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Proceedings of the National Peer Review Meeting of the Monitoring Design and Metrics to Assess the Effectiveness of Habitat Compensation Activities

December 6-8, 2011
Ottawa, ON

Chairpersons: Karen Smokorowski and Roger Wysocki
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Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

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SUMMARY

The Habitat Management (HM) program, has requested advice on developing cost-effective and science-based data collection standards for monitoring programs required as part of habitat compensation plans in order to determine the effectiveness of habitat compensation projects. The HM Program is also seeking advice on appropriate habitat indicators to determine ecosystem health in systems with significant human activity. These indicators will contribute toward future reporting on the state/condition of fish habitat in Canada.

The program seeks to know what type of habitat compensations projects have been effective at achieving their objectives and what has been learned on efficient and scientifically-defensible methods to monitor effectiveness of habitat compensation projects. To effectively manage and report on fish habitat at the ecosystem scale, a comprehensive suite of indicators is required. Reporting on ecosystem status requires a consolidation of the interactions among both biotic and abiotic components, and their functional processes. Fish habitat includes all the environmental (i.e. biological/physical/chemical) conditions within which an organism, population, or community exists.

The meeting was held December 6-8, 2011, in Ottawa ON. Participants included staff from various sectors as well as external experts. A Science Advisory Report (DFO. 2012. Assessing the Effectiveness of Fish Habitat Compensation Activities in Canada: Monitoring Design and Metrics. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/060) was prepared following the meeting.

SOMMAIRE

Les responsables du Programme de gestion de l'habitat (PGH) ont demandé un avis relativement à l'élaboration de normes pour une collecte de données qui soit économique et basée sur la science pour les programmes de surveillance qui sont nécessaires dans le cadre des plans de compensation afin de déterminer l'efficacité des projets de compensation de l'habitat du poisson. Un avis est également demandé sur les indicateurs d'habitat appropriés en vue de déterminer la santé de l'écosystème dans les systèmes où il y a une activité humaine importante. Ces indicateurs serviront à la préparation des futurs rapports sur l'état ou la condition de l'habitat du poisson au Canada.

Les éléments par rapport auxquels des informations supplémentaires sont demandées sont les types de projets de compensation de l'habitat qui ont atteint leurs objectifs efficacement et ce qui a été retenu des méthodes efficaces et justifiables du point de vue scientifique pour surveiller l'efficacité des projets de compensation de l'habitat. Afin de bien assurer la gestion et la production des rapports sur l'habitat du poisson à l'échelle de l'écosystème, il est nécessaire de disposer d'un ensemble complet d'indicateurs. La préparation des rapports sur l'état des écosystèmes nécessite la clarification des interactions entre les composants biotiques et abiotiques, ainsi que leurs processus fonctionnels. L'habitat du poisson englobe toutes les conditions environnementales (c.-à-d., biologiques, physiques et chimiques) dans lesquelles évolue un organisme, une population ou une communauté.

La réunion a eu lieu du 6 au 8 décembre 2011 à Ottawa, en Ontario. Parmi les participants, on comptait des membres du personnel de différents secteurs ainsi que des experts externes. Un avis scientifique (MPO. 2012. Évaluation de l'efficacité des activités de compensation de l'habitat du poisson au Canada : conception de la surveillance et paramètres. Secr. can. de consult. sci. du MPO. Avis sci. 2012/060) a été préparé à la suite de la réunion.

OVERVIEW PRESENTATION: SCIENCE SUPPORT REQUIRED FOR HABITAT MANAGEMENT (NICK WINFIELD)

The Director of Program Policy provided some introductory context regarding the nature of their operational request, and why scientific support would be required.

It was asked how flexible do you expect a management program to be? The question should rather be, how rigid should the program be (we have no way to justify the costs)? Industry seeks scientifically defensible and nationally standardized processes. Any national program examining compensation monitoring will need to be more consistent and disciplined to ensure that a common standard is applied to all projects.

The objectives have been identified to the proponents in some cases, but the methods have not (e.g. consultants are often retained to develop the compensation monitoring methodologies), which can result in increased costs to proponents.

The distinction was made between NNL (no net loss) in fish habitat and fish production – what is the distinction? If habitat is managed properly, the assumption would be that fish production would be de facto increased? If dealing with NNL properly, should always increase fish production.

The point was raised whether ecosystem impact offsetting policies could be considered as a replacement for NNL. This may be possible, but it would have to link to fish production and conservation. It was noted that a net gain of habitat is not achievable without funding. There was also discussion about the limits of fish mortality, and associated decision points. It was recognized that although the Department considers the impacts of habitat loss, these must be assessed within the scope of the associated fisheries, and that management objectives are intended to address this.

There was a question regarding the policy definition of fish productive capacity and its theoretical maximum and associated success criteria: if there are no pre-specified objectives for maximum capacity, the management decision may be problematic. In the end, it was clearly recognized that there is a need to link fish production with productive capacity.

There was a question regarding Section 35 authorizations: some are very specific but perhaps there would be benefit in a more general approach. It was noted that an ecosystem-based approach may alleviate the need to examine all small projects. It was noted that the spatial scale of authorizations was quite variable and as such site-level monitoring and metrics don't necessarily lend themselves to the larger scale projects.

It was recognized that habitat classification framework may be useful for managers. This is a very important issue, as the Department should examine sites/successes based on a standardized approach.

Finally, the importance of resilience of fish habitat and fish populations was recognized, along with defining the data needs to answer the scientific question at hand.

