



NOAA Navigation Services

Pacific Northwest Report

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The Pacific Northwest Region

For this report, the Pacific Northwest region spans Oregon and Washington.

Geography and environment

The Northwest is best known for its vast Pacific coastline and rainy weather. The Oregon-Washington coast of the United States, between California on the south and Canada's British Columbia on the north, is mostly rugged and mountainous, with high land rising abruptly from the sea in many places. The region is home to several geological formations, including the [Olympic Mountains](#) and the [Cascade Range](#), that affect varying climates in Washington and Oregon.

The principal ports for deep-draft commercial ports within the area are Coos Bay and Portland in Oregon, and Vancouver, Grays Harbor, Seattle, and Tacoma in Washington. Other ports include Astoria, Oregon, and Longview, Port Angeles, Anacortes, Bellingham, and Olympia, Washington. There are 200 miles of the Oregon coast from the mouth of the Chetco River to the mouth of the Columbia River. The rivers include the Chetco and Rogue Rivers, Port Orford, Coquille River, Coos Bay, Umpqua and Siuslaw Rivers, Yaquina Bay and River, Nehalem River, and Tillamook Bay. The cities of Coos Bay and North Bend on Coos Bay and Newport on Yaquina Bay are the only deep-draft ports on the Oregon coast.

The Puget Sound shares an international border with British Columbia to the north, and the U.S. and Canada cooperatively operate a [vessel traffic service for the Strait of Juan de Fuca](#), a shared waterway. [Washington State Ferries](#) is a robust passenger ferry system that carries over 24 million passengers per year, many of them daily commuters from Bremerton and Bainbridge Island to downtown Seattle.

The Columbia River is the largest river in the Pacific Northwest and is served by two pilots groups: the [Columbia River Pilots](#) and the [Columbia River Bar Pilots](#). The river is a large and very complex waterway with significant navigation infrastructure requirements. Originating in British Columbia, the river flows south into the state of Washington and then heads west to form much of the border between Oregon and Washington. Stretching over 1,243 miles, the river drains parts of seven states and a Canadian province for a total area of 258,000 square miles. By volume, the Columbia is the fourth largest river in the U.S. and has the greatest flow of any North American river draining into the Pacific. The drop in elevation of 2,690 feet between the mountains of British Columbia and the ocean, combined with its heavy flow, provides enormous potential for generating electrical power. The Columbia produces more hydroelectric power than any other river in North America with 14 power-producing dams on its main stream and many more on tributaries.

NOAA's [Olympic Coast National Marine Sanctuary](#) is located in Washington State and consists of an area of approximately 2,408 square nautical miles of coastal and ocean waters and the submerged lands off the central and northern coast of the State of Washington.

Economic and recreational value

The vibrant maritime community in Washington supports several sectors, including passenger transportation, shipbuilding and repair, maritime logistics, fishing and recreation. According to a [2013 assessment by Community Attributes, Inc.](#), Washington's maritime industry contributes \$15.2 billion to the local economy annually and directly supports 57,700 jobs.

[Captain Rick Williams, from Leidos Maritime Solutions, reports](#) that the Pacific Northwest maritime transportation system represents \$66B annually. The estimate is \$46B through the Puget Sound Region, and \$20B through the Columbia Region.

(See Appendix 1, Pacific Northwest Waterways Association, *OR & WA Shallow Draft Ports Create Jobs.*)



1868 view of Cape Foulweather, Oregon, as painted by A. W. Chase, Assistant in the Coast Survey

Office of Coast Survey

Personnel & products in the Pacific Northwest

Pacific Hydrographic Branch

Coast Survey’s Pacific Hydrographic Branch (PHB), located in Seattle, is the West Coast center for hydrographic data quality assurance and chart update compilation. PHB and the Atlantic Hydrographic Branch review all surveys submitted from NOAA field units and contractors for compliance with NOAA specifications. They also review and apply outside source data from some external sources, i.e., academia and state partners. PHB personnel also support NOAA hydrographic ships, navigation response teams, and other partners with training and technical support.

Sixteen hydrographers, cartographers, and support personnel currently staff the Pacific Hydrographic Branch. The office also hosts the Pacific Northwest navigation manager, Navigation Response Team 3, and personnel from Coast Survey’s Hydrographic Systems and Technology Branch and Information Technology.

Coast Survey regional navigation managers

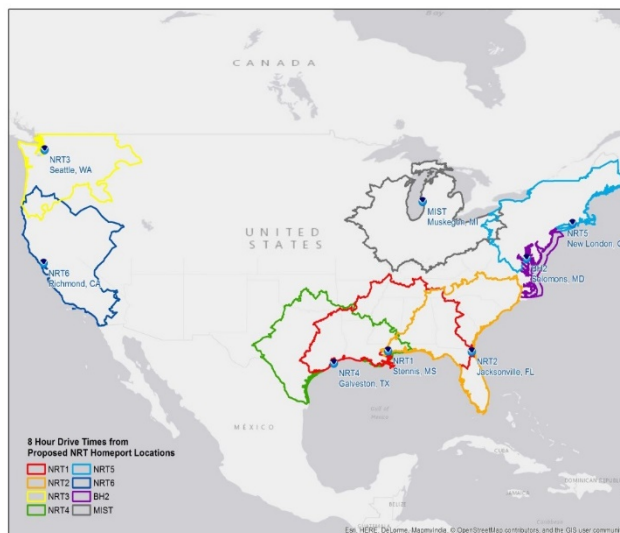
Coast Survey’s [navigation managers](#), stationed strategically in port areas along U.S. coasts and Great Lakes, work directly with the U.S. Coast Guard, pilots, mariners, port authorities, and recreational boaters. They help identify navigational challenges facing the marine transportation system, and provide the resources and services that promote safe and efficient navigation. Coast Survey has one navigation manager in the Pacific Northwest.

Region	Navigation manager (base of operations)	Contact information
Pacific Northwest	Crescent Moegling Crescent.Moegling@noaa.gov (Seattle, WA)	Cell: 206-707-5409 Office: 206-526-6840 Fax: 206-526-4514

Navigation response and mobile integrated survey teams

Coast Survey’s highly mobile [navigation response teams](#) (NRTs) provide both routine and rapid response hydrographic surveys, helping to protect life and property from underwater dangers to navigation. During emergencies, such as following a hurricane, NRTs speed the resumption of shipping that provides critical supplies to the affected area. Outside of emergencies, NRTs serve the maritime economy by identifying critical chart discrepancies and investigating emerging navigational concerns for 175 major ports within the U.S. marine transportation system.

Coast Survey is currently reconstituting a permanent NRT in Seattle, located at NOAA’s Western Regional Center.



Recapitalizing the NRT fleet

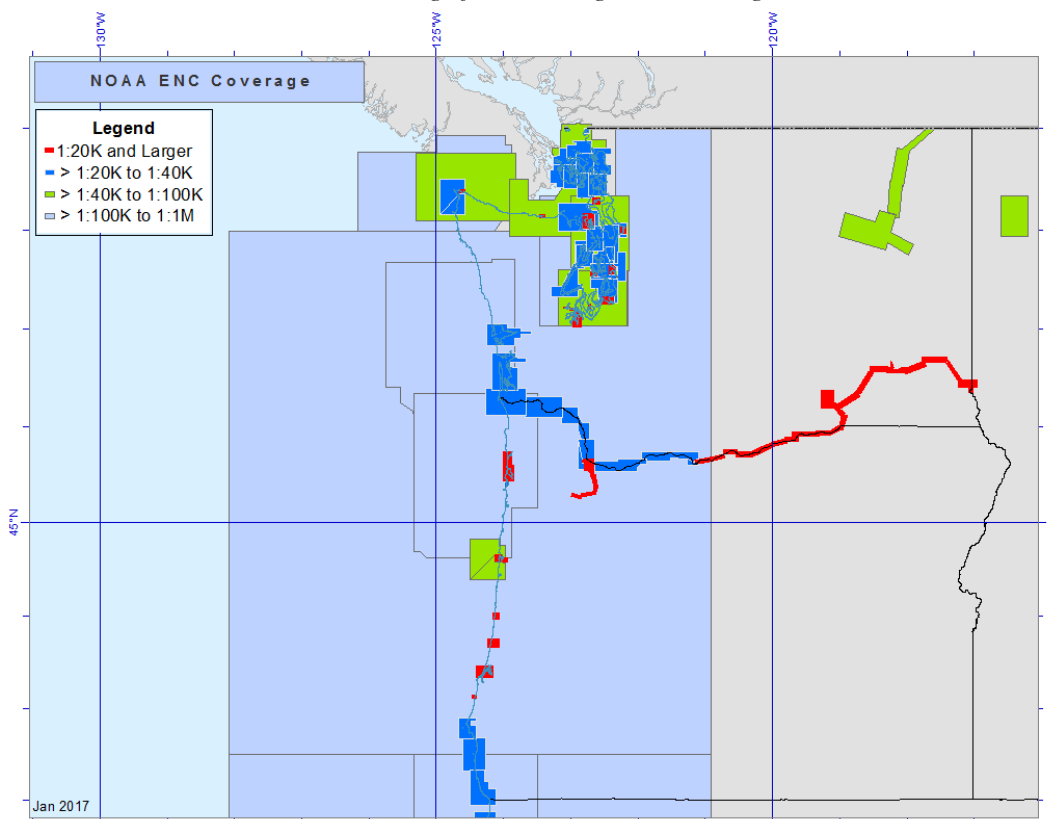
Coast Survey continues to replace the boats used by the navigation response teams. Lake Assault Boats of Superior, Wisconsin, has built and delivered four boats small boats specifically designed for hydrographic surveying. Coast Survey is working with Lake Assault Boats Survey on modifications to the first two. The navigation response team in Seattle has recently taken delivery of a new boat and hopes to get it through its shakedown and tune up in time for surveying this summer.

