REVIEW OF THE VERTICAL LINE ANALYSIS MODEL FOR THE ATLANTIC LARGE WHALE TAKE REDUCTION TEAM (ALWTRT)

Submitted to the Center for Independent Experts

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EXECUTIVE SUMMARY:

Entanglement of Atlantic right, fin, and humpback whales in active or discarded fishing gear continues to add to the population decline of these three, already endangered, large whales in US Northern Atlantic Ocean waters. Whales entangled in this fishing gear can suffer injury, serious injury, or mortality. There is little information on how or why whales become entangled. Fishers are required to report the sighting of an entangled whale, alive or dead, to the National Marine Fisheries Service. A team of volunteers and government employees locate the whale and, at great risk to themselves and the whale, attempt to dislodge the gear from the animal. Many whales bear scars that reflect the number of entanglements they have incurred.

These large whales are protected by three US laws: The National Environmental Policy Act of 1970, the Marine Mammal Protection Act of 1972, and the Endangered Species Act of 1973. The National Marine Fisheries Service is responsible for the conservation and management of these whales. A total of 13 states have coastlines with a variety of gillnet, lobster pot, and trap/pot fisheries (NC, SC, GA, MD, VA, NH, DL, NY, CT, MA, NJ, RI, FL). In addition, each state has its own set of laws, guidelines, and reporting procedures. Many stakeholders are involved with monitoring and reducing entanglements.

NMFS organized an Atlantic Large Whale Take Reduction Team who developed an Atlantic Large Whale Take Reduction Plan (ALWTRP). The team first addressed the reduction of take by using fishing gear modifications, which were somewhat successful. Gear modification included marking the fishing gear to be able to identify its owner, and using “weak link” sections in the lines so if a whale was entangled it could more easily break away. Education of the public and input from local fishers also played a large role in gear modifications. In addition, NMFS has issued a Request for Proposal for further gear modifications. NMFS will submit an Environmental Impact Statement in 2014 to establish if fishing activities are significantly reducing the recovery of these endangered whales.

One cost-effective method used in fishery/marine mammal conflicts is to create a computer model to study the effects of changing characteristics of fishery practices and gear and also to model the severity of entanglement for specific species, ages, sexes, and behaviors of the whales. In 2008, NMFS generated such a model for the large whale/fishery conflict in the US North Atlantic, called the Vertical Line Analysis Model. More recently NMFS contracted Industrial Economics Incorporated (IEC) to refine the model. The model divides the region into 10-minute cells, enters the number of “model vessels” in each cell, and inputs the type of fishery, the gear configuration. The distribution of these three species of whale is entered by month of the year based on several sources of aerial and shipboard surveys. The model, then calculates a “co-occurrence score” for the whales and fishing gear for each cell. The output of the model can be tables, charts, maps, or animation for color-coded cells which plot the co-occurrence score. From this model, researchers can identify “hot spots” with high probability of co-occurrence of gear and whales, and view monthly & seasonal variations in these scores at specific locations.

This report is a review of the inputs, outputs, assumptions, and potential new data that could be added to the model. Generating this model, was a huge effort, involved many government and private agencies, and took advantage of all available data. Overall, the Vertical Line Analysis Model uses basic data, with reasonable assumptions to provide a co-occurrence score that should be useful to NMFS and the fisheries. The model's mathematics is simple and easy to understand. Comments are made on ways to add to or improve the model's output.

BACKGROUND

Based on the most recent, 2010/2011 summary of large Atlantic whale entanglements in fishing gear (see Tables 1), there is still the need to reduce or eliminate entanglement, injury, and mortality of large whales in the US Atlantic waters. The key species of concern are the North Atlantic right whale *(Eubalaena glacialis*), the Atlantic humpback whale (*Megaptera novaeangliae),* and the Atlantic fin whale (*Balaenoptera physalus*). All three species are highly endangered and as such their recovery is under the jurisdiction of three different US laws: the Endangered Species Act (ESA) of 1973, the Marine Mammal Protection Act (MMPA) of 1972, and the National Environmental Policy Act (NEPA) of 1970. The US agency in charge of adhering to these policies is the National Marine Fisheries Service (NMFS) of the National Oceanic and Atmospheric Administration (NOAA).

The issues are complicated, the stakeholders are many, and the stakes for these endangered species are high. The US Atlantic coast is divided into three management zones under the jurisdiction of their respective NMFS offices: Northeast-Atlantic, Mid-Atlantic, and Southeast-Atlantic (See Figures 1-3). The three species of whales occur in these waters and their occurrence is based on food availability, season, and behavioral state. Several fisheries work in these three regions (blue crab, lobster, trap/pot, gillnet), and they too vary in location and time spent in an area. So, trying to reduce entanglement of whales in fishing gear requires a dynamic solution, with inputs from many biological variables, cooperation between the fisheries and government, an understanding of oceanography, and input from the general public.

For years, researchers from several organizations (National Marine Fisheries Service, New England Aquarium, and North Atlantic Right Whale Consortium, NARWC) have studied entanglement in these three species of large whales. In many cases, the solution was to disentangle the gear from the animal; a dangerous proposition for humans and the whale. But, too often the animal is found dead at sea before the disentanglement team arrives.

Under the MMPA, the first goal is to reduce the mortality and injury of the stock incidentally taken by a US commercial fishery within six months. The “take” of the stock must be reduced to be below Potential Biological Removal (PBR) level established for the species’ stocks. The PBR level is the maximum number of animals that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population (does not include natural mortalities).

Within five years after the establishment of a Take Reduction Plan, the incidental mortality and serious injury of strategic marine mammal stock taken during U.S. commercial fishing operations needs to be reduced to levels approaching a zero mortality and serious injury rate (defined as 10% of a stock’s PBR level), commonly referred to as the zero mortality rate goal (ZMRG).

Under the mandate of the Endangered Species Act (ESA), federal agencies are required to ensure that federally permitted activities (such as commercial fisheries) do not jeopardize the continued existence and recovery of an endangered species.

To comply with *National Environmental Policy Act (*NEPA), Federal agencies must prepare a detailed statement on the environmental impacts of any major Federal action significantly affecting the quality of the human environment. This detailed statement is known as an Environmental Impact Statement (EIS). NMFS will prepare an EIS to evaluate the environmental effects of implementing further conservation measures to reduce the risk of serious injury and mortality of large whales that become entangled in the vertical lines of trap/pot and gillnet fishing gear.

<u>History of ALWTRP Activities</u>

The original regulations of the Atlantic Large Whale Take Reduction Plan (ALWTRP) were implemented in 1997 and published in the *Federal Register* as an interim final rule. (See Figure 4 for management and feedback plans for ALWTRP). The regulations were amended in February 1999 and again in December 2000. In January 2002, NMFS published three rules that made further modifications to commercial fishing gear, established a system for restricting fishing in areas where unexpected aggregations of right whales are observed (Dynamic Area Management), and established restricted areas based on annual, predictable aggregations of right whales (Seasonal Area Management). In June 2007, NMFS published a final rule expanding the Southeast U.S. Restricted Area and prohibiting gillnet fishing or possession during the right whale calving season, with exceptions. In October 2007, NMFS issued a final rule implementing broad-based gear modifications largely to replace the Seasonal and Dynamic Area Management programs [21].

This broad-based gear modification strategy includes expanded weak link and sinking groundline requirements, additional gear marking requirements, changes in management area boundaries, seasonal restrictions for gear modifications, expanded exempted areas, and regulatory language changes for the purposes of clarification and consistency [25].

Specifically, the MMPA required that the Take Plan reduces serious injury and incidental mortality (SI&M) of each marine mammal stock to below a stock's Potential Biological Removal (PBR) level. NMFS implemented the Atlantic Large Whale Take Reduction Plan (ALWTRP) in 1997 and it has been modified on several occasions to reduce the risk of injury and mortality of large whales which interact with commercial trap/pot and gillnet fishing gear in the Atlantic.

In 2012, NMFS published the **ATLANTIC LARGE WHALE TAKE REDUCTION PLAN [20].** The ALWTRP consists of regulatory and non-regulatory programs including: broad-based gear modifications, time-area closures, disentanglement, research and outreach. The report included strategies to monitor the Effectiveness of and Regulatory Compliance of fisheries with the ALWTRP. A variety of stakeholders were consulted;

