DEVELOPING REGIONAL BENCHMARKS FOR FISHERIES PRODUCTIVITY FOR NEARSHORE MARINE HABITATS

Figure 1. Fyke net sampling fish in an eelgrass bed. M.C. Wong, DFO.

Figure 2. Department of Fisheries and Oceans' (DFO) six administrative regions.

Context:

The Fisheries Act was amended in 2012 to include new provisions for fisheries protection which came into force in 2013. The amended Act focuses on managing threats to the sustainability and ongoing productivity of commercial, recreational or Aboriginal fisheries and contains a prohibition against serious harm to fish that are part of or support a commercial, recreational or Aboriginal fishery. Serious harm to fish is defined in the Act as the death of fish, the permanent alteration to, or destruction of, fish habitat. If serious harm to fish cannot be avoided, proponents of projects may apply for authorizations.

Although productivity is not part of determining whether serious harm to fish has occurred, Fisheries Protection Program (FPP) considers fisheries productivity, among other factors, when considering whether an authorization is appropriate (section 6, 6.1 of the Fisheries Act) [1].

Building on previous advice in freshwater ecosystems on the feasibility of using regional community and population productivity benchmarks (DFO 2016b), Ecosystems Management requested science advice on the feasibility of determining benchmarks of fish productivity in marine ecosystems, including relevant methodologies and spatial units of variability. This advice is necessary to understand regional variability in fish productivity across Canada. Once developed, regional productivity benchmarks are anticipated to be used in the following ways:

- *To provide estimates of regional productivity that can be used for understanding baselines for the purposes of impact assessment in the absence of site-specific data for small to medium impact projects.*

[1] More information on the Fisheries Protection provisions of the *Fisheries Act* can be found in the Fisheries Protection Policy Statement.

- *To provide estimates of regional productivity that can be used to defensibly estimate targets of potential gains in productivity expected from offsetting.*

Building on previous advice in freshwater ecosystems on the use of area per recruit (APR) metric in setting thresholds (DFO 2015), Fisheries and Oceans Canada (DFO) Ecosystems Management requested advice on marine relevant estimates of APR. Area per recruit (APR) is defined as follows: The area of nursery habitats required to produce one adult recruit with recruits defined as reproductively mature fish.

This Science Advisory Report is from the March 28-30, 2017 Science Advice on Marine Productivity Benchmarks meeting. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

SUMMARY

- The development of regional community-based benchmarks of fisheries productivity for nearshore marine habitats was considered feasible.
- Fisheries productivity is best expressed in terms of the total fish production of each species. Production potential is defined as the production from all age classes of a fish species that use a type of nearshore habitat at some point in their life cycle; this was considered a useful metric as a benchmark for fisheries productivity.
- Standing stock abundance or biomass of fish was recognized as a useful metric in freshwater habitats and will likely be useful in some circumstances for marine habitats.
- A model that estimates production per age class of individual species from estimates of density of at least one age class and knowledge of life history parameters was developed and its use was supported.
- Model outputs can be used to estimate total fish community production or the production of select species, and can evaluate the relative contributions of different habitats to fisheries productivity. Thus the model can estimate loss of productivity that might result from development projects that impact habitats or the potential gains from offsetting measures.
- Preliminary results from the Atlantic coast of Nova Scotia demonstrated differences in fish density and metrics of production among eelgrass, rockweed, and bare habitats. This supports the utility of stratification by habitat type.
- An evaluation of stratification at larger spatial scales was not possible due to shortcomings of datasets that were available. Thus, it was not possible to demonstrate the utility of regional stratification when estimating fisheries productivity.
- Area-per-recruit (APR) is a metric of the contribution of nursery habitat to adult fish production. It was determined that it is feasible to calculate APR for nearshore marine habitats, but more analyses are needed to evaluate the reliability of estimates.
- The utility of the regional benchmark approach is limited by the availability of information on the abundance, biomass and productivity of fish and invertebrates in marine nearshore and coastal habitats across the range of habitat types and regions. There is a need for spatially and temporally extensive monitoring programs that sample a diversity of habitats (with standardized protocols that include species-specific age or size determination) for the development of regional benchmarks.
- While deemed feasible there remains a number of uncertainties with respect to the usage of the benchmark approach in nearshore marine habitats. The potential for sampling protocols

to underestimate densities emphasizes the need to estimate capture probability for each sampling method and habitat type. The presence of depressed populations may also bias the results towards underestimating the habitat production potential.