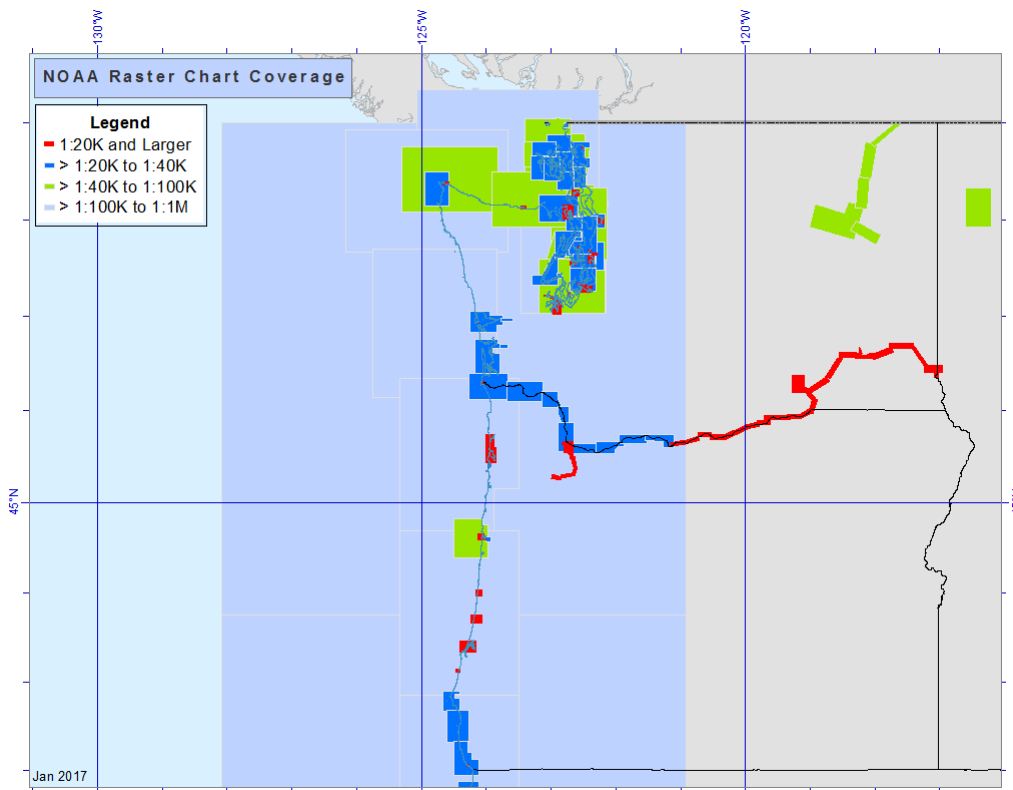
Chart coverage

Coast Survey is transitioning nautical chart production into a single database – the Nautical Information System (NIS) database – from the two databases that were built separately to create raster nautical charts (RNC) and electronic navigational charts (ENC). The transition allows faster simultaneous updates for all NOAA chart products. As cartographers receive new source information, they update the affected ENC and RNC products and release the updated products to the public weekly. This allows Coast Survey to keep both the ENC and RNC in agreement and provides the mariner with the most up-to-date products. With improvements in the chart production system, the raster charts are in a continual maintenance status, meaning that mariners will see shoreline and hydrographic updates more quickly, without having to wait years for a new edition.

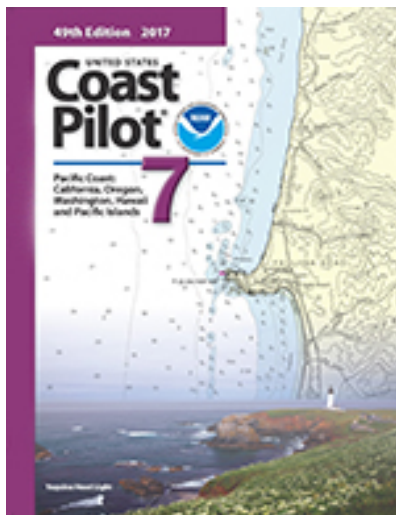
All data in the Pacific Northwest has been loaded into the NIS database. Coast Survey is currently working on new ENC coverage of Pitt and Balch Passage, Washington, with completion expected by summer 2017. This will expand the coverage of the current ENC US5WA10M at 1:20,000 to provide large-scale coverage of Balch Passage.

Chart coverage for Washington and Oregon





United States Coast Pilot®



The *United States Coast Pilot* provides information important to navigators of coastal and intracoastal waters and contains supplemental information that is difficult to portray on a nautical chart. Topics in the *Coast Pilot* include channel descriptions, anchorages, bridge and cable clearances, currents, tide and water levels, prominent features, pilotage, towage, weather, ice conditions, wharf descriptions, dangers, routes, traffic separation schemes, small-craft facilities, and federal regulations applicable to navigation.

Coast Pilot 7 (48th Edition) covers the coasts of California, Oregon and Washington, and includes Hawaii and other United States territories in the South Pacific. All nine volumes of the *United States Coast Pilot* are updated and available for download weekly, and can be used on mobile devices such as smart phones and tablets.

The digital version of *Coast Pilot* provides geotagged reference points that assist mariners with landmark positions and displays the associated nautical chart inset. (A geotag is simply geographical location information assigned to a type of media.) In the online xml versions of *Coast Pilot*, certain place names and objects, (highlighted in green) are now viewable on a nautical chart and linked to entries in the official [U.S. Geographic Names](#) database.

Other features include:

- images that become larger when clicked;
- an interactive table of contents for each book;
- links to raster nautical chart, highlighted in light blue; and
- weekly changes, highlighted in gray, which are retained until the next annual version is published.

Approximately 95 percent of the nine *Coast Pilot* volumes have been geotagged, with more points available each week.

(208) **Blind Bay** is a small inlet just east of Chippewa Point Directional Light. A sign marks the east side of the entrance. Several overhead cables with a reported least clearance of 28 feet (8.5 meters) cross the entrance channel. In 1977, a reported depth of 4 feet could be carried along the north shore to a marina in the northeast corner. Some marine supplies and gasoline engine repairs are available.

(209) **Charts *1436, 14771**

(210) From Blind Bay, the vessel route follows a series of short reaches across the mouth of Chippewa Bay and passes northwest of **Superior Shoal** southeast of **Dark Island** northwest of **Haskell Shoal** thence southeast of Grenadier Island on the southeast sides of **Empire Shoal** and **Sister Island Shoal** northwest of **Third Brother Island** and southeast of **Lone Brother Island**.

(211) **Chippewa Bay** on the southeast side of the river, is enclosed by **Chippewa Bay, NY**, a village on the east side of the bay, can be reached. **Schemerhorns Landing**, 2.5 statute miles (2.2 nm) southwest, has a restaurant, electricity, some marine supplies, and a launching ramp. A 5-ton forklift is available for hull and gasoline engine repairs.

Oak Island. The bay is filled with numerous small islands, rocks, and shoals.

U.S. Coast Pilot® Color Legend

- Chart
- Geotag
- Code of Federal Regulations
- Updated Paragraph

Switch to: **ENC**

Recent Activities

Pacific Northwest stakeholder engagement

Within the maritime community, stakeholders include the U.S. Army Corps of Engineers Seattle District, U.S. Coast Guard District 13 and Sector Puget Sound, Marine Exchange of Puget Sound, Puget Sound Harbor Safety Committee, Pacific Northwest Waterways Association, and others. State and local groups such as Puget Sound Partnership, Washington State Ferries, Washington Department of Ecology, University of Washington, and native tribes also engage on a regular basis. Stakeholders in Oregon include groups such as Columbia River Pilots, U.S. Army Corps of Engineers, U.S. Coast Guard, Port of Portland, and others.

One of the ways that Coast Survey engages our stakeholders and partners is through interactions at industry events. The Northwest navigation manager routinely meets with stakeholder in the region, including the U.S.

Coast Guard, U.S. Army Corps of Engineers, pilots associations, Pacific Northwest Waterways Association, Columbia River Steamship Operator, recreational boaters and commercial fishermen, state and local governments, and academia. Some of the activities in which the Northwest navigation manager has participated over the past year include the following:

Fall 2015

- Spoke at the Columbia River Yacht Club monthly meeting about NOAA's charting mission and how recreation boaters can access and use various navigation products and services.
- Participated in the 2015 Pacific Marine Expo, which is the largest commercial marine trade show on the West Coast, serving commercial mariners from Alaska to California.
- Engaged with USCG Sector Puget Sound in regular Marine Transportation Safety Unit meeting to discuss Cascadia Rising 2016, which is a national drill exercise simulating a magnitude 9.0 earthquake off the coast of Oregon.