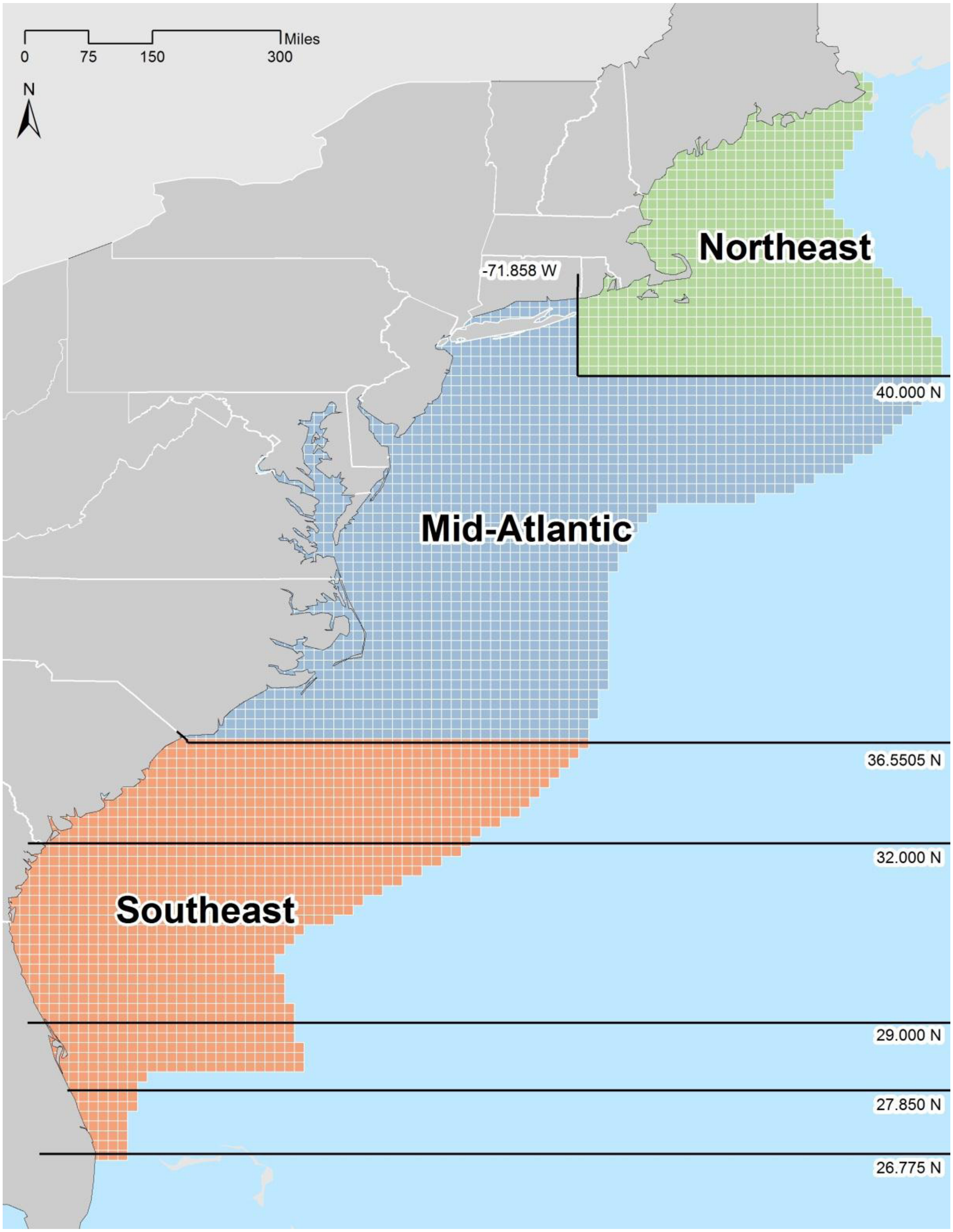
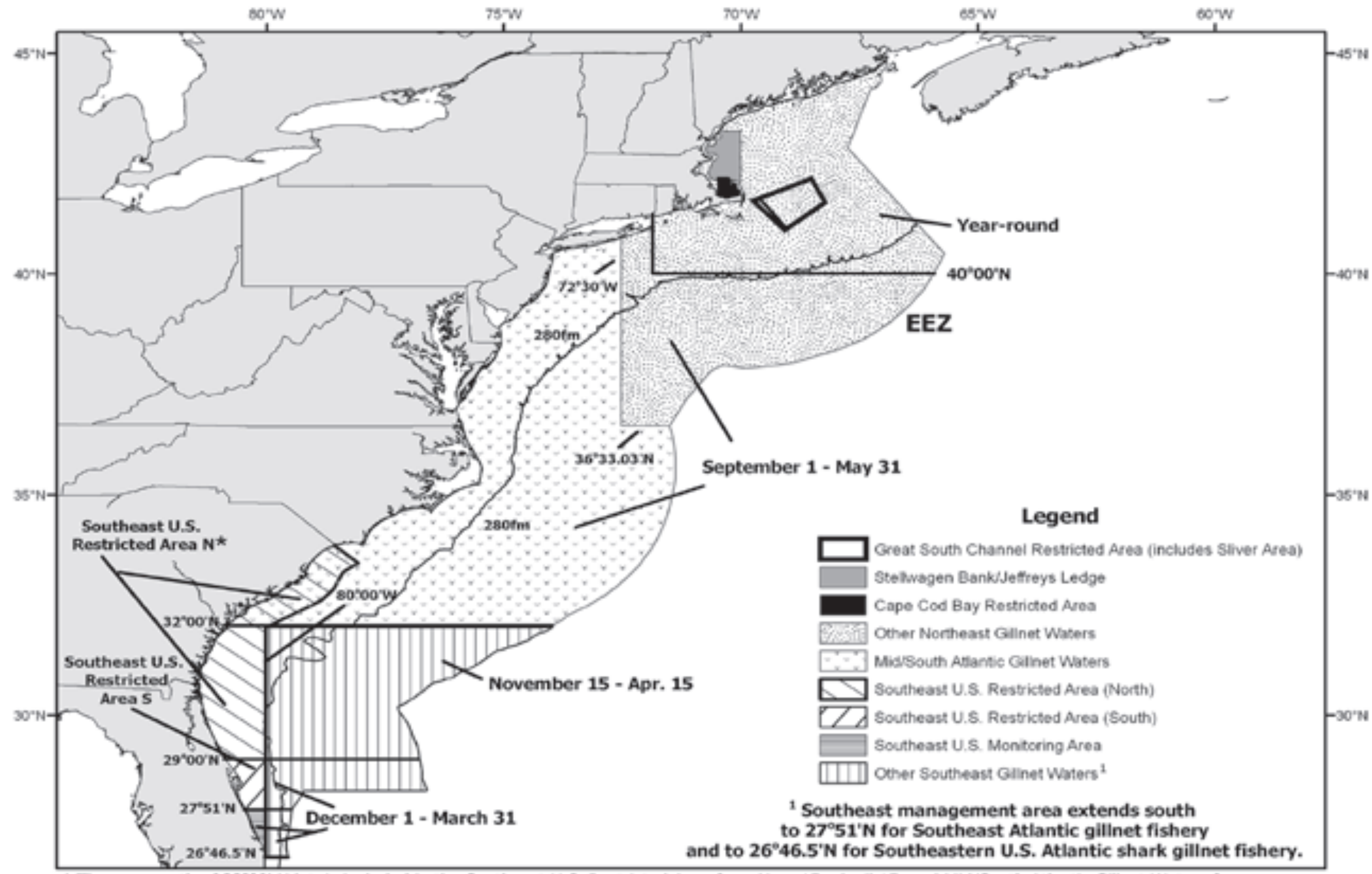


Figure 1. Map of 10-min cells in each management area for large whales in US North Atlantic Costal areas subject to the ALWTRP.



* The area north of 32°00' N lat. is included in the Southeast U.S. Restricted Area from Nov. 15 - April 15, and Mid/South Atlantic Gillnet Waters from Sept. 1 - Nov. 14 and April 16 - May 31.

Figure 2. All pot trap areas in US North Atlantic Costal areas subject to the ALWTRP.

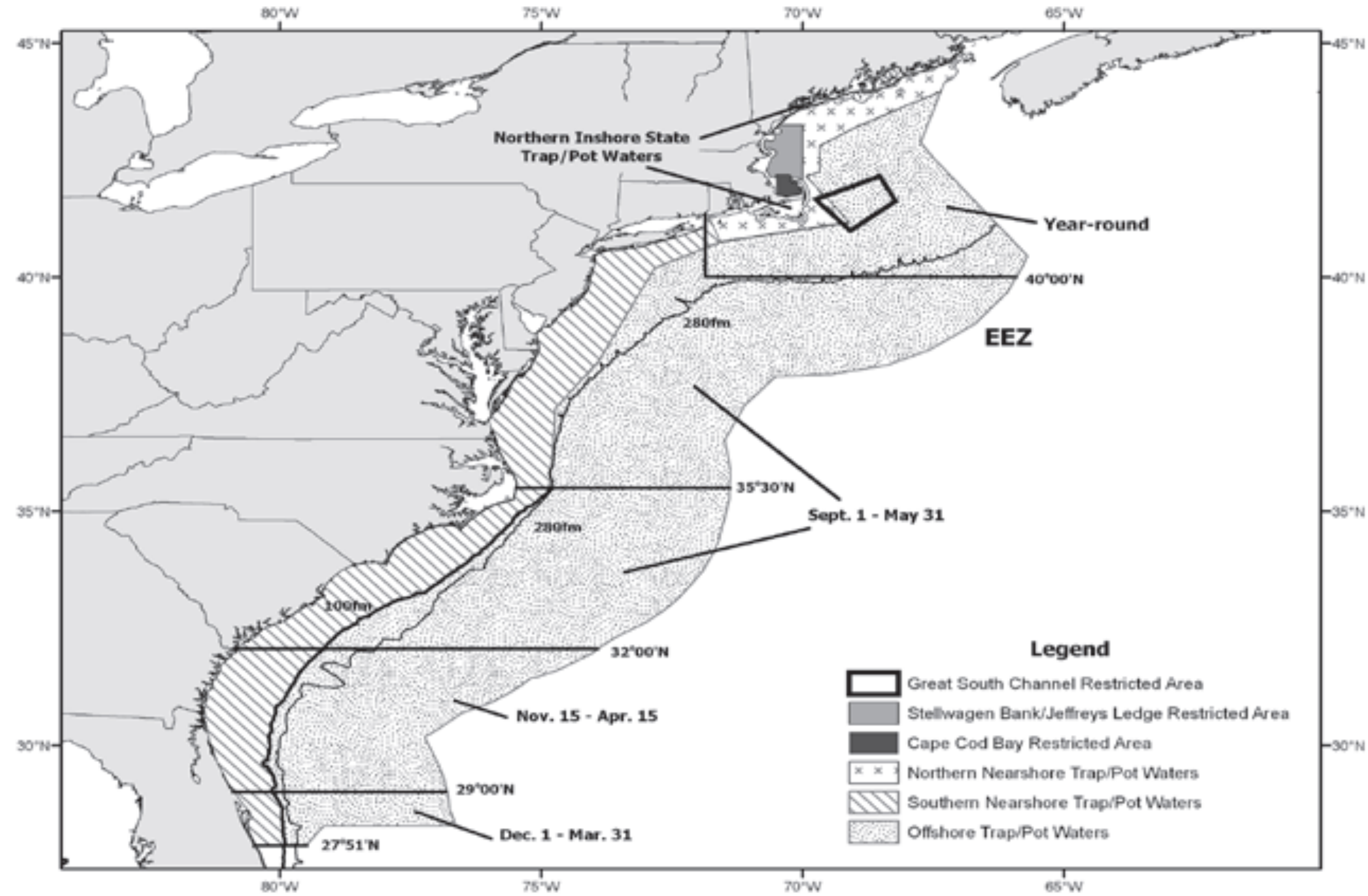


Figure 3. All gillnet areas in US North Atlantic Costal areas subject to the ALWTRP.

fishing industry representatives, scientists, environmental advocates, state and federal officials, and other interested parties.

The ALWTRP has several components, including restrictions on where and how fishing gear can be set, research on whale populations and behavior, research on fishing gear interactions and modifications, outreach to inform and collaborate with fishermen and other stakeholders, and a large whale disentanglement program.

Despite these efforts, there continues to be injuries and mortalities of large whales from entanglements in vertical lines from commercial trap/pot and gillnet fishing gear. Therefore, additional modifications to the ALWTRP are needed. NOAA's National Marine Fisheries Service (NMFS) intends to expand large whale conservation efforts in the Atlantic by amending regulations, allowing the implementation and improvement of the Atlantic Large Whale Take Reduction Plan.

Challenges to ALWTRP

Monitoring the ALWTRP presents several unique challenges. This is primarily due to the widespread lack of reliable and comprehensive data pertaining to large whale/fishery interactions. Large whale entanglements are typically not observed or documented by fishery observers or other sources. Furthermore, in many instances fishing gear found on whales is difficult to attribute to a particular gear type, gear component, fishery, or geographic region. In addition, the data needed to most effectively monitor the ALWTRP spans many regulated fisheries across a wide geographic range along the US east coast.

The ALWTRP monitoring strategy incorporates a variety of measures that will assist in evaluating the levels of compliance and overall effectiveness of the Take Reduction Plan [20]:

• *Biological, oceanographic, and fishing gear analyses* – population growth trends, large whale serious injury and mortality determinations, observed entanglement events over time, entangling gear identification, and oceanic conditions/trends related to large whales;

• *Fishing industry practices and compliance indicators* – using observer data, quantifying enforcement efforts, gear characterization efforts;

• *Education/outreach measures* – distribution of outreach guides and other information, issuing permit holder letters, ALWTRP website maintenance, trade-show participation, industry outreach meetings, ALWTRP trainings, direct communications, and publication.

ALWTRP monitoring strategy is divided into two components: evaluating the ALWTRP's overall effectiveness and evaluating compliance with ALWTRP requirements [20]. See Figure 4; flowchart of ALWTRP monitoring and evaluation.

