ICES CM 2015/A:19

A sustainability assessment framework for fish by-catch in New Zealand deepwater fisheries.

Marie-Julie Roux[1], Charles Edwards[1], Alistair Dunn[1], Malcolm Clark[1] and Ian Doonan[1]
[1]National Institute of Water and Atmospheric Research, 301 Evans Bay Parade, Greta Point, Wellington 6021, New Zealand.
Ian.Doonan@niwa.co.nz, Phone: +64 4 386 0825

Summary
New Zealand demersal trawl and line fisheries incidentally harvest more than a hundred non-target fish species on an annual basis. Until recently, the majority of by-catch species have been managed using qualitative indicators of status, without reference to estimates of productivity or exploitation rate. A semi-quantitative, spatially-explicit framework for sustainability risk assessment of fish by-catch is presently under development. The framework uses an impact/threshold approach to risk evaluation, whereby risk for a species is evaluated as the ratio of an impact level to a maximum impact sustainable threshold (MIST). The impact level is estimated using information on species distribution, fisheries overlap and catchability, whereas the MIST is derived from life history dependent productivity estimates. The framework implements an integrated approach that allows uncertainty in all components to be quantified and propagated through the assessment process. An important outcome is that both risk and uncertainty can be partitioned and distinguished among fishery sectors, allowing more focused management action. This paper will give an overview of conceptual framework design, including key components, structural assumptions and spatial considerations, with reference to data limitations and the information needs of fisheries managers.

Introduction
The assessment and management of fisheries effects on non-target species is a key component of ecosystem approaches to fisheries (Garcia et al. 2003). In practice however, such task is usually complicated by a lack of quantitative information and assessment tools. Risk analyses have developed in support of sustainability assessment of non-target species (Smith et al. 2007, Zhou et al. 2011). These include qualitative tools that consist in scoring and ranking a set of attributes based on expert knowledge and available information (e.g. Smith et al. 2007), and more sophisticated semi-quantitative tools that use an impact/threshold approach to risk estimation (e.g., Zhu et al. 2011). Risk assessment frameworks encourage data synthesis, help to improve the focus of empirical field studies, and serve to identify and prioritize fishery sectors for surveillance and management. In New Zealand (NZ), deepwater fisheries occur over multiple sectors, using multiple gear, and target multiple species at different phases of their life-cycles and over a broad range of habitats. This paper provides a conceptual overview of the semi-quantitative sustainability risk assessment framework that is being developed for evaluating fishing impacts on non-target fish species.

Materials and methods
The analytical framework is risk-based and spatially-explicit. Risk evaluation follows an impact/threshold approach, with methods ranging from semi-quantitative to fully quantitative (Bayesian) estimation, depending on species and data availability. Three types of bycatch species/data situations are distinguished for risk assessment: 1) species with both fisheries-dependent and fisheries-independent data; 2) species with fisheries-independent data but no fisheries data; and 3) rare species lacking fisheries-independent data, for which catch records exist in the fisheries data. The spatially-explicit framework has four spatial components: the management area, the survey or observations area(s), the species range within the management area, and the spatial distribution of fishing effort. Sustainability risk (R) is evaluated as the ratio of an impact (i.e. fishing) mortality, to a maximum impact

sustainable threshold (MIST), which is a limit reference point (Figure 1). Impact mortality is the ratio of total bycatch to a population size proxy. Total bycatch is estimated using gear efficiency (catchability) and species and fishery distribution information. An overlap parameter is estimated that relates species incidence with the occurrence and extent of fishing. The estimation and scaling of the overlap parameter differ among the species/data types described above, as do process equations for impact mortality estimation. MIST is estimated using Monte Carlo sampling of life history parameters distributions, with iterated solving of the Euler-Lotka equation (McAllister et al. 2001). This procedure serves to estimate a maximum intrinsic population growth rate (*r*), with uncertainty. MIST is set as a proportion of *r* which, depending on management objectives, can be more or less precautionary. Uncertainty in all parameters is quantified and propagated throughout the assessment process. Key structural assumptions include: i) single stocks and cumulative impacts; ii) rapid mixing and constant distributions; and iii) stable environment and equilibrium populations.

