# Gulf of Maine Bottom Longline Survey Mitigation Plan

## I. Purpose of the survey

**What data is collected?**

- Catch identified to species level, aggregate catch weights, individual lengths, and biological samples (age, reproductive, tagging, genetic, and others) for fish and invertebrates.
- Survey operations data for each survey station along with bottom temperature, depth, current direction and velocity, and bottom habitat video data at each station.
- Video data of hook disposition.

**Which assessments/science advice pathways currently use this survey?**

NEFSC stock assessments for haddock (*Melanogrammus aeglefinus*), Atlantic cod (*Gadus morhua*), white hake (*Urophycis tenuis*), spiny dogfish (*Squalus acanthias*), Atlantic wolffish (*Anarhichas lupus*), red hake (*Urophycis chuss)*, and Atlantic halibut (*Hippoglossus hippoglossus*) use the bottom longline survey (BLLS) data. The Greater Atlantic Regional Fisheries Office (GARFO) used the BLLS data for the thorny skate (*Amblyraja radiata*) status review. BLLS data will potentially be used in the upcoming assessment for skates and in management track updates for the above mentioned species. BLLS data will also be useful to GARFO for a future cusk (*Brosme brosme*) status review.

**What specific products use this survey?**

- The above mentioned stock assessments and associated working papers.
- A reference document by the thorny skate assessment lead and a document for thorny skate status review by GARFO.

There have been at least 7 peer-reviewed publications that use data or samples from the BLLS. These include studies related to habitat (2), life-history (3), tagging (1), and survey selectivity (1). There are several other publications in progress, by both NOAA and external researchers.

**Who are users of the survey data generated?**

The Northeast Fisheries Science Center (NEFSC) Population Dynamics Branch, Population Biology Branch, and Cooperative Research Branch staff are users of BLLS data. Some coral occurrence data has been shared with NOAA's Deep Sea Coral Research and Technology Program. GARFO has used the data for the thorny skate status evaluation and will be interested in other data-poor species' data. At least 6 external academic and non-governmental organization (NGO) researchers have also requested and used the catch and biological data thus far. Additional internal and external user groups have expressed interest in the catch data, and new collaborations are in development, including the use of the habitat video data by the Deep Sea Coral Program.

**Are there any formal quality standards (e.g., operational/gear requirements or standard operating procedures) for the survey that need to be considered?**

There are standard operating procedures (SOPs) in gear operations and site selection, as well as station evaluation criteria. These could potentially be impacted by alterations in operations due to the presence of offshore wind energy infrastructure. Gear standardization could be impacted, and the randomization of station locations could be affected if some areas are inaccessible. A unique aspect of this survey is the sub-stratification by bottom type. The survey team's ability to site stations appropriately on the designated bottom type could be impacted within the wind energy areas (WEAs). Furthermore, the installation of wind turbines and inter-array cables would change the spatial distribution of bottom types and require the survey to integrate new bottom type maps in the stratification and station selection process.

**Are there added values that cannot be met without this survey?**

The BLLS is the NEFSC's only fixed-gear survey in the Gulf of Maine and is able to sample in areas that are inaccessible to traditional mobile gear surveys. The BLLS captures habitat-specific information and biological data for data-poor species that are not well covered by other surveys. There are historical and ongoing concerns about NEFSC survey coverage of complex structured habitats in the Gulf of Maine, and the BLLS is the only survey that directly addresses these concerns. Furthermore, the BLLS is a unique example of a long-term and productive collaboration between the NEFSC and the fishing industry. There is a supported hypothesis that for some species, structured habitat is preferred. As abundance declines, those declines are greater on less structured (less preferred) habitat and lesser on more structured (more preferred) habitat. Thus, changes in a bottom trawl survey's indices (that samples less structured habitat) will not be linearly scaled to changes in abundance (Davies and Jonsen 2011). The BLLS provides data to empirically evaluate this effect.

