NOAA Science Challenge Workshop Identifying Methods for Quantifying the Societal Impacts of the National Oceanic and Atmospheric Administration

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NOAA Science Challenge Workshop

Identifying Methods for Quantifying the Societal Impacts of the National Oceanic and Atmospheric Administration

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EXECUTIVE SUMMARY

The National Oceanic and Atmospheric Administration (NOAA) generates tremendous value for the nation. The Agency provides critical environmental data, forecasts, cutting edge knowledge, management and stewardship that the United States needs to plan for and react to in a constantly changing global environment. The Agency, however, needs to do more to understand and measure exactly how its activities, products and services affect the well-being of the nation. Existing and emerging social science methods can be harnessed to help the Agency assess the degree to which we are meeting our mission goals and to improve the value we provide to society.

The first NOAA Science Challenge workshop brought together policy makers at NOAA with social science leaders from inside and outside of the Agency to explore methods for better quantifying the ways in which NOAA affects society. As an initial step in better understanding the broader societal impacts of NOAA, we focused on the NOAA line offices and programs that deal most directly with the public: the National Weather Service, the National Marine Fisheries Service, the National Ocean Service, and Oceanic and Atmospheric Research (including the National Sea Grant College Program), and the programs that support climate activities at NOAA (the Climate Program Office and the National Climate Data Center).

While it is easy to see why society needs NOAA, the workshop revealed just how difficult it can be to rigorously quantify the societal impact of NOAA's activities, products, and services. As a first step, the line offices identified specific NOAA products, services, and activities (outputs) for which they would like to quantify societal impacts. These examples were meant to highlight a diversity of products and services. We focused initially on relatively straightforward examples that could serve as both a departure for discussion and illustrations of how programs within the Agency might begin thinking about quantifying the societal impact of their work. For each output, the line offices developed a narrative (story) that linked the output with a sector of society and ultimately a state of societal well-being. Workshop participants further developed these stories and explored methods and approaches to better quantify how these NOAA outputs affect societal well-being.

The workshop identified many methods that can be applied to better understand the way the Agency affects society. One class of methods is data denial, in which intermediate and final users of NOAA data products are asked to operate in the absence of NOAA data. Other methods involve retrospective analyses of the ways in which the public and private sector have used NOAA outputs. Still other approaches require that users imagine how their decisions would differ in the absence of NOAA activities, products and services.

Table 1 provides a sampling of value chains, metrics, and methods developed at the workshop. The participants identified a variety of metrics to measure societal well-being and change including revenues, economic value, lives saved, sense of place, preferences and attitudes, property damages, and crop yields.

While one day is insufficient to fully develop these methods and approaches, the workshop was an important opportunity for policy makers at NOAA and social scientists to work together to understand how the Agency can harness social science methods to do a better job of meeting its mission goals. Certain line offices are still more adept at measuring the baseline of societal well-being than in trying to tease out the contribution of any single program or activity. This corresponds, in large part, to the enterprise nature of many activities at the Agency – many programs inside and outside of the Agency combine to achieve our mission goals.

As the Agency moves forward in its efforts to understand how NOAA affects society, the methods and metrics used to do so will be refined and improved. Possible next steps in the process include:

- More enterprise level approaches to developing value chains and valuations.
- Follow-up workshops or symposia on methods for quantifying the societal impacts of specific types of NOAA outputs including: research, information, and weather.

Table 1: Examples of Stories, Metrics, and Methods Proposed to Measure Selected Societal Impacts of NOAA

OCEANS		
Sea level rise (SLR) forecasts affect communities by identifying the best management practices for shoreline stabilization thereby helping communities to prepare for the long-term impacts of global warming, which results in the preservation of local economies and reduction in property damage.		
Product/Service	**Metric**	**Method**
SLR forecasts	Avoidance of a reduction in economic activity and avoidance of property damage that would otherwise have occurred due to sea level rise	Scenarios of the negative effects of SLR on economic activity & property; estimates of how these effects would be mitigated with shoreline stabilization approaches; scenarios for the respective change in demand by industry
CLIMATE		
Developed by the Southeast Climate Consortium (SECC), AgroClimate provides seasonal climate forecasts, visualization tools, and climate and commodity outlooks to assist producers to understand and plan for climate variation in Florida, Georgia, and Alabama. A suite of AgroClimate tools providing climate, agricultural, and forestry information allows users to assess resource management options with respect to their probable outcomes under forecast climate conditions.		
Product/Service	**Metric**	**Method**
AgroClimate	Improved agricultural profits due to the use of the Agroclimate website	Conduct stated preference survey based on climate conditions examining the predictive aspects of forecasting shifting climate regimes (e.g., ENSO index)
RESEARCH		
The Extended Continental Shelf (ECS) Program affects the natural resource industry and the public interest by improving our understanding of the potential limits of the U.S. “extended continental shelf.” As a result, the US Government and industries will be able to discover and extract new resources, providing significant economic value to the country.		
Product/Service	**Metric**	**Method**
Ocean Exploration related to the ECS Program	Estimates of the extent and value of minerals, oil and gas, and fisheries in the ECS important to industry planning, planning for regulatory regimes, and national security	Analyze potential value of better information on the ECS to major user groups such as industry and government entities

SEA GRANT		
Sea Grant Preserves Working Waterfronts and Coastal Access: Waterfront access is important for the viability of commercial fishing activities, as well as preserving the culture of the community. For example, Michigan Sea Grant plays an integral role in developing and coordinating the Detroit River revitalization project, which resulted in changing the face of Michigan's largest urban area.		
Product/Service	**Metric**	**Method**
Detroit River revitalization project	Change in waterway-related attitudes or behaviors (e.g. visitor days, spending, net revenues of businesses that cater to these visitors, consumer surplus (WTP) of these visitors, sense of place)	Surveys of stakeholders in surrounding area
WEATHER		
As a result of the quick detection of the Japanese tsunami, NOAA's Pacific Tsunami Warning Center issued tsunami warnings for Japan, Russia, Marcus Island, and Northern Marianas Island. Further, NOAA's West Coast/Alaska Tsunami Warning Center issued tsunami information statements assessing potential threat for Alaska, British Columbia, Washington, Oregon and California.		
Product/Service	**Metric**	**Method**
Tsunami Warnings	Lives saved	Behavioral study of use of tsunami warnings in low lying areas (more important for places like American Samoa)
FISHERIES		
Catch shares allocate a dedicated percentage or share of a fishery's total catch to individual fishermen, communities, and/or associations. When participants have a secure portion of the catch, they gain the flexibility to make business decisions that improve safety, enhance the value of their share, and promote sustainable fishing of the stocks.		
Product/Service	**Metric**	**Method**
Catch Share Programs	Revenues, jobs, and profits	Trend analyses

2. INTRODUCTION: WHY QUANTIFY THE SOCIETAL BENEFITS OF NOAA?

The National Oceanic and Atmospheric Administration often thinks of itself as a science Agency, but the core of much of its mission is societal. The first sentence of NOAA's Next Generation Strategic Plan states, "(NOAA) generates tremendous value for the Nation." Later, the NGSP also states, "human health, prosperity, and well-being depend upon the health and resilience of coupled natural and social ecosystems."

Despite the clearly recognized role that the Agency plays in sustaining and improving the well-being of citizens and society, NOAA has not done enough to understand scientifically how its actions impact society. The ways in which NOAA activities, products, and services affect society remain poorly articulated, rarely documented, and almost never quantified in a way that is scientifically rigorous.

Without a good scientific understanding of how NOAA affects society, our ability as an Agency to meet our societal goals is at risk. Without a scientific understanding of the societal impact of its activities, NOAA:

- Is generally hampered in its ability to explain to the public and Congress how investing in NOAA programs and infrastructure benefits society.
- Is unable to allocate resources in the Agency in a way that best benefits society.
- Cannot optimally target new investment in programs and research.
- Is hampered in its ability to improve the societal value of its products and services because it does not have a baseline against which advances and improvements can be compared.

The Agency is entering a new era in which humans and society take center stage in the mission of the Agency. The Agency also is poised to dramatically improve the ways in which it taps the social sciences to begin to understand and improve its value to society.

To help the Agency move forward in leveraging social science methods to meet its societal mission goals, the NOAA Research Council, through its Social Science Committee, sponsored a Science Challenge Workshop entitled "Identifying Methods for Quantifying the Societal Impacts of NOAA." The workshop was intended as a launching point to begin to identify the social science expertise and methods that could help the Agency move forward quickly and rigorously in its pursuit of a better understanding of the value of NOAA.

For many in the Agency, the processes and methods for measuring the value of NOAA are a mystery. This workshop provided a forum in which social science representatives from around the Agency were able to work with policy makers, communication experts, and leadership to identify the types of activities and products the Agency needs to value. These social science representatives brought case studies to the workshop and were able to brainstorm with experts, both internal and external to the Agency, to identify the best and most recent social science available that can be applied to quantify the impacts of NOAA.

3. THE APPROACH

3.1 Value statements: The 30 Stories Project

NOAA is an enterprise that includes data collection, monitoring, modeling, stewardship, funding, research and the development of tools and forecasts. Some of these functions create outputs that are used directly by the public and private sectors outside of NOAA. In other cases, outputs are used internally to "build" a product that ultimately is used by the public and private sectors outside of NOAA.

The first step in the quantification of the societal impacts of NOAA is to develop simple logic models that link an activity (**function)** to something that is produced (**output)** to a user (internal or external) to a change in behavior in the private or public sectors (**outcome)** and ultimately to some measure of well-being that changes as a direct or indirect result of this outcome. We call such logic models, applied to the societal impacts of NOAA, our NOAA Value Chains.

Value chains provide the essential framework required to connect what we do at NOAA to society. Value chains also are the essential outline for the stories we want to tell that show how NOAA contributes to the well-being of the American public.

To date, clear and concise value chains have been developed for only a small handful of NOAA functions and outputs. As a result, the Agency is generally unable to articulate exactly how its essential activities affect society. It is difficult to explain to Congress the potential benefits that will result when programs are funded at the level requested (or the potential costs of failing to fully fund these programs).

To move the Agency forward in the development of more **value chains**, linking NOAA activities to societal well-being, the line offices were asked to develop roughly thirty stories describing how NOAA activities or products affect society. These stories are simply sentences that incorporate the basic elements of the value chain. The basic story template, delivered to the line office social science leads, followed the form:

> *The _____ (what program, activity, product, service at NOAA, choose something identified in a budget) affects _____ (part of society, sector of the economy) by _____ (doing what?) which results in _____ (measure of societal impact).*

For instance,

> *The **2 day snow forecasts**_____ (what program, activity, product, service at NOAA) affects _**airline transportation**___ (part of society, sector of the economy) by _**rerouting flights**___ (doing what?) which results in **fewer cancellations that save time for travelers**_____ (measure of societal impact).*

In the language of our value chain, the story can be translated as:

*The **NOAA function** affects a **sector of society** by creating an **output** that results in an **outcome** which has an **impact on societal well-being.***

3.2 First Steps: Examples

Not surprisingly, many program directors, NOAA staff, and others at the Agency are eager to know how their work affects society. NOAA is a large Agency that touches society in thousands of ways. It is not possible for the Agency to attempt to quantify all of the ways in which it impacts societal well-being. Furthermore, it is not usually possible to value a program in its entirety. With this in mind, we asked each line office to choose five or fewer stories from the list of 30 stories to use as examples of important NOAA outputs for which we need a better understanding of the ways in which NOAA affects society. A packet of materials, containing the example stories and supporting materials developed by the line offices, were distributed to the workshop participants in advance (see Appendices).

3.3 Metrics for Quantifying Societal Impacts

To quantify NOAA's impact on society, it is vital to have a very clear idea of what is being measured, of the best way to measure it, and how much it will cost to measure it. Metrics are the scale with which societal benefits are measured; it is the unit of quantification by which we measure how society's well-being has changed.

It is critical to choose a metric that is appropriate given the nature of the benefits - e.g. to whom they accrue and how they are accrued. It is also very important that the metric represents the delta, or the change in benefits that occurs as a result of NOAA products, services and activities. For example, if the product being addressed deals with coastal and ocean resources, it is not appropriate to merely measure the value of those resources. Rather, the change in the value of resources based on the application of the NOAA product is what should be measured.

Economic metrics include economic value, a change in revenue, or a change in the number of jobs. However, this is not the only way to measure the impact of NOAA on society. Many of NOAA's products are in place to ensure safety or save lives. Ultimately the choice of metric is flexible – it can be anything that measures societal impacts in a rigorous way.

3.4 Identifying Methods for Quantifying Societal Benefits

Once a metric has been chosen, the next consideration is the method by which the metric, or change in the metric, will be estimated. There are many potential methods for identifying benefits and the choice of method must be appropriate given the context in which the product, service or activity is applied and how the benefit comes about. The participants were asked to be as specific as possible in the choice of methods, as this will have implications for the cost and capability required. For example, there are many non-market valuation techniques, so it is not sufficient to simply choose non-market valuation. The specific non-market valuation technique must be chosen. Finally, the

method chosen must be consistent with estimating the delta – it must take into account how the product, service or activity results in the change in metric.

4. RESULTS

4.1 The Societal Impacts of the National Ocean Service
Contact: Peter Wiley, Brent Ache

NOS and Society

The National Ocean Service (NOS) provides ocean-related science, tools, and services to address threats to coastal areas such as climate change, population growth, port congestion, and contaminants in the environment, all working towards healthy coasts, coastal populations and coastal economies. The societal impact of these products, services and activities is highly diverse, both in terms of the sectors and populations impacted and in the nature of the impacts. The NOS mission includes such elements as safe navigation, a national coordinate system, management of and research on coastal and ocean resources, restoration and response, and the provision of data, tools, and technical assistance for coastal zone management. The impacts of these elements reach a significant cross section of society, domestically and internationally.

NOS Stories

The NOS societal impact stories were compiled from several sources within NOS. These include the program office representatives for the Planning and Performance Team and the Communications and Social Science Leads for each program office. Each office turned in several stories through these channels and there were many stories in the initial response. From this point the program offices and the NOS Social Science Leads worked to choose a set of stories that was compelling, and would resonate with NOAA leadership, the Hill, and OMB. They also ensured that a direct causal relationship existed between the product, service or activity and the societal impact. Input was also received from the NOAA Office of Legislative Affairs in determining what stories would be of interest to Hill staffers and members of Congress.

Potential methods for quantifying the societal impacts of NOAA are given in Table 2. These examples are arranged in two categories of product/service/activity: 1) Ocean and Coastal Resource Management and 2) Oceanographic Products. The first story, about Coral Reef Watch, was addressed directly in the workshop, while the other examples were developed afterwards.

Coastal Resources and Communities

Coral Reef Watch: The coral reef watch affects coral reef users by providing coral reef managers around the world a warning system when satellite data indicates a likelihood that a local reef is subject to prime coral bleaching conditions. Bleaching can lead to a loss of recreational use.

The metrics that are appropriate for measuring this depend on the interim activity of the management actions taken as a result of warnings. This is not part of the societal impact, but bears mention as being necessary for the impact to take place. The

metrics used include the avoidance of loss in recreation/tourism and other ecosystem services provided by the coral reef habitat. Although the ecosystem services would be sufficiently broad to be beyond the purview of this exercise, we will focus here on recreation/tourism.

There are several potential methods with which this impact could be measured. The most appropriate in this context would be a total economic value study which would include surveys of fishermen, residents, and tourists

Sea Level Rise Forecasts: Sea level rise forecasts affect communities by providing information on areas likely to be inundated by sea level rise – information that can help identify the best management practices for shoreline stabilization, thereby helping communities to prepare for the long-term impacts of global warming, which results in the preservation of local economies and avoided losses in property damage.

The metrics that could be used are "the avoidance of a reduction in economic activity that would otherwise have occurred due to sea level rise" and "avoidance of property damage that would also otherwise have occurred."

To measure these changes in societal well-being would require forecasts of sea level rise referred to in the story. With this information, scenarios of the negative effects of sea level rise on economic activity and property would be produced, and estimates of how these effects would be mitigated with shoreline stabilization approaches would be estimated. For the negative effects on and mitigation of economic activity, scenarios would need to be developed for the respective change in demand by industry.

Oceanographic Products

3-D Hydrodynamic Model: The 3-D hydrodynamic model affects Great Lakes region residents by providing information about lake level and flow forecasting, and by supporting source water protection, which results in improved drinking water safety. The 3-D hydrodynamic models also support search and rescue operations.

For "safe drinking water" and "rescue operations," the metrics would be human health. In the case of drinking water this would be avoided illness and in the case of rescue operations, the metric would be lives saved. For the purposes of this exercise, a reasonable metric would be avoidance of costs associated with negative impacts to tourism recreation.

To determine the health effects of unsafe drinking water, it is necessary to specify how outputs from the 3-D hydrodynamic model are used in decisions about drinking water safety. It is also necessary to include a health parameter so that the analysis will result in the change in health.

For rescue operations, the methodology would involve a determination of the increase in efficiency that occurs as a result of model outputs, then translating that

into the increase in the number of lives saved.

PORTS®: The Physical Oceanographic Real-Time System (PORTS®) affects marine transportation by measuring and disseminating observations and predictions of water levels, currents, salinity, waves and meteorological parameters which results in dollar valued cost avoidance and improved efficiency.

PORTS® installations result in several benefits including cost avoidance through the reduction in groundings, spills, and other costly events, and through increased efficiency resulting from greater draft allowance/increased cargo capacity and reduced transit delays for commercial maritime transportation.

Information from PORTS® is beneficial because it reduces uncertainty about the present or future state of nature (such as the exact water level in a dredged channel) in the context of marine transportation. The methodology to measure the societal impact of PORTS® would require a model of how this information is used to make decisions that includes how physical outcomes can be translated into economic outcomes.

The Harmful Algal Bloom Operational Forecast System: The Harmful Algal Bloom Operational Forecast System affects aquaculture and recreation/tourism by accurately forecasting harmful algal blooms leading to a reduction in unnecessary closures and warnings.

The appropriate metric here is cost avoidance associated with unnecessary beach closures which results in loss of value to recreation and tourism. This can be measured with two types of metrics: market measures – such as sales, income and employment, and non-market measures - such as consumer's surplus (net economic value).

For both the market and non-market measures, a survey would need to be conducted to determine the demand for recreation/tourism given the scenarios with and without HAB forecasts and the associated warnings. For the market measures, the next methodological step would be would be to run an input-output model such as IMPLAN to determine the market impacts. On the non-market side, the use of a model such as the Random Utility Model (RUM) model would be appropriate.

Table 2: Examples for Quantifying the Societal Impact of National Ocean Service

	Product/Service	Metric	Method
1.	Coral Reef Watch	Avoidance of loss in recreation/ tourism, and other ecosystem services provided by the coral reef habitat	Total economic value study which would include surveys of fishermen, of resident, and of tourists
2.	SLR forecasts and BMPs for shoreline stabilization	Avoidance of a reduction in economic activity and avoidance of property damage that would otherwise have occurred due to sea level rise	Scenarios of the negative effects of SLR on economic activity & property; estimates of how these effects would be mitigated with shoreline stabilization approaches; scenarios for the respective change in demand by industry
3.	3-D hydrodynamic model	Avoidance of human health effects of unsafe drinking water	Specify the relationship between outputs and variability in drinking water safety including a health parameter.
		Increase in lives saved from more effective rescue operations	Determine increase in efficiency from outputs; translating to increase lives saved
4.	PORTS®	Cost avoidance through reduction in groundings, spills, etc, and through increased efficiency resulting from greater draft allowance/increased cargo capacity and reduced transit delays	Model of how PORTS® information is used to make decisions that includes how physical outcomes can be translated into economic outcomes
5.	Harmful Algal Bloom Operational Forecast System	Cost avoidance associated with unnecessary closures which results in loss of value to recreation and tourism	Market: IMPLAN Non-market: RUM

4.2 The Societal Impacts of NOAA's Climate Activities
Contact: Nancy Beller-Simms, Adam Smith

Climate activities at NOAA currently reside in a variety of internal offices. Here we focus on existing climate activities at NOAA, especially those performed in NOAA's Climate Program Office (CPO), which currently resides in OAR, and the National Climatic Data Center (NCDC) which is currently part of NESDIS.

Climate and Society

NOAA's CPO manages the competitive research program in which NOAA funds high-priority climate research to advance our understanding of Earth's climate system and its atmospheric, oceanic, land, snow and ice components. The science contributes to knowledge about how climate variability and change affects our health, economy and well-being. In addition, CPO supports decision support research, assessments and climate services development activities in support of adaptation. NCDC provides quality climate and weather data, information, and decision support products and services that improve business, government, and personal decisions related to planning, operations, and assessments; supports research leading to improved weather and climate forecast models; and provides information on the varying and changing states of the national and global climate.

Climate Stories

Representatives from CPO and NCDC compiled over 30 potential stories from their respective offices and together culled this initial list into a shorter list of the stories they felt were most compelling. A key determinant was to make sure that the stories were representative of a variety of scales from national to local in order to be able to apply lessons learned from this exercise to a range of climate stories. In addition, these representatives nominated one water-related and one coastal-related regional study useful for decision-makers, to relate to the service portion of the Climate mission.

