CIE Independent Peer Review Report

Modeling Larval Transport and Connectivity in Hawaiian Waters

Panel Review Meeting, 19-22 May 2008, Honolulu, Hawaii

Prepared for the Center for Independent Experts

by:

Dr. Robert K. Cowen
Division of Marine Biology and Fisheries
Rosenstiel School of Marine and Atmospheric Sciences
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149

June 10, 2008

I. Executive Summary

The Ecosystems and Oceanography Division at the Pacific Islands Fisheries Science Center (PIFSC) has developed computer simulation modeling to address insular species issues of metapopulation connectivity and larval transport in the Hawaiian Archipelago. These approaches utilize a variety of remotely-sensed and modeled oceanographic data in a Lagrangian, individual-based modeling framework. The project leader for this work is Fishery Biologist Donald R. Kobayashi. From May 19-22, 2008, two reviewers (Drs. R. Cowen and K. Frank) for the Center for Independent Experts (CIE) participated in a review workshop held at the Hawaii Imin International Conference Center, University of Hawaii East-West Center, Honolulu, Hawaii, for the explicit purpose of providing an external, independent peer–review of this program. In addition to attendance by the above two CIE reviewers, presentations were made by Ms. Sarah Malloy (overview of the PIFSC) and Mr. Donald R. Kobayashi (scientific and technical material). No other PIFSC or UH staff were in attendance for the duration of the Panel Review Meeting.

Project leader Donald Kobayashi (DK) presented all review materials during the first 2.5 days of the review workshop. The presentations were intermixed with extensive question and answer sessions between DK and the CIE reviewers. Overall, DK presented a well-organized, thorough overview of the progress, methodologies and future plans of the larval connectivity modeling and research program. During the reminding time on-site, the CIE reviewers worked on a draft of the Consensus Report.

In evaluating the program and associated materials, the TOR requested evaluation on three main issues, whether the: i) (environmental) data, ii) analytical methods and modeling, and iii) biological and population data, model structure and analysis methods (as applied to archipelagic connectivity) were all representative of the best available science. In all respects, this reviewer felt that the best available science was being applied, whether in terms of the data utilized, models developed or analyses conducted. The work performed in the Connectivity program has evolved in accordance with data improvements, development of new models, and technological (hardware) capabilities. The field continues to evolve, and discussion of future work was similarly framed within the best available science.

A series of recommendations are provided with respect to: i) Input/parameterization for simulation models, ii) output/validation of simulation models and iii) cross-cutting issues. Some recommendations are explicitly relevant to the scientific approach being taken; others refer to more programmatic and application related issues.

Overall, the Connectivity program of the Ecosystems and Oceanography Division of the PIFSC has established a strong modeling framework that has high application value to spatial management-based fisheries and conservation planning. Coordination of this program with resource monitoring and management activities in other Divisions of the PIFSC is strongly warranted.

II. Terms of Reference

1. *Evaluate whether the adequacy, appropriateness, and application of data used in the analyses represents the best available science?*

The data utilized to parameterize and evaluate the simulation models were of an environmental or physical oceanographic nature. These datasets were largely derived from either satellite sensors or were generated as output from ocean circulation (numerical) models. As such, these derived data products are generally widely available to end-users and, in most cases, represent the only available source of data at the requisite spatial and temporal scales. These data include the following:

a) Topex Poseidon altimeter and its various successors including ERS, JASON, AVISO which provided the geostrophic flow fields and the bathymetry product used in the simulations;

b) OSCAR – Ocean Surface Current Analysis Real time which provided combined geostrophic and wind driven flow fields;

c) SST and surface chlorophyll derived from AVHRR and SeaWIFs;

d) Positional information on satellite drifter buoy tracks used for the flow field validation;

e) TAO oceanographic mooring data used to compare observed mixed layer depth to the prediction from Topex altimetry;

f) Model outputs from NLOM – Naval Research Laboratory Layered Ocean Model;

g) Model outputs from NCOM – Naval Research Laboratory Coastal Ocean Model;

h) University of Hawaii tidal model output;

i) Various climate indices such as the SOI – Southern Oscillation Index and PDO – Pacific Decadal Oscillation Index.

In each case examined, it was concluded that the data were adequate and appropriate for the simulation modeling exercise. It should be noted that the resolution of the flow field data used became increasingly higher and served to improve the simulation results, a trend expected to continue in the future. However, due to the limited time series for the higher resolution flow field data, some applications will be better served with the lower resolution, longer time series data. The example here is use of altimetry time series (lower resolution) vs. ocean circulation modeling (high resolution – but few years available).

