

**NOAA Science Advisory Board
Climate Information Products and Applications (CIPA)
Program Review**

Based on a Climate Working Group Review Panel Meeting Held
on July 13-15, 2009
Omni International, Broomfield, CO

Final Report

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EXECUTIVE SUMMARY

A review team, constituted by the NOAA Science Advisory Board (SAB) and the SAB Climate Working Group (CWG), reviewed NOAA's Climate Information Products and Applications (CIPA) in two days of teleconferences in May, followed by three days of face-to-face briefings and discussions in Broomfield Colorado in July.

The team was impressed by the NOAA work in many respects. However, the landscape for climate information products and applications is undergoing rapid change as the Nation begins to recognize the importance of climate services in addressing the issues of climate adaptation and mitigation. It is expected that these societal needs will lead to the establishment of a National Climate Service. Within this emerging context, the team believes a new course should be charted for CIPA.

More fundamentally, the team found that both the *level* and the *nature* of the existing NOAA effort fall far short of the national need for climate services.

Resources for the CIPA in aggregate amount to no more than \$40M a year, only some 1% of NOAA's annual budget; these funds are distributed over dozens of small, disaggregated projects. While the vast majority of these individual projects were of high quality, in sum they do not constitute a national program of climate services. Additional resources for CIPA are necessary but not sufficient to create a program that will scale up to the national need. Instead, a new approach and strategy is required. Local, state, tribal, and federal requirements for climate information products and applications are rapidly expanding and evolving as they grow. Decisions and actions totaling trillions of dollars will be made in future years based on anticipated short-term, regional-scale climate variability and longer-term global trends. If NOAA wishes to serve national needs in climate science and services during this period, it must (re)design itself in a short period of *months* (not *years*) to serve a much broader set of customers for more ambitious and extensive climate services that will be considered necessary domestically and internationally. **The team therefore recommends that NOAA**

- **develop a strategic plan and framework for its climate information products, applications, and related services.** As one reviewer noted (Appendix 4.2) *"...although described as a program, the CIPA Program is less of a 'program' and more of an assemblage of individual climate-relevant elements, many of which developed independently over time in a somewhat 'organic' fashion. As such, this review did not assess a programmatic track record but rather reviewed the adequacy of the assembled 'pieces' that could be drawn into a coherent program for the purpose of serving future climate information and services over the next 15 years. But, in general, NOAA appears to have many of the critical pieces assembled but lack an integrated strategic framework to guide program development and decision-making, evaluate program effectiveness, and to identify appropriate performance metrics upon which to evaluate climate services..."*
- **give highest agency priority to scaling up the level of its effort devoted to**

- **climate information products, applications, and services to match the growing scope and accelerating pace of societal needs.** As one reviewer noted (Appendix 4.4) “...although the NOAA panel maintains that they are as much about building external capacity as they are about building their own internal capacity, I do not find their discussion compelling. They have given us few specific examples of what they do to build the capacity of the communities of people who might be users of the kind of information that they are able to contribute. Nor is there any indication of serious collaboration with other agencies and institutions involved in similar programs and efforts.”
- **become, in the process, far less insular, more outward-looking, and do far more to partner and collaborate.** As one reviewer noted (Appendix 4.1) “I believe that collaboration is critical and must become a NOAA core competency if the agency is to be successful in leading a National Climate Service. Collaboration must occur on so many different levels and among so many disparate entities it is almost mind numbing. If NOAA is serious about success in this initiative, it might even consider establishing an Office of Climate Collaboration. Although I say this somewhat with tongue in cheek, it is my firm opinion that strong leaders with a successful track record in building win/win partnerships will be every bit as important as physical science acumen in getting a National Climate Service off the ground and making it a success.”

In addition, the CIPA review team notes that it was asked to review a moving target – to comment on meritorious but small and fragmented projects and programs at precisely the moment NOAA was undergoing a transition in administration and wrestling with how to develop a suite of true climate services. The CIPA review team sees considerable opportunity (and corresponding urgency) here. For example, at the World Climate Conference-3 just concluded participants agreed that what is missing internationally is a vital climate-science-service-user-interaction mechanism. The CIPA elements contain the seeds of such a mechanism within NOAA and the U.S. Accordingly, the team recommends that NOAA:

- **report back promptly to the SAB on its intentions (within 1-2 months) and its progress (within one year) on these recommendations.**

1. BACKGROUND/INTRODUCTION.

The world is at a critical juncture – a period of rapid social change and increasing human impact on the Earth’s atmosphere and the terrestrial environment. The need for climate science-based information, products, and services is growing in scope, complexity, and urgency. In response, climate science and services are rapidly evolving, worldwide. Every nation, including governments at every level, academic and research institutions, the private sector and industries, and non-governmental organizations (NGO’s) are all demanding more reliable and authoritative climate

information. Such demands will only increase further in the coming years, in response to the increasingly evident impacts of climate variability and change. Many sectors and segments of government are moving forward, but current efforts are only a modest start compared with what is needed.

Given these rapid changes and this critical timing, it is altogether appropriate that the National Oceanic and Atmospheric Administration (NOAA), a major provider of climate information products and services, conduct periodic, in-depth external reviews of its programs and plans in these areas.

2. THE REVIEW

In recent years, NOAA has established and maintained an external Science Advisory Board (SAB) – a FACA structure for external advice on science priorities and policies. Over its lifetime, the SAB has in turn established a small number of working groups to carry out specialized tasks. One of these, the Climate Working Group (CWG), has mounted a series of reviews. First of these was a review of the Climate Observations and Analysis Program (COA) of NOAA, held at NOAA’s National Climatic Data Center on April 11-13, 2007. The second was a review of NOAA’s Climate Research and Modeling Program (CRM), held in the Hyatt Regency Hotel in Princeton, New Jersey on March 24-26, 2008.

This report summarizes the work of the third study – a review of NOAA’s Climate Information Products and Applications (CIPA), held at the Omni International Hotel in Broomfield, Colorado on July 13-15, 2009. Terms of reference for the review are included as **APPENDIX 1**. The review team prepared for these onsite discussions in two ways. First, review team members participated in two four-hour teleconferences, on May 5-6, 2009. Second, review team members were referred to several NAS/NRC reports by way of pre-assigned reading¹.

Significantly, NOAA presented its material in the form of a matrix. The teleconferences reported in turn on the *organizational* substructures that currently comprise CIPA:

- Regional Integrated Sciences and Assessments (RISA)
- Regional Climate Centers (RCC)
- International Institute for Climate and Society (IRI)
- National Integrated Drought Information System (NIDIS)
- North Pacific Climate Regimes and Ecosystem Productivity (NPCREP)

¹In general we found the advice in these reports to be thorough and on point. We are happy to see NOAA respond to these. While NAS/NRC reports certainly informed our thinking and deliberations, we did not attempt to restate or duplicate all their findings and recommendations here. Instead, we drew upon three days of presentations and the ensuing discussions to generate an essentially independent set of conclusions and recommendations.

Sectoral Applications Program (SARP)
NWS Climate Services Division (CSD)
Transition of Research Applications to Climate Services (TRACS)

The agenda for the two-day teleconference is attached as **APPENDIX 2**.

By contrast, the Broomfield in-person review was organized *topically*, addressing recent and current status as well as unmet needs, and cutting across the organizations listed above. Panels made up of NOAA staff and external collaborators reported in turn on:

Interagency and private-sector partnerships
Regional/place-based efforts
Water resources
Coastal
LMR/ecosystems
Capacity-building/training and outreach/education
Measuring success/performance

The agenda for the Broomfield sessions is attached as **APPENDIX 3**.

The report here includes three components: (1) a small core set of high-level recommendations on CIPA taken as a whole (**Section 3**); (2) more specific recommendations prompted by each of the panel presentations made during the Broomfield review² (**Section 4**); and (3) personal perspectives submitted by individual review team members, provided to the CWG (and possibly the SAB) unedited and unfiltered in **APPENDIX 4**³.

3. HIGH-LEVEL FINDINGS AND RECOMMENDATIONS.

The CIPA review covered about \$40M/year of NOAA program, about 1% of the \$4B/year budget for NOAA as a whole. Given eight organizational elements with up to six activities per organization, NOAA is spending only about \$1M/year in each activity. Though small, the individual projects are diverse and cross-cutting, addressing many – though not all – of the right problems. The review team noted that NOAA made no presentation on the National Climatic Data Center (NCDC) or the

²The review team included several experts who served as panel moderators during the three (July 2009) days of face-to-face meetings, and these moderators have led in the development of recommendations that refer to each of the cross-cutting panel portfolios. This material also bears the imprimatur of the review team as a whole.

³ Readers concerned primarily with NOAA's function at a strategic level will be most interested in the material of Section 3. Those responsible for specific aspects of the larger NOAA portfolio may be equally interested in one or more of the subsections of Section 4. While the specific, personal material in APPENDIX 4 are not necessarily the views of the entire review team, it was felt that they might serve to stimulate thought and add value for certain readers of the report, and they have been included in this spirit.

NWS Climate Prediction Center (CPC). Though these had been treated in part in the COA and CRM reviews, they embody a significant fraction of NOAA's climate information products and applications, *and it would have been appropriate and useful to have these components incorporated into the CIPA review*. The review team also noted that the NOAA presentations focused more on process than substance and content of climate information, products, and applications. *The NOAA presentations would have been useful if they had provided more specifics, and placed more emphasis on how NOAA climate services assist in identifying and managing climate risk and opportunity on scales ranging from months to decades, and how they treat probabilities, uncertainties, etc.*

The material below (section 4) includes a number of comments and suggestions for improving CIPA program elements. However, if NOAA simply improves these programs and does nothing more over the next several years, it risks becoming irrelevant, or at best finding itself confined to the performance of repetitive and routine tasks. If NOAA wishes to be a credible technical agency serving national interests in climate science and services fifteen years from now, it will need to develop a strategy to scale up its program(s) considerably from their current level. Specifically, it needs to (re)design itself in a short period of years to serve the much broader set of customers for more ambitious and extensive climate services that will be needed domestically and internationally. The following recommendations would support such a transformation:

Recommendation 1: NOAA needs to develop a strategic plan and framework (SP/SF) for its climate information products, applications, and related services (or, if one exists, NOAA needs to start articulating and sharing this both internally and externally).⁴ The SP/SF needs to address: (1) NOAA's central strategy, (2) NOAA's collaborations with others, and (3) other attributes.

