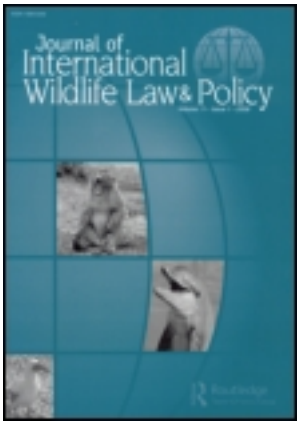

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Tracking and Protecting Marine Species at Risk: Scientific Advances, Sea of Governance Challenges

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Tracking and Protecting Marine Species at Risk: Scientific Advances, Sea of Governance Challenges

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The state of many marine species in the world's oceans is increasingly gloomy. The northern cod stock off Newfoundland, once thought to be inexhaustible, is now listed as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC),[1] while wild salmon populations in the Bay of Fundy, once the joy of recreational and commercial fishers, are listed as endangered under Canada's Species at Risk Act.[2] In parts of the ocean, 90 per cent of the large predators, including tuna, swordfish, and marlins, have disappeared with direct linkages to overfishing.[3] Some 28 per cent of assessed and non-data deficient shark species are considered globally at risk of extinction.[4]

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[1] *See* COSEWIC Assessment Summary and Status Report: Atlantic Cod—Laurentian North, Laurentian South, Newfoundland and Labrador, Southern and Arctic Lakes populations (April 2010), *at* http://www.sararegistry.gc.ca/document/default_e.cfm?documentID=1998 (visited 9 April 2013).

[2] *See* David L. VanderZwaag, Maria Cecilia Engler-Palma, & Jeffrey A. Hutchings, *Canada's Species at Risk Act and Atlantic Salmon: Cascade of Promises, Trickles of Protection, Sea of Challenges*, 22 J. Envtl. L. & Prac. 267, 269 (2011).

[3] *See* Ransom A. Myers & Boris Worm, *Rapid Worldwide Depletion of Predatory Fish Communities*, 423 Nature 280 (2003).

[4] B. Worm et al., *Global Catches, Exploitation Rates, and Rebuilding Options for Sharks*, 40 Marine Pol'y 194, 201 (2013).

Scientific uncertainties continue to abound concerning the status of marine species and the ecosystems on which they depend. The IUCN Red List of Threatened Species, the main global mechanism for evaluating the status of species,[5] poorly covers the marine realm with less than five per cent of the included species being marine.[6] While approximately 250,000 marine species have been formally described in the scientific literature, at least another 750,000 species likely remain to be discovered.[7] The effects of multiple ocean stressors—climate change, overexploitation, pollution, and habitat loss—are difficult to unravel.[8]

A sea of governance challenges surrounds the goal of protecting marine species at risk. The international community has yet to agree on future directions for managing human uses in areas beyond national jurisdiction.[9] Putting ecosystem and precautionary approaches into practice within regional fisheries bodies and regional sea arrangements continues to be constrained by limited political will and strong socioeconomic pressures.[10] At the national level, integrated marine spatial planning is still in its early stages[11] and laws and policies specifically aimed at protecting marine species at risk face common difficulties. Those problems include getting species at risk listed for

[5] *See* Wildlife in a Changing World—An Analysis of the 2008 IUCN Red List of Threatened Species (Jean-Christophe Vié, Craig Hilton-Taylor, & Simon N. Stuart eds., 2009).

[6] *See* IUCN, Red List Overview, *at* http://www.iucnredlist.org/about/red-list-overview (visited 8 April 2013).

[7] Excluding microbes. *See* Census of Marine Life, Scientific Results to Support the Sustainable Use and Conservation of Marine Life: A Summary of the Census of Marine Life for Decision Makers 3 (2011).

[8] A.D. Rogers & D. d'A. Laffoley, International Earth System Expert Workshop on Ocean Stresses and Impacts: Summary Report (2011); and IOC/UNESCO, IMO, FAO, UNDP, A Blueprint for Ocean and Coastal Sustainability (2011).

[9] The *Ad Hoc* Open-ended Informal Working Group to study issues related to the conservation and sustainable use of marine biodiversity beyond areas of national jurisdiction, established to facilitate international discussions on possible ways forward, including the possible negotiation of an implementing agreement on marine biodiversity beyond national jurisdiction, has held five meetings with a sixth scheduled for August 2013, but consensus has yet to be reached on ways forward. *See, for example*, Kristina M. Gjerde & Anna Rulska-Domino, *Marine Protected Areas beyond National Jurisdiction: Some Practical Perspectives for Moving Ahead*, 27 Int'l J. Marine & Coast. L. 351 (2012); and David Freestone, *International Governance, Responsibility and Management of Areas beyond National Jurisdiction*, 27 Int'l J. Marine & Coast. L. 191 (2012).

