Center for Independent Experts (CIE) Independent Peer Review Report on the 2015 PIFSC --- Methodology for Sampling and Estimating Bycatch of the Hawaii Deep-Set Longline Fishery

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Prepared for

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Executive Summary

The 2015 Pacific Island Fisheries Science Center (PIFSC) "*Methodology for Sampling and Estimating Bycatch of the Hawaii Deep-Set Longline Fishery*" was reviewed by a Center for Independent Experts (CIE) review panel. I joined the review at Hemenway Hall, University of Hawaii, Honolulu, Hawaii, from August 24-28 2015. The sampling design used for Hawaii deep-set longline (DSLL) fishery and the corresponding point and interval estimators were presented by Dr. Marti McCracken, an assessment scientist from NMFS, to the review panel. Model-based point and interval estimators were also presented and are mainly used for rare bycatch species and suggested for bycatch within political geographical areas. Questions and discussions took place throughout the review. The review panel then convened on its own on August 27 and the discussion results were communicated to the assessment team according to the predetermined Terms of Reference (ToRs). The Panel Members then prepared their individual review reports.

The purpose of this review was to evaluate the sampling design and estimators used to quantify bycatch from Hawaii DSLL fishery. Since 2002, a unique complex sampling design has been used to collect bycatch data by selecting DSLL trips for observer placement with a 2-stage sampling design: Systematic sampling and a plus sampling (SYSPLUS). This unique sampling design is because of the requirement for 20% observer coverage and fluctuation of the observer availability. The sampling design is special and an adaptive approach, which makes the estimators and approaches used to assess uncertainty (interval estimator here) of the bycatch of more than 100 species with different levels of rarity in the DSLL fishery. The immediate goal of the CIE peer review is to provide an impartial review, evaluation, and recommendations on both the sampling design and estimators used. The ultimate goal is to ensure that the best available science is utilized in quantifying deep-sea longline fishery.

The review panel found that the sampling design SYSPLUS is reasonable given the observer availability constraint and targeted coverage level. The assessment team did a great job in describing the design and the rationale of using the complex 2-stage design in great details. However, because of data confidentiality issues, no plots on bycatch and number of observers over time in a year were provided, so it is not certain whether there are seasonal patterns in bycatch frequency and/or observer placements (especially observers in the PLUS sampling system).

The design-based point estimator of total bycatch is reasonable although a model-based approach is highly recommended by the review panel. Horvitz-Thompson (HTE) and generalized ratio estimators (GREs) were presented and discussed during the review. The assessment team was concerned that the model-based approach may be inappropriate if the model is not a good approximation model and the possible bias and incorrect inference of it because of ignoring the sample design if the design variables are related to the survey variables (McCracken

2015a). The assessment team also felt that the stratified SYSPLUS design is a complex design and is expected to be non-ignorable. The review panel agreed with the assessment team on the use of the point estimators. The review panel suggested that future study be considered to explore bycatch over time and space, and continued work to explore model-based approaches with survey variables considered.

Two types of variance or interval estimators were provided. The first type is for common bycatch species and includes Horvitz-Thompson (HTE), Sen-Yates-Grundy (SYG), Brewer and Hanif (BHE) approximation of HTE GRE estimators, and a nonparametric bootstrap approach. The review panel suggested that the assessment team needs to provide a systematic criterion in selecting estimators for different categories of species according to their data patterns, such as rarity of the bycatch levels. The review panel also suggested that the bootstrap approach may be used for the future, but that further modification on the bootstrap sampling algorithm is needed. For example double bootstrap estimation of variance may be considered especially when sample size is small. The second type of variance estimator is model-based, and is designed and suggested to be used for rare bycatch species by the assessment team. The review panel commented on the model based approaches, and it suggested that seasonal and geographic pattern needs to be explored and included in the model in the future model exploration.

Under the Marine Mammal Protection Act, estimates of annual mortalities and serious injuries of marine mammals that occur within U.S. waters are required. The assessment team presented the estimators for the total number of cetacean bycatch events resulting in a dead and serious injury (DSI) classification. Two basic strategies for estimating total DSI are used: 1) same estimator considered for regular total bycatch; 2) based on the probability of bycatch events resulting in a DSI. The review panel suggested to use the first approach and consider model-based estimators. The review panel also reviewed and commented on the domain estimators for bycatch within political sub-geographical areas which are mainly for protected species and marine mammals. The review panel recognized the assignment of location of the interaction and longline which was said to be reviewed previously already. The review panel suggested that the assessment team should consider model-based estimators for bycatch within political sub-geographical regions since the bycatch events are mainly for protected species and marine mammals and they become even less after being divided into areas.