PRESENTATION A1: THE ROLE OF MODELING IN EFFECTIVENESS MONITORING: A CASE FOR ADAPTIVE HABITAT MANAGEMENT (SE. DOKA, CK. MINNS)

ABSTRACT

The central question of effectiveness monitoring is 'is the approved compensation adequate or effective as a replacement for the net loss of habitat or productive capacity'? At a minimum this question can be answered using basic 'snapshot' information at the site level but given the dynamic nature of physical systems and the fish populations that use them there are important temporal and spatial considerations. These considerations apply equally to the models and the monitoring that may be used to assess change. Model tools and approaches have been developed to assess fish habitat in the context of fish habitat management plans for coastal areas of the Great Lakes (e.g. Areas of Concern). Both site and regional scale assessments have used monitoring and prior knowledge of spatial habitat information and fish-habitat associations to model spatial and temporal changes in the quality and quantity of fish habitat. Key population biomass and abundances have been projected based on modeled habitat supply changes. The scenario results can be used to determine whether compensation, remediation, and restoration efforts would be effective in meeting habitat and population management targets. Coupled with effectiveness monitoring we can assess whether those projected changes are supported by field observations and also use that information to subsequently improve models. Case studies will highlight how monitoring, tool development, and area-based management are being used at different scales. These examples show how models can inform effectiveness monitoring and how monitoring data can improve tools, and thus improve decision-making in an iterative and adaptive way.

DISCUSSION

Can we include a brief paragraph describing the general nature of each research project (likely available from the Abstract).

A participant asked if fish production was matched to predictions – e.g., how much of this work has been done? The author replied that this work is preliminary, but there is promise for model validation and monitoring.

A participant asked if inventory information was gathered as part of this project? The author replied that they do a gap analysis to determine what is missing before they collect any data themselves. Projects can range from spatially intensive to less so.

It was noted that information could be added to improve the precision of the models. It was also noted that Science advice may be modified in terms of post-construction phase. Assessment tools help to inform monitoring and effectiveness analysis.

In terms of the model results presented, it was asked if they can determine what the allowable habitat damage would be? The author replied that yes, but this was a very specific threshold they were asked to examine. It was noted that we have to be cautious if we based decision rules on statistics.

PRESENTATION A3: OPPORTUNITIES FOR IMPROVING AQUATIC RESTORATION SCIENCE AND MONITORING THROUGH THE USE OF ELECTRONIC TAGGING TECHNOLOGY (LAPOINTE, N. W. R., THIEM, J. D., DOKA, S. E., AND COOKE, S. J.)

ABSTRACT

Fundamental to the conservation and management of aquatic resources and biodiversity is the need to protect habitat quality and quantity in terms of both structure and function. Knowledge of critical habitat needs of aquatic organisms and an understanding of the connectivity of the habitat mosaic has benefited from research using a variety of electronic tagging approaches. Electronic tagging includes a range of technologies including radio, acoustic and passive integrated transponder tags and tracking systems and enable the study of macro- and micro-scale habitat use/preference, movement among habitat units, and environmental associations. Given that many aquatic habitats have been altered as a result of human activities and extreme environmental events, habitat improvement activities are often undertaken to restore degraded habitat and/or increase the productivity of existing habitat. Monitoring effectiveness of habitat restoration activities (including rehabilitation, creation, etc) is regarded as a critical component of restoration science, although monitoring is often inadequately resourced or foregone altogether based on the assumption that “if you build it they will come”. Electronic tagging studies have much to offer restoration science in that they serve as an objective tool for understanding how animals respond to physical habitat improvements. Although there are some accounts of using electronic tagging for that purpose, the examples are still relatively scarce. Here, we review how electronic tagging studies have been used to inform and evaluate aquatic improvement activities. We also discuss the potential of this suite of technologies and outline why we believe that electronic tagging has the potential to enhance the science of aquatic restoration. Specifically, use of electronic tags as well as related sensors (e.g., temperature, depth, dissolved oxygen, respiration, activity levels) can reveal not only where animals are located, but also elucidate why habitats are used and determine the associated costs or benefits of doing so. Moreover, given that electronic tags enable year- round monitoring, including under ice, there is great potential to better understand habitat restoration effectiveness across multiple seasons and life- history phases, and to do so without having to repeatedly sample, handle or disturb animals.

DISCUSSION

It was noted that PIT tags don’t work in the marine environment very well (although they do work in estuaries). However, there are existing marine networks for data collection (e.g. Oceans Tracking Network OTN) from which researchers could benefit.

It was asked if there were studies examining the relationships between fish and, for example, wave energy platforms (etc.)? The author replied that yes, there was recently a study released by the National Oceanographic and Atmospheric Administration (NOAA) on this topic.

It was clarified that the author suggested the use of telemetry to explain the response of an indicator (not as an indicator itself). Tagging can contribute to studies of parameters such as mortality rates.

PRESENTATION B1: ASSESSMENT OF MEASURES TO ASSESS COMPENSATION AND MITIGATION AS RELATED TO THE CREATION, REHABILITATION, OR RESTORATION OF SPAWNING HABITAT FOR FLUVIAL OR LACUSTRINE SPAWNING SALMONINES (JOHN D. FITZSIMONS)

ABSTRACT

Not provided.

DISCUSSION

No substantive discussion or questions.

