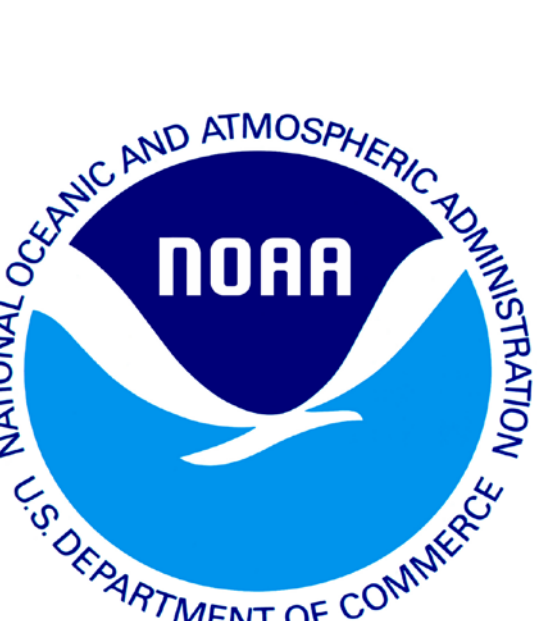




A U.S. Integrated Ocean Observing System (IOOS®): Operational Directional Wave Observation System

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Introduction

A National Plan for observing wind-generated ocean waves has been developed for the United States as an element of the US Integrated Ocean Observing System (IOOS®). Surface gravity waves (with frequencies ranging from 1.0 to 0.033 Hz) entering and crossing the nation's waters have a profound impact on navigation, offshore operations, recreation, safety, and the economic vitality of the nation's maritime and coastal communities. Although waves are a critical oceanographic variable and measurement assets exist, there are fewer than 200 observation sites nationwide (figure below) and only about half estimate directional waves.



Existing US wave observation sites

The goal of this National Wave Measurement Plan is to provide the US with seamless coverage through a well-designed system of directional wave measurements with a level of accuracy that will satisfy the requirements of the broadest range of wave information users. To achieve this goal, the plan requires that the observations satisfy a *First-5* standard. *First-5* refers to 5 Fourier coefficients defining variables at the entire range of energy carrying frequencies. The first variable is the wave energy, related to the wave height, and the other four are the first four coefficients of the Fourier series that defines the directional distribution of that energy. High quality *First-5* observations can be used to resolve two component wave systems at the same frequency, if they are at least 60 degrees apart; whereas other systems cannot.



The proposed plan is a collaborative effort of NOAA and the USACE prepared for the Interagency Working Group on Ocean Observations. It was developed by a steering committee of authors, reviewed by a team of wave observation experts from federal agencies, industry, academia and IOOS® Regional Associations.