> **Climate Normals:** NOAA's NCDC is responsible for producing official Climate Normals (i.e., 30-year averages) of numerous climatological variables every ten years for U.S. locations. The 1981-2010 Normals consist primarily of station-based monthly and daily Normals of temperature (maximum, minimum, and mean), precipitation, and heating/cooling degree days. They also include various divisional and population-based aggregations, phenological/agricultural parameters, distribution characteristics such as standard deviations and percentiles, and other supplemental Normals. Normals are utilized in countless applications across a variety of sectors. These include: regulation of power companies, energy load forecasting, crop selection and planting times, construction planning and building design.
>
> Normals also affect the assessment of equipment requirements for heavy power line loads during extremely hot weather. The frequency, intensity and duration of such heat waves play an important role in determining transmission equipment requirements for efficiently transmitting heavy energy loads to prevent regional

brownouts or blackouts from occurring. To better understand the value of Normals data, one metric of societal impact that should be used is the measurement of economic savings that consumers receive through rate reductions due to the use of Climate Normals by regulators who use these data also to gain a better understanding of future regional energy requirements. One method to capture this is by surveying regulators to determine energy rates with and without the use of Climate Normal information.

Another metric worth examining is determining how Normals currently help inform future energy infrastructure planning. A survey of energy companies would examine how planning energy grid requirements might be done with and without Climate Normals. To augment the survey a statistical model would be used to estimate the economic cost-benefit of energy infrastructure investment during normal and extreme periods of energy demand and would include a section on how the performance of the infrastructure may change under future climate scenarios.

National Integrated Drought Information System (NIDIS): The National Integrated Drought Information System (NIDIS) ensures collaboration between Federal, State, tribal, and local government agencies on drought-related issues. It enhances decision-making (e.g., with resource managers, farmers, city planners, and public health officials) by creating an early warning information system that also provides information about current drought conditions, impacts, research, and forecasts in a single location (www.drought.gov). The specific activities currently associated with NIDIS include: public awareness and education, engaging preparedness communities, integrated monitoring and forecasting, interdisciplinary research and applications, and the U.S. Drought Portal.

As NIDIS has many pieces, we concluded that the entire system could not be measured, but suggest that pieces could be measured individually. The portal, for example could be assessed as to whether its creation has improved decision making through information availability and dissemination. For instance, water resource managers could be surveyed to determine specific decisions, investment, and operational decisions that they currently make or anticipate will be made with and without NIDIS information. A cost-benefit analysis or a valuation of the information option could be used to determine how profits and return on investment would differ with and without the use of NIDIS data and warnings.

AgroClimate: Developed by the Southeast Climate Consortium (SECC), AgroClimate provides seasonal climate forecasts, visualization tools, and climate and commodity outlooks to assist producers to understand and plan for climate variation in Florida, Georgia, and Alabama. A suite of AgroClimate tools providing climate, agricultural, and forestry information allows users to assess resource management options with respect to their probable outcomes under forecast climate conditions.

One metric to better understand the value of the AgroClimate in agriculture decision-making would be to examine crop performance for a group of farmers who used the AgroClimate seasonal climate forecasts against farmers who did not at the county-level. Based on the use of AgroClimate, a cost-benefit methodology could examine

the distribution of USDA county-level crop yield market values by crop type (per acre) against the USDA crop insurance claims for failed crop harvests due to drought for both groups of farmers. Additional analysis could contrast crop yield success across geographically adjacent regions along the boundary of the AgroClimate research area, in order to examine if there is a notable difference in using crop decision-making tools under similar climate conditions.

A different methodological approach would be to develop a stated preference survey based on climate conditions examining the predictive aspects of forecasting shifting climate regimes (e.g., ENSO index) and the distribution of temperature and precipitation patterns for each crop year. Such a survey would need to be conducted over at least three years to better capture potential climate variability, as farmers take different courses of action in managing their crops under various ENSO phases. Administering such a survey on farming practices and use of the AgroClimate tools would help differentiate between what farmers indicate they will do via the survey and what they actually do as indicated in the USDA crop insurance data. Such a climate risk-based framing of swings in climatic vulnerability would also be useful to compare not just states in the AgroClimate pilot region, but also in other US regions, as ENSO climate characteristics are regionally variable.

Using NOAA Climate Forecasts With Hydrologic Assessment to Reduce Drought Vulnerability and Improve Water Management in Washington State (funded grant): This project targeted the high stakes and highly drought-vulnerable Yakima River Basin, whose irrigated crops represent the largest agricultural value in the State. Irrigators depend on water from the Yakima Project, operated by the U.S. Bureau of Reclamation (USBR), which issues hydrologic forecasts that could benefit from improved climate information. The Principal Investigators on this grant produced a drought monitoring and forecast system for Washington State enabling detection of the onset and recovery of drought up to four months before State declarations.

With new information on the timing and severity of drought, farmers will be able to change their response or behavior. This might include changes in time of planting or harvesting, changes in water usage, etc. A qualitative approach using focus groups could be used to better understand farmers' behavioral changes as a result of this new data source made available to them. Results from this analysis would show how this information influenced (or did not affect) their decision making but also would provide a better understanding of how new climate data and approaches in general (e.g., tools, methodologies, and knowledge) are assimilated into decision making.

Quantification of Inundation in South Florida Caused by Sea Level Rise and its Social and Economic Impacts (funded grant): This project will develop the nexus between sea level rise and storm surge, and its socioeconomic implications for long range planning and adaptation in low lying areas in South Florida (Miami-Dade) to provide maps of inundation and increased storm surge flooding and present the severity and range of the impacts of sea level rise on society and economy to enhance local community decision making. Accurate forecasts of sea level rise could help coastal towns and cities adapt to sea level change.

As this tool is still being developed and has not been introduced to planners yet, one could assess the potential impact of this new information by decision makers. Given different IPCC scenarios, an economic analysis could be done using the results of this study to determine the value of the loss avoided given the use of this methodology. The results would show the potential damage to properties if NOAA data and methods are not used in the future.

Table 3: Examples for Quantifying the Societal Impact of NOAA's Climate Activities

	Product/Service	Metric	Method
1.	Climate Normals	Rate reductions (savings to consumers) due to the use of Climate Normals	Survey regulators to determine energy rates with and without Climate Normal information
		Reduction in infrastructure costs	Economic cost-benefit of energy infrastructure investment with and without Climate Normals
2.	National Integrated Drought Information System (NIDIS)	Improved agricultural profits or return on investment due to the use of NIDIS data	Surveys of farmers asking about investment and operational decision-making with and without NIDIS data
			Cost-benefit analysis of the differences in available decision-making information with and without NIDIS data and warnings
3.	AgroClimate	Estimates of crop yield with and without use of the Agroclimate Website	Cost-benefit analysis. This could be done by comparing the distribution of USDA-RMA county-aggregate crop yield market values by crop type (per acre) against RMA crop insurance claims for failed crop harvests due to drought, heat, etc.
			This could also be done by contrasting with annual average costs of investment by crop year (per acre) for the seed, water, labor, etc. needed to produce a crop across spatial-temporal equivalent scales, both before and after the AgroClimate suite of decision-making tools was available for use.
		Improved agricultural profits due to the use of the Agroclimate website.	Conduct stated preference survey based on climate conditions examining the predictive aspects of forecasting shifting climate regimes (e.g., ENSO index)
4.	Using NOAA Climate Forecasts With Hydrologic Assessment to Reduce Drought Vulnerability and Improve Water Management in Washington State	Measures of farmers' behavioral changes, such as timing of planting/harvesting or water usage in comparison with before this data became available	A qualitative approach using focus groups could be used to better understand farmers' behavioral changes as a result of this new data source made available to them.
5.	Quantification of Inundation in South Florida Caused by Sea Level Rise and its Social and Economic Impacts	Value of potential economic losses due to property damage	Given different IPCC scenarios, an economic analysis could be done to assess the potential impact of this tool.

4.3 The Societal Impacts of the Office of Oceanic and Atmospheric Research
Contact: John Gaynor

OAR and Society

Through innovation, incubation, and integration of research throughout NOAA, OAR improves and creates new products and services in weather, climate, the coastal ocean, and ecosystems. These improved products and services benefit society by saving lives, protecting property, and improving the health and well-being of the public.

OAR Stories

OAR's Office of Policy, Planning, and Evaluation (PPE) first developed a spreadsheet with the information requested from the NOAA Acting Chief Economist. The subject matter experts in PPE then created a list of the 30 research activities in OAR, not including Sea Grant or the Climate Program Office. The PPE staff worked with OAR laboratories and programs in developing the initial list. The OAR Communications Office reviewed the list and provided suggestions on prioritization and wording of the activity titles or headlines.

The OAR Strategy, Execution, and Evaluation (SEE) Council, consisting of the OAR laboratory and program directors, excluding the Climate Program Office, the CFO and PPE director reviewed the long list, provided comments and then voted for their top five choices based on criteria provided by the Acting NOAA Chief Economist. The PPE staff then reviewed the results from the OAR SEE Council and from this process evolved the five example stories to value for OAR.

The following five stories are examples of some of the major types of research performed in OAR. Included in each story is a suggested metric for valuing the impact of the research and its transition to applications, the valuation methodology, and the resource requirements for the valuation.

High impact weather research: The improvement of meteorological models within the Next Generation Air Transportation System (NextGen) affects airline transportation by providing improved short-term aviation weather predictions at terminals and along flight paths. This results in more efficient routing and scheduling of flights, increased airport safety, and fewer cancellations and delays, all of which will protect lives and save money for the airlines and the fliers.

One measure of societal impact would be estimates of operational savings that would result from reduced fuel use, cancellations and increased on-time arrivals. This could be accomplished by running aircraft and traffic control models to estimate flight time, fuel use, and other factors with high impact weather data and forecasts. Similar methods could be employed to estimate improved safety from nears misses and private aircraft accidents.

Ocean exploration: The Extended Continental Shelf (ECS) Program affects the natural resource industry and the public interest by improving our understanding of

the potential limits of the U.S. “extended continental shelf.” As a result, the US Government and industries will be able to discover and extract new resources, providing significant economic value to the country.

The societal benefit of ECS exploration includes the economic value associated with minerals, oil and gas, and fisheries that can be claimed by the U.S. Economic analysis, informed by surveys of major user groups, would identify and estimate the potential economic value of these resources and the contribution of OAR ocean exploration to these values.

Coastal ecosystem research: Integrating knowledge from biological, physical, chemical, and social science research, the nascent Gulf of Mexico (GoM) Research and Monitoring Program affects coastal managers, commercial and recreational fisheries, recreational users, and the general public by providing a synoptic view of the GoM ecosystem in order to support effective, efficient, and timely responses to natural and anthropogenic perturbations.

The GoM Research and Monitoring Program is quite environmentally comprehensive. Therefore, the potential socioeconomic benefits may include several societal and economic sectors. For the recreational and fisheries sector, the best method is probably a willingness to pay survey and analysis. The other aspect of this effort is to determine a value or values of potential new policies, regulations, and/or statutes resulting from the comprehensive environmental surveys. This requires an economic assessment through sector surveys of the effects of such regulations or policies. A cost-benefit analysis is most appropriate for this aspect. It is certainly possible that the results will be a negative.

Hurricane research: The research performed within the NOAA Hurricane Forecast Improvement Project (HFIP) affects emergency managers and coastal residents by providing more accurate forecasts of hurricane track and intensity with longer lead times which result in more efficient, effective and fewer unnecessary evacuations and other preparations leading to the savings of lives and financial loss. The improvements in the forecasts of hurricanes themselves will in turn improve the accuracy and timeliness of hurricane storm surge forecasts, heavy rainfall events, and wind events.

There have been several past studies, most of them willingness to pay surveys focusing on hurricane evacuation. There is also information on the costs of evacuation from several economic sectors. A literature search should be completed to determine what information on the value of hurricane landfall forecasts is already available. For evacuation, cost avoidance studies from improved track and intensity forecasts in specified coastal areas needs to be accomplished. Also, more household willingness to pay studies must be done to determine the value of improved landfall hurricane forecasts.

Coastal inundation research: NOAA Pacific Marine Environmental Laboratory’s tsunami forecasting model development and monitoring program affects emergency managers and other decision-making officials by providing accurate tsunami coastal

flooding guidance and more timely and precise warning, which results in lives and property saved.

The studies that need to be done for improved forecasts of coastal inundation due to tsunamis are very similar to that needed for improved hurricane landfall forecasts. Household willingness to pay studies must be done, but also studies of the value of improved information resulting from better warning systems to coastal economic sectors, such as the recreational boating sector and other businesses adjacent to the coast should be done. The most vulnerable coastlines to tsunamis in the U.S. are Hawaii and the West Coast, particularly the Northwest Coast and Alaska.

Table 4: Examples for Quantifying the Societal Impact of the Office of Oceanic and Atmospheric Research

	Product/Service	Metric	Method
1.	High impact weather research	Operational savings from fuel use, cancellations, and on-time arrivals from improved weather information	Estimations from combining aircraft and traffic control models with estimations of improved weather products to estimate economic benefits of improved weather products and use of weather information in airport operations
		Increased safety such as fewer near misses and reduced private aircraft accidents due to improved utilization of weather information	Methods would be determined as part of the larger task above.
2.	Ocean exploration	Estimates of the extent and value of minerals, oil and gas, and fisheries in the ECS important to industry planning, planning for regulatory regimes, and national security	Analyze potential value of better information on the ECS to major user groups such as industry and government entities
3.	Coastal ecosystem research	Improved threshold indicators of water quality for recreational users (swimming, boating, recreational fishing)	Willingness to pay estimates in both market and non-market recreational uses of improved metrics
		Value of deepwater habitats health thresholds to commercial fishing	Willingness to pay surveys of commercial fishers
		Incremental economic value of coastal statutes and policies to coastal planners	Economic cost/benefit analysis of implementation of statutes and policies by coastal planners
4.	Hurricane research	Savings in market evacuation costs	Synthesize existing literature; focus cost-avoidance analysis on sample representative areas
		Increased consumer surplus (welfare) to households from improved hurricane forecasts	Study of willingness to pay for improved forecasts by households in hurricane prone regions, building on pilot studies
5.	Coastal inundation research	Reduced loss of life (and possibly property) in coastal communities	Value of information framework to estimate benefits of improved warning systems in U.S. West Coast communities and Hawaii

4.4 The Societal Impacts of NOAA National Sea Grant College Program
Contact: Heather Triezenberg

NOAA National Sea Grant College Program and Society

The NOAA National Sea Grant College Program (NSGCP) is a national network of 32 programs located in all coastal and Great Lakes states and Puerto Rico with more than 300 participating institutions involving over 3,000 scientists, engineers, outreach experts, educators and students. Sea Grant is a trusted source of science and information with a 40-year history of transferring cutting edge university research, technology and policy information to users. Administered through NOAA, Sea Grant is the Agency's primary university-based program dedicated to helping citizens utilize scientific information to support a vibrant economy while ensuring ecological sustainability.

Sea Grant Stories

The National Sea Grant College Program has developed a five-year strategic plan (2009-2013), in conjunction with an enhanced Planning, Implementation, and Evaluation (PIE) system. Each Sea Grant Program is required to develop a program plan that is aligned with the National Sea Grant plan. Within the framework of their state program plan, Sea Grant Programs administer the funds they receive through their four-year omnibus awards. To comply with granting requirements, programs must submit reports annually to the NOAA National Sea Grant Office. These annual reports include socioeconomic impact statements, which were used to identify the examples that were the basis for discussion during the workshop.

NOAA's National Sea Grant College Program has four national focus areas within its national plan. They are: Hazard Resilient Coastal Communities, Healthy Coastal Ecosystems, Safe and Sustainable Seafood Supply, and Sustainable Coastal Development. In preparation for the workshop, NSGO staff reviewed the major themes from the most recent focus area team reports and selected five example headlines. Several staff from NSGO (e.g., communicators, social scientist, strategic planner, and director) reviewed the impact statements and themes and provided their input. Next, the OAR Strategy, Execution, and Evaluation (SEE) Council, consisting of laboratory and program directors (excluding Climate Program Office), the CFO and director of the Policy, Planning, and Evaluation office reviewed the five headlines. Almost all of OAR SEE Council participants deferred to the director of the NOAA National Sea Grant College Program to make the final decision on which impact statements should be selected as the example headlines and discussion topics for the workshop. The NSGO staff modified the impact statements to ensure each headline story conformed to the template provided by the Chief Economist.

> **Sea Grant Preserves Working Waterfronts and Coastal Access:** Waterfront access is important for viability of commercial fishing activities, as well as preserving the culture of the community. For example, Michigan Sea Grant has played an integral role in developing and coordinating the Detroit River revitalization project, which resulted in changing the face of Michigan's largest urban area.

One measure of societal impact could be changes in economic activity, such as tax revenue or migration. This could be accomplished by surveying local businesses to assess changes in customer-base or by conducting a pre-post comparison of tax records. A second metric, "change in visitors' water-way related attitudes, behaviors, and/or sense of place;" could be measured by surveying stakeholders in the surrounding area.

Sea Grant scientists collaborate with industry and managers to develop technology that benefits fishing Industry: NOAA Sea Grant collaborates with fishermen, federal managers, and conservationists to curb bycatch of endangered albatrosses and other seabirds in commercial fishing operations. This led to new NOAA Fisheries seabird bycatch regulations and circumvented potential lawsuits that might have shut down a $300 million fishery. For example, Sea Grant-developed seabird avoidance measures have drastically reduced seabird mortalities in Alaska longline fisheries.

Two possible metrics could be "the number of fisheries jobs preserved or created" and "the number and extent of potential lawsuits prevented because there was no shut down." The first metric would rely on an analysis of fisheries' economic data to determine the extent of the commercial fishery that would have been closed. The second metric would rely on a legal and policy analysis.

Sea Grant benefits fishing communities by developing alternative marketing approaches: Sea Grant programs are working with fishers to help them sell directly to consumers (e.g. community supported fisheries).

One possible method for measuring the societal impact in this case could be to determine "the number of fisheries jobs preserved or created," by interviewing commercial fishermen and collecting time-series data on state and federal permits (i.e. collecting baseline data and then collecting data again three years later). Another relevant metric could be "sense of place", which could be measured through questionnaires or willingness to pay surveys.

Sea Grant Helps to Develop Renewable Energy Resources: The Nation needs new sources of renewable energy from the coastal and ocean environment, but that development must be economically and environmentally sound to gain acceptance. Delaware Sea Grant has assessed public opinion of wind as an alternative energy. This work was catalytic in moving the state debate forward.

There are several possible methodologies here. One method could be to measure "public preferences for and perceptions of renewable energy sources" through interviews or mail-back questionnaires. A second method could be to perform a cost-benefit analysis of renewable energy projects to measure "net economic benefit." A third potential method could be to perform a cost-benefit analysis of renewable energy projects to measure "cost savings."

Sea Grant prevents seafood-related illness and saves consumers millions of dollars: Since 2001, training courses led by Sea Grant extension and others with the National Seafood Hazard Analysis and Critical Control Point (HACCP) Alliance (an intergovernmental partnership with industry and academia) have trained about 90 percent of all nationally based seafood processing firms, plus over 10,000 international participants from 30 nations. Trainings have reached more than 5,000 U.S. processing plants and 14,000 employees and regulators since the mid-90's.

Interviews and mail-back questionnaires are two possible methods for measuring the societal impact. For example, these interviews or questionnaires could be used to measure "the number of detected contaminations due to HACCP trained inspectors." The interviews or questionnaires could also be utilized to create an "estimated economic value of averted-crisis due to HACCP detection."

Table 5: Examples for Quantifying the Societal Impact of the NOAA National Sea Grant College Program

	Product/Service	Metric	Method
1.	Sea Grant Preserves Working Waterfronts and Coastal Access	Changes in economic activity ● Tax revenue ● In migration	Survey local business to assess changes in customers; Conduct a pre-post comparison of tax records
		Change in waterway-related attitudes or behaviors (e.g. visitor days, spending, net revenues of businesses that cater to these visitors, consumer surplus (WTP) of these visitors, sense of place)	Surveys of stakeholders in surrounding area
2.	Sea Grant scientists collaborate with industry and managers to develop technology that benefits fishing Industry	Number of fisheries jobs preserved or created	Analyze fisheries' economic data to determine the extent of the commercial fishery that would have been closed.
		Number and extent of potential lawsuits prevented because there was no shut down	Legal and policy analysis
3.	Sea Grant benefits fishing communities by developing alternative marketing approaches	Fisheries jobs preserved or created	Interviews of commercial fishermen, state and federal permits (time series, baseline then three years out)
		Sense of place (social psychological, sense of place, measuring local fish consumption, WTP for local place)	Interviews, questionnaires (for sense of place) – KAPB
			Willingness to pay (CS, PS) for local seafood consumption
			Community survey of fish consumption
4.	Sea Grant Helps to Develop our Renewable Energy Resources	Public preferences for and perceptions of renewable energy sources	Interviews or mail-back questionnaires of stakeholders of place and interest
		Net economic benefit	Cost-benefit analysis of renewable energy projects
		Cost Savings Metric	Cost-benefit analysis of renewable energy projects
5.	Sea Grant prevents seafood-related illness and saves consumers millions of dollars	Number of detected contaminations due to HACCP trained inspectors	Interviews or mail-back questionnaires to assess #1 and #2
		Estimated economic value of averted-crisis due to HACCP detection	Interviews or mail-back questionnaires to assess #1 and #2

4.5 The Societal Impacts of the National Weather Service
Contact: Jennifer Sprague

NWS and Society

The National Weather Service (NWS) provides weather, water, and climate forecasts and warnings for the United States, its territories, adjacent waters, and ocean areas for the protection of life and property and the enhancement of the national economy. NWS data and products form a national information database and infrastructure, which can be used by the public, other governmental agencies, the private sector, and the global community.

