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REPORT

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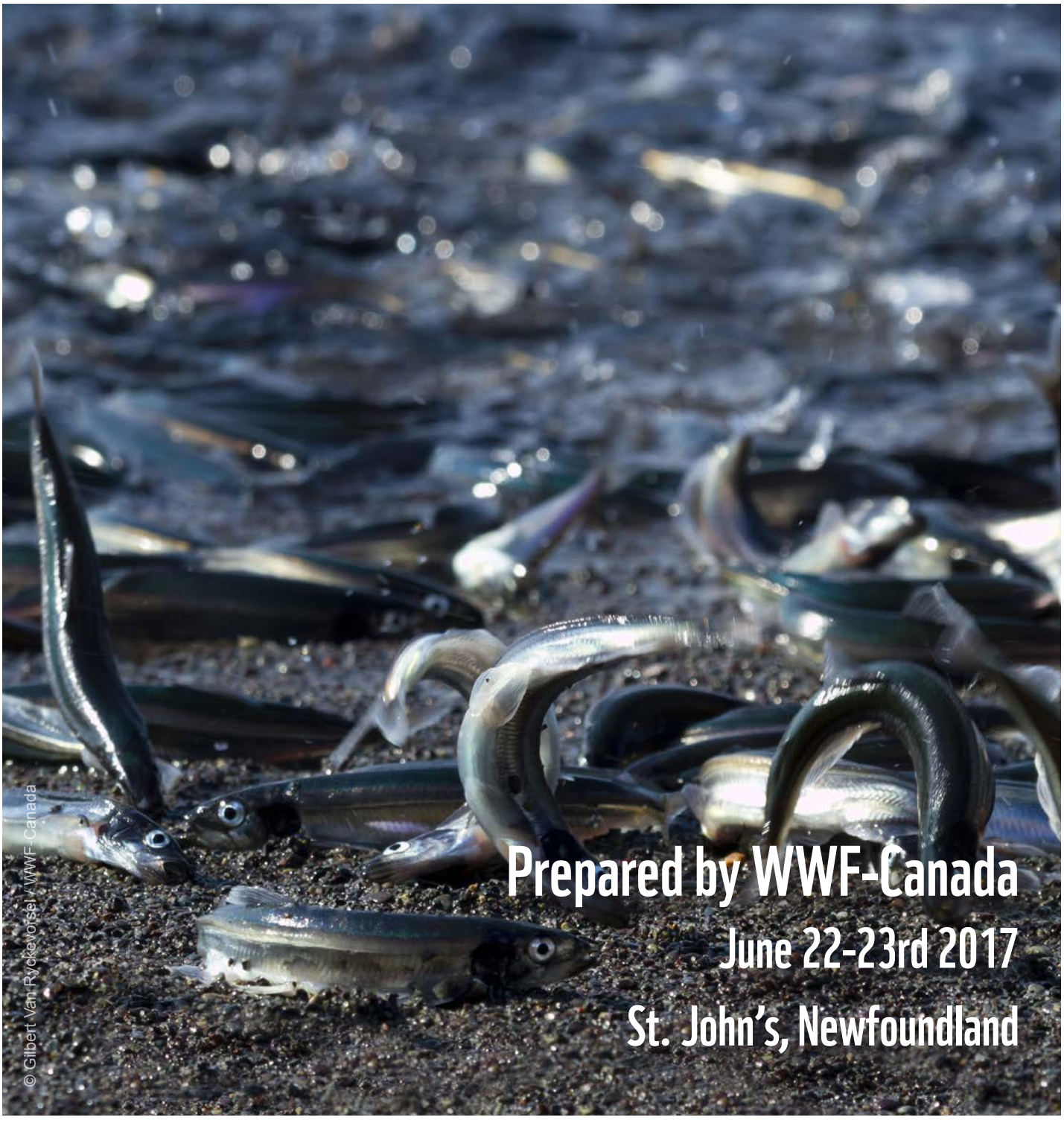
WWF-Canada - Fisheries and Oceans Canada

JOINT CAPELIN WORKSHOP



Prepared by WWF-Canada

June 22-23rd 2017

St. John's, Newfoundland

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WWF-Canada, 4th Floor 410 Adelaide Street West, Toronto, ON M5V 1S8 Canada
Toll-Free: 1-800-267-2632
Email: **ca-panda@wwfcanada.org** Website: **wwf.ca**
Donate: **wwf.ca/donate**

LIST OF ACRONYMS

B_{Lim}	Biomass limit reference point
CCGS	Canadian Coast Guard Ship
DFO	Fisheries and Oceans Canada
FSC	Food, social and ceremonial
IFMP	Integrated fisheries management plan
IK	Indigenous knowledge
IQ	Individual quota
LEK	Local ecological knowledge
NAFO	North Atlantic Fisheries Organization
NCC	NunatuKavut Community Council
NOAA	National Oceanic and Atmospheric Association
SLGO	St. Lawrence Global Observatory
SSB	Spawning stock biomass
SST	Sea surface temperature
TAC	Total allowable catch
VMS	Vessel monitoring system
WWF	World Wildlife Fund

SUMMARY

The joint Fisheries and Oceans Canada (DFO) and WWF-Canada workshop on capelin (*Mallotus villosus*) took place June 22nd and 23rd, 2017 in St. John's Newfoundland. Over 60 participants from Quebec and Newfoundland and Labrador with expertise in capelin biology, ecology, environmental influences, and management participated. A diverse group of stakeholders was represented through the inclusion of capelin harvesting and processing industries, Fisheries and Oceans Canada (DFO) scientists and managers, the Province of Newfoundland and Labrador, environmental non-government organizations (ENGOs), Indigenous organizations, and academics. Presentations were made by a range of stakeholders to inform participants of the current state of capelin science and management and the socio-economic and cultural value of capelin. Participants then engaged in discussion sessions to identify knowledge and management gaps. Recommendations for moving forward were developed based on these discussions. This report contains a summary of the presentations and discussions, and details the recommendations produced by the participants of the workshop.

INTRODUCTION

A joint workshop on capelin (*Mallotus villosus*) organized by WWF-Canada and Fisheries and Oceans Canada (DFO) took place on June 22nd and 23rd 2017 in St. John's Newfoundland. There were over 60 participants at the workshop representing a diversity of groups including the fishing industry (harvesters and processors), Indigenous organizations, environmental non-government organizations (ENGOs), academia and government. Presentations on the science, management, socio-economic and cultural value of capelin were made by the different groups in attendance. The presentations were followed by facilitated group discussions, which were used to develop recommendations to address capelin knowledge and management gaps.

This report summarizes the presentations and discussions which occurred at the workshop, and outlines recommendations for future research and management. The presentations were designed to educate workshop participants on the breadth of knowledge available on capelin, current management strategies for capelin in the northwest Atlantic as well as other jurisdictions, and the social, economic ecological and cultural value of capelin. The facilitated discussion sessions focused on four main topics: the science needs of management, capelin populations, the role of capelin in the ecosystem, and the impact of environmental change on capelin. The recommendations produced during the discussion sessions, and stated in this report, are divided into two main groups: i) Knowledge Improvement, and ii) Management Approaches. Each recommendation is accompanied by a set of specific action items designed to facilitate achieving the recommendation, and prioritized according to whether it requires immediate action, or should be incorporated into a long-term scientific or management plan.

