Coastal Informatics:
Web Atlas Design and Implementation

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Section 2
Coastal Web Atlas Case Studies around the World

Chapter 5
Overview of Coastal Atlases

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ABSTRACT

This chapter provides a brief overview of various coastal web atlas projects around the world, providing a contextual bridge to the atlas case studies of Chapters 6-14. A summary of the policy context within which many European atlases operate is followed by a summary of other efforts emerging in Australia, the Western Pacific, Africa, and the Caribbean (as facilitated mainly by the Ocean Data and Information Network of the United Nations Educational, Scientific and Cultural Organization's International Oceanographic Data and Information Exchange). Atlas projects in the U.S. are summarized mainly via the results of a recent national survey of coastal managers reporting on the deployment and content of their atlases, with concluding thoughts on where there might be opportunities to develop approaches for a federated coastal atlas of the U.S.

INTRODUCTION

Having defined and explained the principles of coastal web atlas design, implementation, and interoperability, it is the task of Section 2 of the book to present various case studies of actual projects in action (Chapters 6-14). The aim of these case study chapters is to appreciate the diversity in approaches (e.g., lead agency or organization, intended audiences, software tech-

nologies used, degree of interactivity, available datasets, geographic extent of atlas, etc.) but also to understand, as pointed out in Hills *et al.* (2006) that certain aspects of good practice transcend these various categories, regardless of user, local or regional situations and culture. For example, a recent U.S. workshop hosted by the Washington State Department of Ecology and National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center, brought together over thirty participants from Alaska, British Columbia, Washington, Oregon and California, representing twelve different coastal web atlas (CWA) projects (including a legislative atlas and digital multipurpose marine cadastre for the entire U.S.). These atlases were presented in detail, but there were also discussions and a data table drawn up on important comparisons between the atlases from which to learn (e.g., distinguishing features, data included, challenges encountered, future directions, textual vs. map content, geographic extent, inland vs. marine extent, limits to number of displayed layers, public access to layers, and more; Purce, 2009), and how atlases may ultimately work together for regional ocean governance.

This chapter provides a gateway to the case studies of the chapters that follow, by first summarizing very briefly the policy context within which the European atlases are developing, four of which are described in detail in Chapters 7, 10, 13, and 14. Next, a summary of similar efforts in Australia, the Western Pacific, Africa, and the Caribbean are included, two of which are detailed in Chapters 11 and 12, but the rest are either nascent efforts not yet resulting in mature atlases or for which full case studies are not yet available. Finally, an overview of atlas efforts in the U.S. is given from the standpoint of a recent national survey of coastal managers who reported on the characteristics of their atlases, the audiences served, and the various technical issues. This provides some context for the U.S. case study examples presented in Chapters 6, 8, and 9.

OVERVIEW OF EUROPEAN UNION ATLASES

Recently a number of important policy decisions and developments have taken place in the European Union (EU) regarding the management of coastal, marine and maritime resources. These will shape the design, functioning and sharing of coastal and marine information services in the coming years, including the design and implementation of CWAs. One critical need is to streamline monitoring and reporting activities that support the production of policy-relevant assessments of the marine and coastal environment, including an emphasis on ecosystem-based management issues. Several activities at the EU level have been initiated and/or further developed in 2007-2009 to prepare the production of regular indicator-based assessments and the delivery of information services over the period 2009 to 2012 in support to new policies adopted by the EU.

Interoperable coastal information systems and useful operational services are becoming of more use to a large community of practitioners and users at the coastal zones across the world. In Europe, this is in particular important in light of the emerging Integrated Maritime Policy (IMP) of the EU, where initiatives such as the web-based European Atlas of the Seas, broad-scale seabed habitat mapping and promotion of maritime spatial planning have prominent roles (European Commission, 2007; Vivero *et al.* 2007; see also Chapter 16).

A 2008 EU marine environmental law (Marine Strategy Framework Directive or MSFD) aims at applying an ecosystem-based approach to the management of human activities. There is work going on towards the establishment of a limited set of pan-European common indicators for the marine environment by 2010. It should be noted that "pan-European" includes the whole continent from the Urals to Portugal, but at this time only the EU member states will be participating.

Within the framework of the EU initiative on global monitoring for environment and security (GMES; joint initiative of the European Commission and the European Space Agency), the EU is developing operational oceanography services in line with Global Ocean Observing System community needs. Operational oceanography has been identified as a GMES fast track service. These core and derivative web services services are to be integrated into European Marine Observation and Data Network (EMODNET) and a future European marine information system and thus be made easily available to the European user community; development of coastal information systems also facilitates the coordination of on-ground monitoring data in the context of GMES.

