outcomes of scientific research and the development of capacity to make use of those outcomes (including access to knowledge and data and the transfer of technology, and the development of scientific capacity), are widely considered as conceptual pillars of the international framework for sharing benefits from genetic resources.

Indeed, scientific research and development, technology and knowledge exchange and capacity building are considered together in several international legal instruments related to the conservation and sustainable use of genetic resources. For example strengthened research capacity to enhance and conserve biological diversity is a priority under the ITPGRFA regime for the sustainable use of genetic resources. The Nagoya Protocol recognises the important contribution to sustainable development made by technology transfer and

59 LOSC, art 87. See Section 5.2 of Chapter 5 for a critical analysis of the LOSC framework for marine scientific research, including in the high seas.


62 ITPGRFA art 6.2(b).
cooperation to build research and innovation capacities for adding value to genetic resources in developing countries. It also recognises that technology transfer, collaboration and cooperation incorporates scientific research and development and capacity building. The CBD highlights the promotion of scientific and technical cooperation, includes special attention to development and strengthening of national capabilities, through human and institution building, and for the development and use of technology. The 2002 Bonn Guidelines on Access to Genetic Resources and Fair and Equitable Sharing of the Benefits Arising out of Their Utilization, reflect the interconnections between science and technology, stating that “mechanisms for sharing benefits should include full cooperation in scientific research and technology development.

These examples highlight one aspect of integration for benefit-sharing: that benefit-sharing and the conservation and sustainable use of biodiversity should be considered holistically (Figure 4.1). As noted in Chapter 2, the conservation and sustainable use of biological diversity are considered together with the sharing of benefits from genetic resources in the CBD, Nagoya Protocol and ITPGRFA. The CBD and Nagoya Protocol refer to the importance of benefit-sharing in creating incentives for conservation and sustainable use of biodiversity. Sharing benefits from marine genetic resources of ABNJ could be considered as a way to create incentives for the conservation and sustainable use of biodiversity. In turn, one form of incentive could be measures to achieve research cooperation, scientific capacity building and technology to advance knowledge of marine life of ABNJ. Furthermore, by strengthening the system for global science in an integrated manner, there can be broader

63 Nagoya Protocol Preamble. CBD arts 16 and 19.
64 Nagoya Protocol art 23 provides an obligation for Parties to cooperate and collaborate in technical and scientific research and development programs, in order to enable the development and strengthening of a sound and viable technological and scientific base. This builds on CBD arts 15 (access to genetic resources), 16 (access to and transfer of technology), 18 (technical and scientific cooperation), and 19 (handling of biotechnology and distribution of its benefits).
65 CBD art 18(1).
66 CBD art 18(2).
67 CBD art 18(4). See also CBD art 17 (exchange of information about training programs as well as results of research).
69 Ibid [50].
70 CBD art 11.
71 Nagoya Protocol, Preamble.
flow-on benefits. For example, the potential for the development of the ILBI to strengthen capacity building for sustainable development in general has been recognised by New Zealand, Australia and the European Union (EU). Figure 4.1 provides a conceptual illustration of the interconnectivity between scientific research cooperation, technology transfer and scientific capacity building which, as the foregoing discussion has shown, is enshrined in several international legal instruments.

**Figure 4.1: Integrated measures for conservation, sustainable use and benefit-sharing of genetic resources.**

This Section has demonstrated the role of science and technology in achieving equity through sustainable development. It has also introduced the role of science and technology in sharing...
benefits from genetic resources. It has been suggested that an integrated approach to benefit-sharing that builds scientific and technological capacity could support achieving equity through sustainable development. The following Section examines how an integrated approach to benefit-sharing has been adopted through several international agreements.

4.3. Precedent

The aim of this Section is to examine a range of international legal instruments to ascertain if and how measures relevant to benefit-sharing have been elaborated. 76 International legal instruments of relevance to genetic resources are examined in Section 4.3.1, instruments relevant to ABNJ are considered in Section 4.3.2. Adhering to the framework for benefit-sharing established in Chapter 3, this analysis focuses on:

- International scientific research cooperation (see also Table 4.1);
- Technology transfer, including sharing of information, data and knowledge (see also Table 4.2); and
- Scientific and technological capacity building.

4.3.1. International legal instruments: genetic resources

This Section considers the following international legal instruments concerning genetic resources and highlights examples of measures relevant to benefit-sharing that have been elaborated:

- CBD
- Nagoya Protocol

76 It is acknowledged that provisions in international legal instruments are not, by themselves alone, strong evidence of the customary international law status of the duty to cooperate in science and technology. It is beyond the scope of this chapter to examine whether or not the duty to cooperate in marine scientific research and technology transfer is part of customary international law. Rather, the purpose of this analysis is to ascertain if, and more importantly, how, provisions for science and technology have been elaborated and what types of measures are incorporated in the various legal frameworks to implement scientific research cooperation and technology transfer.
4.3.1.1. CBD

The CBD created an international framework for the conservation and sustainable use of biodiversity and the sharing of benefits from genetic resources, applicable to areas within national jurisdiction. The objectives of the CBD recognise the interconnections between benefit-sharing of genetic resources and technology transfer:

“(….) fair and equitable sharing of the benefits arising out of the utilisation of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding (…).”

Under the CBD, contracting States have an obligation to facilitate access to genetic resources and technology. The CBD contains provisions for research and training, particularly in developing countries, exchange of information, technical and scientific cooperation, and the handling of biotechnology and distribution of its benefits. The latter includes provisions relating to the translation of benefits to the ‘provider’ country, such as: legislative, administrative or policy measures to provide for the effective participation in biotechnological research activities, especially of developing countries; and the promotion and advancement of priority access on a fair and equitable basis to results and benefits arising

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77 CBD art 1.
78 CBD art 15(b). However, this only applies where the genetic resources provided by the States that are countries of origin or have acquired the genetic resource in accordance with the CBD (CBD art 15(c)). CBD art 16 contains provisions for facilitating access to and transfer of technology, including biotechnology. Under CBD art 2 technology includes biotechnology.
79 CBD art 12(a).
80 CBD art 17.
81 CBD art 18.
82 CBD art 19.
83 CBD art 19(1).
from biotechnologies based upon genetic resources. The CBD also specified a financial and institutional mechanism to support the implementation of treaty objectives.

4.3.1.2. Nagoya Protocol

The Nagoya Protocol establishes a legally binding international framework for accessing, using and sharing genetic resources from areas within national jurisdiction. It is the instrument implementing the access and benefit-sharing provisions of the CBD, which it seeks to advance by “providing greater legal certainty and transparency for both providers and users of genetic resources”. The Nagoya Protocol aims to create incentives to conserve and sustainably use biological diversity and further enhance the contribution of biological diversity to sustainable development and human well-being through promoting the use of genetic resources and associated traditional knowledge and by strengthening the opportunities for fair and equitable sharing of benefits from their use.

The fact that the Nagoya Protocol is based on a bilateral situation whereby there is a ‘provider’ State and a ‘user’ State means that it is not applicable in ABNJ. The European Union (EU) regulation, one of the first pieces of legislation to be adopted on compliance

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84 CBD art 19(2).
85 The financial mechanism under the CBD also applies to the Nagoya Protocol, Nagoya Protocol art 25.
86 CBD arts 16(2), 20 and 21.
87 Developed after the World Summit on Sustainable Development (Johannesburg, September 2002) called for the negotiation of an international regime within the framework of the CBD to promote and safeguard the fair and equitable sharing of benefits arising from the utilisation of genetic resources – one of the three objectives of the CBD. Nagoya Protocol Introduction.
89 Nagoya Protocol Introduction.
90 It should be recognised that the need to develop an innovative new model for transboundary situations is recognised in Nagoya Protocol art 10: “Recognizing that an innovative solution is required to address the fair and equitable sharing of benefits derived from the utilization of genetic resources and traditional knowledge associated with genetic resources that occur in transboundary situations or for which it is not possible to grant or obtain prior informed consent.” This is foreshadowed in NP Preamble [13]. However, while this highlights a recognition of potential problems by States, it is not clear that this would provide any basis for ABNJ. Although, on the other hand, an integrated approach for BBNJ could provide an implementation for a “global multilateral benefit-sharing mechanism” as per article 10 of Nagoya Protocol, because ‘granting or obtaining prior informed consent’ in ABNJ is currently not applicable; and the benefits shared by users of MGR in ABNJ through the benefit-sharing system being proposed in this thesis could be used to support the conservation of biological diversity and the sustainable use of its components globally. See, eg: Matthias Buck and Clare Hamilton, ‘The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity’ (2011) 20(1) Review of European Community & International Environmental Law 47-61.
measures for users consistent with the Nagoya Protocol, explicitly clarifies that the Nagoya Protocol is not applicable to marine genetic resources in ABNJ.91

The Nagoya Protocol does, however, highlight the intrinsic value of genetic resources for mankind and the link between sustainable development, genetic resources and biodiversity conservation. For example, the preamble to the Nagoya Protocol recognises the potential role of access and benefit-sharing to the conservation and sustainable use of biological diversity, poverty eradication and environmental sustainability; and the importance of genetic resources to food security, public health, biodiversity conservation, and the mitigation of and adaptation to climate change.92

4.3.1.3. ITPGRFA

The ITPGRFA establishes a multilateral system for access and benefit-sharing for a list of plant genetic resources for food and agriculture, according to criteria of food security and interdependence, listed in Annex 1 of the treaty.93 This system is far narrower in scope than what may be required for ABNJ. Nevertheless, as a multilateral system for sharing genetic resources, it is a relevant model.

The ITPGRFA places conservation of genetic resources at the centre of the multilateral benefit-sharing system – which is firmly grounded on scientific research and development, including through technology development and capacity building. The integrated approach is referred to under ITPGRFA Article 5 and 7.94 The following features of the integrated approach provided for under the ITPGRFA Article 5 highlight how conservation and

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92 For a discussion of measures adopted by Nagoya Protocol, including due diligence measures; compliance measures such as certificates, and potential measures to increase legal certainty for researchers see: Geoff Burton and Elizabeth A Evans-Illidge, 'Emerging R and D Law: The Nagoya Protocol and Its Implications for Researchers' (2014) 9 ACS Chemical Biology 588-591.

93 ITPGRFA art 11.1.

94 ITPGRFA art 5.1.
sustainable use considerations guide the scientific research and technological cooperation relating to genetic resources:

- Survey and inventory of genetic resources;\(^{95}\)
- Collect genetic resources and information about those “that are under threat or are of potential use”;\(^{96}\)
- Support efforts to manage and conserve genetic resources \textit{in situ};\(^{97}\) and
- Cooperate for “the development of an efficient and sustainable system for \textit{ex situ} conservation …[with] adequate documentation, characterization, regeneration and evaluation” and promote the development and transfer of technology for this purpose to improve the sustainable use of genetic resources.\(^{98}\)

The multilateral system of access and benefit-sharing, established by ITPGRFA Article 13, aims to be “efficient, effective, and transparent, both to facilitate access to [genetic resources] and share, in a fair and equitable way, the benefits arising from the utilization of these resources(…)”.\(^{99}\) As discussed in Chapter 3, there are four mechanisms identified in ITPGRFA Article 13 to share benefits from non-commercial and commercial use of genetic resources as follows (Figure 4.2):

- Exchange of information;
- Access to and transfer of technology;
- Capacity-building; and
- Sharing of monetary and other benefits arising from commercialization.

\(^{95}\) \textit{ITPGFA} art 5.1(a)
\(^{96}\) \textit{ITPGFA} art 5.1(b)
\(^{97}\) \textit{ITPGFA} arts 5.1(c) and 5.1(d).
\(^{98}\) \textit{ITPGFA} art 5(1)e).
\(^{99}\) \textit{ITPGFA} art 10(2).
The ITPGRFA includes provisions for research to enhance and conserve biodiversity, and strengthening capacity to utilise genetic resources. It further identifies “exchange of information, access to and transfer of technology and capacity-building” as mechanisms to share benefits from genetic resources. With respect to the exchange of information, Article 13.2(a) specifies the type of information, including catalogues and inventories, information on technologies, results of technical, scientific and socio-economic research, including characterization, evaluation and utilization. It also specifies different obligations for confidential and non-confidential information. The ITPGRFA establishes a mechanism, the Global Information System, to facilitate information sharing.

With regard to access to and transfer of technology, art 13.2(b) specifies:

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100 ITPGRFA art 6(b).
101 ITPGRFA art 6(c).
102 ITPGRFA art 13.2(a).
• **Purpose of technologies**: for the conservation, characterization, evaluation and use of genetic resources;

• **Measures, examples and guidance for access to and transfer of technology**: such as the establishment and maintenance of, and participation in, thematic groups on utilization of genetic resources, all types of partnership in research and development, human resource development, and effective access to research facilities;

• **Provisions for access to technology under IP**: such as access to and transfer of technology including that protected by intellectual property rights, provided and/or facilitated under fair and most favourable terms, particularly technologies for use in conservation; and

• **Specifically identified modalities for technology transfer**: including through partnerships in research and development.

With respect to capacity-building, Article 13.2(c) stipulates that the needs of developing countries can be expressed through the priority they accord to building capacity in genetic resources in their plans and programmes. This could include: (i) programmes for scientific and technical education and training in conservation and sustainable use of genetic resources; (ii) developing and strengthening facilities for conservation and sustainable use of plant genetic resources for food and agriculture; and (iii) carrying out scientific research in cooperation with research institutions of developing countries, and developing capacity for such research in fields where they are needed.

Facilitated access to genetic resources is recognised in the ITPGRFA as “a form of benefit-sharing in itself”.

Facilitating research access to samples and associated data, information and knowledge *ex situ* is provided for under Article 12, as follows:

• **Access accorded expeditiously, without the need to track individual accessions and free of charge, or, when a fee is charged, it shall not exceed the minimal cost involved**;

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103 *ITPGRFA* art 13.1.
104 *ITPGRFA* art 12.3(b).
• All available passport data and associated available non-confidential descriptive information, shall be made available with the genetic resources provided;\textsuperscript{105}

• Genetic resources accessed under the Multilateral System shall continue to be made available to the Multilateral System;\textsuperscript{106} and

• Access will be provided in accordance with standards set by the Governing Body.\textsuperscript{107}

There is some provision for the facilitation of non-commercial research and the distinction between non-commercial and commercial research. Facilitated access is to be provided solely for purposes of utilisation and conservation for research, training for conservation and sustainable use, provided that such purpose does not include chemical, pharmaceutical and/or other industrial uses.\textsuperscript{108} A caveat such as this is one option for inclusion in the ILBI to help to differentiate between non-commercial and commercial research.\textsuperscript{109}

On the other hand, legal certainty for commercial research is addressed by the ITPGRFA through provisions for intellectual property and research and development, as follows:

• Recipients shall not claim any intellectual property or other rights that limit the facilitated access to the genetic resources, or their genetic parts or components, in the form received from the Multilateral System;\textsuperscript{110}

• Access to genetic resources under development shall be at the discretion of its developer, during the period of its development;\textsuperscript{111}

• Access to genetic resources protected by intellectual and other property rights shall be consistent with relevant international agreements, and with relevant national laws;\textsuperscript{112} and

\textsuperscript{105} \textit{ITPGRFA} art 12.3(c).
\textsuperscript{106} \textit{ITPGRFA} art 12.3(g).
\textsuperscript{107} \textit{ITPGRFA} art 12.3(h).
\textsuperscript{108} \textit{ITPGRFA} art 12.3(a).
\textsuperscript{109} See discussion in Section 4.3. of Chapter 4 on defining research activities.
\textsuperscript{110} \textit{ITPGRFA} art 12.3(b)(d).
\textsuperscript{111} \textit{ITPGRFA} art 12.3(e).
\textsuperscript{112} \textit{ITPGRFA} art 12.3(f).
• Material transfer agreements for sample sharing.\textsuperscript{113}

The ITPGRFA also specifies guidelines and standards for the sharing of benefits. Furthermore, specific implementation measures are provided. For example, the ITPGRFA identifies a role for a guiding plan, the Global Plan of Action, and an institutional mechanism, the governing body, to implement the multilateral benefit-sharing system. This is discussed further in Section 4.4.3.1.

\textit{4.3.1.4. Pandemic Influenza Preparedness Framework}

The PIP Framework was established with the objective to improve pandemic influenza preparedness and response, and strengthen the protection against the pandemic influenza. Improving and strengthening the WHO global influenza surveillance and response system (WHO GISRS) is central to this objective. As a multilateral system for benefit-sharing, albeit a soft law instrument and narrow in scope, it is a relevant model to consider.

The PIP Framework identifies a clear purpose and responsible bodies for benefit-sharing, including for capacity building. One of the purposes of benefit-sharing under the PIP framework is to build capacity in countries through technical assistance, transfer of technology, skills and know-how. Detailed guidance and requirements, including enabling implementation and institutional mechanisms are identified to enable benefit-sharing. In terms of institutional responsibilities:

• WHO to serve as coordinating body;\textsuperscript{114}
• WHO secretariat\textsuperscript{115} to work with States to contribute to the benefit-sharing system;\textsuperscript{116}

\textsuperscript{113} ITPGRFA arts 12.4, 12.5. For discussion on access issues relating to marine genetic resources see, eg: Broggiato et al, above n 61; Thomas Greiber, An international instrument on conservation and sustainable use of biodiversity in marine areas beyond national jurisdiction: exploring different elements to consider, \textit{Options and approaches for access and benefit-sharing}, (IUCN and German Federal Agency for Nature Conservation, 2014).

\textsuperscript{114} PIP Framework 6.1.

\textsuperscript{115} These are the WHO Secretariat, and relevant institutions, organisations and entities. Ibid.

\textsuperscript{116} PIP Framework 6.
• WHO GISR laboratories to share information with WHO Secretariat relating to summary reports of lab analyses regarding PIP biological materials;
• WHO and Secretariat to facilitate information sharing;
• WHO Collaborating Centres on Influenza and WHO H5 Reference Laboratories and Director-General to provide technical assistance to enhance research and surveillance capacity,\textsuperscript{117} including particular details on scientific research equipment and roles,\textsuperscript{118} and regulatory capacity building;\textsuperscript{119}
• Specified roles for Member States with advanced laboratory and influenza surveillance capacity to work with WHO and developing country Member States to develop national laboratory and influenza surveillance capacity;\textsuperscript{120}

Technology transfer measures are provided, including a role for the WHO Global Pandemic Influenza Action Plan to Increase Vaccine Supply to guide what measures should be implemented. There are also provisions for how implementation should proceed, including that it should be facilitated progressively over time, on mutually agreed terms and with a focus on developing capacity, with a recognised role for needs assessments to shape capacity building measures.\textsuperscript{121} Specific guidance is provided on: antivirals and vaccine stockpiles,\textsuperscript{122} access to vaccines,\textsuperscript{123} and tiered pricing for vaccines and anti-virals.\textsuperscript{124}

The PIP Framework provides an illustration of a multilateral system to address an identified common goal. The highly detailed and specific nature of the framework provisions is a striking characteristic of the PIP Framework. This could be made possible by the narrowly defined and specific nature of the purpose of the PIP Framework, which enables it to elaborate specific measures. While the conservation and sustainable use of biodiversity of ABNJ is a broader goal, the lessons from the PIP Framework relating to identified

\textsuperscript{117} PIP Framework 6.2.
\textsuperscript{118} PIP Framework 6.4 and 6.5.
\textsuperscript{119} PIP Framework 6.7.
\textsuperscript{120} PIP Framework 6.6.
\textsuperscript{121} PIP Framework 6.13.5.
\textsuperscript{122} PIP Framework 6.8 and 6.9.
\textsuperscript{123} PIP Framework 6.10 and 6.11
\textsuperscript{124} PIP Framework 6.12.
institutional responsibilities, specific capacity building and technology transfer concepts, and clear global goals and targets are pertinent to the development of the ILBI.

4.3.2. International legal instruments: ABNJ

The discussion in Section 4.3.1, suggests that there is a precedent for sharing benefits from genetic resources through elaborating measures to implement scientific research cooperation, technology development and transfer, and capacity building. This Section examines whether other legal instruments relating to ABNJ have adopted similar approaches to manage a common space.125 International legal instruments relating to common spaces are considered, as follows:

- Antarctica and the Southern Ocean
- Outer Space
- Arctic Ocean126

4.3.2.1. Antarctica and the Southern Ocean

The 1959 Antarctic Treaty127 (Antarctic Treaty),128 is based on international recognition that “it is in the interests of all mankind that Antarctica shall continue forever to be used exclusively for peaceful purposes” and acknowledgement of the “substantial contributions to scientific knowledge resulting from international cooperation in scientific investigation in Antarctica”. Freedom of scientific investigation in Antarctica—and cooperation to that end—is a central aim.129

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125 The Brundtland report, above n 40, identified oceans, space and Antarctica as “managing the commons” and common endeavours. For a discussion on the role of collective approaches to manage common spaces, see: Elisabeth Borgese, Oceanic Circle (United Nations University Press, 1998) 5-7. See for discussion of ABNJ: Brunnee, above n 16; Tladi, above n 30.
126 Note that the central Arctic Ocean is high seas, however, the seabed is either extended continental shelf or as yet undefined as maritime boundaries in the Arctic region are subject to dispute.
128 The Antarctic Treaty is applicable to the area south of 60° South Latitude: Antarctic Treaty art VI.
129 Antarctic Treaty art II.
The Antarctic Treaty highlights six key principles and objectives, including: scientific research in Antarctica; international scientific cooperation in Antarctica and preservation and the conservation of living resources in Antarctica. The 1980 Convention on the Conservation of Marine Living Resources (CCAMLR) and the 1991 Protocol on Environmental Protection to the Antarctic Treaty (Madrid Protocol) codify these principles and, with the Antarctic Treaty, collectively form the Antarctic Treaty System.

Science cooperation is a defining feature of the Antarctic Treaty system. The Antarctic Treaty recognises that it is in the interests of “…science and the progress of all mankind…” to establish a firm foundation to continue and develop international scientific cooperation “… as applied during the International Geophysical Year…”. This illustrates the role of science cooperation in building consensus in international spaces.

While neither the Antarctic Treaty nor CCAMLR mention technology transfer, as observed by Puig (2014), provisions under the Antarctic Treaty System for sharing of information relating to scientific research programs do offer a modality of benefit-sharing relevant to genetic resources. For example, Article III(1)(c) of the Antarctic Treaty concerns the exchange of scientific observations and results from Antarctica and to make them freely available, in order to promote international cooperation in scientific investigation. The

130 Antarctic Treaty art IX.

132 CCAMLR noted the growing interest in Antarctic marine living resources as a source of protein, recognised the responsibility to protect and preserve the Antarctic environment under the Antarctic Treaty art IX (1(f)), and underscored the importance of international cooperation to increase knowledge of the Antarctic marine ecosystem in order to enable decisions on harvesting to be based on sound scientific information.
134 Antarctic Treaty: Preamble [4].

Madrid Protocol includes provisions for the promotion of cooperative programmes of scientific, technical and educational value, and sharing of information.\textsuperscript{137}

The designation of institutional mechanisms to operationalise science cooperation, including knowledge sharing, is an objective of CCAMLR. CCAMLR recognises the “essential” need to increase knowledge of the Antarctic marine ecosystem. To this end, CCAMLR Article XV(1) stipulates that scientific cooperation to “extend knowledge” will be promoted by the Scientific Committee.\textsuperscript{138} The Scientific Committee is charged with providing a forum for “consultation and cooperation concerning the collection, study and exchange of information”,\textsuperscript{139} as well as formulating proposals for international research programs concerning Antarctic marine living resources.\textsuperscript{140} The CCAMLR Commission is charged with a number of roles and responsibilities, including facilitating research and publishing data and other information arising from research\textsuperscript{141} and to collect and share information on living marine resources.\textsuperscript{142} The Scientific Committee for the Conservation of Antarctic Marine Living Resources (Scientific Committee) is mandated to provide a forum for consultation and cooperation in the study and exchange of information with respect to Antarctic marine living resources. It has a role to encourage and promote cooperation in scientific research concerning the collection, study and exchange of relevant information,\textsuperscript{143} to extend knowledge of the marine living resources of the Antarctic marine ecosystem.\textsuperscript{144} Members of the Commission are required to provide data to the Scientific Committee.\textsuperscript{145} This shows how States, through CCAMLR, implemented the duty to cooperate by specifying institutional mechanisms and elaborating examples of the functions it would take.

\textsuperscript{137} Madrid Protocol, art 6.
\textsuperscript{138} Scientific Committee for the Conservation of Antarctic Marine Living Resources, established by CCAMLR art XIV.
\textsuperscript{139} CCAMLR art XV(1).
\textsuperscript{140} CCAMLR art XV(2)(f).
\textsuperscript{141} CCAMLR art XI.
\textsuperscript{142} CCAMLR art IX (1) provides obligations to: facilitate research, compile data, acquire statistics, analyse, disseminate and publish data.
\textsuperscript{143} CCAMLR art XV (2) provides requirements to: establish criteria and methods, conduct regular assessments, data analysis, transmit data and formulate proposals.
\textsuperscript{144} CCAMLR art XV.
\textsuperscript{145} CCAMLR art XX.
This discussion of the Antarctic Treaty System has illustrated how the identification of specific institutional functions and responsibilities can give effect to the implementation of the duty to cooperate to facilitate scientific research, including for the exchange of information. This provides an example of how scientific cooperation could be facilitated under an ILBI, this will be discussed in Section 4.4.1.

4.3.2.2. Outer space

Although technology transfer is not included in any UN treaty or declaration of principles relating to outer space,\textsuperscript{146} international scientific cooperation and the sharing of information and knowledge are prominent features in such instruments. The 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies\textsuperscript{147} (Outer Space Treaty) desired to “contribute to broad international cooperation in the scientific as well as the legal aspects of the exploration and use of outer space for peaceful purposes”\textsuperscript{148} and sets out an obligation for States to facilitate and encourage international cooperation in scientific investigation\textsuperscript{149} including by sharing information about activities with the scientific community.\textsuperscript{150} The 1979 Agreement Governing the Activities of States on the Moon and Other Celestial Bodies\textsuperscript{151} (Moon Agreement) provides for sharing information between States Parties and the international scientific community.\textsuperscript{152} Principles developed in the 1980s in relation to remote sensing and television broadcasting make reference to the free dissemination and mutual exchange of

\textsuperscript{146} There are five UN treaties and five declarations of principles adopted by the UNGA: United Nations Treaties and Principles on Outer Space, Text of treaties and principles governing the activities of States in the exploration and use of outer space, adopted by the United Nations General Assembly, ST/SPACE/11, (UN New York, 2002).
\textsuperscript{147} Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, opened for signature on 27 January 1967, 610 UNTS 205, (entered into force on 10 October 1967).
\textsuperscript{148} Outer Space Treaty Preamble. Note this exact phrase also appears United Nations General Assembly, Resolution Adopted by the General Assembly, ‘Declaration of legal principles governing the activities of states in the exploration and use of outer space’, GA Res 18/1962, 18\textsuperscript{th} sess, Agenda Item 28 (a), (13 December 1963), Preamble [4].
\textsuperscript{149} Outer Space Treaty art I.
\textsuperscript{150} Outer Space Treaty art XI.
\textsuperscript{151} Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, opened for signature on 18 December 1979, 1363 UNTS 3 (entered into force on 11 July 1984).
\textsuperscript{152} Moon Agreement, art 5.
information and knowledge in scientific fields for social and economic development. Furthermore, the “establishment and operation of data collecting and storage stations and processing and interpretation facilities, in particular within the framework of regional agreements or arrangements wherever feasible” is recognised as important to “maximise the availability of benefits from remote sensing activities”.154

The 1996 Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries (International Cooperation in Space Declaration) recognised the need to further strengthen international cooperation to develop collaborations for “mutual benefit”.155 The promotion of the “development of space science and technology and of its applications” is identified as an aim of international cooperation, along with capacity building and exchange of expertise and technology.156 This reflects a recognition of the need for scientific capacity building. This declaration also makes reference to the “exchange of technology”.157

This discussion of international legal instruments relating to outer space suggests that the importance of scientific and technological cooperation, as well as the sharing of information, is of recognised importance. The recognition of technology exchange, instead of transfer, and of the role of regional facilities for data collection and storage from a common space, could be relevant considerations for the development of benefit-sharing measures under an ILBI, this will be discussed in Section 4.4.

156 Ibid, [5].
157 Ibid, [5(c)].
The 2017 Agreement on Enhancing International Arctic Scientific Cooperation (Arctic Science Cooperation Agreement) provides a number of relevant lessons for the question of sharing benefits from marine genetic resources of ABNJ, particularly given that it is an international legally binding instrument involving some of the major researching nations active in ABNJ.\textsuperscript{158} This further demonstrates the continuing significance of science cooperation in international spaces.\textsuperscript{159} The Arctic Science Cooperation Agreement provides the most recent example of concrete measures adopted by States to advance the three elements considered in this thesis: international science cooperation to advance knowledge; sharing of data, information and knowledge; and scientific capacity building. Although the agreement is focused on a specific northern hemisphere location, the fact that it includes nations, including United States of America, actively involved in researching marine genetic resources in ABNJ makes it especially relevant to this thesis.

For data access, the agreement illustrates possible priorities for the adoption of measures to facilitate access to scientific information.\textsuperscript{160} It also indicates a willingness among some States to adopt legally binding measures for open access to data: Parties commit to support “full and open access to scientific metadata” and encourage “open access to scientific data and data products and published results”.\textsuperscript{161}

For capacity building, the agreement highlights the need for, and measures to achieve, scientific research capacity building, including through education, career development and training opportunities. Students and early career scientists are highlighted as recipients of

\begin{itemize}
  \item Section 4.3.2.1. See, eg: Paul A Berkman et al, 'The Arctic Science Agreement propels science diplomacy' (2017) 358(6363) Science 596-598.
  \item Arctic Science Cooperation Agreement art 7(1).
  \item Arctic Science Cooperation Agreement art 7(2).
\end{itemize}
capacity building in order to “to foster future generations of researchers and to build capacity and expertise to advance knowledge about the Arctic”.  

Furthermore, the Arctic Science Cooperation Agreement provides a definition of “scientific activities” that includes activities that could also be considered as technology transfer and capacity building (such as training workshops, data sharing). It also provides a definition as to what is meant by facilitate as: “pursuing all necessary procedures, including giving timely consideration and making decisions as expeditiously as possible.” Finally, the agreement recognises that a number of different actors could be participants in scientific research, defining “participant” as “the Parties’ scientific and technological departments and agencies, research centres, universities and colleges, and contractors, grantees and other partners acting with or on behalf of any Party or Parties, involved in Scientific Activities under this Agreement”.

This discussion highlights a number of points that are relevant to the development of benefit-sharing measures under the ILBI. It gives an example of how scientific cooperation could be facilitated under an ILBI, by specifying the nature of facilitation, the components of research activities, and the actors involved. It also highlights options to facilitate data access, by enshrining a commitment to open data, and scientific capacity building, by identifying focus areas and potential recipients of training opportunities.

4.4. Discussion: building blocks for an integrated approach to benefit-sharing

Drawing on the preceding analysis of this Chapter, measures that have been adopted in some international legal instruments, to achieve benefit-sharing are summarised in this Section. Measures relating to international science cooperation are examined in Section 4.4.1; measures for technology transfer and exchange of data, information and knowledge are

162 Arctic Science Cooperation Agreement art 8.
163 Arctic Science Cooperation Agreement art 1. See Section 5.5.2.3 of Chapter 5 for a discussion on definitions of scientific research.
164 Arctic Science Cooperation Agreement art 1.
considered in Section 4.4.2; and measures for scientific capacity building are considered in Section 4.4.3.

### 4.4.1. International scientific cooperation

A prominent feature of the instruments considered in this Chapter is that the duty to cooperate in science and technology is specified (Table 4.1). The duty to cooperate is elaborated through concrete obligations and identified institutional and implementation mechanisms. Based on the analysis in Section 4.3, the development of the ILBI could include specification of:

- Institutional mandates to support international cooperation in science and technology;\(^\text{165}\)
- Purpose of cooperation: in the case of benefit-sharing, this is often to contribute to the conservation and sustainable use of the resource;\(^\text{166}\)
- Nature of cooperation, including focus areas: for example, to share knowledge, to advance data sharing, develop technology, or engage in biotechnology research;\(^\text{167}\)
- Measures to guide cooperation, such as guidelines, codes of conduct, \(^\text{168}\) standards, statements of principles or Global Plans of Action;
- Roles for research and development collaborations, \(^\text{169}\) and joint ventures \(^\text{170}\) including with industry, \(^\text{171}\) for the transfer of technology, skills and know-how and access to funding;\(^\text{172}\)

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\(^\text{165}\) See, eg: CCAMLR, PIP Framework and ITPGRFA as discussed in Section 4.3.2.1, Section 4.3.1.4 and Section 4.3.1.3 of this Chapter.

\(^\text{166}\) See, Section 4.3.1.3.

\(^\text{167}\) See, eg: Nagoya Protocol art 23.


\(^\text{169}\) See, eg: Nagoya Protocol art 23. ITPGRFA art 13.2(a).

\(^\text{170}\) See, eg: CBD art 18(5).

\(^\text{171}\) See, eg: PIP Framework 6.13.

• Cooperation in sample sharing,173 and
• Modality for information sharing to support scientific and technical cooperation, such as a clearinghouse.174

The potential for these measures to be adopted under an ILBI will be discussed in Chapter 7.

173 See, eg: ITPGRFA article 15, PIP Framework, Moon Agreement art 6.
174 See, eg: CBD art 18(3).
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<td>2017</td>
<td>Agreement on Principles of International Law, Including the United Nations Declaration on the Protection of the Environment in a State Caused by Activities Taking Place in the Territory of Another State</td>
<td>arts 14: 14; 4.2:</td>
<td></td>
</tr>
</tbody>
</table>
4.4.2. Sharing data, information and knowledge

The sharing of data, information and knowledge is a key characteristic of international instruments relating to genetic resources and ABNJ (Table 4.2). All instruments involving genetic resources have specified obligations and identified or established mechanisms for sharing data and/or information. Access to data, information and knowledge can be considered to include the outcomes of scientific research, as well as access to information about the conduct of scientific research, training programs and capacity building opportunities. In other words, for ABNJ, this could include the benefits of marine genetic resources themselves (e.g. data relating to biological and genetic diversity, as well as genetic or biochemical properties of marine organisms); and information about benefit-sharing (e.g. information on activities relating to the utilisation of genetic resources or opportunities for capacity building). Therefore, it would be necessary to establish a framework that specifies: firstly, what data, information and knowledge should be shared and in what format; and secondly, what mechanism(s) should be used to do so.

On the first point, one way to support timely and accurate data exchange is the adoption and use of principles and standards. International legal instruments have a role in elaborating principles and criteria for data and information exchange. However, there can be complicated challenges to sharing benefits, and transparency in access to genetic data, including through public-access databases, is a recognised issue for genetic resources. The significance of clearly identified institutional mandates and specific implementation mechanisms is evident from the discussion in Section 4.3. Research institutions are often identified as key actors in facilitating data and information exchange, however, the capacity of research institutions to deliver benefit-sharing obligations for ABNJ is an issue requiring further discussion that will be further discussed in Chapter 6.

On the second point, it can be noted that clearinghouse and information sharing mechanisms are a tool to promote information exchange and support benefit-sharing. They often include a

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175 See, eg: Antarctic Treaty art III(1); CBD art 17.
176 PIP Framework 5.2.1.
177 PIP Framework 5.2.2.
178 PIP Framework 5; ITPGRFA art 13.
specified purpose such as to promote biodiversity conservation\textsuperscript{179} and the sharing of benefits.\textsuperscript{180} However, the complexity and resourcing of clearinghouse mechanisms vary widely. For example, CBD Article 18(3) established a CBD clearinghouse for the exchange of information in order to facilitate technical and scientific cooperation.\textsuperscript{181} It is implied that research results and data would be included in the scope of what information is to be made available by Parties. However, the clearinghouse under the CBD has been described as “underutilised and developed rather haphazardly”.\textsuperscript{182} The Nagoya Protocol established an access and benefit-sharing clearinghouse to share information relevant to access and benefit-sharing (ABS clearinghouse) under the CBD.\textsuperscript{183} Perhaps due to its bilateral nature, the Nagoya Protocol ABS clearinghouse does not provide a mechanism for sharing benefits, rather, it shares information about benefit-sharing mechanisms. The scope of the Nagoya Protocol ABS clearinghouse includes only information about the modalities of benefit-sharing,\textsuperscript{184} including information on capacity-building and development initiatives.\textsuperscript{185} For example, the Nagoya Protocol clearinghouse mechanism provides information about access and benefit-sharing (i.e. policies and programs) rather than delivering information as a tool for benefit-sharing. In other words, it does not enable sharing of scientific data and information as benefits per se.\textsuperscript{186}

The Global Information System on Plant Genetic Resources for Food and Agriculture was established by the ITPGRFA as a mechanism to share benefits from genetic resources, in Article 17.\textsuperscript{187} This system could be considered as a providing a platform to enable the

\textsuperscript{179} CBD encourages the free and open access to data and information for conservation purposes, See, eg: Convention on Biological Diversity, Decision adopted by the Conference of the Parties to the Convention on Biological Diversity at its Tenth Meeting: X/15. Scientific and technical cooperation and the clearing-house mechanisms, 10\textsuperscript{th} meeting, Agenda Item 4.3 (f), (18-29 October 2010) UNEP/CBD/COP/DEC/X/15 [5(c)].
\textsuperscript{180} ITPGRFA art 17.1.
\textsuperscript{181} CBD art 18(3).
\textsuperscript{182} Morgera, above n 61. See also: Smith et al (2018), above n 168.
\textsuperscript{183} Nagoya Protocol art 14.
\textsuperscript{184} Nagoya Protocol arts 14(2) and 14(3).
\textsuperscript{185} Nagoya Protocol art 22(6).
\textsuperscript{186} Nagoya Protocol art 14(2) and (3) the information shall include: a) Legislative, administrative and policy measures on access and benefit-sharing; b) Information on the national focal point and competent national authority or authorities; and c) Permits or their equivalent issued at the time of access as evidence of the decision to grant prior informed consent and of the establishment of mutually agreed terms. Additional information, if available and as appropriate, may include: a) Relevant competent authorities of indigenous and local communities, and information as so decided; b) Model contractual clauses; c) Methods and tools developed to monitor genetic resources; and d) Codes of conduct and best practices.
\textsuperscript{187} ITPGRFA art 17.
integrated approach to benefit-sharing, by providing access to scientific information, as well sharing information about opportunities for scientific capacity-building and technology transfer.\textsuperscript{188} Although, as specified in Article 17(1), it relies on existing information systems and cooperation with the CBD clearinghouse mechanism.

