Science Research and Capacity Needs for California's North Coast: From Wigi to the Coastal and Marine Environment

Workshop Summary

November 2026





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About This Report

In August 2026, the Schatz Energy Research Center (Schatz Center) and the California Ocean Science Trust (OST) hosted a workshop to discuss science capacity and research needs for Wigi and the nearby coast and ocean environment. Wigi is the Wiyot name for California's second-largest estuary, which is located on the north coast between the Eel and Baduwa't Rivers. Wigi is also known as Humboldt Bay.

This report summarizes the workshop conversation and synthesizes opportunities, challenges, science and research needs, and associated ideas identified by participants. It is not intended to serve as a comprehensive review of all science and research needs for the area, nor to prioritize between needs. Instead, it captures knowledge gaps that participants identified as timely and necessary to address for the future of the region.

The findings and recommendations reflect the workshop discussions and do not necessarily reflect the views of the convening organizations, or any individual participant or participating organization.

OST strengthens the bridge between scientific research and sound ocean management. Created by state legislation, we support and bring world-class science and innovation together with state and federal policymakers to accelerate progress toward a healthy and resilient coast and oceans. OST report contributors include Kiya Bibby and Dr. Tanner Waters.

The Schatz Energy Research Center is committed to addressing climate change and improving human and ecosystem health through work that supports clean energy, climate resilience, equity, and justice. The Center co-leads the Pacific Offshore Wind Consortium (POWC) alongside the Center for Coastal Marine Sciences at Cal Poly San

Luis Obispo and the Pacific Marine Energy Center at Oregon State University. Schatz Center report contributors include Maia Cheli.

We are grateful to the workshop participants for sharing their expertise and for providing feedback on this report. We appreciate and acknowledge the Park Foundation and Firedoll Foundation for supporting this work.

Key Workshop Takeaways

1. ***Addressing long-standing gaps in data and understanding along the north coast and within Wigi is critical for safeguarding local ecosystems and communities, whether or not proposed developments proceed.***

Dedicated funding and coordination are necessary to strengthen monitoring and research in this area, because investments have historically lagged behind other regions in California. This lack of data constrains basic understanding of physical, chemical, and ecological processes in the region and limits the effectiveness of efforts to assess and respond to environmental and climate impacts. Potential impacts of the proposed floating offshore wind (OSW) farms and associated bay redevelopment plans have raised the visibility of this information gap. Even if these developments do not proceed in the immediate future, timely support for sustained observations is needed to prepare the region for environmental change, including marine heatwaves, harmful algal blooms (HABs), El Niño events, and sea level rise, and to address longstanding industrial pollutants and environmental justice concerns, and support healthy port redevelopment.

2. ***Tribal science and stewardship must be central to a regional research agenda.***

Centering Tribal science and stewardship will require sustained investment in Tribal science capacity and in Tribally led and informed research. Tribes have stewarded Wigi and the north coast since time immemorial and future research must meaningfully advance Tribal priorities. Building sustained Tribal science capacity requires more than support for dedicated staffing, equipment, and long-term funding; it requires working on longer time horizons to develop relationships and partnerships. Uplifting Traditional

Ecological Knowledge (TEK) and Tribal stewardship will be essential to guide climate adaptation, ecological restoration, and equitable co-management across the region.

3. ***Capacity and planning are needed for data stewardship to ensure that information collected is widely accessible for public benefit on a timely basis - and also protected where necessary to support Tribal sovereignty and cultural resources.***

Requirements or regulations for transparency, access, and sovereignty of developer-collected local data are urgently needed. There is significant concern that environmental data collected by consultants on behalf of developers has been, and will continue to be, proprietary, limiting public understanding and benefit. Beyond that, there is a general need to synthesize and collate data, especially for Wigi, so that it is available for multiple groups across multiple project types. Some Tribes experience challenges or encounter barriers when accessing data and research from the university. Academics expressed concern about sharing data with developers without compensation.

4. ***Local capacity and science leadership is needed for the north coast to advance meaningful research programs that benefit multiple groups and applications.***

Support for a regular (every 1-5 years) Humboldt Bay Assessment would promote coordinated research across multiple biological and physical features of Wigi, thereby anchoring science advancements for the region. Participants also discussed various methods of staying connected and coordinated moving forward, such as via the biennial Humboldt Bay Symposium, which will be next held in April 2027.

5. ***Proposed port development highlights the need for improved fundamental understanding of Wigi's physical environment.***

A one-time investment to develop a robust physical model for the bay would address critical gaps in physical oceanography and sediment dynamics of the bay environment. Addressing these needs is essential for assessing the potential impacts of dredging for bay redevelopment, such as risk from resuspended toxins, how altered sediment pathways may affect shoreline erosion, and many other applications.

Background

Wigi and the surrounding north coast of California are often described as “behind the redwood curtain” to illustrate the region’s remoteness and contrast to other parts of California. Tribes have stewarded the area since time immemorial, and continue to do so. Ten federally recognized Tribes call the region home. While the natural environment is relatively less developed and populated, its history is marked with intense periods of industrialization and development around the gold rush, the timber boom, commercial fishing, and the cannabis industry.

Wigi is the ancestral home of the Wiyot people. Today, the Wiyot Tribe, the Bear River Band of the Rohnerville Rancheria, the Blue Lake Rancheria, and the Trinidad Rancheria are four federally recognized Tribal Nations whose citizens maintain enduring relationships to the Wiyot ancestral territory. Different parts of the bay are generally associated with different uses, namely, the Humboldt Bay entrance opens to “Entrance Bay”, with a channel running north, which is where most of the maritime use is concentrated. Tidal mudflats dominate the northern and southern parts of the bay (Arcata Bay or North Bay, South Bay). Historical lumber mill sites (over 120) have mostly been found in the north and entrance bays, and it follows that the southern part of the bay is considered relatively pristine, and a useful “reference site” for certain types of research. The South Bay culminates in the Humboldt Bay National Wildlife Refuge and the South Humboldt Bay State Marine Recreational Management Area. This area is located northwest of Table Bluff, and includes both eelgrass and coastal marsh habitats.

