# ERADOM

# Expanding Regional Application of Dynamic Ocean Management

SCOR working group proposal submitted April 2017

Prepared by co-chairs:

**Alistair Hobday**

CSIRO, Australia

Email: Alistair.Hobday@csiro.au

**Stephanie Brodie**

University of California Santa Cruz, USA

Email: sbrodie@ucsc.edu

## 1. Summary

Oceans are physically and biologically dynamic, yet strategies to manage oceans are often implemented at overly coarse spatiotemporal scales. Dynamic Ocean Management (DOM) is a management strategy that rapidly changes in space and time in response to changes in the ocean and its users. DOM is an emerging field of research that has been demonstrated to have wide application to ocean users around the globe. To date, DOM applications have rapidly expanded across a diverse range of timescales, biota, levels of data availability, and objectives, yet these applications have occurred as independent efforts which has resulted in limited application in regions lacking scientific and management capacity. Given ongoing sustainable ocean use challenges, approaches such as DOM are vital. This proposal aims to synthesize existing DOM applications, identify barriers to DOM implementation in areas with ocean use conflict, and develop a suite of tools to aid implementation of DOM. In addition to open-access primary publications, a major output of ERADOM will be a “How-To Guide” to facilitate implementation of DOM applications, particularly in novel regions. The working group outputs will enhance DOM uptake to minimize ocean conflict in the face of competing social, economic, and ecological objectives. The international experience required is expansive, and a SCOR working group provides the ideal mechanism to achieve our aims.

## 2. Scientific Background and Rationale

### *2.1 Dynamic Ocean Management*

Spatial management is one strategy to regulate ocean use and provide protection for vulnerable species and habitats. Traditionally, spatial management options are implemented as a static approach that seek to separate apparently incompatible activities, such as shipping, tourism, petroleum extraction, fisheries, and conservation zones. As an example, static boundaries for conservation purposes often need to encompass very large areas in order to ensure year-round protection for highly mobile and migratory species. With increasing pressure and ocean activities, this may be inefficient as some activities (e.g. fishing, shipping) can be excluded from areas at times when the protection is not needed, as the focal species needing protection is absent (Agardy *et al.* 2003). Seismic testing, as part of petroleum industries, is another activity that may need to be separated from fishing or tourism activities, but is not a permanent feature of the seascape (Carroll *et al.* 2016). There is often resistance to placing restrictions on ocean activities that provide significant economic and social benefits - evidence-based scientific solutions are needed to resolve often competing objectives. There is a clear need in both developed and developing economies for scientific development of management tools that offer flexibility and efficiency in ocean management.

Dynamic Ocean Management (DOM) is one such approach that allows management strategies to rapidly change in space and time in response to changes in the ocean and its users (Maxwell *et al.* 2015). DOM can offer a flexible alternative that allows trade-offs between competing objectives (e.g. harvest or conserve) to be met, and has potential application around the globe (Dunn *et al.* 2014). To date, the new field of DOM research has covered a diverse range of biota (e.g. from scallops to tuna to turtles (Maxwell *et al.* 2015)), objectives (e.g. conservation outcomes to industry adaptation to climate variability (e.g. Spillman & Hobday 2014)), spatiotemporal scales (e.g. from real-time observations to seasonal and decadal forecasts (e.g. Tommasi *et al.* 2017)), and levels of data availability (e.g. data poor to fishery-independent to satellite telemetry (e.g. Hazen *et al.* 2016)). To realize wider benefits there is a need to develop scientific capability and support for those seeking DOM as a solution to local resource use conflicts.

