ABOUT THIS DOCUMENT

This summary represents the continuation of an ongoing collaboration with the Office of National Marine Sanctuaries (ONMS), Olympic Coast National Marine Sanctuary (OCNMS), and the National Centers for Coastal Ocean Science (NCCOS) Center for Coastal Monitoring and Assessment (CCMA), through a comprehensive regional oceanographic data synthesis and integration effort for the U.S. Pacific Northwest (PNW). Multiple long-term satellite oceanographic datasets made available through NASA, NOAA and other world-wide operational data centers were evaluated and summarized to provide scientific information and insights on system variability and processes affecting the PNW and, in particular, the OCNMS. The synoptic-scale viewpoint provided by satellite data made it possible to combine multiple observations on physical, biological, and sediment characteristics to fill existing data gaps, and document oceanic events for the entire region. The result is a unique representation of PNW ocean climate and behavior, an oceanographic baseline from which multiple ecosystem-based assessments can be built. Intended audiences of the assessment include the National and Regional Sanctuary Management Offices, IOOS Associations, NOAA Ecosystems Program, and other Federal and State agencies, universities, and tribal staff.

The characterization consists of three complementary components: a text report; a suite of quantitative spatial and statistical analyses that characterize oceanographic and physical patterns of the PNW and OCNMS region; and an extensive geodatabase of all spatial, temporal, derived, and primary remote sensing datasets acquired, assimilated, and analyzed to conduct the characterization. This particular work builds on and advances data synthesis and analytical techniques developed for other National Marine Sanctuaries, including the Channel Islands, Cordell Bank, Gulf of the Farallones, Monterey Bay, Gray's Reef, and Stellwagen Bank (NCCOS, 2003, 2006, 2007).

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EXECUTIVE SUMMARY

This report presents the results of a two-year investigation and summary of oceanographic satellite data obtained from multiple operational data providers and sources, spanning years of operational data collection. Long-term summaries of Sea Surface Temperature (SST) and SST fronts, Sea Surface Height Anomalies (SSHA), surface currents, ocean color chlorophyll and turbidity, and winds are provided.

Overall Conclusions

Merged satellite oceanographic data revealed information on: (1) seasonal cycles and timing of transition periods; (2) linkages between seasonal effects (warming and cooling), upwelling processes and transport; and (3) nutrient/sediment sources, sinks, and physical limiting factors controlling surface response for Olympic Coast marine environments. These data and information can be used for building relevant hind cast models, ecological forecasts, and regional environmental indices (e.g. upwelling, climate, "hot spot") on biological distribution and/or response in the PNW.

Key Findings

(1) Patterns of SST and SSHA reveal linkages between seasonal heating effects and dominant physical processes affecting the sanctuary including upwelling, downwelling, and transport.

- SST patterns reveal seasonal maximums in August and minimums in January, with spring and fall transitions in May and November. Juan de Fuca Strait outflow results in suppressed SST during summer. Upwelling influences on SST are more dramatic inside the sanctuary versus points south of the sanctuary.
- SSHA patterns reflect vertical changes from mean sea level and reveal seasonal maximums in January and minimums in July, coincident with the peak of the downwelling and upwelling seasons, respectively. Maximum transition periods occur in March and November. Heights respond to coastal wind forcing, upwelling-induced (salinity and temperature driven) effects and freshwater influence inside the sanctuary.
- Altimetry-derived radar estimates of SSHA could be used in combination with thermal infrared SST to isolate upwelling activity and biological response for PNW marine environments.

(2) Patterns of ocean color chlorophyll and turbidity reveal insights on nutrient/sediment sources, timing of bloom response, and wind-driven processes affecting the sanctuary.

- Chlorophyll patterns show spatially distinct pulses during the spring bloom period (April-June) just north of and inside the sanctuary, followed by strong upwelling-induced pulses inside the sanctuary from July through mid-October.
- Turbidity maximums occur during the fall-winter period inside the sanctuary; minimums occur in association with the Juan de Fuca Strait outflow in summer.
- Columbia River plume influence on ocean color is most evident in southern portions of the study area, with seasonal precipitation significantly correlated with ocean color turbidity inside the sanctuary.

(3) Co-variability of surface water properties reveals subseasonal processes and modes of influence that limit chlorophyll production during the downwelling/upwelling cycles.

- Correlation patterns among precipitation, discharge, and ocean color in January suggest a strong coastal influence on surface sediment response characteristics inside the sanctuary.
- Correlation patterns among SST, SSHA, and ocean color in May suggest that increased regional heating, physical circulation and mixing processes limit chlorophyll production most dramatically.
- Correlation patterns among SST, SSHA, and ocean color in July suggest that increased light and temperature, along with upwelling, drive production inside the sanctuary.
- Correlation patterns in September suggest that coastal processes (Juan de Fuca outflow and Ekman transport) lead to fall chlorophyll maximums inside the sanctuary.

(4) Climatological anomalies of surface water properties reveal varied levels of response to environmental perturbations.

- Broad-scale climate patterns such as El Niño Southern Oscillation (ENSO) promote varying levels of surface anomalies inside the sanctuary, including extreme positive and negative SST, SSHA, chlorophyll, and turbidity.
- Regional and local OCNMS SST and SSHA anomalies trend positive with ENSO warm phases and negative with cool phases.
- Regional and local OCNMS chlorophyll and turbidity anomalies vary in both strength and direction with documented ENSO and non-ENSO (neutral) periods.

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