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Developing priority variables ("ecosystem Essential Ocean Variables" — eEOVs) for observing dynamics and change in Southern Ocean ecosystems

Andrew J. Constable [a,b,*], Daniel P. Costa [c], Oscar Schofield [d], Louise Newman [e], Edward R. Urban Jr. [f], Elizabeth A. Fulton [g,h], Jessica Melbourne-Thomas [a,b], Tosca Ballerini [i], Philip W. Boyd [b,j], Angelika Brandt [k], Willaim K. de la Mare [a], Martin Edwards [l], Marc Eléaume [m], Louise Emmerson [a,b], Katja Fennel [n], Sophie Fielding [o], Huw Griffiths [o], Julian Gutt [p], Mark A. Hindell [b,j], Eileen E. Hofmann [q], Simon Jennings [r], Hyoung Sul La [s], Andrea McCurdy [t], B. Greg Mitchell [u], Tim Moltmann [v], Monica Muelbert [w], Eugene Murphy [o], Anthony J. Press [b], Ben Raymond [a,b,j], Keith Reid [x], Christian Reiss [y], Jake Rice [z], Ian Salter [p], David C. Smith [g,h], Sun Song [aa], Colin Southwell [a,b], Kerrie M. Swadling [b,j], Anton Van de Putte [ab], Zdenka Willis [ac]

[a] Australian Antarctic Division, Channel Highway, Kingston, Tasmania 7050, Australia
[b] Antarctic Climate and Ecosystems Cooperative Research Centre, Private Bag 80, Hobart, Tasmania 7001, Australia
[c] Ecology & Evolutionary Biology, University of California Santa Cruz, CA 95060, USA
[d] Center for Ocean Observing Leadership, 71 Dudley Road, Department of Marine and Coastal Sciences, Rutgers University, New Brunswick, NJ 08901, USA
[e] Southern Ocean Observing System International Project Office, c/-IMAS, University of Tasmania, Private Bag 129, Hobart, Tasmania 7001, Australia
[f] Scientific Committee on Oceanic Research, University of Delaware, Newark, DE, USA
[g] CSIRO Oceans and Atmosphere, Hobart, Tasmania 7001, Australia
[h] Centre for Marine Socio-ecology, University of Tasmania, Hobart, Tasmania 7001, Australia
[i] Mediterranean Institute of Oceanography, Université de Toulon, Aix-Marseille Université, CNRS/INSU, IRD, MIO, UM 110, La Garde Cedex 83957, France
[j] Institute for Marine and Antarctic Studies, University of Tasmania, Private Bag 129, Hobart, Tasmania 7001, Australia
[k] Centre of Natural History (CeNaK), Zoological Museum, University of Hamburg, Martin-Luther-King-Platz 3, 20146 Hamburg, Germany
[l] Sir Alister Hardy Foundation for Ocean Science, The Laboratory, Citadel Hill, Plymouth PL1 2PB, United Kingdom
[m] Muséum National d'Histoire Naturelle, Département Milieux et Peuplements Aquatiques, UMR 7208-BOREA MNHN-CNRS-UPMC-IRD, CP26, 57 rue Cuvier, 75231 Paris Cedex 05, France
[n] Department of Oceanography, Dalhousie University, Oxford Street 1355, Halifax, NS B3H 4R2, Canada
[o] British Antarctic Survey, High Cross, Madingley Rd, Cambridge CB3 0ET, United Kingdom
[p] Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Am Alten Hafen 26, D-27568 Bremerhaven, Germany
[q] Center for Coastal Physical Oceanography, Old Dominion University, Norfolk, VA, USA
[r] Centre for Environment, Fisheries and Aquaculture Science, Lowestoft NR33 0HT, United Kingdom
[s] Korea Polar Research Institute, 12 Gaetbeol-ro, Yeonsu-gu, Incheon 406-840, South Korea
[t] Consortium for Ocean Leadership, 1201 New York Ave. NW, Washington, DC 20005, USA
[u] Scripps Institution of Oceanography, University of California, San Diego, USA
[v] Integrated Marine Observing System, University of Tasmania, Private Bag 110, Hobart, Tasmania 7001, Australia
[w] Instituto de Oceanografia, Universidade Federal do Rio Grande (IO-FURG), Av. Itália, KM 8, Campus Carreiros, 96203-270, Rio Grande, RS, Brazil
[x] CCAMLR Secretariat, PO Box 213, North Hobart 7002, Tasmania, Australia
[y] NOAA Fisheries, Antarctic Ecosystem Research Division, 8901 La Jolla Shores Drive, La Jolla, CA 92037, USA
[z] Department of Fisheries and Oceans, 200 Kent Street, Ottawa, Ontario, Canada
[aa] Institute of Oceanology, Chinese Academy of Sciences, 7 Nanhai Road, Qingdao 266071, China
[ab] BEDIC, OD Nature, Royal Belgian Institute for Natural Sciences, Vautierstraat 29, B-1000 Brussels, Belgium
[ac] NOAA's National Ocean Service, N/MB6, SSMC4, 1305 East-West Hwy, Silver Spring, MD 20910, USA