PRESENTATION B2: THE EFFECTS OF COOL AND VARIABLE TEMPERATURES ON THE HATCH DATE, GROWTH AND OVERWINTER MORTALITY OF A WARMWATER FISH IN SMALL COASTAL EMBAYMENTS OF LAKE ONTARIO (SHIDAN C. MURPHY, NICHOLAS C. COLLINS, SUSAN E. DOKA)

ABSTRACT

Small coastal embayments (< 32 ha) have been and will continue to be constructed in the Great Lakes. However, little is known about the ecology of warmwater fish in these embayments where temperatures are lowered by exchange with colder waters of the adjacent lake. Using pumpkinseed (*Lepomis gibbous*) as a model warmwater fish, we compare hatch dates and overwinter survival in two embayments with higher and lower amounts of cold-water input from Lake Ontario, and a warmer and cooler year. In 2007, the embayments differed by approximately 2-5°C until late-July. The temperatures in the cooler embayment delayed hatching times (July 18 – August 20) and almost all offspring were likely too small to survive the winter. In 2008 both embayments had similar temperatures. In that year, pumpkinseed hatched starting in early-June, and most offspring were likely large enough to survive the winter. The findings from the two intensively sampled embayments are confirmed with a 21-year fish monitoring dataset; adult pumpkinseed were captured in the littoral zone of warm embayments 6-8 weeks earlier than in cooler embayments. Relative to pumpkinseed in the small inland lakes of eastern and central Ontario, spawning is delayed by at least two weeks in coastal embayments. Using water temperatures to predict growth rates, we calculate that only 5 of the 17 embayments for which we have temperature records are able to consistently produce successfully overwintering age-0 fish. Nevertheless, we find pumpkinseed age >1 in embayments too cold to produce age-0 pumpkinseed suggesting immigration from warmer embayments.

DISCUSSION

It was asked if the authors take fetch into consideration? Yes, they did, in terms of determining embayment temperature; authors were surprised to learn that fetch did not influence the embayment temperature.

It was asked if the authors might expect different results depending on upwelling/downwelling conditions? The author replied that, no matter what the conditions, the exposed shoreline will still be colder.

It was asked if there is a hydrologic model that might have predicted these results? The author replied that, yes, this information was available and could have been taken into account (but was not) when designing the embayments.

It was asked if this has led to the designers changing their approach? The author replied that perhaps this will contribute to future plans; there is a need to invest in science ahead of time instead of creating questions post hoc.

It was asked if there were any water quality issues in embayments that were highly cut off from lake? The author replied that yes, there were some exposed to cormorant colonies and sediment contamination (but this was not explicitly examined).

It was noted that studies such as this will help to determine the likelihood of site success at the pre-development stage.

DAY 1 GENERAL DISCUSSION:

- There was discussion regarding how each presentation met each of the six questions outlined in the Terms of reference.
- The Chairs created a list of recommendations for each author to contribute to.
- The Chairs presented a draft Table of Contents, summarizing the elements of a compensation monitoring program:
    - Classification needed for categories of monitoring program (scale of impact, ecosystems/habitats, intended outcomes (goals/objectives), define limiting factors at landscape, watershed scale, habitat banking, risk framework/classification
    - Requirement will guide what type of monitoring is needed
- There was a comment regarding how cumulative effects are captured – the Chairs indicated that this is something to be kept in mind but we are not there yet.
- It was suggested that the group start discussion on how habitats should be classified.
- There was a comment that discussions are limited to the monitoring side and not determining the type of compensation – the monitoring plan will not help define limiting factors – this is done up front – monitoring needs to ensure that it has addressed those limiting factors, risk, uncertainty etc.
- It was noted that the scale of the impact determines the amount of compensation.
- Science needs to be involved in habitat banking (suggestion that wording be changed to monitoring banking and distinguished from habitat banking). It was also suggested that capturing both as a potential policy direction to be considered later.
- It was noted that there is a need for Habitat Management to pay attention to baseline conditions. It was noted that establishing baseline (pre-monitoring) conditions was not included in the TOR for this meeting.
- Database management roles and responsibilities need to be sorted out (this is a larger issue for DFO). There is concern that this is a huge request and needs an IT side as well. Participants agree with electronic archiving of reports. The details can be sorted out after the meeting, but will likely be Science led (in consultation with Habitat Management). We need to be realistic about expectations; there may be some minimal amount of metadata that must be entered and maintained.

- It was asked if there was a standardized monitoring program that was published in standardized reports, could we get this metadata easier than if it was provided in raw data?
- It was noted that Science should be involved in developing monitoring programs for large scale developments.

PRESENTATION C1: MONITORING TO DETERMINE THE EFFICACY OF UTILIZING FISHLESS LAKES AS FISH HABITAT COMPENSATION IN LABRADOR (MICHELLE M. ROBERGE AND TONYA WARREN)

ABSTRACT

Fish Habitat Compensation associated with the issuance of a *Fisheries Act* S. 35(2) Authorization is one of the most common tools used by DFO to achieve its Habitat Policy guiding principle of No Net Loss (DFO 1986). Habitat Management (HMP) personnel work with proponents to develop compensation plans that are comprehensive and scientifically defensible and include monitoring programs to collect the necessary information to determine the effectivess of the compensation.

Between 2003 and 2005 two mining projects, one in western Labrador and another in northern Labrador, resulted in the loss of lacustrine habitats. To compensate for such losses, the transfer of fish from the impacted lakes into fishless lakes located within their respective watersheds was authorized. Prior to DFO approval, baseline monitoring was undertaken to determine whether the lakes were indeed fishless as well as the suitability of these waterbodies to provide habitat that would support sustainable fish populations.

Subsequent to the fish transfers, monitoring programs were implemented to determine whether there was an increase in productive capacity (i.e., the sustainability of the fish populations). Methods used to determine this included; visual surveys along the shoreline, outlets and into tributaries; electrofishing to determine recruitment success; as well as fish and mark-recapture studies to estimate population size and health. At one location an outlet stream was created to provide for spawning and rearing habitats. Monitoring to determine effectiveness of the created outlet included surveys to assess habitat features, including wetted width, depth, shape, bank height, water discharge/velocity (high, medium, low flows) and habitat utilization (visual and electrofishing surveys).