Some key recommendations are summarised below:

- Bycatch species may be classified into different categories clearly. Methodology for bycatch estimates may be recommended or selected based on these categories. Categories can include the bycatch observation rarity or frequency, and spatial and temporal patterns of the bycatch events.

- The PLUS sample pattern may be explored to find possible mechanisms or patterns that can be used to sample them, both in the 2-stage sampling and in the bootstrap sampling algorithm when estimating interval of mean of the bycatch.

- The assessment team intended to move to model-based approaches for rarely bycaught species but no predictors are included so far and yearly data are used. Future research may include spatial and temporal predictors and environmental predictors if necessary with all the years of data used. Bayesian estimators are recommended, which can provide the bycatch estimate as posterior distributions.

- Hierarchical models may be explored since the sample size is small and percentage of zeros is high for protected species and marine mammals. Hierarchical models allow borrowing strength for data-limited situations. They have been used to deal with multi-species and multi-experiment or multi-ecosystem studies because of the advantages of borrowing strengths from each other, easy modeling of cross-level interactions, and increasing the stability of the results (Jiao et al. 2011). For example, when estimating protected species and marine mammals in the political geographical regions, a domain estimator from different regions can borrow strength from among regions by using a hierarchical model.

- For common bycatch species, a comparison between model-based (with spatial and temporal predictors at least) estimator and design-based estimator may help understand the performance of model-based estimator and facilitate future research on rarely bycaught species. Simulation studies may be performed based on the historical observations since 1994.

1.   BACKGROUND

This report reviews the "*Methodology for Sampling and Estimating Bycatch of the Hawaii Deep-Set Longline Fishery*" mainly conducted by Dr. Marti McCracken from Pacific Islands Fisheries Science Center (PIFSC), at the request of the Center for Independent Experts (CIE). I was provided with three documents on Hawaii deep-set longline fishery (DSLL) bycatch sampling design and estimation, access to relevant presentations, and participated in the panel review meeting in Honolulu, Hawaii, during August 24-28 2015.

Quantifying bycatch in the Hawaii DSLL fishery is required by the Magnuson-Stevens Fishery Conservation and Management Act (MSA), Endangered Species Act (ESA), Marine Mammal Protection Act (MMPA), and Migratory Bird Treaty Act (MBTA) and their implementing regulations. The Hawaii DSLL fishery bycatches more than 100 species, including seabirds, marine mammals, turtles, elasmobranches and fishes. Some of them are listed as endangered or threatened. Reliable bycatch data collection and estimates are critically needed. A unique complex sampling design, which is a 2-stage sampling design including a systematic sample and a plus sample, has been used to select DSLL trips for observer placement since 2002. Based on the sampling design, bycatch estimates are then computed yearly (based on one year data) for all marine mammals, protected species, sharks, and fish that have been observed at least once in the fishery or are of special interest. Multiple estimators for point estimates and uncertainty estimates are used. The selection of the estimators depends on the observed frequency distribution of bycatch events for the species of interest.

The annual bycatch estimates of protected species from the Hawaii DSLL fishery are provided for inclusion in the National Bycatch Report, seabird and sea turtle estimates are submitted annually to the Inter-American Tropical Tuna Commission (IATTC) per Resolution C-11-02 and C-04-05, and marine mammal, seabird, and sea turtle estimates are provided for inclusion in the annual Western and Central Pacific Fisheries Commission (WCPFC) National report.

The purpose of this review is to evaluate both the sampling design and the bycatch estimation approaches to improve the scientific basis for management. Specifically, the CIE review panel reviewed:

1) The sampling design used to collect the bycatch data based on observer program.
2) Bycatch estimators, both point and uncertainty estimators, used for common and rare bycatch species.
3) Estimators for marine mammal bycatch events resulting in a death or serious injury (DSI).
4) Domain estimators used for estimating bycatch within political geographical areas of the DSLL fishing grounds.

2.   REVIEW ACTIVITIES

The "*Methodology for Sampling and Estimating Bycatch of the Hawaii Deep-Set Longline Fishery*" review was held at the Hemenway Hall, University of Hawaii, Honolulu, Hawaii, from August 24-28 2015.