This need is also particularly urgent as climate change is affecting the distribution of marine activities (e.g. Arctic shipping) and species (e.g. range change). New and more variable environmental conditions are already creating novel challenges for ocean-users and managers (Pecl *et al.* 2017). DOM offers a strategy to allow ocean-users and managers to adapt to the challenges of a changing ocean. Historically DOM has been implemented on a near real-time basis, but improvements in ocean forecasting on time scales of weeks to decades offer additional opportunities to develop approaches to resolve ocean conflicts (Tommasi *et al.* 2017). For example, seasonal forecasting of ocean conditions and animal habitats has been used as a decision-support tool in marine industries adapting to climate variability (Hobday *et al.* 2016) . There is opportunity to clarify, expand, and integrate more timescales and more applications under the definition of DOM, and as such likely improve future users understanding and uptake of DOM.

### *2.2 The Challenge*

To date, published literature indicates that application of DOM has mostly been in developed nations. While reviews and syntheses on DOM and seasonal forecasting have been published (e.g. Hobday *et al.* 2014; Lewison *et al.* 2015; Maxwell *et al.* 2015), these reviews focus on DOM examples from developed nations. There is currently limited knowledge on if, or what, DOM strategies are appropriate in emerging economies, and how science can support these efforts.

There may be barriers that limit the uptake of DOM across new regions and in developing nations. Although investigation of barriers is required as part of the proposed working group activities, they are likely to include: 1) Knowledge - limited knowledge transfer between researchers and managers/policymakers (Cvitanovic *et al.* 2015); 2) Fiscal – potential DOM applications are expensive to research and implement (Hobday *et al.* 2014); 3) Expertise – DOM approaches can be diverse and complex, and difficulties can arise from limited expertise and issues with data (e.g. scarcity, biases, quality) ; 4) Communication - communication between users and managers needs to be possible and occur at timescales relevant to the management approach (e.g. cell phones, printed maps, email, website access).

*2.3 The ERADOM initiative*

Our vision is to provide a means to increase uptake of DOM globally. To do so we aim to understand and overcome barriers to DOM uptake by identifying and individually addressing the barriers, such as: 1) Knowledge – reviewing how existing DOM applications have become operational, which will inform guidelines on how to increase knowledge transfer and improve operationalization (Objective 1); 2) Fiscal – providing code and guidelines on how to access freely-accessible data sources, thus reducing many of the initial and ongoing costs of DOM (Objectives 2 and 3); 3) Expertise – creating a How-To Guide that provides instructional information on how to develop and apply DOM applications (Objectives 2, 3, and 4); 4) Communication – reviewing existing DOM applications and the levels of communication required to maintain an operational product (Objective 1). We will draw upon the existing knowledge of international partners, and seek to support and encourage implementation DOM in new regions and new applications.

*2.4 Why a SCOR working group?*

The work proposed here aims to understand the barriers to implementation of dynamic ocean management in areas with ocean use conflict. We seek to enable uptake of DOM by those seeking approaches that complement traditional spatial management approaches, particularly in areas where implementation of extensive static management areas, such as closed areas, will lead to considerable social and economic harm. This SCOR effort will bring together an interdisciplinary group of scientists with an established track record in development and application of DOM to unify disparate approaches and tools. A primary goal is to understand the success of existing applications and package the tools to allow wider uptake where useful. To date, perhaps as DOM is an emerging research field, independent efforts have been the norm which limits DOM applications in areas that may have limited capacity. Thus, a primary goal is to develop a “How-To Guide” to explain DOM as a management choice. The breadth of international collaboration proposed here is unique, yet without SCOR funding is unlikely to be realized. We believe the working group deliverables will support enduring DOM uptake, minimize ocean conflict, and support sustainable social, economic, and ecological objectives.

## 3. Terms of Reference

**Objective 1:** Review and synthesize the current state of operational ecology, including identifying how existing dynamic ocean management tools have become operational, and to publish the results in a peer-reviewed journal.

**Objective 2:** Develop a code library that provides freely accessible and easy ways to connect environmental data sets and specific local data sets.

**Objective 3:** Create a How-To Guide for dynamic ocean management, drawing on the general code library (Objective 2), which encompasses both operational (Objective 1) and research (Objective 4) aspects, and provide this Guide as an online open-access and updatable resource.