While information sharing systems vary in terms of content and aim - a feature common to all mechanisms is that they are based on a network mechanism, usually consisting of a central portal and nodes. The CBD clearinghouse consists of a central node (the CBD website)\textsuperscript{189} which provides a global information service, as well as a network of national clearinghouse mechanisms,\textsuperscript{190} totalling 105 clearinghouse mechanism websites from 198 countries.\textsuperscript{191} The mission, goals and objectives of the CBD clearinghouse mechanism for the period 2011-2020 were agreed by the tenth Conference of the Parties.\textsuperscript{192} The ITPGRFA Global information system is based on existing information systems, to facilitate exchange of information, on scientific, technical and environmental matters relating to plant genetic resources for food and agriculture.\textsuperscript{193} The Nagoya Protocol ABS clearinghouse mechanism\textsuperscript{194} is designed to serve as an “organised global repository”.\textsuperscript{195}

The design, development and implementation of information systems for the conservation and sustainable use of genetic resources, is a long-term process. This is illustrated by the ongoing development of the Global Information System of the ITPGRFA.\textsuperscript{196} Furthermore, such systems can be difficult to fund. For example, there have been repeated calls to secure funding from Parties and partners to sustain the CBD clearinghouse.\textsuperscript{197} The report of the

\textsuperscript{188} Morgera (2015) above, n 61.
\textsuperscript{191} Ibid.
\textsuperscript{192} CBD above n 179. See also CBD art 18(3).
\textsuperscript{196} ITPGRFA above n 193.
\textsuperscript{197} CBD above n 179, [2].
PrepCom indicates that a clearinghouse mechanism is envisaged as part of the ILBI, stating that:

“The text would set out modalities to facilitate the exchange of information relevant to the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction for the implementation of the instrument. It would make provision for mechanisms such as data repositories or a clearing-house mechanism. Possible functions of a clearing-house mechanism could include:

Dissemination of information, data and knowledge resulting from research relating to marine genetic resources of areas beyond national jurisdiction, information on traditional knowledge associated with marine genetic resources of areas beyond national jurisdiction, as well as other relevant information related to marine genetic resources.

Dissemination of information relating to capacity-building and transfer of marine technology, including facilitation of technical and scientific cooperation; information on research programmes, projects and initiatives; information on needs related to capacity-building and transfer of marine technology and available opportunities; and information on funding opportunities.”

The fact that the PrepCom report refers to information about capacity building separately to data and knowledge relating to marine genetic resources highlights that the scope of data, knowledge and information sharing is an area requiring further work. It is therefore necessary to consider the applicability of the lessons from other international legal instruments, this will be continued in Chapter 7.

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198 PrepCom report, above n 11, 16. This appeared in section A i.e. it generated convergence among most delegations.
<table>
<thead>
<tr>
<th>Year</th>
<th>Treaty</th>
<th>Article</th>
<th>Section(s)</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1959</td>
<td>Antarctic Treaty</td>
<td>19</td>
<td></td>
<td>Provision for the Stationing of Scientific Research Station at Antarctica.</td>
</tr>
<tr>
<td>1979</td>
<td>Agreement Governing the Activities of States on the Moon and Other Celestial Bodies</td>
<td>5</td>
<td></td>
<td>Agreement Governing the Activities of States on the Moon and Other Celestial Bodies.</td>
</tr>
<tr>
<td>1980</td>
<td>Convention on the Conservation of Antarctic Marine Living Resources</td>
<td>IX(1)(d); XV</td>
<td></td>
<td>Article 9(x)(d); Article 15.</td>
</tr>
<tr>
<td>1982</td>
<td>Convention on Biological Diversity</td>
<td>17</td>
<td></td>
<td>Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilization.</td>
</tr>
<tr>
<td>2001</td>
<td>International Treaty on Plant Genetic Resources for Food and Agriculture</td>
<td>13.2(a); 17</td>
<td></td>
<td>Article 13.2(a); Article 17.</td>
</tr>
<tr>
<td>2001</td>
<td>International Treaty on Plant Genetic Resources for Food and Agriculture</td>
<td>17</td>
<td></td>
<td>Article 17.</td>
</tr>
<tr>
<td>2010</td>
<td>Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilization</td>
<td>23; annex[2(e)]</td>
<td></td>
<td>Article 23; annex[2(e)].</td>
</tr>
<tr>
<td>2017</td>
<td>Agreement on Enhancing Arctic Scientific Cooperation</td>
<td>7</td>
<td></td>
<td>Article 7.</td>
</tr>
</tbody>
</table>

To international spaces and/or genetic resources.

Table 4.2: Examples of international legal instruments specifying requirements for international cooperation in sharing data (including the publication and dissemination of data and/or sharing outcomes of scientific research) and providing access to technology in relation to international spaces and/or genetic resources.
4.4.3. Human, institutional and technical capacity building

The observation in Chapter 3 that technology transfer and scientific capacity building are interlinked is further supported in this Chapter. The Nagoya Protocol recognises “technology transfer, and infrastructure and technical capacity to make such technology transfer sustainable”\(^{199}\) as a means to boost capacity. Nagoya Protocol Article 23 obliges Parties to “promote and encourage access to technology by, and transfer of technology to, developing country Parties (…) to enable the development and strengthening of a sound and viable technological and scientific base for the attainment of the [CBD] and [Nagoya] Protocol”.

Technical assistance is linked to technology transfer in ITPGRFA Articles 8 and 13.2.\(^{200}\) The CBD provides some information on technology needs assessments, although none explicitly relate to genetic resources.\(^{201}\) The examination of international legal instruments for genetic resources reveals the following specific enabling measures to support capacity building: global plans of action (discussed in Section 4.4.3.1); networks and institutional capacity building (discussed in Section 4.4.3.2); training and skills for human capacity building (discussed in Section 4.4.3.3); and enabling environments (discussed in Section 4.4.3.4).

4.4.3.1. Global plans of action

Global plans of action are instruments used to identify strategic priorities and guide international cooperation and collaboration. They have been developed for animal genetic resources,\(^{202}\) plant genetic resources for food and agriculture,\(^{203}\) forestry genetic resources,\(^{204}\) and global pandemic influenza.\(^{205}\) For example, the first Global Plan of Action for Plant Genetic Resources for Food and Agriculture was adopted by 150 countries in 1996, laying

\(^{199}\) Nagoya Protocol, art 22(5)(g).
\(^{200}\) ITPGRFA arts 8, 13.2 (bi) (biii).
\(^{205}\) See, eg: PIP Framework 6.13.1.
the foundations for the negotiation of the ITPGRFA.206 The Global Plan of Action for the Conservation, Sustainable Use and Development of Forest Genetic Resources was adopted in 2014 as a voluntary, non-binding document under the auspices of the FAO. The purpose of plans include serving as central reference points for national, regional and global efforts to conserve and sustainably use genetic resources, assisting governments in formulation of policies and strategies, prioritising activities and shaping research and development agendas of international organisations, establishing long term goals, and strengthening understanding and knowledge of genetic resources. A comparison between global plans of action for animal, plant and forest genetic resources reveal four common themes, as shown in Table 4.3:

- Availability and access to information;
- In situ conservation & ex situ conservation;
- Sustainable use; and
- Capacity building.

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206 FAO Commission on Genetic Resources for Food and Agriculture, above n 203, 5-6.
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Availability and access to information</strong></td>
<td>Characterisation, Inventory and Monitoring of Trends and Associated Risks (e.g. inventory and monitor trends; international technical standards)</td>
<td><em>In situ</em> conservation (e.g. surveying and inventorying genetic resources)</td>
</tr>
<tr>
<td><strong>In situ conservation &amp; ex situ conservation</strong></td>
<td>Sustainable Use and Development (e.g. national policies, strategies and programmes)</td>
<td><em>Ex situ</em> conservation (e.g. sustaining <em>ex situ</em> collections)</td>
</tr>
<tr>
<td><strong>Sustainable use</strong></td>
<td>Conservation (e.g. national policies and programmes, national/regional and global strategies, standards)</td>
<td>Sustainable use (e.g. characterising, evaluating and developing collections of genetic resources)</td>
</tr>
<tr>
<td><strong>Capacity building</strong></td>
<td>Policies, institutions and capacity-building (e.g. strengthen national institutions, education and research, international information sharing,</td>
<td>Capacity building (e.g. national programs, networks, information systems, monitoring systems, human resources, public awareness)</td>
</tr>
</tbody>
</table>
Global plans of action serve as tools to shape the implementation of benefit-sharing under the ILBI. The plans for plant genetic resources have a specified role in the multilateral benefit-sharing system under the ITPGRFA.\textsuperscript{207} For example, ITPGRFA 13.2. states that the multilateral benefit-sharing system shall take into account “priority activity areas in the rolling Global Plan of Action, under the guidance of the Governing Body” (emphasis added).\textsuperscript{208} The “rolling” plan provides flexibility for updates. Parties to the ITPGRFA are required to cooperate with the Commission on Genetic Resources for Food and Agriculture in periodic reassessments of the state of the world’s genetic resources to update the rolling Global Plan of Action. Similarly, the implementation of the “WHO Global Pandemic Influenza Action Plan to Increase Vaccine Supply” (which includes strategies to build new production facilities through transfer of technology, skills and know-how) is part of the technology transfer element of the benefit-sharing system under the PIP Framework.\textsuperscript{209} This illustrates the link between national capacity building and worldwide benefit-sharing.

Implementation of plans will be dependent upon capacity and resources. The plans for forestry, plant and animal genetic resources have been conducted under the auspices of the Food and Agriculture Organisation (FAO), however, with no formal implementation mechanism, the responsibility rests with governments.

At present, there is no ‘global plan of action for marine genetic resources’. However, such a plan could serve as a tool to shape the implementation of benefit-sharing under the ILBI. By providing a comprehensive strategy to conserve and sustainably use marine genetic resources of ABNJ, a plan could support coordination, cooperation and collaboration in science, technology transfer and capacity building relating to ABNJ, with beneficial results and national, regional and global levels. This is discussed in Chapter 7.

\textsuperscript{207} See, eg: \textsl{ITPGRFA} arts 13.2 and 14.
\textsuperscript{208} See also \textsl{ITPGRFA} arts 14, 18.3.
\textsuperscript{209} See, eg: PIP Framework 6.13.1.
4.4.3.2. The role of networks: institutional capacity building

The role of networks is explicitly recognised and promoted in a number of international instruments, including the ITPGRFA,\(^{210}\) CBD, Nagoya Protocol, PIP Framework,\(^{211}\) and the Arctic Science Cooperation Agreement.\(^{212}\) Strategic priority 25 of Global Plan of Action for Forest Genetic Resources encourages “the establishment of network activities” and support for the “development and reinforcement of international networking” to support research, management and conservation of genetic resources. ITPGRFA Article 16 calls for participation by governmental, private, non-governmental, research and other institutions in networks.\(^{213}\) The PIP framework Preamble recognises the “role of industry as an important contributor to technology innovation and transfer in addressing the challenges of pandemic influenza preparedness and response”.\(^{214}\) The Nagoya Protocol also recognises the importance of partnerships. A further example on the role of networks is provided by the specified role of the Consultative Group on International Agricultural Research in implementing benefit-sharing under the ITPGRFA, and the GISRs in implementing benefit-sharing under the PIP Framework. This illustrates how some international legal instruments have specified roles for networks of scientific institutions to implement benefit-sharing measures.

4.4.3.3. Human capacity building

Human capacity building is a focus of all international legal instruments relating to genetic resources. In the CBD, for example, there are references to research and training,\(^{215}\) participation in biotechnology research,\(^{216}\) and the establishment of and access to research facilities.\(^{217}\) Nagoya Protocol Article 22 sets out obligations for capacity-building, capacity building and strengthening of human resources and institutional capacities in developing

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\(^{210}\) ITPGRFA art 16.1.
\(^{211}\) PIP Framework 4.3. provides for the WHO GISRS – an international network of influenza labs coordinated by WHO.
\(^{212}\) For example, Arctic Science Cooperation Agreement Preamble refers to a number of scientific institutions by name.
\(^{213}\) ITPGRFA art 16.2.
\(^{214}\) PIP Framework, Preamble.
\(^{215}\) CBD arts 12, 16, 18(4).
\(^{216}\) CBD art 19(1).
\(^{217}\) CBD art 9(b).
countries. It specifies particular areas for capacity building, including: bioprospecting, associated research and taxonomic studies; and technology transfer and infrastructure and technical capacity to make such technology transfer sustainable.\footnote{Nagoya Protocol art 22 (5).} This provides an example of how the ILBI could specify areas for training and skill development.

4.4.3.4.\textit{Towards an integrated approach: an enabling environment for capacity building}

The importance of creating enabling environments for technology transfer has been recognised in the context of fisheries,\footnote{J Bolger, ‘Capacity building Why, What and How’, Canadian International Development Agency. Occasional Series. 1: (2000) http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.458.7262&rep=rep1&type=pdf} climate change, and biodiversity.\footnote{CBD, Convention on Biological Diversity, \textit{Decision adopted by the Conference of the Parties to the Convention on Biological Diversity at its Ninth Meeting: IX/14. Technology transfer and cooperation, \textnumero 9 meeting}, Agenda Item 4.3, (19-30 May 2008) UNEP/CBD/COP/DEC/IX/14, Annex. ‘Strategy for Practical Implementation of the Programme of Work on Technology Transfer and Scientific and Technological Cooperation’.} According to a report published by the UNFCCC secretariat, an enabling environment includes “the local context-specific circumstances that encompass existing market and technological conditions, institutions and practices…the resources and conditions within which the technology and the target beneficiaries operate.”\footnote{UNFCCC-UNEP Technology Executive Committee, ‘Enhancing implementation of technology needs, Guidance for preparing a technology action plan’ (UNFCCC, UNEP, Bonn, Copenhagen 2017), 9, available at http://unfccc.int/itc/itclarealmisc_/StaticFiles/enwoerk_static/TNR_HAB/33b283a23442ab8c04e734bc545a/bbd4572425e84815834512ebdf13964.pdf accessed 01/02/2018.} An enabling environment incorporates measures at network, organisational and individual levels (Figure 4.3).
Figure 4.3: Conceptual framework for an enabling environment.
(Source: Bolger 2000).\textsuperscript{222}

An enabling environment will include some or all of the following elements. Elements may vary between recipients and providers of technology:

- Assessment of priority technology needs through consultative multi-stakeholder processes;
- Policies and regulations that incentivise and enable the development and transfer of technology (for providers and recipients);
- Institutional and administrative frameworks conducive to technology transfer (national, regional and international);
- Designation of central national consultation points;
- Incentives for technological innovation and measures to accelerate the deployment and use of technologies, including accelerator hubs and networks;
- Capacity building opportunities to enable technology uptake; and

\textsuperscript{222} Bolger, above n 219.
• Public participation.

Based on the discussion of the key enabling measures discussed in this Section, the merits of an integrated approach to creating an enabling environment can be seen. The interlinkages between the proposed measures, and the different levels of capacity building, can be seen in the context of creating an enabling environment, in Figure 4.4. Global plans of action could support the development of global capacity. In turn, global plans could guide national or regional or global initiatives for capacity building. Global plans could also be informed by national and regional technology needs assessments or strategic priority setting exercises, that help guide actions for national and regional capacity building. Networks could help to build collective and individual capacity, in turn, this could increase opportunities for training and individual level capacity building. Individual level capacity building could also be informed by. Creating an enabling environment that fosters this type of multi-level capacity building could empower States to conserve and sustainably use marine genetic resources of ABNJ, as suggested in Section 4.2.3.

![Figure 4.4: Conceptual framework for an enabling environment for benefit-sharing (left), showing illustrative examples of measures and interactions (right).](image)
4.5. Conclusion

This Chapter has analysed the concept of benefit-sharing, through an examination of international legal instruments, in order to identify potential elements for an ILBI to enable the sharing of benefits from marine genetic resources of ABNJ. It has shown that an integrated approach to benefit-sharing is supported in several international agreements, and suggested that such an approach is needed for the ILBI. Given that the term “benefit-sharing” is not clearly defined in international law, the related principles and approaches of inter-generational equity, intra-generational equity and equitability have been examined in the context of sustainable development and integration. The significance of science and technology in these principles has been demonstrated and this analysis supports the link between benefit-sharing, conservation and sustainable use that was identified in Chapter 2.

The observation in Chapter 3 that science cooperation, technology transfer and scientific capacity building are interlinked is further supported in this Chapter. Based on a textual analysis of international legal instruments relating to genetic resources and to ABNJ, the significance of the three elements of benefit-sharing considered in this thesis—1) scientific research cooperation, 2) technology transfer and 3) scientific capacity building—has been demonstrated. It has been suggested that these three elements are interlinked and should be considered as mutually dependent. It has been shown that capacity building is necessary to enable fair equitable use, and to help build capacity to use sustainably marine genetic resources to promote both conservation and sustainable development.

A comparison between the provisions of the international legal instruments considered, drawing on illustrative examples of measures adopted to support implementation, has enabled the identification of common measures that support benefit-sharing through each of the three elements. These measures include: specification of purpose, identification of institutional mechanisms, and establishment of enabling tools such as information systems. It has been suggested that this could inform the development of the ILBI. Thus, the ILBI—as an enabling mechanism for developing countries to utilize new resources, to gain knowledge for sustainable management, and to develop new technologies—could support an integrated approach to the conservation and sustainable use of biodiversity, through benefit-sharing, as
discussed in Chapter 2. The potential measures that could be adopted through the development of ILBI will be discussed in Chapter 7. First, the LOSC framework for marine scientific research and technology transfer will be examined in Chapter 5 to establish the existing legal framework applicable to the question of sharing benefits from marine genetic resources of ABNJ. The level of implementation of the existing LOSC framework provisions for marine scientific research cooperation and technology will then be examined in Chapter 6.
Chapter 5
The law of the sea framework for marine scientific research, technology transfer and capacity building

5.1. Introduction

The aim of this Chapter is to critically analyse the existing legal basis for sharing benefits from marine genetic resources of areas beyond national jurisdiction (ABNJ) under the 1982 United Nations Convention on the Law of the Sea\(^1\) (LOSC). In Chapters 2, 3 and 4 it was suggested that benefit-sharing is dependent on three interlinked elements: 1) scientific research cooperation; 2) the development and transfer of technology, including for the sharing of data and knowledge; and 3) scientific and technological capacity building. The LOSC framework for marine scientific research, technology transfer and scientific capacity building is examined in this Chapter, in order to determine the existing legal basis for benefit-sharing in the international law of the sea.

The LOSC framework is examined in three parts: marine scientific research is addressed in Section 5.2; the development and transfer of marine technology is considered in Section 5.3; and scientific and technological capacity building is discussed in Section 5.4. Definitional and implementation gaps are identified and discussed in each Section. The relevance of the LOSC framework to the question of sharing benefits from marine genetic resources of ABNJ is analysed in Section 5.5, strengths and weaknesses are identified. The Chapter concludes with a suggestion of how the implementation of the existing LOSC framework provisions for marine scientific research and the development and transfer of marine technology could be strengthened through the development of a new international legally binding instrument.

(ILBI) for the conservation and sustainable use of marine biological diversity of ABNJ, in order to share benefits from marine genetic resources.

The principal focus of this Chapter is on the framework provisions of the LOSC Parts XIII, on Marine Scientific Research, and XIV, on the Development and Transfer of Marine Technology. Attention is also paid to the 1995 United Nations Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (UNFSA) and the 1994 Agreement relating to the implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982 (1994 Implementing Agreement). As implementing agreements under the LOSC, these are informative in considering how the development of a new ILBI could strengthen the implementation of existing LOSC provisions, in order to enable the sharing of benefits from marine genetic resources of ABNJ.

5.2. Marine scientific research

The aim of this Section is to examine the LOSC framework for marine scientific research in order to determine its relevance to the sharing of benefits from marine genetic resources in ABNJ. The LOSC regime for marine scientific research in ABNJ is critically analysed in Section 5.2.1, highlighting that international cooperation, sharing data and information and scientific capacity building are key features. Implementation challenges are considered in Section 5.2.2.

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5 Potential measures that could be included in the ILBI to enable the sharing of benefits through scientific cooperation, technology transfer and capacity development are proposed in Chapter 7.
5.2.1. Marine scientific research in ABNJ: cooperation and capacity building

This Section introduces the LOSC framework for marine scientific research in ABNJ in Section 5.2.1.1. The basis for an integrated approach to scientific cooperation, access to data and knowledge, and capacity building is discussed in Section 5.2.1.2.

5.2.1.1. Marine scientific research in ABNJ

In ABNJ, the regime for marine scientific research is less stringent than in areas within national jurisdiction. For example, in areas within national jurisdiction, the coastal State has the right to grant or withhold consent for the conduct of marine scientific research in waters under national jurisdiction including its territorial sea and exclusive economic zone. In ABNJ, there is no such consent regime, and access to marine genetic resources is free and open.

Marine scientific research is a freedom of the high seas, yet this freedom is not absolute. It must be conducted with due regard for the rights and interests of other States in their exercise of the freedom of the high seas and with respect to activities in the Area. The LOSC definition of activities in the Area refers to the exploration and exploitation of non-living mineral resources including solid, liquid and gaseous resources and hence this does not incorporate marine genetic resources. Freedom of marine scientific research in the high seas is subject to Parts VI and XIII of the LOSC.

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6 See Section 1.2.1 of Chapter 1 for a discussion of the high seas and the Area, see Figure 1.2 for a depiction of maritime zones established under the LOSC.


8 LOSC art 87(1)(f); marine scientific research is one of six freedoms of the high seas.

9 LOSC art 87(2).

10 “Activities in the Area” are defined by LOSC art 1(2) as “all activities of exploration for, and exploitation of the resources of the Area”, “Resources”, for the purposes of the Area, are defined in LOSC art 133 as “For the purposes of this Part [Part XI] (a) “resources” means all solid, liquid or gaseous mineral resources in situ in the Area at or beneath the seabed, including polymetallic nodules; (b) resources, when recovered from the Area, are referred to as “minerals”.”

11 LOSC art 87(1)(f). Part VI relates to the continental shelf and is therefore not included in this subsequent analysis, which is focused on ABNJ. It is acknowledged that in instances where there is an extended continental
In the Area, marine scientific research could be considered to be subject to more stringent requirements than in the high seas. Article 143 provides that marine scientific research in the Area “shall be carried out exclusively for peaceful purposes and for the benefit of mankind as a whole” (emphasis added). Marciniak (2017) notes that this phrase involves more obligations than the “regular” marine scientific research regime. Article 143 highlights three elements that can be considered to be necessary for marine scientific research to benefit mankind as a whole. These are, in summary form: a) cooperation in scientific research programs; b) strengthening research capabilities, including through training programs; and c) dissemination of research results. It is notable that these are the same three elements considered necessary for benefit-sharing in this thesis. The preceding discussion has shown that marine scientific research in ABNJ—whether in the high seas or the Area or both—must be conducted in accordance with Part XIII. It can be recalled from Chapter 1 that a growing volume of academic literature has identified LOSC Part XIII as a possible basis for sharing some benefits from marine genetic resources of ABNJ. This is explored in this Section.

LOSC Part XIII establishes rights and responsibilities for researching States, coastal States and international organisations in the conduct of marine scientific research. Article 240 of the
LOSC articulates four general principles for the conduct of marine scientific research. Marine scientific research shall:

a. be conducted exclusively for peaceful purposes;

b. be conducted with appropriate scientific methods and means compatible with [the LOSC];

c. not unjustifiably interfere with other legitimate uses of the sea compatible with [the LOSC] and shall be duly respected in the course of such uses; and

d. be conducted in compliance with all relevant regulations adopted in conformity with [the LOSC] including those for the protection and preservation of the marine environment.

The role of international marine scientific and technological cooperation for the protection and preservation of the marine environment is recognised in the LOSC. Article 242(2) supports the notion that international cooperation in marine science and technology is needed to facilitate information sharing to enable the marine environmental protection. Furthermore, Article 202(a)(ii) provides that States (directly or through competent international organisations) should promote participation in international science and technology programmes in the context of protection and preservation of the marine environment. This link between scientific cooperation and the protection of the environment supports considering the integration of international cooperation in science and technology with the conservation and sustainable use of marine genetic resources in ABNJ. The basis for an integrated approach is further examined in the following sub-section.

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16 Section 2.4 of Chapter and Section 3.5 of Chapter 3.
5.2.1.2. The basis for the integrated approach in ABNJ: cooperation in research, sharing research results and building capacity

Article 244 concerns the publication and dissemination of information and knowledge. It provides that:

“1. States and competent international organisations shall, in accordance with [the LOSC] make available by publication and dissemination through appropriate channels information on proposed major programmes and their objectives as well as knowledge resulting from marine scientific research.

2. For this purpose, States, both individually and in cooperation with other States and with competent international organisations, shall actively promote the flow of scientific data and information and the transfer of knowledge resulting from marine scientific research, especially to developing States, as well as the strengthening of the autonomous marine scientific research capabilities of developing States through, inter alia, programmes to provide adequate education and training of their technical and scientific personnel.”

This highlights that three elements of benefit-sharing considered in this thesis are established requirements for the conduct of marine scientific research, as per Article 244(2) (Table 5.1). Thus, Article 244 could provide a basis for benefit-sharing. It is also notable that these are same elements as required under Article 143 (Table 5.1). This suggests that, the three elements for benefit-sharing in this thesis would be consistent with the exercise of marine scientific research in the high seas as well as achieving “marine scientific research for the benefit of mankind as a whole”. To further explore the responsibilities for the conduct of marine scientific research, Part XIII is examined in the following Section.
Table 5.1: Comparison between Article 143 and 244 reveals three common elements for benefit-sharing (international scientific research cooperation, disseminating research results, and strengthening research capacity)

<table>
<thead>
<tr>
<th>Elements</th>
<th>Article 143(3)</th>
<th>Article 244</th>
</tr>
</thead>
<tbody>
<tr>
<td>International scientific research cooperation, including participation in scientific research programs by developing states</td>
<td>(a)</td>
<td>(2)</td>
</tr>
<tr>
<td>Disseminating results of research and analysis</td>
<td>(c)</td>
<td>(1) (2)</td>
</tr>
<tr>
<td>Strengthening research capacity, including through training and education</td>
<td>(b)</td>
<td>(2)</td>
</tr>
</tbody>
</table>

5.2.2. Implementation challenges

In this Section, challenges for implementing international cooperation in marine scientific research are discussed in Section 5.2.2.1. Definitional challenges and ambiguities are discussed in Section 5.2.2.2.

5.2.2.1. International cooperation and institutional mechanisms

As observed by Long (2007) “international cooperation in marine scientific research and technology are pre-requisites to reaping the full benefits of the LOSC.” However, the LOSC duty to cooperate is fairly general, and does not specify specific actions, institutions or enabling implementation mechanisms that are applicable to marine genetic resources in ABNJ. For example, Article 242 provides for the promotion of international cooperation in marine scientific research by States and competent international organisations, “on the basis

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of mutual benefit”. However, the LOSC does not specify which organisations are considered to be competent for this purpose, nor is it clear what is meant by “basis of mutual benefit”.

States and competent international organisations are required to promote and facilitate the development and conduct of marine scientific research, in accordance with the LOSC. Other provisions elaborate this duty. For example, Article 255 urges States to adopt measures (such as rules, regulations and procedures) that facilitate marine scientific research and assist research vessels, including through access to harbours. The LOSC also provides that communications concerning marine scientific research projects should be made through appropriate official channels. It does not, however, specify what “appropriate official channels” are. In practice, communication usually occurs between contact points in foreign ministries, where scientific research is occurring in areas within national jurisdiction. Information sharing is a requirement under Article 244(1), which provides that “States and competent international organisations shall “make available by publication and dissemination through appropriate channels information on proposed major programmes and their objectives”. For research occurring in ABNJ, there is at present no designated communication channel. This is a gap that could be filled through the development of the ILBI to facilitate information sharing about scientific research and any activity involving access to marine genetic resources of ABNJ. For example, one option would be a clearinghouse or similar mechanism to facilitate sharing information about research activities.

19 LOSC art 242(1).
20 In areas within national jurisdiction, this could be considered as a coastal State receiving some recompense from consenting to the conduct of research by a researching State. In ABNJ, this does not apply, hence, a far broader interpretation is possible.
21 LOSC art 239.
22 LOSC art 250. See also LOSC art 244(1).
23 For example, the International Seabed Authority is identified in LOSC art 143(3c) as one of the international channels to facilitate information exchange relating to the Area.
24 See Section 5.5.2. For a discussion on the use of clearinghouses (or similar information systems) to facilitate information exchange, see Sections 4.3.1 and 4.4.2 of Chapter 4.
5.2.2.2. Definition of marine scientific research

The absence of a definition of “marine scientific research” is one of the gaps in the LOSC framework. This ambiguity leaves it open to interpretation which activities fall within the scope of the LOSC regime for marine scientific research. Some ocean data collection activities are not generally considered to fall within the scope of the LOSC regime for marine scientific research, including resources exploration, ex-situ observation technologies and hydrographic and military surveying. However, there is nothing to say that data collection activities relating to marine genetic resources of ABNJ are exempt. Nevertheless, the absence of a definition of marine scientific research complicates attempts to decipher whether activities relating to marine genetic resources constitute marine scientific research.

Different definitions of “marine scientific research” were proposed during the LOSC negotiations. The 1976 Informal Single Negotiating Text contained a definition of marine scientific research as “any study or related experimental work designed to increase mankind’s knowledge of the marine environment.” This definition was not retained in the final text of the LOSC. Despite the absence of a definition, the context of the references to the term “marine scientific research” in the LOSC enable the meaning to be interpreted. Article 243, which refers to scientific study of “the essence of phenomena and processes occurring in the marine environment, and the interrelations between them.” The inherent role of knowledge advancement through scientific research in order to achieve the objectives of the LOSC is reflected in the LOSC Preamble, which enshrines the:

- equitable and efficient utilisation of [marine] resources;

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25 Soons, above n 7, 151.
27 See Section 3.4.2 of Chapter 3.
30 LOSC Preamble [3].
• conservation of living resources; and
• “study, protection and preservation of the marine environment”.

LOSC Article 246 distinguishes between marine scientific research carried out “to increase scientific knowledge of the marine environment for the benefit of all mankind” and to be “of direct significance for the exploration and exploitation of natural resources, whether living or non-living”. This suggests that, in addition to knowledge advancement, activities relating to commercial exploitation could also be classified as scientific research under the LOSC.

However, opinion is divided on this. One point of view is that the distinction between marine scientific research and commercial exploitation lies in the intent and purposes of the activity. For example, Francioni (2006) argues that “prospecting” for deep-sea minerals in ABNJ, under the LOSC, “is considered to be an investigative activity undertaken, inter alia, for the estimation of the economic value of a resource, prior to its future commercial exploitation” and does not constitute marine scientific research. The Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) to the 1992 Convention on Biological Diversity (CBD) observed that the primary purpose of marine scientific research, under the LOSC, is to further mankind’s knowledge of the marine environment, not to conduct resource exploration for commercial purposes. On this basis, the SBSTTA suggest that marine scientific research has to be distinguished from other investigative marine activities with a commercial component (such as prospecting, exploration, or fish stock exploitation).

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31 LOSC art 246(3).
32 LOSC art 246(5)(a).
35 For a discussion on the definition of “prospecting”, see: Francesco Francioni, 'International Law for Biotechnology: Basic Principles' in Francesco Francioni and Tullio Scovazzi (eds), Biotechnology and International Law (Hart, 2006) 3, 29; ibid, [48].
37 SBSTTA, above n 34, [39].
assessment, which may involve confidentiality or proprietary rights), and proposed a definition that specifically excluded economic gain:

“an activity that involves collection and analysis of information, data or samples aimed at increasing mankind’s knowledge of the environment, and is not undertaken with the intent of economic gain. Since the object is the enhancement of knowledge, marine scientific research is characterized by openness, dissemination of data, exchange of samples, as well as publication and dissemination of research results as provided for in Part XIII [of the LOSC].”

However, as discussed in Chapter 3, this distinction can be difficult to achieve in practice in the case of marine genetic resources. Indeed, other scholars have cautioned against an interpretation that marine scientific research under the LOSC is predicated on the absence of intention of economic gain.

In the absence of a definition of marine scientific research in the LOSC, in practice, the validation of a marine scientific research project by a coastal State is one way to define the nature of marine scientific research. However, in the case of genetic resources research in marine areas within national jurisdiction, the validation of a project will be shaped by the more detailed requirements for access and benefit-sharing under the CBD and the 2010 Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilization to the Convention on Biological Diversity (Nagoya Protocol), and dependent on national access and benefit-sharing legislation. These instruments elaborate a more detailed framework for accessing genetic resources than the LOSC and hence will exert a stronger influence on the validation or otherwise of a marine

38 SBSTTA, above n 34, [47].
39 See Section 3.4.1.2 of Chapter 3.
40 Scovazzi, above n 33, 85.
scientific research project in areas within national jurisdiction. Thus, coastal State validation of research projects does little to explain whether State practice supports the notion that research involving marine genetic resources of ABNJ would be classified as scientific research.

Marine scientific research must not constitute the legal basis for any claim to the marine environment or its resources. This suggests that distinguishing between pure and applied research is necessary. However, it can be challenging to distinguish commercial from non-commercial scientific research in the case of marine genetic resources in ABNJ, and to apply such a distinction in practice. The difficulty of differentiating pure research (i.e. to advance knowledge) from applied research (i.e. for industrial purposes or economic gain) became a core and unresolved issue of the United Nations Conference on the Law of the Sea (UNCLOS III) negotiations. After the adoption of the LOSC, the struggle to find a satisfactory distinction between ‘pure’ and ‘applied’ research continued. Today, the boundaries between pure and applied research are increasingly blurred as technological advances and disruptive innovation drive changes relating to where, how and by whom scientific research can be conducted. The challenges in developing international agreements relating to marine scientific research are illustrated by the development of the 1993 Draft Convention on the Legal Status of Ocean Data Acquisition Systems, Aids and Devices (ODAS). The ODAS Convention was developed to address coastal States’ concerns about the use of ocean data acquisition systems such as profiling floats and buoys; however, it did not enter into force. This illustrates that defining scientific research is a long-standing challenge for the international community.

43 LOSC art 241. For a discussion on the application of LOSC art 241, see Montserrat Gorina-Ysern, 'Marine scientific research activities as the legal basis for intellectual property claims?' (1998) 22(4–5) Marine Policy 337-357.
44 DOALOS, above n 41, 4-6.
46 Glowka, 'Evolving Perspectives on the International Seabed Area's Genetic Resources: Fifteen Years after the Deepest of Ironies', above n 15. See also Section 3.4 of Chapter 3.
Given the ambiguities surrounding potential definitions of marine scientific research and activities relating to genetic resources, concerns have been raised that marine scientific research could be hindered by future benefit-sharing arrangements under an ILBI, including by Japan and the USA during the second session of the PrepCom.48 The need to avoid hindering marine scientific research and to promote, rather than stifle, research and innovation was also emphasised by numerous interventions, including those delivered on behalf of CARICOM, PSIDS, Australia, New Zealand, Japan, China, Singapore and Russian Federation during the third session of the PrepCom.49

Already, many actors, including scientists engaged in ‘non-commercial’ research, fall under access and benefit-sharing legislation relating to genetic resources.50 Fears about potentially negative consequences that hinder marine scientific research arising from developments in the international law of the sea are not new.51 Regarding the Area, Bowen (1985) warned that broad and vague definitions could have “alarming implications for the conduct of marine scientific research in international waters”.52 This illustrates the potential challenges posed by the absence of a definition of marine scientific research.

Article 251 provides for the “establishment of general criteria and guidelines to assist States in ascertaining the nature and implications of marine scientific research”, through competent


51 For example, after the adoption of the LOSC, various concerns were raised about timing, administrative, financial and logistical issues, including for access to research results and the data and samples. Soons, above n 7, 145.

52 Bowen, above n 45.
international organisations. However, to date, no such criteria have been published. One possible way forward would be to attempt to define features or categories of marine scientific research or activities, as discussed in Section 5.5.2.3.

On one hand, the absence of a definition of marine scientific research is a source of ambiguity for the question of benefit-sharing. There are questions of scope, such as whether the Part XIII regime applies only to marine scientific research (i.e. collection of samples and data at sea) or to data, information and knowledge derived from subsequent iterations of research and development processes including on-shore laboratory analysis (e.g. genetic sequence data or taxonomic knowledge). Given that “knowledge” implies cumulative research and analysis processes that occur after initial data collection, it could be argued that the duty to publish and share information does apply to ‘at sea’ and all subsequent ‘on-shore’ research and development. Nevertheless, the point at which marine scientific research, and the duty under Article 244, ends and other forms of research (such as commercial) research begin, is a question that needs to be considered in order to address the sharing of benefits from marine genetic resources of ABNJ. On the other hand the absence of a definition of marine scientific research, and the reality of the scientific research process involving marine genetic resources of ABNJ, suggests that Part XIII is relevant to activities involving marine genetic resources and a relevant basis for benefit-sharing. Therefore, although access to marine genetic resources is free and open, these provisions of Part XIII place some obligations that are relevant to benefit-sharing.

5.3. The development and transfer of marine technology

The aim of this Section is to examine the LOSC framework for the development and transfer of marine technology. Key elements of the LOSC framework are identified in Section 5.3.1. Challenges in the implementation of Part XIV of the LOSC are examined in Section 5.3.2.

53 Section 4.3.1 of Chapter 4.
54 See Section 2.3 of Chapter 2.
5.3.1. Conceptualising technology transfer: equipment, skills, knowledge, data, and more

The LOSC sets a broad framework for technology transfer, in particular, through Parts XI on the Area, XIII on Marine Scientific Research and XIV on the Development and Transfer of Marine Technology. In this Section, the historical context of technology transfer in the law of the sea is established in Section 5.3.2.1, before turning to an examination of Part XIV of the LOSC in Section 5.3.2.2. Finally, the meaning of technology transfer in the LOSC, and the implications for the sharing of benefits of marine genetic resources of ABNJ, is discussed in Section 5.3.2.3.

5.3.1.1. Understanding the historical context: bilateral hardware donation

To understand the issue of technology transfer under the law of the sea, it is necessary to consider the historic context. The inclusion of technology transfer in the UNCLOS negotiations was a pivotal moment,\(^{55}\) partially driven by scientific and technological advances and concerns about equity. For example, Arvid Pardo referred to an “oceanographic technology race” in his historic 1967 speech to the UNGA.\(^{56}\)

The LOSC identifies many purposes for technology transfer, ranging from social and economic development\(^{57}\) to the protection and preservation of the marine environment (Table 5.2).\(^{58}\) Of the 18 articles in the LOSC that refer to “technology” six articles are specifically related to the Area (Table 5.2).\(^{59}\) Furthermore, the only sectoral or geographically specific references in Part XIV relate to sea-bed mining activities in the Area. For example, article 274(d) refers to “the acquisition of necessary equipment, processes, plant and other technical

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\(^{56}\) Intervention delivered by Arvid Pardo on behalf of Malta During: ‘Examination of the question of the reservation exclusively for peaceful purposes of the sea-bed and the ocean floor, and the subsoil thereof, underlying the high seas beyond the limits of present national jurisdiction, and the use of their resources in the interests of mankind’ United Nations General Assembly (1967), 22nd sess, Item 92. First Committee, 1515\(^{th}\) meeting, 1 November 1967, UN doc. A/C.1/PV.1515, [27].