**How does offshore wind energy impact survey objectives going forward?**

Offshore wind will prevent the BLLS SOPs from being adhered to in areas that are developed, and thus will potentially disrupt the time series if care is not taken in developing and implementing survey mitigation strategies. Offshore wind will limit access to certain areas (the survey's 1 nautical mile [nm] longlines potentially cannot be fished safely within floating wind arrays depending on the design), effectively reducing the spatial footprint and impacting the statistical design of the survey. The installation of offshore wind turbines and anchors will also likely change bottom types within the BLLS area, impacting the survey's ability to maintain sub-stratification by bottom type. Changes in the amount of structured habitat could impact the design of the survey and the ability of the survey to achieve comprehensive coverage of structured habitats if precluded from sampling these areas (due to anchors, transmission cables, or other infrastructure). In addition, offshore wind will impact the operations of the BLLS by increasing transit times (to travel through or around WEAs) and increasing costs (fuel, ship time, overtime, insurance). Finally, expected changes in species distributions, abundance, and biomass due to offshore wind construction and operation will increase uncertainty in BLLS indices of abundance. Overall, offshore wind will limit the survey's ability to meet objectives for filling in data gaps for a number of fish species and habitats.

# II. Survey Details

**Beginning Year:** 2014

**Frequency:** Biannual

**Season:** Spring (April-May) and Fall (Oct-Nov)

**Geographic Scope:** Central Gulf of Maine: Bottom Trawl Survey offshore strata 26, 27, 37, and portions of 28, 29, and 36

**Platform(s):** 2 commercial fishing vessels: 41’ *F/V Tenacious II*, Dennis, MA; and 55’ *F/V Mary Elizabeth*, Scituate, MA.

**Statistical Design:** Random stratified within the 6 offshore bottom trawl survey strata and further sub-stratified by bottom type (rough/smooth). Station density is allocated based on the bottom trawl survey (BTS) design but with a greater allocation to the rough bottom substrata for the bottom longline survey (stations per unit area defined in McElroy et al. 2019). In 2017, the number of smooth stations were reduced and strata combined for smooth bottom, allocation to rough bottom stations was increased, and those strata were unchanged. The bottom type substrata were defined using a measure of rugosity, the terrain ruggedness index (TRI), with rough bottom defined as the 70th percentile of the TRI within each stratum. The TRI was defined using bathymetric data.

**Methods:** Tub-trawl bottom longline with 1,000 #12 semi-circle hooks on fixed gangions on a ~1 nm groundline (4 x 250 hook tubs tied together). The longline is baited with squid (*Illex spp.*) prior to sailing and kept frozen. The gear is buoyed and anchored at both ends with environmental sensors attached to or near the anchors. The gear is deployed 1 hour prior to slack tide and soaked for 2 hours across the slack tide. The captains set the gear on the bottom most consistent with the bottom type substrata within 1 mile of the random point, while accounting for operational safety. If the gear deployment, safe operation, and bottom type criteria can not be met within a 1-mile radius, the search can be extended out to a 3-mile radius (consistent with BTS protocols). A video camera system is deployed at each station to capture video for characterizing the bottom type. After the gear is soaked for 2 hours, the catch is brought on board and dehooked, and the scientists process the catch. Aggregate catch weights and individual lengths are taken for all species. Biological sampling, tagging, or other samples are taken following protocols from requesting groups. Each station is evaluated after completion for operational and gear criteria by the scientists to maintain consistency in operations, data collection, and the functioning of the fishing gear; if a station does not meet criteria, it is excluded from index analyses. Data is collected digitally through a tablet-based application, a variety of integrated electronic hardware and software, and a laptop. The vessels operate simultaneously, and the stations are divided up evenly between the 2 vessels and locations covered based on operational logistics. Survey seasonal timing is maintained as best as possible within the safety limits of the weather. The use of 2 vessels helps maintain this seasonal consistency and provide operational redundancy.

# III. Effect of Four Impacts

1. **Preclusion** of NOAA Fisheries sampling platforms from the wind development area because of operational and safety limitations.

