Background and PIFSC Response:
Panel Reports of the Ecosystem Science Program Review
April 4-8, 2016
Honolulu, Hawaii

The following provides an overview of the objectives of the Pacific Islands Fisheries Science Center (PIFSC) 2016 program review, summary of reviewer remarks and the PIFSC response to the review panel's reports. The terms of references, background materials, presentations and the panelists' reports are provided on our webpage at:

http://www.pifsc.noaa.gov/peer_reviews/program_review_of_ecosystem_sciences_2016/index.php

Program Review: NOAA Fisheries constantly strives to improve the quality and timeliness of our science at each of the agency's six science centers and the headquarters Office of Science and Technology. A standardized five-year cycle of peer review and evaluation of our fundamental science programs at both the national and regional level help us to stay at the cutting edge of science and still meet the needs of our stakeholders. Each year of the cycle has a specific thematic focus. In 2016, the focus shifted to ecosystem science research that is conducted pursuant to the Magnuson-Stevens Fishery Conservation and Management Act, Endangered Species Act, Marine Mammal Protection Act, Coral Reef Conservation Act, and related executive orders. For the purposes of this review ecosystem science programs are defined as: those elucidating ecological, oceanographic, climate, and habitat-related processes as they are linked to living marine resource (LMR) species. Socioeconomics was outside of the scope of this review.

Panel: The PIFSC program review was held on April 4-8, 2015 in Honolulu, Hawaii. The review panelists were respected members of the scientific community from across the country:

- Chair: Dr. Jo-Ann Leong (External Scientist - Hawai'i Institute of Marine Biology)
- Dr. Michael Fogarty (NOAA Fisheries Scientist - Northeast Fisheries Science Center)
- Dr. Cisco Werner (Science Center Director - Southwest Fisheries Science Center)
- Dr. Chris Kelble (NOAA Scientist - Atlantic Oceanographic & Meteorological Lab)
- Dr. Anne Cohen (External Scientist - Woods Hole Oceanographic Institution)
- Dr. Jeff Drazen (External Scientist - University of Hawai'i)

Themes and Overarching Questions for Reviewers: The review was intended to address nine specific overarching questions in the context of five general ecosystem themes. The five general ecosystem themes were:

1. Ecosystem-related science activities and regional management needs including strategic planning and prioritization
2. Collection of and access to ecosystem - related data
3. Advances in ecosystem level analyses and modeling
4. Integration of ecosystem - related information into management

5. Communication of research results and resource needs, peer review.

The **nine overarching questions** and the *general findings* from the panel chair's summary report were:

1. **Does PIFSC have clear goals and objectives for an ecosystem-related science program? Is ecosystem-related science integrated with the other science activities across Divisions within the PIFSC? Are PIFSC's ecosystem science and research activities appropriately prioritized and evaluated as part of an overall strategic plan?**

   The panel was provided the PIFSC Science Plan (SP) for 2013 and the PIFSC Priorities and Annual Planning Guidance for 2016. Since the SP was written before the creation of the Ecosystem Sciences Division, it does not fully reflect the changes that took place with the reorganization. The Annual Planning Guidance 2016 document does highlight a priority to improve the integration of both environmental data and ecosystem models into fishery and protected species research programs. To support this research priority, Ecosystem Sciences has listed in order of rank the need to project climate impacts on ecosystems, to develop ecosystem indicators for federal and state resource managers, to conducted Integrated Ecosystem Assessments (IEA), to develop ecosystem models for key ecosystems, to monitor and document historical ecosystem changes, to conduct foraging ecology surveys and research, and to develop methods to investigate ecological connectivity across and between archipelagos. For Coral Reef Activities, the first priority was to continue to conduct reef assessment and monitoring surveys. In order of rank, they also listed the need to "identify, characterize, and rank priority areas for protection within each jurisdiction, including: 1. spawning sites, nursery habitats, or other areas critical to particular life-history states; 2. Biodiversity hotspots; 3. Areas with greatest resilience or potential for restoring resilience; and 4. Areas facing the greatest threats." Third on their list of activities was "increase effort and observations (such as life history information) useful for providing science support to NMFS management responsibilities related to reef fisheries, to coral reef monitoring in the Pacific." The list continues and makes clear that Ecosystem Science research goals and objectives are clear, are designed to reach across divisions, and PIFSC in in the process of implementing these research efforts.

2. **Does PIFSC's ecosystem-related science programs focus on information to address the priority needs of the Regional Offices, other NOAA managers, Fishery Management Councils and Commissions, and other partners that require ecosystem-related information to achieve their mission?**

   There will always be some tension in the science programs of PIFSC and the needs of PIRO and WPRFMC because of differences in responsibilities under their legislative mandates. Nevertheless, the ESD team does collaborate with the regional office on a number of different efforts, e.g. the Coral ESA listing, and the provision of monitoring

data for Guam and American Samoa. Although PIFSC does not have a formal seat on the WPRFMC, two PIFSC ESD scientists do sit on the Scientific and Statistical Committee of the WPRFMC.