Two weeks before the review meeting, I received three documents from the NMFS Project Contact, Dr. Marti McCracken, and they are listed below:

1. Sampling the Hawaii deep-set longline fishery and point estimators of bycatch;
2. Interval estimation of annual bycatch in the Hawaii deep-set longline fishery;
3. Domain estimators for the total number of cetacean bycatch events resulting in a dead or serious injury classification.

Prior to the meeting, I reviewed the material above and read some related background documents.

During the Open meeting, as a CIE reviewer I participated as a peer reviewer in the discussions on materials provided and presented, and gave appropriate feedback to the assessment scientists on the sufficiency of their analyses. The meeting comprised three reviewers from the Center for Independent Expert (Drs. Mary Christman, Yan Jiao and Shijie Zhou), Dr. Marti McCracken and Dr. Chris Boggs, and research staff from the PIFSC and other agencies (see the list of review participants in Appendix 3). At the beginning of the meeting, Dr. Chris Boggs restated the meeting agenda (Annex 3 of Appendix 2) which was followed throughout the meeting. Dr. Boggs also presented the background information on Hawaii DSLL fishery and the need for bycatch estimation. Dr. Joe Arceneaux, NMFS PIRO Observer Program, presented "Hawaii Longline Observer Program". The program targeted 20% observer coverage each year for the DSLL fleet. Dr. McCracken presented the background information on the need of the bycatch estimation and the constraint on the sampling design first. She then presented the complex 2-stage sampling design in great details in the first day. Dr. McCracken presented estimators for common and rare bycatch species in the following two days. A closed review panel discussion was conducted on the fourth day. The Terms of Reference (ToRs) were reviewed during the closed panel discussion time, to ensure that they had been answered, and that the best available science is utilized. The review panel then communicated the discussion results to the assessment team according to the predetermined ToRs on Aug 28. Each of the CIE reviewer led the discussion for two of the six ToRs.

After the Open meeting, I prepared this independent CIE review report. This report followed the guidance in Annex 1 of the statement of the work for the reviewer.

3. SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS FOR EACH TERM OF REFERENCE

Considerable research effort has been devoted to both the sampling design and the bycatch estimations for Hawaii DSLL fishery, which can be seen both from the detailed documents and the presentations. The assessment team uses a complex sampling design to place observers on board to collect data for more than 100 bycatch species, with many of them being very rare. The assessment team also implemented both design-based estimators and model-based estimators to deal with bycatch species with different rarity. Because of data confidential problem, no detailed examples were provided, especially the number of observers over time and the bycatch frequency over time, which somewhat influences more direct recommendations on possible approaches for future use. Below is a summary of the finding on the evaluation of the sample design and estimation approaches. Conclusion and recommendation for future research are also included.

> **TOR 1:** *Review the sampling design used to select trips for observer placement and determine if it is a preferred design for estimating bycatch considering constraints and reporting requirements.*
>
> The current sampling design is complex and includes two stages in place observers: a systematic sample (15% coverage) and a PLUS sample (5% coverage). The systematic sample is a multistart-systematic sampling design; the plus sample is designed to be adaptive to the observer availability, and budget limitation so that 20% coverage is maintained and does not go beyond. The design is for all the bycatch species found in the DSLL fishery. The assessment team needs to conduct annual bycatch estimates for DSLL fishery for all the species and there is usually little time between data verification and bycatch estimates deadlines. Information compiled and presented in the review meeting helps the participants to understand this complex sample design and evaluate the appropriateness of this complex design.
>
> The review panel found that the current 2-stage complex SYSPLUS sample design is adequate and acceptable given the constraint on observed coverage and availability variation. The methods to deal with inclusion probability, group determination, and missing values are appropriate in general. However, a few extra types of information may help further justification of these methods: 1) the distribution of the fishing trips over time; 2) the observer number distribution over time; 3) the bycatch frequency distribution over time. Historical observations on the above three types of information should help better understand the influence of the PLUS sample and the application of the estimators for this complex design.
>
> A few extra analyses may further help evaluate both the sampling design and the estimation approaches.

1) The review panel understands that the 20% coverage is required by the court. A table on the precisions of the bycatch estimates of all the species, especially the protected species, should help understand whether the 20% coverage yields acceptable precision or not. A simulation study based on historical observations can help to derive how the precision of the estimates of species of interest to change given different levels of observer coverage.