Winter 2016

- Coordinated a partnership with the University of Washington, School of Oceanography, to use the R/V Thomas J. Thompson to conduct hydrographic surveys in support of marine planning off the coast of Washington State. NOAA will work with the university during their annual hydrographic training.
- Assisted USCG Portland Marine Safety Unit in planning navigation response and readiness in preparation for Cascadia Rising 2016.

Spring 2016

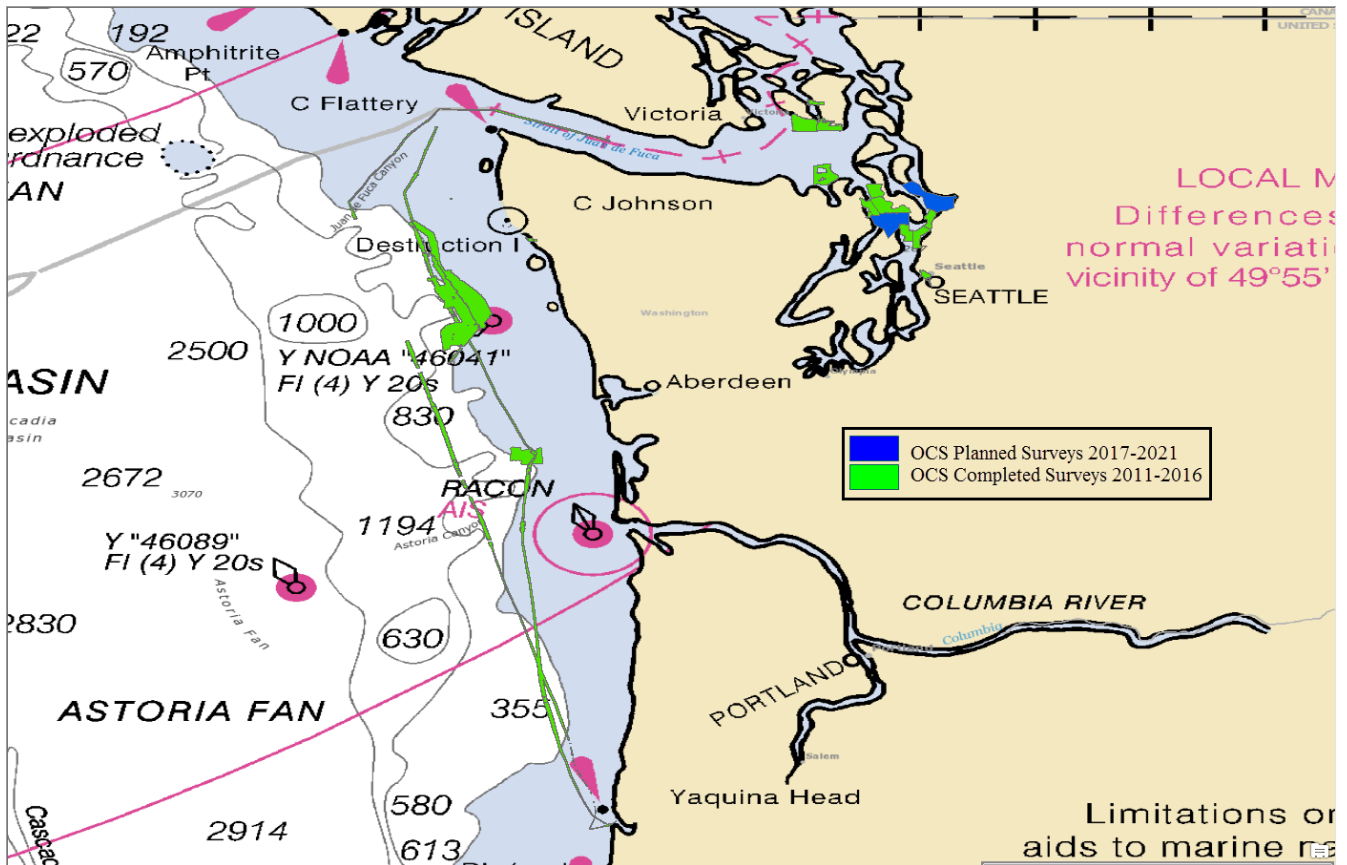
- Met with Pearl Harbor Pilots to discuss chart updates and coordinating hydrographic surveys.
- Facilitated a project in the Olympic Coast National Marine Sanctuary between the sanctuary and NOAA Ship Rainier to conduct a hydrographic survey in priority areas of the sanctuary that had never before been surveyed using high-resolution multibeam. The subsequent data was useful in providing a baseline to the R/V *Nautilus*, which conducted ROV dives and later discovered over 500 new methane plumes.
- Provided assistance in the planning of the National Harbor Safety Committee Meeting in Portland, Oregon. Working with the Merchant's Exchange of Portland and the Lower Columbia Region Harbor Safety Committee Meeting to establish agenda topics and select speakers.

Summer 2016

- Coordinated with the USCG Portland Marine Safety Unit to survey in the Columbia River Cottonwood Anchorage, at the site of a grounding. This resulted in a chart update depicting a new shoal.
- Met with the director of the Pacific Islands Ocean Observing System to discuss opportunities to collaborate.
- Met with Puget Sound Pilots to discuss prioritization of Physical Oceanographic Real Time System upgrades to support existing infrastructure in the region.

Survey operations in the Pacific Northwest in the past five years

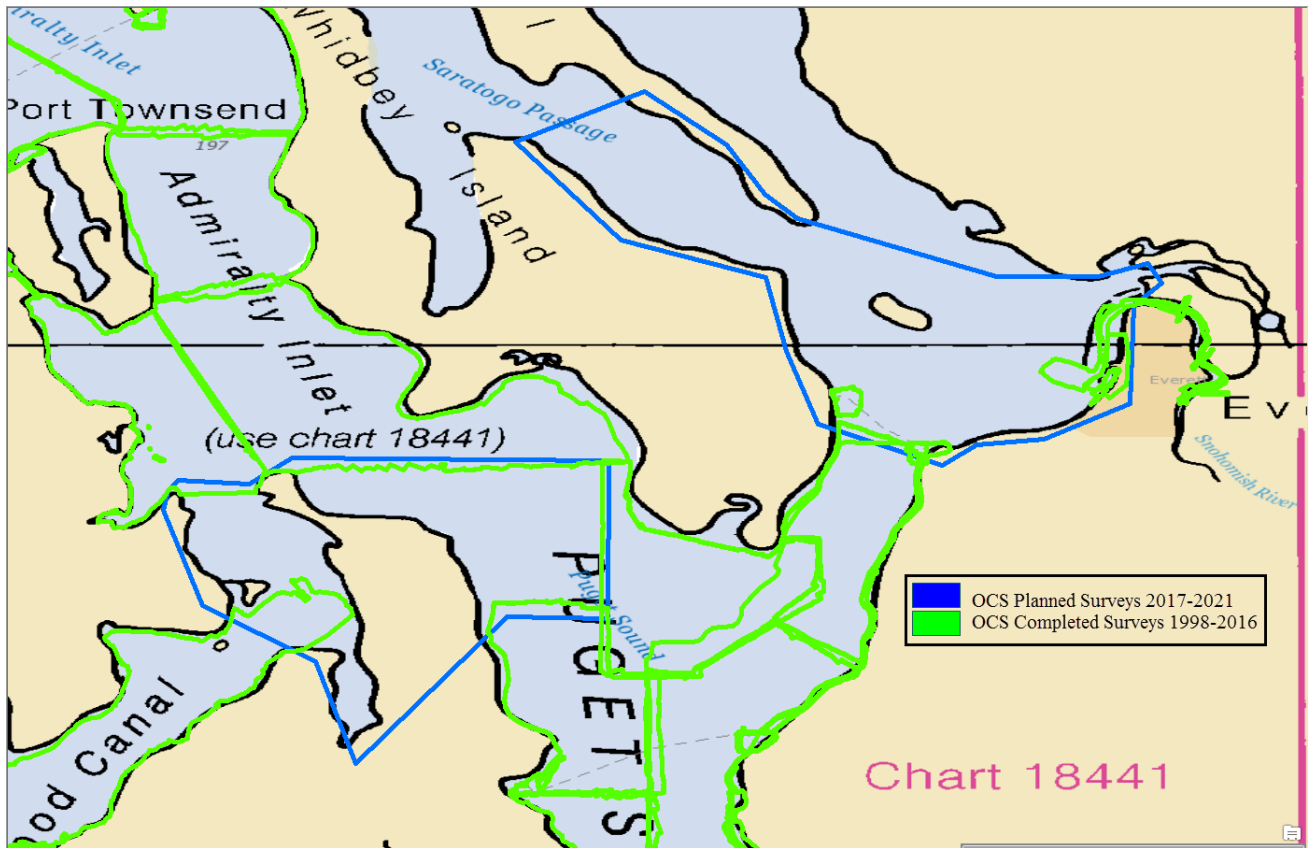
NOAA ships *Rainier* and *Fairweather* have conducted 13 surveys in the Pacific Northwest, totaling 626 square nautical miles, in the past five years.



Pacific Northwest survey priorities

Coast Survey currently has only two survey areas planned for the near future in the Pacific Northwest: (1) Possession Sound and the Approaches to Everett, Washington; and (2) where Hood Canal meets Admiralty Inlet and Puget Sound. These two survey areas fill in gaps in our modern survey coverage of the Puget Sound region.

