

Greater Atlantic Region

Potential Protected Resources Interactions with Longline Aquaculture

Workshop Summary. September 28 – 29, 2015

NOAA FISHERIES

Contact Us For More Information

NOAA Fisheries Greater Atlantic Regional Office
55 Great Republic Drive
Gloucester, MA 01930
www.greateratlantic.fisheries.noaa.gov

Or Visit

www.greateratlantic.fisheries.noaa.gov

This document may be cited as: Potential Protected Resources Interactions with Longline Aquaculture Workshop Summary. 2015. NOAA Fisheries Greater Atlantic Regional Office, 14p.

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Workshop Summary. September 28 – 29, 2015

U.S. DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Greater Atlantic Regional Fisheries Office

NOAA FISHERIES

Blue mussel. Credit: Chris Bartlett, Maine Sea Grant.

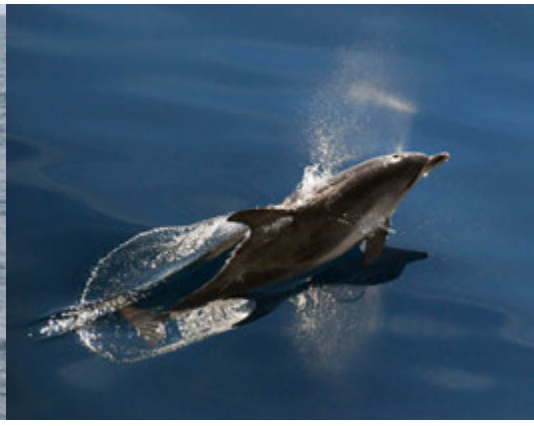
WORKSHOP SUMMARY

September 28-29, 2015. Gloucester, MA

Experts in aquaculture, commercial fishing gear technology, marine sciences and protected species (see participant list, Appendix I) met to discuss the potential for interactions, including entanglements, of sea turtles and marine mammals with longline aquaculture gear. Aquaculture is increasing in both near and offshore waters, making it important to assess the potential risk of interactions and to determine ways to minimize or reduce harmful and fatal events. The goals of the workshop were to:

- Collectively review a draft NOAA Technical Memorandum regarding interactions of protected species, such as sea turtles and marine mammals, with longline aquaculture operations.
- Develop tools and strategies to support development of longline aquaculture while conserving protected resources.
- Collect and discuss information that federal, state and local regulators and coastal managers can use to assess the potential risks that longline aquaculture poses to protected species.





Photos Credits (Left to Right): Chris Bartlett, Maine Sea Grant; NOAA

Oysters. Credit: Dana Morse, Maine Sea Grant

This workshop was hosted by NOAA's Office of Aquaculture and NOAA Fisheries Greater Atlantic Regional Fisheries Office's Protected Resources Division.

NOAA's OFFICE OF AQUACULTURE

NOAA's Office of Aquaculture supports the development of sustainable aquaculture in the United States. Its work focuses on regulation and policy, science and research, outreach and education, and international activities.

PROTECTED RESOURCES DIVISION

The Protected Resources Division works to conserve, protect and recover endangered and protected marine species under the authority of the Marine Mammal Protection Act and Endangered Species Act.

References:

Price, C.S., J.A. Morris, Jr., E. Keane, D. Morin, C. Vaccaro and D. Bean. 2016 in prep. Protected Species & Longline Mussel Aquaculture Interactions. NOAA Technical Memorandum NOS-NCCOS -211. 80 pp.

Prien, V., J. Prien, and P. Flanigan. 2014. Aquaculture Permit for Open Ocean Blue Mussel Farming. Submitted to NOAA Office of Aquaculture, February 18, 2014. 17pp.

US Army Corps of Engineers (USACE). 2013. Public Notice for Cape Ann Mussel Farm Permit Application. File Number: NAE-2013-1584.

BACKGROUND

Permitting, siting and operating longline aquaculture installations must comply with federal regulatory processes and requirements under the Endangered Species Act and the Marine Mammal Protection Act to avoid, minimize or mitigate any potential adverse effects on protected species. As NOAA Fisheries reviews these applications we must use the best available information to assess potential impacts to protected species, including the risk of entangling marine mammals and sea turtles, and the marine ecosystems they depend on for survival.