2. *Evaluate whether the adequacy, appropriateness, and application of analytical methods and modeling represents the best available science?*

A variety of analytical and statistical methods were employed to search for patterns in the simulated particle distributions, partition variance in settlement output data, validate particle trajectories, and summarize dispersal outcomes. The analytical methods included:

a) Generalized additive modeling (GAMs);

b) NMDS (non-metric multi-dimensional scaling);

c) Linear regression analysis;

d) Student's t-test;

e) Contouring algorithm for spatial analysis known as ConREC;

f) Matrix presentation of the probability density functions.

All the analytical/statistical methods were adequate and appropriately applied and have precedent in the contemporary ecological literature dealing with connectivity research.

3. *Do the biological data, population data, model structure and assumptions, and the analysis methods applied to archipelagic connectivity represent the best available data and methodology for sound science?*

The Lagrangian simulation model is based upon an individual-based modeling structure (IBM). Further, the model incorporates a random walk subcomponent to address sub-grid diffusion. The approach is the appropriate framework for addressing larval dispersal and general questions of connectivity across large geographic scales. The development and application of this model rests upon several assumptions including:

a) Constant diffusivity of 500 m^2/s;

b) Spawning output proportional to habitat area defined by the 0-100m depth range;

c) Constant rate of spawning throughout the year (uniform distribution);

d) Pelagic larval duration or PLD ranging from 15 – 365 days, with no variability in settlement at the imposed PLD;

e) Circular settlement zone of detection by dispersing larvae with a radius of 25 – 140 km;

f) Passive and mixed (occupation of different broad layers) vertical distribution of larvae depending on the simulation run;

g) No response by dispersing larvae to coastal boundaries.

The primary data input to the simulation model was the u and v components from altimetry or NLOM and these were taken to be representative of the flow fields dispersing larvae experienced. The assumptions were considered reasonable and appropriate given the scale of resolution evaluated, particularly when the simulations were based on flow field input from the altimeter. However, several of the assumptions will require modification in order to move the modeling from its present generic emphasis to a species-specific, high-resolution depiction of the dispersal/connectivity process.

Output from the Lagrangian simulations were used in a multiple generation metapopulation model. An important component of this model was the imposition of density dependence on spawning output (capped at an input value based on the number of simulation runs scaled by available habitat). A constraint to this exercise was that the derived measures of connectivity were based on a single year of modeled flow fields but applied to 1,000 generations. This modeling exercise was illustrative of the potential development of spatial structure and bio-geographic patterning among populations in the Hawaiian archipelago. This was considered a minor and largely exploratory component of the larval connectivity research program. The extremely long times scales associated with this exercise makes it less relevant to potential management applications, although the generation length was not specified.

The simulation modeling exercise was intended to be strictly generic and as such no species-specific biological or population level data was used. Only the PLD parameter was based upon a broad range of known values. It appeared that moving forward with the simulation modeling required making several assumptions (e.g. constant spawning timing, location and egg production), rather than waiting for detailed information to eventually become available. Embarking on such a strategy was deemed

appropriate. Several suggestions were offered as recommendations to lessen the dependence on the existing assumptions.

III. Further Analyses and Evaluations

No requests were made for further analytical development of work to date. It was felt that the material presented was sufficiently comprehensive to allow a thorough review. Some ancillary documents were provided as further background, e.g. extent of existing biological data on species of interest within the Hawaiian Archipelago.

IV. Additional Comments

- The scale of effort performed to date is impressive given the low level of manpower allocated (mostly DK with collaborations with Dr. Jeff Polovina, and various colleagues at UH). However, given the potential for future application of the Connectivity research output, there is likely to be greater demand for products, necessitating developing/running models for new organisms/systems/seasons, etc. that will require an expansion of resources within the Connectivity shop. Since it is clear that resources are tight everywhere, some reallocation of time/effort by DK may facilitate meeting the higher demand (see below). However, administrative staff should be aware of the potential value of this work and seek means of facilitating mechanisms to get this work to the critical management users and potentially expanding cooperative interactions that may serve to foster input of additional resources for specific applications.
- The Fisheries management community is primed for more detailed input on connectivity of exploited species. Specific statements to this need are made in several of the Ancillary documents reviewed (e.g. items #14-16). Further, with the requirement of spatial management options to accomplish Ecosystem approaches to management, the development of a **2-5 yr** research/output planning effort is warranted with participation by not just the Connectivity working group (and its parent Division – Ecosystems and Oceanography), but the related Divisions with the potential to provide critical input data and assessments (i.e. Coral Reef Ecosystem Division, Protected Resources Division, and Fish Biology and Stock Assessment Division).