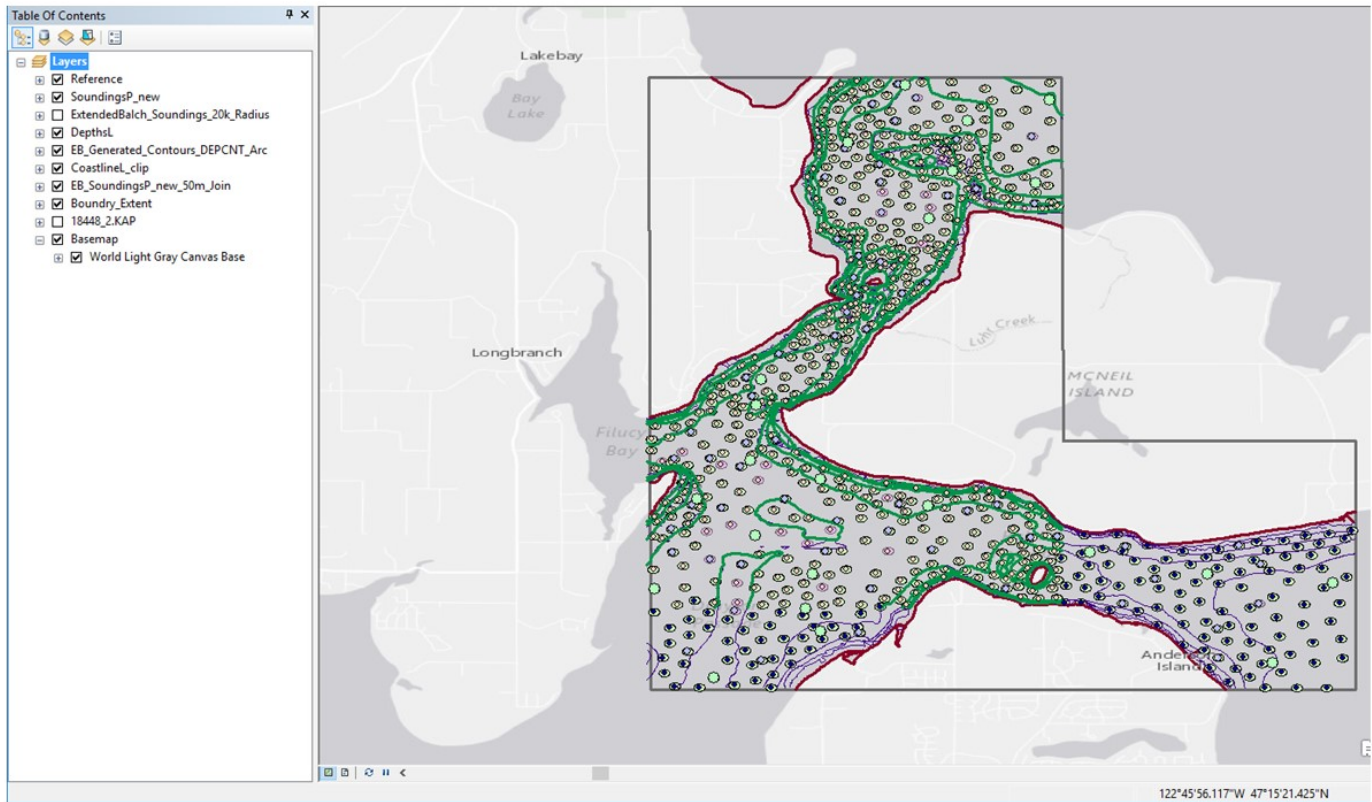
It is important to note that Coast Survey is in the process of developing new methodology for evaluating survey priorities, by modeling the “hydrographic health” for a given survey area. With the completion of the initial run of the “Hydro Health” model, Coast Survey will have better tools to assess the urgency of navigational needs in an area. While not the only factor in future prioritization, survey plans in the region may change in 2018 and beyond based on the analysis results of this new model, as well as the pending designation of the Puget Sound area as a “no discharge zone.”



Implementing a navigational bathymetric database and testbed for Puget Sound

Coast Survey Development Laboratory, with the support of the Hydrographic Services Division, is developing a bathymetric database that will store the full resolution of all bathymetric data collected through multiple sources. This will include traditional multibeam surveys, historical single beam surveys, the latest lidar topo-bathy surveys, and even crowdsourced bathymetry. To demonstrate the ability to support navigational products, the project began by collecting all the available bathymetric data in the Puget Sound region. Specific rule sets were developed to select soundings at multiple gridded resolutions to validate the data with the current charted soundings. The goal will be to use the navigational bathymetric database to support future re-scheming of the ENCs, create products and services with higher resolution bathymetric contours, and provide seamless soundings and contours throughout the navigational charting suite.

The Puget Sound boasts a significant amount of hydrographic coverage with contemporary multibeam surveys and, for this reason, it was selected as the test bed for a bathymetric database to assist in feeding chart production and potentially chart re-scheming under the National Charting Plan.



Comparing the navigational bathymetric database using current charted sounding (Pitt and Balch Passage)

Unmanned systems for maritime mapping: AUVs and USVs

Coast Survey is continuing to adopt unmanned systems as complementary technology to its maritime mapping capabilities, where the unmanned systems can provide a meaningful benefit by either expanding capabilities or making more effective use of manned resources.

Small, man-portable autonomous underwater vehicles (AUVs) and unmanned surface vehicles (USVs) have both been put to operational use for Coast Survey's mapping requirements. Small AUVs have been integrated with Coast Survey's navigation response capability, and small USVs are used aboard NOAA Ship *Thomas Jefferson* to meet very shallow water mapping requirements.

Coast Survey completed evaluations of a large, deep-diving AUV and a large, long-endurance USV. Coast Survey determined that large AUVs are not well suited for coastal hydrographic surveys, but can meet the high-resolution, deep-water mapping requirements of other NOAA offices, so is evaluating alternatives for operational transition. As evidenced by a successful operational demonstration of a leased USV in September 2016 aboard NOAA Ship *Nancy Foster*, long-endurance USVs do have the potential to enhance the capabilities and effectiveness of the hydrographic survey fleet.

Based on the lessons learned during the demonstration, Coast Survey is pursuing the conversion of an existing survey launch to operate in both manned and unmanned modes.

Center for Operational Oceanographic Products & Services (CO-OPS)

Personnel & products in the Pacific Northwest

CO-OPS personnel

The Pacific Regional Field Office, with 11 federal and three contract employees, operates and maintains about 100 oceanographic and meteorological observing system equipment in the West Coast, Pacific Islands and Alaska regions. These personnel are divided into two complementary teams. The Field Team executes CO-OPS requirements in the field including installation, preventative maintenance, repairs, and upgrades, providing contract oversight, as well as field training for CO-OPS' partners. Members of the Field Team have oversight of smaller regions within the overall area of responsibility. The Seattle Instrument Lab Team supports that fieldwork and CO-OPS technology advancements in the Lab. This includes remote diagnostics and repair from the lab, providing in-lab training to CO-OPS' personnel and CO-OPS' partners, preparing equipment for field deployment, troubleshooting, and repairing equipment. The Seattle Instrument Lab also works with other parts of CO-OPS to advance its technologies to support the development of new products, improve data quality, and continuity.

National Water Level Observation Network

CO-OPS operates and maintains the National Water Level Observation Network (NWLON), which is a network of 210 continuously operating water-level stations throughout the U.S., including its island possessions and territories. Additionally, the NWLON is the foundation for reference stations supporting NOAA's tide prediction products, and U.S. coastal and marine boundaries for charting data. It also serves as control stations in determining tidal datum for all short-term water-level stations. The NWLON provides relative sea level trends and is capable of producing real-time data for storm surge warnings. The NWLON platforms collect meteorological data in addition to water level data.

There are 15 NWLON stations in the Northwest. Water level stations contain the water level sensors and data collection platforms. Data is transmitted hourly via geostationary orbiting environmental satellite. Real-time data is acquired every six minutes by connecting to the gauge via a telephone modem. In addition to a primary and secondary water level sensor, some stations also acquire meteorological data including wind speed and direction, air temperature and water temperature.

CO-OPS operates the following NWLONs in the Pacific Northwest:

- Five in Oregon: Port Orford; Charleston; South Beach; Garibaldi; Astoria
- Ten in Washington: Longview; Toke Point; Westport; La Push; Neah Bay; Port Angeles; Port Townsend; Seattle; Cherry Point; Friday Harbor

Upgrade in water level technology

CO-OPS is upgrading the National Water Level Observation Network using microwave water level sensors (MWWL) instead of traditional acoustic sensors. With a MWWL system, the sensors sit up out of the water, meaning less maintenance is needed, resulting in lower costs. It is also more accurate in high-energy conditions and has the potential to provide information on waves. In order to ensure accuracy of the data, CO-OPS leaves

both the MWWL and acoustic sensors in place for one year for comparison. To date, CO-OPS has installed MWWL sensors at 38 NWLON stations across the country, and six of those stations have been fully transitioned to using MWWL as the primary sensor in FY16. CO-OPS has installed MWWL at 22 non-NWLON locations (PORTS, etc.), 16 of which have transitioned to MWWL as primary. Five stations in the Northwest have been upgraded with this new technology.