INTRODUCTION

Nearshore marine habitats are found within the coastal zone (see Glossary of Terms for definitions) and are areas where most shore-based development activities can be expected to impact fish and fish habitat. Such nearshore habitats (including estuaries) can be particularly important for fisheries productivity as they often serve as nursery areas for larval and juvenile fish.

Benchmarks of fisheries productivity can serve a number of useful roles in the management of nearshore habitats. These include:

- Serving as information that could be used by both proponents and regulators in planning exercises.
- Informing the assessment of impacts to habitat from development projects when site-specific data are not available or the information available is insufficient.
- Providing estimates of potential productivity from offsetting activities, including the determination of equivalency among habitats of different types.

If habitats and species are not unduly impacted by human activities, habitat type-specific estimates of productivity can serve as information on the “reference condition”, providing estimates of the productive capacity that might be expected for that habitat. This can be equated to the carrying capacity (DFO 2016a). Differences between the reference benchmarks and those observed can be used to make inferences about habitat or population status.

The precision of benchmarks can potentially be increased by stratification of the data that can occur at a variety of spatial scales, from individual habitats to large ecoprovinces (DFO 2016b). The utility of stratification is revealed through an analysis of the components of variation of productivity metrics.

Recently, the potential to develop regional productivity benchmarks for freshwater habitats was considered (DFO 2016a). An extensive set of stream electrofishing data were compiled from wadable streams across Canada, and density, biomass and production were computed for fish living in those streams. The analysis showed that regional differences existed that were partly due to variation in temperature, and were likely also affected by stream productivity (nutrients) and other factors.

It was concluded that the regional benchmarks for stream fish communities were feasible to develop although it was noted there remained considerable variation in metrics among sites and streams that will limit drawing precise values for a particular benchmark.

ANALYSIS

Research documents reviewed

Production foregone model

Wong and Dowd[2] developed a method to estimate the productivity that results from fish found in nearshore habitats. These are the habitats that are often used by juvenile (e.g., Age-0) stages. The method uses field-based estimates of density of a life stage found in nearshore habitats, and projects abundance and production through all age classes based on known or literature-based estimates of growth and survival for each species. The model yields estimates of abundance, biomass and production per age class, which were used to develop three metrics:

1. Production potential, the lifetime production of fish biomass that results from fish found in the nearshore habitat.
2. Equivalent adults, the number of adult fish expected from fish in nearshore habitats.
3. Area per recruit, the nursery habitat area predicted to be required to produce one recruit to the adult population.

These metrics can be summarized for individual species, groups of species, or the whole fish community.

Field data required for this approach can also be used to estimate standing stock density and biomass of fish present in the habitat during sampling. These metrics are comparable to those also used in the analysis of freshwater productivity benchmarks (DFO 2016a).

The approach is based on a common modelling approach for age-structured populations that uses the Leslie matrix. Estimates of growth, age at maturity, total lifespan, survival and the density of at least one age class in sampled habitats are required as inputs and the model predicts the expected adult cohort per unit area of sampled habitat. Methods are described to incorporate the uncertainty associated with both field-based density estimates and life history parameters.

The model requires unbiased estimates of density for the target habitat types. This means that field-based catch data needs to be calibrated for capture probability using methods appropriate for that sampling technique. This is particularly important for comparisons of fisheries production across habitat types if the capture probability varies by habitat type or if different sampling gears are used at different sites.

To illustrate the method, data collected from eelgrass, rockweed, and unstructured benthic habitats located along the Atlantic coast of Nova Scotia were used for a worked example (Table 1). The summary shows that it is feasible to calculate the metrics for different habitat types and groups of species. There are consistent differences in metrics among habitat types with generally greater production coming from habitats with macrophytes compared to sites without. However the differences depend on the metrics used and the suite of fish species included in the calculations. Uncertainty in the metrics is significant, and the result of both variability in the field sampling data and uncertainty in model inputs.

[2]Wong, M.C. and Dowd, M. 2017. Towards regional benchmarks of fish productivity in nearshore marine ecosystems: model framework, habitat comparisons, and examination of regional data.