3. **Has PIFSC appropriately established a Regional Action Plan to identify the major climate threats to the ecosystem, identify major vulnerabilities of living marine resources with respect to climate, address the core science needs to address impacts from a changing climate, and integrate this information into management advice, congruent with the NOAA Fisheries Climate Science Strategy?**

   Jeffrey Polovina, Director of the EOP, has assembled a Pacific Islands Region drafting team consisting of 16 people drawn from PIFSC, PIRO, and WPFMC. The first draft of this plan was completed in February 2016 and the first draft of this plan is under review. The plan is designed to be congruent with the NOAA Fisheries Climate Science Strategy and it specifically reviews ongoing climate work; identifies priorities for climate information; and sets out a plan for future work over the next 5 years. The final version is due October 1, 2016.

4. **What is the status of oceanographic, habitat, climate and ecological data required to fulfill ecosystem-related science needs? Has PIFSC developed strategies to obtain and manage such data?**

   There is a wealth of valuable ecosystem data that has been collected and compiled over the last 15 or so years. The current data archival needs are massive and it is still unclear that PIFSC data management capability is able to provide the core function for this activity. The Center is also in the process of adopting the NOAA Plan for Increasing Public Access to Research Results.

5. **Is PIFSC appropriately analyzing and modeling ecosystem-level processes? Are cumulative and integrative ecosystem-level analyses being conducted? If not, is there a plan in place to initiate or contribute to the science needed to address cumulative impacts?**

   The ESD does conduct long term monitoring of ecosystems for coral reefs and with a wealth of data available for analysis needs to develop its ecosystem modeling capabilities and embed those capabilities as a core function of ESD. The ESD is barely a year old and its reorganization to conduct the cumulative and integrative ecosystem-level analyses is under development. This need was recognized by the panel and by PIFSC leadership.

6. **Is PIFSC's oceanographic, habitat, climate and ecological advice sufficiently included into living marine resource management advice? Are there suitable mechanisms to determine when such inclusion is warranted?**

   EOP has developed ecosystem models for living marine resource management; the panel did point out the need to engage the regulatory and management agencies to include the information from these models in their assessments and resource management policies. The panel has recommended more frequent meetings between PIFSC, PIRO, and WPRFMC leadership and the development of a joint annual guidance document that considers the science and the regulatory agendas and priorities.

7. **Are PIFSC 's ecosystem-related science programs and products adequately peer-reviewed relative to their purpose and use? If not, has PIFSC developed a strategy for peer-review?**

   The panel review unanimously applauded the productivity of ESD in terms of the timeliness and quality of their publications in peer-reviewed journals.

8. **Does PIFSC appropriately communicate research results and resource needs to conduct ecosystem-related science to various managers, partners, stakeholders and the public?**

   The panel pointed out the products such as Ocean Watch and Turtle Watch as examples of communicating research to managers, partners, stakeholders, and the public. The panel did note that the restriction on travel to scientific meetings has been a major obstacle to dissemination of the research results and resource needs.

9. **A new Ecosystem Science Division was created a year ago and it now includes the former Coral Reef Ecosystem Program, the Ecosystems and Oceanography Program, and the Socioeconomics Program. The PIFSC Director asked the panel to provide comments on how this program should be configured.**

   This is addressed amply in the summary, the recurrent observations, and recommendations in review panel reports.

Panel Observations and Recommendations: Although the panel brought differing perspectives and expertise, there were recurrent observations and recommendations from the review. Below are all of those recurring findings numbered 1-18 below, with selected text from the Chair's report in italics and any supporting text from individual panelists recommendations marked with a, b, c, etc. The PIFSC response to each recommendation immediately follows and are noted by roman numerals i, ii, iii etc.. Recommendations that could involve a PIFSC specific action are listed in a table following the list of 1-18 recurring findings, with the PIFSC response detailed as well as a likely date of implementation.

1. *With the reorganization of the Ecosystem Sciences Division (ESD) at PIFSC, there is an opportunity to create greater synergies among the ecosystem scientists in oceanography, coral reefs, and socioeconomics. How that will be brought about was the subject of much discussion by the panel members. It was clear that stronger integration is needed. The restructuring of ESD at some level was recommended by all panel members. The intent of this recommendation is to create synergies for complementary activities and reduce duplications. The most common activity/function selected for a core team was ecosystem and climate modeling. Other suggested core teams included field operations and monitoring (ecosystem observations), indicator development and assessment, and a lab-based genetics-analytical team.*

    a. For historical reasons, research, monitoring and modeling activities are conducted by staff in both teams (Ecosystem and Oceanography Program and Coral Reef Ecosystem Program), each with their own lead, and for the most part, functioning independently. Yet it appears from a reviewer's perspective that enhanced integration and stronger collaboration on all aspects of ecosystem-level research, monitoring, and modeling, in addition to the development of embedded capacity in certain areas (specifically climate and ecosystem modeling and experimental capabilities) might better serve PIFSC's objectives, build on existing strengths and reduce duplicity of effort.
    b. One way to achieve a more effective and fluid integration might be to do away with separate programs altogether and establish teams based on activities - a laboratory-based experiments/genetics/analytical team, a field operations monitoring team, a climate and ecosystem modeling team - rather than ecosystems (coral reef vs pelagic).
    c. Another possibility is to place scientists across coral reefs, pelagics, and socioeconomics in similar disciplinary units, or physically co-locating, to encourage them to work together.
    d. Given the broad ramifications (and opportunities) related to the establishment of ESD, it is time to update the PIFSC Science Plan to reflect the new organizational structure at PIFSC.

        i. We agree that further integrating the programs and/or staff that comprise ESD will result in improved synergies and efficiencies. How we do this will be the focus of considerable thought and discussion going forward. The

panelists offered several useful suggestions on how ESD might be organized that can serve as a starting point in this process. There are already numerous recent examples of increased collaboration between the different Programs of ESD, especially regarding ecosystem modeling, development of indicators within the West Hawaii IEA, joint development of the Regional Climate Action Plan, and a collaborative effort to begin monitoring meroplankton that can be replicated and build upon to expand collaboration and integration of efforts.