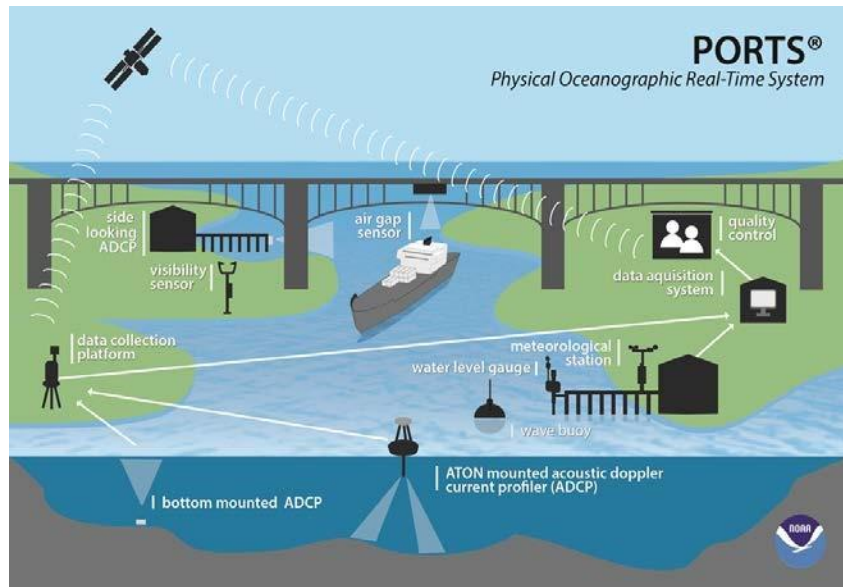
Support for hydrographic and shoreline mapping surveys

CO-OPS supports the Office of Coast Survey and National Geodetic Survey (NGS) with hydrographic and shoreline mapping missions through data collected at operational NWLON and subordinate water level stations. Coast Survey uses oceanographic data collected by CO-OPS to subtract the tide in order to reduce bathymetric soundings to accurate chart depth above MLLW. NGS uses the data for planning and proper determination of MHW and MLLW flight windows for shoreline mapping surveys. All Coast Survey hydrographic surveys and NGS shoreline mapping tidal surveys require existing NWLON station data to provide tidal control. If existing NWLON station data is not available, CO-OPS may require the installation of subordinate water level stations to meet NOS specifications for some surveys.

CO-OPS' Seattle office also provides training for tidal and datum theory, tide gauge installation and troubleshooting, and precise leveling to NOAA ship personnel. The Seattle Instrument Lab customizes and issues tide gauges for hydrography and photogrammetry operations to NOAA ships and field parties as required. The Lab continually seeks to improve functionality, ease of operation, and reliability. Examples include adding Iridium communications for locations unable to transmit to GOES satellites, and engineering smaller gauges and ancillary equipment to improve transport and installation. Future development will focus on further size and weight reduction of the equipment and adding WiFi or Bluetooth technology to improve ease of setup, diagnostics, and data retrieval. The Seattle Instrument Lab provides real-time technical support to ships' personnel and field parties during hydrographic operations to assist in initial setup challenges or other gauge-related technical issues that could impact the success of hydrography or photogrammetry projects.

Physical Oceanographic Real-Time System (PORTS®)

In addition to NWLON, this office also operates and maintains CO-OPS' West Coast Physical Oceanographic Real-Time System (PORTS®) stations. PORTS is a decision-support tool that improves the safety and efficiency of maritime commerce and coastal resource management through the integration of real-time environmental observations, forecasts and other geospatial information. PORTS measures and disseminates observations and predictions of water levels, currents, salinity, waves and meteorological parameters (e.g., winds, atmospheric pressure, visibility, and air and water temperatures) that mariners need to navigate safely. NOS operates 28 PORTS, three of which operate in the Pacific Northwest: Lower Columbia River, Ore.; Tacoma, Wash.; and Cherry Point, Wash.



[Lower Columbia River PORTS](#)

A PORTS is operated cooperatively with the Port of Portland and provides real-time data quality-controlled and disseminated to local users for safe and efficient navigation. Real-time data is available for water levels from seven stations, meteorological data from one location and wave data from one wave buoy.

[Port of Tacoma PORTS](#)

A PORTS is operated cooperatively with the local maritime community in the Port of Tacoma at which real-time data are quality-controlled and disseminated to local users for safe and efficient navigation. Real-time data is available from one water level station, and meteorological data from two stations at this location.

[Cherry Point PORTS](#)

A PORTS is operated cooperatively with Cherry Point BP Refinery and provides real-time data quality-controlled and disseminated to local users for safe and efficient navigation. Real-time data is available for a water level station, current meter station and two meteorological stations at both ends of the refinery.

Current surveys in Puget Sound

As a part of the National Currents Observing Program, CO-OPS is deploying current meters in over 120 locations throughout Puget Sound, the San Juan Islands and the Strait of Juan de Fuca. The results of this survey will improve tidal current predictions in the NOAA Tidal Current Tables, to support a new operational forecast model, and will be provided to partners, stakeholders and the public.

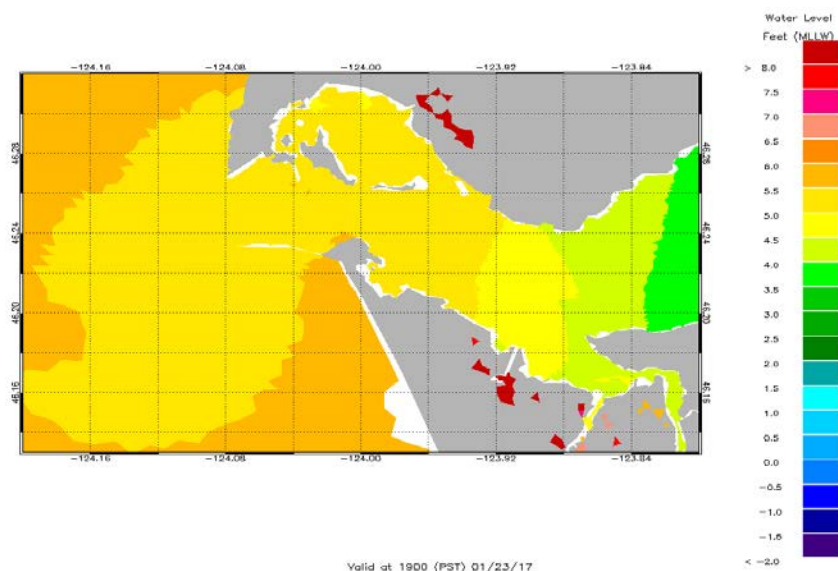
In 2017, CO-OPS will complete the three-year effort to collect tidal current information in Puget Sound and plans to deploy 46 current meter stations in the summer. In 2015, 48 stations were surveyed in the Central and Southern Sound. [Data](#) has been quality assured and processed with the results updating the predictions in the Tidal Current Tables and [NOAA Current Predictions website](#). CO-OPS is analyzing the data from the 41 stations collected during the 2016 currents survey of the Northern Sound and the Strait of Juan de Fuca; it will be available in the early summer of 2017. The results of these surveys will be used to improve tidal current predictions in the NOAA Tidal Current Tables, and to support a new operational forecast model. CO-OPS will provide the results to partners, stakeholders and the public. The NOAA tidal current predictions for the Puget Sound region are presently being generated from limited amounts of data collected in the 1930s-1960s. With the

improvements in measurement and computing technology available today, the accuracy of these modern predictions will be significantly improved.

In addition to current measurements, conductivity, temperature, and depth sensors (CTDs) were deployed at select locations to measure water temperature and salinity. In addition, in partnership with the University of Washington Northwest National Marine Renewable Energy Center, acoustic hydrophones were deployed at a select number of locations to observe background noise and perform an acoustic census of the Sound.

Operational forecast systems

Operational nowcast and forecast hydrodynamic model systems support NOAA's mission goals and priorities by providing automated integration of observing system data streams, hydrodynamic model predictions, product dissemination, and continuous quality-control monitoring. State-of-the-art numerical hydrodynamic models driven by real-time data and meteorological, oceanographic, and/or river flow rate forecasts, form the core of these end-to-end systems. The OFS will perform nowcast and short-term (0 hr. – 48 hr.) forecast guidance of pertinent parameters (e.g., water levels, currents, salinity, temperature, waves) and disseminate them to users.



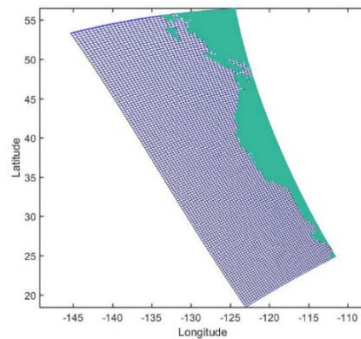
Columbia River Estuary Operational Forecast System (CREOFS)

NOAA's National Ocean Service has developed a [Columbia River Estuary Operational Forecast System](#). CREOFS is based on a three-dimensional SELFE model that runs on NOAA's high performance computers. CREOFS provides water level, currents, water temperature and salinity nowcast and forecast guidance as well as interpolated winds from National Weather Service products for five separate subdomains: Upper Columbia River, Middle Columbia River, Lower Columbia River, Columbia River Bar Entrance, and the mouth and offshore subdomain of the Columbia River. CREOFS runs four times per day and generates six-hour nowcasts and 48-hour forecast guidance. CREOFS products include time series graphics at station locations and aerial animations of the Columbia River Estuary for all five parameters (wind, water level, currents, temperature and salinity).