   Substantial portions of the BLLS is within the Gulf of Maine planning area for floating offshore wind. The degree of impacts will vary depending on the type and configuration of the turbines and sub-surface infrastructure. Complete preclusion is likely if a common or overlapping anchor system is employed, limiting the amount of free space between turbines for deploying longline gear. The BLLS requires at least 1.5 nm (linear) to safely deploy the longline gear, with more space required at increasing depths. Due to drift and weather considerations, a wider corridor for gear deployment may be required. If the area between turbines, anchors, and cabling is less than 1 nm, the BLLS in its current protocols will be precluded completely. Preclusion would decrease the BLLS coverage of smooth and rough bottom types and spatial continuity, and reduce comparability to historical survey data.

2. **Impacts on the statistical design of surveys** (including random-stratified, fixed station, transect, opportunistic, and other designs), which are the basis for scientific assessments, advice, and analyses.

   Offshore wind in the Gulf of Maine is likely to impact the BLLS design (random-stratified by depth with sub-stratification by bottom type) and will increase the uncertainty in abundance estimates if the BLLS is precluded from sampling within wind areas. At a minimum, offshore wind will limit spatial coverage of the survey and require alternative gear configurations or technology to achieve any sampling within WEAs. The station density of the BLLS may need to be increased to account for spatial preclusion, and longline length will need to be reduced to enable deployment in WEAs.The impact of offshore wind on the statistical design of the survey will depend on the location of the wind areas relative to bottom type, with less impact to the BLLS statistical design if floating wind areas are concentrated on smooth bottom that is less heavily sampled by the BLLS (16% of stations) and greater impact to BLLS statistical design if floating wind areas are concentrated in rough bottom areas that are more heavily sampled by the BLLS (84% of stations).

3. **Alteration of benthic and pelagic habitats and airspace** in and around the WEAs, requiring new designs and methods to sample new habitats.

   The scale of the impact of floating wind on BLLS survey design will depend on the bottom type where the turbines are installed. The wind infrastructure could increase the amount of complex habitat in traditionally smooth bottom habitats, impacting both the stratification of the BLLS as well as the distribution of species. The scale of this and if it impacts the fish distribution or survey substrata are unknown. If the turbine anchor structures significantly increase the amount of bottom structure, it would increase the areas of the BLLS rough bottom strata, which would require increased sampling density. Finally, offshore wind development will introduce new uncertainties for species distributions, abundance, and biomass, which will likely impact survey indices. The related habitat alterations and impacts (e.g., increased structure, construction activities) could have a variety of impacts and increase uncertainty in abundance estimates.

4. **Reduced sampling productivity** caused by navigation impacts of wind energy infrastructure on aerial and vessel surveys.

   Transit time to sampling stations could be increased due to navigational safety, especially during inclement weather. The BLLS is standardized relative to the tidal stage, so having to transit around wind turbines could substantially limit the ability to cover the same number of stations per day. This is dependent on the exact locations of the floating wind areas relative to the portion of the Gulf of Maine covered by the BLLS. The survey trips are short (2-5 days) due to the size of the vessels and ability to keep the bait fresh. Increased transit times could limit the ability to conduct the survey within the current timeframe. This could result in shifts in survey timing relative to the past and increase the impact of fish availability to the survey due to seasonal movements of fish outside the survey area. This would impact the comparability to the historical BLLS data and possibly increase uncertainty in abundance estimates.