Table 1. Density (m^{-2}, SE shown) of fish found in nearshore habitats and the total expected lifetime production (g WW m^{-2} y^{-1}; WW: wet weight), and number of equivalent adults (number m^{-2}) expected from each square metre of nearshore habitat. Equivalent adults are calculated as the sum of the number of mature adults across the entire lifespan of the fish. Estimates are provided per m^2 of eelgrass (Zostera marina), rockweed (Ascophyllum nodosum) and associated bare sediment habitats. Production potential and equivalent adults are median values from Monte Carlo simulations, followed by the 60% credible interval in brackets. Commercial, recreational, and aboriginal (CRA) fishery species include rock crab, Jonah crab, lobster, eel, silverside, tomcod, pollock, winter flounder, white hake, smelt, mackerel, herring, and cod.

Habitat Type	Species	Density	Production potential	Equivalent adults
Eelgrass	All	12.6 (1.5)	155 (58-420)	10 (7-14)
-	CRA	0.33 (0.06)	83 (31-228)	0.4 (0.3-0.8)
Bare sediment (adjacent to eelgrass)	All	4.8 (1.5)	154 (47-522)	27 (19-40)
-	CRA	0.33 (0.30)	17 (4-76)	0.4 (0.2-0.8)
Rockweed	All	0.53 (0.09)	50 (16-157)	5.7 (1.9-24)
-	CRA	0.09 (0.02)	13 (5-35)	0.20 (0.05-0.87)
Bare sediment (within rockweed)	All	0.06 (0.01)	21 (7-58)	1.3(1.0-1.7)
-	CRA	0.001 (0.0001)	0.8 (0.3-2.2)	0.003 (0.001-0.006)

The model was also used to develop area-per-recruit (APR) estimates for species found in nearshore habitats. APR is defined as the area of nursery habitat required to produce one adult fish that can recruit to the adult population each year (DFO 2015). For commercial, recreational, and aboriginal fishery (CRA) species APR estimates span a wide range of values from less than 100 m^2 for abundant species in preferred habitats to very high values (>10 000 m^2) for rare species such as mackerel. High values can occur for species that are naturally rare, prefer other habitats than the ones sampled, or are depleted by fishing or other causes.

In addition, several large datasets on nearshore fish community composition for the Southern Gulf of Saint Lawrence were examined for potential utility in the model. It was hoped that these datasets would provide a larger spatial scale for the evaluation of the potential benefits of using a regional stratification to obtain more precise benchmark estimates. However, the datasets were not sufficient for estimating production because of the lack of size or age information, so analysis of regional stratification was not possible. Further work is needed on these data to determine if missing age data can be replaced by surrogate information for age so that the data can be used in the model. Some modification of data collection protocols is needed to ensure future surveys collect appropriate information for the computation of habitat-based production estimates.

Nursery areas in Newfoundland

Gregory et al.[3] summarized long-term research on the production of juvenile fish in coastal areas of Newfoundland and comment on the potential to use this information for the development of regional benchmarks of fisheries productivity. Their work was directed towards understanding processes that affect the juvenile stages of Atlantic cod, including the effect of different habitat types on rates of settlement, growth and survival. In support of their work, ongoing research on the role of predation on the distribution of cod in and around eelgrass beds was also presented. Results showed that cod recruitment could be predicted by the abundance of Age-1 cod in eelgrass beds, highlighting the importance of this habitat to determining year class strength. Experimental removals of eelgrass resulted in a decrease in the abundance of those species that preferred eelgrass habitats as juveniles. Detailed telemetry studies showed that juvenile cod use eelgrass as cover from predation as predators are generally located around the edges of eelgrass beds and in deeper water.

In addition to cod, information on the abundance and biomass of other species are being collected in a form that appears to be suitable for use in the Wong and Dowd approach. Although production estimates were not attempted it appeared as if it was feasible to do so. The existing work has a limited spatial scale but could easily be expanded if greater coverage of the region is desired. Comparisons among two habitat types (eelgrass/non eelgrass) are feasible with data currently available.

Advice on Objectives

Is it feasible to use estimates of fisheries productivity in marine ecosystems to develop benchmarks relevant to evaluate project impacts and offsetting?

Fundamentally it was considered feasible to estimate fisheries productivity in marine ecosystems. Estimating the loss of fisheries productivity, either as numbers of fish or production is consistent with earlier advice on metrics suitable for use in freshwater environments (DFO 2016a).