\(^{57}\) *LOSC* art 266.

\(^{58}\) *LOSC* art 202.

\(^{59}\) *LOSC* arts 144, 150(d), 155, 170, 273, 274. *LOSC* art 62 refers to technology in the context of the exclusive economic zone.
know-how” regarding activities in the Area. This suggests the development of the regime for technology transfer under the LOSC was strongly influenced by the development of the regime for the Area and its mineral resources.

Table 5.2: References to “technology” in the LOSC.

<table>
<thead>
<tr>
<th>Article</th>
<th>Context</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>62</td>
<td>Utilization of the living resources</td>
<td>EEZ</td>
</tr>
<tr>
<td>144</td>
<td>Transfer of technology</td>
<td>Area</td>
</tr>
<tr>
<td>150(d)</td>
<td>Policies relating to activities in the Area</td>
<td>Area</td>
</tr>
<tr>
<td>155</td>
<td>Review conference</td>
<td>Area</td>
</tr>
<tr>
<td>170</td>
<td>The Enterprise</td>
<td>Area</td>
</tr>
<tr>
<td>266</td>
<td>Promotion of the development and transfer of marine technology</td>
<td>General</td>
</tr>
<tr>
<td>267</td>
<td>Protection of legitimate interests</td>
<td>General</td>
</tr>
<tr>
<td>268</td>
<td>Basic objectives</td>
<td>General</td>
</tr>
<tr>
<td>269</td>
<td>Measures to achieve the basic objectives</td>
<td>General</td>
</tr>
<tr>
<td>270</td>
<td>Ways and means of international cooperation</td>
<td>General</td>
</tr>
<tr>
<td>271</td>
<td>Guidelines, criteria and standards</td>
<td>General</td>
</tr>
<tr>
<td>272</td>
<td>Coordination of international programmes</td>
<td>General</td>
</tr>
<tr>
<td>273</td>
<td>Cooperation with international organizations and the Authority</td>
<td>Area</td>
</tr>
<tr>
<td>274</td>
<td>Objectives of the Authority</td>
<td>Area</td>
</tr>
<tr>
<td>275</td>
<td>Establishment of national centres</td>
<td>General</td>
</tr>
<tr>
<td>276</td>
<td>Establishment of regional centres</td>
<td>General</td>
</tr>
<tr>
<td>277</td>
<td>Functions of regional centres</td>
<td>General</td>
</tr>
<tr>
<td>278</td>
<td>Cooperation among international organizations</td>
<td>General</td>
</tr>
</tbody>
</table>

This is further demonstrated by the only definition of technology to be found in the LOSC. LOSC Annex III article 5(8) defines technology as:

“the specialized equipment and technical know-how, including manuals, designs, operating instructions, training and technical advice and assistance, necessary to assemble, maintain and operate a viable system and the legal right to use these items for that purpose on a non-exclusive basis”.

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60 Note also that “LOSC Annex III article 17 (2)(b) refers to “state of the art technology (…) for seabed mining”.

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This illustrates that, for the purposes of the Area, the focus of technology transfer was on equipment. The 1994 Implementing Agreement further illustrates this, specifying the acquisition of deep seabed mining technology as a priority.\footnote{See, eg: 1994 Implementing Agreement Section 5.} This is a stark contrast to the more expansive conceptualisation of technology that is enshrined in Part XIV of the LOSC, as will be discussed in Section 5.3.2.

The specific and compulsory nature of the LOSC regime for technology transfer relating to the Area was, however, objectionable to many industrialised States.\footnote{See, eg: Marvasti, above n 55. C. C. Joyner, 'The united states and the new law of the sea' (1996) 27(1-2) Ocean Development and International Law 41-58.} There was a need to re-evaluate the technology transfer aspects of the LOSC regime for the Area in order to achieve universal participation in the LOSC. Consequently, the 1994 Implementing Agreement was developed to “facilitate universal participation in [the LOSC]”. According to Joyner (1996), the 1994 Implementing Agreement made international consensus on the law of the sea possible by replacing “an overly detailed and costly regime” in Part XI with a more streamlined approach.\footnote{Joyner, above n 62.} Indeed, many developed States ratified the LOSC after the adoption of the 1994 Implementing Agreement and the LOSC entered into force shortly afterwards. It is therefore instructive to consider how the 1994 Implementing Agreement addressed the issue of technology transfer.

An examination of the 1994 Implementing Agreement reveals that it largely eclipsed the mandatory requirement for technology transfer in relation to the Area. It explicitly stated that “the provisions of Annex III, article 5, of [the LOSC] shall not apply”, hence the definition referred to above is no longer relevant.\footnote{1994 Implementing Agreement, Section 5 [2].} It also softened the regime from mandatory technology transfer\footnote{LOSC Annex III article 5 sets out detailed requirements for the transfer of technology, rendering technology transfer a requirement for activities to take place in the Area.} to emphasise “fair and reasonable commercial terms and conditions on the open market” and the protection of intellectual property rights.\footnote{1994 Implementing Agreement, Section 5 [1(a) (b)].} The 1994 Implementing Agreement...
Agreement replaced the more stringent elements of Part XI with provisions for greater cooperation, such as joint-venture arrangements, to conduct technology transfer.

Marine scientific research was a prominent focus of the principles for the transfer of technology transfer articulated in the 1994 Implementing Agreement, which calls for the promotion of international technical and scientific cooperation with regard to activities in the Area. The 1994 Implementing Agreement emphasises the need for scientific and technical cooperation for the purposes of “developing training, technical assistance and scientific cooperation programmes in marine science and technology and the protection and preservation of the marine environment.” The emphasis on marine scientific research arising from the 1994 Implementing Agreement is illustrated by training initiatives provided by contractors through the ISA, including at-sea training, fellowships, master and PhD programmes in science and engineering related to sea-bed mining. This again illustrates the link between science cooperation, technology transfer and scientific and technological capacity building. In summary, the 1994 Implementing Agreement demonstrates that scientific research programmes and training initiatives are key components of the transfer of technology in ABNJ. This is further examined in the following Section, which turns to Part XIV of the LOSC.

5.3.1.2. Part XIV: a system for multilateral acquisition, sharing and utilisation of knowledge?

LOSC Part XIV establishes the international legal framework for the development and transfer of marine technology. Despite the various objectives and measures of technology transfer described in Part XIV, the LOSC does not include a definition of “technology” or

67 Joyner, above n 62.
68 1994 Implementing Agreement, Section 5 [1(a) (b)].
69 1994 Implementing Agreement, Section 5 [1(c)].
70 Ibid.
71 Seabed mining contractors have an obligation to provide training opportunities to developing States, see: ISA Contractor training program, available at https://www.isa.org.jm/contractor/training-activities accessed 28/12/2017.
“technology transfer”. This leaves the scope of technology open to interpretation. To understand the meaning of technology transfer, it is necessary to examine the LOSC.

Article 266 provides for the promotion of the development and transfer of marine science and technology, on “fair and reasonable terms and conditions”, and to foster “favourable economic and legal conditions” for “transfer of marine technology for the benefit of all parties concerned on an equitable basis”. The exploration, exploitation, conservation and management of marine resources, the protection and preservation of the marine environment, and marine scientific research are identified as priority areas for scientific and technological capacity building in order to accelerate social and economic development.

The basic objectives of the development and transfer of marine technology articulated in Article 268 are for States, directly or through competent international organizations, to promote:

a. “the acquisition, evaluation and dissemination of marine technological knowledge and facilitate access to such information and data;
b. the development of appropriate marine technology;
c. the development of the necessary technological infrastructure to facilitate the transfer of marine technology;
d. the development of human resources through training and education of nationals of developing States and countries and especially the nationals of the least developed among them;
e. international cooperation at all levels, particularly at the regional, subregional and bilateral levels”

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72 See Section 3.3.3 of Chapter 3.
73 LOSC art 266(1).
74 LOSC art 266(3).
75 LOSC art 266(2).
76 LOSC art 268.
This suggests that technology could be interpreted to encompass equipment, data and information involved in or arising from the acquisition, evaluation and dissemination scientific and technological data and knowledge. This interpretation is also reflected in the IOC Criteria and Guidelines on the Transfer of Marine Technology.\textsuperscript{77}

It is notable that the word “transfer” only appears once in Article 268. The primary focus is on the development of technology and scientific capacity, including equipment and infrastructure, trained people, knowledge, information and data, and cooperation. The following measures to achieve these objectives are identified in Article 269:

\begin{itemize}
\item[a.] “establish programmes of technical cooperation for the effective transfer of all kinds of marine technology to States which may need and request technical assistance in this field, particularly the developing land-locked and geographically disadvantaged States, as well as other developing States which have not been able either to establish or develop their own technological capacity in marine science and in the exploration and exploitation of marine resources or to develop the infrastructure of such technology;"
\item[b.] promote favourable conditions for the conclusion of agreements, contracts and other similar arrangements, under equitable and reasonable conditions;
\item[c.] hold conferences, seminars and symposia on scientific and technological subjects, in particular on policies and methods for the transfer of marine technology;
\item[d.] promote the exchange of scientists and of technological and other experts;
\item[e.] undertake projects and promote joint ventures and other forms of bilateral and multilateral cooperation.”
\end{itemize}

This suggests that international cooperation in science and technology is crucial to achieve the development and transfer of marine technology, including through technical cooperation

\textsuperscript{77} Intergovernmental Oceanographic Commission, \textit{IOC Criteria and Guidelines on the Transfer of Marine Technology} (UNESCO, 2005). See discussion in Section 3.3.3 of Chapter 3.
programs, conferences and scientist exchanges. Indeed, international cooperation in marine science and technology is repeatedly referred to as the main driver of implementing Part XIV, including through scientist exchanges and conferences. Part XIV Section 2 is dedicated to international cooperation, which is also a major focus of Section 3. Section 4 is dedicated to cooperation among international organisations. Regional cooperation is especially encouraged to establish regional marine science and technology centres in order to achieve, among other objectives, the acquisition and processing of marine scientific and technological data and information. Bilateral and multilateral agreements as well as bilateral, regional and multilateral programs are identified as means to achieve international cooperation in marine science and technology. The examination of Part XIV suggests that technology transfer is inextricably linked with marine scientific research and scientific capacity building. Further, it appears that the implementation of Part XIV rests on global, regional and sub-regional cooperation mechanisms, agreements, activities, projects and programs, implemented by networks of individuals and institutions, particularly through national and regional marine science and technology centres.

5.3.1.3. Discussion: the meaning of technology transfer under the LOSC

The verb “transfer” is defined by the Merriam-Webster dictionary as “to convey from one person, place, or situation to another”. This would imply a one-way activity, such as a bilateral hardware donation. However, as discussed above, a far broader interpretation of technology and technology transfer is implied in LOSC Part XIV, incorporating many elements from scientific knowledge to training and education. This suggests that

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78 **LOSC** art 269 refers to: (a) technical cooperation programs, (b) favourable conditions, (c) conferences, seminars and symposia, (d) exchange of scientists, and (e) projects, joint ventures, bilateral and multilateral cooperation.
79 **LOSC** art 269, 277(d). See also **LOSC** arts 266(1), 268(e), 269(a), 270, 272, 273, and 278.
80 **LOSC** arts 270, 271, 272, 273, 274.
81 **LOSC** arts 275, 276, 277.
82 **LOSC** art 278.
83 **LOSC** art 276. See also **LOSC** arts 266(1), 268(e), 269(a), 270, 272, 273, and 278.
84 **LOSC** art 277.
85 **LOSC** arts 243 and 270.
86 For a related discussion on benefit-sharing, see Section 4.2 of Chapter 4.
87 **LOSC** arts 268 and 269. See also **LOSC** art 144, concerning technology transfer in the Area, which also supports a broad interpretation of technology development and transfer.
“technology transfer” is analogous to cooperative research activities, training, knowledge exchange and technology development.

In support of this broad interpretation of technology transfer, it can be recalled from Chapter 3 that marine technology, as defined by the Intergovernmental Oceanographic Commission of UNESCO (IOC) in the Criteria and Guidelines on the Transfer of Marine Technology (CGTMT), reflects a broad range of elements, including: information and data, skills and equipment.88 The CGTMT were developed in response to Article 271, which called on States to promote the establishment of generally accepted guidelines, criteria and standards for the transfer of marine technology.89 The CGTMT have been the focus of much of the PrepCom deliberations and are recognised in the PrepCom report.90 The CGTMT are identified in the UN Sustainable Development Goal 14, Target 14.a, as having a role in increasing scientific knowledge, developing research capacity and transferring marine technology.91 A further example is provided by the 1987 Brundtland report, which referred to the “international diffusion of technology”, recognising that technology is not an independent variable, but dependent on various factors such as a social change.92 This is particularly relevant to the case of marine genetic resources of ABNJ, where there are already several drivers and applications of biodiversity research and technology.93 Therefore, in order to be consistent with Part XIV of the LOSC, it would be necessary to consider technology transfer as a multi-way exchange of knowledge, skills, and opportunities (such as access to infrastructure), rather than a one-way conveyance, in developing benefit-sharing measures under the ILBI.

88 Section 3.3.3 of Chapter 3.
89 Intergovernmental Oceanographic Commission, above n 77.
93 Section 2.5 of Chapter 2 and Section 3.2 of Chapter 3.
5.3.2. Implementation challenges

The actual requirements on States under Part XIV are fairly soft, constrained by weak language with clauses such as ‘States shall promote’ or ‘States shall endeavour to’. Vague requirements that technology transfer should be conducted on reasonable, fair and reasonable terms to States that “need and request” it on the basis of “mutual benefit” while ensuring “protection of legitimate interests” leave it a matter of interpretation as to when and for what technology transfer is required, and how it could be conducted. The requirement for technology transfer to be on “fair and reasonable” terms and conditions introduces some flexibility to negotiate terms of technology transfer. Flexibility could be important where commercial or proprietary material is in question, but would be less relevant where technology is open access.

There is no comprehensive institutional mechanism specified in Part XIV. States are obliged to endeavour to ensure that competent international organisations coordinate their activities relating to transfer of marine technology. States are further obliged to cooperate with competent international organisations and the International Seabed Authority (ISA) to encourage and facilitate transfer of technology and skills to developing States with regard to activities in the Area. The ISA is attributed with various roles, including to provide training and assistance to facilitate the acquisition of technology, skills and knowledge by developing States with regard to activities in the Area. However, no other institutions that play a role in technology transfer are explicitly named.

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94 See, eg: LOSC arts 266 and 268.
95 See, eg: LOSC arts. 266(1), 269(b), 144 (2)(a); 266(1).
96 LOSC arts 266, 275, 269(a), and 266(2).
97 The protection of legitimate interests is also provided for in LOSC art 267.
98 See discussion in Section 3.4.2.2 of Chapter 3.
99 For a brief discussion on this, see Section 7.5.1 of Chapter 7. For an analysis on the role of IOC in sharing benefits through science cooperation, technology transfer and capacity development, see Harriet Harden-Davies, "Marine science and technology transfer: Can the Intergovernmental Oceanographic Commission advance governance of biodiversity beyond national jurisdiction?" (2016) 74 Marine Policy 260-267.
100 LOSC art 272.
101 LOSC art 273.
102 LOSC art 274.
As discussed in Section 5.3.1, there is a strong focus on international cooperation in science and technology to deliver the objective of the development and transfer of marine technology in Part XIV. Bilateral, regional and multilateral marine scientific research programs (existing, expanded and new) are identified as the primary “ways and means of international cooperation” in Part XIV.\(^{103}\) The purposes of such programmes are to facilitate: marine scientific research; the transfer of marine technology, particularly in new fields; and appropriate international funding for ocean research and development.\(^{104}\) However, without a clearly identified institutional responsibility, this creates an over-reliance on unspecified, unsupported international scientific cooperation for capacity building. Furthermore, there are no specified tools to facilitate international cooperation, such as an information sharing system. This represents a significant weakness in Part XIV.

In contrast, Part XI does identify an institutional mechanism. Article 144 mandates a role for the ISA to facilitate technology transfer in relation to the Area including to cooperate in promoting and encouraging the transfer of technology and scientific knowledge to developing States.\(^{105}\) This includes initiating and promoting programmes for the transfer of technology (including facilitating access to relevant technology) and the advancement of the technology, particularly by providing opportunities for training in marine science and technology.\(^{106}\) The 1994 Implementing Agreement further specified the institutional mechanism to give effect to this scientific cooperation by tasking the ISA secretariat with the “acquisition of scientific knowledge”\(^{107}\) from marine scientific research conducted in the Area, and “monitoring of the development of marine technology”\(^{108}\); it was also mandated to perform the functions of the Enterprise including assessment of marine scientific research, evaluation of information and data.\(^{109}\) This highlights the skewed nature of the LOSC technology transfer regime towards seabed mining activities in the Area and that, unlike Part XIV, a specific institutional

\(^{103}\) LOSC art 270.

\(^{104}\) LOSC art 270.

\(^{105}\) LOSC art 144. Furthermore, Article 148 reinforces the emphasis on effective participation of developing States in activities in the Area, especially States that have difficulty accessing the resources of the Area. Article 150 sets out policies relating to activities in the Area, again reinforces the need to foster healthy development of the world economy and balanced growth of international trade, and to promote international cooperation for the over-all development of all countries, especially developing States.

\(^{106}\) See LOSC art 144(2).

\(^{107}\) 1994 Implementing Agreement, Section 1 [5(h)].

\(^{108}\) 1994 Implementing Agreement, Section 1 [5(i)].

\(^{109}\) 1994 Implementing Agreement, Section 2 [1].
mandate for technology transfer in the Area is provided under Part XI. In view of this imbalance, comprehensive institutional mechanisms to capture the breadth of technology transfer opportunities that could be associated with marine genetic resources of ABNJ need to be developed.

A further gap is that there are no funding mechanisms provided for in Part XIV. Article 270 is the only reference to funding, and this is entirely reliant on international cooperation through unspecified programmes. ¹¹⁰ This is especially relevant for ABNJ where the financial, technical and human resource requirements to undertake research demand international cooperation.¹¹¹ Article 270 emphasises the need for international cooperation to fund ocean research and development, especially in emerging fields and highlights the interlinkages between marine scientific research and technology transfer; this is therefore particularly relevant to marine genetic resources which are associated with various emerging fields of research.¹¹² Other omissions in Part XIV that can be identified include the absence of targets, performance measures, evaluation provisions or compliance tools.

Furthermore, there is no mechanism for States to assess technological need, or to request technology. Although Part XIV provides for development of marine scientific and technological capacity to States that “need and request” it.¹¹³ This is a gap that could be filled through the development of the ILBI, by specifying some way to identified, communicated and assess technological and scientific capacity building need, in addition to requesting technology.

In summary this Section has shown that LOSC provides a framework for the development of transfer of marine science technology that is inextricably linked to the acquisition, distribution and evaluation of scientific knowledge, including through access to equipment, training and information, knowledge and data. Thus, the LOSC provides a basis for sharing benefits from marine genetic resources of ABNJ. However, absent or unclear institutional,

¹¹⁰ See Section 7.5.2 of Chapter 7.
¹¹¹ Section 2.5.3 of Chapter 2.
¹¹² Section 2.5.2 of Chapter 2.
¹¹³ LOSC art 266(2).
funding and implementation mechanisms render many provisions of Part XIV little more than weak inducements for States. Some of the key measures in Part XIV, such as the establishment of regional and national science and technology centres, appear to have not been implemented as outlined in Part XIV. These are gaps that could be filled, in part, through the development of benefit-sharing measures under the ILBI.

5.4. Scientific and technological capacity building

The aim of this Section is to discuss the LOSC framework for scientific capacity building as a foundation for the sharing of benefits from marine genetic resources in ABNJ. As discussed in Chapters 2 and 3, scientific and technological capacity are critical factors for the acquisition, sharing and utilisation of benefits from marine genetic resources of ABNJ. All States and competent international organisations have the right to conduct marine scientific research, and thus to access marine genetic resources in situ in ABNJ, in accordance with Part XIII and other relevant provisions of the LOSC on the basis of equality. However, not all States have the means to do so. As observed by Pugh and Holland (2010) “the lack of needed local scientific skills in many parts of the world calls for scientific cooperation and the transfer of technology.”

Scientific and technological capacity building is an intrinsic element of the frameworks for both marine scientific research and the development and transfer of technology, as elaborated in Parts XI, XIII, and XIV of the LOSC. Scientific capacity building, can be considered as an objective and also an enabler of the development and transfer of marine technology under the LOSC. Increasing scientific and technological capacity is identified in Article 266(2) as an aim of technology transfer, and the development of technological infrastructure and human

114 Section 2.5 of Chapter 2 and Section 3.2.2 of Chapter 3.
115 LOSC art 238. Furthermore, Article 257 provides that all States and competent international organisations have the right to conduct marine scientific research in the water column beyond the limits of the exclusive economic zone, in conformity with the LOSC. Articles 143 and 256 provide that all States and competent international organisations have the right to conduct marine scientific research in the Area, in conformity with Part XI.
117 Geoffrey Holland and David Pugh (eds), Troubled waters: ocean science and governance (Cambridge University Press, 2010) 3.
resources (through training and education) are among the basic objectives of technology transfer articulated in LOSC Article 268.\textsuperscript{118} The LOSC provisions for technical, human and institutional scientific capacity building include:

- the acquisition of technological infrastructure;\textsuperscript{119}
- development of human resources through training and education;\textsuperscript{120} and
- the establishment of national and regional marine science and technology centres.\textsuperscript{121}

The establishment of national and regional marine science and technology centres is promoted in the LOSC to advance the conduct of marine scientific research, enhance capabilities to utilise and preserve marine resources, and transfer marine technology.\textsuperscript{122} \textsuperscript{123}

States are required to promote the establishment of, and cooperation with, regional marine scientific and technological research centres.\textsuperscript{124} Such regional centres are envisaged to serve a number of functions, including:

- training and educational programmes, management studies, organisation of regional conferences;
- acquisition and processing of marine scientific data and information;
- disseminate results;
- publicise and analyse national policies for transfer of marine technology;
- provide information on the technology marketing, contracts and patents; and
- technical cooperation with other States.\textsuperscript{125}

\textsuperscript{118} LOSC arts 268(c) and (d).
\textsuperscript{119} LOSC art 268(c).
\textsuperscript{120} LOSC arts 275(2), 277(a), and 268(d).
\textsuperscript{121} LOSC arts 274, 275, 276, and 277. Article 244 further provides that States should strengthen the autonomous marine scientific research capabilities of developing States, including through technical and scientific training programmes, see Section 5.2.
\textsuperscript{122} LOSC arts 269, 274, and 277.
\textsuperscript{123} LOSC art 275. Part XIV Section 3 provides for national and regional marine scientific and technological centres in the development and transfer of marine technology.
\textsuperscript{124} LOSC art 276.
\textsuperscript{125} LOSC art 277.
The need to strengthen national capabilities in marine science and technology to achieve equitable use of the ocean and its resources was a prominent feature during the development of the LOSC. This is illustrated by the Resolution on Development of National Marine Science, Technology and Ocean Service Infrastructures—part of the Final Act of UNCLOS III—which states that “unless urgent measures are taken, the marine scientific and technological gap between developed and developing countries will widen further and thus endanger the very foundations of the new [LOSC] regime”. The resolution recognized the importance of strengthening national capabilities in marine science, technology and ocean service infrastructures to ensure developing countries can share in rapid advances made in marine scientific research and enable the rapid absorption and efficient application of technology and scientific knowledge available. The development of national scientific and technological capacity remains an important priority.

Regional scientific and technological capacity is also important today. The UNGA has recognised the importance of coordinating activities with regional and national marine science and technology centres to achieve development objectives, and the SAMOA Pathway has highlighted the “establishment of dedicated regional oceanographic centres” and the provision of technical assistance. As will be discussed in Chapter 6, national and regional marine science and technology centres play an important role in developing global scientific capacity, advancing knowledge and fostering the development and transfer of marine technology. However, it is evident from Part XIV that the LOSC provides an overarching common vision for such centres, but does not specify resources or institutional support for implementation.

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The LOSC framework for scientific and technological capacity building has been elaborated through the 1994 Implementing Agreement and the UNFSA. The 1994 Implementing Agreement sought to develop training, technical assistance and scientific cooperation programmes in marine science and technology and the protection and preservation of the marine environment.\(^\text{129}\) UNFSA recognised the need for scientific and technological assistance in order for developing States to participate effectively in the conservation and sustainable use of straddling and highly migratory fish stocks.\(^\text{130}\) Both instruments identified implementation mechanisms.\(^\text{131}\) These examples illustrate how the broad LOSC provisions in Part XIV could be elaborated and given greater effect through the development of the ILBI by identifying institutional mechanisms.

For marine genetic resources of ABNJ, scientific capacity building was a key issue identified at the PrepCom.\(^\text{132}\) The Group of 77 (G77) plus China have stated that the ILBI should promote increased scientific knowledge, research capacity building and marine technology transfer.\(^\text{133}\) The Alliance of Small Island Developing States (AOSIS) and Pacific Small Island Developing States (PSIDS) highlighted at the PrepCom that capacity limitations of small island developing states hinder their ability to participate in and benefit from scientific research in ABNJ.\(^\text{134}\) The Federated States of Micronesia has suggested that the ILBI should

\(^{129}\) 1994 Implementing Agreement, Annex, Section 5 [1(c)].
\(^{130}\) UNFSA Preamble. See also UNFSA arts 14(3), 25(3)(b), Annex 1 art 1(2).
\(^{131}\) For example, the ISA is identified in the 1994 Implementing Agreement and Regional Fisheries Management Organisations (RFMOs) are identified institutions in the UNFSA. For further discussion see Section 7.2.2 and 7.5.1 of Chapter 7.
include measures for the acquisition of scientific knowledge relating to biodiversity in ABNJ and training in marine science and technology.\textsuperscript{135}

The discussion in this section has shown that scientific and technological capacity building is an integral part of the LOSC regime for the development and transfer of marine technology and is inextricably linked to the LOSC regime for marine scientific research. This suggests that science cooperation and the development and transfer of technology can support scientific and technological capacity building. In turn, scientific and technological capacity building can also enable participation in scientific cooperation and technology transfer. These links are discussed further in the following Section.

\textbf{5.5. Discussion: the LOSC as a basis for sharing benefits from marine genetic resources of ABNJ}

This Section examines the basis for sharing benefits from marine genetic resources of ABNJ. The links between marine scientific research, the development and transfer of marine technology, and scientific capacity building in the LOSC are discussed in Section 5.5.1. The gaps and ambiguities in the LOSC framework are identified in Section 5.5.2 and the opportunities and challenges for sharing benefits from marine genetic resources of ABNJ through the development of an ILBI are analysed.

\textit{5.5.1. Marine scientific research, technology transfer and scientific capacity are linked: the LOSC provides a basis for an integrated approach}

The analysis of LOSC Parts XIII and XIV presented in this Chapter suggests that international science cooperation, sharing knowledge and data, and scientific and technological capacity building are inextricably interlinked in the LOSC framework provisions for marine scientific research and the development and transfer of technology.

These links can also be seen in individual provisions in Part XI, XIII, and XIV, as illustrated by Articles 143, 244 and 268. The link between science and technology is articulated in Article 266(1), which encourages States to promote the development and transfer of “marine science and marine technology”.\textsuperscript{136} The link between Parts XIII and XIV is noted by Gonzales (2007), who observed that the introduction of measures to implement LOSC Part XIV through transfer of marine technology would have a dual effect and also promote the implementation of marine scientific research under LOSC Part XIII.\textsuperscript{137}

The analysis has shown that the right to conduct science in ABNJ is balanced by the responsibility to share the outcomes of science and to help build capacity of States to use such outcomes through international cooperation and the transfer of marine technology, including in research programs, training and provision of technical assistance.\textsuperscript{138} This is discussed by Long (2007), who suggests that the international legal principle that the enjoyment of rights is balanced by the discharge of duties is most evident with respect to those provisions in the LOSC which are aimed at promoting marine scientific research and technology transfer.\textsuperscript{139}

As discussed in Chapter 3, data, information and knowledge can be considered as benefits from marine genetic resources. The link between acquisition, dissemination and application of scientific knowledge has been long recognized as important in the context of ABNJ. The 1970 Declaration of Principles Governing the Sea-Bed and the Ocean Floor, and the Subsoil Thereof, Beyond the Limits of National Jurisdiction,\textsuperscript{140} for example, called on States to promote international cooperation in scientific research through: (a) participation in international programs including by encouraging participation of personnel from different

\textsuperscript{136} For example, the promotion of the development of marine scientific and technological capacity of States to conserve and manage marine resources, protect and preserve the marine environment and conduct marine scientific research, are some of the guiding principles provided for in Article 266(2) for the development and transfer of marine technology. Article 266(1) “marine science and marine technology” are considered together, furthermore, in Article 270 international cooperation, through programmes, to facilitate marine scientific research and the transfer of marine technology are considered together.

\textsuperscript{137} González, above n 7.

\textsuperscript{138} LOSC art 244; See, eg: Long, above n 17, 309.

\textsuperscript{139} Ibid.

countries; (b) publication of research programs and dissemination of results; (c) strengthening research capabilities. The 1994 Implementing Agreement identifies the promotion of international technical and scientific cooperation in the Area as a guiding principle for technology transfer, and includes references to scientific capacity building. It also includes an obligation for States Parties to promote international technical and scientific cooperation. This again illustrates that international scientific cooperation and the development and transfer are interlinked in the law of the sea and illustrate the broad significance of the benefit-sharing elements considered in this thesis for ABNJ.

Consequently, this suggests that the LOSC provides the basis for an integrated approach the sharing of benefits from marine genetic resources of ABNJ through scientific and technological capacity building, including marine scientific research cooperation, sharing knowledge and data, technology development, and human, institutional and technical scientific capacity building (Figure 5.1). As discussed in Chapters 3 and 4, these three elements must be considered together in benefit-sharing.

141 Ibid at [10].
142 1994 Implementing Agreement Annex (Section 5 (1)(c)).
143 See Section 5.3.1 and 5.4 of this Chapter.
144 1994 Implementing Agreement, art 144.
Figure 5.1: International science cooperation, sharing knowledge and data, and scientific capacity building are interlinked in the LOSC framework provisions for marine scientific research and the development and transfer of technology. Sources: LOSC Part XI (Articles 143 and 144), Part XIII (Article 244) and Part XIV (Article 268 and 269).

Specifying the interlinkages between science cooperation, technology transfer and capacity building under an ILBI would offer two advantages. Firstly, this would recognise the breadth of the framework under Part XIV. In doing so, this would capture the alignment between “non-monetary” benefits of marine genetic resources and scientific and technological capacity building. Secondly, this would recognise that scientific capacity building can be considered at global, regional and national levels, highlighting the focus on regional scientific capacity building and the development of new technologies that is embodied in Part XIV. The question that follows is how comprehensive the current LOSC regime is, and whether

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145 Section 3.2.3.3 of Chapter 3.
146 This is further illustrated by the focus on the development of technology in LOSC art 266, see Section 4.3.1.4.
there are gaps that could be filled by the development of an ILBI in order to enable the sharing of benefits from marine genetic resources of ABNJ.

5.5.2. The need to strengthen the implementation of the LOSC

Although the LOSC provides a basis for benefit-sharing in Part XIII and XIV, the analysis in this Chapter has also revealed weaknesses and ambiguities in this framework which suggest that implementation could be strengthened. This has been widely recognised throughout the deliberations of the PrepCom, for example, interventions delivered on behalf of the PSIDS and Bangladesh during the second session of the PrepCom called for the ILBI to ‘operationalise Part XIV’, while an intervention delivered on behalf of CARICOM during the third session of the PrepCom called for the ILBI to operationalise the CGTMT.

The international imbalance in scientific and technical capacity (including institutions, infrastructure and financial resources) hinders the ability of States to undertake and benefit from scientific research and technological advancement. The need for ocean science and technology transfer and increased implementation of the LOSC to this end is well established. As observed by Long (2007), this gap “makes it difficult to implement the broader principles of international cooperation and benefit-sharing enshrined by the LOSC”. As discussed in Chapter 1, these implementation challenges could hinder benefit-sharing from marine genetic resources of ABNJ.

The need for greater international collaboration in marine scientific research and technology transfer is well recognised. Recalling Annex VI of the Final Act to UNCLOS III Long

149 Aldo Chircop, 'Advances in ocean knowledge and skill: Implications for the MSR regime', in Nordquist, Myron H, Ronan Long, Tomas H Heidar, John N Moore (eds), Law Science and Ocean Management (Martinus Nijhoff, 2007) 575; Long, above n 17, 308; González, above n 17.
150 Holland and Pugh above n 117, 4.
151 Long, above n 17, 308.
152 Ibid, 302.
(2007) makes three points that support the argument set forth in this Chapter. First, that the international community should strengthen the institutional mechanism for science and technology capacity building to foster international cooperation in marine scientific research and provide scientific and technical assistance to Developing States. Second, that without this, it will not be possible to achieve equitability. Thirdly, that the enjoyment of rights under the LOSC goes hand in hand with “the discharge of obligations by implementing both the letter and the spirit” of [Part XIII and Part XIV]. This reinforces the suggestion that Part XIV of the LOSC is ripe for further implementation through the development of the ILBI.

The contemporary relevance of the need to strengthen the implementation of LOSC Part XIV is articulated by the United Nations General Assembly which, in 2015 and 2016, recognised that realising benefits of the LOSC could be enhanced by international cooperation, technical assistance and capacity-building. Thus, the need to strengthen the implementation of Part XIV of the LOSC overall is apparent – for marine genetic resources of ABNJ and for sustainable development overall. This presents a range of opportunities and challenges to States in the negotiation for the ILBI, to address the gaps and ambiguities in the LOSC framework for scientific and technological capacity building. Successful implementation will be dependent, to an extent, on the relevance of the provisions to the issue at hand. Changes in international legal and scientific environments influence the relevance and implementation of Part XIV and XIII; as noted by Golitsyn (2007), given the changes since the 1970s it is not surprising that the drafters of the LOSC did not anticipate the technical complexities involved in application of the provisions of Part XIII and XIV.

Although Part XIV is considered poorly implemented, it is not necessarily the case that there has been no implementation. On the contrary, there are undoubtedly examples of implementation (either directly or indirectly), as will be discussed in Chapter 6. One possibility is that implementation is occurring, perhaps on bilateral levels, but is not being captured in a reporting framework – this would point to a gap in the evaluation framework.

153 Ibid, 311.
155 Golitsyn, above n 17.
Another possibility is that implementation is, on the whole, not occurring. One of the key challenges for States in the development of the ILBI is to provide for the scientific and technical complexities of processes relating to marine genetic resources of ABNJ and to anticipate future technological developments. The opportunities and challenges for the development of the ILBI can be considered as follows:

- International cooperation in marine scientific research (Section 5.5.2.1);
- Sharing data, information and knowledge (Section 5.5.2.2);
- Clarifying terminology – marine scientific research (Section 5.5.2.3); and
- Implementation tools (Section 5.5.2.4).

5.5.2.1. International cooperation in marine scientific research

Regarding international cooperation, the report of the PrepCom stated that:

“The text would set out the obligation of States to cooperate for the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction, and elaborate on the content and modalities of this obligation” (emphasis added).\(^{156}\)

The LOSC establishes a requirement to cooperate to promote and facilitate marine science\(^{157}\) in order to advance knowledge and develop technology,\(^{158}\) and to share the outcomes of research,\(^{159}\) including data and knowledge, with other states. The purposes of these measures include to accelerate social and economic development\(^{160}\) and to protect and preserve the marine environment.\(^{161}\) Furthermore, international cooperation in marine scientific research (facilitated through scientist exchanges and conferences),\(^{162}\) especially at the regional and

\(^{156}\) PrepCom report, above n 90, 18.
\(^{157}\) LOSC arts 239, 242, 243.
\(^{158}\) LOSC arts 266, 268.
\(^{159}\) LOSC art 244.
\(^{160}\) LOSC art 266.
\(^{161}\) LOSC art 202.
\(^{162}\) LOSC art 269, 277(d).
subregional level\textsuperscript{163} facilitated through the envisaged regional science and technology centres, is the primary method to achieve technology transfer identified by the LOSC.\textsuperscript{164}

However, the lack of specified institutional and funding mechanisms has rendered these little more than a conceptual idea under the LOSC framework and this in turn weakens the implementation of Part XIV. The continued emergence of internationally collaborative programmes requires the coordinated involvement of many States.\textsuperscript{165} Strengthening the implementation of scientific and technical cooperation provisions of the LOSC could provide opportunities for benefit-sharing through capacity building and technology transfer.\textsuperscript{166}

For example, Article 243 stipulates that “States and competent international organisations shall cooperate through the conclusion of bilateral and multilateral agreements, to create favourable conditions for the conduct of marine scientific research in the marine environment and to integrate the efforts of scientists in studying the essence of phenomena and processes occurring in the marine environment and the interrelations between them”. This highlights that multilateral agreements are identified in the LOSC as a mechanism for international cooperation to facilitate marine scientific research being conducted at sea. Further, by stating that such agreements should “integrate efforts of scientists”, Article 243 implies a more sophisticated and comprehensive process than cooperation – more akin to collaboration.\textsuperscript{167} The development of the ILBI could be considered as an opportunity to further the implementation of Article 243 by creating favourable conditions for international collaboration in marine scientific research involving marine genetic resources in ABNJ in studying the essence of marine life. The potential measures that could be adopted under the ILBI for this are further explored in Section 7.2 of Chapter 7.

\textsuperscript{163} LOSC art 268(e).
\textsuperscript{164} LOSC arts 266(1), 268(e), 269(a), 270, 272, 273, 278. For a discussion on the role of international scientific cooperation regarding the implementing Part XIII and XIV by EU member States, see Ronan Long, ‘Regulating marine scientific research in the European Union: It takes more than two to Tango’ (2012) 15 Center for Oceans Law and Policy 428-491.
\textsuperscript{165} Section 2.5 of Chapter 2 and Section 6.2 of Chapter 6.
\textsuperscript{166} DOALOS, above n 41.
\textsuperscript{167} For a discussion of the difference between cooperation and collaboration see Section 6.2.2.1 of Chapter 6.
5.5.2.2. Sharing data, information and knowledge

Under Part XIV, the acquisition, evaluation and dissemination of marine technological knowledge, as well as facilitated access to information and data, is identified in article 268(a) as a basic objective of technology development and transfer. The dissemination of marine scientific and technological research results is a modality of technology transfer, under articles 276 and 277(f). The sharing of scientific knowledge, data and information is provided for throughout the LOSC, for purposes ranging from the conservation of the living resources of the high seas to the protection of the marine environment (Table 5.2). In some instances there are references to ‘technology and scientific information’. In others, such as Article 144, there are provisions concerning the transfer of ‘technology and scientific knowledge’ “so that all States Parties may benefit therefrom”. The references to such terms in the LOSC suggest that outcomes of scientific research, such as knowledge and information, can be considered to be synonymous with technology. In turn, this suggests that benefits from marine genetic resources of ABNJ could be considered to include a range of data, knowledge and information outcomes from scientific research.