**Objective 4:** Demonstrate the applicability of the How-To Guide by creating case studies of dynamic ocean management in developing nations, including a data poor case study, and publish these case studies in a peer-reviewed journal.

## 4. Working plan

To deliver Objective 1 we will review and synthesize how existing dynamic ocean management applications transitioned from a research output to an operational tool. An operational tool is one that is ready or being used in a real-time application. The transition from a research output to an operational tool is often an obstacle when attempting to implement DOM. The synthesis will aim to include examples from developing nations and artisanal fisheries. This will help to summarize what formats DOM takes across a broad spectrum of ocean users, and will inform the scope of the proceeding objectives. As a part of this objective we will review levels of stakeholder involvement in planning and implementation of existing DOM applications, and identify barriers to DOM uptake. The synthesis will help new projects plan for and achieve the transition from a research output to an operational product, and ultimately support a greater implementation of DOM. The results of Objective 1 will be published in a peer-reviewed open access journal.

To deliver Objective 2 we will use the groups knowledge, experience, skills, and existing code to develop a code library. The code library will focus on ways in which to connect environmental data sets, environmental forecasts, and local data sets, and will be written in R language but can be expanded to include other software (e.g. Matlab, ArcGIS) should the need arise. The code library will be developed in conjunction with Objectives 3 and 4 so as to ensure useful linkages between code, the How-To Guide (Objective 3), and case studies (Objective 4). The code library will be hosted on a freely accessible public platform, such as an R vignette or on Github, and will be maintained beyond the lifetime of the SCOR working group.

Objective 3, entitled the How-To Guide, will be a guidance document to provide instructional information on how to apply DOM. The Guide will have a simplistic core structure, with complexity added incrementally to ensure that all levels of user-experience are able to effectively and constructively use the Guide. The Guide will be centered around 1) a decision tree (e.g. (Dunn, Boustany & Halpin 2011)); and 2) an idealized workflow (e.g. (Hobday *et al.* 2014)). The decision tree will step through various spatiotemporal scales of management interest, and will ultimately identify DOM approaches that best suit specific applications. The workflow will show an idealized step-wise approach to achieving DOM that will reference leaves on the decision tree. Each step within the workflow will be expanded upon, with a description of potential data sources and methods. For example, issues surrounding species data (e.g. data poor fisheries, data with inherent biases) will be summarized and potential solutions suggested.

The workflow will form the backbone of the How-To Guide, and will be targeted towards overcoming the barriers to DOM implementation. For example, the Guide will describe ways in which to source freely accessible environmental products for multiple time scales (e.g. historical, real-time, forecast); and outline methods for building species distribution models using freely accessible software (e.g. R, Maxent) and/or existing global habitat models (e.g. raquamaps). The Guide will: integrate results from Objective 1 using examples of how to operationalize and communicate DOM; draw on the general code library (Objective 2); and outline examples of how to use the Guide to implement DOM (Objective 4). The Guide will be an online, updatable resource and will allow for updates as information changes and new products become available (e.g. links to access new global or regional environmental products; or links to new operational DOM tools and applications). We will explore options for an existing organization to host the Guide location (e.g. https://www.openchannels.org/; http://www.copernicus.eu/), which will extend the reach of this guide, as well as provide a long-term location beyond the lifetime of the SCOR working group.

To deliver Objective 4 we will seek additional partners to identify and collaborate on case studies in regions where DOM has not yet been applied. We will use the How-To Guide to implement a stepwise approach to creating DOM for these case studies, ultimately ending with an application of DOM that can be transitioned to an operational stage. Potential regions for case studies include southern Africa, south-east Asia, and South America, and working group members from these regions will help to cultivate collaborations. Collaborations will focus on a two-way knowledge exchange to ensure that knowledge of existing DOM applications in developing nations (part of Objective 1) is integrated into the How-To Guide (Objective 3). Case studies, in collaboration with regional partners from participating countries, will be published in a peer-reviewed open access journal and also integrated into the How-To Guide and code library.

