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Introduction

International collaboration and comparative research on ocean top predators under CLIOTOP

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ABSTRACT

Oceanic top predators have ecological, social and economic value of global significance. These wide-ranging marine species, which include sharks, tunas and billfishes, marine mammals, turtles and seabirds, are the focus of international research attention under the Climate Impacts on Oceanic Top Predators (CLIOTOP) science programme, one of the Integrated Marine Biosphere Research (IMBeR) projects. Over more than a decade, research conducted under CLIOTOP has involved scientists from more than 30 countries, with international collaboration increasing markedly over time, and comparative analyses resulting in new knowledge and understanding of oceanic top predators. This special issue presents 27 papers arising from the 3rd CLIOTOP symposium, held in San Sebastián, Spain in September 2015, spanning topics such as conservation biology, trophic ecology, fisheries science, climate change, and adaptive management. The maturation and synthesis of CLIOTOP's collaborative research is now resulting in real-world management applications and improving understanding of potential ecological and socio-economic impacts of climate change in oceanic systems. The ultimate CLIOTOP goal of preparing both climate-sensitive predator populations and the human societies dependent on them for the impending impacts of climate change is now within reach.

1. Introduction

Oceanic top predators include those species that occupy a high trophic level (e.g. predatory tuna), have few predators and hence are at the top of their food chain (e.g. marine turtles and seabirds), and those that exert top-down control on food webs due to their large energetic demands (e.g. whales). While many species in the open ocean are widely distributed (e.g. Read et al., 2013; Reygondeau et al., 2012), top predators are noteworthy as they can also be wide-ranging (e.g. Block et al., 2011). These wide-ranging species can serve as ecological linkages within and across ocean basins, through both ontogenetic (larvae to adult) and seasonal migrations (Boustany et al., 2010; Hobday et al., 2015a, 2015b). Many wide-ranging species demonstrate site fidelity to well-defined areas at particular times during their lives (Weng et al., 2008; Costa et al., 2013), which facilitates both exploitation (e.g. Hobday et al., 2015a, 2015b; Fromentin et al., 2014) and protection (e.g. Ban et al., 2014). This fidelity can be related to the temporal and spatial predictability of their physical habitats aided by sensory capabilities that permit them to locate specific physical and biological features, as evidenced by predictable seasonal aggregations of high trophic level fishes, birds, turtles, and mammals (Scales et al., 2014).

Many oceanic top predator populations have considerable commercial, cultural, and ecological value (e.g. Weng et al., 2015). Top predators in marine ecosystems are supported by the productivity of primary and secondary consumers, thus their population dynamics integrate a range of processes across these lower levels in the trophic food web. Their long- life spans and wide-ranging movements mean that populations of many marine predators also integrate variability across larger spatial and temporal scales than many lower-trophic-level populations (Shaffer et al., 2006). These characteristics make assessments of top predator populations particularly valuable for investigations of large-scale ecosystem variability and change. Further, given the socio-economic value of these species, understanding and predicting responses to global change is an urgent global research priority for managing predator populations and preparing the human societies dependent on them for the impending impacts of climate change.

The Climate Impacts on Oceanic Top Predators (CLIOTOP) programme, one of four regional science programmes of the Integrated Marine Biosphere Research (IMBeR) project, is an international research network open to researchers, managers, and policy makers involved in research related to top predator species. Network participants organise large-scale comparative efforts to elucidate key processes involved in the interaction between climate variability, global change and human uses of the ocean on the structure and function of pelagic ecosystems and ecology of wide-ranging oceanic species. The CLIOTOP programme seeks to develop predictive capability for these socio-ecological systems and evaluate adaptation options to maximise future sustainability in the management of oceanic systems.

The third open science symposium of the CLIOTOP programme was held in Donostia–San Sebastián in the Basque Country, Spain during 14–18 September 2015. Approximately 120 delegates attended from 24 countries (compared with some 200 participants from 25 countries at the first (Lehodey and Maury, 2010) and approximately 70 participants from 18 countries at the second symposium (Hobday et al., 2015a, 2015b). The overall objectives of the 3rd CLIOTOP symposium were to:

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1. Evaluate impacts of climate variability and change over seasonal to decadal time scales on pelagic species and dependent socio-economic and management systems
2. Identify risk assessment and evaluation tools that incorporate climate variability in order to improve sustainable resource management (conservation, fisheries, spatial planning, etc.)
3. Identify sustainable pathways for coupled socio-ecological oceanic systems
4. Position CLIOTOP science for its next 10-year phase, and build a collaborating community of scientists, managers, and policy-makers

Research topics presented at the symposium included conservation biology, fisheries science and management, socio-economics, ecosystem modelling, trophic ecology, oceanography, meteorology and climate data management. Presentations on migratory fish, and regional studies in the Pacific Ocean dominated the symposium, similar to previous symposia. However, while there was still a focus on system-specific findings, many studies made the progression from single response variables to integrating multi-species, multi-region, global-scale and longer-term datasets. There was also a greater focus on forecasting shorter time scale responses (seasons to years) in addition to longer term projections (decades to centuries).