2. *The mismatch between science needs of PIRO and WPRFMC and those of PIFSC is due in part to their responsibilities under different mandates. Despite this, leadership should meet regularly and perhaps, develop and publish a joint Annual Guidance Document that considers the science and regulatory agendas and priorities.*

    a. Regarding the apparent discrepancy between the needs of PIRO and the activities of PIFSC, these differences are not easily reconciled and may need a division of the science labor between short term, local specific projects, and longer term, ecosystem level projects.
    b. There also appears to be a need for a more systematic and collaborative way to share data between PIFSC and PIRO as the current system is not working as well as intended.
    c. PIFSC could also provide site specific information required by managers to evaluate management decisions and future regulatory options. If monitored on an annual basis these sites would provide high frequency sampling (see recommendation regarding sentinel sites) to augment the lower frequency sampling across the rest of the islands. With appropriate designs (e.g. BACI) more spatially focused study would provide time series data to robustly separate the effects of fishing or development from climate change (as is the case in the West Maui study).
    d. Development and publication of a joint (PIFSC and PIRO) Annual Guidance Document that considers the science and the regulatory agendas and priorities.
    e. Both the PIRO and the WPRFMC identified as the biggest need and challenge, the ability to predict effects of climate change on marine ecosystems and species and building climate variability and trends into production projections.

        We agree that there are some inherent mismatches in both time and space scales, particularly with regards to PIRO's short-term needs to address Section 7 essential fish habitat (EFH) consultations. Since the review, PIFSC and PIRO Leadership have discussed and agreed to meet at least annually to jointly assess and identify the regional ecosystem priorities, particularly with regards to coral reefs research and monitoring. These meetings will go a long way to identify assignment of resources to meet the regional priorities. We do think it is important to continue on-going proactive research and monitoring across the entirety of the Pacific Islands

Region to support future management decisions that will require information on the status and trends of trust living marine resources and ecosystems and the various human and environmental drivers of change. So striking a balance of program activities to best address the broad scale monitoring and research and place-based needs is the goal going forward and PIFSC will internally review its priorities and programs to determine how this balance can be achieved.

3. *Integration and collaboration between the programs on ecosystem data management, ecosystem modeling, and socioeconomics for climate change and adaptation may help create those synergies and has the potential to reduce duplications and create greater program flexibility.*

    a. There would be real value in developing a well-defined Ocean and Ecosystem Observing Plan for the Center that brings the different monitoring programs at PIFSC under an integrated strategic design. This would of course encompass the Center as a whole and not ESD alone. The potential for capitalizing on economies of scale and more fully integrated monitoring programs designed to meet multiple objectives could pay important dividends. Migration of data to InPort should be continued and usage metrics should be kept so that the importance of PIFSC data products to the wider community can be evaluated. Further, such data tasks should be coordinated across divisions and led by centralized services such as ITS.
    b. A deliberate analysis strategy – to complement the field efforts – is essential as we strive to understand how changes in climate are affecting coral populations globally. Need to rapidly and efficiently analyze and interpret the data as it comes in to enable revision of the monitoring plan. Plans for data analysis should be explicitly included in the two Programs' and the Center's activities and thus better balance the time spent conducting field collection efforts and the time in analytical efforts.
    c. Improvements should focus on increasing efficiency of data processing and interpretation to support regular review and adjustment of the long-term science monitoring plan based on new information, and room for improved co-ordination between field data collection and modeling efforts. The lack of on-site analytical capabilities slows the turn-around time for sample processing.
    d. ESD should request additional funds for satellite data and continue to explore less expensive satellite data products to support benthic habitat mapping. ESD should begin exploring next generation sampling methods that could supplement their observations in their difficult to reach study regions. Perhaps a glider could be used to increase understanding of the TZCF or ASV, AUVs, and UAS could help increase RAMP sampling frequency.
    e. ESD should develop a comprehensive ecosystem observations plan that is their core observational ecosystems program for PIFSC. This should at a minimum include all ESD programs (EOP, CREP, and Socioeconomics). This comprehensive observations plan would ensure their data collection informs their

ecosystem research, is well designed for EBFM, and advances ecosystem science in key areas of need for PIFSC.

i. We agree that there are opportunities to increase collaboration and integration across the various Programs of ESD and with other Divisions of the Science Center. Since moving to IRC in 2014, there have already been significant increases in collaboration between EOP, CREP, and SEP that demonstrate a clear desire among staff for increased collaboration and integration as funding and other opportunities arise. There are numerous recent examples of increased collaboration between the different Programs of ESD, especially regarding ecosystem modeling, development of indicators within the West Hawaii IEA, joint development of the Regional Climate Action Plan, and a collaborative effort to begin monitoring meroplankton that can be replicated and build upon to expand collaboration and integration of efforts. The Center is currently in the process of developing a RoadMap process for soliciting input from staff and discussing and evaluating options for structuring ESD moving forward.