An evaluation of the above metrics has been conducted, which revealed that most metrics utilized to date are indeed useful, especially when used in conjunction with others. The metrics have been successful in identifying changes over time and have enabled the assessment of the status of the compensation and determine whether additional changes are required in order for the compensation to function more efficiently. The only metric that was determined to be ineffective was the use of visual surveys for redds. When assessing compensation, metrics should be collected over a sufficient time period, be used in conjunction with other metrics, and should be detailed enough (i.e. length groups vs. mean lengths) to provide a clear picture of trends. Baseline data is also critical when using fishless lakes as a compensation option as the lake must be determined to be fishless as well as provide a suitable environment for the transferred populations to survive and successfully reproduce.

DISCUSSION

A participant inquired about reference conditions (introduced X number of fish); but the reference condition should not be the number introduced but should reflect reference data from other similar lakes that have fish. The author responded that every single fish had been moved.

It was noted that when you talk about numbers of fish, you need to consider size and age structure, or only take adults into account, otherwise the comparison is limited. It was suggested that the proponent monitor every few years to stagger the data and get at the long term variability. The author replied that they actually do this already.

It was noted that ponds were comprehensively sampled to determine whether they were fishless. The investigator transferred all fish species that were going to be impacted (including forage fish).

PRESENTATION C2: EVALUATING STREAMS AND FISH HABITAT FOLLOWING DAM REMOVALS (MARIE CLÉMENT, DANIEL CAISSIE AND FRANÇOIS PLANTE)

ABSTRACT

Dam removal is a useful tool to restore upstream access to fish habitats and is gaining popularity among habitat managers for use in compensation projects. Nonetheless, the efficiency of dam removals remained poorly documented. We conducted detailed and basic monitoring programs to provide such needed information. Depending of the programs, the monitored parameters included suspended-sediment concentration (SSC), sedimentation rate, percent of fine particles (particles < 2 mm) within the stream substrate, water temperature, relative fish abundance and the percent of PIT tagged fish that successfully navigated in the fishway constructed following dam removal. In the detailed monitoring program (White Rapids Brook), elevated SSCs occurred during water diversion from the side channel into the newly constructed stream, but these events were of short durations (few days). During this five year project, bank erosion in an unmodified (not stabilized) reach within the reservoir area was observed and higher increases in percent of fine particles within the sedimentation trap and substrate was recorded at downstream sites (below the dam). Nonetheless, the stream appeared to have stabilized after 5 years. No effect on water temperature was observed in both the detailed (White Rapids Brook) and basic (Tomogonops River) monitoring programs and migration of juvenile salmonids into the newly accessible habitats was confirmed. However, no evidence of spawning in the upstream reaches has been documented yet, but delays in recolonization after dam removal is expected. A detailed fish movement study was conducted in the Pisquid River using PIT tag technology to quantify the efficiency of dam removal and associated fishway in restoring access to upstream habitat. Smelts were chosen as they have a low swimming capacity and represent a good indicator species to study fish passage efficiency. Fifty percent of the tagged smelt that approached the fishway crossed over the first weir and entered the structure. Six percent of these smelts successfully navigated the entire structure. Further studies on passage efficiency of fishways and culverts should be initiated to quantify the efficiency of hydraulic structures. Such studies would provide better data, not only to restore fish access to upstream habitat during dam removals as prescribed in compensation projects but also to assess these structures in terms of fish passage in general.

DISCUSSION

It was asked if there were additional parameters the investigator would have liked to have measured? The author replied that yes, they wanted to monitor stream dynamics, how efficient was the stream reconstruction was, and stream hydrology, but these would have been extremely labor intensive.

It was asked why was smelt was chosen? The author replied that it is often considered that smelt cannot pass fishways, so they focused on smelt, which are migratory, but are not strong swimmers (good indicator of ability to pass fishways).

It was noted that fine particle concentrations still seem fairly high and may be problematic.

PRESENTATION D1: CAUTIONS ON USING THE BACI DESIGN IN ENVIRONMENTAL EFFECTS MONITORING PROGRAMS (KAREN E. SMOKOROWSKI AND ROBERT G. RANDALL)

ABSTRACT

Often the Before-After-Control-Impact (BACI) design is touted as being a statistically powerful experimental design in environmental studies. If the timing and location of the impact are known and adequate pre-data are collected, the BACI design will help isolate the effect of the development from natural variability. While more rigorous than other designs (e.g., before-after only, or, control-impact only), this paper presents results from a BACI design that demonstrates different impacts depending on the number of years included in the analysis, the grouping of the data, and on the model chosen for analysis. While other articles have cited the need for using caution in application of the BACI design, this paper reinforces those cautions and provides some suggestions to improve its applicability in interpreting data from environmental effects studies.

DISCUSSION

It was asked how expensive is invertebrate sampling? The author replied that they do it "in house" – on the order of $15-20K/year to analyze samples. Taxonomic level desired, number of samples and whether subsampling is required will determine the cost.

Regarding the fish diversity measure, it was asked if there will eventually be biological interactions that will influence interactions observed? The author tends to use the Simpson's Diversity index – they have compared this against the Shannon index and they are similar.

It was asked if replicated reference sites were possible? The author replied that no, this was not possible for this project.

It was noted that "reference" rivers implied environmental covariation – did the authors examine regional climate differences between the two rivers? The author replied that yes, they do indeed track fairly closely, although there are some differences (e.g. precipitation differences). If they identified the environmental drivers, they could use data from just the one river – the authors do intend to examine if same drivers are influencing both rivers. There is a precedent for this methodology in the literature.

It was asked if the difference in results may be the result of pseudoreplication? Are differences in results influenced by the power of the analysis? The author replied that this may be the case.