As part of the implementation of the EU Recommendation on Integrated Coastal Zone Management (ICZM) the Member states together with EU organisations have identified core sets of indicators for sustainable development and ICZM effectiveness. Regional and national authorities have tested this set, with new activities planned in the Mediterranean. Also, the identification and mapping of important biotopes, ecosystems and protected areas - under EU nature directives - is being gradually extended to coastal and marine areas with the view to create a coherent view of ecological networks. These activities include a focus on coastal zone use potentials, vulnerabilities and adaptations to environmental change.

European cooperation in coastal atlas development is beneficial for the integrated assessment of coastal zones and marine environment and wider implementation of Shared Environmental Information System (SEIS) initiative and the INfrastructure for SPatial InfoRmation in Europe (INSPIRE) directive (e.g., Masser, 2007). Key objectives of such cooperation are:

- Achieving the atlases interoperability at the operational level (proof-of-concept) and validating first outcomes;
- Informing and attracting a larger popula-

tion of potential stakeholders of the activity, and promoting an exchange of best practice in coastal and ocean information services;
- Developing a long-term strategy for effective governance of coastal atlases and design of further applications for International Coastal Atlas Network or ICAN (Dwyer and Wright 2008; see also Chapter 15);
- To offer information support for integrated maritime governance of coastal regions and implementation of maritime spatial planning.

This European experience can be shared via international cooperation by way of specific projects contributing to global monitoring and assessment activities, especially under the Global Earth Observation System of Systems (GEOSS). GEOSS promotes scientific, data-centric connections networks of observational systems (hence the "system of systems"), while also promoting applications across nine societal benefit areas (water, climate, weather, ecosystems, energy, health, agriculture, disasters, biodiversity; Craglia *et al*., 2008). Cooperation should also support the UN initiative on "Assessment of Assessments" (Global Regular Assessment of Marine Environments or GRAME). GRAME aims to evaluate existing marine assessments and to propose a framework for a regular reporting process on the state of the marine environment globally.

ATLASES IN AUSTRALIA, THE PACIFIC, AFRICA AND THE CARIBBEAN

There are undoubtedly scores of CWAs around the world that we have yet to learn about, and hence are beyond the scope of this chapter and this book. But this section briefly touches on efforts that were presented at a third workshop of the International Coastal Atlas Network (ICAN)

in Copenhagen, Denmark (Dwyer and Wright, 2008). With regard to Australia, there was a coastal atlas project launched in 1998, originally conceived of as a network of Australian government and state/territory nodes using a variety of interactive mapping tools. The nodes were largely managed by the Commonwealth of Australia, as well as by various states and territories. The commonwealth node has now been incorporated into an Australian Natural Resources Atlas, which is primarily focused on terrestrial data. Coastal data can be found primarily in the New South Wales Coastal Atlas.

Another major effort is the Australian Marine Spatial Information System developed by Geoscience Australia, which contains over 80 layers of information including maritime boundaries, bathymetry, physical and environmental information, legal interests, fisheries and shipping, extending beyond the coastal realm to the Australian Exclusive Economic Zone and in the Antarctic.

In the Pacific region the Regional Sub-Commission for the Western Pacific (WESTPAC), within Intergovernmental Oceanographic Commission or IOC of UNESCO, focuses on small Pacific island nation states and their vulnerabilities to climate change. IOC's International Oceanographic Data and Information Exchange (IODE) is in the process of establishing an Ocean Data and Information Network (ODIN)-WESTPAC to strengthen regional networking of marine related libraries and information resources in the region. Similarly, the South Pacific Applied Geoscience Commission (SOPAC), administered and funded by member counties, as well as the EU, the Office of US Foreign Disaster Assistance, and several UN agencies, has set up MapServer installations on fourteen Pacific islands.

The IODE ODIN program in general links training, equipment, and operational support (i.e., how to set up data centers) within regional contexts focused on Africa, South America, the Caribbean, and Pacific. Two major ODIN efforts are the African Marine Atlas and the Caribbean Marine Atlas (see Chapters 11 and 12). Figure 1 also diagrams related efforts throughout Africa.