V. Recommendations

The recommendations provided in the Consensus Report are an accurate reflection of this reviewer's perspectives and therefore they are included in this report. Additional recommendations are appended to this list to address points either needing further clarification or which are in addition to the Consensus Report list.

i) <u>Input/parameterization for simulation models</u>

- There is a need for basic biological data, based on literature review and directed research, to develop connectivity models for target species. Data on the space/time distribution of spawning

for selected species and if possible some measure of inter-annual variability (comprehensive description of where, when, how long and how much spawning occurs) should be compiled. Similarly, consideration should be given to including estimates of egg and larval mortality, developmental rates, vertical and horizontal behavior, all in the context of the ambient environmental conditions.

- There is a need to evaluate, defend and possibly modify the choice of the single eddy diffusivity constant used for the wide variety of simulations undertaken. This will be particularly important with respect to the effect of changing grid scales. Further, empirical evaluation of the eddy diffusivity constant should be considered such as through buoy deployment, dye or particle releases.
- There is a need for multiple year data products from the ocean modeling to extend the simulations to other years and build links to the physical oceanographic community to ensure timely delivery and interpretation of flow field data.
- Since it is unlikely that the geostrophic flow fields and the regional ocean circulation models adequately resolve shallow coastal water flow fields where the spawning production is assumed to occur, there is a need to couple higher resolution models.
- A sensitivity analysis should be conducted to evaluate the influence of the assumptions associated with the imposed coastal boundary conditions.
- Maintaining flexibility in the Lagrangian particle-tracking component of the simulation model to accommodate a variety of new or future flow field inputs is viewed as an important consideration.
- The value of time series data from the Altimeter has warranted its continual use in the absence of comparable (but higher resolution) data from circulation models. One driver limiting access to long time series data output from ocean circulation models such as NLOM long term data storage requirements that the modeling group (e.g. Navy) may not be prepared to maintain. Therefore, it may be possible to request a time series of runs with the understanding that the data will be downloaded in short order such that long-term storage is shifted to the user (in this case, DK and PIFSC). Requesting this from the NAVY or HYCOM will require that adequate storage capacity be available to the PIFSC Connectivity Program.
- Discussion of plans to add a horizontal orientation and late-stage swimming capacity to the biological portion of the model seems a little premature. Without adequate experimental evidence to the contrary, the orientation/sensory envelope side of the equation is still highly speculative. Though potential relevant, this seems like a low priority in model development effort beyond some simple black box estimates (e.g. expand sensory envelopes) to examine potential impact (sensitivity) analyses.
- With the potential to utilize NLOM and NCOM, it is worth refining the biological model and parameterization of lobster life history to obtain a better estimate of lobster PLD, ontogenetic vertical distribution, and perhaps an expanded sensory envelope. Comparative experimental evidence may be available on the Hawaiian or closely related species.

ii) Output/validation of simulation models

- Validation of the simulation results is presently hampered by the non-specific profile of the model organism. There is an obvious need to develop species-specific scenarios for validation purposes.
- The data derived from historical ichthyoplankton surveys around the Hawaiian archipelago may provide one way of evaluating the model output and should be explored.
- There is a need to initiate and maintain fishery-independent surveys to assess larval and/or juvenile abundances for assessment of the correspondence between simulation results and empirical observations. In addition, testing could be achieved through model-directed sampling of predicted densities or distributions.
- Model validation can also be achieved through studies that characterize population structures, including direct and indirect tagging studies (e.g. genetic markers, otolith micro-chemistry, isotopes, conventional tags).
- Efforts to validate outputs of the physical models should be restricted to those aspects dealing with the choice of diffusivity constants. Aspects beyond this sort of validation should be deferred to the originators of the ocean circulation models.

iii) Cross-cutting

- It is anticipated that in the near future the larval connectivity research program will reach a stage of development where a wide variety of potential applications will exist, including a redefinition of the spatial scale of fishery management units, a first-order description of the metapopulation structure for economically and ecologically key species, and in the evaluation and future citing of marine protected areas. The future, potential collective impact of this research program warrants ranking it as a key contributor to the resolution of the high priority major conservation and management issues within the PIFSC.
- The anticipated, positive developments within the larval connectivity research program will require a commitment to the timely production of reports and publications to be vetted within the local as well as broader scientific community.
- Effort should be expended to develop a web interface to provide information on the connectivity data products for the Hawaiian Island archipelago. A potential framework for such a development is the CSIRO connectivity interface.
- It is anticipated that improvements to the modeling as recommended will strain existing resources, in terms of personnel and computing hardware. Steps should be taken to ensure that this is not a limitation to the execution of future applications.
- The Connectivity work is transitioning from that of examining ‘potential’ dispersal and population consequences to one of predicting realized (even species-specific) dispersal. This shift in focus is associated with access to finer resolution ocean circulation models. Concomitant with such highly resolved ocean circulation models is a need for more detailed biological parameterization in models. Here DK may transition from developing the physical flow field (using Altimetry data) to utilizing output from the circulation models. At this

transition point, DK can step back from the physics (allowing the ocean circulation modelers to deal with model validation, etc.) and focus on the biological component. Here, the choice is to fully develop his own 'biological' model or, alternatively, to seek out an existing model to apply to his system. In the former case, DK maintains control over what attributes are modeled – presumably choosing those that are most relevant to the Hawaiian Archipelagic system; in the latter, time is freed up for application. Comparative analyses are an additional attractor to utilizing an existing biological model – as a focus can be placed on model outputs knowing that differences are not simply due to separate model assumptions.