West Coast Operational Forecast System (WCOFS) - in development

NOAA's National Ocean Service is developing a West Coast Operational Forecast System that provides water level, currents, water temperature and salinity nowcast and forecast guidance, as well as potentially serving as an initialization model for several smaller estuary models along the West Coast, to be developed later. The WCOFS

domain encompasses the whole West Coast from California to Washington and extends offshore for more than 1000 km. The model grid has 696x2032 points in the horizontal with grid resolution of about two km.



WCOFS runs on NOAA's high performance computers in a new coastal ocean modeling framework developed by CO-OPS. As a result, WCOFS has direct access to NWS operational meteorological products that it needs to run reliably. Nowcast and forecast guidance cycles are run four times a day (every six hours).

VDatum updated grids

VDatum is a tool that transforms geospatial data among a variety of tidal, orthometric and ellipsoidal vertical datums. NOAA is in the process of updating model grids around the country to lower the uncertainty within the models for more broad usage. During FY16, CO-OPS installed three water level stations in Washington within the Straits of Juan de Fuca, eight near and along the Columbia River between Washington and Oregon, and one in California. This data, along with an additional 13 locations along coastal Washington, Oregon and California in FY17, will assist with the update to five VDatum model grids, including (1) the Strait of Juan de Fuca, (2) Southern Washington and Columbia River, (3) Central Oregon, (4) Punta Gorda to Cape Blanco, and (5) Southern California from Morro Bay to the Mexico border.

One of the stations, in Swinomish, Washington, was originally installed in 2015 for three months to support VDatum. In partnership with the [Padilla Bay National Estuarine Research Reserve](#), it was able to remain installed for one full year and was removed in summer 2016. With the calculation of a full-year tidal datum, water level data collected throughout the NERR system can now be compared to an established CO-OPS gauge.

Ecological forecasting

The Pacific Northwest has a multifaceted need for ecological forecasts, including information on harmful algal blooms (HAB), hypoxia, and pathogens probability and toxicity. NOAA's Centers for Coastal Ocean Studies has funded research on HABs. An experimental HAB forecast has been developed for the Puget Sound and outer coast areas, and discussions are underway to begin transition of that forecast to operations. NOAA's Northwest Fisheries Science Center is working closely with the Food and Drug Administration and the State of Washington to develop decision support products for shellfish safety related to pathogens. Numerous observations are being collected for harmful algal blooms and hypoxia, including an environmental sample processor in the Juan de Fuca eddy to aid in early detection of HABs.

(For more information, see NOAA articles: [New Biosensor Deployed ahead of HAB Season in Pacific Northwest](#); [West Coast Harmful Algal Bloom](#); [Lack of Oxygen? Hypoxia in Pacific Northwest Waters](#); and [Webinar Provides Shellfish Managers with Vibrio Risk Guidance](#))

National Geodetic Survey (NGS)

Regional mission summary

NGS supports a wide variety of programs and activities in the Pacific Northwest, focused on monitoring elevation changes, improving accuracy of the [National Spatial Reference System](#), and producing a gravity-based vertical datum. This will be accomplished with the help of the NGS regional geodetic advisor, who will improve coordination between NGS and our partners. The regional value of implementing these programs and activities will essentially provide accurate geodetic and water level products that ultimately improve the NSRS and activities between Canada and the United States.

Activities in the Pacific Northwest

NGS regional geodetic advisor program

As of the beginning of FY17, the State Advisor Program has fully transitioned to the Regional Advisor Program. The NGS northwest region advisor is Mark L. Armstrong, PLS. The Northwest region covers Oregon, Washington and Idaho. The NGS northwest region advisor will attend and present at each state's annual survey conference and provide training on NGS products and services such as OPUS-Projects. For more information, contact Mark at mark.l.armstrong@noaa.gov.

GRAV-D update in Oregon and Washington

The GRAV-D program is producing a gravity-based vertical datum that will be accurate at the ~2cm level where possible. GRAV-D flights in the Pacific Northwest started in 2016 and will be continuing in 2017. When complete, the new information will be included in each new xGeoid model. Both the Oregon and Washington coastal flights have been completed. For more information go to the [NGS GRAV-D web page](#) or contact Monica Youngman at monica.youngman@noaa.gov.

Geodetic activities in Washington

Washington now has a geodetic coordinator. Kurt Williamson, PLS, has been named as the Washington state geodetic coordinator. Kurt is the survey and mapping manager for the Washington State Department of Transportation. He will work with the NGS Northwest regional advisor to disseminate geodetic information to local stakeholders. For more information, contact Kurt at williak@wsdot.wa.gov.

The Land Surveyors Association of Washington (LSAW) 2022 NSRS Datum Task Force continues to meet regularly to allow a forum/roundtable for stakeholders interested in the upcoming changes to the National Spatial Reference System (NSRS) from NGS. The task force will next meet at the LSAW annual conference at SeaTac on March 9, 2017. Additional topics will include changes to the parameters of the Washington State Plane Coordinate System (false northings/eastings), vertical component as it relates to definition and RCW/WAC administration, future seminar/training needs and opportunities, LSAW support and stakeholder



inclusion, especially the GIS community. For more information contact Thomas Barger, PLS, chief surveyor - Survey and Mapping for City of Seattle, at Thomas.Barger@seattle.gov.

The City of Bellevue Survey Division is in the process of translating their survey control database from passive control values in NAD 83(2011) HARN, to active station CORS to better align with the National Spatial Reference System. BELNET, as it is referred, has existed since the mid-1990s and consists of data from all terrestrial and GPS measurable, which have maintained a minimum standard of accuracy. Presently, over 4000 points are maintained and regularly relied upon by local survey consultants. This project will be processed and adjusted in OPUS Projects by constraining five local (Puget Sound) CORS stations and also five stations located more distant across the state. Holding these stations fixed, the values for six HARN stations in the database together with three continuously operating city base stations (city, fire, and summit) will be repositioned. An added feature will be to add active stations COB and CITY into the WSRN. They are looking forward to being an active and contributing member of the WSRN. For more information, contact Jon Warren, PLS, Land Survey Division manager for City of Bellevue, at JPWarren@bellevuewa.gov.

City of Seattle survey crews have recently completed (10/26/2017) a 2nd order, 1st class level line in the downtown area of Seattle. The new line consisted of 19 benchmarks, six of which were NGS specific “B” order stability, 3D deep-driven rod marks. The line runs about 25 km from King County Airport, north through downtown, to the Portage Bay area of Lake Union. These benchmarks will be used to extend future level lines in the downtown area. These new benchmarks will soon be published with datasheets and will be available on the NGS website. The leveling work was organized by Brian Ward and Dave Rigney, both NGS advisors who conducted a digital levels workshop for the City of Seattle.

Geodetic activities in Oregon

Oregon now has a geodetic coordinator. Ken Bays, PLS, has been named as the Oregon state geodetic coordinator. Ken is the lead geodetic surveyor for the Oregon Department of Transportation and manages the OR Real-Time GNSS Network. Ken will work with the NGS Northwest regional advisor to disseminate geodetic information to local stakeholders. For more information, contact Ken at kenneth.bays@odot.state.or.us.

The [Oregon Real-Time GNSS Network](#) (ORGN) now has (60%) GPS + GLONASS (GG) coverage statewide. The ORGN consists of approximately 100 reference stations aligned with the NSRS using the NGS CORS and the program OPUS-Projects. They are currently working on a plan to enable GLONASS on all ORGN sites.

VDatum

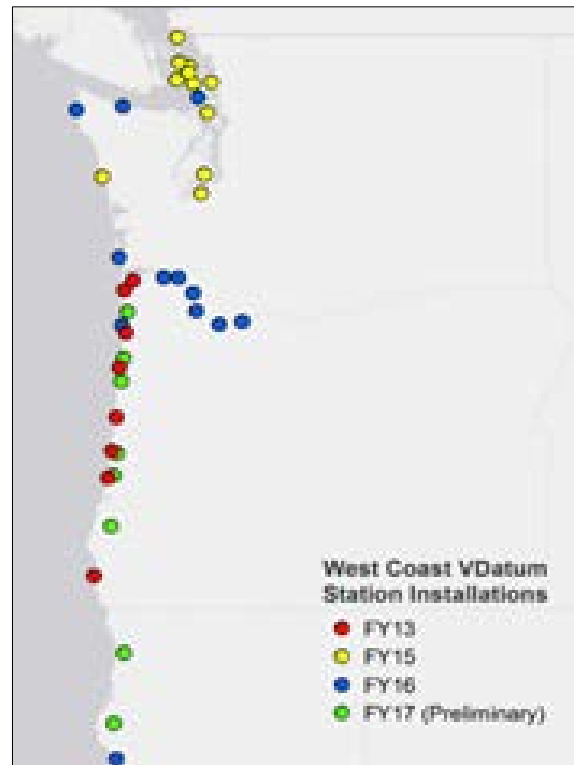
In 2010, NGS, CO-OPS and Coast Survey made available the first edition of NOAA’s [vertical datum transformation \(VDatum\)](#) for the entire contiguous United States. This tool enables users to seamlessly transform geospatial data – based on different vertical reference systems – into one uniform surface or “datum.” Transforming data to a single vertical datum removes the most serious impediments to data sharing and is necessary to harmonize the differences between the vertical reference systems of land- and water-based spatial data.