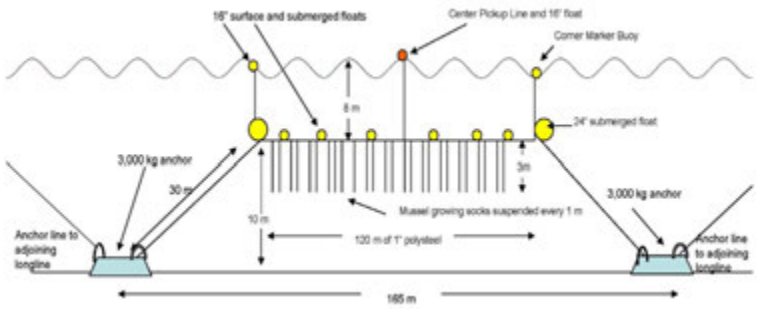
Documented entanglements with longline aquaculture gear worldwide are rare (Price et al., 2016) and close approaches by protected species are seldom documented. The lack of information about how protected species perceive and interact with longline aquaculture gear limits our ability to accurately assess the threat from collision and entanglement with the gear. Conducting scientifically valid, controlled experiments with live animals is not practical. Prior to this workshop there was no comprehensive summary of data describing protected species presence or behavior around longline aquaculture mussel farms globally. In addition, much of the information about protected species interactions at longline farms comes from disparate sources over a wide range of environments and species, making it challenging to analyze collectively in a robust risk analysis.

NOAA Fisheries convened this workshop as an important step to better understand risks to protected species from this type of gear, to identify specific approaches to decrease the likelihood and severity of any interactions, and to develop management strategies with the aquaculture industry that allow expansion of the industry in a manner that conserves protected marine species.

This workshop convened a variety of stakeholders and experts to:

- Discuss what we know about how protected species behave around longline aquaculture operations and how they become entangled in longline aquaculture gear;
- Learn how mussel, shellfish and kelp longline operations are configured and how the gear compares to gear known to entangle marine mammals and sea turtles;
- Identify and prioritize knowledge gaps;
- Consider practical ways to address those knowledge gaps and improve our ability to support the advancement of the longline aquaculture industry within the framework of relevant regulatory mandates.

A.



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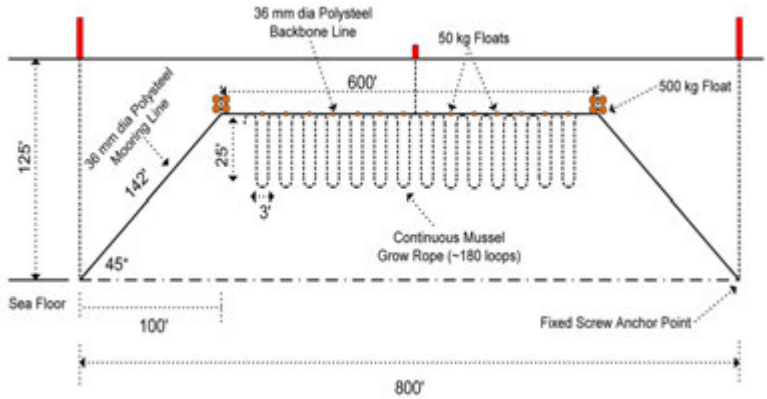


Figure 1.

Examples of mussel longline systems used for suspension culture of mussels. Variations on these designs do occur. View (A) shows individual grow out socks suspended from the backbone (USACE 2013). View (B) shows a single looped grow rope configuration (Prien et. al 2014).

WORKSHOP ACTIVITIES

The specific target outcomes of the workshop were:

- Review a draft NOAA Technical Memorandum on the assessment of potential interactions of protected marine species with mussel longline aquaculture gear;
- Identify gaps in knowledge;
- Compile ideas for performing risk assessments on longline aquaculture operations;
- Compile ideas for recommended guidance on reducing potential risks to protected resources listed under the Endangered Species Act and the Marine Mammal Protection Act.

Presentations

Several presentations and panel discussions provided information on protected species and their potential interaction with different types of aquaculture gear (see workshop agenda, Appendix II). First, Carol Price (NOAA National Ocean Service) presented an overview of a draft technical memorandum *Protected Species and Mussel Longline Aquaculture Interactions* and asked workshop participants for feedback before the document is finalized. The report is a global summary of documented interactions between protected species and aquaculture gear. While the report focused on marine mammal and sea turtle interactions with mussel longline gear, it also includes extensive scientific information about other marine mammals, seabirds, and sharks and how those species interact with offshore shellfish and finfish aquaculture. The report will be a tool for regulators, coastal managers, scientists, industry and the public to aid in permitting, siting and operating marine farms.