4. *The common challenge identified by PIFSC scientists was the temporary funding for projects in the Corals Program. There needs to be some assurance that long term monitoring programs will have stable funding. The need for long term stable funding for CREP was discussed by all panel members. It is time that this program ceases to view itself as a "soft money" program. It should be possible to stabilize CREP funding at a level that it currently receives through the Coral Reef Conservation Program. PIFSC leadership should work with CRCP and NOAA leadership to secure these funds on a longer term basis.*

a. The CREP is writing proposals every year to support many activities that rely on funds from outside of the agency which is inherently less stable, precludes long term planning and runs the risk of science objectives being dictated by shifting priorities.
b. As mentioned in the key findings there is a pressing need to explore a better mechanism for the funding received to support CREP. While this is "soft" money it comes from an internal NOAA process and remains fairly level. PIFSC should explore a mechanism where this money goes directly to the center at a set level about where the average has been and works with CRCP, resource managers, and PIFSC leadership to plan how this money should be used on a 3-year cycle. This will allow CREP to be better incorporated into PIFSC strategic planning and visioning.

i. We agree with the panel that it is important for the Center to discontinue thinking of CREP as a 'soft-money' Program and to work to institutionalize permanent funding for core activities within CREP, such as long-term assessment and monitoring, habitat mapping, ocean acidification and

climate change research, and research to support the Magnuson-Stevens Act and the Endangered Species Act for coral reef ecosystems.

5. *Several panel members pointed out the lack of ecosystem work on deeper water habitats. The ESD should expand its efforts on deep water habitats since characterizing this ecosystem is particularly relevant to bottom fish stock assessments, cetacean distribution (mesopelagic boundary layer communities), and deep water coral communities. This work might be more easily expanded at the NOAA sentinel site in West Hawai'i.*

    a. Deepwater bottomfish are an important resource in Hawaii and a priority listed for stock assessment in PIFSC 2016 Annual Planning Guidance document. Similar stocks are increasingly being exploited around the Pacific. In addition deep water corals and other organisms may become threatened by deep-sea mineral exploitation. Many seamounts within the US EEZ are within the prime Manganese crust zone. Mesophotic reefs may represent important habitat for reef species and/or partial refuges from fishing or climate change. The program leaders both expressed an interest and understanding that deeper work was necessary but there is little attention paid to these important systems in an ecosystem context.
    b. Information could be gathered from stock assessment activities, the developing fishery independent bottomfish surveys, past deep coral work by center staff, HURL and others as available. Deep water migratory organisms are likely a link between insular and offshore ecosystems and deep water corals blend the two programs taxonomic and habitat expertise. Therefore, synergistic efforts between EOP and CREP should be developed and strengthened.

        i. ESD does do ecosystem work on mesophotic corals, which was mentioned in the introduction but wasn't covered in a standalone presentation. We also have ongoing work to advance our understanding of the mesopelagic boundary foodweb that links insular cetaceans to the deep micronekton community. This work was briefly touched on in one of the presentations. Research on the deepwater bottomfish ecosystem as suggested by some panelists was a focus of research in the past using the submersible assets of the Hawaii Undersear Research Laboratory (HURL) and could be a fruitful area to pursue as part of our West Hawaii IEA research. Some limited ecosystem work continues on deep corals using the HURL submersibles and the NOAA *Okeanos Explorer* as they are sporatically available. In addition, we have been conducting deepwater benthic habitat mapping using multibeam and developing a bottomfish fisheries independent resource assessment survey through development and implementation of stereo-video baited Bottomfish Camera systems (BotCam) and the next generation camera system 'Modular Optical Underwater Survey System (MOUSS) (https://pifsc-

www.irc.noaa.gov/cruise/ha1601.php), Baited Remote Underwater Video Systems (BRUVS), and development and deployment of the SeaBED AUV terrain-following Autonomous Underwater Vehicle (AUV) with the Northwest Fisheries Science Center and the Deep Submergence Laboratory at Woods Hole Oceanographic Institution (WHOI). As these surveys become operational for assessment concerns, we expect to expand ecosystem studies involving deep bottomfish resources.

6. *Reviewers recommended that ESD engage in laboratory studies to verify some of the vital rates used in the ecosystem models currently under development.*

    a. Projecting production under climate change and local stressors requires knowledge of the sensitivity of organisms and communities of organisms to these stressors. While the academic science community is active in this arena, their experiments are often focused on model organisms which may not be keystone species for the regions of interest here, or have significant commercial value. There is clearly a need for on-site laboratory manipulation experimental capability to address the need for information on specific species and taxa prioritized for management.
    b. There is clearly a need for on-site laboratory manipulation experimental capability to address the need for information on specific species and taxa prioritized for management. PIFSC should consider developing laboratory work, e.g., exposure experiments, as part of their approaches to better quantify field measurements. OEP's expertise with various modeling approaches (from high-resolution regional connectivity models to basin/biome-scale biome models) offers the opportunity to offers the opportunity to identify laboratory work to improve upon intrinsic model parameters (e.g., vital/metabolic rates of organisms, behaviors, etc.). Field data/samples collected by CREP's efforts that if analyzed could provide a "gold mine" of field-based rate-observations to improve present model parameters.
    c. Need for rapid response capability to characterize environmental and ecosystem changes, to test hypotheses of organism and ecosystem sensitivity to climate change and to provide much needed model input data on these timescales.

        i. We agree that it would be useful to complement on-going comparative analyses-based field observations and monitoring with laboratory-based studies to verify vital rates and responses of different organisms, such as ESA-listed corals, to different stressors, such as warming, acidification, low/high nutrients, and/or contaminants. Some of this work is presently being conducted in partnership with colleagues at the Hawaii Institute of Marine Biology, but it would be helpful to establish capacity to expand these efforts locally at IRC. Prior to moving to IRC, we did not have adequate laboratory facilities. Now we have excellent facilities at IRC, but need and

are seeking additional resources to support experimental scientists and equipment/supplies for experimental work.

