

# **The Role of Coastal Zone Management Programs in Adaptation to Climate Change**

Second Annual Report of the Coastal States Organization's  
Climate Change Work Group

September, 2008



# **The Role of Coastal Zone Management Programs in Adaptation to Climate Change**

## *Synthesis Report from the CSO Climate Change Work Group*

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## **EXECUTIVE SUMMARY**

The Coastal States Organization's (CSO) Climate Change Work Group prepared this second annual report to further explore the current and future roles of state coastal zone management programs in addressing climate change. The accomplishments of the work group this year include the following:

- Testimony before Congressional committees, federal agencies and other coastal conferences to inform these groups of the role of state coastal zone management programs in addressing climate change;
- Completion of a survey to further delineate not only the unmet needs of coastal states in regard to climate change planning and data, but an attempt to quantify the cost of those unmet needs;
- Providing an information exchange among coastal states and territories; and
- Working to identify the various coastal groups working on climate change initiatives to reduce redundancy.

The Final Report of the 2007 CSO Climate Change Work Group remains the most comprehensive assessment of the various states' coastal program's climate change initiatives as well as the statement of national policy needs. The 2007 report is attached as Appendix B to this 2008 report.

## **PURPOSE OF 2008 SURVEY**

### **Background**

The Coastal States Organization (CSO) Climate Change Work Group developed this climate change adaptation survey in order to obtain up to date information on the status of adaptation planning, priority information needs, and the anticipated resource needs of the coastal states, commonwealths, and territories. The results of this survey will be used to help inform members of Congress, federal agencies, and others about the status, anticipated costs, and needs of the coastal states, commonwealths, and territories that will have to address the impacts of climate change at the local community level.

### **Survey**

This survey was designed with input and direction of the CSO Climate Change Work Group and with the use of an online survey tool. Survey Monkey ([www.surveymonkey.com](http://www.surveymonkey.com)) allowed the user to design, collect and analyze survey information online.

The primary purpose for this survey was to obtain as much information as possible from these coastal states, commonwealths, and territories on their collective planning strategies and resource needs regarding sea level rise and lake level changes. The finished design of the survey had 29 questions based on a closed ended survey format consisting of multiple choice questions, categorical questions and Likert scale style questions. Space was provided to allow participants to comment as they deemed necessary.

This survey was sent to the 35 coastal states, commonwealths, and territories of the United States. Of the 35 states, 30 partially or fully completed the survey. 79% (27) fully completed the survey online at the time of this summary (September, 2008). Some states, commonwealths, and territories had more than one survey submission, and in those instances an average of the response was used to provide one entry for each state, commonwealth, or territory. A list of submitters of the 27 fully completed surveys is attached as Appendix A.

DETAILED RESULTS OF THE CSO CLIMATE CHANGE WORK  
GROUP'S 2008 ADAPTATION SURVEY



## **QUESTIONS, ANSWERS & RESPONSE SUMMARY**

All participants were asked to provide name and the name of their respective coastal state, commonwealth or territory and the capacity at which they represent those places (questions one and two).

The following summarizes the responses received for each question.

### **3. What source of data or data interpretation is your state or territory using for sea level rise predictions? IPCC, NOAA, EPA, USGS, Academia, Other?**

<b>Types</b>	<b>States</b>	<b>Percent</b>
IPCC	20	74.07%
Academia	15	55.56%
NOAA	12	44.44%
Other	11	40.74%
USGS	9	33.33%
EPA	6	22.22%

Participating coastal states, commonwealths and territories choose the IPCC (Intergovernmental Panel on Climate Change) as their main source for data on sea level rise predictions. Academia, NOAA and Other sources follow with USGS and EPA being used least. Comments provided consist mainly that not only one source is ever used, rather numerous sources are used by respondents' from the scientific community (agencies, literature, research). Percentages do not add up to 100%, due to the multiple answers for sea level rise predictions given by some states, commonwealths, and territories.

### **4. What rate of sea level rise or lake level change do you find appropriate as planning scenarios for your state, commonwealth or territory?**

<b>Sea Level Rise per year</b>	<b>States</b>	<b>Percent</b>
1-3 mm/year (approx. 0.3 - 1.0 feet/century)	2	9.09%
3-6 mm/year (approx. 1.0 - 2.0 feet/century)	7	31.82%
6-9 mm/year (approx. 2.0 - 3.0 feet/century)	7	31.82%
9-12 mm/year (approx. 3.0 - 4.0 feet/century)	4	18.18%
12-15 mm/year (approx. 4.0 - 5.0 feet/century)	2	9.09%
> 12 mm/year (greater than 5.0 feet/century)	3	13.64%

Approximately 72% of the coastal states, commonwealths and territories find appropriate sea level rise predictions to between 3 and 12 mm per year. Comments made center around the notion that current predictions being made are not appropriate and are, if anything, too low. Many states have yet to determine an appropriate sea level rise rate (SLR) for planning purposes. Percentages do not add up to 100%, due to the multiple answers for SLR predictions given by some states, commonwealths, and territories.

**5. Does your state, commonwealth or territory, currently have an adaptation plan for sea-level rise or lake level change?**

*Please note that the definition or standard of criteria of sea-level rise or lake level change adaptation plan was left up to the participant to determine. Thus, a respondent's positive answer to this question may or may not represent a comprehensive statewide plan.*

SLR Plan Implementation	State	Percent
Yes, and it has been formally adopted and is being implemented	3	12.00%
Yes, and it has been formally adopted	0	0.00%
Yes, but it has not been formalized	1	4.00%
No, but it is currently under development	7	28.00%
No, but we will start development of a plan within a year	5	20.00%
No, but we are considering one	7	28.00%
No, and we have other priorities that will preclude development of a plan	2	8.00%

84% of the participating states, commonwealths, and territories do not have a SLR plan completed, and are either currently working on one, plan on having one ready within a year, or are considering drafting one. Only three states have currently adopted or are beginning to formalizing a SLR. Most comments focus around the first steps in adopting an SLR, and what the states, commonwealths, and territories are currently developing with the help of state agencies, fellows and universities.

**6. What year was your sea level rise/ lake level change adaptation plan completed?**

Years	States	Percent
Greater than 10 Years ago	0	0.00%
1999	0	0.00%
2000	1	3.70%
2001	0	0.00%
2002	0	0.00%
2003	0	0.00%
2004	0	0.00%
2005	0	0.00%
2006	1	3.70%
2007	1	3.70%
2008	1	3.70%
No sea level change plan completed	21	77.78%

88% of the participating states, commonwealths, and territories do not have a current SLR adaptation plan. Comments explain that most participating states, commonwealths, and territories have an SLR plan currently under development.



**7. How long did or will development of a sea level rise/ lake level change adaptation plan take?**

Time	States	Percent
Up to 6 months	0	0.00%
6 months – 1 year	5	20.00%
1 – 2 years	9	36.00%
More than 2 years	11	44.00%

80% of coastal states, commonwealths, and territories participating in the survey believe that in order to be thorough and inclusive, 1 to 2 or more years will be needed to develop an SLR adaptation plan.

**8. What was or is expected to be the staffing requirement for the development of a sea level rise/ lake level change adaptation plan?**

Employees	States	Percent
Less than 1 full time employee (FTE)	3	13.04%
1 FTE	6	26.09%
2 FTE	4	17.39%
3 FTE	4	17.39%
More than 3 FTEs	6	26.09%

Staffing requirements range from less than one employee to more than three, however 87% expect a need of one or more full time employees (FTEs), and 61% expect a need of 2 or more FTEs. Comments vary about the number of full time staffers (possibly due to state, commonwealth, or territory size), but many noted, fellows and aid from university researchers will be utilized as well as action teams. The broad spread of anticipated staffing need is speculated to be an affect of the size of the coastal area of the state, commonwealth or territory. Several states stated that that needed much higher staff levels with as many as 10 FTEs.

**9. What was the total or projected cost of data collection and analysis for use in the sea level rise/ lake level change adaptation plan?**

Cost	States	Percent
Less than \$ 50K	2	10.53%
\$ 50-100K	2	10.53%
\$ 100 - 200K	0	0.00%
\$ 200 - 300K	3	15.79%
More than 400K	12	63.16%

63% of the coastal states, commonwealths and territories feel that data collection and analysis for use in a SLR would come at a cost greater than \$400,000. Comments focus on the bulk of this money being allocated to obtaining and utilizing LIDAR information on the coastal regions.