**Month 1:** 1st WG meeting. The meeting will include planning for the entire project with a focus on Objective 1 and 4. Task oriented sub-groups will be organized to progress Objective 1 during and after the meeting. The meeting will aim to be held in a region where creation of a first case study can be supported (Objective 4), sub-groups will be allocated to progress Objective 4.

**Months 2 - 11:** Continue work on Objective 1 and submit to a peer-reviewed journal within this period. Continue work on Objective 4.

**Month 12:** 2nd WG meeting – discuss framework for Objectives 2 and 3. Use framework to create sub-groups to progress work during and after the meeting. The meeting will aim to be held in a region where creation of a second case study can be supported (Objective 4), as such sub-groups will be allocated to progress Objective 4.

**Month 13 - 23:** Continue work on Objectives 2, 3, and 4.

**Months 24:** 3rd WG meeting – discuss and plan the finalization of Objectives 2, 3, and 4. The meeting will aim to be held in a region where creation of a third case study can be supported (Objective 4), as such sub-groups will be allocated to progress Objective 4.

**Months 25 - 36:** Release code (Objective 2) and How-To Guide (Objective 3) as freely accessible resources online. Continue work on Objective 4 and submit to a peer-reviewed journal.

## 5. Deliverables

1. Publish a review/synthesis paper on operationalizing dynamic ocean management and stakeholder involvement (Objective 1)
2. Release a code library as a freely accessible resource (e.g. R vignette; Github) (Objective 2)
3. Release the DOM How-To Guide as a freely accessible online resource (Objective 3)
4. Collaboration with developing nations by completing case studies of dynamic ocean management implemented using the stepwise approach in the How-To Guide. To be published open-access in a peer-reviewed journal (Objective 4).
5. Coordinate a session and/or Town Hall meeting at an international conference to showcase the application and capacity of the website and the How-To Guide.

## 6. Capacity Building

Dynamic ocean management has immense potential for current and future ocean management globally. However, one of the barriers to uptake of DOM is limited knowledge on how to create and implement DOM applications. The vision of our proposal is to remove the barriers to DOM implementation, and create better communication and applicability between researchers and stakeholders.

We believe our proposed code library and How-To Guide will be important in supporting global uptake of DOM. The WG will actively build capacity by seeking participants from developing nations in which to identify and create case studies for these regions. The working group meetings will be hosted in developing nations which will ultimately foster international collaborations into the future and also foster wider uptake of the How-To Guide and DOM by association. Furthermore, collaborations with these regions may identify existing DOM applications that are novel, and our proposed objectives will ensure such novel applications are communicated. Such collaborations are critical to developing and strengthening skills and expertise, which will ultimately support wider uptake of DOM. The proposed How-To Guide has global applications, and the online, updatable resource will ensure the WG outputs are recorded globally accessible into the future, and long lasting.

## 7. Working Group composition

### *7.1 Full Members*

| **Name** | **Gender** | **Place of work** | **Expertise relevant to proposal** |
|---|---|---|---|
| 1 Alistair Hobday (co-chair) | M | Commonwealth Scientific and Industrial Research Organisation, **Australia** | Dynamic ocean management; Ecological forecasting; climate adaptation |
| 2 Stephanie Brodie (co-chair) | F | University of California Santa Cruz, **USA** | Spatial ecology; ecological forecasting |
| 3 Mark Payne | M | Technical University of Denmark, **Denmark** | Statistical modelling; oceanography; fisheries. |
| 4 Lynne Shannon | F | University of Cape Town, **South Africa** | Ecosystem dynamics; fisheries management |
| 5 Sei-Ichi Saitoh | M | Hokkaido University, **Japan** | Fisheries science; biological oceanography; remote sensing |
| 6 Priscila Lopes | F | Universidade Federal do Rio Grande do Norte, **Brazil** | Fisheries research; ecosystem services |
| 7 Kylie Scales | F | University of the Sunshine Coast, **Australia** | Spatial ecology; dynamic ocean management; statistical modelling; remote sensing |
| 8 Jon Lopez | M | AZTI-Tecnalia, **Spain** | fisheries ecology; statistical modelling; bycatch mitigation |
| 9 Desiree Tommasi | F | National Oceanic and Atmospheric Administration, **USA** | Biological oceanography; dynamic ocean management |
| 10 Jean-Noel Druon | M | European Commission, **Italy** | Spatial fisheries management; remote sensing |