[10] *See, for example*, Recasting Transboundary Fisheries Management Arrangements in Light of Sustainability Principles: Canadian and International Perspectives (Dawn A. Russell & David L. VanderZwaag eds., 2010); and Daniela Piz Pereira Pinto, Fisheries Management in Areas beyond National Jurisdiction: The Impact of Ecosystem Based Law-Making 117–157 (2013); Sarika Cullis-Suzuki & Daniel Pauly, *Failing the High Seas: A Global Evaluation of Regional Fisheries Management Organizations*, 34 Marine Pol'y 1036 (2010).

[11] For recent reviews on the limitations, *see* J. Zachary Koehn, Daniel R. Reineman, & John N. Kittinger, *Progress and Promise in Spatial Human Dimensions Research for Ecosystem-based Ocean Planning*, 42 Marine Pol'y 31 (2013); Robin Kundis Craig, *Ocean Governance for the 21st Century: Making Marine Zoning Climate Change Adaptable*, 36 Harv. Envtl. L. Rev. 305 (2012); and Stephen Jay et al., *International Progress in Marine Spatial Planning*, 27 Ocean Y.B. 171 (2013).

protection, determining appropriate levels for incidental takings and harms, identifying and designating critical habitats, and ensuring the effectiveness of recovery planning.[12]

The collection of nine articles in this special two-part issue [16(2–3) and 16(4)] of the *Journal of International Wildlife Law & Policy* joins the efforts of natural and social scientists in highlighting the scientific advances in tracking marine species, many of them at risk, and the on-going sea of governance challenges.[13] These studies have primarily, although not exclusively, been conducted through the Ocean Tracking Network (OTN), a novel seven-year project based at Dalhousie University in Halifax, Nova Scotia, to tag and track the movement of these species, primarily in Canadian oceans, but increasingly on a global basis. Canada has long been a leader in ocean science and animal tracking technology, and the activities of OTN serve to codify those strengths but to also export such technologies, expertise and knowledge elsewhere.

OTN research is organized around three primary questions and five basic themes. The questions are:

1. What are the physical, chemical, and biological oceanographic linkages that determine the population structure, dynamics, movement, and critical habitat of marine organisms?
2. How will climate variability, environmental change, and anthropogenic activities affect the distribution and abundance of marine organisms?
3. What are the ocean governance implications, including social, economic, and legal dimensions, of OTN findings?[14]

The associated themes may be schematized as shown in Figure 1.[15]

Foundational to OTN studies are significant innovations and advances in the technology that enable aquatic animals to be studied in the wild. Quite simply, 30-plus years ago the thought of tracking continental-scale or trans-oceanic movements of fish and other aquatic organisms was just a dream. Consider the challenges in studying animals that spend most or all of their

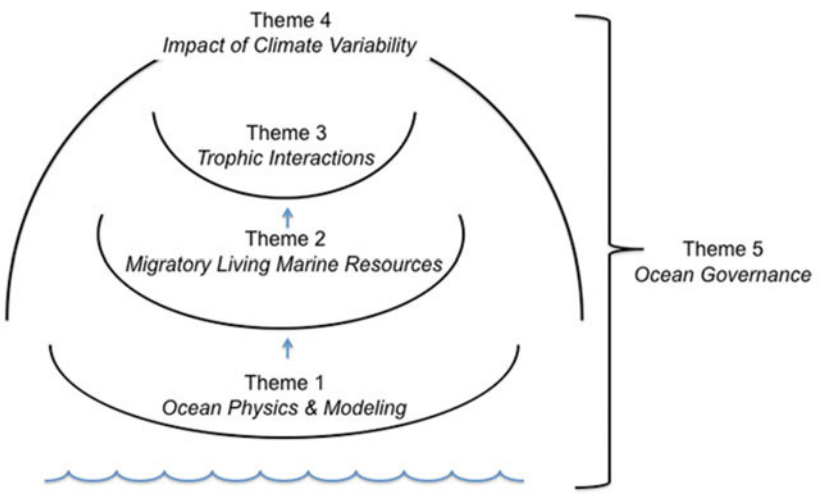
[12] Robert Shaffer, *Judicial Oversight in the Comparative Context: Biodiversity Protection in the United States, Australia and Canada*, 43 ENVTL. L. REP. NEWS & ANALYSIS 10169 (2013).