The organizers of the workshop recognized that there would be a diversity of opinions on the capelin fishery among participants. However, the facilitated discussion sessions were designed to develop recommendations based on consensus to chart a path forward for the management of capelin. The recommendations produced highlight the need for continued engagement with all stakeholders to address knowledge gaps and implement effective management strategies. Given that each group provides a unique perspective and knowledge base on capelin, continued collaboration amongst all groups will be important for moving forward with addressing the report recommendations.

PRESENTATIONS

2J3KL CAPELIN – STOCK ASSESSMENT AND LATEST TRENDS

Fran Mowbray (DFO)

This presentation provided an overview of capelin life history, the drivers of capelin abundance, approaches to assessing capelin abundance, and new and ongoing work to address knowledge gaps in capelin 2J3KL stocks.

Capelin have a life span of four to six years, with first spawning occurring at age two or three. The 2J3KL capelin stocks spawn inshore along the northeast coast of Newfoundland in the late spring to early summer and then migrate northwards in the fall to overwinter. In the spring, capelin migrate south along the shelf break to 3L. Most juveniles are found in the 3L area.

A combination of physical and ecological forces can affect capelin abundance. Temperature, ice coverage and the timing of ice retreat in the spring drive ecosystem dynamics at the base of the food web, which in turn affects capelin abundance. For example, ice coverage and retreat drives the timing and magnitude of the spring phytoplankton bloom, and zooplankton abundance thereafter. Adult capelin feed on copepods, and therefore zooplankton abundance can affect the condition, survival and spawning success of adult capelin. There is no proven relationship between capelin spawner biomass and cohort strength, however, there is a relationship between larval biomass and cohort strength. Drivers of larval survival include the timely evacuation of larvae from beach sediments, food availability, and predation. Wind direction may have influenced capelin larval survival in the past, but is no longer thought to be a primary driver. A number of predators feed on capelin, potentially affecting capelin abundance, and include seals, birds, Greenland halibut and cod. The consumption of capelin by cod has been increasing since 2012, and is not expected to decrease.

In the late 1970's and early 1980's there was no dedicated survey for capelin. Spring and fall acoustic surveys were started in the late 1980's. In addition to the acoustic surveys, there was a bottom trawl conducted in the fall in 2J3KL from

1995-2016, and larval capelin surface tows at Bellevue Beach from 2002 to 2015. Data from these surveys are used to inform the management of the fishery, and multiplicative models are used to assess trends. Multiple data inputs are required for capelin stock assessments, including the in-coming cohort strength, the cohort strength of age 3+ and surviving age 2+ spawners, the proportion maturing at age, natural mortality, and growth rates. Information on environmental conditions, larval recruitment and predator consumption estimates are required to effectively manage capelin.

Capelin and larval production were relatively low in the early 2000s, increased in the mid-2000s, but have decreased again in recent years to numbers similar to those in the early 2000s. Current evidence indicates that capelin abundance was poor in 2016, and that cohorts contributing to the 2017 and 2018 spawning biomass will be weak. The poor forecast for 2017 and 2018 may be driven by poor feeding conditions and/or an increase in capelin predator abundance with a simultaneous decrease in alternate prey sources for capelin predators.

Future work includes a dedicated capelin acoustic survey in the fall of 2018, the gathering of data from opportunistic surveys, the development of a predictive model for ice and capelin dynamics, the study of the effect of predators on larval dynamics, and the study of larval and adult capelin diets and capelin genetics. In addition, remote sensing will be used to study copepod phenology and subsequent availability to capelin. A new research scientist will begin the development of an analytical assessment in 2017.

CAPELIN IN THE GULF OF ST. LAWRENCE (4RST)

Martin Castonguay (DFO)

This presentation provided participants with an update on the state of the capelin fishery in 4RST, sources of data on these capelin populations and future work aimed at addressing knowledge gaps.

There are commercial capelin fisheries in the 4RST North Atlantic Fisheries Organization (NAFO) areas in the Gulf of St. Lawrence, with the majority of catches occurring in 4R. The total allowable catch (TAC) is 11 195 tons in 4R and 1805 tons in 4ST, most of which is harvested by purse seine. Catches in 4RST declined from 9593 tons in 2012 to 5576 tons in 2014, but rose again in 2015 to 11 480 tons. Currently there is no abundance survey conducted in 4RST. Presence/absence data is available from bottom trawls conducted aboard the CCGS Teleost research vessel, which provides some information on the distribution of capelin. Capelin length data has been collected by seine in 4R since the 1980s; lengths of capelin were the highest recorded in 2014. The most recent Science Advisory Report on capelin in 4RST was published in 2013, with an interim Science Response published in 2015.

The Capelin Observers Network has been operating since 2002 and was established by DFO and other partners. Through this network the public can report observa-

tions of capelin spawning. A database of these observations is available at SLGO.ca. An online platform has been developed (ecapelin.ca) for the public to report observations and locations of capelin spawning. The ecapelin.ca project is a partnership between WWF-Canada and the St. Lawrence Global Observatory (SLGO).

Future plans for capelin work in the Gulf of St. Lawrence include starting an annual acoustic survey in 2018 aboard the CCGS Frederick G. Creed in May, when Gulf capelin are thought to be aggregated in preparation for spawning. The acoustic sampling will be in collaboration with Newfoundland and Gulf region offices of DFO. eDNA samples will be collected and used to assist with identifying acoustic signals. The connection between fishing performance and recruitment will also be investigated further. Data limited methods (DLMTools) will be used to study capelin in the Gulf of St. Lawrence.

OCEANOGRAPHIC CONDITIONS ON THE NEWFOUNDLAND SHELF AND NORTHWEST ATLANTIC

Pierre Pepin (DFO)

This presentation provided a summary of physical and biogeochemical indexes within and among regions on the Newfoundland Shelf and in the northwest Atlantic. The data was presented using annual standardized anomalies, which allowed participants to compare current conditions with historical conditions.

Sea ice extent off the coast of Newfoundland has been low since the 1990s, was above normal in 2014, and returned to below normal in 2016. The north Atlantic has been experiencing a warm period as evidenced by above normal sea surface temperature (SST) since 1995. SST has been increasing over the past 33 years, amounting to a total increase of about 1 °C. However, in the short term, SST has decreased since 2012, with 2015 and 2016 being below normal. There is significant annual variability in bottom water temperature, however, a general warming trend since 1990 has amounted to an increase of 1.5 °C during that period. Bottom temperatures reached a record high in 2011 but then decreased significantly from 2014 through 2016. Bottom salinity has been below normal for the past 4 years. Stratification increased in 2016 relative to 2015 but remains slightly below average, while the mixed layer depth shows a trend towards deepening. Stratification and mixed layer depth are exhibiting some decoupling.