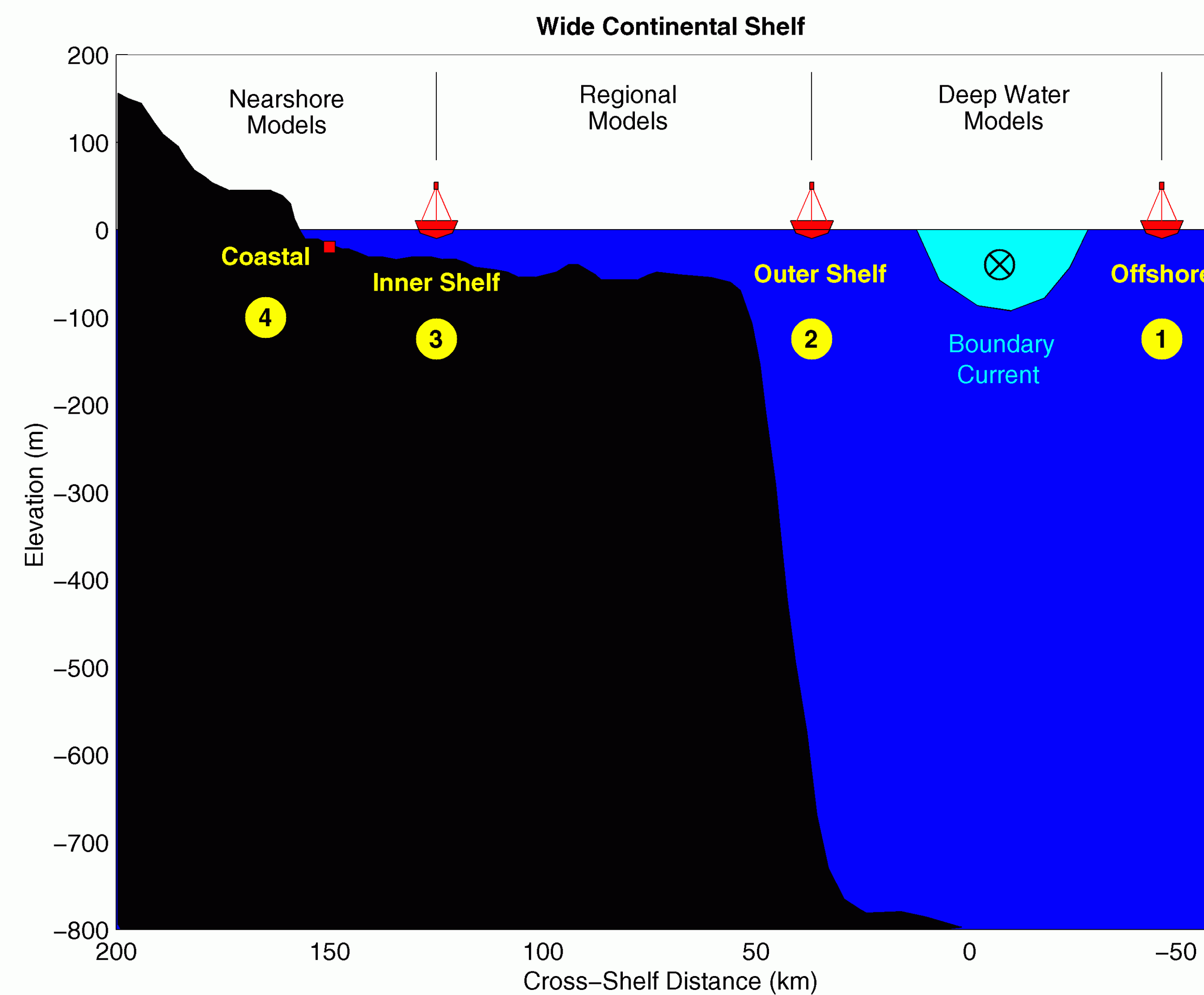
For additional information and to download the plan, visit:

<http://ioos.gov/program/wavesplan.html>

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Network Design

The network design is based on four along-coast subnets shown below:



Offshore Subnet: deep ocean outpost stations that observe waves, prior to passing through coastal boundary currents;

Outer-Shelf Subnet: stations along the deepwater edge of the continental shelf-break where waves begin to transition from deep to shallow water behavior;

Inner-Shelf Subnet: on wide continental shelves (Atlantic and Gulf of Mexico), shallow water stations to monitor cross-shelf bottom dissipation and wind generation of waves;

Coastal Subnet: shallow coastal wave observations, which provide local, site specific information.