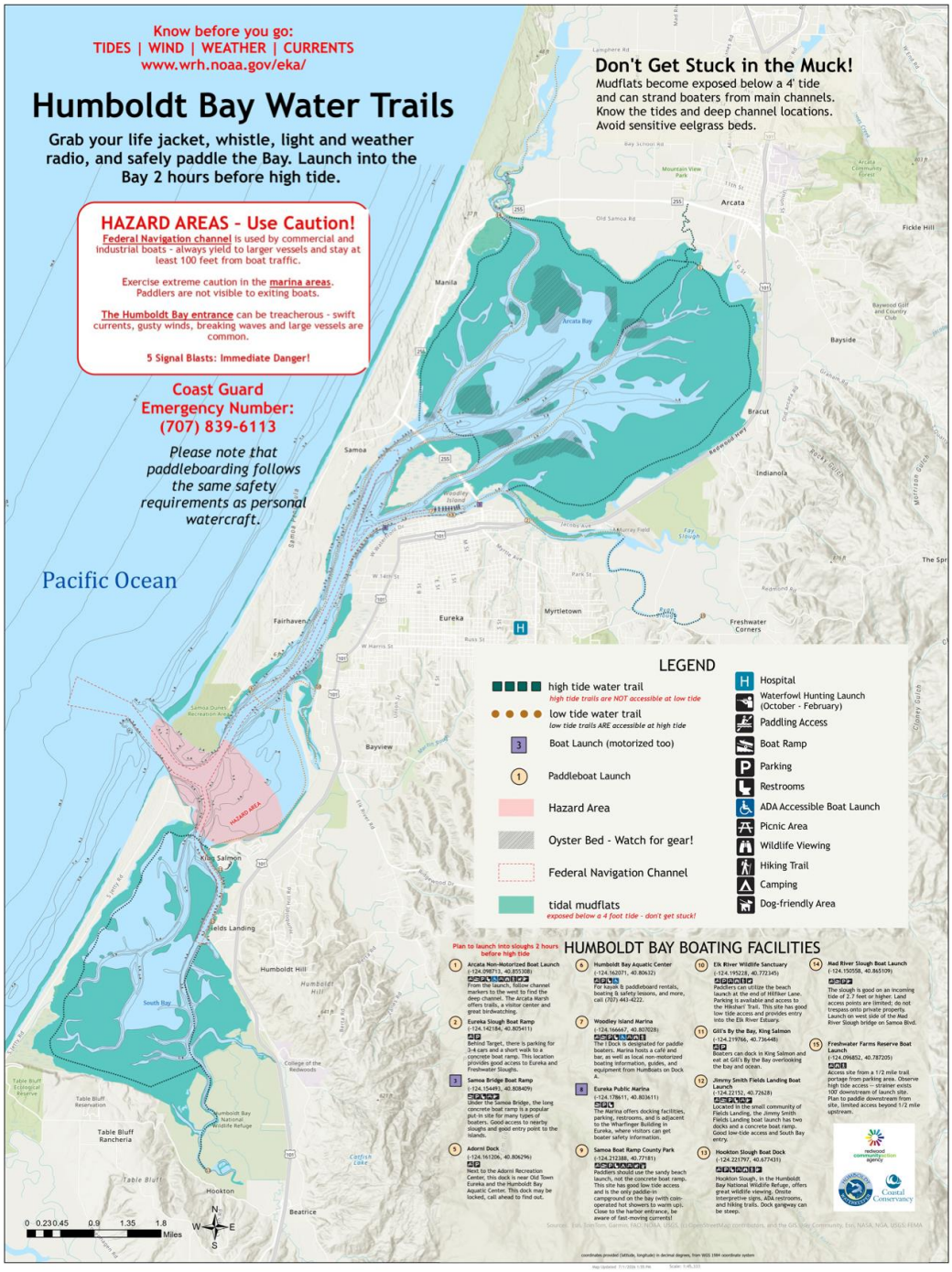


Figure 1: The Humboldt Bay Water Trails Map provides a visual of Wigi's North and South extent. Credit: Humboldt Bay Waterkeeper & Redwood Community Action Agency.

Beyond Wigi, the ocean offshore the north coast is to some degree bounded by two major headlands: Cape Blanco in Southern Oregon and Cape Mendocino to the south, an approximately 300-mile stretch of ocean that transitions between oceanographic features farther north and south, which profoundly influences ocean dynamics. Retentive circulation, or coastal eddies occur in the region, trapping nutrients and affecting ecosystem dynamics, such as the structure and recruitment of the zooplankton community or potentially increasing the risk of harmful algal blooms (HABs). Coastal rivers in this region have stronger influences compared to other parts of California. El Niño events propagate up into this area but do not typically pass Cape Blanco.

The proposed development of floating offshore wind energy in the Humboldt Wind Energy Area (HWEA), 21 miles offshore, and the associated redevelopment of the Humboldt Bay Harbor, represent potentially significant changes to the bay, coast, and ocean environment. A Heavy Lift Marine Terminal is also proposed, and may continue in some form, even if offshore wind development is halted at this time. Any major redevelopment of the bay raises concerns about environmental impacts from maritime vessel traffic, increased noise and light concerns, and impacts from dredging, including mobilization of legacy contaminants and changes in circulation patterns within Wigi. If offshore wind does not proceed, it is critical for science to be prepared to answer questions about potential impacts of other kinds of development, such as offshore oil and gas, minerals extraction, marine carbon dioxide removal, etc.

Science and Knowledge Landscape: Wigi

Existing Research

A wide range of research and monitoring is currently underway in Wigi. While the work discussed at the convening is not an exhaustive inventory of projects, it does reflect the breadth of research currently being done across the bay. The individual research and monitoring activities discussed during the workshop are further summarized in the Appendix.

Much of the work being conducted is focused on building and maintaining baseline data about the species and ecosystems within the bay. Researchers are monitoring marine mammals, sea and shore birds, fish communities, eelgrass, wetlands, and other habitats to better understand their abundance, distribution, and condition over time. Water quality is another active area of research, including the distribution and impact of harmful algal blooms and contaminants. In addition, observational programs and modeling efforts are building our understanding of processes shaping the Bay. Building from this baseline work, researchers are also examining how environmental change and human activities, including sea level rise, habitat restoration, fisheries, vessel traffic, ocean warming, and offshore wind development, are affecting Wigi and its inhabitants.

Tribal-led research and monitoring is an important part of the work being done in Wigi. This includes a breadth of activities, e.g., cultural landscape and ethnoecology research, studies on climate change impacts on coastal resources, ocean and coastal monitoring, and efforts related to stewardship and co-management.

Wigi's Future: Questions and Challenges

While existing research provides a starting place for understanding Wigi, participants identified several issues, questions, and challenges relevant to the bay's present and future. Many of these relate to how the bay is changing, and whether current data is sufficient to understand and respond to those changes.

Sea Level Rise

One of the primary and cross-cutting challenges is sea level rise. The Wigi area is especially vulnerable to sea level rise and flooding due to its many low-lying areas that sit behind artificial shorelines. That exposure is compounded by vertical land movement, which is causing Humboldt to sink and experience some of the fastest relative sea level rise in California. Events like the anticipated 2026 El Niño will further intensify the risk of flooding. Sea level rise is projected to rise at the North Spit tide station by 0.6 ft in 2030, 0.9 ft in 2040, 1.2 ft in 2050 and 3.9 ft in 2100 under the Intermediate Scenario. However, the effects of sea level rise are already being felt.

Ecological Impacts

Many habitats within the bay occupy narrow ranges, leaving them particularly vulnerable to inundation and shifting sediment supply. These changes jeopardize not only the habitats but also the species that rely on them.

Mudflats, for example, are an important feeding habitat along one of the Western Hemisphere's most important migratory bird flyways. These ecosystems may not be able to accumulate sediment quickly enough to keep pace with rising water levels. If they become permanently submerged, substantial areas of bird foraging habitats could be lost. Sand Island has already lost its function as a nesting habitat in the bay. Harbor

seals face similar pressures as established haul-out areas may disappear. Because harbor seals' exhibit high site fidelity, they may struggle to relocate to an alternative suitable habitat under rising seas.