Chlorophyll *a* concentration was used as a proxy for phytoplankton biomass, and shows a general reduction in intensity and duration of the spring bloom and reduced biomass in the autumn across the Newfoundland shelf within the last four years. Sea ice off the coast of Labrador and the northeast coast of Newfoundland could be a driver of spring phytoplankton trends: higher sea ice results in a delayed spring bloom with a lower biomass, while lower sea ice means an earlier spring bloom with higher biomass levels. There has been a decade long decline in nutrient

availability and phytoplankton standing stocks when averaged across all NAFO areas. Copepods are increasing in abundance, but decreasing in biomass, with a strong reduction in the abundance of large energy rich copepods, resulting in an overall shift towards smaller species.

CAPELIN MANAGEMENT

Jackie Kean and Antoine Rivierre (DFO)

This presentation provided participants with an overview of past and current capelin management strategies within Canada.

There are three capelin stocks in eastern and southern Newfoundland (2J3KL, 3NO and 3Ps), and one capelin stock in the Gulf of St. Lawrence (4RST), which includes the west coast of Newfoundland. In the late 1970's and early 1980's there was low participation in the 2J3KLPs capelin fishery, with participation increasing in the late 1980's, mainly in the fixed gear sector. Fixed gear licenses increased in 4R in the 1980's, with less of an increase in 4ST. The bulk of the capelin fishery currently occurs in 3KL, although there is also a significant commercial fishery in the Gulf of St. Lawrence in 4R. Within the Gulf of St. Lawrence, the largest landings occur in 4R. Starting in 1998, the 2J3KLPs and the 4RST fisheries were managed under separate Integrated Fisheries Management Plans (IMFP).

The 2J3KLPs and 4RST fisheries are both competitive fisheries with a TAC and some individual quotas (IQ). Dockside monitoring, at sea observer coverage, Vessel Monitoring Systems (VMS), and logbooks are used by both fisheries to monitor catches. In the 2J3KLPs fishery there are daily trip limits, harvest caps and area limits in addition to the IQs. The 2J3KLPs TAC is currently 30 496 tons, with the fishery remaining open until the quota is taken. In 4R the fishing season is determined based on recommendations by the industry, independently in each quota area. In 4ST, the fishing season starts on June 1. The TAC has been 14300 since 2013.

In 2016 the total landed amount in 2J3KLPs was 27 390 tons with a value of $10 million. The total landed catch in 4RST was 9899 tons with a value of $3.88 million. Current challenges in the capelin fishery include setting opening and closing dates in 2J3KLPs and 4R. As well, there is no defined sharing arrangement between 4T and 4S.

MANAGEMENT OF CAPELIN IN OTHER JURISDICTIONS

Hannah Murphy (DFO)

This presentation provided workshop participants with an overview of how capelin fisheries in other jurisdictions are managed.

There are three main capelin populations in the North Atlantic: the Barents Sea population, the Iceland-East-Greenland-Jan Mayen population (hereafter referred

to as the Iceland population) and the Newfoundland and Labrador population. The Barents Sea and Iceland populations are managed to ensure that a given number of capelin remain in the ocean to spawn. The number of capelin required to remain in the ocean is determined by the amount of fish in excess of the pre-determined Biomass limit (B_{Lim}), which is the limit reference point necessary for a healthy Spawning Stock Biomass (SSB).

To assess the Barents Sea population, a joint Norwegian-Russian acoustic survey is conducted for the area in autumn. A forward projection of the future SSB is calculated in April. If the SSB is below the set B_{Lim} of 200 000 tons, then the capelin fishery is closed for that season. Data from the acoustic survey on the abundance of maturing capelin of ages 1 and 2 are input into a model (Bifrost) along with an estimate of capelin maturation and cod predation. Quotas are calculated using a second model (Captool). Uncertainties associated with this modeling approach include the difficulty of testing the model (the majority of capelin die post-spawning), error in cod abundance estimates, habitat areas not covered by the acoustic survey, and uncertainty in estimates of predation on capelin. There is no fishery for the Barents Sea capelin population in 2017.

The Iceland capelin population is assessed with two acoustic surveys, one in autumn and one in winter. The initial quota is based on the abundance of immature capelin in a given spawning class obtained during the autumn acoustic survey that occurred 16 months previous. The intermediate quota is determined by the abundance of the maturing capelin for the same spawning class in the autumn acoustic survey that occurred four months previous. The final quota is determined by a model based on the abundance of mature capelin in the winter survey. The model takes into account the uncertainty of the acoustic survey, predation on capelin (by cod, haddock and saithe), and ensures a <5% chance that the SSB drops below the B_{Lim}. The B_{Lim} for this fishery is 150 000 tons. The revised winter survey quota for the 2017 Iceland fishery is 196 075 tons. The Iceland fishery is certified sustainable by the Marine Stewardship Council.

CAPELIN FISHING INDUSTRY

Dwan Street and Erin Carruthers (FFAW-Unifor)

This presentation provided workshop participants with an overview of the capelin fishing industry in Newfoundland and Labrador.

The FFAW-Unifor union (Fish, Food & Allied Workers) is the largest private sector union in Newfoundland and Labrador and consists of owner-operators, crew members and plant workers. The two main capelin fisheries in Newfoundland and Labrador are on the west coast (4R) and the northeast coast (2J3KL). The fishery consists of small (< 35 feet, 54.8% of vessels) and large (> 35 feet, 45.2% of vessels) vessels which use both fixed and mobile gear. The capelin fishery supports a market for large, roe bearing females and mixed capelin. The total number of active

licenses in 2016 is 1475 with most active licenses held in 3L (650), 3K (548) and 4R (219). Active licenses are paid for and retained for a year, but it is not necessary that they be actively fished. The majority of the catch is exported to the Asian market.

The capelin fishery is an important component of the economy in Newfoundland and Labrador. In 2016 capelin made up 53.8% of pelagic landings in the province and contributed $21 million to the economy, from both harvesting and processing. There are thirty-one facilities which reported processing capelin in 2016. Small vessels harvested approximately 10 000 tons in 2016 for a value of over $3 million, while large vessels harvested almost 25 000 tons for a value of around $9 million.

The Newfoundland and Labrador fishing industry is in transition; environmental and ecological parameters are shifting to conditions less favorable for shellfish such as snow crab and shrimp, while groundfish stocks are rebuilding. The role of capelin within this ecosystem is unclear, but there is a need for multi-fishery and multi-species management. Science needs for the management of capelin include an estimate of capelin biomass, surveys covering the scope of capelin habitat throughout the year, and an understanding of the recruitment of capelin to the fishery. The experience and knowledge of fish harvesters should be used by government to contribute to capelin assessments, which in turn should contribute to an ecosystem based management approach with recovery plans that are consistent across species.

CAPELIN PROCESSING INDUSTRY

Bill Barry (Barry Group Inc.)

This presentation provided workshop participants with a perspective on the capelin fishery from the processing sector of the industry.