### *7.2 Associate Members*

| **Name** | **Gender** | **Place of work** | **Expertise relevant to proposal** |
|---|---|---|---|
| 1 Jason Hartog | M | Commonwealth Scientific and Industrial Research Organization, **Australia** | Ecological forecasting; dynamic ocean management |
| 2 Claire Spillman | F | Bureau of Meteorology, **Australia** | Seasonal forecasting; dynamic ocean management; remote sensing |

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|---|---|---|---|
| 3 Michael Jacox | M | University of California Santa Cruz, **USA** | Oceanography; ocean modeling; remote sensing |
| 4 Kristin Kaschner | F | University of Freiburg, **Germany** | Spatial ecology; Conservation biology |
| 5 Haritz Arrizabalaga | M | AZTI-Tecnalia, **Spain** | Fisheries management; population dynamics |
| 7 Daniel Dunn | M | Duke University, **USA** | Dynamic Ocean Management |
| 8 Marta Coll | F | Institute of Marine Science, **Spain** | Ecosystem functioning; Fisheries; Conservation biology. |
| 9 Ryo Kawabe | M | Nagasaki University, **Japan** | Fisheries management; animal behaviour |
| 10 Emmanuel Chassot | M | Institute of Research for Development, **Seychelles** | Population dynamics; fisheries ecology |

## 8. Working Group contributions

**Alistair Hobday**: lead developer of DOM applications, seasonal forecasting and adaptation approaches for fisheries and conservation. Expertise in risk assessment, climate change, management and policy.

**Stephanie Brodie**: marine ecologist with experience in species distribution modelling and seasonal forecasting. Her research has included working with data poor fisheries and citizen science programs.

**Mark Payne**: marine ecologist researching climate change and climate variability on marine life. Experience with forecasting and projecting distributions of multiple trophic levels and across multiple scales.

**Lynne Shannon**: expert in ecosystem dynamics and the application of the ecosystem approach to fishing in an African case study (Benguela upwelling system, South Africa) in an international context. Brings ecological indicator and food web modelling expertise to the group.

**Sei-Ichi Saitoh**: fisheries scientist with experience in remote sensing and species distribution modelling. He has researched fisheries ecology across multiple trophic levels.

**Kylie Scales:** marine ecologist, with expertise in spatial ecology, species distribution modelling, biologging, remote sensing, and DOM applications in the California current system. Her work is primarily focused on understanding the influence of heterogeneity and variability in the physical environment on habitat use by migratory marine vertebrates.

**Priscila Lopes**: ecologist working on interdisciplinary approaches to small-scale fisheries. Her work has focused on understanding fishers' behavior and their socio-ecological resilience to changes (e.g.: changes in fish stocks or in management), socioeconomic incentives to fisheries and to (non-)compliance, and also on providing solutions to co-management using local ecological knowledge and the ecosystem services approach. Her work relies on existent fishing databases and on direct contact with fishers from small villages in different environments (oceanic, coastal, semi-arid and Amazonian).

**Jon Lopez**: fisheries ecologist working on tropical tunas and has been involved in several EU projects of bycatch mitigation and tuna and tuna-like behavior and ecology, using both fisheries (VMS, logbooks, etc.) and unconventional data (local ecological knowledge, alternative acoustics platforms, etc.). He is currently member of various ICCAT and IOTC working groups, including the subcommittee on ecosystems and FAD groups, among others, and works towards the sustainability of tropical tuna fisheries.

