2016 NOAA Integrated Ecosystem Assessment (IEA) Program "Face to Face" meeting

March 1 – 3, 2016

NOAA Earth System Research Laboratory

325 Broadway, Boulder, CO

IEA F2F planning committee:

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TABLE OF CONTENTS

List of acronyms

CEM	Conceptual Ecosystem Models
CESM	Community Earth System Models
EAFM	Ecosystem Approach to Fisheries Management
EBFM	Ecosystem-Based Fisheries Management
EBM	Ecosystem-based management
EFR	Ecological Forecasting Roadmap
ERA	Ecosystem Risk Assessment
FMC	Fishery Management Council
FEP	Fisheries Ecosystem Plan
GAM	Generalized Additive Model
ICES	International Council for the Exploration of the Sea
IBM	Individual Based Modeling
IEA	Integrated Ecosystem Assessment
IMR	Institute of Marine Research (Norway)
I/O	Input/ Output Model
LME	Large Marine Ecosystem
MARBL	Marine Biogeochemistry Library
MIC	Models of Intermediate Complexity
MSE	Management Strategy Evaluation
NCAR	National Center for Atmospheric Research
NEIS	NOAA Earth Information System
NHCT	NOAA Habitat Conservation Team
NPZ	Nutrient-Phytoplankton-Zooplankton (model)
PICES	North Pacific Marine Science Organization
QNM	Qualitative Network Model
RCP	Representative Concentration Pathway
ROMS	Regional Ocean Modeling System
SOS	Science on a Sphere
SSC	Science and Statistical Committee

SST	Sea Surface Temperature
WGIBAR	Working Group on the Integrated Assessments of the Barents Sea
WGINOR	Working Group on the Integrated Assessments of the Norwegian Sea

Office of Oceanic and Atmospheric Research (OAR) Laboratories

AOML	Atlantic Oceanographic and Meteorological Laboratory
ESRL	Earth System Research Laboratory

National Marine Fisheries Service (NMFS) Laboratories

AKFSC	Alaska Fisheries Science Center
NEFSC	Northeast Fisheries Science Center
NWFSC	Northwest Fisheries Science Center
PIFSC	Pacific Islands Fisheries Science Center
SEFSC	Southeast Fisheries Science Center
SWFSC	Southwest Fisheries Science Center

National Ocean Service (NOS) Laboratories

NCCOS	National Centers for Coastal Ocean Service

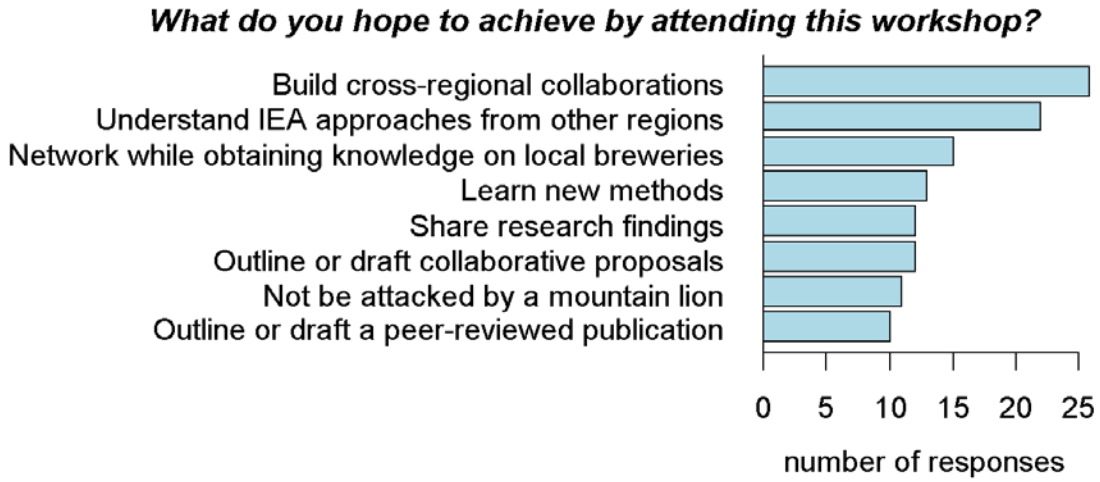
2016 Integrated Ecosystem Assessment (IEA) Meeting Pre-workshop Survey

The organizing committee requested input from previous IEA meeting participants with the goal of crafting an agenda for the 2016 meeting that was tailored to the specific needs of the group. A pre-workshop survey was formulated via Google Forms, and 32 responses were received. Participants expressed that they were primarily interested in focusing on two topics: 1) incorporating human dimensions into aspects of IEAs, and 2) synthesis and "closing the IEA loop." Topics such as translating science to management, and methodological approaches to climate change analyses, also were of interest. Respondents were asked to share ideas for collaborative efforts that they would be interested in, and a wide range of responses were given (see text box). In addition, the survey sought requests for short presentations, such that individuals with novel research findings or ideas would be given the opportunity to share their work.

List any ideas for collaborative efforts that you would be interested in seeing pursued.

- More comprehensively link the ecological status of the ecosystem with the current and expected future human uses of the ecosystem
- Identifying reference points and thresholds
- Exploring the value of using conceptual models as analytical tools and communication tools
- Creation of generalized frameworks for conducting risk assessments
- Predicted biophysical impacts of climate change or ocean conditions translated into social impacts
- A review of how environmental factors are incorporated into single-species assessments or management across the region
- Continued human dimensions collaboration
- Developing a common list of human activities that should be accounted for in each habitat type across regions (Freshwater, Estuarine, Coastal, Open ocean, etc.).
- Working with other sectors to develop a true IEA
- Developing approaches to downscale output from Earth System models
- Building a resource hub that provides information on methodology, publications, and possible code (R or matlab) that support moving regions forward through the IEA process.

Respondents were also asked for input on structural elements of the meeting. On average, the respondents indicated they wished to spend approximately 1/3 of the meeting time in plenary discussions, listening to presentations, and breakout groups, respectively. Input regarding several survey questions indicated that participants generally wished to spend time on more actionable science, synthesis, and cross-collaboration, as opposed to being subject to reviews of projects that might be specific to a particular region or discipline. Another finding was that respondents indicated that time outside the formal meeting setting was extremely valuable for networking, brainstorming ideas, and forming collaborative groups that could form the basis for intersessional research activities. Thus, the 2016 agenda was structured so as to maximize these less formal interaction opportunities.



2016 NOAA Integrated Ecosystem Assessment (IEA) Program "Face to Face" meeting

Meeting Summary

On March 1-3, 2016, over 50 research scientists and program partners met at the NOAA Earth System Research Laboratory (ESRL) in Boulder, Colorado in order to review ongoing and developing Integrated Ecosystem Assessment (IEA) research in each IEA region, strengthen national and international collaborations, and advance understanding of how the IEA program can and does support broader ecosystem-based management of marine systems. The following represent the overarching goals:

1. Identify how the IEA is being implemented in the US and elsewhere (Norway Institute of Marine Research: IMR).
2. Explore the attributes that make up a successful, operational IEA.
3. Identify how the IEA integrates with and/or adds value to other NOAA programs.
4. Identify how the IEA enables an ecosystem-based approach to management.
5. Build cross-regional collaborations through development of proposals and papers on advancing IEA methods.
6. Identify methods to advance integrating human dimensions into all aspects of IEA.

During the three-day meeting, the ambitious agenda provided opportunity for invited speakers to review emerging socio-economic and ecological science, statistical frameworks, and methods of communication. In breakout sessions, challenging topics were tackled such as how to integrate socioeconomic information into each step of the IEA, methods for conducting Ecosystem Risk Assessments, and approaches for engaging stakeholders and managers in the IEA process to ensure management-explicit IEA science. The breakout sessions also enabled integration and collaboration that yielded six cross-regional working groups formed to advance IEA approaches to ecosystem-based management.

Day #1 – Tuesday, March 1st (Morning Session): Trends and Status of the IEA

Opening remarks and overarching goals of the workshop

The 2016 workshop commenced with remarks by Chris Kelble, Chair of the IEA national Steering Committee, Rebecca Shuford, Program Manager for the IEA program, and Mike Alexander, Steering Committee member and 2016 workshop planning committee local coordinator. Chris noted that this was the fourth national IEA program meeting, with the first meeting occurring in Pacific Grove in 2011. It was noted that the program has grown tremendously in the past five years. In particular, the program has seen growth in inclusion of social sciences. For example, in the first IEA meeting, participation of social scientists was limited to a single economist. Clearly the idea of including human dimensions in aspects of the IEA process has gained momentum, and this is represented in both the terms of reference of the 2016 meeting and increased participation from social scientists.

Overarching goals and questions of the 2016 workshop:

1. Identify how the IEA is being implemented in the US and elsewhere (IMR).
2. Explore the attributes that make up a successful, operational IEA
3. Identify how the IEA integrates with and/or adds value to other NOAA programs.
4. Identify how the IEA enables an ecosystem-based approach to management.
5. Build cross-regional collaborations through development of proposals and papers on advancing IEA methods.
6. Identify methods to advance integrating human dimensions into all aspects of IEA.

After a brief review of the overarching goals of the workshop, the 2016 workshop planning committee was introduced (Jamison Gove, PIFSC; Mandy Karnauskas, SEFSC; Kirstin Holsman, AKFSC; and Elliott Hazen, SWFSC). The planning committee discussed the reasoning behind the structure of the 2016 workshop agenda, which had been formulated based on feedback via a pre-workshop questionnaire focusing on what participants hoped to gain from the workshop. In general, the agenda was designed to ensure opportunities for all participants to voice their opinions, via a variety of outlets such as plenary discussions, breakout groups, short presentations, informal coffee hours, and social events. It was noted that the success of such a dynamic workshop format would necessitate that participants were fully engaged in the meeting, and it was requested that attendees make efforts to reduce casual computer usage and actually be "present" at the meeting.

Plenary: National IEA perspective

The first morning's plenary session was kicked off with national perspectives delivered by a number of NOAA leadership representatives.

Ned Cyr, Director of the NOAA Fisheries Office of Science and Technology, led with a discussion of the strengths and weaknesses of the IEA Program. He noted that the IEA program represents the first NOAA framework for ecosystem-based management, despite a long history of recognition of the importance of this type of work. Strengths of the program, in his view, included the ability to collectively leverage different science capabilities, the efficiencies gained in a limited budget environment, and the trust built

with stakeholders. In terms of challenges, while large advances have been made in science capacity, there is still a need to work with partners to tacitly demonstrate the utility of IEAs in the field. Ned felt that NOAA leadership as a whole is not fully aware of the products coming out of the IEA program, and that there was a lingering perception that the work was more academic than pragmatic in nature. He noted that the way to dispel such notions would be to better showcase how IEAs are forming the basis of decisions.

Steve Fine, Deputy Assistant Administrator for NOAA's Oceanic and Atmospheric Research line office, described how IEAs are an essential piece of taking an ecosystem approach to management, and felt that OAR was making important contributions in the area of understanding impacts of climate change and in downscaling climate models for ecosystem assessments. A number of specific examples were highlighted, such as ESRL's efforts to facilitate access to climate information, and Atlantic Oceanographic and Meteorological Laboratory's (AOML) work in South Florida supporting issues related to coastal management in a changing climate. Steve noted that the Research line office is home of Sea Grant, a forum for bringing together scientists and decision makers, and encouraged IEA researchers to use the program as such.

John Armor, the Acting Director of NOAA's Office of National Marine Sanctuaries Program, described the Sanctuaries Program as both a "customer" and a "practitioner" of IEA products. He highlighted that such data integration activities were actually codified in the legislation for sanctuaries and that there was a need to accelerate and continue to grow the science in order to make smarter management decisions. As near-term research needs, John described four particular areas of focus: 1) accounting of ecosystem services, 2) working with IEA to understand status and trends, particularly via Sanctuary Condition Reports, 3) facilitation of cross-line office collaboration to address mandates such as Endangered Species Act and Essential Fish Habitat, and 4) integration of smaller-scale management issues into the typically large-scale IEA framework. Finally, John noted that two participants of the 2016 program were heavily involved in the Sanctuary Program and encouraged individuals to reach out to discuss collaborations.

Robin Webb, Director of the Earth System Research Laboratory's Physical Sciences Division, gave a brief introduction to the four divisions at ESRL, and noted the unique opportunity that the IEA held to meld physical, biological and socioeconomic sciences. Robin highlighted the recent workshop of North Pacific Ecosystem Tipping Points as a useful activity and noted that better observations, predictions, and quantitative models were necessary to advance this type of work.