It was asked what are author's recommendations regarding the differences between the analyses presented? The author replied that they are still trying to figure this out (e.g. examining variance and power).

PRESENTATION D2: POTENTIAL FOR USING SITE MONITORING INFORMATION TO DETERMINE REGIONAL BENCHMARKS FOR MEASURING NO NET LOSS OF PRODUCTIVE CAPACITY OF FISH HABITAT (R. RANDALL, R. CUNJAK, J. GIBSON, S. REID, AND A. VELEZ-ESPINO)

ABSTRACT

Basic fish and habitat monitoring data from stream sites can be used to determine region-specific benchmarks for measuring no net loss of productive capacity. The data would include estimates of survey area, fish abundance, and fish weight by species. Stream electrofishing data from three regions, Bay of Fundy (NS), Miramichi (NB) and Toronto region (ON), were used to illustrate the method. Regression and covariance analyses were used to tentatively quantify the relationship between fish community biomass (B) and survey area and region. Region-specific productive capacity, measured as $HPI = \Sigma B_i(P/B)_i$), was estimated as differences in elevation of ANCOVA models, assuming a common slope between P and survey area among the three regions. Data on survey area and fish abundance could be obtaining from science-based monitoring programs or from existing data (e.g., salmon stock assessment). The use of region-specific benchmarks of fish biomass to calibrate estimates of weighted suitable area for measuring productive capacity is demonstrated.

DISCUSSION

It was asked if the biomass was based on an assumed area to determine site productivity? Regional-specific values would be used depending upon the footprint being looked at. The author replied that yes, the estimates were calculated based on a given area.

Regarding the ANCOVA for the 3 regions – it was noted that relationships were harder to see within regions – what are the implications of this? The authors are exploring this further with an analysis that is not yet complete. Regional definitions of capacity may end up being different than what the authors are showing here.

It was asked if habitat suitability index examples were across species and life stage? The author replied that yes, and you can also derive a composite index using all species. In terms of habitat capacity, it should be the sum biomass of all species. It was noted that it might be interesting to just look at salmonids independently.

It was noted that this analysis requires an estimate of absolute biomass (although expressed as density?) - in the case of the stream data, it is density that is being measured. Some of the CUPE data could bracket reasonable estimates.

It was noted that most of species the investigators are interested in are fisheries species, so they are influenced by habitat but also by the fishery recapture. There are several factors that could influence results and the authors need to be aware of these. The biomass will most likely be a good reflection of what the habitat can support.

It was noted that the authors have illustrated the difference among regions but note that there is also a difference within a region with respect to the productive capacity. The authors needed to start somewhere, and so they started at a relatively coarse level.

PRESENTATION D3: MONITORING HABITAT COMPENSATION IN THE PACIFIC REGION, LESSONS FROM THE PAST 30 YEARS (MIKE BRADFORD, STEVE MACDONALD, COLIN LEVINGS)

ABSTRACT

In the Pacific region the practise of compensation for lost habitats, and restoration of degraded ones has a long history that predates the 1986 Habitat Policy (DFO 1986), particularly for the region's iconic species, the Pacific salmon (*Oncorhynchus spp*.). Early examples include the development of spawning channels to compensate for habitats lost due to hydroelectric development (Hourston and Mackinnon 1956), and efforts to restore degraded estuary habitats (Pomeroy et al. 1981). Since the implementation of the Policy compensatory habitat works are much more common and occur in freshwater, estuary and marine habitats. The need to evaluate the efficacy of compensation and restoration activities has also long been recognized, and a number of studies, surveys and reviews have resulted over the past 40 years (e.g.,Cooper 1977; Kistritz 1996; Levings and Nishimura 1997; Lister and Bengeyfield 1998; Cooperman et al. 2007). Studies in the Pacific region were expanded to the national scale by Harper and Quigley (2005). This paper provides a brief summary of habitat monitoring in the Pacific region, and concludes with recommendations for future work.

DISCUSSION

It was noted that rapid assessment survey methodology has an application in aquatic invasive species biology – may be effort-dependent though.

Regarding the diagram showing the threshold in terms of being able to determine effectiveness in monitoring, it was asked if this is applicable to developing a standard set of metrics? The author says it is difficult to imagine this, and noted that the sampling was not standardized or structured enough to really say anything

It was asked how they decide on the type of compensation (e.g. what to put in and where?)? The author replied that the reality is that options are very limited. The author replied that there is a program in Pacific Region (often dealing with anadromous fish and their abundance) – they know enough about watersheds to direct funds appropriately. An offset approach would be good here.

PRESENTATION D4: EVALUATING HABITAT COMPENSATION IN INSULAR NEWFOUNDLAND RIVERS: WHAT HAVE WE LEARNED? (KEITH D. CLARKE)

ABSTRACT

Habitat compensation is necessitated when a development project is expected to negatively impact fish habitat. The main goal of any compensation program is to offset the lost 'productive capacity' which stems from the 'no net loss' guiding principle outlined in the *Policy for the Management of Fish Habitat.* In Newfoundland, a number of compensation programs have been the subject to detailed scientific evaluations. An overview of these results will be presented and discussed with respect to the 'no net loss' principle. The lessons learned from these projects, as well as other habitat related research, have led to some generalizations about habitat population linkages within the freshwater habitats of Newfoundland. These will be outlined to allow a discussion on moving habitat compensation from a purely 'physical habitat' perspective to one that focuses more on 'production'. The change in focus will be necessary as compensation plans become more complicated.