7. *Several reviewers recommended that EOP should strengthen their field work and include zooplankton sampling, mesopelagic boundary layer sampling, and connectivity analysis for deep water habitats.*

    a. There is significant data collection at all trophic levels, except for the base of the planktonic food web, specifically nutrients, phytoplankton and zooplankton; would recommend the addition of depth stratified zooplankton and phytoplankton sampling as part of the sample design (in West Hawaii in particular).
    b. Pelagic ecosystem work has largely utilized existing data sets which could be expanded and augmented by greater field data collection with the addition of an ecosystem ecologist.
    c. The lack and loss of lower trophic level data collection should be investigated and increased if it is found to be vital for understanding ecosystem interactions. These samples are often only expensive to analyze if you are infrequently analyzing a small number of samples for nutrients, phytoplankton, and/or zooplankton.
    d. Connectivity/dispersal models can infer connectivity independently and answer many questions about meta-population structure, MPA design etc. EOP has conducted some connectivity modeling with very interesting results. Managers acknowledge the importance of this area of research. For instance, the Council has listed connectivity as a priority area for ecosystem research in its latest planning document. However, only a single staff member has been involved in the use of dispersal/connectivity models.
    e. PIFSC pelagic ecosystem research should consider strengthening their field work and include zooplankton sampling. It might be most effective if added to their regular sampling cruises to the TZCF and/or West Hawaii to complement and leverage existing time series. The lack and loss of lower trophic level data collection should be investigated and increased if it is found to be vital for understanding ecosystem interactions. OEP does not have a sustained field effort, but given the clear climate variability signals (and resulting effects on ecosystem components) observed recently in the North Pacific, it may be opportune to consider establishing a time series, e.g., a sentinel ocean transect, that could be maintained with a combination of ships and advanced technologies, such as gliders. One example could be a time series of the North Pacific Transition Zone (NPTZ) that has been identified through OEP work as critical to a number of species (e.g., turtles' aggregation as well as providing a favorable environment to monk seals).
    f. Greater investment in larval connectivity models could be very profitable and might be further expanded through graduate student projects. Data on larval behavior is often lacking but some data on ichthyoplankton distributions (see

zooplankton sampling) could be useful in determining vertical distribution and thus exposure to differing currents.

i. The panelists made a number of good suggestions about increasing field sampling. We do conduct several oceanographic cruises each year and with current budget and staff are stretched pretty thin. With additional staff and budget we could address the new sampling suggested by some of the panelists. One new sampling program that we have recently adopted and just briefly mentioned in the program review consists of using the longline observers to collect stomachs of lancetfish that provide broad spatial and temporal coverage of pelagic ecosystem micronekton in a very cost effective manner and the functional composition of micronekton may be even more informative in predicting the pelagic ecosystem dynamics than zooplankton. Recently, CREP has established a collaborative effort with the University of Florida, EOP, SOD, and potentially the University of Hawaii to begin long-time monitoring of meroplankton during all future NCRMP/Pacific RAMP cruises across the region. There have also been preliminary discussions about exploring opportunities for zooplankton monitoring of pelagic waters during routine Pacific RAMP and Hawaii Ocean Time Series (HOTS) cruises, though funding has not been identified.

8. *The ecosystem science research being conducted at PIFSC is high quality and every effort must be made to maintain this quality.*

    a. To remedy the larger issue of analysis, PIFSC leadership and CREP staff need to work together to increase their personnel for sample analysis.

        i. As we organize ESD, we will seek to maintain the high quality and productivity of the research and monitoring that we conduct to support management and conservation of trust living marine resources and their supporting ecosystems. We very much appreciate the positive review of the scientific efforts within CREP and EOP and the clear support for maintaining and stabilizing funding for CREP and the long-term ecosystem monitoring that has been established.

9. *There is a need for careful review of their long term monitoring strategies and the data analysis and modeling studies in ESD in order to understand the mechanisms of ecosystem change. They need to continually assess that they are obtaining the data that is needed and that they are conducting the monitoring in an optimal and cost effective way.*

    a. The goal of CREP's monitoring science plan is, in large part, to detect variability and trends in environmental conditions and to attribute organism and ecosystem responses to those changes. The repeat broad surveys have been enormously

successful, generating data unprecedented in scope and value to the Center and to the global scientific community. Nevertheless, there is need to rapidly and efficiently analyze and interpret the data as it comes in to enable revision of the monitoring plan – for example, density of sampling stations, types of samples collected, establishment of sentinel sites - as deemed appropriate based on the data. For this, I would recommend a power analysis looking at ability to detect change based on climate projections, predicted ecosystem response, and simulated sampling designs. This will determine the trade-offs between different sampling designs and could even include the ability to evaluate higher frequency climate variability.