Threats to Community and Infrastructure

The same rising water levels affecting habitat are increasingly reaching low-lying residential areas and infrastructure around Wigi, including during sunny, clear conditions. In January 2026, King Salmon experienced record-high water events, leaving dozens of homes flooded. Managing water and sewer infrastructure in the area is already difficult, and is expected to face greater pressures as coastal flooding becomes more frequent and intense.

Critical infrastructure faces similar exposure and long-term risks. The Humboldt Bay Independent Spent Fuel Storage Installation near King Salmon is adjacent to the bay, and currently holds spent nuclear fuel from a PG&E plant that was deactivated in 1976. Although the fuel is contained in underground storage systems, rising water levels, shoreline erosion, and significant tectonic activity raise concerns about maintaining protection of and access to the site.

Sea level rise also intersects with the bay’s legacy of industrial contamination. Many former mill sites are located along shorelines and contain dioxins. Increased flooding, shoreline erosion, rising groundwater, and site redevelopments could potentially impact the mobilization of these contaminants. Mapping where hazardous sites overlap with areas vulnerable to sea level rise, and thus determining which sites should be prioritized for cleanup, remains an important challenge. Humboldt Waterkeeper has been developing a comprehensive hazardous site database, and anticipates releasing this to the public in 2027.

The core challenge lies not only in analyzing where and how sea level rise will impact Wigi, but in balancing competing priorities when protecting infrastructure, habitat, and land-use conflict. Highway 101 highlights this. As a vital transportation lifeline for the region, relocating the highway poses significant complications. The question is therefore how to accommodate sea level rise while maintaining the highway, minimizing its impacts on sediment movement and replenishment in the bay, and accounting for adjacent land uses and habitats. A broader difficulty is moving from vulnerability assessment and adaptation planning into implementation. Costs, permitting pathways, land-use constraints, and community support can all limit or impact which projects advance.

Port Redevelopment and Bay Use

The second cross-cutting challenge is the potential development projects in Wigi, including the Heavy Lift Marine Terminal and other offshore wind infrastructure. These projects would increase vessel traffic into the bay and require additional dredging to accommodate larger and more frequent vessels.

Dredging and Contaminant Risk

Dredging is of particular concern because of legacy contamination in bay sediments. Historically, the Wigi area had over 120 lumber mills concentrated around the north (Arcata) and central bay. Mills often used wood preservatives such as pentachlorophenol, leaving a legacy of dioxin contamination around many of the former sites. Dioxins are a highly persistent class of chemicals and can remain in sediment for decades, particularly in fine sediment and mudflats. Disturbing these areas through dredging could remobilize dioxins, mercury, and other pollutants,

making them available to enter the food web and affect fish, birds, marine mammals, and humans.

Managing dredged sediment creates an additional challenge. Dredging could provide sediment that supports restoration elsewhere in the bay. However, where dredged material is contaminated, it is often required to be disposed of at a hazardous waste facility. Disposing of material outside Wigi removes valuable sediment from a system where it is needed to support shorelines, mudflats, and tidal wetlands. Meanwhile, the full spatial extent of legacy contamination is poorly characterized. While there are ongoing efforts to create and map a dioxin database around the bay, many former industrial sites have received very little testing, leaving uncertainty about where contaminants occur and at what concentrations.

Potential Impacts from Vessel Traffic

The vessel traffic associated with development introduces a set of separate but overlapping challenges. Larger and more frequent vessel traffic increases the risk of marine mammal strikes and changes the underwater acoustic environment. Harbor seals and salmonids, for example, move through many of the same areas used by vessels, creating unknowns around how the additional noise and physical disturbance would change their distribution, movement, and use of the bay. Larger vessels and more frequent vessel traffic could increase sediment resuspension and redistribute persistent contaminants through propeller wash, while larger and more frequent vessel wakes could contribute to further shoreline erosion.

Vessels arriving from outside the region create new and additional pathways for introducing invasive species and disease to the bay. Wigi plays a major role in oyster cultivation, as one of the largest shellfish nurseries on the West Coast, currently

supplying oyster seed to over 140 farms. Shellfish in the bay are doing notably well, compared to other regions. Its relative isolation and disease-free profile make the bay an important control site for studying shellfish. The introduction of new pathogens or diseases could therefore have consequences both for the bay and for shellfish production elsewhere along the West Coast. Increased vessel traffic also raises the potential for oil spills, a risk that participants indicated has received relatively little attention to date, despite the potential consequences for wildlife and habitats.

These changes in vessel traffic would also intersect with existing human uses of the bay. Commercial and recreational fishing vessels already move through the navigation channel. Transporting infrastructure through these same areas creates conflict with existing traffic. Understanding when, where, and how fishing vessels currently use the bay and its entrance will be important for identifying where those conflicts are most likely to occur and how they can be minimized.

Pile Driving

Another key concern for marine mammals, birds, fish, and other acoustically sensitive species is the number of piles that would be driven during the development process of the proposed terminal. As of October 2026, the Humboldt Bay Harbor, Recreation, and Conservation District anticipates that approximately 4,925 piles will be installed in total – 2,840 in water and 1,235 on land for the wharves, plus another 650 piles for the wet storage structures near Tuluwat, and 200 piles for a temporary trestle to demolish the existing dock.

Potential Loss of Sensitive Habitat

The proposed OSW terminal development would put pressure on the complex and often competing habitat needs within the bay, including eelgrass meadows, harbor

seal haul-outs, and sea and shorebird rookeries – each of which could be directly impacted by the proposed terminal development and operations.

Tuluwat

Tuluwat is the traditional site of the Wiyot Tribe's World Renewal Ceremony, and home to a clamshell mound whose history stretches back over 1,000 years. The Tribe has conducted numerous restoration efforts on the island – engaging in a healing process at the cultural, environmental, and historical level. In 1860, settlers massacred Wiyot women, children, and elders who were gathered on the island for ceremony. For over a hundred years following, the island suffered from shipbuilding and other damaging industries – but through land purchase and land return, the Tribe has now reclaimed and restored significant portions of the island. For all of these reasons, Tuluwat holds a significant and complex cultural role in the region.

The proposed terminal is across the deepwater channel from Tuluwat, with in-bay "wet storage" proposed for two locations in immediate proximity to the island. The two storage sites are proposed to house up to seven fully assembled wind turbines awaiting offshore deployment, plus two floating platforms awaiting final assembly.

Research Coordination and Data Availability

Many of the challenges identified in the convening are compounded by limited coordination of research (e.g., between local agencies, consulting firms, and campus departments) and minimal resources to support effective and ongoing coordination efforts. Participants noted that while opportunities exist to maximize available resources–such as co-planning UAV flights, co-deploying multi-sensor instruments, sharing vessel time, or aligning monitoring efforts–formal structures to coordinate

these efforts are lacking. Similar fragmentation occurs in regional planning for topics like sea level rise adaptation and restoration efforts, which can be siloed by funding structures, local government jurisdictions, and result in isolated research and planning efforts.