The capelin fishery is important for the well-being of the residents of Newfoundland and Labrador, and therefore there is a need for good science and investment in the management of the fishery. Capelin are a pelagic fish stock which undergo boom and bust cycles, and the fishery has a limited impact on the capelin stock. There are unknowns surrounding capelin predator-prey relationships.

The presenter shared a video produced by the University of Washington, which featured interviews with academic scientists. The scientists interviewed had recently published a paper in a peer reviewed journal which questioned a main conclusion of the Lenfest Task Force paper on the importance of forage fish. The Lenfest Task Force suggests using the precautionary principle when designing fisheries management plans for forage fish in order to protect the food source of marine predators. The academic scientists in the video assert that the models the Lenfest Task Force applied are not accurate, and that according to their models, forage fish abundance is not a driver of predator abundance. There is uncertainty surrounding the importance of capelin to predators in the northwest Atlantic.

THE SOCIO-ECONOMIC / CULTURAL IMPORTANCE OF CAPELIN: THE SOUTHERN INUIT OF NUNATUKAVUT PERSPECTIVE

Patricia Nash (NunatuKavut Community Council)

This presentation provided workshop participants with a description of the social, economic and cultural importance of capelin to the people of NunatuKavut.

NunatuKavut means Our Ancient Land, and is the territory of the Southern Inuit people, encompassing central and southern Labrador. The NunatuKavut Community Council (NCC) is responsible for ensuring that their land, water and ice rights and titles are recognized and respected. NunatuKavut encompasses 700 kilometers of coast line and twenty coastal communities. The communities of NunatuKavut have Food, Social and Ceremonial (FSC) fisheries and hold commercial fishing licenses. Traditionally the people of NunatuKavut practiced a transhumance lifestyle in which they moved seasonally to follow the availability of resources, and families spaced themselves apart in order to reduce pressure on the resources of a given location.

The definition of Traditional Knowledge according to UNESCO and the Internal Council of Science was presented:

> "Traditional knowledge is a cumulative body of knowledge, know-how, practices and representations maintained by peoples with extended histories of interaction with the natural environment. These sophisticated sets of understandings, interpretations and meanings are part of a cultural complex that encompasses language, naming and classification systems, resource use practices, ritual, spirituality and worldviews".

There are numerous differences between the world view of Indigenous people and that of western science. Indigenous people have a subordinate relationship with nature and approach nature with intuition and respect. They communicate orally through storytelling, songs, tradition and skills, and have holistic, subjective and experimental characteristics. They observe data in a slow and inclusive way and make predictions that are cyclical and span long time frames. Indigenous people explain the world in a spiritual, interrelated way and classify land as sacred. In contrast, western science has a dominant relationship with nature, and approaches it in an analytical way to improve upon it. Western science communicates through literature in a moralistic way and has reductionist, objective and quantitative characteristics. Western science observes data in a fast and selective way and makes predictions in a short term linear way which has poor long-term prediction capabilities. Western science is skeptical by nature, requires proof and suggests that land should be developed for the benefit of humans.

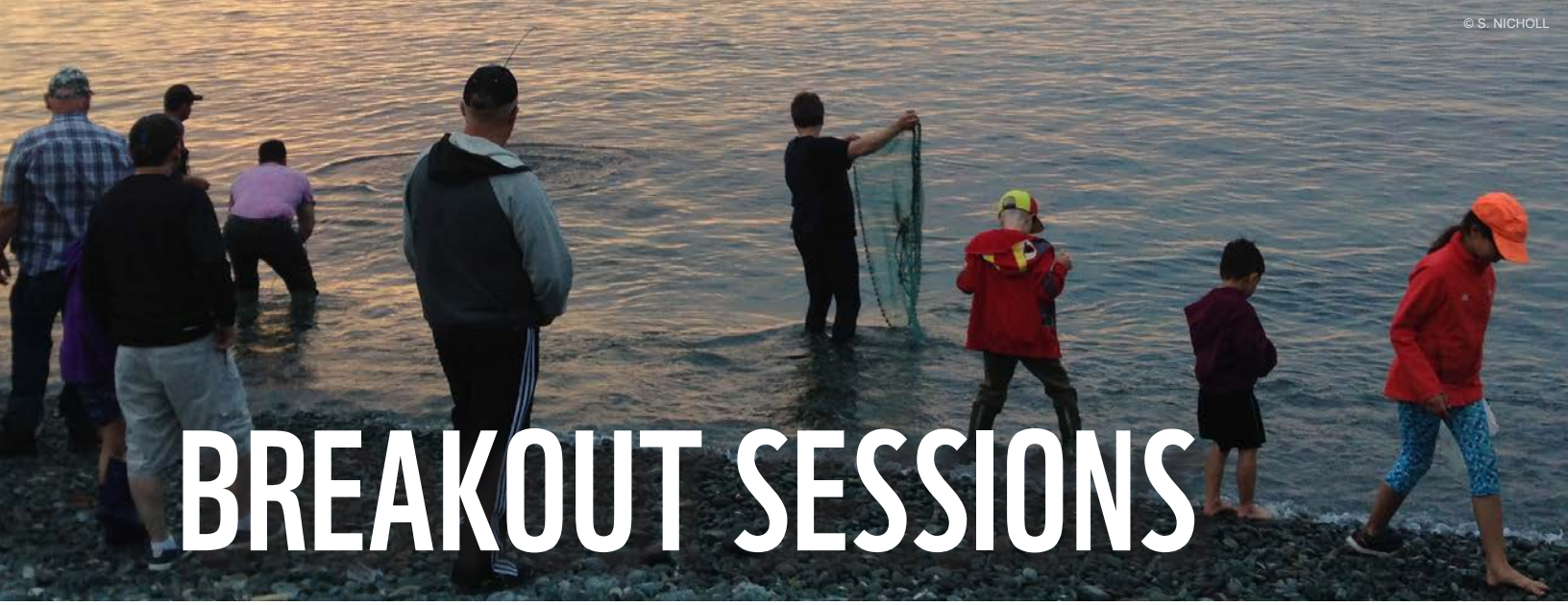
The Canadian government operates under the premise that western scientific knowledge is true knowledge. Many western scientists view Indigenous knowledge (IK) as a useful addition to science, but not part of science. Western scientists

refuse to recognize the spiritual aspect of IK and the oral transmission through which it is communicated, despite the fact that IK has been used to inform science.

Capelin are an important food source for the well-being of southern Inuit. Capelin play a critical role in the food chain and therefore the southern Inuit do not rely on a commercial capelin fishery. The long relationship between the southern Inuit and capelin has resulted in knowledge of their life cycle, habitat use and population dynamics. The knowledge gaps which the southern Inuit have identified include a lack of knowledge surrounding the origin of stocks, and they are working with researchers to identify, conserve and protect capelin stocks. Their research objectives include understanding population genomics and connectivity, defining morphometric and life history traits, and integrating IK and Local Ecological Knowledge (LEK).