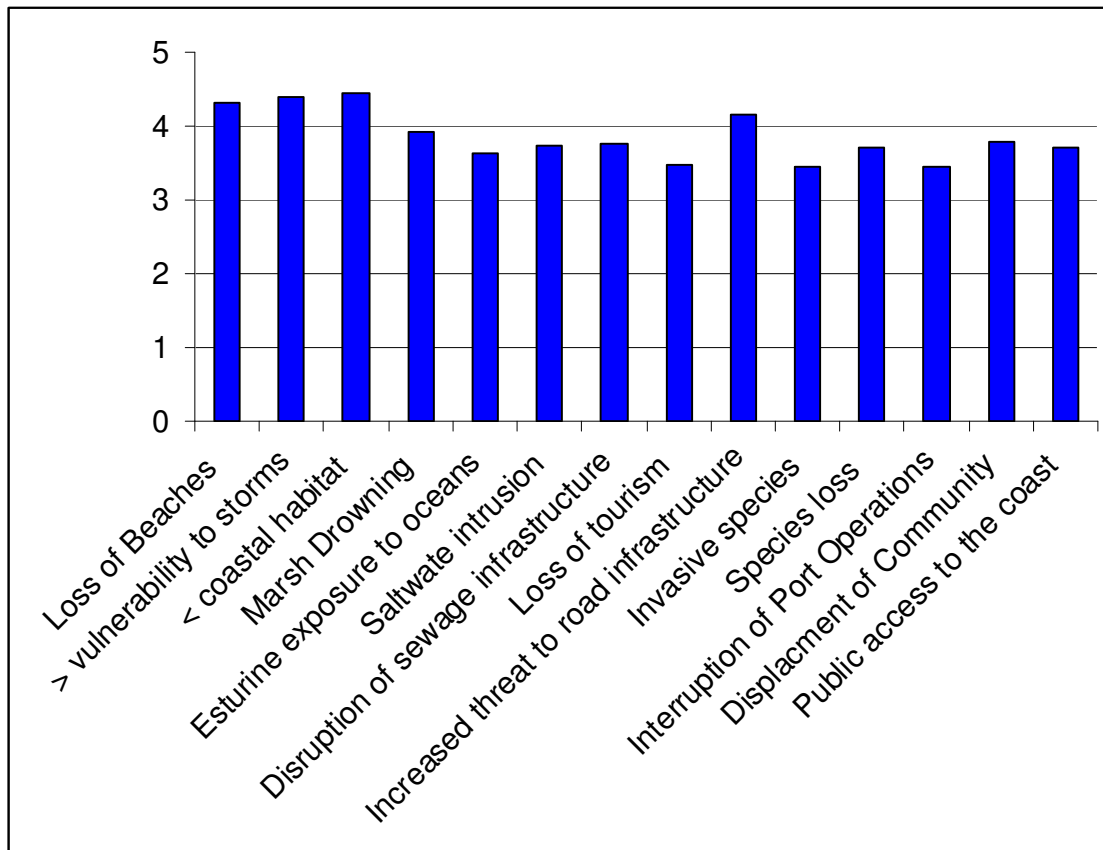
**10. Was or has an official state, commonwealth, or territory level task force (or the equivalent) been designated for development of a sea level rise / lake level change plan?**

Planning Initiative	States	Percent
Yes	11	42.31%
No	9	34.62%
We have no sea level rise planning initiative at this time.	6	23.08%

42% of the coastal states, commonwealths and territories that participated in the survey currently have a task force in place specifically for a SLR plan. The other 58% either do not have a task force in place (35%), or have no SLR planning initiative at this time (23%). Comments centered on local advisory committees that are, or will be in place in the immediate future.

**11. Please weight to what degree that you believe each of the following will be impacted by sea level rise or lake level changes in your state, commonwealth or territory on a scale of 1 to 5; 1 being minimal impact and 5 being significant.**

The average of the answers provided for each of the sub-categories does not fall below 3.44, with most of the averages in the high threes to mid fours, meaning impacts that are moderate or greater. Comments focus on the difficulty of weighting the impact without conducting appropriate vulnerability studies. See Fig. 1, for a visual graph of average answers for this question.



**Fig. 1:**

Degree that is believed each of the following will be impacted by sea level rise or lake level changes in your state, commonwealth or territory  
\*(Scale of 1 to 5; 1 being minimal impact and 5 being significant)

**12. On a scale of 1-5; how important are the following elevation data types to the development of your plan; 1 being least important, 5 being most important).**

Elevation Data Types	Average Score
Detailed Topographic Data (i.e. LIDAR)	4.73
Shallow water Bathymetric data of your coastal zone	3.86

The average of the participating states, commonwealths and territories feel that the most important data types that would aid in the development of a SLR plan are detailed topographic data, or LIDAR. Shallow water bathymetric data and map of the coast are also very important. Comments again focus on the importance of LIDAR for the states, commonwealths or territories coastal zone, particularly the lack and availability of such data.

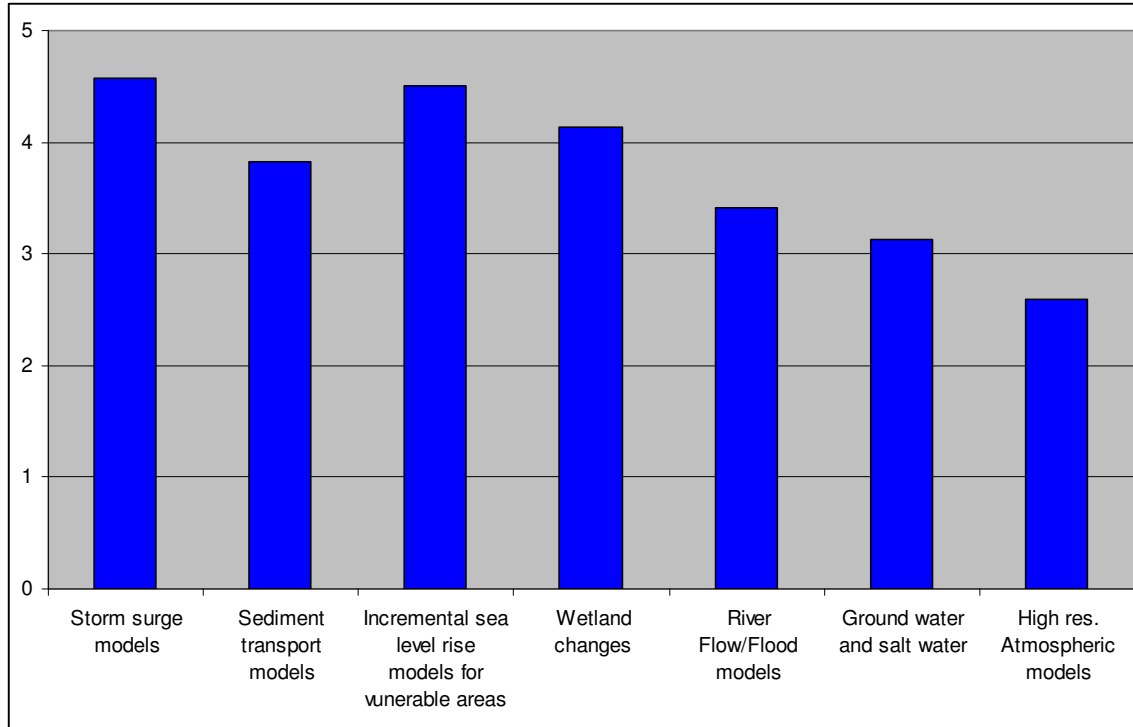
**13. What was or is the estimated cost of this elevation data to meet your programs needs?**

Cost	States	Percent
Less than 100K	1	4.76%
\$ 100-250K	1	4.76%
\$ 250-500K	2	9.52%
\$ 500-1 million	2	9.52%
\$ 1-3 million	8	38.10%
> \$ 3 million	1	4.76%
Don't Know	6	28.57%

43% of the participating states, commonwealth and territories feel that the cost of this elevation data will range from one million to three million dollars and greater. A large percentage, 29% feel they do not know what the estimated cost of this data will be.

**14. On a scale of 1-5, how important are the models to development of your adaptation plan (1 being least important, 5 being most)?**

The importance of different models in the states, commonwealths and territories for development of an adaptation plan are all found to be moderately to highly important. Only high resolution atmospheric data falls below the moderate importance mark. The importance of these models varied between states. A graphical explanation of the answer can be seen in Fig. 2.



**Fig 2:**  
 Various types of models and there importance in the development of and SLR adaptation plan

\*(Scale of 1 to 5; 1 being minimal impact and 5 being significant)

**15. What was or is the cost of obtaining these models or their outputs to meet your program needs?**

Cost	States	Percent
Less than \$ 50K	1	4.35%
\$ 50-100K	1	4.35%
\$ 100-200K	0	0.00%
\$ 200-300K	1	4.35%
\$ 300-400K	0	0.00%
More than 400K	6	26.09%
Don't Know	14	60.87%

61% of the participating states, commonwealths and territories feel that they do not have the knowledge to predict what the cost of obtaining models of data to aid in an SLR. Comments are few, but of those states that provided cost estimates, 67% articulate that more than 400,000 dollars is needed per state, and currently there is no funding to support these models.