b. Comparative assessments should be given a high priority and there is a range of disturbance continuums from the MPAs, national monuments, and remote islands that PIFSC can take advantage of to advance these analyses. CREP is doing a good job of comparative analysis in their study region, but could be expanded to coral reefs globally, to examine effects of short-term climate variability where these effects are heterogeneous across the CREP sampling region, and to EOP activities. Improvements would include a shift in focus from century-long projections to near-term climate change and ecosystem responses, including inter-annual to decadal variability and extreme events. Additionally, improved co-ordination between modeling and data collection efforts could help to both provide the input data and validate the models. Some data collection/generation tends to be opportunistic rather than hypothesis-driven, fueled by needs and/or ideas that could be seen as peripheral to the main objectives of the program.

i. The Center remains committed to continuing on-going efforts to periodically review the long-term monitoring strategies of the CREP to make certain our efforts are both cost effective and that they support the evolving needs of management. As background, the monitoring program went through an external review in 2001 when we were part of the Honolulu Laboratory; again in 2007 as part of the CRCP Program Review; again in 2010 as the National Coral Reef Monitoring Program (NCRMP) was established, and in 2016 with this External Review. Our ocean acidification monitoring protocols were reviewed and revised following a Coral Reef Ocean Acidification Monitoring Portfolio (CROAMP) workshop in 2012. Each of our long-term monitoring methods and approaches has been through extensive peer review leading to an extensive body of published journal articles and scientific reports. Over time, we have steadily made modifications to both methods and approaches to continually improve the robustness of our ability to detect changes in populations and ocean conditions influencing those populations. In 2009, we shifted from the use of permanent sites to a stratified random survey design based on power analyses to detect changes in reef fish abundance. We likewise shifted our benthic

monitoring approaches in 2013 to enable similar power analyses and an ability to detect changes in abundance of coral and other benthic communities. Going forward, particularly as PIFSC moves forward with building out and defining the ESD, we will continue efforts to evaluate, reassess and improve our approaches regarding the long term monitoring strategies for the program.

10. *Ecosystem observations in the marine environment provide opportunities that may benefit from a centralized ecosystem observatory program.*

    a. The Integrated Ecosystem Assessment being conducted here provides a natural integration point for data collection, analysis, and management delivery of ecosystem science being conducted by the two programs. The micronekton and associated trophic dynamics suggest there is significant linkage between the pelagic and coral reef ecosystems in this region. The Chief Scientist of such a program would have a broad understanding of both the natural and social sciences and the need for focused synergistic research designs for developing integrated ecosystem assessments and for modeling and forecasting ecosystem changes. Reporting to the Chief Scientist would be Research Leaders of each team whose primary role would be to determine the most effective scientific approaches to achieve those goals, and most importantly, ensure active, open lines of communication and information flow with other teams so that tasks can be set up and/or adjusted based on new information coming from field monitoring programs, laboratory experiments, and modeling results.
    b. Additional the West Hawaii IEA should explicitly incorporate deep water habitats and species. Information could be gathered from stock assessment activities, the developing fishery independent bottomfish surveys, past deep coral work by center staff, HURL and others as available.

        i. The Center will evaluate whether a centralized ecosystem observatory program across the existing pelagic and coral reef ecosystems would increase efficiency and effectiveness. Currently, CREP maintains a well-functioning integrated interdisciplinary long-term ecosystem observations program for coral reef ecosystems that is often highlighted nationally and internationally as an example of an integrated ecosystem observing program. It is certainly worth considering an expansion to include prioritized deepwater and pelagic ecosystems within this same framework.

11. *One panel reviewer pointed out the potential of ESD to become a leader in EBM, EBFM under the need for broad ecosystem monitoring of coral reefs. In order to realize this potential, ESD needed to be strategic in its new hires. A recurrent recommendation was the hiring of another researcher in ecosystem/climate modeling. This new hire could serve to operationalize the core function of ecosystem/climate modeling for ESD/PIFSC. The question of whether the funded position for Management Services Evaluation*

should be included in the consideration of this position or whether the position should result from the allocation of new resources was raised in discussions by several members.

a. Collaborations between EOP and CREP modelers should be actively encouraged and cross-program modeling teams established to take full advantage of the expertise in both groups and to establish best practices. It does in fact appear that fruitful collaborative partnerships and interactions does already occur. To assist in this overall endeavor, the Center should hire at least one new ecosystem modeler (preferable more) on permanent staff.
b. Consideration should also be given to adding capabilities (i.e., a new hire) in climate/ecosystem modeling to interface with OAR/GFDL, NCAR and other (e.g., academic and international) modeling efforts. In-house capabilities should include downscaling models locally to address space/time-scales not resolved by global models but of key importance to PIFSC science and their advice to management bodies.

    i. We concur with the recommendation for the need for an ecosystem/climate modeler. A pelagic ecologist is another need. Given that less than 10% of CREP staff are permanent Federal employees after 17 years of relatively stable funding between $5.5M and $7.4M per year, we agree with the panel recommendation to stabilize CREP funding and staffing to increase long-term continuity and enable better recruitment of talented scientists.

