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Antarctic State of the Environment Indicator 72 - Windmill Islands terrestrial vegetation dynamics.

Sharon A. Robinson
University of Wollongong, sharonr@uow.edu.au

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Abstract

Survey of quadrats along permanent transects in the Windmill Islands, East Antarctica, involving: quantitative analysis of relative bryophyte species distribution and abundance; area moribund versus healthy moss.

Disciplines

Life Sciences | Physical Sciences and Mathematics | Social and Behavioral Sciences

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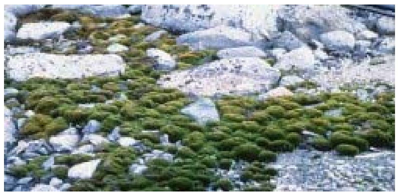
SIMR - (State of Environment)

System for Indicator Management and Reporting - an on-line State of Environment system for the Antarctic.

State of Environment

Indicator 72 - Windmill Islands terrestrial vegetation dynamics

Index - Description | Data | Custodian evaluation | Related resources | Parameters



Print indicator

Indicator Definition	Survey of quadrats along permanent transects in the Windmill Islands, East Antarctica, involving: quantitative analysis of relative bryophyte species distribution and abundance; area moribund versus healthy moss.
Responsible Organisation	University of Wollongong The University of Wollongong (details)
Custodians	SHARON ROBINSON sharonr@uow.edu.au — INVESTIGATOR TECHNICAL CONTACT — Department of Biological Sciences Northfields Ave University of Wollongong WOLLONGONG New South Wales 2522 Australia Ph +61 2 4221 5753
Theme Area	Biodiversity
Indicator Type	Condition
Criteria the Indicator Satisfies	The following 14 out of 15 criteria 1. Serve as a robust indicator of environmental change 2. Reflect a fundamental or highly-valued aspect of the environment or an important environmental issue 3. Be either national in scope or applicable to regional environmental issues of national significance 4. Provide an early warning of potential problems 5. Be capable of being monitored to provide statistically verifiable and reproducible data that shows trends over time and, preferably, apply to a broad range of environmental regions 6. Be scientifically credible 7. Be easy to understand 8. Be monitored with relative ease 9. Be cost-effective 10. Have relevance to policy and management needs 11. Contribute to monitoring of progress towards implementing commitments in nationally important environmental policies 12. Where possible and appropriate, facilitate community involvement 13. Contribute to the fulfillment of reporting obligations under international agreements 15. Where possible and appropriate, be consistent and comparable with other countries' and state and territory indicators For details of indicators, see the State of Environment Bibliography entries 16336 and 16337
Date Input	Yearly measurements
Monitoring Location	Robinson Ridge (details) ASPA 135 (details) Any Named places Geographic Coverage is Latitude (-66.5 to -66.0) Longitude (110.0 to 110.5)