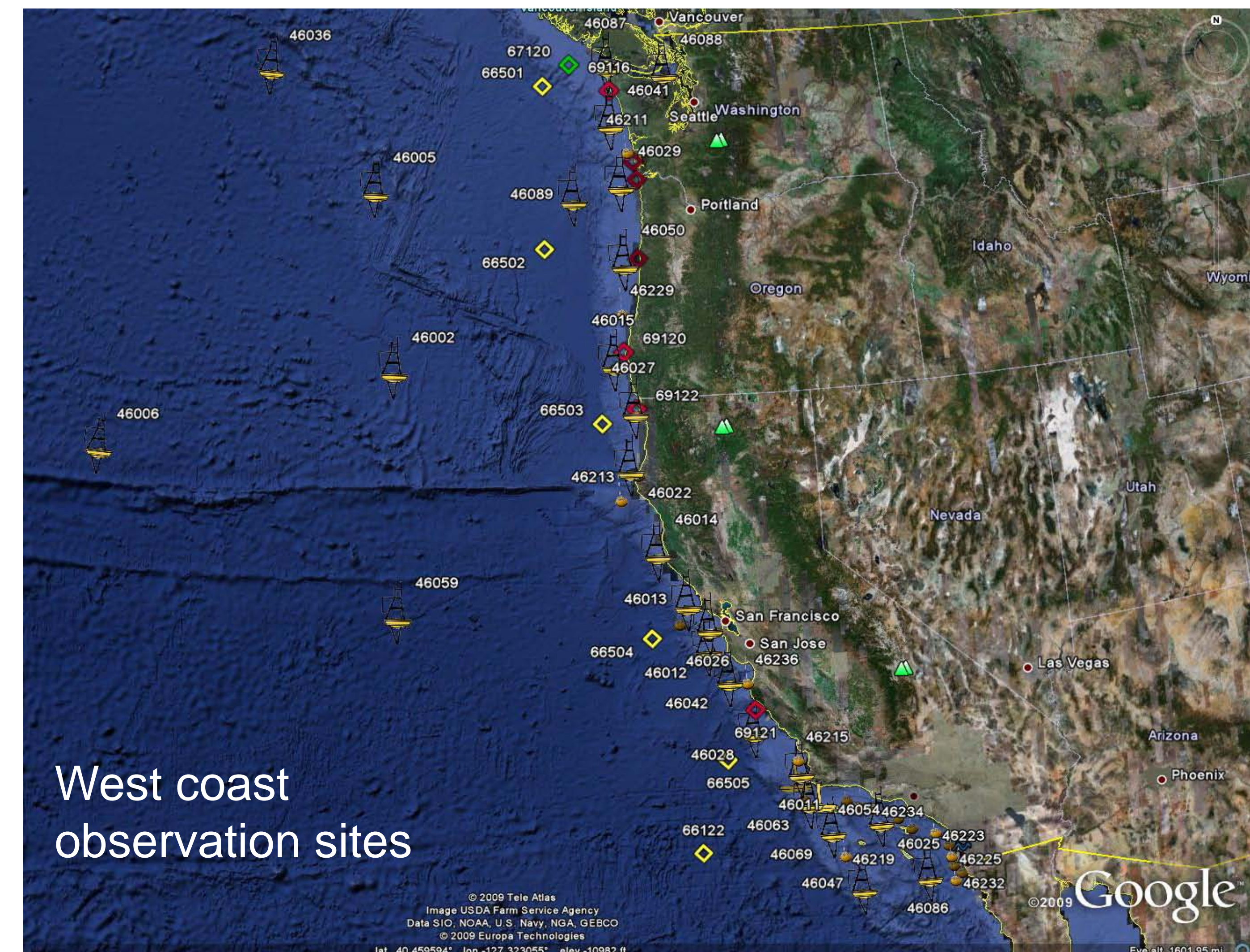
Primary Tasks

The plan identifies existing wave observations, presents a comprehensive system design and then makes specific recommendations to: (1) upgrade existing sensors; (2) add observations in critical "gap" locations; (3) implement a continuous sensor testing and evaluation program; (4) support quality control and integration of wave observations from a large number of IOOS operators; (5) support the operation and maintenance requirements; (6) include training and education of wave operators; and (7) promote the development of new sensors and measurement techniques.