This advice focussed primarily on nearshore marine habitats as these are where most development-related impacts on fish and fish habitat are expected to occur. For many species, nearshore habitats are only used for a small part of the life cycle as most stages and much of the production occurs in deeper habitats elsewhere. Thus, it is important to consider the implications of impacts to nearshore habitats to fisheries productivity over the whole life cycle. This is a fundamental difference between freshwater and marine habitats, as in many freshwater ecosystems all life stages are found within impacted habitats and approaches based on resident species can be used to estimate abundance, biomass or productivity benchmarks. An approach similar to that reviewed here may be needed to evaluate the contributions of habitats that are used by migratory freshwater species.

Regional benchmarks are estimates of the productivity of properly functioning habitats at their carrying capacity and can guide what can be reasonably expected from such habitats. Care must be taken to ensure data used to estimate benchmarks are not from habitats that are significantly degraded from activities such as industrial use or affected by pollution. There was also considerable discussion about the effects of depleted commercial fish species on

[3] Gregory, R.S., Laurel, B.J., Cote, D., Newton, B.H., Dalley, K.L., Sargeant P.S., Snelgrove, P.V.R., Clarke, K.D., and Wong, M.C. 2016. Fish production metrics from a nursery area in the marine coastal zone of Newfoundland.

nearshore fish communities, and how sampling those communities may underestimate the potential production from habitats if key species have been depleted by commercial fishing. It was also recognized that a single “snapshot” of the fish community in a limited number of locations is less preferred to benchmarks based on more comprehensive and longer duration sampling that will be less vulnerable to short-term localized fluctuations in fish community structure and abundance.

What approaches and methodologies would be appropriate to determine fish productivity in marine ecosystems?

A broad suite of metrics have been suggested as potentially useful as indicators of fisheries productivity (DFO 2014) and these can be used as regional benchmarks. An important application of benchmarks may be during the process of establishing offsetting requirements. In many cases the choice of metrics will depend on the equivalency calculation being used to determine potential offsetting requirements.

Where like-for-like habitat replacement is proposed to offset project impacts, simple measures such as habitat area and measures of habitat function may be sufficient. In this case fish community composition, abundance and biomass in the affected habitat can be used to characterize the impact and similar data can be used to establish reference conditions for offsetting. For these situations benchmarks based on the estimated abundance, biomass or productivity of fish species in the habitat are appropriate. Standard field methods are available to determine the density, size and age of fish in the habitat, and production can be estimated directly, or indirectly based on allometric relations using body size. This was the approach taken for evaluating benchmarks in freshwater environments (DFO 2016a).

Production estimates may be required in cases where the community composition, or growth and survival may be expected to change as a result of the creation of offsetting habitats. For many marine species nearshore habitats may only be used for a short, albeit critical, period during the juvenile stage. Most of the growth and production occurs in other habitats, often those that are deeper and offshore. Metrics such as in situ biomass and production will underestimate the contribution that these nursery habitats play in fisheries productivity. For this reason methods that estimate abundance, biomass and production through to the adult age classes are used to evaluate the contribution and importance of nursery habitats to fisheries productivity.

The method of Wong and Dowd is an adaptation of previously developed approaches to estimate production foregone as a result of fish mortality or impacts to habitat. Sampled densities of fish in nearshore habitats are assumed to be representative of that habitat type and the method projects the production from those fish through their lifespan. Benchmarks based on this approach will be robust if the density estimates are unbiased (i.e. corrected for capture probability and other sampling issues) and replicated in space and time so that average species composition and density can be estimated. Adjustments may need to be made if the habitats are degraded, or if the fish populations are known to be depleted by factors outside of the nursery habitat such as environmental effects or fishing on subsequent life stages.

Estimates of age, growth and survival are required for the Wong and Dowd model; where possible, population specific parameter estimates will yield the most accurate predictions. However, if unavailable, Wong and Dowd enlist various allometric relations and data from FishBase to obtain required parameters. Detailed field studies, such as those presented at the meeting from Newfoundland can yield site-specific survival and growth rates will reduce the reliance on predicted or extrapolated inputs to the model.