Rationale For Indicator Selection	The high latitudes are predicted to be first and most severely affected by climate change. Bryophytes (mosses and liverworts) are the highest plants inhabiting continental Antarctica. Although bryophytes are able to withstand some of the most extreme growing conditions on Earth, they are sensitive to their environment and are good indicators of environmental change. Plant growth and productivity in continental Antarctica is slow, and in turn community change in this environment is likely to be gradual. Detection in vegetation communities therefore requires sensitive methodologies that will maximise detection of change. Change is most likely to be detected at fine scale patterns, within communities. An additional bryophyte community component to be measured is the percentage cover of moribund moss versus healthy moss. The presence of moribund moss in the Windmill Islands is thought to be evidence of a recent drying trend. Percentage cover moribund moss will be quantified in permanent quadrats using digital photography and image analysis software.
Design and Strategy For Indicator Monitoring Program	Sites: ASPA135 and Robinson Ridge Transects: Ten transects at each site, transects span a moisture and vegetation gradient; from wet vegetation communities dominated by live bryophytes, through drier communities representing the transition between bryophytes and lichens, to dry communities dominated by lichens with scarce live bryophytes. Quadrats: Three 20x20cm quadrats per transect, each representing Bryophyte, Transitional and Lichen communities, Quadrat measurements: - tweezer pinch (negligible impact) sample at 9 x 5cm intervals (for which species abundance is scored) - digital photograph of each quadrat for analysis of broad vegetation percent cover including area moribund. - sponge cores implanted for two days to calculate Turf Water Content (TWC). Survey of transects (collection of bryophyte samples, digital pictures) to be conducted every 5 years. Surveys conducted in mid-summer, during the melt period (December or January).
Research Issues	In order to identify correlations with environmental parameters that directly affect the growth conditions of these plants, the analysis should include as a co-variant other local data sources, such as meteorological data (temperate, wind and sunshine hours) and UV data.
Data	Temporal range of the available data, as described by the metadata record, is from 30-Sep-01 to 31-Mar-03. **Timespan**: 2003 to 2008. **Number of data points**: 48. To view or download any of the data, you must be logged into the Data Centre Portal. If you return to this indicator, you will find a **Search Data** link that will allow you to view or extract the data for this indicator.
Data Quality, Interpretation and Analysis of Indicator Data	Some vegetation characteristics that are of importance to understanding broad scale and fine scale vegetation patterns within these bryophyte and lichen communities are as follows. In the Windmill Islands transition occurs from bryophyte to lichen communities with reduced water availability (Smith 1990a, Wasley 2004) as bryophytes require liquid water for survival while lichens are not dependent on liquid water and are known to experience net photosynthetic depression with excess water contents. At a finer scale, within communities, bryophyte species tend to occupy distinct distributions strongly linked with water availability (Selkirk and Seppelt 1987) and reflecting their individual physiological tolerance to desiccation and submergence (Robinson et al. 2000, Wasley et al. 2006b). Lichen species distribution responds to a combination of microclimate characteristics including water availability. A further tie with water availability may be lichen morphology. Surface area to volume ratio influences the rate of water uptake/loss, and this was found to concur with the difference rates of water uptake/loss between two fruticose and one foliose lichen species (Huiskes et al. 1997). It is expected that environmental changes to water availability will result in a shift in patterns of distribution and abundance of bryophyte species and lichen species, although the very slow growth rates of lichens (estimates of 0.01mm.yr-1, Green 1985) may render insignificant changes between surveys. Thus, the ratio of live to moribund bryophyte cover, and abundance of key bryophyte species are the most reliable components from which to assess the impacts of environmental change.
Data Usage Constraints	This data set conforms to the PICCCBY Attribution License (http://creativecommons.org/licenses/by/3.0/) Please follow instructions listed in the citation reference at the provided URL when using these data.
Data Distribution	DATA OFFICER AADC metadata@aad.gov.au Australian Antarctic Division 203 Channel Highway Kingston Tasmania 7050 Australia Ph +61 3 6232 3244
Data Access Constraints	Much of the data collected for this project has not yet been published, and are therefore not yet publicly available. However, the following datasets are available for download from the metadata record, or via the related resource links in the State of the Environment indicator: Pilot study data A summary sheet detailing data trends, etc Photographic comparisons of the sites from 2003 and 2008.