NWS strives to meet society's need for weather and hydrological forecast information. As more sectors (energy, agriculture, health, etc.) recognize the impacts of weather and water on their businesses, they become more adept at using sophisticated weather and water information to improve commerce.

The societal impact of these products, services and activities is highly diverse, as weather is directly linked to public safety, and a significant portion of the United States economy is weather-sensitive.

Below are five examples from the 30 stories that were compiled for NWS.

NWS Stories

The NWS societal impact stories were based off the NWS portion of the NOAA 2012 Budget "blue book" and compiled from various sources within NWS, including program office representatives from the NWS Office of Strategic Planning and Policy Office, NWS Congressional Affairs and NOAA Policy Office.

Because NWS products, services and activities result in such a broad range of impacts, it is difficult to narrow down the methods and metrics needed to estimate societal impacts. During the June 2011 Science Challenge Workshop on measuring the impacts of NOAA on society, this issue was addressed, but the results were examples of what would be needed to measure societal impacts and were not meant to be representative. In preparation for the workshop, five stories were selected as good examples of the kind of stories that would describe the impact NWS has on society. The metrics and methods developed in the workshop and afterwards by workshop participants are presented in Table 6.

Tropical Weather Forecasts: Tropical weather forecasts, providing longer hurricane warning lead times, result in more efficient and effective evacuations resulting in the reduction of economic loss for local communities.

The metrics used could include reduced economic losses due to lost economic activity caused by unnecessary evacuations; and benefits to households of improved forecasts.

There are several potential methods with which this impact could be measured. One such method could focus on the economic value of improved forecasts in reducing costs of unnecessary evacuations. Another important method could involve a non-market valuation study of willingness to pay for improved forecasts by households in hurricane prone regions.

4D Weather Data Cube: Information provided in the 4D Weather Data Cube will reduce weather delays resulting in savings. The impact on society could be measured using the metrics of cost avoidance through reduction in flight cancellations or fuel savings for airplanes.

The methodology to measure this would require estimations from model outputs.

Space Weather Forecasts: Space weather forecasts provide advanced notice of a geomagnetic storm which gives power grid operators time to transfer load or take preventative measures, minimizing the risk of damage to the power grid and critical infrastructure.

The metric used is avoidance of blackouts or damage to the power grid. The method used could be an economic value of information study that models decision-making within the power industry to estimate benefits of improved lead time for warnings.

River and Flood Forecasts: Specific and timely information provided by Advanced Hydrological Prediction Service (AHPS) and utilized by NWS Incident Meteorologists (IMETs) increases flood lead time and allows local communities to evacuate and prepare for the flooding through sandbagging, etc.

The metric used is lives saved through specific, timely and actionable flood forecasts. The methodology could focus on conducting a behavioral study of how AHPS information is used to make decisions.

Tsunami Warnings: As a result of the quick detection of the Japanese tsunami, NOAA's Pacific Tsunami Warning Center issued tsunami warnings for Japan, Russia, Marcus Island, and Northern Marianas Island. Further, NOAA's West Coast/Alaska Tsunami Warning Center issued tsunami information statements assessing potential threat for Alaska, British Columbia, Washington, Oregon and California.

This model might result in a variety of benefits. Those listed here are some of the ones with definite metrics which can be measured

Regarding cost savings from avoided unnecessary evacuations (false alarms), the methods used could be a behavioral study of evacuation behavior, emergency management behavior; and an economic study of costs of evacuation (lost net revenues, transportation costs).

Regarding a metric of lives saved, the method used could be a behavioral study on the use of tsunami warnings in low lying areas.

Regarding the metric relating to avoided vessel damage, a method that could be utilized is a survey of vessel owners and captains for providing estimates of property damage from failure to respond to warnings.

Table 6: Examples for Quantifying the Societal Impact of the National Weather Service

	Product/Service	Metric	Method
1.	Tropical Weather Forecasts	Reduced economic losses due to lost economic activity caused by unnecessary evacuations	Cost and revenues study on effect of change in unnecessary evacuations
			Evacuation behavior modeling integrating qualitative research & quantitative modeling
2.	4D Weather Data Cube	Cost avoidance through reduction in flight cancellations or fuel savings for airplanes	Estimations from model outputs
3.	Space Weather Forecasts	Avoidance of blackouts or damage to the power grid and critical infrastructure	Economic value of information study that models decision-making within the power industry
			Behavioral economic study to determine how people/businesses cope with power outages
4.	River Forecasts	Lives saved	Behavioral study of how AHPS information is used to make decisions
5.	Tsunami Warnings	Savings from avoided unnecessary evacuations (false alarms)	Behavioral study of evacuation behavior, emergency management behavior
			Economic study of costs of evacuation (lost net revenues, transportation costs)
		Lives saved	Behavioral study of use of tsunami warnings in low lying areas (more important for places like American Samoa)
		Avoided vessel damage	Survey of vessel owners and captains; Estimates of property damage from failure to respond to warnings

4.6 The Societal Impacts of NOAA's National Marine Fisheries Service
Contact: Rita Curtis, Heather Sagar

NOAA Fisheries' mission is to manage, conserve and protect fish, whales, dolphins, sea turtles and other ocean creatures in a way that ensures their continuation as functioning components of marine ecosystems, affords economic opportunities, and enhances the quality of life for the American public. NMFS achieves this mission through science-based conservation and management and the promotion of healthy ecosystems.

Under this mission, NMFS's goal is to maximize the benefits of living marine resources to the Nation through sound science and management. This requires a balancing of multiple public needs and interests in the sustainable benefits and use of living marine resources, without compromising the long-term biological integrity of coastal and marine ecosystems.

In the workshop, we explored a suite of NOAA Fisheries programs that are just a subset of NOAA Fisheries capabilities. The stories associated with these programs were selected from a larger set of stories compiled by NMFS. See below for information about what it would take to estimate the societal benefits associated with these programs.

NMFS Stories

The NMFS societal impact stories were compiled from several sources within NMFS. At the direction of the NMFS Assistant Administrator, Eric Schwaab, the initial source of stories came from the NMFS Office of Management & Budget and represent major initiatives for the Agency. The Office of the Assistant Administrator and the Office of Science & Technology then outlined a story for each of the fourteen programs that were identified and included the potential societal impacts of each program. With input from Legislative Affairs and the NMFS Communications Office, Eric Schwaab then selected five stories to be developed under this NOAA-led initiative. The result of this effort is a suite of stories that are compelling to a broad audience, including NOAA leadership, the Hill and OMB because of their importance to NOAA Fisheries mission as well as because they exemplify the relevance of NOAA Fisheries efforts to the sustainable well-being of the American people.

Estimating Societal Impacts

NMFS Economics & Social Sciences Program conducts a wide variety of economic and socio-cultural assessments that result in improved science advice to fishery managers. A number of the metrics identified herein are those that are produced from existing research and management efforts. As such, it was often difficult to separate mission-driven activities from those for a study that assesses the societal impacts of a particular program if that information already exists or should exist as part of NMFS mandated responsibilities to conduct cost-benefit analyses in support of the Agency's stewardship mission.

At the workshop, the OMB Budget Analyst for NMFS pointedly discouraged the investment of significant resources in valuing NOAA's products and services. Instead,

the Budget Analyst encouraged the NMFS to selectively identify key product and services or key societal impacts and limit the effort to these metrics only. The discussion on catch shares illustrates this point. In particular, the OMB budget analyst suggested that NMFS limit its performance metrics for this program to four to five catch share programs instead of all 16 programs. NMFS, however, already produces much of this information as part of its ongoing management of existing catch share programs. Moreover, NMFS wants to conduct a comparative analysis of trends and performance to improve the design of existing programs not just to value the program for the sake of assessing the cost-effectiveness / return on the NOAA investment. In sum, if NMFS were only producing the information for valuing NMFS catch share programs, it would only do so for a handful of programs. Since NMFS is conducting these assessments for management reasons, it will do so for all catch share programs but will strictly adhere to OMB guidance for any metrics not produced for stewardship reasons.

Fisheries Stories

The following five stories were chosen for the workshop on the societal impacts of NOAA products services and activities. The first two stories, Catch Shares and Stock Assessments, were addressed in the workshop. At the workshop, NMFS benefitted from the input of its OMB budget examiner, who provided feedback on proposed metrics, including providing input on how to focus and scale the planned work, and who also came prepared with several potential metrics, as well.

Catch Shares Programs: Catch shares allocate a dedicated percentage or share of a fishery's total catch to individual fishermen, communities, and/or associations. When participants have a secure portion of the catch, they gain the flexibility to make business decisions that improve safety, enhance the value of their share, and promote sustainable fishing of the stocks. Coupled with an observing, monitoring, and catch accounting system, incentivizing specific entities to control catch is extremely effective in preventing overfishing. Nationwide, there are 16 catch share programs currently in operation in six different regions. We provide recommendations on how any one of these catch share programs might be valued.

Given the scope of the program, potential metrics were binned into three categories:

- Changes in economic dimensions of the fishing fleet (e.g., revenue/boat, season length, employment, etc.) that address key objectives of the catch share program. While it was agreed that these metrics can be coarse, they are also easily produced, easy to communicate in terms of the societal objectives of each program, and readily understood and transparent to stakeholders.
- Changes in economic performance, including profits (for evaluating benefits), productivity (for evaluating efficiency), and regional economic impacts (for evaluating job impacts). Methods are clearly identified in the Table 7 below.
- Changes in social indicators (unemployment, poverty, etc.) and social assessments, including diversification, community resiliency, etc. While it

was commonly agreed that the social indicators were relatively straight-forward, all agreed that there no commonly agreed upon methodologies for assessing community resiliency and that NMFS should strive to make progress given National Standard 8, the sustained participation of fishing communities in fishing.

Fisheries Stock Assessments: NMFS stock assessments are essential to the sustainable prosecution of commercial and recreational fisheries. The fish stock assessment program provides scientific information for achieving fishery management goals, including preventing overfishing and attaining optimum yield from U.S. fisheries. Among the management questions answered with this information are:

- What is the upper biological limit for a sustainable fishery catch policy?
- Has overfishing been occurring and is the fish stock overfished (depleted) and in need of rebuilding?
- What level of future catch would prevent overfishing and attain the optimum yield from the fishery?

Two potential metrics for valuing fish stock assessments were discussed at the workshop. The first metric considered the cost of an inadequate assessment for "noisier / ephemeral" fisheries in which the stocks may be unexpectedly larger than earlier stock assessments predicted. While it is apparent that the biomass could support a higher harvest rate, managers are tied to harvest levels dictated by the earlier stock assessment.

The second metric discussed at the workshop is maximum economic yield. When a stock has been overfished, NMFS stock assessments are used to implement rebuilding plans. Most rebuilding plans are based upon maximum sustainable yield (MSY). Economic theory suggests that maximum economic yield (MEY) would yield more optimal management of the stocks.

Marine Protected Species Stock Assessment: Congress passed the Endangered Species Act on December 28, 1973, recognizing that the natural heritage of the United States was of "esthetic, ecological, educational, recreational, and scientific value to our Nation and its people." It was understood that, without protection, many of our nation's living resources would become extinct. The Protected Species Research & Management Program provides accurate and timely information and analyses for the conservation of the Nation's living marine resources. The program implements and monitors living marine resource conservation measures to recover protected species. The ultimate desired outcome is to recover and sustain all protected species as fully functioning components of their ecosystems for current and future generations.

At the workshop, three potential metrics were discussed. A fourth metric, which can be produced at no cost, was identified by NMFS post-workshop and is included here. The first metric discussed was society's willingness to pay to recover marine protected resources. NMFS has initiated a series of national-level public surveys to estimate the economic value of marine protected species under the stewardship of NMFS. Data from the surveys will allow researchers to estimate the public's value for recovering the species from their current ESA-listing status, either threatened or endangered. To

date, fielded surveys have collected information on 16 threatened or endangered marine species in six regional ecosystems. Three of these species include the Hawaiian monk seal, the smalltooth sawfish, and the Puget Sound Chinook salmon. Nationally, the average annual value for recovering these species is $6.8 billion (results for other species are forthcoming.) The value of NMFS is the degree to which NMFS programs contribute to the recovery of these species.

A second metric that was discussed was to estimate the increase in landings revenue that may occur as a result of delisting a marine protected species. Several NMFS economists have been contacted to determine a) which species would be the most straight-forward to address; and b) what methodology to use. If earlier production relationships still hold, a duality-based empirical model may suffice.

A third metric that was discussed was for NMFS to assess the cost associated with the backlog of consultations (General Counsel, staff time, FOIA, etc.). NMFS has already begun to compile this information.

A fourth metric that was proposed was to assess the cost-savings to commercial fishermen and/or taxpayers if the protected species status improves and results in a change in their incidental take category. Incidental take categories have prescribed observer coverage levels. NMFS is capable of calculating the cost savings that would arise from lower observer coverage requirements with no additional costs.

Habitat Conservation & Restoration: Habitat restoration is the process of re-establishing a self-sustaining habitat that closely resembles a natural condition in terms of structure and function. Habitats support fish and wildlife, as well as human uses such as swimming, diving, boating, and recreational and commercial fishing. Coastal, marine, and riverine habitats play an essential role in the reproduction, growth, and sustainability of commercial and recreational fisheries and protected species by providing shelter, feeding, spawning, and nursery grounds for fish and wildlife. Habitat restoration efforts support a range of job types in local communities including construction workers and project managers working directly onsite, as well as other businesses and professionals who design, engineer, provide materials for, and monitor the success of these projects. NOAA also helps prepare the next generation of restoration professionals by supporting organizations that provide training and work experience for those entering the coastal restoration field in the public, private, and non-profit sectors.

Four metrics have been proposed for assessing the societal impact of this program. The first is assessing the regional economic impacts (jobs, sales, value-added) from restoration activities using IMPLAN.

A second metric is derived from the societal benefits achieved by conservation and restoration efforts, measured as the consumer surplus associated with public preferences or willingness to pay for changes in various uses and conditions of habitat that result from restoration.

A potentially cost-effective way to estimate the value of a particular habitat area is to use benefit transfer, i.e., apply the benefits estimated for one habitat type in one location to the same type in a different location. This type of work can be undertaken by staff to give a first approximation of habitat values.

A fourth approach for assessing the societal impact of habitat conservation and restoration efforts is to use hedonic modeling to assess how restoration-based changes in ecosystem attribute affect property values.

Marine Recreational Information Program: Marine Recreational Information Program (MRIP)'s top priority is to reduce potential bias and increase the accuracy of recreational catch and effort estimates. MRIP provides detailed, timely, scientifically sound estimates that fishery managers, stock assessors, and marine scientists need to ensure the sustainability of ocean resources. Collectively, these improvements will enhance the Agency's ability to monitor recreational catch as required to track Annual Catch Limits and Accountability Measures applied to these fisheries by the Regional Fishery Management Councils. They also address head-on stakeholder concerns about the reliability and credibility of recreational fishing catch and effort estimates.

Three metrics are proposed for assessing the societal impacts of the MRIP. The first set of metrics is the change in economic impacts (sales, value-added, and job impacts) from saltwater recreational fishing. These impacts can be estimated using the NMFS Recreational Fishing Economic Impact model, which NMFS will update in the coming year. The model provides invaluable information for understanding how saltwater angling contributes to a state and/or the national economy and, in particular, how it stacks up against other ocean resources users. The model also provides information on both federal and state taxes generated from this sector, which can be used to justify increased funding for infrastructure development such as boat ramps.

A second metric NMFS uses to demonstrate the value of the MRIP program is to estimate the change in consumer surplus attributable to the MRIP. This could be estimated using stated preference surveys that ask anglers to identify their preferred management options, a methodology often referred to as choice experiments. Newly emerging methods that NMFS will develop into a tool for managers will link behavior information obtained from choice experiments with both biological data as well as information on actual angler trips and can be used to benefits from management alternatives.

A third metric is to estimate the change in angler benefits (consumer surplus) that result from the MRIP, including the increased ability to fish from particular sites, modes, or target particular species. Often referred to as travel cost models or random utility models (RUMs), NMFS has extensive experience in modeling angler benefits with this approach and has developed a preferred methodology for implementing these models. NMFS has used these models to examine fishery closures, value water quality changes, and numerous other topics.

Aquaculture: NOAA is at the forefront of an ongoing national effort to help the United States become more self-sufficient in the production of safe and sustainable seafood. Additional domestic seafood production will reduce the nation's dependence on imports. Although the United States is a major consumer of aquaculture products, importing 84 percent of our seafood, of which half is from aquaculture, we are a minor producer of these products. NOAA is working to address the regulatory, technical, and scientific barriers to marine aquaculture production.

Development and promotion of offshore aquaculture has been proposed as one approach for satisfying an increasing domestic demand for seafood and promoting community economic sustainability. To fulfill these needs, NOAA's overall aquaculture efforts are focused on creating a domestic supply to meet the nation's growing demand for seafood; enabling a sustainable aquaculture industry to create jobs and other economic opportunities in coastal communities; establishing aquaculture as a viable technology for replenishment of important commercial and recreational marine fisheries; and creating opportunities for the United States to engage the global aquaculture community through scientific and technological exchange. NOAA's aquaculture efforts fall into four capabilities: legal and regulatory, research and technology transfer, outreach and education, and international engagement.

Two metrics are proposed for assessing the impact of the NMFS Aquaculture Program on society. The first is to assess the how the NMFS Aquaculture Program affects the producer surplus from aquaculture operations using a bioeconomic model that relies upon improved firm-level information on operating costs, fixed costs, and earnings.

The second metric NMFS proposes is to assess the regional economic impacts (jobs, sales, value-added) from aquaculture operations using IMPLAN. Again, the focus should be on how NMFS Aquaculture Program affects these outcomes.

Subsequent research should focus on assessing the economic viability of aquaculture operations, the interactions between aquaculture and wild harvest fisheries in a risk framework, and the economic effects of increased domestic aquaculture production on U.S. job creation and the seafood supply chain, including feed production, equipment suppliers, boat owners, processing, and food service. NMFS needs to more scope these mission requirements.

Table 7: Examples for Quantifying the Societal Impact of the National Marine Fisheries Service

	Product/Service	Metric	Method
1.	Catch Share Programs	Revenue/boat, species price, catch share price and lease price, season length, trips, etc.	Trend analyses of key descriptive statistics for five key catch share programs
		Profits	Empirically estimate fishing costs
		Productivity	Malmquist Index
		Job, sales, income and value-added impacts	Regional Economic modeling using IMPLAN
		Social Indicators	Descriptive statistics of primary fisheries data (permits, landings, etc.) and secondary data (Census, BLS, BEA)
		Community Resilience	Factor analysis, index development
2.	Stock Assessments	Potential change in Landings revenue	Calculated as the foregone revenue from "noisier" stocks that may have a strong biomass one year but managers are restricted by the existing stock assessment
		Maximum economic yield (Profits to fishermen or net benefits to society)	In practice, MEY is usually measured as the value of landings that sustainably maximizes profits and is typically measured using a dynamic bioeconomic model.
		Consumer surplus	Stated preference survey for valuing marine protected species
		Potential increase in landings revenue	TBD but are considering duality based methods based upon restricted profit function or restricted revenue function
		Tax payer savings of NMFS expenditures	Accounting costs associated with the backlog of consultations (GC, staff time, FOIA requests, etc)
		Fishermen or tax payer savings on observer program coverage cost	Accounting costs associated with reduction in required observer coverage provided protected species incidental take level increases.
3.	Habitat Conservation & Restoration	Job, sales, income and value-added impacts	Regional Economic modeling using IMPLAN
		Consumer surplus	Stated preference surveys assessing societal preferences for habitat uses, conditions
		Consumer surplus	Benefits transfer of existing measures of benefits from a habitat type in one area to the same habitat type in a different area
		Consumer Surplus	Hedonic modeling of property values to assess capitalized value of habitat in home values
4.	Marine Recreational Information Program	Job, sales, income and value-added impacts	Regional Economic modeling using IMPLAN
		Consumer surplus	Angler stated preference surveys identifying preferred management options
		Consumer surplus	Random utility model estimated using NMFS methodology
5.	Aquaculture	Producer surplus	Bioeconomic model, with improved firm-level information on operating costs, fixed costs, and earnings.
		Job, sales, income and value-added impacts	Regional Economic modeling using IMPLAN

5. CONCLUSIONS AND RECOMMENDATIONS

Across the Agency, many programs are only now embarking on well-planned efforts to begin to design methods and collect the data needed to estimate the impact that NOAA activities and products have on society. This white paper captures the current state of thinking across the Agency for selected products and services. Because we are early in this process, many of these methods and data need significant further refinement. This white paper is not intended to be a guide, but should stimulate the reader and the Agency to begin thinking deeply about how we can better measure the societal impacts of our work and indeed better design what we do to achieve these impacts.