Discussion, question & answer session

Discussion following the opening plenary focused on communication between "on the ground" researchers and NOAA leadership. Leadership representatives felt that the IEA program needed to better document the successes of the program. If researchers are more aggressive about pulling together these stories and sending them up the chain, then Leadership is better prepared to advocate for the program. In general, however, the discussion revealed that leadership is largely unaware of the specific products coming out of the IEA program, and that researchers should focus on highlighting specifically how their work has led to improved decision-making.

Related to this discussion, the group focused on identifying the appropriate partners to help ensure that research products were applied to management. Sea Grant was highlighted as an important partner that has probably gone underutilized in the IEA program to date. It was also mentioned that it would be useful to focus on partners outside of NOAA such as sister federal agencies and state agencies. Also, in

addition to the Fisheries Management Councils who have been the customers for much IEA work, Sanctuary Advisory Councils were recognized as another important audience. Finally, there was some discussion of how to bring the Large Marine Ecosystem (LME)-scale IEA work down to local scales relevant to management. Ultimately, this session served as a useful way to ensure IEAs were familiar to NOAA leaders but also to highlight areas of communication improvement.

Plenary: the EBM spectrum

Mike Fogarty from the Northeast Fisheries Science Center gave a presentation focusing on the various directives relating to ecosystem-based management work. He noted that there is an Office of Management and Budget directive to integrate an ecosystem services perspective in decision making. Also, the U.S. National Ocean Policy calls for the establishment of regional planning bodies. Mike stressed the importance of identifying customers for the research outputs and pushing for a role in the advisory panels to ensure that there is direct input into the hands of the managers. The development of Fisheries Ecosystem Plans (FEP) was contrasted with Regional Ocean Plans, the latter of which deals with different ocean use sectors. Several Regional Ocean Plans are currently undergoing development and these efforts were highlighted. Just as stock assessments are the framework used for single-species assessments, IEAs were described as the "analytical engine" for ecosystem-based management. Finally, the up-and-coming ecosystem-based fishery management policy statement was mentioned and it was noted that the document will contain guidance on practical implementation.

IEA Speed Dating

Attendees took part in an icebreaker activity designed to let participants familiarize themselves with new faces in the group. Participants were directed to stand up, find someone they had never met, and share with that person their name and affiliation, and explain what they hoped to take out of the IEA workshop. Pairs of individuals were allowed to talk for two minutes, and the group cycled through five rotations. The exercise went quickly but provided an important opportunity for individuals to broaden their network within the IEA community.

Plenary: Introductions and regional updates

Before the workshop, IEA regions were asked to provide a single slide capturing the major accomplishments of their respective IEA programs over the past year. A representative from each region was then asked to present the slides to the group in the plenary session. The summary slides from the five IEA regions appear below. Workshop facilitators noted that any common themes or topics of interest arising from the regional updates should be tagged as potential discussion subjects, to be revisited later in the workshop during informal coffee hours or working group sessions.

NEFSC Ecosystem Considerations

NOAA FISHERIES

Ecosys Links NEFSC Links

Ecology of the Northeast Continental Shelf
Background information on the structure and function of the Northeast Shelf Ecosystem

Climate Change
Effects of Climate Change on the Northeast Continental Shelf

Ecosystem Status
Assessment of Ecosystem Condition, Threats, and Impacts

Current Conditions
Semiannual Review of the Physical and Biological Status of Ecosystem

Spatial Analyses
Species Distribution Patterns in Space and Time

Modeling Approaches
Development and Application of Multispecies and Ecosystem Models

There is now broad agreement that we need to adopt a more holistic approach to marine resource management at both the national and international levels. To accomplish this goal, the foundation of marine Ecosystem-based Management is now being developed and refined. Virtually all specifications of marine EBM share at least three common elements: (1) a commitment to establishing spatial management units based on ecological rather than political boundaries, (2) consideration of the relationships among ecosystem components, the physical environment, and human communities, and (3) the recognition that humans are an integral part of the ecosystem. We need to account for the important goods and services derived from marine ecosystems and the diverse and cumulative impacts of human activities in these systems (Figure 1) to forge a sustainable future.

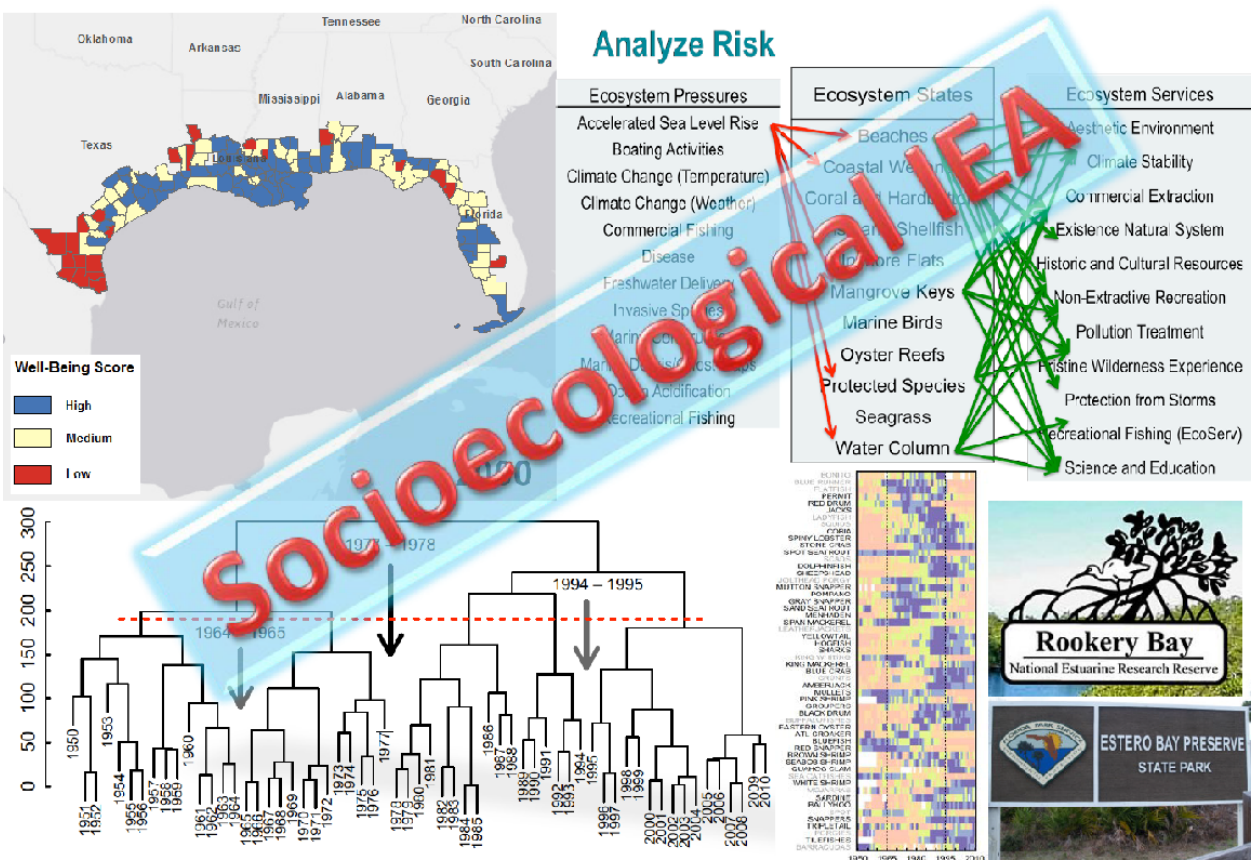
The importance of implementing marine Ecosystem-based Management in the United States has recently been highlighted with the adoption of a new National Ocean Policy, established under presidential order on July 19, 2010. This policy identifies nine objectives, the first of which establishes Ecosystem-based Management (EBM) as its guiding principle. The second priority highlights the importance of Coastal and Marine Spatial Planning as a tool for EBM. It is clear that the impetus toward adopting the basic tenets of EBM is gaining momentum. We need to establish the scientific architecture in support of EBM in the region to meet these emerging challenges and opportunities. The objective of our Ecosystem Considerations website is to provide a broad overview of the ecology of the Northeast U.S. Continental Shelf to support this overarching need. This region as a whole is recognized as one of more than 60 Large Marine Ecosystems distributed throughout the world ocean.

Figure 1. Examples of some important ecosystem services (blue icons), stressors (red), adverse effects (yellow), and issues of special concern (green) that will be considered in Ecosystem-Based Management on the Northeast U.S. Continental Shelf (adapted from image by Barbara Ambrose, National Coastal Data Development Center).

Print

This site comprises several inter-related components designed to address different issues and needs. We seek to provide basic information on fundamental ecological properties of the system to the broad spectrum of stakeholders who will be engaged in the discussion of policy alternatives to meet the needs for Ecosystem-Based Management in the region. We build on the longstanding commitment of the Northeast Fisheries Science Center to understand and monitor changes in ecosystem structure and function in this region with the objective of informing management decisions.

Gulf of Mexico IEA update



CCIEA HIGHLIGHTS

- Physical forcing: the dominant story for the last 2 years
- Multiple indicators → poor productivity; anomalous events including:
  - Major harmful algal blooms → fishery closures
  - Mass mortalities (pinnipeds, seabirds, pre-spawn salmon)
  - Distribution shifts causing management problems
- Ecosystem reference points project: manuscript near completion
- HD projects making progress, including:
  - Development of coastal community vulnerability and human wellbeing indicators
  - Central Valley water use policies
  - Fishery participation in response to management and ecosystem change
- Progress in revision of CCIEA website, including interactive indicator pages
- PFMC Ecosystem Working Group → Council-specific indicator portfolio
- Supporting activities within climate RAP
- Developing "early warning indicators"
- Conduct marine mammal MSEs in concert with Protected Resources
- IEA loops for Sanctuaries, starting in 2016 with Channel Islands

Alaska IEA – "It's the climate, stupid"

- Four IEA regions (Bering Sea, Gulf of Alaska, Aleutian Islands, High Arctic)
- EBFM + protected species only (by mandate)
- Bering Sea "maturing", Gulf of Alaska "scoping", others "pending"

	Bering ROMS/NPZ modeling, PMEL/AFSC partnership	Bering multispecies/ ecosystem models	Econ/ social	Bering FEP	GOA IEA
FY13	Development				
FY14	Operational council product: 9-month forecasts of Bering physics, biological indicators	CEATTLE model (multispecies assessment model)			
FY15	Climate-driven MSEs (driven by 50-year IPCC forecasts)	CEATTLE MSEs + Ecosim toolbox	FishSET toolbox		
FY16	Council Priorities: Rapid climate assessment Fur seal declines Yukon salmon survival (Forage fish theme)	Ecosim toolbox Support model updates - several models for multi-model MSEs (ACLIM)		Council priority: Conceptual models, analysis support	Conceptual models, GOA IEA planning and scoping

West Hawai'i IEA

Conceptual Ecosystem Models

- Initial focus on coral reefs, but expanding to include pelagic fishes, water column, beaches, reef fishes, benthic community.

Cetacean Habitat Modeling: Predicting Hotspots in Abundance

- Support HI Sanctuary's transition from single species to entire ecosystem

Ecosystem Trends and Status Report

- 30 Indicators that span social, ecological and climate/ocean

Developing the State's Coral Reef Management Plan

- Mass Coral Bleaching Event: 40 – 80%

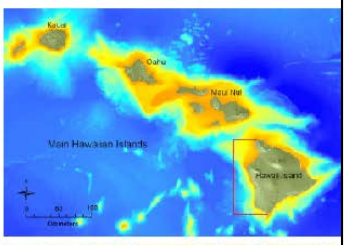
Climate: Downscaled Projections of Future Coral Bleaching

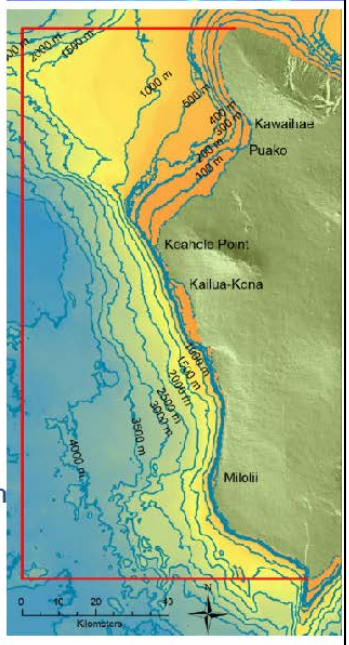
Ecosystem Modeling of Coral Reefs

- Indicators performance
- Community-based surveys to inform fishing pressure and ecosystem services

Management Strategy Evaluation

- Scenarios based on proposed management objectives





Plenary: International approaches to Integrated Ecosystem Assessments

Hein Rune Skjoldal from Norway's Institute of Marine Research (IMR) gave a presentation on Norway's perspective in implementing integrated ecosystem assessments. IMR and NOAA have a bilateral agreement to work collaboratively in fisheries and in ecosystem management as well. The focus of the presentation was the ecosystem assessment in Barents Sea and Norwegian Sea. IMR has a developed framework for ecosystem approach to management that aims to define the ecosystem, describe the ecosystem, set ecological objectives, assess the ecosystem, value the ecosystem, and manage the human activities. Within the defined LMEs, there are issues of spatial scale and scale integration; LMEs tend to be impacted by large-scale forcing, while habitat factors affect small scales.