Custodian Evaluation	**Date entered**	**Evaluation**
	2-Sep-2002	Quantification of bryophyte community dynamics along the transects measured, showed that the three Windmill Islands moss species, *Bryum pseudotriquetrum*, *Grimmia antarctici*, and *Ceratodon purpureus*, and the liverwort, *Cephaloziella exiliflora*, have differences in their relative distributions. *Grimmia antarctici* and *B. pseudotriquetrum*, the two most abundant species, show opposite abundance trends along the transects: *G. antarctici* increases in abundance with increasing distance along the transects, while *B. pseudotriquetrum* decreases. *Ceratodon purpureus*, and the liverwort, *C. exiliflora*, present at lower levels of abundance, respond in the same direction as *B. pseudotriquetrum*, decreasing in abundance with increasing distance along the transects. These relative species distribution patterns have significant implications for the quantification of Windmill Islands community dynamics in response to climate change. With respect to the Windmill Islands three moss species, research shows that the physiological tolerance of desiccation is greatest in *C. purpureus* and lowest in the Antarctic endemic, *G. antarctici* (Robinson, Wasley et al. 2000). The relative species distribution patterns we have found support these physiological responses: *C. purpureus* is most abundant in higher, drier, areas, while *G. antarctici* is highest in abundance in lower, wetter, areas. The status of future water availability in the Windmill Islands is unclear. Currently the Windmill Islands are undergoing a drying trend, due to isostatic uplift associated with deglaciation. The influence of future climate warming has the potential to offset this drying trend if increases in precipitation occur. Water availability for plant growth, in the Windmill Islands, will only increase, however, if precipitation levels both offset the current drying trend and also exceed the predicted increase in snow and ice melt associated with warmer temperatures. Based on our current knowledge of the physiological response of the Windmill Islands bryophyte species, combined with what we now know of their relative distributions, under increasingly wet conditions, we predict an increase in the extent of G. antarctici, and under drying conditions, a relative decline in *G. antarctici* and an increase the relative dominance of *C. purpureus*.
	26-Nov-2009	A strong TWC gradient existed between communities in January and was still apparent though weaker in February (Figure 3). Mean Turf Water Content (TWC) was highest in bryophyte communities, decreased from bryophyte to transitional communities by over half in January and more than 40% February, followed by a 18 to 19-fold decrease from transitional to lichen communities. For broad scale vegetation patterns, percent cover of live bryophytes significantly declined along the community gradient from 85% in bryophyte communities to 3% in lichen communities (Figure 4). The proportion of total bryophyte cover that was moribund increased from 10% in bryophyte communities to 55% in transitional communities and over 90% in lichen communities. Macrolichen cover was negligible in bryophyte and transitional communities, (0.5% to 1.5%) but increased to 40% in lichen communities where this vegetation type was co-dominant with moribund bryophytes (Figure 4). Crustose lichen cover and unvegetated cover were also highest in lichen communities. This demonstrates a transition from live to moribund bryophytes, and from bryophytes to lichens, with decreasing water availability. The same transition in vegetation from wet to dry areas was been observed at these locations in 1999-2000 (Wasley 2004), as well as in earlier studies of the Windmill Islands and other continental regions of Antarctica (Smith 1990a, Melick and Seppelt 1997, Brabyn et al. 2006). Under a drying climate regime, the lichen community will be an important place to detect vegetation change as live bryophytes exist in trace amounts and may disappear with large decreases in water availability. Another key indicator of drying will be the reduction in the ratio of live to moribund bryophytes in the transitional community, which at present is approximately 50:50. The community shift from bryophyte to lichen dominated vegetation under a drying climate is expected to be slow, due to the exceedingly slow growth rates of lichen species (Green 1985). Under a wetter climate, transitional communities have the potential to return to bryophyte communities as moribund bryophytes may regenerate if sufficient water becomes available. Water availability must be extensive and prolonged for this to occur (Melick and Seppelt 1997, Wasley et al. 2006a). In addition, a key indicator of vegetation response to increased water availability will be in the lichen community, where bryophytes may expand and out-compete lichens. This highlights the importance of monitoring lichen communities for trace live bryophytes to detect long term change, since there are parent live bryophyte propagules for potential expansion. At the finer scale, Schistidium antarctici dominated over 70% of bryophyte community samples, and declined to less than 10% and 2% dominance along the community gradient (Figure 5). In contrast, Ceratodon purpureus showed highest abundance in transitional communities, dominating 20% of samples. Abundance was intermediate in lichen communities, and was less than 2% in bryophyte communities. Differences in abundance between communities were found to be significant for both bryophyte species. The distinct species niches reflect the low tolerance of S. antarctici to desiccation requiring high water content for photosynthesis and growth combined with the ability to survive submergence events (Wasley et al. 2006b). C. purpureus is known to have high ability to avoid and tolerate desiccation and a relatively low tolerance to submergence (Robinson et al 2000, Wasley et al. 2006b). Thus, it is not surprising that C. purpureus occupies drier habitats in the Windmill Islands, co-occurring with lichens but still requiring some free water during the season. Under a drying climate, lower abundance of S. antarctici in transitional and bryophyte communities is expected, combined with further establishment of C. purpureus, particularly in this latter community where present abundance of C. purpureus is low. In contrast, a wetter future climate may see an increase in submergence events, which is likely to reduce the abundance of C. purpureus in bryophyte and transitional communities and restrict this species to drier lichen communities. Crustose lichen showed similar domination of samples in transitional and lichen communities, yet occurred in a greater percentage of samples in transitional communities. (Figure 5). Bryophyte communities contained crustose lichen in at least 15% of samples, which was significantly less than the other communities. Crustose lichen may establish on rocks in wetter communities and on bryophytes as they become moribund. Already established in drier communities, expansion of crustose lichen in bryophyte communities may relate to increased drying of bryophyte vegetation. Modern climate change is likely to occur at a rate fast enough for detection over decadal time intervals, or even sooner, since preliminarily analysis between the pilot and baseline study suggests species in bryophyte communities have shifted over a 3 year period. Other environmental changes in the region including drying due to isostatic uplift are likely to occur at a much slower rate. However, recent evidence suggests that this region is also experiencing more recent climate change induced drying (Hodgson et al 2006). While this indicator currently predicts vegetation changes with environmental change, future surveys commencing in 2007-08 will be able to confirm the impact of climate change on continental Antarctic communities. In addition, new survey methodologies to be employed in