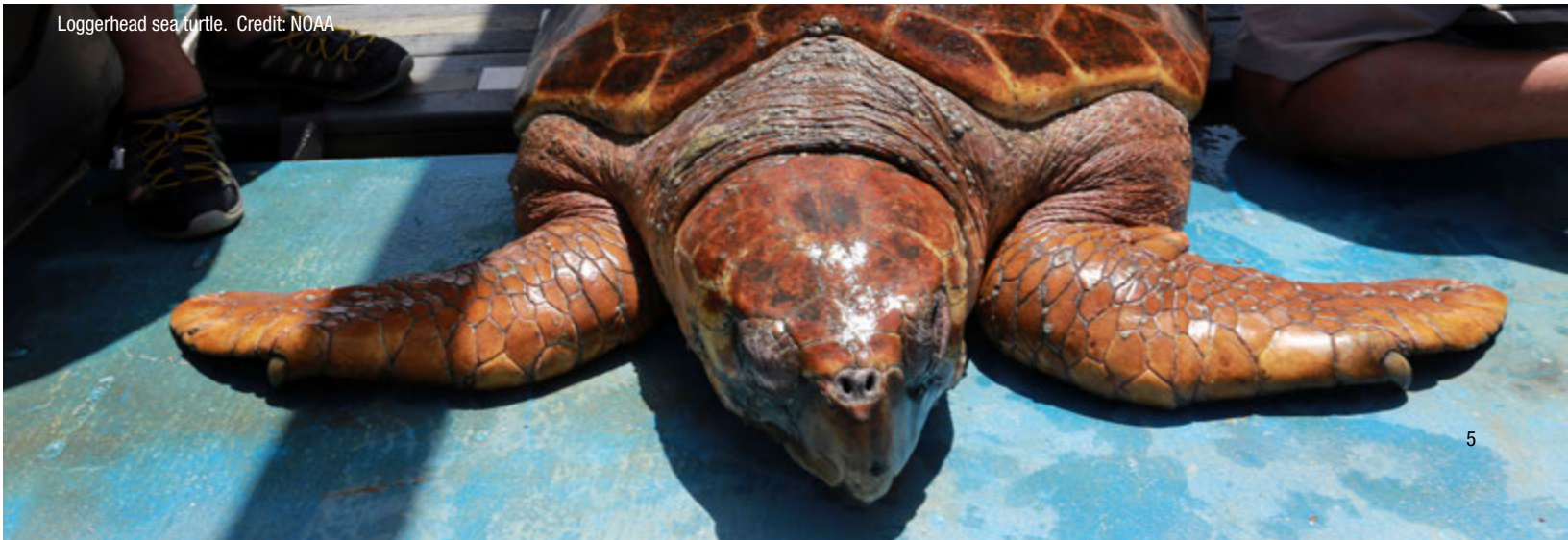
Bernd Würsig (Texas A&M University) presented his work on the behavior of dusky dolphins and interactions with mussel aquaculture gear in New Zealand. He reported that dusky dolphins use Admiralty Bay for cooperative bait-ball foraging. However, they rarely enter the mussel farms in Admiralty Bay, and have never been seen bait-ball foraging in the farms. Thus, they appear to be excluded from areas with mussel farms, which could limit dusky dolphins' cooperative foraging in areas with densely spaced farms. Other marine mammals (short-beaked, common, bottlenose, and Hector's dolphins; NZ fur seals, killer whales) do not appear to be seriously affected by the presence of the farms.

Kate Sampson (NOAA Fisheries Greater Atlantic Regional Fisheries Office- GARFO) and Kara Dodge (Integrated Statistics) gave presentations on sea turtles in our region. Kate highlighted what we currently know about the interactions of sea turtles with aquaculture and commercial fishing gear. Kara described specific leatherback turtle behaviors that could inform conservation gear modifications and site selection to reduce entanglements.

John Bullard, Regional Administrator for NOAA Fisheries Greater Atlantic Region, addressed the group and reiterated NOAA Fisheries' commitment to supporting the aquaculture industry and its development in state and federal waters while continuing the agency's roles under federal mandates, such as the Endangered Species Act.

Panel Discussion

A panel discussion that included regulators and researchers focused on information and management needs to facilitate the complex permitting process. Researchers Richard Langan (University of New Hampshire) and Owen Nichols (Center for Coastal Studies) discussed aquaculture installations that are operating in local waters. GARFO staff David Gouveia and Chris Vaccaro addressed regulatory issues related to the permitting and operation of aquaculture facilities. These included the Section 7 consultation process under the Endangered Species Act and mandates under the Marine Mammal Protection Act.