Prior to the 1980s, capelin populations off the coast of NunatuKavut were plentiful and spawned for weeks. In the late 1980s and 1990s, the NCC noticed foreign trawlers harvesting capelin and alerted DFO. The capelin fishery in the 1990s was an inshore fishery that harvested spawning females, and large seiners were seen in the region. The fishery was unsustainable and in recent years there has been a decline in the size of capelin and a change in habitat use to deeper waters. In 2016 no capelin were seen spawning in NunatuKavut.

For the southern Inuit, capelin are not a fish for a fishery, but a fish that is needed to feed the ocean. There is a need for meaningful consultation with Indigenous Groups and a recognition and inclusion of IK. Management should shift its goals from determining the highest Total Allowable Catches to allowing the highest returns for the ecosystem. It is worth considering the trade-offs between harvesting capelin for a commercial fishery versus leaving fish in the ocean to conserve the ecosystem for the future.



BREAKOUT SESSIONS

WHAT ARE THE SCIENCE NEEDS OF MANAGEMENT?

To effectively manage the capelin stock, science based information is needed by managers. The information required includes: the influence of environmental conditions and climate change on capelin populations, predator consumption rates, the impact of the commercial fishery on capelin stocks, the origin and structure of the capelin populations, seasonal movements of capelin, the critical habitat of capelin and capelin spawning behavior. Knowledge of the current state of capelin stocks is needed, as well as the ability to make future projections. Acceptable levels of risk should be defined by scientists within the context of the precautionary approach, and these levels of risk should be communicated to managers.

A capelin communications strategy, whereby DFO scientists communicate with management, harvesters and the public what is known, what the uncertainties are and general information on the role of capelin within the ecosystem should be developed. This may include communication training for DFO scientists. There should be transparency in communicating science and decision making in the absence of solid data. The provision of information from scientists needs to be done in a timely way so that the TAC and fishery opening dates can be set in advance.

Mechanisms for collaborative management and participatory monitoring are needed. An investment in capacity and resources would be necessary to develop these mechanisms. Data collection protocols should be developed to guide harvesters and processors to ensure the data collected meets the standards necessary for inclusion and integration in DFO science assessments.

DFO scientists should better integrate Indigenous knowledge with western scientific knowledge. Indigenous rights should be recognized.

There needs to be an increased capacity of fisheries economics and social science within DFO to work on ecosystem based fisheries management. Best practices from other countries should be identified and evaluated to determine if they are applicable in Canada.

CAPELIN POPULATION (DYNAMICS/DISTRIBUTION/SURVEYS)

Information on the range, distribution and abundance of capelin is lacking. This knowledge gap could be addressed by increasing the spatial and temporal coverage of surveys. Technologies such as eDNA and citizen science could be used to supplement the surveys. However, the accuracy of citizen data should be assessed prior to inclusion in stock assessments. Data gaps increase with latitude in the north, and as such we need to determine the range and distribution of capelin in the Arctic, and their potential interaction with Arctic cod.

The diet of capelin, and the distribution and abundance of capelin prey items requires better understanding. Euphausiids are thought to be the main food source of capelin, however, there is no complete picture of the capelin diet in space and time. Euphausiids are difficult to sample and therefore no biomass or distribution data is available for them.

Capelin habitat needs to be better understood. For example, the relationship between capelin abundance and distribution, the extent to which capelin use natal homing and the proportion of mixing among different stocks is not well understood. Without this knowledge, it is difficult to design effective acoustic surveys, an abundance index or separate capelin populations into management areas. Tagging studies and otolith microchemistry could be used to help separate stocks and their habitat. However, abundance indices which are fixed in space and time may remain ineffective given the variability of capelin population dynamics.

There are significant knowledge gaps in our understanding of capelin spawning dynamics. For example, the timing of spawning across the range of capelin, the threats to capelin spawning sites, larval production, factors driving age at maturity and predictors of egg survival need further study. Expanding the observer network and the #eCapelin program could provide more information on capelin spawning sites, if citizen reporting can be proved reliable. However, a citizen science approach may be limited, particularly in the 3Ps region, where there are few communities and these communities are not necessarily close to beaches. In addition to an expanded observer network, it is important to identify and study offshore spawning sites, and to determine differences in recruitment and survival between spawning site types.

It is essential to undertake a stock assessment of capelin which defines reference points such as the B_{Lim}. However, given the variability in capelin population dynamics, some flexibility in defined reference points is required. Identifying critical drivers of capelin abundance, and incorporating them in a multi-species and/or ecological model could inform the setting and adjusting of flexible reference points.

Socio-economic considerations should be included in capelin management approaches. For example, studies which assess the trade-offs between leaving capelin in the ecosystem versus removing capelin via direct fisheries would help to quantify the benefits of different approaches. The inclusion of socio-economic factors in management approaches could require more investment by DFO, but

would contribute to building healthy capelin stocks and sustainable communities. Organizations in other countries such as the National Oceanic Atmospheric Administration (NOAA) in the US have conducted this type of analysis, thus best practices from other jurisdictions could be used to inform this approach. Regardless of the approach, current management decisions should be assessed in future years to determine their effectiveness and their impacts on capelin and the broader ecosystem.

CAPELIN ROLE IN THE ECOSYSTEM (PREDATOR-PREY DYNAMICS)

Capelin are a forage fish within the ecosystems they inhabit and play an important role as a source of food for larger predators. Capelin predators include cod, groundfish, seals, whales, sea birds, turbot, redfish, Atlantic salmon and plaice. While there is a positive relationship between adult capelin abundance and cod growth rates, it is not well understood how much capelin each of the different predators consume. Even less information is available on the predation rates of different species on capelin larvae.

Capelin consume invertebrates such as euphausiids and copepods, and therefore act as a link to transfer energy from the base of the food web to higher trophic positions. The reliance of capelin on invertebrate grazers means that capelin productivity is linked to the timing of ice retreat and the spring phytoplankton bloom through their influence on invertebrate abundance. Climate change related shifts in abundance or distribution of capelin prey and predators may impact capelin abundance, however more information is required to determine this. Given the key role of capelin within the ecosystem and the effect that prey and predator dynamics might have on capelin, it is important to manage capelin from an ecosystem perspective and include environmental factors such as climate change in management plans.

ENVIRONMENTAL CHANGE

Temperature is an important environmental factor for capelin abundance. Temperature influences capelin spawning location and timing. Climate change related temperature increases are shifting the distribution of various species northward, which could have an impact on capelin abundance as new potential predators appear in their range. Additional environmental factors which may be important for capelin include changes to habitat, beach erosion, pollution, and human alterations of beaches. To truly understand environmental change, it is important to build, maintain and monitor long-term data sets.

RECOMMENDATIONS

Recommendations were developed by participants based on the presentations and discussions during the workshop. These recommendations are listed under the two main categories of Knowledge Improvement, and Management Approaches. Each recommendation is followed with suggestions for tangible actions which support the recommendation. The actions are prioritized as "Immediate", meaning the action is a top priority for short term action, and/or "Ongoing", meaning the action should be incorporated into a broader program on a long-term, continuous basis. The parties responsible for undertaking or participating in the action are listed in parentheses.