**16. On a scale of 1-5, how important are the following socioeconomic data sets to the development of your plan (1 being least important and 5 being most important)?**

Socioeconomic Data Sets	Average Score
Population vulnerable to inundation from various scenarios, and their demographic characteristics	4.27
Economic value and potential lost revenue due to sea level rise/lake level change	4.41
Value of coastal tourism affected by sea level rise	3.71

Most of the participating states, commonwealths and territories agree that vulnerable populations and the possible economic loss (revenue) due to SLR are very important data sets to consider when making an SLR adaptation plan. Comments surround the idea that socioeconomic data is important to encourage state and local government to become engaged in a SLR adaptation plan.

**17. What was the cost or estimated cost of obtaining this and other needed types of socioeconomic data to meet your program needs?**

Cost	States	Percent
Less than \$ 10K	0	0.00%
\$ 10-25K	0	0.00%
\$ 25-50K	2	9.52%
\$ 50-100K	1	4.76%
\$100-200K	1	4.76%
More than \$ 200K	3	14.29%
Don't Know	14	66.67%

67% of participating states, commonwealths and territories do not know how much it will cost in order to achieve these socioeconomic data sets. Only one comment states there is no or little funding for this type of work.

**18. On a scale of 1-5, how important are the following geologic data to the development of your adaptation plan (1 being least important, 5 being most important)?**

Geologic Data Sets	Average Score
Sediment elevation table data for short term wetland accretion rates	3.48
Lead 210 and Cesium 137 dating for long term wetland accretion rates	2.90
Geologic map/bathymetric maps of shallow water areas	3.95
Sand resource areas	4.10

Participating states, commonwealths and territories feel that sand resources and bathymetric/geological map data of shallow water areas along with sediment elevation tables are the more important geological data to the development of an SLR adaptation plan. Commenters note that they are not sure how these data sets can be used and how important they are.

**19. What was the cost or is the estimated cost of obtaining this and other needed types of geologic data to meet your program needs?**

Cost	States	Percent
Less than \$ 25K	0	0.00%
\$ 25-50K	1	4.55%
\$ 50-100K	0	0.00%
\$ 100-200K	1	4.55%
\$ 200-400K	1	4.55%
More than 400K	5	22.73%
Don't Know	14	63.64%

64% of coastal states, commonwealths and territories feel that they do not know how much geologic data would cost in order to apply it into an SLR adaptation plan. Commenters cite the lack of funding to obtain this kind of data and the State wide geologic data would cost several million dollars over time.

**20. On a scale of 1-5, how important are the following infrastructure assessment data on the development of your plan (1 being least important, 5 being most important)?**

Infrastrurcture Assesment Data	Average Score
Identification of communities/residences most at risk	4.77
Evaluation of evacuation routes at risk to storm surge or inundation	3.86
Economic value and cost of replacement/relocation of vulnerable infrastructure	4.45
Improved siting criteria for public infrastructure that considers SLR	4.36
Structures survey	4.09
Dike/levees survey	2.91

Infrastructure assessment data with the most significance deals with the identification of communities and/residences that are the most at risk. On average, dikes and levees seem to be the least important topic, but several states ranked it very high.

**21. What was the cost or is the estimated cost of obtaining this and other needed types of infrastructure data to meet your program needs?**

Cost	State	Percent
Less than \$ 10K	0	0.00%
\$ 10-25K	0	0.00%
\$ 25-50K	0	0.00%
\$ 50-100K	3	13.64%
\$100-200K	1	4.55%
More than \$ 200K	7	31.82%
Don't Know	10	45.45%

45% of the participating states, commonwealths and territories do not know how much it will cost to obtain infrastructure assessment data in order to meet their program needs, while 32% believe the cost will be greater than 200,000 dollars. Comments focus around the lack of knowledge on how to obtain the funding for the data that is needed.

**22. On a scale of 1-5, how important is the following policy and/ or regulatory review information to the development of your plan (1 being least important, 5 being most)?**

Policy/ Regulatory Review Information	Average Score
A comprehensive analysis of your state, commonwealth, or territory	4.18
A comprehensive analysis of Federal Authorities	3.68
A comprehensive analysis of local authorities	4.18

Coastal states, commonwealths and territories, on average, feel that comprehensive analysis of state and local authority’s policy and regulatory review information would be the most important to an SLR adaptation plan. Commenters state that it will be the local, or possible sub-regional authorities, not the state, to provide communities with municipal adaptation plans and key insights into developing sustainable communities.

**23. What was the cost or is the estimated cost of obtaining this and other needed types of policy and regulatory information to meet your program needs?**

Cost	States	Percent
Less than \$ 10K	1	4.55%
\$ 10-25K	0	0.00%
\$ 25-50K	2	9.09%
\$ 50-100K	4	18.18%
\$100-200K	1	4.55%
More than \$ 200K	4	18.18%
Don't Know	10	45.45%

45% of the participating coastal states, commonwealths and territories do not know how much it will cost in order to obtain this and other types of policy and regulatory information to meet their needs. Another 41% feel between 50,000 dollars and >200,000 dollars.

**24. On a scale of 1-5, how important are the following Climate, wave and current data sets to the development of your plan (1 being least important, 5 being most important)?**

Climate/ Wave/ Current Data	Average Score
Improved climate change prediction data	4.27
Temperature Data	3.32
Precipitation Data	3.73
Tidal Data	4.05
Wave Data	4.00
High Frequency Radar	3.10

Improved climate change prediction data, along with tidal and wave data, are on average the more important types of climate, wave and current data needed to aid in the development and implementation of an SLR adaptation plan. Comments (one) shared the importance of high frequency radar for storm predictions, important in coastal hazard planning.

**25. What was the cost or is the estimated cost of obtaining this and other types of needed climate, wave and current data to meet your program needs?**

Cost	States	Percent
Less than \$ 10K	0	0.00%
\$ 10-25K	0	0.00%
\$ 25-50K	0	0.00%
\$ 50-100K	0	0.00%
\$100-200K	1	4.35%
More than \$ 200K	5	21.74%
Don't Know	17	73.91%

74% of the participating states, commonwealths and territories do not know how much it will cost to obtain this type of data.

**26. On a scale of 1-5, how important are the following habitat data to the development of your plan (1 being least important and 5 being most important)?**

Habitat Data	Average Score
Wetland Loss	4.59
Shoreline Change/Erosion Rate Data	4.77
Invasive Species Data	3.19
Low lying dry lands for wetland migration	3.86
Fiscal cost of land protection/acquisition to permit landward migration of the sea	3.76
Protected or Unique Habitat Data	3.95

On average, coastal states, commonwealths and territories rank shoreline change/ erosion and wetland loss as the most important habitat data needed to complete and SLR. Data on unique habitats is also important information that is needed for and adaptation plan. Comments talk about the realization of some communities being unable to prevent low lying areas from marine water inundation and the up-keep of biodiversity in these areas for years to come. Some commentors feel this is a subject to be dealt with at a “future” time and not a necessity right now.



**27. What was the cost or is the estimated cost of obtaining this and other needed types of habitat data to meet your program needs?**

Cost	States	Percent
Less than \$ 10K	0	0.00%
\$ 10-25K	0	0.00%
\$ 25-50K	0	0.00%
\$ 50-100K	1	4.35%
\$100-200K	1	4.35%
More than \$ 200K	9	39.13%
Don't Know	12	52.17%

52% of the participating states, commonwealths and territories do not know how much this information will cost to obtain. Comments include current information is too outdated to assign a cost, while others feel it would be more in the \$500,000 dollar range.

**28. Do you feel that you have adequate technical staff to develop and coordinate a sea level rise or lake level change adaptation plan?**

Technical Staffing	Average Score
Policy Staff	3.61
Coastal Engineering	2.70
Habitat/ Biological Staff	3.27
Geological Staff	3.17
Other Staff Needs	2.81

Policy and habitat/biological staffs are moderately adequate for the coastal states, commonwealths and territories to develop and coordinate a SLR plan. Comments focus on the need for more staff, including economists, staff for training and general planning as well as staff for data gathering.

**29. What would be your best estimate cost of implementing and adaptation plan for your state, commonwealth or territory annually for each of the next five years based on the information you have today?**

Cost	States	Percent
Less than 100K	1	4.00%
\$ 100-250K	1	4.00%
\$ 250-500K	1	4.00%
\$ 500-1 million	2	8.00%
\$ 1-2 million	2	8.00%
\$ 2-5 million	2	8.00%
> \$ 5 million	4	16.00%
Don't Know	12	48.00%

48% of the participating coastal states, commonwealths and territories feel that they do not know how much money per year it would take to implement an SLR for each of the next five years. Comments focus around implementation option and the leaving out of possible land acquisition during wetland mitigation.

## **APPENDIX A: PARTICIPANTS IN THE 2008 SURVEY**

The following is a list of the 27 participating states, commonwealths, and territories that fully completed the CSO 2008 Adaptation to Climate Change Survey. Included in the list are the names of the individuals completing the survey and the capacity to which they represent their states, commonwealths, or territories.