# IV. Mitigation Planned, as per Six Elements

1. ***Evaluation of survey designs***

The primary unknowns that prevent full evaluation of the impacts of offshore wind on BLLS design are: 1) the location of floating wind turbines within the BLLS area (by bottom type), 2) turbine and anchor design and spacing (vertical vs. steeply angled anchor cables), and 3) the location and height in the water column of inter-turbine and shoreward power cables. Clarity on these details will enable a more precise quantification of the impacts of offshore wind on BLLS design. Regardless, new analyses of sampling density and impacts to the spatial footprint consistent with analyses for other comparable surveys (i.e., BTS) will be necessary. Statistical analysis of station allocation implications relative to bottom type substrata are an essential component for the BLLS. Ongoing areas of concern include:

1. Will the preclusion or limitation of coverage within WEAs require additional sampling, and will it be the same across both bottom type substrata (2a)?
2. Will alternative sampling methods (e.g., shortening of the gear) withinWEAs result in the need for changes to station density, and will that differ in or around wind areas (2b)?
3. If the spatial footprint of the BLLS is reduced (e.g., shorter gear length), will this have implications for the abundance index trends and inferred spatial coverage (2b)?

2. ***Identification and development of new survey approaches***

**Technical Unknowns:**

Exact turbine spacing and design is not fully known for the floating wind areas and could vary among wind energy companies. If turbine spacing is ~1 nm between floating wind turbines (and no interference of sub-surface cabling and anchors), the BLLS design will only require minor alterations, including reduced gear length and altered sampling density and distribution. The BLLS vessels are small and will likely be able to operate within floating wind areas, weather permitting. The limitations of that operation within these areas are not fully known yet, but some degree of operation is likely possible. The ability to operate safely at night or in a variety of weather states has to be evaluated. Offshore WEAs may impact BLLS soak times and consistency of gear deployment (e.g., more risk of issues during deployment resulting in invalid stations), which may increase the sea days (and resources) required to complete the survey. Changes in survey gear or protocols would also require calibration experiments to be able to integrate new gear and/or protocols with existing gear and protocols.

**Operational and Statistical Design:**

The existing bottom longline methods should largely be able to be applied but with a reduction in the gear length (0.5 nm, 500 hooks). Two rapid sequential deployments of half the current gear configuration are proposed (2 0.5-nm, 500-hook gear portions) for sampling within WEAs, assuming distance between turbines is ~1 nm and dependent upon the layout of anchor cables and interturbine cables. Half the gear would be set on either side of any wind structures acting as a non-contiguous but single gear deployment to maintain a general consistency in spatial coverage of the gear with the rest of the survey region. This will require calibration experiments to evaluate differences in catch rates between the 2 separated shorter gear sets (0.5 nm, 500 hooks) and traditional BLLS gear sets (1 nm, 1000 hooks) as well as different spacing options between the shorter sets. In addition to survey design and gear changes, the software used to collect the BLLS operations data would need to be modified to account for the multiple gear deployments within 1 sampling location.

The Gulf of Maine experimental floating wind area could potentially provide an area for testing feasibility of deploying shorter sets of longline gear, the ability to safely operate, and the impacts of gear changes within floating wind areas. If the turbine configuration is too close for half-mile gear sections, a further reduction in gear length could be tested, but this could impact the comparability to survey stations outside of WEAs, which would continue to use 1-nm, 1000-hook longlines. The required number of comparative gears sets in and outside the wind areas using the standard (1 nm, 1000 hooks) and modified (0.5 nm, 500 hooks) longline gear would be determined by sample size analysis.

**Assumptions:**

Assumptions include the limited information on the different turbine designs and configurations as well as their associated anchoring structures and cables for floating wind areas in U.S. waters at this time. These may vary among the leases and companies. This could increase or decrease the ability to implement new approaches, and it is dependent on the spacing and number of connecting structures. If common anchors are used for the turbines, this could potentially completely prevent the ability to safely operate and might result in exclusion. If there are many broadly extended cables, as opposed to taught vertical or buried cables, this would limit the BLLS gear that could be deployed. The proposed mitigated survey methods also assume that small vessels will be allowed to operate among the floating turbines by the wind energy companies and their insurance providers. There is also an assumption that safe operation at night and a range of sea states is also feasible, consistent with current survey operations.