DISCUSSION

In second example of the channel, the investigators used presence of spawning fish as measure if success – was this indicator set before the construction? The author replied that no, this was examined afterwards. They wanted to examine what proportion of fish are finding the channel and using it for spawning and where they are coming from (they are coming from all over the reservoir). If the indicator of success is the number of fish in the channel, did the authors examine increased productivity of the system or did they just move things around? The author replied that they were not able to compare production levels before construction.

It was noted that it would take 3-5 years before this would work, but is this temporal effect was taken into consideration in the overall scheme of compensation.

PRESENTATION E1: THE EFFECTIVENESS OF HABITAT COMPENSATION INVOLVING THE ADDITION OF HARD ROCK SUBSTRATE IN THE MARINE COASTAL ENVIRONMENT

(ROBERT S. GREGORY, MARIE CLEMENT, MICHEL COMEAU, SIMON COURTENAY, MARK HANSON, HERB HERUNTER, ANDREA LOCKE, STEVE MACDONALD, COREY MORRIS, JORDAN MUSETTA-LAMBERT, DAN PORTER, MICHELLE ROBERGE AND TONYA WARREN)

ABSTRACT

Construction activities in marine coastal areas (e.g., wharves, breakwaters and similar facilities) are undertaken to improve access to nearby marine resources and sea lanes and to protect industrial and personal property onshore. Natural beaches have been replaced with modifications to inter and shallow sub-tidal habitat that include rock rubble walls, floating breakwaters, dredged harbours, docks and marine service outlets. Following a policy of “no net loss” to habitat productivity, harbour construction and operation is intended to avoid negatively influencing local biota. In fact many recent harbour development plans include habitat compensation features to mitigate for possible environmental impacts (e.g., artificial reefs). The harbour structures themselves may also provide substrate for biological communities (an "artificial reef effect"). The purpose of artificial reefs in a habitat compensation context is to enhance the complexity of rocky coastal habitat by increasing shelter availability for juveniles of various marine fishes (e.g., flounder, cod) and benthic macroinvertebrates (e.g., lobster, scallop) and enhance ecosystem services. They are also constructed as compensation to offset the loss of marine habitats impacted by nearshore, and even those in the offshore.

The type of biological communities promoted by introduced structures and their value relative to the habitat and communities being lost due to construction, remain common and unresolved issues, regardless of their initial intended purpose. Despite the need for scientifically defensible approaches, empirical studies of introduced structures on biota have been few and limited in scope. Currently, there is little information available on whether such anthropogenic structures really do reduce habitat for plants and animals or, in fact, present new or different habitat.

Construction of breakwaters and coastal armoring is expected to increase as numbers of people living along coasts increase, sea levels rise, and severe meteorological events become more frequent. Similarly, artificial reefs are seen as an effective habitat

compensation tools, in Canada and elsewhere worldwide. We have examined the results of seven scientific studies conducted by DFO scientists across the country in the past decade, which have examined the introduction of hard rock substrates and similar structures in the marine coastal environment. Our objective was to identify methods of compensation monitoring which are effective in such cases.

DISCUSSION

It was noted that building a breakwater is often a habitat conversion – what is the value before vs. what is the value after. This is an important issue in some communities where the valuable species are clams, etc. The authors are trying to come up with an assessment to develop metrics for a cost-benefit analysis. They are also trying to determine which species benefit and which do not. The concern is related to making the value judgement as to what is good and bad. It was clarified that compensation for a HADD is always focused on the commercial fishery.

It was noted that if you make the habitat, the fish will show up but you also need to find a way to make sure they survive once they do show up.

It was asked if they have any ideas regarding the differences observed between the breakwater and natural habitat in the Gulf region? The author replied that there are differences, but this is a work in progress (M.Sc. project).

PRESENTATION E2: USING METRICS OF ECOSYSTEM FUNCTION TO DETERMINE APPROPRIATE HABITAT REPLACEMENT RATIOS, HABITAT VALUE, AND TO MEASURE RESTORATION SUCCESS (MELISA C. WONG)

ABSTRACT

The goal of current habitat restoration practice in estuarine and coastal ecosystems is to compensate for habitat damage or loss through replacement of lost ecological functions, services, and values (Fonseca et al. 2000). While compensation of lost acreage has been conducted in the past, ecosystem approaches are now preferable and are practiced worldwide (Fonseca et al. 2000, Peterson et al. 2008).

In most cases, compensatory restoration attempts to elevate lost ecosystem functions by converting a less valued habitat into a more valued one (Peterson et al. 2003), usually away from the original site of injury. Consequently, estuarine and coastal restorations generally target biogenically structured habitats, which are assumed to provide higher ecosystem services and functions per unit area. Effective restoration of habitats clearly depends on our ability to ascribe habitat value reflective of one or more important ecosystem functions. Metrics of habitat value are thus important tools that can guide all stages of a restoration project, from inception to monitoring project success.

Restoration ecologists face two major challenges when attempting to restore habitat to compensate for lost ecosystem services and functions: (1) how to quantitatively compute the amount of new habitat required to replace the lost ecosystem functions and services from the damaged habitat, and (2) how to determine if and when the restored habitat reaches full ecological functionality. In both cases, metrics of habitat value that represent ecosystem functions and services are required to ensure that lost ecosystem services are elevated, replaced, and maintained by restoration activities (Fonseca et al. 2000).

DISCUSSION

The authors are using grams carbon as a measure of secondary production –it was noted that there are other ways they could go. They are interested in the food base for little fish, then forage fish, and so on. In other ecosystems, you could use another imported fish species. In these systems, there is the idea that we have a rich system to support higher trophic levels so in this context we are interested in the forage levels as well as secondary production.

It was asked if restoration activities have been used to test for the effects of anthropogenic changes? The author replied that yes, they have compared restored and reference sites.