The workshop and the resulting white paper demonstrate that NOAA affects societal well-being in many ways. The Agency improves and protects economic value, jobs, lives, property, and the ecosystems upon which we all depend. The examples here only begin to touch open the many ways the agency contributes to the overall welfare of the nation and the world.

One clear message emerged from the workshop: understanding our societal impacts means better understanding the nexus between NOAA and society. The Agency has long been a world leader in pushing the cutting edge of physical, natural, meteorological, and environmental sciences in the service of the nation. As a result, we are the world's preeminent environmental data and science agency. Now, NOAA needs to harness the leading edge of social science so we can more effectively harness the natural sciences and engineering to continue to provide and improve the data, services, and stewardship our country needs.

Valuing NOAA means understanding how people, businesses, governments, and society make decisions with NOAA's products and services and how they might do so if NOAA's many products and activities did not exist in their current state. This exercise is far from a simple intellectual exercise. These are the types of scenarios the Agency confronts every day when deciding how to invest in future improvements in our work. It also is the kind of decision Congress and the President make each year, even if only implicitly, when they craft our budget for the coming years. To better improve our ability to help the Agency, Congress, and the President make better decisions about investments at NOAA and to help the Agency in its constant efforts to better meet the needs of society, we must press on in the development of social science methods and data to quantify the societal impact and importance of the agency. Here we describe a few of the key lessons learned and offer suggestions for next steps to move this conversation forward in the NOAA Science Challenge process.

5.1 NOAA Is An Enterprise

When examining NOAA products and activities, it is apparent that the complexity of the relationship between the resources, activities, outputs, and outcomes vary on a case by case basis. In order to effectively estimate the societal impacts of NOAA products and activities, it is important to acknowledge these differences. To better understand the role of complexity in estimating the societal impact of NOAA

activities, we consider three categories of activities: 1) sole-sourced products and activities, 2) interconnected NOAA products and activities, and 3) multiple partner NOAA products and activities.

Sole-sourced products and activities

A sole-sourced product or activity is one whose production and delivery is contained entirely within one line office. In this type of product or activity, the resources, activities, and outputs are produced within a single office. An example of this type of product is the National Weather Service's (NWS) data on historical precipitation. NWS weather stations (resource) collect the data (activity) and make it directly available to the public (output). This example follows the classical logic model format with resources, activities, and outputs in a simple linear form (See Figure 1).

Figure 1: Classical Linear Logic Model

Enterprise Products and Activities

Enterprise NOAA products and activities are those products that reach across more than one line office within NOAA. With these types of products and activities, outputs from one line office may be a resource or input for another line office, resources may stem from more than one office, activities may produce more than one output, and outputs can be distributed through a variety of mechanisms. An example of this particular relationship structure is the production of outputs, such as weather forecasts, stemming from NOAA's Joint Polar Satellite System (JPSS). JPSS-related products stretch across various line offices including: NWS, NESDIS, and OAR. In this example, there are many complex interactions which suggest it would be better captured by a web-like structure as opposed to the classical linear logic model (See Figure 2). This sentiment regarding complexity is also echoed in the multi-partner discussion.

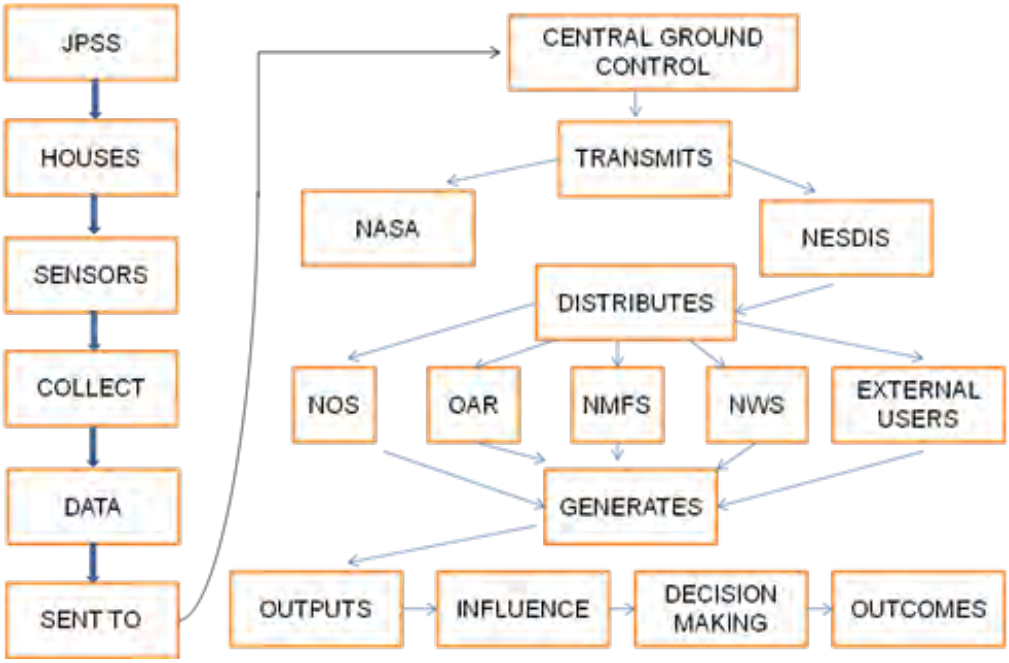

Figure 2: JPSS Enterprise-level Logic Model

Multi-partner NOAA Products and Activities

Multi-partner NOAA products and activities are those that depend on multiple partners. NOAA currently partners with numerous agencies, universities, non-profit organizations, and NGOs. Currently, NOAA partners with entities, such as: FEMA, American Red Cross, USGS, Oregon State University, and private firms. The addition of partners can further complicate the logic model for a particular NOAA product or activity. An example of this type of product is the Sea Level Rise and Coastal Flooding Impacts Viewer. Not only does this particular example involve multiple partners, but the resources, activities, and outputs are also interconnected. By acknowledging the different types of relationship structures that exist within NOAA products and activities, insight can be gained for valuing those products and activities' impact on society.

NOAA products and activities are not always a sole sourced activity or product produced by a single line office. For the Social Science Challenge Workshop, we started with the most basic structure, sole-sourced products and activities, as a first step that the line offices could embark upon. In order to value more complex NOAA products and activities, an enterprise approach is needed to quantify the societal impacts. In addition, the valuation process should focus on a select few strategic examples in quantifying the societal impacts of NOAA and take into consideration different audiences' perspectives.

5.2 Towards More Realistic Estimates of the Contribution of NOAA

NOAA is a large organization with hundreds, if not thousands, of discernable products, services, and activities. Some outputs are enjoyed directly by society, some outputs are

inputs that support public-private partnerships or partnerships we have with other agencies and even other nations.

Despite the large number of ways in which NOAA affects society, many of the Agency's outputs fall into discrete types of products. For instance, the Agency provides many types of data (historical, current, and predicted) that business, governments, and individuals use to plan their activities. These information products include weather, climate, fisheries, coastal, and oceanic information. The methods that can be applied to understand and quantify the value of these products are often similar across the Agency, regardless of whether the application is to weather or oceans, for instance.

At least three important "types" of output emerged in our workshop:

Information

Information products include historical data, real time monitoring, predictions and assessments, and charts and maps. Weather and climate information represent a subset of information products around which a substantial academic community and literature has developed.

Social Capital or Stewardship

Many programs at NOAA strive to help others make better decisions about managing natural resources, especially coastal and marine resources. These activities include, but are not limited to, stakeholder processes, efforts to rebuild working waterfronts, NMFS work with fishing communities, and trainings provided by Sea Grant and the Coastal Services Center.

Research and Development

As a self-proclaimed "science Agency" NOAA engages in and supports high-level research and development intended to improve NOAA's products and services. This includes, but is not limited to, research at NOAA laboratories, science centers, cooperative institutes and Sea Grant affiliates.

5.3 Proposed Future Workshops

The Agency would benefit from future Science Challenge workshops targeted at understanding the estimation of societal values in each of these areas of endeavor. As described in the introduction to this white paper, the quantification of these impacts will also help the Agency provide new and better social science so that the Agency can better meet its research goals. Future workshops, like those described above, should include explorations of both methods to quantify NOAA's impacts on society and also new methods for better designing NOAA activities. NOAA may need to harvest external expertise to reach these goals.

APPENDICES

NOAA Social Science Needs Assessment Workshop

HCHB 1414

Wednesday, June 1, 2011, 9:00 a.m.-9:30 a.m.

Jane Lubchenco, Under Secretary of Commerce for Oceans and Atmosphere

As Delivered

Key message: *NOAA must better integrate the social sciences into its decision-making and planning processes to help NOAA garner the public, Congressional and budgetary support necessary to fulfill the agency's mission.*

Thank you & Welcome

Thank you, Linwood, for the introduction and for the invitation to speak here this morning. Welcome, everyone, to NOAA's Social Science Needs Assessment Workshop.

I appreciate that so many of you from NOAA and elsewhere in the government, from academia and the non-profit and private sectors have joined us for this Workshop. Your conversations here today will help catalyze the integration of the social sciences into NOAA's decision-making and planning processes. Such a synthesis is long overdue, and is critical in terms of helping NOAA garner the public, Congressional, and budgetary support necessary to fulfill the agency's mission.

Importance of Social Science NOAA has a tripartite mission: Science, Service, and Stewardship. We seek to:

1. Understand and predict changes in climate, weather, oceans, and coasts;
2. Share that knowledge and information with others; and
3. Conserve and manage coastal and marine resources.

As a consequence, our activities provide tangible benefits to society.

- We protect lives, health, and property;
- We help create and sustain coastal and ocean jobs; and
- We contribute to social and economic well-being by protecting and restoring ecosystems, and by managing activities that affect those ecosystems.

NOAA's products and services—from daily weather forecasts and severe storm warnings, to climate monitoring, fisheries management, and habitat restoration—support economic vitality and affect more than one-third of America's gross domestic product.

By providing the public, private enterprise, and government agencies with our products and services, NOAA facilitates informed decision-making. Informed decision-making, in turn, ensures that society operates efficiently, effectively, and competitively in a constantly changing natural environment.

The social sciences offer us the opportunity to better understand people, their institutions, and their decision-making processes. For example, these disciplines provide us with insight into why people make the choices they do given the information they have. If we can find more effective ways of providing individuals and institutions with important information, and if we can better understand how individuals and institutions use that information to make choices, we can facilitate more informed decision-making processes.

The social sciences have rich potential to help NOAA fulfill its mission by enabling us to more effectively provide the critical information, products, and services that the public needs.

Historically, NOAA has not used social science knowledge or information effectively, or in some cases, at all. As a result, stakeholders may not get all of the information they need or get it in ways they can trust or use. The information they do receive may not be communicated in the most effective way, and consequently this information may not inform decision-making as well as it could. The social sciences offer NOAA tools needed to address and remedy these shortcomings. In short, NOAA needs you!

"Social science" encompasses a broad range of disciplines, each of which can inform decision-making. For example:

- Economics allows us to quantify the existing and potential benefits of various programs, products, and services. These estimates can be used to understand trade-offs or help justify proposed budgets, and evaluate program performance.
- Sociology, anthropology, demography, and geography help us understand various populations' vulnerabilities and behavioral responses to weather risk and climate change.
- Psychology helps us understand risk perception and assessment, as well as stakeholder decision-making.

- Political science provides us with insight into institutional governance structures, and helps us analyze political demand for the types of services that NOAA provides.
- Communications, of course, is vital. We must develop more effective means of communicating, for example, the ways in which NOAA information, products, and services directly benefit both individual stakeholders and the public at large.

Social science tools have the potential to help NOAA quantify and communicate the benefits of a variety of our products and services. For example, they can help us assess:

- The ways in which catch shares might improve fishermen's profits and reduce lives lost at sea;
- The lives saved as a result of timely hurricane, tornado, and tsunami warnings;
- The vital contributions of satellite systems like the Joint Polar Satellite System to our weather forecasting capabilities;
- The ways in which better climate forecasts might lead to agricultural savings; and
- Whether harmful algal bloom monitoring and forecasting can reduce the number and severity of associated illnesses.

The social sciences help NOAA tell its story more effectively and to broader and more diverse audiences. These disciplines are not ancillary to NOAA's Mission; they are an integral part of all three facets of that Mission: Science, Service, and Stewardship. Therefore, it is essential that the social sciences be well integrated into NOAA's planning, research, and programmatic functions.

As you all are aware, NOAA's Science Advisory Board Social Science Review Panel found in 2003 that NOAA's ability to fulfill its Mission was hampered by the underrepresentation and underutilization of social science. Social science literacy was poor, and many within NOAA lacked an understanding of what social science is and what its contributions to NOAA could be. As a result, the organizational culture was not conducive to social science research.

What was true in 2003 remains largely true today, with the exception that there is now an increased appreciation of the need for social science. Line office strategic plans are beginning to integrate these disciplines; for example, both the National Marine Fisheries Service and the National Ocean Service have clearly articulated social science research agendas, and last year's Science Workshop identified strengthening and incorporating social sciences as high priorities.

Nonetheless, the social sciences continue to account for a miniscule fraction of NOAA's overall budget—just 0.6% in 2008. Between 2005 and 2008, both budgetary and staff support for social science have weakened. This is unacceptable. Today, with this Workshop, NOAA is reaffirming its commitment to a sustained, coordinated, and comprehensive integration of social science into all of its goals and programs.

Through this sustained, integrated effort, NOAA will be better able to identify and measure how our information, products, and services contribute to societal health and welfare and the national economy. We will be able to use social science as a tool to help improve the effectiveness and cost-efficiency of NOAA's products and services. And we will learn how best to communicate to the public all of the important information that NOAA provides.

Concluding Thoughts

There is no doubt that NOAA must do more to elevate the role of social science within the agency's planning, programmatic, decision-making, and research functions. Until social science is fully integrated into the "One NOAA" framework, our ability to fulfill our mission will fall short.

That is what brings us here today. We commit to a comprehensive, coordinated approach that will bring social science to bear on all that NOAA does.

Through these efforts, we will not only be better able to quantify the value of NOAA products and services, we will be better able to communicate and justify those values to the public, to private industry, and to Congress. We will be able to show that not only are NOAA's products and services critical to the economic and environmental health and wealth of our Nation, but that NOAA is providing these products and services in a cost-effective manner. We will be able to prioritize product and service provision, and improve upon those products and services based upon user needs and feedback.

I wish you the best of luck during today's Workshop, and look forward to hearing all of your ideas about the ways in which NOAA can harness the power of the social sciences. Again, thank you all for coming and for your commitment to bringing social science to NOAA. I'm happy to take a couple of questions.

Acronyms

AHPS: Advanced Hydrological Prediction Service

BEA: Bureau of Economic Analysis

BLS: Bureau of Labor Statistics

BMPs: best management practices

CPO: Climate Program Office

ECS Program: Extended Continental Shelf Program

ENSO Index: El Niño/La Niña-Southern Oscillation Index

ESA: Endangered Species Act

FEMA: Federal Emergency Management Agency

FOIA: Freedom of Information Act

GIS: Geographic Information System

GoM: Gulf of Mexico

GPS: Global Positioning System

HAB: harmful algal bloom

HACCP: the National Seafood Hazard Analysis and Critical Point Control

HFIP: Hurricane Forecast Improvement Project

IMETs: Incident Meteorologists

IMPLAN: **IM**pact analysis for **PLAN**ning

JPSS: Joint Polar Satellite System

KAPB: Knowledge, Attitude, Practices, and Behaviors

MEY: maximum economic yield

MRIP: Marine Recreational Information Program

MSY: maximum sustainable yield

NCDC: National Climatic Data Center

NESDIS: National Environmental Satellite, Data & Information Service

NextGen: Next Generation Air Transportation System

NGOs: Non-governmental Organizations

NGSP: Next Generation Strategic Plan

NIDIS: National Integrated Drought Information System

NMFS: National Marine Fisheries Service

NOAA: National Oceanic and Atmospheric Administration

NOS: National Ocean Service

NSGCP: National Sea Grant College Program

NSGO: National Sea Grant Office

NWS: National Weather Service

OAR: Office of Oceanic and Atmospheric Research

OMB: Office of Management & Budget

ORBIMAGE: Orbital Imaging Corporation

PIE system: Planning, Implementation, and Evaluation system

PORTS®: Physical Oceanographic Real-Time System

PPE: OAR's Office of Policy, Planning, and Evaluation

RUM: Random Utility Model

SECC: The Southeast Climate Consortium

SEE Council: OAR's Strategy, Execution, and Evaluation Council

SLR: sea level rise

USBR: U.S. Bureau of Reclamation

USDA-RMA: U.S. Department of Agriculture - Risk Management Agency

USGS: U.S. Geological Survey

WTP: willingness to pay

Science Needed to Quantify NOAA's Impacts on Society
Social Science Needs Assessment Workshop
Herbert C. Hoover Building
14th Street and Pennsylvania Avenue, N.W.,
Washington, DC.
Room 1414

June 2, 2011
9 am - 5 pm

~ GOAL ~

This workshop will create a roadmap for measuring the societal impacts of NOAA's products, services and activities. This includes developing metrics, methods and identifying the human and financial capital needed to conduct this work.

~ OBJECTIVES~

1. Identify categorically the types of societal impacts of NOAA's products, services and activities
2. Review and refine a list of prioritized products, services and activities to measure (use stories submitted for starting point)
3. Identify example metrics for measurement
4. Identify example methods for measurement
5. Identify examples of human capital required to undergo this work (FTE's and skills)
6. Evaluate process (internal objective)

~ AGENDA~

Time	ACTIVITIES and OBJECTIVES	Presenter
9:00 - 9:30	**1. Welcome - Dr. Lubchenco** **The Importance of Social Science to NOAA's mission**	Dr. Lubchenco
9:30 - 10:00	**2. Overview: Setting the stage**	Linwood Pendleton
10:00 - 10:15	**3. Review of SAB reports**	Pete Wiley
10:15 - 10:35	**4. Overview of NOAA's Societal Impacts**	

	Linking NOAA to society	Linwood Pendleton
10:35 - 10:45	*Short Break*	
10:45 - 12:00	**5. From 30 to 5: Tell us your story** **Describe categories and prioritization of 30 stories to 5 stories by each LO and how they got there.**	Line Office Leads
12:00 - 12:45	*Break for Lunch - on your own*	
12:45 - 1:30	**6. Tools for Measuring Societal Impacts**	Pete Wiley
1:30 - 1:45	*Short Break*	
1:45 - 3:15	**7. Breakout - Attaching metrics, methods and costs to stories. (**meet in main room, then small groups**)**	Linwood Pendleton
3:15- 3:30	*Break for coffee*	
3:30 - 4:30	**8. Report out from above**	Line Office Leads
4:30	**9. Wrap up: next steps and writing assignments for completing the roadmap.**	Tricia Ryan
5:00	**Adjourn to Happy Hour at Old Ebbitt Grill**	

	Name	Affiliation	Breakout Group
External	Dr. John Pine	*Appalachian State University*	Climate
	Dr. Doug Lipton	*University of Maryland*	Fisheries
	Dr. Jim Boyd	*Resources for the Future*	Oceans
	Dr. Troy Hartley	*Virginia Sea Grant Director, Virginia Institute of Marine Science (VIMS)*	Oceans
	Dr. Jim Murray	*NOAA Sea Grant*	Oceans
	Dr. Rodney Weiher	*Independent Consultant/Formerly NOAA*	Weather
	Dr. Shirley Fiske	*University of Maryland*	Weather
	Dr. Eve Gruntfest	*University of Colorado at Colorado Springs, NOAA Science Advisory Board*	Weather
	Dr. Stuart Levenbach	*Office of Management and Budget*	Unassigned Floater
NOAA	Dr. Nancy Beller-Simms	NOAA/CPO	Climate
	Dr. Theresa Goedeke	NOAA/NOS	Climate (facilitator)
	Dr. Melissa Kenney	NOAA/CPO	Climate
	Adam Smith	NOAA/NCDC	Climate
	Dr. Eric Wolfe	NOAA/NOS	Climate
	Jainey Bavishi	NOAA/Office of the Undersecretary	Fisheries
	Dr. Rita Curtis	NOAA/NMFS	Fisheries
	Dr. Matthew McPherson	NOAA/NMFS	Fisheries
	Heather Sagar	NOAA/NMFS	Fisheries
	Avery Sen	NOAA/PPI	Fisheries (facilitator)
	Dr. Christy Loper	NOAA/NOS	Oceans
	Dr. Heather Triezenberg	NOAA/Sea Grant	Oceans
	Dr. Paul Sandifer	NOAA/NOS	Oceans
	Pete Wiley	NOAA/NOS	Oceans (facilitator)
	Dr. John Adler	NOAA/OMAO	OMAO-may float to other groups
	Doug Hilderbrand	NOAA/NWS	Weather
	Jennifer Sprague, Esq.	NOAA/NWS	Weather
	John Gaynor	NOAA/OAR	Weather
	Tricia Ryan	NOAA/NOS	Weather (facilitator)
	Dr. Linwood Pendleton	NOAA/PPI	Unassigned Floater
	Hillary Huffer	NOAA/PPI	Unassigned Floater
	Charlie Morris	NOAA/PPI	Unassigned Floater
	Josh Stoll	NOAA/NMFS	Unassigned Floater
	Total		**32**

NOAA Science Challenge Workshop

Stories by Breakout Group

6/2/2011

Contents

Climate – Climate Stories

1) AgroClimate, developed by The Southeast Climate Consortium (SECC), provides seasonal climate forecasts, visualization tools, and climate and commodity outlooks to assist producers to understand and plan for climate variation via Cooperative Extension Services in Florida, Georgia, and Alabama.

