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Proceedings of the Regional Peer Review of the Assessment of American Eel (*Anguilla rostrata*) in the Maritimes Region

**September 5–6, 2018
Dartmouth, Nova Scotia**

**Chairperson: Jennifer Ford
Editor: Jennifer Ford**

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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

A Regional Science Peer Review meeting was held on September 5–6, 2018, at the Bedford Institute of Oceanography in Dartmouth, Nova Scotia, to review the status of American Eel in the Maritimes Region and the consequences of various harvest levels and strategies. Participation in this meeting included Fisheries and Oceans Canada (DFO), Indigenous organizations, non-government organizations, the fishing industry, and scientific reviewers.

The status of the eel and elver fisheries in the Maritimes Region was last assessed in 1996. More recently, indices of general status were compiled in support of a national pre-COSEWIC and Recovery Potential Assessment of the American Eel and to help measure progress towards reducing human-induced mortality by 50%. The 2012 COSEWIC assessment designated the American Eel as threatened. The species is currently under consideration for listing under the *Species at Risk Act*. In 2017, a framework review established the scientific basis for the provision of advice to management in a manner that is consistent with the DFO precautionary approach. This review process aimed at evaluating the effects of human-induced mortality on American Eel productivity and biodiversity at both the regional and local scales. The peer review meeting could not provide an assessment of stock status because of data deficiencies in the reporting of catch and effort in eel fisheries prior to 2016 and because key fisheries-independent indices of standing stock are not expected to be updated until 2019 or later.

This proceedings document includes a summary of the presentation and is the record of the meeting discussions. A Science Advisory Report resulting from this meeting will be published on the [Fisheries and Oceans Canada \(DFO\) Canadian Science Advisory Secretariat's \(CSAS\) Website](#) as soon as it is available.

INTRODUCTION

The meeting Chairperson, Jennifer Ford, introduced herself, followed by an introduction of meeting participants (Appendix 1). The Chair thanked meeting participants for attending the DFO Regional Peer Review Process. The Chair provided a brief overview of the Canadian Science Advisory Secretariat (CSAS) peer review process and invited participants to review the meeting Terms of Reference (Appendix 2) and Agenda (Appendix 3).

To guide discussions, a draft Science Advisory Report had been prepared and distributed to participants prior to meeting. This Proceedings report constitutes a record of the discussion of the meeting.

PRESENTATION AND DISCUSSION

ASSESSMENT OF THE EEL AND ELVER FISHERIES

Working paper: Assessment of the Maritimes Region American Eel and Elver Fisheries

Science Leads: R. Bradford, A. Cook, and S. Smith

Rapporteur: L. Stevens

Presentation Summaries and Discussion

Background

Background information was presented on the life-history of American Eel. American Eel are a panmictic (single population) species; therefore, a multi-jurisdictional management plan might be a long-term goal.

In the Maritimes Region, there is a large catchment area. In Nova Scotia, hundreds of watersheds exit the province, creating habitats (streams and lakes), rearing capacity, adult production, and flow attraction for American Eel.

Fisheries in this region include the Food, Social and Ceremonial (FSC) fisheries carried out by Indigenous groups, in addition to commercial fisheries for elvers, as well as juvenile (yellow) and maturing (silver) American Eel. Recreational fisheries also occur on the juvenile and maturing eels.

Recap of the 2016 Framework Review

The purpose of the framework was to assess American Eel population status, the location and extent of human impact resulting in mortality, and loss of habitat (e.g., from hydroelectric facilities), and to develop an analytical framework to assess human-induced mortality.

A review of the proposed precautionary approach framework for eels was provided. The approach allows estimation of mortality level thresholds (i.e., how many eels would you want to “escape” human-induced mortality), which can be used as removal references. This approach allows for development of reference points without estimating population abundance, which is not possible at this time.

Fisheries-Dependent Indices

Large eel fishery potential and catch and effort

For large eel fisheries, information was provided on fishery type (commercial, recreational, commercial communal), number of licenses fished, gear type and amount used, and logbook return records (2015 and 2016). The logbook returns provide information on the number of persons fishing, amount of gear, fishing location and catch.

Available information for the Mactaquac Dam indicates the dam is virtually impassable for eels, making the habitat above the dam unusable.

While electrofishing surveys from 1995–2005 show a decline in standing stock in some rivers, some of the surveys were not planned to survey eel populations; thus, data may not be fully representative of the local populations.

Elver fishery potential and catch and effort

Elver licenses are specific to individual rivers and, therefore, river-specific information (e.g., catch and effort) is required. A policy is in place that when elver rivers are first identified, a large eel fishery must not have taken place on the river in the three years prior. Effort controls in the elver fishery include limits on the number, size, and type of fishing gear, minimum distances between elver fishing gears, and the number of fishers authorized by each license. It was mentioned that inconsistent reporting on catches by gear type is challenging for assessments.

The elver fishery Total Allowable Catch (TAC) was reduced by 10% in 2005, although fishers were allowed to fish an additional 10% to support conservation stocking within Canada.

The East River Chester Elver Abundance Index was fished from 1996–2002 and 2008–2018. The study is an industry funded project that is invested in annually and completed by a third-party non-profit organization (Bluenose Coastal Action Foundation, BCAF). These data, in combination with the commercial elver harvest, provide information on total run size (recruitment), and level of escapement (elver survival past the commercial fishery). Juveniles, which are approximately 1 year of age, are caught in the Irish style elver boxes used by BCAF in the elver abundance index. These box counts are a good indication of annual run strength and variability. The question was raised as to whether juvenile American Eel may be a potential indicator of the local population status. Juveniles are counted and sampled during this study and were used this year to determine if the numbers reflect the run size or number remaining after fishing occurs. Juvenile counts and sampling may be used to compare to other rivers over time.

A goal is to standardize all the names of rivers and to work more closely with hydro facilities to gain a better understanding of drainage and downstream passage.

The distribution of the swim bladder parasite was mapped, and the known distribution of the swim bladder parasite in our region has been found to be quite patchy.

Discussion

A question was raised regarding how the 10% decrease of catch in 2005 was determined. It was discussed that the information was not based on any advice provided by science. Instead, it was a resource management decision in response to a ministerial call to reduce the potential

removal by directed fishing. Because fishers were allowed to catch an additional 10% to support conservation in Canada after the decline, the data should show in what years that occurred. It is believed that many of the elver fishers would have formally applied to do this but stopped in 2012 because of the swim bladder parasite. Stocking applications take time to get approval and this should be considered in the future.

It was asked if there is bycatch of American Eel in other fisheries and whether or not it is substantial. It was discussed that bycatch of American Eel in other fisheries is likely but there is no way to quantify it. If bycatch were to occur while trout or bass fishing, then ideally it would be released alive. While some commercial gear directed towards smelt and gaspereau could potentially catch eels, these are live catch fisheries that could release bycatch alive.

A discussion was had regarding recreational fishing. Gear type for recreational large eel fishing is baited pots (generally four per person) and requires a license. Historically, fyke nets may have been allowed. Spearing large eels is restricted to tidal waters and, therefore, no license is required.

Large eel commercial fisheries require the license holder to submit their logbook from the previous year in order to get the following year's license conditions. One challenge is that science is not permitted to directly access the licensing information because of the *Privacy Act*, so it takes a long time to spot inconsistencies in reporting. It was mentioned that the number of licenses issued in Nova Scotia vary from year to year and, in some instances, a few more are available than previous years, which should not be the case. Generally, the number of licenses should be decreasing because they are terminal. This could be due to a number of factors, but it is likely a glitch in the DFO licensing system and/or a possible lag in logbook reporting. Some information exists regarding the number of licenses that have been retired, terminated due to death, or transitioned over to green crab licenses (approximately 35 licenses).