It was asked if the food network model has been used to predict perturbations in other systems? The author replied that they are interested in using these models for scenario analysis, such as effects of removing green crabs from the system.

It was asked if they are using the lagoon restoration as a bank for destruction of marine habitat? The author replied that there are policy issues that need to be addressed (e.g. can't rob Peter to pay Paul), and the only tool we have to use is compensation. They can try to change compensation ratios to reduce net loss. There was further discussion regarding destroyed habitats that may pre-date the policy, and how much more we should ask for. Habitat Management replied that both the 2002 and 1986 policies do not deal with abandoned sites. Recently there has been a re-think on this and a policy shift – the only tool we have is to do compensation and to make gains in fish production.

It was asked if they used eel grass production as a surrogate to determine overall fish production? The author replied that yes, this is the idea, as it is much easier to measure secondary production and as well do not have obvious fish species present to measure. It was then asked, if you are not measuring fish production directly, have you figured out what the relationship is between fish production and eel grass so that you can figure out what the offset credit would be?

Participants indicated that they liked the author's approach, including the metrics (very science based) and suggested they could make quantitative linkage between secondary production and fish production. The author replied that, in terms of making linkages, it can be done somehow.

It was noted that Parks Canada Agency is trying to reduce green crabs to allow for eelgrass recovery.

There was a clarification of terminology regarding habitat replacement ratio. It was noted that linking with other jurisdictions makes the argument stronger

DAY 2 GENERAL DISCUSSION:

There was substantial discussion regarding whether participants accept the proposed framework. Notably:

- Suggest program needs to be scaled to level of impact, scaled to species, life stage, need to know relative indicators, but also need a standard approach to collection of baseline data. Suggest including in ToC as first step. Also proposed a standard format.
- Need to focus on the specific objectives of this meeting (but this is informed by the front end work). Not trying to get the front end prediction models perfect – but people can't focus on effectiveness monitoring without considering this.
- Need baseline info on the harmful alteration, disruption or destruction (HADD) of fish habitat to demonstrate compensation offsets.

- Need a preface to this process (e.g. site description, etc.). Then can go on to the guts of the cookbook. Should do this as a table of contents as opposed to a table. RW noted this info.
- A diagram of the process of a project vs. the compensation monitoring was presented – clarified that this workshop is about effectiveness monitoring and not making HAAD predictions.
- Suggestion that we need to collect the right metric/data in the pre-construction stage.
- If standardized information/metrics for effectiveness monitoring are available, then this will also inform data collected at prediction stage.
- The group drafted/refined points, and discussed which point to start from in the framework (need to start at compensation and now need to determine if and how to monitor effectiveness).

DAY 3 GENERAL DISCUSSION:

- There was a change in the agenda for the day to allow the group to focus on drafting the Science Advisory Report.
- The discussion on Day 3 focused on effectiveness, functional and compliance monitoring.
- It was noted that we are focusing on effectiveness of compensation – i.e., is it doing what we thought it was going to do? There is a separate prediction for compensation- i.e., was compensation effective at achieving its objective?
- The key question is whether the compensation project is functioning as intended. But how does this address whether we are dealing with NNL? It was suggested that one of recommendations should be that the Department should take on task of looking at metrics to determine whether NNL is being achieved.
- It was noted that functional monitoring must be able to account for cumulative habitat loss.
- We must accept that not all projects will include effectiveness monitoring (all should have minimal functional monitoring though) – effectiveness monitoring should be done where there is a high level of certainty. We need to be able to provide evidence that some projects do not require this, and can make do with functional monitoring.
- Will proposed monitoring program guide selection of metrics? And then habitat will determine effectiveness? No, this approach will be more holistic and comprehensive.
- Effectiveness monitoring will either be scientifically defensible or not. It must be held to a high standard to be defensible and statistically robust.
- There is a movement towards standards – this is essentially a national standard for effectiveness monitoring, and may take various forms. The biggest gap identified is standards for information gathering. We should be consistent regarding what type of information is collected, stored, analyzed (etc.) so that we can start building databases that we can use in the future.
- The proponent is writing the report and determining whether they did a good job; it was noted that this represents a conflict of interest for some participants. We are trying to set out a standardized method for the proponents to follow, and these standards can be audited. Some participants would rather see scientists doing the research rather than the proponents. There may be cases where the proponent may pay DFO science/other academics to do the work, but this is not commonly applied. The scientists, at the very least, should be allowed to work on them (i.e. not prohibited from doing so).

- There were some concerns that effectiveness monitoring would only focus on larger projects; we need effectiveness monitoring for all projects, but the approach must be scalable. We need to know if the compensation functions as intended. However, we can't ask untrained people to provide scientifically defensible data. The Chair stated that we may still do effectiveness monitoring for smaller projects, but there is no sense to collect data that won't be of any use.
- For some larger projects, the work may have to be partitioned out.
- It was asked if a protocol could request an annual review of a project – e.g. "State of the Project/Habitat" updates to evaluate progress (similar to State of the Ocean in the U.S.)?
- It was suggested that terminology is tripping people up (effectiveness vs. functionality) and the group suggested a change of terms.
- Functional monitoring relies more on the use of measuring surrogates (physical or biotic attributes that have an assumed relationship with the parameters of interest), where effectiveness monitoring relies more on a direct measurement of biological parameters.
- Functional monitoring alone does not mean that we are not going to be able to assess some measure of effectiveness.
- It was asked if there is a case study of a common compensation activity to use as a reference. Decision to set this up as under Section 34 of the *Fisheries Act* (e.g. rearing, spawning grounds, nursery, migration, food supply, etc.). Habitat Management supported this approach. In theory, any monitoring program should work in all habitats. This approach would work for habitat managers and is based on current legislation. We could also add "ecosystem" as a level.
- Will Section 34 adequately address marine and freshwater habitats? These parameters are important to include, but may not be enough, especially if we want to describe specific metrics (and not just characteristics of metrics) for each major habitat type.
- We will start with an example of spawning grounds, and see if this works across ecotypes. Others will need to be done subsequently.
    - Discussion of targets
    - For some species (e.g. salmonids) can include numbers; these will be regional and species-specific.
    - Suggest using a percentage of the control rather than a hard and fast number; suggest it should be a function of the variability in the reference condition.
- It was suggested that, in the Introduction section of the Science Advisory Report (SAR), we should add something to the effect that the Monitoring Plan is part of a broader AMP (adaptive management plan).
- Since the SAR will not be completed by the end of the meeting, there will be homework and some reiterations via email and teleconferences to finalize following the meeting.
    - The Steering Committee will schedule a conference call to attempt to populate the format for the remaining habitat types.
    - This document will be distributed to entire group for comment.
    - The entire review group will agree on a final guidelines document.
    - The SAR will be separate from the detailed guidelines document (SAR will include the basics regarding the table of contents, etc.).