Applying the production potential calculations to all species found in nursery habitats yields a complete estimate of the biological production expected from those fish. However, for management applications it may be desirable to focus on certain species such as those that are part of fisheries, or to be consistent with regional fishery management priorities. These calculations are straightforward as the model calculates production for each species, which can then be summed over groups of species.

The model is conservative in that it assumes that the habitats that fish are found in at the time of sampling are essential for the completion of the life cycle and that the loss of that habitat results in a proportional loss of adult production. Thus it is assumed that there are no alternative habitats that could be used, and there are no compensatory processes that could mitigate the loss of habitat. These are defensible assumptions in the absence of alternative information.

What are the representative habitats or spatial units within which fish productivity can be evaluated, and how do they compare?

The precision of regional benchmarks can be improved if there are consistent differences in metrics among habitat types, and among habitat types across regions; those differences can form the basis for stratification of benchmark information.

Data presented at the meeting suggests there are differences in metric values among habitat types for sampled areas along the Atlantic coast of Nova Scotia (largely defined by structure provided by macrophytes and substrate). Habitat type also varies in the role that it serves in the life history of CRA fish species and those species that support CRA species and consideration of habitat preferences will be an important part in determining or evaluating the overall productive value of the habitat being assessed.The data presented from Newfoundland suggest comparisons among regions should be possible with further analysis.

A hierarchical multi-level classification scheme for the marine environment has been developed by DFO (DFO 2016b) that can inform an analysis of regional benchmarks for the current application. Level 4 biophysical units (100-1000s km) can form the basis of a regional stratification, and Level 6 (“biotopes”) and 7 (“biological facies”) are similar to the habitat types that were used in the examples reviewed here.

To determine whether it is useful to establish regional benchmarks, consistent sampling of nearshore areas across a broad geographic range is required. Some datasets that approach an appropriate spatial scale are available for Atlantic Canada, but shortcomings with respect to the data were identified. These shortcomings prevented an assessment of regional patterns in productivity. Data may also be available for the Pacific Coast but they were not available for the meeting.

The sampling needed to generate benchmarks is within the realm of standard monitoring protocols that can be undertaken as part of citizen science programs or standard environmental monitoring efforts. The key technical issue to resolve is the development of capture probability estimates by gear and habitat type for the computation of density estimates. It will also be important to ensure the appropriate level of taxonomic expertise is available and that fish size, a measure not always recorded by monitoring programs, is determined. Fish size can often be used as a surrogate for age for younger age classes.

Is it feasible to use an area per recruit approach as a common metric for discussing impacts to habitat quantity and/or quality on Canadian marine fish?

Area-per-recruit (APR) is a metric designed primarily as a communication tool to assist decision making with respect to small-scale habitat impacts. The information needed to compute APR is the density of fish in the nursery habitat, and the expected survival for the juvenile to recruit stage. These values are also required for application of the Wong and Dowd model and so calculating APR for species sampled in nearshore habitats is straightforward.

APR was originally developed for freshwater species and estimates collated for individual species that were often the most common species of recreational or commercial value in the lake or river. A similar approach could be used in marine habitats and this may be appropriate for situations where there is a dominant species or a species of particular management interest.

A multi-species APR is also possible to compute, and might be more relevant for habitats that are nursery habitats for a number of important species. In these cases APR values will be smaller.

In summary, it was concluded that it is possible to compute APR values for marine species using data collected for the benchmarks analysis. A comparison of values obtained for marine species to those of lakes and rivers may provide useful guidance for the application of this metric (DFO 2015).

Sources of Uncertainty

A method for including uncertainty in fish density data and input parameters was developed for the Wong and Dowd model and is a strength of their approach. A variety of statistical methods can be used to summarize the field data depending on the sampling design that was employed. The proof-of-concept information reviewed at the meeting was based on data from relatively few habitat types and a limited spatial scale and the uncertainty in estimates was significant. It is expected that uncertainty bounds may be reduced with data from more locations, and additional stratification, if appropriate.

The appropriateness of sampling techniques and the challenge of estimating capture probability for species or groups of species requires more analyses. It was noted that the gear used in the current study may underrepresent or not sample some taxa such as clams or other invertebrates.

Many of the survival and growth parameters required for the Wong and Dowd approach were drawn from species summaries or predictive allometric relations. For commercial species, population-specific estimates of some parameters may be available from stock assessments. The use of local values may reduce some of the uncertainty that results from species-level parameters.