Two International Council for the Exploration of the Sea (ICES) working groups, WGIBAR (Barents Sea) and WGINOR (Norwegian Sea) are focused on understanding physical forcing in the two ecosystems. Hein Rune discussed some of the shifts that have been observed in fish stocks in response to physical forcing. For example, mackerel stocks are expanding and have moved west to the south of Iceland and along the west coast of Greenland. The presentation also included some results on IMR's monitoring of zooplankton biomass, as well as multivariate analyses to understand ecosystem change in the Norwegian Sea.

Discussion following this presentation focused on challenges present in implementation of IEAs in both Norway and the U.S., including issues related to spatial scales and the incorporation of human dimensions. In reference to scaling, it was noted that IEA is an adaptive process and that part of the adaptation is adjusting analysis and products to the appropriate scales to meet needs of managers. Several examples were given from different regions to demonstrate how this is accomplished. Norwegian colleagues also provided some clarification on how human dimensions are being incorporated into their work and the challenges related to this integration.

Plenary: Recent collaborative IEA efforts

Jameal Samhouri reviewed the 'California Current Thresholds Working Group'. They have developed a generalized framework that could be used in other regions, if the interest is there. Jameal presented some of the preliminary results from the applications in the California Current LME. The Group had a 3-day workshop in July 2015 and progress has continued, including a manuscript nearing submission. The purpose of the working group is to establish generalizable methods, and to establish reference points for indicators in the California Current IEA. A key concept is that thresholds in nonlinear relationships can distinguish pressures with large versus small impacts. Many analytical tools are available to analyze these relationships, including Generalized Additive Models (GAM) and gradient forest analysis.

Kirstin Holsman reviewed the 'Ecosystem Risk Assessment Working Group' which developed out of a breakout group of the last national IEA meeting. The main objective is to determine what an Ecosystem Risk Assessment (ERA) is and how to define it. The group began with the Levin et al. (2013) [1]definition where ERA allows managers to 'quickly' balance management tradeoffs and objectives, and also the Hobday et al. (2011) [2] framework, which describes a process of doing risk assessments that range from quick and qualitative to fully quantitative. Kirstin reviewed the corresponding ERA manuscript that is currently in preparation.

Plenary: Future IEA Working Groups

Doug Lipton discussed a potential future working group on Human Dimensions. There has been an expansion of the human dimensions community in the IEA program. The group is working on concrete goals and Terms of Reference. Becky noted that it will be important for the working group to have a diverse membership including natural scientists – not just human dimensions expertise.

Elliott Hazen discussed ideas for web-based IEA tools. In particular, the CCIEA is going to an online-only product, with data being updated in near-real-time and with a number of visualization tools, data selection tools, and interpretative text. Elliott walked through the CCIEA template, and asked: What efforts are underway in other regions? Should we create a working group to share tools or even develop common tools? There seemed to be general interest in developing such a working group.

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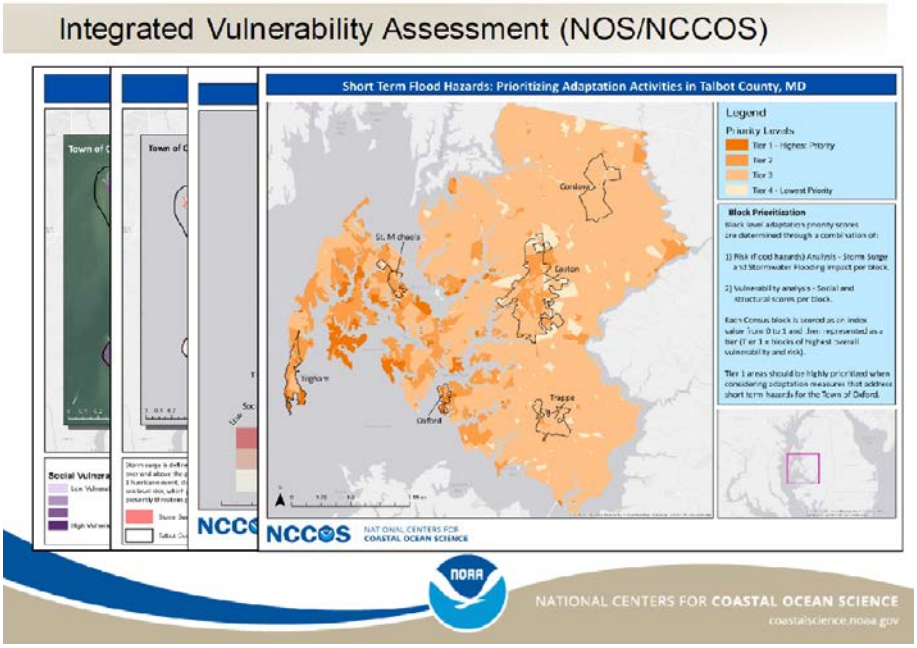
[1] Levin, P. S., Kelble, C. R., Shuford, R., Ainsworth, C., deReynier, Y., Dunsmore, R., Fogarty, M. J., Holsman, K., Howell, E., Monaco, M., Oakes, S., and Werner, F. 2013. Guidance for implementation of integrated ecosystem assessments: a US perspective. – ICES Journal of Marine Science, doi:10.1093/icesjms/fst112.

[2] Hobday, A. J., A. D. M. Smith, I. C. Stobutzki, Cathy Bulman, Ross Daley, J. M. Dambacher, R. A. Deng et al. "Ecological risk assessment for the effects of fishing." Fisheries Research 108, no. 2 (2011): 372-384.

Day #1 – Tuesday, March 1st (Afternoon Session): Human Dimensions and the IEA

Plenary: Integrating social science into the IEA

Maria Dillard gave a presentation on how the NOAA IEA program has been incorporating Human Dimensions science into the IEA process. The best examples for the integration of human dimensions into IEAs are Conceptual Ecosystem Models (CEMs); many of which refer to coupled socio-ecological systems and include multiple aspects of the human community. There are a number of Human Dimensions indicators that have already been developed, such as: 1) Human Well-Being indices in the Gulf of Mexico, 2) Social Vulnerability indices for the entire nation; 3) Northwest Atlantic Regional Sea indicators; 4) fishing diversity and personal use indicators for the West Coast. All of these indicators have, to some degree, worked to incorporate climate change aspects. However, they have not been integrated with biophysical data as readily as have CEMs. Furthermore, there are few examples of human dimensions being incorporated into Management Strategy Evaluations (MSEs). There are several roadblocks impeding the integration of human dimensions and biophysical data: 1) scales, 2) temporal mismatch, and 3) communication. The best examples of integration are between fisheries and economics, but this is a direct link between the fishermen who are extracting and selling the resource. This may in part be due to many other social data being collected for communities of place, instead of communities of practice.



Panel Discussion and question and answer

The plenary was followed by brief remarks from a panel of human dimensions experts: Maria Dillard, Stephen Kasperski, Doug Lipton, Michael Jepson, Geret DePiper, and Karma Norman. Discussion revolved around: mechanics of linking human dimensions data to physical and ecological data sets, existing examples of incorporating human dimensions, and capturing the critical information within indicators.

Roadblocks to integration are primarily in the form of mismatched temporal or spatial scales. Some existing tools, such as the Gulf of Mexico Data Atlas (gulfatlas.noaa.gov), were mentioned as useful for presenting social data on the same scales and platforms as ecological and physical data and for

visualizing potential relationships. While biological and physical data sets are usually on annual time scales or finer, and in gridded formats, socioeconomic work is typically done with frequencies of three to five years, and at a census block or county scale. It was noted that the term "community" can mean different things in different disciplines; for example there are communities of place (e.g. a town), communities of practice (e.g. the haddock fishing community that could be up and down the coast), and that we often have better fisheries data for communities of practice versus community of place.
Panel members discussed the challenges related to integrating human dimensions in conceptual models and noted some useful examples, such as the following:

- Steve Kasperski is working with EcoPATH models in Alaska where there is a relatively good record of catch, but not necessarily a good record of who caught what. He noted that getting the data to be vessel specific is useful for tying back to community impacts and understanding how people are actually using the resources.
- The Northeast is coupling an Atlantis Model with an economic model and other bio-economic models of recreational fishing choice behavior.
- The Gulf of Mexico IEA has been working with social impact assessments for specific regulations; social indicators are now being put in fisheries management plans to see whether they can be used to evaluate potential social impacts of management and also whether they can detect responses in major shocks (such as oil spills, hurricanes).
- The California Current IEA is looking at identifying communities with different levels of dependence on different fishery species. The region has also done work integrating human dimensions into conceptual models.

There was also discussion of human dimensions work that has attempted to fold in climate impacts, such as the species vulnerability work in the Northeast region, and socioeconomic vulnerability work being done in the Chesapeake Bay.

In the development of indicators, the first step is to identify the goals and objectives of management. Several participants discussed how they went about identifying objectives and developing related indicators. There was a question on why the concept of ecosystem services was generally absent from the prior plenary and discussion. Largely, the concept of ecosystem services is inherent in much of the work being conducted by this group of social scientists. However, it was noted that ecosystem services are difficult to quantify and that human well-being could be considered an outcome of ecosystem services changing as a result of changes in ecosystem condition. It was also thought that while there is a large literature on social indicators, fewer operational examples of social indicators that are directly impacted by ecosystem services exist and as a result, much work is needed to advance in this respect.

Breakout #1: Incorporating Human Dimensions in Indicators and Risk Assessment

Obstacles to integrating human dimensions into indicator development and risk assessment can occur due to limitations in data, resources, or analytical methods, but obstacles can also arise from challenges in communication between disciplines. Likely, all of us working in the realm of interdisciplinary sciences have encountered challenges in communicating with experts from other disciplines at one time or another. The goal of this breakout group was to understand when and where these communication challenges can occur, and to offer solutions to how we can work through these challenges. Breakout groups revolved around a series of real-life case studies focused on incorporating human dimensions into indicator and risk assessment work.

The objectives of this breakout group are to:

- Understand the nature of obstacles to integrating human dimensions in IEAs
- Practice articulating challenges in a way that is understandable to a cross-disciplinary audience
- Improve communication between experts in different disciplines
- Outline steps for making progress with regard to integrating human dimensions in indicator development and risk assessment
- Identify opportunities for cross-regional collaborations

Meeting participants were randomly split into three groups and broke out into discussion for an hour. Summaries of the small group discussions are given below.

Group 1

The IEA Program has done an excellent job of developing a broad suite of candidate human dimension indicators that may be useful for completing the IEA loop and future iterations. It is now time to focus in on what the priority indicators should be and further develop the connection between those human dimension indicators and ecosystem conditions. Therefore it is appropriate to look at the start of the IEA loop and have a dialogue with the management community about what their specific concerns and management decisions are within the different regions (e.g., what major management decisions are you facing in the next few years?). From that interaction, we can start to determine what existing indicators are relevant, and whether additional indicators need to be developed. At the same time, we must develop a solid understanding of how the indicator links to ecosystem condition and its potential sensitivity to changes in ecosystem states.

Group 2

This breakout group focused primarily on the communication between scientists and managers. In particular, in the literature surrounding indicator development and vetting, a substantial amount of effort has focused on the objective identification of thresholds. These thresholds represent shifts in the system that are relatively easy to communicate to managers as tipping points. The group discussed two primary issues. The first is whether threshold analysis was appropriate for indicators of social objectives, given that multiple social objectives are often being considered concurrently (e.g. employment, food provision, profitability), and these objectives tend to be more subjective in terms of the relative weights individuals assigned to each. The second was whether the methodological and theoretical complexity associated with developing thresholds for social indicators is an idiosyncrasy of the social sciences, or whether other disciplines currently face, or are likely to face, similar issues.