2) How to handle the PLUS sample is a big problem, which influences how the design-based estimators are used and how the bootstrap algorithm is coded. Historical observations on the seasonal distribution of observers in the PLUS sample may provide a mechanism or pattern in interpreting the PLUS sample. This mechanism will further help the design of the bootstrap sampling algorithm.

3) Typical species for common, seldom, and rare species need to be defined and examples with thorough analyses and plots, such as their temporal and spatial patterns observed historically should help to justify the appropriateness of the sample design to a large degree.

TOR 2: *Evaluate the point estimators and determine if they are good estimators given the sample design, observed frequency distribution of bycatch events, and constraints.*

Four bycatch point estimators were used and discussed during the review and they are Horvitz-Thompson (HTE) and generalized ratio estimators (GRE, including using # of trips, # of sets, and # of hooks). These estimators do not involve model selection and can be computed quickly, which is an advantage in meeting the time constraint when estimating total bycatch annually for more than 100 bycatch species. HTE is widely used as a design-based estimator (Thompson 1992). The application of GREs tends to move to model-based approaches, except that only effort is considered as a predictor of the bycatch.

The review panel felt that both HTE and GREs are classical estimators in sampling technique and are generally appropriate given the sampling design. The assessment team alerted the possible impact of ignoring the sample design when using model-based approaches. However, the review panel realized that: 1) there are no detailed information/data provided to identify possible design variables that may influence model based approaches; 2) there are conflicts in dealing with sample design when applying design-based and model-based estimators. When using the design-based estimator and bootstrap (TOR 3), the assessment team tries to capture sample design details or possible pattern across time; but when using the model-based approaches the assessment team tries to ignore the sample design, the possible differences between PLUS sample and SYS

sample, and the other possible predictors. However, this could be because of the limited time window to conduct bycatch estimates each year.

The assessment team has a preference on when each type of estimators should be used but are not well documented. Species categories, such as common (defined during the review meeting, more than 20 observations each year), seldom (between 10 and 20 observations) and rare (less than 10 observations) or very rare needs to be clearly defined and documented in the future. The procedure in selecting estimators also needs to be documented and should relate to the species categories.

Confidential data might be shown as plots to the reviewers for better understanding of the possible variables and patterns, and such kinds of plots should help interpret bycatch observed. Suggestions on using model-based approaches, using historical observations instead of annual data, and using Bayesian approaches were discussed during the review meeting.

***TOR 3:** Evaluate the interval estimators and determine if they are good estimators given the sample design, observed frequency distribution of bycatch events, and constraints.*

When the point estimators are either HTE or GREs, three design-based interval estimators and one nonparametric bootstrap approach were used to estimate the uncertainty of the population mean, and were discussed during the review meeting. The three design-based interval estimators are Horvitz-Thompson (HTE), Sen-Yates-Grundy (SYG), Brewer and Hanif (BHE). The HTE and SYG can yield negative variance estimates, and BHE is then recommended because of being invariably nonnegative although it is biased (Lohr 2010).

A nonparametric bootstrap sampling approach was also used to estimate interval of the population mean of the total bycatch. The review panel suggested that the assessment team needs to provide a systematic criterion in selecting estimators for different categories of species according to their data patterns, such as rarity of the bycatch levels. The review panel also suggested that the bootstrap approach may be used for the future, but further modification on the bootstrap sampling algorithm is needed. For example, double bootstrap estimation of variance may be considered, especially when the sample size is small. The current bootstrap algorithm tries to mimic the details of the sampling design and sample collection, but the PLUS sample causes the algorithm to become too complicated. Also, some of the groups have only one sample or limited samples shown in some of the examples during the review meeting, which brought concerns on the resampling of the bootstrap. Better understanding the PLUS sample in the future, and how it may be interpreted based on season, may help simplify the process and at the same time improve the bootstrap resampling.

The confidence intervals (CIs) were computed based on central limit theory and/or the idea of shortest CIs. The review panel suggested that the use of equal two-sided alpha is pretty common in fisheries and recommended that equal alpha may be used for common bycatch species with enough positive trips. Clarification needs to be provided when reporting bycatch as to the CI is for the population mean or population total.