1A. NOAA's central strategy

- **Distinguish among three broad classes of products, applications, and services necessary for government to do its job: (i) Support of regulatory functions and providing standards, best-practices for a range of functions where such standards are needed such as floodplain management. (ii) Services in the public good. (iii) Services that support specific activities by non-federal intermediaries. Develop a clear vision of how each class is best provided, and build those ideas into the SP/SF.**

⁴ The review team notes that the COA and CRM reviews found a strategic framework lacking for these larger efforts as well. The three frameworks should be supplemented by or together include an umbrella structure joining the three and integrating them. The plan needs to be less about where NOAA will be in 20 years and more process-oriented, with an emphasis on developing attributes (nimbleness, perceptiveness, adaptability, utility, etc.)

- **Think strategically and explicitly about what NOAA will NOT do. NOAA also needs to be clear about its expectations of others – what other agencies, partners, etc. will or will not do.**
- **Recognize that although climate information, products, applications, and related services and weather services have differences, they share many similarities. NOAA should draw on the existing NWS infrastructure (as well as other institutional precedents) directly where possible and appropriate and/or model its approach to climate after existing and relatively tested and successful NWS engagement of users. The NAS/NRC Fair Weather Report and NOAA’s partnership policy constitute examples here. This implies an in-house emphasis on observation and modeling of the environment, with work on impacts and decision-making to be done collaboratively.**
- **Emphasize scaling up; start by listening; look for multi-purpose products and applications; plan to deliver many services and products to end-users including intermediaries who will themselves do any needed, specialized tailoring.**
- **Develop a set of criteria to match NOAA investment to need: should NOAA choose what receives priority and what can wait based on the economic impact? Number of people affected? Likelihood of a climate threat? Prospect that others will fill a gap if NOAA leaves something undone? Urgency? Some combination of the above, etc.?**
- **Define and address NOAA’s international role**

1B. NOAA’s collaborations with others

- **Provide explicitly for the user/partner feedback to shape not only immediate CIPA activities but also the supporting COA and CRM work, NOAA science and research, more broadly.**
- **Emphasize steps/actions for improving the ease of access of potential users and new users to access and enter the system.**
- **Distinguish between, and balance climate services to support policy-makers engaging in top-down governance versus those to support community-based or stakeholder-inclusive decision-making .**
- **Provide for continual dynamic feedback from users as well as information sharing from outside partners.⁵**

⁵The review team notes that the review included a great deal of material that was very useful on the philosophy of evaluation, and what constitutes good practice, especially the recent NRC report on

1.C. Other attributes

- **Distinguish between need for internal capacity to support (i) internally-produced products and services and (ii) externally-produced products and services.**
- **Address the balance between a focus on concrete information products, applications, and services and attention to the process of user/partner engagement.**
- **Differentiate between work that is essentially research or experimentation aimed at product development and definition and work that is operational, or service-oriented, and provide for the appropriate balance between the two.**
- **Plainly distinguish between planning for climate services for short-term adaptation (including emergency services, for example), and planning for climate services supporting long-term investments in major infrastructure such as roads, ports, electrical utilities, etc.**
- **Explicitly plan for building the capacity and culture of the professional workforce as needed to execute the SP/SF going forward.**
- **Address the input side as well as the output side.**
- **Explicitly address public education and outreach, and training/capacity building.**
- **Provide for a robust process of (and capacity for) self-evaluation.**
- **Build in dynamism and flexibility, recognizing that the CIPA arena is unique relative to COA and CRM with respect to (i) the nascent nature of climate information products, applications, and services, and (ii) the rapid pace of social change and technology advance that is qualitatively transforming user requirements month to month and year to year.**

Informing Decisions in a Changing Climate, but provided essentially no evidence that any of this is actually being used in NOAA. Even making allowances for how new much of this work has been, this was disappointing.

Recommendation 2: NOAA should embrace as an urgent priority the task of developing its current array of climate information products and applications into a much more robust set of NOAA climate services⁶, able to meet our nation’s current and future needs.

NOAA is not doing this work in a vacuum. As noted in the introduction, governments worldwide (at national, regional, and local levels) are all rapidly exploring ways to address the problem, as are private enterprise, academic institutions, and environmental NGOs. Thinking solely in terms of disaggregated information products and applications will not do. Provision of climate science and climate services will be threaded through every aspect of societal fabric now and well into the world of the future. The aggregated level of this worldwide work far exceeds the NOAA resources available today or likely to be available in the future.

Throughout the course of the review, several reviewers stated on more than one occasion that NOAA is too insular (internally as well as externally: the three programs COA, CRM, and CIPA are themselves not well integrated). Some made reference to “fortress NOAA” (although reviewers differed on their perception of this degree of insularity, perhaps related to their own institutional settings). Specific suggestions were made as to how NOAA might make use of existing entities to reach out more effectively: (i) extend the focus of the SAB Partnership Working Group (WG), which initially focused on weather, to climate; (ii) engage the American Meteorological Society Weather and Climate Enterprise Commission to be more active toward this end;⁷ and (iii) actively seek ways to work more collaboratively with other federal and state organizations and initiatives. Reviewers noted that NOAA should recognize that this approach to users/practitioners/partners carries with it large transactional costs, and greater need for timely communication and easily accessible information, and should explicitly acknowledge and budget for these. This is simply the “cost of doing business” in the reality of the new climate world. Likewise, NOAA’s partners should acknowledge that NOAA is embedded in a large federal government process, and that there will therefore be unavoidable constraints on the speed and flexibility with which it can respond to calls for change, however justified those changes may be. Overall, NOAA should also acknowledge that these partnerships don’t represent just a cost but an historic opportunity. Together the partners can achieve things that none of the partners can alone.

Recommendation 3: NOAA needs to become a far better listener, information-gatherer, and facilitator than it has been to date. Outreach and engagement of

⁶ The review team is acutely aware of the larger national dialog with respect to (possible) or (optimal) formulation and establishment of a “National Climate Service” but has confined its recommendations here to steps that NOAA should be taking *regardless* of those larger pending decisions.

⁷ The chair of the review team wants it clearly understood that as an AMS employee he is in a conflict-of-interest with respect to this recommendation, but that it came from other members of the team. It was/is *not* recommended that the AMS be the sole means toward this end, only that this avenue be exercised.

other information providers, users, and stakeholders need to be far more effective and strategic. In particular, NOAA needs to engage a broader range of intermediaries. NOAA leadership should recognize that this work will necessarily be ongoing, extensive, and costly, and budget, staff, structure, and plan accordingly.

In scaling up, NOAA will continue to do some work that is very close to the end-use customer and will tailor products for their needs as appropriate (respecting its policies calling for partnerships as opposed to competition with respect to private-sector service providers). In addition, however, NOAA should develop and expand a range of offerings of other climate science and services that are of broader, more general utility. These may be taken up directly and adapted by end users, including local, state, tribal and federal stakeholders. However, these offerings should by design also provide input to and serve an extensive set of intermediaries, a number of whom are in the private sector. The diverse needs of local, state, tribal, federal, and international stakeholders may require services at all three scales: tailor-made products for specific needs, more multi-use products that these stakeholders can adapt themselves, and custom services provided by expert intermediaries providing value-added to NOAA's products and services.

The review team believes strongly that the opportunity for moving from the present suite of climate information products and applications to a more robust array of NOAA Climate Services is great, the rate of change is rapid, and the need for improvement/growth is urgent. Therefore

Recommendation 4: NOAA should respond prior to the next-scheduled SAB meeting following the presentation (November 3-4, 2009) of this report, describing what measures NOAA intends to take over the coming year to address the review team's concerns.

And in the same spirit,

Recommendation 5: The CWG and the SAB, as they revisit NOAA programs in COA, CRM, and CIPA, should recognize the transitional nature of CIPA and conduct, perhaps within a year, a true NOAA climate services review. This should comprehend the whole of NOAA's climate service activities across the agency (explicitly including, for example, CPC, and NCDC), not just those aspects considered in the CIPA 2009 review. It should also focus not just on *process* but also on *substance* (explicitly addressing, for example, aspects such as the incorporation of probabilistic information and uncertainty into products and services).

4. MORE SPECIFIC RECOMMENDATIONS, TARGETED AT THE INDIVIDUAL PANEL PRESENTATIONS

4.1. Interagency and private-sector partnerships (Lee Branscome)

NOAA Partnerships in the Climate Services Enterprise

Dan Walker (Division Chief, NOAA Climate Program, Climate Assessment), who provided an overview of NOAA climate programs, observed that the programs currently lack the breadth to meet the nation's growing needs for climate products and services. Furthermore, NOAA has inconsistent connections to end users, making it difficult to ascertain the nature and scope of their specific needs. Even if perfect communication with end users was achieved, the agency lacks the capacity to meet the rapidly growing demand and does not have the broad capability to tailor products to fit unique user needs outside of a handful of specialized areas.

As noted by Eileen Shea (Chief, NCDC Climate Services and Monitoring Division), no single agency can meet every challenge. However, partnerships with other agencies and the academic and private sectors allow NOAA and its partners to combine and leverage their resources so that diverse groups of end users can be served. Dan Walker noted that NOAA already has a general partnership policy, which may serve as a guide. Furthermore, NOAA can benefit from the experience and contacts with end users that its partners can bring to joint efforts in the climate service enterprise. Many of these partners have developed significant long-term trust and service relationships with stakeholders, customers and clients in the public and private sectors, and already have considerable knowledge about their users' needs and concerns.

NOAA faces constraints on how its limited resources can be allocated. These constraints include, for example, Congressional guidance on specific programs and questions about the "Federal role" or "NOAA role" with regard to some issues and projects. In addition, the current portfolio of NOAA efforts within CSD reflects historical approaches, with particular emphasis on meeting the immediate goals of various line offices. Greater emphasis on the expansion of NOAA-wide capacity to provide a broad spectrum of climate products and services will likely to force a change in the management and structure of the agency, although the rate and nature of the evolution of the NOAA climate portfolio is subject to external factors—such as Congress.

Given the realities above, two of the challenges in developing NOAA's climate programs are determining how to prioritize climate service efforts within NOAA, working together with its partners, and what general profile of climate products and services would seem to be the most appropriate (e.g., large number of small efforts, or smaller number of larger, higher profile efforts, or a mix of both). Partnerships can assist NOAA in meeting these challenges and developing effective programs in the face of limited resources and external constraints.