166 LOSC art 277(f) identifies “prompt dissemination of results of marine scientific and technological research in readily available publications” as a function of regional [marine science and technology] centres, which, under art 276, is envisaged to stimulate scientific research and foster technology transfer.
169 LOSC arts 61(5), 119 (2), 144, 200, 201, 268 (a), 277 (e).
Table 5.2: Knowledge, information and data exchange provisions of the LOSC.  

<table>
<thead>
<tr>
<th>Term</th>
<th>Article</th>
<th>Article [context]</th>
<th>Part</th>
<th>Application</th>
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<td>119 [2]</td>
<td>Conservation of the living resources of the high seas</td>
<td>VII</td>
<td>high seas</td>
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<tr>
<td>&quot;Scientific knowledge&quot;</td>
<td>144</td>
<td>Transfer of technology</td>
<td>XI</td>
<td>Area</td>
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<td>Marine scientific research in the exclusive economic zone and on the continental shelf</td>
<td>XIII</td>
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<tr>
<td>&quot;Knowledge&quot; [in context of science and technology]</td>
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<td>Publication and dissemination of information and knowledge</td>
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<td></td>
<td>268</td>
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<td>&quot;Information&quot; [in context of science and technology]</td>
<td>200</td>
<td>Studies, research programmes and exchange of information and data</td>
<td>XII</td>
<td>general</td>
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<td></td>
<td>201</td>
<td>Scientific criteria for regulations</td>
<td>XII</td>
<td>general</td>
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<td>&quot;Data&quot;</td>
<td>61 [5]</td>
<td>Conservation of living resources</td>
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<td>62[4][f]</td>
<td>Utilization of living resources</td>
<td>V</td>
<td>EEZ</td>
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<td>119 [2]</td>
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<td>Studies, research programmes and exchange of information and data</td>
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<td>Duty to comply with certain conditions</td>
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<td>277(e)</td>
<td>Transfer of data</td>
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<td>Annex III, Article 14</td>
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Both Articles 244 (Part XIII) and 268 (Part XIV) provide a basis for sharing information and data; this suggests that sharing information and data is a requirement for both marine scientific research and the development and transfer of marine technology, and that the LOSC could in this way provide a basis for benefit-sharing. However, this is not an unequivocal requirement to share data relating to marine genetic resources from ABNJ as a form of benefit-sharing, for two reasons. Firstly, the absence of definitions of “marine technological data"...
knowledge (…) information and data” (article 268), “knowledge resulting from marine scientific research” (article 244(1)) and “scientific data and information” leave it open to interpretation as to whether this would apply to the outcomes of scientific research on marine genetic resources in ABNJ. The references to these terms elsewhere in the LOSC do not provide a clearer definition of these terms (Table 5.2). Secondly, articles 244(2) and 268 are vague and fairly weak; calling on States to “promote” information sharing. Article 244(1) is slightly more prescriptive “States shall”, but is still not unequivocal. The “flow of scientific data and information” called for under 244(2) is also vague, for example, there is no guidance on the types of data and information that should be included, the time frame for sharing, or the institutional or technical arrangements to enable this to take place. These ambiguities make it practically impossible to enforce and monitor the exchange of scientific information and data. The extent to which Article 244 provides a basis for sharing benefits from marine genetic resources—in terms of what forms of data and information would be within scope—is unclear and an issue requiring further deliberation among States in the negotiation of the ILBI. Options to elaborate and further implement this obligation in order to share benefits from marine genetic resources of ABNJ are discussed in Section 7.3 of Chapter 7.

5.5.2.3. Clarifying criteria of marine scientific research

As noted in Chapter 3, a legal definition of marine scientific research would be desirable to add legal certainty to research activities and enable the distinction between commercial and non-commercial research activity involving marine genetic resources of ABNJ. However, the challenges of this have also been discussed in Section 5.2. For the development of the ILBI, a distinction is particularly difficult given the increasingly blurred boundary between pure and applied scientific research, with the advent of new technologies driving transformative change in where, how and by whom marine scientific research can be conducted. The definitional gaps mean that the promotion and facilitation of marine scientific research will be particularly important, as referred to above. Rather than seeking to define

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171 LOSC art 244(2).
172 Definitions of data are discussed in Section 3.4 of Chapter 3.
173 LOSC art 244 makes no reference to time, art 143(3)(c) refers to “when appropriate”.
174 Section 3.3.1 of Chapter 3.
175 Section 3.4.1.1 of Chapter 3.
“marine scientific research”, an alternative pathway would be to elaborate criteria and guidelines for marine scientific research as envisaged in Article 251. This code could be based on existing practices in marine scientific research. Article 240(b) could be a basis for elaborating criteria or guidelines for “appropriate scientific methods and means” for accessing marine genetic resources of ABNJ in situ, including to ensure the protection and preservation of the marine environment.

The establishment of guidelines or criteria for research relating to marine genetic resources of ABNJ could be informed by prior attempts to define scientific research in the law of the sea. Three examples are considered in the following discussion: an Assessment Framework for Scientific Research (2010); an attempt to decipher the meaning of “scientific research” in the context of whaling (2014); and a definition of “scientific activities” in the context of the Arctic (2017).

The first example is the Assessment Framework for Scientific Research Involving Ocean Fertilisation. This was developed under the 1992 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention) and the 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Protocol), in order to determine whether a project constitutes “legitimate scientific research”. The framework creates an approval process for proposed ocean fertilisation scientific research projects, consistent with the provisions of the LOSC, that requires any proposed project to satisfactorily demonstrate that it displays ‘proper scientific attributes’ and that environmental impact assessment criteria have been met. As

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176 Scovazzi, above n 33, 95.
179 Resolution LC-LP.2 (2010) on the Assessment Framework for Scientific Research Involving Ocean Fertilisation’, 32nd Consultative Meeting of the Contracting Parties to the London Convention and 5th meeting of the Contracting Parties to the London Protocol (14 October 2010). In 2007, the Scientific Groups of the London Convention and London Protocol issued a statement of concern regarding iron fertilisation of the oceans. The resulting resolution provided that, given the limited knowledge on iron fertilisation, activities other than “legitimate scientific research” should not be allowed. Legitimate scientific research is regarded as placement of matter for a purpose other than the mere disposal thereof, see: ‘Resolution LC-LP.1 (2008) on the Regulation of Ocean Fertilisation’, 30th mtg of the Contracting Parties to the London Convention and 3rd mtg of the Contracting Parties to the London Protocol (31 October 2008) [3].
observed by Markus and Ginzky (2011), the strong involvement of scientific experts within the London Convention-London Protocol Scientific Groups played an influential role in the development of the Assessment Framework as a tool for transparent decision-making and international coordination in knowledge creation.180 Similarly, scientific bodies could play a role in informing the creation of guidelines or assessment tools to determine scientific research involving marine genetic resources.

A second example is provided by the decision181 by the International Court of Justice with respect to ‘scientific whaling’ or ‘special permit whaling’ under the 1946 International Convention for the Regulation of Whaling (ICRW).182 Scientific research is not defined by the ICRW. Australia argued that scientific research in the context of the ICRW has four essential characteristics, including: defined and achievable objectives (questions or hypotheses);183 “appropriate methods”; peer review; and the avoidance of adverse effects on stock.184 The Court was not persuaded that activities must satisfy these four criteria in order to constitute “scientific research”, rather, it considered that these criteria reflected well-conceived scientific research rather than serving as an interpretation of the term as used in ICRW Article VIII.185 However, the Court observed that scientific research should proceed on the basis of particular questions, which could take the form of a hypothesis.186 This example illustrates some of the features that could be considered as constituting scientific research, including identified research questions.

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181 Whaling in the Antarctic (Australia v. Japan: New Zealand Intervening), 31 March 2014. A key focus of this case was the interpretation of scientific research by the Japanese Whale Research Program under Special Permit in the Antarctic (JARPA).
182 1946 International Convention for the Regulation of Whaling, opened for signature 2 December 1946, 161 UNTS 72 (entered into force 10 November 1948), art VIII.
183 i.e. to contribute to knowledge.
184 Australia v. Japan above n 181, [74].
185 Ibid [85].
186 There was no agreement about the level of specificity required of such a hypothesis, Ibid [76] [77] [84].
The third example is provided by the *2017 Arctic Science Cooperation Agreement*. Article 1 of this agreement defined “scientific activities” as:

“efforts to advance understanding of the Arctic through scientific research, monitoring and assessment. These activities may include, but are not limited to, planning and implementing scientific research projects and programs, expeditions, observations, monitoring initiatives, surveys, modelling, and assessments; training personnel; planning, organising and executing scientific seminars, symposia, conferences, workshops, and meetings; collecting, processing, analysing, and sharing scientific data, ideas, results, methods, experiences, and traditional and local knowledge; developing sampling methodologies and protocols; preparing publications; and developing, implementing, and using research support logistics and research infrastructure.”

In addition to the conduct of scientific research, this definition also captures many activities relating to technology transfer and capacity building (such as training workshops, data sharing). This further supports the link between science, technology transfer and capacity building. It also provides an example of how a comprehensive definition capturing the breadth of possible activities that would be relevant to benefit-sharing of marine genetic resources of ABNJ can be elaborated in treaty form.

Taken collectively, these three examples illustrate that over the past decade, the question of “defining scientific research” is a growing issue for the international law of the sea and that a range of approaches have been taken to overcome the definitional gap relating to “marine scientific research” in the LOSC. Possible options to elaborate the meaning of marine scientific research relating to marine genetic resources include: an assessment framework, a definition of “scientific activities”, or the establishment of guidelines. Establishing guidelines

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that elaborate the nature of marine scientific research could support the facilitation of marine scientific research involving access to marine genetic resources.

5.5.2.4. Implementation tools: institutional clarity, funding pathways

According to Sands (2012), technology transfer is an explicit objective in most international environmental instruments, but one that is not always matched with implementation mechanisms. The difficulty in achieving internationally agreed approaches to implement technology transfer under the LOSC is discussed by Marvasti (1998), who notes the importance of institutional capacity and cooperation. The challenges in implementing LOSC Part XIV are illustrated by the progress in implementing the CGTMT. Three broad mechanisms of technology transfer are envisaged in the CGTMT. First, the IOC has a recognised role in: establishing and coordinating a clearinghouse mechanism for the transfer of marine technology, promoting the establishment of regional focal points for the transfer of technology, organising meetings and events and seeking trust fund contributions. Second, Transfer of Marine Technology Applications are envisaged to be used for member States to submit requests for technology transfer to the IOC. Third, assistance from IOC is envisaged to implement Transfer of Marine Technology Projects. Implementation of the guidelines has occurred, to varying degrees. However, as will be discussed in Chapter 6, several barriers have also been encountered in implementing the development and transfer of marine technology as envisaged in Part XIV. The importance of institutional clarity and funding pathways to implement transfer of marine technology with respect to benefit-sharing

189 Sands, above n 55, 680.
190 Marvasti, above n 55.
191 IOC above n 77, [C(1)].
192 Ibid [C.2.3.4], Annex.
193 Ibid [C(5)].
195 See, eg: Harden-Davies, above n 99.
is discussed in Chapter 6. Options to support marine technology transfer under the ILBI are discussed in Section 7.5 of Chapter 7.

5.6. Conclusion

This Chapter has examined the framework provisions for marine scientific research and the development and transfer of technology under the LOSC, with particular attention to Parts XIII and XIV. It has been shown that the LOSC provides an obligation for international cooperation to advance the study of the marine environment, to share information and knowledge and to develop scientific and technological capacity in order to accelerate sustainable development and to protect the marine environment. The analysis has demonstrated that the paradigm of technology transfer under the LOSC has progressively shifted, from a focus on bilateral hardware donation regarding industrial seabed-mining equipment to a focus on multi-lateral exchange of knowledge and skills to develop scientific and technological capacity through research. Thus, it is suggested that the ILBI is an opportunity to further shift the paradigm of technology transfer from bilateral hardware donation to a more holistic and multi-faceted enabling system for scientific and technological capacity building at global, regional and national scales.

The analysis has demonstrated that the three elements of benefit-sharing considered in this thesis (international scientific research cooperation, development and transfer of technology, and scientific capacity building) are interlinked in the LOSC framework, as illustrated in Articles 244, 268 and 143. For example, the framework for the development and transfer of marine technology rests on scientific and technological cooperation, and places a strong emphasis on the development of human, technical and institutional scientific capacity at global, regional and national scales. This supports the conclusion of Chapter 4 that the three elements of benefit-sharing considered in this thesis are linked and should be considered as integrated. Further, it suggests that the LOSC provides a basis for an integrated approach to the sharing of benefits from marine genetic resources of ABNJ through the development of scientific and technological capacity.
However, the current LOSC framework for the development of scientific and technological capacity is currently weakened by gaps and ambiguities, whereby the scope of technology transfer is open to interpretation and implementation mechanisms are minimal or absent. These gaps and ambiguities pose both a challenge and an opportunity for the development of the ILBI. The challenge is that the gaps are likely to need to be filled in order for benefit-sharing to occur; this will be examined in Chapter 6 through an examination of current practices in science cooperation, technology transfer, data sharing, and capacity building. On the other hand, the development of the ILBI is an opportunity to enable States to better implement existing obligations under the LOSC contained in Parts XIII and XIV; this will be discussed in Chapter 7.
Chapter 6

Current practice: sharing benefits through scientific and technological capacity building

6.1. Introduction

The aim of this Chapter is to examine current practices in sharing benefits from marine genetic resources of areas beyond national jurisdiction (ABNJ) through scientific research cooperation, technology transfer and capacity building. It was demonstrated in Chapter 3 and Chapter 4 that scientific research cooperation, technology transfer (including access to data and knowledge), and scientific capacity building are elements of benefit-sharing. In Chapter 5, it was shown that the 1982 United Nations Convention on the Law of the Sea (LOSC) establishes a framework in which international cooperation in marine scientific research, the development and transfer of marine technology and the development of scientific capacity are interlinked.\(^1\) It was suggested that, in this way, the LOSC provides a legal basis for an integrated approach to sharing benefits from marine genetic resources of ABNJ. However, it was also observed that gaps and ambiguities constrain implementation and weaken the LOSC framework as a basis for benefit-sharing.

In this Chapter, current practices in science cooperation, technology transfer and scientific and technological capacity building are examined. The purpose of this Chapter is to determine whether the implementation of those framework provisions could be strengthened in order to share benefits from marine genetic resources of ABNJ through the development of new international legally binding instrument (ILBI).\(^2\) The acquisition and sharing of benefits through international marine scientific research cooperation is reviewed in Section 6.2. As an illustration of technology transfer, the sharing of data and samples relating to marine genetic resources of ABNJ are examined in Section 6.3. Human, technical and institutional aspects of scientific capacity building are then considered in Section 6.4. A cross-cutting analysis of the

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preceding three Sections enables common factors influencing the sharing of benefits from marine genetic resources of ABNJ in practice through science cooperation, technology transfer and capacity building to be identified in Section 6.5.

A lack of long-term information on the implementation of the LOSC Parts XIII and XIV presents a challenge to this analysis. A comprehensive reporting mechanism is lacking; and there are few studies on this issue. As explained in Chapter 1, it is not within the scope of this thesis to undertake a quantitative evaluation of implementation of Part XIII and XIV. Rather, this Chapter offers a qualitative assessment drawing on an analysis of illustrative examples of existing practices, a literature review, and informal unstructured interviews conducted with key scientists. This discussion is based, in part, on several interviews conducted with a number of leading scientists engaged in marine scientific research involving marine genetic resources of ABNJ. The purpose of the interviews was to gather background information about marine scientific research being conducted in relation to marine genetic resources of ABNJ. The interviews were informal and unstructured, with a set of questions used to reveal current practices in benefit-sharing through marine scientific research cooperation, technology transfer and capacity building. Scientists were selected based on their reputation in peer-reviewed published scientific literature, facilitated through the International Network for the Investigation of Deep-Sea Ecosystems (INDEEP) and Deep Ocean Stewardship Initiative (DOSI). In accordance with the ethics approval for this study, the identity of the scientists is withheld. By consulting scientists on benefit-sharing practices,

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3 Some surveys of State practice have been conducted through IOC. See for example: Elizabeth J Tirpak, *Practices of States in the Fields of Marine Scientific Research and Transfer of Marine Technology: An update of the 2005 Analysis of Member State Responses to Questionnaire No. 3*, UN Doc. IOC/ABE-LOS VIII/8 (UNESCO-IoC, 2008); UNESCO-IoC, ‘Global Ocean Science Report: The current status of ocean science around the world’, L. Valdés et al. (eds), (Report, UNESCO-IoC, 2017). However, these initiatives do not capture all marine scientific research, technology transfer and capacity building activities for all States. For example, the 2017 Global Ocean Science Report was based on survey to which 34 IOC Member States responded, representing just 23% of IOC membership, see: UNESCO-IoC, 47. This illustrates the challenges in obtaining information about the current status of global ocean science capacity.

4 For a discussion on the difficulty in monitoring the implementation of marine scientific research provisions, and the need to further study these issues, see: Soons, Alfred H A, ‘The legal regime of marine scientific research: Current issues’ in Nordquist, Myron H, Ronan Long, Tomas H Heidar and John N Moore (eds), *Law Science and Ocean Management* (Martinus Nijhoff, 2007) 139, 163.

5 Section 1.3.3 of Chapter 1.
this study seeks to contribute to filling a gap in the literature that was identified by Glowka (1996).  

6.2. International marine science cooperation

The importance of international marine science cooperation has been explicitly recognised by the G7, which noted that: “the interconnectivity of the global ocean means that challenges need to be addressed as a global community […] it is essential to understand the ocean as a whole through international scientific cooperation”. This Section examines the current level of international cooperation in marine scientific research to investigate marine life and access marine genetic resources of ABNJ in situ. Illustrative examples of current practices in international marine scientific research cooperation are provided in Section 6.2.1. The need to enhance international cooperation in marine scientific research in order to share benefits from marine genetic resources from ABNJ is considered in Section 6.2.2.

6.2.1. Examples of international marine scientific research cooperation

Examples of global marine scientific research cooperation are discussed in Section 6.2.1.1. Examples of regional marine scientific research cooperation are provided in Section 6.2.1.2.

6.2.1.1. Global

Marine scientific research in ABNJ is an inherently global endeavour. Two examples are used to illustrate the importance of international science cooperation to advance knowledge

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6 Lyle Glowka, 'The Deepest of Ironies: Genetic Resources, Marine Scientific Research and the Area' (1996) 12 Ocean Yearbook 154. For a discussion on the need to examine the implementation of international cooperation in marine scientific research, see: Yoshifumi Tanaka, A Dual Approach to Ocean Governance: The Cases of Zonal and Integrated Management in International Law of the Sea (Ashgate, 2008) 230.
7 G7, ‘G7 Ministers of Science, 8-9 October 2015, Berlin, Communique: Science Ministers and their representatives from Canada, France, Germany, Italy, Japan, the United Kingdom, the United States, and the Commissioner for Research, Science and Innovation of the European Union (G7 Communique, 2015).
8 See Section 2.5 of Chapter 2.
of marine genetic resources of ABNJ. The first relates to the study of marine life, the second relates to the study of the marine environment.

The first example is the Census of Marine Life. The goal of the Census of Marine Life (2000-2010) was to record life in the ocean: past, present and future. The diversity, distribution and abundance of marine life was assessed during this “decade of discovery”.9 The geographic scope of the research undertaken during the Census of Marine Life was global—from the shallowest to the deepest part of the planet—organised into six identified “ocean realms” and 17 scientific projects (Figure 6.1). It was a global endeavour from the perspective of the participants involved; the Census of Marine Life involved 2,700 scientists from more than 80 countries engaging in more than 540 scientific expeditions.10 The program was overseen by a Scientific Steering Committee. The program generated more than 30 million distribution records and resulted in 2,600 scientific publications.11 The Census of Marine Life is an example of a fixed-term global ocean biodiversity research program.

The lasting impact of the interpersonal scientist connections and collaborations that are formed through international marine science programs is illustrated by the fact that many of the Census of Marine Life collaborations were sustained past the end of the program through alumni and international scientific networks. One example of this is the International Network for Scientific Investigation for Deep-Sea Ecosystems (INDEEP).12 This demonstrates that scientists see the value in international scientific networks and proactively work to maintain them. These networks can also support capacity building, by facilitating cooperation between scientists, at national, regional and global levels.

Coordination of international research activities and cooperation with scientific and intergovernmental bodies, were key factors in the success of the Census of Marine Life. For

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9 Jesse H Ausubel, Darlene T Crist and Paul E Waggoner (eds), First Census of Marine Life 2010: Highlights of a Decade of Discovery (Census of Marine Life, 2010).
11 Ibid.
12 INDEEP is a network of more than 1000 deep-sea scientists, formed from the Census of Marine Life http://www.indeep-project.org/ accessed 30/04/2017.
example, Census of Marine Life partnered with Encyclopedia of Life,\footnote{http://www.eol.org/ accessed 25/04/2017.} World Register of Marine Species,\footnote{http://www.marinespecies.org/ accessed 25/04/2017.} Marine Barcode of Life,\footnote{http://www.marinebarcoding.org/ accessed 25/04/2017 (this ended in 2010 with the Census of Marine Life) and is now \url{http://ibol.org/} accessed 25/04/2017).} and Catalogue of Life\footnote{http://www.catalogueoflife.org/ accessed 25/04/2017.} projects as well as various international intergovernmental and non-governmental organisations, highlighting the plethora of organisations relevant to marine biodiversity research, including in ABNJ.

The Census of Marine Life was sponsored by the Alfred P. Sloan Foundation, a philanthropic organisation that provided US$78 million.\footnote{https://sloan.org/ accessed 25/01/2017.} This funding was leveraged to generate a total of US$650 million to fund the program over its ten year duration. It also illustrates the role of philanthropy in providing seed funding for international marine biodiversity research cooperation; especially to build interpersonal networks at an early stage, and enable the planning of scientific collaborations for workshops to develop research plans and project proposals, which subsequently generated further funds. However, the struggles to continue Census of Marine Life collaborations after the end of the program highlight the challenges of sustaining scientific activities involving marine biodiversity in ABNJ over the long term.\footnote{For example, a strategy for a second decade of discovery, “Life in a Changing Ocean”, was developed after the CoML but it was not possible to secure funding for it.}
The second example is the Global Ocean Observing System (GOOS). GOOS is a collaborative international system of integrated, international observations under a common agreed set of principles set out in the framework for ocean observing. It was founded by the Intergovernmental Oceanographic Commission of UNESCO (IOC) in 1991. GOOS has a mandate to coordinate global ocean observations to provide scientific information in three areas (climate, ocean health, and real-time services) corresponding to three international legal and policy frameworks. GOOS is an example of an ongoing global ocean research program.

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According to GOOS (2017) “its success relies on the coordinated contributions of several people and organizations worldwide.” For example, the Argo array includes 3,839 floats that are funded and operated by 29 countries. The contributions by countries varies widely, for example, South Africa contributes one float to the Argo program, while the USA contributes 2,210 (approximately 55% of the global total). This dependency on a relatively small number of nationally funded programs to obtain critical data on which climate change models are based, illustrates the fragility of international marine scientific research systems that are vulnerable to cuts in national funding. The 2016 GOOS Steering Committee identified the need for further discussion on how to support sustained ocean observing systems. GOOS partners with the World Meteorological Organisation, UN Environment, and ICSU, illustrating the role of cooperation between intergovernmental and non-governmental organisations in global ocean observations. GOOS functions under three expert panels (physics, biogeochemistry, and biology and ecosystems) that guide the scientific work. There are also 13 regional alliances that focus on meeting identified regional priorities, as discussed in the following Section. The GOOS model of operation, via regional committees and national research platforms, illustrates the importance of international coordination, including of research infrastructure, for networked observations to advance knowledge of the global ocean and support management.

6.2.1.2. Regional

Scientific cooperation and collaboration also occurs at a regional scales. For example, GOOS operates 15 regional alliances (Figure 6.2). This illustrates that regional scientific initiatives can involve coordination by global international bodies and actors from within and outside a region. The following example illustrates this. The first International Indian Ocean

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25 The Argo array collects data on the temperature and salinity of the upper 2000m of the ocean, forming part of both the Global Climate Observing System (GCOS) and GOOS, http://www.jcommops.org 19/09/2017; IOC, above n 3, 70-72.
26 Ibid.
Expedition (IIOE) was initiated by the Scientific Committee on Oceanic Research (SCOR) to promote “a combined assault on the largest unknown area on Earth, the waters and sea-bed of the Indian Ocean” following its first meeting in 1957. IOC assumed the coordinating functions of the IIOE in 1961, in consultation with SCOR. The second IIOE (2015-2020) is now underway. The example of the IIOE highlights that an intergovernmental mandate can help to formalise cooperation and support international coordination at the highest levels of governance, especially in developing regions, and the role of institutional or scientific connections in instigating cooperative programs.

![GOOS regional alliances](Source: GOOS, 2017)

In the North Atlantic, international research cooperation has been promoted through the *Galway Statement on Atlantic Ocean Cooperation: Launching a European Union – Canada – United States of America Research Alliance* (Galway Statement). The statement committed to align ocean observation efforts, coordinate data sharing, increase cooperation on

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29 Charnock, ibid.
knowledge. Collaborative projects relevant to marine genetic resources of ABNJ, have been developed between the USA, EU and Canada. This illustrates that intergovernmental commitments to science cooperation can be instrumental in securing support for international science collaborations, including to investigate marine genetic resources of ABNJ.

More recently, the Belém Statement on Atlantic Research Cooperation (Belém Statement) reflects the desires of the EU, South Africa and Brazil to “further collaborative scientific efforts in the Atlantic Ocean” and “sustainably cooperate on marine science, research and innovation”. The Statement refers to the “mutual benefit would accrue from linking research activities in the South Atlantic and Southern Ocean with those in the North Atlantic”, to develop “common understanding and deepening scientific knowledge of ecosystems” and their role in climate, food and other issues of societal relevance. Measures identified in the Belém Statement include:

- Sharing of research infrastructures;
- Access to data and platforms, and “emerging methods of data science”;
- Promote human capacity building and scientific exchange;
- Provide a platform for scientific and technological cooperation and instigation of joint activities; and
- Encourage new models for cooperation in key areas of common interest, including ocean observation and ocean technology.

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33 Examples include: the trans-Atlantic assessment and deep-water ecosystem-based spatial management plan for Europe (ATLAS) project (http://www.eu-atlas.org/ accessed 20/04/2017); and the Deep-sea Sponge Grounds Ecosystems of the North Atlantic (SponGES) project (http://www.deepseasponges.org/?page_id=242 accessed 20/04/2017).


36 Ibid, 2.
These identified areas for cooperation reflect the objectives and measures for the development and transfer of marine technology established under LOSC Part XIV. The Belém Statement therefore suggests that international marine scientific research is a way for States to implement Part XIV in practice. These measures also align with the framework for benefit-sharing considered in this thesis. This is a further illustration that international scientific cooperation, including in ABNJ, is recognised as a way to advance knowledge, enable access to data and information, and grow scientific and technological capacity (including through training and developing new technology) in developing and developing countries alike.

A further example of the recognised importance of agreements in enhancing scientific cooperation is the 2017 Agreement on Enhancing International Arctic Scientific Cooperation (Arctic Science Cooperation Agreement). This agreement was developed under the auspices of the Arctic Council, which includes Canada, Denmark, Finland, Iceland, Norway, Russian Federation, Sweden, and the United States of America. It recognises the importance of international scientific cooperation to provide the best available knowledge for decision-making and for the sustainable use of resources, and the benefit gained from the International Polar Year, in particular “new scientific knowledge, infrastructure and technologies for observation and analysis”.

Unlike the Galway Statement and the Belém Statement, the Arctic Science Cooperation Agreement is legally binding. This is therefore a key example of the recognised importance of facilitating science cooperation, including in ABNJ.

This Section has provided illustrative examples of the importance of global and regional level cooperation in marine scientific research to advance knowledge of the ocean and its resources. This suggests that this shows the significance of international cooperation to access and derive benefits from marine genetic resources, and that there are indications that States see value in increasing international cooperation to pursue advances in knowledge.

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37 See Section 5.3 of Chapter 5.
38 Agreement on Enhancing International Arctic Scientific Cooperation 2017, signed 11 May 2017, Arctic Council, Fairbanks Ministerial meeting.
39 Arctic Science Cooperation Agreement, Preamble.
access to data and information, and developing scientific and technological capacity. This will be further discussed in the following Section.

6.2.2. Increasing international cooperation in marine scientific research?

In the previous Section, it was suggested that there are indications that there is a need for strengthened international marine scientific research cooperation. In this Section, this is examined further. The United Nations General Assembly and the UN Decade of Ocean Science provide illustrative examples of the desire of the international community to foster international cooperation in marine scientific research, as discussed in Section 6.2.2.1. The Group of 7 (G7) provides an example of a subset of major researching States, as discussed in Section 6.2.2.2. The Deep Ocean Observing Strategy (DOOS) illustrates a view from the scientific community, as discussed in Section 6.2.2.3.

6.2.2.1. UNGA Resolutions and the Decade of Ocean Science

The UNGA has repeatedly recognised the need to increase marine scientific research activities through international science collaboration in order to advance knowledge of deep-sea biodiversity and ecosystems. The following quote first appeared as the opening paragraph to Section XI (Marine science) in UNGA Resolution 59/24, “Oceans and law of the sea”, adopted on 17 November 2004. It is the only paragraph to have been repeated verbatim in Section XI of each resolution over this 12 year period.\(^{40}\) The UNGA:

“Calls upon States, individually or in collaboration with each other or with competent international organizations and bodies, to continue to strive to improve understanding and knowledge of the oceans and the deep sea, including, in particular, the extent and vulnerability of deep sea biodiversity and ecosystems, by increasing their marine scientific research activities in accordance with [the LOSC].”

The reference to the need for “collaboration” is notable. A further reference to “collaboration” can be found in relation to marine biodiversity of ABNJ. The UNGA has recognised the need for further study of, and “measures for enhanced cooperation, coordination and collaboration relating to”, the conservation and sustainable use of marine biodiversity in ABNJ.41 This first appeared in the preamble of UNGA Resolution 63/111, “Oceans and the law of the sea”, adopted by the UNGA on 5 December 2008, and has been repeated verbatim in every successive resolution of this kind since.

The UN Sustainable Development Goal (SDG) 14, Target 14.a is a further illustration of the recognition by States to strengthen mechanisms for international science cooperation and enable equitable participation.42 The adoption by the United Nations of the Decade of Ocean Science for Sustainable Development (2021-2030),43 suggests that international marine scientific research cooperation, coordination and collaboration is a growing priority for


States. The IOC—tasked with preparing an implementation plan for the Decade—suggested that a potential outcome of the Decade could “provide science support towards the conservation and sustainable use of biodiversity in [ABNJ]”. Some of the knowledge advancements that could arise from the Decade would be potential benefits from marine genetic resources of ABNJ.

6.2.2.2. G7

The G7 includes the States most active in researching marine genetic resources of ABNJ (United States, Germany, Japan and the United Kingdom), hence, it provides a useful indicator of practices relevant to marine genetic resources in ABNJ. It is relevant to note, therefore, that the G7 have identified a need for “comprehensive and continuous coordination of publicly funded research” to secure the future of oceans and seas. Marine biodiversity, ABNJ and marine environmental protection are focus areas. The benefits of and need for concerted international cooperation in Global Research Infrastructure, has been recognised by the G7 as crucial to solve global challenges, develop a global knowledge society, and enhance the role of science in driving prosperity through inclusive innovation. The 2015 G7 Science Ministers Statement outlined a commitment to engage in close cooperation on joint

46 See, eg: Martin Visbeck, ‘Ocean science research is key for a sustainable future’ (2018) 9(1) Nature Communications 690.
47 The G7 is an informal bloc of the United States, Canada, France, Germany, Italy, Japan, and the United Kingdom. It was formally the G8, including the Russian Federation, however Russia has not been included since 2014.
49 G7 Ministers of Science, above n 7.
51 G8 Science Ministers, above n 50.
52 G7, ‘Science and Technology Ministers Meeting, 15-17 May 2016, Tsukuba, Communique: Science and Technology Ministers of Canada, France, Germany, Italy, Japan, the United Kingdom, the United States, and the European Commissioner for Research, Science and Innovation’ (G7 Communiqué, 2016).
53 G7 Science Ministers, above n 7. See also G8 Science Ministers, above n 50.
marine ecological research to enhance the preservation of the marine environment,\textsuperscript{54} including through:\textsuperscript{55}

- Enhancing global ocean observation, including of biodiversity,
- Enhancing ocean assessment through the UN regular process,
- Improving global data sharing infrastructure and “promoting open science for the benefit of all”,
- Developing regional observing capabilities and knowledge networks, and
- Enhancing future routine ocean observations.

These G7 commitments suggest that States actively engaged in research involving marine genetic resources of ABNJ recognise a need and an opportunity for strengthened cooperation in marine scientific research. The development, construction and operation of complex and costly ocean observing research infrastructure, and the critical mass of highly qualified human resources required, to address global challenges cannot be provided by one country or region alone. The recognised importance of international partnerships to advance knowledge and achieve shared objectives echoes the sentiments contained in the Galway Statement and the Belém Statement.\textsuperscript{56} This suggests that adopting measures to increase international marine scientific research cooperation, through the development of the ILBI, would be consistent with the aims of many States.

\textit{6.2.2.3. DOOS}

The Deep Ocean Observing Strategy (DOOS) was instigated in 2015 by a group of deep-sea scientists and is one of the most recent additions to the GOOS framework. DOOS is compiling an inventory of deep-sea observing activities, including those that are occurring in ABNJ (Figure 6.3).\textsuperscript{57} The inventory highlights that observing capabilities lie in the hands of a

\textsuperscript{54} G7 Science Ministers, above n 7.
\textsuperscript{55} G7 Science and Technology Ministers, above n 52.
\textsuperscript{56} See Section 6.2.1.2.
\textsuperscript{57} DOOS objective: “The purpose of the Deep Ocean Observing Strategy is to improve understanding of the state of the deep ocean with respect to baseline conditions, response to climate variability and response to human disturbance. DOOS will identify approaches to address key scientific questions and societal needs,
few countries and that the number of observations decreases as depth increases. This illustrates gaps in global scientific capacity to undertake research relevant to marine genetic resources in ABNJ, and highlights the importance of international science cooperation to identify and address those gaps. This further illustrates the need for strengthened international support for ocean investigation to advance knowledge of marine genetic resources in ABNJ.

**Figure 6.3: Deep Ocean Observing Activities.**
(Source: DOOS, 2017).

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58 Ibid.
6.3. Sharing outputs from scientific research: data and samples

The aim of this Section is to examine the current practice in sharing the outcomes of scientific research; data sharing is discussed in Section 6.3.1, sample sharing is discussed in Section 6.3.2. Challenges and potential opportunities for the sharing of benefits from marine genetic resources of ABNJ are identified.

6.3.1. Data

In this Section, the potential to share benefits from marine genetic resources of ABNJ by enabling access to data is considered in Section 6.3.1.1. Challenges are identified in Section 6.3.1.2.

6.3.1.1. Benefit-sharing through open data?

For marine genetic resources, databases are crucial tools to enable understanding of marine biodiversity, identify new species, analyse taxonomic data, confirm discoveries of novel marine natural products. Thus, data-sharing can enable benefit-sharing.

There is a growing recognition of the merits of open data among scientists and governments. Numerous statements of open data principles have been published, including by: Science International, the International Council for Science, the United Nations, the Group on

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61 Science International ‘Open Data in a Big World’ (Report, Science International, 2016) http://www.science-international.org/. Science International includes four major organisations representing global science, the International Council for Science (ICSU), the InterAcademy Partnership (IAP), the World Academy of Sciences for the advancement of science in developing countries (TWAS) and the International Social Science Council (ISSC) http://www.science-international.org/.


Earth Observations, G8, and OECD and the Conservation Commons. For example, Science International, an alliance of eminent scientific and engineering associations, advocate that publicly funded science should provide open data, and that it is essential to update historic values to achieve the full benefits to society offered by “a new era of technology”. The IOC has an open data policy that must be applied to projects conducted under its auspices. The G7 have “committed to openness in scientific research data”, recognising that “free and rapid public access to published, publicly funded research” supports both “effective global scientific research” and “commercial innovation by enterprises”. Some States have adopted national open data policies that require publicly funded science to be made open. These examples suggest that open data is a growing priority.

There is currently no single portal for data relating to marine genetic resources from ABNJ. Data is currently dispersed over a number of different databases and there are differences in the openness of data accessibility; ocean environmental, marine biodiversity and

65 G8 Science Ministers, above n 50.
70 For a rigorous discussion of the diversity of databases, see, eg: Royal Society, above n 69, 83-87.
genetics,\textsuperscript{75} are largely open access, whereas some natural products\textsuperscript{76} databases incur a charge.\textsuperscript{77} Marine biodiversity data, for example, is spread over a variety of different databases (some global, some regional, some project specific), with a number of key datasets and services which have varying degrees of connectedness between them (Figure 6.4).\textsuperscript{78}

\textbf{Figure 6.4: The marine biodiversity informatics landscape.} Non-exhaustive map of the global and European biodiversity informatics landscape (left) and the network of biodiversity

\textsuperscript{75} See, e.g: GenBank: \url{http://www.ncbi.nlm.nih.gov/genbank/}. GenBank is part of the International Nucleotide Sequence Database Collaboration, which comprises the DNA DataBank of Japan (DDBJ), the European Nucleotide Archive (ENA), and GenBank at NCBI.

\textsuperscript{76} See, e.g. ChemSpider \url{http://www.chemspider.com/}.

\textsuperscript{77} For natural products, there are a range of public and private databases, some are freely accessible, some incur a charge. Open access and open source natural product databases and other resources have also created a rapidly growing volume of chemical information that is publically available, with at least seven publicly available natural product databases. Not all databases are publicly available, private domain databases are maintained by individual pharmaceutical companies and are not open to researchers, there are at least 12 private domain natural product databases. Commercial natural product databases charge a fee for access to data and there are at least ten commercial natural product databases, with considerable variation between them. See: John W Blunt, Murray H G Munro and Meg Upjohn, ‘The Role of Databases in Marine Natural Products Research’ in E Fatturussos, W H Gerwick and O Tagliatalata-Scafati (eds), \textit{Handbook of Marine Natural Products} (Springer, 2012) 389.