2) Program/project

AgroClimate

3) Part of society impacted – Primarily the agricultural and forestry sectors

4) Current level of funding - for the product, service or activity

5) Detailed paragraph about the technical details of the story. Use this to provide more information about the program, what it does, and how people use it

AgroClimate is an interactive website with climate, agriculture, and forestry information that allows users to assess resource management options with respect to their probable outcomes under forecast climate conditions. AgroClimate uses crop simulation models along with historic and forecast climate data to allow decision makers to compare changes in probable outcomes under different climate conditions.

AgroClimate is a product that is still under development. At present it includes: 1) background climate information and a climate tool that allows decision makers to compare climate variability under different ENSO conditions; 2) crop information and tools for peanut, tomato, and potato; 3) forest management and wildfire risk assessment; and 4) links to other sources of related information of value to decision makers. Planned additions coming soon to AgroClimate include: 1) tools for assessing management options for additional crops, pastures, and livestock that are important to the agricultural economy of the southeastern USA; 2) a tool to help decision makers to assess the value of irrigation water; 3) a tool to help decision makers assess the value of crop insurance; and 4) a county-level database that links historic agricultural production data with climate so that decision makers can assess the effects of past climate variability of agricultural commodities.

6) Information about any previous attempts to quantify the impact of this activity

Anecdotal evidence of AgroClimate economic impacts includes the use of more than 50 SECC outlooks in agricultural commodity publications distributed to over 10,000 people in 10 states. Tampa Bay Water, which supplies water to municipalities and counties in the Tampa area, regularly uses information from AgroClimate as part of its water balance optimization planning. In 2007-08, the SECC began transferring AgroClimate to New Mexico and to the North Carolina State Climate Office.

7) Links or supporting info

http://agroclimate.org/about/

1) Using NOAA Climate Forecasts With Hydrologic Assessment to Reduce Drought Vulnerability and Improve Water Management in Washington State

2) Program/project

NOAA Sectoral Applications Program - grant

3) Part of society impacted – water managers in the Yakima Valley, Washington (and indirectly those in the agricultural sector) Their focus was the high stakes and highly drought-vulnerable Yakima River Basin, whose irrigated crops represent the largest agricultural value in the state. Irrigators depend on water from the Yakima Project, operated by the U.S. Bureau of Reclamation (USBR), which issues hydrologic forecasts that could benefit from improved climate information.

4) Current level of funding - for the product, service or activity – They were funded in FY2006 at $293k; their project is completed.

5) Detailed paragraph about the technical details of the story. Use this to provide more information about the program, what it does, and how people use it

The Principal Investigators on this grant produced a drought monitoring and forecast system for Washington State enabling detection of the onset and recovery of drought up to four months before State declarations. (Note: This drought information is currently being used by decision-makers and stakeholders in Washington State; it is also being used as a foundation for the U.S. Surface Water Monitor).

6) Information about any previous attempts to quantify the impact of this activity
Droughts are the nation's most costly natural disaster. In Washington State, in 2005(?) drought inflicted more than $300 million in damage to the agricultural sector, and halved the expected summer runoff that feeds Washington State's economy.

Since the end of the project, the lead PI has been working with water managers and other stakeholders in the western U.S., particularly California, to assess the use and value of the hydrologic forecast system for decision-making. For example, as stated by the former manager of drought decisionmaking in Washington State, the system they developed provides the information that was needed, and in a way that's highly useful for decision-making. In particular, it was judged to be useful for drought decisions because it can assess drought by Water Resource Inventory Area, according to multiple indicators based on percentiles, and provide early warning for the onset of drought.

7) Links or supporting info

http://www.hydro.washington.edu/forecast/sarp/- This website presents a near real-time (daily-updating) analysis of hydrologic conditions throughout Washington State, and a prediction aspect will soon be added. **The objective of the site is to monitor departures from normal conditions (anomalies) that may help characterize evolving drought and/or flood risks.**

State-of-the-art climate forecasts, such as the NOAA CPC seasonal outlooks, offer the potential to mitigate drought damages through advance warning. Yet this potential is largely untapped by water managers; a gap remains between forecast products and their applications, often due to socio-organizational factors. This study bridged that gap by working directly with users in the transition of NOAA climate forecasts, coupled with hydrologic assessments, to water resources operations and drought management.

The results of this project suggest that the system provides a method for early detection of the onset, duration, severity, and recovery from drought, and an approach that would allow for finer-scale resolution of drought declaration. The system approach also provides a scientific basis for indicators and triggers that can assist in drought management decisions for Washington State and other regions.

Expected benefits of the project include improved water management and drought mitigation in a key socioeconomic sector and throughout Washington State, improved understanding of how to integrate NOAA climate forecast products into water resources decision-making, and a model implementation of climate and hydrologic forecasts in a statewide drought plan and NIDIS application. In addition, because the Yakima River basin exemplifies many water management challenges and conflicts across the U.S., successful transition of NOAA products in this case study is expected to generate broader lessons and national attention. integrating NOAA climate forecast products with advanced hydrologic assessments through an advanced experimental hydrologic forecast system for the western U.S. that incorporates a semi-distributed hydrologic model.

A key aspect of this project was the close interaction with our operations partners, and the exploration of advanced forecast products within their operational water management decision process. To do so, they worked directly with the USBR and DOE offices, in addition to state and local water managers, to adapt forecast products into formats that were considered most useful for their operations.

1) The NOAA/CPO/SARP- funded "Quantification of Inundation in South Florida caused by Sea Level Rises and its Social and Economic Impacts" project

2) Program/project

NOAA Sectoral Applications Program - grant

3) Part of society impacted

The products from the proposed project will provide local communities and the public with information on inundation extent and dynamics in low-lying areas, and associated social and economic impacts on South Florida caused by global sea level rise. The maps of inundation and increased storm surge flooding will allow local communities and the public to better understand the severity and range of the impacts of sea level rise on society and economy, and hence to make better decisions.

4) Current level of funding - for the product, service or activity $300,000 – began September 2010

5) Detailed paragraph about the technical details of the story. Use this to provide more information about the program, what it does, and how people use it
This project will develop the nexus between sea level rise and storm surge, and its socioeconomic implications for long range planning and adaptation in low lying areas in South Florida (Miami-Dade) to provide maps of inundation and increased storm surge flooding and present the severity and range of the impacts of sea level rise on society and economy to enhance local community decision making.

6) Information about any previous attempts to quantify the impact of this activity

The total population, property, and gross domestic product of the three counties represent more than 30% of the totals for the State of Florida (67 counties), making the three counties a center of Florida's society and economy.

Harrington and Walton (2007) estimated the values of impacted real property in Miami-Dade County to be approximately $57 and $128 million with rises in sea level of 0.31 and 0.65 m, respectively. Unfortunately, the accuracy of these analyses is limited by the poor vertical resolution of DEMs, which, in turn, prevents local communities from applying the inundation information to their planning and policy-making process.

7) Links or supporting info

No links

Sea level rise has caused inundation, erosion, and saltwater intrusion, and exacerbated storm surge flooding along coastal zones. The 2007 IPCC report projects a global sea level rise of 0.18-0.59 m by 2100 and recent studies show that sea level rise could reach 1.4 m at the end of this century. Such a large sea level rise would threaten millions of people, the economy, and unique ecosystems such as Everglades National Park in South Florida. Quantitative information on inundation and intensified storm surge flooding caused by sea level rise is needed for local communities to make sound policy to cope with the impacts. However, accurate quantification cannot be derived due to the lack of high-resolution digital elevation models (DEM) for lowlying areas. The vertical resolution of existing DEMs provided by USGS is about 1.5 m (5 feet) for South Florida, which can correspond to a horizontal extent of tens of kilometers. Fortunately, the Florida Division of Emergency Management (Division) is completing state-wide, airborne light detection and ranging (LiDAR) mapping of coastal areas vulnerable to storm surge flooding, which provides valuable data set for quantifying the impacts of sea level rise.

The first objective of this project is to create high-resolution DEMs for South Florida using LiDAR measurements and to develop methods in geographic information systems (GIS) to estimate land areas inundated by potential sea level rise, and to quantify the impact of sea level rise on the real property, population, and critical infrastructure. The second objective is to examine the effect of topography and acceleration in sea level rise on inundation, to identify patterns of inundation caused by sea level rise, to seek a tipping point in the inundation process beyond which the flooding of land, property, and population becomes calamitous. The third objective is to examine the non-linear interaction of storm surge and sea level rise through numerical modeling, to compute the surge flooding under various sea level rise scenarios. The fourth objective is to collaborate with the NOAA Coastal Services Center to incorporate the results into the Digital Coast and to work with local communities including Palm Beach, Broward, Miami-Dade, and Monroe Counties, U.S. Fish and Wildlife Service, and The Nature Conservancy to incorporate the inundation information into their management plans.

As more LiDAR data are collected for coastal states through the Federal Emergency Management Administration (FEMA) Map Modernization program, the proposed methods have the potential of being applied to the entire nation, aiding our society to make sound policy for coping with the impacts of sea level rise.

Background Information For the NIDIS and Climate Normals Stories

The Climate Normals affect energy rates charged to customers by providing spatial / temporal averages of climatological variables describing base climatic conditions which result in a formal process by which Public Service/Utility Commissions determine the rate that each utility is allowed to charge its customers.

The Climate Normals also affect the assessment of equipment requirements for heavy power line loads during extremely hot weather by providing mean climatic information that describe the base climate to which current conditions can be compared which results in cost savings.

2) Program / project
NOAA Climate Normals

3) Part of society impacted

NCDC is responsible for producing official 'climate normals' (i.e., 30-year averages) of numerous climatological variables every ten years for U.S. locations. The 1971-2000 climate normals consist primarily of station-based monthly and daily normals of temperature (maximum, minimum, and mean), precipitation, and heating/cooling degree days. They also include various divisional and population-based aggregations, phenological/agricultural parameters, distribution characteristics such as standard deviations and percentiles, and other supplemental normals.

For 1981–2010, we plan to compute precipitation normals for almost 8,000 precipitation stations; a fraction of these will have snowfall and snow depth normals as well. Temperature normals (including derived products such as degree days) will be computed for about 6,000 stations.

4) Current level of funding - for the product, service or activity

1 FTE over the last 1.5 years; Currently ramped up to 5 FTEs + 1 contractor until end of this calendar year to produce new suite of data products (1980-2010); In 2012, resources scaled back to 1 FTE to develop new Alternative Normals data products suite.

5) Detailed paragraph about the technical details of the story. Use this to provide more information about the program, what it does, and how people use it.

The core 1981–2010 Normals are the most-widely used Normals as identified by NCDC in close consultation with the National Weather Service (NWS) and a wide array of climate data users. Specifically, core Normals refer to the daily and monthly station-based Normals of temperature, precipitation, snowfall, snow depth, and heating and cooling degree days.
Normals are utilized in countless applications across a variety of sectors. These include: regulation of power companies, energy load forecasting, crop selection and planting times, construction planning, building design, and many others.

6) Information about any previous attempts to quantify the impact of this activity

We have not current, direct measure on the value of the Normals, but we do have a tangential study of use: For every **$1 that energy companies** spend in acquiring NOAA climate station data, they receive a potential **benefit savings of $495** in related costs (i.e. not having to implement their own observing system to collect the data). This yields a cumulative **$65 million benefit** when extrapolated across the entire US energy market. See: Centrec Consulting Group, LLC, 2003: *Investigating the Economic Value of Selected NESDIS Products, 2003: Benefits of*

meteorological services. A report to National Environmental Satellite, Data, and Information Service (NESDIS). Centrec Consulting Group, Savoy, IL, 50 pp.

7) Links or supporting info

Information on the current version of NOAA's Normals, as well as the history on the Normals, can be found at: http://www.ncdc.noaa.gov/oa/climate/normals/usnormals.html
The most current information on the development of 1981–2010 Normals is an extended abstract by Arguez et al. (2011) and can be accessed here:
ftp://ftp.ncdc.noaa.gov/pub/data/aarguez/Normals/1981-2010/Arguez-Extended-Normals-AMS2011.pdf

1) The National Integrated Drought Information System (NIDIS) enhances agriculture decision-making in producing crops by providing information about current drought conditions, impacts, research, and forecasts in a single location (www.drought.gov).

2) Program / project

National Integrated Drought Information System (NIDIS)

3) Part of society impacted

People can take steps ahead of time to reduce the effects of drought, just as they would for other natural disasters. Planning ahead gives decision-makers, resource managers and citizens the chance to relieve the most suffering at the least expense. Reacting to drought in 'crisis mode' is often expensive and not well-targeted.

The initial focus of NIDIS is:

- Developing the U.S. Drought Portal
- Integrating and fostering coping strategies through research, preparedness, education and public awareness
- Integrating data and predictions
- Developing pilot programs for design and implementation of early warning systems in selected locations

4) Current level of funding - for the product, service or activity

5) Detailed paragraph about the technical details of the story. Use this to provide more information about the program, what it does, and how people use it

The NIDIS U.S. Drought Portal is part of the interactive system to:

- Provide early warning about emerging and anticipated droughts
- Assimilate and quality control data about droughts and models
- Provide information about risk and impact of droughts to different agencies and stakeholders
- Provide information about past droughts for comparison and to understand current conditions
- Explain how to plan for and manage the impacts of droughts
- Provide a forum for different stakeholders to discuss drought-related issues

6) Information about any previous attempts to quantify the impact of this activity
The Federal Emergency Management Agency (FEMA) estimated in 1995 that the nation's annual average drought loss was $6 to $8 billion. FEMA and other disaster management organizations have also estimated that for every $1 spent on reducing vulnerability to disaster -- 'mitigation' -- $4 is saved. This finding was recently reiterated in a 2005 study by the Multihazard Mitigation Council.

7) Links or supporting info

See: www.drought.gov

Story 1: Catch shares give fishermen greater flexibility and control in their industry, while also rebuilding and sustaining healthy fish populations.

Program: National Catch Share Program
Part of Society Impacted: Commercial fishermen and related shoreside businesses (processors and dealers, wholesalers, importers/exporters, seafood retailers, including restaurants, grocery stores, and seafood markets); seafood consumers; fishing households; fishing communities
Current Level of Funding: $24.6 Million (FY 2010 Enacted)

Catch shares allocate a dedicated percentage or share of a fishery's total catch to individual fishermen, communities, and/or associations. When participants have a secure portion of the catch, they gain the flexibility to make business decisions that improve safety, enhance the value of their share, and promote sustainable fishing of the stocks. Coupled with an observing, monitoring, and catch accounting system, incentivizing specific entities to control catch is extremely effective in preventing overfishing.

Nationwide, there are 18 catch share programs currently in operation in six different regions. The total landings revenue of the fisheries for which information was available was $879 million in 2009 amounting to 23% of the total landings revenue for all U.S. commercial fisheries. Benefits from catch shares include eliminating the race for fish among fishermen competing for a common quota—a race that can lead to overcapacity in the fishery, increased bycatch and waste, and overfishing. Catch shares improve the economics of the fishery by allowing fishermen to harvest their shares when the markets are best and to take other actions to reduce costs and increase revenue without fear of losing access to their share of the quota. An additional benefit of catch share programs is that they provide a market-based incentive to sustainably self-govern, thus reducing the need for more rigid regulatory measures.

New England Groundfish Sectors: In the past, NMFS did not monitor the socioeconomic performance of catch share fisheries using a standardized approach. However, with the publication of the 2010 National Catch Share Policy, NMFS has recognized the need for a more programmatic approach to assessing social and economic performance of both catch share and non-rationalized fisheries. The nine month performance report for the New England groundfish fishery, Sectors and Common Pool, is illustrative of this more rigorous approach and includes metrics on trends in earnings, employment, and effort. Subsequent studies will include the annual performance report, a break-even analysis and profitability estimates, and will evaluate the effects of quota trading and changes in ownership.
Brief Results: Revenues from all species landed were higher in 2010 than in 2008 or 2009, but were $4 million less than in 2007. Combined yearly average prices for all species were higher in 2010 than any other year in the time series. Economic performance, as indicated by revenue per unit effort, improved in 2010. Other performance measures indicated the continuation of existing trends into 2010. These metrics include lower landings of both groundfish and non-groundfish species by roughly 15% since 2008; 18% fewer active vessels in 2010 than in 2007, and fewer crew positions, days, and trips. There has also been an increase in concentration of groundfish revenues among top earning vessels, as revenues have become consolidated on fewer vessels. Nearly all measures of revenue per trip and per day absent in 2010 were higher for the average Sector vessel relative to the average vessel managed under the Common Pool, the pre-existing effort control management structure.
Cost of Implementation: Excluding the data collection costs associated with data used in this analysis, FTE and contractor time for producing the Interim report is roughly $340K. (3 FTEs @ 0.25; 1 full-time contractor; 1 FTE @0.5 all valued at $150K per year). Forthcoming analyses are estimated to cost $375K (four FTEs and one contractor all @ 0.5) but do not yet include any metrics on community resiliency, efficiency, or safety at sea, all MSA goals.
Who did it? NMFS staff, with some contractor support

Supporting Information: The NMFS Economics & Social Science Research Program has launched an initiative to track socioeconomic performance of catch share fisheries and non-rationalized fisheries. Selected metrics will cover the full spectrum of Magnuson-Stevens Act limited access privilege goals as

well as other relevant MSA objectives, e.g., National Standard 8, the sustained participation of fishing communities. The overarching objective is to evaluate and track the performance of the catch share fisheries in terms of ensuring economic sustainability of the fishing industry and the resiliency of fishing communities. This initiative will also address OMB's requirement to develop an economic health index for fisheries. *This effort will also contribute to NMFS knowledge base for making allocation decisions.*

Interim Report for Fishing Year 2010 on the Performance of the Northeast Multispecies (Groundfish) Fishery (May 2010–January 2011) http://www.nefsc.noaa.gov/nefsc/publications/crd/crd1107/1107.pdf

Fisheries – NMFS Stories

Story 2: Habitat restoration employs people and improves the environment, creating a better future economically and environmentally.

Program: Habitat Conservation & Restoration

Part of Society Impacts: Coastal households, firms, communities; commercial and recreational fishermen and related shoreside firms; eco-tourists (e.g., those who go whale watching), Americans who value the preservation of retaining marine habitats, including preserving marine protected species

Current Level of Funding: $58.2 Million (FY 2010 Enacted)

Habitat restoration is the process of re-establishing a self-sustaining habitat that closely resembles a natural condition in terms of structure and function. Habitats support fish and wildlife, as well as human uses such as swimming, diving, boating, and recreational and commercial fishing. Coastal, marine, and riverine habitats play an essential role in the reproduction, growth, and sustainability of commercial and recreational fisheries and protected species by providing shelter, feeding, spawning, and nursery grounds for fish and wildlife.

Estuaries provide habitat for more than 68 percent of America's commercial fish catch by value and for 80 percent of the recreational fish catch by weight. Habitat restoration efforts support a range of job types in local communities including construction workers and project managers working directly onsite, as well as other businesses and professionals who design, engineer, provide materials for, and monitor the success of these projects. NOAA also helps prepare the next generation of restoration professionals by supporting organizations that provide training and work experience for those entering the coastal restoration field in the public, private, and non-profit sectors.

Economic Contribution of Habitat Restoration Activities

In 2009, NOAA received $167 million from the ARRA funding to restore coastal habitat and help jumpstart the nation's economy. NOAA selected 50 high quality, high priority projects to restore U.S. coasts on a grand scale. These projects were recognized as an engine for job creation and, in particular green job creation, with funding going for restoration of wetlands, salt marshes, oyster and coral reefs as well as removal of fish passage barriers on coastal rivers and streams. In addition to improving the environment, these efforts will assist recreational and commercial fishing, support more resilient coasts in the face of climate change, and create jobs–many in areas of high unemployment.

Results: In 2009, saltwater angling contributed $23 billion to GNP, generated $50 billion in sales impacts and supported 327,000 jobs in recreational fishing and across the broader economy.

Cost: $30K (0.2 FTE @$150K per year) **Who did it?** NMFS staff, contracted survey services

Economic Value of Salmon Habitat Conservation & Restoration

Control of sediment from logging roads in California's redwood region is important to protecting streams inhabited by endangered salmonids. Both private and public landowners have limited resources to devote to road erosion control, and must make difficult choices about which roads to treat and how to treat them. In a recent case study, NMFS developed an operations research model to identify cost-effective strategies defined in both spatial and temporal terms for reducing sediment delivery.

Results: Model identifies conditions and timing factors under which it is optimal to retain status quo road, upgrade the road, or to remove the road entirely, including exporting unstable material.

Cost: $140K: Erosion Monitors: $28K; 0.25 FTE/yr for 3 yrs @ $150K/yr.**Who did it?** NMFS staff

Valuing Critical Habitat

Ecological studies have suggested that protecting 10 to 40% of regional ecosystems is needed to restore habitats and protect species diversity. Prior to a recent NMFS study that examined public preferences for critical habitat designations in the Northeast, public preferences for MPA size had not been assessed. The NMFS study estimated the value of protecting species and habitat diversity on the sea floor in areas that vary in size and allowable uses of the water column.