Figure 1. Example of the many partners of, contributors to and linkages with the African Marine Atlas project at global, continental, regional, and national levels from Dwyer and Wright (2008). Acronym definitions available online at: http://ican.science.oregonstate.edu/acronyms. (© 2009, Oregon State University & University College Cork. Used with permission.)
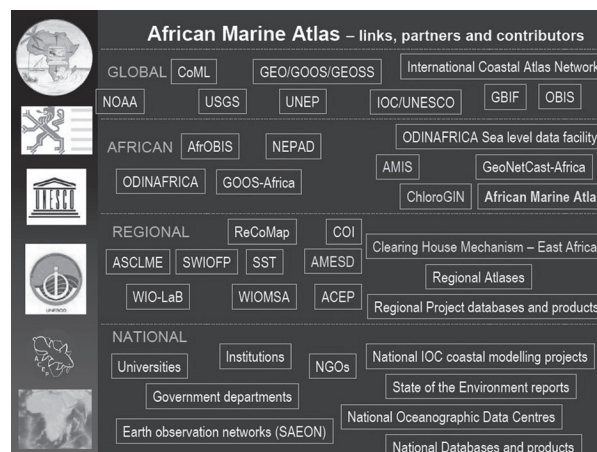
OVERVIEW OF U.S. ATLASES: A TALE OF TWO SURVEYS

The recent reports of the Pew Oceans Commission and the U.S. Commission on Ocean Policy (Pew Oceans Commission, 2003; Juda, 2005) have clearly shown that coastal communities are critical to the economy of the U.S., and to its overall health and well-being as a nation, and further that geographic technologies will be a fundamental, critical tool to address the threats of climate change, coastal hazards, overpopulation, and more. In a 2006 survey of coastal managers, the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center (Center) found that almost 75% of the respondents considered the geographic information system (GIS) to be a highly useful tool in their jobs (NOAA Coastal Services Center, 2006). According to Crossett *et al.* (2004), coastal counties in the U.S. are home to over 53% of the population, while these counties consist of only 17% of the land mass. High population densities and the coastal regions' need for geographic information make coastal atlases an essential resource for a range of coastal management activities. In addition to providing geographic information to coastal managers, the atlases can also provide a valuable educational resource to the local communities on ecosystems, coastal hazards, and a vast number of other topics.

Though almost all coastal states and territories provide access to geographic information and related tools and materials in atlases, there is very little coordination between neighboring states or regions on the format of the information provided. Groups such as ICAN seek to document best practices for CWAs (see Chapter 15), but there are no requirements or compelling business drivers for states or other groups to follow the best practices or coordinate across state boundaries. This may change as various regional ocean governance bodies are formed within the United States to address ocean and coastal management issues on a regional basis.

In October of 2008, ICAN and the Center performed an informal survey of the coastal atlas sites available for each coastal state and territory to better understand what type of information is being provided, in what manner, and where there might be opportunities to develop approaches for a federated coastal atlas of the U.S. The survey consisted of linking to atlas sites provided by the Office of Ocean and Coastal Resource Management's partner states website (OCRM, 2009). This was then followed by further Internet searches using keyword combinations, including individual state names, "atlas," "coastal atlas," "coastal zone management," "GIS," and "coastal maps." This Internet-based search allowed for the collection of information on the types of geographic mapping resources available (static vs. dynamic), main data themes, and availability of other resources (tools, outreach materials, permitting information, etc). The results were recorded in Microsoft Excel, and some basic statistics were tabulated (See Appendix).

Of the thirty-four coastal states and territories in the U.S., all but one had at least one site with a mapping component (Figure 2 and see Appendix). Fifteen of the thirty-four (44%) coastal states and territories had multiple atlases. Of the fifty-five total atlas sites surveyed, forty-four (80%) had a mapping component available, and, of those forty-four, thirty (68%) had interactive maps. The interactive maps themselves were quite varied. Some sites had clickable PDF or JPEG images, while others contained interactive mapping applications that use ESRI's ArcIMS software, open source map servers, or mashups (web applications that combines data or functions from two or more sources – e.g., Google Maps with weather forecasting information – to create a new service). Mapping tools were fairly consistent and primarily included the ability to zoom in and out, pan around the map, turn map layers on and off, and identify features. Some atlases had additional

Figure 2. Map of the thirty-four coastal states of the U.S., including the Great Lakes region. (© 2009, under the auspices of the GNU Free Documentation License, Creative Commons Attribution ShareAlike 3.0, http://creativecommons. org/licenses/by-sa/3.0/. Used with permission.)
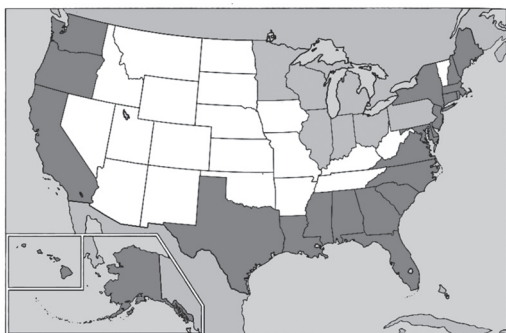
map tools, such as Alaska's dynamic nearshore fish query and Washington State's Percent Land Cover tool.