KNOWLEDGE IMPROVEMENT

There are several knowledge gaps which hinder the management of capelin stocks. These gaps relate to capelin populations, their predators, their food supply and environmental factors which affect capelin. There are a variety of actions which may contribute to addressing gaps in our understanding, including collaborative approaches amongst a variety of stakeholders. Collecting data to fill these knowledge gaps will facilitate the management of capelin stocks from an ecosystem-based perspective.

1. Improve abundance estimates of capelin stocks

- Increase the spatial and temporal coverage of capelin surveys, conducted on an annual basis.
  - » A fall survey in 2J3KL (***Immediate priority***, DFO responsibility)
  - » Continue spring survey in 3L (***Ongoing***, DFO responsibility)
  - » Continue monitoring capelin by-catch in 2GH, the Baffin and Davis Straits (***Ongoing***, DFO, fishing industry responsibility)
- Develop an annual acoustic survey for the Gulf of St. Lawrence (***Immediate priority***, DFO responsibility)
- Increase opportunistic acoustic sampling in areas outside the core distribution of capelin, i.e., 3Ps, Labrador and Arctic region (***Ongoing***, DFO responsible for leading coordination of data collection and sharing; industry, Indigenous organizations, academia responsibility)

2. Define stock origins and connectivity

- Develop and undertake sampling plan for capelin genomics, otolith microchemistry and acoustic tagging (***Ongoing***, academia, DFO and NCC responsibility)

3. Develop an analytical capelin assessment

- Begin or continue gathering data on incoming cohort strength, cohort strength of 3+ and 2+ spawner survival, maturation at age, natural mortality, growth rate, larval abundance and larval recruitment for all capelin populations (***Immediate***, DFO responsibility)
- Assess each capelin population continuously and annually (***Ongoing***, DFO responsibility)
- Develop a method for establishing a B_{Lim} or index of abundance which is adjustable based on environmental factors (***Ongoing***, DFO responsibility)

4. Collect data and develop models to explore environmental and ecological interactions such as:

- Climate change effects on capelin habitat, including capelin spawning locations (***Ongoing***, DFO and academia responsibility)
- Spatial and temporal resolution of predation on capelin at all life history stages (***Ongoing***, DFO and academia responsibility)
- Spatial and temporal resolution of prey availability and environmental drivers of prey availability (***Ongoing***, DFO and academia responsibility)
- Identify critical drivers and mechanisms of capelin abundance to inform adjustments to limit reference points (***Ongoing***, DFO and academia responsibility)

5. Communicate science to public and managers

- Develop training program to educate scientists on how to communicate results (Ongoing, DFO responsibility)
- Ensure timely communication of science findings so managers can establish TACs (***Ongoing***, DFO responsibility)

MANAGEMENT APPROACHES

Participants at the workshop identified a number of gaps in the management approach to capelin stocks, as well as opportunities to include input from a range of stakeholders who have knowledge of capelin. Participants also highlighted the need for management approaches to be flexible and developed within the context of the precautionary approach.

1. Include social, cultural and economic drivers and impacts in assessments and fisheries management decision processes

- Formalize and standardize the incorporation of other data sources, specifically IK and LEK (***Ongoing***, DFO, Indigenous organizations responsibility)
- Invest in the integration of social science and economics in the stock assessment process (Define and address possible impacts on coastal communities and fishing regions in the context of achieving sustainability) (***Ongoing***, DFO responsibility)
- Recognize Indigenous rights within capelin management approaches (***Ongoing***, DFO responsibility)

2. Develop an ecosystem based approach to manage capelin fisheries

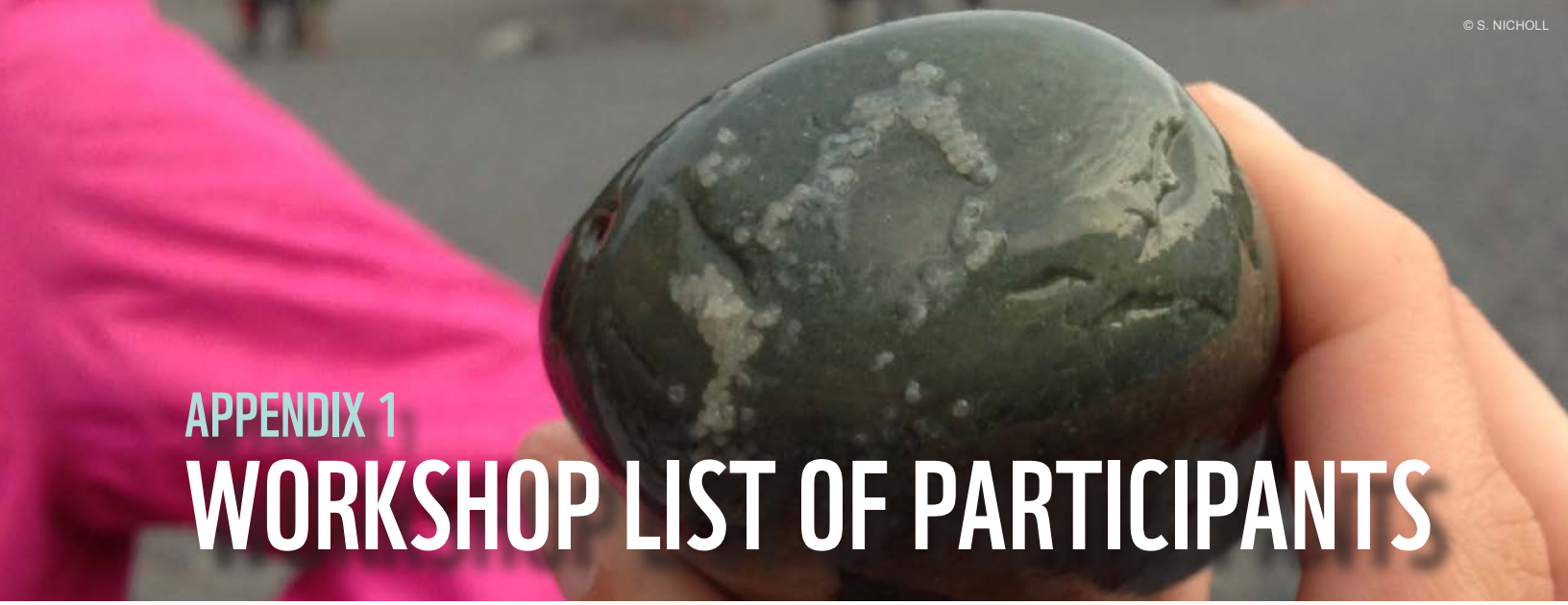
- Integrate the capelin analytical assessment with the environmental and ecological models to develop new IFMPs which approach capelin management from an ecosystem-based approach (***Ongoing***, DFO responsibility)
- Incorporate predator and prey dynamics and environmental change into capelin management (***Ongoing***, DFO responsibility)