Loggerhead sea turtle. Credit: NOAA

Working Groups

After the panels and presentations, participants joined one of four breakout groups to conduct a knowledge gap analysis and identify areas of focus and research. The topics for these small groups were:

- Industry
- Permitting
- Sea turtles
- Marine mammals

Each group identified questions in their subject area that need to be addressed to better understand technology needs, regulatory hurdles, research questions and data needs. The full lists of knowledge gaps for each topic were written on large paper posters and displayed for the entire group (Appendix III). After the breakout sessions, all of the workshop participants reconvened to discuss and prioritize which knowledge gaps were the most critical for the regulatory agencies and industries to address. Each participant voted (using sticky dots on the posters) to prioritize the most important topics. Once votes were tallied, six topics emerged as priorities for further research (see box).

These topics could inform next steps for the group and provide a structure for small working groups to concentrate on areas of particular interest and expertise. It should be noted that voting was likely in part affected by the affiliation of attendees. There were fewer actual farmers or industry group members in attendance compared to scientists and regulators. This may have influenced which topics became priorities after the votes were tallied.

RESEARCH PRIORITIES IDENTIFIED BY WORKING GROUPS

- **Understanding the distribution and migration patterns of protected species to determine areas where longline aquaculture installations were likely to have less risk of interactions;**
- **Enhancing interagency coordination, particularly between state and federal agencies;**
- **Developing clear methods to determine risk thresholds in longline aquaculture gear;**
- **Developing a model or template for risk assessments that demonstrates how to present data associated with the risk determination;**
- **Studying the behavior of protected species around fishing and longline aquaculture gear and other structures in the marine environment to learn how entanglements occur;**
- **Addressing observational data gaps, especially to learn more about situations in which protected species were known to be near aquaculture (or other) gear and entanglements did not occur.**

Reducing Entanglement Risk Discussion

The next day focused on the identification, definition, and reduction of entanglement risk in the aquaculture industry. Tim Werner, New England Aquarium, spoke about his experiences and lessons learned about the interactions of protected species with commercial fishing gear and what could be applied to the aquaculture industry. While much of the prior discussion had focused on the risks associated with thinner, more flexible lines (e.g., those typically used for marker buoys), he pointed out that other components of longline aquaculture systems may also pose a risk. He explained that the severity of lacerations on protected species could increase during their interactions with lines under high tension.

A panel was also convened to address similarities between fixed fishing gear and mussel longline equipment. Henry Milliken (Northeast Fisheries Science Center), Bill Silkes (American Mussel Harvesters), and Scott Landry (Center for Coastal Studies) contributed to these presentations.

North Atlantic right whales. Credit: NOAA

WORKSHOP OUTCOMES

Discussions about the six major topics identified during the break out groups as well as the panels and presentations during the two days resulted in the following key messages and ideas:

Key Messages

- Several participants noted the significance of vertical ropes/lines, such as buoy lines and spat lines associated with longline aquaculture operations, in the water column that create hazards for entanglement. For large whales (including the North Atlantic Right Whale), there was uncertainty about the entanglement risk that the horizontal longlines pose. Although most lines used are high tensile strength lines, there are questions about the results of a large whale encountering a longline, possibly breaking it, and becoming entangled.It is unknown how large whales perceive longlines, how they respond to such structures and how high the risk is for collision and/or entanglement.
- Information on seasonal migrations of protected species may be useful as an element of siting longline aquaculture operations. For example, sea turtles are not present in the cold winter months.
- A comprehensive summary of existing knowledge about protected species interactions with aquaculture gear is needed to inform the on-going development of the aquaculture industry.
- The complex permitting process for aquaculture operations should be streamlined, made more transparent and explained clearly to industry participants.
- Enhanced coordination is needed among government agencies that are involved in the permitting and regulation of aquaculture.
- Industry and regulatory agencies should work together to develop and approve best management practices.
- The various components of longline gear should be defined.
- NOAA Fisheries supports the advancement of aquaculture which is a strategic planning goal for the Greater Atlantic Regional Fisheries Office. Opportunity exists in aquaculture. Both jobs and seafood for the American people can be derived from this industry.
- NOAA mandates require that a sustainable aquaculture industry must balance seafood production with stewardship of ocean resources including protected species.
- Evaluating the potential risks from marker buoys associated with mussel longline gear should be informed by prior assessments of impacts from marker buoys used in other fisheries (e.g., lobster fisheries). NMFS should strive to develop consistent management approaches and strategies for marker buoys across various fisheries, including mussel longline culture when appropriate.