VDatum is a free software tool jointly developed by NGS, CO-OPS and Coast Survey. It was first introduced to support a seamless bathymetric-topographic digital elevation model (DEM) for Florida’s Tampa Bay region. The DEM that resulted from the VDatum demonstration project has not only solved the problem of inconsistency among diverse datasets that causes difficulty in mapping coastal regions, but also provides

standard geospatial data for multiple applications, such as inundation modeling, monitoring sea level change impacts, coastal management, and more.

VDatum grid updates for the Pacific Northwest and updated VDatum tools overall

VDatum will be releasing an updated model for the West Coast in FY19. Below is an image of the Pacific Northwest VDatum station installations from FY13-17



Additionally, in an effort to make the VDatum tool easily available to users, without the need to download software and install it on a computer, the VDatum team has released an initial [online version](#). The online version (see image below) provides a similar user interface and transformation functionality as the standalone application, but has reduced input/output format capabilities since it is web-based. In addition, an updated standalone version (3.6.1) is released, fixing an issue with the lidar LAS conversion providing incorrect horizontal coordinates.

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION UNITED STATES DEPARTMENT OF COMMERCE

ONLINE VERTICAL DATUM TRANSFORMATION

INTEGRATING AMERICA'S ELEVATION DATA

[Home](#) | [About VDatum](#) | [Download](#) | [Docs & Help](#) | [Contact Us](#)

Horizontal Information

	Source		Target
Datum:	NAD83(2011/2007/CORS96/HARN) - North American tech		NAD83(2011/2007/CORS96/HARN) - North American tech
Coor. System:	Geographic (Longitude, Latitude)		Geographic (Longitude, Latitude)
Unit:	meter (m)		meter (m)
Zone:			

Vertical Information

	Source		Target
Datum:	NAVD 88		NAVD 88
Unit:	meter (m)		meter (m)
	<input checked="" type="radio"/> Height <input type="radio"/> Sounding <input type="checkbox"/> GEOID model:		<input checked="" type="radio"/> Height <input type="radio"/> Sounding <input type="checkbox"/> GEOID model:

Point Conversion ASCII File Conversion

Input		Output
Longitude: <input type="text"/>	<input type="button" value="Convert"/>	Longitude: <input type="text"/>
Latitude: <input type="text"/>	<input type="button" value="Reset"/>	Latitude: <input type="text"/>
Height: <input type="text"/>	<input type="button" value="DMS"/>	Height: <input type="text"/>
<input type="checkbox"/> to DMS Vertical Uncertainty:		

Leaflet | Select a point by clicking on map.

Alternating Mean Datum Ellipsoidal Datum Orthometric Datum Tidal Datum

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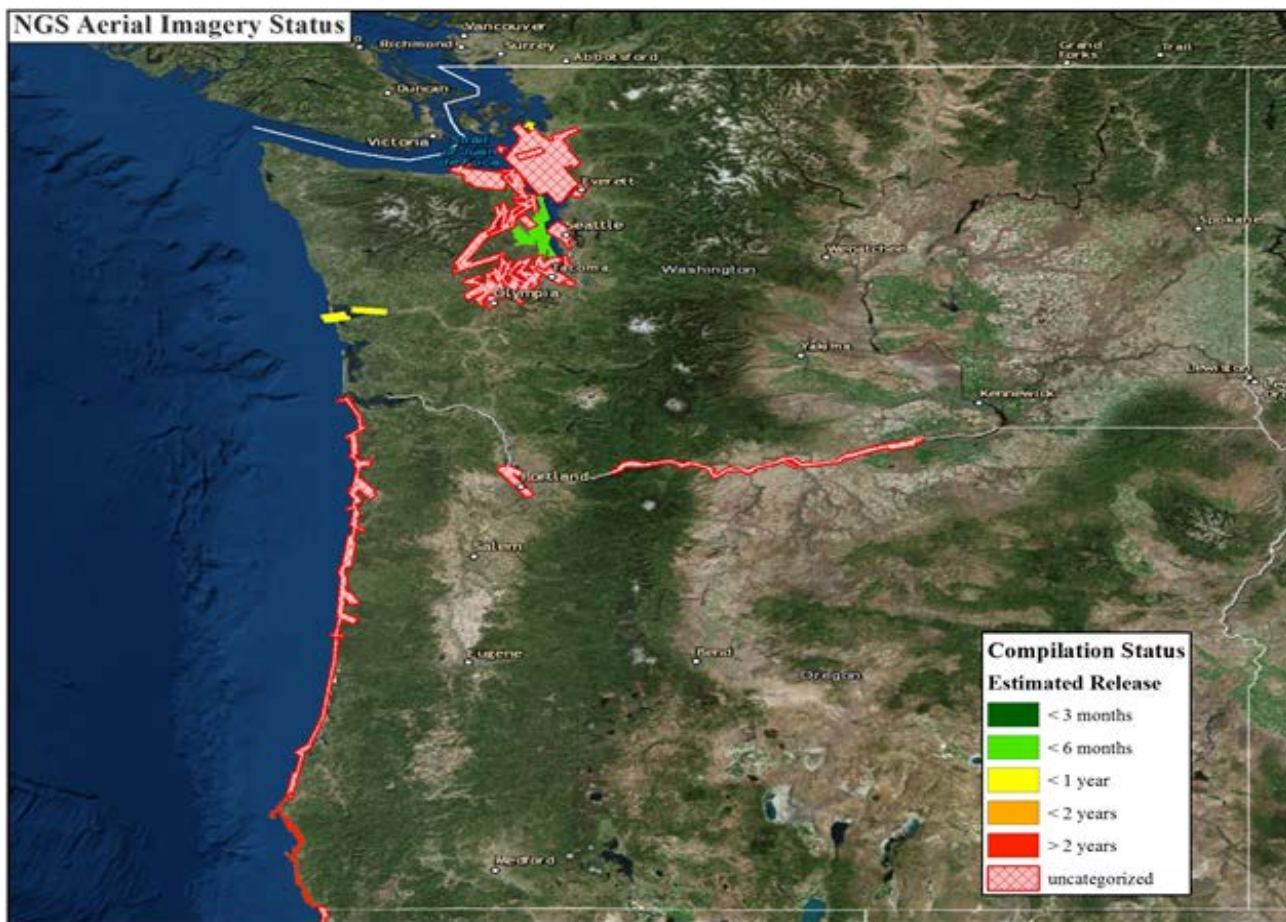
Web site owner: National Ocean Service NOAA Department of Commerce

Height modernization in the Pacific Northwest

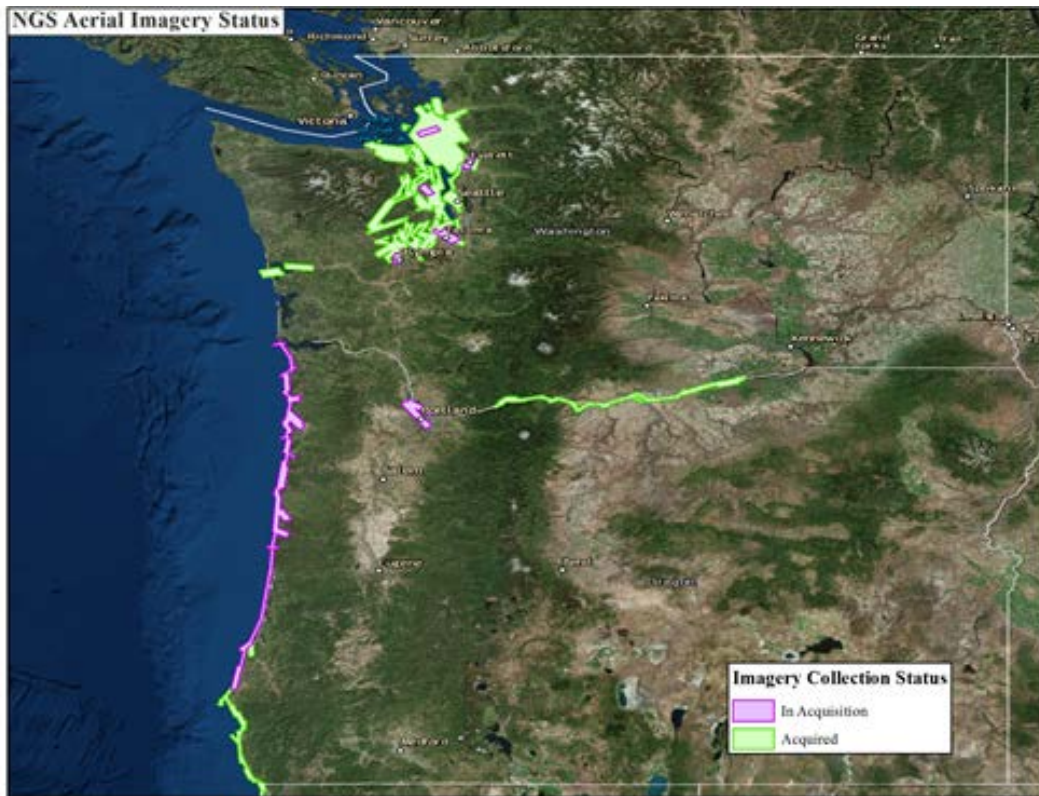
Much work on future height modernization techniques has been going on at the Oregon State University Geomatic Graduate Program under a CIMRS grant from NGS. Research into hybrid networks combining static GNSS with real-time Network RTK promises to provide improved heights with less occupation time than is the current practice following the NOS/NGS-58, guidelines. Watch for a new revision to NOS/NGS 58 in the next six months. For more information, contact Dan Gillins at daniel.gillins@noaa.gov.