No reporting of logbooks is required for large eel recreational fishing. One commercial communal report came in from 2014. It is difficult to capture information and data from all eel fisheries in the Maritimes Region. One thing to keep in mind for the report is that there are provisions to include Aboriginal and Traditional Knowledge (ATK) and information on FSC fishing. Additionally, bag limits should be included (page 3).

It was mentioned that a distribution map of the swim bladder parasite is not included in the document and should be updated to add it and include new information, specifically for the Bras d'Or Lakes.

Status Trends and Spatial Overlap Between Eel and Elver Fisheries

Licensing information including commercial, recreational, and commercial communal were discussed in terms of the number of licenses available and amount of gear (pots, traps and weirs). Sources of American Eel mortality were mentioned and include:

- FSC (reporting is not available through the DFO reporting system)
- Elver (reported)
- Adult commercial eel (reported, but a lag of 1 year exists)
- Adult commercial communal (supposed to be reporting)

-
- Hydro dam facilities

Discussion

A point was raised regarding reporting and how more reporting from FSC fisheries is necessary because it is a source of mortality. Currently, FSC fishing is not recorded through the DFO report system.

Interpreting the summary of commercial fishing licenses available (Table 7 of the research document) is causing confusion and should be looked at again. One possibility is that there are licenses that DFO owns that show up in the system that are not actually issued. The numbers in the table will need to be explained in more detail.

FSC fisheries' overlap with other fisheries is currently unknown because there is no mechanism reporting to DFO Science. Overlapping should encompass all sources of mortality, including FSC, commercial, commercial communal, elver and hydro. Additionally, and although rare, it should be shown where adult commercial fisheries, elver fisheries and hydro overlap simultaneously.

In terms of the annual extent of spatial overlap of the large eel and elver fishery, the policy of not authorizing elver fisheries in rivers that have a previous three-year history or large eel fishing can be considered to be reasonably effective.

As the refurbishing of the Mactaquac Dam moves forward, thought should be given on how to increase fish passage because there is a lot of potential eel habitat.

Over the past six years, elver landings have increased and higher landings have been seen with higher drainage. Elver recruitment could be estimated based on the size of the river as larger rivers would yield larger catches.

In 2018, the East River Chester Elver Abundance Index showed the highest number of elvers in the time series to date, reaching nearly 3.8 million fish. Elver run sizes in the East River, Chester, have been highly variable but increasing by approximately 50–70 thousand eels per year. Juvenile eels that are captured during the East River Chester Abundance Index are caught in tidal waters, which could imply that they are not entering the freshwater. Instead, they may be staying in the estuary or dropping further downstream to remain in the marine environment. There doesn't appear to be any relationship of elver run to juvenile catches. No significant trend over time in terms of the number of juveniles (majority are approximately 1 year older than the elvers) captured in the boxes was seen. Behaviour and density dependence are a couple of factors that could contribute to the lack of a trend.

Escapement increases with the size of the run. Exploitation rates tend to be higher when elver runs are smaller. Therefore, when run sizes are larger, exploitation rates are likely lower.

A question was raised as to why the quotas are not being caught for the elver fishery. TAC was not based on anything other than a general sense of availability. Individual TAC is in some ways aspirational and should be looked at in the context of potential habitat. Some licenses have a good chance of reaching TAC, especially if the runs are good. Elver recruitment may be limited by habitat and, therefore, some rivers may have a more difficult time reaching TAC. Elver recruitment may also be limited by environmental factors, such as temperature and water levels.

The question was raised as to why there has been a catch reduction in the adult yellow eel fishery. In Nova Scotia, there have been issues with access to the European market because of mercury levels that exceeds their acceptable threshold. Declining prices may have impacted fishing effort. Finally, availability of the resource may be another factor. These issues may all contribute to the catch reduction in the yellow eel fishery but the extent and magnitude of each factor is unknown.

More information regarding the swim bladder parasite and where it affects eels in our region is required.

It was discussed whether any biological sampling occurs in the fisheries (elver, yellow and silver). No individual weight or length measurements are recorded from the commercial elver landings but weight-length information is recorded from the East River Elver Abundance Index. In terms of adult eels, weight-length information is fairly consistent across datasets, but uncertainty exists for size-at-age. Size-at-age may be variable in eels that spend the majority of their life in freshwater versus those that spend the majority of their life in the marine environment, as growth rates and sex ratios differ by environment.

A point was made to include landings, total effort, number of fishers, and which rivers are fished in Elver Fishery Table 12. Because each river has a TAC of 400 kg, it is important to include which rivers met their annual TAC. This would provide useful information on the fishery and effort distribution.

Within the stock assessment document, “run size” and “recruitment” are used interchangeably, but only one should be used for consistency. Additionally, “Escapement” was used to describe the number of elvers that bypass the fishery.

It was mentioned that the data should be explored to look at modelling Catch Per Unit Effort (CPUE) as a level of recruitment and as a basis for comparison to other rivers.

There was discussion on why the 2004 TAC was reduced from 13.3 to 9.6 mt when it appears that the total TAC was not met. This reduction was a management measure put in place for conservation purposes based on a ministerial call to reduce human mortality by 50%.

Developing Spawner Per Recruit Reference Points for American Eel in the Maritimes Region

The Spawner Per Recruit (SPR) model looks at different life-history parameters of American Eel. It is a simple model that has strong assumptions. It is suggested that SPR 30% is used as a limit and SPR 50% is used as a target. The F-value at SPR 30% is the limitation point that should not be passed based on ICES and the F-value at SPR 50% is a more conservative estimate for fisheries. Decreasing SPR should occur when growth levels decrease, thus having more conservative F-value reference points when growth is slow. If two fisheries (elver and adult eel) are occurring at the same location, they should be considered side-by-side. For instance, fishing mortality of elvers and fishing mortality of adult eels. More information is needed for some life-history characteristics. One goal is to set some reference points and refine them as more information becomes available. Overall, the goal is to take the model, define reference points, and find a value that is representative across the region.

Discussion

It was mentioned that it would be beneficial to include more details on the sensitivity and diagnostic information in the report. Many questions were answered in the presentation but it would be useful to include them in the document.

In terms of “fishing vulnerabilities”, more information could be included in addition to the information given on the 35 cm cut-off.

Males and female have different growth rates, sex ratios, etc., and this information could be valuable to include.

Reference from age-length data is from Scotia Fundy, and it was not mentioned if the eels were from the freshwater or marine environment.

It was mentioned that F30 should not be used to determine TAC for individual watershed.

The life-history traits for the model were chosen based on the mid-latitude freshwater environment. It was mentioned that there is a paper that lists life history characteristics per region that should be used to get the best biological parameters for the most accurate model.

Table 5 needs to be checked.

Regionally, characteristics (e.g., growth rates) would be monitored spatially and temporally but having region specific information is challenging as sampling eels is a huge task.

Having a better understanding of marine mortality would be beneficial to the SPR model. It was discussed how the University of Laval did satellite tagging studies to map American Eel migration to the Sargasso Sea and that this information could be useful. In contrast, because the eels were carrying satellite tags, the information may not be applicable because satellite tags are so cumbersome that they prevent normal swimming behaviour and make eels more vulnerable to predation. Regardless, the information is not pertinent to the model unless it pertains to fishing at sea.

Managing escapement and how it contributes to spawning is a key factor. Adding mortality is also important but because it is difficult to determine, it may be better to get the information from the hydro-electric facilities.