The group was roughly split as to whether threshold development is a valid construct for social indicators, and this division did not seem to fall along clear disciplinary boundaries. The major conclusions of the group were that although thresholds are important, particularly for identifying regime shift points in hysteretic systems, other approaches including statistical trend analysis provides important information regarding the system that should be utilized. Further, regardless of the approach, the key issue is assessing trade-offs in the system. The group generally felt that the theoretical and methodological issues surrounding threshold identification were likely to be the norm across disciplines, as opposed to an exception relegated to a quirk of the social sciences. Our final recommendation is that

additional research regarding threshold development and communication aimed specifically at addressing these complexities is warranted.

Group 3

The goal of this breakout group is to understand when and where communication challenges can occur, and to offer solutions to how we can work through these challenges. The first observation made in the group was that integration is key. It was noted that social scientists and environmental scientists may often come together to discuss one another's work but generally the result is simply using outcome products from one another's work rather than truly integrating the work. The group acknowledged that differences in the approach for the two sciences often lead to incomplete or inaccurate assessments. For example, in many fishing communities, fisheries scientists focus on actual port landings. However, if a social scientist were to perform a study based solely on the data of the port landings, there could be a significant misrepresentation of the community because it is not uncommon for fishermen who unload at the port to not be residents of that community. Therefore, translating landings data into the community where the port is located could be misleading since the community of residence where additional economic impacts are experienced is not reflected in the analysis. This discussion led to the realization that one issue is that of scale. But to define the scale, one would need to go back to the scoping stage and better define the question. Scale will be dependent on the specific question. For a risk assessment, the practitioner must first identify the context of the decision(s). What is the decision for? Ultimately, risk assessment is intended to provide technical support for decision making. It is imperative that the precise question is understood. This topic of scale, and the need for continued scoping, both emphasize the need for communication. Communication between the social scientists and the environmental scientists must commence at the start of an integrated ecosystem assessment and must continue throughout. Likewise, communication with the decision makers, and the community involved, must begin immediately and be maintained for the duration of the project.

Breakout #2: Incorporating Human Dimensions in Ecosystem Modeling and Management Strategy Evaluation

Ecosystem modeling is a useful tool to simulate the complex dynamics of ecological systems. Ecosystem models can have a variety of applications within the context of the IEA, including evaluating indicator performance, identifying thresholds, and assessing changes in ecological communities driven by variations in current and future ecosystem pressures. Importantly, ecosystem models provide a means by which to evaluate ecosystem state and the delivery of ecosystem services under varying management regimes, thereby supporting a key IEA-step, Management Strategy Evaluation (MSE). A formal MSE can be used to test the effectiveness of management targets and strategies, decisions rules, assessments, and monitoring plans.

Requisite to modeling ecological systems and assessing the efficacy of management is the appropriate characterization of human activities through space and time. As such, incorporating human dimensions data and using social science methods to obtain input from management and stakeholders are critical for ecosystem modeling and MSE. By engaging social scientists throughout the modeling and MSE process – from model set-up to evaluating management scenarios – we include not just the impacts of human-activities but also include changes in ecosystem services as an outcome of this process.

The overall theme of this breakout group is on *incorporating human dimensions into Ecosystem Models and MSE*.

The objectives of this breakout group are to:

- Identify current regional efforts that have attempted to incorporate human dimensions in ecosystem models and MSE
- Identify key steps and methodological approaches for incorporating human dimensions data and social science methods in ecosystem models and MSE
- Discuss the engagement of stakeholders and regional management to guide the ecosystem modeling and MSE process

Meeting participants were randomly split into four groups and broke out into discussion for an hour. Summaries of the small group discussions are given below.

Group 1

Compromise is the key to a successful IEA and it is important to be inclusive, ensure all voices are heard, and concerns addressed. IEAs require a lot of time and effort from all parties involved, and it is important to meet often. It is also important to have products in hand when you meet, even if they are modest. Having products will instill a sense that progress is being made. Prioritization of tasks, deliverables, and developing a straw man can be a good way to keep scenarios simple and focused, which will be important in engaging stakeholders and customers. Forging an alliance with a co-champion can help with the introduction of an IEA and the touting of its utility. Collaborations on the science side can be made through the newly approved NOAA Fisheries MSE positions and a central repository for network analysis and modeling tools.

Incorporating human dimensions in IEAs can be difficult, but inclusion is easier when they are incorporated early in the process. Developing a suite of objectives that are simple relative to the many disciplines represented in the IEA, and drawing from the management objective itself is encouraged. Direct links to economics are rare at present, but more linkages between ecosystem services, dollar amounts, and community vulnerabilities are expected in the future. The best way to succeed with integration efforts is to not look for perfection, but to continue to make advances despite setbacks. Engaging stakeholders at the beginning of the process is also key, while approaching them with a finished product will not work. Approach the development of objectives objectively. Offer stakeholders a variety of approaches and let them decide which one they like best. Rapid, informal presentations that are direct and easy to understand is generally the best approach.

Group 2

The discussion started with an attempt to identify current regional efforts that have effectively integrated Human Dimensions into ecosystem models. The point was raised that it depends on how you define ecosystem model. In the Southeast/Gulf of Mexico, based on a classic definition of ecosystem model, there probably are not any good examples of this. The closest example for the Southeast may be the complex economic model that Marty Smith developed related to hypoxia. However, the linkages between systems (ecosystems and human systems) need to be identified, and that has not been done in the Southeast. The California Current developed an Atlantis model for the LME and linked the results to

an economic input/output (I/O) model that uses multiplier effects to evaluate the economic impact of changing revenues. In the Northeast, Geret DePiper has been developing a portfolio analysis focusing on optimizing commercial fish harvest portfolios. In Alaska, the Fishset tool has been used for the spatial modeling of the Pollock fleet. There are probably other examples but the group agreed that not all of the right people were in the room to be able to generate a thorough inventory of the different projects. It was also pointed out that the examples that were provided all focus on fisheries but in the future objectives need to go beyond fisheries. In California, a model has been developed to look at the impacts of protected resources restrictions on agricultural production focusing, for example, on the tradeoff between water use and salmon impacts. Doug Lipton mentioned that he has a post-doc adding an economic component to MSEs. Economic analysis can be integrated into most MSEs but there are a lot of different kinds of MSEs so it might not be appropriate for all of them. There are a number of examples available of economic models linked to ecosystem models such as Atlantis and Ecosim that should be looked at. It was pointed out that the output of an Atlantis model linked to an I/O model can also be used to conduct a social analysis.

Challenges mentioned included those of adding dynamic qualities to the coupling of the systems and temporal scaling issues (e.g. I/O models are not useful when applied to projections 50 years out). The treatment of uncertainty is also an important consideration – how do different modeling approaches generate uncertainty in different ways? Also, how do we engage management so that we can run the scenarios that matter most to them? Social scientists can play different roles in the process other than just modeling. For example, social scientists can engage managers/stakeholders/communities to better understand what kind of information they want. Social scientists from different disciplines should also be integrated into the process. There is a need to identify human dimensions response variables that would be relevant to MSEs. The importance of strong communication between all of the different researchers and stakeholders will be critical to model development. Management structures may not be ready to incorporate Atlantis level outputs so the development of simpler MICs (Models of Intermediate Complexity) was proposed as a potential option. Also, the question was asked, are we engaging the right clients? For example, the fishery management councils (FMCs) typically have not demonstrated a strong concern for the human dimensions aspects, so maybe we should be working with different stakeholders. What other clients are there and how can we diversify our client base? For example, the States tend to be more interested in human dimensions aspects than the FMCs. We need to think about the pathway, the end result and who will be the end user. Marine sanctuary condition reports may provide a good opportunity for the use of ecosystem models and the integration of human dimensions, focusing for example on ecosystem services components and how to sequence model results with management plans.

The point was raised that the ideal model currently does not exist so perhaps it would be useful to have a workshop to develop an MIC model, bringing experts together in a room to work out a model “from scrap”, using a problem or question from one region as a case study. Another option would be to have two groups develop models around the same question independently and then compare results. The suggestion was made to set up a working group for the development of a pilot MIC model.

Group 3

The discussion in this group focused around existing regional efforts that have incorporated human dimensions in management strategy evaluation, methodological approaches for incorporating human dimensions, engagement of stakeholders, and cross-regional collaborations. The discussion was summarized in three key points. Firstly, it was proposed that incorporating human dimensions in

ecosystem modeling and management strategy evaluation should be a foundational element of these exercises. The group emphasized that qualitative data can be successfully incorporated into modeling efforts, and progress has already been made on this front in the California Current IEA and Northeast IEA. Secondly, the group noted that long-term predictive power of models is limited and that this is particularly true when including human dimensions. The challenge is that underlying societal assumptions will likely change substantially over shorter time scales. Finally, the group felt that if human dimensions-infused modeling is to be useful to management, it would be necessary to recognize that multiple spatial scales may be relevant.

Group 4

The following points summarize key elements of the discussion in this group:

1. From the beginning, scoping needs to contain individuals from all three groups (social and natural scientists and governance). In addition, ground truthing (progress evaluation) needs to be done continuously at each stage of the IEA.

2. Integrated natural and societal models are complex, with different temporal and spatial scales. To successfully build such models all parties (physics, biology and societal) must sit together in the same room and development should go forward in an integrated manner.

3. These integrated models would improve our understanding and management of resources, but also could be used as a tool for outreach to public/stakeholders. Simplified versions could be used to provide understanding of the balances required for management and stakeholders in turn could provide insight into how they view the ecosystem to function.

4. There is a need for regional collaboration to leverage resources. For instance, EcoSim is used by multiple groups around the country, and shared resources (e.g. a single shared post doc) could improve aspects of the model and also create software to better utilize and visualize the model output.

Day #1 recap

The first day of workshop guided the group from the national high-level perspective, through introductions and updates of regional, international, and cross-regional collaborative efforts, and back to focused conversations on the topic of integrating human dimensions in all aspects of IEA work. After this very intensive day, the group reconvened briefly as a plenary to report on the various discussions from the breakout groups. It was noted that there were several commonalities that appeared within the different breakout group discussions. These included: effective communication of products and results, issues relating to the appropriate scales of work, the importance of scoping at all stages of the IEA process, and discussions of model complexity. At the end of the day, several Coffee Hour discussion topics were presented, and participants were encouraged to join these groups on the morning of Day 2.

Evening Social

An evening social was held at the FATE Brewery Company in Boulder. To continue introductions with the large and diverse group, an IEA Bingo game was created in which participants had to complete squares by finding other participants who fit a number of interesting descriptor statements. Jameal Samhouri came in second place and was awarded Kona IEA paraphernalia. Becky Allee was the winner and was awarded a FATE Brewery t-shirt.

Day #2 – Wednesday, March 2nd (Morning Session): Topics from Around the Nation

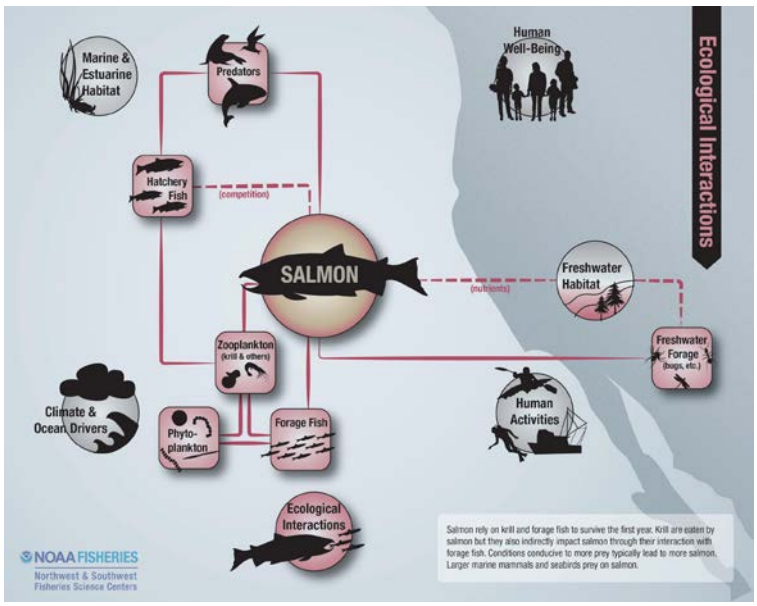
Coffee Hour Topic Discussions

Prior to the start of Day 2, participants met informally over various coffee hour discussions. One group met to discuss web visualization of IEA products. The group identified the target audience for such products, presentation of conceptual diagrams, and frequency of updates of web products. The Gulf of Mexico IEA program also held a meeting to discuss continuing work and next steps for implementation of the three-year plan.