Gaps in Baseline Data

Wigi lacks sufficient physical, chemical, and biological data to characterize bay-wide baseline conditions and evaluate long-term trends. Although CeNCOOS maintains shoreline monitoring stations, one in Wigi near Entrance Bay and another along the coast in Trinidad, observations of fundamental physical parameters such as temperature, salinity, water depth, flow velocity, and wave dynamics remain spatially limited. More geographically distributed and consistent monitoring would improve our understanding of changing conditions and provide data to support hydrodynamic and other modeling efforts. Sediment dynamics also remain poorly understood, making it difficult to trace sediment sources, transport pathways, and active zones of erosion or deposition. Chemical monitoring is similarly incomplete, particularly for dissolved oxygen, nutrients, pH, alkalinity, and the carbonate system.

These gaps make it difficult to interpret changes in the biological system. For many species, basic information such as population size, distribution, habitat use, and diet is not well known. When changes are observed, there is often not enough corresponding physical or chemical data to understand what is driving them. Without these linked baseline datasets, it is difficult to establish existing conditions and determine how they are changing across the bay.



Figure 2: Shorebirds gather in Wigi's North Bay. Photo Credit: Maia Cheli.

Data Transparency and Stewardship

Many participants emphasized that data accessibility and sharing has been historically neglected, posing a significant concern with proposed future development. Environmental data is often generated by private consultants for developers, and is rarely made publicly available, even when the project involves public lands or public funding. This not only constrains transparency and public trust around potential impacts but hinders the potential benefits that could be realized from improved knowledge in this data-poor environment. It also shifts the resources and capacity outside of the region without building the local workforce and investment needed for long-term monitoring of the area.

Local researchers can face the inverse problem as well. Oftentimes they are asked to provide long-term datasets, without compensation, that they have collected with limited support or funding for use in externally-led analyses. When those analyses are conducted by people with limited familiarity with Wigi, there is the risk that the local context is lost.

The challenge of data stewardship is not unique to developer-collected data. Some Tribes identified barriers to accessing university data and research. Participants identified a need for planning and coordination to synthesize and collate data, especially for Wigi, so that the information is available for multiple groups and applications.

At the same time, protection of Tribally led research and data is fundamental to Tribal sovereignty, and Tribes maintain their own distinct data-governance principles and sharing philosophies. Understanding Tribal data priorities and negotiating data exchange and protection in the context of overlapping Tribal stewardships will continue to be a priority for research efforts in this region.

Future Science Needs

The research and science needs identified during the workshop build on the challenges described in the section above. Participants emphasized the need for a coordinated approach to collecting and using foundational information, such as better baseline data and sustained long-term monitoring. Participants also highlighted the need to create shared tools and datasets that support a range of research and management questions.

Baseline Understanding of Bay Components

There is a fundamental need for a better, more complete understanding of existing conditions across Wigi. This includes expanding the monitoring of baseline physical, chemical, and biological characteristics of Wigi already underway and filling gaps where basic measurements are still limited. For the physical characteristics, priorities include temperature, salinity, dissolved oxygen, flow and velocity data, depth, and related conditions within the bay. A standardized network of low-cost, continuous real-time monitoring throughout Wigi could expand existing monitoring capacity to achieve this.

Sediment is another identified baseline science need of the bay. General data collection is needed to support and develop sediment transport and pathways modeling and build a stronger conceptual understanding of Wigi's sand and fine-sediment dynamics. This would help clarify how local tributaries and watershed changes affect sediment delivery to the bay and the Eureka Littoral Cell, and how these changes, combined with climate change and sea-level rise, may affect shorelines, mudflats, and intertidal and submerged habitats.

A stronger water-quality baseline is also needed to understand the conditions within Wigi and the different inputs affecting those conditions. Participants identified nutrients, pH, alkalinity, and carbonate chemistry as important components of the bay that should be measured. For North Bay, participants highlighted its unique phytoplankton communities and stressed the need to monitor microalgae broadly–not just species harmful to human health–given the importance of Wigi's shellfish industry. Similarly, stormwater runoff, sewage spills, and urban runoff remain poorly monitored, creating a need for better mapping of where these inputs originate and how they affect the bay.

Environmental contaminants are another part of the baseline monitoring needs in Wigi. A more in-depth baseline is needed to determine where contaminants occur in the bay, at what concentrations, and what potential impacts could result if sediment is resuspended. Marine mammals may provide a useful biological indicator of these conditions. Documenting contaminant loads and stress hormones in individual seals could help show how exposure in Wigi is being reflected in animals that are directly influenced by the health of the bay.

A stronger biological baseline requires understanding habitats and the species that depend on them. Doing a sensitive habitat assessment and monitoring of mudflats, wetlands, and eelgrass would establish where habitats occur and in what abundance. For marine mammals, birds, fish, and other culturally and commercially important species, more complete population-level information is needed on abundance, habitat use, diet, and condition. Migratory species add another dimension to the work, with a need to understand their spatial and temporal occurrence regionally and their migration routes. Participants also identified the need for research on the relationship and interactions within the bay, for example, between eelgrass and shellfish.

Human activity should also be characterized with the same baseline approach. Better information is needed on vessel traffic, including the number and type of vessels, acoustic signatures, and potential contaminants and risks associated with the vessels. Participants also identified the need to characterize commercial fisheries in the bay and understand how they may be impacted by development.

Continued Research and Monitoring

Beyond building more capacity for monitoring, participants emphasized the need to sustain and connect the work that is currently being done. A standardized, long-term

monitoring program in Wigi could combine and support existing long-term datasets with newly identified monitoring priorities and provide continuity across time. This continuity is needed to understand the long-scale impacts of climate change. Doing so is also necessary to be able to understand the conditions of Wigi before and after discrete events or disturbances occur. Sustained biological monitoring is therefore needed to detect change as well as disentangle environmental drivers behind the observed change.

Environmental DNA metabarcoding (eDNA) was highlighted as one tool to build this sustained biological monitoring across multiple areas of interest. Participants discussed using eDNA as a way to track and measure multiple taxa from a single sample including fish, zooplankton, pathogens, etc.

Long-term research is also needed to support sea level rise adaptation as planning moves into implementation. For nature-based solutions, participants raised questions about how restoration could reduce coastal flood risks and improve the resilience of built and natural environments to sea-level rise and climate change. Research is needed to also support additional adaptation approaches, such as voluntary buyout programs. Understanding social acceptability, governance, and coordination will be necessary to evaluate strategy feasibility and implementation plans for Humboldt.

Tribal Co-Management and Monitoring

Addressing Wigi's future science needs requires meaningfully supporting both Tribal-led and Tribal-informed research. Participants called for a Tribal inventory of research priorities that could identify where interdisciplinary support from academic and community partners is needed. They also identified long-term, Tribally informed monitoring of water quality, eelgrass, wetlands, mudflats, culturally important species,

and climate impacts as priorities for future work. True support goes beyond incorporating Tribal participation into existing research projects. Participants emphasized the need for supporting greater Tribal science capacity, including staff, equipment, GIS/data management, and long-term funding.

Participants also identified a need for long-term strategic planning across bay jurisdictions and innovating science and policy to enable Traditional Ecological Knowledge and Tribal stewardship of Wigi. Doing so would help to inform restoration priorities, climate adaptation, infrastructure planning, resource management, and co-management decisions.