Current NOAA Programs

Dan Walker presented the review panel with an overview of existing NOAA climate programs particularly relevant to the discussion of partnerships, as summarized below.

OAR-Sectoral Application Research Program (SARP)-

Designed to systematically build an interdisciplinary and expressly applicable knowledge base and mechanism for the creation, dissemination and exchange of climate-related research findings and decision support resources critical for understanding and addressing resource management challenges in vital social and economic sectors, through one- to two-year competitive grants

NWS-Climate Services Division (CSD)-

Intended to provide oversight and strategic vision for NWS climate services, resources and support to the NWS Regions for the provision of local climate activities; and oversees NWS climate operations plans, policies and procedures, training, outreach, and data stewardship

NESDIS-Regional Climate Centers (RCCs)-

Intended to provide operational climate services, while leveraging collaborations with partners to augment NCDC capabilities, particularly access, archival, and assessments, at the regional level; RCCs concentrate on applied climatology, making research operational, connecting NCDC, NESDIS, and OAR at the regional level

OAR-Regional Integrated Sciences and Assessments (RISAs)-

Intended to support interdisciplinary research and innovative outreach activities at local and regional scales. RISA teams collaborate directly with people who are involved with activities, resources, or property that may be vulnerable to climate variability and change, enhancing their capacity to use climate information and related decision-support resources effectively, through competitive five-year grants

OAR-Climate Prediction Center (CPC) / Climate Test Bed (CTB) -

Intended to accelerate the transition of scientific advances from the climate research community to improved NOAA climate forecast products and services, and to partner with RISAs and related groups in the development of collaborative regional products, through competitive grants

OAR-Transition of Research Applications to Climate Services (TRACS) -

Intended to support the transition of experimentally mature decision-support tools and climate information products to operations, maximizing the impacts of these products through effective education and outreach, and collectively learning how to best accomplish technology transition processes for public goods applications and improved risk management. This program is evolving toward a contract program.

Details on specific activities within these programs were presented during this session. Many of the activities are region- and/or sector-specific and depend on cooperation and collaboration with local/regional partners and interested stakeholders. Most of the partners are local/regional government agencies, with authority to manage resources, and NGOs with particular interests. Local authorities and managers typically benefit from the services created by the programs. To date, there is relatively little activity within these programs that directly connects to private sector end users or providers of climate products and services.

The review panel was impressed by the innovativeness of the programs and the high level of commitment and superior performance of the NOAA personnel involved in these programs. However, the reviewers noted the lack of overarching guidance and coordination within the agency regarding the overall goals and objectives of the climate programs. No framework seems to exist for determining what to work on. There are no well-established project decision guidelines—thus leading to disparate activities that are not well-connected. If an opportunity arises, how does a NOAA program determine whether to pursue it? Furthermore, there is relatively little collaboration between the programs and no clear policies or procedures on how such collaboration might be fostered and made effective.

Insights from External Organizations

Representatives from external organizations (Sharlene Leurig of CERES, Stephen Jordan of US Chamber of Commerce, Nancy Colleton of Institute for Global Environmental Strategies) gave very informative and thoughtful presentations on end-user needs and interests in climate services. The presenters demonstrated considerable understanding of how climate change and variability affect their clients and constituents, demonstrating the value to NOAA of communication with knowledgeable intermediaries. The private sector has its own limitations, including financial limitations of resource-poor sectors and the competitive need for protection of proprietary platforms and information. Nevertheless, long-term planning, investment and risk require knowledge of climate change and variability and that involves joint efforts with NOAA. It was observed by Nancy Colleton that NOAA needs to develop a systematic approach to keep up with the rapid changes in private sector needs, to provide effective entry points for the private sector and to look for new models of cooperation and collaboration.

Some Recommendations Related to Partnerships

1. NOAA should assess the strengths and weaknesses of its existing climate programs with respect to partnering with other federal, state and local agencies, NGOs, academia, and commercial enterprises
2. NOAA should assess existing climate products and services outside the agency, with the goal of effectively leverage existing and complementary resources, products and services through long-term partnerships. For example, the

Department of Interior has a parallel network of research centers on climate impacts with little or no connection to NOAA.

3. NOAA should develop a taxonomy of users, based on such categories as climate information space and time scales, authority, management responsibility, level of government, decision-making responsibility.
4. NOAA needs to better connect and communicate with the intermediaries and end users of climate products and services to accurately assess their needs and to explore avenues of collaboration. The communication may be accomplished in part by an advisory council drawn from diverse sectors
5. In the light of this information and enhanced communication, NOAA needs to determine its role in various potential partnerships within the climate service enterprise, developing well-conceived goals, plans and policies for collaboration with its diverse partners. Some guidance on this topic may be provided by the partnership policies and framework of NWS.
6. NOAA should foster and enhance partnerships within its existing climate programs (as well as with external entities), guided by overarching goals and policies. For example, RISAs and RCCs seem to be natural collaborators, such that results from research projects at RISAs can be transitioned to operations at RCCs.
7. NOAA needs to better utilize the expertise and resources of intermediaries, such as RISAs, RCCs, state climate offices, academic and private sector specialists, to expand its reach and improve its services to end users in broadly diverse regions and sectors.

4.2. REGIONAL/PLACE BASED EFFORTS (Michael A. Crimmins)

The NOAA team presented an impressive suite of programs that aim to identify and respond to climate information and product needs at local to regional scales. Overall, these programs recognize the importance of developing and sustaining partnerships at these scales to build credibility and trust, crucial in providing high-quality service. The regional/place-based efforts presented through the review represent a diverse range of climate services from stakeholder engagement and needs assessments to product development and support. The programs highlighted include:

- The International Research Institute for Climate and Society (IRI)
- Regional Integrated Sciences and Assessments (RISA)
- Regional Climate Centers and State Climatologists (RCC)
- NWS Climate Service Program Managers & Focal Points
- National Integrated Drought Information System (NIDIS)
- Sea Grant, and Sea Grant Extension

- Coastal Services Center
- National Estuarine Research Reserves
- NOAA Regional Collaboration

All of these programs have direct interactions with stakeholders, but have different climate service missions and engagement approaches and are located throughout different NOAA line offices, cooperative institutes, or NOAA-supported university research programs. Each program presented case studies of developing successful partnerships and providing valuable decision support to diverse stakeholder groups. These existing efforts provide an excellent starting point from which a strategically formulated and coordinated approach to delivering climate services can be developed to meet the needs of society in a changing climate.

Key Panel Session Recommendation: Given the high-quality of these existing programs, the review panel’s main recommendation was to develop a strategic plan to thoughtfully scale-up these efforts in a coordinated way to meet future climate service needs.

Specific Recommendations

- **Conduct a national climate services needs assessment to guide CIPA strategic planning:** The provision of useful products and services requires ongoing and iterative needs assessments across a diverse range of users and sectors. An initial, comprehensive national assessment of existing climate services and unmet service needs could be used to guide strategic planning within NOAA and as a tool to evaluate the effectiveness of current CIPA programs. This assessment would help identify the cross-section of key issues across sectors, opportunities for interagency and institutional partnerships, and current capacity to meet present and future climate service needs. The role of private sector partnerships would also be a key outcome of this assessment, helping to define the role of the federal government in delivering products and services and guarding against developing overly specialized efforts. This assessment could be conducted through existing regional and place-based efforts like the RISA and RCC programs, but could also be used as a mechanism to engage new institutional and agency partners.
- **Develop and maintain a database of climate service activities across all NOAA programs:** A database of climate service activities would help to identify overlaps in CIPA program activities and opportunities for collaboration and leveraging of existing efforts. This database could be initially developed through the national assessment process, but should be regularly updated to document product and service success stories, key partnerships, leveraged resources, and geographic coverage of activities. Online, public access to this database could be provide through the new climate portal being developed at www.climate.gov.

- **Develop and support relationships with ‘boundary organizations’ that have strong existing connections to stakeholders:** The 2009 National Research Council report titled ‘Informing Decisions in a Changing Climate’ lists both USDA Cooperative Extension System and NOAA RISA program as models of institutionalized decision support given their strong existing relationships with diverse stakeholder groups across the country. Increasing investment in these programs to support local and regional climate services as well as identifying new partners (e.g. Chamber of Commerce) that could serve as intermediaries would limit NOAA's need to bear all of the transactional costs associated with developing and maintaining good stakeholder relationships.
- **Support coordination and communication between regional/place-based climate service programs:** NOAA has a great deal of existing community-level infrastructure from local National Weather Service Offices to RISA programs and State Climate offices. The roles and responsibilities of each program as well as coordination mechanisms to deliver climate information and products is unclear. Efforts to provide regional coordination would help leverage existing efforts and increase efficiency of local climate services. The new Regional Collaboration effort within NOAA could be used to help support this coordination need.
- **Increase support of state climate programs to anchor state-level NOAA climate services efforts:** The role of the state climatologist has been identified as an important role in assessing local climate science needs and delivering climate services in coordination with local NWS offices, RISAs, and Regional Climate Centers. Most state climate programs are underfunded with many losing additional support due to state budget shortfalls. Matching and helping to increase state-level funding could encourage more stable support of state climate offices, building local-level climate services capacity.
- **Develop communication mechanisms to ensure that regional and place-based needs assessments are guiding national level research and development agendas:** Research needs identified at local to regional scales need to be incorporated into national level research programs being conducted at universities and federal laboratories. Communication mechanisms including workshops, exchange programs, teleconferences, and blogs should be explored to connect place-based programs with research community, as well as build partnerships for local and regional services. NOAA's Regional Collaboration effort could be used to support these efforts.
- **Develop joint inter-agency funding mechanism (e.g., a grant program) to encourage inter-agency and stakeholder partnerships in interdisciplinary, applied climate science research, education, and capacity building:** Use the Joint Fire Science Program as a potential model.

- **Improve partnerships and collaboration with Tribal Nations, trusts, and territories:** Evaluate the effectiveness of current regional and place-based efforts at meeting climate service needs of Tribal Nations across the U.S. Develop strategies and mechanisms (e.g. NOAA Tribal Affairs office modeled after EPA Indian Program) to improve partnerships with and climate service delivery to tribal governments and resource managers.