<b><u>Name</u></b>	<b><u>State/Commonwealth/Territory</u></b>	<b><u>Title</u></b>
Ernesto L. Diaz	Puerto Rico	Coastal Program Manager/Marine Scientist
Douglas Tom	Hawaii	Program Manager
John B. Joyner	Northern Mariana Islands	Commonwealth of Northern Mariana Islands
Lelei Peau	American Samoa	American Samoa Deputy Director
Shepard Moon	Virginia	Coastal Planner
Gwynne Schultz	Maryland	Senior Coastal and Ocean Policy Advisor
Robert Bailey	Oregon	Coastal Program Manager
Braxton Davis	South Carolina	Director of Science and Policy for CZM Program
Bruce Carlisle	Massachusetts	Assistant Director
Anne McMahon, Steve Goldbeck, Sam Schuchat	California	CCC, BCDC
Tom Calnan	Texas	Coastal Biologist
Stephen M. Dickson	Maine	Marine Geologist
Carrie Byron	Washington	Washington State
Terry Howey	Louisiana	Coastal Resources Administrator
Ron Rozsa	Connecticut	Coastal Ecologist
Stephen C. Adams	Florida	Staff Director of Gov. Crist's Action Team for Energy and Climate Change
Tacred Miller	North Carolina	Coastal Policy Analyst
Andrea Cooper	Massachusetts	Shoreline and Floodplain Management Coordinator
Jill Andrews	Georgia	Coastal Resources Program Manager
David Carter	Delaware	Environmental Program Manager
Ted Diers	New Hampshire	Coastal Program Manager

Barry Pendergrass	New York	Coastal Zone Management Program
Shamus Malone	Pennsylvania	Chief, Monitoring and Technical Assistance
Cathie Cunningham Ballard	Michigan	Coastal Program Manager
Steve Holland	Ohio	Federal Consistency Coordinator/Section Manager
Mike Molnar	Indiana	Program Manager
Grover Fugate	Rhode Island	Coastal Zone Management Program

**APPENDIX B: THE ROLE OF COASTAL ZONE MANAGEMENT PROGRAMS IN ADAPTATION TO CLIMATE CHANGE, FINAL REPORT OF THE CSO CLIMATE CHANGE WORK GROUP, SEPTEMBER 2007**

**The Role of  
Coastal Zone Management Programs  
in Adaptation to Climate Change**

Final Report of the  
CSO Climate Change Work Group

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September, 2007



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We appreciate the support of NOAA's Office of Ocean and Coastal Resource Management and Rhode Island Sea Grant for providing additional information on coastal states' climate change policies and activities.

**September 2007**

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## **Executive Summary**

Coastal areas are vulnerable to climate change, especially with respect to accelerated sea level rise and lake level changes, shoreline erosion, increased storm frequency or intensity, changes in rainfall, and related flooding. Other impacts may include changes in chemical (ocean acidification) and physical characteristics (thermal stratification) of marine systems, saltwater intrusion into groundwater aquifers, increased harmful algal blooms, spread of invasive species, habitat loss (especially coastal wetlands), species migrations, and changes in population dynamics among marine and coastal species. Preparing for these impacts has been termed “adaptation” by the coastal research and management community. As state and local governments consider future climate change policies and strategies, coastal zone management programs will play an important role in identifying vulnerabilities and fostering adaptation to climate change.

The Coastal States Organization’s (CSO) Climate Change Work Group prepared this report to explore the current and future roles of state coastal zone management programs in addressing climate change. While other reports have synthesized broader state-level climate change initiatives, this report aims to:

- Inform Congress and federal agencies of the role of state coastal zone management programs in addressing climate change;
- Inform CSO & NOAA’s efforts to reauthorize the Coastal Zone Management Act;
- Inform federal agencies of key research, information, and policy needs; and
- Provide for information exchange among coastal states and territories.

The CSO Work Group developed and distributed a survey to the full membership of the Coastal States Organization. Recognizing that there are many programs at the federal and state level that address climate change either directly or indirectly, CSO focused its survey questions specifically on the roles of state and territory coastal zone management programs authorized under the CZMA. The survey did not cover the activities/needs of Sea Grant, National Estuarine Research Reserves (NERRs), National Estuary Programs (NEPs), or other partners. A total of eighteen state coastal programs responded to the survey. The

summary of results is provided below. Please refer to the full text for the complete list of recommendations and context for the suggestions outlined here:

### **Coastal Programs' Involvement in Climate Change Initiatives**

Several state coastal programs are addressing climate change issues via statewide, interagency climate change partnerships or commissions – often under Governors' climate change initiatives. The coastal programs are providing information for, or responding to, specific action items generated by these state climate commissions. In this capacity, coastal programs are playing a key role in ensuring the consideration of coastal impacts and adaptation strategies.

### **Adaptation Strategies**

Coastal programs are beginning to address climate change by examining the social, environmental, and economic impacts of accelerated sea level rise scenarios, resulting shoreline changes, and potential adaptation strategies. Existing coastal zone management programs and policies were based upon a relatively predictable rate of sea level rise. The challenge for coastal managers is to devise adaptations strategies for a variety of sea level rise scenarios and adjust these in the future as forecasting improves. New policies are being developed to address the siting of public infrastructure, site-level project planning, wetland conservation and restoration, shoreline building setbacks, building elevations, and alternatives to shoreline “armoring.” Coastal programs are interested in decision-support tools that compile historical shorelines, geomorphology, socioeconomic data, and model projections. Coastal programs are partnering with Sea Grant and NERRs for extension and outreach activities.

### **Mitigation Strategies for Greenhouse Gas Emissions**

While some coastal programs have permitting, enforcement, or other management authorities that support them in playing a significant role in reducing emissions through direct and/or indirect management of coastal activities, many state coastal zone management programs are focused primarily on developing strategies for adaptation to the social, environmental, and economic coastal impacts of climate change over the coming

decades. The development of mitigation strategies for greenhouse gas emissions is considered appropriate and encouraged for those coastal programs with sufficient authorities and missions.

### **State Data Collection/Research Efforts and Future Needs**

To better understand the effects of accelerated sea level rise on coastal communities and resources, state coastal programs are increasingly sponsoring or supporting research and data collection efforts focused on:

- Historic shoreline position maps; historic shoreline erosion rates, inventories of shoreline features and conditions;
- Acquisition of high resolution topography and bathymetry;
- Sea level rise inundation models;
- Storm surge - sea level rise linked inundation models;
- Shoreline change modeling based on sea level rise projections;
- Sea level rise vulnerability analyses/socio-economic studies;
- Environmental/habitat changes associated with sea level rise (e.g. coastal wetlands, salt wedge migration).

A common concern of state coastal managers is that their research efforts and those conducted by the federal government be well coordinated and not duplicative. The states welcome a discussion on the efforts listed above, and cited the following as their continuing research and information needs:

#### ***High Resolution Topography and Bathymetry***

- Consistent temporal and spatial coverage of high-resolution topography and bathymetry data (for example, LIDAR, shallow water-penetrating LIDAR);
- Training for coastal program managers in shoreline delineation, mapping, vertical and horizontal reference datums, and legal definitions.

### ***Inundation Mapping vs. Shoreline Change Modeling***

- Federal guidance for modeling local- and subregional-scale shoreline changes associated with varying sea level rise projections;
- Guidance for monitoring changes along “sheltered” coastlines.

### ***Impacts of Accelerated Sea Level Rise***

- Federal guidance on best practices, case studies, trainings, workshops, and/or software tools focused on community-level and statewide vulnerability assessments and adaptation planning for state coastal programs.
- Improved models that predict coastal wetland and beach migration and vertical accretion in response to accelerated sea level rise, information on the costs of response options, and the consequences of taking no action.
- Assessments of social, legal, and economic issues related to shoreline “retreat,” armoring, renourishment, and “no action” alternatives across developed and urbanized coastlines.

### ***Other Climate Change Impacts***

- Information, research, and guidance on a variety of other climate change issues, such as the introduction of invasive species, ocean acidification, ecosystem migration, freshwater resources, and storm surge models.
- Federal guidance for modeling local/regional-scale effects of storm events coupled with rainfall, river flooding, and sea level rise projections.

### **Federal Policy Needs**

Participants called for a clear federal strategy for intergovernmental coordination on coastal adaptation to climate change. A key component of this strategy should be a new, stronger focus on interagency cooperation between NOAA, state coastal management programs, FEMA, and state floodplain managers. Suggestions were also made for the development of regional “clearinghouses” for ongoing information exchange among federal, state, and local programs and research activities. Finally, the federal Coastal Zone Management Act should be recognized by Congress and the Administration as one of the primary statutes that can foster adaptation to climate change at the state and local levels.