- During the course of panel discussions, several names were suggested as possible contacts for information and/or advice on specific issues. These are listed here with contact information:
    - Dr. Eric Chassignet – FSU – HYCOM (chassignet@ocean.fsu.edu)
    - Dr. Iliana Baums – Penn State – coral genetics/connectivity – (ibb3@psu.edu)
    - Mr. Johnathan Kool – UM/RSMAS – modeling genetic connectivity – (jkool@rsmas.miami.edu)
    - Dr. Claire Paris – UM/RSMAS – Biological connectivity model (BOLTS) – (cparis@rsmas.miami.edu)
    - Dr. Mark Butler – ODU – spiny lobster ELH information (mbutler@odu.edu)
    - Dr. Gary Hitchcock (and Bill Arnold) – diffusivity coefficients – (ghitchcock@Rsmas.miami.edu) -- see also:
        - Hitchcock GL, et al. 2008. Short-term dispersal of an intentionally-released patch of larval *Mercenaria* spp. in the Indian River Lagoon, Florida, USA. Bull Mar. Sci. 82:41-57.
- Some clarification of terminology use was suggested. For example, it is recommended that the term larval 'subsidy' be utilized instead of larval 'reception' when referring to larvae that arrive at a particular site that originated elsewhere (as opposed to larval retention). Similarly, the use of the term 'sink' has very specific connotations, e.g. defined as a 'population in which the net import of individuals is greater than the net export of individuals', thereby referring to an explicit difference in import vs. export. Thus, when referring to the receiving sites (vs. source) in a matrix, perhaps using 'settlement location' or 'receiving location' would be better.

VI. Reviewer Statement

The Peer Review Consensus Summary report is an accurate and concise summary of this independent reviewer's perspective of the issues covered. The two review panelists shared similar viewpoints on most issues, the primary differences really only being on the reviewers' different perspectives due to the unique systems each work within (e.g. high vs. low latitude). Consequently no significant differences occurred.

The review panel and IFPSC participant list was surprisingly small. While this did allow for extensive discussion with the key player in the Connectivity program, I cannot help but feel that greater participation by other personnel within and outside the EOD would have provided an opportunity for the review panel to better assess existing and potential linkages and opportunities within and between

the various Divisions within the PIFSC pertaining to the Connectivity program. This is not really intended as a criticism, but merely consideration for future reviews.

The review agenda was manageable and the presentation prepared by DK was thorough and well organized allowing the review panel to address specific issues throughout the review, while maintaining a logical temporal (historical) perspective of the development of the connectivity program at the PIFSC. The review venue was also suitable to the review effort.

Appendix 1: Review Materials:

Primary Materials:

1. Polovina, J.J., P. Kleiber, and D.R. Kobayashi. 1999. Application of TOPEX-POSEIDON satellite altimetry to simulate transport dynamics of larvae of spiny lobster, *Panulirus marginatus*, in the Northwestern Hawaiian Islands, 1993–1996. Fish. Bull. 97:132–143.
2. Kobayashi, D.R., and J.J. Polovina. 2006. Simulated seasonal and interannual variability in larval transport and oceanography in the northwestern Hawaiian Islands using satellite remotely sensed data and computer modeling. Atoll Research Bulletin 543: 365-390.
3. Kobayashi, D.R. 2006. Colonization of the Hawaiian Archipelago via Johnston Atoll: a characterization of oceanographic transport corridors for pelagic larvae using computer simulation. Coral Reefs 25: 407- 417.
4. Kobayashi, D.R. In review. Larval retention versus larval reception: Marine connectivity patterns within and around the Hawaiian Archipelago. Marine Ecology Progress Series.
5. Kobayashi, D.R. In review. Natal retention mediated by diel vertical migration: Larval transport modeling in the Hawaiian Archipelago with layered current fields. Pacific Science.