Shoreline coverages for the Pacific Northwest

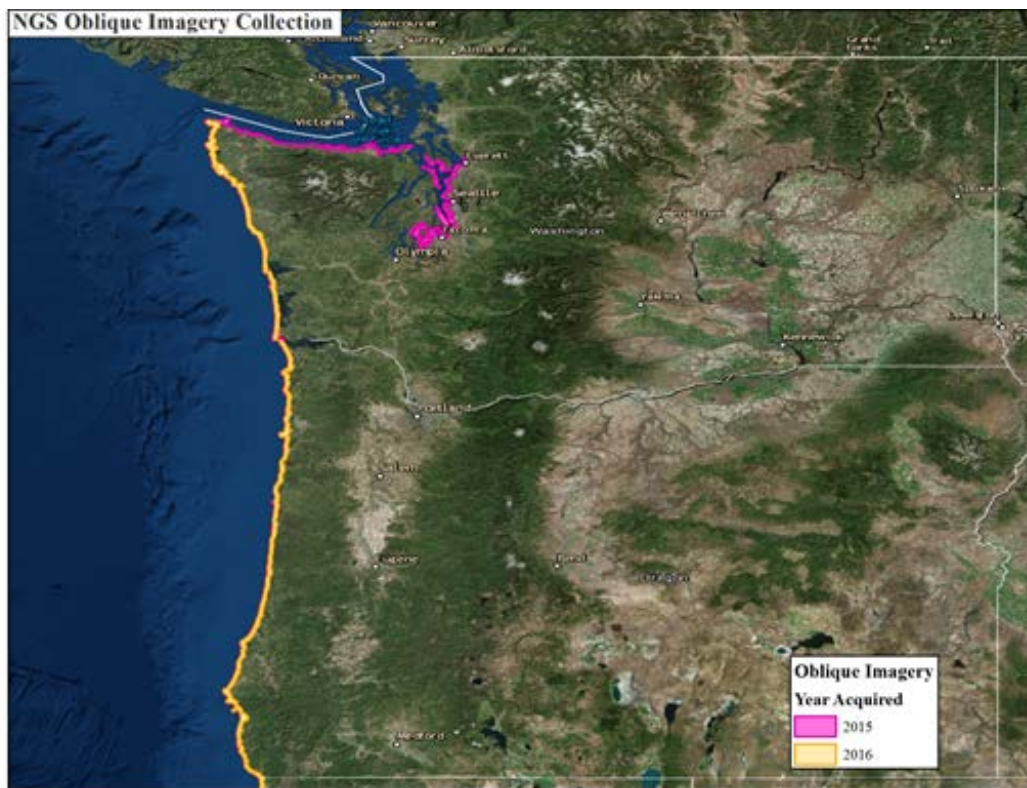
NOAA continues to acquire and compile the national shoreline for the Pacific Northwest. Shoreline was recently released for part of the Puget Sound, and the project area west of Seattle should be available within six months. NOAA plans to collect RGB aerial imagery for six CSCAP Ports in FY17. The ports that will be surveyed are: Everett, Keyport, Oak/Crescent Harbor, Olympia, and Tacoma in Washington, and the Portland, Oregon, region.



Compilation status

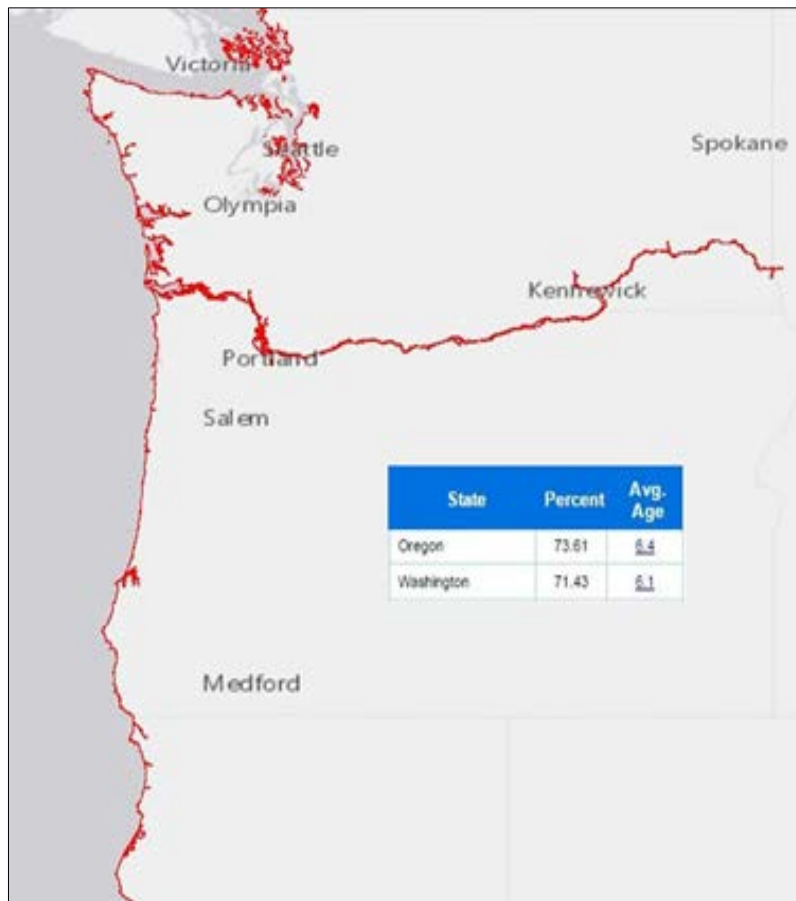


Imagery status



Oblique imagery status

NOAA's [continually updated shoreline product](#) (CUSP) provides the most current shoreline representation of the U.S. and its territories. CUSP is built upon NGS national shoreline data and uses both NOAA and non-NOAA contemporary sources to replace vintage shoreline areas. The goal of CUSP is to represent the dynamic interface between land and water; therefore, CUSP is designed to deliver continuous shoreline with frequent updates.



CUSP coverage in Pacific Northwest

Emergency response imagery

NGS conducts flights to collect imagery after natural (hurricane, earthquake, tsunami, flood and tornado) and man-made (oil spill) disasters. The high-resolution, geo-referenced airborne imagery images, which support NGS' coastal mapping program, also support homeland security and FEMA requirements, as well as state and local interests. NGS posts the images on the web, often within hours, to make them available to the public.

NGS has been called on to collect [emergency response imagery](#) following many different types of disasters, including the 2016 flooding in the Midwest and after Hurricane Matthew (see image below) as well as all major hurricanes since 2003. From the imagery, those in charge of response and restoration can determine the effect of disasters on the land; for example they can determine where flooding has wiped out parts of barrier islands and affected their formation.

In 2013, NGS enhanced its imagery collection by developing hardware, software, and processes to allow for the collection of oblique aerial imagery. In 2015, NGS began collecting pre-event imagery along most of the U.S. shoreline using oblique imagery.

February 6-9, 2016, the National Geodetic Survey completed an extensive aerial collection of oblique geo-referenced imagery of the West Coast, to assess impacts of the ongoing El Nino event to several NOS mission areas including navigation and coastal zone management. Additionally, the imagery supported other mission partners, including other NOAA offices, the U.S. Geological Survey, the U.S. Army Corps of Engineers, Federal Emergency Management Agency, and other state, local, and academic interests. The imagery was collected from the U.S. Mexico border to Cape Flattery, Washington, and the 13.5 GB dataset consists of 3,106 images. Using the oblique imagery dataset provides an accurate snapshot of what the “normal” shoreline and its associated infrastructure look like prior to an event, making it easier to assess the extent of damage cause from a single event.

Office of Marine and Aviation Operations

NOAA’s [Office of Marine and Aviation Operations](#) operates a fleet of 16 survey and research vessels worldwide. Included in this fleet are NOAA ships *Rainier* and *Fairweather*, NOAA’s largest hydrographic survey ships. Homeported in Newport, Oregon, and Ketchikan, Alaska, respectively, each are equipped with ship-mounted survey systems, four hydrographic survey launches, and numerous skiffs for inshore work. Each ship is staffed with a crew of approximately 50 NOAA Corps officers and civilian professional mariners. *Rainier* and *Fairweather* continue to focus on surveying Coast Survey priority areas in the Pacific Northwest and Alaska, as they have since their commissioning in 1968.



NOAA ships *Fairweather* (S220) and *Rainier* (S221)