## **Introduction**

Socioeconomic and environmental impacts of climate change are projected to be most significant in coastal areas of the United States.<sup>1-3</sup> The U.S. population is concentrated in coastal areas,<sup>4</sup> where communities and natural resource-based economies are especially vulnerable to accelerated sea level rise and lake level changes, shoreline erosion, increased storm frequency or intensity, changes in rainfall, and related flooding. Other impacts may include changes in chemical (ocean acidification) and physical characteristics (thermal stratification) of marine systems, saltwater intrusion into groundwater aquifers, increased harmful algal blooms, spread of invasive species, habitat loss (especially coastal wetlands), species migrations, and changes in population dynamics among marine and coastal species. These impacts will vary regionally, but scientists contend that many are likely to be experienced in the coming decades - even if greenhouse gas emissions are reduced significantly.<sup>1-2</sup>

Preparing for and coping with the impacts of climate change has been termed “adaptation” by the coastal research and management community. Many of these impacts will require adaptation solutions that cross federal, state, regional, and local agencies, programs, policies, and political jurisdictions. A number of federal agencies and programs have begun to explore information needs and policy options at the federal level; however, state and local governments have immediate responsibilities for managing many of the resources and communities that are likely to be impacted by climate change. Some states and local governments have launched major initiatives focused on reducing greenhouse gas emissions. Attention toward adaptation has been more limited and recent.<sup>5</sup> As state and local governments consider future climate change policies and strategies, coastal zone management programs will play an important role in identifying climate change impacts, vulnerabilities, and opportunities for adaptation; and fostering interagency collaboration on climate change issues.

The Coastal States Organization (CSO) was established in 1970 to represent the Governors of the nation’s thirty-five coastal states, commonwealths and territories on legislative and policy issues relating to the sound management of coastal, Great Lakes and ocean

resources. In January 2007, CSO established a Climate Change Work Group, which was charged with three key tasks:

- 1) Tracking and responding to federal legislative proposals related to climate change;
- 2) Developing a draft CSO Climate Change Policy Statement;
- 3) Assessing state activities and needs related to climate change.

The Work Group drafted this report in response to the third task. The report explores the current and future roles of state coastal programs in addressing climate change, and identifies the states' shared needs for federal agencies and programs to consider. More specifically, the report seeks to:

- Inform Congress and federal agencies on the role of state coastal zone management programs in addressing climate change;
- Inform CSO and the National Oceanic and Atmospheric Administration's (NOAA) efforts to reauthorize the Coastal Zone Management Act;
- Inform federal agencies of key research, information, and policy needs; and
- Provide for information exchange among coastal states and territories.

## **Approach**

The Work Group developed and distributed a survey to the full membership of the Coastal States Organization (Appendix A). Recognizing that there are many programs at the federal and state level that address climate change either directly or indirectly, CSO focused its survey efforts specifically on the roles of state and territory coastal zone management programs authorized under the federal Coastal Zone Management Act (CZMA). Each of these programs is unique: some include a broad range of "networked" state and local agencies and policies that are coordinated or supported through the CZMA; others are more centralized within a single agency. As a result, the missions, jurisdictions, and policies of state-level coastal programs vary with respect to climate-related activities. The Work Group did not distribute the survey to, and therefore this report does not cover, the activities and needs of Sea Grant, National Estuarine Research Reserves, National Estuary Programs, or other partners. Some of these national programs are currently developing parallel reports.

Fifteen state coastal programs initially responded to the survey, and the results were synthesized in a draft report. The draft report was edited by the CSO Climate Change Work Group, then distributed to the full CSO membership for review and input. In response to the draft report, three additional programs provided information for the final report, bringing the total number of state responses to eighteen. Additional edits were received and incorporated from seven state programs. Preliminary results of the survey were also presented and discussed in June 2007 at a meeting of the state-federal Coastal Coordination Committee in Washington, DC; and at a special session during the Coastal Zone 2007 Conference in Portland, OR. Under each section below, CSO has summarized the responses of the state participants.

## **Results**

### *Coastal Programs' Involvement in Climate Change Initiatives*

Several state coastal programs are addressing climate change issues via statewide, interagency climate change partnerships – often under Governors' climate change initiatives. The coastal programs are providing information for, or responding to, specific action items generated by these state climate commissions. In this capacity, coastal programs are playing a key role in ensuring the consideration of coastal impacts and adaptation strategies. For example:

Maryland's Coastal Program is chairing and staffing an Adaptation and Response Working Group for their Governor's Commission on Climate Change (Executive Order 01.01.2007.07). The Working Group is developing a "Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change" for the Governor and General Assembly in 2008.

Washington's Coastal Program is involved in the Washington State Governor's Climate Change Challenge (Executive Order No. 07-02). Washington's Coastal Program is part of a Coastal and Infrastructure Preparation/Adaptation Working Group that will examine the specific steps for the state to take to prepare for impacts to the coastline.

South Carolina's Coastal Program serves on a "Crosscutting" Technical Work Group under the Governor's Climate, Energy, and Commerce Advisory Committee (Executive Order 2007-04) and is highlighting coastal impacts and potential adaptation strategies.

New Jersey's Coastal Program helped organize a Climate Change Summit chaired by the Governor, members of his Cabinet, financial services and insurance industry leaders, and recognized experts from the scientific community and industry. The Coastal Program intends to address issues raised by the participants related to sea level rise, flooding and coastal storms.

California's Coastal Commission is working with the State's Ocean Protection Council to respond to state climate change legislation (AB 32). The Council recently adopted a resolution to inform mitigation and adaptation strategies statewide. In December 2006, the Commission held the first in a series of climate change workshops designed to inform the Commission on climate change, and to help identify specific actions within the Commission's authority to reduce greenhouse gas emissions and adapt to anticipated impacts of global warming.

The San Francisco Bay Conservation and Development Commission (BCDC) is updating its *San Francisco Bay Plan* policies on sea level rise and developing new policies pertaining to climate change. BCDC is also working with the California Ocean Protection Council, the State Climate Action Team, and joined with three other regional agencies to develop a comprehensive strategy aimed at reducing greenhouse gas emissions and adapting to the impacts of climate change.

Louisiana's Coastal Program is participating in a state/ nongovernmental organization initiative entitled "Climate, Energy, and the Coast." The initiative is focused on the restoration of Louisiana's wetlands.

Oregon's Coastal Program is working with Oregon Sea Grant, South Slough National Estuarine Research Reserve, and the Governor's Office of Climate Change to convene an interagency forum to develop a climate change report for the 2009 Oregon legislature.

Massachusetts' Coastal Program chaired and staffed a Coastal Hazards Commission comprised of state legislators, state agency representatives, and local officials to address



erosion and flooding primarily due to storms, decreased sediment supplies, and sea level rise. The Coastal Hazards Commission released a report in May 2007 with 29 recommendations including one to map and model climate change and sea level rise data related to coastal hazards in Massachusetts.

North Carolina's Coastal Program serves on a Legislative Commission on Global Climate Change, which will issue its final report no later than April 15, 2008.

Some coastal programs are taking lead roles in regional partnerships to address hazards related to climate change, among other issues. For example, the Northeast Regional Ocean Council recently proposed the development of an action plan to render New England a "Coastal Hazards Ready" region, including the identification of infrastructure at risk from accelerated sea level rise. The Southern New England Ocean Partnership has also named coastal hazards (including climate adaptation) as an initial priority.

In 2006, nearly two-thirds of the coastal states reported to NOAA that "coastal hazards" were a high priority, and developed 5-year strategies to address issues such as flooding, shoreline erosion, and coastal storms in their most recent program updates (309 Assessment and Strategies).<sup>6</sup> Although many of these coastal hazards exist without human-induced climate change, they are expected to intensify in future climate scenarios. Therefore, even in states that have not engaged in broad climate change initiatives, related policies are already being developed and advanced by most coastal zone management programs.

### *Adaptation Strategies*

To date, most coastal programs have primarily focused on the potential social, environmental, and economic impacts of accelerated sea level rise, resulting shoreline changes, and adaptation strategies. Existing coastal zone management programs and policies were based upon a relatively predictable rate of sea level rise. The challenge for coastal managers is to devise adaptations strategies for a variety of sea level rise scenarios and adjust these in the future as forecasting improves. For example:

Maryland's Coastal Program developed "A Sea Level Response Strategy for the State of Maryland." The Strategy set forth short and long-term objectives, along with key activities, to address the three primary impacts of sea level rise - erosion, flooding, and inundation - and recommended policies and actions to reduce vulnerability to sea level rise.

The San Francisco Bay Conservation and Development Commission mapped areas along the shoreline of San Francisco Bay that are vulnerable to sea level rise and require more focused adaptation planning.

Delaware's Coastal Program published an updated version of "*Striking a Balance*" in 2005. This report expands on the issues of sea level rise, coastal processes, and related impacts to habitats and coastal water quality.

South Carolina's Coastal Program is launching a multi-year "Shoreline Change Initiative" in 2007 to address beachfront and estuarine shoreline management issues, as well as concerns about intensifying sea level rise and coastal storms.

Maine's Coastal Program published a report entitled "Anticipatory Planning for Sea Level Rise Along the Coast of Maine" in 1994. More recently, in 2006, the Maine Coastal Program funded the Maine Geological Survey to develop a report on "Impacts of Future Sea Level Rise on the Coastal Floodplain."