Plenary: Lightning Presentations

Chris Harvey: Can conceptual models and loop analysis advance IEAs?

Chris Harvey from NWFSC discussed the application of Qualitative Network Modeling (QNM) to conceptual models in the California Current IEA. The method allows one to translate qualitative relationships between a species and its ecological, environmental, and human-dimensions interactions into quantitative interaction matrices. In an example focused on salmon management, he showed that management actions were unable to mitigate a theoretical climate perturbation. Another example focused on quantifying the influence of different links on "sense of place", and found that the influence of individual links was more evenly distributed and more difficult to disentangle when multiple management actions were combined. Overall, this technique appeared to be a promising method to quantify the influences one thinks may be important in a system.



Jamie Tam: Thresholds of ecological indicators in multiple ecosystems

Jamie Tam, a postdoctoral associate working with NMFS at a national level, has been working to develop methods to identify reference points that take into consideration the fact that ecosystems may be affected by a variety of different pressures, and these may combine in different ways across ecosystems. She used two different techniques-- gradient forest, and dynamic factor analysis with generalized additive models-- to look for thresholds and nonlinear relationships between a collection of pressures and drivers across IEA regions. She found that a mix of different pressures explained responses across ecosystems, but that both techniques showed similar threshold results when applied to the same set of data.

Chris Kelble: Three reference points for EBM

Chris Kelble from AOML proposed a new conceptual framework for defining desirable versus undesirable ecosystem conditions from both an ecological and social perspective. Past studies define an ecological ceiling based on environmental indices, considering conditions to be bad if they exceed a set value. Conversely, social considerations set an inner limit, with social well-being considered bad if certain basic needs are not met. The resulting indicator space can be seen as a donut, with the environmental ceiling setting the outer ring and the social foundation setting the inner one, and the center representing a safe space for both ecology and humans.

Chris talked about donuts.

Toby Garfield (for Andrew Leising): How to deal with emerging states that aren't captured in past indices

Toby Garfield from the SWFSC presented a case study on how changing conditions can lead to the need for new indicators. Two examples were given. The first concentrated on a situation where an indicator had historically been measured but not considered important. In this case, snow water equivalent had previously showed little variation, but in the past few years dropped significantly due to warming and low precipitation. The second example focused on the warm blob that developed in Pacific sea surface temperatures. In this case, a new metric was developed to quantify the area of space deviating more than a certain number of standard deviations above the historical mean. This new metric may show promise in forecasting El Niño events. Overall, these examples emphasize the importance of regularly reviewing existing indices to determine whether they are still applicable to the current conditions and whether new ones may need to be developed.

Greg Williams: California Current IEA website update

Greg Williams from the NWFSC gave an update on the nationally-hosted California Current IEA website. The main impetus was to run through the basic design of the website and identify some key challenges for scientists developing a website. The design of the website is organized around the conceptual models developed for the California Current IEA and allows for users to “dig down” into these conceptual models to retrieve status and trend results, and to actually download data and view integrative analyses such as risk assessments and MSE. Several iterations of the CCIEA webpage have been criticized for poor navigation and having outdated data. The question: “Is the IEA irrelevant if we don’t have a functional website?” was posed to highlight the need for a user-friendly functional website.

The new website integrates the conceptual models with flexible real time data presentations with the indicator time series data as the central theme. Summary tables are dynamic to allow new status and trend summary statistics to be calculated in real time and with flexible parameters to allow the end-user to have some level of control. The audience of this website includes scientists, managers, stakeholders and the general public.

Numerous challenges were identified with the current method of web design. Overwhelmingly, having scientists perform the role of web design is a bad idea and the IEA needs dedicated funding and a dedicated web designer committed to implement regional and national visions of the website; current levels of funding and personnel toward this end have not met our needs.

Mark Monaco: Coupling of NOAA's Ecological Forecasting Roadmap and IEAs

Mark Monaco from NCCOS explained how the Habitat Science and Ecological Forecasting team is supporting NOAA's Habitat Conservation Team (NHCT) to coordinate habitat science and provide leadership and access to habitat science that includes products such as weekly and seasonal updates for HAB blooms. One of the priorities of this team is to identify gaps in habitat science and has resulted in the downscaling of climate models to predict impacts of nearshore habitat changes on fishes and models linking climate change effects on habitat to biodiversity.

So, the question is whether foundational datasets and products from the Habitat Science and Ecological Forecasting Team can be used by the IEA? This synergy could build on strong NOAA support for the Ecological Forecasting Roadmap (EFR) and help inform the NHCT of IEA habitat products and data that could support EFR needs. Moreover, current NOAA investments in computational capacity could be leveraged to store and deliver IEA products. This theme was a common one throughout the meeting – that there are needs yet limited opportunity for cross-program integration.

Michael Alexander: Access to climate information: update on climate change web portal and future climate change working group

Mike Alexander from ESRL showcased the ability of NOAA's Climate Change Web Portal to output and display various environmental variables output from the collection of CMIP5 climate and earth system models (www.esrl.noaa.gov/psd/ipcc). This website allows the user the ability to make plots of physical variables over various periods of time including current conditions and future projections.

Numerous physical variables across land and ocean domains as well as biogeochemical variables in the ocean are accessible for plotting and analysis. Output includes both maps of current and future conditions along with time series plots including statistical measures of uncertainty. New variables of interest have been added, along with analyses that will continue to be developed. Ideas for new variables and analyses are welcomed.

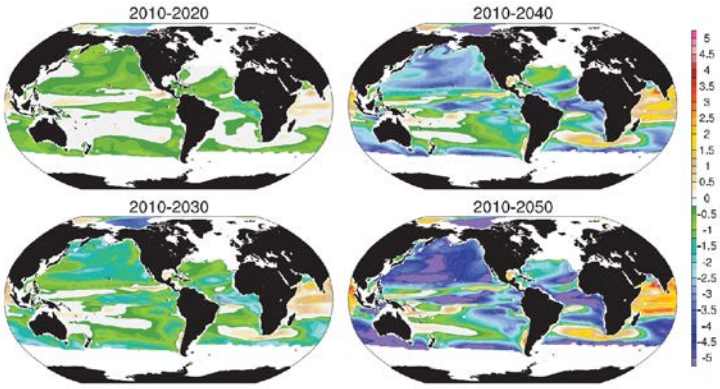
After the series of lightning presentations, a question and answer session occurred. Meeting participants asked for clarification on specific aspects of the different projects and initiatives that had been presented.

Day #2 – Wednesday, March 2nd (Afternoon Session): Climate change and Closing the Loop

Plenary: National Center for Atmospheric Research (NCAR) presentation on earth system models

Matthew Long from NCAR discussed research that he and his group at NCAR have been doing with the Community Earth System Model (CESM). CESM is a coupled model, including active atmospheric, ocean, land, sea and land ice, which conserves mass and energy. A carbon cycle model is designed to account for natural sources and sinks of CO2 and one question that he is interested in is how the natural sinks of CO2 change in the future. The ocean component of the CESM has three configurations: 3 degree, 1 degree and 0.1 degree. Spatial resolution is important because higher resolutions capture mesoscale variability, which is the dominant energetic scale in the ocean. The biogeochemical model is based on an NPZD (Nutrient-Phytoplankton-Zooplankton-Detritus) paradigm, with grazing/respiration, 3 explicit

plankton types, and one adaptive zooplankton class. Matthew showed applications of the Earth system modeling framework, assessing the impacts of anthropogenic forcing on marine ecosystems using CMIP5 projections of global mean quantities, under four different scenarios. An example of CESM large ensembles illustrated how internally generated variability is seen in trends (over 1963-2012) for 30 integrations of the coupled model and how the different ensemble members have lots of spatial variability. These large ensembles allow for an analysis of signal to noise partitioning, by separating out natural variability from anthropogenic forcing. He is currently evaluating the potential to develop meaningful forecasts of biogeochemical variables; the ocean contains the memory for such predictive capacity. As a final example, he showed an approach to quantifying optimal migration pathways of juvenile turtles using Individual Based Modeling (IBM). He is improving the CESM biogeochemical model and developing the next version called Marine Biogeochemistry Library (MARBL). The motivation of MARBL is to enable portability to alternative physical frameworks (in the questions he mentioned that he wants to implement MARBL to regional ocean modeling system, ROMS, but is not currently funded to do so).



Signal to Noise Ratio for trends (Long et al., 2016 GBC)

Breakout #3: Risk assessment: Climate change & Management Strategy Evaluation

Climate change represents an unprecedented challenge to marine resource managers. Through direct and indirect alteration of ecosystem processes and trophodynamic interactions, it has the potential to impact every aspect of a marine ecosystem and cause reorganization of ecosystem topography. At the same time, significant uncertainty about future projections and emission scenarios, stochastic regional climate variability, and variability in species response and compensatory dynamics, and diversity in adaptive responses by human communities present challenges when forecasting impacts for risk analyses, including vulnerability assessments. In this respect, climate change risk analyses and MSEs are an ideal case study for examining methods and challenges in conducting IEA ecosystem risk assessments and MSEs.

The objectives of this breakout group are:

- What climate change information is available and what is needed?
- Identify commonalities in climate change ERAs and MSEs in each region (if applicable)
- Identify challenges and methods to address challenges in ERAs/MSEs in each region
- Discuss how to engage stakeholders and regional management to guide ERAs and MSEs (iterative process?)

Group 1

The group initially focused on regional efforts on incorporating climate change into MSE and risk assessments. Although there are a number of examples, by in large, the IEA community is only just beginning to deal with this. Some examples from the regions: The California Current is doing some regional dynamical downscaling via ROMS, assessing the impacts of climate change on sablefish, hake and albacore, and short-term forecasting for bycatch risk based on environmental change. In the Northeast Shelf, efforts include assessing the impacts of ocean acidification on crab, vulnerability to climate change for coastal pelagics, and the human dimensions researchers are looking how future changes in species (e.g. pollock) catch may influence the local community. The Gulf of Mexico has focused on spawning of bluefin tuna and associated risk to future climate change, and is dynamically downscaling climate models that will eventually be integrated into risk assessments. They have also developed a single and multi-species framework that could include climate change. West Hawaiʻi has done some statistical downscaling of sea surface temperature (SST) to look at future coral bleaching and will do a reef-fish vulnerably assessment to changes in habitat induced by climate change.

Beyond this, the group discussed how to communicate climate change, as it is often beyond the time horizon of what many management entities are focused on. In Alaska, they have had fairly good success at engaging the subcommittees of the Council, such as the Science and Statistics Committee (SSC). It was recommended that communicating with the Council early and often is helpful, although initial scoping of the questions being asked really helps for update and communication. The other big issue is uncertainty, which appears to be a hurdle that also needs to be communicated more appropriately.

Group 2

There are currently similar projects looking at climate change across regions, though no one in our breakout session was conducting official risk assessments and the manner of study varied slightly. The GOM region is looking at several study sites in South Florida with semi-quantitative network analysis and some hydrodynamic models for estuaries and collaborating with economists to look at changes in valuation of ecosystems/services. Every region across the board has been tasked with analyzing the vulnerability of valuable stocks; some specific efforts on the west coast are looking at salmon populations related to climate adaptation scenarios. There are also some supporting efforts to determine regional baselines for climate models to identify anomalies and deliver high-resolution models. All regions agree that there are strong management implications throughout the projects, but the delivery of information to managers and the public is lacking. There is a common difficulty in getting managers to understand the implications of climate change models, especially in areas where drastic change is not evident. Providing a range of case studies/scenarios of real time risks of certain implications could be a way to make people understand that climate change doesn't have to be visible in their area to be happening overall. The group agreed that one of the most important things is to reduce emissions across the board to avoid large-scale catastrophe, but that this may be better suited to a full NOAA approach.

Group 3

The group identified communication across disciplines as essential for incorporating climate change into broader projects. There is currently a mismatch between the temporal and spatial scales that managers and stakeholders are most interested in (interannual-decadal, local-regional), and the scale of

projections that global climate models can provide. The strengths and limitations of models should be made as clear as possible to users of model outputs.

When using projections from climate models, it is important to quantify uncertainty by considering internal model variability. The advantages of using model ensembles were also highlighted. It is good practice to use multiple climate models, different downscaling methods, and more than one Representative Concentration Pathways (RCP) (CO_2) scenario. Some variables (e.g. temperature) have comparatively low uncertainty within global models, while others (e.g. primary productivity) are much more uncertain. There's also considerable uncertainty deriving from future land use, fishing fleet capacity, human use etc., which is difficult to predict on longer timescales. Similarly, users should be cautious about attributing trends in past time series to climate change, when monitoring programs have not been in place for long enough to separate natural variability from climate change. These issues and uncertainties should be effectively communicated to the users of model outputs and products.