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informatics organisations (right). Red arrows indicate OBIS, highlighting its role as a hub linking to many different databases.
(Source: Bingham et al., 2017).79

The Ocean Biogeographic Information System (OBIS),80 part of the IOC’s International Oceanographic Data and Information Exchange (IODE), has been explicitly referenced in the BBNJ PrepComs by many delegations as a platform for technology transfer through sharing of information and data.81 The mission of OBIS reflects the need for a technology transfer framework to share benefits from MGR in ABNJ: to “build and maintain a global alliance that collaborates with scientific communities to facilitate free and open access to, and application of, biodiversity and biogeographic data and information on marine life”.

There are 23 regional nodes of OBIS,82 and 7 thematic nodes, (including a Deep-Sea OBIS node currently being developed)83 (Figure 6.5). Through these nodes, OBIS connects more than 500 institutions from 56 countries that have provided more than 45 million observations of nearly 120 000 marine species. Of these, OBIS includes 3 million observations from ABNJ, representing 20,387 different species (of which 2,819 are only observed in ABNJ), drawing from 643 datasets contributed by 346 different institutes. The OBIS ABNJ portal is an example of how OBIS can provide access to different sub-sets of data. OBIS connects a

79 Ibid.
80 OBIS emanates from the Census of Marine Life (2000-2010) and was adopted as a project under IOC-UNESCO’s International Oceanographic Data and Information (IODE) programme in 2009. UNESCO-IOC’s oceanographic data and information exchange includes a network of 80 National Oceanographic Data Centres http://www.iode.org/ accessed 23/07/15.
82 Support for OBIS by regional nodes includes resources such as tools, language versions and portal sites. For example, Antarctica (AntOBIS) is hosted by Biodiversity and Ecosystems Data and Information Centre (BEDIC) Royal Belgian Institute of Natural Sciences.
number of different data systems, illustrating the strengths of a network model for marine biodiversity data.

Figure 6.5: OBIS network. OBIS connects many data providers (red dots) and data nodes (blue dots) to provide open access to marine biodiversity data for users. (Source: OBIS, 2017).84

It is likely that deep sea scientists would support increased open access to data under an ILBI. In a survey of deep-sea scientists via the International Network for the Investigation of Deep-Sea Ecosystems (INDEEP)85 83 per cent indicated that they would benefit from increased sharing of deep-sea biological data, agreeing that the following priorities were of high or very high importance:

• Stricter requirements to lodge data in international databases;
• Adopting a common format for data standards;
• Creating a deep-sea biodiversity data sharing platform in OBIS;
• Open access data portals e.g. Genbank; and
• Open access peer reviewed publications.

However, deep-sea scientists have cautioned against imposing stricter requirements to share data without providing funding to meet those costs. There are mixed views in the scientific community about how to enable data exchange. One scientist suggested that there could be a set, enforced time period in which national or institutional repositories should grant scientists’ requests for data stored therein. This highlights the importance of strengthening the international enabling framework for open science in order to share benefits from marine genetic resources in ABNJ.

6.3.1.2. Challenges to open data

Deep-sea scientists, active in producing data relating to marine life in ABNJ, indicate that enabling access to biological and genetic data is standard scientific practice on the whole, however, it can be hindered by resource or capacity constraints. Questions remain about how to handle different types of data – from genetic sequence data and video data. A lack of reporting measures internationally means that it remains unclear whether all data relating to marine genetic resources of ABNJ are made open. Different types of data will be subject to different levels of openness depending on what the data is, where it was collected and by whom. There are various challenges to realising benefits through open access. According to OECD (2007), challenges to open data include:

86 DOSI, above n 85.
87 DOSI, above n 85.
88 DOSI, above n 85.
89 Section 3.3 of Chapter 3.
90 See, eg: Boulton, G ‘Reproducibility: international accord on open data’ 530 Nature 281.
91 OECD, above n 66.
• Technological (e.g. availability of physical and digital infrastructure, interoperability, and data quality control);
• Institutional and managerial (a variety of institutional models and tailored data management approaches will be needed to allow for the diversity of the scientific enterprise involving marine genetic resources in ABNJ);
• Financial (continued and dedicated budgetary planning and appropriate financial support for data infrastructure and management costs to be integrated into project budgets);
• Legal and policy (national laws and international agreements e.g. intellectual property rights and access and benefit-sharing); and
• Cultural and behavioural (educational and reward structures to promote access and sharing practices) issues.

For marine genetic resources of ABNJ, in terms of technical challenges, the sheer number of databases would make interoperability between data systems a challenge.92 Bespoke data portals might be created for specific marine scientific research projects, and the proliferation of data portals and dispersal of data over a number of different portals can then cause fragmentation in a complex system. Globally unique persistent identifiers could help to link an individual genetic resource to data and other digital documentation, in order to help trace genetic resources.93

Securing long-term funding support for data management and curation is another challenge.94 The Royal Society (2012) highlighted that the costs of maintaining a repository for research data have been estimated to be “an order of magnitude greater than that for a typical repository focused on e-publications”, the cost of data curation spans 1% to 10% of the

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94 IOC, above n 4.
research budget for earth science centres. In developing countries this can be particularly challenging. When a research project ends, continued funding is not always assured. OBIS is an example of how international research projects can evolve and change hands in order to secure long-term viability under an intergovernmental body. OBIS was established as the data system for the Census of Marine Life and was fostered by IOC at the close of the Census of Marine Life. Costs of data sharing for marine genetic resources of ABNJ could be high. Meeting the costs of additional data sharing measures through international organisations such as IOC could be challenging given current resources; IOC has highlighted that its staff situation is “underfunded”. The network model of OBIS, linking data providers and end-users, is one of its key strengths and illustrates how problems can be overcome. It is important to understand the different policy, cultural, technical and scientific influences on data sharing for the effective design and implementation of benefit-sharing measures under the ILBI.

6.3.2. Samples

Current practices in sample sharing related to marine genetic resources are discussed in in Section 6.3.2.1. The potential to enhance sample sharing and related technology transfer as a modality of benefit-sharing is considered in Section 6.3.2.2.

6.3.2.1. Sample sharing

A sample could come in a number of different forms. It could be a whole (or part) of an organism in wet, dry or frozen form, or it could have already been prepared for biodiscovery
analysis and be in powdered form (Figure 6.6). When a sample is collected on a research cruise, it will be preserved and stored (usually by freezing or preservation in ethanol or formaldehyde) on board the vessel and then transferred to the host institution of the lead researcher for further study and analysis. In practice, deep-sea biological samples (including but not limited to those from ABNJ) are stored in various places, depending on the collector and the mode of collection. Samples will predominantly be stored and curated in research institutions and museums. The mandate for the sharing of samples of genetic resources in international legal instruments often falls to these institutions, which are considered to be agents of benefit-sharing through technology transfer.

For marine genetic resources of ABNJ, there is no single biorepository or collection(s) at present. Existing collections of samples from ABNJ arguably function as a network of biorepositories, albeit ad hoc and informal. Self-organisation via the scientific community plays a key role in sharing samples and related technology transfer. While in theory access to samples is open and part of the scientific endeavour, in practice, various barriers are faced. It takes time for samples to make it to museums, and even longer for the sample to be taxonomically described, given the shortage of taxonomists worldwide and that many are specialised in particular classes of organisms. Samples could be stored for years awaiting further study due to a lack of human or financial resources. Some deep sea scientists have sought to address this by surveying what samples are being stored awaiting further analysis, and where, but this has been without success. Deep-sea sample collections have needed to innovate in the face of uncertain funding futures. For example, the Discovery Collection, a collection enabling access to deep and open ocean samples collected from 1925 to present day expeditions in the Porcupine Abyssal Plain (a research site situated in ABNJ), is run as a charity. This highlights that there are weaknesses and gaps in the existing international framework for sample sharing.

99 The method of initially preserving and storing the sample will dictate the purposes that it can be later utilised for, and influence the related opportunities or challenges for technology transfer (including knowledge, equipment and techniques) and benefit-sharing.
100 DOSI, above n 85.
Providing access to samples can benefit the host collection, such as the museum. For example, the providing samples of genetic material can benefit the museum collection by depositing voucher material from projects, collaborative research; further exchange of genetic samples; acknowledging the source collection and registration number in relevant publications in the GenBank record following the deposit of genetic sequences identified during the research into GenBank.\textsuperscript{102} Such benefits can be articulated in guidelines for sample sharing.

\textbf{Figure 6.6. Examples of different types of sample storage.} Dry powdered samples for biodiscovery (left three, taken at Eskitis institute, 16 May 2016), dry specimens for taxonomic research (middle, taken at Queensland Museum, 15 May 2016), wet specimens for taxonomic research (right, taken at Museum Victoria, 20 December 2016).

\textbf{6.3.2.2. Benefit-sharing through enhanced sample sharing?}

Increased sharing of deep-sea biological samples would be beneficial to scientists. In a survey of deep-sea scientists,\textsuperscript{103} more than 70 per cent of respondents indicated that they would

\begin{footnotesize}
\begin{enumerate}
\item[103] DOSI, above n 85.
\end{enumerate}
\end{footnotesize}
benefit from increased sharing of deep-sea biological samples. The following priorities were of high or very high importance:

- Include funds in research grants for curation and long-term care;
- Samples retained in registered national collections open for use on a loan basis;
- International network of registered collections;\(^{104}\) and
- Taxonomic standardisation.

These priorities identify gaps in the sample sharing system and could help shape the design of measures in the ILBI to facilitate access to samples. One option to facilitate benefit-sharing would be to create a single biorepository. However, this is unlikely to work in practice, as samples are already dispersed across a number of collections and institutions where scientific research is undertaken.

Another option would be to enhance the existing network of collections by strengthening the links between collections and ensuring a central repository of information about sample location. This could improve accessibility to samples of marine genetic resources of ABNJ. A network of sample collections could be linked to national and international oceanographic data centres. However, differing views in the scientific community and constraints in scientific and technological capacity would need to be considered. For example, one scientist commented that enhanced mechanisms to share samples “may be the only way to access such samples for developing countries, especially small island developing states”, however, another ventured that “I already have more samples than I can deal with and receive more requests for specimens than I can accommodate”.\(^{105}\) This suggests engagement with the scientific community, including from developed and developing countries, would support the design of effective measures. Furthermore, the operation and maintenance of a formal

\(^{104}\) Collections, such as museums and national marine research institutions, form a network of reputable institutions for storage and access of biological samples. Collections are already widely acknowledged for their role in streamlining access to ex situ repositories of data and samples of non-commercial research. European Union, Regulation (EU) No. 511/2014 of the European Parliament and of the Council of 16 April 2014 on compliance measures for users from the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization in the Union Text with EEA relevance, L 150/59, [27] [28].

\(^{105}\) DOSI, above n 85.
network sample repositories would require concerted approaches at global and regional scales.\textsuperscript{106}

6.4. Scientific capacity building

The usefulness of benefits from marine genetic resources (including access to data, knowledge and samples) is largely dependent on scientific and technological capacity, including skilled personnel, scientific equipment, and technical infrastructure such as computers and reliable internet access.\textsuperscript{107} The role of capacity building in enabling developing States to benefit from genetic resources, in general, is well established. For example, in Africa, studies have demonstrated the importance of capacity building in the context of identifying research and development priorities for fish genetic resources,\textsuperscript{108} and addressing shortfalls in human, technical and financial resources for medical genetics.\textsuperscript{109}

Many developing States, face capacity constraints which hinder their ability to participate in and benefit from scientific research in ABNJ; Small Island Developing States (SIDS) face particular challenges.\textsuperscript{110} For example, the Alliance of Small Island Developing States\textsuperscript{111} and Pacific Small Island Developing States have highlighted the capacity limitations and special case of SIDS in the context of biodiversity in ABNJ\textsuperscript{112} and the Federated States of Micronesia has suggested that the ILBI should take extra measures to acquire scientific

\textsuperscript{106} See Section 7.2.1 of Chapter 7.
\textsuperscript{107} See Section 3.3 of Chapter 3.
knowledge relating to biodiversity in ABNJ and enable training in marine science and technology.\footnote{113} Also, the Group of 77 (G77) plus China have stated that the ILBI should promote increased scientific knowledge, research capacity building and marine technology transfer.\footnote{114}

This Section examines current practices in developing scientific and technological capacity. Institutional capacity is discussed in Section 6.4.1. Human capacity is discussed in Section 6.4.2 and technical capacity is discussed in Section 6.4.3.\footnote{115}

6.4.1. Institutional capacity building

The importance of regional scientific networks to enable States and individuals to benefit from marine genetic resources in ABNJ is illustrated by examples from SIDS. In the South-West Pacific, for example, low population, large geographic area, remoteness, and limited human, financial, technical and scientific resources constrain scientific and technological capacity (such as offshore ocean research vessels and sampling equipment, and onshore laboratory equipment and information technology infrastructure) and hinder the ability of Pacific Island Countries to access, use or benefit from marine genetic resources in ABNJ.\footnote{116}


\footnote{115}It can be recalled from Chapter 5 that scientific capacity building is interwoven into the LOSC framework provisions of Part XIII and XIV, including: the establishment and functioning of regional marine scientific and technological centres, in accordance with LOSC Articles 276 and 277; the development of human resources through training and education in accordance with LOSC Articles 268(d) and 244(2); and the development of technological infrastructure to facilitate the transfer of marine technology in accordance with LOSC Article 268(d).

Few Pacific Island Countries have established national marine scientific research institutions and scientific research capacity in the South-West Pacific region is largely concentrated in regional organisations and institutions.\textsuperscript{117} For example, the University of the South Pacific (USP), established in 1968, is a regional university owned by the governments of twelve member countries.\textsuperscript{118}

USP is a regional hub for international marine research collaborations and provides education and training and data exchange. Thus, USP fulfils the majority of the criteria for a “Regional marine science and technology centre” elaborated in LOSC Article 277.\textsuperscript{119} It can be recalled from Chapter 5 that regional marine science and technology centres are envisaged to serve a crucial function in the development and transfer of marine technology in the LOSC. USP also represents all Pacific Island Countries in the International Council for Science,\textsuperscript{120} a role usually played by Learned Academies, further illustrating its pivotal role in promoting scientific excellence and capacity in the region.

Regional research networks can also involve multiple regional organisations. USP cooperates with the Pacific Community\textsuperscript{121} and the South Pacific Regional Environment Program\textsuperscript{122} in

\begin{footnotesize}
\begin{itemize}
\item Conservation and Sustainable Use of Marine Biological Diversity Beyond Areas of National Jurisdiction. (IUCN Environmental Law Centre, 2013) 15.
\item Salpin, above n 110.
\item The USP member countries are: Cook Islands, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu and Samoa. USP’s mission includes tertiary education and the application of research to deliver benefits and solutions to communities and countries in Pacific region, available at https://www.usp.ac.fj/index.php?id=usp_introduction accessed 06/07/2016. There are campuses in all member countries, the main campus is in Fiji, the School of Agriculture and Food Technology is situated in Samoa, the School of Law is situated in Vanuatu.
\item See Section 5.4 of Chapter 5.
\item Of the 121 Members of the International Council for Science, USP is the only Member that is a university representing multiple countries, available at http://www.icsu.org/asia-pacific/about-icsu-roap/asia-pacific-members accessed 04/07/16.
\item The Pacific Community is the regional scientific and technical organisation, it has a role to facilitate international cooperation in scientific research and deliver scientific and technical services. Pacific Community, ‘Pacific Community Strategic Plan 2016-2020’ (Pacific Community, 2016) 5,6,7, available at http://www.spc.int/images/publications/en/Corporate/Strategic-Plan-2016-2020.pdf accessed 30/10/2016.
\item The South Pacific Regional Environment Program also has involvement in marine scientific research, including as the regional point of contact for the Pacific regional alliance for the Global Ocean Observing System (PI-GOOS). PI-GOOS is a long-term sustained scientific cooperation between SPREP, USA and Australia to monitor the Pacific Ocean, as part of GOOS http://www.goosocean.org/index.php?option=com_content&view=article&id=40&Itemid=140 accessed 30/06/2017.
\end{itemize}
\end{footnotesize}
marine science and technology, including in relation to BBNJ.\textsuperscript{123} This illustrates the importance of regional scientific networks for SIDS.

Another example of the importance of regional scientific networks is the University of the West Indies (UWI). UWI was established in 1948, incorporates four campuses and is owned by seventeen countries in the Caribbean.\textsuperscript{124} The “Open Campus” of UWI, established in 2008, offers “open education”, such as online and distance education, learning and educational networks, access to educational materials and data across 42 “Open Campus” site locations in the Caribbean region, serving 16 countries.\textsuperscript{125} This further illustrates the importance of enabling national and regional marine science and technology centres to operate as a decentralised, interconnected network model. It also highlights the importance of enabling technologies such as information and communication technology to develop scientific capacity through communication and distance learning approaches to capacity building.

The importance of intergovernmental regional mechanisms to support capacity building for biodiversity in ABNJ is also recognised by the IOC.\textsuperscript{126} IOC’s regional network comprises three regional sub-commissions,\textsuperscript{127} one regional committee,\textsuperscript{128} two regional programme


\textsuperscript{124} University of West Indies has four campuses, it is owned by Anguilla, Antigua and Barbuda, Barbados, the Bahamas, Belize, Bermuda, the British Virgin Islands, Cayman Islands, Dominica, Grenada, Jamaica, Montserrat, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Trinidad and Tobago, and the Turks and Caicos Islands, https://www.mona.uwi.edu/ accessed 14/09/2017.

\textsuperscript{125} https://www.mona.uwi.edu/ accessed 14/09/2017.


\textsuperscript{127} Ibid. The sub-commissions are: IOC Sub-Commission for Africa and the Adjacent Island States (IOCAFRICA); IOC Sub-Commission for the Caribbean and Adjacent Regions (IOCARIBE); IOC Sub-Commission for the Western Pacific (WESTPAC).

\textsuperscript{128} Ibid. The regional committee is the IOC Regional Committee for the Central Indian Ocean (IOCINDIO).
offices,\textsuperscript{129} and eight project offices\textsuperscript{130} (Figure 6.7). The different types of regional organisations, in IOC alone, illustrate that there is no ‘one-size-fits-all’ model for regional marine science capacity building.

![Figure 6.7. IOC regional sub-commissions, committees, programme offices and project offices.](source:IOC 2017)\textsuperscript{131}

The specific needs of different regions is further demonstrated by the variation in marine scientific research specialisation. For example, marine ecosystems and ocean health are

\begin{itemize}
\item Ibid, the program offices are: Rio Regional Programme Office, Brazil; Perth Regional Programme Office, Australia.
\item Ibid. Caribbean Tsunami Information Center CTIC, Bridgetown, Barbados; Data Buoy Cooperation Panel (DBCP) Argo Project Office (JCOMMOPS), Brest, France; IOC Science and Communication Centre on Harmful Algae/ Harmful Algal Bloom (HAB) Project Office, Copenhagen, Denmark; International Oceanographic Data and Information Exchange (IODE) Project Office, Ostend, Belgium; Indian Ocean Tsunami Information Centre (IOTIC), Jakarta, Indonesia; Ocean Data and Information Network for Africa (ODINAfrica), Nairobi, Kenya; Omani National Multi-Hazard Early Warning System (NMHEWS), Muscat, Oman; Strengthening Haitian Early Warning Services for Coastal Hazards, Port-au-Prince, Haïti.
\item IOC, above n 126.
\end{itemize}
specialisations in Oceania, and ocean technology and engineering are specialisations in Asia (Figure 6.8). This highlights that there are different capacity building needs and scientific and technological priorities in different regions.

![Figure 6.8: Illustrative examples of different regional marine science specialisations.](source: IOC, 2017)

IOC regional bodies have a specified role and mandate to support scientific capacity building, but resource limitations restrict their effectiveness. For example, the IOC regional SubCommission for the Western Pacific (IOC-WESTPAC), has a mandate to promote and coordinate international cooperation in marine scientific research and capacity building in the region. IOC-WESTPAC capacity building activities include: training courses, summer schools, and international scientific symposiums with young scientist awards, travel grants and internship programs. The IOC Regional Network of Training and Research Centres on Marine Science was established in 2008 to improve regional capacity on marine science, recognising the “disparity in capacity and capability among the Member States of the region,

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132 IOC, above n 3.
133 IOC, above n 3, 113-114.
and high capability of several Member States in marine science, ocean observations and services.”\textsuperscript{136} However, IOC-WESTPAC has expressed “deep concern over the long-time overloaded and unstable staffing situation at the WESTPAC Office”\textsuperscript{137} and requested assistance from IOC Member States to implement regional capacity building activities, including the Regional Network of Training and Research Centres on Marine Science, by encouraging Member States, donors, organizations, and institutions to engage in the regional network.\textsuperscript{138} This suggests that regional capacity initiatives can struggle to obtain funding supporting.

Further, limited membership also appears to hinder the effectiveness of regional mechanisms to deliver capacity building. For example, although eleven Pacific Island Countries are member States of IOC,\textsuperscript{139} only three Pacific Island Countries are IOC-WESTPAC Member States.\textsuperscript{140} This could be one reason why most of the regional capacity building activities of IOC-WESTPAC take place in South-East Asia and why there has been little engagement with Pacific Island countries to date. Furthermore, while increasing the participation of Pacific Island Countries in IOC could help promote regional capacity building priorities at the international level, resource constraints could still be a limiting factor.\textsuperscript{141}

As an intergovernmental organisation for marine science with 148 Member States, IOC provides a good indicator of State priorities, practices and problems in marine science capacity building and technology transfer. For example, the IOC SIDS Action Plan\textsuperscript{142} provides a renewed impetus for IOC and its Member States to support marine science

\textsuperscript{138} IOC-WESTPAC, above n 134.
\textsuperscript{139} Nauru, Cook Islands, Fiji, Vanuatu, Tuvalu, Tonga, Solomon Islands, Samoa, Papua New Guinea, Palau, Niue.
\textsuperscript{140} Samoa, Solomon Islands, Tonga. There are 22 IOC-WESTPAC Member States, including USA, UK, France, Australia, New Zealand.
\textsuperscript{141} For example, the IOC Capacity building fund is dependent on voluntary Member State contributions. Chapter 7.4.
capacity building and technology transfer; IOC also has a role in implementing the Small Island Developing States Accelerated Modalities of Action (SAMOA) Pathway. The IOC Capacity building Strategy 2015-2021 identifies six intended outputs, including the development of human resources and access to physical infrastructure (Table 6.1).

Regional and sub-regional mechanisms are recognised as a capacity building priority by States.

Table 6.1: IOC Capacity building Strategy (source: IOC, 2015).

<table>
<thead>
<tr>
<th>Output</th>
<th>Activity</th>
</tr>
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| 1. Human resources developed | • Academic (higher) education  
• Continuous professional development  
• Sharing of knowledge and expertise/community building  
• Gender balance |
| 2. Access to physical infrastructure established or improved | • Facilitating access to infrastructure (facilities, instruments, vessels) |
| 3. Global, regional and sub-regional mechanisms strengthened | • Further strengthening and supporting secretariats of regional commissions  
• Enhance effective communication between regional sub-commission secretariats and global programmes as well as other communities of practice (incl. other organisations) |
| 4. Development of ocean research policies in support of sustainable development objectives promoted | • Sharing of information on ocean research priorities  
• Developing national marine science management procedures and national policies |
| 5. Visibility and awareness increased | • Public Information  
• Ocean Literacy |
| 6. Sustained (long-term) resource mobilization reinforced | • In-kind opportunities  
• Financial support by Member States for IOC activities |

145 Ibid.
To implement capacity building, IOC offers a range of tools to achieve capacity building via the IOC Capacity building website, including information on: training course opportunities available through IOC or its Member States, travel grants and mentoring networks, and infrastructure sharing.\textsuperscript{146} However, the implementation of these initiatives rests on funding by member States,\textsuperscript{147} and gaps in implementation have been identified.\textsuperscript{148} This illustrates the challenges that face the international community in implementing existing aspirational goals and targets for scientific and technological capacity building due to resource constraints on existing institutions.

The importance of collaboration between regions to access skills and build human scientific capacity in a region is observed by Veitayaki and South (2001).\textsuperscript{149} Collaborations between regions are also often necessary to fund capacity building activities. For example, the USP Centre of Drug Discovery and Conservation has been the recipient of three consecutive International Cooperative Biodiversity Grants from the US National Institute of Health (2005-2018) in a consortium with the Georgia Institute of Technology and Scripps Institute of Oceanography.\textsuperscript{150} The USP marine studies program, established in 1978, has relied on foreign donor programs as well as funding from USP member countries,\textsuperscript{151} highlighting the challenges in securing human, financial and infrastructure resources to develop regional scientific capacity. Global collaborative approaches are also important for capacity

\textsuperscript{147} For example, Action 6.2.1 of the IOC Capacity building Strategy is resource mobilization from Member States, institutional and private sector partners; IOC invites contributions from Member States financial contributions in addition to the regular “assessed contribution” through the complementary additional programme (CAP), see: \url{http://www.ioc-cd.org/index.php?option=com_content&view=article&id=26&Itemid=170} accessed 15/09/2017.
\textsuperscript{149} Veitayaki and South, above n 96.
\textsuperscript{150} Another example this to illustrate how bilateral links aim to support sustainable Pacific development through science and technical innovation (including through technical meetings, joint lectures, exchange initiatives, sharing samples and instrumentation) is the memorandum of understanding between the Republic of Korea Institute of Ocean Science and Technology and the Pacific Community, signed Noumea 28 June 2016, 46\textsuperscript{th} meeting of the Committee of Representatives of Governments and Administrations (CRGA 46); See also UNGA Res 70/235 [248].
\textsuperscript{151} For example, funding from Sweden was instrumental in setting up USP, see: Veitayaki and South, above n 96.
building. For example, Scherf and Baumung (2015) highlight the role of the 2007 Global Plan of Action for Animal Genetic Resources in lifting scientific capacity for food security related research. This highlights the role of collaborations involving institutions within and between regions in order to develop scientific and technological capacity.

**6.4.2. Human scientific capacity building**

Deriving and sharing benefits from marine genetic resources in ABNJ requires trained scientists. Depending on the nature of the activity, this could include disciplines such as taxonomy, ecology, genetics, molecular biology, microbiology, chemistry, oceanography and bio-informatics. Training programs can be delivered in a number of ways, varying in delivery modalities (face-to-face or online), duration (short courses or academic degree programs), and location (at sea, on shore; national, regional or international scales).

The suitability of different human capacity building options will depend on regional characteristics and national needs. For example, participation in research cruises could provide an opportunity for research training and access to marine genetic resources. One example of “at-sea” training is the EAF-Nansen program, a program designed to support the ecosystem approach to fisheries management, supported by the Norwegian government and the Food and Agriculture Organisation (FAO). Research collaborations with an equal or greater focus on post-cruise mentoring, including on-shore laboratory based research, could be particularly useful for developing research capacity for marine genetic resources of ABNJ and support continuous professional development. Scientific networks could enable this by

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152 For a discussion on the importance of collaborative approaches to capacity building that involve a range of stakeholders and have public support at early stages. G Leroy, R Baumung, D Notter, E Verrier, M Wurzinger, B Scherf, ‘Stakeholder involvement and the management of animal genetic resources across the world’ (2017) 198 Livestock Science 120-128.


154 See Section 2.3 of Chapter 2. Note: LOSC art. 277(a) refers to training and educational programmes across a number of disciplines relating to marine scientific and technological research, including marine biology, conservation and management of living resources, oceanography, hydrography, engineering, geological exploration of the seabed, mining and desalination technologies.

155 USP, for example, offers short-term training opportunities such as workshops, as well as long-term academic education programs (pre-degree, undergraduate and post-graduate) in various marine scientific research disciplines. See Veitayaki and Manoa 2014 for comprehensive discussion.

providing access to mentoring opportunities. Training can be delivered face-to-face, such as through workshops. Distance learning opportunities can enable participation in training across a wide geographic region and are increasingly prevalent at regional and international scales. However, information technology infrastructure is required to enable distance learning opportunities and to support knowledge diffusion across a region. This has been raised by Pacific Small Island Developing States at the PrepCom. Ebikeme et al (2016) observe that regional data science capacity will be crucial to address the dual issues of “big data” and “open data” for sustainable development. “Training the trainers” can also help to ensure that regional actors have ownership over training materials, can adapt focus areas to suit national or regional needs, and that training can reach a wide group of recipients within a region. This is used in OBIS. This highlights the importance of institutional capacity to support human capacity building.

Several organisations can play a role in human capacity building. Intergovernmental international organisations including the IOC, International Seabed Authority (ISA) and FAO offer training courses. Non-governmental international organisations can also play a role in capacity building. For example, there are courses offered under the auspices of IOC in partnership with other international organisations such as SCOR and others. The importance of ensuring that competent international organisations coordinate technology transfer activities is highlighted in LOSC Article 272. However, there is no mechanism to assist in cooperation and coordination relating to capacity building activities. The establishment of a clearinghouse mechanism, or similar modality to enable access to information about these opportunities, could be considered through the ILBI to enhanced coordination between international organizations in scientific capacity building related to marine genetic resources and other marine biodiversity in ABNJ.

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158 PSIDS, above n 112.
159 Ebikeme et al, above n 68.
160 For example, 27 training courses were co-organised by IOC in 2017 and 230 people from 60 countries were trained in 2016: IOC, above n 126, 9.
161 See Section 5.3.1 of Chapter 5.
Funding sources vary, and some initiatives are reliant on scientists donating their time free of charge. This is a further illustration that of the role of ad hoc “bottom-up” collaborative approaches and “top-down” international level coordination. It also suggests that there are problems with the sustainability of funding models, given the reliance on scientific goodwill to deliver human capacity building opportunities. This further highlights the importance of cooperation and coordination to support capacity building and to enable access to information.

6.4.3. Technical scientific capacity building: equipment

The derivation, sharing and use of benefits from marine genetic resources in requires various different forms of scientific and technical equipment, ranging from research vessels and underwater vehicles, to laboratory equipment and computers. The cost of maintaining and operating equipment will influence whether technology transfer involving equipment will support meaningful capacity building in the long-term. For example, ‘downstream’ technologies (i.e. not involved in in situ access to genetic resources) such as laboratory equipment and computers that enable research on samples and data could be more advantageous, especially for small island developing States, than research vessels and deep-sea sampling equipment needed to access marine genetic resources in situ. This is supported by Kaluwin and Smith (1997), who report that low technology, low-key, low-cost and long-term approaches to technology transfer and capacity building are often more effective in Pacific Island Countries than short-term, high-technology approaches.

Some equipment could serve multiple purposes, including research on marine and non-marine organisms from areas within and beyond national jurisdiction, for pure and applied research. For example, DNA sequencer machines (required to investigate genes) could be used for research purposes ranging from health to biotechnology. Similarly, “shotgun” DNA sequencing technology could be used to monitor water quality or identify target candidates.

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162 See Section 2.3 of Chapter 2, and Section 3.4 of Chapter 3.
for biodiscovery.\textsuperscript{164} The importance of multi-purpose technical equipment to build scientific capacity that can be sustained over the long term to utilise marine genetic resources in ABNJ is illustrated by the Centre of Drug Discovery and Conservation of USP,\textsuperscript{165} which has a dual focus on marine biodiscovery and ecological surveys. This illustrates that concentrating scientific capacity is important, not only geographically (Section 6.4.1.2), but also technically, to yield the highest outcomes from individual items of equipment. Much of this equipment is not proprietary in nature.

Information communication technology is important for developing States, especially SIDS, to access technology transfer and capacity building opportunities and participate in distance learning. Such technologies also have the benefit of being lower in upfront cost which could make equipment transfer more palatable under foreign aid programs, as well as in terms of maintenance and operation costs.

The discussion in this Section suggests that, in terms of equipment, a broad interpretation of technology that incorporates low-tech as well as high-tech equipment should be included in the ILBI in order to support capacity building for marine genetic resources of ABNJ. This supports the notion that an enabling framework for scientific capacity building is required for marine genetic resources in ABNJ. Given the variety of technical equipment that States may require in order to participate in benefit-sharing (either making benefits available or accessing benefits), it will be important for the ILBI to provide a framework through which needs can be identified and met. This is discussed in the following Section.

\textbf{6.5. Discussion: towards an integrated approach to benefit-sharing}

In this Section, the analyses of current practices in marine scientific research, sharing data and samples, and scientific and technological capacity building (provided in Sections 6.2, 6.3 and 6.4) are considered collectively, in order to consider the potential for an integrated approach to benefit-sharing of marine genetic resources of ABNJ. The links between marine

\textsuperscript{164} See Section 2.5.3.2 of Chapter 2.
\textsuperscript{165} \url{https://www.usp.ac.fj/index.php?id=580} accessed 20/09/2016. Note, the Centre has now been re-named the ‘Pacific Natural Products Research Centre’ \url{https://www.usp.ac.fj/index.php?id=18023} accessed 10/06/2018.
scientific research cooperation, technology transfer and capacity building in practice are considered in Section 6.5.1. It is suggested that there is a need to increase the implementation of Part XIII and XIV of the LOSC in order to share benefits from marine genetic resources of ABNJ, key elements that could be included under an ILBI are identified in Section 6.5.2.

6.5.1. Marine scientific research cooperation, technology transfer and capacity building are linked in practice

In this Section, the preceding Section is briefly reviewed to ascertain whether marine scientific research cooperation, technology transfer and capacity building are linked in practice.

In Section 6.2, it was demonstrated that international cooperation in marine scientific research supports the development of global scientific capacity through the development and deployment of new technologies (such as through GOOS) in order to advance knowledge of the global ocean. As discussed in Chapter 2, marine scientific research can be considered as a way to generate benefits from marine genetic resources of ABNJ, by producing data, knowledge and samples and by providing opportunities for capacity building such as through research collaborations, training or access to infrastructure. In Section 6.3, it was suggested that enabling access to data, information, knowledge and samples is a form of benefit-sharing through technology transfer, but requires institutional and human capacity. In Section 6.4, it was shown that the development and transfer of technology is strongly reliant on regional scientific capacity. Scientific capacity building can support technology transfer by enabling more scientists in more countries to make use of the outcomes of scientific research, in turn, this supports the conduct of marine scientific research.

Thus, the examination of current practices suggests that marine scientific research, technology transfer and scientific capacity building are interlinked in practice (Figure 6.9). This supports the proposal for an integrated approach to benefit-sharing.
6.5.2. Increasing implementation of Part XIII and XIV: enabling measures

The analysis in this Chapter suggests that the LOSC framework provisions for marine scientific research and technology development and transfer, as discussed in Chapter 5, are being implemented to an extent. However, the current system for science cooperation, technology transfer and capacity building appears to be fragmented and fragile. Implementation mechanisms are either lacking (as in the case of sharing information about marine scientific research activities or capacity building opportunities), or have weak financial and institutional support (as in the case of sharing the outcomes from marine scientific research, data and samples). Complexities in the institutional framework mean that there is no single pathway to access the technology transfer and capacity building opportunities offered by different national, regional and international organisations. The gaps in ‘top-down’ public sector funding and coordination are illustrated by the proliferation of ‘bottom-up’ science initiatives, from the Census of Marine Life to data sharing platforms to
regional and bilateral scientific capacity building initiatives, as well as the growth of deep-sea scientific research projects that have sought private sector funding. These gaps could pose an obstacle to the sharing of benefits from marine genetic resources of ABNJ. The importance of stable rules and solid agreements to enhance international cooperation in order to build an integrated system for marine scientific knowledge advancement is recognised by Bernal (2007). It is therefore timely to consider how the development of the ILBI could serve as an agreement to support an integrated system for the sharing of benefits from marine genetic resources of ABNJ, based on scientific and technological capacity building.

The examples provided in Section 6.2.2. (including the Arctic Science Cooperation Agreement, the Galway Statement, the Belem Statement, the G7 Science Ministers Statements, and several UNGA resolutions), indicate that increasing international marine scientific research cooperation is a recognised priority for the international community. This suggests that the global landscape for science and technology has developed, in response to growing demand for sustained measurements and technical advancements, and gone beyond what is provided for in the LOSC. These examples also illustrated that marine scientific research cooperation supports the development and transfer of technology and capacity building are interlinked in practice, by providing opportunities for training, joint activities, knowledge advancement, data sharing and technology development and access. This suggests that adopting measures to increase international marine scientific research cooperation, through the development of the ILBI, would be consistent with policy objectives that have been articulated by several States. There is arguably therefore an opportunity for the LOSC framework provisions to be elaborated and further implemented in order to support the sharing of benefits from marine genetic resources of ABNJ in the future ILBI.

Based on the analysis of current practice conducted in this Chapter, the following enabling measures for the sharing of benefits from marine genetic resources of ABNJ can be identified:

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166 Bernal, ibid, 44.
• Cooperation mechanisms and policy incentives that balance ‘top-down’ international coordination with ‘bottom-up’ stakeholder-driven collaboration (Section 6.5.2.1);
• Networks of scientific institutions, including a decentralised global network of regional and national marine science and technology centres, that support institutional capacity building (Section 6.5.2.2);
• Information sharing for scientific research activities and capacity building opportunities (Section 6.5.2.3);
• Principles, standards and mechanisms to share data, knowledge and information relating to marine genetic resources (Section 6.5.2.4);
• Technology and scientific capacity needs assessments to guide capacity building and technology request and acquisition mechanisms to support technical and institutional capacity building (Section 6.5.2.5);
• Technology development and deployment as a focus of global scientific collaboration (Section 6.5.2.6); and
• Funding mechanisms for long-term capacity building support (Section 6.5.2.7).

6.5.2.1. Cooperation mechanisms

This discussion of current practice shows that international science cooperation programs operate through a variety of models, with differing geographical, temporal, funding, and governance aspects depending on the needs of a region or a particular group of States. An appropriate balance between ‘top-down’ and ‘bottom-up’ cooperation appears to be important. The role of both ‘top-down’ coordination and ‘bottom-up’ scientific networks in international marine science cooperation projects supports the finding of the Royal Society (2009) that international science cooperation is often serendipitous, driven ‘bottom up’ by scientific networks that must be balanced with ‘top-down’ coordination.167 The need for both ‘top-down’ and ‘bottom-up’ coordination of marine science has long been recognised, for example, the IOC (1975) encouraged “all those interested in the [International Decade of

Ocean Exploration (1971-1980)] to co-operate at the scientist-to-scientist level, and at the
government-to-government level” to achieve international participation.

Bottom-up collaborations between individual scientists and institutions mobilise research
efforts, for example, for the conduct of science, development of data sharing standards, and
maintaining long-term researcher mentoring links to sustain capacity building. For example,
the Census of Marine Life was orchestrated by a single Scientific Steering Committee and
thirteen “National and Regional Implementation Committees” that “crossed geographic,
cultural and political boundaries to orchestrate studies of the world’s ocean”.168 Top-down
coordination, often from an international or intergovernmental institution, is a critical factor
in ensuring long-term funding sustainability, policy certainty, formalisation of procedures and
standards, and harmonisation across multiple international programs. This is further
illustrated by GOOS, which shows that internationally coordinated, regionally collaborative
and nationally funded ocean observing infrastructure is crucial to support the monitoring,
design and implementation of international legal and policy frameworks.169 The importance
of international coordination of national and regional initiatives is also illustrated by OBIS
for data sharing, and USP for scientific capacity building. The imminent beginning of the
Decade of Ocean Science for Sustainable Development suggests that international
cooperation in marine scientific research remains a priority for the international community.
Furthermore, the repeated calls to increase international science cooperation, technology
transfer and capacity building point to a need and an appetite to strengthen the international
framework.170 The ILBI could contain provisions that foster bottom-up scientific
collaboration while providing strengthened top-down coordination, including identified
institutional responsibilities, in order to support benefit-sharing.