Connecticut's Coastal Program is working with the flood management section of Inland Water Resources Management Division of the state Department of Environmental Protection (DEP) to acquire high-resolution digital elevation maps for improved coastal hazard planning. The Coastal Program also provided a technical review and assessment of potential sea level rise impacts for the 2007-2010 DEP Hazard Mitigation Plan.

North Carolina's Coastal Program, in collaboration with the Division of Water Resources, will address sea level rise and other issues in the State's first comprehensive beach and inlet management plan (to be completed by March 2009).

Based on these and other planning efforts, states are beginning to implement a number of specific policies and strategies to encourage adaptation to climate change impacts:

Establishing public infrastructure siting policies	Massachusetts' Cape Cod Commission requires new and redeveloped infrastructure, such as stormwater systems and roadways, to consider sea level rise in their design.
	New York's Long Island Sound Coastal Program requires consideration of sea level rise when siting and designing projects involving substantial public expenditures.
Including effects of climate change in site-level project planning	Washington State's Coastal Program is examining use of the State Environmental Policy Act (SEPA) to incorporate effects of climate change in project planning.
	California's Coastal Program requires applications for new shorefront development (buildings and shore protection) to consider an increase in sea level in the examination of flooding and wave hazards. The anticipated rise in sea level has been similar or slightly higher than historic trends.
Modifying wetland conservation and restoration policies	New Jersey's Coastal Program is developing methodologies, protocols, regulations, and/or guidance documents designed to accommodate the adaptation of coastal wetlands to sea level rise.
	Connecticut's Coastal Program has developed recommendations for a bi-state Habitat Restoration Committee of the Long Island Sound Study (NEP) to devise a new strategy for estuarine restoration, including avoiding risky restoration projects such as low marsh, restoring tidal wetlands adjacent to lands where marine transgression can occur, identifying refugia sites (future marine transgression areas) for protection, and seed banks to protect the most threatened plants species.
Increasing shoreline setbacks	California's Coastal Program considers future increases in bluff erosion when establishing bluff edge setback criteria.
	North Carolina's Coastal Resources Commission has approved draft rule language that increases setbacks for single-family homes greater than 5,000 sf to 60 times the erosion rate, and increases setbacks for all structures between 10,000 and 100,000 sf by creating a graduated setback that increases with structure size.
Increasing "free board" above Base Flood Elevation	Massachusetts' Coastal Program serves on a technical advisory committee to the Board of Building Regulations & Standards, and recommended that the State Building Code include 2 ft of freeboard in V zones and coastal dunes to accommodate sea level rise and mapping accuracy.
Promoting alternatives to shoreline "armoring"	Maryland's Coastal Program has developed a "Living Shoreline Stewardship Initiative" that promotes and encourages shoreline stabilization alternatives through demonstration projects, field assessments of location suitability, education and outreach programs, and grant/funding support for project construction.

	<p>Virginia’s Coastal Program is undertaking a “Living Shorelines” initiative to develop improved design criteria, a contractor certification program, information on shoreline conditions, revised policies, and outreach materials to promote the use of nonstructural or “hybrid” approaches to shoreline stabilization.</p>
<p>Encouraging the consideration of climate change impacts in state and local planning efforts</p>	<p>Maryland’s Coastal Program ensured that sea level rise considerations were included in the recent Comprehensive Conservation and Management Plan for the Maryland Coastal Bays National Estuary Program; the Chesapeake 2000 Bay Agreement; the Baltimore and Prince George’s County Hazard Mitigation Plans; the Coastal Bays Hazards Initiative; and the Worcester County Comprehensive Plan.</p>
	<p>New Jersey’s Coastal Program is working to develop consistent, comprehensive municipal coastal hazards mitigation plans that address climate change-related issues.</p>
	<p>California’s Coastal Program staff are participating in the State’s Multi-Hazard Mitigation Plan and urging the Governor’s Office of Emergency Services to include global warming issues in the Plan; and are encouraging coastal communities to amend their local coastal plans (LCPs) to include an element that focuses on sea level rise, erosion, flooding, and other climate change impacts.</p>
	<p>Virginia’s Coastal Program is working with 8 regional planning district commissions (PDCs) that provide technical assistance to the 87 localities of the coastal zone. As part of this assistance, PDCs have helped localities develop FEMA-approved "All Hazards Plans" that address preparedness and response to events such as hurricanes.</p>
	<p>Rhode Island’s Coastal Program is undertaking a project with RI Sea Grant to incorporate climate change/sea level rise considerations into siting, building standards criteria and policies that would eventually become part of the State CZM enforceable policies for the Upper Narragansett Bay and Metro Bay Special Area Management Plans.</p>
	<p>Texas’ Coastal Program is supporting local geohazard maps that include sea level rise, erosion rates, wetlands, and other information, such as one developed as a planning tool for the City of Galveston by the University of Texas (<a href="http://www.beg.utexas.edu/coastal/GalvHazIdx.htm">http://www.beg.utexas.edu/coastal/GalvHazIdx.htm</a>). A similar map is being developed with CZ Section 309 funding for Mustang Island and the City of Port Aransas.</p>
	<p>Washington’s coastal program is investigating how and whether to address climate change through city and county Shoreline Master Programs.</p>

Development of GIS-based decision-support and visualization tools	<p>Maine’s Coastal Program is supporting the state Geological Survey’s development of a GIS-based compilation of historical shorelines, beach and dune geomorphology, development setbacks, 100-year flood vulnerability, Erosion Hazard Areas, sea-level rise inundation, etc. to improve decisionmaking with respect to dune restoration, beach nourishment, infrastructure changes, etc.</p>
	<p>Connecticut’s Office of Long Island Sound Programs (OLISP), through partnerships with USGS and the Long Island Sound Integrated Coastal Observing System (University of Connecticut), will host a NOAA Coastal Fellow in the fall of 2007 to develop a coastal hazards visualization website with data layers accessible through a browser-based Internet Mapping Service.</p>
	<p>Maryland’s Coastal Program recently launched an interactive web portal (Shorelines Online) that centralizes information and data on coastal hazards management and sea level rise.</p>
	<p>Massachusetts’ Coastal Program compiled a Coastal Hazards Characterization Atlas for the South Shore that presents shoreline variables, including sea level rise, to aid local officials in the review of projects proposed in areas vulnerable to coastal hazards.</p>
	<p>North Carolina provides access to shoreline data and aerial photography online through an interactive coastal hazards mapping tool. Long-term erosion rates can be super-imposed on aerial imagery.</p>
Supporting outreach/extension activities, often through partnerships with NERRS or Sea Grants	<p>Puerto Rico’s Coastal Management Program and Sea Grant co-sponsored a climate change roundtable with the University of Puerto Rico in May 2007.</p>
	<p>Rhode Island’s Coastal Program recently partnered with the RI Sea Grant to hold a one-day Sea Level Rise Workshop focused on policy and science issues.</p>
	<p>Massachusetts’ Coastal Program has a NOAA Coastal Management Fellow developing a “StormSmart Coasts” Program that includes a website, fact sheets, case studies, and a series of regional workshops to assist local officials assess resources and create new regulatory tools and plans.</p>
	<p>Washington’s coastal program participates and partners with Padilla Bay NERR, which through its Coastal Training program provides popular informational sessions related to climate change including topics such as estuaries, alternative energy, and how to teach climate change.</p>

## *Mitigation Strategies for Greenhouse Gas Emissions*

According to the survey results, state participants held differing views on the role of coastal programs in addressing greenhouse gas emissions through indirect (e.g. promoting energy efficiencies) or direct (e.g. energy siting) approaches. In some states, coastal programs are undertaking specific activities to reduce emissions through interagency partnerships. For example:

California's Coastal Commission and the San Francisco BCDC are working with sister state agencies, such as the California Air Resources Board and Energy and Public Utilities Commission, to develop programs to reduce greenhouse gas emissions and to conduct research aimed at achieving renewable energy sources.

Virginia's Coastal Program is involved in a partnership with the American Lung Association to promote "Commute Smart Virginia" by funding bus signs, events and radio ads that encourage carpooling, using public transit, and taking other actions to reduce greenhouse gas emissions.

Maryland's Coastal Program supports a Green Building Network – an informal group of over 3,000 architects, builders, contractors, developers, planners, landscape architects, and citizens focused on promoting the design and construction of buildings and sites in a manner that encourages efficient use of natural resources and raw materials, protects the environment, and promotes sustainable communities. The Coastal Program has also funded a number of "Environmental Design" projects with green development aspects.

Maine's Coastal Program is comprised of networked agencies with jurisdiction over environmental siting and reviews of energy facilities, and has been involved in several environmental scoping efforts related to in-stream tidal power projects.

In other states, greenhouse gas emissions were considered, for the most part, to be outside of the jurisdiction of the coastal zone management program or overlapping with other state agencies' jurisdictions. All approved state coastal programs have some authority for energy facility siting, and can review federal energy projects through the "federal consistency" provision of the Coastal Zone Management Act. However, some states indicated that while

they have authorities to influence the siting of energy facilities, coastal programs often do not have authority to regulate emissions.