**Desiree Tommasi:** fisheries oceanographer whose interdisciplinary research centers on understanding the impacts of climate variability on marine ecosystems and the development of environmentally-informed fisheries management frameworks. Her current work uses management strategies evaluations to assess the value of integrating seasonal to multi-annual climate forecasts into fisheries management decisions.

**Jean-Noel Druon**: marine ecologist working on dynamic and ecosystem-based management of fisheries. He has expertise in habitat modelling and ocean monitoring across multiple spatial scales.

## 9. Relationship to other international programs and SCOR Working groups

*9.1 IMBeR Activities*

<u>Science Plan and Implementation Strategy:</u> Our proposed WG directly relates to the IMBeR SPIS, specifically Theme 4 “Responses of Society”. Our proposed WG deliverables will help clarify what human institutions can do to mitigate or adapt to anthropogenic impacts on ocean systems.

<u>Working Groups:</u> Our proposed WG complements two of the IMBeR working groups - the Capacity Building Task Team and the Human Dimensions Working Group (HDWG). Firstly, our proposed collaborations aim to enhance research capabilities in developing nations, and secondly our proposed deliverables can be informed by the integrated assessment framework developed by the HDWG.

<u>Regional Programmes:</u> The Climate Impacts on Top Ocean Predators (CLIOTOP) is an IMBeR regional programme, and currently has two task teams on seasonal forecasting, and operational oceanography. We anticipate that the task team outputs can directly contribute to the proposed

code library and How-To Guide. The links between these task teams and the proposed WG will be supported by concurrent membership of certain WG members (Hobday, Scales, Arrizabalaga, Lopez).

*9.2 WG149 Changing Ocean Biological Systems (COBS)*

The proposed WG compliments WG149 by focusing on dynamic strategies to support management and industry adaptation to a changing ocean. The proposed WG can directly use the WG149 glossary of terms and implementation guide (TOR 8) to better align language and ensure greater uptake and understanding of DOM by manager and policy makers.

*9.3 United Nations Sustainable Development Goal 14: Life Below Water*

The outputs of the proposed working group will be useful for, and directly contribute to the United Nations Sustainable Development Goal 14. Specifically, by facilitating the wider uptake of DOM globally we will support the 2020 targets of sustainable management (target 2), effective regulation of marine resources (target 4), and greater conservation of coastal regions (target 5). Our proposed collaboration with developing countries will also support increased economic benefits of ocean sustainability (target 7) and transfer of marine technology (target 8) to such countries.

*9.4 ICES and PICES Working Groups on Seasonal to Decadal Predictability*

Working groups within ICES and PICES are focusing on various levels of spatiotemporal ecosystem predictability. The ICES working group investigation of seasonal to decadal forecasts is directly relevant to this WG proposal, and links will be supported by concurrent membership (Payne and Jean-Noel). The PICES investigation into ocean products for use in marine ecosystem predictions is relevant to the proposed WG and outputs can be integrated into the How-To Guide and case studies.

*9.5 FiSCAO: Fish Stocks in the Central Arctic Ocean*

FiSCAO is an international collaborative group to ensure sustainable commercial harvest in new and existing areas of the pan-Arctic ecosystem. There is potential for the proposed WG outputs to directly inform current and future management in the pan-Arctic ecosystem, and support dynamic ocean management at the initial stages of new management regimes.

*9.6 ICCAT, IATTC, and IOTC groups on Ecosystems and Bycatch*

ICCAT, IATTC, and IOTC Regional Fisheries Management Organizations are responsible of the conservation and management of tuna and tuna-like species in the Atlantic, Pacific, and Indian Oceans, including target and non-target species. The application of DOM in regions of interest would provide key material to work towards the sustainability of both intentionally and unintentionally exploited resources.

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## Appendix

### Alistair Hobday


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