Results: Study found that the public is willing to pay for a network of marine protected areas that protect marine life and habitat on the sea floor, though the economic benefits were greater for networks that allow a limited level of commercial fishing as compared to no-take reserves. Households in the Northeast Region were divided on whether MPAs have positive utility.

Cost: $400K: $250K, survey; $150K, 2FTE@0.25 FTE/yr for 2 yrs @$150K/yr **Who did it?** NMFS Staff

Supporting Information NOAA Fisheries needs to improve its ability to link habitat restoration activities and outcomes with commercial and recreational fishing benefits. The benefits provided by non-fishery ecosystem services such as coastal protection, flood regulation, aesthetics and sequestration of carbon and other green house gases in coastal habitats (Blue Carbon) also need to be valued. Changes in societal welfare as a result of improvements in coastal habitats also need to be assessed (e.g., property value changes in areas adjacent to restored coastal habitat).

Story 3: Stock assessments are the essential foundation of science-based management that is both economically and environmentally sustainable.

Program: Expand Stock Assessments
Part of Society Impacts: Commercial and recreational fishermen, related shoreside firms (marinas, marine supply, seafood industry, including processors, dealers, wholesalers, seafood retailers), seafood consumers, fishing households, fishing communities, eco-tourists (e.g., those who go whale watching), Americans who value the preservation of marine protected species for current and future generations.
Current Level of Funding: Total $97.2million (FY 2010 Enacted): $51.0 million, Expand Annual Stock Assessments; $46.2 million, Protected Species Stock Assessments

Fisheries: NMFS stock assessments are essential to the sustainable prosecution of commercial and recreational fisheries. The fish stock assessment program provides scientific information for achieving fishery management goals, including preventing overfishing and attaining optimum yield from U.S. fisheries. Among the management questions answered with this information are:
- What is the upper biological limit for a sustainable fishery catch policy?
- Has overfishing been occurring and is the fish stock overfished (depleted) and in need of rebuilding?
- What level of future catch would prevent overfishing and attain the optimum yield from the fishery?

Fishery Independent Surveys Days at Sea: Information collected from fishery independent surveys are a critical component of the data underpinning fish stock assessments. Additional sampling days (days at sea) will increase the precision of stock abundance estimates, thereby reducing the uncertainty buffer and allowing for a larger annual catch limit (ACL).
Results A recent NMFS study found that if there were a 50% reduction in the Alaska groundfish survey days at sea, the uncertainty buffer would increase substantially, resulting in lower annual ACLs. Harvest revenue would then fall $30 to $50 million, which corresponds to a $76 to $138 million decrease in sales impacts in Alaska and a loss of 840 to 1,400 full- and part-time jobs in the Alaska economy.
Cost: $75K (0.25 biologist FTE; 0.25 economist FTE) since both analyses use pre-existing NMFS models
Who did it? NMFS staff

Fisheries Rebuilding Plans: When a stock has been overfished, NMFS stock assessments are used to implement rebuilding plans. Most rebuilding plans are based upon maximum sustainable yield (MSY). Economic theory suggests that maximum economic yield (MEY) would yield higher benefits than MSY but fishermen are leery that MEY will reduce harvest levels. Since estimates of MEY are not typically reported in fishery management plans, neither fishermen nor managers have a baseline for comparison. A NMFS study underway of the North Pacific crab fishery estimates MEY using a dynamic bioeconomic model that is estimated under varying assumptions (e.g., with/without population age structure, varying recruitment).
Results: Results find that the harvest levels associated with MSY may be more or less than MEY, depending upon the underlying assumptions.
Cost: $195K, $80K for contract with biologist at University of Washington; 1 FTE @0.25 for three yrs
Who did it? NMFS staff, with contractor

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Protected Resources: Congress passed the Endangered Species Act December 28, 1973, recognizing that the natural heritage of the United States was of "esthetic, ecological, educational, recreational, and scientific value to our Nation and its people." It was understood that, without protection, many of our nation's living resources would become extinct. The Protected Species Research & Management Program provides accurate and timely information and analyses for the conservation of the Nation's living marine resources. The program implements and monitors living marine resource conservation measures to recover protected species. The ultimate desired outcome is to recover and sustain all protected species as fully functioning components of their ecosystems for current and future generations.

Protected Species Valuation Initiative: This project is comprised of a series of national-level public surveys to estimate the economic value of marine protected species under the stewardship of NMFS.

Data from the surveys will allow researchers to estimate the public's value for recovering the species from their current ESA-listing status, either threatened or endangered.

Results: To date, fielded surveys have collected information on 16 threatened or endangered marine species in six regional ecosystems. Three of these species include the Hawaiian monk seal, the smalltooth sawfish, and the Puget Sound Chinook salmon. Nationally, the average annual value for recovering these species is $6.8 billion (results for other species are forthcoming).

Cost: $840K, 8-species survey, $105K/specie: Survey, focus groups, $540K; 2 FTE @.5 for 2 yrs, $300K

Who did it? NMFS staff, contracted data collection, independent peer reviews, other peer reviews

Supporting Information:

Fisheries: In FY11, the NMFS Economics & Social Science Research Program will initiate a series of studies to estimate the value of information obtained from NMFS fishery independent surveys similar to the Alaska groundfish study. This multi-year effort will proceed forward on a region-by-region basis. Estimating MEY for use in evaluating fishery rebuilding management options is a major goal of the NMFS Economics Program. Cumulatively, this information can be used to inform decision makers of the potential value from rebuilding fisheries.

Protected Species: Public values for all 16 species will be available in the coming year. A decision support tool for managers that will enable them to use this information in management actions is also underway. Contingent upon funding, the next phase will focus on marine protected species most threatened by climate change (e.g., ice dependent species, sea turtles, etc.).

Links

NMFS Economics & Social Sciences Program: http://www.st.nmfs.noaa.gov/st5/

Commercial Fisheries: http://www.st.nmfs.noaa.gov/st5/CommercialFisheriesEconomics.html

Protected Species: http://www.st.nmfs.noaa.gov/st5/ProtectedSpeciesEconomicsResearch.html

Story 4: Better data on recreational fishing improves stock assessments and understanding of the industry is fully understood.

Program: Recreational Fisheries Statistics
Part of Society Impacted: Saltwater anglers, coastal communities with recreational fishing

Marine Recreational Information Program (MRIP)'s top priority is to reduce potential bias and increase the accuracy of recreational catch and effort estimates. MRIP provides detailed, timely, scientifically sound estimates that fishery managers, stock assessors, and marine scientists need to ensure the sustainability of ocean resources. Collectively, these improvements will enhance the Agency's ability to monitor recreational catch as required to track Annual Catch Limits and Accountability Measures applied to these fisheries by the Regional Fishery Management Councils. They also address head-on stakeholder concerns about the reliability and credibility of recreational fishing catch and effort estimates.
Current Level of Funding: $9.0 Million for MRIP (FY 2010 Enacted)

Economic Contribution of Saltwater Recreational Angling:
The NMFS is mandated to estimate the economic impacts of recreational fisheries management actions. Estimating economic impacts requires MRIP data, angler expenditures, and preferences for saltwater fishing opportunities. One component of NMFS' economic analyses includes estimating the sales, value-added, and job impacts using an input-output model. The model provides invaluable information for understanding how saltwater angling contributes to a state and/or the national economy and, in particular, how it stacks up against other ocean resources users. The model also provides information on both federal and state taxes generated from this sector, which can be used to justify increased funding for infrastructure development such as boat ramps.
Results: In 2009, saltwater angling contributed $23 billion to GNP, generated $50 billion in sales impacts and supported 327,000 jobs in recreational fishing and across the broader economy.
Cost: Survey year: $1180K=$900K survey; 0.5 FTE for 2 yrs=$160K; 0.75 FTE for 1 yr=$120K
Non-survey years: $40K=0.25 FTE each year (years 2-5 given 5 year cycle for survey)=$40K
Who did it? NMFS staff, contracted survey services

Economic Value of Coral Reef based upon Angler Preferences:
Measures for coral reef protection are typically costly and often conflict with economic development programs and other local policies. Providing decision makers with an accurate economic measure of these ecosystem services are crucial for ensuring their continued presence in future generations. Spatially-delineated information is particularly important in assessing usage of specific habitats and ecosystem services but such data is often difficult to acquire due to prohibitive costs and access restrictions. An economic add-on to the MRFSS collected both spatial information and economic information. Coupling this information with the base MRFSS catch and effort survey, NMFS was able to estimate willingness to pay estimates for coral reef fishing in Puerto Rico.
Results: Results supported that anglers prefer to both fish in shallow waters and they value coral reefs, which are located in shallower waters around the island. Neither man-made fish aggregating devices such as buoys nor spawning locations were statistically significant, which was surprising given anecdotal evidence that anglers are more likely to fish in known spawning points. Marginal willingness to pay estimates for coral reef fishing were considerably higher for coral reef areas located closer to shore, which could have significant implications for future coral reef protection and use policies since extrapolating these per-party-trip-square-mile reef values to aggregate consumer surplus for entire coral reef systems result in multi-million dollar differences.
Cost: $375K: $240K survey; 3 FTEs at 0.25 for 1 yr= $120K; student services=$15K
Who did it? NMFS staff, contracted survey services, student support

Supporting Information

Spatial modeling has long been a strength of the NMFS economics program. For recreational fishing, NMFS has primarily implemented random utility models of site, target and fishing mode choice to estimate benefits from proposed management options. To make these models more timely and cost-effective to implement, NMFS plans to include a recreational module of FishSET, a spatial econometric modeling decision support tool currently being pilot-developed for commercial fishing.

NMFS Marine Recreational Information Program: http://www.countmyfish.noaa.gov/index.html
NMFS Marine Recreational Economics Program: http://www.st.nmfs.noaa.gov/st5/RecFishEcon.html

Story 5: U.S. aquaculture can supply safe and sustainable seafood, create jobs, and reclaim a part of the global seafood trade.

Program: Aquaculture
Part of Society Impacted: Seafood consumers, aquaculture operations (current and future)
Current Level of Funding: $6.0 Million (FY 2010 Enacted)

NOAA is at the forefront of an ongoing national effort to help the United States become more self-sufficient in the production of safe and sustainable seafood. Additional domestic seafood production will reduce the nation's dependence on imports. Although the United States is a major consumer of aquaculture products, importing 84 percent of our seafood, of which half is from aquaculture, we are a minor producer of these products. NOAA is working to address the regulatory, technical, and scientific barriers to marine aquaculture production.

NOAA's overall aquaculture efforts are focused on creating a domestic supply to meet the nation's growing demand for seafood; enabling a sustainable aquaculture industry to create jobs and other economic opportunities in coastal communities; establishing aquaculture as a viable technology for replenishment of important commercial and recreational marine fisheries; and creating opportunities for the United States to engage the global aquaculture community through scientific and technological exchange. NOAA's aquaculture efforts fall into four capabilities: legal and regulatory, research and technology transfer, outreach and education, and international engagement.

Economic Feasibility of Offshore Aquaculture
Development and promotion of offshore aquaculture has been proposed as one approach for satisfying an increasing domestic demand for seafood and promoting community economic sustainability. A recent NMFS study assesses the economic feasibility and potential contribution to the US economy of selected offshore aquaculture products. Economic feasibility is assessed using a series of bioeconomic and related models for assessing stocking densities, growth and survivability, time required to reach marketable size, and, subsequently, net returns for three finfish species (Atlantic cod, salmon, winter flounder) and two shellfish species (blue mussel and sea scallops).
Results: Results found that farmed production of all five species was economically feasible, provided certain conditions prevailed. These conditions include that prices hold at certain levels and that credit is available (necessary due to high investment costs). The study recommended higher levels of investment and larger projects, overall.
Cost: $80K: contractor
Who did it? Contractor

Employment Potential of Offshore Aquaculture
The job creation potential of US offshore aquaculture hinges on three factors, the volume of production, the scale and technology of individual operations, and the mix of species farmed, all of which will ultimately depend upon how offshore aquaculture is regulated. A recent study by NMFS estimates potential employment under varying growth scenarios that reflect these features.
Results: The estimated range of job impacts was large. The paper highlighted several more likely scenarios. In the short-run, assuming a 20% increase in production, job impacts varied from 1,000-

10,000 jobs created economy wide. If production were to double, which more consistent with a longer timeframe, job impacts varied from 5,000 to 50,000.
Cost: $80K; contractor
Who did it? Primarily a contractor

Supporting Information
NMFS needs to assess economic viability of aquaculture operations, the interactions between aquaculture and wild harvest fisheries in a risk framework, and the economic effects of increased domestic aquaculture production on U.S. job creation and the seafood supply chain, including feed production, equipment suppliers, boat owners, processing, and food service.
Links
NOAA Aquaculture Program: http://aquaculture.noaa.gov/
Citation: Offshore Aquaculture in the United States: Economic Considerations, Implications & Opportunities http://aquaculture.noaa.gov/news/econ.html

Oceans – NOS Stories

1. The Physical Oceanographic Real-Time System (PORTS®) affects Marine Transportation by measuring and disseminating observations and predictions of water levels, currents, salinity, waves and meteorological parameters which results in Dollar valued cost avoidance and improved efficiency valued at $7.6 - $20M per year.

2) Name of Program: Center for Operational Oceanographic Products and Services (CO-OPS)
3) Part of society impacted: Marine Transportation
4) Current level of funding - for the product, service or activity.
5) Detailed paragraph about the technical details of the story: PORTS® is a decision support tool that improves the safety and efficiency of maritime commerce and coastal resource management through the integration of real-time environmental observations, forecasts and other geospatial information. PORTS® measures and disseminates observations and predictions of water levels, currents, salinity, and meteorological parameters (e.g., winds, atmospheric pressure, air and water temperatures) that mariners need to navigate safely. The objectives of the PORTS® program are to promote navigation safety, improve the efficiency of U.S. ports and harbors, and ensure the protection of coastal marine resources.
6) Information about any previous attempts to quantify the impact of this activity
7) Links or supporting info: http://tidesandcurrents.noaa.gov/ports.html

2. The 3-D hydrodynamic model affects Great Lakes region residents by addressing lake level and flow forecasting needs, and supporting source water protection, spill response and search and rescue operations which results in improved drinking water safety

2) Name of Program: Integrated Ocean Observing System (IOOS)
3) Part of society impacted: Great Lakes Residents
4) Current level of funding - for the product, service or activity.
5) Detailed paragraph about the technical details of the story: New tools created in part by the U.S. IOOS region in the Great Lakes are improving the safety of drinking water in that area. In partnership with NOAA's Great Lakes Environmental Research Laboratory (GLERL), the Great Lakes Observing System (GLOS) supported the development of a 3-D hydrodynamic model for the Lake Huron-Lake Erie corridor that addresses lake level and flow forecasting needs, and supports source water protection, spill response and search and rescue operations. In addition, GLOS worked with a regional partner, the Cooperative Institute for Limnology and Ecosystems Research, to leverage the efforts of four research universities and NOAA-GLERL to plan and implement a near-shore observing network. Deployed in the near shore zone (i.e., at 20-50 m contour lines) and near municipal water intakes, the network has improved water quality monitoring for water intakes and public beaches.
6) Information about any previous attempts to quantify the impact of this activity: None to date
7) Links or supporting info:
http://www.glerl.noaa.gov/res/Programs/climate_change/media/Science%20Presentations/Physical%20Environment/Anderson_Climate_Change_Workshop.pdf

3. The forecasts on sea level rise affects communities by identifying the best management practices for shoreline stabilization thereby helping communities to prepare for the long-term impacts of global warming, which results in the preservation of local economies and reduction in property damage.

2) Name of Program: National Centers for Coastal and Ocean Science (NCCOS)
3) Part of society impacted: Coastal Communities
4) Current level of funding - for the product, service or activity: ~ $120K/year
5) Detailed paragraph about the technical details of the story: NCCOS helps communities prepare for the long-term impacts of global warming by providing forecasts on sea level rise and research that identifies best management practices for shoreline stabilization. This information will result in more efficient and targeted planning that can help to preserve local economies and reduce damage to property. Context: NCCOS is on the forefront of research documenting and projecting changes to coastal ecosystems as a result of sea level rise, a byproduct of global climate change. As a part of these programs, NCCOS research is helping coastal managers better understand and evaluate the options available for adapting their coastal management policies. For example, research produced by NCCOS has helped coastal managers in North Carolina to better assess the ecological costs and benefits of employing different types of shoreline stabilization strategies, such as bulk heads versus oyster reefs. State and local governments have few resources to develop and implement climate change adaptation strategies. Therefore, the information produced by NCCOS can help them to target their management resources more strategically, focusing efforts on options that have the most ecological and social benefits, with the least costs.
6) Information about any previous attempts to quantify the impact of this activity: None to date
7) Links or supporting info:
NCCOS Marine Scientist Carolyn Currin on Shoreline Stabilization in Coastal North Carolina
http://coastalscience.noaa.gov/news/feature/carolyn_currin.aspx
Defense Coastal/Estuarine Research Program (DCERP) at the Marine Corps Base Camp Lejeune in North Carolina
https://dcerp.rti.org/
Sustainable Estuarine Shoreline Stabilization: Research, Education, and Public Policy in North Carolina
http://www.nccoastalreserve.net/Research/CICEET-grant/156.aspx

4. The coral reef watch affects coral reef users by providing coral reef managers around the world a warning system when satellite data indicates a likelihood that a local reef is subject to prime coral bleaching conditions which results in avoiding loss use value.

2) Name of Program: Office of Ocean and Coastal Resource Management (OCRM)
3) Part of society impacted: Coral Reef Users
4) Current level of funding - for the product, service or activity.: ~ $1 Mil
5) Detailed paragraph about the technical details of the story: NOAA's Coral Reef Watch (CRW) Satellite Bleaching Alert (SBA) system is an automated coral bleaching e-mail alert system designed to monitor the status of thermal stress conducive to coral bleaching via the use of the CRW global satellite near-real time HotSpot suite of products. The SBA was developed by the NOAA CRW satellite team as a tool for coral reef managers, scientists, and other interested people. The SBA became operational in July 2005. Currently, the alert messages are available for a number of coral reefs around the world (see the subscription page for a list of available reef sites). A sample of the SBA message can be viewed here. An automated e-mail will be sent to a subscriber for a reef site when the status level of thermal stress changes regardless of the current status level, or when the current Degree Heating Week value exceeds the historical maximum Degree Heating Week value for that reef site. The status level of thermal stress at selected reef sites is updated twice per week. There are five status levels: "No Stress", "Bleaching Watch","Bleaching Warning","Bleaching Alert Level 1" and "Bleaching Alert Level 2". The existence of a HotSpot value indicates that thermal stress potentially conducive to bleaching is present, and the value of the HotSpot quantifies the intensity of the thermal stress. A Degree Heating Week (DHW) is a measure of accumulated thermal stress over a consecutive 12-week period. Please note that since the DHW is a 12-week accumulated anomaly, it is possible for a location to have a non-zero DHW value when the HotSpot value is already less than one or even zero. Hence, at a status level of "No Stress" or "Bleaching Watch", it is possible for the corresponding DHW value to be greater than zero.
6) Information about any previous attempts to quantify the impact of this activity: None to date
7) Links or supporting info: http://coralreefwatch-satops.noaa.gov/SBA.html

5. The Harmful Algal Bloom Operational Forecast System affects aquaculture and recreation/tourism by accurately forecasting harmful algal blooms leading to only issuing closures when necessary.

2) Name of Program: Center for Operational Oceanographic Products and Services (CO-OPS)
3) Part of society impacted: Aquaculture and Recreation/Tourism
4) Current level of funding - for the product, service or activity.
5) Detailed paragraph about the technical details of the story: Advance warning of harmful algal blooms (HABs) increases the options for managing impacts resulting from these events. NOAA's Harmful Algal Bloom Operational Forecast System (HAB-OFS) provides information on the location, extent, and the potential for development or movement of harmful algal blooms in the Gulf of Mexico. The forecast system relies on satellite imagery, field observations, models, public health reports and buoy data to provide the large spatial scale and high frequency of observations required to assess and predict bloom conditions, location and movements.
6) Information about any previous attempts to quantify the impact of this activity: None to date
7) Links or supporting info: http://tidesandcurrents.noaa.gov/hab/

Oceans – Sea Grant Stories

Sea Grant Preserves Working Waterfronts and Coastal Access

Program Name: NOAA National Sea Grant College Program (NSGCP) Sustainable Coastal Development Focus Area

Societal Impact: Waterfront access is important for viability of commercial fishing activities, as well as preserving the culture of the community.

Estimated Current Annual Federal Funding Level: $1,500,000

The NOAA NSGCP affects working waterfront and waterway communities by conducting research to inform decision-makers which results in policies that enable communities to maintain their working waterfronts and waterways. For example, North Carolina Sea Grant, through its Coastal Resources Law, Planning and Policy Center, provided critical research information to the North Carolina Waterfront Access Study Committee. Ultimately, the North Carolina General Assembly approved several of the committee's recommendations, including change in the tax designation for working waterfronts and the establishment of a new state fund.