The second type of variance estimator is model-based, and it is used for seldom and rare bycatch species by the assessment team. The model-based approaches include: 1) a binomial model (termed as 2.3 model-based CIs for rarely bycaught species), 2) Bayesian interval estimates based on a Poisson model, 3) Bayesian interval estimated based on a conditional binomial model, and 4) Bayesian Poisson-SYSPLUS model. The first model assumes that total observed bycatch (η) among the year follow a binomial distribution $\eta|_{\tau, P_{obs}} \sim Binomial(\tau, P_{obs})$ with total bycatch unknown from all the annual DSLL trips (τ) and proportion of trips with successful observers on board (P_{obs}). By doing this, the stochastic process of observing η among the trips with observers is ignored. Instead, the equations used to describe the Poisson process (model 2) are more reasonable and should be considered. The review panel also suggested to include possible predictors such as time and location in the model. There are no disadvantages of solving the model using Bayesian approach and estimating the posterior distribution of total bycatch. Both models 3 and 4 have flaws. Model 3, a conditional binomial model, is the same as model 1, except that it is computed in a Bayesian way by including prior of τ; model 4, using the PLUS sample as prior to include the PLUS sample, does not seem to be appropriate and needs to be improved as stated in the document by McCracken (2015b). Instead, the assessment team may consider using multi-year data and using previous year's analysis as possible informative priors.

The review panel commented on the model-based approaches and suggested that seasonal and geographic patterns be explored and included in the models in the future model exploration. Bayesian estimator is suggested when model-based approaches are used.

***TOR 4:** Evaluate estimators of total bycatch events resulting in a death or serious injury (DSI) classification and determine if they are good estimators given the sample design, observed frequency distribution of injury classifications (non-serious or DSI), and constraints.*

The assessment team presented the estimators for the total number of marine mammal bycatch events resulting in a dead and serious injury (DSI) classification. Two basic strategies for estimating total DSI used are: 1) same estimator considered for regular total bycatch but only using the DSI events observed; and 2) based on the probability of a bycatch events

resulting in a DSI. Both approaches have advantages and disadvantages as discussed in the document and during the meeting.

The review panel realized that both approaches use annual data although approach 2 tries to use previous year's data (2002-2010) to derive the probability of being DSI. The review panel suggested using the first approach with consideration of using all the survey data across years based on the selection by the assessment team when appropriate and using the model-based estimators. A combination with Bayesian estimator and hierarchical Bayesian models is suggested since the estimation of DSI is mainly for marine mammals with very low bycatch rates.

TOR 5: *Evaluate the subpopulation estimators being applied to estimate bycatch within a political geographical boundary and determine if they are good estimators given the sample design, reporting requirements under the MMPA, and constraints.*

The review panel also reviewed and commented on the domain estimators for bycatch within political sub-geographical areas, which is mainly for protected species and marine mammals. Design-based estimators, HTE and GREs, addressed in the ToRs 1 and 2, are used for bycatch estimates within each geographical areas.

The review panel felt the approach used to assign the location of the interaction and longline is appropriate, which was said to be reviewed previously already. The review panel suggested that the assessment team should consider model-based estimators for bycatch within political sub-geographical regions since the bycatch events are mainly for protected species and marine mammals and they become even less after divided into areas. A hierarchical Bayesian approach is appropriate in this case to have data from each geographical areas treated as hierarchically structured. Historical data are suggested to be included in the models also. The model once built is easily updated in the future by using all the data and possible predictors.

TOR 6: *Suggest future research priorities to improve methods for estimating bycatch with increased efficiency given the current data structure. Suggest future research priorities for improving the sampling design for the purposes of estimating bycatch, with efficient use of sampling resources as a consideration.*

o   The PLUS sample over time may be explored to find possible mechanisms or patterns that can be used to sample them, both in the 2-stage sampling and in the bootstrap sampling algorithm when estimating interval of the mean of the bycatch. This also helps to understand

whether the sample design is ignorable or non-ignorable when using model-based approaches.

o   Bycatch species may be classified into different categories clearly and methodology for bycatch estimates may be recommended or selected based on these categories. Categories can include the bycatch observation rarity or frequency, and spatial and temporal patterns of the bycatch events.

o   The assessment team intended to move to model-based approaches for rarely bycaught species, but no predictors are included so far and yearly data are used. Future research may include spatial and temporal predictors and environmental predictors if necessary with all the years of data used. Bayesian estimators are recommended, which can provide the bycatch estimate as posterior distributions.