Research Needs and Technical Comments

Critical areas of research:

- Reduce hazards associated with buoy lines including examining cage design, line flexibility, line sheathing, tension and tensile strength, float buoyancy, slack line reduction, surface vs. bottom culture cultivation techniques, and line configuration.
- Determine effective float buoyancy levels and line tensile strength, tension, and breaking points to reduce hazard and severity of entanglement.
- Assess the differences and similarities between longline aquaculture and commercial fishing gear. Identify gear modifications or management that may transfer well from commercial fishing to longline gear to reduce entanglement risk.
- Comparisons of longline farm gear to commercial fishing gear should be done with properly engineered and scaled drawings of all the gear being considered. This should also include a description of how these gear types behave and move once deployed.
- Document the occurrence and impacts of protected species interactions with longline aquaculture gear (see Price et al. 2016). This will be difficult because documented interactions are rare, the majority of interactions are undocumented, and subsurface events may not be observed at all.
- Examine the behavior of marine protected species in and around longline aquaculture gear in situ.
- Determine which acoustic and visual warning systems may be most effective at reducing protected species interactions with aquaculture gear.
- Establish secondary and cumulative ecosystem effects of aquaculture farms, such as food web interactions, marine debris, animal behavior alterations, and habitat exclusion.

Other comments:

- When research is conducted, commercially feasible longline aquaculture operations (at least 30 lines) should be evaluated in order to generate accurate data.
- Longline gear configuration can be easily altered prior to deployment. Industry members just need to know exactly what changes should be made to reduce entanglements.
- Industry suppliers and gear manufactures should be involved in the development of best practices of using longline aquaculture gear.
- Currently no information on aquaculture gear interactions with protected fish species (Atlantic salmon and sturgeons) is available.

RISK ANALYSIS

The group also talked about how to define and reduce the risk of entanglement and how to assess that risk moving forward.

Ideas about risk analysis:

- A three-tiered matrix could be developed to generate a context for risk assessment in longline aquaculture: 1) define what the hazards are, 2) define the probability and severity of the risks, and 3) craft avoidance and/or mitigation measures.
- Elements of risk include potential conflicts among different gear type users and other stakeholders, expanding vs. concentrating gear areas, the placement of gear relative to the habitat needs of protected species, issues of scale, and the spatial and temporal placement of gear.
- Monitoring of longline aquaculture operations could be used to collect information about the rates of entanglements and the behavior of protected species around the gear, although the low probability of witnessing an interaction makes the attainment of such data difficult.
- Risk associated with this gear type should be placed within the context of other risk factors, including other types of fishing gear.
- NOAA Fisheries could seek the help of a professional risk assessor to help develop this framework.

NEXT STEPS

Although no specific next steps were agreed upon, some meeting participants suggested the following be considered for next steps:

- Better understand the distribution and migration patterns of protected species to determine areas where longline aquaculture installations are likely to have less risk of interactions.
- Enhance interagency coordination, particularly between state and federal agencies.
- Develop clear methods to determine risk thresholds in longline aquaculture gear.
- Develop a model or template for risk assessments that demonstrates how to present data associated with the risk determination.
- Study the behavior of protected species around commercial fishing gear, longline aquaculture gear and other structures in the marine environment to learn how entanglements occur.
- Address observational data gaps, especially to learn more about situations in which protected species were known to be near aquaculture (or other) gear and entanglements did not occur.

CONCLUSIONS

The workshop brought together interdisciplinary experts to engage in a collaborative process to share knowledge about interactions between longline aquaculture and protected species in the Greater Atlantic Region. Participants provided valuable feedback for a NOAA Technical Memorandum on the topic. Group activities identified priority knowledge gaps, and discussions led to better understanding of the various components of risk posed by longline aquaculture gear that need to be examined. The participants identified six priority areas for research which could improve the ability of farmers and regulators to work toward common goals of supporting aquaculture development while reducing risks to protected species. Comparisons between longline aquaculture gear and commercial fishing gear revealed several important differences in gear type and deployment density. These differences may (or may not) mitigate the relative risk of entanglement. These unknowns suggest the need for monitoring around farms until these questions can be resolved. Most importantly, the workshop provided an opportunity for networking among stakeholders to support future collaboration and information exchange.