Risk communication is well accepted within NOAA, and commonly used within the Weather Service for hurricanes, extreme events etc. It is often more practical and effective at local rather than national levels. Our sector can learn from these practices to enhance our risk communication with stakeholders and the general public. Some "climate readiness" is already happening at a local level, through Sea Grant for example.

The group agreed on the importance of working with local groups, managers and stakeholders to identify climate-driven risks of importance at the local level, rather than imposing products in a "top-down" manner. For example, some communities (e.g. Maryland eastern shore) are particularly vulnerable to sea level rise. Sea Grant could be a good source of connections to local communities, and the group recommended enhanced connections with Sea Grant in the future, including meeting participation.

The group proposed using objectives highlighted in the IEA 3-year work plans and other documents to identify some demonstration case studies for particular regions, and pressures. Some of the more "certain" climate change impacts could be used, such as acidification, deoxygenation (in some regions) or sea level rise. These case studies could connect climate models to impacts models, and provide outputs designed to engage with the local community and managers, including potential management actions and trade-off analyses. This is likely to be more constructive than presenting multiple climate change impacts with varying uncertainties with multiple impact models. The role of IEA could be to work to incorporate climate information into modeling and risk assessment, and then to work with state and local managers, and giving them tools to communicate with local communities.

There may also be good opportunities to work with NOAA Protected Resources division. Several groups are working on threatened species and ecosystems (corals, marine mammals, etc.), and are particularly interested in future pressures from climate change.

It may also be useful to perform gap analyses of models and capabilities by region. This would include an inventory of ecosystem models, in terms of spatial and temporal scale and resolution, as well as climate model forecast ability and projection capability. This could highlight gaps in knowledge and expertise, and provide a framework for future research focus.

Group 4

This group noted that overall, IEA regions are primarily involved in risk assessment, rather than management strategy evaluations. This was likely because in many cases, councils and managers may be

more amenable to looking at risk and past impacts, rather than testing future alternative management strategies. The group felt that the choice of scenarios for climate change was a bit opportunistic, and that we may need to think more carefully about rationale for choosing scenarios in the future. They noted that different IEA regions are using a variety of downscaling approaches, from statistical downscaling for coral bleaching projections in Hawaii, to much more challenging dynamical downscaling for California Current.

Breakout #4: "Closing the Loop:" Connecting IEA Science to Management

The NOAA IEA approach is built on an iterative and step-wise approach, affectionately called the IEA "Loop". The IEA approach is also fundamentally a decision-support process to provide more complete and comprehensive information to inform decisions managers have to make. "Closing the loop" is a priority, and this can be interpreted in at least two complementary ways. The first is more philosophical in the sense of transferring IEA science and products to management. The second is more process oriented: putting the pieces and parts, or steps, of the 'loop' together. Each region has different experiences and levels of development with regard to both of these aspects that can provide best practices and lessons learned, as well as define a way forward to achieve "Closing the Loop". The goal of this breakout group is to explore what "closing the loop" means and how we achieve it.

The objectives of this breakout group are to:

- Define what a "closed loop" might look like? Provide some concrete examples
- Discuss what steps have been most challenging or most straightforward to achieve in the IEA process and why
- Discuss what scientific and management objectives the IEA approach is supporting in each region
- Identify opportunities for cross-regional collaborations towards "closing the loop"

Group 1

We loosely defined a closed loop as a process where a question or issue is raised by a manager or policymaker and brought to scientists; the scientists develop findings and then close the loop by reporting back to the manager/policymaker. The closing of the first loop is merely an iteration and signifies the beginning of the next loop of the ongoing process to address the question. Within a loop, there are also iterative mini-loops of communication, analysis, validation, and feedbacks as perhaps best illustrated by the "inner loop" of adaptive management within the IEA loop diagram. As our definition of a closed loop originates with the question or issue coming from managers or policymakers, it is clear that "opening the loop" is just as critical as closing it within the IEA framework. Beyond this definition, our discussion ranged around several points; our four key take-away points are: (1) the closing of a loop is a two-way interaction between scientists and managers/policymakers/stakeholders, but "closing" the loop likely does not mean the question has been answered or the process is finished; it is more likely the start of the next loop. (2) Working with clients in this collaborative way is advantageous because it enables them to speak on their own behalf of the merits of the IEA approach, and their voices will resonate more than ours. (3) To assist clients in opening loops, we should be prepared to share with them our capabilities, in particular what the IEA science framework can provide that NOAA science wasn't providing already; this includes IEA-specific products, integrative methods, and collaborations. (4)

Closing the loop, in many cases, means providing near-real time information, tools and analysis to clients, which is a different paradigm from the slower processes of science development and peer review that many of us are familiar with. Ideally, the IEA program should help to pioneer this type of science delivery.

Group 2

The main themes of the discussion in this group were as follows:

In general, the "loop" is part of the scoping (back and forth between scientists and stakeholders), so there's a lot of back-and-forth and "loop closing" in the initial determination of targets. There are many "small steps" that go back and forth continually.

Many of these examples don't complete the "whole IEA loop" (e.g. including indicators, status, and MSEs in full IEA cycle), and it is not necessary to complete the whole IEA loop to "close the loop" between science and management - although there are examples that are approaching that (e.g. ICES, and California Current is approaching that).

Issues can arise when scientific advice "reverses." For example, our previous understanding may be that herring changes led to a collapse in capelin, whereas in another year, the changes may be associated with collapse in cod. Another example from Alaska is that previously, "warm conditions" were thought to be better for productivity, but the current understanding is that "cold" is better. This is a specific type of "uncertainty" that we haven't discussed much. We need to ensure that "getting it wrong" is framed in the context of "adapting" and adaptive management.

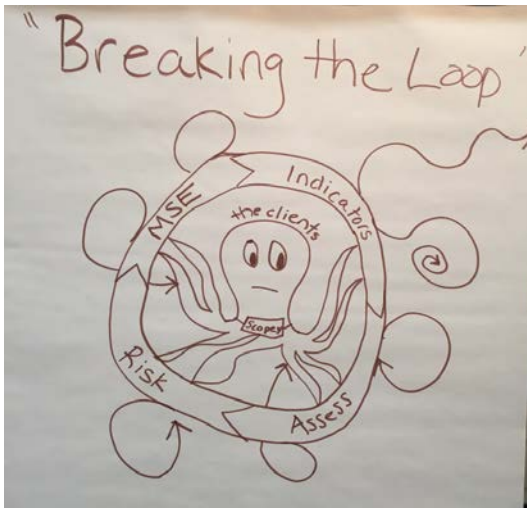
The biggest challenge is in providing the information we have in a means that it is desired. We should be considering communication in terms of clear frameworks (e.g. conceptual models) so that a context for engagement progresses forward in both science and management.

There is plenty of room for cross-regional collaboration to help with our limitation of resources, such as sharing methods and sharing specific peoples' expertise. The group noted a number of examples of very successful sharing: the ticker trend plots; conceptual modeling; and cross-regional postdocs such as Jamie Tam.

Group 3

This group understood the concept of "closing the loop" to represent successful science-to-management exchange, and recognized the importance of considering IEA as a process rather than something that could be brought to an end. The group first considered regional examples of successful information exchanges, such as the California Current IEA contribution to groundfish regulations and whale-ship strike interactions, as well as the management strategy evaluation work informing management of grouper stocks under scenarios of episodic natural mortality in the Gulf of Mexico IEA. It was recognized that there exists no "gold standard" IEA example with which to compare ongoing work, and also that many IEA products were the result of opportunistic situations, where a certain management issue came to light and IEA products and tools were in place to inform decisions. The group also felt that the original IEA loop as proposed by Levin et al. (2009) was not entirely pragmatic. It was noted that often times, there were nonlinear processes or extensions of the IEA framework which produced products useful to management. It was also thought that rather than considering the "scoping" phase as the start of an IEA iteration, it should instead be considered a process that percolates through all steps of an IEA, in the form of constant dialogue with managers.

Based on the group's discussion and understanding of how IEAs are implemented in real life, the group proposed a new schematic representation of an IEA Loop. Instead of positioning the scoping process as a step in the Loop, the group positioned it in the center of the loop with connections to indicator development, assessment of the ecosystem, risk assessment and management strategy evaluation. To emphasize that effective scoping can be a complex and difficult balancing act, the group chose to represent this process with a confused octopus, struggling to reach each part of the loop. Various eddies and currents spinning off the main loop were chosen to represent the often nonlinear nature of IEA work, which sometimes loops back and meets the original purpose, but oftentimes drifts and adopts to other mandates or management needs.



"Scopey" the beleaguered octopus, in his rightful position.

Group 4

There was consensus that while progress had been made on many aspects of the IEA loop, no regions had yet fully completed the loop linearly (i.e., no regions are yet in the "inner-loop" of iterative feedback with management). That may be largely a reflection of a lag in available Regional Planning Bodies to serve as the user for the "full IEA", although these are likely to be established soon. Most regions agreed that progressing through the steps of assessing the ecosystem had been done, but the next steps which involve significant interaction with managers had not been completed (some under-way). Successful engagement with management was discussed and these examples generally involved engaging sub-committees of federal fisheries, state regulatory, and marine sanctuary councils. There was an excellent example from WA state, whereby a legislative directive was developed to use the "full IEA" to inform coastal zone management - from scoping through risk analysis. The group discussed the need for engaging with management early and often, starting with development of objectives and goals (step 1); this should be done with input from managers and stakeholders. It was suggested that completing the outer loop quickly and qualitatively as a first pass would be a good way to prioritize management needs and objectives (i.e., complete the loop at a Tier 1, but complexity level 3 in the ERA framework). The group also stated the need to provide a short summary of clear management-relevant advice at completion of the loop.

Day #2 recap

Participants briefly convened in plenary to report back summaries from each of the breakout groups. For the breakout group focused on risk assessment and climate change, all groups discussed to some extent the challenges in communicating risk to managers. It was noted that communicating uncertainties was particularly of importance and that lessons could be learned from other disciplines. Several groups highlighted that there are a variety of approaches for risk assessment in different regions, and that it could be useful to highlight key case studies as success stories for the IEA program. For the breakout group on linking science to management, much discussion focused on considering IEA as an iterative process rather than a single loop, and the need for bidirectional information flow between scientists and

managers. Several groups highlighted how the actual implementation of the IEA process differed from the conceptual diagrammatic workflow.

After a brief discussion of potential Coffee Hour discussion topics for the following morning, Day 2 of the workshop was adjourned.

Day #3 – Thursday, March 3rd (Morning Session): Cross-Regional Collaborations and Meeting Synthesis

Coffee hour: IEA topic discussion (off campus)

Prior to the start of Day 3, participants met informally over various coffee hour discussions. For example, the West Hawai'i IEA program held a meeting to discuss implementation of the recently developed 3-year plan and how the ideas and collaborations generated from the National meeting could be incorporated into regional planning. A human dimensions focus group also met to discuss the progress of various research projects, and additional concrete products that could be developed in the near future (see working group descriptions below).

Plenary: Science on a Sphere: Explorer demo

Jebb Stewart from ESRL Global Systems Division provided us with a high-level overview of the application of the NOAA TerraViz to the Science on a Sphere (SOS):Explorer project. Briefly, the SOS:Explorer is a tool for visualizing various forms of data (e.g. temperature, wind speed, primary productivity, etc.) within a "google-earth"- like platform. The SOS:Explorer is an exceptional tool for broader outreach and educational activities, but it could also be used within the IEA process to visualize, for example, local, regional, or global scale implications associated with alternative management strategies. It could be used as a platform for displaying data to communicate issues to diverse audiences (e.g. managers, scientists, educators, students) ranging from IEA status and trends, visualizing vulnerability, or asking/answering large-scale questions related to land use, population density, etc.

Science on a Sphere was pretty awesome.

The SOS has two primary "versions" 1) the NOAA Earth Information System (NEIS) or 2) the SOS explorer. The SOS explorer is aimed more toward educators and students, and has immediate utility in the broader applications aspects of our research, while the NEIS is aimed more toward the power-user. The NEIS is compatible with ERDDAP, and there is the possibility of pulling ERDDAP to power/develop individual modules within SOS:Explorer; it was suggested that Jason Link's existing fish visualization tool could possibly be embedded/nested within the SOS:Explorer platform. Currently adding/updating data is a manual process, but there is a future possibility of independently uploading data sets. In the future, integrating NOAA's multiple data sources/sets within the SOS:Explorer framework could enable novel understanding of broad-scale phenomena and processes at inter-IEA regional scales, while facilitating a wealth of educational outreach opportunities and broader impacts.