[13] A further OTN-related paper, addressing scientific and management challenges surrounding the protection of the southern resident orcas of the Salish Sea off the coast of British Columbia and the state of Washington, was not completed in time for this special issue but is expected to be published in the next edition of the *Journal*.

[14] S. J. Cooke et al., *Ocean Tracking Network Canada: A Network Approach to Addressing Critical Issues in Fisheries and Resource Management with Implications for Ocean Governance*, 36 FISHERIES 583, 585 (2011).

[15] *Id*. at 586.

FIGURE 1. (Color figure available online).



time underwater in an environment hostile to humans—sometimes at depth or in weather conditions that are simply impossible to work in. Scientists have certainly tried to study behaviour and mortality rates of wild aquatic animals using "low technology" approaches such as mark-recapture tagging studies for many decades. However, one only knows where an animal was tagged and where it was recaptured but little about the behaviour in the intervening time. It is rather unlikely that the animals simply moved in a straight line between those two points! And if an animal is not recaptured, does that mean it died? Or is it simply avoiding recapture?

Electronic tags of various types—some that log data, some that transmit data, as well as hybrid types[16] now exist that provide unprecedented opportunities to study the behaviour and survival of wild aquatic animals. When coupled with sensor technology (e.g., to measure the heart rate of an animal or the temperatures or depth experienced) one can then attempt to understand the costs and consequences of different activities (including interactions with humans) as well as providing detailed information on habitat selection. The OTN technologies are centred on acoustic telemetry curtains,[17] with complementary tools and techniques from biology (e.g., pop-up satellite tags, radio telemetry, business card tags, biologgers, genomics, physiological sampling)

[16] All reviewed in S.J. Cooke et al., *Biotelemetry and Biologging, in* FISHERIES TECHNIQUES 819–860 (3rd ed.) (A. V. Zala, D. L. Parrish, & T. M. Sutton eds., 2012).

[17] M. R. Heupel, J. M. Semmens, & A. J. Hobday, *Automated Acoustic Tracking of Aquatic Animals: Scales, Design and Deployment of Listening Station Arrays*, 57(1) MAR. FRESHWATER RES. 1 (2006).

and oceanography (e.g., gliders, satellites, current profilers, and conductivity, temperature, and depth loggers (CTDs)).

This special issue begins with an overview article on the OTN project and the numerous associated data collection and dissemination issues such as intellectual property and access rights. The latter issue involves the sometimes thorny problem of interest groups—conservation and public interest groups, commercial ventures, fisherfolk, Aboriginal groups, and government agencies—that may have differing agendas, sharing access to the same information.

Seven case studies in relation to specific marine species follow. While varying in format and geographical focus, each case study reviews the status and limitations of marine scientific research, describes social and economic interests, and highlights governance approaches and challenges. The role of scientific advances and uncertainties in policy-making represents a cross-cutting theme.

The first five are Atlantic case studies, covering the American eel, Atlantic sturgeon, bluefin tuna, the right whale, and the grey seal. The American eel article highlights the importance of eels to indigenous communities and commercial fishers and discusses how OTN is trying to answer some of the unknowns of the eel's life cycle including their migration paths to the Sargasso Sea and their open ocean habitat requirements. Future governance directions are suggested including a Canada-U.S. agreement on eel conservation and scientific cooperation and possibly forging inter-regional cooperation under the umbrella of a new Sargasso Sea Commission.

The Atlantic sturgeon study reviews the multiple threats to conservation, including fishing pressures to obtain the distinctive luxury food of caviar, and the significant gaps in data and scientific knowledge. For example, accurate assessments of population status are lacking and critical habitats are largely unknown. The emerging role of sturgeon aquaculture, especially closed containment aquaculture, is described, which holds promise in the preservation of a species taking a long time to mature.[18] The special challenge of managing the Saint John /Bay of Fundy transboundary sturgeon stock is emphasized along with the need for greater bilateral cooperation between the United States and Canada, possibly through an Atlantic sturgeon management strategy and action plan.