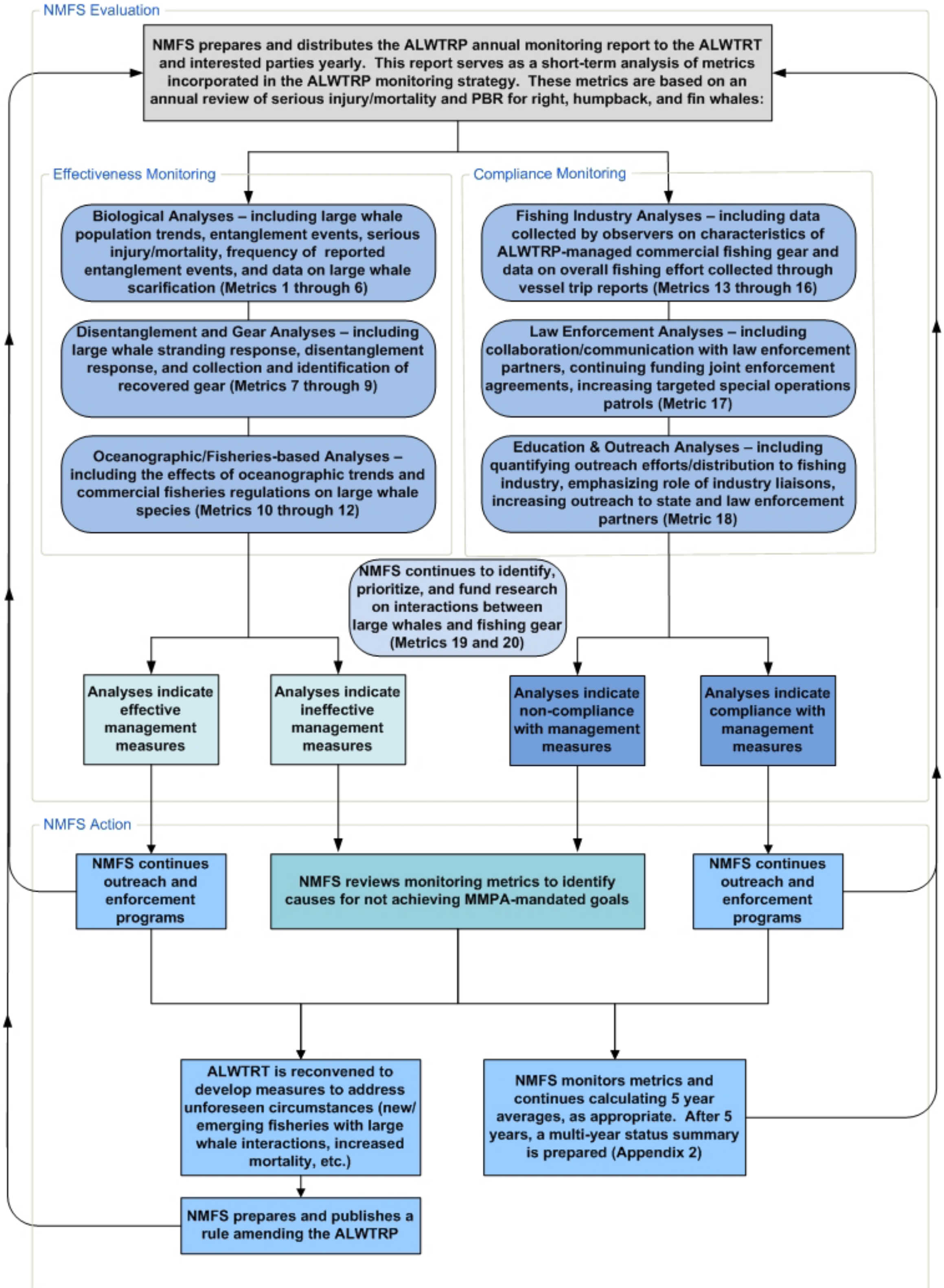


Figure 4. Flowchart of the processes that NMFS uses to monitor the effectiveness of ALWTRP.

Comparing serious injury and mortality estimates to PBR and ZMRG annually can indicate the effectiveness of the ALWTRP regulations, enforcement, and education/outreach efforts, and provide an indicator of compliance levels. Presently, the two best available indicators of the effectiveness of ALWTRP regulations are determinations of serious injury and mortality due to entanglement and the frequency of observed/reported large whale entanglement events.

Scarification Data

Large whales accumulate scars with every entanglement episode. So, theoretically a photo catalog of identified animals should be able to track successive entanglements, reveal what body parts are most often entangled, and help estimate the entanglement rate; however, scarification records have not be as informative as hoped. Regardless, NMFS stated that further discussions with those collecting and analyzing scarification data are necessary to fully explore this metric as an indicator of ALWTRP effectiveness. To that end, future ALWTRP annual monitoring reports will consider developments in scarification analysis in its discussion of ALWTRP effectiveness monitoring, and will compare rates of scarification with rates of large whale serious injury and mortality.

As of December 2011, PBR values for the three large whale species of concern were:

- North Atlantic right whale – 0.5 whales
- Gulf of Maine humpback whale – 1.1 whales
- Western North Atlantic fin whale – 6.5 whales

From recent entanglement data, it is clear that NMFS is not achieving its conservation objectives under the ESA and the MMPA (See Table 1). Specifically, entanglements are still occurring and mortality and serious injury exceeds PBR for both right and humpback whales. For right whales SI&M is currently 0.8 and the PBR is 0.7; for humpback whales the SI&M is currently 3.0 and the PBR is 1.1 (Waring et al. 2010, [30]).

Gear Recovery as an Indicator of ALWTR Gear Modifications Effectiveness

As of 2008, the recovery of entangling fishing gear and its potential identification to a specific gear type/fishery was a primary source of data on the effectiveness of fishing gear modifications at reducing the occurrence of large whale entanglements [25].

Of the 364 large whale entanglement events recorded from 1997 through 2008:

- Gear was recovered or known in 129 (35%) of the cases;
- Gear type was identified in 103 (28%) of the cases;
- Fishery and location in which gear was set was known in 53 (15%) of the cases;
- Fishery, location, and date was known in 36 (10%) of the cases.

Compliance

Entangling gear that is recovered within the U.S. is provided to NMFS gear experts for analysis and possible identification, and could be provided to the NOAA Office of Law Enforcement. Currently, the recovery of entangling fishing gear and its potential identification to a gear type/fishery is a primary source of data on the effectiveness of fishing gear modifications at reducing the occurrence of large whale entanglements. Recovered fishing gear is helpful from a regulatory compliance standpoint since in some cases it is possible to determine if the gear contains the required gear modifications and was therefore being fished in a manner consistent with the ALWTRP requirements. This information can be collected through an examination of recovered gear and/or interviews with fishing gear owners, if known. When recovered gear is concluded to be not in compliance with the ALWTRP, there is an existing protocol for transferring the non-compliant gear to NOAA OLE for investigation [21].

The primary method for monitoring compliance with ALWTRP regulations is to monitor the practices of fishermen in the regulated commercial fisheries using the best data sources available.

Data from the NMFS Northeast Fisheries Observer Program (NEFOP) is included in the ALWTRP annual monitoring report contributing to the analysis of compliance with ALWTRP regulations. In 2007, the NOAA Fisheries Service Northeast Fisheries Science Center (NEFSC) gillnet and trap/pot observer logs were modified to include various ALWTRP-managed gear characteristics, such as weak links (number, type), surface system (presence/absence, number of buoys), buoy line (number, composition), groundline (length if present, composition), anchors (number, type), and presence of gear marking. Data collected by observers on these characteristics are an important measure of compliance with ALWTRP regulations. Analyses of observer data summaries will be used as an indicator of compliance, as well as to target specific areas for outreach and/or law enforcement.

All commercial fishing vessel owners or operators, regardless of the fishery in which they participate, must report all incidental injuries and mortalities of marine mammals that have occurred as a result of commercial fishing operations. Reports must be sent to NMFS within 48 hours of the end of a fishing trip [25, 27].

NMFS reviews data collected through fishing vessel trip reports (VTR), or logbooks, in specific commercial fisheries along the east coast to monitor commercial gillnet fishing within ALWTRP-managed waters and especially during seasonal ALWTRP closure areas.

Table 1. Preliminary Entanglements of Atlantic Large Whales documented in 2010 and 2011 [16].

2010

- 25 new confirmed entanglements
  - o 5 right whales
  - o 15 humpback whales
  - o 4 minke whales
  - o 1 unknown

- 8 whales have been disentangled completely or partially (with what is believed to be non-life threatening gear remaining)
  - o 2 right whales (1 later died)
  - o 3 humpback whales
  - o 3 minke whales

2011

- 15 new confirmed entanglements (as of June 9, 2011)
  - o 8 right whales (4 non-life threatening; 1 dead)
  - o 6 humpback whales
  - o 1 minke whale (dead)

In further attempts to reduce injury and mortality of large whales that become entangled in fishing gear, NMFS has issued a Request for Proposal to allow all stakeholders to submit proposals outlining vertical line risk reduction strategies tailored to specific areas and fisheries [2]. The proposal needs to include a description of: the area and fisheries affected, management approach, monitoring plan, and enforcement plan. The proposed management action can be incorporated into the model to see the corresponding reduction of vertical lines as a result of the action. NMFS is looking for answers to the following questions: 1) Where to manage? 2) When to manage? 3) How to manage? 4) How can the current gear marking strategy improve? and 5) How can gear characterization reporting improve?

NMFS intends to expand large whale conservation efforts by amending regulations that implement the Atlantic Large Whale Take Reduction Plan. Since its implementation in 1997, the ALWTRP was modified on several occasions to reduce the risk of injury and mortality of large whales that interact with commercial trap/pot and gillnet fishing gear.

The ALWTRP consists of regulatory and non-regulatory programs including: broad-based gear modifications, time-area closures, disentanglement, research and outreach. Despite these efforts, there continues to be injuries and mortalities of large whales from entanglements in vertical lines from commercial trap/pot and gillnet fishing gear. Therefore, additional modifications to the ALWTRP are needed.

At the 2003 Atlantic Large Whale Take Reduction Team (ALWTRT) meeting, the group agreed to two overarching principles associated with reducing large whale entanglement risks: reducing entanglement risks associated with groundlines (lines between trap/pots) in commercial trap/pot gear; and reducing entanglement risks associated with vertical lines (endlines or buoy lines) in commercial trap/pot and gillnet gear.

NMFS addressed the first principle; reducing entanglement risk from groundlines in October 2007 with the implementation of a sinking groundline requirement for all trap/pot fisheries throughout the entire East coast (72 FR 57104, October 5, 2007). NMFS is addressing the second principle, reducing entanglement risks associated with vertical lines in commercial trap/pot and gillnet gear, in this current process.

NMFS committed to publishing a final rule to address vertical line entanglement by 2014. Unlike the broad-scale management approach taken to address entanglement risks associated with groundlines, the approach for the vertical line rulemaking will focus on reducing the risk of vertical line entanglements in finer-scale high impact areas.

Using fishing gear characterization data and whale sightings per unit effort (SPUE) data, NMFS and Industrial Economics, Incorporated (IEc) developed a model to determine the co-occurrence of fishing gear density and whale density to serve as a guide in the identification of these high risk areas. The ALWTRT agreed that NMFS should use the model to develop suites of conservation measures that would ultimately serve as options for the ALWTRT to consider when identifying management alternatives. The conservation measures would address vertical line fishery interactions with large whales by reducing the potential for entanglements and minimizing adverse effects if entanglements occur.

Under contract to NMFS, IEc developed a tool that provides the information described above: the Vertical Line Analysis Model [9-14]. The model is designed to help NMFS address basic questions that are fundamental to whale conservation and fisheries management, such as:

- Where do fisheries subject to the requirements of the ALWTRP operate?
- Where are concentrations of vertical line likely to be the greatest?
- Are whales likely to frequent areas with high concentrations of line?

Vertical Line Analysis Model

One method to address whale/fisheries interactions is to model the system. Plaganni and Butterworth (2008) discussed the use of models to address whale/fisheries conflicts. [29] p. 271. They reported that often models do not work because of oversimplification. They reported that models need to address three characteristics:

1. How many of the interacting species in an ecosystem is need to be considered in the model?
2. Is age-structure considered in the model?
3. Models often assume that species interactions occur homogeneously over space.