6.5.2.2. Networks: institutional capacity building

168 Census of Marine Life, above n 19.
169 GOOS, which has a three tiered governance model including a multinational Steering Committee, three
Expert Panels (Physics, Biogeochemistry, Biology and Ecosystems.
and various Observation Coordination Groups (Networked Observations are coordinated by JCOMM, the Joint
Technical Commission for Oceanography and Marine Meteorology, which provides a mechanism for
international coordination of oceanographic and marine meteorological observing, data management and
services. Support for the in situ observing platform is provided by JCOMMOPS).
170 Section 6.2.2.
Networks bring together different actors, from different countries and help to overcome resource and capacity constraints to deliver benefit-sharing. Networks, often functioning as decentralised ‘hub and spoke models’ with a central international coordination point, enable global engagement with nationally funded, regionally coordinated systems. This is illustrated in the conduct of international science projects such as GOOS and Census of Marine Life, the sharing of data and samples through OBIS and the development of regional capacity through IOC. GOOS and DOOS, for example, illustrate how a number of different systems can function together as a coherent whole to link the acquisition and evaluation of scientific information to policy and societal needs articulated through international legal frameworks. The importance of networks is also evident within individual regions such as through USP, and the networks of scientists and institutions that participate in the Ocean Teacher Global Academy. In a network the system relies on each node functioning as required, and international linkages to provide the ‘spokes’ that link them together. This illustrates the importance of having some level of formal, centralised, coordination and funding to oversee the system. The role of scientific networks, and of cooperation mechanisms linking global, regional and national initiatives could be recognised in the ILBI. Sharing information is one way to support network function, as discussed below.

6.5.2.3. Information sharing mechanism

The analysis of current practice in this Chapter suggests that three criteria are needed to share information relating to benefit-sharing. Firstly, there is a need for adequate financial and human resources for technical data-sharing infrastructure. Secondly, there is a need for engagement, ownership and buy-in from stakeholder constituents to ensure that opportunities are transmitted through the clearinghouse by providers, and that they can be readily identified and accessed by users. Thirdly, there should be sufficient governance and oversight to manage the content according to standards and principles agreed by the user communities. The potential role of a clearinghouse mechanism is further discussed in Chapter 7.
Openness could play a pivotal role in accessing, sharing and using benefits from MGR, for example, through participation in international marine scientific research activities, access to data, samples and information, and through training opportunities.\textsuperscript{171} However, the landscape for this is complex and fragmented; there are various challenges to realising benefits through open access.\textsuperscript{172} Existing practice in data sharing systems illustrate the need for data systems to be properly resourced with the tools and infrastructure required, and developed with buy-in from user communities. Addressing the challenges to open data will require cooperation between a number of actors, including scientists, research institutions and universities, publishers, funding agencies, professional associations and academies, archives and repositories.\textsuperscript{173} This further illustrates the need to engage scientific stakeholders in the development of the ILBI in order to ensure that benefit-sharing measures can be implemented in practice.

OBIS has been identified as a potential mechanism for sharing data, and hence as a mechanism for sharing benefits from marine genetic resources in ABNJ.\textsuperscript{174} However, for resources requirements must be considered. For example, the Worldwide Protein Data bank has a multi-million pound budget and more than 60 full time staff.\textsuperscript{175} The international office for OBIS, in contrast, is staffed by 1.5 full time equivalent staff, paid for by the contributions of IOC’s member states and funding from the Flanders government. IOC has highlighted that its staff situation is “underfunded”.\textsuperscript{176} There are also potential technical challenges, such as interoperability between data systems.\textsuperscript{177} Noting the ambitious expectations implied at the

\begin{enumerate}
\item Chapter 3.5.2.2.
\item Science International. 2016. ‘Open Data in a Big World’. ICSU.
\item Earth Negotiations Bulletin, above n 81.
\item Royal Society, above n 69, 66. The Worldwide Protein Data Bank (wwPDB) archive, holds around 80,000 structures, but the data it holds occupies no more than 150GB in total (less than the hard disk storage of an inexpensive laptop). A rule of thumb estimate of cost used in some universities is that the provision of storage and backup of research data is approximately £1/gigabyte/5yrs total cost, excluding extended data curation.
\item IOC Assembly Item 10.1 Part 3. [91]. \url{http://ioc.unesco.org/index.php?option=com_content&view=category&layout=blog&id=29&Itemid=124}.
\item A Broggiato, 'Exchange of Information on Research Programs Regarding Marine Biodiversity in Areas beyond National Jurisdiction', IUCN Information Papers for the Intersessional Workshop on Marine Genetic Resources 2-3 May 2013, United Nations General Assembly Ad Hoc Open-ended Informal Working Group to
PrepCom in relation to using OBIS as a clearing house mechanism, a feasibility assessment may be necessary to examine the technical, policy and resourcing questions that remain. Existing mechanisms would need to be strengthened in order to share benefits from marine genetic resources of ABNJ.

Principles and standards could play a role in facilitating benefit-sharing through access to data and knowledge. For example, ensuring that data is logged in common formats is an important first step in streamlining access. This also applies to the collection of samples. Practice suggests that while open data relating to marine genetic resources of ABNJ is becoming available, it is not uniform and there is support among the deep-sea science community for the introduction of measures to enable increased openness (Section 6.3.1). There are standards and principles already in use. One example is the Darwin Core Standard, a set of standards to facilitate the sharing of biodiversity information. For instance, data shared via OBIS must use the Darwin Core Standard. These are voluntary on the whole and self-administered through the scientific community. The development of the ILBI could incorporate open access principles and make reference to the use of standards to help build unity in the user community and support efficiency in the system.

6.5.2.5. Needs assessment and request mechanism

Different States have different benefit-sharing wants and needs. For example, different regions specialise in different scientific disciplines (Section 6.4.1). Furthermore, LOSC articles 266(2) and 275(2) provide for technology to States that “need and request” technology. It is therefore important for States to be able identify their benefit-sharing needs. Furthermore, technology transfer projects can take many forms. In some cases,

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Footnotes:

180 Chapter 5 pinpoint ref.
181 See Section 5.3.2.4 of Chapter 5.
including for SIDS, low technology, low-key, low-cost and long-term approaches to technology transfer and capacity building are often more effective than short-term, high-technology approaches. This highlights the importance of enabling States to identify benefit-sharing needs and ensuring sufficient flexibility in any new system for benefit-sharing for those needs to be met through the acquisition of technology and access to capacity building opportunities. A technology needs assessment, or assistance in developing a capacity building strategy could be a useful tool to help States identify technological needs, and to design technology transfer and capacity building programs. Information sharing mechanisms to enable access to capacity building opportunities, as well as a mechanism to request technology, would be necessary features to enable technology transfer to work in practice. This is discussed in Chapter 7.

6.5.2.6. New technologies

The development and deployment of new technologies is crucial in developing global ocean science capacity to advance knowledge of the global ocean and support management. This is illustrated by the emergence of State practice to foster global marine research infrastructure through the GOOS program and G7 proposed initiatives; this need is also highlighted in LOSC article 270. The establishment of global marine research infrastructure could be particularly important to increase knowledge of biodiversity in ABNJ and derive benefits from marine genetic resources of ABNJ. This further illustrates the importance of strengthening mechanisms to enable international marine scientific research cooperation and collaboration, at regional and global scales, in order to develop and deploy new technology to study ABNJ and underpin capacity building.

6.5.2.7. Funding

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182 See for example Kaluwin and Smith above n 163; for a contrasting perspective on technology transfer, see Gandenberger et al, above n 163.
Ocean science faces sustainability challenges.\(^{183}\) The financial and institutional challenges for developing scientific capacity and advancing knowledge are well recognised.\(^{184}\) While the primary source of funding for marine science programs is public, programs involving marine genetic resources in ABNJ can be funded from philanthropic and private sources too.\(^{185}\) The private sector can support scientific research by providing access to research infrastructure, such as equipment and ROVs.\(^{186}\) However, philanthropic private sources are ad hoc and at least some level of public funding appears to be essential for the long-term sustainability of programs. Funding for ocean science is largely dependent on a few major researching nations supporting international collaboration for global ocean research infrastructure,\(^{187}\) and to coordinate ocean research.\(^{188}\) However, as observed by Bernal (2007), international projects change the dynamics of ownership and funding.\(^{189}\) The development of a financial mechanism for sharing of benefits from MGR in ABNJ under the ILBI should allow for a diverse range of funding sources, while ensuring there is some level of publicly funded financial mechanism to address shortfalls in current funding.

### 6.6. Conclusion

This Chapter has considered current practices in international cooperation in marine scientific research, the sharing of data and knowledge, and the development of scientific capacity, in order to ascertain how benefits from marine genetic resources of ABNJ can be shared. It has demonstrated that marine scientific research cooperation, technology transfer and scientific capacity building are interlinked in practice. This provides a basis for an integrated approach to benefit-sharing through scientific and technological capacity building. However, a lack of

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\(^{183}\) IOC, above n 4, 27.

\(^{184}\) For a historical perspective on ocean science funding, see: Bernal, Patricio, Observations and knowledge of the oceans: Marine scientific research, the transfer of marine technology and capacity building, in Nordquist, Myron H, Ronan Long, Tomas H Heidar, John N Moore (eds), *Law Science and Ocean Management* (Martinus Nijhoff, 2007) 21-62, 44.

\(^{185}\) For a discussion of philanthropic organisations that support marine biodiversity research see: IOC, above n 3, 93. For a discussion of innovative financing options for the development and implementation of the ILBI, see Torsten Thiele and Leah R Gerber, 'Innovative financing for the High Seas' (2017) 27 *Aquatic Conservation: Marine and Freshwater Ecosystems* 89-99.

\(^{186}\) See, eg: Peter I Macreadie et al, 'Eyes in the sea: Unlocking the mysteries of the ocean using industrial, remotely operated vehicles (ROVs)' (2018) 634 *Science of the Total Environment* 1077-1091.

\(^{187}\) Durack et al, above n 27.


\(^{189}\) Bernal, above n 44.
institutional responsibility, weak or absent coordination mechanisms, and gaps between bilateral, regional and global initiatives in marine scientific and technology create fragmentation and the potential for duplication. Gaps between internationally coordinated, regionally implemented and nationally funded initiatives cause fragility in the global ocean science and technology system. There is thus a need to strengthen the implementation of Part XIII and XIV of the LOSC and fill these implementation gaps in order to share benefits from marine genetic resources of ABNJ.

The analysis of existing practices has revealed a series of criteria and enabling measures that could facilitate enhanced implementation of Parts XIII and XIV of the LOSC in relation to marine scientific research cooperation, technology transfer and capacity building. Options to include these enabling measures in the ILBI in order to enable the sharing of benefits from marine genetic resources of ABNJ are provided in Chapter 7.
Chapter 7
Towards an integrated approach: potential measures to share benefits

7.1. Introduction

This Chapter considers potential measures that could be adopted to enable the sharing of benefits from marine genetic resources of ABNJ through scientific cooperation, technology transfer (including the sharing of data and information) and capacity building. The foregoing research suggests that these elements constitute principal features of an integrated approach, whereby sharing benefits from genetic resources contributes to the conservation and sustainable use of biodiversity, as demonstrated in Chapters 3 and 4. In Chapter 5, it was established that the LOSC provides a basis for an integrated approach to benefit-sharing. This is because the LOSC framework provisions for the development and transfer of marine technology are inextricably linked to international marine scientific research cooperation, access to data and knowledge, and capacity development. However, the analysis in Chapter 5 also revealed that the current framework for technology transfer is largely aspirational and weakened by gaps and ambiguities in the LOSC. The analysis in Chapter 6 highlighted the way in which existing practices are characterised by fragmentation and fragility caused by a lack of implementation mechanisms and illustrate the advantages of an integrated approach to benefit-sharing. In this Chapter, potential measures that could be adopted under the ILBI to enable the sharing of benefits from marine genetic resources in ABNJ by strengthening the implementation of the LOSC framework provisions for technology transfer are discussed.

This Chapter articulates a series of suggested measures based on the forgoing research, that could, and ideally should, be incorporated into the development of a new international legally binding instrument (ILBI), for the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (ABNJ)\(^1\) under the 1982 United Nations Convention on the Law of the Sea (LOSC).\(^2\) Building upon the analysis contained in the

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preceding Chapters, a conceptual framework for an integrated approach to benefit-sharing is proposed in Figure 7.1. It is suggested that benefit-sharing should occur at the nexus between:

- international marine scientific research cooperation (a);
- access to data and information (b); and
- scientific capacity development (c).

It is further suggested that these elements should be supported within an international enabling framework (d). This, it is suggested, would constitute an integrated approach to sharing benefits from marine genetic resources of ABNJ.

Figure 7.1: An illustration of the integrated approach to sharing benefits from marine genetic resources of ABNJ. Benefit-sharing occurs at the nexus between international marine scientific research cooperation (a; Section 7.2), access to data and information (b; Section 7.3); and scientific capacity development (c; Section 7.4) within an international enabling framework (d; Section 7.5).
Building on the framework shown in Figure 7.1, this Chapter consists of five key parts.

- Potential measures to support international cooperation in marine scientific research relating to marine genetic resources of ABNJ are proposed in Section 7.2;
- Potential measures to share outcomes of scientific research through access to scientific data and knowledge are examined in Section 7.3;
- Potential measures to enhance scientific capacity are explored in Section 7.4;
- Cross-cutting measures to create an enabling framework for benefit-sharing are identified in Section 7.5; and
- Finally, the potential to create an international enabling environment for benefit-sharing through scientific and technological capacity development is considered in Section 7.6.

The Chapter concludes with a summary of the potential measures that could be adopted under an ILBI to enable the sharing of benefits from marine genetic resources of ABNJ through scientific and technological capacity development.

7.2. Potential measures to increase international scientific and technical cooperation

International scientific and technical cooperation is a prominent feature in the acquisition, sharing and utilisation of benefits from marine genetic resources in ABNJ. However, despite being the primary focus for achieving technology transfer in the LOSC, the duty for international cooperation in marine scientific research is weakened by vagueness and ambiguity and a lack of identified institutional responsibilities and inconsistent support for implementation mechanisms.

This Section examines how the development of the ILBI could elaborate and further implement the general duty to cooperate in marine scientific research, established in LOSC

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3 LOSC arts 269(a), 269(d) and 269(e); 270, 272, 273, 276, 277 and 278.
4 See Section 5.2 of Chapter 5, and Section 6.2 of Chapter 6.2. For a discussion on the vague nature of the duty to cooperate, see Yoshifumi Tanaka, A Dual Approach to Ocean Governance: The Cases of Zonal and Integrated Management in International Law of the Sea (Ashgate, 2008) 229.
Article 242(1), in order to share benefits from marine genetic resources in ABNJ. The precedent for implementing agreements under the LOSC to create favourable conditions for marine scientific research and technology transfer is reviewed in Section 7.2.1. Drawing on this analysis, measures to operationalise technology transfer and enable benefit-sharing are examined in Section 7.2.2 as follows:

- specifying the purpose and nature of the duty to cooperate (Section 7.2.2);
- facilitating in situ access, including through the development of guidelines to determine the nature of marine scientific research (Section 7.2.3); and
- facilitating ex situ access to marine genetic resources and associated technology (Section 7.2.4).

A summary of proposed measures, including the LOSC Articles that would be implemented and the instruments that could provide precedents, is provided in Table 7.3.

### 7.2.1. Mechanisms and modalities for the creation of favourable conditions


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Both UNFSA and the 1994 Implementing Agreement illustrate how the LOSC duty to cooperate can be given greater effect by specifying the purpose of scientific research cooperation and institutional modalities. UNFSA Article 5(k) clarifies that “fulfilling [the] obligation to cooperate” includes the promotion, conduct, and dissemination of results of scientific assessments, and identifies “subregional or regional fisheries management organisations or arrangements” as institutional mechanisms to implement this cooperation. The three conventions establishing regional fisheries management organisations relating to tuna that have been adopted since the mid-1990s include obligations to cooperate in scientific research (Table 7.1) and more detailed requirements on the sharing of data and information. This suggests that UNFSA had some influence on subsequent State practice. Similarly, the 1994 Implementing Agreement also specified focus areas for international cooperation and identified institutional responsibilities for States and the International Seabed Authority (ISA). These observations support the argument by Tanaka (2008) that the LOSC duty to cooperate in scientific research can be given greater effect through: specification of the contents of the obligation; institutional mechanisms for the implementation of the obligation; and scientific and technical assistance to developing States.

The merits of identifying institutional roles and responsibilities in scientific cooperation is further illustrated by other instruments (Table 7.3). For example, the 2001 International Treaty on Plant Genetic Resources for Food and Agriculture (ITPRGFA) Article 7.1

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7 Various other international legal instruments have sought to specify the LOSC obligation to cooperate in marine scientific research in order to improve the quality of scientific information to support biodiversity conservation. See, eg: Tanaka, above n 4, 230.
8 UNFSA art 5(k) requires States to promote and conduct scientific research and develop appropriate technologies in support of fishery conservation and management.
10 1994 Implementing Agreement Section 5 (1)(c) provides that “States Parties shall promote international technical and scientific cooperation with regard to activities in the Area…by developing training, technical assistance and scientific cooperation programmes in marine science and technology and protection and preservation of the marine environment”.
11 Tanaka identifies three conditions to increase the implementation of the LOSC provisions relating to international cooperation in marine science: 1. Specification of contents of the obligation; 2. Institutional mechanisms for the implementation of the obligation; and 3. Scientific and technical assistance to developing States. Tanaka, above n 4, 229. See also Ronan Long, ‘Marine Science capacity building and technology transfer: Rights and duties go hand in hand under the 1982 UNCLOS’ in Myron H Nordquist et al (eds), Law Science and Ocean Management (Martinus Nijhoff, 2007) 299-312.
specifies that international cooperation can happen directly or through FAO and other relevant international organisations. The 2017 Agreement on Enhancing International Arctic Scientific Cooperation\textsuperscript{13} (Arctic Science Cooperation Agreement) recognised the “excellent existing scientific cooperation under way” and lists of intergovernmental and non-governmental international organisations involved.\textsuperscript{14} Potential options for institutional roles and responsibilities to be designated under an ILBI are discussed in Section 7.5.1. The remainder of this Section focuses on options to specify the purpose of cooperation and create favourable conditions for scientific research cooperation.

Table 7.1: International legal instruments establishing tuna regional fisheries management organisations showing the obligation to cooperate in (a) scientific research and (b) the sharing of scientific data/information.

<table>
<thead>
<tr>
<th>Year</th>
<th>Instrument</th>
<th>RFMO acronym</th>
<th>(a)</th>
<th>(b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>Convention for the establishment of an Inter-American Tropical Tuna Commission</td>
<td>IATTC</td>
<td>N/A</td>
<td>art II(7)</td>
</tr>
<tr>
<td>1969</td>
<td>International Convention for the Conservation of Atlantic Tuna</td>
<td>ICCAT</td>
<td>N/A</td>
<td>art IV(2)(d)</td>
</tr>
<tr>
<td>1996</td>
<td>Agreement for the establishment of the Indian Ocean Tuna Commission</td>
<td>IOTC</td>
<td>arts X(3), XII(4)(c)</td>
<td>art X(4)</td>
</tr>
<tr>
<td>2004</td>
<td>Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean</td>
<td>WCPFC</td>
<td>arts 12(2)(c)</td>
<td>arts 10(1)(d), 10(1)(e)</td>
</tr>
</tbody>
</table>

7.2.2. Specify the duty to cooperate in marine scientific research

\textsuperscript{13} Agreement on Enhancing International Arctic Scientific Cooperation, signed at the Fairbanks Ministerial meeting, 11 May 2017, Arctic Council.
\textsuperscript{14} Arctic Science Cooperation Agreement, Preamble.
The following discussion explores how the duty to cooperate in marine scientific research could be strengthened through the ILBI by articulating the purpose of cooperation, and elaborating the duty to include collaboration.

7.2.2.1. Purpose

A clear statement of the purpose of international cooperation could shape and support efforts to implement research, technology transfer and capacity development. For example, Article 5 of the ITPGRFA includes a clear statement of purpose for activities involving genetic resources, including “discovery, exploration, collection, characterisation, analysis and documentation”. The purpose is further elaborated in ITPGRFA Article 7.2,\textsuperscript{15} to include maintaining and strengthening institutional arrangements\textsuperscript{16} and implementing the funding strategy.\textsuperscript{17} The LOSC identifies that international cooperation for the development and transfer of marine technology should “facilitate marine scientific research, the transfer of marine technology, particularly in new fields, and appropriate international funding for ocean research and development” in Article 270. The ILBI could build on this to specify a purpose for cooperation. This could include the acquisition, sharing and utilisation of marine genetic resources from ABNJ, including marine scientific research to advance knowledge of biodiversity of ABNJ, access to data, capacity development, and support for institutional and funding mechanisms. The present research reveals this would be consistent with the requirement for marine scientific research in the Area to be conducted for the “benefit of mankind as a whole”, in accordance with LOSC Article 143, and with the responsibilities associated with the freedom of marine scientific research in the high seas.\textsuperscript{18}

7.2.2.2. Development of technology

\textsuperscript{15} \textit{ITPGRFA} art 7.2 refers to a) building or developing capacity in developing countries for conservation and sustainable use of genetic resources; b) international activities for conservation, evaluation and documentation; and sharing, providing access to and exchanging genetic resources and information and technology.

\textsuperscript{16} \textit{ITPGRFA} art 7.2 (c).

\textsuperscript{17} \textit{ITPGRFA} art 7.2 (d).

\textsuperscript{18} See Section 5.2 of Chapter 5.
International cooperation and collaboration is critical to develop, deploy and utilise novel technologies to advance marine scientific research and enable the acquisition, sharing and utilisation of benefits from marine genetic resources.\textsuperscript{19} As observed in Chapter 4.3, the objectives of LOSC Part XIV place a strong emphasis on the development of technology, in contrast to the transfer of technology, including infrastructure and capacity, with the word “transfer” appearing just once in Article 268. In contrast, the UNGA resolution 69/292 does not refer to the development of technology, only “technology transfer”. Recognising this, the need to consider technology development as well as technology transfer in the development of the ILBI was emphasised in an intervention made by Algeria during the second session of the PrepCom.\textsuperscript{20} Similarly, the \textit{IOC Criteria and Guidelines on the Transfer of Marine Technology},\textsuperscript{21} are more heavily focused on technology transfer than technology development. By including technology development, as well as technology transfer, as an explicit purpose of international cooperation, the ILBI could give greater effect to the implementation of Part XIV and support the acquisition and sharing of benefits relating to marine genetic resources of ABNJ.\textsuperscript{22} The development and deployment of new technologies, such as ocean observing systems, could support global ocean science capacity to advance knowledge of marine biodiversity of ABNJ.\textsuperscript{23}

\textbf{7.2.2.3. Cooperation and collaboration}

Scientific and technological collaboration is a recognised way to address global challenges through research and innovation, and to enhance efficiency and effectiveness.\textsuperscript{24} The role of collaboration in sharing benefits from genetic resources is reflected in Article 23 of the 2010 \textit{Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilization to the Convention on Biological Diversity} (Nagoya

\textsuperscript{19} See Section 2.5.3 of Chapter 2, and Section 6.2 of Chapter 6.
\textsuperscript{22} See, eg: \textit{UNFSA} art 5(k) and \textit{CBD} art 18(4).
\textsuperscript{23} Section 6.2 of Chapter 6.
\textsuperscript{24} See, eg: Section 6.2 of Chapter 6.
Collaboration requires the combination of resources and expertise in order to go beyond aligning different elements of a system, as in cooperation. Collaboration thus requires a more comprehensive enabling framework than cooperation, including coordination schemes.

Although the LOSC makes no reference to scientific collaboration, LOSC Article 243 does provide for the conclusion of agreements to “integrate the efforts of scientists in studying the essence of phenomena and processes occurring in the marine environment and the interrelations between them.” This points to active efforts to combine efforts and use resources collectively, that would be more analogous to scientific collaboration than cooperation. Building on Article 243, the ILBI could provide pathways to operationalise international scientific collaboration to support marine scientific research in ABNJ and the sharing of benefits from marine genetic resources through specific measures for the development and transfer of technology and scientific capacity development.

7.2.3. In situ access: guidelines and communication

Facilitating marine scientific research in ABNJ is one of the primary challenges in the development of the ILBI in relation to marine genetic resources. This is partly due to the lack of a definition of marine scientific research in the LOSC. Consequently ambiguity exists as to what activities constitute “marine scientific research”. The blurred boundary between pure and applied research made it impossible to include a definition of “marine scientific research” in the LOSC. As the pace of scientific and technological advances will undoubtedly further exacerbate this challenge, it would be an ambitious undertaking for States to seek to define “marine scientific research” in the negotiations for the ILBI and such an activity may prove to be a significant distraction with the potential to delay or derail negotiations. Nevertheless, the development of the ILBI does offer an unparalleled opportunity to help address this challenge.

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27 See, eg: Ibid 33.
28 See Sections 7.3 and 7.4 of this Chapter.
29 Section 3.3 of Chapter 3, Section 5.3 of Chapter 5.
30 Section 5.2 of Chapter 5.
challenge. It could do so by providing for the development of guidelines, criteria and characteristics for “marine scientific research activities”, in order to better enable States to determine the nature of marine scientific research activities.

Criteria and guidelines for marine scientific research could support the implementation of LOSC Article 251, which calls on States to “promote through competent international organisations the establishment of general criteria and guidelines to assist States in ascertaining the nature and implications of marine scientific research”. However, to date no such criteria and guidelines have been established. The development of criteria and guidelines could also support the development of international standards. For example, the 1993 Draft Convention on the Legal Status of Ocean Data Acquisition Systems, Aids and Devices (ODAS), although at the time of writing it had yet to enter into force, did underpin the setting of globally agreed standards for the use of ocean data acquisition systems. As a draft convention developed by the IOC, this also demonstrates the role of an international intergovernmental body in advancing discussions to address gaps and ambiguities in the LOSC Part XIII on issues that are critical to the facilitation of scientific research. The development of international standards and guidelines for sampling, data collection, and reporting, could further promote the sharing of benefits from marine genetic resources of ABNJ.

Under an ILBI, a set of guidelines could be developed to establish criteria for research activities relevant to the sharing of benefits from marine genetic resources of ABNJ. Potential options could include the development of a definition or criteria relating to ‘scientific research activities’ and an assessment framework for determining legitimate ‘non-

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31 The reason for this could be linked to the challenges in defining marine scientific research under the law of the sea, see Section 5.2.2.2 of Chapter 5.
32 IOC, Draft Convention on the Legal Status of Ocean Data Acquisition Systems, Aids and Devices (ODAS) Intergovernmental Oceanographic Commission of UNESCO (IOC) IOC-XVII/Inf.1 (21 January 1993), not in force; See also Section 5.2.2 of Chapter 5.
33 IOC, Draft [Practical] Guidelines of IOC, Within the Context of UNCLOS, for the Collection of Oceanographic Data By Specific Means, IOC/ABE-LOS VII/7 (IOC, 2007); IOC, Guidelines for the Implementation of Resolution XX-6 of the IOC Assembly Regarding the Deployment of Profiling Floats in the high seas within the framework of the Argo programme, IOC/EC-XLI/3 Annex II (IOC, 2008); See also Section 4.3 of Chapter 4.
34 The Nagoya Protocol Article 20(2) recognises the role of codes of conduct, guidelines and standards in support of benefit-sharing, providing that the Conference of the Parties shall periodically take stock of the use of voluntary codes of conduct, guidelines and best practices and/or standards and consider the adoption of specific codes of conduct, guidelines and best practices and/or standards.
commercial’ scientific research.\textsuperscript{35} Criteria would need to be sufficiently broad to encompass a range of collaborations and scientific research activities. Guidelines could include principles and standards for the collection, storage, curation and sharing of marine genetic resources samples to facilitate access to marine genetic resources of ABNJ \textit{in situ} and \textit{ex situ}.

Such guidelines could have the effect of facilitating international cooperation in marine scientific research and, in turn, enable capacity building. For example, it could provide a framework for sharing information about scientific research activities. The information to be provided could be based on LOSC Article 248 and include, for example objectives, methods, location, date, principal investigator and institution. Information could also be provided on relevant standards used, where data and samples will be accessible from and when, and capacity building opportunities such as participation of scientists from developing countries. The effectiveness of guidelines or codes of conduct could be assessed through reporting mechanisms that provide for periodic updates of the guidelines.\textsuperscript{36} However, the implementation would be dependent on resources.\textsuperscript{37}

The IOC Criteria and Guidelines on the Transfer of Marine Technology (CGTMT), developed in response to LOSC Article 271, are an example of how an international organisation could facilitate the development of such guidelines.\textsuperscript{38} The InterRidge code of conduct for responsible research practice could provide a useful model for the development of guidelines.\textsuperscript{39} Engagement with the scientific community would enable the development of guidelines to build on existing best practice. Noting the precedent for international organisations to collaborate in setting global standards for ocean science,\textsuperscript{40} the present research suggests that a task force involving the IOC, ISA, and non-governmental scientific organisations (e.g. the Scientific Committee on Oceanic Research, SCOR) and self-

\textsuperscript{35} Section 5.5.2.3 of Chapter 5.
\textsuperscript{36} Section 7.5.4.
\textsuperscript{37} See Section 7.5.
\textsuperscript{38} IOC, above n 21.
\textsuperscript{40} There is a long history of international organisations collaborating to set standards for global ocean science, for example, the ICES/UNESCO/IAPSO/SCOR Joint Panel on Tables and Standards developed the 1980 Equation of the State for Seawater; IOC, above n 32.
organising scientific networks (e.g. the International Network for the Investigation of Deep Sea Ecosystems, INDEEP) could be mobilised.

7.2.4. Ex situ access

Access to *ex situ* samples of marine genetic resources of ABNJ is an element of benefit-sharing requiring enhanced international cooperation. Access to genetic resources is recognised as a benefit under the ITPGRFA, and sharing samples is recognised as a form of benefit-sharing and technology transfer under several international legal instruments. As noted in Chapter 6, existing measures for sample sharing of marine genetic resources in ABNJ are ad hoc and based on self-organisation in the scientific community. The development of the ILBI could facilitate international scientific cooperation involving *ex situ* marine genetic resources samples by providing for standards and recognising the role of collections.

Standardisation underpins international scientific and technical cooperation and sample sharing. For example, standards are enshrined in Article 15.1(d) of the ITPGRFA, which requires *ex situ* collections to be managed and administered “in accordance with internationally accepted standards, in particular the Genebank Standards as endorsed by the FAO Commission on Genetic Resources for Food and Agriculture.” Similarly, the ILBI could promote the adoption of existing standards and the development of new standards for *ex situ* samples of marine genetic resources of ABNJ.

Sample collections, such as museums and research institutions, are agents of technology transfer by supporting the advancement and sharing of knowledge and information relating to

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42 Section 4.3.1 of Chapter 4.
genetic resources and the provision of education and training.\textsuperscript{43} Such collections are acknowledged and promoted under the ITPGRFA, and the Pandemic Influenza Preparedness Framework for the sharing of influenza viruses and access to vaccines and other benefits (PIP Framework).\textsuperscript{44}

For example, the ITPGRFA recognises the importance of genetic resources being “held in trust” by the International Agricultural Research Centres (IARCs) of the Consultative Group on International Agricultural Research (CGIAR).\textsuperscript{45} IARCs undertake to manage and administer \textit{ex situ} collections in accordance with internationally accepted standards. Further, the ITPGRFA promotes benefit-sharing through cooperation and standardisation by encouraging Parties to call upon IARCs to sign agreements with the ITPGRFA Governing Body, which in turn has authority to provide policy guidance to the IARCs. Such agreements are envisaged to reinforce the availability of genetic resources in accordance with the requirements of the ITPGRFA access and benefit-sharing system;\textsuperscript{46} and to provide for IARCs to periodically inform the Governing Body about the utilisation of genetic resources.\textsuperscript{47} As another example, the PIP Framework specifies a role for scientific research institutions as part of the Global Influenza Surveillance and Response System (GISRS), including laboratories and scientific research centres, national centres, collaborating centres.\textsuperscript{48} The rules governing the role of this system provide an example of a potential exemption for access and utilisation of genetic resources for certain purposes that could be adopted under the ILBI, in order to facilitate non-commercial research.\textsuperscript{49}

The governance models of the IPTGPRFA and PIP framework could provide inspiration for a global network of national and regional science and technology centres for ABNJ. The role of collections of marine genetic resources of ABNJ in enabling benefit-sharing could be recognised in the ILBI and specific institutional responsibilities could be established for these

\textsuperscript{43} Section 6.5 of Chapter 6.
\textsuperscript{44} Pandemic Influenza Preparedness Framework for the sharing of influenza viruses and access to vaccines and other benefits (PIP Framework) adopted by: World Health Assembly, ‘Pandemic Influenza Preparedness Framework’, WHA64.5, 64\textsuperscript{th} sess, Agenda Item 13.1 (24 May 2011).
\textsuperscript{45} ITPGRFA art 15.1.
\textsuperscript{46} ITPGRFA Part IV, art 15.1(a).
\textsuperscript{47} ITPGRFA art 15.1 (c).
\textsuperscript{48} PIP Framework [4.2] and [4.3].
\textsuperscript{49} Ibid.
bodies, such as facilitating access to samples and associated technology transfer and capacity building. Such networks would promote the formalisation of a network of sample collections, potentially modelled on the IARCs of the ITPGRFA, to institutionalise support for standardisation and facilitated access to marine genetic resources *ex situ*. Finally, the ILBI could support international cooperation by providing for engagement between a governing body and the marine genetic resources collections. This is further discussed in Section 7.5.1. The following Section examines potential measures to facilitate benefit-sharing through access to data and knowledge.

### 7.3. Potential measures to facilitate access to data and knowledge

Online access to data repositories and biodiversity knowledge would support benefit-sharing in ABNJ, and expand collective capacity. The LOSC provides an obligation for States to publish and disseminate knowledge resulting from marine scientific research, and to “actively promote the flow of scientific data and information and the transfer of knowledge resulting from marine scientific research” in Article 244. The promotion of the “acquisition, evaluation and dissemination of marine technological knowledge” and facilitating “access to information and data” is a basic objective of the development and transfer of technology, according to LOSC Article 268(a). However, the measures to achieve this are vague and general in nature, with weak or absent implementation mechanisms. Similarly, LOSC Article 144, which requires States to promote the transfer of scientific knowledge relating to the Area, does not specify mechanisms or modalities. The need to improve access to data has been articulated in various statements by scientific bodies and States. Practice shows that the sharing of data relating to marine genetic resources of ABNJ is occurring but it is not uniform and there is support among the deep-sea science community for the introduction of

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51 **LOS** art 244(1).
52 **LOS** art 244(2).
53 See, eg: **LOS** art 269, this is discussed in Section 5.4 of Chapter 5.
54 It can be noted that Article 143(c) is slightly more specific, requiring States to disseminate the results of marine scientific research and analysis relating to the Area through the ISA or other international channels.
55 See Section 6.3.1 of Chapter 6.
measures through the ILBI to enable increased openness with a view to promoting consistency and standardisation.57

This Section examines how the development of the ILBI could strengthen the international framework for the implementation of LOSC Articles 244 and 268(a) to facilitate the sharing of benefits from marine genetic resources of ABNJ. A summary of potential measures, including the instruments that could provide inspiration for the ILBI, is provided in Table 7.3. The potential role of a clearinghouse mechanism or global information system is discussed in Section 7.5.3.

The specification of requirements for sharing marine data has been used to improve international cooperation, as illustrated by UNFSA.58 In this way, Tanaka (2008) argues that UNFSA greatly strengthens the obligations of States to collect and share marine scientific information.59 UNFSA Article 14 provides for the “collection and provision of information and cooperation in scientific research.” UNFSA Article 14 emphasises the importance of cooperation for data specification and sharing of analytical techniques and methodologies.60 It establishes requirements for the collection and exchange of scientific data to be conducted in accordance with standard requirements as articulated in UNFSA Annex I.61 These requirements specify principles,62 types of data,63 reporting system,64 verification,65 and data exchange – including designation of institutional mechanisms and modalities at global and regional levels.66 The data sharing criteria of timeliness, completeness and accuracy specified in UNFSA67 are also reflected in the Arctic Science Cooperation Agreement.68

57 Section 6.3.1 of Chapter 6.
58 The UNFSA Preamble notes that unreliable databases and a lack of sufficient cooperation between States were among the problems that the UNFSA sought to address.
59 Tanaka argues that UNFSA “greatly strengthens obligations of States to collect and share marine scientific information enshrined in Arts 119(2) and 61(5) of LOSC”, Tanaka, above n 4, 220.
60 UNFSA art 14(2).
61 UNFSA art 4(1)(b)(c).
62 UNFSA Annex I arts 1 and 2.
63 UNFSA Annex I arts 3 and 4.
64 UNFSA Annex I art 5.
65 UNFSA Annex I art 6.
66 UNFSA Annex I art 7.
67 UNFSA art 14(1)(b)(c).
68 Arctic Science Cooperation Agreement art 7(2): states that Parties shall support “full and open access” to scientific metadata, distinguishing between metadata, scientific data, data products and published results. The
Similarly, the ILBI could support the exchange of data and knowledge by elaborating specific details and criteria for data sharing. The present research suggests that, in particular, the following four requirements identified by the Royal Society (2012) could be adapted under the ILBI:

- Accessible (readily located and accessed);
- Intelligible (different data communication for different audiences);
- Assessable (sufficient information to enable recipients to assess data e.g. who funded the research); and
- Usable (potential for data to be re-used).

Standardised reporting requirements and principles would support open-access to marine genetic resources data by ensuring that information is made available, in a timely fashion, through international databases. Standards and principles are already in use, although they are predominantly voluntary and self-administered through the scientific community. The importance of principles for open data has been further highlighted by State and non-State actors. Elaborating standards and criteria, based on scientific best practice, would allow flexibility to adapt to future technological and scientific developments.

An international enabling environment will be needed to ensure that standards can be met by all, in practice. Drawing on the examples of existing practice, the types of elements that would be included in an enabling environment include: a plan for long-term preservation, funding of staff and infrastructure, and network membership. Enabling practices include citation and provenance; interoperability; non-restrictive reuse; and linkability. Existing international data sharing systems could provide a basis for further development, however,

Agreement also points to timeliness, and identifies preferable features of data access, including “online” and “free of charge” or “at no more than the cost of reproduction and delivery”.