Ancillary Materials:

6. Power Point Presentation: "Regional model evaluation of circulation of the Hawaiian Islands" by Sachiko Yoshida et al., IPRC, UH.
7. Robert C. Rhodes, Harley E. Hurlburt, Alan J. Wallcraft, Charlie N. Barron, Paul J. Martin, E. Joseph Metzger, Jay F. Shriver, Dong S. Ko Ole Martin Smedstad. Scott L. Cross, A. Birol Kara. 2002. Navy Real-time Global Modeling Systems. Oceanography 15(1):29-43.
8. Condie, S.A., J. Waring, J.V. Mansbridge, M.L. Cahill. 2005. Marine connectivity patterns around the Australian continent. Envir. Modeling and Software, 20:1149-1157.
9. Kobayashi, D.R., H.Y. Okamoto, F.G. Oishi. Manuscript. Movement of the deepwater snapper opakapaka, *Pristipomoides filamentosus*, in Hawaii: Insights from a large-scale tagging program and computer simulation
10. Kobayashi, D.R., J.J. Polovina, D.M. Parker, N. Kamezaki, I-J. Cheng, I. Uchida, P.H. Dutton, G.H. Balazs. 2008. Pelagic habitat characterization of loggerhead sea turtles, Caretta caretta, in the North Pacific Ocean (1997–2006): Insights from satellite tag tracking and remotely sensed data. JEMBE 356:96–114.
11. Ongoing and future connectivity work at PIFSC (May 1, 2008)
12. Curriculum Vitae - DONALD RIKIO KOBAYASHI
13. Computer simulated, 'behavior animations', 100 particles released at each depth strata on January 1, 2007 for 180 day PLD. Oriented sustained swimming towards nearest land mass at 6 specified swimming speeds.
14. Final Panel Report - Bottomfish Stock Assessment Workshop, January 13-16, 2004, Western Pacific Fishery Management Council
15. Amendment 14 to the Fishery Management Plan for the Bottomfish and Seamount Groundfish Fisheries o the Western Pacific Region. Dec 19, 2007
16. Interim Final Report - Coral reef Fish Stock Assessment Workshop, Feb. 10-13, 2004.
17. DiNardo, G.T. and R. Marshall. 2001. Status of lobster stocks in the northwestern Hawaiian Islands, 1998-2000

Appendix 2 –Statement of Work for Dr. Robert Cowen

External Independent Peer Review by the Center for Independent Experts

Modeling Larval Transport and Connectivity in Hawaiian Waters

Panel Review Meeting, 19-22 May 2008, Honolulu, Hawaii

Overview:

Computer simulation modeling has been undertaken at the Pacific Islands Fisheries Science Center to address insular species issues of metapopulation connectivity and larval transport in the Hawaiian Archipelago. These approaches utilize a variety of remotely-sensed and modeled oceanographic data in a Lagrangian modeling framework. These activities have taken place within the Ecosystems and Oceanography Division at the Science Center (Project Leader: Fishery Biologist Donald R. Kobayashi).

The review workshop provides an independent peer review of these modeling approaches. The review panel will be composed of two Center for Independent Experts (CIE) appointed reviewers. Other PIFSC, PIRO, Council, or UH staff may attend the review panel meeting as observers or participants.

Overview of CIE Peer Review Process:

The Office of Science and Technology implements measures to strengthen the National Marine Fisheries Service's (NMFS) Science Quality Assurance Program (SQAP) to ensure the best available high quality science for fisheries management. For this reason, the NMFS Office of Science and Technology coordinates and manages a contract for obtaining external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of stock assessments and various scientific research projects. The primary objective of the CIE peer review is to provide an impartial review, evaluation, and recommendations in accordance to the Statement of Work (SoW), including the Terms of Reference (ToR) herein, to ensure the best available science is utilized for the National Marine Fisheries Service management decisions.

The NMFS Office of Science and Technology serves as the liaison with the NMFS Project Contact to establish the SoW which includes the expertise requirements, ToR, statement of tasks for the CIE reviewers, and description of deliverable milestones with dates. The CIE, comprised of a Coordination Team and Steering Committee, reviews the SoW to ensure it meets the CIE standards and selects the most qualified CIE reviewers according to the expertise requirements in the SoW. The CIE selection process also requires that CIE reviewers can conduct an impartial and unbiased peer review without the influence from government managers, the fishing industry, or any other interest group resulting in conflict of interest concerns. Each CIE reviewer is required by the CIE selection process to complete a Lack of Conflict of Interest Statement ensuring no advocacy or funding

concerns exist that may adversely affect the perception of impartiality of the CIE peer review. The CIE reviewers conduct the peer review, often participating as a member in a panel review or as a desk review, in accordance with the ToR producing a CIE independent peer review report as a deliverable. At times, the ToR may require a CIE reviewer to produce a CIE summary report. The Office of Science and Technology serves as the COTR for the CIE contract with the responsibilities to review and approve the deliverables for compliance with the SoW and ToR. When the deliverables are approved by the COTR, the Office of Science and Technology has the responsibility for the distribution of the CIE reports to the Project Contact.