Modeling

The value of this new and sustained monitoring increases considerably when the different datasets can be used to understand how Wigi is connected. Participants called for a better understanding of the linkages and processes between the ocean, the bay, and contributing watersheds. Hydrodynamics are central to many of those linkages. A better understanding of watershed–bay and ocean–bay linkages and circulation dynamics is needed to characterize how freshwater inputs and ocean conditions influence water movement, mixing, and retention throughout the bay. Existing hydrodynamic modeling indicates that North Bay, Entrance Bay, and South Bay have distinct water characteristics, including differences in temperature, salinity, water age, and flushing rates. Further hydrodynamic modeling and monitoring would improve our understanding of water exchange among these regions, the influence of watershed and ocean conditions on water quality, and the resulting effects on habitat conditions and environmental exposure, particularly as these processes respond to climate change and sea-level rise.

One of the strongest recommendations from participants was to develop and maintain an operational hydrodynamic modeling framework for Wigi. Rather than developing separate models for individual research questions, a common platform could provide consistent information on circulation, water levels, wave dynamics, and other physical processes. The model could support hindcasting of historical conditions, forecasting of future conditions, and evaluation of how dredging, shoreline modifications, climate change, sea-level rise, and other disturbances may affect the bay.

This physical framework could also support studying sediment transport, geochemical, biological, and ecological linkages through integrated process-based models or empirical relationships. These applications could address key species (e.g., salmon and sturgeon), key concerns (e.g., harmful algal blooms and contaminants), habitat conditions, species behavior and movement, cultural and social priorities, and exchanges between the bay and surrounding watersheds and ocean.

Development, maintenance, and application of the modeling framework should remain grounded in the local scientific and Tribal communities, supporting local expertise, collaboration, continuity, and long-term stewardship of the modeling tools and associated data.

Coordination

Many of the science priorities identified during the convening will depend on stronger coordination and collaboration among the people and organizations working in Wigi. Participants discussed several possible models for a collaborative framework connecting researchers, agencies, Tribes, long-term monitoring, and management. This could help fill some of the science gaps by supporting connections between disparate research projects that use the same techniques to maximize the amount and

diversity of data being collected. The coordination also needs to extend to the information itself. Participants identified the need for a publicly accessible GIS map and database to share and compile biological data, habitat data, water quality data, and other information.

A more current or 'living' State of the Bay assessment could provide the synthesis of this work. Regularly updating the status of habitats, key species, and ongoing projects in Wigi would establish a shared assessment of conditions to guide impact assessments, permitting, restoration projects, and current risks and uncertainties.

The underlying need for all of this work is investment and support for local science capacity and development. Participants emphasized that current funding and consultant-driven models of science in the bay do not build the support and capacity needed to establish long-term science. Local researchers, agencies, and Tribes already hold substantial knowledge of Wigi and have developed long-term datasets, often with little to no funding support. Future investments are therefore needed not only for individual research but for the staffing, data systems, and infrastructure to support place-based capacity.

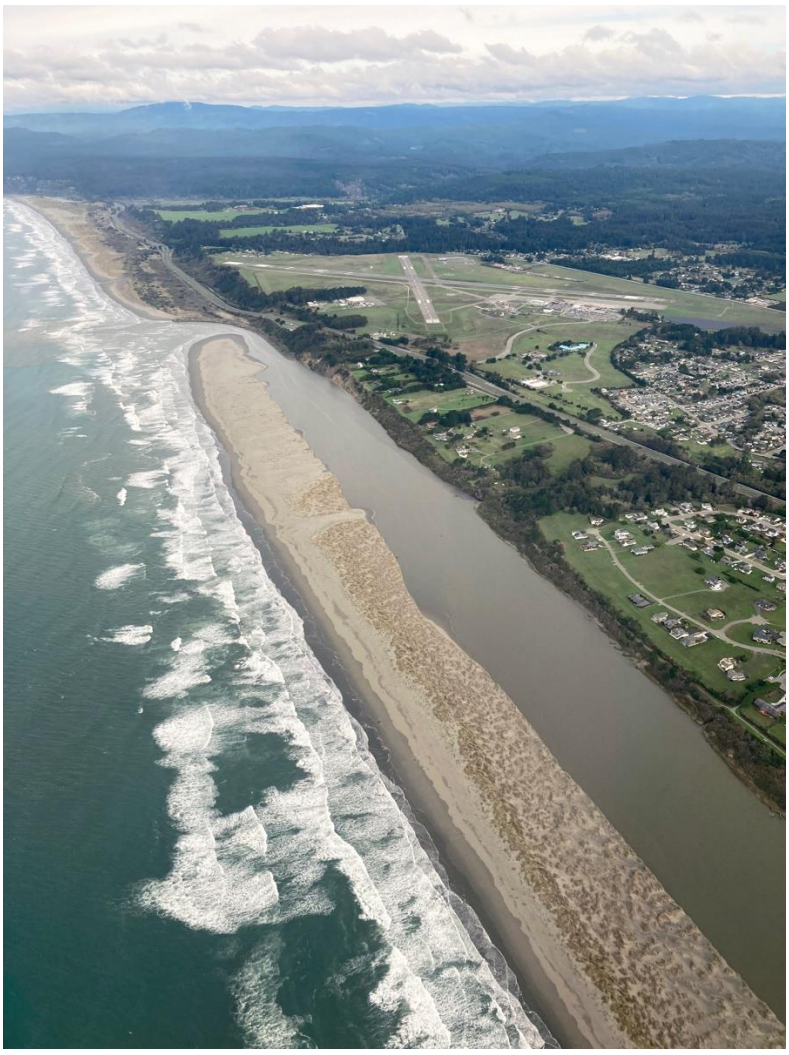


Figure 3: The Baduwa't River (Mad River) where it meets the ocean north of Wigi.

Photo Credit: Maia Cheli

Science and Knowledge Landscape: Ocean and Coast

Existing Research

Much of the existing ocean monitoring is focused on observing ocean conditions through the Trinidad Head Line. Along this transect, researchers collect a mix of physical data (e.g. temperature, salinity), chemical data (e.g. dissolved oxygen, pH, nutrients, domoic acid), and biological data (e.g., chlorophyll, zooplankton, copepods, larval fish). Additional near-real-time observations are taken at the Trinidad Wharf shore station on the Trinidad Pier, and by the Trinidad Ocean Observing Node, an offshore mooring that takes water-column profile measurements every 8 minutes.

A substantial amount of research is also focused on marine species and ecological processes. This includes work on rockfish recruitment, krill abundance and size, seabird surveys, marine and mammal distribution, and marine mammal strandings. Researchers are also studying how changing ocean conditions impact marine life, such as the impacts of harmful algal bloom toxins on krill and multi-stressor experiments testing the combined impacts of temperature, ocean acidification, and low dissolved oxygen.

Additional monitoring is underway within the Humboldt Wind Energy Area and Wigi, through two complementary projects funded by the COAST State Science Information Needs Program (SSINP). One project is establishing more intensive baseline offshore information through CTD casts, eDNA, and acoustic and visual surveys of marine mammals, seabirds, salmon, and other fish, to identify potential impacts of offshore development. The other is focused on building a baseline understanding of harbor seal abundance, distribution and diet within Wigi to inform activities associated in infrastructure development.