4.3. Water resources (Jeanine Jones)

Members of the academic research community have identified challenges facing the water sector from climate variability and change, challenges that span the full range of time scales from the weather domain to multi-decadal. Similarly, practitioners in the water management community have begun to consider and plan for climate change adaptation and for other actions to entrain climate information into resource management decision-making. However, there is little meaningful dialog between these two communities that would facilitate development of useful climate information and products, and the application of such materials in practice. The real challenge – and the great opportunity -- lies in linking the communities to enable two-way dialog and flow of information.

Process

Although NOAA's RISA centers have been doing a yeoman's job of serving as small-scale boundary organizations between academics and practitioners in a few selected regions, the level of demand for water sector climate services far exceeds the capacity of existing programs to meet this need. The water sector is not monolithic, and different sub-sectors (e.g. urban and agricultural water supply agencies, flood control agencies, water quality regulatory agencies, hydropower utilities, fishery management agencies) have differing information needs and differing institutional networks for communicating information. Public agencies – federal, state, local, tribal – are dominant players in the water sector, offering opportunities for government-to-government partnerships with NOAA, either directly or through associations of governments (e.g. Western States Water Council, Association of State Floodplain Managers), to facilitate the provision of climate services. USGS Circular 1331, co-authored by four federal agencies (USBR, USACE, NOAA, USGS), is a promising start to consideration of the federal agency role in climate change and water, but there is presently no clear path or commitment for implementation of the suggestions made in that report.

Some other considerations pertinent to providing climate services for the water sector include:

- ▶ Distinctions typically made in the research community – weather v. climate, variability v. climate change – are of lesser importance to practitioners, and do not provide a useful schema for organizing provision of climate services.
- ▶ A process of ongoing interaction between developers of climate information and the users of that information is a necessity (e.g. NRC, 2009; CDWR, 2007). An annual workshop or a web portal is not a substitute for this interaction.
- ▶ There are many pre-existing social networks within the water sector and its sub-sectors that could be leveraged in support of providing climate services. Examples include state climatologists, state water and emergency management agencies, and associations representing various sub-sectors. Using existing social networks could facilitate NOAA’s dissemination of information and products.
- ▶ Information must be timely. Public agency decision-makers must routinely make decisions on the basis of the best information available at the time. Decision-makers will not wait for a years-long peer review process in the academic literature to answer pending questions. Impliedly, a climate service must then actively take the lead to develop its own content, rather than passively waiting for material to be published by the research community.
- ▶ An important role of a climate service is to serve as the authoritative voice or referee on the status of climate science questions, a function now performed on an ad hoc basis to a very limited extent by some RISA centers. The work coordinated through the Western Water Assessment to attempt to reconcile wildly disparate academic projections of climate change impacts in the Colorado River Basin is an example of this referee role.

Products

Examples of specific products that would support water sector adaptation to climate change have been described in sources such as USGS Circular 1331. Similarly, policy documents produced by the water management community have also identified products, tools, or guidance documents that are needed sooner rather than later in the process of planning for adaptation. Frequently mentioned needs include:

- ▶ Regional climate models and/or regional downscaling of general circulation models, in all likelihood the most commonly cited product. Outputs at a regional or watershed scale are especially needed in the Western U.S., where topography is of paramount importance to orographic precipitation.
- ▶ An accepted methodology for incorporating non-stationarity into hydrologic analyses. Engineering design of public works projects ranging in size from local storm drainage projects to spillways at major dams is based on a standard of practice – one accorded standing in legal challenges related to project design -- that does not consider non-stationarity. An opportunity to institutionalize non-stationarity in federal water agency

planning is presented by the proposed revision of the 1983 Principles and Guidelines used by USACE and USBR.

► Updated federal agency hydroclimate guidance documents/manuals/data-derived products. A variety of federal documents, some of them decades old, are important references or parts of the standard of practice used by water managers. Examples include USGS Publication 17B (Guidelines for Determining Flood Flow Frequency), NWS precipitation frequency data (i.e. the former Weather Bureau technical paper series) and estimation of probable maximum precipitation (not now funded), and FEMA flood insurance rate maps. NOAA, as the most “upstream” federal agency in the hydroclimate discipline, has the opportunity to take a leadership role in spearheading federal development of updated guidance documents and products.

► Capacity building is needed in both the practitioner and the research communities. Water managers typically do not have a disciplinary background in weather or climate, and do not access the academic literature. Researchers typically are not familiar with resource management decision-making, and do not access policy information (legislation, regulations, and public agency reports). As a further example of potential capacity building, there may be opportunities to introduce climate-related risk management methodologies for consideration by public water agencies -- the culture of the water sector has historically tended to be risk-averse, reflecting typical missions of public agencies to protect public health and safety and the environment.

4.4. Coastal

Presentations highlighted a range of issues. The population of the coastal zone continues to increase; economic activity, urbanization, and infrastructure exposure are rising concomitantly. Residents and communities vary widely in resilience. Climate variability and change are accompanied by corresponding changes in the frequency, intensity, and track of severe storms. These have cumulative effects; in addition, individual events can be catastrophic. Water levels are changing...rising along the sea, and dropping around the Great Lakes. Impacts include inundation, flooding, erosion, salt intrusion, and loss of natural protective features. Coastal precipitation, temperature, and circulation patterns are also demonstrating variability on all time scales. Ecosystem integrity is in jeopardy even as demand for, and dependence upon, ecosystem services rise. The Arctic coasts present special challenges.

Jeff Payne from the NOAA Coastal Services Center summarized the NOAA work. NOAA is attempting to take a systematic, holistic approach encompassing observations and modeling (not just physical processes but also social infrastructure and human practices); conducting risk and vulnerability assessments; developing decision support tools, maps, and visualizations; and attempting to build public awareness. SARP, the RISA's, TRACS, and the Coastal Services Center are all providing climate information

products and applications. Mike Beck summarized the global reach and activities of the Nature Conservancy. Betsy Blair provided an overview of the work at the Hudson River research reserve. The ensuing discussion focused on the accessibility of NOAA information products and applications; the degree to which they were open-source; specific mechanisms (workshops, training opportunities; etc.); and how NOAA interacted with government at the local level (mayors, town councils, etc.) versus the state level. In general, the problems that surfaced in this session reflected those throughout the rest of the review. NOAA and its collaborators demonstrated a good conceptual grasp of the what's needed in the way of climate information, products, and applications in all their comprehensive aspects, as well as detailed specifics. However, the joint enterprise (NOAA coastal climate science and services and those of NOAA's collaborators) lacks the resources to do more than illustrate in particular cases what could and should be achieved more generally. Speakers and questioners acknowledged a considerable overlap between much of the coastal work and the work on LMR/ecosystems as discussed in the session following.

4.5. LMR/ecosystems (Jake Rice)

The NOAA Presentation on the Ecosystem aspects of work under the Climate Goal focused on the Sector Applications Research Programs (SARP). SARP has two thematic foci at present: Water and Coasts, and Coping with Drought. In the past 3 years it has supported 14 different projects, including vulnerability assessments, adaptation strategies for coastal several coastal threats, tools for specialized ecosystems such as coral reefs, and developing means to translate technical results into usable information for managers. The individual projects include both improving strategies for community engagement (programmes on climate variability and community resilience in Oregon and Maine) and improving tools for forecasting future states of ecosystems or their components under various scenarios for future climate. These tools are developed possibly most fully in the North Pacific Climate Regimes and Ecosystem Productivity (NPCREP) initiative, looking at both the North Pacific ecosystem generally and Pacific salmon returns coastwide. Many of the projects have components that focus on decision-support. SARP does have a forward vision, and displays awareness of many of the issues raised in the main body of this report (a need for clear priorities, strong links to clients with continuing support, producing a limited number of high quality and broadly useful products that can use used directly in decision support).

Individually each SARP and NPCREP project seems well-targeted. However, collectively they represent a collection of generally small projects around specific well-chosen themes, not a comprehensive plan within NOAA for addressing the ecosystems dimension of climate change and climate adaptation. Moreover, it was clear from the contributions of the discussants and general discussion there are many other projects going on, in and out of NOAA, addressing climate impacts on marine, freshwater, and terrestrial ecosystems; the implications of those impacts for prosperity and well-being of society; and strategies to adapt to those possible impacts and reduce the threats they may pose. In the largest sense the absence of a comprehensive plan for dealing with the

ecosystem dimension of climate change and climate adaptation is not surprising. By definition, an ecosystem includes everything – physical substrate, land, water, plants, animals (including people) and their inter-relationships – and it was acknowledged that by itself this small part of the Climate Goal cannot make an adaptation plan for “everything”. On a more realistic scale, however, many comments had as an implicit core message, that just because of the vast scale of the “ecosystem dimension” the Climate Goals needs a very clear idea of how it is going to proceed to provide the best and most appropriate products and services where they will do the most good and serve the broadest range of clients possible. Several important considerations about such a path forward emerged from the discussions in the Ecosystem session.

There appear to be some important differences between “ecosystem clients” in commercial sectors who depend directly on ecosystem components that are likely to be impacted by climate change and “ecosystem clients” whose lives may be affected by the state of their ecosystems, but who are less aware of such dependencies. These are broad generalizations, of course, and exceptions can be found for both of the perspectives discussed in the two following paragraphs.

Commercial (and many recreational and subsistence) fishers are an example of the first type of client. In that community, client awareness of the importance of climate change impacts to their livelihoods is relatively high. They want climate products and services to use in their planning and decision processes, but they want them to be clear and reliable. The science assessment of climate-related risks in fisheries is progressing well, and there is some work towards use of these risk evaluations in decision-support tools. The demand is for much more rigorous testing of the models, their predictions, and the sustainability of alternative strategies for mitigating the risks. The need is for high-end science products delivered to mature and structured decision processes designed to use scientific and technical information.

The discussion noted several times that the situation is different for the ecosystem dimension of coastal management issues. Both awareness of the importance of climate change impacts to their well-being and their receptivity to actions (particularly actions involving costs or constraints on choice) to address climate risks is not as high. Coastal communities are vulnerable to diverse climate related threats, and there are good case histories of providing information on such threats to communities, collectively building an awareness of their implications, and bringing the information into planning and decision processes. However, these case histories do not seem to be the norm for all coastal communities or even all climate-related threats at a given community. Moreover the success stories seem to have invested a lot of time in the “building an awareness of their implications” step. For this group of clients, the climate products and services need more steps of processing from high-end science to publicly accessible outputs, and more investment in building receptivity to using the products once they are available.

It is clear from the above that a single approach to producing and delivering ecosystem climate products and services will not meet all needs. However, an encouraging number of consistent messages did emerge from the Ecosystem discussion.