CSO participants agreed that, while some coastal programs are playing a significant role in reducing emissions through direct and/or indirect management of coastal activities, a fundamental role for state coastal zone management programs is in fostering adaptation to the social, environmental, and economic coastal impacts of climate change over the coming decades. The development of mitigation strategies for greenhouse gas emissions was considered appropriate and encouraged for coastal programs with sufficient authorities and missions.

### *Existing Funding Sources and Future Needs*

State coastal programs have used some core federal program funds (CZMA Section 306) to support climate change-related activities, and are increasingly utilizing CZMA Section 309 Enhancement Grants to study or plan for climate change impacts (e.g. ME, MD, DE, NC, NJ, SC, VA). Some coastal programs have also pursued funds from a variety of other state and federal sources, including other NOAA branches, the Environmental Protection Agency (EPA), U.S. Army Corps of Engineers (USACE), Federal Emergency Management Agency (FEMA), and U.S. Geological Survey (USGS), and even some private sources.

A number of states indicated a need for additional financial support to better address climate change. Funds are needed for research and data acquisition, as well as to expand permitting and enforcement/compliance activities. Technical and planning staff are needed to work with existing coastal program staff, other federal, state, and local agencies, and academia to address key climate change issues and to build capacity. State coastal programs also cited the need for federal coordination at the regional scale to better address shoreline management issues, including the establishment of a “clearinghouse” for information exchange among federal, state, and local agencies, programs, and research activities.

## *State Data Collection/Research Efforts and Future Needs*

State coastal programs are increasingly sponsoring or supporting research and data collection efforts to better understand and predict the impacts of accelerated sea level rise on coastal communities and resources, including:

- Historic shoreline position maps; historic shoreline erosion rates, inventories of shoreline features and conditions (CT, DE, MA, ME, MD, NC, SC, TX, VA, WA);
- Acquisition of high resolution topography (LIDAR – LIght Detection And Ranging) (CT, DE, MD, ME, NC, NJ, TX, VA); and bathymetry (CA, MA, NC);
- Sea level rise inundation models (CA, CT, DE, MD, ME, NC, NH, NJ, BCDC, TX);
- Storm surge - sea level rise linked inundation models (CT, DE, MD, NC);
- Shoreline change modeling based on sea level rise projections (DE, NC, TX, WA);
- Sea level rise vulnerability analyses/socio-economic studies (DE, ME, NC, NJ, BCDC);
- Environmental/habitat changes associated with sea level rise (e.g. coastal wetlands, salt wedge migration) (CT, DE, ME, NC, NJ, TX).

A common concern of state coastal managers is that their research efforts, and those conducted by the federal government and academia, should be well coordinated and not duplicative. The states welcome a discussion on the efforts listed above, and cited the following as their primary research and information needs:

### High Resolution Topography and Bathymetry

High-resolution topography and nearshore bathymetry data were described as a critical need in 7 state responses, and as a recent and critical acquisition for inundation/storm surge mapping in 5 other responses to the CSO survey. In some cases, high-resolution spatial data are available for beachfront areas, but do not capture the full extent of estuarine or “sheltered” shorelines. Funding to support one-time Light Detection and Ranging (LIDAR) mapping was obtained, to varying extents, from FEMA, USACE, the NOAA Coastal Services Center, or through state and local interagency partnerships.



LIDAR mapping of state coastal zones is a high priority in order to begin assessing the most vulnerable areas by overlaying sea level rise projections onto digital elevation models. Current topography data are often at coarse 10-20 foot contour intervals at the scale of USGS 7.5' topographic maps (1:24,000), and do not have sufficient detail for impact studies, modeling, or policy and regulatory use. **There is a strong need for consistent temporal and spatial coverage of high-resolution topography and bathymetry;** at least one state indicated a preference for full coastal LIDAR coverage on an *annual* basis. **High-resolution bathymetry (e.g. shallow water-penetrating LIDAR) data are also needed to support assessments of shoreline changes,** since shoreline positions do not accurately convey changes to sand volumes and the steepness of shoreline slopes.

The National Research Council recently described this lack of standardized, uniform geospatial data in the coastal zone:<sup>7</sup>

“This inability to produce a seamless map (or chart) across the land-water interface is a severe impediment to understanding the many processes that are continuous across the shoreline. The lack of standardization has also led government agencies, the research community, and the private sector to undertake the expensive and time-consuming task of separately generating new data and maps to accompany almost all new studies and initiatives. The lack of coordination of coastal zone mapping efforts inevitably leads to the potential for redundancy of surveys or products. At least 15 federal agencies are involved in the primary collection or use of coastal geospatial data, often with responsibilities shared among multiple divisions within the same agency. In addition, a plethora of state and local agencies, academic institutions, and other organizations also gather and use coastal zone information. This has resulted in a chaotic collection of potentially overlapping, and often uncoordinated, coastal mapping and charting products that can frustrate the efforts of users to take advantage of existing datasets and build on past studies.

The CSO survey conducted here reinforces the NRC report's findings that:

**“Specific areas where better coordination among federal agencies is urgently needed include high-resolution topographic and bathymetric data acquisition at the land-water interface,** including aerial and satellite imagery, Light Detection and Ranging (LIDAR) surveys, bathymetric surveys, seamless topographic/bathymetric Digital Elevation Models (DEMs)/Digital Depth Models (DDMs), and derived products for mapping

shoreline change, habitat change, hazard vulnerability, and coastal erosion and inundation” (emphasis added), and

“There is a widespread need for more and better data to be collected in the coastal zone... [including] enhanced bathymetric data, particularly in very shallow coastal waters. These data provide the basic geospatial framework for almost all other studies and are a key component for derived products such as offshore habitat maps.”

### Inundation Mapping vs. Shoreline Change Modeling

Many of the state coastal programs have begun, or will soon begin, to conduct assessments of the potential impacts of sea level rise using basic inundation mapping that compares various projections of future sea level rise against high resolution coastal topography (digital elevation models). These inundation maps will help coastal programs identify the lands most vulnerable to sea level rise, and estimate impacts associated with storm surge and flooding events on a large scale. Several of these maps have also been produced by federal agencies on a regional scale, including the EPA and the USGS.<sup>8-9</sup>

While these models of coastal inundation exist in some areas of the country, and detailed shoreline erosion models exist in some areas, few models appear to combine the two. Sea level rise, storm surge, erosion, circulation, wave climates, sediment budgets, and other shoreline changes are interrelated. Large-scale inundation models are effective in identifying low-lying lands, but coastal states and communities will need more detailed and complex models of future changes in coastal geomorphology, hydrological conditions, and human alterations and responses (seawalls, sand replenishment, etc.) in order to adequately assess social, environmental, and economic vulnerabilities. The EPA has established a Coastal Elevations and Sea Level Rise Advisory Committee to address these issues through a study of the impacts of sea level rise across the mid-Atlantic region (New York to North Carolina) as part of the U.S. Climate Change Science Program.<sup>10</sup> **State coastal programs would benefit from the development of uniform methods for modeling local- and regional-scale shoreline changes associated with varying sea level rise projections; as well as guidance for monitoring changes along “sheltered” coastlines.**<sup>11</sup>

### Impacts of Accelerated Sea Level Rise on Social and Economic Resources

A related need exists for coastal programs in assessing vulnerabilities to anticipated sea level rise. The potential for significant losses of economic and cultural resources, such as public infrastructure (wastewater treatment systems, roads, ports, public facilities, river flood protection levees and bridge clearances for shipping interests),<sup>12</sup> historic and cultural sites, shoreline property values, and coastal tourism activities, among other losses, are difficult to quantify, but need to be anticipated and planned for in light of sea level rise projections, shoreline change models, and potential adaptation strategies. **NOAA should partner with other federal agencies to provide best practices, case studies, trainings/workshops, and/or software tools focused on community-level and statewide vulnerability assessments and adaptation planning for state coastal programs.**

### Impacts of Accelerated Sea Level Rise on Coastal Habitats

Several coastal programs have begun focusing on the impacts of accelerated sea level rise on coastal wetlands, as well as potential conservation, mitigation, and restoration strategies. However, further research is needed to better understand natural erosion and deposition cycles in tidal marshes, and to improve our ability to predict the effects of accelerated rates of sea level rise. Natural sediment sources, the movement of sediment within the system, and the locations and rates of sediment deposition need to be quantified for discreet shoreline reaches in order for predictive capabilities to be developed. Artificial sediment supply needs to be further evaluated as a mitigation option. Similarly, beaches respond to the background sea level rise rate through the accumulation of sand on the berm and dune from wave and wind forces. The ability of sand supplies in coastal systems to keep pace with an accelerated rate of sea level rise is not well understood. **There continues to be a need for improved models that predict the migration and/or vertical accretion of coastal wetlands and beaches in response to accelerated sea level rise, information on the costs of response options, and the consequences of taking no action. There is also a need for research on the anticipated role of sea level rise in beach nourishment frequency and volumetric requirements; as well as the potential use of artificial sediment supplies to “nourish” coastal wetlands.**

Other habitats at risk include submerged aquatic vegetation, coral reefs, oyster reefs, and fringing maritime forests. Thermal and chemical changes in coastal waters may affect marine species survival and distributions. Further research is needed to understand the potential for latitudinal habitat changes as northern climates begin to resemble today's southern climates.