Marine mammal stranding and oil spill response programs

The Cal Poly Humboldt Marine Mammal Stranding Program (CPH MMSP) is directed by faculty member Dawn Goley and is responsible for responding to dead stranded marine mammals along the 240 miles of coastline from the Oregon border to northern Mendocino County. In addition to responding to public reports of stranded marine mammals, student interns in the CPH MMSP survey over 140 km of coastline every month, building a 15-year controlled baseline of marine mammal strandings. This program also includes community hubs in rural communities across the response area. From this shared stewardship baseline, researchers have determined the 'normal' spatial and temporal patterns of strandings in the area, and respond quickly when numbers exceed that baseline. The team attempts to determine the cause of death of all stranded marine mammals, documenting the impact of natural (e.g. domoic acid toxicity, disease, starvation) and human caused (e.g. ship strikes and entanglement) mortality. The CPH MMSP is also part of the NOAA large whale entanglement response, responding to entangled whales and pinnipeds in the region.

Cal Poly Humboldt hosts the Humboldt Marine Wildlife Care Center (MWCC), a purpose-built oiled wildlife response and care facility created and supported by the Oiled Wildlife Care Network and the California Office of Spill Prevention and Response. The MWCC is directed by Cal Poly Humboldt faculty member Daniel Barton and stands ready 24/7/365 to engage in emergency oiled wildlife response efforts in the North Coast region, through training, staging equipment and materials, and capacity building. The MWCC and associated Humboldt faculty and partners have previously conducted research on both oil spill response efforts and oiled wildlife rehabilitation, and could play a key role in minimizing and mitigating spill risk associated with increased vessel traffic and industrial development in Humboldt Bay.

Future of the North Coast: Questions and Challenges

The ocean and coast surrounding Humboldt are experiencing multiple, overlapping challenges, from shifts in ocean conditions to changes in coastlines. At the same time, Humboldt has comparatively limited baseline information and monitoring with which to understand these changes. These issues are compounded by losses in funding, scientific capacity, and uncertainty about future offshore development.

Climate Variability and Ecological Change

Climate variability is already impacting the physical conditions that structure the north coast. Offshore, the ocean column is increasingly stratified, requiring more energy (i.e., more wind) for upwelling to occur. This warmer water, combined with retentive circulation (i.e., coastally trapped currents and eddies that hold nutrients and algae in place) in the Mendocino to Blanco region, are contributing to an increased frequency of harmful algal blooms.

Onshore, climate variability and anthropogenic impacts are reshaping Humboldt's coastline. In previous decades, differing land-use management, timber harvest, and large floods brought sediment down the watersheds and 'plugged' Humboldt's littoral cells (a relatively self-contained current within which sediments circulate). Since the 1980s, however, sediment input has decreased, and sea levels have continued to rise. Dredged sand is also removed from the system and disposed of at the Humboldt Open Ocean Disposal Site (HOODS). As a result, the beach dune system has become highly vulnerable.

Simultaneously, significant ecological changes are becoming visible. For example, marine mammals are currently experiencing the highest stranding rate in the last 15 years. Ongoing and expanded funding of the marine mammal stranding network led

by Cal Poly Humboldt, in conjunction with associated activities led by north coast Tribes, is key to both understanding these events, and coordinating rescue and rehabilitation efforts where possible.

Gaps in Monitoring Data

Much of the north coast remains poorly observed. Outside of the Klamath River, participants described local estuaries and rivers as a data desert, with relatively little physical data monitoring. These gaps in monitoring mean that researchers miss opportunities to analyze the impacts of management decisions, such as before-and-after plume studies of the Klamath dam removals. Without greater spatial and temporal coverage of the region, researchers and managers risk losing similar opportunities to collect and analyze this kind of change in the future.

Monitoring gaps extend offshore and throughout the water column. North of the Trinidad Head Line, sustained oceanographic monitoring in the region remains sparse, despite the fact that additional lines have been considered and debated in decades past. Offshore observations are also concentrated near the surface, leaving very few measurements of subsurface and bottom-boundary-layer conditions that are important for understanding processes affecting resources, such as the Dungeness crab fishery.

Uncertainty and Loss of Capacity

The backdrop to all the challenges is the loss of federal funding and support in the region. This is especially pronounced with cuts to ocean observing programs, which have experienced substantial funding loss and resulting inefficiencies with associated staffing cuts. When buoys go offline or float away, it takes longer to get back or replace that infrastructure, leaving gaps in the data's time series. Other long-term monitoring

programs have continued without dedicated funding beyond their initial funding period. Offshore wind energy development adds another layer of uncertainty to the mix. Much of the recent scientific planning has focused on establishing conditions before development, but substantial uncertainty remains over whether or when offshore wind will proceed and whether the funding associated with that work will continue.

Future Science Needs

Participants identified the need for sustained investment in science infrastructure, monitoring programs, modeling, and partnerships to understand change across Humboldt's coast and ocean.

Long-term Monitoring

Ocean Observing Systems

A primary need is greater frequency and spatial coverage of oceanographic observations across the north coast, most pressingly through dense, real-time monitoring and permanent observation system stations, buoys, moorings, and gliders that are capable of measuring physical and oceanographic processes in the nearshore and offshore environment. Measurements of water level, wave height, and surface currents are also needed to support coastal inundation forecasting.

Ecology

Long-term biological surveys of habitats and species are another priority. Participants emphasized establishing and maintaining monitoring of nearshore ecosystems, including kelp forests, rocky reefs, eelgrass meadows, and other intertidal habitats,

alongside continued support for at-sea oceanographic, fisheries, ornithological, and marine mammal surveys. This monitoring would strengthen baseline data on the abundance, distribution, and ecology of local species and allow managers to understand how ocean warming, ocean acidification, harmful algal blooms, and climatic events like El Niño are affecting ecosystems.

Marine mammals were identified as a particular priority since there is relatively little known about the marine mammal communities that utilize the nearshore and marine environments of Northern California. Stronger baseline data could also help determine whether changes in marine mammal health could provide early signals of broader ecological problems affecting Humboldt's ecosystems and communities. Participants also identified the need to monitor marine mammals together with vessel traffic, including developing or implementing tools such as passive acoustic monitoring, thermal imaging, and AIS communication to reduce vessel-strike risk.

Fisheries and subsistence resources also require improved data on abundance, recruitment, habitat use, and climate vulnerability of key species. Participants called for the evaluation of the effectiveness of north coast marine protected areas, given their role in limiting fishing activity.

Model Support

Similar to the Wigi session, a major science need is the development of a higher resolution, downscaled circulation model for the north coast. Participants emphasized a need to better understand the dynamics of the Mendocino-Blanco system, specifically regarding enrichment, retentive circulation, and other processes that structure the region. The objective is to better understand how these dynamics affect ecosystem processes, including harmful algal bloom formation, plankton recruitment, and salmon

survival. There is also a need to connect river discharge with estuarine and coastal circulation. Workshop participants noted that this modeling can examine how changes in these systems propagate through adjacent waters.

Higher-resolution models should be developed alongside the previously mentioned biological and physical monitoring so that field observations adequately calibrate model components.