Michigan Sea Grant has played an integral role in developing and coordinating Detroit River revitalization projects that have changed the face of Michigan's largest urban area.The 32-mile Detroit River is one of the most significant natural resources in Southeast Michigan, providing drinking water to approximately five million people, supporting a major recreational fishery and serving as a vital commercial transportation route. Michigan Sea Grant partnered with several organizations to develop and co-chair the Downriver Linked Greenways Initiative—an effort to improve access to and use of the Detroit River waterfront. Now comprised of twenty-one communities located downriver from Detroit, this initiative has developed a network of water and shore-based trails. Initiative members directed municipal resources to updating and integrating master plans and modifying local ordinances in order to facilitate local, state, federal and private funds to extend the linked greenways an additional 5 miles in 2010. Under Sea Grant's leadership, the Downriver Linked Greenways Initiative is poised to see the system more than double from 37 to 88 miles, reconnecting 2.4 million citizens to the Detroit River waterfront and improving their quality of life. In addition, through efforts lead by Sea Grant and other partners, more than eight miles of riverfront have been transformed from urban-industrial to mixed use development, featuring pedestrian promenades and more than 18 riverfront greenways projects.

Evaluation: NOAA Sea Grant has not conducted additional impact evaluation of this activity beyond our planning, implementation, and evaluation system.

Sea Grant scientists collaborate with industry and managers to develop technology that benefits fishing Industry

Program Name: NOAA National Sea Grant College Program Safe and Sustainable Seafood Supply and Sustainable Coastal Development Focus Areas

Societal Impact: Washington Sea Grant collaborated with fishermen, federal managers, and conservationists to curb bycatch of endangered albatrosses and other seabirds in commercial fishing operations. This led to new NOAA Fisheries seabird bycatch regulations and circumvented potential lawsuits that might have shut down a $300 million fishery.

Estimated Current Annual Federal Funding Level: $150,000

The NOAA NSGCP affects the commercial fishing industry on the West Coast and internationally by engaging fishermen, federal managers, and conservation organizations to curb bycatch of endangered albatrosses and other seabirds which result in NOAA fisheries seabird bycatch regulations, circumventing potential lawsuits that might have shut down a $300 million fishery. The Sea Grant-developed seabird avoidance measures have drastically reduced seabird mortalities in Alaska longline fisheries. Sea Grant is working with regional partners (West Coast groundfish fishery) and international fishing fleets and managers in New Zealand, Australia, Uruguay, Argentina, Brazil and South Africa. Foreign fisheries agencies are beginning to change domestic and joint-venture regulations to limit seabird interactions.

Evaluation: NOAA Sea Grant has not conducted additional impact evaluation of this activity beyond our planning, implementation, and evaluation system.

Sea Grant benefits fishing communities by developing alternative marketing approaches

Program Name: NOAA National Sea Grant College Program Safe and Sustainable Seafood Supply Focus Area

Societal Impact: Sea Grant programs are working with fishers to help them sell directly to consumers.

Estimated Current Annual Federal Funding Level: $150,000

The NOAA NSGCP affects local fishers' revenue by working with them to establish Community Supported Fisheries (CSF) programs that allow fishers to sell directly to consumers. Modeled after community-supported agriculture, a CSF is a shore-side community of people collaborating with local fishermen to buy fish directly for a predetermined length of time. Sea Grant programs, including North Carolina, New Hampshire, Maryland, Maine, and MIT Sea Grant, have been at the forefront of this innovative direct-marketing movement. In New Hampshire, in 2009, fishers developed CSFs for shrimp and fish. The CSFs engaged more than 400 local shareholders, resulting in an additional sale of 12,000 pounds of shrimp valued at $20,000 and 21,000 pounds of fish filets valued at $17,000. Sea Grant is also helping ensure that fishers are included in local winter and summer farmer's markets by building partnerships between the agriculture and fishing industries.

Evaluation: NOAA Sea Grant has not conducted additional impact evaluation of this activity beyond our planning, implementation, and evaluation system.

Sea Grant Helping to Develop our Renewable Energy Resources

Program Name: NOAA National Sea Grant College Program Sustainable Coastal Development Focus Area

Societal Impact: The Nation needs new sources of renewable energy from the coastal and ocean environment, but that development must be economically and environmentally sound to gain acceptance

Estimated Current Annual Federal Funding Level: $750,000

The NOAA NSGCP affects the economy by funding the development of renewable energy projects from wave energy to wind power. Delaware Sea Grant has assessed public opinion of wind as an alternative energy. This work was catalytic in moving the state debate forward. Delaware has now approved a $1.6 billion project to develop a wind farm that will generate renewable energy for the area. In addition, Sea Grant-funded research to develop electrical power from ocean waves has initiated a national initiative. Sea Grant researchers and Extension agents worked closely with local fishermen and recreation industries, as well as other stakeholders in Oregon to identify possible test sites and discuss concerns. Community engagement was critical for support and identification of the first site in Newport, Oregon, an area that is now considered the leader in the Nation's wave energy potential. Additional outreach programs have expanded along Oregon's coast in order to engage coastal communities in ocean renewable energy planning.

Sea Grant is currently involved with offshore wind projects being proposed in Rhode Island, Maine, North Carolina, Delaware, New Hampshire, Michigan, as well as in Korea through international collaboration. For example, Michigan: Sea Grant-funded research focused on locating wind energy facilities using integrated assessments of Michigan's coastal counties. One study extended upon the use of brownfields as renewable energy sites with solar panels and wind turbines that would generate enough energy to support half of the homes in Michigan while creating a $15 billion investment and creating more than 17,500 long-term jobs. Continued research with support from Sea Grant will look into redevelopment of coastal brownfields.

Evaluation: NOAA Sea Grant has not conducted additional impact evaluation of this activity beyond our planning, implementation, and evaluation system.

Sea Grant prevents seafood-related illness and saves consumers millions of dollars

Program Name: NOAA National Sea Grant College Program Safe and Sustainable Seafood Supply Focus Area

Societal Impact: Since 2001, training courses led by Sea Grant extension and others with the National Seafood Hazard Analysis and Critical Control Point (HACCP) Alliance (an intergovernmental partnership with industry and academia) have trained about 90 percent of all nationally based seafood processing firms, plus over 10,000 international participants from 30 nations. Trainings have reached more than 5,000 U.S. processing plants and 14,000 employees and regulators since the mid-90's.

Estimated Current Annual Federal Funding Level: $750,000

The NOAA NSGCP and other partners affect seafood industry by developing and implementing the National Seafood Hazard Analysis and Critical Control Point (HACCP) program which results in training for >14,000 U.S. employees, from >5,000 processing plants (~90% of nationally-based firms), and >10,000 international participants, including regulators, since the mid-1990s [estimated lives saved and economic benefit not known]. Sea Grant programs around the nation provide standardized HACCP trainings that help businesses comply with FDA requirements and stay in operation. This protects consumers by ensuring that all domestic and imported seafood products are processed in the safest manner possible. This training has also been used to design or renovate seafood processing plants to optimize sanitation and efficiency.

Evaluation: NOAA Sea Grant has not conducted additional impact evaluation of this activity beyond our planning, implementation, and evaluation system.

Weather – NWS Stories

Specific and timely information provided by Advanced Hydrological Prediction Service (AHPS) and utilized by NWS IMETS increased the flood lead time and allowed local communities along the Red River to evacuate and prepare for the flooding through sandbagging, etc; ultimately saving lives during the Red River flood of 2009.

Program Name: Advanced Hydrological Prediction Service (AHPS)

Approximate current level funding:

AHPS is a web-based suite of river-forecast products providing new information on the magnitude and certainty of occurrence of floods or droughts, from hours to days and months before an event. These graphical products are useful information and planning tools for many economic and emergency managers. These new products will enable government agencies, private institutions, and individuals to make more informed decisions about risk based policies and actions to mitigate the dangers posed by floods and droughts.

AHPS objectives include: 1) Produce more accurate forecast information incorporating advanced hydrologic science in NWS models, 2) Provide more specific and timely information on fast-rising floods with increased lead time, 3) Create new formats, including graphics, for products that are easier to understand and use, 4) Create more information to assess the risk to flooding, including forecast probability, 5) Provide products with forecast horizons two weeks or further into the future, 6) Increase the distribution of products using advanced information technologies (such as web-based geographic information system (GIS) formats and the internet) to provide broader and more timely access and delivery of information, 7) Implement partnered flood forecast inundation mapping, and 8) Expand outreach and engage partners and customers in all aspects of hydrologic product improvement.

AHPS forecast products are a basis for operation and management of flood-control structures. Emergency management officials at local and state levels use these forecasts to fight floods, evacuate residents, and to take other measures to mitigate the impact of flooding. As the population grows, people increasingly choose to live near water, creating an increased need for the NWS to educate the public about flood hazards and to improve flood forecasts. These products can be used by a wide range of people, such as barge operators, power companies, recreational users, farmers, households, businesses, and environmentalists.

Previous valuation and social science research:

1) Economics of Water Resource Information: A Proposed Research Agenda for NOAA's Hydrology Program
   - Develop multiple ways to demonstrate the economic value of various water resource products and services
2) Potential Economic Value of Soil Moisture Data for Irrigation Management in the Central Great Plains
   - Demonstrate value of soil moisture forecast information for irrigation management
3) Ranch and Rangeland Management: Perspectives of the Rangeland Economy and its Relationship to Weather Information
   - Demonstrate value of soil moisture forecast information for rangeland management

4) The Value of In-stream Water Temperature Forecasts: An Application to Salmonid Management in the Pacific Northwest
   - Demonstrate potential economic value of water temperature forecasts; refine study to state results in a more applicable manner.
5) Evaluation of National Weather Service Flood Severity Categories and Use of Gage Station Flood History Information
   - Moved from one (Flood Stage) to three (Minor / Moderate / Major) flood categories
6) Cooperative Institute for Research in the Atmosphere at Colorado State University
   - Conducted several focus groups and constituent meetings to understand the hydrology customer base; Reviewed early probabilistic forecasts created for Advanced Hydrologic Prediction Service (AHPS); Helped design second generation of graphics based on social science methodology; Provided training modules to help explain the statistics used in AHPS probabilistic products; Provided insights into the use of NWS hydrologic products on the web. Advocated the NWS practice of providing a decision-making context for the information, rather than simply providing numbers.
7) Aptima Uncertainty Visualization Grant
   - Focusing on Emergency Managers, identified the sources/types of uncertainty related to predicting, communicating, and acting upon flood events, ways to factor uncertainty estimates into the decision-making processes of each community of interest to improve overall quality and efficiency of outcomes, and determined what each community of interest needs to know about the uncertainty that exists to assess potential risks and choose a course of action.
8) Aptima River Regulation Grant
   - The research program addressed the problem of accounting for river regulation activities using a method for predicting how different classes of water management agencies will react to a given set of current river conditions and forecasts. (River regulation (reservoir operations, river diversions for water supply and irrigation, returns, consumption sue, etc.) complicates the forecasting of streamflow for a number of reasons, such as availability of planned reservoir releases and water derivations, deviations from those plans when available, and the very complex problem of addressing water rights, especially in the Western United States.)

Link: http://water.weather.gov/ahps/

Longer hurricane warning lead times result in more efficient and effective evacuations resulting in the reduction of economic loss for local communities.

Program Name: Hurricane Forecast Improvement Project

Approximate current level funding:

HFIP provides the basis for NOAA and other agencies to coordinate hurricane research needed to significantly improve guidance for hurricane track, intensity, and storm surge forecasts. It also engages and aligns the inter-agency and larger scientific community efforts towards addressing the challenges posed to improve hurricane forecasts. The goals of the HFIP are to improve the accuracy and reliability of hurricane forecasts; to extend lead time for hurricane forecasts with increased certainty; and to increase confidence in hurricane forecasts. These efforts will require major investments in enhanced observational strategies, improved data assimilation, numerical model systems, and expanded forecast applications based on the high resolution and ensemble-based numerical prediction systems.

The specific goals of the HFIP are to reduce the average errors of hurricane track and intensity forecasts by 20% within five years and 50% in ten years with a forecast period out to 7 days. The benefits of HFIP will significantly improve NOAA's forecast services through improved hurricane forecast science and technology. Forecasts of higher accuracy and greater reliability (i.e., user confidence) are expected to lead to improved public response, including savings of life and property.

There have been a number of socio-economic studies with regard to HFIP, but no real coordination of the studies or coordinated effort to take the research into operations. A HFIP Socio-economic Team has been organized with a first meeting set for the June 27/28, 2011 timeframe.

Previous valuation studies:

1) Hurricane Forecast Improvement Project (HFIP) and economic valuation (Dan Sutter, University of Texas Pan American and Bradley Ewing, Texas Tech University).
    - Specify the current knowledge of the economic value of NOAA's tropical cyclone forecasts and warnings, including the value of potential improvement in these services.
    - Develop a research plan to address knowledge gaps
2) Five (5) NOAA-NSF Funded Projects:
    - Communicating Forecast Information to Optimize Evacuation Decisions (P. Mozumder, FIU, H. Gladwin, FIU, H.E. Willoughby, FIU, B. Norcross, America's Emergency Network)
        - Better evacuation decisions due to products that better communicate uncertainty.
    - Collaborative Research: Communicating Hurricane Information to Local Officials for Protective Action Decision Making (M. Lindell, Texas A&M, C. Prater, TAMU)
        - Products that provide the local emergency community with information they can comprehend and use in decision-making.
    - Dynamics of Hurricane Risk Perception (C. Trumbo, L. Peek, W. Schubert, B. McNoldy, CSU, E. Gruntfest, UC Colorado Springs)
        - Greater understanding in how individuals view risk and shape decision-making.
    - Understanding Dynamic Responses to Hurricane Warnings – Implications for Communication and Research (Univ. of Miami, S. Chen, UM, R. Meyer, UM. B. Orlove, UC Davis)

        - Target communication of hurricane info through most effective media outlet.
    - Examining the Hurricane Warning System: Content, Channels, and Comprehension (NCAR in collaboration with Jamie Rhome (NHC), Mark DeMaria (NESDIS), & Gene Hafele (MIC at Houston/Galveston WFO)
        - Products that targets users' need & effectively conveys risk & uncertainty.
3) Economic Value of Improved Hurricane Warnings (FIU, Michael Thomas & David Letson)\
    - Greater understanding in how individuals view risk and shape decision-making.
4) Household Evacuation Decision Making and the Benefits of Improved Hurricane Forecasting: Developing a Framework for Assessment (NCAR and NOAA.)
    - Better evacuation decisions due to products that better communicate uncertainty.
5) Hurricane Forecast Improvement Project (HFIP) Socio-Economic Impacts Assessment (NCAR in collaboration with HFIP.)
    - Better understanding of risk and impacts. Products that translate weather information into to impact-based actionable decision support.
6) Investigation of the Hurricane Katrina Case in New Orleans: National Weather Service Environmental Risk Communications Across Cultures (NOAA Graduate Scientist - NOAA Office of Education)
    - Development of a model to be used by NWS to develop a training module for forecasters on communicating risk across cultures.
7) Assessing Current Storm Surge Information from the Public Perspective (Phase 1 & 2) (NCAR in collaboration with NOS Coastal Service Center, and NWS OCWWS.)
    - Development of new storm surge informational approaches to improve communication and decision-making.
8) Warning Decisions in Extreme Weather Events: An Integrated Multi-Method Approach (NCAR in collaboration with Larry Mooney (Retired MIC, Denver/Boulder WFO)
    - Lead to improved warning dissemination processes.
9) Economic Value of Improved Hurricane Warnings (FIU, Michael Thomas & David Letson)
    - Greater understanding in how individuals view risk and shape decision-making.

10) Socio-Economic Impacts of Hurricanes (FIU/HMA, Pallab Mozumder)
    - Greater understanding in how individuals view risk and shape decision-making.

11) The Economic Cost of Evacuations: Tampa Bay Region Pilot Study (FIU/HMA, Dario Moreno)
    - Greater understanding in how individuals view risk and shape decision-making.
12) Dynamically Modeling Hurricane Evacuation Decisions (FIU, Jeffrey Czajkowski)
13) Socio-Economic Evaluation of Hurricane Evacuation Response (Wally Milon)
14) Direct and Indirect Mortality Associated with Tropical Cyclones (UWF/HMA, Klaus Meyer-Ardent)

Link: http://www.hfip.org/

NextGen 4-D Weather Data Cube could reduce weather delays by 46 percent and save up to $19 billion annually.

Program Name: Next Generation Air Transportation System (NextGen) Weather Program

Approximate current level funding:

The NextGen Weather Program serves as the focal point for NOAA's role in the multi-agency Next Generation Air Transportation System (NextGen) and is the lead for NOAA's development of the NextGen 4-D Weather Data Cube services. The NextGen 4-D Weather Data Cube will improve access and availability of observed and forecast weather information and enable its integration into an automated, multi-agency air traffic management system.

NOAA NextGen investments will result in a significant increase in weather prediction and dissemination capabilities with wide-ranging benefits across NOAA. The weather information in the NextGen 4-D Weather Data Cube will enhance decision-support systems by offering consistent information at high spatial and temporal resolutions. While the NextGen 4-D Weather Data Cube will be applied initially in the aviation industry, it has the potential to yield benefits to all federal and commercial sectors that require environmental information. NOAA, other governmental agencies, private industry, and the public will have more effective and efficient access to more accurate, consistent, and timely weather information to drive their decision-making systems and processes.

The air transportation industry is an important element of the U.S. economy, and weather impacts to the National Airspace System result in significant economic losses. The industry generates 5.4 percent of America's Gross Domestic Product, $640 billion in revenue and over 11 million jobs. The Congressional Joint Economic Committee estimates that air traffic delays cost the U.S. economy over $41 billion in 2007, of which 70 percent are related to adverse weather. The FAA has determined that two-thirds of these weather delays are avoidable with more accurate and better integrated weather information into decision-making, potentially reducing the number of delays by 46 percent and saving $19 billion annually.

NOAA needs assistance in ensuring weather information is appropriately integrated into NAS decisions by providing expert advice to FAA in the communication of weather information and its impact on air traffic management decisions. NOAA intends to utilize social science principles to ensure aviation products, services, and information, with appropriate expressions of uncertainty, are effectively communicated to decision makers.

Previous valuation studies:

Link:

http://www.weather.gov/nextgen/

http://www.faa.gov/nextgen/

Advanced notice of a geomagnetic storm provides power grid operators time to transfer load or take preventative measures, minimizing the risk of damage to the power grid and critical infrastructure.

Program Name: Space Weather Prediction Center (SWPC)
Approximate current level funding:
SWPC provides real-time monitoring and forecasting of solar and geophysical events, conducts research in solar-terrestrial physics, and develops techniques for forecasting solar and geophysical disturbances.
SWPC provides services to a broad user community of government agencies, industries, public institutions, and private individuals. These users are involved in satellite operation, space exploration, satellite navigation, high-altitude polar flights, high-frequency communications, remote intelligence gathering, long-line power and data transmissions, and geophysical exploration. SWPC serves many government, industry and private-sector clients, and such end-product users as the power industry, the airline industry, satellite operators, and the National Aeronautics and Space Administration (NASA).
Without timely and accurate alerts and warnings, space weather has the demonstrated potential to disrupt virtually every major public infrastructure system, including transportation systems, power grids, telecommunications, and global positioning systems (GPS). Our national security and economic wellbeing that are now dependent on our advanced technologies are in danger without accurate 1-4 day advanced warnings of impending geomagnetic storms. According to a recent report by the National
Academies, storm-disabled electric power grids and collateral impacts could result in projected economic and societal costs of approximately $1 to $2 trillion, and full recovery could take 4-10 years (note that the power grid industry is still debating the economic and societal impact). Precision GPS-enhanced agriculture is an $8 billion per year enterprise, and the Next Generation Air Transportation System is based entirely on GPS-enabled positioning, navigation and timing. Aircraft flying polar routes now include space weather as an integral part of the weather pre-brief, providing the pilot a big-picture view of the flight environment, including potential impacts to critical communication and navigation systems, and the potential for hazardous solar radiation exposure. Strong storms with the potential to impact critical elements of our Nation's infrastructure can occur over 100 times during a solar cycle. The Nation's advanced technology service providers will be looking to NOAA for alerts, watches and warnings needed to protect lives and livelihood and ensure continuity of critical operations.

Previous valuation studies:

9) "An Estimate of the Value of Geomagnetic Storm Forecasts," by Rodney F. Weiher and Thomas J. Teisberg.
   - Use of good forecasts by the power industry could save the US $365 M per year, averaged over the solar cycle.
10) "On the Vulnerability of Electric Power to Geomagnetic Storms," Oak Ridge National Laboratory, Oak Ridge, Tennessee, 1990.
   - Electric power outage could result in a direct loss to US Gross Domestic Product of $3 - $6 billion

Link: http://www.swpc.noaa.gov/

As a result of the quick detection of the Japanese tsunami, NOAA's Pacific Tsunami Warning Center issued tsunami warnings for Japan, Russia, Marcus Island, and Northern Marianas Islands. Further, NOAA's West Coast/Alaska Tsunami Warning Center issued tsunami information statements assessing potential threat for Alaska, British Columbia, Washington, Oregon and California.