o   Hierarchical models may be explored since the sample size is small and percentage of zeros is high for protected species and marine mammals. Hierarchical models have been increasingly recommended because of the advantages of borrowing strengths from each other, easy modeling of cross-level interactions, and increasing the stability of the results (Jiao et al. 2011). For example, when estimating protected species and marine mammals in the political geographical regions, domain estimator from different regions can borrow strengths from among regions by using a hierarchical model (Gelman 2006). Hierarchical models with multi-level prior distributions have been found to produce robust results (Roberts, and Rosenthal 2001; Gelman et al. 2004).

o   For common bycatch species, a comparison between model-based (with spatial and temporal predictors at least) estimator and design-based estimator may help understand the performance of model-based estimator and facilitate future research on rarely bycaught species. Simulation studies may be performed based on the historical observations since 1994.

o   For rare bycatch species, probability distributions with overdispersion may be considered in the future beside Poisson distribution. Possible candidates include negative binomial, delta-distributions, zero-inflated Poisson or negative binomial, and Conway-Maxwell Poisson, etc. (Guikema and Goffelt 2008; Francis et al. 2013).

o   Estimation on the precisions of the bycatch estimates of all the species, especially the protected species, should help understand whether the 20% coverage yields acceptable precision or not. A simulation study based on historical observation can help to derive how the precision of

the estimates of species of interest to change given different levels of observer coverage.

4. SUGGESTIONS FOR IMPROVEMENT OF NMFS REVIEW PROCESS

The current review process is very well organized. The communication between the NMFS project contact and CIE reviewers may start somewhat earlier rather than two weeks before the review. The review process can be further improved if a follow-up review, which may be composed of one reviewer, can be conducted in the near future to address the research recommendations. The CIE review and discussion should be implemented more effectively by this extra follow-up review.

5. ACKNOWLEDGEMENTS

I would like to thank Dr. Marti McCracken and Dr. Chris Boggs for their informative presentations on the Hawaii Deep-Set Longline Fishery background information and bycatch assessment, and for their meaningful responses to the review panel's questions. Many thanks also to the other staffs and scientists at the meeting for their contributions to the discussions throughout the meeting. Special thanks also go to the other members of the review panel, Dr. Zhou and Dr. Christman, for our productive discussions on the bycatch data collection and assessments.

6. REFERENCES

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Appendix 1: Bibliography of Materials provided for review

Bibliographies prior to the review meeting

McCracken, M.L. 2015a. Sampling the Hawaii deep-set longline fishery and point estimators of bycatch. Pacific Islands Fisheries Science Center. 17p.
McCracken, M.L. 2015b. Interv al estimation of annual bycatch in the Hawaii deep-set longline fishery. Pacific Islands Fisheries Science Center. 18p.
McCracken, M.L. 2015c. Domain estimators for the total number of cetacean bycatch events resulting in a dead or serious injury classification. Pacific Islands Fisheries Science Center. 11p.

Material during the meeting

- o Longline logbook protected species marine mammals and turtles.
- o NMFS Western Pacific Longline Fishing Log.
- o Regulation Summary: Hawaii Pelagic Longline Fishing.
- o Hawaii Longline Observer Program Field Manual, version LM.14.04.
- o Sample notification logs m08d23y15.xlsx.
- o Multiple figures as examples for bycatch frequency.
- o Examples of marine mammal bycatch in spreadsheets.

PowerPoint presentations during the review meeting

See review meeting agenda (Annex 3 of Appendix 2)

Appendix 2: Statement of Work

External Independent Peer Review by the Center for Independent Experts

**Methodology for Sampling and Estimating Bycatch
of the Hawaii Deep-Set Longline Fishery**

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 Technical Representative (COTR), 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:

Quantifying bycatch in the Hawaii deep-set longline fishery is required by the Magnuson-Stevens Fishery Conservation and Management Act (MSA), Endangered Species Act (ESA), Marine Mammal Protection Act (MMPA), and Migratory Bird Treaty Act (MBTA) and their implementing regulations. As over a hundred species, some of them listed as endangered or threatened, have been recorded as being caught in the Hawaii deep-set longline fishery, reliable bycatch estimates need to be computed in a relatively quick manner on a yearly basis. Since mid-year 2002, a unique complex sampling design has been used to select deep-set longline trips for observer placement. While aboard a selected longline trip, NMFS trained observers collect information on bycatch and ancillary variables for each longline fishing operation. Based on the sampling design, bycatch estimates are computed for all marine mammals, protected species, sharks, and fish that have been observed at least once in the fishery or are of special interest. What estimators are used depends on the observed frequency distribution of bycatch events for the species of interest. Interval estimators have been developed for commonly, seldom, and very rarely bycaught species. Methods for estimating bycatch within political geographical areas within the fishing grounds and the total number of marine mammal bycatch events resulting in a death or serious injury (DSI) have also been developed as the MMPA requires estimates of DSI within and outside the Economic Exclusive Zones (EEZ) of the United States.