2007-08, including digital image analysis, will allow enhanced change detection and improved data capture, storage and accessibility.

For definitions of the Scale categories, consult the Explanation of the Status Categories

Related resources

Registered File 2789 - Windmill Islands terrestrial vegetation dynamics - summary sheet

Registered File 2836 - Windmill Islands terrestrial vegetation dynamics - image comparisons

Metadata SOE_Windmill_Island_veg - Windmill Islands terrestrial vegetation dynamics

SOE Indicator 1 - Monthly mean air temperatures at Australian Antarctic Stations

SOE Indicator 10 - Daily broad-band ultra-violet radiation observations using biologically effective UVR detectors

Taxonomy 100157 - *Bryum pseudotriquetrum*

Taxonomy 100163 - *Cephaloziella exiliflora*

Taxonomy 100169 - *Ceratodon purpureus*

Taxonomy 100173 - *Grimmia antarctici*

Parameters

There are no parameters set against this indicator.
The following parameters and/or sensor notes are from the metadata record.

Parameters -
EARTH SCIENCE > BIOLOGICAL CLASSIFICATION > PLANTS > MOSSES/HORNWORTS/LIVERWORTS
EARTH SCIENCE > BIOSPHERE > ECOLOGICAL DYNAMICS > SPECIES/POPULATION INTERACTIONS

Related URL's

http://data.aad.gov.au/aadc/metadata/citation.cfm?entry_id=SOE_Windmill_Island_veg
Citation reference for this metadata record and dataset

http://data.aad.gov.au/aadc/portal/download_file.cfm?file_id=1272
Download page for Australian Antarctic Data Centre - SIMR software

http://data.aad.gov.au/aadc/portal/download_file.cfm?file_id=2786
Download excel spreadsheets of data from the pilot study.

http://data.aad.gov.au/aadc/portal/download_file.cfm?file_id=2789
Download point for the summary document

http://data.aad.gov.au/aadc/portal/download_file.cfm?file_id=2831
Download data from the main study

http://data.aad.gov.au/aadc/portal/download_file.cfm?file_id=2836
Download point for the comparative images

http://data.aad.gov.au/aadc/portal/download_file.cfm?file_id=3049
Download point for the maps

http://www.uow.edu.au/science/biol/icb/antdiary/90s/index.html
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