Plenary: Future of the IEA Facilitated Discussion

Currently NOAA is five to six years into using and implementing the IEA framework, and while we have achieved success by many metrics, some issues and challenges continue to recur. Across all regions there has been a noted increase in the appreciation for interdisciplinary science and the incorporation of the social sciences into the IEA framework; this improvement is particularly noticeable over the past two years. Also we have succeeded in improving our cross-line office and inter-regional communication and collaboration as evidenced by the diversity of representatives in each of the working groups and breakout sessions. However, the IEA continues to be dominated by NMFS personnel and those working on the California Current IEA. Strategies for increasing involvement from other line offices and resources for building up the body of IEA practitioners in other regions, particularly the West Hawai'i IEA are needed.

An outstanding challenge for the IEA community is to identify how the IEA will work alongside the single species stock assessment process; the incorporation of ecosystem considerations into stock assessments appears to be a logical conduit for communication between these two complementary processes. However, we continue to grapple with the transition from Ecosystem Approaches to Fisheries Management (EAFM) to Ecosystem-Based Fisheries Management (EBFM) to EBM, and the true value of IEAs will not be realized until we embrace multi-sectoral EBM. This highlights one of the primary challenges facing the IEA community of practitioners: to build support for IEAs in the broader NOAA community we must better highlight our successes. This latter point is particularly relevant given the remarks of senior administrators on day one of our meeting. Future efforts must be made to engage resource managers, identify pressing management questions, and show clearly how the IEA framework can be (and is) used to enhance and inform decision-making. Funding is always limited, but this is the current state of affairs so no easy solutions were presented here.

The future of the IEA program should build upon its strong foundation of consensus building, and strive to integrate the portfolio of inter-regional projects in a manner that produces synthetic products; taken as a whole, this portfolio will increase our understanding of IEAs. Through the synthesis and integration of broad-scale ecosystem data, in conjunction with clear and specific illustrations of the tactical application of IEAs within NOAA and the broader scientific community, we will be able to highlight the utility of the IEA framework in both generating fundamental understanding of large marine ecosystems, and acting as an analytical tool that can be used to operationalize ecosystem-based management, ultimately moving our nation's marine ecosystems and trust resources toward sustainability.

The morning plenary was concluded by carrying out a visioning exercise. Attendees were asked to brainstorm answers to a series of questions:

1. Three years from now, where do we want the IEA program to be?
2. How do we get to (1)?
3. What is needed from the Steering Committee to ensure success?

Ideas from the group are captured in the table below.

Visioning exercise

Three years from now, where do we want to be?	How do we get there?
● Be in all regions (5/8 now; expand to other 3: Great Lakes, Caribbean, South Atlantic) + Norway (IMR partnership) ● Clear understanding of what the IEA is (managers, stakeholders & scientists) and concrete products (website, reports, management scientific advice, etc.) ● IEAs role in advancing ecosystem science, e.g. better understanding of ecosystem reference points (size structure, species composition). ● Cross-sectoral integration - EBFM to EBM. ● Greater clarity from headquarters for how IEA fits in with other programs (Regional Action Plans, EBFM policy, Fisheries and the Environment program, Climate Vulnerability Assessments, Ecological Forecasting, etc.) ● Decision process with a 3 year horizon to allow time-scale for re-assessment. - in each region, identify a decision process and partner that needs IEA science (National Marine Sanctuaries, Protected Resources, FMCs, state agencies, etc.) with a 2-3 year time horizon; then bring whatever tools are needed to inform the decision that is going to be made. ● Technical capacity building - currently the IEA serves as a home for things that need to be operational but don't have a home. MSE positions as an example of what could be done. - Continue and expand IEA as a community for practice that can inform EBM. - Facilitate exchange of technical tools (e.g. through google groups, mailing lists; working-groups) - Automated data-delivery systems, indicator updating & web-portal ● Inform management decisions outside of fisheries councils (sanctuaries, state entities, etc.)	● Start with your 3- year plans - use existing leveraging / don't over-commit ● Steering committee feedback on 3-year plans to ensure consistency with national IEA vision - Use 3-year plans to identify cross-regional collaborations/themes ● Stay the course ● Cross-regional working-groups ● Case studies of engagement with management and we need more managers in the room ● Directors of line-offices → incentivize. - Link IEA process to language of directives so that budget is not limiting and that IEA work can be in staff performance plans - Like Healthy Ocean goals, we need national recognition & cross-line office collaboration on EB(F)M needs to push this forward ● Incentivize management products in addition to publications. Support risk-taking (e.g., ecological predictions, ecosystem status, and management advice) ● Increase intra-regional collaborations and engage other regional partners working on habitat, etc. ● Protect the integrity of the science - transparency in the process and interface between science and management advice ● Identify commonality among regions - assessment of human impacts on ecosystems. ● Better / clearer connection between single species stock assessments and the IEA - Ecosystems considerations are one way towards those efforts. ● Have good project management but we need better portfolio management of projects to

- good engagement to date of fisheries councils ● Increase other-line office engagement ● Concrete examples of integrated End-to-End models of biophysical through human dimension	increase leveraging and coordination (coming back to engagement with other national programs) ● Focus on a way to communicate to NOAA leadership
What is needed from the Steering Committee? ● Continue communicating to IEA team (and broader science center community) - for example, IEA engagement to other national opportunities. Identify common themes and ensure they resonate across the regions and internationally with ICES / PICES. ● Incentivize high-risk, high-reward research activities. ● Communicate and advertise upwards to center directors and to NOAA Headquarters as well. ● Formalize structure for cross-regional integration and common tools and themes (e.g, web-based tools, working groups) - frequency of national IEA meeting versus intersessional working group meetings - Number of intersessional working groups ● Make sure the leaders have concrete examples of successes before the next meeting (if not sooner).	**Questions / concerns:** ● Blend of an ecosystem approach to management and the role of IEAs. Where does one begin and the other end? Contrast and compare the Bergen vs. NOAA model. - Stock assessments as the analytical engine for single species management, the IEA as the engine for ecosystem based management. ● Blueprint for interfacing with management is unclear - We have learned that scoping is not a step but instead part of each step of the process. - Opportunistic engagement with targeted management problems has been a huge step forward in the process. - Multiple planning bodies exist and need to engage the NOAA engagement on each of these planning bodies. ● What needs to be added to ecosystem status report to make it an IEA? - Multivariate analyses, thresholds, tipping points, phase shifts, etc. ● Need to come up with a common definition of "reference point" or multiple reference points. ● Future meetings need to have more managers in the room.

Day #3 – Thursday, March 3rd (Afternoon Session): Putting it all Together

Break out groups

Working group topics for the afternoon of Day 3 were derived from ideas formulated throughout the workshop and even before the workshop began. Meeting participants were asked to add their ideas for potential work group topics to a Google Drive document that would provide the basis for project selection. Workshop facilitators coalesced the group's combined ideas into a smaller number of topic areas. These topic areas included:

1. climate change and modeling
2. thresholds and reference points
3. conceptual models and loop analysis
4. web-based communication tools
5. ecosystem modeling and food web toolbox development
6. human dimensions integration

Meeting participants were asked to vote on their personal topic of greatest interest, and working groups were thereby formed. Each group elected a leader and a rapporteur for their respective working groups. Groups were asked to work towards the development of a terms of reference document and/or a work plan, which would provide the basis for progress on the topics between meetings.

It was determined that working group organization would be accomplished via Google Groups or other dynamic frameworks that would allow for regular updates and addition of participants as the topics evolved. Thus, within this summary we report only the main point of contact for each group, and a brief discussion of the focus.

Climate change working group

Contact: Isaac Kaplan, NWFSC, Isaac.Kaplan@noaa.gov

The IEA climate change working group aims to share and/or coordinate marine climate change research across NOAA IEA regions, and with other partners. Climate change is intended to also mean global change, including ocean acidification.

The working group is a way of sharing solutions related to:

- Downscaling from global to regional physical and biogeochemical models
- Handling uncertainty at all levels of modeling and analysis
- Linking from physics and biogeochemistry to biological responses
- Linking to human dimensions, including human wellbeing and social vulnerability
- Providing advice to relevant US and international processes.

Primarily this working group is meant to facilitate communication and dissemination of tools across regions. Secondarily this may lead to cross-region synthesis, manuscripts, or other products.

Thresholds and reference points working group

Contact: Jameal Samhouri, Northwest Fisheries Science Center, Jameal.Samhouri@noaa.gov

The thresholds working group agreed to produce is a glossary of terms related to reference points. No specific near-term objectives were planned. However, other regions interested in applying and improving upon approaches that have implemented for the California Current or Northeast IEAs are welcome to contact the group for support.

Conceptual models and loop analysis working group

Contact: Chris Harvey, NWFSC, Chris.Harvey@noaa.gov

This group felt that progress was not far enough along to allow for development of specific objectives or products. Thus, the group proposed simply forming a "study group" that might communicate occasionally to update on progress, new findings, or new tools. The group decided that initial steps would include setting up a mechanism for sharing literature on the topic. There was also discussion of developing a "cookbook" to outline the pros, cons, and pitfalls of different conceptual modeling techniques, so as to facilitate exploration of the methods in the IEA realm.

Web-based tools working group

Contact: Elliott Hazen, SWFSC, Elliott.Hazen@noaa.gov

The group decided on a two-part strategy to work on 1) the national IEA web page and 2) a web plotting tool pulling data from ERDDAP. There will be cross-collaboration between these two groups, but the efforts should be underway simultaneously. A WG call is planned for May 2016 with the purpose of coming up with task timelines and cost estimates.

Food-web user group and toolbox development working group

Contact: Kerim Aydin, NWFSC, Kerim.Aydin@noaa.gov

All regions have developed some type of "bulk biomass and flow" model. The food web modeling working group will continue the development of a food web modeling toolbox including implementations of the popular Ecopath with Ecosim software in R and Matlab. This includes the development of supporting tools such as model fitting with "stock assessment" level transparency, automated updating, and online visualization tools for complex network diagrams.

- Create a NOAA user group including a point of contact for each IEA region. This group will connect researchers doing similar work and foster a community development atmosphere.
- Attempt to better capture NOAA policies by incorporating socio-economic box model along with ecological box models. Identify core functionality that will be needed to span ecological to human dimensions. Determine which policies are being broadly applied across regions and figure out how to implement them.
- Develop visualization tools that better convey the results of food web models.
- Compare models across regions and identify common data gaps. This information can be used to suggest targeted research priorities.

Human dimensions working group

Contacts: Maria Dillard, National Centers for Coastal Ocean Science, maria.dillard@noaa.gov & Stephen Kasperski, Alaska Fisheries Science Center, stephen.kasperski@noaa.gov

This working group is a continuation of ongoing efforts from the past several years. An existing terms of reference, and research carried out to date, formed the basis of discussion at this workshop (see

Appendix IV). The working group focused on additional concrete products that could be developed. The potential ideas that were discussed are as follows:

- Indicator inventory and guidance – building upon existing ad hoc collaboration, we could compile an inventory of all existing social indicators along with the specific plans within each region for the indicator work. This would also include guidance about the use/application of these indicators.
- Peer reviewed publication of case studies from each region that demonstrate how social and biophysical indicators have been integrated.
- Policy paper on EBM or other high level topic (interest from leadership in having NMFS carve out an area for social science success); possibilities include climate adaptation
- Inventory of methods and analyses being used in different regions; opportunities to advance work based on expertise of other HD social scientists not located in a region where the work is needed
- Workshops where participants bring data and work through specific analyses/models in person; while these could be regional workshops, it would be beneficial for the larger group of social scientists to be present to support the work. Explore possibilities for getting funding for in person workshops.
- Write up of how HD fits into each IEA loop step and the expertise needed/best suited to each. This would be very useful for Doug in speaking about the importance of this work at a higher level.

Workshop wrap up

Meeting participants came back to plenary to hear brief summaries of the progress of each of the working groups. It was agreed that a working group participant sign-up/ list would be circulated so that individuals interested in multiple groups, or individuals not present at the meeting, could become involved in the working groups of their preference. The group agreed that continued follow-up would be achieved through email lists and through the use of Google Drive or Google Groups, to be spearheaded by each working group's primary contact.

