

## Final Report of activities undertaken by CLIOTOP Task Team 2016/01:

### Global comparative analysis of marine trophodynamics in top predators.

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Moving from regional-based trophic studies of top marine predators to global-scale comparative studies of oceanic food web dynamics was a core objective of Task Team 2016-01. Work undertaken by the task team over the last 12 months has resulted in the completion of a large-scale isotope dataset of samples collected over 15 years and several peer-reviewed publications (listed below). Other papers are in the final stages of preparation. Through the production and dissemination of these outputs, the task team has improved our scientific understanding of the trophic pathways that underlie the production of tunas and other pelagic predators in the open ocean, the movements of these predators, and the natural variability forced by the environment. Such understanding will directly assist IMBeR in addressing a cadre of overarching scientific questions in relation to advanced understanding of marine ecology, food web dynamics, movements of top predators in a changing climate, and ocean biogeochemistry. Furthermore, an understanding of top predator diets and movements in the open ocean is crucial to the management of commercially important species and to determine shifts in distribution and foraging patterns in a changing climate.

The task team has been dedicated to compiling new data, analysing data, interpreting results, and writing manuscripts. To assist with the writing component, two successful workshops, co-funded by IMBeR and CSIRO were held at CSIRO, Hobart, in November: (1) on the 7-11<sup>th</sup> for the carbon isotope paper attended by Heidi Pethybridge, Anne Lorrain (IRD) and Brittany Graham (NIWA); and (2) on the 14-21<sup>st</sup> for the nitrogen isotope paper attended by Heidi Pethybridge and Anela Choy (MBARI). Both workshops were successful with visions and structures for both papers established and around 30-40% of the papers content written. During the carbon isotope workshop scientists concluded that enough data and content was available for two papers; one focused on the spatial trends and the other focused on temporal trends. Specifically, we undertook additional time-series analyses and found a significant temporal decline of carbon isotopes across all oceans in all three tuna species which reflected carbon dioxide emissions and declines in primary productivity. For the nitrogen paper, geographical location was the best predictor of baseline adjusted and non-adjusted  $\delta^{15}\text{N}$  values of tunas, showing clear regional gradients and differences between hemispheres. The target journal for the two isotope papers focused on spatial trends is the *Journal of Global Ecology and Biogeography*. As of March 2017 a completed draft of the nitrogen isotope paper is currently being reviewed by the co-authors and will be submitted in April 2017. Drafts of the two carbon isotope papers but should be completed by this July. The target journal for the temporal carbon isotope paper, will be a higher impact journal such as *Nature*, *Scientific Reports*, or *Global Climate Biology*.

Work was not undertaken to complete a white paper as outlined in the proposal due to several time constraints. However, we are confident that our peer-reviewed publications will

provide very good visibility and reach for overlapping goals. Here we outline a few recommendations for future work on open-ocean trophodynamics that could be commenced under IMBeR-CLIOTOP:

- Examine environmental drivers and spatial patterns of community-level trophic properties and metrics. This would best be achieved by (1) continued compilations of isotope data, and (2) connecting with other international isotope groups undertaking meta-analyses on isotopes of other marine consumers (such as mid-trophic fish and squid; S. Jennings, and sharks; C. Bird).
- Explore linkages between overlapping temporal and spatial tagging studies and isotope data to better understand movement and migration patterns of top predators. This could be achieved by connecting with previous members of task teams (e.g. 2016-05 and 2016-06) and through the use of Bayesian modelling with Gaussian processes.
- Undertake multi-biogeochemical tracer studies, including incorporating data from the analysis of compound-specific stable isotopes, trace metals and/or fatty acid analysis. Such effort would directly assist with disentangling baseline versus trophic influences and to understand patterns of trophic fractionation through the food web.

These objectives will be the focus of work in the next two years under the proceeding CLIOTOP task team 2017/01 'Global analyses of top predator isotopes' to be co-led by H. Pethybridge, A. Lorrain and B. Graham. It is also worth noting that while some of our more senior members have recently retired (Bob Olson and Jock Young), our network of early- and mid-career researchers is growing and we expect to see greater involvement from other countries and institutions in the coming years.

#### **Summary of main task team activities in 2016:**

1. Countless and continuous email and phone/Skype correspondences to exchange data, ideas and paper drafts.
2. Co-funding acquired for the writing workshops; CSIRO Payne Scott Fellowship awarded to H. Pethybridge.
3. Writing workshop "global analysis of carbon isotopes in tuna" (7-11<sup>th</sup> Nov, CSIRO, Hobart).
4. Writing workshop "global analysis of nitrogen isotopes in tuna" (14-21<sup>st</sup> Nov, Hobart).
5. Data analysis for, and writing of, multiple peer-reviewed publications as listed below.

#### **Databases produced:**

1. 4300 records of carbon isotope values corrected for lipid content, for yellowfin, albacore and bigeye tunas, and matching output from a model of biogeochemical isotopes in which to correct for baseline variability.
2. 4300 records of nitrogen isotopes values for yellowfin, albacore and bigeye tunas, and output from a model of biogeochemical isotopes in which to correct for baseline variability.

#### **Publications:**

1. Pethybridge, H., Choy., *et al.* Extending regional nitrogen isotope analyses to global scales to understand the trophic status and connectivity of highly mobile marine predators

within oceanic ecosystems. *Global Ecology and Biogeography*. In final stages of preparation.

2. Duffy, L.M., Kuhnert, P., Pethybridge, H.R., Young, J.W., Olson, R.J., Logan, J.M., Goñi, N., Romanov, E., Allain, V., Staudinger, M. *et al.*, 2017. Global trophic ecology of yellowfin, bigeye, and albacore tunas: understanding predation on micronekton communities at ocean-basin scales. *Deep Sea Research Part II: Topical Studies in Oceanography*. In Press
3. Pethybridge, H., Lorrain, A., Graham, B., Choy, C.A., 2016. Global patterns and trends of tuna isotopes. IMBER Webpage summary, online: 30-11-2016: <http://www.imber.info/en/news/global-patterns-and-trends-of-tuna-isotopes>
4. Pethybridge, H. (2016) Global analyses of tuna diet and isotopes: moving from regional to macro-scale understanding of marine food webs. Keynote presentation at Australian Society of Fish Biology Conference, Hobart, Australia 7/09/2016.
5. Albo-Puigserver, M., Muñoz, A., Navarro, J., Coll, M., Pethybridge, H., Sánchez, S., & Palomera, I. (2017). Ecological energetics of forage fish from the Mediterranean Sea: seasonal dynamics and interspecific differences. *Deep Sea Research Part II: Topical Studies in Oceanography*. In press.
6. Sardenne, F., Bodin, N., Chassot, E., Amiel, A., Fouché, E., Degroote, M., Hollanda, S., Pethybridge, H., Lebreton, B., Guillou, G. and Ménard, F., 2016. Trophic niches of sympatric tropical tuna in the Western Indian Ocean inferred by stable isotopes and neutral fatty acids. *Progress in Oceanography*, 146, pp.75-88.