These annual bycatch estimates of sea turtles, seabirds, and marine mammals are used to monitor takes within the deep-set longline fishery. These estimates have a large potential impact on endangered species and the valuable longline commercial fishery in Hawaii. Additionally, bycatch estimates of all species are provided for inclusion in the National Bycatch Report, seabird and sea turtle estimates are submitted annually to the IATTC (Inter-American Tropical Tuna Commission) per Resolution C-11-02 and C-04-05, and marine mammal, seabird, and sea turtle estimates are provided for inclusion in the annual WCPFC (Western and Central Pacific Fisheries Commission) National report. The methods to be reviewed have not undergone independent peer review and there is a need to evaluate the methods to improve the scientific basis for management.

The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**. The tentative agenda of the panel review meeting is attached in **Annex 3**.

Requirements for CIE Reviewers:

Three CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. Reviewers shall have working knowledge and recent experience in the application of statistical inference for finite populations. Reviewers should be statisticians with comprehensive knowledge of both theoretical and applied sampling design and analysis. Furthermore, reviewers should have some knowledge of analyzing rare events, bootstrap techniques for finite population sampling, and frequentist and Bayesian inference for finite populations. Experience in statistics related to natural resources is beneficial.

Each CIE reviewer's duties shall not exceed a maximum of 14 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 during the panel review meeting scheduled in Honolulu, HI during August 24-28, 2015.

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

Prior to the Peer Review: 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 COTR, who forwards this information to the NMFS Project Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE 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, foreign national security clearance, and other information concerning pertinent meeting arrangements. The NMFS Project Contact is also responsible for providing the Chair a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

Foreign National Security Clearance: When CIE reviewers participate during a panel review meeting at a government facility, the NMFS Project Contact is responsible for obtaining the Foreign National Security Clearance approval for CIE reviewers who are non-US citizens. For this reason, the CIE reviewers shall provide requested information (e.g., first and last name, contact information, gender, birth date, passport number, country of passport, travel dates, country of citizenship, country of current residence, and home country) to the NMFS Project Contact for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website: http://deemedexports.noaa.gov/ http://deemedexports.noaa.gov/compliance_access_control_procedures/noaa-foreign-national-registration-system.html

Pre-review Background Documents: Two weeks 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. 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. CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

Documents will describe:
- The stratified systematic-plus design and approximation of inclusion probabilities.
- Point estimators of total bycatch.
- Interval estimators of total bycatch, including estimators for very rarely bycaught species.
- Estimators for subpopulation totals, specifically estimators of bycatch within geographical areas of the fishing grounds.
- Estimators of total number of marine mammal bycatch events resulting in a classification of dead or serious injury (DSI).

Panel Review Meeting: 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 COTR and CIE Lead Coordinator.** Each CIE reviewer shall actively participate in a professional and respectful manner as a member of the meeting review panel, and their peer review tasks shall be focused on the ToRs as specified herein. The NMFS Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The NMFS Project Contact is responsible for ensuring that the reviewers understand the contractual role of the CIE reviewers as specified herein. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements.

<u>Contract Deliverables - Independent CIE Peer Review Reports</u>: 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) Participate during the panel review meeting in Honolulu, HI, from August 24-28, 2015.
3) Conduct an independent peer review in accordance with the ToRs (**Annex 2**).
4) No later than September 14, 2015, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Dr. Manoj Shivlani, CIE Lead Coordinator, via email to mshivlani@ntvifederal.net, and Dr. David Die, CIE Regional Coordinator, via email. ddie@rsmas.miami.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.

July 20, 2015	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
August 10, 2015	NMFS Project Contact sends the CIE Reviewers the pre-review documents
August 24-28, 2015	Each reviewer participates and conducts an independent peer review during the panel review meeting
September 14, 2015	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
October 2, 2015	CIE submits CIE independent peer review reports to the COTR
October 5, 2015	The COTR 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 COTR within 10 working days after receipt of all required information of the decision on changes. The COTR 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 COTR 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 COTR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COTR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards:
(1) The CIE report shall completed with the format and content in accordance with **Annex 1**,
(2) The CIE report shall address each ToR as specified in **Annex 2**,
(3) The CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon acceptance by the COTR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COTR. The COTR will distribute the CIE reports to the NMFS Project Contact and Center Director.

