OFI/CANSSI Workshop on Spatial Modelling of Fishery Survey Data to Improve Stock Assessment

April 28-May 1, 2020
Department of Mathematics and Statistics
Dalhousie University
Halifax, Nova Scotia, Canada

Background:

Scientific research surveys of fisheries resources provide fundamental inputs to fish stock assessments (e.g. Kimura and Somerton, 2006). Time series of surveys provide information on how stock size and distribution, age and size structure, and body growth and maturation rates change over time. This is important information for assessing the status of a stock relative to past or reference values, and for projecting the consequences of future fishing on the stock. Longer time series usually produce a better assessment of the stock. In fact, Canada's Sustainable Fisheries Framework (https://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/precaution-eng.htm) indicates that as long a time series as possible should be used. Time series of summary statistics derived from these surveys are often used in stock assessment models. The summary statistics were traditionally derived using the sampling design-based approach, but increasingly spatial statistical models (e.g. Thorson, Stewart, and Punt, 2011; Thorson et al., 2015; Thorson and Ward, 2014; Nielsen et al., 2014; Ono et al., 2017; Thygesen et al., 2019), and model-assisted approaches (e.g. Chen, Thompson, and Wu, 2004) have been used to address various problems with purely design-based estimators. However, in the Canadian context, many problems and challenges remain.

Challenges:

1. Survey procedures invariably change over time because survey objectives change, equipment and vessels need to be replaced, etc. In the assessment of some Canadian fish stocks, historical surveys have been abandoned because they were not calibrated with current surveys. Also, if improper calibration was performed then there is a risk of confounding spatial and temporal differences in survey procedures with true variation in stock abundance.

2. Vessel breakdowns, scheduling conflicts, inclement weather and other factors routinely result in surveys that cannot be fully completed every year. Furthermore, existing bottom-contacting surveys are now being excluded from some newly created marine conservation areas, resulting in no sampling in previously monitored areas. When a survey does not cover the entire stock area there is a risk of confounding shifts in stock distribution with true changes in stock abundance.

3. In many important Canadian stock assessments (e.g. Atlantic cod), separate indices from several surveys with different spatial coverage are used to inform assessment models. The stock trends

indicated by these surveys often differ and the whole-stock (i.e. non-spatial) assessment models are ill-equipped to sort out these differences.

4. Some Canadian marine ecosystems are monitored by multiple broad-scale surveys over varying time periods, such as in the southern Gulf of St. Lawrence where three multi-species bottom-trawl surveys are undertaken annually (DFO research vessel, snow crab and Sentinel mobile surveys). Models that jointly consider data from multiple sources may result in increased precision of abundance estimates, which is of particular value for rare or spatially restricted species.

Purpose:

The purpose of this 4-day workshop is to review current scientific information regarding the challenges outlined above, and establish further research activities to address these challenges. The workshop will build new collaborations on existing and <u>new</u> research projects, and also introduce <u>new</u> case studies. It is anticipated that the workshop will generate scientific publications that describe proposed solutions.

Tentative Research Projects:

1) Survey indices of stock size and length composition for Witchflounder and redfish species in NAFO Divisions 2J3KL that adjust for incomplete and reduced survey coverage.
2) Extending survey indices for 3Ps cod to include historical surveys.
3) Combined survey indices and vessel effects for snow crab in the southern Gulf of St. Lawrence.
4) Combining DFO research vessel bottom trawl survey and fixed gear survey catches rates in the northern Gulf of St. Lawrence.
5) Spatiotemporal models of growth and reproduction rates, and age-length keys.

Participants can suggest additional case studies and projects for consideration by the steering committee.

Steering Committee: Joanna Mills Flemming (Dalhousie), Noel Cadigan (Marine Institute, MUN), Hugues Benoît (DFO).

Registration: contact [Noel Cadigan](#)
Attendance will be limited and will be confirmed by January 30, 2020.

Invited Speakers:

1. Kasper Kristensen, DTU AQUA. Denmark
2. Anders Nielsen, DTU AQUA. Denmark
3. James Thorson, Alaska Fisheries Science Center, NMFS. United States.
4. Sean Anderson, DFO. Canada.

Accommodations: A block booking (group name is 'OFI/CANSSI Workshop') at Atlantica Hotel Halifax, 1980 Robie Street, Halifax. Contact the reservation team at 1-888-810-7288 or at reservations@atlanticahalifax.com. Use that email and number to get the $135.00 plus taxes rate (with hot breakfast for 1). Onsite parking is available and the rate is $23.00 plus taxes per night.

References:

Chen, J., Thompson, M.E. and Wu, C., 2004. Estimation of fish abundance indices based on scientific research trawl surveys. *Biometrics*, *60*(1), pp.116-123.

Kimura, D.K. and Somerton, D.A., 2006. Review of statistical aspects of survey sampling for marine fisheries. Reviews in Fisheries Science, 14(3), pp.245-283.

Nielsen, J.R., Kristensen, K., Lewy, P. and Bastardie, F., 2014. A statistical model for estimation of fish density including correlation in size, space, time and between species from research survey data. *PLoS One*, *9*(6), p.e99151.

Ono, K., Ianelli, J.N., McGilliard, C.R. and Punt, A.E., 2017. Integrating data from multiple surveys and accounting for spatio-temporal correlation to index the abundance of juvenile Pacific halibut in Alaska. *ICES Journal of Marine Science*, *75*(2), pp.572-584.

Thorson, J. T., I. Stewart, and A. Punt. 2011. Accounting for fish shoals in single- and multi-species survey data using mixture distribution models. Canadian Journal of Fisheries and Aquatic Sciences 68:1681–1693.

Thorson, J.T., Ward, E.J., 2014. Accounting for vessel effects when standardizing catch rates from cooperative surveys. Fish. Res. 155, 168–176.

Thorson, J.T., Shelton, A.O., Ward, E.J., Skaug, H.J., 2015. Geostatistical delta-generalized linear mixed models improve precision for estimated abundance indices for West Coast groundfishes. ICES J. Mar. Sci. J. Cons. 72(5), 1297–131.

Thygesen, U.H., Kristensen, K., Jansen, T. and Beyer, J.E., 2019. Intercalibration of survey methods using paired fishing operations and log-Gaussian Cox processes. ICES Journal of Marine Science.