70 DOSI, above n 41.
71 Section 3.4.2.2 of Chapter 3.
72 Section 6.4 of Chapter 6.
73 ICSU, ‘ICSU-WDS Data Sharing Principles’ (ICSU, 2015); Section 6.3 of Chapter 6.
further resourcing and support would be needed.\textsuperscript{75} This could be provided as part of a wider
global information system or clearinghouse for the ILBI, as discussed in Section 7.5.3. In
doing so, the ILBI could support the growth of open knowledge systems\textsuperscript{76} as part of a ‘global
knowledge society’.\textsuperscript{77}

The ILBI could specify different allowances for confidential or non-confidential information,
similarly to the ITPGRFA. However, as noted in Chapters 3 and 4, the delineation between
commercial and non-commercial use could be difficult to achieve in practice. A further
challenge will be to define and clarify the scope of ‘data’.\textsuperscript{78} Subsequently, it will be necessary
to conclude whether to build a bespoke data sharing system for marine genetic resources, or
adopt a more holistic approach. The present research suggests that a holistic approach would
be the most useful to achieve flow-on benefits for conservation and sustainable use of
biodiversity in ABNJ and capacity development outcomes. The potential role of a
clearinghouse in this context is discussed in Section 7.5.3. It is recognised that, addressing
the challenges to open data will require cooperation between a number of actors, including
scientists, research institutions and universities, publishers, funding agencies, professional
associations and academies, archives and repositories.\textsuperscript{79} The involvement of scientific
networks could facilitate engagement and develop effective solutions. The foregoing research
suggests that these challenges could be overcome through the development of the ILBI by
adopting the following measures to enable benefit-sharing through enhanced access to data and
knowledge:

\begin{itemize}
  \item Clarify the types of data to be shared;
  \item Require and/or establish standards, principles and guidelines for acquisition, storage
        and curation of data and data exchange (including quality control);
\end{itemize}

\textsuperscript{75} Chapter 6.3.3.
\textsuperscript{76} See Section 3.4.2.2 of Chapter 3 for a discussion on the merits of open access.
\textsuperscript{77} Royal Society, above n 69, 37.
\textsuperscript{78} Section 6.4 of Chapter 6.
\textsuperscript{79} Scientists, institutions, funders, publishers and government could all play a role, see: Royal Society, above n
69, 70; C Ebikeme, S Hodson, G Boulton, H Hackmann, A S Stevance and L Spini, ‘Open Data in a Big Data
World: challenges and opportunities for sustainable development. Brief for GSDR – 2016 Update’ (International
Council for Science Committee on Data for Science and Technology, 2016), available at
https://sustainabledevelopment.un.org/content/documents/95519_Ebikeme%20et%20al__Open%20Data%20in
%20a%20Big%20Data%20World__challenges%20and%20opportunities%20for%20sustainable%20development.pdf
7. Identify an existing, or establish a new, mechanism for data exchange (i.e. a data sharing platform); and
8. Designate an institution with responsibility to facilitate data exchange, for example, IOC at a global level with regional nodes, working in consultation in conjunction with the ISA and other relevant bodies (for example, SCOR, ICSU and self-organising scientific networks).

7.4. Potential measures to enhance scientific capacity development

The development of scientific capacity at individual, national, regional and global scales is the hallmark of the integrated approach to sharing benefits from genetic resources and is inextricably linked to technology transfer.\(^{80}\) The LOSC framework provisions for the development and transfer of marine technology, set out in Part XIV, place a strong reliance on international scientific and technical cooperation for the development of scientific capacity to implement its objectives. However, the weaknesses and ambiguities in Part XIV, including a lack of implementation mechanisms, seem to have restricted the ability of States and international organisations to fully realise the vision set out in the LOSC.\(^{81}\)

In comparison to the LOSC, other international instruments have far more developed technology transfer frameworks. Under the 1992 United Nations Framework Convention on Climate Change (UNFCCC), for example, a comprehensive framework has been developed based around five themes: technology needs and needs assessments, technology information, enabling environments for technology transfer, capacity building for technology transfer, and mechanisms for technology transfer.\(^{82}\)

\(^{80}\) Section 3.4 of Chapter 3, Section 4.3 of Chapter 4, Section 5.3 of Chapter 5.
\(^{81}\) Section 5.4 of Chapter 5.
This Section examines the following measures that could be adopted in, or alongside, the ILBI to further implement LOSC Part XIV and thus enable the sharing of benefits from marine genetic resources of ABNJ:

- Global Plan of Action (Section 7.4.1);
- Technology and Scientific Capacity Development Needs Assessment (Section 7.4.2);
- Mechanism to request technology (Section 7.4.3);
- Institutional capacity development mechanisms (Section 7.4.4);
- Human capacity development mechanisms (Section 7.4.5); and
- Enabling environments (Section 7.4.6).

A summary of proposed measures, including the LOSC Articles that could be implemented and the instruments that could provide inspiration, is provided in Table 7.3.

7.4.1. Global Plan of Action

As discussed in Chapter 4, global plans of action are soft law instruments used to identify strategic priorities and guide international cooperation and collaboration for benefit-sharing and the conservation and sustainable use of genetic resources. Global plans of action have already been developed for animal genetic resources,83 plant genetic resources for food and agriculture,84 forestry genetic resources,85 and global pandemic influenza.86 The purpose of such plans include serving as central reference points for national, regional and global efforts to conserve and sustainably use genetic resources, assisting governments in formulation of policies and strategies, prioritising activities and shaping research and development agendas.

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86 See, eg: PIP Framework [6.13.1].
of international organisations, establishing long term goals, and strengthening understanding and knowledge of genetic resources.

At present, there is no Global Plan of Action for marine genetic resources. However, a comprehensive strategy to conserve and sustainably use marine genetic resources of ABNJ could have beneficial results and national, regional and global levels. Such a plan could also serve as a tool to shape the implementation of benefit-sharing under the ILBI. Drawing from existing global plans of action for genetic resources, such a plan could include:

- Availability and access to information (e.g. surveying and inventorying genetic resources; developing international technical standards)
- *In situ* conservation and *ex situ* conservation (e.g. sustaining *ex situ* collections)\(^{88}\)
- Sustainable use (e.g. characterising, evaluating and developing collections of genetic resources)
- Capacity development (e.g. national programs, networks, information systems, monitoring systems, human resources, public awareness)

A Global Plan of Action could provide a coherent framework for benefit-sharing through information exchange, technology transfer and capacity development. It could also facilitate and focus international research collaboration and technology development efforts, including those under initiatives such as the United Nations Decade of Ocean Science for Sustainable Development (2021-2030),\(^{89}\) by identifying priority areas for marine genetic resources research. This would also help mobilise efforts under Sustainable Development Goal target 14a, and could inform broad reporting mechanisms such as the World Ocean Assessment.\(^{90}\) It could guide, monitor and evaluate the implementation of benefit-sharing measures under the ILBI (Section 7.5). This could be useful in addressing the challenge that vague targets

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\(^{87}\) See Section 4.4.3.1 of Chapter 4.

\(^{88}\) Noting that the conservation of marine genetic resources *in situ* in ABNJ is the subject of the ILBI, a global plan could focus on *ex situ* conservation.

\(^{89}\) United Nations General Assembly, *Resolution Adopted by the General Assembly*, ‘Oceans and the law of the sea’, GA Res 72/73, 72nd sess, Agenda Item 77 (a), A/RES/72/73 (5 December 2017) [292].

\(^{90}\) Inniss, L and A Simcock (eds), *The First Global Integrated Marine Assessment: World Ocean Assessment I* (Report, United Nations, 2016). For example, the Global Plan for Forestry Genetic Resources (above n 85) contributes to the FAO Forestry Programme and Global Forest Resource Assessment.
contribute to poor performance in biodiversity technology transfer.\textsuperscript{91} It could guide funding targets that could be set by a Governing Body in order to mobilise resources for planning and delivering programmes.\textsuperscript{92}

A number of considerations would be necessary, including who would compile such a plan and how it could be implemented. Existing plans for plant, animal and forest genetic resources have been conducted under the auspices of FAO. Existing practices in the scientific community could provide a basis for such a Plan. For example, the IOC has coordinated the development of plans for the Global Ocean Observing System Biology and Ecosystems Panel, and harmful algal blooms – although, as focused research efforts, these are of a narrower nature to the conservation and sustainable use of genetic resources.

A further question is that of implementation. For example, the plans for animal and forest genetic resources have no formal implementation mechanism and the responsibility rests with governments. In the case of marine genetic resources in ABNJ, noting the pre-existing legal framework under Part XIV and the inherently international nature of the acquisition and sharing of benefits from marine genetic resources in ABNJ, some form of international level support for the implementation of such a Plan would be necessary. This is illustrated in the following discussion, and will be an important consideration for the institutional framework of the ILBI (Section 7.5.1).

The ILBI could recognise a potential role for a rolling ‘Global Plan of Action for the Conservation and Sustainable Use of Marine Genetic Resources of ABNJ’. This could help to encourage specificity and ambition in science and technology transfer measures, as well as flexibility to adapt to future research priorities or technological advancements. Given the imminent commencement of the intergovernmental conference for the development of the ILBI, it is unlikely that such a plan will be finalised before the ILBI is developed and adopted. However, key lessons from the Plans could inform the design of benefit-sharing measures under the ILBI, including: recognised importance of cooperation in scientific

\textsuperscript{91} Böhm and Collen, above n 50.
\textsuperscript{92} For example, the \textit{ITPGRA} art 18.3 recognises the role of the Global Plan of Action for Plant Genetic Resources for Food and Agriculture in guiding funding targets set by the Governing Body.
research for an agreed common goal, access to information and capacity development. The implementation of such a plan could help maintain ambition, focus cooperation, and guide implementation of the ILBI in future.

7.4.2. Technology and Scientific Capacity Development Needs Assessment

The report of the PrepCom identified “building capacity of developing countries to access and use marine genetic resources of [ABNJ]” as an objective of benefit-sharing. More generally, reference is also made to capacity building and transfer of marine technology that is “country-driven and responsive to periodically assessed needs and priorities.” The specific technological and scientific needs of each State to participate in benefit-sharing from marine genetic resources in ABNJ vary depending on a number of factors, such as national scientific proficiency and priorities. LOSC Articles 266(2) and 275(2) provide for the transfer of technology to States that “need and request” technology. It is therefore necessary for States to be able to identify their scientific and technological needs for benefit-sharing, as well as to request technology (technology request is discussed in Section 7.4.3).

The IOC Criteria and Guidelines on the Transfer of Marine Technology recognise that due regard should be given to “the needs and interests of developing States” in conducting technology transfer, and that to support implementation IOC should encourage Member States to include specific components on the transfer of marine technology in their strategic planning. However, it does not allude to the provision of assistance to States to identify needs or develop strategic plans. The IOC Capacity Development strategy (2015-2021) identifies capacity development work plans and needs assessments as preliminary elements of

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94 Ibid. 14, [6.2].

95 Chapter 6.4.1 of Chapter 6.

96 Section 5.3.1 and Section 5.5.2 of Chapter 5.

97 IOC, above n 21 [B.(c)(i)].

98 IOC, above n 21 [C.1.(b)].
an overall draft work plan, although this will inevitably be dependent on successful mobilisation of resources to reinforce staffing of IOC programmes.99

Technology needs assessments are recognised under international frameworks for climate change,100 biodiversity, and pandemic influenza preparedness.101 National needs assessments are one way that a State can express technology transfer and capacity development needs.102 According to the UNDP-UNFCCC “Handbook for conducting technology needs assessment for climate change”, the purpose of assessments are to “identify, evaluate and prioritize technological means for both mitigation and adaptation, in order to achieve sustainable development ends.”103 The handbook observes that technology needs assessments can contribute to enhanced capacity in developing countries through the acquisition of technology, strengthened stakeholder links and the formation of networks. This supports the notion that technology diffusion and spill-over benefits could be expected from marine genetic resources of ABNJ.104

Examples from the UNDP-UNFCCC and the 1992 Convention on Biological Diversity105 (CBD) illustrate that there is a role for international frameworks to assist countries in conducting technology needs assessments, and also provide lessons for the development of the ILBI. For example, the inclusion of benefit-to-cost ratios of technology programmes and projects has been recommended in order to facilitate securing funding for technology investments for climate change technology action plans (developed on the basis of technology needs assessments).106

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101 PIP Framework 6.13.5.
102 For example, under the PIP Framework it is recognised that countries can express need through priority accorded to building capacity in PIP related elements, through national plans and programmes, see: PIP Framework 6.13.5.
104 See Section 4.3 of Chapter 4.
106 UNFCCC Technology Executive Committee, ‘Good practice of technology needs assessments’ (UNFCCC, 2015) available at
Furthermore, a 2011 study found that more than half of countries had not completed biodiversity technology needs assessments.\textsuperscript{107} This further suggests that understanding the obstacles faced by countries could inform the design of a strategy for technology needs assessments under the ILBI.

One option this research suggests is that the ILBI could task a specified institution to assist States to conduct technology and capacity development needs assessments with an overall goal to identify technology options to support the conservation and sustainable use of marine genetic resources from ABNJ. This could include the conduct of studies on national and regional challenges and priorities for the conservation and sustainable use of marine genetic resources,\textsuperscript{108} and the development of national enabling environments for technology transfer. This is discussed in Section 7.6.1. Such assessments could be undertaken with a narrow focus on the acquisition and sharing of benefits from marine genetic resources in ABNJ, however, a more holistic approach to the conservation and sustainable use of BBNJ would be advantageous in supporting an integrated approach. The UNDP-UNFCCC handbook is a good example of a systematic approach to the conduct of technology needs assessments.\textsuperscript{109}

Technology needs assessments typically involve different stakeholders in a consultative process to identify barriers to technology transfer and measures to address barriers.

Assessments for marine genetic resources in ABNJ could complement existing regional strategies and ocean science programme planning at global, regional and national scales.\textsuperscript{110} In turn, the incorporation of scientific capacity development objectives into national plans and programmes would be another way for States to express technological needs.\textsuperscript{111} By better enabling States to identify, articulate and communicate technological “need”, technological needs assessments would support the implementation of LOSC Articles 266(2) and 275(2).

\textsuperscript{107} Böhm and Collen, above n 50.
\textsuperscript{108} See for example PIP Framework [6.13.5]; ITPGRFA art 13.2(c).
\textsuperscript{109} UNDP, above n 103.
\textsuperscript{111} See for example ITPGRFA art 13.2(c).
under the ILBI. They could also inform the development of a Global Plan of Action for marine genetic resources in ABNJ.

7.4.3. Mechanism to request technology

Although LOSC Articles 266(2) and 275(2) provide for the transfer of technology to States that “need and request” technology, mechanisms to request technology are unclear and limited. The technology transfer request forms published with the IOC Criteria and Guidelines on the Transfer of Marine Technology\(^\text{112}\) have not been widely utilised by States, with one account suggesting they have only been used once.\(^\text{113}\) On one hand, bilateral mechanisms could be favoured by some States, negating a role for facilitation by an international organisation or mechanism. However, the repeated calls from various States throughout the PrepCom to lift technology transfer would suggest the international framework for requesting technology should be improved through the ILBI.

Two approaches could be adopted under the ILBI to enable States to “request” technology and satisfy LOSC Articles 266(2) and 275(2). Firstly, an intergovernmental mechanism whereby States can formally request technology, facilitated by an international organisation, could be specified. Such a mechanism could enhance utilisation of new and existing technology request channels, facilitated by international organisations (including the IOC, ISA, and FAO) at global and regional scales. Embedding such a mechanism in a wider clearinghouse (Section 7.5.3) could raise awareness about existing technology request mechanisms and thus could help to address challenges arising from capacity constraints or coordination gaps. This request avenue could be particularly useful to enable States to request technology that will support long-term national capacity development programs requiring significant institutional, technical and human resources, especially relating to hardware and scientific research equipment.

\(^{112}\) IOC, above n 21.

Secondly, creating an international enabling environment for technology transfer would facilitate individual research institutions and scientists to participate in the provision, exchange and receipt of technology – without relying on formal intergovernmental request processes. Examples of this might include: workshops and meetings to facilitate ‘bottom-up’ scientific cooperation and the development of collaborative research proposals; online portals for scientists to request and access information and data from other scientists. This type of global scientific capacity development could be facilitated under an ILBI by the implementation measures identified in this Chapter, including information systems, support for international research, technology development and globally available education programs (Section 7.6.2).

7.4.3.1. Clarify the meaning of “technology” and “benefit”

The absence of a definition of “technology” and “technology transfer” in the LOSC is a source of ambiguity that could hinder the implementation of Part XIV. Building on the IOC CGTMT, and recalling LOSC Article 271, the ILBI could include a definition of technology. Further, the ILBI could clarify what is meant by “benefits” and “benefit-sharing. This would clarify what activities are to be facilitated through the ILBI. As noted in Chapter 3, the Nagoya Protocol Annex, PIP Article 6.1, ITPGRFA Article 13, and the IOC CGTMT provide examples of the types of criteria that the ILBI could elaborate. The link between technology transfer and the sharing of scientific data and knowledge is implicit in LOSC Articles 268(a), 143 and 144; the ILBI could explicitly clarify that knowledge and data are both benefits and technology (Section 3.3.3). This clarification could help to build a common understanding of the meaning of technology transfer and benefit-sharing, and support meaningful implementation. Furthermore, this could help to move away from the concept of benefits being “non-monetary” or “monetary” and avoid the potential for non-financial benefits to be perceived as a ‘runner-up’ prize.

114 The formulation under *ITPGRFA* art 13.2 (bii) provides an example.

115 See discussion in Section 3.2.3 of Chapter 3.
7.4.4. Institutional capacity development including networks

The LOSC places a strong emphasis on international cooperation to deliver the development and transfer of marine technology, with a particular focus on the establishment of regional marine scientific and technological research centres.\textsuperscript{116} However, the LOSC does little to specify how this international cooperation is to be facilitated or who is to be involved.

The importance of scientific networks in acquiring and sharing benefits from marine genetic resources in ABNJ was demonstrated in Chapter 6. As noted by Bohm and Collen (2015), networks are important to achieve technology transfer and benefit-sharing of genetic resources, through equality of biodiversity knowledge.\textsuperscript{117} Scientific networks operate at global, regional and national scales—ranging from informal to intergovernmental in nature—and foster ‘top-down’ intergovernmental coordination as well as ‘bottom-up’ collaboration between scientists. These networks often function as decentralised ‘hub and spoke’ models, whereby a formal central global point facilitates international cooperation and collaboration between nationally funded, regionally coordinated systems.\textsuperscript{118} International networks can thus help to overcome national or regional resource and capacity constraints. However, networks can also be subject to fragility—if one ‘spoke’ fails, the central node must be resilient enough to address the shortfall to sustain technology exchange systems. Top-down international cooperation and coordination, facilitated by an international organisation, can support long-term funding sustainability, policy certainty, formalisation of procedures and standards, and harmonisation across multiple international programs.

International legal instruments can formalise and institutionalise the role of networks in implementing technology transfer.\textsuperscript{119} For example, under the framework of the UNFCCC, networks are recognised as crucial for technology needs assessments,\textsuperscript{120} and have been

\textsuperscript{116} See, eg: LOSC arts 268(e), 270, 276, 277; Section 5.4 of Chapter 5.
\textsuperscript{117} Böhm and Collen, above n 50.
\textsuperscript{118} See discussion in Section 6.3 of Chapter 6.
\textsuperscript{119} For a discussion on how the role of networks is reflected in the ITPGRFA, CBD, Nagoya Protocol, PIP Framework and Arctic Science Cooperation Agreement, see Section 4.4.3.3 of Chapter 4.
\textsuperscript{120} UNDP, above n 103, 17.
afforded a targeted implementation mechanism in the form of the Climate Technology Centre and Network.\textsuperscript{121}

The development of the ILBI could enhance technology transfer through institutional capacity development in three ways.

Firstly, the ILBI could explicitly recognise a role for scientific networks in implementing benefit-sharing and technology transfer. For example, ITPGRFA Article 16 calls for participation by governmental, private, non-governmental, research and other institutions in networks.\textsuperscript{122} The ILBI could specify particular networks for particular roles.\textsuperscript{123} These networks could promote access to research facilities, promote technology diffusion, develop absorptive capacity and strengthen facilities for the conservation and sustainable use of marine genetic resources.\textsuperscript{124} Furthermore, the establishment of an international network of marine genetic resources sample collections, based on existing national research institutions, could promote sample sharing and associated technology transfer, as suggested in Section 7.2.4.

Such networks could provide for participation by the diverse array of actors involved in scientific research and technology transfer relating to marine genetic resources of ABNJ. For example, the role of research and development partnerships, involving public and private sector actors, could be recognised as a modality of benefit-sharing through technology transfer. For example, the PIP framework Preamble recognises the “role of industry as an important contributor to technology innovation and transfer in addressing the challenges of pandemic influenza preparedness and response.”\textsuperscript{125} Analogously, the Nagoya Protocol also recognises the importance of partnerships. Further, the ILBI could specify modalities for the

\textsuperscript{122}ITPGRFA art 16.2.
\textsuperscript{123}For example, this could include existing networks such as those discussed in Chapter 6.
\textsuperscript{124}See for example ITPGRFA art 13.2(bii); (cii); Nagoya Protocol art 22(5)(g).
\textsuperscript{125}PIP Framework, Preamble.
involvement of scientists from developing countries, including through the identification of institutional mechanisms.\textsuperscript{126}

Secondly, the ILBI could support the establishment of regional marine scientific and technological centres envisaged in LOSC Part XIV. Specifying the international organisations that are to assist States and the ISA to establish such centres could give greater effect to the implementation of Article 276 (1).\textsuperscript{127} Articulating that the functions of regional centres include, in addition to those elaborated in Article 277, the development, deployment and operation of research equipment would support international research collaboration and technology transfer. The role of the CGIAR in implementing benefit-sharing under the ITPGRFA (Section 7.2.4.1), and the GISRS in implementing benefit-sharing under the PIP Framework,\textsuperscript{128} offers useful models for strengthening institutional scientific capacity development.

Thirdly, strengthening the competency of international organisations to facilitate the implementation of technology transfer through supporting top-down coordination of marine scientific research and technology transfer programs and promoting national and regional scientific capacity would could constitute part of the institutional mechanism of the ILBI, as discussed in Section 7.5.1. The UN Decade of Ocean Science for Sustainable Development (2021-2030) could provide an avenue for enhancing international science collaboration by developing and formalising scientific and technical networks thereby increasing scientific capacity at global, regional and national scales.\textsuperscript{129}

\begin{footnotesize}
\begin{enumerate}
\item See, eg: \textit{UNFSA} art 14(3) provides for the participation of scientists from developing States in international scientific programmes. \textit{ITPGRFA} art 13.2(ciii) provides for scientific research to be conducted in cooperation with research institutions of developing countries (including developing capacity for research in fields where needed). See also \textit{ITPGRFA} art 7.1.
\item \textit{LOSC} art 276(1) provides that “States, in coordination with the competent international organisations, the Authority [ISA] and national marine scientific and technological research institutions, shall promote the establishment of regional marine scientific and technological research centres…”.
\item Section 4.3.1 of Chapter 4.
\item Section 6.2.2.1 of Chapter 6.
\end{enumerate}
\end{footnotesize}
7.4.5. Human capacity development: training and education opportunities

Individual scientists and technical experts are critical for the acquisition, sharing and utilisation of benefits from marine genetic resources of ABNJ. The development of human capacity is encouraged in LOSC Part XIV, but existing mechanisms to foster human capacity development are poorly resourced and largely dependent on ad hoc scientific practice.\textsuperscript{130}

The development of the ILBI could provide for scientific and technical education and training in the conservation and sustainable use of marine genetic resources. This could include research and training programs relating to marine biology, taxonomy, genetics, biodiscovery, bioinformatics, engineering and many other disciplines. Training could be delivered online, potentially using existing platforms such as the Ocean Teacher Global Academy (Section 6.4), and via in-person workshops. It could also include participation of scientists from developing countries in research at sea involving in situ genetic resources.\textsuperscript{131} A clearinghouse mechanism could enable scientists to identify and access training opportunities directly, as well as enabling States to request formal training programs through a technology or financial support request mechanism.\textsuperscript{132} A number of actors would need to be involved, including museums/collections to enable taxonomy training and access to ex situ samples and research institutions. Funding would be a critical issue influencing the success of training programs.

7.4.6. Enabling environments

As discussed in Chapter 4, many of the measures proposed here would contribute to an enabling environment.\textsuperscript{133} International negotiations provide an opportunity for the setting of targets and lifting of ambition.\textsuperscript{134} The research indicates that the ILBI could, indeed should, encourage States to promote enabling environments for technology transfer and capacity development to achieve the aspirational targets set in the LOSC. The ILBI could encourage

\textsuperscript{130} Section Section 6.4.5 of Chapter 6.
\textsuperscript{131} See, eg: ITPGRFA art 13.2(b)(c.iii); UNFSA art 14(3); Annex I art1(2); CBD art 12; Nagoya Protocol art 22(4)(d); 22(5)(g).

\textsuperscript{132} Section 7.5.3.
\textsuperscript{133} See Section 4.4.3 for list of elements that would be included in an enabling environment.
\textsuperscript{134} M Glachant and A Dechezleprêtre, "What role for climate negotiations on technology transfer?" (2016) 17(8) Climate Policy 962-981.
States to make national commitments, such as those outlined above, and to integrate activities relating to marine genetic resources research and development into national policies and programmes. Further, the ILBI could provide for technical assistance to States. This could include the conduct of technology and scientific capacity development needs assessments (Section 7.4.2), mechanisms to acquire technology (Section 7.4.3), establishment of research and innovation programs and institutions (Section 7.4.4), and the provision of training programs (Section 7.4.5). Measures such as these would support the creation of an ‘end-to-end’ framework, from planning, delivery, to evaluation of benefit-sharing through technology transfer. Enabling mechanisms are further discussed in Section 7.5.

7.5. Enabling mechanisms

This Section considers cross-cutting mechanisms to support an integrated approach to sharing benefits from marine genetic resources in ABNJ, to bring together the analyses of international science cooperation (Section 7.2), sharing data, information and knowledge (Section 7.3), and scientific and technological capacity development (Section 7.4). The following factors are considered:

- Institutional framework (Section 7.5.1)
- Financial mechanism (Section 7.5.2)
- Clearinghouse mechanism (Section 7.5.3)
- Evaluation and monitoring mechanism (Section 7.5.4)

7.5.1. Institutional framework

The specification of institutional mechanisms can enhance the implementation of the duty to cooperate, as discussed in Section 7.2.1. The thesis demonstrates that almost all international instruments concerning either genetic resources or ABNJ have identified institutional mechanisms for international cooperation in scientific research as being critical, including UNFSA and the 1994 Implementing Agreement. Although the LOSC refers to the role of

135 See for example ITPGRFA art 7.1.
“competent international organisations” in facilitating international scientific and technical cooperation,\textsuperscript{136} it does not specify particular institutions.\textsuperscript{137}

The ILBI could address this gap, and enable benefit-sharing, by specifically identifying institutions to facilitate international cooperation in the development and transfer of technology. Clearly identified institutional roles and responsibilities would support accountability and facilitate enhanced international cooperation. Roles would include coordinating scientific collaboration, facilitating international cooperation in the collection and dissemination of data and samples, and coordinating capacity development initiatives. As discussed in Section 7.4.4, a network of regional research centres could promote scientific capacity development, as envisaged in LOSC Articles 276 and 277. The development of the ILBI could support this by specifying a role for such centres and networks, as suggested in Sections 7.2.4 and 7.4.4.

Existing organisations could play a crucial role in operationalising Part XIV and sharing benefits, noting the activities already underway as described in Chapter 6. These include intergovernmental organisations at global (e.g. IOC, ISA, FAO) and regional scales and non-governmental organisations (e.g. ICSU, SCOR, INDEEP).\textsuperscript{138} The IOC and the ISA are the two most prominent existing institutions that could promote benefit-sharing from MGRs in ABNJ through technology.

The IOC is well-placed to promote benefit-sharing, given its mandate to assist States in the implementation of the provisions of the LOSC relating to marine scientific research and technology transfer. Some of the key activities undertaken by IOC that could have particular relevance in a new regime include: the collection, analysis and distribution of information relating to scientific research capacity and activities; the support of States in implementing

\textsuperscript{136} See for example LOSC arts 242(1), 272, 278
\textsuperscript{137} This was discussed in Section 4.4 of Chapter 4. The ISA is a notable exception to this, LOSC arts 273 and 274 have a particular focus on the role of the ISA with respect to the development and transfer of marine technology with respect to activities in the Area. This is also a useful example of how the ILBI could hone in on particular types of the development and marine technology transfer, as related to marine genetic resources of ABNJ.
\textsuperscript{138} For a discussion on regional aspects of ABNJ governance, see: Julien Rochette et al, ‘The regional approach to the conservation and sustainable use of marine biodiversity in areas beyond national jurisdiction’ (2014) 49 Marine Policy 109-117.
LOSOC provisions for marine scientific research;\(^\text{139}\) the development and publication of guidelines relating to the development and transfer of marine technology and the facilitation of capacity building initiatives; the management of international databases for marine scientific research results and data;\(^\text{140}\) and promoting science-policy engagement. However, its complex institutional situation within UNESCO, budgetary constraints, and resourcing challenges, coupled with an unclear institutional mandate for technology transfer, are issues that would need to be considered before it assumes such a role.\(^\text{141}\) Lessons from the experiences of IOC in implementing the IOC CGTMT could be informative in identifying best-practice approaches to shape the ILBI. The mechanisms of technology transfer envisaged in the CGTMT include: a clearinghouse mechanism,\(^\text{142}\) transfer of marine technology applications,\(^\text{143}\) and projects.\(^\text{144}\)

The ISA has a clear but fairly narrow mandate relating to marine scientific research and technology and there could be various roles for ISA in the institutional framework established under the ILBI.\(^\text{145}\) Other options could be the establishment of a new international organisation, the designation of a subsidiary body under the ILBI. Given the wide reach of activities relating to marine genetic resources of ABNJ, cooperation and coordination between existing institutions (including international organisations and national scientific research organisations such as museums) will be crucial, whether or not a new institution is established.


\(^\text{140}\) See: Intergovernmental Oceanographic Commission International Oceanographic Data and Information Exchange (IODE) [http://www.iode.org/](http://www.iode.org/)


\(^\text{142}\) IOC, above n 21, [C(1)].

\(^\text{143}\) IOC, above n 21, [C.2.3.4], Annex.

\(^\text{144}\) IOC, above n 21, [C(5)].

\(^\text{145}\) The mandate of ISA is focused on activities relating to the Area and its resources. David K Leary, More than just bugs and bioprospecting in the abyss. Designing an international legal regime for the sustainable management of deep-sea hydrothermal vents beyond national jurisdiction (PhD Thesis, Macquarie University, 2005) 336.
The importance of cooperation among international organisations to implement the development and transfer of marine technology is recognised in LOSC Article 278. The IOC capacity development strategy recognises that,

“Delivering benefits at global, regional, national and individual levels requires a highly coordinated and collaborative programme within IOC, collaboration with numerous partners to maximise synergies and prevent duplication…”146

By specifying a coordinating institution or cooperation mechanism for cooperation between international organisations, the ILBI could support efficient benefit-sharing measures and enhance the implementation of Article 278.

Organisations would be operating within a broader institutional framework that would need to be determined through the development of the ILBI. Although a thorough examination of institutional options is beyond the scope of this thesis, key elements could include a governing body, secretariat, advisory body, and focal points at national,147 regional and global scales (Table 7.2).

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146 IOC above n 99, 34 [95].
147 Under the Nagoya Protocol, each party is to designate a national focal point on access and benefit-sharing (Nagoya Protocol art13). Each Party is to take measures to monitor and enhance transparency about the utilisation of genetic resources, for the purposes of supporting compliance (Nagoya Protocol art 17). Under this provision, ‘checkpoints’ are to be designated whereby they are “relevant to the utilization of genetic resources, or to the collection of relevant information at, inter alia, any stage of research, development, innovation, pre-commercialization or commercialization” (Nagoya Protocol art 17 (1) (a) (iv)).
Table 7.2: Potential elements of an institutional framework for benefit-sharing

<table>
<thead>
<tr>
<th>Element</th>
<th>Responsibility</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Governing body</td>
<td>Decision-making (e.g. conference of parties)</td>
<td>E.g. ITPGRFA art 13; CBD art 18(3)148</td>
</tr>
<tr>
<td>Secretariat</td>
<td>Implementation support (e.g. clearinghouse, reporting mechanism)</td>
<td>PIP 6</td>
</tr>
<tr>
<td>Advisory body</td>
<td>Implementation advice (e.g. scientific and technical committee)</td>
<td>CBD, NP, SBSTTA</td>
</tr>
<tr>
<td>Focal points: global</td>
<td>Coordinate and facilitate global scientific research collaboration, data sharing, training programs</td>
<td>PIP 4.3</td>
</tr>
<tr>
<td>Focal points: regional</td>
<td>Data and information sharing (e.g. regional data and information nodes), coordinate regional science collaboration and capacity development (e.g. regional research and training centres and networks), reporting</td>
<td>LOSC arts 276 and 277</td>
</tr>
<tr>
<td>Focal points: national</td>
<td>Technology needs assessment, information sharing, enabling environment, reporting</td>
<td>NP arts 13, 17</td>
</tr>
</tbody>
</table>

7.5.2. Financial mechanism

The need for international cooperation to fund science and technology for sustainable development has long been recognised, including the role of both public and private sources.149 The need for international approaches to fund ocean science for sustainable development is echoed in the LOSC Article 270 and the 1982 Resolution on development of national marine science, technology and ocean service infrastructures.150

Article 270 of the LOSC recognises the importance of international cooperation through multilateral programmes to facilitate “appropriate international funding for ocean research and development.” In practice, funding for marine scientific research and the development

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148 CBD art 18(3) provides that Conference of the Parties should determine how to establish the CBD clearinghouse mechanism, see discussion in Sections 4.3.1.1 and 4.4.2 of Chapter 4.
and transfer of technology relating to the acquisition and sharing of benefits comes from a diversity of funding sources. At least some level of public funding appears to be critical to overcome uncertainty arising from ad hoc private and philanthropic funding and to ensure long-term sustainability.\textsuperscript{151} Sustainable funding will be required for a number of components to enable the acquisition, sharing and utilisation of benefits, including: marine scientific research, sample collections, databases, information systems and technology development and transfer measures including education and training programs. Some of these are likely to be funded on a national basis, such as national data nodes and research programs. Others, could be funded on a global basis, such as capacity development programs, technology transfer programs and the compilation and analysis of technology needs assessments.

Potential global funding sources could include: existing funding sources or the establishment of a new fund.

One existing source that could be considered is the Global Environment Facility (GEF), which already serves as a financial mechanism to five international conventions, including the UNFCCC and CBD.\textsuperscript{152} The GEF was established in 1992 as a partnership that now consists of eighteen agencies, (including the World Bank, United Nations Development Program and the United Nations Environment Program) and 183 countries. The GEF aims to provide new and additional funding to achieve environmental benefits in focal areas including biological diversity and international waters. Freestone (2007) observes that the negotiators of UNCLOS III “underestimated the resources” needed for developing States to capture benefits under LOSC, and that the GEF “has become the financing instrument for many of the LOSC’s “global public goods”.\textsuperscript{153} A 2017 working paper recognised the GEF as the “only entity focused on the global commons” and well placed to lead on the science of integration and “systems thinking” to deliver global environmental benefits.”\textsuperscript{154} In light of its

\textsuperscript{151} Section 6.4 of Chapter 6.
\textsuperscript{154} GEF, ‘GEF-7 Replenishment draft STAP working paper: why the scientific community is moving towards integration of environmental, social, and economic issues to solve complicated problems (prepared by the
environmental and developmental focus, the GEF could be considered as an option to fund benefit-sharing through science and technology transfer under the ILBI. However, existing limitations in accessing and utilising GEF funds for technology transfer and capacity building relating to conservation and sustainable use of biodiversity would need to be better understood and addressed.

The establishment of a new financial mechanism is another option. However the nature, source and sustainability of contributions would be critical. Similar challenges could be faced in ‘institutionalising support’ for BBNJ research under the ILBI, particularly given that the uncertainty surrounding marine genetic resources in ABNJ mean that monetary benefits from this source are unlikely to be a reliable source of funding (Section 3.3). A mixture of voluntary or mandatory contributions could be provided for under the ILBI to promote sustainable financing.

Innovative financing (the development of new funding sources and mechanisms including from the private sector) could also be encouraged under the ILBI, as in the PIP framework. Thiele and Gerber (2017) outlines how innovative finance could be used to support ocean conservation in ABNJ, including through the development of a comprehensive ocean data infrastructure. This would reflect the role of the private sector in driving innovation through research and development. The ‘user pays’ model under the PIP framework is another approach to private sector engagement. Specific funding could be allocated to individual components. The funding mechanism for the Global Seed Vault (plant genetic resources) established under the Crop Trust agreement offers an attractive model. The 2006

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155 David Leary and S Kim Juniper, 'Addressing the marine genetic resources issue: is the debate heading in the wrong direction?' in Clive H Schofield, Seokwoo Lee and Moon-Sang Kwon (eds), The Limits of Maritime Jurisdiction (BRILL, 2013) 769-785.
158 See, eg: PIP Framework [6.14].
Relationship Agreement Between the Global Crop Diversity Trust and the Governing Body of the International Treaty on Plant Genetic Resources for Food and Agriculture, which defined the relationship of the Crop Trust with ITPGRFA, recognised the Trust as an essential element of the ITPGRFA Funding Strategy for the implementation of benefit-sharing. Drawing from these models, an ‘Ocean Trust’ could be established to promote sustainable and innovative financing, utilising public-private partnerships, for a global network of research and development centres and sample collections.

The mobilisation of a funding strategy for marine genetic resources in ABNJ could be guided by identified global priorities such as through the Global Plan of Action proposed in Section 7.4.1. It could further encourage Parties to accord due priority in their own plans and programmes for building capacity in genetic resources to undertake conservation and sustainable use of marine genetic resources from ABNJ.

