OFI Workshop on Fisheries Management Reference Points in Highly Dynamic Ecosystems

Background:
Reference points are used in fisheries management to represent desired and undesired stock and fishery states, and provide a means by which to evaluate the status of fish stocks. Biomass and fishing reference points are also often used as operational control points to trigger changes in the management measures (e.g., fishing rate) in response to changes in the stock. Reference points are key components of the precautionary approach (PA), which is considered a cornerstone for sustainable fisheries management. PA reference points are usually estimated from models taking into account historical fish population dynamics and their response to fishing mediated by environmental conditions and the life-history characteristics of the stock. These reference points are mostly estimated to be static characterizations of a stock's productivity assuming equilibrium dynamics (hereafter referred to as static reference points). However, in reality, it is well known that a stock's distribution and productivity vary in time both randomly and often with trends (Karp *et al.* 2019), sometimes even showing regime-like characteristics. This means that management decisions based on such static reference points may not reflect the productivity of a stock in the future, especially as climate change is already impacting environmental conditions, primary productivity, and distributions of fish stocks (Lotze *et al.* 2019). This may affect the risk of management decisions that are either 1) unsustainable or 2) overly cautious with foregone yield, because of the mismatch between actual productivity and the productivity inherent in a static PA framework.

Challenges:
Time-varying (non-stationary) reference points are points that can change according to the "prevailing" environmental conditions. For example, time-varying reference points can be calculated by incorporating environmental covariates into models and projections (a "mechanistic approach" including dynamic B_0, moving windows or the STARs approaches to calculating reference points (Punt *et al.* 2014). However, there are several challenges with this approach: 1) ecosystem regimes or prevailing conditions are difficult to define and detect, 2) the environmental mechanisms are often elusive and tend to change over time, 3) forecasting environmental conditions could be highly uncertain, and 4) inclusion of such methods may not lead to substantially better management outcomes. Another option is to use static reference points in harvest strategies that are then evaluated for robustness to time-varying productivity by accounting for possible broad scenarios of future dynamics (an "empirical approach"; Punt et al. 2014). This approach does not require identifying, understanding, or projecting explicit mechanisms affecting fish population dynamics, thereby avoiding the above-mentioned challenges associated with time-varying reference points. However, implementation of such reference points in harvest strategies may lead to over-exploitation/under-exploitation in periods with poor/good environmental conditions, resulting in sub-optimal harvesting in fisheries (Rindorf *et al.* 2017). Limitations of the use of both time-varying and static reference points in harvest strategies suggest the choice of reference points should be evaluated in the context of specific fisheries and ecosystems, and some general and practical guidance on how to make such choices is warranted (e.g. Holt & Michielsens 2019).

Two-parts Workshop Format:
The workshop has two parts:

1. Part 1 is an online workshop featuring keynote talks followed by discussions.
2. Part 2 is an in-person workshop focusing on actual practices of defining and/or changing reference points in case studies, identify research gaps, and develop general guidance or recommendation of best practices.

Part 1: Online workshop:
Date: January 25-29, 2021

Time: 12:30-2:30 PM Newfoundland Time (GMT-3:30)

Meeting link: TBD.

Keynote speakers:
Andre Punt (University of Washington)
Anna Rindorf (Technical University of Denmark)
Jason Link (NOAA)
Robyn Forest (Fisheries and Oceans Canada)

Participants: Invited experts, researchers and government scientists.

Terms of reference:
1. Participation in online survey prior to workshop Part 1 indicating experience with dynamic reference points with examples.
2. Overview of experience and ideas from keynote speakers about management reference points in dynamic ecosystems, and provide basis for discussions about 3-5.
3. Discuss whether we need to consider changing management reference points, the conceptual change of fisheries management from single equilibrium assumption to multiple states assumption, and the implications to our definitions of fisheries status (e.g. healthy, endangered, etc.), collapse and recovery.
4. Discuss when we should change management reference points, the qualitative and quantitative evidence that needed to trigger the change, and the methodologies to test for such evidence.
5. Discuss how to change management reference points, the methodologies to implement the change, and the caveats and limitations of these methodologies.

Output: A workshop report on whether, when and how to change management reference points, which will help to inform planning in workshop Part 2.

Part 2: In-person workshop:
Date: TBD.

Location: Fisheries and Marine Institute of Memorial University, St. John's, NL, Canada

Participants: Invited national and international experts, government researchers and managers, industry stakeholders, Indigenous stakeholders.

Terms of reference (to be adjusted depending on workshop part 1):
1. Discuss whether, when and how to change management reference points in dynamic ecosystems from scientific perspectives.

2. Review current scientific knowledge and management practices of defining and implementing harvest strategies with reference points in drastically changing ecosystems using examples from around the world.
3. Identify potential research gaps for some key eastern Canadian fish stocks, and establish further research activities to fill these gaps.
4. Develop a general framework to guide individual fisheries to decide whether, when and how to change management reference points.

Output: A report and potential review paper about current management practices and recommended best practices on identifying management reference points in highly dynamic ecosystems.

Steering Committee: Fan Zhang (Memorial University of Newfoundland), Tyler Eddy (Memorial University of Newfoundland), Daniel Duplisea (Fisheries and Oceans Canada)

Registration: Free. Please contact Fan Zhang (fan.zhang@mi.mun.ca), Tyler Eddy (tyler.eddy@mi.mun.ca) or Daniel Duplisea (Daniel.Duplisea@dfo-mpo.gc.ca) to register for the workshop. To make the workshop more efficient and productive, participants are required to fill a survey to finish the registration.

References:

Holt, C.A. & Michielsens, C.G. (2019). Impacts of time-varying productivity on estimated stock-recruitment parameters and biological reference points. *Can. J. Fish. Aquat. Sci.*, 1–41.

Karp, M.A., Peterson, J.O., Lynch, P.D., Griffis, R.B., Adams, C.F., Arnold, W.S., *et al.* (2019). Accounting for shifting distributions and changing productivity in the development of scientific advice for fishery management. *ICES J. Mar. Sci.*, 76, 1305–1315.

Lotze, H.K., Tittensor, D.P., Bryndum-Buchholz, A., Eddy, T.D., Cheung, W.W.L., Galbraith, E.D., *et al.* (2019). Global ensemble projections reveal trophic amplification of ocean biomass declines with climate change. *Proc. Natl. Acad. Sci. U. S. A.*, 116, 12907–12912.

Punt, A.E., Teresa, A., Bond, N.A., Butterworth, D.S., Moor, C.L. De, Oliveira, A.A. De, *et al.* (2014). Fisheries management under climate and environmental uncertainty: control rules and performance simulation. *ICES J. Mar. Sci.*, 71, 2208–2220.

Rindorf, A., Cardinale, M., Shephard, S., De Oliveira, J.A.A., Hjorleifsson, E., Kempf, A., *et al.* (2017). Fishing for MSY: using “pretty good yield” ranges without impairing recruitment. *ICES J. Mar. Sci.*, 74, 525–534.