APPENDIX I

WORKSHOP PARTICIPANT LIST

First Name	Last Name	Affiliation/Organization
Regina	Asmutis-Silvia	Whale and Dolphin Conservation
David	Bailey	Marine Biological Laboratory
David	Bean	NOAA Fisheries GARFO
Jess	Beck	NOAA Aquaculture Southeast Region
Erin	Burke	MA Div. of Marine Fisheries
Beth	Casoni	MA Lobsterman's Association
Kevin	Chu	NOAA Fisheries GARFO
Paul	Dobbins	Ocean Approved, Llc.
Kara	Dodge	Woods Hole Oceanographic Institute
Tina	Fahy	NOAA Fisheries West Coast Region
Cliff	Goudey	Resolute Marine Energy
David	Gouveia	NOAA Fisheries GARFO
John	Higgins	NOAA Fisheries GARFO
Ellen	Keane	NOAA Fisheries GARFO
Scott	Landry	Center for Coastal Studies
Richard	Langan	University of New Hampshire
Jon	Lewis	Maine Div. of Marine Resources
Kevin	Madley	NOAA Fisheries GARFO
Eric	Matzen	NOAA Fisheries NEFSC
Dan	McKiernan	MA Div. of Marine Fisheries
Harry	Mears	NOAA Fisheries GARFO
Shea	Miller	Coonamesett Farm Foundation
Henry	Milliken	NOAA Fisheries NEFSC
David	Morin	NOAA Fisheries GARFO
James	Morris	NOAA National Ocean Service
Owen	Nichols	Center for Coastal Studies
Dave	O'Brien	NOAA Aquaculture
Samir	Patel	Coonamesett Farm Foundation
Carol	Price	NOAA National Ocean Service
Jeff	Ray	NOAA Fisheries GARFO
Robert	Rheault	East Coast Shellfish Growers Association
Olivia	Rugo	NOAA Fisheries GARFO
Mike	Rust	NOAA Aquaculture
Kate	Sampson	NOAA Fisheries GARFO
Thomas	Shields	MA Div. of Marine Fisheries
Liese	Siemann	Coonamesett Farm Foundation
Bill	Silkes	American Mussel Harvesters
Mike	Tlusty	New England Aquarium
Christine	Vaccaro	NOAA Fisheries GARFO
Tim	Werner	New England Aquarium
Lisa	White	NOAA Fisheries Office of Protected Resources
Diane	Windham	NOAA Aquaculture West Coast Region
Bernd	Würsig	Texas A & M
Sharon	Young	Humane Society of the US

APPENDIX II

WORKSHOP AGENDA: DAY 1

Time	Agenda Item
8:30	Arrival, Registration, and Lunch Orders
9:00	Welcome *Harry Mears - NMFS GARFO*
	Workshop goals and background *Kevin Madley - NMFS GARFO* *Dave O'Brien – NMFS Office of Aquaculture*
9:30	NOAA Tech Memo overview Objective: Provide an overview of the draft NOAA Tech Memo on the topic of longline aquaculture gear and collect critical feedback *Carol Price – National Ocean Service NCCOS Beaufort Lab*
10:10	Summary of the marine mammals and aquaculture project in New Zealand *Bernd Würsig – Texas A&M University*
10:45	Break
11:00	Sea Turtle interactions with aquaculture and fishery gears *Kate Sampson – NMFS GARFO*
11:15	Leatherback sea turtle behavior – what's known and what's needed to better inform conservation engineering *Kara Dodge – Woods Hole Oceanographic Institute (WHOI) and NMFS Northeast Fisheries Science Center*
11:30	Greater Atlantic Regional Fisheries Office perspective on aquaculture *John Bullard – Regional Administrator, NMFS Greater Atlantic Regional Fisheries Office*
12:00	Lunch - Bring your own or pay cash for delivered lunch to the building (i.e. sandwiches, salads, coffee and water)
1:00	Panel Discussion, information and management needs *Panelists* • *Richard Langan, Director, Coastal and Ocean Tech. Programs, UNH* • *Chris Vaccaro, NMFS GARFO, ESA Section 7 Team* • *Owen Nichols, Center for Coastal Studies* • *Dave Gouveia, NMFS GARFO, Marine Mammals and Sea Turtle Programs*
2:30	Break
2:45	Gap analysis – Identify data gaps and research needs What do we need to know to provide the best regulatory guidance and permit review for protected species and longline aquaculture? Breakout Groups: Marine Mammals, Sea Turtles, Industry, Permitting/Regulatory
3:30	Break
3:45	Prioritize research needs to fill gaps Full group exercise to prioritize identified data gaps and ideas for study sites and funding sources to get some partnership ideas rolling
4:45	Day 1 Closing Comments
5:00	Adjourn
6:00	Evening Social in Gloucester – Seaport Grille, 6 Rowe Square, Gloucester, MA 978-282-9799 (Dinner on Your Own)