First, there need to be close and effective linkages between the Climate Goal and the Ecosystem Goal. The ecosystem impacts and adaptations component of the Climate Goal work is a large and important part of that mandate, just as forecasting and dealing with change is a crucial component of the Ecosystem Goal mandate. Neither can succeed in this large area of overlap unless both don't just communicate but actually integrate their work.

Notwithstanding the observation that awareness and receptivity to climate impact information is often high in the resource management and resource user communities, there are some incongruous gaps. In particular the US makes large investments annually in habitat restoration and recovery of depleted / endangered species and populations. Restoration and recovery are inherently medium-term to long-term initiatives. The state of the ecosystem in which the initiatives are implemented matters greatly to their likelihood of success. Climate variation and climate change is almost certainly going to alter the state of the ecosystem over the time course of the recovery or restoration initiatives. However, it is the norm that the planning for recovery and restoration is done assuming present state of the environment, and the only drivers of change are the components of the recovery or restoration plans. It is essential that recovery and restoration initiatives come to include plausible future states of the ecosystems, reflecting potential impacts of climate change, as a core part of their planning frameworks. It should be a priority for climate services to feed into these frameworks, to improve the chances for some benefits to accrue from the often large investments.

For all uses, easy and reliable downscaling of existing climate model results and scenario exploration is essential. This is the same message delivered in several other sessions, and for similar reasons.

Climate modellers correctly highlight that climate processes are complex, and even the best results will have high uncertainty. The climate research community rightly includes scenario exploration and stochastic projections as essential for any serious climate products and services. Ecosystem modellers have to deal with even greater complexity of components, linkages, functional relationships, and diversity of drivers. Serving the ecosystem dimension of climate adaptation should not be seeking greatest certainty of outcomes. The greatest realistic "certainty" will still be highly *uncertain*. Rather there should be an emphasis on performance evaluation of a range of possible adaptive strategies for climate pressures and impacts, seeking options that are robust to a wide range of plausible future conditions rather than optimal for a single set of possible conditions. Decision-making in an ecosystem approach to management has learned already that it is impossible to be *sure* of anything, but it is possible to make choices that are likely to be *safe* under a wide range of possible circumstances. Climate products and services can take advantage of that experience both in designing the products and services that it feeds into the ecosystem applications, and in transferring that experience to other applications where it is likely to be equally true that decisions can be relatively safe without being absolutely certain.

The final message is a crucial one. In ecosystem applications as much or more than any other dimension of using climate products and services, decisions are choices of society, and arrived at by social processes. Moreover, a basic tenet of the Ecosystem Approach is that sustainability has three dimensions; economic and social as well as environmental. Therefore social science research is essential in all aspects of the ecosystem dimension of climate products and services. It is particularly important in performance evaluations of adaptation options; what does each choice mean for society and what is society's willingness to make that choice.

4.6. Capacity-building/training and outreach/education⁸ (Jerry R. Schubel)

Finding: While NOAA already has significant capacity within the agency itself, unrealized potential remains. To fulfill its vision, mission, and promise NOAA must increase significantly both its internal capacity and the capacity of its partners—existing and prospective. Education, training, and outreach are critical to the success of these efforts. The new formal education mandates for NOAA (America Competes Act, 2007; the Land Management Act, 2009), the formation of the Office of Education, the Climate Program Office Communications and Education Program; the expansion of the Education Council, and the resulting improvements in communication and collaboration across the agency are all encouraging signs.

Recommendation: (1) Using the existing structure, establish and fund appropriately a core education and outreach team within NOAA with the experience, expertise, and capacity to engage with NOAA's diverse extension networks and external partners, (2) Promote and expand existing programs sponsored by AMS, AAAS, NSTA, NEEF, ASTC, Sea Grant, Coastal Services Center, (: *AGU, AAG*) and many others to bridge the chasm between fundamental research and outreach to diverse audiences including the public, educators, students, decision/resource managers, and policy-makers . This will increase the standing stock of people with scientific credentials who have added skill sets in the process of governance and decision-making as well as communication. Added emphasis needs to be placed on enhancing the social science capacity both within NOAA and in its partners.

Finding: NOAA has an impressive array of education and training programs related to climate change, directly and indirectly, across the Administration. But these currently are only loosely connected at best, and are not working together in an efficient, effective, cohesive way. Also, there is no comprehensive, easily accessible inventory of them. Until there is, it will be virtually impossible to tell if any important gaps exist.

Recommendation: That under the leadership of the NOAA Education Council and Communications Committee, a comprehensive inventory of educational and outreach products, programs, and partnerships be completed; sorted by subject/theme and by

⁸ The terms training, education, and outreach are used here as defined in the NOAA SAB report on Engagement.

audience—primary and secondary—by objective, by subject/theme, and by medium. That products and programs that deal explicitly with climate change be highlighted and the entities within NOAA that have the lead role be identified. That for every product or program, information be provided on how to access it. An appropriate home for this inventory would be the NOAA-led climate portal.

Finding: NOAA has an impressive number of networks for distributing information and for engaging different audiences to increase awareness and deepen understanding about climate change and its implications, and to enhance stewardship through personal actions. These networks include (in no particular order):

- The Climate Literacy Network
- Coastal Services Centers
- GLOBE, CoCoRAHS, and other citizen science networks
- Association of Science and Technology Centers
- IGLO and C2 Networks
- The Internet2 Consortium’s K20 Initiative
- Science on a Sphere institutions
- The GeoDome Network
- COSEE institutions
- Sea Grant/Land Grant
- Smithsonian Institution Ocean Hall-Coastal America Ocean Today kiosks
- National Science Teachers Association E-learning portal.

Recommendation: That NOAA take the lead in developing and delivering with its partner networks a portfolio of coherent programs using a uniform set of messages tailored to different audiences.

Finding: ORRAP—the Ocean Research and Resources Advisory Panel—recommended to the Obama administration that NOAA should take the lead in developing with other federal agencies a comprehensive and coherent federal ocean education program.

Recommendation: Given the recent findings of The Ocean Project and Jon Krosnick, *et al.* that climate change is on the list of public priorities and the ocean is not, and that the public failed to make connections between climate change and the ocean, climate change might be a “good horse to ride” to get the public engaged in the ocean’s role in climate change and how climate change is affecting the ocean. “Climate Literacy: Essential Principles and Fundamental Concepts” provides a valuable framework.

Finding: NOAA’s vision calls for

“An informed society that uses a comprehensive understanding of the role of the oceans, coasts, and atmosphere in the global ecosystem to make the best social and economic decisions.”

The results of the recent survey by the Pew Research Center for the People and the Press and the American Association for the Advancement of Science include the following statements that underscore how poorly much of society is grounded in several major scientific issues, including climate change.

July 9, 2009

Public Praises Science; Scientists Fault Public, Media

*“Most notably, 87% of scientists say that humans and other living things have evolved over time and that evolution is the result of natural processes such as natural selection. Just 32% of the public accepts this as true. **And the near consensus among scientists about global warming is not mirrored in the general public. While 84% of scientists say the earth is getting warmer because of human activity such as burning fossil fuels, just 49% of the public agrees.**”*

Against the backdrop of these findings, consider this statement by Thomas Jefferson concerning the importance of an educated public in a democracy:

“I know no safe depositary of the ultimate powers of the society but the people themselves; and if we think them not enlightened enough to exercise their control with a wholesome discretion, the remedy is not to take it from them, but to inform their discretion by education. This is the true corrective of abuses of constitutional power.” --Thomas Jefferson to William C. Jarvis, 1820.

It seems clear that NOAA has an important and challenging opportunity and responsibility to educate the public about climate change, including the roles of the ocean, if it is to achieve its vision.

NOAA’s new Administrator, Dr. Jane Lubchenco, says NOAA is about “Science-Service-Stewardship.” The latter two depend upon an informed public and public support for NOAA’s science mission is critical in ensuring an appropriate level of sustained support.

Recommendation: That the value of NOAA’s extensive programs, projects, people, and partnerships—and as a result its service to the Nation—could be enhanced significantly through better coordination and collaboration within NOAA and with their external partners in developing and delivering products and services—including education and training—to the public on climate change, including mitigation and adaptation. To do this, NOAA must get closer to its customers—existing and prospective—to determine their needs and wants. By engaging them early in the process of developing and delivering the NOAA portfolio of climate information products and services according to needs of its diverse set of audiences the partnerships will be strengthened. That NOAA’s initiatives in education, training, and outreach be integrated more fully into this effort recognizing that it will require additional resources. That customer service success be included in NOAA performance reviews and acknowledged and rewarded.

Finding: New ways of communication are sweeping across the landscape, particularly for younger people. These include a rapidly growing portfolio of social networking tools as well as tools and technologies for data visualization, display, and interactive analysis.

Recommendation: That NOAA embrace these new channels of communication along with more traditional channels to reach the public. That NOAA establish a culture of outreach, education, and engagement that is two-way and symmetrical, rather than one-way, asymmetrical models that have been traditionally employed by federal agencies for decades.

4.7: Measuring Success/Performance Measures (Roberta Balstad)

This session began with a presentation by Margaret Davidson about the need for performance monitoring in NOAA's climate services and its role in evaluation, program management, and conveying information for federal and agency budget processes. Additional presentations were also given by individuals outside NOAA. Thomas Wilbanks (Oak Ridge National Lab) summarized various indicator efforts currently underway and stressed that the effectiveness of performance metrics is dependent on contextual conditions and program priorities that determine what is measured. Eric Barron (NCAR) spoke about various process metrics that could be used for a NOAA climate service, distinguishing among input metrics, output metrics, outcome metrics, and impact metrics. He noted that outcome and impact metrics are the most challenging, in part because they are so broad. Suzanne Moser (Suzanne Moser Research & Consulting) said that whatever is measured relating to performance and productivity will be a narrow slice of what is important and stressed the importance of understanding the incentives and constraints on those who are working within the NOAA climate service in evaluating performance metrics.

The review committee believes that performance monitoring and evaluation is critically important for NOAA's climate service and was pleased that the subject is being considered as the climate service is being organized rather than after these climate services were fully defined and operational. At the same time, however, there were a number of recommendations for NOAA in this discussion.

Recommendation 1: Developing and analyzing performance measures requires special training and skills. This is a discipline in its own right and NOAA should get input on its work in this arena from individuals with appropriate experience. This effort will also require cooperation among evaluation specialists, external subject matter specialists, and users.