2. International collaboration is critical in understanding wide-ranging species

An important goal of CLIOTOP is to use comparative methods to improve understanding of pelagic species, ecosystems and human uses, and to predict the future under climate change. Given the wide geographical range occupied by most pelagic species, this goal necessitates collaboration between researchers from many parts of the world. To assess the success of the collaborative approach, we collated symposium abstracts from the three symposia (n=341) and four special issues (n=105), three from the CLIOTOP symposia (Lehodey and Maury, 2010; Hobday et al., 2015a, 2015b; this issue), and a special issue devoted to the role of squid in pelagic ecosystems (Young et al., 2013). We then assessed these for (i) topics covered by the special issue papers, (ii) the number of authors involved in the publications; (iii) the number of countries represented by publication and symposium authors, and; (iv) the linkages between countries based on co-authors. Because not all affiliations were listed on abstracts from the symposia, country-linkages were conducted on special issue publications only.

The 105 papers covered a range of pelagic taxa, dominated by tuna and squid (due to the squid special issue), with more limited coverage for marine mammals, seabirds and turtles. (Fig. 1A). Trophic studies were most prevalent, followed by studies on species distribution and movement (including behavioural studies) (Fig. 1B). Implications for management and socio-economics, while commonly raised in the discussion section on many papers, were the primary focus in few articles.

The number of authors involved in publications increased over time as did the number of countries represented across all authors in each publication (Fig. 2A). Publications involved a total of 30 countries, with each country contributing 1 – 29 publications. Lead authors were from 18 countries, with the United States (28%) Australia (19%), Spain (15%), France (10%) and Japan (8%) collectively representing 80% of all publications. Symposium abstracts were led by authors from 25 different countries, with United States (32%), France (14%), Mexico (12%), Australia (11%) and Spain (11%) representing the top five (also 80% of all abstracts). The exchange of Japan for Mexico in the top five publication and presentation lists, respectively, suggested Japanese scientists converted presented work into CLIOTOP publications more frequently (42% – 8 publications from 19 presentations) than Mexican scientists (5%). Of the other top five publishing countries, the United States had a conversion ratio of 26%, Australia 56%, Spain 44%, and France 23%. The lower rate for Mexico, for example, suggests that more support might be needed to turn work from presentations into CLIOTOP publications. Of course, work may have been published in other fora, but we cannot evaluate that with the data at hand.

When linkages between the country of the lead author and the countries of co-authors were assessed (n=65 different country-pairs and n=388 links), publications with lead authors associated with South Africa and New Caledonia on average involved the highest number of co-authors and countries (Fig. 2B, Fig. 3). Among 30 countries represented in the publications, lead authors from fifteen countries collaborated with co-authors from the same country on a publication, and the other 15 countries had no same-country collaborators on publications suggesting that researchers from these countries might particularly rely on the CLIOTOP network.

The steady increase in the number of co-authors involved in CLIOTOP-affiliated presentations and publications from less than 4 in 2007 to more than 6 in 2015–2017 suggests collaboration has increased, particularly compared to an average global estimate of 3.8 in 2007 and 4.5 co-authors in 2011 (King, 2012). Whether this steady increase is indicative of wider increases in collaboration across the scientific community is difficult to determine given variability in collaboration across scientific disciplines, however, increases in international collaboration have been noted elsewhere (Haustein and Lariviere, 2015; Witze, 2016). Further the general pattern of scientists from smaller counties collaborating with other countries more frequently than large-country scientists has also been noted elsewhere (Witze, 2016).

Patterns in collaborations derived from publications to date are useful for guiding further development of networks and collaborations within international science programs such as CLIOTOP. For example, although authors from Japan were amongst those that produced most publications, they had only collaborated with authors from the United States on those publications. Additionally, authors from Southern Hemisphere countries demonstrated more collaborative links with authors from the Northern Hemisphere than those from other Southern Hemisphere countries. Further, based on publications in special issues, to date there has been no involvement of authors from a number of regions including areas of Asia other than Japan, eastern Europe and North Africa.[1] These patterns thus identify areas where more effort could be directed in establishing regular and ongoing linkages between researchers. Involvement from Chinese or southeast Asian scientists, in particular, must be addressed in future given the importance of these nations in high seas fisheries.

3. Progress on top predator species research

In this special issue, 27 papers representing work from a total of 174 authors and 17 countries provide further insights into the trophic ecology and habitat preferences of a wide range of oceanic species. These insights can be used to inform development of predictive habitat and ecosystem models for management applications, improve overall management of populations of open ocean top predators, and support ecosystem-based management.

[1] Note a small number of authors from Asia and eastern Europe have been involved in presentations at symposia.