APPENDIX II

WORKSHOP AGENDA: DAY 2

Time	Agenda Item
8:30	Arrival and Lunch Orders
9:00	Welcome and Introduction of Day 2 Goals – Harry, Carol, and Kevin
9:30	Risk Assessment • What features of longline aquaculture are low, medium and high risk? • Immediate versus long-term risk? • Which species are at greatest risk in north Atlantic? In the US? • How can regulatory agencies work through gaps in information and uncertainty of interaction risks? Monitoring as permit conditions? What type of monitoring is feasible?
10:45	Break
11:00	Fishing gear and protected species: lessons learned and recommendations for applications to aquaculture • Tim Werner – Director, Consortium for Wildlife Bycatch Reduction, New England Aquarium
11:45	Lunch - Bring your own or pay cash for delivered lunch to the building (i.e. sandwiches, salads, coffee and water)
12:45	Panel Discussion Fishery Gear Similarity Assessment • What can we learn from fishery gear interactions research and data? • Can we draw analogies? • Are there real similarities? What gear is the most similar? • What are differences in the gear? Panelists • Henry Milliken, NMFS Northeast Fisheries Science Center • Bill Silkes, American Mussel Harvesters • Scott Landry, Center for Coastal Studies
1:45	Consider list of possible best management practices • Discuss and provide feedback on draft best management practices for risk reduction to ESA and MMPA species
2:45	Closing comments – Harry, Carol, and Kevin • Outline next steps post-workshop
3:00	Adjourn

APPENDIX III

KNOWLEDGE GAPS SUGGESTED DURING BREAKOUT GROUPS

NOTE: the number of dots contained within the parentheses below indicates the number of votes that participants gave to each of the listed topics during the breakout sessions.

Sea Turtles

- Fine scale habitat use – suction cup tags (6 dots)
- Animal behavior around/ response to gear – attracted? Avoidance? (8 dots)
  - *UAV (wide focus)*
  - *Camera tags (narrow focus)*
- Identifying leatherback and other sea turtle hot spots (leatherback – throughout range, hard shells mid-Atlantic priority) (7 dots)
  - *Predicting distribution in relation to climate change*
- Visual research – what can sea turtles see? (2 dots)
  - *Evaluating previous research and mitigation measures used – applicability*
- Modeling forces exerted by a turtle vs. tension of line (2 dots)
- Operational feasibility
- Impediments:
  - *Few funding sources for behavioral research (through mechanisms like Bycatch Reduction Engineering Program (BREP) and Saltonstall-Kennedy grant program)*
- **Recommendation: Need to fund research in step by step manner that makes sense, i.e. behavior followed by informed gear modifications**

Aquaculture Industry

- Tension – loose vs. tight, regionally specific (4 dots)
- Breaking strength – minimum possible vs. maximum possible (1 dot)
- Best managament practices and interagency workgroup (4 dots)
- Observational data gaps – entanglement vs. no entanglement data, risk framework (15 dots)
- Permitting process well-defined with designated lead (8 dots)
- Gear type differences in other countries (1 dot)
- Modeled risk assessment (13 dots)
- One-stop information portal – data on species, regional coordinators (2 dots)
- Acreage that is economically viable – maximum acreage should be science-based (1 dot)
- Opportunities:
  - *Community resilience*
  - *Industry cooperation*
  - *Regional Coordinators*

APPENDIX III

KNOWLEDGE GAPS SUGGESTED DURING BREAKOUT GROUPS (CONTINUED)