APPENDIX I: TERMS OF REFERENCE

Monitoring Design and Metrics to Assess the Effectiveness of Habitat Compensation Activities

National Peer Review, National Capital Region[1]

December 6-8, 2011
Ottawa, ON

Co-chairs: Karen Smokorowski and Roger Wysocki

Context

The Habitat Management (HM) program, has requested advice on developing cost-effective and science-based data collection standards for monitoring programs required as part of habitat compensation plans in order to determine the effectiveness of habitat compensation projects.

The HM Program is also seeking advice on appropriate habitat indicators to determine ecosystem health in systems with significant human activity. These indicators will contribute toward future reporting on the state/condition of fish habitat in Canada.

Objectives

Primary Objective – Monitoring the effectiveness of habitat compensation projects in achieving conservation objectives.

The Habitat Management program, has requested advice on developing cost-effective and science-based data collection standards for monitoring programs required as part of habitat compensation plans in order to determine the effectiveness of habitat compensation projects.

The program seeks to know what type of habitat compensations projects have been effective at achieving their objectives and what has been learned on efficient and scientifically-defensible methods to monitor effectiveness of habitat compensation projects.

Secondary Objective – Guidance for Indicator Selection at the Ecosystem State:

To effectively manage and report on fish habitat at the ecosystem scale, a comprehensive suite of indicators is required. Reporting on ecosystem status requires a consolidation of the interactions among both biotic and abiotic components, and their functional processes. Fish habitat includes all the environmental (i.e. biological/physical/chemical) conditions within which an organism, population, or community exists.

NB: Although the primary focus of this CSAS review is metrics and monitoring design at the site (project) scale, contributors and participants are encouraged to consider how the site-level indicators related to habitat compensation may also be useful in development of ecosystem-level indicators to report on the state of fish habitat.

In order to guide the scientific advice, several scientific papers will be presented. During the course of the scientific review of these working papers, workshop participants will be guided by the following general question: Was the monitoring program a success? (i.e., did it achieve the goals of monitoring?) If yes, answer the following questions in light of highlighting why it worked. If not, responses to the following questions will help provide guidance to future monitoring efforts:

[1] Updated December 5, 2011.

- What was the goal of the monitoring program? (eg, compliance with Authorization; area-based; function-based (physical/chemical characteristics, lower trophic levels; fish use or production). Was the program for individual projects or program evaluation?
- What was the overall design of the monitoring program? (e.g., before-after only, reference site used? Reference-impact only? Other?). What type of statistical analysis was proposed (descriptive, ANOVA-type, Bayesian, etc.)? What was the decision rule used to evaluate success?
- What metrics were used (or proposed) as measures of success of fish habitat compensation at sites? Assess the metric(s) in terms of the sampling and natural variability and as a (potential) measure of NNL. Do you feel the choice of metric affected the outcome of the monitoring?
- Given these metric (s), and potential use for measuring NNL, what would be the temporal (timeframe) and spatial scales, and sample sizes needed for an effective survey design, to determine change with reasonable precision?
- Do you feel the design of the monitoring program and metrics used could be reasonably conducted by Habitat Management and/or proponents? If the design and monitoring program cannot be reasonably be expected to be conducted by Habitat Management, provide suggestions on a different approach that could be used by practitioners.
- If applicable, identify ecosystem indicators that can be used (demonstrate by example) to assess fish habitat status, and consider feasibility and limitations/constraints.

Peer Review of papers: All papers will be circulated to participants for comments approximately two weeks before the workshop. Following the workshop, if it is the author(s) wish to have their work published as a Research Document, the Chairpersons will ask 2-3 peers to provide such review.

Expected Publications

The intent of this Science workshop will be produce guidance for Habitat Management practitioners, via a Science Advisory Report (SAR) and accompanied by a Proceedings document. At their discretion, authors may choose to have their papers published as related Research Document(s).

Participants

- DFO Science
- DFO Habitat Management
- External academic experts

APPENDIX II: LIST OF PARTICIPANTS

Keith Clarke	Fisheries & Oceans Canada
Mike Bradford	Fisheries & Oceans Canada
Susan Doka	Fisheries & Oceans Canada
John Fitzsimons	Fisheries & Oceans Canada
Carolyn Bakelaar	Fisheries & Oceans Canada
Nick Lapointe	Fisheries & Oceans Canada
Shidan Murphy	Fisheries & Oceans Canada
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Julie Richter	Fisheries & Oceans Canada
Christine Abraham	Fisheries & Oceans Canada
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