**Exclusion:**

A complete exclusion from the floating wind areas for the longline gear would require exploration and testing of alternative gear types. These would then require calibration relative to the existing techniques. The BLLS is focused on structured habitat, so the most probable alternative gears would be fish pots, gillnets, and automated jig machines. Rod and reel or jig machine approaches would present an additional challenge for direct comparison to the existing sampling due to the large difference in spatial footprint of the sampling and the more limited volume of catch. A pot survey might be the simplest approach for comparing to the longline as it uses bait, and a number of connected pots could be used to make the spatial coverage more comparable. However, similar operating challenges could be an issue for pots and might require individual pot deployments and not connected trawls. Any alternative gear will impact the species complex sampled, and certain species could be excluded (larger species, in particular).

**3. *Calibration and integration of new survey approaches***

The new presumptive BLLS operational approach (2 short consecutive sets) will be calibrated against the traditional 1-nm, 1000-hook deployment through paired sets. The 2 survey vessels will conduct paired sets across BLLS strata (depth- and habitat-based) and during the spring and fall seasons that are surveyed by the BLLS. These comparison sets will then be statistically compared for differences in catch rate and species composition to determine if they are similar enough to be treated as the same or require a calibration coefficient. Analysis would include comparisons in both seasons and across multiple depth strata and habitats representative of potentially impacted survey coverage areas. This work could be completed before construction of the wind energy structures.

**4. *Development of interim provisional survey indices***

An analysis of historical BLLS data to compare indices of abundance that use data from all survey stations to indices of abundance that use data only from stations that fall outside of wind energy areas (WEAs) should be conducted to explore the scale of impacts on data and indices due to changes in BLLS operations. This analysis would need to be conducted for a range of species with different data densities, life histories, and habitat preferences. Given the similarity of the modified BLLS approach, provisional indices may not be required once the paired sets are analyzed. Analytical results will determine whether the 2 approaches can be considered comparable or require modeled adjustments to survey indices between the historical and new approaches.

**5. *Wind energy monitoring to fill regional scientific survey data needs***

There is uncertainty about the impacts of WEAs to the BLLS due to the unknowns of floating wind turbines. If we assume some capacity to set bottom longlines within the floating wind areas, then a complete statistical redesign or significant changes would be unnecessary to maintain the data streams to end users. Also, the survey design is focused on structured bottom that is less suitable for floating wind development, so impacts to station coverage may be lower than other surveys. Statistical analysis and potential adjustment to the index models may be required, as well as some changes to bottom strata classification if there are significant increases in the amount of structured habitat. Calibration studies of the 2 longline operations (in and outside wind area) would be required to evaluate impacts and need for statistical adjustments to indices.

**6. *Development and communication of new regional data streams***

The industry partners for the BLLS have already been consulted for this draft plan, and they will need regular consultation going forward. Additionally, other small vessel and fixed-gear fishing industry members and organizations could be solicited for input. Outreach meetings to describe proposed survey mitigation approaches and solicit feedback could be beneficial. If alternative gear types are to be deployed due to an inability to set longlines within the floating wind areas, then a new contracting process would be required that solicits input and bids from appropriately experienced vessels. Staff in the NEFSC Population Dynamics Branch should also be included in the decision process for alterations to the sampling design and for awareness of the changes to the data and comparability to the time series. The New England Fishery Management Council (NEFMC) and Scientific and Statistical Committee (SSC) and the Northeast Trawl Advisory Panel (NTAP) should be briefed about proposed mitigation strategies. Communication with GARFO will be required, including for permitting changes and potential National Environmental Policy Act/Endangered Species Act/Marine Mammal Protection Act compliance related to new sampling methods.

The new survey approaches would increase demands for data acquisition and management. The quantity and complexity of changes to the BLLS data collection and management systems will vary depending upon how the survey operations change. New data acquisition and management needs will be minor if the BLLS operations only have to be altered slightly (shorter sets inside wind energy developments), but data acquisition and management needs would be significant if the survey approach has to be completely changed or an alternative fishing gear employed. Changes in sampling density would increase the data management and auditing requirements for the BLLS. The survey software application would require some changes, as well. The scale of these needs is again dependent on the assumption of turbine spacing and an ability to still fit at least some portion of the longline within the wind areas.