The data themes available were disparate and varied according to the principal coastal management issues for each given state. In addition, the geographic scope of the data was very different for many of the atlases. Some atlases were focused solely on the coastal region, while others were statewide geographic clearinghouses that contained coastal data. The Center found in its prior survey of coastal managers (NOAA Coastal Services Center, 2006) that the most common datasets used for coastal management were current shoreline, coastal land use and land cover, bathymetry, elevation and topography, sensitive habitats, protected areas, and public access areas. These data types, though not quantified in the current survey, were among the most commonly seen.

In addition to maps, most of the atlases had online technical assistance resources. Two of the most common resources were the ability to fill out or search building or dock permits in the coastal area, and the listing of laws and regulations specific to the coastal region. Many sites had educational materials available, ranging from

short overviews of the coastal region ecosystem to full scientific white papers. Only a few of the atlas sites provided additional tools to aid coastal managers with decision-making. Examples of decision-making tools include the Oregon Coastal Atlas' Coastal Risk and Vulnerability Assessment Tool (documented also in Haddad *et al.,* 2005), the Illinois Ecological Compliance Assessment Tool (EcoCAT), the Gulf of Maine's Northeast Regional Ecosystem Assessment, and the Michigan Coastal Management Program's Lake Superior Decision Support Tool.

CONCLUDING THOUGHTS

CWAs are an important and growing resource for coastal managers, scientists, and the public living within those areas. Though most U.S. coastal states and territories have a site to provide information about their coastal regions, there is little consistency in how the information is presented. This is still also the case in Europe and other regions of the world. Survey results show that coastal areas each have their own issues to address, which is one reason why there is little similarity between the types of information provided. Larger-scale issues such as climate change will undoubtedly provide an outlet for different states and regions to address them in a unified manner, through an interconnected network of atlases (see Chapters 15 and 16).

Mapping interfaces of atlases will be another area for future growth within a federated approach. With the advent of mashup mapping technologies, it has become easier for novice developers to create informative maps for little to no cost. With more Web map applications appearing across the Internet, it is likely that coastal managers and the public have become more aware of and more comfortable with the use of geographic mapping services within their websites. CWA developers should continue to take advantage of these tech-

nologies to better serve their constituents in the coastal zone.

To comply with federal and industry standards for geographic data management in the U.S., federal agencies and state and local governments must meet the Office of Management and Budget (OMB) requirements outlined in the OMB Circular A-16 (OMB, 2009) mandate by documenting all GIS and geographic data using the Federal Geographic Data Committee's (FGDC) Content Standard for Digital Geospatial Metadata (CS-DGM; FGDC, 2009), and make their metadata publicly accessible via the FGDC Clearinghouse's E-Government Geospatial One-Stop (GOS) portal (GOS, 2009), as well as the Data.gov portal (Data.gov, 2009). Adherence to OMB and other federal and industry standards (such as the Open Geospatial Consortium, or OGC, and International Standards Organization or ISO), for geographic data and metadata is a critical component of data quality, data management, data distribution and access, and data interoperability. As described in Section 1 of the book, data layers and maps used in CWAs should adhere to FGDC or ISO metadata standards to ensure that all data and maps are properly documented and made accessible to the public for use.

And finally, though many states and countries have several CWAs with different foci (e.g., ecology, hazards, etc.), the atlases do not always link to one another, making it still difficult for a user to find information (solutions for which were proposed in Chapter 4). Therefore, states and nations should seek neighboringneighbouring partnerships to better provide relevant coastal information for regional ocean governance (as evidenced by the recent west coast coastal atlas workshop mentioned at the outset of this chapter).

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KEY TERMS AND DEFINITIONS

Coastal Web Atlas: A collection of digital maps and datasets with supplementary tables, illustrations and information that systematically illustrate the coast, oftentimes with cartographic and decision support tools, all of which are accessible via the Internet. Also known as web atlas, digital atlas, digital coastal atlas.