Recommendation 2: Performance measures should be realistic in terms of program objectives and the growing government demands for accountability. For example, having a single metric is inadequate. Because of the varying purposes for which metrics are needed, there should be a suite of performance metrics for NOAA's climate services. So should the recommendation be that CIPA have a role in researching/developing this?

Recommendation 3: For the metrics to be most useful, NOAA should collect benchmark data now. These benchmark data, because they are obtained prior to implementation of the program, will provide a means of assessing changes in the metrics (and the underlying progress) over time.

Recommendation 4: The NOAA discussion of metrics focused mostly on process and programmatic performance, but the review team pointed out that the specific products of NOAA's climate services also need to be assessed, quite apart from the programs that produce these climate products.

Recommendation 5: Programs should be assessed in terms of their goals and aspirations as well as their concrete accomplishments. Monitoring programs solely in terms of their specific accomplishments could be too limited if the assessment fails to take into account whether the aspirations of the program are as broad and inclusive as they should be.

APPENDIX 1. TERMS OF REFERENCE FOR THE CIPA REVIEW

Purpose

To evaluate the climate information products and applications program activities and its ability to meet increasing demands for climate information to address decision maker needs through applied and issue focused research; develop prototype products and tools; transition research products into applications, operations and decision processes; and provide operational delivery of climate services, capacity building and support to users. The review will occur as follows: July 13-15, Boulder, CO – Identification of cross-program connections, synergies and gaps; climate information products and applications strategic planning and recommendations for the way forward

Background

□ The NOAA Science Advisory Board is the only Federal Advisory Committee with responsibility to advise the Under Secretary of Commerce for Oceans and Atmosphere on long- and short-range strategies for research, education and the application of science to resource management and environmental assessment and prediction. The SAB considers eight themes when providing advice to NOAA: 1) Quality, Creativity and Credibility; 2) Timeliness and Scale; 3) Science Connected to the Application and Operational Implementation of Policy; 4) Capacity Building; 5) Education; 6) Efficiency; 7) Social Science Integration; and 8) Diversity.

□ The Climate Working Group (CWG), as a sanctioned working group of the NOAA SAB, advises on the condition and capabilities of NOAA's climate activities and supporting NOAA systems and submits formal reports that identify current issues, deficiencies, recommendations for remedial action, and proposed initiatives. The CWG provides scientific advice and broad direction to NOAA's climate program, in the context of national and international activities.

□ The CWG conducts a review of one major climate program each year. The focus is on the broad research and operational components of the climate program, as well as on the underlying observations and data management issues.

Framing Questions and Topics for Review

1. Program Framework

a. What does the program framework provide in the way of flexibility and creativity to address emerging national, regional and local climate service requirements? Sector priorities? International objectives? Integrated capabilities on the sector/regional scale? What does the program framework provide in terms of support internally to other NOAA entities as well as externally to NOAA customers/decision makers?

b. How do NOAA labs/centers interact with this program? Climate information is developed in several different parts of NOAA (e.g. NCDC, GFDL, NCEP). The provision of climate services also occurs in many different areas of NOAA (e.g.

National Marine Fisheries Service, Coastal Services Center, NWS-Climate Services Division, RISA, new NOAA Regional Collaboration Teams, NIDIS)

c. What is the contribution from the program to support the efficiency of R20 and O2R capabilities?

d. What is the role of the external community in developing cutting-edge impacts and adaptation research and tools; leveraging years of research, expertise and work with regional/local stakeholders?

e. What are NOAA policies and experiences with the public/private provider relationships on services?

f. How are the priorities for the program determined and what is the extent to which the external community has an influence on that priority setting?

2. Performance Metrics

a. What are key performance metrics to measure the success of the program in achieving stated goals? [Use NRC study for guidance?]

b. Do these metrics need to be revised/updated? What would those proposed changes be?

3. Program Activities

a. What is the effectiveness of the current 'climate services laboratories' (RISAs, RCCs)?

b. What are effective means for employing the program's service capabilities in national programs and setting out appropriate delivery strategies?

c. What climate product lines are useful to scientists and decision makers, and provide a pathway for feedback from these user communities?

d. What is the effectiveness of the current international influence (IRI's) on the program?

4. Future Directions

a. How can the program build a needed culture of excellence, innovation, responsiveness, and customer-orientation?

b. How can the program best communicate (listen as well as speak) and collaborate with partners and users moving forward? This is multi-level:

i. internally, within NOAA

ii. between NOAA and DOC

iii. with other federal agencies, departments

iv. with regional/state/local governments

v. with private-sector providers of climate services

vi. with sector-by-sector users of climate services

c. Is the program effectively managing rapidly evolving capabilities for service provision with rapidly evolving needs? How can the program make these two trends more congruent? How are those needs assessed and how often?

d. What can the program do to build capacity, both

i. *internally*, with respect to its ability to develop the natural and social science needed to assess climate impacts (given that the needed science is not in hand); and

ii. *externally*, with respect to improving its *customers'* ability to use climate services?

APPENDIX 2. TELECONFERENCE AGENDA

Agenda

Climate Information Products and Applications Virtual Review:

May 5 & 6, 2009

1 – 5:30 pm EDT

SSMC 3, 12836

Call in Number: 866-746-3284

Participant Passcode 1702950

Goal(s)/Purpose of the Review:

- An annual programmatic review conducted by the Climate Goal of their individual programs
- To review the existing capabilities and activities of the Climate Information Products and Applications program

Questions for each program to address in the review:

1. What existing goals and/or objectives guide the program or activity?
2. What strategies, if any, were developed and/or implemented to achieve these goals and objectives?
3. What were the program's or activity's accomplishments and outcomes?
4. How was performance monitored and evaluated?
5. Were goals and objectives met?
6. How this case study exemplifies the goals of the program

Day 1 – Tuesday, May 5

1:00 Executive Session: Climate Working Group and Review Team

1:30 Introduction:

Chester Koblinsky, Climate Goal Team Lead
Anthony Busalacchi, Climate Working Group
William Hooke, Climate Information Products and Applications
Review Chair

1:45 RISA: Caitlyn Simpson
10 minutes Presentation
20 minutes Q & A/discussion

2:15 RCC's: Marjorie McGuirk/Tim Owen
10 minutes Presentation
20 minutes Q & A/discussion

2:45 TRACS: Sarah Abdelrahim
10 minutes Presentation
20 minutes Q & A/discussion

- 3:15 Break
- 3:30 IRI: Chet Ropelewski
10 minutes Presentation
20 minutes Q & A/discussion
- 4:00 NPCREP: Jeff Napp/Phyllis Stabeno
10 minutes Presentation
20 minutes Q & A/discussion
- 4:30 Overview of the COM Program Portfolio: John Jensen
- 4:50 Overview of the CRM Program Portfolio: V. Ramaswamy
- 5:10 Executive Session: Climate Working Group and Review Team Preliminary Thoughts/Comments
- 5:30 Adjourn

Day 2 – Wednesday, May 6

- 1:00 NIDIS: Roger Pulwarty/Chad McNutt
10 minutes Presentation
20 minutes Q & A/discussion
- 1:30 SARP: Nancy Beller-Simms/Adrienne Antoine
10 minutes Presentation
20 minutes Q & A/discussion
- 2:00 NWS Climate Information Products and Applications: Ahsha Tribble/Michelle Hawkins
10 minutes Presentation
20 minutes Q & A/discussion
- 2:30 Comm/Ed: Frank Niepold/David Herring
10 minutes Presentation
20 minutes Q & A/discussion
- 3:00 Break
- 3:15 Executive Session: Plan for July meeting/steps forward (Climate Working Group)

APPENDIX 3. BROOMFIELD AGENDA

AGENDA
Climate Working Group (CWG)
Climate Information Products and Applications Program Review
July 13-15, 2009
Omni Hotel
500 Interlocken Blvd
Broomfield, Colorado 80021
Conference call in number: 866-740-1260
or 303-248-0285 (Local Denver-Boulder participants)
Passcode (for both) 4978663

Day 1 – Monday, July 13

2:00 **Executive Session:** William H. Hooke, Senior Policy Fellow and Director, AMS Policy Program, Moderator and Chair

2:15 **Welcome and Meeting Logistics: Goal of the Review (open session):**

- Chester J. Koblinsky, Climate Goal Team Lead
- Antonio Busalacchi, Climate Working Group
- William H. Hooke, Chair of the Review

2:30 **Setting the Context**

- National Climate Service: Eileen Shea, Chief, Climate Services and Monitoring Division, NCDC
- Climate Goal Overview: Chester J. Koblinsky
- Overview of the Program: Margaret Davidson, Program Manager

Panel 1: Private Sector/Partnerships/Interagency

Moderator: Lee Branscome (Review Team)

3:45 Panel Lead: Dan Walker
Supporting NOAA panelists: RCC's (M.McGuirk), NWS-CSD (M. Hawkins), RISA (C. Simpson), NIDIS (R. Pulwarty), CTB (F. Horsfall), TRACS (S. Abdelrahim)

4:15 Externals:

- Sharlene Leurig/CERES
- Nancy Colleton/Institute for Global Environmental Strategies
- Stephen Jordan/U.S. Chamber of Commerce

4:45 Discussion

5:15 Adjourn

6:30 Dinner with speaker (Omni Hotel, The Pavilion): Jack D. Fellows, Director, UCAR Community Programs

DAY 2 – Tuesday, July 14

Panel 2: Regional/Place-based Efforts

Moderator: Michael Crimmins (Review Team)

8:00 Panel Lead: Eileen Shea
Supporting NOAA panelists: IRI (C.Ropelewski), NIDIS (R.Pulwarty), RISA (C. Simpson), RCC (M.McGuirk), NWS-CSD (D. Kluck), Sea Grant (J. Murray)

8:30 Externals:

- Jeffrey Payne/NOAA Coastal Services Center/Regional Collaboration
- Kevin Robbins/Director, Southern RCC
- Brad Udall, WWA RISA

9:00 Discussion

9:30 Break

Panel 3: Water Resources

Moderator: Jeanine Jones (Review Team)

9:45 Panel Lead: Roger Pulwarty/Chad McNutt
Supporting NOAA panelists: NWS-CSD (M. Timofeyeva; G. Bonnin), RISA (C. Simpson), SARP (N. Beller-Simms), TRACS (S. Abdelrahim), IRI (C. Ropelewski), CTB (F. Horsfall), RCCs (M. McGuirk), PFE (G. Bonnin)

10:15 Externals:

- Eric Kuhn/ Colorado River Conservation District
- Molly Hellmuth/The International Research Institute for Climate and Society
- Chad Berginnis/Michael Baker Jr., Inc.