It was asked whether the researchers were using the Nashwaak River as an index river for electrofishing and if it could be used as an indicator for the St. John River. It was discussed how no American Eel decline was seen in the Nashwaak River in the mid-1990s. Electrofishing data report mean abundance for the first sweep through the river. Unfortunately, collecting eels was done during Atlantic Salmon surveying out of a sense of duty rather than planned sampling, and results may not be an accurate indicator of abundance.

It was discussed how much length-weight data were available from the Maritimes Region. Currently, the models look at the general condition and life-history parameters for eels. American Eel length-weight information was offered to the researchers as it could be used to improve the model's robustness. It was mentioned that some of the data may be size selective, but other data come from fyke nets that may be less size selective. Size and age at which eels may be vulnerable is important to have.

Hydro-electric reference points

It was asked what the recommendations would be for escapement at hydro-electric facilities and what the F-values may be for mortality in turbines. These results are more applicable to the elver fishery than to the large eel fishery because elvers are “hit” once by the turbines. If an effort is being made to improve bypass efficiency, it would be important to have local information on the eels so the facility can be tailored around preventing or reducing mortality. This does not consider the impact to resident yellow eels which often migrate back and forth through fishways. Currently, no information exists on yellow eel mortality from migration.

Acceptable levels of mortality from turbines were generated by the SPR analysis. These are eels that have found a way above the dam and will eventually be migrating downstream, assuming no mortality occurs above the dam. If another source of mortality occurs above the dam (e.g., large eel or elver fishery), it could be included in the SPR model but a decision would have to be made on the acceptable levels of mortality. Currently, the reference points are in the absence of fisheries for average biological traits.

It was discussed whether escapement would be cumulative for every facility an eel passed through if more than one facility occurs in a watershed. Escapement is defined in terms of what is leaving the river. If escapement was cumulative for a series of facilities, the escapement target would not be set at the head of tide. It would be set at the top of the system and be very high.

F-based Reference Points for Elver Fisheries in the Maritimes Region

Because reference points now exist for elvers, it was discussed how they relate to the history of commercial elver fishing on the East River, Chester. One suggestion was to use observed information where possible.

For Figure 22, the intent was to use recruitment (based on East River, Chester, run size) per km² and scale that information for individual rivers. Each dot represents the exploitation rate (landings) related to the run size for that year. The line corresponds to SPR30 converted to an exploitation rate. It was recommended to add a line for SPR50 to the plot.

It was discussed that, if there was potential to over exploit elvers, it would likely occur on smaller rivers. Figure 23 shows that smaller rivers have a greater risk of over exploitation and larger rivers have a smaller risk. Fishers have the same gear restrictions on each river and, therefore, catch efficiency drops on larger rivers. It is important to look at minimizing the negative effects of the elver fishery. Over exploiting small rivers likely doesn't have an impact on the overall population but it may in terms of the river fished under a license. Up to 70% of rivers are over exploited but only in some years. Each dot represents the landings in a year, and the size of the dot reflects the effort (bigger dot means greater effort). The lines represent TAC. Effort is calculated as the total hours fished and all gear combined. This is recognized as not being the best way to calculate effort, especially where dipping and fyke nets occur simultaneously because fyke nets are set for a longer period of time.

“Over exploited” refers to landings. On the East River, Chester, the tendency has been to fish harder when the runs are small.

Most of the Region's information on American Eels comes from one watershed (East River, Chester). It was asked how the researchers felt about this. In discussion, it was mentioned that

the researchers felt comfortable with it for the fishery, especially along the south coast of Nova Scotia. The commercial elver fishing history closely tracks the East River Elver Abundance Index. The data may not be as representative when looking at the Bay of Fundy because river sizes change and elvers may be attracted to different flow rates. Currently, this is the best available data and, moving forward, researchers can look at catch rates based on gear type and question whether using the East River, Chester, is reasonable. Ideally, the East River, Chester, is not where research ends.

It was suggested that Figure 24 could be broken down into different time periods. It is difficult to anticipate run size given the variability over a three-year period. The likelihood of wrongly estimating the variability is high because the fishery is difficult to predict. In terms of setting reference points, it is better to use the most data over the longest period to maintain a more indicative average.

The goal for the elver fishery is the value of SPR50. Either line provides scope to continue fishing at a reasonable level but, given the cautious approach, SPR50 would be more applicable. Because the document refers to SPR30 as the limit, it may cause confusion and it should be clarified that SPR50 is the goal.

If TAC is set by river based on the median value on the East River, Chester, it may be beneficial to look at the SPR50 value every five years. The value should be robust (possibly smooth it), otherwise it may be adjusted annually by management.

It was discussed if the East River Elver Abundance Index looked at environmental data in addition to the abundance estimates. The East River Elver Abundance Index does look at environment data including, but not limited to, water temperature and levels.

If elver quotas are adjusted based on watershed size, the area will be generated by Resource Management and provided to license holders. If TACs were set in this manner, some license holders would have considerably higher TACs on large rivers that could extend beyond 400 kg. This 400 kg limit is an arbitrary cap to reduce the amount of human induced mortality and, therefore, setting TAC by river size is reasonable because it may prevent over exploitation. Another option would be to have a TAC of 400 kg and reduce it only for smaller rivers. Overall, the TAC would remain the same regardless of whether or not individual rivers' TACs were increased or decreased.

Assessment Schedule and Plan for Large Eels

Planned DFO electrofishing surveys, replicated from the assessment framework, are to be completed in 2019 will and include New Brunswick. In addition to the 2019 electrofishing, there will be five years of catch data for the commercial fishery unless there is a biological reason to do something else. Planning for the 2019 surveys is scheduled to occur in the fall of 2018. These surveys are to be completed in Atlantic Salmon freshwater rivers. While the survey is an extensive index, it may not be preferred eel habitat. It was stressed how important these surveys are to stakeholders and that there should be a plan to assess the swim bladder parasite in large eels during surveys because it may be impacting their decline. It's important and helpful for meeting participants to have a lot of details on what the surveys entail. Currently, researchers are reluctant to include the impact of hydro dams because it is unknown when new information will become available. The goal of these surveys would be a technical report that includes electrofishing survey data in the Maritimes Region.

It was mentioned how it would be useful to start large eel advisory committee meetings. Historically, broad consultations took place and it was concluded that advisory committee meetings weren't necessary and that ad hoc meetings could be scheduled if any issue arise. Another round of consultations took place when a ministerial call occurred to reduce mortality by 50%, and the results of those consultations were the same. It was discussed how this is something that could be revisited as advisory committee meetings are a good opportunity to discuss logbook records and science issues. It was asked what the triggers would be to prompt an emergency assessment meeting, and for large eels, it would be if something alarming was seen during the electrofishing surveys.

ASSESSMENT SCHEDULE AND PLAN FOR ELVER

The East River Chester Elver Abundance Index and the commercial elver catch data, such as CPUE are the two main indices that will be used going forward. While basic commercial elver catch data could be included, overall catch data are not meaningful unless they are broken down by gear type, which will take several years to determine. In addition to the East River Chester Elver Abundance Index and the commercial elver catch data, the Eastern Shore Elver Index could be looked at. Ideally, researchers could meet with industry to review fishing practices among fishers and aim for gear type and effort consistency across similar size rivers. It is easier to compare "apples to apples" and, although gear type is specific to individual licenses, this could be looked at for future years and analyses.

The elver fishery is directed at recruits with high annual variation meaning there is no sustained trend. Because of the biological nature of American Eel and how response time from elver to yellow/silver eels is long, it is not possible to provide effective advice related to the fishery.