To address entanglement risks associated with vertical lines, NMFS developed a whale/fishery "co-occurrence" model, the Vertical Line Analysis Model [4-5, 9, 12-13]. The model combines effort-corrected, whale Sightings Per Unit Effort data (SPUE) and fishing gear characterization data to identify areas in the three Atlantic regions where whales and gear overlap [4, 9-14]. This approach will help NMFS develop a management scheme focused on smaller, high-priority areas, rather than a generic coastal wide-scale broad approach.
The model required several types of data from the fishing industry: total number of traps fished, total number of end lines, configuration of gear, areas fished (exempt, non-exempt, and federal), time of year (months fishing), and zones of fishing [9, 13].

The model also required the best available data on the distribution of right whales, humpback whales, and fin whales by location and month of the year. These data were gathered from aerial and shipboard surveys by several agencies. The NMFS, the New England Aquarium and the Right Whale Consortium provide sighting and life history information for right whales. Life history and sighting information for humpback whales is provided by PCCS, with contributions from Blue Ocean Society, Brier Island Whale and Seabird Cruises, and The Whale Center of New England.

The model overlays the distribution of fishing gear (of various types) and whale sightings at a particular location and time [14]. The model was not generated to determine the probability of entanglements, injury or mortality in the whales, rather as a means to identify locations and times of year where fishing gear and whales most often co-occurred and least often co-occurred.

The Vertical Line Analysis Model resides on a combined platform of *Microsoft Access* 2003 and *ESRI ArcGIS* Desktop Version 10.0. *Microsoft Access* provides the user an interface with the model and supports efficient storage, retrieval, and analysis of the large datasets used to characterize fishing activity and whale sightings. *ArcGIS* enables spatial analysis and provides outputs in map form. The model also produces map images that can be imported into *Microsoft PowerPoint* to create animations to demonstrate changes.
By altering inputs to the model, the user can simulate characteristics of either/both the fishing gear and whale species to create different coexistence scenarios. The Vertical Line Analysis Model allows the user to change several features of the model fishery to determine the effects and magnitude of change each fishing method will have on the co-occurrence score [9-14].

The Vertical Line Analysis Model generates four indicators to describe fishing activity and the potential for interactions between large whales and fishing gear:

- Number of Active Vessels: Using Federal and state data sources, the model estimates the number of commercial fishing vessels that participate in each fishery. Depending on the location and fishery, the model employs a variety of methods to estimate the number of active vessels.
- Number of Vertical Lines: Based on the number of active vessels and data on typical gear configurations (e.g., the number of vertical lines employed per vessel), the model estimates the number of vertical lines employed by each fishery [9].
- Length of Groundlines: The model can estimate the total length of groundline (i.e., fishing line linking traps to traps and/or traps and gillnets to anchors) in the water.
- Whale Sightings and Vertical Line Co-Occurrence Indicator: As a relative measure of the potential for an entanglement, the model combines effort-adjusted whale sightings information with estimates of the number of vertical lines in the water at a particular location and time. The co-occurrence indicator can be generated for each whale species (right, humpback, and fin) or for any combination of the three [14].

The final product of the model is a set of indicators that provide information on factors that contribute to the risk of entanglement at various locations and times. These indicators can be displayed as charts, tables, maps, and animations.

By integrating available information on patterns of fishing activity, gear configurations, and seasonal changes in the likely distribution of the species of concern, the model provides indicators of relative entanglement risks at various locations and at different points in time. This information will help NMFS identify and evaluate the potential impact of management options designed to reduce the chances that whales will encounter and become entangled in commercial fishing gear.

Description of the Individual Reviewer's Role in the Review Activities
The NMFS Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects, such as ALWRT and the Vertical Line Analysis Model. The Statement of Work was established by the NMFS Project Contact and Contracting Officer's Representative, and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest.

CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review.

Each CIE reviewer is contracted to produce an independent peer review report, which is reviewed and approved by the CIE Steering Committee. The format of the report is specified in **Annex 1 (See Appendix 2).** The tasks and deliverables of the CIE reviewer include an independent peer review of the ALWRTP, identification of current literature on the topic of entanglement of large whales in the Atlantic, review of the population status of humpback, right, and fin whales in the Atlantic, review of inputs and outputs to the Vertical Line Analysis Model, review of assumptions of the model, recommend improvements or additions to the Vertical Line Analysis Model, and suggest further analysis of fishing and whale density and distribution data.

Given the significant public interest in this topic, it is critical for NMFS to obtain a transparent and independent review of the model documentation. It is important that the model contains the best available information on both whale density and fishing gear density and that the associated caveats seem reasonable.

Summary of Findings for each ToR (weaknesses and strengths)

Terms of Reference (ToR):

<u>This review is to address the following questions:</u>

1. Does the documentation provide a clear description of the model's purpose and scope, and of the data and methods it employs to characterize:

The purpose of the Vertical Line Analysis Model is clearly described, in several documents provided to the reviewer, as a way to simply estimate the probability that any of three species of large whales (right, fin, or humpback whales) in US Atlantic waters could be in the same 10-min cell at the same time and place as vertical fishing lines for each of three types of fishing gear (buoy lines associated with lobster trap/pot gear, other trap/pot gear, or gillnet gear). The Vertical Line Analysis Model provides a simple indicator of the likelihood that whales will encounter fishing gear, the co-occurrence score. The co-occurrence score is based on an estimation of gear concentration in a 10-min cell of the fishing area during a particular month. The monthly co-occurrence score is calculated for each of the three whale species using shipboard and aerial survey data on whale densities. Furthermore, the co-occurrence score is calculated in 3-month averages to examine seasonal changes in the co-occurrence score.

Four groups of large whales are examined by the model: Atlantic right whales, humpback whales, fin whales, and right & humpback whales combined. Maps of the co-occurrence scores are provided for three regions of the US Atlantic coastline: Northeast-Atlantic, Mid-Atlantic- and Southeast-Atlantic (Figure 1). Over time, more surveys for whales have been added to the model, so currently available data are from 1978 to 2010.

The probability that an entanglement will occur may depend on the amount of gear deployed in a particular area, the number of whales present, whether the gear is actively tended, and the whale's behavior when gear is encountered (e.g., whether the whale was feeding). The risk of injury or death from an entanglement may depend on the characteristics of the species, size, age, & health of the whale, whether the gear has "weak links" designed to help free a whale, and the feasibility or success of human efforts to disentangle the whale. The interrelationships among these factors are not fully understood. Data are needed to better characterize the risk of injury versus mortality.

Given the current state of knowledge, the model cannot provide a direct assessment of the probability of an entanglement at a particular place and time, nor does it assess the risk of injury or death in the event of an entanglement. It focuses on the relative indicators of the potential for an entanglement to occur, using this as a proxy measure of risk.

a. Does the documentation provide a clear description of the model's purpose and scope, and of the data and methods it employs to characterize vessel activity in the fisheries subject to the requirements of the ALWTRP?.

The current version of the Vertical Line Analysis Model uses the number of several types of fixed-gear in a cell, including a number of gillnet fisheries, the American lobster fishery, the blue crab fishery, and other trap/pot fisheries. Through the comparison of information on fishing activity and gear configurations, the model analyzes geographical and temporal variations in fishing effort and the distribution of vertical fishing line in waters subject to the ALWTRP.

The documentation provided did not describe details of practices used by the three different types of fixed-gear fishing methods, i. e., the typical water depth fished, particular bottom type fished, typical density of fishing gear in an area, length of time deployed, patterns of setting the gear, how often gear is guarded, do vessels operate independently or in groups, dimensions of the fishing gear, or the target species for each type of gear.

More specific documentation of the practices of these fisheries would have been helpful to the reviewer. Which type of gear results in the highest rate of whale entanglements? What percentage of fishers use the weak link gear modification? When fishers sight an entangled whale, do they follow the recommendations by NMFS on how to report the event? Do fishers also collect data on the whale's behavior, gear type, and degree of entanglement?

b. Does the documentation provide a clear description of the model's purpose and scope, and of the data and methods it employs to characterize: the distribution of gear associated with these fisheries?

Yes, the model clearly maps the distribution of vertical lines in each 10-min cell in a standardized grid of each fishing region. The number of vertical lines per cell on the map is color coded into these categories < 1, 1 – 10, 10 – 100, 100 - 1,000, 1,000 - 10,000, and 10,000 - 100,000. Maps can be created for each of the three regions (Northeast-Atlantic, Mid-Atlantic, & Southeast-Atlantic).

The user can specify specific gear configurations and view or plot any change in co-occurrence. For example, the model's interface allows users to assign one or more model vessels to a suite of management areas, including: Lobster Management Areas (LMAs), ALWTRP trap/pot areas, State waters (exempt and non-exempt), State management areas (where available), and special management areas, including Stellwagen Bank/Jeffreys Ledge, the Great South Channel Restricted Area, and the Cape Cod Bay Restricted Area.

For each lobster, blue crab, or other trap/pot model vessel, the model allows the user to specify the following gear configuration parameters: total traps fished, number of traps per trawl, number of endlines (i.e., buoy lines) per trawl, length of groundline between traps (in feet), number of anchors per trawl, and length of anchor lines (in feet).

For each gillnet model vessel, the model allows the user to specify the following gear configuration parameters: total strings fished, endlines per string, number of anchors per string; and length of anchor lines.

For each fishing group, the model first estimates the average number of vertical lines per grid cell based on the model vessels assigned to that grid cell, adjusted by their monthly scalars. Where data permit, several model vessels may be assigned to the same grid cell. In these cases, each model vessel represents the percentage of vessels within the grid cell that operate with its particular configuration. This effectively allows for the development of weighted average estimates for the number of vertical lines in a given grid cell.

To estimate the total length of groundline in the water, the model employs the same approach described above for vertical lines, but uses the length of groundline estimates developed for each model vessel.

The model allows users to test for the impact of different management scenarios on the four indicators (number of active vessels, number of lines, length of groundlines, and whale sightings in area of fishing gear. Users may develop scenarios that employ one or more of the following actions:

Gear configuration requirements. The user can develop scenarios that impose specific gear configuration requirements, such as establishing restrictions on the number of traps per trawl allowed in a given area.

Redistribute fishing effort. The user can develop scenarios that call for an increase or decrease in fishing effort in an area.

c. Does the documentation provide a clear description of the model's purpose and scope, and of the data and methods it employs to characterize seasonal variation in the potential distribution of endangered right, humpback, and fin whales?

The most detailed Vertical Line Analysis Model provides monthly maps for the three Atlantic Coast regions [16-19], the three species of large whales, and the three fisheries. The model can detect larger scale (seasonal changes) by averaging the co-occurrence scores over a three month-period, thus producing maps for each season.

As a relative indicator of the potential for whale entanglement in commercial fishing line, the model combines effort-adjusted whale sightings information provided by NARWC [14] with estimates of the number of vertical lines in the water at a particular location and time.

To account for seasonal variation in the number of traps or strings fished per vessel, each model vessel is also characterized by monthly scalars. For the month in which the model vessel is assumed to fish, the highest number of traps or strings, the monthly scalar is set to one.

2. With respect to the characterization of fishing activity in Federal and state waters:

a. Are the data, methods, and assumptions the model employs to estimate the *number of vessels* active in each fishery appropriate?

Because states have different data collection programs that have developed over time, the availability of data characterizing fishing in state waters varies by state. There are a total of 13 states which have coastlines in which whales can be entangled in fishing gear (NC, SC, GA, MD, VA, NH, DL, NY, CT, MA, NJ, RI, FL).

At minimum, the Vertical Line Analysis Model incorporates state data that characterizes vessel activity from 2008 to 2010; many states have provided data from prior years, and some have recently provided data for 2011.

For each vessel, the model then apportions activity based on the ratio of trips reported within a particular grid cell to the total number of trips taken within the month.