Collaboration and Capacity

Expanding local and Tribal scientific capacity is integral to the future science and research needs of the Humboldt coast and ocean. Participants called for increased capacity for Tribal-led SCUBA, ROV, drone, eDNA, and intertidal monitoring. This support would allow Tribes to lead in sustained monitoring and evaluation of culturally and ecologically important species and habitats. Participants also identified the need for better integration of Indigenous Knowledge with ecological monitoring and decision-making.

A related priority is creating clearer pathways to share locally generated data with decision-makers. Participants noted that there aren't clear mechanisms for sharing useful analyses or studies that don't fit the traditional structure for journal publication, even when the information could be valuable to local management. Having efficient and effective mechanisms to share these results – both with others in Humboldt and to state and federal managers – is needed to make locally informed decisions.

The conversations held at this convening reflect a willingness by Tribes, state agencies, academics, researchers, and environmental groups to share information and build on one another's work. The convening and its output demonstrate the value of collaboration and bringing people together across disciplines and organizations.

Strengthening these connections through sustained investment will help to further bolster the region's capacity to engage in science-informed decision-making and ultimately protect local communities and ecosystems.

Conclusion

Expanding research capacity and collaboration is key to empowering the north coast to adapt to climate change, restore cultural and environmental resources, support bay and coastal communities, advance healthy and sustainable economies, and nourish the species that live and migrate through the region's waterways. The August 2026 workshop hosted a rich discussion between experienced scientists, and we want to acknowledge their gifts of time and expertise.

In addition to the topics covered in the August workshop, we anticipate that future discussions could explore the specific research needs associated with the Smith, Klamath, Baduwa't (Mad), and Eel Rivers, and their commingling with the marine environment.

Workshop members highlighted the importance of continuing collaboration and knowledge exchange. Upcoming engagement opportunities include:

Events

- Humboldt Bay Symposium – the next biannual symposium will be held April 8-10, 2027 in Eureka, CA

Agency processes and publications

- Humboldt Bay Harbor, Recreation and Conservation District Notice of Preparation of Draft Environmental Impact Report and

associated scoping meetings (comment period open through December 7, 2026)

- California's Fifth Climate Change Assessment Statewide Summary and North Coast Regional Report (ongoing)

Educational Programs about Wigi and the Coast

- Chah-pekw O' Ket'-toh "Stone Lagoon" Visitor Center (operated by the Yurok Tribe)
- Da Gou Rou Louwi' Cultural Center and Wigi educational programs (Wiyot Tribe)
- Friends of the Dunes nature center and educational programs
- Self-guided Humboldt Bay Trail Audio Tour (released October 2026) and guided bay tours with Humboldt Waterkeeper
- Trinidad Seascape Pier, Harbor, and Interpretive Center (Trinidad Rancheria, see Harbor Tours)



Figure 4: A view of Wigi from Woodley Island on a calm day. Photo Credit: Maia Cheli

Appendix

Appendix A: Existing Research and Science in the Wigi Area

The research summarized below reflects the work that participants in the convening have conducted, are currently conducting, or are planning to start. It is not intended to be a comprehensive inventory of all research underway in Wigi or along the north coast. Rather, this section captures the range of research experience represented in the room and the body of work that helped to inform workshop discussions. The research below largely reflects the language shared in the participant survey, and as such, Wigi, bay, and Humboldt Bay are used interchangeably.

Species and Habitat

Marine Mammals

Monitoring:

- Surveying harbor seal abundance, distribution, and diet in Wigi, using methods including scat metabarcoding, tagging, and aerial surveys over two years
- Year-round surveying of gray whale distribution, abundance, and ecology over thirty years
- Surveying of elephant seal abundance, distribution, and ecology studies on the Lost Coast over ten years
- Fifteen years of surveying Steller sea lion abundance and distribution in northern California
- Characterizing the marine mammals in the Humboldt Wind Energy Area as part of baseline research associated with potential offshore wind development

- Long-term observing to examine changes in marine mammal distribution through time to understand seasonal patterns of coastline use and track impact of El Niño, warm water blobs, and domoic acid blooms on marine mammal populations
- Surveying 240 miles of Del Norte, Humboldt, and Mendocino coastlines for stranded marine mammals as the marine mammal stranding response authority for NOAA, working with Cal Poly Humboldt students and local rural and Tribal communities
- Using marine mammal strandings to develop baseline information on impact of domoic acid, warm water events, entanglement, and ship strikes on marine mammal strandings
- Aerial surveying to examine whale occurrence in relation to the crab industry

Sea and Shore Birds

Monitoring:

- Long-term monitoring of seabird populations, including cormorants, terns, and murres, around the Trinidad and Humboldt Bay areas using UAVs and remote cameras
- Long-term, at-sea monitoring of marbled murrelets in California and Oregon
- Surveying seabird colonies along the outer coast
- Researching brant migration, connectivity, spatial use, and interactions between hunters and populations
- Monitoring heron ecology

Offshore Development:

- Characterizing the seabirds in the Humboldt Wind Energy Area as a part of baseline biological monitoring
- Modeling three-dimensional seabird distribution using several decades of survey data to evaluate seabird presence and vulnerability to collision relative to potential offshore-wind projects
- Cross-validating these models with field observations to assess model validity
- Surveying bird use of mudflats affected by proposed Heavy Lift Marine Terminal development via drone

Ecological Interactions and Habitat:

- Studying the impacts of sea level rise on cormorants and terns nesting in Humboldt Bay
- Studying the impacts of cormorant and tern predation on coho salmon and other anadromous fish populations
- Studying brant habitat use and the relationship with eelgrass in the bay
- Restoring storm-petrel habitat on islets around Trinidad, California
- Post-restoration bird monitoring associated with habitat restoration

Fish

Biodiversity:

- eDNA metabarcoding used to characterize fish biodiversity within Wigi and biodiversity indexing focused around the Klamath River plume and Wilson Creek
- Collecting SMURF-based recruitment data related to rockfish

- Nearshore integrated surface eDNA sampling to identify salmon distribution as it relates to the Wind Energy Area

Other Species

Krill:

- Surveying krill size and distribution, as well as researching combined effects of temperature, ocean acidification, and dissolved oxygen on krill and the effects of HAB toxins

Shellfish:

- Examining HAB distribution and effects in in-situ bivalves in Humboldt Bay
- Comparing oyster growth rates and mortality between Morro, Humboldt, and Tomales Bays

Otters:

- Surveying suitability of food, predators, and habitats for sea otters

Habitats

- Eelgrass monitoring in the bay, including three years of transect surveys at eelgrass sites and MPA sites with the goal of doing long-term eelgrass monitoring
- Conducting overflight eelgrass mapping and eelgrass wasting disease monitoring
- Engaging in wetland marsh restoration and fish habitat using local knowledge through the Blue Lake Rancheria's ethnoecology database

- Managing kelp forests, monitoring Tribal subsistence harvest, and conducting Tribal-led marine monitoring of coastal ecosystems
- Researching incorporating otter benches into culverts to support wildlife passage