3. Evaluate capelin management practices from other jurisdictions to develop best practices

- Evaluate the acoustic survey - modeling joint approach used in the Barents Sea and Iceland capelin fisheries (***Ongoing***, DFO responsibility)
- Determine feasibility of applying best practices from other jurisdictions for the Canadian capelin fisheries (***Ongoing***, DFO responsibility)

4. Collaborate and communicate with industry (harvesters and processors), Indigenous organizations, academics, ENGOs, and the general public

- Develop mechanisms for broad collaboration on the management of capelin with industry (harvesters and processors), Indigenous Groups, academics, ENGOs (Ongoing, DFO, industry, Indigenous Groups, academia, ENGOs responsibility)
- Create policy and/or agreements for data sharing among groups which collect data on capelin (***Ongoing***, DFO, industry, Indigenous organizations, academia, ENGOs responsibility)
- Develop platform for communicating science and decision-making process to the public, specifically with regards to knowledge gaps, the precautionary principle, and acceptable levels of risk (***Ongoing***, DFO)

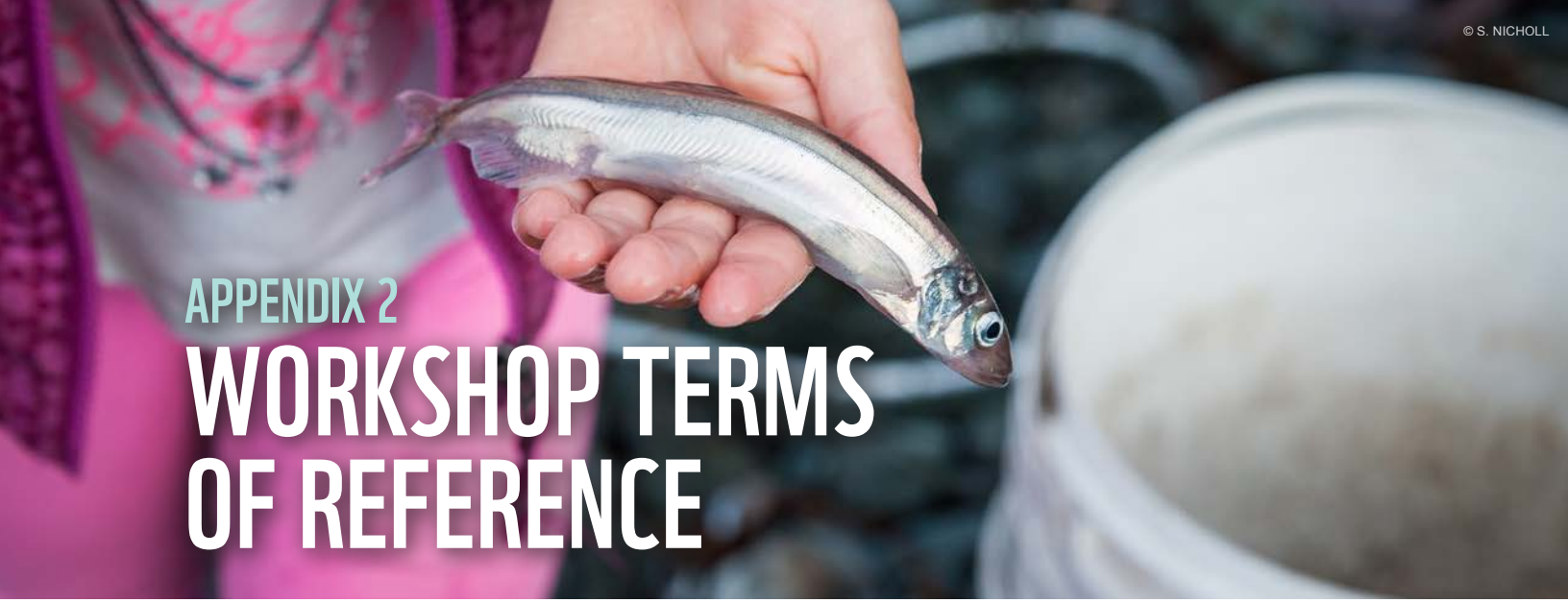


APPENDIX 1

WORKSHOP LIST OF PARTICIPANTS

NAME	AFFILIATION
Sam Andrews	Memorial University
James Baird	TriNav Consulting
Phil Barnes	Fogo Island Cooperative Society Ltd.
Bill Barry	Barry Group Inc.
Ivan Batten	Food Fish and Allied Workers - Unifor
Chelsea Boaler	The Marine Institute
Ken Budden	Fogo Island Cooperative Society Ltd.
Derek Butler	Association of Seafood Producers
Rod Butt	Golden Shell
Erin Carruthers	Food Fish and Allied Workers - Unifor
Martin Castonguay	Fisheries and Oceans Canada
Jenness Cawthray	Fisheries and Oceans Canada
Doug Chiasson	WWF-Canada
Aurelie Cosandey-Godin	WWF-Canada
Wanda Lee Wiseman	Department of Fisheries and Land Resources
Gail Davoran	University of Manitoba
Anastasia Day	Atlantic Canada Opportunities Agency
David Decker	Food Fish and Allied Workers - Unifor
Jennifer Duff	Fisheries and Oceans Canada
Shelley Dwyer	NL Department of Fisheries and Land Resources
Graham Epstein	University of Waterloo
Brett Favaro	The Marine Institute
George Feltham	Food Fish and Allied Workers Union
Susan Fudge	The Marine Institute
Maxine Geoffroy	The Marine Institute
Paul Grant	Beothic Fish Processors Ltd.

NAME	AFFILIATION
John Head	Happy Adventure Seafood Products (1991) Ltd.
Jackie Kean	Fisheries and Oceans Canada
Janet Kelly	Fisheries and Oceans Canada
Don Kippenhuck	NunatuKavut Community Council
Mariano Koen-Alonso	Fisheries and Oceans Canada
Sigrid Kuehnemund	WWF-Canada
Keith Lewis	Fisheries and Oceans Canada
Gilbert Linstead	Labrador Fishermen's Union Shrimp Company Limited
Francis Littlejohn	Seafood Processors of Newfoundland and Labrador
Mary MacDonald	WWF-Canada
Pierre Mallet	Fisheries and Oceans Canada
Julie Marentette	Fisheries and Oceans Canada
Barry McCallum	Fisheries and Oceans Canada
Gayle McClelland	WWF-Canada
Jenni McDermid	Fisheries and Oceans Canada
Steven Miller	Food Fish and Allied Workers - Unifor
Fran Mowbray	Fisheries and Oceans Canada
Hannah Murphy	Fisheries and Oceans Canada
Patricia Nash	NunatuKavut Community Council
Glen Newbury	Food Fish and Allied Workers - Unifor
Stephanie Nicholl	WWF-Canada
Alastair O'Reilly	The Northern Coalition
Pierre Pepin	Fisheries and Oceans Canada
Nancy Pond	Department of Fisheries and Land Resources
Brad Porter	Food Fish and Allied Workers - Unifor
Robin Quinlan	Quinlan Brothers Ltd.
Antoine Rivierre	Fisheries and Oceans Canada
Dominique Robert	Université du Québec à Rimouski
Bettina Saier	WWF-Canada
Jason Simms	Fisheries and Oceans Canada
Dwan Street	Food Fish and Allied Workers - Unifor
Michael Symmonds	Food Fish and Allied Workers - Unifor
Divya Varkey	Fisheries and Oceans Canada
Keith Watts	Torngat Fish Producers Co-operative
Colin Webb	Nunatsiavut Government



APPENDIX 2

WORKSHOP TERMS OF REFERENCE

The terms of reference for the workshop outlined here were taken from the Fisheries and Oceans Canada – World Wildlife Fund Canada Contribution Agreement, Annex A.