12. *Collaborative studies between EOP and Stock Assessment scientists were not readily apparent in this review and reviewers point out the need to engage Stock Assessment to realize the potential of EBFM. It was noted that the 2016 Annual Planning Guidance that sets PIFSC Priorities for 2016, lists "Improve the integration of both environmental data and ecosystem models into fishery and protected species research programs."*

    a. PIFSC should explore the development of an EBFM team that is going to work across ESD programs and across PIFSC divisions to develop and conduct the science essential for implementing EBFM and provide EBFM advice to managers.
    b. It was not clear in the course of the review the extent to which stock assessment and ecosystem modelers interact in the development of approaches to EBFM in the region. collaborative efforts involving ESD and stock assessment scientists on extended single-species models and multispecies models would be an important step in the transition to EBFM and should be actively encouraged. Further interaction between ecosystem scientists and modelers in the Protected Species Division would also be beneficial.
    c. Integrating these indicator efforts to focus on incorporation into FEPs could improve integration within ESD, improve management of fisheries, and provide an example product for EBFM in NMFS. Additionally, the models currently being

used to investigate this shift in pelagics should be applied to answer the questions being asked by PIRO specific to HI-based long liners. However, to fully answer these questions may require coordination with the socioeconomics program.

d. The most effective way for the Center to be in a position to assist in the transition to EBM and EBFM is to have a seat on advisory committees established to evaluate alternative management actions.
e. Participate in the ISC and PICES Working Groups to include environmentally forced spatial structure in stock assessments of Highly Migratory Species (HMS). Collaboration with ISC/PICES can result in additional research opportunities given the overlap of the geographic footprint of PIFSC, PICES and ISC.

    i. The lack of engagement between EOP and stock assessment was acknowledged in the presentation as an area for future direction and noted by the panelists. Developing more climate-informed stock assessments for bottomfish and striped marlin has been highlighted as work to be done in the Pacific Islands Climate Regional Action Plan and can serve as a first step in developing this collaboration. There has been considerable collaboration between CREP and the PIFSC Stock Assessment Program (SAP) as CREP reef fish survey data have been used to support the development of 17 of the 19 stock assessments of reef fish species over the past 2 years. CREP staff have also been working closely with the SAP to support fishery independent surveys of bottomfish species using BRUVS, BotCam, the MOUSS, and the SeaBED AUV. Additionally, the CREP Ecospatial Information Team has conducted much of the benthic habitat mapping that supports allocation of effort for both the fishery independent surveys and fishery dependent stock assessments. More recently, there have been discussions with the SAP to begin the process of determining how to incorporate considerations of ocean and climate variability into the stock assessment process.

13. *There is a mismatch between the information needs of PIRO and the activities of PIFSC in terms of spatial and temporal scales. Since it was clearly explained that the science mission needs to be housed at PIFSC but be relevant to and inform management needs, leadership for PIFSC, PIRO, and WPRFMC should meet regularly to identify and prioritize issues, funds, and research opportunities to alleviate this problem.*

    a. CREP needs to consider modifications to its monitoring plans to address mismatches in the spatial scales of management needs and to address higher frequency temporal change.
    b. In the case of watershed work there seemed to be a disconnect in knowledge between managers and scientists. It is understood that these projects involve a great number of partners working across jurisdictional boundaries which might be

the cause. Developing a means to increase communication across partners for these projects is needed.

c. Assigning a “response” team that focuses on locale-specific, rapid generation of data to satisfy a specific, one-time need may go some way to alleviating this mismatch.

    i. We reiterate here the response provided for item “2” above adding that plans are moving forward to meet more frequently with our management partners to improve communication and identify where regional priorities for locale-specific science advice can be accommodated. Otherwise as above, we agree that there are some inherent mismatches in both time and space scales, particularly with regards to PIRO’s short-term needs to address Section 7 essential fish habitat (EFH) consultations. We do think it is important to continue on-going proactive research and monitoring across the entirety of the Pacific Islands Region to support future management decisions that will require information on the status and trends of trust living marine resources and ecosystems and the various human and environmental drivers of change. The CREP has been actively conducting place-based work at priority sites in West Maui and West Hawaii in the main Hawaiian Islands, and Faga’alu and Vatia Bays in American Samoa. In many ways, the space and time scales between PIFSC research and monitoring are well-aligned with the WPRFMC’s Archipelagic Fisheries Ecosystem Plans (FEP).

14. *The collaborative effort with PIFSC leadership in the development of the Pacific Islands Regional Climate Plan was applauded by all.*

    a. To the extent possible PIFSC scientists should continue to work with the Council and the RFMO’s (perhaps through PICES) to provide information on climate change and ecosystem effects on these important exploited species with the hope that a more ecosystem based approach to their management could be implemented.

        i. As an update, the draft plan is now being reviewed by external partners and a final version was sent to S&T for their review on July 29, 2016.

15. *The two programs, Ecosystems and Oceanography and the Coral Reef Ecosystem, are highly productive and their outreach and publication efforts are excellent.*

    a. Publication and communication of results by EOP and CREP are taking place at a fast rate and in top peer-reviewed scientific journals. Similarly, access to newly collected data is occurring on pace with the requirements for their public dissemination. The recommendations that follow are not new; they are meant to

emphasize the support to “stay on course” and to continue the already established successful track record of PIFSC in these areas.

b. Continue the efforts in making particularly the legacy data available. This will not only ensure access to the data by the community of scientists that can provide analyses but also increase the collaboration between external communities and PIFSC Programs.
c. Consolidation of data management, archiving and improving access to the broader scientific community, partners and clients.
d. It was not clear how the PIFSC database would be discoverable in other national databases such as BCO-DMO, currently being populated by NSF funded science projects. It is recommended that NOAA as whole, with each centers help, explore options for making their data discoverable (if not fully available) through these archives.
e. Recommend NCEI be charged with uptake of ecological data and have NCEI partner with NSF’s data management infrastructure to develop a single ocean database that could advance ecosystem science to support NMFS throughout the country.

    i. The Center appreciates the panel’s comments about the high productivity of our outreach and publication efforts and will seek to ensure that these levels of productivity within the Programs of ESD are maintained moving forward.