Observing and Modeling

Long-Term Ocean and Coast Monitoring

Trinidad Head Line

- Repeated Trinidad Head Line cruises measuring physical, chemical, and biological ocean conditions including temperature, salinity, chlorophyll, pH, dissolved oxygen, nutrients, domoic acid, copepods, larval fish, and zooplankton
- Trinidad Ocean Observing Node that collects 8-minute water column profiles of temperature, salinity, dissolved oxygen, chlorophyll and Acoustic Doppler Current Profiler (ADCP) measurements
- Trinidad Wharf shore-based ocean observing system
- Building out a NOAA glider program to do coastal gliders on acoustics, shadowgraphs, and basic oceanography
- Collecting Coastal Data Information Program (CDIP) buoy observations of wave conditions and major wave events along the coast

Additional Observing Systems

- Webcam Coastal Observation System (WebCOOS) initiative monitoring Humboldt Bay using continuous, real-time views of coastal conditions

- Fishing Vessel Observation Network (FVON) enabling fishers to collect oceanographic data during routine fishing activities
- Backyard Buoys providing community- and Tribal-led nearshore wave observations

Coastal Change

Sea Level Rise and Shoreline Change

- Studying how climate change and sea level rise affect coastal resources of Tribes
- Developing a living database of relational knowledge through a coastal lens to document relationships among coastal resources, climate change, sea level rise, and Tribal stewardship
- Researching sea level rise and vertical land motion across Humboldt Bay and the north coast
- Assessing vulnerability to sea level rise across Humboldt Bay
- Monitoring geomorphic changes along the bay
- Using CoastSat and satellite-derived shoreline data to examine long-term beach change
- Adjusted water-level observations and tidal predictions at three North Coast tide stations (Crescent City, North Spit, and Arena Cove) to account for vertical land motion and regional sea-level rise. These adjustments support tracking of tidal residuals, monthly sea-level anomalies, and skew surge to inform local communities and monitor evolving 2026 El Niño conditions.

Water Quality

- California Harmful Algal Risk Mapping (C-HARM) forecasting to provide predictive information on coastal harmful algal conditions
- Developing a science-based framework for sampling 6PPD-Q
- Monitoring of mercury in fish and shellfish
- Maintaining a contaminated sites database

Physical Models

- Modeling nearshore and Humboldt Bay hydrodynamic conditions and sediment transport
- A first look at modeling Humboldt Bay salinity, temperature and circulation response to global climate change and sea level rise
- Modeling regional ocean and atmospheric conditions using ROMS-based circulation models, COAMPS atmospheric models, CDIP wave models, and C-HARM harmful algal bloom forecasts
- Developing a nested 800m circulation model extending from the mouth of Humboldt Bay through the offshore wind lease area
- Remotely sensing and modeling of West Coast freshwater plumes

Industry and Infrastructure

Fisheries:

- Quantifying temporal patterns of how commercial fishing boats operate in the Port of Humboldt Bay to inform avoidance and minimization measures associated with development projects
- Characterizing the spatial and temporal patterns of commercial and recreational fisheries that operate inside Humboldt Bay
- Surveying crab-gear debris on beaches and modeling how lost fishing gear moves offshore

Offshore Wind:

- Modeling entanglement hazards associated with floating offshore-wind mooring systems, including interactions of lost fishing gear under different current, wave, and wind conditions
- Developing sensor packages and custom ROVs to detect and confirm entanglement on mooring systems
- Developing sensor packages to evaluate seabird interactions with future offshore wind projects
- Design mooring configurations to reduce the number or density of mooring lines and anchors and evaluate potential design scenarios on entanglement risk
- Conducting community engagement surveys in the Samoa Peninsula about social and environmental concerns of noise pollution

- Advancing Tribal sovereignty and engagement in offshore development and Heavy Lift Marine Terminal planning and permitting

Nuclear Fuel

- Conducting long-term planning for Humboldt's spent nuclear fuel site

Appendix B: About the Workshop

Workshop Design

The single-day, in-person workshop was convened in Eureka, California. Before the workshop, participants received a survey soliciting information about active research projects and future science needs, which were then shared at the workshop for discussion and additions. The geographic focus of the workshop was centered around A) Wigi and, B) the surrounding outer coast and offshore ocean environments. The discussion format featured two main sessions, one for each of these areas, and participants were invited to contribute to a list of active/ongoing research projects, raise current environmental issues and future challenges, and identify science capacity and research needs to address those challenges.

Workshop Goals

The goals of the convening were to:

- Create a space for north coast scientists & knowledge holders to discuss priority research goals to inform decision-making related to Wigi, the coast, and the marine environment.
- Develop an understanding of local expertise and capacity gaps, and identify opportunities for collaboration & learning across silos.
- Articulate major research themes that can be effectively communicated to state and local decision makers, Tribes, and community leaders – and inform the West Coast Ocean Science Action Agenda.

- Identify timely investment needs and opportunities related to stewardship & management of the region's coastal & marine environment, including in the context of the proposed port infrastructure and offshore wind farm developments.

Participants

Participants were invited to represent science perspectives from Cal Poly Humboldt (CPH), Tribes, state agencies, federal research agencies, nonprofits, consultants, and industry. Participants received a draft of this report before publication to ensure that workshop comments and outcomes were synthesized accurately. Participants included:

Jeff Anderson- Principal Engineer, Northern Hydrology & Engineering
Daniel Barton- Professor, Department of Wildlife, CPH
Eric Bjorkstedt- Director, Marine Operations/Adjunct Professor, CPH
Robert Blenk- Professor, Department of Wildlife, CPH
Corianna Coyne- Senior Environmental Scientist (Supervisor), CDFW Marine Region's Offshore Renewable Energy Project
Dawn Goley- Professor, Department of Biology, CPH
Jessica Gravelle- Marine and Fisheries Program Manager, Trinidad Rancheria
Alex Harper- Deputy Director, Central & Northern California Ocean Observing System
Madison Hunt- Climate Resilience Specialist, Blue Lake Rancheria
Jen Kalt- Executive Director, Humboldt Waterkeeper
Sharon Kramer- Senior Ecologist, Integral Consulting
Molly Lowney- Coastal Development and Sustainability Fellow, Blue Lake Rancheria
Jen Marlow- Associate Professor, Department of Environmental Science, CPH
Raven McAdams- Senior Marine Biologist, Yurok Tribe Marine Department

Lorna Mcfarlane- Climate Change Branch Supervisor, Caltrans District 1

Kevin McKernan- Marine Director, Yurok Tribe

Justin Mojonnier- Director of Science and Technology, Hog Island Oysters

Laurie Richmond- Professor in Environmental Planning, CPH, & California Sea Grant

Jay Staton- Environmental Scientist, CA Dept. of Fish and Wildlife

The workshop team included:

Kiya Bibby- Associate Director, Science-Policy Engagement, California Ocean Science Trust

Maia Cheli- Senior Development Manager, Schatz Energy Research Center at CPH

Jessica Coming- Communications Specialist, Schatz Energy Research Center at CPH

Kayla Corder- Project Manager, Schatz Energy Research Center at CPH

Tanner Etherton- Economic Analyst, Schatz Energy Research Center at CPH, and Extension Specialist, CA Sea Grant

Arne Jacobson- Director, Schatz Energy Research Center at CPH

Tanner Waters- Science Officer, California Ocean Science Trust