WWF-Canada - Fisheries and Oceans Canada
Joint Capelin Workshop

June 22-23rd 2017, St-John's, Newfoundland

FACILITATOR

James Baird

CONTEXT

Capelin play a key role in marine ecosystems within Atlantic Canada – providing food for many species of seabirds, whales, and commercial and recreational fish as well as supporting commercial and recreational fisheries off the coast of Newfoundland and Labrador and in the Gulf of St. Lawrence.

Information currently available on capelin stocks remains insufficient to determine reference points and limit exploitation rates according to the Fishery Decision-Making Framework Incorporating the Precautionary Approach. Current shortcomings include lack of surveys to monitor and assess capelin stock and issues on data quality related to harvest rates and assessment models.

This workshop is positioned to support a number of priorities under the government's mandate in meeting requirements under the Oceans Act and subsequent policies and recommendations from the 2016 Fall Reports of the Commissioner of the Environment and Sustainable Development on Sustaining Canada's Major Fish Stocks:

- Using ecosystem-based science to support fisheries management in order to maintain biological diversity and productivity in the marine environment. This workshop will help operationalize the ecosystem-based and precautionary approach to fisheries management in Canada by:
  - Identifying and planning priorities with regards to monitoring such that targets, and timelines for establishing reference points and harvest control rules can be developed.
  - Examining hot to take into account species interactions and the interdependencies between species and their habitats when making resource management decisions.
- Updating Integrated Fisheries Management Plans and developing a Rebuilding Plan
  - Recommendations developed in the workshop could guide regulators and managers in
    - (1) updating and developing goals and objectives for the conservation and sustainable use of capelin, their supporting ecosystems, and social, cultural and economic value and
    - (2) developing indicators that could trigger a full stock assessment earlier than scheduled.
- Increasing collaboration with other ministers, public service, and stakeholders
  - There is a need to increase participation across stakeholder groups with multi-sectoral interests to best integrate goals and objectives for decision-making that considers both current and cumulative impacts; this workshop will lay a solid foundation for their meaningful engagement.

All stakeholders and government departments have an interest in the success of an ecosystem-based and precautionary approach to fisheries management for sustainable development and to preserve the health of Canada's oceans. Setting priorities, targets, and timelines and increase collaboration are needed to turn information and research into action and achieve that success, and this workshop will make an important contribution.

FORMAT

Approximately 50 participants from Quebec and the Atlantic region with expertise on capelin biology/role in the ecosystem, environmental and anthropogenic drivers and management will gather over two days. Various sectors will be represented, including government departments, industry, ENGOs and academia. The workshop will be guided by a professional third-party facilitator.

OBJECTIVES

The purpose of the Capelin Workshop is to inform a research strategy and framework for the enhancement of capelin fisheries management, their supporting habitat and ecosystems in Atlantic Canada by:

- Identifying shortcomings in science
- Setting short and long-term priorities with clear objectives and responsible parties
- Promoting collaboration amongst representatives from the coastal communities, fishing industry, First Nations and governments

OUTPUTS

WWF-Canada will produce a workshop report, summarizing the proceedings and capturing discussions and conclusions about capelin science and management. This summary report will include a research strategy and framework based on scientific and management shortcomings to address unanswered questions, and identify research and monitoring priorities to help inform fisheries management decision-making.

PARTICIPATION

Fisheries and Oceans Canada
WWF-Canada
Fishing Industry
Indigenous organizations
Academia

APPENDIX 3
WORKSHOP AGENDA

WWF-Canada - Fisheries and Oceans Canada
Joint Capelin Workshop
June 22-23rd 2017, St-John's, Newfoundland

DAY 1	
Time	**Activity**
7:45 – 8:15	Light Breakfast and coffee Registration
8:15 – 8:30	Welcome – James Baird Opening Remarks – Minister Crocker
8:30 – 9:00	Registration continues
9:00 – 9:30	Introduction of additional speakers: J. Baird Welcome from DFO: Barry McCallum Welcome from WWF-Canada: Sigrid Kuehnemund
9:30 – 9:45	Vision, Objectives, Agenda, Introduction of presenters: J. Baird
9:45 – 10:15	DFO Science: Fran Mowbray
10:15-10:30	DFO Science: Martin Castonguay
10:15 – 10:30	DFO Science: Pierre Pepin
10:30 – 10:50	DFO management: Jackie Kean and Antoine Rivierre
10:50 – 11:05	Coffee break and refreshments
11:05 – 11:15	Capelin science and management in other countries: Hannah Murphy
11:15 – 11:30	Industry presentation: Dwan Street and Erin Carruthers
11:30 – 11:45	Processor presentation: Bill Barry
11:45 – 12:00	Indigenous presentation: Patricia Nash
12:00 – 13:00	Lunch

Time	Activity
Concurrent Break-out sessions Part I	
13:00 – 13:45	What are the management needs of science? Capelin population (dynamics/distribution/surveys
13:45 – 14:45	J. Baird and group facilitator summary, Q/A, discussion
Concurrent Break-out sessions: Part II	
15:00 – 15:45	Capelin role in the ecosystem (predator-prey dynamics) Environmental changes
15:45 – 16:45	J. Baird and group facilitator summary, Q/A, discussion
16:45 – 17:00	Final remarks and closing Day 1: J. Baird
17:30 – 19:30	Reception at Rocket Food on 272 Water St.

DAY 2

Time	Activity
8:00 – 9:00	Light breakfast and coffee
9:00 – 9:30	Review of Day 1 and Day 2 Agenda: J. Baird
9:30 – 9:45	Open Q/A
9:45 – 10:45	Break-out session: Research strategy and framework prioritizing Based on Day 1 outputs, prioritize short and long-term research objectives
10:45 – 11:10	Break: Coffee and refreshments
11:10 – 12:10	Break-out session II: Research strategy and framework prioritizing
12:10 – 13:40	Lunch
13:30 – 14:30	J. Baird and group facilitator summary, Q/A, discussion
14:30 – 14:45	Break: Coffee and refreshments
14:45 – 15:45	Open discussion, reaching consensus and defining the primary workshop output: Setting short long-term priorities with clear objectives and responsible parties
15:45 – 16:00	Final remarks