However, Federal lobster permits currently impose no trip report requirements. As a result, the VTR database typically does not contain information on the activity of vessels that hold a Federal lobster permit, but no other Federal permit. Information on the location of trips taken by vessels that hold Federal lobster permits is limited to those that also hold other permits. For each LMA, the model compares VTR and permit data to identify vessels that are permitted only for the lobster fishery and thus not subject to VTR requirements.

NMFS needs to continue working with state marine resource officials to develop standardized, defensible modeling variables and assumptions for the number and types of vessels fishing exclusively in state waters. Key modeling parameters for lobster, blue crab, and other trap/pot vessels include: (1) the number of vessels active in different months of the year; (2) the total number of traps fished in different areas; and (3) the typical number of traps per trawl. For gillnet vessels, key parameters include: (1) the number of vessels active in different months of the year; and (2) the total number of strings typically fished.

At minimum fishers holding a Federal lobster permit should be required to file a Vessel Trip Report that includes the same basic data as provided in other states. Specifically, fishermen should provide longitude and latitude coordinates that represent their average location for each fishing trip.

Because some fishermen maintain a Federal permit, but do not actively fish, the model estimates the number of such vessels that are active within the LMA by scaling the total number of permitted vessels by the proportion of other permitted lobster trap/pot vessels (i.e., those vessels required to report to VTR) that actively fished in a given month.

b. Are the data, methods, and assumptions employed to characterize the *location* of fishing activity appropriate?

Most commercial fishing permits administered by NMFS' Northeast Regional Office (NERO) require fishermen to file a Vessel Trip Report (VTR) at the conclusion of every trip. VTR provides data on the gear the vessel employed and the area in which it fished, along with other information. Specifically, fishermen provide longitude and latitude coordinates that represent their average location for each fishing trip.

The Southeast Logbook, which covers Federal waters south of Cape Hatteras, North Carolina, similarly requires trip-level reporting; however, fishermen are required to identify the location of their fishing effort on a 1-degree grid, as opposed to a specific location.

In the absence of more detailed information on the location of fishing activity, the model assumes that the activity of these vessels is distributed evenly across the LMA, and apportions activity to each grid cell within the LMA accordingly. For LMA 3, the model assumes that permitted activity is concentrated north of the divide between LMA 4 and 5; thus, active vessels are only apportioned to this area.

Finally, to estimate the total number of vessels active in each grid cell for each month, the model adds the number of active vessels estimated from the permit data to the number obtained from VTR. This seems to be a reasonable treatment of these data.

Most blue crab fishing occurs south of New Jersey. To reflect blue crab's importance in these waters, the model identifies blue crab as a separate fishery (based on VTR and Logbook gear and species codes) in Federal waters south of the New Jersey/Delaware border. Blue crab fishing activity occurring north of this border is characterized as a component of the other/trap pot fishery.

c. Are the data, methods, and assumptions employed to characterize *monthly variation* in fishing activity appropriate?

Currently, the Vertical Line Analysis Model produces outputs on a monthly time scale and 3-month averages to demonstrate larger scale, seasonal changes in the co-occurrence score. However, as identified in the ALWTRP, there are several biological characteristics and oceanographic variables that could significantly affect the output of the Vertical Line Analysis Model [20].

External factors can influence the effectiveness of the ALWTRP regulations, including changing oceanographic conditions that may influence fishing effort. Certainly inclement weather, high sea states, tidal cycles affect when, where, and how long fishing will occur. Oceanographic conditions can affect the type of fixed-gear used and the amount of the catch. Oceanographic variables, such a sea surface temperature, sea state, water depth, bottom type, tidal cycle, can affect the migration, distribution, and food supply for large whales. The model should be modified to include these variables as much as possible.

Biological Factors can affect the distribution of prey species like copepods, other zooplankton, and fish can affect the distribution and behavior of large whales in the Atlantic. Whales that are actively feeding or breeding could be more susceptible to entanglement. The daily vertical migration of the deep scatter layer likely affects large whale feeding times, water depth of feeding and the amount of time at the water surface. Young, curious whales could be inclined to investigate fishing gear and become entangled. Mothers with calves could be more vulnerable to entanglement. As much as feasible, biotic variables should be included in the model.

Unfortunately, there have been few observations of a newly entangled whale. The behavior of the whale at the time of entanglement may greatly affect the degree of entanglement. Data on entangled whales should be mined from existing data to determine: Which body region is more likely to become entangled? Which body region is more likely to result in mortality? How often does an individual whale become entangled? Are these patterns different among the three species of whales?

In addition, the probability of entanglement could be affected by a whale's previous entanglement. Do whales learn to avoid fishing gear, once they have become entangled? Is a previously entangled whale more or less likely to become entangled or have greater injury or mortality?

Biological and/or oceanographic features can vary on a daily or weekly basis. Pendleton et al. (2012 [28]) published a recent article entitled "Weekly predictions of North Atlantic right whale, *Eubalaena glacialis,* habitat reveal influence of prey abundance and seasonality of habitat preferences". The authors tested the feasibility of a system designed to predict potential right whale habitat on a weekly time scale. The system paired right whale occurrence records with a collection of data layers including: results from a coupled biological−physical model of *Calanus finmarchicus* (the primary prey). They trained, tested, and compared models for 3 time periods: winter, spring, and winter and spring combined. They also trained and tested models with and without *C. finmarchicus*. Predictions of habitat suitability were highly dynamic within and across years. **Their results support the hypothesis that right whale environmental preferences change between winter and spring. The inclusion of prey abundance, satellite-derived sea surface temperature and chlorophyll, and bathymetry improved the accuracy of the model predicting suitability habitats for the right whales**.

This new research supports the notion that co-occurrence scores should be calculated on a weekly or bi-weekly basis in addition to monthly and seasonal scores. The publication also documents that adding oceanographic data, such as sea surface temperature, bathymetry, and chlorophyll concentrations helped identify the best habitats for right whales. Because these variables were derived from satellite images, they would be standardized, regardless of which region was being studied. The inclusion of prey abundance by location and time, could also better determine the probability of a large whale being in a specific place at a given time.

These potential biological factors should be considered in evaluation of the effectiveness of the ALWTRP and added to the Vertical Line Analysis Model.

d. Are key *data* *limitations and uncertainties* appropriately identified?

The documentation clearly points out the limitations of the Vertical Line Analysis Model [12, 14, 17-19]:

- The co-occurrence score is an *indicator* of the potential for an entanglement to occur; not a direct measure of the probability or risk of an entanglement.
- The Vertical Line Analysis Model does not calculate the risk of injury or death, when an entanglement occurs.
- Co-occurrence scores are not subject to a threshold, i.e., a minimum concentration of gear and/or whales below which the potential for an entanglement is assumed to be eliminated.
- Co-occurrence scores are assigned on a discrete basis to individual grid cells; this may imply a higher degree of geographic precision in characterizing the potential for an entanglement than the underlying data warrant.

It is important to note that the model will assign a co-occurrence score of zero whenever the vertical line score or SPUE score is zero. IEc is working with NMFS on how to characterize this.

e. Within the limits of available data, how could IEc *improve* the model's characterization of fishing activity?

IEc could improve the Vertical Line Analysis Model by using existing data to determine:

- Which part of the gear and depth of lines is entanglement most likely to occur?
- Are entanglements occurring more often with a specific type of fixed-gear?
- What is the rate of re-entanglement?
- How long after setting a trap does entanglement occur?
- What time of day do entanglements occur?

3. With respect to the characterization of gear use in the fisheries of interest:

a. Is the *use of model vessels* to describe the typical configuration of gear in particular areas and at different times of year a reasonable and appropriate approach?

Yes, this is a reasonable approach. The model vessel concept provides the key characteristics of different fishing types, without the need to have several variations that may be different among fisher practices.

b. Are the *parameters* employed to characterize configurations of gear in *trap/pot fisheries* – i.e., total traps fished, number of traps per trawl, number of endlines per trawl, length of groundline between traps, number of anchors per trawl, and length of anchor lines – appropriate for the model's purpose?

Use of all of these parameters to describe gear configuration in the trap/pot fishery is appropriate. However, the water depth of the set, time of day gear was set, density of the trap/pots, and the amount of time fished also could be important.

Gear information sources vary from state to state. For some states, key gear configuration parameters are estimated based on reporting data (e.g., logbook data) furnished by fishermen in accordance with state requirements. For other states, surveys are the primary source of gear configuration information. In some cases, these surveys are one-time efforts, while others are administered annually (e.g., recall surveys). For other states, gear configurations are largely based on the best professional judgment of state fisheries experts.

In several cases, the gear data are taken from a mix of sources (e.g., surveys and best professional judgment). All baseline gear configuration assumptions are based on information from 2009, 2010, or 2011.

There should be an effort to standardize the variables and methods used to report fishing gear configuration among states.

c. Are the *parameters* employed to characterize configurations of gear in *gillnet fisheries* – i.e., total strings fished, number of endlines per string, number of anchors per string, and length of anchor lines – appropriate for the model's purpose?

Use of all of these parameters to describe gear configuration in the gillnet fishery is appropriate. However, the water depth of the set, the time of day gear was set, density of gillnets set, and the amount of time fished also could be important.

d. Are the *equations* the documentation specifies to calculate the number of vertical lines and length of groundline associated with each model vessel conceptually correct?

Yes, they are conceptually correct, but does the model assume the vertical lines and whales are randomly distributed, clumped, or uniformly distributed in a cell?

e. Are the data, methods, and assumptions employed to define model vessels in the *Federal lobster fishery* appropriate?

Given that Lobster fisheries do not all have the same post-trip report requirement, the methods and assumptions are the best available.

f. Are the data, methods, and assumptions employed to define model vessels in the *Federal blue crab fishery* and *other Federal trap/pot fisheries* appropriate?

Yes.

g. Are the data, methods, and assumptions employed to define model vessels in *Federal gillnet fisheries* appropriate?

Yes.

h. Are the data, methods, and assumptions employed to define model vessels in *state waters* appropriate?

Yes.

i. Are key *data limitations and uncertainties* appropriately identified?

Yes.

j. Within the limits of available data, how could IEC *improve* the model's characterization of gear use?

IEc could improve the model's characterization of gear use by:

- Providing a method to demonstrate the effects of having different types of fixed-gear fishing in the same cell at the same time.
- Providing a method to determine the effects of having gear arranged at random in a cell, clustered in a cell, and uniformly distributed in a cell.
- Providing a method to compare any differences in entanglement rates for anchored fixed-gear versus "ghost gear".

4. With respect to the seasonal distribution of endangered species of large whales in waters subject to the ALWTRP:

a. Are the whale sightings data the model employs to characterize monthly variation in the *potential distribution of right whales, humpback whales, and fin whales* appropriate for this purpose?

IEc has succeeded in including whale sighting data from a variety of sources, shipboard and aerial survey data. Unfortunately, data are not always available from the same time periods. However, this is the best data available. And, now that the need is known agencies can better collaborate to insure that data collection is standardized.

The NARWC SPUE dataset includes information obtained from surveys conducted between October 1978 and May 2010. Appendix A lists the sources of the NARWC SPUE data, which include both aerial and shipboard track surveys.

The records included from each survey in the dataset include only those which meet NARWC's minimum standards for acceptable sightings conditions; i.e., visibility of at least 2 nautical miles, a sea state of Beaufort 4 or lower, and, for aerial surveys, a maximum altitude of no greater than 1,200 feet. The dataset includes only sightings of live whales, and excludes all records in which the identification of the species is uncertain. Whale sighting data are adjusted for the level of effort employed to locate whales from the air and sea, providing an indication of sightings per unit of survey effort (SPUE).

b. Are key *data* *limitations and uncertainties* appropriately identified?