It was discussed whether the elvers captured in the boxes during the East River Elver Abundance Index are still in the East River, Chester, watershed. This could potentially be related to how many silver eels are leaving the East River, Chester, by linking back year classes based on recruitment. However, if American Eels are living 30 years, the period is so long that it is difficult to track responses. This is why it is important to continue the East River, Chester, large eel and elver study and why a three-year assessment is important given future information. Even if it is not a formal assessment, there should be an opportunity to share these data. It was mentioned that indices of 10 consecutive years are generally good, but 20 is better especially for American Eel, given their biology. It is necessary to be cautious of the data and aware of these factors.

It was discussed whether a three- or five-year moving average should be used to determine population trends. Using a power analyses, it may be possible to detect a change of x% of elvers. The average used would likely be the moving median because means hold on to past data points and are less representative of trends overtime. Based on if there is decline, and how much, it may be warranted to reinvestigate and adjust assessment timelines. It is important to consider that science should be used to obtain a value in the range of acceptable sustainability. Additionally, it is important to consider looking at the elver catch data over a two plus year period as opposed to just one because of extenuating circumstances, like weather, which can lead to high variability. Because the results from the moving average and advice would apply to the fishers the following year, major impacts could occur on the elver fishery with little notice and, therefore using the long-term median is an important factor.

It was asked what the triggers would be to prompt an emergency assessment meeting. For elvers, it would be related to the East River Elver Abundance Index and if drastic changes occur in the moving median if it dropped below the long-term median. It was discussed how a traffic light analyses may be beneficial when more data becomes available; hence, because the East River Elver Abundance Index is so variable, it would be difficult to manage.

REVIEW OF TERMS OF REFERENCE

On Day 2, the first four terms of reference from Day 1 were reviewed and the last two terms of reference were discussed.

1. What trends in stock status and exploitation are seen in the fishery-dependent and fishery-independent time series used to inform status of elver recruitment and fisheries in the Maritimes?

Fisheries dependent indicators of large eels

- Overall, the stock status of eels has not been addressed because of the lack of information. This should be addressed in the Science Advisory Report/research document.
- FSC fishing should be discussed early in the research document. Currently, there is no reference to the FSC fishery but there is a substantial fishery.
- Licensed recreational fishing for large eels in the research document is related to pots. Reference to spear fishing was removed because it only occurs in tidal waters. Spearfishing should be mentioned somewhere in the research document as well as bag size limits that apply to all recreational gear types.
- There has been a reduction in both the recreational activity and landings of large eels. Recreational fisheries are not required to report their landings, which causes an information gap.
- There is no figure related to large eel landings over time in the research document. This is not used for an indicator of status, but it could be good for context. In New Brunswick, eel fishing is concentrated on one large river system, while in Nova Scotia it is concentrated in approximately 38 drainages.

Fisheries dependent indicators of elvers

- There has been a large increase in the number of available elver rivers, but not a large increase in the amount of available habitat. The potential effects of directed elver fishing on eel status are, therefore, modest both at the regional and Atlantic Canada coastal levels. In a particular river, it may be different, and local concerns may exist.
- In general, landings from the elver fishery have increased with time but the annual TAC has not been achieved in any fishing year. It was suggested that the 2018 landings data should be included, as well as a reference to the price. Landings for elvers may increase as price and/or effort increase but it is difficult to disentangle the differences between elver availability, incentive or market availability.

Fisheries dependent indicators of eels

-
- Elver runs are highly variable, with the runs in adjacent years varying by 50% or more in some instances.
 - It is also important to clarify in which years extra landings of 10% occurred for conservation purposes. Most of the stocking was done in the St. Lawrence River system, but some fishers may have stocked rivers above dams.

2. What has been the annual extent of spatial overlap of the large eel and elver fisheries, since 2015.

- Because large eel river names are not standardized within the logbooks, it is difficult to decipher large eel reporting and standardize monitoring.
- In terms of gear type, the biggest overlap for the region is pots and weirs. Fyke nets occur in fixed locations.
- The terms of reference should be changed from “large eel” to “commercial large eel”.

3. Based on a spawner-per-recruit analysis, what are the recommended reference points for large eels to allow for escapement from fisheries and hydro-electric facilities, and is current mortality within those levels?

- Reference points are appropriate for total mortality from each of the activities (eel, elver and hydro-electric facilities) regionally, not the total anthropogenic overlap of these activities.
- It may not make biological sense to reduce mortality if two different American Eel life stages are being targeted in a given system. For instance, elver mortality in the elver fishery and large eels in hydro-electric facilities.
- If multiple mortalities occur from various sources on a river, then the sources would have to be reduced to decrease mortality to reach the appropriate F levels.
- Estimating the over impact of hydro-electric facilities on eel productivity is not presently possible. It is possible to determine cumulative impacts but this requires a lot of research. It would be possible to compare one region to another but it would be a broad estimate and information on the dam type would have to be known. Hydro-electric facilities in Nova Scotia are small and mortality is high.
- It was discussed that if reference points are considered for one fishery (elver) it may be good to include a buffer to account for hydro-electric facilities. This may not be beneficial because very few elver fisheries occur on rivers where hydro-electric facilities exist.

4. What is the recommended F-based reference points for elver fisheries in the Maritime Region? What is the status of current exploitation relative to the reference points?

- F based reference points are 1.2 and 0.69 for SPR30 and SPR50, respectively. Calculated mortality rates are below the limit in some cases, but they are sometimes above the target.
- Part of this process was to evaluate the 400 kg river TAC, which is not effective, especially in the smaller rivers where TAC isn't met and there is a risk of exploitation. There is a need

to adjust river quotas based on the available habitat area. Information on how eel productivity varies with habitat is lacking, and this should be captured in the document. Overall, the TAC should be adjusted based on river drainage area. While there was consensus to leave this as is in the research document, previous catches in individual rivers should be considered because they could be an indicator of the amount of eel the river is able to support. However, this could be difficult to determine if the river has been exploited over a long period as the baseline would be unknown. Therefore, it may be useful to set the TAC based on when the fishery was believed to be sustainable.

- More information on habitat quality is needed to produce a more sophisticated method for determining river specific TACs.

5. What are the implications for existing management measures in the eel and elver fisheries if these reference points are adopted?

- Discussion was minimal.

6. What is the schedule for future assessments of American Eel, and what will be included in the updates provided between assessments?

- Assessments occur every five years by default, which was met by consensus in the meeting. However, there may be enough information to have an interim update. Currently the goal is to meet in 2021 to review new information from the East River Elver Abundance Index and the large eel electrofishing surveys. During the 2021 meeting, river quotas could be revisited.
- Elver quotas would not change annually based on the moving median. Generally, industry prefers stability, and sudden annual quota changes could cause industry concern.

SOURCES OF UNCERTAINTY

- The existing data may not be representative of the overall American Eel status.
- The rivers that are being fished may not be representative of the region.
- Fisheries may not reflect recruitment to the river.
- Unreported catch data (recreational, FSC, commercial and illegal) for all life stages of American Eel.
- A lack of information exists on adult escapement.
- A lack of information exists on watershed areas and habitat quality.
- More information is needed on the effects of environmental covariates (temperature, dissolved oxygen, etc.).
- The mortality that occurs from hydro-electric facilities is unknown.

WRAP UP

The meeting was adjourned with a few items of unfinished business. It was concluded that the meeting would continue via conference call.