* Corresponding author at: Australian Antarctic Division, Channel Highway, Kingston, Tasmania 7050, Australia.
E-mail addresses: andrew.constable@aad.gov.au (A.J. Constable), costa@ucsc.edu (D.P. Costa), oscar@marine.rutgers.edu (O. Schofield), newman@soos.aq (L. Newman), ed.urban@scor-int.org (E.R. Urban), beth.fulton@csiro.au (E.A. Fulton), jess.melbourne-thomas@aad.gov.au (J. Melbourne-Thomas), tosca.ballerini@mio.osupyhteas.fr (T. Ballerini), philip.boyd@utas.edu.au (P.W. Boyd), abrandt@zoologie.uni-hamburg.de (A. Brandt), bill.delamare@aad.gov.au (W.K. de la Mare), maed@sahfos.ac.uk (M. Edwards), marc.eleaume@mnhn.fr (M. Eléaume), louise.emmerson@aad.gov.au (L. Emmerson), katja.fennel@dal.ca (K. Fennel), sof@bas.ac.uk (S. Fielding), hjg@bas.ac.uk (H. Griffiths), julian.gutt@awi.de (J. Gutt), mark.hindell@utas.edu.au (M.A. Hindell), hofmann@ccpo.odu.edu (E.E. Hofmann), simon.jennings@cefas.co.uk (S. Jennings), hsla@kopri.re.kr (H.S. La), amccurdy@oceanleadership.org (A. McCurdy), gmitchell@ucsd.edu (B.G. Mitchell), tim.moltmann@imos.org.au (T. Moltmann), monica.muelbert@furg.br (M. Muelbert), ejmu@bas.ac.uk (E. Murphy), tony.press@acecrc.org.au (A.J. Press), ben.raymond@aad.gov.au (B. Raymond), keith.reid@ccamlr.org (K. Reid), christian.reiss@noaa.gov (C. Reiss), Jake.Rice@dfo-mpo.gc.ca (J. Rice), Ian.Salter@awi.de (I. Salter), david.c.smith@csiro.au (D.C. Smith), sunsong@qdio.ac.cn (S. Song), colin.southwell@aad.gov.au (C. Southwell), kerrie.swadling@utas.edu.au (K.M. Swadling), antonarctica@gmail.com (A. Van de Putte), zdenka.s.willis@noaa.gov (Z. Willis).

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ABSTRACT

Reliable statements about variability and change in marine ecosystems and their underlying causes are needed to report on their status and to guide management. Here we use the Framework on Ocean Observing (FOO) to begin developing *ecosystem Essential Ocean Variables* (eEOVs) for the Southern Ocean Observing System (SOOS). An eEOV is a defined biological or ecological quantity, which is derived from field observations, and which contributes significantly to assessments of Southern Ocean ecosystems. Here, assessments are concerned with estimating status and trends in ecosystem properties, attribution of trends to causes, and predicting future trajectories. eEOVs should be feasible to collect at appropriate spatial and temporal scales and are useful to the extent that they contribute to direct estimation of trends and/or attribution, and/or development of ecological (statistical or simulation) models to support assessments. In this paper we outline the rationale, including establishing a set of criteria, for selecting eEOVs for the SOOS and develop a list of candidate eEOVs for further evaluation. Other than habitat variables, nine types of eEOVs for Southern Ocean taxa are identified within three classes: state (magnitude, genetic/species, size spectrum), predator–prey (diet, foraging range), and autecology (phenology, reproductive rate, individual growth rate, detritus). Most candidates for the suite of Southern Ocean taxa relate to state or diet. Candidate autecological eEOVs have not been developed other than for marine mammals and birds. We consider some of the spatial and temporal issues that will influence the adoption and use of eEOVs in an observing system in the Southern Ocean, noting that existing operations and platforms potentially provide coverage of the four main sectors of the region — the East and West Pacific, Atlantic and Indian. Lastly, we discuss the importance of simulation modelling in helping with the design of the observing system in the long term.
Regional boundary: south of 30°S.

Contents

1. Introduction

Assessments of status, variability and change in marine ecosystems are needed to inform management decisions for sustaining goods and services (see Table 1 for a glossary of terms used in this paper). Long-term observations of many attributes of these ecosystems are often lacking. This limits the capacity to report on changes in status, to identify key processes driving marine ecosystems, to judge the long-term effects of people on marine resources, food webs and biodiversity, to determine sustainable levels of activities, such as fisheries, and to assess

Table 1
A glossary of terms used in this paper.

Term	Context
Change	Restricted in this paper to mean any difference in the status or function of a system that is of interest to society, policy-makers, managers and scientists
Status	The condition of an ecosystem property or the ecosystem as a whole. Measures of status can include mean, variability or other short and long-term aspects of an ecosystem's dynamics (e.g. seasonal cycles, decadal oscillations). Thus, status includes the relative abundances of components (habitats, taxa), the processes by which those components interact with other physical, chemical and biological components of the ecosystem and the subsequent dynamics and variability in the components.
Trend	A general tendency or direction of change over time-scales longer than a few years. Such changes may be in the mean and/or variability of status, such as the frequency of extreme events.
Step change	A relatively large change that occurs over a short time period.
Attribution	The process of determining and assigning the cause of a trend.
Future scenarios	Possible changes in ecosystem status and trends in the future.
Assessment	The quantification (including the process leading to that quantification) of (i) status of ecosystem properties and the ecosystem overall, (ii) trends and/or step changes in those properties, (iii) attribution of trends and step changes to causes, and (iv) likely future scenarios for the ecosystems.
Observation	A quantity directly measured in the field and from which an eEOV may be derived.
ecosystem Essential Ocean Variable (*eEOV*)	The name has its origin in the Framework on Ocean Observing. An eEOV is a defined biological or ecological quantity which is derived from field observations. It would be expected to contribute significantly to assessments and be feasible to collect at appropriate spatial and temporal scales. Its utility arises from its contribution to the roles: (i) direct estimation of status, trends and/or attribution, and/or (ii) development of ecological models (e.g. qualitative, statistical/empirical, dynamic mathematical models) to support assessments.
Indicators	Indicators are defined as variables, pointers or indices of a phenomenon.
Evaluation	To judge or calculate the importance or performance of candidate eEOV in relation to criteria and qualities for pilot and mature EOVs.