16. *There are strong partnerships between PIFSC scientists and academic, state, and federal scientists. The partnerships provide opportunities to train graduate students from the University of Hawai‘i and other institutions of higher education.*

    a. PIFSC should continue to work with and strengthen connections with climate experts in NOAA, other agencies and academia. This will ensure PIFSC is using the most appropriate models and downscaling techniques for their study areas, since their study areas are so unique with small islands that are often not well resolved in earth system models.

        i. The Center appreciates the panel’s concurrence on the importance of maintaining strong and effective partnerships with academic, state, and federal scientists. We realize that these partnerships are essential to supporting the science to management enterprise and that they greatly leverage resources and capabilities to support integrated ecosystem science.

17. *Overall structure of review was effective and well organized.*

    a. The review was well run, the quality of presentations high, and the willingness of PIFSC scientists, and director Mike Seki, to engage in frank conversation,

address the panel's sometimes tough questions, and to share their work enthusiastically, is appreciated and highly commended.

i. The Center appreciates the hard work of Jenni Samson, Matthew Vandersande, all the presenters, and the support staff to successfully mobilize this challenging event.

18. There is a need for succession planning.

a. It's recommended that the center begin succession planning (possibly but not necessarily direct replacements) in advance of major retirements to maintain and expand strengths. To the extent possible, planning should provide some overlap of personnel to assist with the exchange of institutional knowledge and vision.
b. There is an immediate need to hire the ESD Director who will have to oversee integration of work across programs in the Division (e.g., completing the triangle of field, laboratory and modeling work).

i. The Center realizes the importance of succession planning and with the implementation of the recent Center realignment and consolidated ESD, PIFSC Leadership is currently undergoing a strategic planning effort to build an integrated ecosystems program. PIFSC views this as an opportunity to create the idealized framework for the future while embracing and accommodating the transfer of institutional knowledge of long time senior scientists to the next generation of scientists. Throughout the programs at PIFSC, new recruitments assessed and targeted to address our biggest capacity gaps, training programs for existing staff, and investment in students, are fundamental to the approach we've undertaken in the Center staffing model and for succession planning consideration.The recruitment for the ESD Director is PIFSC's top priority among hiring actions currently queued in the NOAA work-force management system.

Recommendation	Action	Date
The restructuring of ESD at some level was recommended by all panel members. (#1)	Structured effort is being planned to directly engage with all division staff for feedback in this regard. First step will be the roll out the road map of the process to the staff	August 4, 2016
Development and publication of a joint (PIFSC and PIRO) Annual Guidance Document that considers the science and the regulatory agendas and priorities. (#2)	This document will be drafted by staff in the DO with input from ESD leadership.	October, 2017
Increase integration and collaboration between the programs on ecosystem data management, ecosystem modeling, and socioeconomics for climate change and adaptation. (#3)	This effort will occur simultaneously with the restructuring of ESD.	August, 2016- October 2017
Stabilize CREP funding at a level that it currently receives through the Coral Reef Conservation Program. (#4)	Discussions are underway between NMFS leadership and CRCP leadership towards this goal.	August 2016 – March 2017
Expand efforts on deep water habitats since characterizing this ecosystem is particularly relevant to bottom fish stock assessments, cetacean distribution (mesopelagic boundary layer communities), and deep water coral communities. (#5)	Much work is already being accomplished, future work will expand on this theme as funding and logistical support permits.	October, 2017
Verify some of the vital rates used in the ecosystem models currently under development. (#6)	Some of this work is presently being conducted in partnership with colleagues at the Hawaii Institute of Marine Biology with plans to establish capacity to expand these efforts locally at IRC live animal and laboratory facilities. First step is prioritizing the parameters needed	May 2017

Strengthen field work and include zooplankton sampling, mesopelagic boundary layer sampling, and connectivity analysis for deep water habitats. (#7)	These activities are being included as higher priorities into future field missions.	October, 2017
Review long term monitoring strategies and the data analysis and modeling studies to understand the mechanisms of ecosystem change. Continually assess that they are obtaining the data that is needed and that monitoring is optimal and cost effective. (#9)	These questions are being examined quantitatively and we will be able to compare the tradeoffs of multiple survey strategies in an MSE type framework.	October, 2017
Develop a centralized ecosystem observatory program. (#10)	The West Hawaii IEA project is growing in many aspects, with eventual expansion to other geographies in the inhabited portion of the archipelago.	October, 2017
Hire a researcher in ecosystem/climate modeling. (#11)	Multiple positions are targeted but there is a lengthy administrative process.	July, 2017
Improve interactions of ecosystem scientists with modelers in the Stock Assessment Program and in the Protected Species Division. (#12)	Ecosystem modelers will be partnered into stock assessments to provide advice on inclusion of environmental variability.	January, 2017
Leadership for PIFSC, PIRO, and WPRFMC should meet regularly to identify and prioritize issues, funds, and research opportunities. (#13)	Such meetings already occur and are being arranged on a more frequent basis.	January, 2017
The center should begin succession planning in advance of major retirements to maintain and expand strengths. (#18)	We will do our best given the knowledge of retirements and strategic staffing plans.	January, 2017