11:00 Discussion

11:45 Panel adjourns – box lunches provided

11:45 Executive Session: Climate Working Group and Review Team only

Panel 4: Coastal

Moderator: Anthony Janetos (Review Team)

12:45 Panel Lead: Jeffrey Payne
Supporting NOAA panelists: SARP (A. Antoine), CSC (M. Culver) TRACS (S. Abdelrahim)

1:15 Externals:

- John Dorman/N.C. Department of Emergency Management
- Mike Beck/The Nature Conservancy
- Betsy Blair/Hudson River Estuarine Research Reserve

1:45 Discussion

Panel 5: LMR/Ecosystems

Moderator: Jake Rice (Review Team)

2:15 Panel Lead: Paul Sandifer
Supporting NOAA panelists: NPCREP (K. Osgood), SARP (A. Antoine), EGT (R. Griffis), EGT (J. Phinney)

2:45 Externals:

- Mike Beck/The Nature Conservancy
- Penny Dalton/Washington State Sea Grant

- Denise Reed/University of New Orleans

3:15 Discussion
3:45 Break

Panel 6: Capacity Building/Training and Outreach/Education
Subpanel A: Tuesday PM, focusing on Capacity Building/Training

Moderator: Jerry Schubel (Review Team)

4:00 Panel Lead: Ahsha Tribble
Supporting NOAA Panelists: Comm/Ed (D. Herring, F. Niepold), NWS-CSD (M. Timofeyeva),
CSC (M. Culver), Sea Grant (J.Murray), NERRS (L. McGilvray)

4:30 Externals:

- Susi Moser/Susanne Moser Research & Consulting

5:00 Discussion
5:30 Adjourn
6:00 Dinner - on your own (links on Website)

Day 3 – Wednesday, July 15

Panel 6: Subpanel B Outreach/Education

Moderator: Jerry Schubel (Review Team)

8:00 Panel Lead: Ahsha Tribble
Supporting NOAA Panelists: Comm/Ed (D. Herring, F. Niepold), NWS-CSD (M. Timofeyeva),
CSC (M. Culver), Sea Grant (J.Murray), NERRS (L. McGilvray)

8:30 Externals:

- Debbie Sliter/National Environmental Education Foundation

9:00 Discussion

Panel 7: Measuring Success/Performance Measures

Moderator: Roberta Balstad (Review Team)

9:30 Panel Lead: Margaret Davidson
Supporting NOAA Panelists: CGT (K. Arzayus)

10:00 Externals:

- Eric Barron/Science Advisory Board
- Susi Moser/Susanne Moser Research & Consulting
- Tom Wilbanks/Oak Ridge National Lab

10:30 Discussion

11:00 Break

11:15 Executive Session: Climate Working Group and Review Team Brief

1:00 Meeting Adjourns

APPENDIX 4. INDIVIDUAL PERSPECTIVES⁹

Appendix 4.1. Raymond J. Ban, The Weather Channel (comments here are more related to an NCS than CIPA)

First off, I would like to once again extend my compliments to the NOAA staff members who presented at the Review Meeting. I was greatly impressed with both the depth and the breadth of the climate services being provided by the agency today and had no idea that the volume and diversity of the information was so large.

I would also like to extend compliments to Bill Hooke for running a smooth and effective meeting.

Although challenging, the prospect of a National Climate Service is a great opportunity for NOAA. It presents the agency with the chance to leverage multiple skills in a number of areas and really take a high profile leadership role in an area of significant importance. The Review Panel report captures this concept quite well and the recommendations are consistent with the discussions that took place during the meeting. My individual input is to simply underscore a couple of these points.

NOAA/NWS has for decades been and still is the hub of the US Weather Enterprise. Over the years as the Weather Enterprise has evolved, the agency has had to learn to become less of a stand-alone silo and more of an engaging partner. This transition has been made more difficult from my perspective by an insular NOAA culture that appears to place more emphasis on avoiding mistakes than it does on making progress. However, despite this embedded culture and the strong root guards that seem to surround it, NOAA/NWS has made significant progress and today is much more open and enfranchising in its Weather Enterprise relationships.

It seems to me that the establishment of a National Climate Service is a fabulous opportunity to apply the learning gained from the weather side of the house and as the Review Report strongly recommends, leverage some of the collaborative mechanisms that have evolved from years of interaction with the other sectors of the weather community. Although a National Climate Service will have different dimensions than the National Weather Service, there are some overlaps and NOAA should have no reservation or hesitation in taking advantage of these established partnering forums and processes.

I believe that collaboration is critical and must become a NOAA core competency if the agency is to be successful in leading a National Climate Service. Collaboration must occur on so many different levels and among so many disparate entities it is almost mind numbing. If NOAA is serious about success in this initiative, it might even consider

⁹ As stated in the introduction, while these contributions from individual team members are not necessarily the views of the entire review team, it was felt that they might stimulate thought and therefore add value for certain readers of the report, and they have been included in this spirit.

establishing an Office of Climate Collaboration. Although I say this somewhat with tongue in cheek, it is my firm opinion that strong leaders with a successful track record in building win/win partnerships will be every bit as important as physical science acumen in getting a National Climate Service off the ground and making it a success.

In closing, I would like to thank the Climate Working Group for the opportunity to participate on the Review Panel. A lot of great work has been done by a lot of good and smart people and I am honored to be able to make a small contribution to this very exciting effort.

Appendix 4.2 Jean Brennan, Defenders of Wildlife

Several key aspects of this review should be noted.

First, although described as a program, the CIPA Program is less of a ‘program’ and more of an assemblage of individual climate-relevant elements, many of which developed independently over time in a somewhat ‘organic’ fashion. As such, this review did not assess a programmatic track record but rather reviewed the adequacy of the assembled ‘pieces’ that could be drawn into a coherent program for the purpose of serving future climate information and services over the next 15 years. But, in general, NOAA appears to have many of the critical pieces assembled but lack an integrated strategic framework to guide program development and decision-making, evaluate program effectiveness, and to identify appropriate performance metrics upon which to evaluate climate services (*see “options/individual recommendations” below.*)

Second, NOAA must do a better job at integrating all three of its climate-related programs (COA, CRM, CIPA); a recommendation that has also come out of earlier reviews of the other programs and submitted to the SAB/CWG. Recommendations on how to achieve this were beyond the scope of this individual program review but should be address by a higher-level review.

Third, the existing regional infrastructure that exists in several program elements is not being utilized to provide the organizing foundation to more effectively link the various CIPA elements (i.e., RISAs, RCCs, SARP, TRACS). This is a missed opportunity to achieve closer coordination and possibly greater efficiency and cost effectiveness.

Fourth, although the international work of the (IRI) is undoubtedly benefits the host country, expands the US humanitarian efforts, and minimally promotes the transfer of

technology and training, this program element appears to lack any strategic coordination with other US-sponsored water and drought-related efforts (e.g., the work of the US Agency for International Development, the UN sponsored research (and funded with support from the US through the World Bank grants) to the CGIAR Centers, and research tool training through START.) It is not clear to this reviewer what contribution the IRI offers to a larger programmatic purpose, other than its contribution of basic research products on a thematic topic that is covered by other CIPA program elements. Obviously a well articulated strategic framework may help to clarify. Absent a framework, the international portion of the CIPA deserves a more critical examination relative to the broader national effort.

Beyond the issues raised above, the following options/individual recommendations are offered to help the growth and evolution of the CIPA Program achieve its full potential and contribute to our nation's climate change needs.

Identify a strategic framework to draw the various CIPA elements together and create a more structured program. This will require that NOAA

- clearly **articulate the goal of the program** in light of the agency's comparative advantage over other Federal, State, and non-governmental and private entities and industries in serving the nation's need for climate information and products;

Recommendation: conduct a systematic assessment of 'who's doing what' across key sectors.

- **identify the end-users** and clients and assess their current and near-term needs in terms of climate information, assessments, and products, as well as risk management under predicted climate impacts; and

Recommendation: conduct a survey that minimally includes climate scientists, natural resource managers, water management authorities, regional planners, and key industry associations to identify (a) the end-users or clients (both traditional and non-traditional users) that will need to be served, and (b) identifies their needs over the next 15 years. Based on the survey results it would then be possible to identify the level of coverage and to propose a systematic process to expand the client and users-served base. It should be noted that this approach recognizes the inherent limitation of our current understanding of the climate system that the end-user may not yet know what they need.

- **describe the organizational structural and functional changes, and training required**, to develop the 'climate-ready' staffing capacity required to generate and deliver climate information and services over the next several decades.

Recommendation: work with the NOAA Administrator to recognize the inherent 'transaction costs' required to invest in the training and capacity building of the agency's workforce, and to facilitate a process to achieve the required cultural and programmatic transformation needed to advance a new business model. To paraphrase a comment raised in our review by another Review Team members, NOAA is going to have to expand (and

evolve) from weather forecasting logic and culture to earth system analysis.

This new model to address the nation's climate challenge must recognize that no single agency can address the climate needs and must work as a multi-agency initiative, that programs will need to work in public-private partnerships, recognize that it's not just about the science, it is also about timely and authoritative information for decision-making, and produce not only assessments but also information, tools, and strategies to advance climate change adaptation efforts across the nation and across sectors (e.g., health, energy, natural resource management).

Appendix 4.3. Bryan Hannegan, Electric Power Research Institute

I share the view expressed by several other panel members that NOAA has made a good start at defining its role with respect to climate products and information services. I also agree that the current program set suffers from a lack of strategic direction and the cohesion among program elements that a strategic vision will provide. The CIPA programs present themselves as a confederation of loosely associated activities with little overarching objective, and as such, will be hard pressed to make the case for expanded resources in a world where they must compete with other agency priorities.