There is a risk that some habitats may be undervalued if the species that use them have been depleted by fishing or other offshore factors. Similarly, some species may only use certain habitats for short periods, and may not be captured if sampling only occurs once per season. Some judgment may be required to determine if fish sampling data are sufficient to provide a representative estimate of the potential fisheries production from those sites.

CONCLUSIONS AND ADVICE

The development of benchmarks of fisheries productivity for marine environments was considered feasible. The modelling approach that projects potential production resulting from fish found in nearshore habitats is a useful approach to evaluate the full contribution of nearshore habitats on fisheries productivity.

Although the focus of this review was on three types of nearshore marine habitats, the method can be applied to any habitat type. It could equally be used for other shallow water nursery areas such as estuaries or the shores of large lakes.

The application of the benchmarks approach is limited by the availability of standardized fish density data for nearshore habitats across a large spatial scale. Adaptation of existing datasets, modification of existing programs or the development of new sampling programs will all contribute to the data needed to implement the benchmark approach. Given the extensive nature of some existing datasets there is value in attempting to overcome some of the identified shortcomings so that these data can be used in the model.

Additional analysis of metrics and potential corroboration with alternative approaches to estimating productivity will enhance the reliability of benchmarks estimated by the proposed approach.

OTHER CONSIDERATIONS

This feasibility analysis is based on relatively limited data from a small number of habitats. Additional sampling with a standardized protocol is needed to establish the likely precision of benchmarks and the need for stratification. Sampling of other habitat types is needed to broaden the applicability of the results.

The approaches that were considered are appropriate for habitat-based impacts. For projects that cause mortality, the original production foregone or equivalent adult approaches are appropriate for evaluating the loss of adult fish from an activity that causes mortality of younger life stages.

Benchmarks are appropriate for nearshore nursery areas, but are not designed to assess impacts to specialized habitats such as spawning areas or migratory corridors.

Both fish communities and habitat productivity are expected to change with climate change. Benchmarks may have to be reevaluated at regular intervals if changes in environmental conditions occur.

SOURCES OF INFORMATION

This Science Advisory Report is from the March 28-30, 2017 Science Advice on Marine Productivity Benchmarks meeting. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

DFO. 2014. A science-based framework for assessing changes in productivity, within the context of the amended *Fisheries Act.* DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/071.

DFO 2015. Science guidance for fisheries protection policy: advice on equivalent adult calculation. Can. Sci. Adv. Sec. Sci. Advis. Rep. 2015/011.

DFO 2016a. Science advice on regional productivity benchmarks. Can. Sci. Adv. Sec. Sci. Advis. Rep. 2016/053.

DFO 2016b. Evaluation of Hierarchical Marine Ecological Classification Systems for Pacific and Maritimes Regions. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2016/003.

GLOSSARY OF TERMS

- Bare habitats: unstructured areas that do not have aquatic macrophytes, or rocky or biogenic features that provide cover and structure.
- Biomass: Mass of all individuals in a unit area at any given time.
- Community: a site-specific assemblage of organisms.

- Fish: in the *Fisheries Act*, including fish and shellfish, crustaceans, and marine animals.
- Fisheries productivity: the sustained yield of all component populations available to support fisheries (including forage fish).
- Fisheries production: the sum of fish production in a given habitat).
- Habitat area: areas or patches of habitat with similar physical or biological attributes (structure provided by macrophytes and substrate). For this SAR, habitats types were defined by the presence of eelgrass, rockweed or proximal/vicinity bare sediment patches.
- Habitat unit: small patches of habitat defined by the dominant habitat type. This is equivalent to levels 6 and 7 of DFOs marine ecological classification scheme (DFO 2016b).
- Nekton: organisms that can actively swim in the water column.
- Nearshore habitats: shallow habitats within the photic zone that can be sampled with shore- or small-boat based methods and are likely to be impacted by shore-based development projects.
- Coastal habitat: habitat < 50m deep as in DFO (2016b).
- Production*:* total elaboration of fish tissue during a unit of time (often 1 year) regardless of whether fish survives the whole time interval.
- Production potential*:* expected production over all age classes of an individual fish species.
- Regional: in this context refers to the spatial stratification of marine areas at scales larger than local habitat units.
- Standing stock: refers to the density or biomass of fish present in a habitat type, as estimated by a quantitative sampling program.

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