CIE Reviewer Requirements:

The CIE shall provide two CIE reviewers to conduct independent peer reviews in accordance with the ToR and Schedule herein, and each CIE reviewer's duties shall not exceed a maximum of 14 days for pre-review preparations, conducting the peer review, and completion of the CIE independent peer review reports. The CIE reviewers shall have expertise in one or more of the following areas: larval transport processes, recruitment dynamics, physical oceanography, larval ecology, zooplankton ecology, coral reef ecology, biogeography, population dynamics, and fisheries oceanography to complete their primary task of conducting an impartial and independent CIE peer review report in accordance with the ToR to determine if the best available science is utilized in this research.

Statement of Tasks for CIE Reviewers:

Roles and responsibilities:

1. Approximately 3 weeks prior to the meeting, CIE reviewers shall be provided with supporting documents and review workshop instructions including terms of reference. CIE reviewers shall read these documents to gain an in-depth understanding of the transport modeling methodology, the oceanographic data utilized, and their responsibilities as reviewers.
2. During the review panel meeting, CIE reviewers shall participate in panel discussions and conduct an independent peer review on methods, data, validity, results, uncertainties, recommendations, and conclusions in accordance to the Terms of Reference (ToR). Each CIE reviewers shall conduct an independent peer review in accordance with the ToR and guidelines in Annex II. The CIE reviewers shall participate in development of a peer review consensus summary report, as described in Annex I.
3. Following the review panel meeting, reviewers shall work together to complete and review the peer review consensus summary report, as described in Annex I. This report shall be completed, reviewed by both panelists, and comments submitted to the Chair by June 5, 2008.
4. Following the review panel meeting, each reviewer appointed by the CIE shall prepare an individual CIE reviewer report. These reports shall be submitted to Mr. Manoj Shivlani, CIE Lead Coordinator, via email at shivlanim@bellsouth.net, and to Dr. David Die, CIE Regional Coordinator, via email at ddie@rsmas.miami.edu no later than June 12, 2008. See Annex II for complete details on the report outline.

The duties of each review panelist shall not exceed a maximum of 14 workdays; several days prior to the meeting for document review; four days at the review panel meeting; and several days following the meeting to complete the independent peer review in accordance with the ToR, and to assist the review panel Chair with the development of the summary report.

The CIE reviewers shall conduct necessary preparations prior to the peer review, conduct the peer review, and complete the deliverables in accordance with the ToR and deliverable dates herein.

Prior to the Peer Review: The CIE shall provide the CIE reviewers contact information (name, affiliation, address, email, and phone) to the Office of Science and Technology COTR no later than the date as specified in the SoW, and the COTR will forward this information to the Project Contact.

Foreign National Clearance: The CIE shall provide the necessary information (e.g., name, birth date, passport, travel dates, country of origin) for each CIE reviewer to the COTR who will forward this information to the Project Contact. The Project Contact is responsible for the completion and submission of required Foreign National Clearance forms with sufficient lead-time (30 days) in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations at the Deemed Exports NAO link http://deemedexports.noaa.gov/sponsor.html

Pre-review Documents: Approximately three weeks before the peer review, the Project Contact will send the CIE reviewers the necessary documents for the peer review, including supplementary documents for background information. The CIE reviewers shall read the pre-review documents in preparation for the peer review. This list of pre-review documents may be updated prior to the panel review meeting. Meeting materials will be forwarded electronically to review panel participants and made available through the internet (http://www.hawaiieod.com/CIE/); printed copies of any documents are available by request. The names of reviewers will be included in workshop briefing materials.

Panel Peer Review Meeting: The CIE reviewers shall participate and conduct the peer review panel meeting as specified in the dates and location of the attached Agenda and Schedule.

The review workshop will take place at the Hawaii Imin International Conference Center, University of Hawaii East-West Center, Honolulu, Hawaii, from 8:30 a.m. Monday, May 19, 2008 through 4:30 p.m. Thursday, May 22, 2008. The Project Contact is responsible for the facility arrangements.

Please contact Donald Kobayashi (PIFSC Research Fishery Biologist; (808) 983-5394, Donald.Kobayashi@noaa.gov) for additional details.

Review Workshop Panel Tasks:

The review workshop panel will evaluate modeling of larval transport and connectivity in the Hawaiian Archipelago conducted by the PIFSC. Before the evaluation the panel will review the provided documents and any supporting material. During the evaluation the panel will consider the data, methods, and results of the material presented. The evaluation will be guided by terms of reference that are specified in advance. A summary report as described in Annex I will be prepared by

the Chair with input from the review workshop panel. The individual reviewers on the panel will document their findings in separate CIE reviewer reports produced as described in Annex II to provide distinct, independent analyses of the technical issues and scientific merit.