APPENDICES

APPENDIX 1: LIST OF MEETING PARTICIPANTS

Name	Affiliation
Anstead, Kristen	Atlantic States Marine Fisheries Commission
Austin, Deborah	DFO NHW / FPS
Bennett, Lottie	DFO Maritimes / Centre for Science Advice
Bradford, Rod	DFO Maritimes / Population Ecology Division
Carey, Genna	Canadian Committee for a Sustainable Eel Fishery
Carey, Yvonne	Canadian Committee for a Sustainable Eel Fishery
Chaput, Gerald	DFO Gulf / Centre for Science Advice
Cook, Adam	DFO Maritimes / Population Ecology Division (BIO)
Cornic, Maelle	DFO Central & Arctic, Science
Davis, Donald	Waycobah Fisheries / Fisheries
Deller, Sarah	DFO Maritimes / Species at Risk Management
Denny, Shelley	Unama'ki Institute of Natural Resources (UINR)
Ford, Jennifer	DFO Maritimes / CSAM
Fraser, Matthew	DFO Resource Management
Giroux, Brian	Shelburne Elver
Goshulak, Larissa	DFO Maritimes / Fisheries Management
Hatt, Terry	NB Agriculture, Aquaculture and Fisheries
Holland, Mary Ann	Brunswick Aquaculture Ltd
Hughes, Phil	Fundy North Fishermen's Association
Jayawardane, Aruna	Maliseet Nation Conservation Council (MNCC)

Name	Affiliation
Kavanagh, Sana	Confederacy of Mainland Mi'kmaq (CMM)
Lantz, Jamie	Mi'Kmaq Conservation Group
MacIntosh, Robert	DFO Maritimes / Aboriginal Fisheries Management
Marshall, Charlie	Atlantic Policy Congress of First Nation Chiefs Secretariat
McCall-Thomas, Elyse	Evaluation Division, DFO NHQ
Mitchell, Lillian	Fundy North Fishermen's Association
Mitchell, Vanessa	Maritime Aboriginal Peoples Council
Nicholas, Hubert	Membertou First Nation / Fisheries
Nurse, Stacey	DFO Maritimes, Fisheries Protection program
Perley, John	Tobique First Nation / Negootgook Fisheries
Pernette, Danielle	Bluenose Coastal Action Foundation
Polchies, Patrick	Kingsclear First Nation Fisheries
Reiss, Dawn	Atlantic Canada Eels
Sack, Nathon	Glooscap First Nation
Sappier, Harry	Peskotomuhkati (Passmaquoddy) Nation at Skutik
Sappier, Justin	Peskotomuhkati (Passmaquoddy) Nation at Skutik
Stevens, Greg	DFO Maritimes / Resource Management
Stevens, Lydia	DFO Maritimes
Thomas, Brontë	Peskotomuhkati (Passmaquoddy) Nation at Skutik
Wamboldt, Louis	License Holder (Medway River)
Zelman, Kaleb	Maliseet Nation Conservation Council

APPENDIX 2: TERMS OF REFERENCE

Assessment of American Eel in the Maritimes Region

Regional Peer Review – Maritimes Region

September 5–7, 2018

Dartmouth, NS

Chairperson: Jennifer Ford

Context

The American Eel, *Anguilla rostrata*, is a widely distributed fish that occurs from northern South America to Greenland and Iceland. They are panmictic (all are members of a single population), catadromous (spawn at sea and spend a portion of their lives in freshwater) and semelparous (a single reproductive episode followed by death). Spawning occurs in the Sargasso Sea well to the south of Canadian territorial waters. Juveniles recruit as glass eels (elvers) to Canadian continental waters in the year following the year of their hatch. In Canada, the American Eel can be found in nearly all the accessible fresh, brackish and coastal waters from the Canada/United States of America border in the south to Lake Melville, Labrador in the north, including the Laurentian Basin of the provinces of Ontario and Québec and the island of Newfoundland. They have historically been fished by indigenous peoples for Food, Social, and Ceremonial purposes, and these fisheries remain culturally important. American Eels have also supported commercial and recreational fisheries throughout much of their Canadian range. The Maritimes Region commercial fishery is the only eel fishery in Canada that results in the removals of eels as recruits (glass eels or elvers), as well as juveniles (yellow eel), and adults (silver).

The status of the eel and elver fisheries in the Maritimes Region was last assessed in 1996 (Jessop 1996a,b). More recently, indices of general status were compiled in support of a national pre-COSEWIC and Recovery Potential Assessment of the American Eel (Bradford 2013; DFO 2014) and to help measure progress towards reducing human-induced mortality by 50 percent (DFO 2010). The 2012 COSEWIC assessment designated the American Eel as threatened. They are currently under consideration for listing under the *Species at Risk Act* (COSEWIC 2012).

In support of the management of American Eel and elver fisheries, DFO Maritimes Fisheries Management has asked DFO Science for an assessment of resource status and the consequences of various harvest levels and strategies. DFO Science determined that a framework review of the assessment information and approach was required to establish the scientific basis for the provision of advice to management. This framework meeting was completed in October 2016 (DFO 2017). An assessment meeting is now being held to develop advice to management using the framework approach.

Assessment of standing stock (i.e., abundance of eels in freshwater ecosystems) will not be included in this meeting; it will be addressed following regional electro-fishing surveys planned for 2019.

Objectives

The objectives of this regional peer review are to answer the following questions:

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- What trends in stock status and exploitation are seen in the fishery-dependent and fishery-independent time series used to inform status of elver recruitment and fisheries in the Maritimes Region?
 - Based on a spawner-per-recruit analysis, what are the recommended reference points for large eels to allow for escapement from fisheries and hydro-electric facilities, and is current mortality within those levels?
 - What has been the annual extent of spatial overlap of the large eel and elver fisheries, since 2015?
 - What is the recommended F-based reference points for elver fisheries in the Maritimes Region? What is the status of current exploitation relative to the reference points?
 - What are the implications for existing management measures in the eel and elver fisheries if these reference points are adopted?
 - What is the schedule for future assessments of American Eel, and what will be included in the updates provided between assessments?

On the third day of this meeting, DFO Science is inviting Indigenous communities and organizations to participate in further discussion about what information on American Eel has been collected through science programs, traditional knowledge studies, or other activities run by Indigenous groups in the Maritimes Region, and how these information sources might be incorporated into future eel stock assessment.

Expected Publications

- Science Advisory Report
- Research Document(s)
- Proceedings

Participation

- DFO Science
- DFO Resource and Aboriginal Fisheries Management
- DFO Policy and Economics
- DFO Fisheries Protection Program
- Indigenous Groups
- Provincial Governments (NS and NB)
- Industry Representatives
- Environmental Non-Government Organizations
- Academics

References

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- COSEWIC. 2012. [COSEWIC Assessment and Status Report on the American Eel *Anguilla rostrata* in Canada](#). Committee on the Status of Endangered Wildlife in Canada. Ottawa. xii + 109 pp.
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- DFO. 2014. [Recovery Potential Assessment of American Eel \(*Anguilla rostrata*\) in Eastern Canada](#). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/078.
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- Jessop, B.M. 1996a. [The Status of American Eels *Anguilla rostrata* in the Scotia-Fundy Area of the Maritime Region as Indicated by Catch and License Statistics](#). DFO Atl. Fish. Res. Doc. 96/118. 15 p.
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APPENDIX 3: MEETING AGENDA

DAY 1 (Wednesday, September 5, 2018)

Time	Topic
9:00–9:15	Welcome & Introductions
9:15–10:00	Background and Recap of 2016 Framework meeting
10:00–11:00	Trends in stock status and exploitation
11:00–11:15	Break (coffee/tea provided)
11:15–12:30	Spatial overlap between eel and elver fisheries
12:30–1:30	Lunch (hospitality not provided)
1:30–2:30	Large eel reference points
2:30–2:45	Break (hospitality not provided)
2:45–4:30	F-based reference points for elver fisheries in Maritimes Region