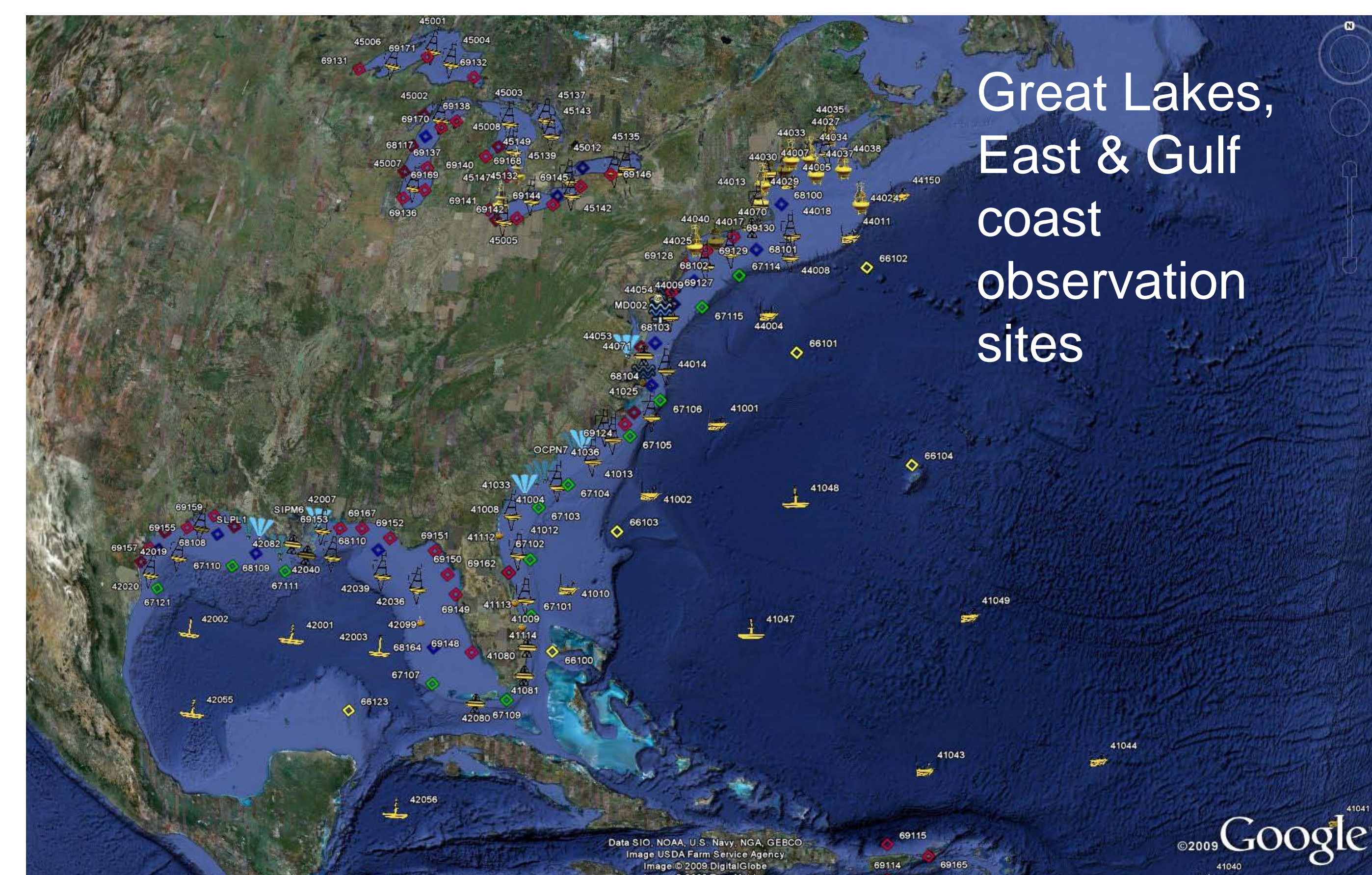
Summary

Station positioning for the existing network was essentially ad hoc, based on funding availability and local requirements. Plan development provided an opportunity to reassess and develop an integrated wave network based on national requirements. The existing wave measurement network consists of 181 operational wave measurement devices (as of 2007). This is based on platforms actively measuring waves 24/7 and transferring the information to NDBC for dissemination to National Weather Service field offices and over the GTS. As shown in the table and figures below, the proposed system will increase the wave observation spatial coverage along and across the US coasts to 296 sites and would upgrade 130 platforms to *First-5* capabilities.

Region	Total		Offshore Subnet				Outer-Shelf Subnet				Inner-Shelf Subnet				Coastal Subnet			
	Design	Exists	Design	Exists	New	Upgrade	Design	Exists	New	Upgrade	Design	Exists	New	Upgrade	Design	Exists	New	Upgrade
Atlantic Coast	89	60	14	9	5	9	12	3	9	2	21	15	6	14	42	33	9	26
Gulf of Mexico	45	22	6	5	1	5	9	5	4	5	6	1	5	1	24	11	13	11
Pacific Coast	64	50	16	10	6	6	26	25	1	6	2	2	2	20	13	7	1	
Alaska	39	22	6	6		6	12	9	3	9	6	1	5	1	15	6	9	3
Pacific Islands	16	10	6	5	1	3	1	1						9	4	5	1	
Great Lakes	32	9									12	9	3	9	20		20	
Caribbean	11	8	8	8		8								3		3		
Total	296	181	56	43	13	37	60	43	17	22	47	28	19	27	133	67	66	42



West coast observation sites



Great Lakes, East & Gulf coast observation sites