Yes.

c. Within the limits of available data, how could IEc *improve* the model's characterization of seasonal variation in the potential distribution of endangered whales?

IEc could improve the model's characterization of whale data by:

- Calculating the co-occurrence score at weekly or two-week intervals.

- Using scarification data, calculate if a previously entangled whale, is more or less likely to become entangled again.

- Considering that whales are feeding on deep scatter layer organisms, which have a distinct diel migration pattern, determine if entanglements of whales are more likely to occur at a certain time of day.

- Incorporate the influence of oceanographic features, such as surface sea temperature, water depth, sea state in calculating the co-occurrence score.

- Incorporate the influence of biological factors, such as the amount of chlorophyll and abundance of zooplankton in calculating the co-occurrence score.

- Determine if there is a difference in entanglement rate, injury rate, or mortality among the three species of whales. Develop three different "model whales" with different dive patterns and behaviors.

- Examine data for differences in entanglement rate, injury rate, or mortality among different age classes of whales?

- Examine data for differences in entanglement rate, injury rate, or mortality between male and female whales.

5. The model's primary outputs include:

    - estimates of the number of vessels that participate in a given fishery, by month and location;
    - estimates of the number of vertical lines deployed in waters subject to the ALWTRP, by month and location; and
    - an indicator of the potential "co-occurrence" of whales and vertical line, by month and location.

a. Are the *data, methods, and assumptions* employed to develop these measures appropriate for the model's purposes?

- The key output from the Vertical Line Analysis Model is the "co-occurrence" score. This is the likelihood that x number of whales (regardless of species) will be located in the same 10-min cell as x number of vertical lines.

- The vertical lines can represent any of the fishery types or a mix of fishery types.

- The model assumes that the behavior of the three species of whales is the same and does not change over time.

- The model assumes that neither the whales nor the lines change location.

- The model does not specify a percentage of time the whale would be underwater versus at the surface.

- The model assumes that oceanographic features do not change over time and the conditions are homogeneous over the cell.

- So, the model is the simplest of calculations and there is room for improvement to the model by adding

    - the ability of whales to move and behave differently;
    - the ability of fishing gear to have a time limit on the fishing period and vary the length of the lines;

- the typical seasonal differences in oceanographic features, and
- allow the prey species of the whales (deep scatter layer) to move diurnally and seasonally.

These are many variables to add to the model and a stepwise approach should be used to verify the effects of each change to the model.

b. Given the limits of available data and knowledge concerning factors that contribute to the risk of an entanglement, does the co-occurrence indicator provide a reasonable basis for evaluating *relative differences* in the likelihood that whales will encounter vertical line in a particular area during a particular month?

The Vertical Line Analysis Model is a first, best-approach attempt to develop an indicator of how often co-occurrence exists, where, and when. Using this basic information, will help inform resource managers where the "hot spots" of co-occurrence in the fishing region occur, how long an area remains a "hot spot", and when "hot spots" occur. With this information, funds and resources can best be allocated or prioritized to management efforts.

c. Are key *data limitations and uncertainties* appropriately identified?

There are several limitations to the data on gear configuration, vertical line locations, and whale distribution and behavior. Many of them are not identified in the review materials (see my comments above).

d. Within the limits of available data, how could these indicators be *improved*?

There are other variables that can be mined from the existing data (See list on pages 42-44 of this report). In addition the use of satellite data to input oceanographic and weather data should be incorporated.

e. Overall, what steps should IEc take to improve the model and/or its documentation?

Several steps that IEc could take to improve the model have previously been listed in this review and will be summarized in the Conclusions and Recommendation section below (pp. 42-44).

Conclusions and Recommendations in accordance with the ToRs:

Terms of Reference:

The review is to address the following questions:

1. Does the documentation provide a clear description of the model's purpose and scope, and of the data and methods it employs to characterize:

(a) vessel activity in the fisheries subject to the requirements of the ALWTRP,

- Yes, The purpose of the Vertical Line Analysis Model is clearly described, in several documents provided to the reviewer, as a way to simply estimate the probability that any of three species of large whales (right, fin, or humpback whales) in US Atlantic waters could be in the same 10-min cell at the same time and place as vertical fishing lines for each of three types of fishing gear (buoy lines associated with lobster trap/pot gear, other trap/pot gear, or gillnet gear).

- The Vertical Line Analysis Model provides a simple indicator of the likelihood that whales will encounter fishing gear, the co-occurrence score. The co-occurrence score is based on an estimation of gear concentration in a 10-min cell of the fishing area during a particular month. The monthly co-occurrence score is calculated for each of the three whale species using shipboard and aerial survey data on whale densities. Furthermore, the co-occurrence score is calculated in 3-month averages to examine seasonal changes in the co-occurrence score. Lastly, the co-occurrence scores are calculated for three major regions: Northeast-Atlantic, Mid-Atlantic, and Southeast-Atlantic.

- Given the current state of knowledge, the model cannot provide a direct assessment of the probability of an entanglement at a particular place and time, nor does it assess the risk of injury or death in the event of an entanglement. It focuses instead on relative indicators of the potential for an entanglement to occur, using this as a proxy measure of risk.

1. Does the documentation provide a clear description of the model's purpose and scope, and of the data and methods it employs to characterize:

(b) the distribution of gear associated with these fisheries, and

- The probability that an entanglement will occur may depend on the amount of gear deployed in a particular area, the number of whales present, whether the gear is actively tended, and the whale's behavior when gear is encountered (e.g., whether the whale was feeding).

- The risk of injury or death from an entanglement may depend on the characteristics of the species, size, age, & health of the whale, whether the gear has "weak links" designed to help a whale free itself, and the feasibility or success of human efforts to disentanglement the whale.

- The interrelationships among these factors are not fully understood. Data are needed to better characterize the risk of injury versus mortality.

1. Does the documentation provide a clear description of the model's purpose and scope, and of the data and methods it employs to characterize:

(c) Seasonal variation in the potential distribution of endangered right, humpback, and fin whales?

- The number of large whales in that same 10-min cell by month is taken from available survey data (ship and/or aerial surveys). Co-occurrence scores are provided at the ten-minute grid cell level.
- Maps of the co-occurrence scores of four groups of large whales: Atlantic right whales, humpback whales, fin whales, and right & humpback whales combined are provided for three regions of the US Atlantic coastline: Northeast-Atlantic, Mid-Atlantic- and Southeast-Atlantic.
- Over time, more surveys for whales have been added to the model, so currently available data are from 1978 to 2010.
- New research by Pendleton et al. (2012) supports the notion that co-occurrence scores should be calculated on a weekly basis in addition to monthly and seasonal scores [28]. The publication also documents that adding oceanographic data, such as sea surface temperature, bathymetry, and chlorophyll concentrations helped identify the best habitats for right whales.
- Because these oceanographic variables were derived from satellite images, IEc should seek out sources of satellite oceanographic data and develop a standard set of variables to collect at each region and for each cell.
- The inclusion of prey abundance by location and time, could also better determine the probability of a large whale being in a specific area at a specific time.

2. With respect to the characterization of fishing activity in Federal and state waters:

(a) Are the data, methods, and assumptions the model employs to estimate the number *of vessels* active in each fishery appropriate?

- NMFS needs to continue working with state marine resource officials to develop standardized, defensible modeling variables and assumptions for recording the number of vessels for each fishery using exclusively Federal or Federal and state waters.
- Key modeling parameters for lobster, blue crab, and other trap/pot vessels include: (1) the number of vessels active in different months of the year; (2) the total number of traps fished in different areas; and (3) the typical number of traps per trawl.

- For gillnet vessels, key parameters include: (1) the number of vessels active in different months of the year; and (2) the total number of strings typically fished.

2. With respect to the characterization of fishing activity in Federal and state waters:

(b) Are the data, methods, and assumptions employed to characterize the *location* of fishing activity appropriate?

- At minimum, fishers holding a Federal lobster permit should also be required to file a Vessel Trip Report that includes the same basic data as provided in other state's fisheries.

- Specifically, fishermen provide longitude and latitude coordinates that represent their average location for each fishing trip.

2. With respect to the characterization of fishing activity in Federal and state waters:

(c) Are the data, methods, and assumptions employed to characterize *monthly variation* in fishing activity appropriate?

- The co-occurrence maps for each monthly cell in the three regions indicate where vessels are fishing and how many vessels, but there should be a way that IEc could weight these cells to identify cells of the highest co-occurrence versus the lowest co-occurrence (i.e. rather than having to visually compare colors of cells on monthly maps create some type of index for each cell to represent "hot spots" of co-occurrence.

2. With respect to the characterization of fishing activity in Federal and state waters:

(d) Are key *data limitations and uncertainties* appropriately identified?

- The location of Federal and State fishing is a complicated situation that varies with the type of gear, type of catch, and time of year. The documentation provided gives a detailed discussion and maps of fishing activities in different cells of the three regions.

- The largest limitation is the lack of ability to compare these data among states.

- NMFS should work with state resource managers to standardize data collected by each fishery, each month, in all three regions.

2. With respect to the characterization of fishing activity in Federal and state waters:

(e) Within the limits of available data, how could IEc *improve* the model's characterization of fishing activity?

- External factors can influence the effectiveness of the ALWTRP regulations, including changing oceanographic conditions that may influence fishing effort.
- Certainly inclement weather, high sea states, tidal cycles affect when, where, and how long fishing will occur.
- Oceanographic conditions can affect the type of fixed-gear used and the amount of the catch.
- IEc should incorporate variables that describe oceanographic conditions, which dictate fishing effort to be reduced or eliminated in specific areas and seasons.

3. With respect to the characterization of gear use in the fisheries of interest:

(a)Is the *use of model vessels* to describe the typical configuration of gear in particular areas and at different times of year a reasonable and appropriate approach?

- Yes, the use of a "model" vessel to describe gear configuration and fishing activity is practical and eliminates some variability among vessels so this simple Vertical Line Analysis Model can concentrate efforts on calculating co-occurrence scores.

3. With respect to the characterization of gear use in the fisheries of interest:

(b)Are the *parameters* employed to characterize configurations of gear in *trap/pot fisheries* – i.e., total traps fished, number of traps per trawl, number of endlines per trawl, length of groundline between traps, number of anchors per trawl, and length of anchor lines – appropriate for the model's purpose?

- All these parameters help characterize the gear used in the trap/pot fishery; however, perhaps some measure of trap/pot densities and depth of gear should be included.

3. With respect to the characterization of gear use in the fisheries of interest:

(c) Are the *parameters* employed to characterize configurations of gear in *gillnet fisheries* – i.e., total strings fished, number of endlines per string, number of anchors per string, and length of anchor lines – appropriate for the model's purpose?

- All these parameters help characterize the gear used in the gillnet fishery; however, perhaps some measure of gillnet densities and water depth at the gear should be included.

3. With respect to the characterization of gear use in the fisheries of interest:

(d) Are the *equations* the documentation specifies to calculate the number of vertical lines and length of groundline associated with each model vessel conceptually correct?

Yes.

3. With respect to the characterization of gear use in the fisheries of interest:

(e)Are the data, methods, and assumptions employed to define model vessels in the *Federal lobster fishery* appropriate?

Yes.

3. With respect to the characterization of gear use in the fisheries of interest:

(f)Are the data, methods, and assumptions employed to define model vessels in the *Federal blue crab fishery* and *other Federal trap/pot fisheries* appropriate?

Yes.

3. With respect to the characterization of gear use in the fisheries of interest:

(g)Are the data, methods, and assumptions employed to define model vessels in *Federal gillnet fisheries* appropriate?

Yes.