DAY 2 (Thursday, September 6, 2018)

Time	Topic
9:00–9:15	Recap of Day 1
9:15–9:45	Stock status and implications for management
9:45–10:15	Future assessment schedule and interim updates
10:15–10:30	Break (coffee/tea provided)
10:30–12:00	Draft Science Advisory Report
12:00–1:00	Lunch (hospitality not provided)
1:00–2:30	Draft Science Advisory Report
2:30–3:00	Wrap up

APPENDIX 4: PROCEEDINGS FROM A WORKSHOP ON INCLUSION OF INDIGENOUS KNOWLEDGE IN STOCK ASSESSMENT FOR AMERICAN EEL IN THE MARITIMES REGION

Workshop on Inclusion of Indigenous Knowledge in Stock Assessment for American Eel in the Maritimes Region

September 7, 2018

Dartmouth, Nova Scotia

Chairperson: Jennifer Ford

Rapporteur: Larissa Goshulak

INTRODUCTION

This workshop was held as part of the **Assessment of American Eel in the Maritimes Region**, held on **September 5–7, 2018**. The first two days of the meeting were the stock assessment, and included participation from Indigenous groups, Provincial governments, the fishing industry, other invited experts, and several DFO sectors. For the workshop, Indigenous communities and organizations were invited to participate in further discussion with DFO science and management sectors about what information on American Eel has been collected through science programs, traditional knowledge studies, or other activities run by Indigenous groups in the Maritimes Region, and how these information sources might be incorporated into future eel stock assessment.

Specifically, the workshop objectives were to:

- review the Maritimes plan for upcoming assessment to identify opportunities for participation and input;
- review what types of information about eels are collected through Science programs or other activities run by Indigenous groups in the Maritimes, and how this information might be incorporated into the stock assessment;
- discuss what work has previously been done by Indigenous groups to collect and synthesize traditional and ecological knowledge about the American Eel in the Maritimes, and how this can be incorporated into the stock assessment; and
- identify knowledge gaps and areas of common interest for development of new data collection programs or activities.

The meeting Chair, Jennifer Ford, requested that meeting participants introduce themselves (Appendix A1). The Chair thanked participants for attending the workshop and provided a brief overview of the Canadian Science Advisory Secretariat (CSAS) science advisory process and the meeting agenda (Appendix A2). The chair indicated that a Proceedings document would constitute the record of meeting discussions and conclusions.

PRESENTATIONS AND DISCUSSION

Eel Stock Assessment Background and meeting context

Presenter: Rod Bradford, DFO Science Maritimes Region

R. Bradford provided a presentation on the workshop's context, including the Stock Assessment of American Eel in the Maritimes Region that took place on September 5–6, 2018. He identified that, through this Assessment, DFO is adopting reference points for the species compliant with the Fishery Decision-Making Framework Incorporating the Precautionary Approach (DFO 2009). The proposed reference points can also be used in the evaluation of mortality from hydroelectric activities and other human-induced impacts, which will take place in a future assessment. Rod reminded the group that information from Food, Social, and Ceremonial fisheries, including landings, is incomplete and not collected through DFO's standard data collection process, which has resulted in information gaps in the stock assessment for these fisheries. However, it was noted that this is one of many data gaps related to eels, and that recreational fishers are not required to report landings, for example.

Approaches to incorporating Indigenous knowledge in the development of science advice at DFO—national context

Presenter: Steven Alexander, DFO Science National Capital Region

S. Alexander led a presentation on approaches to increase integration and inclusion of Indigenous knowledge in DFO science and science advice processes. He noted that DFO staff in the National Capital Regional are examining the current and potential connections between DFO Science and Indigenous knowledge systems. Outputs from this work will include updating some of the guidance documents for the CSAS program and case studies from across the country regarding the integration of Indigenous knowledge into the development of science advice. He discussed the intersection of Indigenous knowledge systems with DFO activities and noted that Indigenous knowledge systems can have a role in DFO decision-making for Fisheries Protection Program, Oceans Management, Science, SAR, and Fisheries Management (Figure 1a).

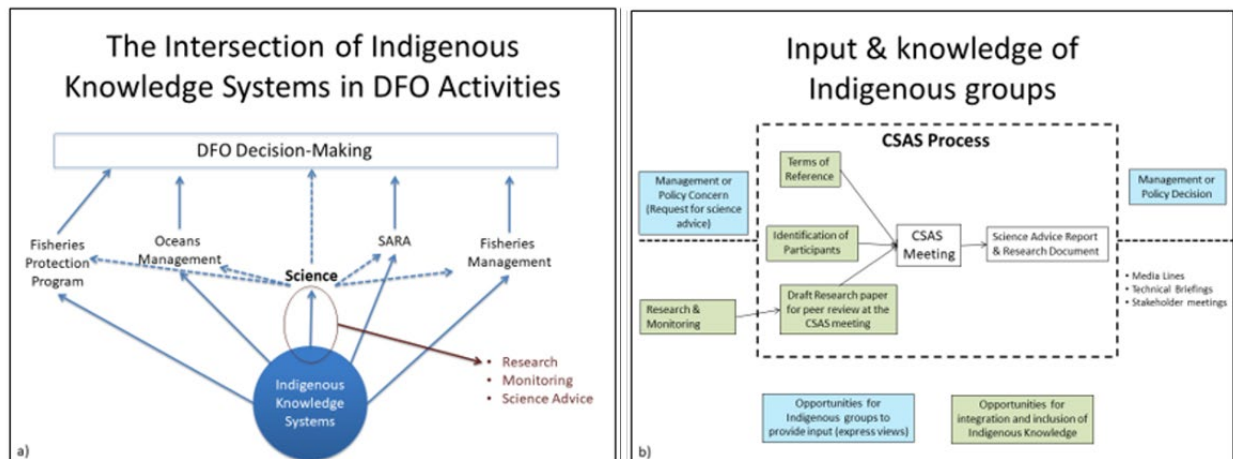


Figure 1a) Schematic showing the potential for Indigenous Knowledge Systems to feed into many streams of DFO decision-making, as well as science activities. b) Diagram of the DFO science advisory process, showing opportunities for indigenous groups to provide input and for integration and inclusion of Indigenous knowledge.

It was suggested that there is an implied hierarchy in Figure 1a., with Indigenous knowledge systems at the bottom and DFO decision-making at the top. Steven clarified that the diagram was not meant to be hierarchical but that the visual depictions are important and could be revised to better reflect the intent. The workshop group then discussed options for how to illustrate integration of Indigenous knowledge systems throughout the decision-making process. A participant also pointed out that the diagram does not illustrate that there are impacts of DFO decision-making on Indigenous groups.

S. Alexander then reviewed the current CSAS process and noted that this process begins with management or policy questions that may be raised within DFO or by Indigenous groups or stakeholders (although the requests to DFO Science for advice only come from within the Department). He identified that there is the potential for input from Indigenous groups to be integrated throughout the CSAS process, including in identifying concerns and questions, developing the Terms of Reference, drafting a research paper for review, peer review, generation of advice, and ongoing research and monitoring (Figure 1b). It was noted that in the majority of cases in the Maritimes Region, participation from Indigenous groups is limited to the CSAS meeting itself, although there are examples of participation throughout the process, such as for Cape Breton salmon populations.