Content Standard: A document that fully outlines all the vital information pertaining to a data set's source, content, format, accuracy, and lineage (i.e., what processing changes the data set has gone through over time). A national and international content standards for geographic metadata

Federated: A condition in which it is possible to simultaneously search multiple sources (such as coastal web atlases or other online databases or resources) and to place them on a single map. A federated search often provides a single search interface, as well as single map canvas on which to place data layers.

Information Management: The means by which an organization, agency, or individual collects, documents, shares, and uses information. It

often involves creating or identifying the appropriate resources to find quality information in order to fill gaps in knowledge. Coastal web atlases are therefore a key component of information management as applied to coast region of the world.

Metadata: Information that fully describes or documents a dataset, such as its geographic coverage, quality, completeness, accuracy, etc. are a "pedigree" of sorts for a data set and helps you to judge its "fitness for use" or reliability, thereby helping one to use it more appropriately and efficiently. Metadata allow a potential user, for comparative purposes, to understand how the data were collected. They also provide the all-important details of how you can actually obtain the data in question, or who best to contact. Data that do not have accompanying metadata are often hard to find, difficult to access, troublesome to integrate, and perplexing to understand or interpret.

Spatial Data Infrastructure or SDI: A framework via an organization of people or government agencies, via the Internet, or via a series of guiding policies or standards to assist people with acquiring, processing, using, and preserving spatial data. The spatial data are often in geographic information system (GIS) format, are not, but not limited to this.

Web GIS: Geographic information systems functions as deployed via a web site or series of web sites rather than just on the desktop.

CSDGM: Content Standard for Digital Geospatial Metadata.

EcoCat: Ecological Compliance Assessment Tool.

EMODNET: European Marine Observation and Data Network.

FGDC: Federal Geographic Data Committee.

GEOSS: Global Earth Observation System of Systems.

GMES: Global Monitoring for Environment and Security.

GRAME: Global Regular Assessment of Marine Environments.

ICAN: International Coastal Atlas Network.

ISO: International Standards Organization.

INSPIRE: INfrastructure for SPatial InfoRmation in Europe.

MSFD: Marine Strategy Framework Directive.

OGC: Open Geospatial Consortium.

SEIS: Shared Environmental Information System

APPENDIX

Table 1. Coastal Atlases of the U.S. Resulting from 2008 Survey. (All are official partners in the U.S. Coastal Zone Management Program.)

State	Organization	Maps	URL
AK	**Alaska Coastal Management Program**	yes	http://www.alaskacoast.state.ak.us/
AL	**Outdoor Alabama**	yes	http://www.outdooralabama.com/
AL	**Alabama Coastal Area Management Program**	no	http://www.adem.state.al.us/fieldops/coastal/coastal.htm
AS	**Environment Division**	no	http://www.asdoc.info/CZM/1CZMGT.htm
CA	**Central Coast Joint Data Committee**	no	http://www.ccjdc.org/index.htm
CA	**California Coastal Commission**	yes	http://www.coastal.ca.gov/
CT	**Connecticut's Changing Landscape**	yes	http://clear.uconn.edu/projects/landscape/analysis/calcap.htm
CT	**Connecticut Coastal Management Program**	no	http://www.ct.gov/dep/cwp/view.asp?a=2705&q=323536&depNav_GID=1622
DE	**Delaware Coastal Programs**	yes	http://www.swc.dnrec.delaware.gov/coastal/Pages/CoastalPrograms.aspx
FL	**Florida Blueways**	yes	http://research.myfwc.com/features/view_article.asp?id=3108
FL	**Florida Coastal Management Program**	no	http://www.dep.state.fl.us/cmp/
GA	**Georgia Coastal Comprehensive Plan**	yes	http://www.georgiaplanning.com/coastal.htm
GA	**Coastal Resources Division**	yes	http://crd.dnr.state.ga.us/content/displaynavigation.asp?TopCategory=6
Guam	**Guam Bureau of Statistics and Planning**	yes	http://www.bsp.guam.gov/content/category/6/15/37/
HI	**Hawaii Coastal Zone Management**	yes	http://hawaii.gov/dbedt/czm/
IL	**Coastal Management Program**	yes	http://dnr.state.il.us/owr/CMP/
IN	**Lake Rim GIS**	yes	http://igs.indiana.edu/arcims/lrim/index.html
IN	**Indiana Lake Michigan Coastal Program**	no	http://www.in.gov/dnr/lakemich/
LA	**Louisiana Coastal Area**	no	http://www.lca.gov/index.aspx
LA	**Coastal Louisiana Resource Information System**	yes	http://www.ladigitalcoast.uno.edu/index.html
LA	**Coastal Management Division**	no	http://dnr.louisiana.gov/crm/coastmgt/coastmgt.asp
MA	**Mass Office of Geographic and Env. Information**	yes	http://www.mass.gov/mgis/massgis.htm
MD	**Eyes on the Bay**	yes	http://mddnr.chesapeakebay.net/eyesonthebay/index.cfm
MD	**Maryland Shorelines Online**	yes	http://shorelines.dnr.state.md.us/default.asp
MD	**Chesapeake and Coastal Program**	no	http://www.dnr.state.md.us/bay/czm/index.html
ME	**Maine Coastal Program**	Yes	http://maine.gov/spo/coastal/resources/dataandmaps.htm
ME	**Department of Marine Resources**	yes	http://www.maine.gov/dmr/maps/mapindex.html
ME	**Gulf of Maine Coastal Program**	no	http://www.fws.gov/r5gomp/gisindex.htm
ME	**Gulf of Maine Council**	yes	http://www.gulfofmaine.org/
ME	**Earth Systems Data Collaborative**	yes	http://www.datacollaborative.unh.edu/gulfofmaineportal.shtml
MI	**Coastal Management**	yes	http://www.michigan.gov/deq/0,1607,7-135-3313_3677_3696---,00.html
MN	**Minnesota Coastal GIS**	yes	http://www.nrri.umn.edu/coastalGIS/default.html