### Other Climate Change Impacts

As described in the opening paragraph of this report, coastal zones are subject to a wide variety of climate change impacts, many of which are not well understood. **State coastal programs need further information, research, and guidance on issues like invasive species introductions, ocean acidification, ecosystem migration, freshwater resources, and improved storm surge models.** Participants suggested that coastal and ocean observing systems within the U.S. Integrated Ocean Observing System (IOOS) will generate useful information products related to real-time and projected climate, storm surge, and physical, chemical, and biological changes in ocean and coastal systems. Guidance is also needed for modeling local/regional-scale effects of storm events coupled with rainfall, river flooding, and sea level rise projections.

### Policy Analyses

There is a general need for federal support of state and local policy analyses to increase awareness among state coastal program managers of adaptation strategies and policy options, such as those described in this report, as well as their potential implications. In particular, **there is a need for assessments of the social, legal, and economic issues related to sea level rise and shoreline “retreat,” armoring, renourishment, and “no action” management alternatives across developed and urbanized coastlines.**

### Information Synthesis

While the EPA and other federal agencies provides excellent synthesis products related to climate change, **state coastal programs need a “clearinghouse” for federal, state, and local programs, research activities, and other information related to climate change in**

**their region.** Coastal programs need to be aware of research that the USACE, FEMA, USGS, EPA, NOAA and others are conducting (or have conducted) in their state or region, and of management activities and lessons learned by neighboring states. State coastal programs also described a need for a single source for the most up-to-date sea level rise and climate projections and information at the national level, including documented coastal and ocean changes that have occurred or are occurring due to climate change. Beyond a single inventory, state participants expressed an interest in establishing sustained mechanisms for regional collaboration on climate change issues.

### Technical Training

Coastal states recognize that a sustained technical training strategy for state and local government officials and coastal decision-makers is also required to help address the ongoing need for informed decisions regarding climate change. Many states, working with partner agencies, have conducted workshops on climate change issues such as sea level rise. Effective coastal training programs are already in place that can be utilized to help meet this need; examples include the NERRS Coastal Training Programs that provide science-based training for local decision-makers, and NOAA's Coastal Services Center training programs on GIS and coastal hazards.

Training needs for state and local officials include:

- local and regional perspectives on impacts of climate change;
- technical training in shoreline delineation, mapping, and vertical and horizontal reference datums, mapping errors and error quantification;
- sea level rise, shoreline change models, and adaptation strategies for coastal communities;
- monitoring and mitigating impacts associated with ecological changes, such as wetlands migration.

**The NERRS Coastal Training Programs, NOAA's Coastal Services Center, and Sea Grant should partner with state coastal programs to design and conduct technical training programs targeting state and local officials.**

## *Federal Policy Needs*

### Federal Coordination on Coastal Adaptation

**There is a need for a clear federal strategy for intergovernmental coordination on coastal adaptation to climate change.** The strategy should clearly define the roles of the various federal agencies, and the mechanisms by which federal programs will coordinate with state partners on coastal adaptation issues. Because the impacts of climate change will vary regionally, and because regional coastal/ocean governance initiatives are well underway, an opportunity exists to develop a regional framework for federal-state coordination on climate change adaptation. (Some states also pointed to a parallel need for a clear federal strategy for the reduction of greenhouse gas emissions).

**A key component of this federal strategy for coastal adaptation should be a new, stronger focus on interagency cooperation between NOAA, state coastal management programs, FEMA, and state floodplain managers.** The recent collaboration between the NOAA Coastal Services Center and the Association of State Floodplain Managers (ASFPM) that led to the development of the “No Adverse Impact (NAI) in the Coastal Zone” toolkit is an encouraging first step.<sup>13</sup> Several state coastal programs advocated the NAI policy in survey responses, and described a need for further training or workshops on this subject. However, because FEMA’s flood-related programs are critical drivers of shoreline development and are the basis for many local ordinances, NOAA and state coastal programs also need to be made aware of or included in these activities. This includes: the ongoing Flood Map Modernization Initiative,<sup>14</sup> any federal discussions regarding modifications of the National Flood Insurance Program, and any other opportunities to advance floodplain policies that take into account erosion and sea level rise projections and increased risks of storm damage in local ordinances of coastal communities.

## Expanding the Coastal Zone Management Act

**The Coastal Zone Management Act (CZMA) should be recognized by Congress and the Administration as one of the primary statutes that can foster adaptation to climate change at the state and local levels.** States coastal programs often directly manage shoreline development, and work closely with local governments on land use planning, habitat acquisition, and a variety of other activities. States coastal programs also play a key role in coordinating state and local agencies, and have the authority to review and condition federal permits in the coastal zone.

State coastal programs are interested in amending the CZMA to expand their climate change authorities and to allow states and territories to develop specific coastal climate change plans or strategies. States also support increased funding for climate change activities and support legislation that would encourage NOAA and other agencies to assist the states via technical assistance, mapping, modeling, data, and forecasting products, and intergovernmental coordination. However, federal activities related to coastal adaptation should be coordinated closely with states by involving coastal zone management programs early in the planning process.

### **Next Steps**

Among other goals, this report is intended to educate Congress and federal agencies and programs about coastal states' needs with respect to climate change. The Coastal States Organization will distribute the report to federal officials, and hopes that Congress, the federal Coastal Coordination Committee, the Joint Subcommittee on Ocean Science and Technology (JSOST), the Council for Environmental Quality's Subcommittee on the Integrated Management of Ocean Resources (SIMOR), and others will suggest ways that the federal government might help address the needs identified in this report.

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## Appendix A: CSO Survey

The Coastal States Organization's Climate Change Work Group is preparing a report that explores the current and future roles of state coastal programs in addressing climate change.

### To do this, we need your help!

While other reports have synthesized broader state-level climate change initiatives (e.g. [www.pewclimate.org](http://www.pewclimate.org)), this report is being developed to:

- Inventory what actions the state CZM programs are taking on climate change;
- Educate Congress on the role state CZM programs can play in climate change;
- Inform CSO and NOAA on CZMA "Envisioning the Future of Coastal Management" efforts and reauthorization;
- Inform federal science programs on key research, information, and data needs;
- Provide information exchange among states on the strategies and approaches states are using to address climate change.

Under each item below, please concisely summarize the activities or needs of your state or territory's coastal zone management program in 200 words or less. We recognize there are many programs at the federal and state level that address climate change either directly or indirectly; however, the purpose of this survey is to find out specifically what the CZM programs are doing and what they need in the future.

For the purpose of this survey, we have defined the following terms for you:

- CZM or Coastal Program – This is limited to the state CZM programs authorized under the Coastal Zone Management Act. Please do not report on the National Estuarine Research Reserves, Sea Grant, National Estuary Programs, or other partners' activities.
- Climate Change – Regional changes in climate due to global warming, which may result in a variety of impacts to coastal areas, including sea level rise, lake level changes, ocean acidification, habitat loss, loss of freshwater resources, and increased frequencies or intensities of coastal storms, among others.
- Involvement – The CZM program has had a specific function, grant task, or mechanism (e.g. government coordination) to be involved in or carry out activities related to climate change in the past ten years.

The results of this survey will be compiled by members of the Climate Change Work Group and synthesized into a final report.

We ask you to please send an electronic copy of your completed survey to Braxton Davis ([DavisBC@dhec.sc.gov](mailto:DavisBC@dhec.sc.gov)) or Jena Carter ([jcarter@coastalstates.org](mailto:jcarter@coastalstates.org)) by **May 23, 2007**.

Please describe your Coastal Zone Program's...

- 1) ... establishment of any climate change-related initiatives.
- 2) ... involvement in broader *Governors' or statewide* climate change policy initiatives.
- 3) ... involvement in climate change *research initiatives* (including mapping activities, vulnerability assessments, modeling, etc.)
- 4) ... tools/strategies/authorities being used to address *adaptation or mitigation of climate change impacts*.
- 5) ... tools/strategies/authorities being used to address *reduction of greenhouse gas emissions* – either directly (i.e. energy siting) or indirectly (energy efficiency - green development, etc).
- 6) ... existing *funding sources* for climate change-related efforts (e.g. federal, state match, NERRS, other partner funds)?
- 7) ... *resource* needs (e.g. technical, staffing, funding) to better address climate change.
- 8) ... *research/data/information* needs from the NOAA Climate Change Program, EPA, and/or other federal science programs.
- 9) ... *federal policy* needs (that may be addressed by CSO) to better address climate change.