3. With respect to the characterization of gear use in the fisheries of interest:

(h)Are the data, methods, and assumptions employed to define model vessels in *state waters* appropriate?

Yes.

3. With respect to the characterization of gear use in the fisheries of interest:

(i) Are key *data limitations and uncertainties* appropriately identified?

Yes.

3. With respect to the characterization of gear use in the fisheries of interest:

(j) Within the limits of available data, how could IEc *improve* the model's characterization of gear use?

- Providing a method to demonstrate the effects of having different types of fixed-gear fishing in the same cell at the same time.

- Providing a method to determine the effects of having gear arranged at random in a cell, clustered in a cell, and uniformly distributed in a cell.

- Providing a method to compare any differences in entanglement rates for anchored fixed-gear versus "ghost gear".

- Determine with gillnet fishing, whether whales get entangled in anchor line, net or both.

4. With respect to the seasonal distribution of endangered species of large whales in waters subject to the ALWTRP:

(a)Are the whale sightings data the model employs to characterize monthly variation in the *potential distribution of right whales, humpback whales, and fin whales* appropriate for this purpose?

There are several types of biological data that should be added to the model:

- The distribution of prey species like copepods, other zooplankton, and fish can affect the distribution and behavior of large whales in the Atlantic. Whales that are actively feeding or breeding could be more susceptible to entanglement.

- The daily vertical migration of the deep scatter layer likely affects large whale feeding times, water depth of feeding and the amount of time at the water surface.

- Young, curious whales could be inclined to investigate fishing gear and become entangled.

- Mothers with calves could be more vulnerable to entanglement.

4. With respect to the seasonal distribution of endangered species of large whales in waters subject to the ALWTRP:

(b) Are key *data limitations and uncertainties* appropriately identified?

- As identified in the ALWTRP, there are several biological characteristics and oceanographic variables that could significantly affect the output of the Vertical Line Analysis Model.

- Unfortunately, there have been few observations of a newly entangled whale. The behavior of the whale at the time of entanglement may greatly affect the degree of entanglement.

- Data on entangled whales should be mined to determine:
  - which body region is more likely to become entangled?

- Which body region is more likely to result in mortality?
- How often does an individual whale become entangled?
- Are these patterns different among the three species of whales?

- In addition, the probability of entanglement could be affected by a whale's previous entanglement. Existing data should be examined to determine whether:
  - Whales learn to avoid fishing gear, once they have become entangled?
  - Is a previously entangled whale more or less likely to become entangled?
  - Is a previously entangled whale more or less likely to have greater injury or mortality?

4. With respect to the seasonal distribution of endangered species of large whales in waters subject to the ALWTRP:

(c) Within the limits of available data, how could IEc *improve* the model's characterization of seasonal variation in the potential distribution of endangered whales?

- Oceanographic variables, such a sea surface temperature, sea state, water depth, bottom type, tidal cycle, can affect the migration, distribution, and food supply for large whales. IEc should find a way to incorporate these variables into the Vertical Line Analysis Model. By excluding areas that are unlikely to be fished or unlikely to be used by large whales, the task of calculating a co-occurrence score becomes easier.

- Biological and/or oceanographic features can vary on a daily or weekly basis. Pendleton et al. (2012) published a recent article entitled "Weekly predictions of North Atlantic right whale, *Eubalaena glacialis,* habitat reveal influence of prey abundance and seasonality of habitat preferences". The authors tested the feasibility of a system designed to predict potential right whale habitat on a weekly time scale. The system paired right whale occurrence records with a collection of data layers including: results from a coupled biological−physical model of *Calanus finmarchicus* (the primary prey). They trained, tested, and compared models for 3 time periods: winter, spring, and winter and spring combined. They also trained and tested models with and without *C. finmarchicus*. Predictions of habitat suitability were highly dynamic within and across years. Their results support the hypothesis that right whale environmental preferences change between winter and spring. The inclusion of prey abundance, satellite-derived sea surface temperature and chlorophyll, and bathymetry improved the accuracy of the model predicting suitability habitats for the right whales.

- This new research supports the notion that co-occurrence scores should be calculated on a weekly basis in addition to monthly and seasonal scores. The publication also documents that adding oceanographic data, such as sea surface temperature, bathymetry, and chlorophyll concentrations helped identify the best habitats for right whales.

- Because these variables were derived from satellite images, they could be standardized, regardless of which region was being studied.

- The inclusion of prey abundance by location and time, could also better determine the probability of a large whale being present in a specific time.

- These potential biological and oceanographic factors should be considered in evaluation of the effectiveness of the ALWTRP and inclusion in the Vertical Line Analysis Model.

5. The model's primary outputs include:

- estimates of the number of vessels that participate in a given fishery, by month and location;

- estimates of the number of vertical lines deployed in waters subject to the ALWTRP, by month and location; and

- an indicator of the potential "co-occurrence" of whales and vertical line, by month and location.

(a)Are the *data, methods, and assumptions* employed to develop these measures appropriate for the model's purposes?

- These outputs are appropriate for the simple Vertical Line Analysis Model; however a variety of other biotic and abiotic parameters could also be incorporated in the model (see below).

(b)Given the limits of available data and knowledge concerning factors that contribute to the risk of an entanglement, does the co-occurrence indicator provide a reasonable basis for evaluating *relative differences* in the likelihood that whales will encounter vertical line in a particular area during a particular month?

- The Vertical Line Analysis Model assumes the fishing gear does not move and it does not specify the type of distribution of gear in the cell; random, clustered, uniform?

- The Vertical Line Analysis Model also assumes the whales do not move and does not specify the type of whale distribution in the cell; random, clustered, uniform?

- The Vertical Line Analysis Model does not specify the depth of the fishing gear versus the depth of the whale. If all whales are on the surface and all gear is on the bottom, even if they co-occur, they will not encounter each other.

(c)Are key *data limitations and uncertainties* appropriately identified?

- The model uses a number of whales present in the cell to calculate a co-occurrence score with fishing gear. However, three species of whales, with different ecologies are involved.

(d) Within the limits of available data, how could these indicators be *improved*?

- Having the gear in the model be stationary is acceptable, but whales do move; sometimes at the surface and sometimes under water. It would be useful if the model could incorporate movement of the whales in horizontal and vertical space. Perhaps sighting data could be used to generate a proportion of time a whale is at the surface versus under water.

- Perhaps the model should include three different "model whales" (similar to "model vessels), or anabots, that could move in different dive patterns, move at different depths, and be active at different times of day.

(e)Overall, what steps should IEc take to improve the model and/or its documentation?

In summary, to improve the Vertical Line Analysis Model and assist in evaluating the effectiveness of ALWTRP, NMFS and IEc should consider these tasks:

IEc could improve the model's **characterization of vessel numbers and fishing activities** by:

- NMFS should work with state resource managers to standardize data collected on number of vessels, fishing location, gear type used, and total catch by each fishery, each month, in all three regions.
- The Vertical Line Analysis Model assumes the fishing gear and whales do not move and it does not specify the type of distribution of gear and whales in the cell; random, clustered, uniform? A feature should be added to the model to allow the user to change the distribution and density of whales and/or fishing gear.
- Data should be examined to determine if entanglements occur more often with a specific type of fixed-gear.
- Data should be examined to determine how long after setting a trap entanglement occurs.

IEc and NMFS could improve the model's **characterization of gear** use by:

- Providing a method to demonstrate the effects of having different types of fixed-gear fishing in the same cell at the same time.
- Providing a method to determine the effects of having gear arranged at random in a cell, clustered in a cell, and uniformly distributed in a cell.
- Providing a method to compare any differences in entanglement rates for anchored fixed-gear versus "ghost gear".
- Determine with gillnet fishing, whether whales get entangled in anchor line, net or both.

IEc and NMFS could improve the model's characterization by **adding abiotic external factors** to the model:

- As identified in the ALWTRP, there are several biological characteristics and oceanographic variables that could significantly affect the output of the Vertical Line Analysis Model.
- Oceanographic variables, such a sea surface temperature, sea state, water depth, bottom type, tidal cycle, can affect the migration, distribution, and food supply for large whales. IEc should find a way to incorporate these variables into the Vertical Line Analysis Model.

- Because these oceanographic/climate variables can be derived from satellite images, they should be standardized, regardless of which region is modeled.

<u>IEc and NMFS could improve the model's characterization of whale behavior and distribution by</u> **<u>adding biotic features to the model:</u>**

- The distribution of prey species can affect the distribution and behavior of large whales in the Atlantic. Whales that are actively feeding or breeding could be more susceptible to entanglement. The daily vertical migration of the deep scatter layer likely affects large whale feeding times, water depth of feeding, and the amount of time at the water surface. It would be helpful if the model could include some variables to reflect the probability a whale will encounter its prey, will be at a particular depth, or will be at the surface.

- The behavior of the whale at the time of encountering gear will likely affect its reaction to the gear. Young, curious whales could be inclined to investigate fishing gear and become entangled. Mothers with calves could be more vulnerable to entanglement. The model could be improved by allowing the user to enter the age class of whales and the behavior of the whales at the time of a gear encounter.

- Unfortunately, there have been few observations of a newly entangled whale. The behavior of the whale at the time of entanglement may greatly affect the degree of entanglement. Data on entangled whales should be mined from existing datasets to determine: which body region is more likely to become entangled, which body region is more likely to result in mortality, how often does an individual whale become entangled, and are these patterns different among the three species of whales.

- The probability of entanglement could be affected by a whale's previous entanglement. Is a previously entangled whale more or less likely to become entangled or have greater injury or mortality? The model should allow the user to enter a variable to indicate if previous entanglement(s) have occurred.

- Examine and further analyze scarification data to fully explore this metric to determine entanglement rates, body regions most often impacted by entanglement, species, age, and sex difference in entanglement rates, the rate of re-occurrence of entanglements, and the extent of injuries from entanglements,

- For this first model, having the gear stationary is acceptable, but whales do move; sometimes at the surface and sometimes under water. It would be useful if the model could incorporate movement of the whales in horizontal and vertical space. Perhaps sighting data could be used to generate a proportion of time a whale is at the surface versus under water.

- Perhaps the model should include three different “model whales” (similar to “model vessels), that could move in different dive patterns, move at different depths, and be active at different times of day.

- New research by Pendleton et al. (2012) supports the notion that co-occurrence scores should be calculated on a weekly basis in addition to monthly and seasonal scores. IEc should modify the model to handle weekly calculations of co-occurrence scores for each cell.

- Pendleton et al. (2012) documented that adding oceanographic data, such as sea surface temperature, bathymetry, and chlorophyll concentrations helped identify the best habitats for right whales.

- The inclusion of prey abundance by location and time, could also better determine the probability of a large whale being in a specific time and place.

- Existing scarification data should be examined to determine which body region of the whale is most likely to become entangled.

- Existing data should be examined to determine if there is a difference in entanglement rate, injury rate, or mortality among the three species of whales.

- Existing data should be examined to determine if there a difference in entanglement rate, injury rate, or mortality among different age classes of whales.

- Existing data should be examined to determine if there is a difference in entanglement rate, injury rate, or mortality between male and female whales.

- Considering that whales are feeding on deep scatter layer organisms, which have a distinct diel migration pattern, entanglement rates by time of day should be analyzed to determine if whales are more likely to be entangled at a certain time of day.

- The rate of re-entanglement should be calculated using scarification data.

- In addition to calculating the co-occurrence score by season and month, it also should be calculated in two-week intervals.

- Incorporate the influence of oceanographic features, such as surface sea temperature, water depth, sea state in calculating the co-occurrence score.

- Incorporate the influence of biological indicators, such as amount of chlorophyll and abundance of zooplankton in calculating the co-occurrence score.