Marine Mammals

- Is a taut line beneficial to large whales? If so, how tight (not stiffness)? (2 dots)
- What is the behavior when/if they approach gear? Depending on activity, i.e. feeding, mating, transit, what does it do? (13 dots)
- Determine risk of where whales are both year-round and seasonally (8 dots)
    - *Distribution in feeding, calving, breeding areas*
    - *Use of different parts of the water column*
- The force that whales exert on lines
- Gear research – acoustic devices, colored rope
- Regional information gap – lowest breaking strength of longlines (New Zealand may have this info)
- Ecological impacts – impacts to other species (example is dusky dolphins and bait balls)
    - *Cumulative impacts*
    - *Displacement impacts into higher risk areas or lower value habitats*
- Gear carrying capacity (what is spacing of farms?)
- Does design impact risks (looping vs. dropping grow out ropes)
- Potential for mobile gear for seasonal sets
- Volume of gear lost (marine debris)
- Options for gear modifications
- Gear research:
    - *Is breakaway feasible? If so, what tolerance? (1 dot)*
    - *Continue acoustic gear research (3 dots)*
    - *Continue colored rope research*
    - *Gear carrying capacity (4 dots)*
    - *Does design impact risk (looping vs. up down grow out rope)? (1 dot)*
    - *Potential for mobile gear for seasonal sets*
    - *Data on marine debris/ lost gear*
    - *Options for gear modifications (reconfiguring gear for lower impacts) (4 dots)*
    - *Ecological impacts/ impacts to other species (1 dot)*
    - *Cumulative impacts (7 dots)*
    - *Displacement impacts for whales and other species (to higher risk areas)*

Regulatory/ Permitting

- Determining risk thresholds given lack of information (14 dots)
- Better understanding of longline aquaculture engineering – risks and strategies (4 dots)
- Increase information sharing with the Army Corps of Engineers (2 dots)
- Possible discrepancy between Endangered Species Act determinations in federal vs. state waters (3 dots)
- Establish a regional interagency coordination group (NOAA, Army Corps of Engineers, states, etc) (11 dots)
- Two-prong approach to get more information: industry monitoring and research (NOAA labs, grants, demo projects) (1 dot)
- “Use it or lose it” clause for lease holders (2 dots)
- More outreach from NOAA on aquaculture science, permitting, etc (6 dots)

KNOWLEDGE GAPS IDENTIFIED DURING BREAKOUT GROUPS ON DAY ONE (CONTINUED)

Other Notes Recorded During Discussion of Break-Out Groups

Note: there were no "dots" for these ideas because they were not on the spreadsheets available for voting. These suggestions were added during discussions that occurred after the dot ranking excercise.

- Distribution of hot spots of sea turtles and marine mammals
  - *Are there areas where longline aquaculture should be excluded?*
  - *Hot spots will help determine areas where risks of gear entanglement is high, but we should also be learning about migratory pathways.*
  - *Is there less of a risk to marine mammals and sea turtles in migratory corridors vs. foraging sites?*
  - *What risk prone areas (high use fisheries, ship lanes, etc) are in or near hot spots? This may create risk if displacement occurs*
- Interagency coordination
  - *Need consistency in NOAA Fisheries consultation process in state and federal waters*
- Risk thresholds
  - *What is risk of various gear components (horizontal vs. vertical line)?*
  - *How does NOAA Fisheries decide that a risk is acceptable in the absence of sufficient data?*
  - *A quantitative limitation or restriction is needed*
  - *Caution should be taken against relying on one gear diagram/ method of grow out. Although proven methods are good, innovation is better*
- Modeled risk assessment
  - *Need a 'how to' primer for writing an ecological assessment that lists alternatives and provides a model or an example*
  - *Do a formal risk assessment*
  - *Specific monitoring requirements and expectations as move from pilot to commercial scale*
  - *Consider risk of displacement into more risk prone areas (e.g. lobster gear, shipping lanes, etc) if whales do divert around longline farms*
- Sea turtle and marine mammal behavior
  - *There is limited funding available for behavior research. NOAA Research Funding Programs like the Bycatch Reduction Engineering Program and Saltonstall-Kennedy Grant programs prioritize conservation engineering solutions but not the collection of behavior data needed to understand the problem. Missing a key step!*
  - *Consider putting under or above water cameras on existing farms during expected times of whale/ turtle occurrences in the area*
  - *Consider using Stellwagen Bank National Marine Sanctuary's D-tag model (3-D) to examine the use of the water column by whales and how this may inform encounter probabilities*
- Observational data gaps
  - *No amount of data will prove a negative!*
  - *Most entanglement reports come from private boaters in areas where farms are located. There may be data able to be collected from negative reports as boaters look closely at farms and would be able to observe surface interactions.*
  - *Caution with mandatory observer coverage – must be lucrative industry to cover the cost of this coverage*

NOAA FISHERIES

June 2016

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OFFICIAL BUSINESS

National Marine Fisheries Service
Greater Atlantic Regional Fisheries Office
55 Great Republic Drive
Gloucester, MA 01930