Table 1. continued

State	Organization	Maps	URL
MN	**Minnesota Lake Superior Coastal Program**	**yes**	http://www.dnr.state.mn.us/waters/lakesuperior/index.html
MS	**Coastal Management and Planning Office**	**yes**	http://www.dmr.state.ms.us/
NC	**Division of Coastal Management**	**yes**	http://dcm2.ehnr.state.nc.us/
NC	**North Carolina Coastal Reserve & NERR**	**yes**	http://www.nccoastalreserve.net/
NH	**New Hampshire Dept. of Environmental Service**	**yes**	http://www2.des.state.nh.us/gis/onestop/
NJ	**Jacques Cousteau NERR**	**yes**	http://www.jcnerr.org/
NJ	**New Jersey Coastal Management Program**	**yes**	http://www.state.nj.us/dep/cmp/czm_data.html
NJ	**New Jersey Dept. of Environmental Protection**	**yes**	http://www.state.nj.us/dep/gis/depsplash.htm
NMI	**Coastal Resources Management Office**	**yes**	http://www.crm.gov.mp/default.asp
NY	**Long Island South Shore Estuary Reserve Council**	**no**	http://www.estuary.cog.ny.us/
NY	**New York State Division of Coastal Resources**	**yes**	http://www.nyswaterfronts.com/maps_relief.asp
OH	**Ohio Department of Natural Resources**	**yes**	http://www.dnr.state.oh.us/AtlasGIS/tabid/19562/Default.aspx
OR	**Oregon Coastal Atlas**	**yes**	http://www.coastalatlas.net/
PR	**Puerto Rico Coastal Zone Management Program**	**yes**	http://www.drna.gobierno.pr/oficinas/arn/recursosvivientes/costasreser-vasrefugios/pmzc/coastal-zone-management-program
RI	**Coastal Resources Management Council**	**yes**	http://www.crmc.ri.gov/
SC	**South Carolina Office of Ocean and Coastal Resource Management**	**yes**	http://www.scdhec.net/environment/ocrm/
TX	**Texas Coastal Management Program**	**yes**	http://www.glo.state.tx.us/coastal/cmp.html
VA	**Center for Coastal Research Management**	**yes**	http://ccrm.vims.edu/index.html
VA	**Virginia Coastal Zone Management Program**	**yes**	http://www.deq.state.va.us/coastal/
VI	**Division of Coastal Zone Management**	**yes**	http://www.czm.dpnr.gov.vi/
WA	**Washington State Department of Ecology**	**yes**	http://www.ecy.wa.gov/programs/sea/sma/atlas_home.html
WI	**Wisconsin Lake Superior Coastal Mapping Portal**	**yes**	http://maps.aqua.wisc.edu/lscmp/wlscmp_index.htm
WI	**Wisconsin Coastal Management Program**	**yes**	http://www.doa.state.wi.us/section.asp?linkid=65&locid=9