A workshop participant requested more information on the process for requesting science advice in DFO. T. Worcester explained that a call for requests is distributed nationally from the CSAS program to DFO's management sectors (Fisheries Management, Species at Risk, Fisheries Protection Plan, etc.) in the fall of each year. The management sectors can develop requests internally or work with external partners to do so. This could include working with Indigenous groups, although no standard procedures are in place to facilitate that. Discussions between CSAS, Science leads and their managers, and Management Sectors are held to determine feasibility of request and identify risks should the request not be completed. A draft list of regional requests for advice are presented at a national meeting in January, along with a risk assessment, and it is determined whether requests can be addressed in the following fiscal year. For the requests that will be addressed, CSAS, in consultation with Science and client sectors, identifies a Science lead, determines the type of review process, and determines the timeline for provision of advice. The [schedule](#) is published on the CSAS website, around the end of March.

R. MacIntosh asked if the involvement or interest of Indigenous communities could help elevate the weighting of a request. T. Worcester explained that CSAS has a framework to evaluate factors such as risk, international commitments, stakeholder expectations, and public interest. Also, management sectors might consider interest from Indigenous groups when prioritizing their requests to Science. T. Worcester also suggested that CSAS look into ways to flag Indigenous participation or interest in a CSAS request and prioritize these requests when possible and feasible.

A participant asked how weight is given to the contributions of Indigenous knowledge during a CSAS process. Steven commented that it is challenging to track how individual streams of knowledge are used and valued when co-producing research and advice. Alex Levy identified that a lot of collaborative work with Indigenous groups (often the Unama'ki Institute of Natural Resources, UINR) occurs in salmon stock assessments. With respect to eel, a technical working group of the Mi'kmaq Rights Initiative (also known as Kwilmu'kw Maw-klusuaqn, KMK) was initiated to increase collaboration related to eels; however, this process would accommodate

some Nova Scotia First Nations but not all First Nations in the Region or other Indigenous groups.

With respect to fisheries Advisory Committees, it was noted that there is an eel, Shad, and Gaspereau Advisory Committee for Southwest New Brunswick and an Elver Advisory Committee for the Region, but no advisory committee in Nova Scotia for large eel fisheries.

Indigenous Knowledge and Mi'kmaq Worldview of American Eel

Presenter: Shelley Denney, Unama'ki Institute of Natural Resources

S. Denney presented information on Indigenous Knowledge and Mi'kmaq Worldview of American Eel, *katew* in Mi'maq. She first reviewed sources of Indigenous knowledge and its four orientations as described in Latulippe (2015): ecological, critical, relational, and collaborative. She also reviewed how Indigenous knowledge systems might be considered in the management of eel, related to each of the four orientations. She noted that there are challenges in applying a collaborative orientation while working in partnership with government agencies.

S. Denney also discussed the Mi'kmaq worldview and how it establishes the foundations of the Mi'kmaq culture. It was also explained that the Mi'kmaq knowledge system is more reflective of a verb rather than a noun, as there is a focus on how one knows what they know. Shelley explained the interconnection between sustainability of self, both physically and spiritually, to the natural environment. Furthermore, she identified emphasis on self-limitation (taking only what you need), prevention of waste, sharing, and giving back, in Mi'kmaq worldviews.

A case study of eels in the Bras d'Or lakes was reviewed, as that the area is a unique ecosystem and an important fishing area for Mi'kmaq communities in the region (Giles et al. 2016). S. Denney noted that eels sustain the life, health, and spirituality of the Mi'kmaq, are central to the Mi'kmaq identity, and are a source of revenue. Shelley identified that the Mi'kmaq FSC eel fishery includes a spring/summer fishery and a winter spear fishery, both of which are characterized by seasons and rotated fishing areas. Research efforts at UINR have found that over 99% of the eels caught and tested from Bras d'Or lakes were female, in contrast to the majority of the Maritimes Region, where the majority of eels mature as males.

S. Denney then summarized the central concerns identified in Giles et al., regarding the management of eel fisheries in Cape Breton. Primarily, it was noted that in the life cycle of eels, the commercial and recreational eel and elver fisheries have access before the Mi'kmaq FSC fishery as Mi'kmaq FSC fishing methods focus on large eels, particularly out-migrating adults. Furthermore, the waste generated in the recreational eel fishery as a result of size limits was of concern, as undersized eels must be returned to the water but are not expected to survive. Lastly, it was argued that the recreational bag limit for eel should be reduced as a conservation measure.

She communicated that the Mi'kmaq elders and eel fishers recommended the following management changes (Giles et al. 2016):

- increase the minimum legal length of eels for commercial and recreational fisheries;
- propose measures to protect the silver eel;
- minimize waste in the non-Mi'kmaq spear fishery;

-
- update statistical districts for the Bras d'Or lakes;
 - licence the recreational fishery in tidal waters; and
 - prevent elver fishing in the Bras d'Or watershed.

DFO Science plan for Eel stock assessment in the Maritimes Region

Presenter: Rod Bradford

As proposed in the stock assessment on September 5–6th, the workshop group agreed that, in general, it would be appropriate to do stock assessments of eels on a 5-year schedule. However, it was noted that there are several new data streams that may be available in the next two to three years, which might justify a stock assessment in 2021. One of these data streams that was of interest to the group was the planned Regional electrofishing survey, which would allow for estimation of the standing stock of eels in rivers in the Maritimes Region and evaluation of trends. This is tentatively planned for 2019 but with some uncertainty. Several groups present indicated that they had experience with electrofishing and would be interested in collaborating with DFO on this project. In particular, the electrofishing surveys run by DFO have traditionally focused on salmon habitat; while they can be used as an index of eel abundance, they are not designed to fully sample eel populations. Some participants felt that there could be value in collaborating to expand the area surveyed to be more representative for eels. It seemed that the regional Aboriginal Aquatic Resources and Oceans Management (AAROM) groups would be the best points of contact for this.

It was also noted that the Maliseet Nation Conservation Council (MNCC) has been working with the University of New Brunswick to develop non-lethal methods to detect the presence of the swim bladder parasite. There could be potential to use this technique in the regional electrofishing survey.

R. Bradford noted that there could be potential for data collected by some of the workshop participants, such as the pot surveys MNCC is undertaking on the Saint John River, to be included in the interim year updates before the next stock assessment.

Indigenous-led science and monitoring activities related to American Eel in the Maritimes Region: Group Discussion

A representative of the Mi'kmaw Conservation Group (MCG) identified that the group has 5 years of eel data from smolt wheel sampling, as well as various electrofishing datasets. The MNCC has also been doing Eel pot surveys and other field-based research on eels in the Saint John River system. It was determined that there was not sufficient time to identify all relevant research activities or datasets during the workshop. Rather, participants expressed their support for determining what eel data has been collected by Indigenous groups in the Region, and making that information available to DFO, other Indigenous groups, and other potentially interested parties such as academic researchers. Furthermore, participants identified that progress could be made in incorporating Indigenous knowledge in DFO research by doing collaborative work between DFO and First Nations groups that would lead to producing a research report together as co-authors.

DFO Science staff will follow up with workshop participants regarding specific science projects that are candidates for being incorporated into interim year updates or future stock assessments.

Traditional and ecological knowledge related to American Eel: Group Discussion

Similarly, there was not sufficient time to identify in the workshop itself what work has been undertaken to collect and document traditional knowledge related to eels in the Maritimes Region. Information about use of tidal areas outside of rivers in the Maritimes Region was identified as an example of an area where traditional knowledge likely exists, but science surveys have not taken place. Representatives from UINR and MCG identified that they had done relevant research projects on traditional knowledge for eels. It was recommended that DFO undertake to identify the work that has been done to date and discuss with the organizations that have produced this work how it could be incorporated into future eel science and management activities.

It was also noted that there is work being undertaken at the national level within DFO on the appropriate way for DFO to identify and incorporate traditional knowledge into generation of advice and decision-making. At this time, no results of that work were available.