Terms of Reference for CIE Peer Review:

The CIE reviewers shall conduct a peer review of the pre-meeting documents specified above, participate during the panel review meeting, and complete their CIE reports according to the Terms of Reference herein;

1. Evaluate whether the adequacy, appropriateness, and application of data used in the analyses represents the best available science?
2. Evaluate whether the adequacy, appropriateness, and application of analytical methods and modeling represents the best available science?
3. Do the biological data, population data, model structure and assumptions, and the analysis methods applied to archipelagic connectivity represent the best available data and methodology for sound science?

Each CIE reviewer shall evaluate and indicate as to whether the presented models, analysis and conclusions are the best available science at this time. The CIE reviewers shall not provide specific management advice. If the panel rejects the models or any components, analysis, results or conclusions, the panel should explain the rejection and provide recommendation for suitable alternatives. According to the schedule outlined below, two CIE reviewers shall submit independent peer review reports in accordance with the ToR and schedule herein, and assist as the panel review Chair in the development of a summary report.

Request for Changes:

Requests for changes shall be submitted to the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the Contractor within 10 working days after receipt of all required information of the decision on substitutions. The contract will be modified to reflect any approved changes. The Terms of Reference (ToR) and list of pre-review documents herein may be updated without contract modification as long as the role and ability of the CIE reviewers to complete the SoW deliverable in accordance with the ToR are not adversely impacted.

Submission and Acceptance of CIE Reports:

Upon review and acceptance of the CIE reports by the CIE Coordination and Steering Committees, CIE shall send via e-mail the final independent CIE reports to the COTRs (William Michaels William.Michaels@noaa.gov and Stephen K. Brown Stephen.K.Brown@noaa.gov) at the NMFS

Office of Science and Technology by the date in the Schedule of Deliverables. The COTRs will review the CIE reports to ensure compliance with the SoW and ToR herein, and have the responsibility of approval and acceptance of the deliverables. Upon notification of acceptance, CIE shall send via e-mail the final CIE report in *.PDF format to the COTRs. The COTRs at the Office of Science and Technology have the responsibility for the distribution of the final CIE reports to the Project Contacts.

The COTR shall provide the final CIE reviewer reports to:

PIFSC Director: Dr. Samuel Pooley, NMFS Pacific Islands Fisheries Science Center, 2570 Dole Street, Honolulu, HI 96822 (Samuel.Pooley@noaa.gov)

Schedule:

April 2, 2008:	CIE shall provide COTR contact information for the selected CIE reviewers, and the COTR will forward this to the Project Contact who is responsible for the Foreign National Clearance during the CIE reviewers participation on the panel review meeting.
April 28, 2008:	Pre-meeting documents provided to CIE technical reviewers
May 19-22, 2008:	CIE technical reviewers participate in panel review workshop in Honolulu, HI
May 22, 2008:	CIE technical review panel completes first draft of review panel consensus report (conclusion of review workshop)
June 5, 2008:	CIE technical review panel submits final draft review panel consensus report to workshop Chair.
June 12, 2008:	CIE technical reviewers submit individual reviewer reports to CIE.
June 26, 2008:	CIE submits final versions of review panel consensus report and all reviewer reports to the COTR
July 10, 2008:	COTR provides final CIE reviewer reports to PIFSC Director

Key Personnel:

Contracting Officer's Technical Representative (COTR):

William Michaels
NMFS Office of Science and Technology
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910
William.Michaels@noaa.gov Phone: 301-713-2363 ext 136

Stephen K. Brown
NMFS Office of Science and Technology
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910
Stephen.K.Brown@noaa.gov Phone: 301-713-2363 ext 133

Contractor Contacts:

Manoj Shivlani, CIE Primary Coordinator
10600 SW 131st Court, Miami, FL 33186
shivlanim@bellsouth.net Phone: 305-383-4229

Project Contact:

Donald Kobayashi
NMFS Pacific Islands Fisheries Science Center, 2570 Dole Street, Honolulu, HI 96822, USA
Donald.Kobayashi@noaa.gov Phone 808-983-5394