The Atlantic bluefin tuna and North Atlantic right whale while not being tracked under OTN, are of special interest to the social and legal component of OTN in light of their high political and social profiles and the difficult transboundary management challenges they raise. The bluefin tuna article, following a synopsis of tuna biology and ecology, reviews the powerful socioeconomic forces behind the serious decline of tuna stocks. Those forces

[18] Richard Apostle, *Closed-Containment Aquaculture in Atlantic Canada*, 11(1) MAR. STUD. 13 (2012).

include purse seining and recreational fishing in the western Atlantic, industrialized tuna fattening and farming operations in the eastern Atlantic, and the high demands emanating from Japanese markets for sushi. The main reasons for the failure of the International Commission for the Conservation of Atlantic Tunas (ICCAT) to halt declines are highlighted, specifically the ignoring of scientific advice, lack of compliance with management measures, illegal, unreported and unregulated (IUU) fishing, and overcapacity in fishing fleets.

The right whale article reviews the multiple threats to the endangered species, particularly vessel strikes and fishing gear entanglements, and the authors discuss the complex array of measures taken to address the threats including fishing gear restrictions, ship reporting and speed requirements, shifting of shipping lanes, and designation of areas to be avoided and recommended routes. The use of acoustic auto-detection buoys, installed along the main shipping route to and from the port of Boston and Massachusetts Bay shipping terminals, is lauded for the ability to locate whales in near real time but the risk of attracting many whale watching boats is also noted.

The fifth Atlantic case study addresses perhaps the most contentious topic in this two-part special issue, the grey seal-cod debate over whether grey seals are responsible for the decline and limited recovery of endangered and threatened cod stocks and whether there should be a seal cull. After reviewing the history of the Atlantic cod collapse, the authors discuss the tension between conservation and economic development, both in formal legislation and in related bureaucracies. The current trend to attempt to turn a grey seal cull into a commercial venture is specifically considered. The conflicting scientific evidence on whether a reduction in grey seal stocks will facilitate recovery of Atlantic cod is carefully canvassed, with a focus on the novel contributions of OTN's biotelemetry tools. The scientific uncertainty is then framed in terms of scientific ambiguity, and its potential risks and contributions.

Individual Arctic and Pacific case studies round out the picture. The Greenland shark study reviews the very limited knowledge regarding a northern species still thought to be relatively abundant due to lack of directed fishing. It suggests future scientific and governance directions for avoiding a species at risk, including the imposition of a precautionary fisheries moratorium in the central Arctic Ocean beyond national jurisdiction. The Pacific salmon case study examines the rapid advancing technology of biotelemetry and its potential impacts on the management of salmon species in British Columbia's Fraser River watershed. The challenges of transferring scientific knowledge up to the bureaucratic "ladder" is discussed with examples of successful knowledge mobilization (adjusting harvest levels based on predicted water temperatures) and unsuccessful transfer (considering sex ratios when setting escapement targets, that is, the number of fish expected to reach spawning grounds). The authors suggest various ways forward, including the

development of more collaborative forums for scientists and managers to discuss research priorities and findings and enhanced transparency in how resource management decisions are reached.

The final article addresses the question of whether to tag or not to tag fish with electronic tags. The authors highlight the need to consider animal welfare, stakeholder perspectives, and conservation concerns for endangered/threatened species when embarking on a tracking study.

The collection of articles is what we regard as the first step in more explicit and direct collaboration among natural scientists, social scientists, and legal experts to advance marine conservation and management. The unprecedented volume and specificity of knowledge generated when conducting animal tracking studies generates many questions that begin when a scientist considers embarking on a tracking study. For example, what will the data be used for and can they be misused or abused if in the "wrong hands"? And of course the ethics of tagging animals or working on endangered species. Questions expand even further once tracking data are in hand. For example, what does it mean for management, conservation, and governance? And what are the barriers for the application of tracking data? The integration of natural sciences, social sciences, and legal/governance studies are best achieved when research agendas are co-created and when there is mutual respect and understanding. Multidisciplinary research that crosses boundaries and demands that different types of expertise are rallied and integrated is by no means easy. However, as demonstrated here in diverse case studies, it is the only way to begin solving the complex and pressing conservation and management problems facing the world's oceans.

The co-editors of this special issue wish to acknowledge the editorial assistance of Susan Rolston, Seawinds Consulting Services, and the research funding support for OTN through the Canadian Natural Sciences and Engineering Research Council (NSERC), the Canadian Foundation for Innovation (CFI), and the Social Sciences and Humanities Research Council of Canada (SSHRC). The funding contribution of the Schulich Academic Excellence Fund is also recognized.

Due to space considerations, the articles in this issue end with the Atlantic tuna case study. The remaining five articles will appear in Part 2.