Closing remarks were made by Rebecca Shuford and Chris Kelble who noted that the 2016 IEA workshop had been very productive and that many good ideas had been brought to light. Participants were thanked for their engagement and energy throughout the workshop. The organizing committee was thanked for their work in planning and facilitating the meeting and they vowed never to do it again. Rebecca Shuford was recognized for her leadership throughout the entire workshop planning and implementation process and Mike Alexander was given special thanks for his assistance with local accommodations and facilities. Recognition was also given to the tremendous logistical support from ESRL, and perhaps most importantly for their success in maintaining an adequate caffeine supply throughout the three days of workshop. Particular thanks went to Madeline Sturgill and Chesley McColl for their support.

Post-workshop evaluation

There were a total of **19** respondents out of the **60** attendees. There were a few common themes highlighted by multiple people in the exit survey that are summarized below.

- The mix of formal presentations and free form opportunities was great. Coffee hour was a huge success.
- In the future, we would suggest less formality to breakout groups (e.g. more free form) to have greater success.
- The NOAA IEA process is working and fostering collaboration amongst science centers and disciplines.
- Everyone (94%) responded affirmatively that their voices were heard!
- Almost everyone had something from the workshop that they were going to take home with them - answers were too diverse to summarize!
- As for remaining gaps, there is still more work to be done on human dimension indicators and MSEs.
- GREAT job organizing and running the meeting.

Appendices

Appendix I. IEA Steering Committee and Workshop Participant list

2016 IEA Steering Committee:

Chair:	Chris Kelble	Chris.Kelble@noaa.gov
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Appendix II. Meeting agenda

2016 NOAA Integrated Ecosystem Assessment Program "Face to Face" meeting
March 1 – 3, 2016
NOAA Earth System Research Laboratory
325 Broadway, Boulder, CO
Room: GC-402 (main conference room)
http://www.esrl.noaa.gov/about/visiting.html

Remote Access information:
Please join "my meeting" from your computer, tablet or smartphone.
https://global.gotomeeting.com/join/684742181

You can also dial in using your phone.
United States: +1 (646) 749-3122
Access Code: 684-742-181

Thank you for participating in the 2016 IEA national meeting. We have a few overarching goals for this meeting and have accordingly tailored the agenda to make our time together as productive as possible. Our goals include developing both national and international collaborations, and also understanding how the IEA process fits into the broader ecosystem-based management landscape. For the meeting to succeed, we hope each one of you will take ownership of a component of this and think about how best to improve the meeting as it unfolds. The schematic for this meeting is to begin with a few talks to get everyone on the same page, allow increased opportunities for non-traditional participation (e.g. coffee shop meetings), and most importantly, work toward a series of goals (products, collaborations, outcomes) that we hope to achieve in the near (3 days) and far (10 years) term.

Overarching goals

1) Identify how the IEA is being implemented in the US and elsewhere (IMR).
    a) What would an operational IEA look like? How do we make it operational?
    b) How does the IEA integrate with and/ or add value to other NOAA programs?
    c) How does the IEA enable an ecosystem-based approach to management?
2) Build cross-regional collaborations through development of proposals and papers on advancing IEA methods.
3) Identify methods to advance integrating human dimensions into every aspect of IEA

Day #1 - Tuesday, March 1st: Morning Session: Trends and Status of the IEA

8:15 – 8:45 Arrive at ESRL for check-in
8:45 – 9:00 Opening remarks and overarching goals of the workshop
9:00 – 9:45 Plenary: National IEA perspective

- Where the IEA currently stands and where we see it going (Ned Cyr, Steve Fine, John Armor, Robin Webb)

- Overview of the EBM spectrum of management and how can ecosystem information inform management: and IEA perspective (Mike Fogarty).

9:45 – 10:00 Discussion, question & answer session

10:00 – 10:30 Plenary: Introductions and regional updates

- Introductions: name, region, what you hope to walk away from the workshop with.
- Regional updates: one person from each region presents regional highlights and big picture goals.

10:30 – 11:00 Coffee break

11:00 – 11:20 Plenary: International approaches to Integrated Ecosystem Assessments

- Norway's Institute of Marine Research (IMR) (Hein Rune)

11:20 – 11:30 Discussion, question & answer session

11:30 – 12:30 Plenary: Recent collaborative IEA efforts

- Recent collaborative IEA working groups (15 min each)
  - California Current thresholds working group (Jameal Samhouri)
  - Ecosystem Risk Assessment working group (Kirstin Holsman)
- Future IEA working groups (15 min each)
  - Human Dimensions (Doug Lipton)
  - Web-based tools for data exploration and IEA visualization (Elliott Hazen / Greg Williams)

12:30 – 13:30 Lunch (Order in)

Day #1 - Tuesday, March 1st: Afternoon Session: Human Dimensions and the IEA

13:30 – 14:00 Plenary: Human dimensions

- Integrating social science into the IEA (Maria Dillard)

14:00 – 14:15 Discussion, question & answer session

14:15 – 14:30 Breakout Groups

- Desire is to achieve actionable outcomes on how best to incorporate human dimensions in each of the IEA steps

14:30 – 15:30 Breakout #1: Human dimensions in Indicators and Risk Assessment

15:30 – 16:00 Coffee break and change groups

16:00 – 17:00 Breakout #2: Human dimensions in Ecosystem Models and Management Strategy Evaluation

17:00 – 17:30 Report Back to Plenary

17:30 – 17:45 Day #1 recap

Evening Social: **6:30 at** FATE Brewing Company (http://fatebrewingcompany.com/)
1600 38th Street Boulder, CO 80301 | one block west of Foothills Parkway on Arapahoe Road

Day #2 - Wednesday, March 2nd: Morning Session: Topics from Around the Nation

8:30 – 9:30 Coffee hour: IEA topic discussion (off campus)

10:00 – 10:50 Lightning presentations (10 min each)

1. Can conceptual models and loop analyses advance IEAs (Chris Harvey).

2. Establishing thresholds of multi-ecosystem responses to anthropogenic and environmental pressures (Jamie Tam).
3. Three reference points are required for IEA indicators (Chris Kelble).
4. How to deal with emerging states that aren't captured in past indices (Andrew Leising).

10:50 – 11:00 Discussion, question & answer session
11:00 – 11:20 Coffee break
11:20 – 11:50 Lightning Presentations (10 min each)

5. Communicating California Current IEA products to end users: web design, improvements, and challenges (Greg Williams).
6. The coupling of NOAA's Ecological Forecasting Roadmap and IEAs (Mark Monaco).
7. Access to climate information: update on climate change web portal and future climate change working group (Michael Alexander).

11:50 – 12:00 Discussion, question & answer session
12:00 – 13:30 Lunch (on your own/ off campus)

Day #2 - Wednesday, March 2: Afternoon Session: Climate change and Closing the Loop

13:30 – 14:00 Plenary: Climate Change

- NCAR presentation on earth system models (Matthew Long)

14:00 – 14:15 Breakout group exercise
14:15 – 15:15 Breakout #3: Risk assessment: Climate change & Management Strategy Evaluation
15:15 – 15:45 Coffee break and change groups
15:45 – 16:45 Breakout #4: Closing the IEA loop and science to management
16:45 – 17:15 Report back to plenary
17:15 – 17:30 Day #2 recap

Day #3 - Thursday, March 3rd: **Morning Session: Cross-Regional Collaborations and Meeting Synthesis**

8:30 – 9:30 Coffee hour: IEA topic discussion (off campus)
10:00 – 10:30 Science on a Sphere: Explorer demo (John Schneider/Jebb Stewart)
10:30 – 11:30 Plenary: Future of the IEA (Chris Kelble: facilitated discussion)
11:30 – 12:00 Brainstorming exercise to identify key themes for afternoon breakout
12:00 – 12:30 Lunch (Order in)
12:30 – 13:30 Building tour

Day #3 - Thursday, March 3rd: **Afternoon Session**: **Putting it all Together**

13:30 – 16:00 Break out groups:

- Sketch collaborative topic ideas, work plan, funding opportunities, etc.

16:00 – 17:00 Report back to plenary
17:00 – 17:30 Wrap up

Appendix III. Pre-workshop questionnaire

1. Name (optional)
2. Affiliation (optional)
3. E-mail (optional)
4. IEA Region
   - NE Shelf
   - Gulf of Mexico
   - California Current
   - Pacific Islands
   - Alaska Complex
   - Other:
5. What topics are you most interested in discussing during the workshop? *Check all that apply.*
   - Incorporating human dimensions into aspects of IEAs
   - Synthesis / "closing the IEA loop"
   - Translating science to management
   - Climate change analyses - methods and approach
   - Other:
6. Are you interested in giving a brief 'lightning' presentation (~10 minutes) at the workshop on an emerging IEA research topic or finding? If yes, please indicate a proposed title for your talk.
7. How much time would you prefer to spend in each of the following types of activities? *Please enter percentages summing to 100.*

	0%	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Plenary discussions																					
Listening to presentations																					
Breakout groups																					

8. In your opinion, what is the ideal length of time for mid-morning and mid-afternoon coffee breaks?
9. Please list what you believe are the three biggest SUCCESSES for the IEA program in your region.
10. Please list what you believe are the three biggest CHALLENGES for the IEA program in your region.
11. Please list any ideas for collaborative efforts that you would be interested in seeing pursued (either at this meeting or over the longer term).
12. What has been MOST useful from past IEA workshops?
13. What has been LEAST useful from past IEA workshops?
14. What do you hope to achieve by attending this workshop? *Check all that apply.*
    - Learn new methods
    - Build cross-regional collaborations
    - Outline or draft a peer-reviewed publication
    - Outline or draft collaborative proposals
    - Share research findings
    - Understand IEA approaches from other regions
    - Network while obtaining knowledge on local breweries
    - Not be attacked by a mountain lion
    - Other:

Appendix IV. Human Dimensions working group support material

NOAA INTEGRATED ECOSYSTEM ASSESSMENT
Human Dimensions Workgroup
TERMS OF REFERENCE
1/6/15 DRAFT

I. Objective
Establish an Integrated Ecosystem Assessment Human Dimensions Working Group (IEA-HDWG) that will encourage and guide development and incorporation of human dimension approaches throughout the IEA program.

1. The working group will have a term limit of two years, beginning with the first face-to-face meeting
2. Renewal or continuation of the working group beyond the two year limit will be determined by the IEA Steering Committee

II. IEA-HDWG responsibilities

1. Establish goals, priorities, and develop plans for integration of HD approaches in IEA implementation, such as is being done with the development of human dimension indicators for IEA's.
2. Track progress towards successful regional implementation of HD in IEAs and recommend adjustments to the regional programs when necessary to ensure national consistency with regional flexibility
3. Identify and seek leveraging opportunities to advance the incorporation of human dimensions in IEA's.
4. Communicate ongoing human dimension IEA activities across NOAA and the wider scientific community, and guide the publication and dissemination of human dimension IEA results.
5. Develop a white paper (potential high level publication) on best practices to incorporate human dimension into IEA's (or similar topic to be determined by HDWG)
6. Meet via telecom three times per year and once in person to carry out those functions established above of the HDWG.

III. IEA-HDWG membership

1. The IEA-HDWG will include:
    a. All Human Dimension researchers actively working as part of a regional IEA program.
    b. A representative from the IEA steering committee.
    c. Additional members from NOAA line offices, as identified by existing IEA-HDWG members, with interest in increasing involvement with HD and IEA's.
2. Chairmanship of the HDWG will consist of two co-chairs:
    a. The Human Dimensions representative on the IEA Steering Committee
    b. An individual chosen by consensus from among HDWG members

Summary of Social Wellbeing Indicators for Marine Management "SWIMM" Process, People and Products for integrated ecosystem assessments and EBM

To foster a better understanding of the social dimensions of marine and coast environments, NOAA's NMFS Northwest Fisheries Science Center and OAR Washington Sea Grant initiated an effort to develop social indicators of human wellbeing for marine ecosystem-based management. The local team convened an interdisciplinary expert working-group of 12 expert advisors, called the "Social Wellbeing Indicators for Marine Management (SWIMM)" group. The SWIMM working group got together in three multi-day meetings in 2014, plus inter-sessional conference calls and writing efforts to produce a series of important contributions to ecosystem based management. These contributions include: a framework of human wellbeing, a social-ecological systems conceptual model linking wellbeing to the environment, criteria to select and evaluate indicators, dozens of top indicators for two focal domains of wellbeing (access to natural resources and self-determination), and a guiding document for best available social science. The SWIMM results are being written up in five peer-reviewed manuscripts.

Local Team

Phil Levin, Senior Scientist, NWFSC
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Karma Norman, NWFSC
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Expert Working Group

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