Knowledge gaps and areas of common interest for new programs or activities

T. Worcester expressed that there is a need to determine what questions DFO is looking to answer regarding the eel fishery and what questions Indigenous groups are looking to answer, so that DFO Science activities can also be useful to Indigenous communities. Some priority areas identified by workshop participants concerned standing stock, trends in stock size over time, movement patterns within freshwater systems, natural mortality and fishing mortality, and eel size. The potential impact of other activities, including commercial fisheries, on availability of eels for FSC fishing was raised as a concern by some participants. This is relevant to the provision of science advice for fishery management, particularly given the established priority of rights-based fisheries, including FSC fisheries, in decisions that affect access to resources.

Various meeting participants expressed that they would like DFO Science documents to better describe rights-based fisheries. Participants suggested that this emphasis could lead to changes in how Indigenous knowledge and views are incorporated in these documents, what questions are addressed in stock assessments, and potentially in management decisions. Participants went on to discuss whether this approach could be reflected in management documents as well, such as Integrated Fisheries Management Plans (IFMPs). As an example, a participant suggested that river-specific abundance targets be established for eels in order to support rights-based fisheries, based on science advice.

It was suggested that a separate meeting with Indigenous groups might be warranted for stock assessments of culturally important species, to identify Indigenous knowledge of all types that might be missing, as well as to address issues such as implications for FSC fisheries. A further suggestion was including a peer reviewer from an Indigenous community in CSAS processes that relate to culturally important species, particularly if and when Indigenous knowledge is more explicitly included.

J. Ford asked the group if there is interest in reviewing the extent of voluntary FSC reporting that exists. One participant noted that the level of interest for participating in voluntary FSC

reporting varies between communities, which may be due to factors such as limited resources available or negative experiences with past data sharing processes. Another participant noted that some FSC data is being sent to the Native Council of Nova Scotia, but the data may not be passed on to DFO from there. It was agreed that DFO staff would follow up to clarify what information is received by DFO and how it could become available to DFO Science.

R. Bradford highlighted that it would be valuable to discuss some of these considerations at the next KMK technical working group meeting. A group representative noted that some communities are not represented by the Kwilmu'kw Maw-klusuaqn Negotiation Office (KMKNO) and discussions should, therefore, be extended to these communities. Interest was expressed in a similar venue for discussions in New Brunswick. Rod noted that the existing Southwest New Brunswick Eel, Shad, and Gaspereau Advisory Committee could be used as another venue for discussing eel science and management. Meeting participants felt that while there may not have been interest in advisory committees in Nova Scotia in the past, there may be interest now.

The group then discussed the idea of conducting a review of the research and datasets that have been completed for eel by Indigenous groups in the Maritimes Region, and using that review to propose directions for future work. More detailed discussions will be required between DFO and organizations that are conducting science activities related to eels that might be able to be incorporated into future science activities for eels, such as stock assessments or updates. DFO staff and workshop participants expressed a strong interest in following up on these activities, although all parties acknowledged constraints in capacity.

Summary and Next Steps

J. Ford summarized some of the key messages discussed in the meeting and thanked participants for their contributions. Updates will be provided when possible to the workshop group regarding next steps.

Recommendations related to data and information sources:

DFO staff will follow up with AAROM groups about the regional electrofishing survey planned for 2019, participants were generally interested in partnering on this survey and many have experience with electrofishing for eels in their geographic area.

It was agreed that DFO staff would follow up to clarify what information on FSC fisheries is received by DFO and how it could become available to DFO Science.

Recommendations related to the development of science advice through CSAS:

- Identify how Indigenous groups could be involved in identifying needs for science advice.
- Consider how to include interest to Indigenous groups in the prioritization of requests for advice.
- Several participants recommended that DFO Science documents better describe rights-based fisheries
- A separate meeting with Indigenous groups might be warranted for stock assessments of culturally important species, to identify Indigenous knowledge of all types that might be missing, as well as to address issues such as implications for FSC fisheries.
- Including a peer reviewer from an Indigenous community in CSAS processes that relate to culturally important species was recommended, particularly if and when Indigenous knowledge is more explicitly included.

Recommendations related to collaborating on science related to American Eel:

- Participants expressed their support for determining what eel data has been collected by Indigenous groups in the Region and compiling that information so that it is available to DFO, other Indigenous groups, and other potentially interested parties such as academic researchers. This would be led by DFO Science but how it will be undertaken needs to be determined.
- DFO Science staff will follow up with workshop participants regarding specific science projects that are candidates for being incorporated into interim year updates or future stock assessments.

REFERENCES CITED

Giles, A., Fanning, L., Denny, S., and Paul, T. 2016. Improving the American Eel Fishery Through the Incorporation of Indigenous Knowledge into Policy Level Decision Making in Canada. *Human Ecology*. 44: 167–183.

Latulippe, N. (2015). Situating the Work: A typology of traditional knowledge literature. *AlterNative: An International Journal of Indigenous Peoples*. 11(2): 118–131.

WORKSHOP AGENDA

Time	Topic	Lead
9:00–9:15	Welcome & Introductions	Jennifer Ford and Rod Bradford
9:15–9:25	Background and meeting context	Rod Bradford
9:25–9:45	Approaches to incorporating Indigenous knowledge in the development of science advice at DFO – national context	Steven Alexander
9:45–10:00	DFO science plan for eel stock assessment in the Maritimes Region	Rod Bradford and Jennifer Ford
10:00–10:30	Indigenous Knowledge and Mi'kmaq Worldview of American Eel	Shelly Denny
10:30–10:45	Break (coffee/tea provided)	
10:45–12:00	Indigenous-led science and monitoring activities related to American Eel in the Maritimes Region– what has been done to date and what key gaps exist?	Roundtable
12:00–1:00	Lunch (hospitality not provided)	
1:00–2:00	Traditional and/or ecological knowledge related to American Eel - what has been done to date and what key gaps exist?	Roundtable
2:00–3:00	Knowledge gaps and areas of common interest for new programs or activities	Roundtable
3:00–3:30	Summary and next steps	Jennifer Ford
3:30	Adjourn	

WORKSHOP PARTICIPANTS

Participant	Organization
Rob MacIntosh	Aboriginal Fisheries Management, DFO Maritimes
Charlie Marshall	Atlantic Policy Congress of First Nations Chiefs
Alanna Syliboy	Confederacy of Mainland Mi'kmaq
Jennifer Ford	CSAS, DFO Maritimes
Tana Worcester	CSAS, DFO Maritimes
Lottie Bennet	CSAS, DFO Maritimes Region
Élyse McCall-Thomas	Evaluation Unit, DFO National Capital Region
Patrick Polchies	Kingsclear First Nation
Aruna Jayawardane	Maliseet Nation Conservation Council
Vanessa Mitchell	Maritime Aboriginal Peoples Council
Hubert Nicholas	Membertou First Nation
Jamie Lantz	Mi'kmaw Conservation Group
Sana Kavanaugh	Mi'kmaw Conservation Group
Brontë Thomas	Peskotomuhkati Nation
Sophie Pitre-Arseneault	Policy Research Division, DFO Maritimes
Matthew Fraser	Resource Management, DFO Maritimes
Larissa Goshulak	Resource Management, DFO Maritimes
Rod Bradford	Science, DFO Maritimes
Alex Levy	Science, DFO Maritimes
Steven Alexander	Science, DFO National Capital Region
Sarah Deller	Species at Risk, DFO Maritimes
John Perley	Tobique First Nation
John Couture	Unama'ki Institute of Natural Resources
Shelley Denny	Unama'ki Institute of Natural Resources