Program Name: National Tsunami Hazard Mitigation Program (NTHMP) and TsunamiReady Program

Approximate current annual funding:

The NTHMP is designed to reduce the impact of tsunamis through hazard assessment, warning guidance, and mitigation. Primary goals of NTHMP are to: 1) raise awareness of the affected population; 2) develop integrated tsunami maps and models that can be used to develop improved warning guidance and evacuation maps; 3) improve tsunami warning systems; 4) incorporate tsunami planning into state and federal multi-hazard programs. Because tsunami mitigation is applicable beyond tsunamis and is integral to the nation's overall effort to reduce coastal losses and improve resilience, the mitigation capability takes a multi-hazards physical, commercial and ecological approach that responds to socio-economic and disaster management priorities.

Schools, playgrounds, hospitals, factories and homes are often built in areas vulnerable to tsunamis. The TsunamiReady Program, developed by NWS, is designed to help cities, towns, counties, universities and other large sites in coastal areas reduce the potential for disastrous tsunami-related consequences. TsunamiReady has helped community leaders and emergency managers strengthen their local operations. TsunamiReady communities are better prepared to save lives through better planning, education and awareness. Communities have fewer fatalities and property damage if they plan before a tsunami arrives. No community is tsunami proof, but TsunamiReady can help minimize loss to your community.

Current Social Science Research:

1) Tsunami Social Science Project: (East Tennessee State University, PI - Dr. Chris Gregg (et al)).

    - Purpose: 1) Improve Tsunami Warning Center (TWC) products, including warnings, advisories, watches, and information statements, 2) Evaluate the TsunamiReady Program Improvement, and 3) Assess previous and on-going tsunami-related social science studies including regional, state, and local efforts, to determine how to best integrate such information at the national level.

2) NTHMP Tsunami Planning and Hazard Mitigation Survey (Survey was co-authored by Drs. James Goltz (CALTech) and Walter Diaz (University of Puerto Rico-Mayaguez); Implementation contract awarded to Strategic Research Group, PI - Dr. Kristen Heimdal).

    - Survey targets all local coastal EMs to assess their communities' current capabilities with regard to tsunami hazard mitigation, preparedness, planning, and TsunamiReady implementation.

Links:

NTHMP: http://nthmp.tsunami.gov/about_program.html

TsunamiReady Program: http://www.tsunamiready.noaa.gov/

Weather – OAR Stories

The improvement of meteorological models supporting aviation within the Next Generation Air Transportation System (NextGen) affects airline transportation by providing improved short-term aviation weather predictions at terminals and along flight paths. This results in more efficient routing and scheduling of flights, increased airport safety, and fewer cancellations and delays all of which will protect lives and save significant money for the airlines and the fliers.

Program Name: Meteorological Models in Support of NextGen

Approximate current level of annual funding for research support: $1.6M

Next Generation Air Transportation System (NextGen) is a U.S. Congressionally-mandated initiative outlined in public law in 2003 to modernize the U.S. Air Transportation System in order to increase capacity and reliability, improve safety and security, and minimize the environmental impact of aviation. With the expectation that the updated GPS-based control system will allow more accurate and automated location capability for aircraft, planes can be more densely distributed, and landings and takeoffs can be more frequent than today. This expected high space and time density of operation will require more accurate and timely weather information and forecasts enroute and at airports.

Therefore, the NextGen weather vision is focused on:

• A multiple user common weather picture
• Consistent and reliable weather information
• Improved weather information and data management approach
•More accurate and increased temporal and spatial weather predictive information

The goals of the research supporting this vision include the development of high spatial and time resolution forecasts in the vicinity of airports using state-of-the-art observations and immediate dissemination of weather information to the controllers and pilots. Currently, very short term forecasts of severe weather such as tornadoes are simply based on extrapolation of current observations with no atmospheric physics included. This can lead to large errors in forecasted storm intensity and location, higher risk for aircraft, and inefficient terminal operations due to the need to account for uncertainties in the forecasts. To reach the research goals, NOAA research must continue to improve weather radar capabilities with the eventual goal of replacing current scanning radars with fixed-antenna phase array radars that are capable of much faster data ingest. Speed is very important during severe weather events. Short-term forecasts (from minutes to a few hours - the time period most critical for aviation) of high-impact weather such as thunderstorms, high winds, hail, lightning, and tornadoes require forecast models that ingest huge amounts of data, including radar data, in a very short period of time using minimal computer time to provide forecast guidance updated every few minutes over very small spatial scales. This short time frame also places a burden on the intelligent display of the data that support decisions by pilots and air traffic controllers. The displays must be available quickly and must be quick and easy to interpret for fast decisions. Obviously, a high level of accuracy is also required.

The air transportation industry is an important element of the U.S. economy, and weather impacts to the National Airspace System result in significant economic losses. The industry generates 5.4 percent of America's Gross Domestic Product, $640 billion in revenue and over

11 million jobs. The Congressional Joint Economic Committee estimates that air traffic delays cost the U.S. economy over $41 billion in 2007, of which 70 percent are related to adverse weather. The FAA has determined that two-thirds of these weather delays are avoidable with more accurate and better integrated weather information into decision-making, potentially reducing the number of delays by 46 percent and saving $19 billion annually.

Link: http://www.weather.gov/nextgen/

The Extended Continental Shelf Program affects the natural resource industry and the public interest by improving our understanding of the Nation's potential seafloor and natural resource ownership. As a result, the US Government and industries will be able to discover and extract new sources of minerals and petroleum products, providing significant economic value to the country.

Program Name: **Extended Continental Shelf Program**

Approximate current level of annual funding for research support: $7.46M (total Federal); $3.4 (NOAA/OER)

Defining the extended continental shelf (ECS) is likely to be the most important land expansion of the United States in the 21st century, with the potential to add at least one million square kilometers of seafloor for U.S. sovereign rights. It rivals the addition of the Exclusive Economic Zone in terms of its importance to governance and sovereign land rights as well as the profound implications to various industry sectors. NOAA is in the process of collecting relevant ECS data as part of an interagency task force whose goal is to uncover facts that could confirm, enhance or even significantly alter accepted knowledge about our maritime boundaries. Since 2007, NOAA has devoted funding annually to the ECS effort.

The U.S. Interagency ECS Project is the largest and potentially most significant interagency marine survey ever undertaken by the United States. The NOAA *Office of Ocean Exploration and Research (OER)* is leading the nation's acquisition and analysis of bathymetric data that has the potential to vastly extend the ECS beyond the present 200 nautical mile limit. More than 1.6 million square kilometers of the continental shelf and slope (0.4% of the ocean) have been bathymetrically mapped thus far in this effort. During the period of 2011-2017, the OER will carry out a series of Ocean and Coastal Mapping (OCM) surveys in the Arctic and other regions in partnership with Arctic and non-Arctic countries to describe and define the seafloor characteristics, organize a workshop to establish the methodology to define outer limits, and develop standard metadata and vocabularies for ECS cruises. The outputs of these activities are, respectively, partnerships and formal bilateral arrangements with relevant countries for sea ice, safe navigation and ecosystem research, U.S. ECS outer limits defined consistently with the international law, and standard and proven useful ECS information. These activities lead to the outcomes and evidences of progress towards the NOAA NGSP Resilient Coastal Communities and Economies Goal and Holistic Understanding Science and Technology Enterprise Objective.

The economic benefits from this project compare with those from the Louisiana Purchase, the Truman Proclamation, and the purchase of Alaska. The extent of the U.S. ECS is predicted to be equivalent in size to about twice that of California, or half the Louisiana Purchase. The natural resources, including mineral resources, petroleum and "sedentary" species, on and under the seafloor over which we would have sovereign rights are estimated to be worth about $1.2 trillion. While the United States is not party to the UN Law of the Sea Convention (UNCLOS), accession to UNCLOS has been a stated priority for the previous and current U.S. administrations since the 1990s. It is in the U.S. national interest to collect accurate and precise data on the outer limits of its continental shelf in preparation for an eventual submission to the UNCLOS Commission on the Limits of the Continental Shelf within the mandated 10 year time frame. Unexpected delays in the ECS data collection may lead to postponed access to additional seafloor natural resources of economic value and hence potential economic losses.

The U.S., like other countries, has an inherent interest in knowing, and declaring to others, the exact extent of our continental shelf extensions. The ECS delineation effort is critical whether or not the U.S. accedes to UNCLOS – for the purpose of discovering, protecting, using and managing its natural resources—including those resources on the seabed (such as deep-water coral communities or mineral crusts and nodules) and beneath the seabed.

Links: http://explore.noaa.gov/special-projects/ecs-initiative/view
http://continentalshelf.gov/

Integrating knowledge from biological, physical, chemical, and social science research, the nascent Gulf of Mexico (GoM) Research and Monitoring Program affects coastal managers, commercial and recreational fisheries, recreational users, and the general public by providing a synoptic view of the GoM ecosystem in order to support effective, efficient, and timely responses to anthropogenic perturbations.

Program name: **Improved Understanding of Gulf of Mexico Ecosystem Dynamics through Research**

Approximate annual funding: GoM exploration $10M; Water Quality $1.5M; Social Science/Extension $4.5M

As the Nation's agency for ocean and atmospheric sciences, NOAA has a major responsibility in the rehabilitation and continued sustainability of GoM ecosystem services and their intrinsic cultural, natural, and economic resources. NOAA's contributions to research in the Gulf of Mexico are comprehensive and reflective of the challenges affecting this large marine ecosystem (LME): severe weather, nutrient pollution, fisheries resilience, aquaculture, deep sea exploration, coastal restoration, offshore energy, marine mammals, sea level change, wetland subsidence, and coastal development. Here, we focus on OAR's contributions to deep-sea and benthic habitat exploration, water quality, and social science for valuation purposes.

Biological and chemical oceanographic research aims to assess the status of, and to develop predictive capabilities for, GoM LME water quality, resulting in improved understanding of the connections between terrestrial, coastal, and marine ecosystems. Excess nutrient pollution from terrestrial sources upsets the delicate balance between provisioning, regulating, supporting, and cultural ecosystem services. For example, these nutrients support blooms of algae and microorganisms that promote the growth of hypoxic conditions in some areas[1], and in other areas may detrimental to pelagic and benthic food webs thereby affecting economically and ecologically important fisheries, water quality, beach usage, and ultimately, ecosystem health[2]. OAR scientists collect physical oceanographic observations, conduct nutrient and microbiological load assays, and develop oceanographic models to inform resource managers about the relative impact of land-based sources of pollutants entering the coastal zone and affecting open ocean ecosystems. The knowledge gained from research in these areas underpins our ability to restore coastal waterways and wetlands, manage living marine resources sustainably, and inform coastal management decisions. Outputs include peer-reviewed and technical publications, models informing ecological forecasts, observations, and input into decision-making frameworks such as integrated ecosystem assessments that will be tied to efforts in coastal and marine spatial planning.

OAR's National Sea Grant College Program is heavily invested in social science research and the human dimensions of natural resource management in the GoM through our university-based partners in the Texas, Louisiana, Mississippi-Alabama, and Florida Sea Grant Programs. In 2010, these partnerships invested $4.5M in extension, education and communications efforts addressing critical socioeconomic needs in GoM coastal communities. Specific examples of the critical role Sea Grant plays in social science work in the Gulf include investing $600K in the 2008 development of the GoM Regional Research Plan[3], which brought together regionally-focused scientists and stakeholders to highlight critical needs. This plan was amended in 2010 to account for the Deepwater Horizon (DWH) oil disaster. GoM Sea Grant Programs invested approximately $800K and countless personnel hours in response to DWH. They hosted 60+ listening sessions throughout the affected region, executed numerous oil-related research projects, and ensured that knowledge gained was shared with policy and management decision-makers. GoM Sea Grant Programs invest $1M annually in legal research; FL, MS-AL, and LA host legal programs, and the National Sea Grant Law Center is at the University of Southern Mississippi[4]. This legal network contributes to the field of ocean and coastal law and policy through research on marine laws and policies, coordinating ocean and coastal law researchers, and disseminating information to coastal and ocean policy-makers. In 2012, GoM Sea Grant Programs intend to fund over $2M in social science research and technology/information transfer, targeting readiness for coastal storms, ecosystem services valuation, and sea-level rise.

[1] http://www.glerl.noaa.gov/res/region/us/south.html
[2] http://www.aoml.noaa.gov/phod/sfp/
[3] http://gulfseagrant.tamu.edu/
[4] http://www.seagrant.noaa.gov/resources/resources.html

Prior to the GoM DWH oil disaster, OAR's Office of Ocean Exploration and Research (OER) and the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE, formerly the Minerals Management Service) initiated a partnership to jointly explore and characterize deepwater habitats in the GoM[5]. This interagency venture provides essential information on the ecology and biodiversity of these benthic communities to regulatory agencies and energy companies. The value of this investment was recognized by winning the 2006 and 2007 Department of Interior's Cooperative Conservation Awards and the 2006 National Oceanographic Partnership Program Excellence in Partnership Award. Information from more than 15 expeditions since 2001 provides perhaps the biggest source of pre-DWH ecosystem information of GoM deepwater benthic habitats. This foundation of baseline information is incredibly valuable to scientists trying to measure potential change resulting from DWH.

[5] http://www.whoi.edu/oceanus/viewArticle.do?id=99049&sectionid=1000
http://oceanexplorer.noaa.gov/explorations/06mexico/background/oil/oil.html

The research performed within the NOAA Hurricane Forecast Improvement Project (HFIP) affects emergency managers and coastal residents by providing more accurate forecasts of hurricane track and intensity with longer lead times which result in more efficient, effective and fewer unnecessary evacuations and other preparations leading to the savings of lives and financial loss. The improvements in the forecasts of hurricanes themselves will in turn improve the accuracy and timeliness of hurricane storm surge forecasts.

Program Name: **Research in Support of the Hurricane Forecast Improvement Project**

Approximate current level of annual funding for research support: $6M

Begun in 2008, the goals of the HFIP are to improve the accuracy and reliability of hurricane forecasts; to extend lead time for hurricane forecasts with increased certainty; and to increase confidence in hurricane forecasts. These efforts require major investments in enhanced observational strategies, improved data assimilation, numerical model systems, and expanded forecast applications based on the high resolution and ensemble-based numerical prediction systems. It is important to note that hurricane research directed toward improving forecasts has been occurring in NOAA for several decades and capacity to perform such research has been gradually increasing during this time. After Hurricane Katrina, the President and Congress concluded that the progress in improving hurricane forecasts over these decades has been too slow. HFIP provides funding for accelerating progress through increased investment in observational capacity, IT, and scientists. Under HFIP, NOAA OAR closely collaborates with NSF, NASA, the Navy, and the National Center for Atmospheric Research (a non-profit research organization), leveraging observational assets such as aircraft and satellites, as well as computing resources and modeling expertise. The research consists of annual field observing and forecast model testing campaigns during hurricane season. Between hurricane seasons, extensive data analysis is performed to better understand the dynamics of hurricane formation and intensity variations. These analyses annually improve hurricane forecast models through better physical parameterization of hurricanes and improved observational data assimilation. This work improves decision support systems for forecasters and the communication of hurricane information to emergency managers and the public, improvements subsequently tested during the hurricane season. The specific goals of the HFIP are to reduce the average errors of hurricane track and intensity forecasts by 20% within five years and 50% in ten years with a forecast period out to 7 days. The benefits of HFIP will significantly improve NOAA's forecast services through improved hurricane forecast science and technology. Forecasts of higher accuracy and greater reliability (i.e., user confidence) are expected to lead to improved public response, including savings of life and property.

Previous valuation studies:
Value of improved hurricane forecasts by Jeff Lazo (lead), NCAR/Societal Impacts Program: Non-market valuation, cost ~$200K, household willingness to pay (per yr): Forecast time accuracy improvement from 6 to 8 hrs: $4.10. 5 miles/hr improved accuracy in wind speed: $1.50. 20 mi improvement in landfall location: $5.40. 2 ft improved accuracy in storm surge ht.: $3.80.
Lazo, J.K., D.M. Waldman, B.H. Morrow, and J.A. Thacher. forthcoming. “Assessment of Household Evacuation Decision Making and the Benefits of Improved Hurricane Forecasting.” *Weather and Forecasting*.
Link: http://www.hfip.org/

NOAA Pacific Marine Environmental Laboratory's tsunami forecasting model development and monitoring program affects emergency managers and other decision-making officials by providing accurate tsunami coastal flooding guidance and more timely and precise warning, which results in lives and property saved.

Program Name: **Tsunami Forecasting Research**

Approximate current annual funding: $6M (combined OAR and NWS funding)

Emergency managers and other officials are in urgent need of operational tools that will provide accurate tsunami forecasts as guidance for rapid, critical decisions in which lives and property are at stake. Timely and precise warnings promote effective, efficient, and targeted actions by local emergency managers, which save lives and property. The Center for Tsunami Research at PMEL develops methods and tools to mitigate tsunami impacts and protect life through research and development. They focus on tsunami measurement technology improvements, increased speed and accuracy of operational forecasts and warnings through model outputs, and methods and tools to predict tsunami impacts on coastal communities. The tsunami forecasting technology developed at PMEL is based on the integration of real-time measurements and modeling technologies, a well-tested approach used in most hazard forecast systems.

The Deep-ocean Assessment and Reporting of Tsunamis (DART) real-time tsunami monitoring systems, developed by PMEL, are positioned at strategic locations throughout the ocean and plays a critical role in tsunami forecasting. When tsunami waves reach the DART systems, these systems report sea level information measurements back to the Tsunami Warning Centers, where the information is processed to produce a refined estimate of the tsunami source, height, speed, and potential impacts. As more information is collected about a tsunami wave the accuracy of forecasts improve and the Warning Centers issue watches, warnings, or evacuations as needed.

PMEL has been working to develop the forecast models for 75 U.S. coastal communities in support of a tsunami forecast system since shortly after the 2004 Sumatra tsunami. This development is progressing with the concurrence and partnership of NWS and models are transitioned to NWS Tsunami Warning Centers after they have been completed, tested, and documented. Model development began in 2005 and PMEL will complete the initial 75 models by the end of 2012, when funding provided for this development expires. Individual community forecast models are based on the Method of Splitting Tsunami (MOST) numerical model. The effectiveness of this model in forecasting tsunami impact has been demonstrated through applications to over 15 tsunami events, including the recent tsunamis generated by earthquakes near American Samoa, Chile, and Honshu, Japan earthquake on March 11, 2011. The tsunami model development program improves the efficiency of operational forecasting services and provides localized hazard assessments for land managers. The models provide important input to community leaders as they make land-use decisions by providing guidance on where flooding is expected in the event of a tsunami. The forecasting models are also valuable tools for designing tsunami evacuation routes and increasing public awareness of tsunami hazards.

Links: http://nctr.pmel.noaa.gov/index.html

Metrics, Methods and Costs Examples

	Study/Metric	LO	Method	Cost	FTE	Contact
1	Socio-economic study of GOES and potential GOES-R data	NESDIS	Value of Information	$224K		Adam Smith
	Mitigation of Storm Damage Value					
	Mitigatin of Aviation delays					
	Savings in energy sector from more accurate energy demand					
	Saving from accurate water demand for crop irrigation					
2	Assessing the Value of Climate Information in Agriculture	NWS		$133K		Jen Sprague
	Economic Value of Climate Information		Stochastic Production Frontier			
3	Potential Economic Value of Soil Moisture Data for Irrigation Management	NWS		$40K		Jen Sprague
	Increased agricultural efficiency		Cost savings and increased production			
4	Restoration benefit estimates for Huntington Beach and Lincoln Park projects	NMFS		$291K		Peter Edwards
	Sales, Employment, Income		Regional Economic Impact Analysis			
	Economic Value (Recreation and other Ecosystem Services)		Unit Value Benefit Transfer			
5	Elwha River Floodplain restoration ecosystem services valuation	NMFS		$660K		Peter Edwards
	Economic Benefits of Ecosystem Services due to Wetlands Restoration		Contingent Choice			
6	Protected Species Research and Management- Environmental Consultation and Stock Assessments	NMFS		$150K (per species)		Rita Curtis
	Values for recovering threatened and endangered species					
7	Fisheries Rebuilding Programs	NMFS		$125K		Rita Curtis
	Ex Vessel Value, sales, employment		Economic Impact			
8	Estimating the impacts of complex climatic events: the economic costs of drought in Colorado, Nebraska and New Mexico	Climate		$300K		Nancy Beller-Sims
	Production and income		Economic impact			
9	Economic Value of Selected NOAA Products within the Railroad Sector	Climate		$50K	3-4	Adam Smith
	Cost Benefit Ratio		Alternative Cost Approach, Cost Benefit Analysis			
10	Investigating the Economic Value of Selected NESDIS products	Climate		$104K	3-4	Adam Smith
	Cost Benefit Ratio		Alternative Cost Approach, Cost Benefit Analysis			
11	Economic Value of Physical Oceanographic Real Time System (PORTS)	NOS		$30K	1	Wiley
	Increased productivity		Value of Information			
12	Economic Value of Navigation related products and services	NOS		$130K	3	Wiley
	Increased capacity of waterborne freight system		Value of Information			
	Avoided cost due to delays, groundings and spills					
13	Impact of weather variability on US GDP	OAR		$150K		Gaynor
	GDP		econmetric modeling using historical weather / economic data			
14	Assessing validity of Storm Data damage data	OAR		$5K		Gaynor
	Storm Damage		survey of the Warning Coordination Meteorologist in the weather forecast offices			