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Appendix 2: A copy of the CIE Statement of Work

Attachment A: Statement of Work for Dr. Jeanette Thomas

External Independent Peer Review by the Center for Independent Experts

Review of Technical Documentation for the Vertical Line Analysis Model Supporting an Amendment to the Atlantic Large Whale Take Reduction Plan

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Representative (COR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description: NOAA's National Marine Fisheries Service (NMFS) intends to expand large whale conservation efforts by amending regulations that implement the Atlantic Large Whale Take Reduction Plan (ALWTRP). Since its implementation in 1997, the ALWTRP was modified on several occasions to reduce the risk of injury and mortality of large whales that interact with commercial trap/pot and gillnet fishing gear. The ALWTRP consists of regulatory and non-regulatory programs including: broad-based gear modifications, time-area closures, disentanglement, research and outreach. Despite these efforts, there continues to be injuries and mortalities of large whales from entanglements in vertical lines from commercial trap/pot and gillnet fishing gear. Therefore, additional modifications to the ALWTRP are needed.

At the 2003 Atlantic Large Whale Take Reduction Team (ALWTRT) meeting, the ALWTRT agreed to two overarching principles associated with reducing large whale entanglement risks: reducing entanglement risks associated with groundlines (lines between trap/pots) in commercial trap/pot gear; and reducing entanglement risks associated with vertical lines (endlines or buoy lines) in commercial trap/pot and gillnet gear. NMFS addressed the first principle; reducing entanglement risk from groundlines in October 2007 with the implementation of a sinking groundline requirement for all trap/pot fisheries throughout the entire East coast (72 FR 57104, October 5, 2007). NMFS is addressing the second principle, reducing entanglement risks associated with vertical lines in commercial trap/pot and gillnet gear, in this current process.

In 2009, the ALWTRT agreed on a schedule to develop conservation measures for reducing the risk of serious injury and mortality of large whales that become entangled in vertical lines. NMFS committed to publishing a final rule to address vertical line entanglement by 2014. Unlike the broad-scale management approach taken to address entanglement risks associated with groundlines, the approach for the vertical line rulemaking will focus on reducing the risk of vertical line entanglements in finer-scale high impact areas. Using fishing gear characterization data and whale sightings per unit effort (SPUE) data, NMFS developed a model to determine the co-occurrence of fishing gear density and whale density to serve as a guide in the identification of these high risk areas. The ALWTRT agreed that NMFS should use the model to develop suites of conservation measures that would ultimately serve as options for the ALWTRT to consider when identifying management alternatives. The conservation measures would address vertical line fishery interactions with large whales by reducing the potential for entanglements and minimizing adverse effects if entanglements occur.

Given the significant public interest in this topic, it will be critical for NMFS to obtain a transparent and independent review of the model documentation. It is important that the model contain the best available information on both whale density and fishing gear density and that the associated caveats seem reasonable. Therefore, we seek an independent CIE peer review of the model documentation, and the independent CIE peer review reports formatted as described in **Annex 1** will be made publicly available. The CIE reviewers shall conduct an independent and impartial scientific peer review of this scientific information in accordance with the Terms of Reference (ToRs) for the peer review as specified in **Annex 2**.

Requirements for CIE Reviewers: Three CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. The CIE reviewers shall have combined working knowledge and recent experience in spatial analysis, scenario modeling, marine mammal biology, and fisheries management. Each CIE reviewer's duties shall not exceed a maximum of 10 days to complete all work tasks of the peer review described herein.

Location of Peer Review: Each CIE reviewer shall conduct an independent peer review as a desk review, therefore no travel is required.

Statement of Tasks: Each CIE reviewers shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

<u>Prior to the Peer Review</u>: Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer information (full name, title, affiliation, country, address, email) to the COR, who forwards this information to the NMFS Project Contact no later than the date specified in the Schedule of Milestones and Deliverables. The

CIE Coordinator is responsible for providing the SoW and ToRs to the CIE reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers with the background documents, reports, and other pertinent information. Any changes to the SoW or ToRs must be made through the COR prior to the commencement of the peer review.

Pre-review Background Documents: One week before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an FTP site) to the CIE reviewers the necessary background information and reports for the peer review. The CIE reviewers shall read all documents in preparation for the peer review, and are responsible only for the documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE Lead Coordinator on where to send documents.

Desk Review: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. **Modifications to the SoW and ToRs can not be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COR and CIE Lead Coordinator.** The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements.

Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the SoW. Each CIE reviewer shall complete the independent peer review according to required format and content as described in Annex 1. Each CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
2) Conduct an independent peer review in accordance with the ToRs (**Annex 2**).
3) No later than **28 September 2012**, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and CIE Regional Coordinator, via email to Dr. David Sampson david.sampson@oregonstate.edu. Each CIE report shall be written using the format and content requirements specified in Annex 1, and address each ToR in **Annex 2**.

Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

24 August 2012	CIE sends reviewer contact information to the COR, who then sends this to the NMFS Project Contact.
31 August 2012	NMFS Project Contact sends the stock assessment report and background documents to the CIE reviewers. Background documents may be sent to the CIE reviewers one week earlier.
7-21 September 2012	Each reviewer conducts an independent peer review as a desk review.
28 September 2012	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator.
12 October 2012	CIE submits the CIE independent peer review reports to the COR.
19 October 2012	The COR distributes the final CIE reports to the NMFS Project Contact and regional Center Director.

Modifications to the Statement of Work: This 'Time and Materials' task order may require an update or modification due to possible changes to the terms of reference or schedule of milestones resulting from the fishery management decision process of the NOAA Leadership, Fishery Management Council, and Council's SSC advisory committee. A request to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent changes. The Contracting Officer will notify the COR within 10 working days after receipt of all required information of the decision on changes. The COR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COR for final approval as contract deliverables based on compliance with the SoW and ToRs. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (CIE independent peer review reports) to the COR (William Michaels, via William.Michaels@noaa.gov).

Modifications to the Statement of Work: This 'Time and Materials' task order may require an update or modification due to possible changes to the terms of reference or schedule of milestones resulting from the fishery management decision process of the NOAA Leadership, Fishery Management Council, and Council's SSC advisory committee. A request to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent changes. The Contracting Officer will notify the COR within 10 working days after receipt of all required information of the decision on changes. The COR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

Support Personnel:

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Key Personnel:

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Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs.

3. The reviewer report shall include the following appendices:

   Appendix 1: Bibliography of materials provided for review

   Appendix 2: A copy of the CIE Statement of Work

Annex 2: Terms of Reference for the Peer Review

Review of Technical Documentation for the Vertical Line Analysis Model Supporting an Amendment to the Atlantic Large Whale Take Reduction Plan

The Atlantic Large Whale Take Reduction Plan (ALWTRP) is designed to protect three endangered species – the western North Atlantic stock of right whales, the Gulf of Maine stock of humpback whales, and the western North Atlantic stock of fin whales – from the risk of serious injury or death associated with entanglement in commercial fishing gear. A continuing concern in achieving the goals of the ALWTRP is reducing the risk of entanglement in vertical line; i.e., buoy lines associated with lobster trap/pot gear, other trap/pot gear, or gillnet gear. To better understand these risks and the impact of potential management measures designed to address them, the National Marine Fisheries Service (NMFS) requires information on the spatial and temporal distribution of gear used by fisheries that are subject to the requirements of the ALWTRP, along with information on the likely presence of whales in the waters the plan regulates. This information will contribute to formulation of NMFS' vertical line management strategy.

Under contract to NMFS, Industrial Economics, Incorporated (IEc) has developed a tool that provides the information described above: the Vertical Line Analysis Model. The model is designed to help NMFS address basic questions that are fundamental to whale conservation and fisheries management, such as:

- Where do fisheries subject to the requirements of the ALWTRP operate?
- Where are concentrations of vertical line likely to be the greatest?
- Are whales likely to frequent areas with high concentrations of line?

By integrating available information on patterns of fishing activity, gear configurations, and seasonal changes in the likely distribution of the species of concern, the model provides indicators of relative entanglement risks at various locations and at different points in time. This information will help NMFS identify and evaluate the potential impact of management options designed to reduce the chances that whales will encounter and become entangled in commercial fishing gear.

To support the development of the model, NMFS has arranged for a review of its technical documentation by a team of independent experts. The review is to address the following questions:

1) Does the documentation provide a clear description of the model's purpose and scope, and of the data and methods it employs to characterize (a) vessel activity in the fisheries subject to the requirements of the ALWTRP, (b) the distribution of gear associated with these fisheries, and (c) seasonal variation in the potential distribution of endangered right, humpback, and fin whales?

2) With respect to the characterization of fishing activity in Federal and state waters:

   a) Are the data, methods, and assumptions the model employs to estimate the *number of vessels* active in each fishery appropriate?

   b) Are the data, methods, and assumptions employed to characterize the *location* of fishing activity appropriate?

   c) Are the data, methods, and assumptions employed to characterize *monthly variation* in fishing activity appropriate?

   d) Are key *data limitations and uncertainties* appropriately identified?

   e) Within the limits of available data, how could IEc *improve* the model's characterization of fishing activity?

3) With respect to the characterization of gear use in the fisheries of interest:

   a) Is the *use of model vessels* to describe the typical configuration of gear in particular areas and at different times of year a reasonable and appropriate approach?

   b) Are the *parameters* employed to characterize configurations of gear in *trap/pot fisheries* – i.e., total traps fished, number of traps per trawl, number of endlines per trawl, length of groundline between traps, number of anchors per trawl, and length of anchor lines – appropriate for the model's purpose?

   c) Are the *parameters* employed to characterize configurations of gear in *gillnet fisheries* – i.e., total strings fished, number of endlines per string, number of anchors per string, and length of anchor lines – appropriate for the model's purpose?

   d) Are the *equations* the documentation specifies to calculate the number of vertical lines and length of groundline associated with each model vessel conceptually correct?

   e) Are the data, methods, and assumptions employed to define model vessels in the *Federal lobster fishery* appropriate?

   f) Are the data, methods, and assumptions employed to define model vessels in the *Federal blue crab fishery* and *other Federal trap/pot fisheries* appropriate?

   g) Are the data, methods, and assumptions employed to define model vessels in *Federal gillnet fisheries* appropriate?

   h) Are the data, methods, and assumptions employed to define model vessels in *state waters* appropriate?

i) Are key *data limitations and uncertainties* appropriately identified?

j) Within the limits of available data, how could IEc *improve* the model's characterization of gear use?

4) With respect to the seasonal distribution of endangered species of large whales in waters subject to the ALWTRP:

a) Are the whale sightings data the model employs to characterize monthly variation in the *potential distribution of right whales, humpback whales, and fin whales* appropriate for this purpose?

b) Are key *data limitations and uncertainties* appropriately identified?

c) Within the limits of available data, how could IEc *improve* the model's characterization of seasonal variation in the potential distribution of endangered whales?

5) The model's primary outputs include (a) estimates of the number of vessels that participate in a given fishery, by month and location; (b) estimates of the number of vertical lines deployed in waters subject to the ALWTRP, by month and location; and (c) an indicator of the potential "co-occurrence" of whales and vertical line, by month and location.

a) Are the *data, methods, and assumptions* employed to develop these measures appropriate for the model's purposes?

b) Given the limits of available data and knowledge concerning factors that contribute to the risk of an entanglement, does the co-occurrence indicator provide a reasonable basis for evaluating *relative differences* in the likelihood that whales will encounter vertical line in a particular area during a particular month?

c) Are key *data limitations and uncertainties* appropriately identified?

d) Within the limits of available data, how could these indicators be *improved*?

6) Overall, what steps should IEc take to improve the model and/or its documentation?