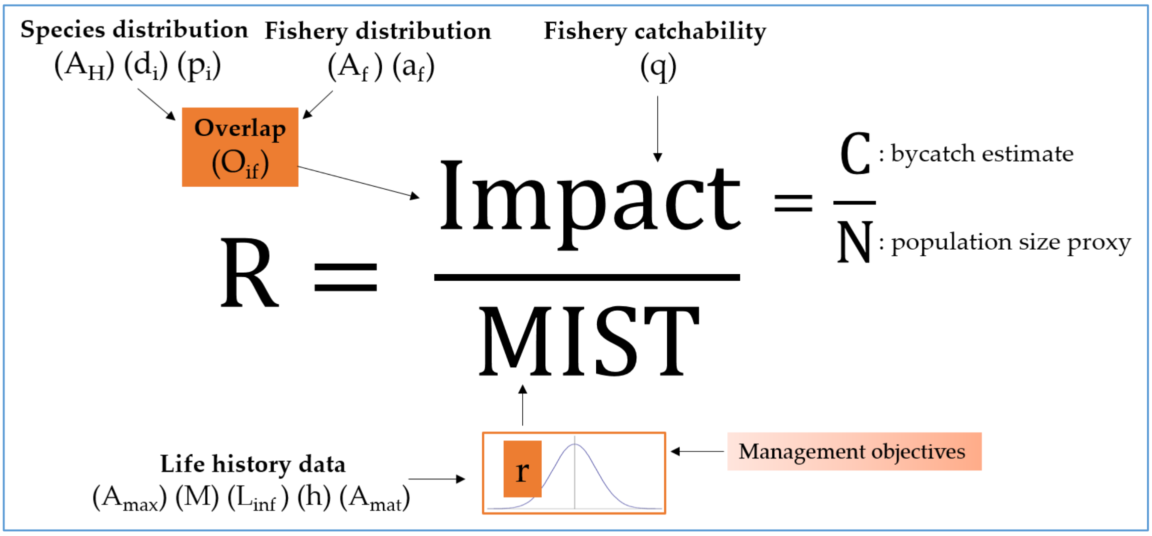

Figure 1. Components of sustainability risk (R) evaluation for non-target species. A_H= habitat area; d_i=species density; p_i=species probability of occurrence; A_f = fishery area; a_f=area fished; O_{if}=overlap between species and fishery distributions; A_{max}=maximum age; M=natural mortality; L_{inf}=asymptotic length; h=steepness; A_{mat}=age at maturity.

Results and Discussion

Preliminary testing and validation are currently being performed on selected bycatch species. The intent is to implement robust algorithms in a flexible framework that is applicable to a diverse range of bycatch species, and allows for incremental improvements as new data become available. The framework provides an instantaneous measure of stock status stating the probability that total impacts from fisheries over the assessment period (i.e. last 5 or 10 years) exceed the MIST. An important outcome is that both risk and uncertainty can be disaggregated among fishery sectors, allowing more focused management.

References

Garcia, S. M., Zerbi, A., Aliaume, C., Do Chi, T., and Laserre, G. 2003. The ecosystem approach to fisheries: issues, terminology, principles, institutional foundations, implementation and outlook. FAO Fisheries Technical Paper, 443. 71 pp

McAllister, M. K., E. K. Pikitch, and E. A. Babcock. 2001. Using demographic methods to construct Bayesian priors for the intrinsic rate of increase in the Schaefer model and implications for stock rebuilding. Canadian Journal of Fisheries and Aquatic Sciences **58**:1871-1890.

Smith, A.D.M., Fulton, E.A., Hobday, A.J., Smith, D.C., Shoulder, P. 2007. Scientific tools to support practical implementation of ecosystem based fisheries management. ICES Journal of Marine Science 64: 633–639.

Zhou S., Smith A.D.M. and Fuller, M. 2011. Quantitative ecological risk assessment for fishing effects on diverse data-poor non-target species in a multi-sector and multi-gear fishery. Fisheries Research 112: 168-178.