Draft Agenda

Modeling Larval Transport and Connectivity in Hawaiian Waters

May 19 – May 22, 2008

Monday

8:30 a.m.	**Convene**	
8:30 – 9:00 a.m.	**Introductions and Opening Remarks** *- Agenda Review, TOR, Task Assignments*	**Coordinator**
9:00 a.m. – 10:00 a.m.	**Presentations** *- TBD*	**Chair**
10:00 a.m. – 10:30 a.m.	**Break**	
10:30 a.m. – 11:30 a.m.	**Presentations** *- TBD*	
11:30 a.m. – 1:30 p.m.	**Lunch Break**	
1:30 p.m. – 2:30 p.m.	**Panel Discussion** *- Data & Methods* *- Identify additional analyses, sensitivities, corrections*	**TBD**
2:30 p.m. – 3:00 p.m.	**Break**	
3:00 p.m. – 4:30 p.m.	**Panel Discussion** *- Continue deliberations* *- Review additional analyses*	**Chair**

***Monday Goals*:** Initial presentations completed, sensitivities and modifications identified.

Tuesday

8:30 a.m. – 10:00 a.m.	**Presentations** *- TBD*	**Chair**
10:00 a.m. – 10:30 a.m.	**Break**	
10:30 a.m. – 11:30 a.m.	**Presentations** *- TBD*	
11:30 a.m. – 1:30 p.m.	**Lunch Break**	
1:30 p.m. – 2:30 p.m.	**Panel Discussion** *- Review additional analyses* *- Consensus recommendations and comments*	**Chair**
2:30 p.m. – 3:00 p.m.	**Break**	
3:00 p.m. – 4:30 p.m.	**Panel Discussion** *- Continue deliberations*	**Chair**

Tuesday Goals: Presentations completed, final sensitivities identified, consensus report drafts begun

Wednesday

8:30 a.m. – 11:30 a.m.	**Panel Discussion** *- TBD*	**Chair**
11:30 a.m. – 1:30 p.m.	**Lunch Break**	
1:30 p.m. – 2:30 p.m.	**Panel Discussion or Work Session** *- TBD*	**Chair**
2:30 p.m. - 3:00 p.m.	**Break**	
3:00 p.m. - 4:30 p.m.	**Panel Discussion** *- Independent peer review*	**Chair**

Wednesday Goals: Complete work and discussions. Final results available. Draft Consensus Report reviewed.

Thursday

8:30 a.m. – 11:30 p.m.	**Panel Discussion or Work Session** - *Draft summary report* - *TBD*	**Chair**
11:30 a.m. – 1:30 p.m.	**Lunch Break**	
1:30 p.m. – 2:30 p.m.	**Panel Discussion or Work Session** - *Draft summary report* - *TBD*	**Chair**
4:30 p.m.	**ADJOURN**	

Thursday Goals: Completion of bulk of report writing.

Annex I. Review Panel Summary Report Contents

I. Executive Summary

An abstract of the summary peer review report.

II. Terms of Reference

List each Term of Reference, and include a concise summary from the panel review discussions and independent CIE reports indicating whether or not the criteria in each element of the Term of Reference are satisfied.

III. Further Analyses and Evaluations

Summary of analytical requests not previously addressed in TOR discussion above.

IV. Additional Comments

Provide a summary of any additional discussions not captured in the Terms of Reference statements.

V. Recommendations

Provide a summary statement as to how to improve upon using the best available science in regard to each of the Term of Reference criteria.

VI. Chair Statement

Provide a statement attesting whether or not the contents of the Summary Peer Review Report provide an accurate and concise summary of the panel review discussions and independent reviewer's views on the issues covered. Chair may also make any additional individual comments or suggestions desired.

CIE reviewers shall assist the panel review Chair will the development of a Summary Report

ANNEX II: Contents of CIE Independent Peer Review Report

I. Executive Summary

An abstract of the peer review report.

II. Terms of Reference

List each Term of Reference(ToR), and include a concise summary indicating whether or not the criteria in each element of the Term of Reference are satisfied.

III. Further Analyses and Evaluations

Summary of analytical requests not previously addressed in ToR discussion above.

IV. Additional Comments

Provide a summary of any additional issues not captured in the Terms of Reference statements.

V. Recommendations

Provide a summary statement as to how to improve upon using the best available science in regard to each of the Term of Reference criteria.

VI. Reviewer Statement

Provide a statement attesting whether or not the contents of the Peer Review Report provide an accurate and concise summary of the independent reviewer's view on the issues covered. Reviewer may also make any additional individual comments or suggestions desired.

- Individual reviewers shall elaborate on any points raised in the Consensus Summary Report as described in Annex I that they feel might require further clarification. Reviewers shall provide a critique of the review process including suggestions for improvements of both process and products. The CIE reviewers shall provide an independent peer review in their reports in accordance to the ToR, which is a separate responsibility from their contribution to the consensus summary report.

- Each CIE reviewer report shall include as separate appendices a copy of the CIE Statement of Work and a bibliography that includes all materials provided for review.