Support Personnel:

Allen Shimada
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Allen Shimada@noaa.gov   Phone: 301-427-8174

Manoj Shivlani, CIE Lead Coordinator
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Key Personnel:

NMFS Project Contact:

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

1. Each CIE independent peer review report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations following Annex 2 Terms of Reference.

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.

    a. Reviewers should describe in their own words the review activities completed during the panel review meeting, including providing a brief summary of findings, of the science, conclusions, and recommendations.

    b. Reviewers should discuss their independent views on each ToR even if these were consistent with those of other panelists, and especially where there were divergent views.

    d. Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.

    e. The CIE independent report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed.   The CIE independent report shall be an independent peer review of each 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
    Appendix 3: Panel Membership or other pertinent information from the panel review meeting.

Annex 2: Terms of Reference for the Peer Review

**Methodology for Sampling and Estimating Bycatch
of the Hawaii Deep-Set Longline Fishery**

1. Review the sampling design used to select trips for observer placement and determine if it is a preferred design for estimating bycatch considering constraints and reporting requirements.

2. Evaluate the point estimators and determine if they are good estimators given the sample design, observed frequency distribution of bycatch events, and constraints.

3. Evaluate the interval estimators and determine if they are good estimators given the sample design, observed frequency distribution of bycatch events, and constraints.

4. Evaluate estimators of total bycatch events resulting in a death or serious injury (DSI) classification and determine if they are good estimators given the sample design, observed frequency distribution of injury classifications (non-serious or DSI), and constraints.

5. Evaluate the subpopulation estimators being applied to estimate bycatch within a political geographical boundary and determine if they are good estimators given the sample design, reporting requirements under the MMPA, and constraints.

6. Suggest future research priorities to improve methods for estimating bycatch with increased efficiency given the current data structure. Suggest future research priorities for improving the sampling design for the purposes of estimating bycatch, with efficient use of sampling resources as a consideration.

Note – CIE reviewers typically address scientific subjects, hence ToRs usually do not involve CIE reviewers with regulatory and management issues unless this expertise is specifically requested in the SoW.

Annex 3: Tentative Agenda

**Methodology for Sampling and Estimating Bycatch
of the Hawaii Deep-Set Longline Fishery**

24-27 August: Honolulu Service Center, NOAA Fisheries Pier 38, Honolulu
Harbor, 1139 N. Nimitz Hwy, Suite 220, Honolulu, HI 96817

28 August: NOAA Daniel K Inouye Regional Center, 1845 Wasp Boulevard,
Building 176, Conference Room 2545, Honolulu, HI 96818

8:30am-5:00pm, 24-28 August 2015

Monday, August 24
    1. Introduction
    2. Background information - Objectives and Terms of Reference
    3. Observer Program and Longline Fishery
        Observer program (presented by Pacific Islands Observer Program)
        Deep-Set Longline Fishery
    4. Review of Sampling Design
    5. Review of Approximation of Inclusion Probabilities
Tuesday, August 25
    6. Review of Point Estimators of Bycatch
    7. Review of Interval Estimators
Wednesday, August 26
    8. Review of Estimators of DSI (marine mammals)
    9. Review of Estimators of Subpopulation Totals. ,
Thursday, August 27
    10. Panel discussions (Closed)
Friday, August 28
    11. Panel discussions and present results
    12. Adjourn

**Note: the meeting location was changed to Hemenway Hall, University of
Hawaii, Honolulu, Hawaii.**

Appendix 3: Panel Membership and Other pertinent information from the panel review meeting

CIE review panel:

      Mary C. Christman
      Yan Jiao
      Shijie Zhou

Assessment team:

      Marti McCracken, NMFS Pacific Islands Fisheries Science Center

Other participants:

      Joe Arceneaux, NMFS PIRO Observer Program
      Chris Boggs, NMFS Pacific Islands Fisheries Science Center
      Asuka Ishizaki, Western Pacific Fishery Management Council
      Jarad Makiau, NMFS PIRO Observer Program
      Ben Richards, NMFS Pacific Islands Fisheries Science Center