# V. Proposed Schedule for Implementation

Table 1. Proposed activities, milestones, and schedule for BLLS wind mitigation plan.

| Element | Task | Activities | Milestone |
|---|---|---|---|
| V. 1. & 2. | -Evaluate BLLS station loss due to WEAs and design comparative calibration study | -Hire ZP3 staff to conduct sensitivity analysis of BLLS data with and without some stations<br>-Prepare logistics and contracts for calibration study | -Hire ZP3 staff<br>-Design calibration study plan<br>-Conduct sensitivity analysis of BLLS indices |
| V. 3. | -Execute a calibration study | -Conduct paired calibration sets over a range of conditions in the Gulf and conduct sets among floating wind structures, if built -Adjust data collection tools and database to account for new data elements | -Conduct standardized paired comparison sets of BLL<br>-Compile summary report of analysis of paired sets<br>-Adjust data model and software to accommodate operational changes |
| V. 4 & 5 | -Continue to produce survey indices with adjustments as necessary to account for WEA impacts | -Implement results of above analyses to maintain data streams | -Deliver data sets and indices to management and stock assessment teams |

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| | | | -Potentially adjust data depending on results to end users |
| V. 6 | -Collaborate on changes with industry partners and population dynamics, and communicate those changes to stakeholders | -Conduct collaborative meetings<br>-Continue our ongoing participation in existing assessment, council, and NTAP meetings | -Meet with partners and assessment staff, and identify changes and needs<br>-Communicate changes at existing assessment meetings<br>-Communicate changes at relevant stakeholder meetings |

*Only the first and last items are covered at all by current funding, but those 2 will happen in part (or have happened already) in fiscal year (FY) 2024.

# VI. Links to Other Surveys

The BLLS already has significant overlap in methods, equipment, and design aspects with the NEFSC bottom trawl and shellfish surveys. Conversations will continue around aspects of collaboration where overlap occurs. There is potential for additional collaborative sampling to support other programs during the BLLS operations. There are limitations to what forms that can take given the limited BLLS staff (2 members), space, and vessel capabilities for this small vessel survey. Discussions will occur with other groups about potential collaborative efforts going forward as other mitigation programs get started, including with programs outside the NEFSC (e.g., state agencies). One such conversation has already occurred relative to improving the technology and quality of video habitat data collected during the BLLS (e.g., with the Deep Sea Coral Research and Technology Program). Additional habitat or oceanographic monitoring collaborations are possible.

# VII. Adaptive Management Considerations/ Opportunities

The main adaptive considerations for the BLLS mitigation plan revolve around the final siting and design of floating wind structures in the Gulf of Maine. Once those plans are publicly known, then additional (or fewer) modifications to the BLLS operations and data streams may be required. BLLS program staff will monitor these developments, identify how these changes could impact the survey, coordinate and discuss with our partners, and revise the mitigation plan as necessary.

# VIII. Statement of Peer-Review Plans

This plan will be peer reviewed in the same processes as the other mitigation plans in the NEFSC portfolio. It will also be presented to external groups such as the NTAP panel and the NEFMC.

# IX. Performance Metrics

The principal metrics for this plan will be changes in the use of the BLLS data in stock assessments. Regular evaluation of the CVs and model diagnostics of BLLS indices of abundance will also continue and can be used to monitor changes in the quality of the data or signs of increasing uncertainty.

# X. References

McElroy WD, O'Brien L, Blaylock J, Martin MH, Rago PJ, Hoey JJ, Sheremet VA. 2019. Design, implementation, and results of a cooperative research Gulf of Maine longline survey, 2014-2017. US Dept Commer Northeast Fish Sci Cent Tech Memo 249. 156 p. Accessible at: https://doi.org/10.25923/2sgn-mx62

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