The development of a strategic plan for the existing NOAA programs in this area is certainly necessary, but more important in my view is the need to develop a long-term vision that places NOAA's CIPA activities in a proper context relative to the basic science activities elsewhere within NOAA and the U.S. Global Change Research Program, and the implementation of decision support tools by affected industries and sectors. My own view is that the science-based core activities (presently a large fraction of NOAA's and the USGCRP's budget, and rightly so) should focus on climate observations and monitoring, as well as climate research and modeling. They generate the "raw material" on which good climate information and products can be based. It is the job of the CIPA program activities to take this raw material and polish it into a finished product that is useful and used by their "customers" – the regions, sectors, and international applications. This "climate service development" function of the CIPA programs should be an essential part of the core vision for this area, and CIPA's structure and program priorities should reflect a regular and ongoing dialogue with the "customers" they serve – who will tell NOAA what information they need, and how it should be delivered to be most effective. Absent a long-term vision that provides a defined and distinct role for CIPA programs, they will either languish for lack of agency priority or be swept into larger more functional organizations within NOAA.

During the review I also stressed on several instances the need for CIPA programs to show their value with some "quick wins" – instances where climate-related information

and products were applied to specific problems in a sector with a demonstrated rate of return on the investment. Correspondingly, the near-term focus of the CIPA programs should be areas where you already have an engaged stakeholder population – drought (NIDIS), coasts (CSC) and marine ecosystems (NPCREP). Other sectors, such as the electric power sector, could be candidates for near-term focus if a partner organization can be found to mobilize stakeholder support in that area with their own resources as a cost share. Doing so will build a larger constituency that will be invaluable in obtaining the resources needed for future program area growth.

Appendix 4.4 Anthony C. Janetos, Joint Global Climate Change Research Institute Thoughts on NOAA Regional Climate Products and Information Services

Initial thoughts are that NOAA has done very little to learn from other agencies' experiences in working with stakeholders – whether good experiences or bad

Also clear that very little internal coordination among the many different parts of the NOAA program – e.g. individual projects on wildfire management and on fuel loading, but they belong to different components of the NOAA program, and apparently haven't talked either to each other, and only limited interaction with outside collaborators

Some very good collaborations with a few other federal agencies, all around local/regional projects – very little or no collaboration or formalized relationships at agency-level

Lots of reliance on the widespread nature of NOAA activities – Sea Grant, coastal management, regional climate centers, RISA's, etc. But these have their own rationale for existence, have not always worked well together in the past, clearly do not have a shared vision for how to move forward with respect to climate-related issues, and are of quite variable scientific capacity – how is this to be reconciled with overall goals?

Also, very clear that a lot of the NOAA activities are still “push” oriented around products, model output, statistical climatology, and not so much “pull” oriented around exactly what the broad variety of collaborative groups might want and need; how is NOAA going to handle this issue?

There has been a lot of discussion about what it will take to build NOAA's capacity to do training, education, communication, etc. in response to this call for climate services. But...although the NOAA panel maintains that they are as much about building external capacity as they are about building their own internal capacity, I do not find their discussion compelling. They have given us few specific examples of what they do to build the capacity of the communities of people who might be users of the kind of information that they are able to contribute. Nor is there any indication of serious

collaboration with other agencies and institutions involved in similar programs and efforts

Perhaps the biggest single issue in the review meeting is that there are at least two visions competing for attention within the overall NOAA climate services program. One is that NOAA needs to continue to improve on delivering services and products to an existing client base, i.e. to continue to improve as an operational service-delivery agency. The other is that NOAA needs to put the scientific foundation in place to improve the Nation's capacity for adapting to climate change, i.e. to do things significantly better than we are currently able to do.

These are not the same vision, although they are clearly related to each other in some interesting and possibly fruitful ways. But without explicitly making this choice, NOAA will underperform at both, and it will be very difficult to demonstrate leadership for the Nation at either.

Another large strategic issue on which NOAA must make a decision is the overall structure of this part of the program. The total funding is about \$40M, which for federal research programs is not large at all. Nearly \$10M of that goes to IRI (I think). But much of the rest is fragmented into a series of very small activities, and the coordination among them is still at a rudimentary stage. There is not an overall framework that has been derived into which the individual activities can identify their own niche, and some are simply too small to be viable in the long term.

Finally, while it is clear that there are lots of advantages and opportunities for partner organizations that are already connected to NOAA programs, it is not at all clear how organizations that are not already connected can become connected. How can people and institutions that are not currently part of the NOAA family become connected? This is an important strategic consideration that NOAA needs to consider.

CIPA Review – Review Team Individual Perspective

Appendix 4.5. Jake Rice, Ecosystem Sciences, DFO-Canada

Of the Review Panel members, I believe I am the only one whose work regularly includes providing science advice to policy-makers and managers on governmental regulatory issues, and explaining the advice to those affected by the possible regulatory actions. The advice is always based on some variant of risk of environmentally unsustainable consequences of the activity being regulated. Typical issues include fish harvest levels, water removals from rivers and lakes for various uses including hydrocarbon extraction, siting of coastal activities such as aquaculture facilities and municipal infrastructure, recovery plans for endangered species, protection from or control of alien invasive species, etc. Even though many of the regulatory decisions may be short term (annual fish quotas, annual water removal levels), evaluation of *sustainability* is necessarily done in long-term perspectives. In all these issues, possible impacts of climate change on the

aquatic ecosystems in which the human activities occur and on the meteorological conditions that are major external drivers of those aquatic ecosystems are crucial considerations in evaluating “sustainability” of the human activities.

Most regulatory agencies have in-house science capacity; in the US NMFS does, so does NOS, USF&G, and most states. However their science support is generally in expertise close to the activities being regulated and the parts of the ecosystem being used directly. NMFS has expertise in fish population dynamics, marine ecosystems, and more recently in the economics and sociology of fishing. The Estuary program has science expertise in coastal aquatic ecosystems, etc. However the agencies don't have in-house expertise in climate modelling and climate science, and it would be inefficient to create such a capacity when it already exists in other parts of NOAA (and elsewhere). A climate service providing timely and scientifically sound products that the experts in the regulatory agencies can use in their own scientific endeavours (for example, possibly take into their ecosystem and population models) is essential, however.

Many of the other participants in the Review Panel work from community-based or “bottom-up” perspectives. To meet their needs they stress the need for the climate service providers to make major and enduring commitments of the time of designated experts, to develop personal trust and credibility within the communities receiving the climate products and services. The climate support for regulatory functions is different. The climate experts in the climate service need to communicate with the science experts in the regulatory agency so there is a mutual understanding; the climate experts need to understand the sustainability issues of concern to the regulatory experts and the regulatory experts need to understand what is realistic to expect with regard to climate products and services. These are expert-to-expert communications. In my experience, it is easy for each group to become interested in the challenges faced by the other. A big infrastructure isn't necessary to facilitate these communications (in fact most of the experts dread “facilitators” – they just get in the way of talking real science). All that is needed is a clear signal from the managers of those producing the climate products that working with the advisors to the regulatory community is a priority, and a comparable signal from the managers of those providing the advice to regulators that they should be taking account of these climate considerations in the evaluation of what is and is not sustainable. Certainly a lot of “face time” might be needed at the beginning to develop that mutual understanding of each others' needs and capacities. Thereafter, though, these are just more professional linkages between experts working on related problems. Some of the linkages will flower into major research collaborations; some will be little more than an annual hand-off of results and de-brief on uses. Personally I have always encouraged oceanographic experts to attend the full duration of a fisheries assessment meeting and not just go the first day, present the annual State-of-the-Ocean Report, and leave. Seeing what problems the assessment experts may be struggling with can prompt the oceanographers to see new opportunities to have their products used, and seeing how the assessment experts use the oceanographic products may even engage them in the advisory process more directly. Such interactions through the course of the advisory process also make the subsequent communication of the advice to the regulators and the communities being regulated more effective. Whether the oceanographers end up part of

the communications team for the advice or not, the experts who are meeting with clients of the advice will actually understand what they are talking about. When climate experts are providing climate products and services to the advisory meetings, I would provide the same encouragement to actually participate in the meetings, and for the same reasons.

Although provision of climate products to expert advisory processes for regulatory responsibilities does not require the same “dedicated face” as seems important for community-based processes, the terms “timely” and “scientifically sound” used earlier are crucial. For “timely”, advice supporting regulatory action is almost always fed into to a decision-process working on a fixed timetable. I find regulators usually would rather have incomplete advice than late advice, because they can’t delay the timetable of the decision process either. Scientifically sound is more than a platitude – there are whole NRC reports on what meets the standard of “best available scientific and technical information”(‘basti’). For regulatory decisions to withstand challenges (and many *will* be challenged) they cannot be or appear to be arbitrary or inconsistent. Consequently the science advice input to the decision process must be consistent as well as peer reviewed. This does not mean the advice has to be fit into some Procrustean bed of always using exactly the same climate information in exactly the same way. However, when different climate information is used in different advice, there has to be scientifically defensible reason why one set of climate products was ‘basti’ for one place or part of an ecosystem and another set of products was ‘basti’ for another. When the same information was used in different ways for different advice, again there has to be a better justification than “the experts were interested in the climate aspects of the regulatory problem for this stock or estuary, but the experts weren’t interested for this other stock or estuary”. It is usually possible to defend inconsistent use of environmental information – and climate information when it starts being part of the information base used for regulatory advice - by saying “The information is already available here but it is not available there”. However if the environmental / climate information makes a difference in the advice, there had better be a plan for having the information available “there” pretty soon.

It is this important feature of credible and defensible science advice on regulation that makes me an advocate for NOAA producing generic climate products and services, and not to approach its task as finding a client, working with that client until the client is fully satisfied, and then seeing if there is capacity left to deal with the next client. “Generic” does not mean low quality, either. Rather, it means making “acetylsalicylic acid” climate products for as large an area as possible. A-s-a is high quality medicine and valuable in and of itself. For many people that is all they need to treat their problems (especially if they combine it with other appropriate measures, few of which might be additional medications). For those who want or need specialized buffers, anti-allergens, designer bottles etc. they can find private sector companies to adapt a-s-a or some relative to meet their specialized needs. I see generic climate products and services as having many analogies with this medical analogy (acknowledging the risks inherent in using any analogy to illustrate a point.)

This aspect of the advisory process means that to service the regulatory community NOAA climate services should focus on providing reliable and timely products and

services that can serve multiple uses directly and on large scales (this may not be one forecast for everywhere – but one forecasting technology providing a map/data base with the forecast of local conditions across a large area), and be adapted by value-added processes for many specialized applications. Other communities may feel that to address their needs NOAA should focus on other types of products and services, or operate in different ways. The Strategic Plan and Strategic Framework referenced in the general report needs to sort out the priority to be given to these communities, if their needs really are different.