7.5.3. Clearinghouse and global information system

The lack of a specified implementation mechanism for the publication and dissemination of research results, data and information—as required under LOSC Articles 244 and 268(a)—was identified in Chapters 5 and 6 as a key gap in the existing framework for marine scientific research under the law of the sea. Clearinghouse mechanisms are a wide-spread tool to promote information exchange and support benefit-sharing in other circumstances. They are commonly composed of a central portal and associated nodes. For example, the establishment of a clearinghouse mechanism was envisaged under the IOC CGTMT. The IOC is taking steps to develop the clearinghouse, however, it is not currently capable of delivering all possible aspects of benefit-sharing. The report of the PrepCom indicates that a

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accessed 30/12/2017; Crop Trust, ‘Securing crop diversity for sustainable development’ (Global Crop Diversity Trust, 2015) 21.
161 See, eg: ITPGRFA art 7 “essential funding and implementation mechanism”.
162 ITPGRFA art 18.4(d).
163 See Section 4.4.2 of Chapter 4.
clearinghouse mechanism would be established, however, questions remain about the scope of data, knowledge and information sharing that would be included under the mechanism.\textsuperscript{165}

The ILBI could establish a new, or strengthen an existing, clearinghouse mechanism including a global information system to enable benefit-sharing through technology transfer. This thesis suggests that the objectives of such a clearinghouse could be based on the ITPGRFA Vision and Programme of Work on the Global Information System,\textsuperscript{166} and therefore include:

- \textit{Vision}: the creation of a web-based platform with user friendly entry points to marine genetic resources information, with identified national and regional human focal points;
- \textit{Access to data and information}: provide a comprehensive overview and facilitate access to sources of marine genetic resources and associated information, including existing national regional and global portals such as OBIS-IODE, and specified resources;
- \textit{Standards, principles and tools}: promote and facilitate interoperability among existing systems by providing clear principles, technical standards and appropriate tools to support their operations in accordance to the principles and rules of the LOSC;
- \textit{International science cooperation, collaboration and communication mechanisms}: create and enhance opportunities for communication and international and multidisciplinary collaboration to increase knowledge about and add value to marine genetic resources; offer a match-maker collaboration partnerships request board; and provide a virtual network to link national sample and data collections, regional scientific clusters, and international scientific networks;
- \textit{Training and education}: provide online portals for training and education, including initiatives such as Ocean Teacher Global Academy; workshops; cruise opportunities; and information regarding meetings and workshops;

\textsuperscript{165} Ibid.
\textsuperscript{166} FAO ITPGRFA, \textit{Vision and Programme of Work on the Global Information System} IT/GB-6/15/Res 3, Resolution 3/2015 (ITPGRA, 2015); Section 4.4.2 of Chapter 4.
• **Information:** technology needs assessments, national policies (including guidance to develop needs assessment and a depository of completed needs assessments);

• **Technology request mechanism:** mechanism to lodge technology requests;

• **Transparency:** promote transparency on the rights and obligations of users for accessing, sharing and using marine genetic resources associated information;

• **Cruise notification scheme:** reporting and notification system for access to genetic resources in ABNJ *in situ* e.g. research cruises; and

• **Reporting:** offer an online a mechanism to assess progress and monitor effectiveness of the system.

Such a clearinghouse could be run by a new or existing institution, cooperation with other regimes will be necessary to maximise capacity development opportunities and avoid duplication.\(^{167}\) However, although the clearinghouse could be a useful tool for cooperation, especially to share information between States, other modalities will also be necessary. For scientific cooperation between individuals and institutions, interpersonal contacts are vital. Furthermore, the usefulness of the information system will depend upon engagement with relevant stakeholders to provide information and to ensure that it is used by those who may need it. Also required are, effective processes for stakeholder and dialogue participation support knowledge networks and open knowledge systems.\(^{168}\) Engaging with existing scientific networks could raise awareness and facilitate the design, resourcing, operation, utilisation and promotion of a clearinghouse.

Securing funding for clearinghouse mechanism operations would be an important priority, however, funding for international information exchange systems can be precarious and challenging.\(^{169}\) The funding challenges facing OBIS illustrate the challenges that will need be overcome to share benefits through the ILBI.\(^{170}\) Allocated resources to data and information sharing will be critical – at international and national levels – for the clearinghouse and to

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\(^{167}\) See, eg: *ITPGRFA*, art 17.1 stipulates that cooperation will be sought with the clearinghouse mechanism of the CBD.  


\(^{169}\) See Section 4.4.2 of Chapter 4.  

\(^{170}\) Section 6.3.1 of Chapter 6.
operationalise LOSC Articles 244 and 268(a). Networks of data providers and users could help to alleviate funding burdens.

7.5.4. Evaluation and monitoring

The monitoring and evaluation of technology transfer is important to track progress, identify strengths and weaknesses of implementation measures, and shape international cooperation efforts. The lack of a mechanism for the monitoring and evaluation of technology transfer under the LOSC, or the IOC CGTMT, is a gap that could be filled through the development of the ILBI. However, there are various challenges to monitoring and measuring technology transfer given its complex and multidimensional nature, and lack of available data regarding indicators.

National reporting is important to provide data to track and assess technology transfer. For example CBD Article 26 requires States to report on activities. However, Bohm and Collen (2015) argue that national reporting does not successfully fulfil its obligation of reporting on progress toward technology transfer, and that there is an urgent need to develop indicators to track and assess biodiversity technology transfer that are cost-effective, reliable and informative with sufficient flexibility to adapt to policy developments. They recommend focusing on direct technology transfer because indirect measures (e.g. R&D cooperation supporting education universally) are difficult to define and measure. Noting that biodiversity knowledge indicators focus on easy-to-measure components that can be used to describe the state of biodiversity knowledge and function as technology knowledge needs assessment. The monitoring framework proposed by Bohm and Collen (2015) for use under the CBD could be modified for marine genetic resources in ABNJ.

Information could be gathered from national reporting statistics (including bilateral technology transfer), funding bodies, regional organisations, intergovernmental organisations

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172 Böhm and Collen, above n 50.
173 Ibid.
174 Ibid.
175 Ibid.
and international non-governmental organisations. However, it could be difficult to get meaningful information without well-established metrics. For example, funding bodies with outcomes aligned to implement international guidelines (such as on open access to data) could be straightforward, but disentangling the contribution of technology transfer to overall total expenditure of a project would be more complex. Aligning technology transfer reporting indicators between the CBD and the ILBI could help to support efficiency and minimise increased administrative burdens for developing countries. Potential metrics could therefore include:

- **Scientific research**: percentage of research projects involving access to marine genetic resources in ABNJ that are internationally collaborative; number of global research infrastructure programs involving marine genetic resources in ABNJ, e.g. ocean observing systems, technology development projects or the establishment of global sample collection(s); number of internationally co-authored research publications;
- **Data**: number of OBIS and/or GBIF records with associated genebank records; number of open access records associated with marine natural products from ABNJ;
- **Funding**: spending per technology transfer project including development assistance and private sector investment, national investment in technology transfer (human and financial resources);
- **Programs**: number of ILBI specific technology development and transfer projects and programs;
- **Assessments**: number of technology needs assessments conducted;
- **Requests**: number of technology requests made and met;
- **Human capacity development**: number of scientists trained; number of courses openly available online; and
- **Institutional capacity development**: number of research institutions engaged in regional research hubs and global research networks.

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7.6. Towards an integrated benefit-sharing system: creating an international enabling environment

The preceding analysis has identified a number of potential measures that could be adopted under the ILBI to enable the sharing of benefits from marine genetic resources of ABNJ. This Section deals with the international enabling environment, following the introduction of this concept in Section 7.4.6. In particular, it summarises the proposed measures for the ILBI (Table 7.3) and presents a conceptual framework for how the development of the ILBI could promote an international enabling environment to share benefits from marine genetic resources in ABNJ (Figure 7.2).
Figure 7.2: Conceptual framework for an enabling environment for benefit-sharing. The framework includes targeted measures for: international cooperation in marine scientific research (a; Section 7.2); access to data, knowledge and information (b; Section 7.3); scientific capacity development (c; Section 7.4); and cross-cutting enabling mechanisms (d; Section 7.5).
Table 7.3: Summary of potential measures for the ILBI, (a) International scientific research cooperation (a) and access to data, information and knowledge (b) (note: table 7.3. is continued on the following page, *see Chapter 4; **see Chapter 5).

<table>
<thead>
<tr>
<th>Potential measure for ILBI</th>
<th>LOSC basis*</th>
<th>Examples**</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) International scientific research cooperation</td>
<td>242</td>
<td>ITPGRFA arts. 5, 7.2; NP art. 22; UNFSA art. 14(3)</td>
</tr>
<tr>
<td>Specify nature, purpose &amp; modalities of international cooperation</td>
<td>arts 242; 270</td>
<td></td>
</tr>
<tr>
<td>Development and deployment of technology</td>
<td>arts 266(1); 268(b)</td>
<td>UNFSA art. 5(k); CBD art. 18(4); SCD [5a]</td>
</tr>
<tr>
<td>Collaboration</td>
<td>art 243</td>
<td>NP art. 23</td>
</tr>
<tr>
<td>Guidelines, codes of conduct for marine scientific research relating marine genetic resources</td>
<td>art 251</td>
<td>ITPGRFA art. 15.1(d); NP art. 20(1); Arctic arts 1, 7</td>
</tr>
<tr>
<td>Facilitated access to samples</td>
<td>art 244</td>
<td>ITPGRFA art. 12</td>
</tr>
<tr>
<td>Specified institutional mechanism</td>
<td>art 239</td>
<td>ITPGRFA</td>
</tr>
<tr>
<td>(b) Access to information, data knowledge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clarify types of data &amp; information to be shared</td>
<td>arts 244(2); 268(a)</td>
<td>UNFSA art. 14(1), 14 (2); CBD art. 17; Arctic art. 7; ITPGRFA art. 13.2(a); 13.3(a); PIP [5.2]; Moon art. 5</td>
</tr>
<tr>
<td>Standards, principles and criteria</td>
<td>arts 251; 271</td>
<td>UNFSA art. 14(1), 14 Annex I arts. 1(1), 2. CBD art. 17; Arctic art. 7(2), 7(3); ITPGRFA art. 13.2(a); PIP [5.2]</td>
</tr>
<tr>
<td>Institutional mechanism</td>
<td>arts 272; 273</td>
<td>UNFSA Annex I art. 7(2) 1994 IA. Annex Section 1 [5(b); (i)]</td>
</tr>
<tr>
<td>Technical mechanism</td>
<td>arts 268(b); 269</td>
<td>see below</td>
</tr>
</tbody>
</table>
Table 7.3 continued: Summary of potential measures for the ILBI (c) scientific and technical capacity development and (d) enabling mechanisms.

<table>
<thead>
<tr>
<th>Potential measure for ILBI</th>
<th>LOSC basis*</th>
<th>Examples**</th>
</tr>
</thead>
<tbody>
<tr>
<td>(c) Scientific &amp; technical capacity development</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Global Plan of Action</td>
<td>arts 251; 271</td>
<td>ITPGRFA art. 13.2; (see also arts. 14 &amp; 18.3) PIP 6.13.1</td>
</tr>
<tr>
<td>Technology and scientific capacity needs assessment</td>
<td>arts 266(2); 275(2)</td>
<td>ITPGRFA art. 13.2(c.); PIP 6.13.5</td>
</tr>
<tr>
<td>Mechanism for technology request</td>
<td>arts 266(2); 275(2)</td>
<td>-</td>
</tr>
<tr>
<td>Institutional capacity development, including networks of scientific and technological organisations</td>
<td>arts 276; 277</td>
<td>ITPGRFA art. 13.2(b(ii)),(c(ii)) NP art 22(5)(g) Moon art.6 SCD[5c] PIP 16.1 PIP 4.3</td>
</tr>
<tr>
<td>Training and skills</td>
<td>arts 268(d); 269; 277</td>
<td>ITPGRFA art. 13.2(b)(c.iii) UNFSA art. 14(3); Annex I art.1(2) CBD art. 12 NP art 22(4)(d); 22(5)(g)</td>
</tr>
<tr>
<td>Enabling environments</td>
<td>arts 243; 266(3); 269(b)</td>
<td>ITPGRFA art. 7.1.</td>
</tr>
<tr>
<td>(d) Framework for international enabling environment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institutional framework</td>
<td>arts 272; 278</td>
<td>UNFSA art. 5(k); ITPGRFA art. 7.1; Arctic Science Preamble</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CCAMLR art VII, XV UNFSA Annex I art. 7 ITPGRFA art. 15 CCAMLR art. VII, XV</td>
</tr>
<tr>
<td>Financial mechanism</td>
<td>art 270</td>
<td>CBD arts 20; 21; ITPGRFA art 18</td>
</tr>
</tbody>
</table>
It is important to note that these measures vary greatly in terms of required ambition and resources (Figure 7.3). Some merely elaborate or clarify existing LOSC provisions, others represent more ambitious innovations to the LOSC framework. Some have minimal resource implications (e.g. clarifying standards for data sharing), others would require considerable political will, time and resources to implement (e.g. funding data sharing infrastructure, staff and policies). They also vary in terms of impact: specifying standards and data will not be useful without enabling mechanisms to enable access. Some measures are long overdue (such as clarifying the meaning of technology and identifying implementation mechanisms for Part XIV) and the ILBI is a significant opportunity to update and also future-proof the law of the sea to effectively harness the benefits of technological advances. Others may seem overly ambitious (such as a fully-funded international network of regional centres). However, one thing that all measures considered here do have in common, is that they build on existing practices. Accordingly, the issue of “voluntary or mandatory” technology transfer, discussed in Chapter 4, is not necessarily a barrier to sharing data, information and knowledge.

The issue of resourcing is perhaps the greatest challenge. Achieving the integrated approach, as proposed in this thesis, also requires a number of measures happening concurrently and being supported holistically. The ILBI could include these provisions, but it alone will not be able to implement benefit-sharing. The efficacy will depend on the level of ambition and sustained political will among States, particularly the researching nations most active in ABNJ.
Figure 7.3: Illustrative examples of the required resources, and relative impact of benefit-sharing measures examined in this Chapter.

7.7. Conclusion

This Chapter has examined how the development of the ILBI could support the sharing of benefits from marine genetic resources in ABNJ by creating an enabling international environment for scientific and technological capacity development (Figure 7.3; Tables 7.3a and 7.3b). Potential measures have been proposed in three specific areas: international scientific research cooperation, access to data and knowledge, and scientific capacity development. Firstly, the development of the ILBI could enhance international marine scientific research cooperation to support benefit-sharing by elaborating the general duty to cooperate in LOSC Article 242, and enhancing the implementation of LOSC Articles 278, 272, 270, 268, 251, 244, 243, 143. Secondly, the development of the ILBI could enable the sharing of data and information and the exchange of scientific knowledge to support benefit-
sharing, thus further implementing the duty to publish and disseminate knowledge resulting from marine scientific research enshrined in LOSC Articles 244 and 268(a). Thirdly, the development of the ILBI could facilitate the increase in scientific and technological capacity to inform and enable benefit-sharing by elaborating and further implementing LOSC Articles 277, 266(2) and 275(2).

In addition, four enabling mechanisms have been proposed. Firstly, clearly identified institutional responsibilities, including adequately resourced international scientific and technical organisations operating at global, regional and national scales, to enable accountability and implementation. Secondly a financial mechanism to support benefit-sharing measures. Thirdly, a clearinghouse mechanism and/or global information system to enable the sharing of benefits, including providing access to data, information and knowledge. Fourthly, an evaluation and monitoring mechanism to track implementation progress and guide future efforts.

The proposed measures have been inspired and adapted from a range of legal instruments, including those discussed in Chapter 5, and build on best-practice approaches to benefit-sharing through technology transfer identified in Chapter 6. It is argued that this approach could strengthen the implementation of the existing framework provisions for marine scientific research and the development and transfer of marine technology established by LOSC Parts XIII and XIV, as discussed in Chapter 4, and address challenges identified in Chapter 6.

An integrated approach combining scientific research and capacity development would represent a new paradigm of technology transfer in the law of the sea. This would require a change in the perception of technology transfer being akin to bilateral hardware donation to one of multilateral knowledge exchange and global scientific capacity development for national (and universal) benefits. By specifying the purpose, institutional modalities, and implementation mechanisms for benefit-sharing through scientific and technological capacity development, the development of the ILBI is a significant opportunity to develop the international framework for technology transfer under the law of the sea. Given that these elements are already required under the LOSC, issues relating to ‘voluntary’ or ‘mandatory’
technology transfer become less important and the key focus can be on enabling implementation.

In concluding, the measures proposed in this Chapter offer a pathway to pursue an integrated approach to benefit-sharing that supports the conservation and sustainable use of biodiversity in ABNJ. The measures are proposed with a view to practical utility and effective implementation. However, it must be noted that this conceptual model for an integrated approach to benefit-sharing provides a foundation for further development that is not without limitations. The proposed measures vary in terms of required resources and level of political and institutional ambition as well as economic factors. Some measures would elaborate or clarify existing LOSC provisions, others represent more ambitious innovations or additions to the LOSC framework. Further work will be required to determine how this proposed integrated approach could be fostered by the ILBI in practice. For example, whether these measures would fall under a specific benefit-sharing system for marine genetic resources of ABNJ, or whether they would be addressed as part of a more holistic enabling environment for scientific capacity development. These issues are summarised in Chapter 8.
Chapter 8. Conclusion

8.1. Introduction

Sharing benefits from marine genetic resources of areas beyond national jurisdiction (ABNJ) is a complex and multi-faceted challenge. It is, however, a challenge that urgently requires practical solutions to be developed. This is because “marine genetic resources including questions on the sharing of benefits” form an integral part of a historic international legal and governance endeavour that States are poised to embark upon – negotiations towards an international legally binding instrument (ILBI) for the conservation and sustainable use of marine biological diversity in ABNJ under the 1982 United Nations Convention on the Law of the Sea (LOSC).\(^1\) This thesis provides the first comprehensive analysis of the potential to enable benefit-sharing from marine genetic resources of ABNJ by strengthening the implementation of existing LOSC framework provisions relevant to scientific and technological capacity through the ILBI. In this Chapter, the three key findings of this thesis are presented in Section 8.2, areas for further research are identified in Section 8.3, and the thesis is concluded in Section 8.4.

8.2. Key findings

The issue of benefit-sharing from genetic resources is entwined with goals set by the international community to conserve and sustainably use biological diversity.\(^2\) It also sits at the heart of an increasingly turbulent nexus of issues relating to scientific advancement, technological innovation, globalisation, open access, sustainable development and equity. The role of science and technology in enabling sharing of so-called “non-monetary” benefits has gradually emerged as a potential avenue to progress this goal. However, an attempt to develop a common understanding and viable solutions to benefit-sharing is quickly confronted by an array of definitional gaps, compounded by scientific and technical

\(^2\) Section 2.6.2 of Chapter 2.
complexities and legal ambiguities. Consequently, an interdisciplinary approach is required to deliver a comprehensive analysis of the issues and to develop innovative solutions that are grounded in international law and can be implemented in practice through the agents of science, technology and innovation. This is the central contribution of this thesis. Three key conclusions are drawn:

- The first conclusion is that sharing benefits from marine genetic resources of ABNJ can be considered through an integrated approach composed of four elements (Section 8.2.1).
- The second conclusion is that the LOSC provides a basis for an integrated approach to sharing benefits from marine genetic resources of ABNJ, however, it is currently weakened by gaps and ambiguities (Section 8.2.2).
- The third conclusion is that the development of the ILBI could foster an integrated approach to sharing benefits from marine genetic resources of ABNJ by adopting an array of measures to strengthen the implementation of the LOSC framework provisions for marine scientific research and the development and transfer of marine technology (Section 8.2.3). This approach would not satisfy all aspects of benefit-sharing, however, it offers a complementary suite of measures that could form part of a robust international agreement for the conservation and sustainable use of biodiversity of ABNJ (Section 8.2.3.3).

**8.2.1. An integrated approach to benefit-sharing**

The first finding of this thesis is that the issue of benefit-sharing from marine genetic resources of ABNJ should be considered as part of an integrated approach to the

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3 Scientific and technological complexities relate to determining: the nature, material scope, and value of ‘marine genetic resources’ (Sections 2.3 and 2.5 of Chapter 2); the nature of benefits, including related issues such as of technology, data and knowledge (Section 2.6 of Chapter 2; Section 4.3 of Chapter 4); the processes through which benefits can be acquired, shared and utilised (Chapter 3.2.2). Legal ambiguities relate to definitional gaps in the LOSC for terms of “marine genetic resources” (Chapter 2.3); “benefit”, “technology”, and “data, information and knowledge” (Chapters 2, 3, 4 and 5); and “benefit-sharing”, “technology transfer”, and “marine scientific research” (Section 3.4.1.1 of Chapter 3; Section 5.2.2.2 of Chapter 5). Legal ambiguities also relate to weaknesses in the legal framework for the development and transfer of marine technology in LOSC Part XIV and for marine scientific research in LOSC Part XIII (Section 5.5 of Chapter 5).

4 As noted in Section 1.4.1 of Chapter 1, this thesis has not addressed the issue of monetary benefit-sharing.
investigation, conservation and sustainable use of marine life. For marine genetic resources of ABNJ, it is argued, the integrated approach can be considered in four parts (Figure 8.1):

- Subject: the material scope of a benefit-sharing regime (Section 8.2.1.1);
- Objective: the objective of benefit-sharing under an ILBI (Section 8.2.1.2);
- Values: the values to be preserved, captured and shared (Section 8.2.1.2); and
- Enablers: measures to achieve the objective, capture value and share benefits (Section 8.2.1.3.)

Figure 8.1: Elements of the integrated approach to benefit-sharing

8.2.1.1. “Marine genetic resources” of ABNJ should be considered as all marine life of ABNJ

An integrated approach would recognise marine genetic resources as an inextricable component of biodiversity. Determining the material scope of marine genetic resources of ABNJ, to which benefit-sharing would apply, requires a consideration of scientific and legal
aspects of the definition. In Chapter 2, it was argued that “genetic resources” is a legal term which is primarily concerned with the distribution of realised value. Considered scientifically, the term “genetic resources” has little meaning and it is difficult to distinguish marine genetic resources from all marine life on the basis of existing legal definitions. This raises challenges for regulation, including how non-commercial scientific and commercial activities involving so-called “genetic resources” could be distinguished. There are two options for considering the material scope of the resource from which benefits would be shared. The first option would be to incorporate all marine life of ABNJ, the second option would be to incorporate a sub-set of life in ABNJ. It is argued that the first option is the most viable for two reasons. The first reason is that existing legal definitions and scientific knowledge are not sufficiently static, stable and comprehensive to warrant the assumptions that would be necessary to identify a subset of species. The second reason is that, in practice, a regime for ABNJ should be harmonious and complementary to existing regimes for areas within national jurisdiction. Consequently, this thesis has considered that a benefit-sharing system for marine genetic resources of ABNJ would potentially need to be applicable to all marine life and its derivatives. Thus, the first element of an integrated approach relates to the material scope of benefit-sharing under an ILBI; marine genetic resources should be considered as an inextricable part of marine life.

8.2.1.2. Multiple values of genetic resources demand a nexus of objectives combining conservation, sustainable use and benefit-sharing

The lack of a common understanding about the “actual or potential value” of genetic material is another issue hindering the delineation of marine genetic resources from biodiversity. In the context of ABNJ, value is often associated with economic value, partly as a consequence of the widely adopted terminology ‘monetary and non-monetary benefits’. A more appropriate and accurate interpretation of the value of genetic resources revolves around the argument that marine life has innate actual environmental, scientific and societal value and potential economic value. This holistic concept offers a constructive and informative guiding

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5 It is not foreseeable that a subset of marine genetic resources would be identifiable for three reasons: i) the knowledge gaps relating to marine biodiversity of ABNJ; ii) the lack of a single vision of the international community for a subset of species to which benefit-sharing would apply; and iii) the potential for scientific and technical advances to discover new species.
approach to considering the value that a system for benefit-sharing of marine genetic resources of ABNJ could capture and distribute. Thus, the second element of the integrated approach considered in this thesis is that marine genetic resources of ABNJ should be considered as having actual environmental, scientific and social values and potential economic value.

Capturing actual or potential value from marine genetic resources depends on the continued existence of species. Thus, the third aspect of the integrated approach is that the conservation and sustainable use of biodiversity should be considered together with benefit-sharing of genetic resources as combined objectives. Furthermore, many of the elements that enable benefit-sharing have dual functions that would also support biodiversity conservation. For example, technology transfer can have a diffuse effect, with one activity (such as training or access to equipment) able to deliver a range of benefits.

8.2.1.3. Scientific cooperation, technology transfer and capacity building are linked

The fourth aspect of the integrated approach is the provision of benefit-sharing through technology transfer, which is considered in terms of international science collaboration, access to data and knowledge and scientific capacity building. As a consequence of vague and undefined terminology, a benefit could arguably be considered to be an advantage gained from research and development processes involving marine life of ABNJ.\(^6\) It can be considered that benefits are acquired when potential value is translated into actual value through scientific research and development processes.\(^7\) Many benefits could be considered under the broad definition of technology, such as knowledge, data and information. These benefits are often termed “non-monetary” but this thesis argues that such a distinction is over-

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\(^6\) As discussed in Section 3.3.2 of Chapter 3, multiple different benefits can be captured throughout the research and development process. The type of benefits to be captured will be influenced by factors such as cost and time.

\(^7\) For example, scientific value can be captured and translated into benefits such as knowledge and information products, as soon as access to marine life is possible. In contrast, realising economic value through, for example, commercialising a product is not guaranteed and can only occur at the end of a process.
simplistic and arbitrary, and proposes that a more inclusive and open interpretation of benefits is more appropriate.\textsuperscript{8}

This thesis has argued that benefits and benefit-sharing from marine genetic resources of ABNJ are inextricably linked to scientific collaboration, technological innovation, sharing research outcomes and scientific capacity building. Scientific and technological capacity is a critical factor influencing the ability of a State to benefit from marine genetic resources of ABNJ. This also reflects the pivotal role of scientific and technological capacity building in the principle of sustainable development. Furthermore, international science collaboration can provide a unifying focus in international approaches to manage international spaces. The fourth element of the integrated approach is therefore, that scientific research, technology transfer and capacity building are interlinked in practice and should be considered together in a benefit-sharing system for ABNJ.

\textbf{8.2.2. The legal basis for an integrated approach to benefit-sharing}

The second finding of this thesis is that the LOSC framework provisions relating to marine scientific research and technology transfer provide a basis for benefit-sharing. The LOSC framework provisions of Part XIII and XIV have been identified as a possible basis for the sharing of benefits from marine genetic resources of ABNJ. This thesis has argued that three duties are inextricably interlinked in the LOSC:

- International cooperation in marine scientific research;
- Technology development and transfer, including the sharing of data, information and knowledge; and
- Human, institutional and technical scientific capacity building, on global, regional and national scales.

Because of the interlinkages between these three elements, it is argued that the LOSC provides the appropriate basis for an integrated approach to benefit-sharing through which

\textsuperscript{8} Section 3.3 and 3.5 of Chapter 3.
science cooperation, technology transfer and capacity building should be considered together. The notion that these three elements should be considered together is enshrined in articles 143, 244 and 268. It is argued that these articles provide a point of departure for an integrated approach to benefit-sharing. It is further argued that there is a precedent for these three elements to be considered collectively, as illustrated by other instruments relating to ABNJ and to genetic resources.

However, it is further argued that gaps and ambiguities, especially in Part XIV, weaken the LOSC framework for science cooperation, technology transfer and capacity building. Gaps include a lack of specified institutional mechanisms and weak or absent implementation mechanisms to facilitate cooperation and sharing data, information and knowledge. These gaps, it is argued, hinder the implementation of the vision enshrined in the LOSC preamble for the ‘study, protection and preservation of the marine environment’ and an ‘equitable economic order’. The fragmentation and fragility visible in current practices in marine scientific research, technology transfer, and capacity building in ABNJ is partly a consequence of these gaps and ambiguities in the LOSC. It is thus concluded that while the LOSC provides a legal basis for sharing some benefits from marine genetic resources of ABNJ, there is a need to strengthen the implementation of the framework provisions established in LOSC Parts XIII and XIV. This systematic critical analysis of the international legal regime—demonstrating that scientific research, technology transfer and capacity building are interlinked in law—further supports the argument for an integrated approach to benefit-sharing. This also gives rise to the third finding of the thesis, that potential measures could be adopted to strengthen the implementation of the LOSC in order to enable an integrated approach to benefit-sharing, as discussed in Chapter 7.

8.2.3. Potential measures to achieve an integrated approach to benefit-sharing

The third finding of this thesis is that there are four suites of measures that could be adopted to enable benefit-sharing by strengthening the implementation of the LOSC framework provisions for scientific research and technology transfer. There is a general duty to cooperate in scientific research, the development and transfer of technology and the development of scientific capacity. The elaboration and implementation of this duty through international
legal instruments relating to either genetic resources or international spaces, combined with an analysis of current practice in implementing LOSC Parts XIII and XIV, enables the identification of potential measures for the sharing of benefits from marine genetic resources of ABNJ. This thesis has argued that there are four key areas where the development of an ILBI could improve the implementation of existing LOSC framework provisions in order to enable the sharing of benefits from marine genetic resources of ABNJ (Table 8.1), by adopting measures for:

- International scientific research cooperation;
- Access to data and knowledge;
- Scientific capacity building; and
- An enabling framework for collaboration and innovation.

Some measures would elaborate or clarify existing LOSC provisions, others represent more ambitious innovations or additions to the LOSC framework. The proposed measures also vary in terms of required resources and level of ambition. The potential measures were discussed in Chapter 7 and are briefly summarised as follows.

8.2.3.1. International marine scientific research cooperation

International marine scientific research cooperation is a necessity to advance knowledge of the marine environment and acquire benefits from marine genetic resources of ABNJ. The development of the ILBI could enhance international marine scientific research cooperation to support benefit-sharing by elaborating the general duty to cooperate in LOSC Article 242 through:

- Specifying the nature of the duty to cooperate, including purpose and collaboration;
- Facilitating *in situ* access, including through the development of guidelines to determine the nature of marine scientific research and by sharing information about research activities; and
- Facilitating *ex situ* access to marine genetic resources and associated technology.
It is argued that adopting these measures through the development of an ILBI would enhance the implementation of LOSC Articles 278, 272, 270, 268, 251, 244, 243 and 143.

8.2.3.2. Technology development and transfer, including access to data, information and knowledge

Data, information and knowledge are outcomes of scientific research relating to marine life of ABNJ and can be considered as benefits from marine genetic resources of ABNJ. The development of the ILBI could enable the sharing of data and information and the exchange of scientific knowledge to support benefit-sharing, thus further implementing the duty to publish and disseminate knowledge resulting from marine scientific research enshrined in LOSC Articles 244 and 268(a) by:

- Clarifying the types of data to be shared;
- Requiring and/or establishing standards, principles and guidelines for acquisition, storage and curation of data and data exchange;
- Identifying an existing, or establishing a new, mechanism for data exchange (i.e. data sharing platform); and
- Designating an institution with responsibility to deliver the aforementioned measures.

8.2.3.3. Scientific and technological capacity building

Scientific and technological capacity—including skilled personnel, research institutions, equipment and infrastructure—is a principal enabler of benefit-sharing. The development of the ILBI could increase scientific and technological capacity to inform and enable benefit-sharing by elaborating and further implementing LOSC Articles 277, 266(2) and 275(2) by establishing:

- Global Plan of Action;

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8 Section 3.4 of Chapter 3 and Section 5.3 of Chapter 5.
• Technology and scientific capacity building needs assessment;
• Mechanism to request technology;
• Institutional capacity building mechanisms;
• Human capacity building mechanisms; and
• Enabling environments.

8.2.3.4. Enabling international framework for collaboration and innovation

To integrate the aforementioned three elements in practice to enable benefit-sharing, a cohesive and coherent enabling international environment for scientific and technological capacity building will be required. Establishing such an environment would entail strengthening existing best-practice approaches to benefit-sharing and establishing new measures to address ambiguities in LOSC Part XIV and fostering scientific collaboration and technological innovation. The following four enabling mechanisms would be required:

• Clearly identified institutional responsibilities, including adequately resourced international scientific and technical organisations operating at global, regional and national scales, to enable accountability and implementation.
• A financial mechanism to support benefit-sharing measures;
• A clearinghouse mechanism and/or global information system to enable the sharing of benefits, including providing access to data and knowledge and information about capacity building opportunities; and
• An evaluation and monitoring mechanism to track implementation progress and guide future efforts.

The results of the critical research analysis of this thesis are summarised in Table 8.1, which sets out practical measures that could, and ideally should, be included in the ILBI to deliver equitable benefit-sharing of marine genetic resources of ABNJ.
Table 8.1: Summary of potential measures that could be included in the ILBI to share benefits from marine genetic resources of ABNJ.

<table>
<thead>
<tr>
<th>Potential element of ILBI</th>
<th>(a) International scientific research cooperation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Specify nature, purpose &amp; modalities of international cooperation</td>
</tr>
<tr>
<td></td>
<td>Development and deployment of technology</td>
</tr>
<tr>
<td></td>
<td>Collaboration</td>
</tr>
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<td></td>
<td>Guidelines, codes of conduct for marine scientific research relating marine genetic resources</td>
</tr>
<tr>
<td></td>
<td>Facilitated access to samples</td>
</tr>
<tr>
<td></td>
<td>Specified institutional mechanism</td>
</tr>
<tr>
<td>(b) Access to information, data knowledge</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Clarify types of data &amp; information to be shared</td>
</tr>
<tr>
<td></td>
<td>Standards, principles and criteria</td>
</tr>
<tr>
<td></td>
<td>Institutional mechanism</td>
</tr>
<tr>
<td></td>
<td>Technical mechanism</td>
</tr>
<tr>
<td>(c) Scientific &amp; technical capacity building</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Global Plan of Action</td>
</tr>
<tr>
<td></td>
<td>Technology and scientific capacity needs assessment</td>
</tr>
<tr>
<td></td>
<td>Mechanism for technology request</td>
</tr>
<tr>
<td></td>
<td>Institutional capacity building forming a global network of regional and national science and technology organisations</td>
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<td></td>
<td>Training and skills</td>
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<td></td>
<td>Enabling environments</td>
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<tr>
<td>(d) Framework for international enabling environment</td>
<td></td>
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<tr>
<td></td>
<td>Institutional framework</td>
</tr>
<tr>
<td></td>
<td>Financial mechanism</td>
</tr>
<tr>
<td></td>
<td>Clearinghouse &amp; global information system</td>
</tr>
<tr>
<td></td>
<td>Evaluation and monitoring mechanism</td>
</tr>
</tbody>
</table>

8.3.2.5. Advantages and disadvantages of an integrated approach to benefit-sharing

This thesis has argued that sharing benefits from marine genetic resources of ABNJ could be attained through an integrated approach based on a suite of measures that would, in summary, enhance scientific and technological capacity. The proposed measures would strengthen the implementation of the existing framework provisions for marine scientific research and the development and transfer of marine technology established by the LOSC, as discussed in Chapter 5, and build on best-practices currently used in the scientific community, as discussed in Chapter 6. By specifying the purpose, institutional modalities, and
implementation mechanisms for benefit-sharing through scientific and technological capacity building, the development of the ILBI is an opportunity for States to increase the implementation of the duty established by the LOSC to cooperate to develop scientific and technological capacity at global, regional and national scales. In this way, the adoption of the proposed integrated approach and its constituent elements could not only address issues relating to marine genetic resources, but could also support the broader implementation of LOSC Parts XIV and XIII.

However, it is acknowledged that this model also presents three key challenges. The first challenge is that, due to definitional gaps and unclear terminology, an integrated approach combining scientific research and technological capacity building would represent a new paradigm of technology transfer in the law of the sea. This would require an ambitious change in perception of technology transfer as a form of bilateral hardware donation to a more holistic notion including multilateral knowledge exchange. It would also challenge traditional views of capacity building – from national capacity for a national interest, to global capacity for a global interest.

The second challenge is the potentially large scope of the integrated approach. Currently there is no multilateral system encompassing such a large scope of benefit-sharing from genetic resources that operates over such a large scale and hence there is limited international legal precedent for how such an undertaking could be attempted. A large scope would face challenges of monitoring and enforcement, and require a complex and comprehensive regime and institutional framework. This would be likely to incur significant financial, technical and human resources costs. Therefore, it is instructive to consider the opportunities and challenges of current practices in the scientific community in order to consider the options for an integrated approach to be pursued under an ILBI, as discussed in Chapter 6. Specifying the nature of actions and clearly identifying institutional responsibilities in the ILBI could support sharing of benefits from marine genetic resources of ABNJ and avoid the potential risk that the scope of the system would become too general. At the same time, ensuring that there is sufficient flexibility in the ILBI to adapt to future scientific and technical advances would be important in order to position the international community to harness the full potential benefits of collaboration and innovation.
The third challenge is that the efficacy of the measures proposed for the sharing of benefits of marine genetic resources of ABNJ will depend on a number of factors and could face a number of potential limitations. These include the adoption and ratification of the ILBI and the political will and financial support to enable measures to be implemented in practice, especially among major researching States. Engagement with all relevant actors, including the scientific community, would also be important to operationalise the measures proposed and ensure buy-in from all key stakeholders.

8.3. Suggested avenues for further research

The ILBI intergovernmental conference phase provides a rare and valuable opportunity for the international community to deliberate on issues relating to marine scientific research and the development and transfer of marine technology, these are therefore critical areas for future scholarship. This thesis has unearthed a number of issues that require further research, including:

- The material scope of a benefit-sharing regime for marine genetic resources of ABNJ, including access to marine genetic resources both *ex situ* and *in situ*;
- The scope of benefits including whether data constitutes a benefit from marine genetic resources; and whether monetary benefits should be included;
- The role of the private sector including intellectual property issues relating to data; privacy issues, and challenges for data ownership;
- The balance between incentives and requirements;\(^\text{10}\)
- Funding options; and
- Institutional options.

Because the scope of thesis does not extend to include all potential benefits of marine genetic resources of ABNJ, an analysis of the alignment and complementarity between the various

\(^{10}\) For example, potential incentives and/or compliance measures for States and non-State actors to participate in the development and transfer of technology and capacity development in relation to marine genetic resources of ABNJ; and policy frameworks that support sustained and inclusive scientific research relating to ABNJ, such as measures to encourage business to research partnerships.
governance options for addressing the question of benefit-sharing of marine genetic resources of ABNJ, including monetary benefits, alongside broader questions of scientific capacity building and technology transfer, is an area for further research.

8.4. Conclusion

The key argument advanced in this thesis is that benefits from marine genetic resources of ABNJ can be shared through an integrated approach to international science collaboration, technology transfer and capacity building. It is argued that the LOSC provides a basis for this approach and it is suggested that the development of the ILBI could include a suite of measures that would enable benefit-sharing by strengthening the implementation of the LOSC framework provisions of Part XIII and XIV. By proposing measures that are practical from both scientific and legal perspectives, it is suggested that the issue of marine genetic resources could be transformed from a polarising challenge into a tangible opportunity for the international community. At the outset of the intergovernmental conference for the development of the ILBI, it is hoped that this thesis will contribute to international deliberations regarding this historic advancement in the international law of the sea. Ultimately, this thesis hopes to contribute to strengthening the international framework for scientific and technological capacity in support of an integrated approach to the conservation and sustainable use of marine biological diversity in the vast area of the global ocean that lies beyond national jurisdiction.
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