



Meeting summary

December 16, 2025

9:30 a.m. to 12:30 p.m.

Hybrid meeting

Meeting attendance and objectives

The Washington Marine Resources Advisory Council (MRAC) held its 33rd meeting on December 16, 2025, in person and by conference call. The meeting was facilitated by Angie Thomson, Thomson Strategic Consulting.

Members in attendance: Martha Kongsgaard (Former Chair), Betsy Peabody (Chair), Cynthia Catton (Department of Natural Resources), Meg Chadsey (WA Sea Grant), Bill Dewey (Taylor Shellfish Farms), Aaron Dufault (Washington Department of Fish and Wildlife, alternate), Rod Fleck (Washington Coast Marine Advisory Committee), Jennifer Hennessey (Washington State Department of Ecology), Senator Keith Wagoner (Washington State Senate), Marilyn Sheldon (Coastal Shellfish Grower), Erika McPhee-Shaw (Western Washington University)

MRAC members not in attendance: Brian Allison (Puget Sound Commercial Crab Association), Mike Cassinelli (Recreational Fishing), Tom Davis (Washington State Farm Bureau), Norm Dicks (Van Ness Feldman LLP), Representative Joe Fitzgibbon (Washington State House of Representatives), Tony Floor (Northwest Marine Trade Association), Lucas Hart (Puget Sound Partnership), Dennis McLerran (Puget Sound Partnership), , Mindy Roberts (Washington Environmental Council), Senator Jesse Salomon (Washington State Senate), Douglas Steding (Association of Washington Business), Laura Watson (Washington State Department of Ecology).

Other participants: Simone Alin (National Oceanic and Atmospheric Association), Cory Archer (True Wind Collaborative), Richard Feely (National Oceanic and Atmospheric Association -- Retired), Kirsten Feifel (Puget Sound Partnership), Micah Horwith (Washington Department of Ecology), Terrie Klinger (Washington Ocean Acidification Center), Tommy Moore (Northwest Indians Fisheries Commission), Peter Murchie (Environmental Protection Agency), Jan Newton (Washington Ocean Acidification Center), Liz Perotti (National Oceanic and Atmospheric Association), Candice Plendl (MRAC facilitation team), Angie Thomson (Thomson Strategic Consulting, MRAC facilitation team), Jodie Toft (Puget Sound Restoration Fund), Jenna Inglese (Puget Sound Restoration Fund), Jay Manning (Cascadia/Puget Sound Restoration Fund), Mackenzie Gaverty (NOAA Fisheries), Jennifer Anstey (Puget Sound Restoration Fund), Jasmine Tomasettie (Puget Sound Restoration Fund), Natalie Coleman (Washington State Department of Ecology MMU), Ryan Crim (Puget Sound Restoration Fund), Christopher Biggs (Washington Department of Fish and Wildlife), Malise Yun (Puget Sound Restoration Fund), Jessie Turner (OA Alliance)

Meeting objectives:

- Share updates on recent ocean acidification efforts.
- Recent updates with MRAC Chair
- Introduction to West Coast Ocean Science Action Agenda

- Discuss MRAC website homepage refresh

Welcome and introductions

Martha Kongsgaard, former MRAC Chair, welcomed participants to the in-person/hybrid meeting and reflected on MRAC's origins, noting that the Council emerged from the Governor's Blue Ribbon Panel on Ocean Acidification and has remained focused on addressing anthropogenic carbon dioxide impacts on Washington's marine waters. Martha shared appreciation for the Council's longevity, adaptability, and collaborative spirit, emphasizing the urgency of continued action as ocean acidification and related stressors intensify.

Martha also recognized the leadership transition underway, expressing gratitude for the willingness of Betsy Peabody, Puget Sound Restoration Fund and new MRAC Chair, to step into the Chair role and for her long-standing contributions to ocean acidification science, policy, and advocacy in Washington. Betsy thanked the group, acknowledged the challenges and opportunities ahead, and emphasized the importance of collective, science-driven work to remain adaptive and resilient in the face of changing ocean conditions.

Recent ocean acidification happenings

Participants shared recent developments across ocean acidification science, monitoring, and policy. Highlights included:

- Betsy Peabody highlighted that Taylor Shellfish Farms is the first bivalve producer to receive Aquaculture Sustainability Certification (ASC) and thanked Senator Keith Wagoner for helping arrange a January 15 update to the Senate Agriculture and Natural Resources Committee on Washington's ocean acidification efforts.
- Bill Dewey noted that ASC is the gold standard for aquaculture sustainability and that Taylor Shellfish, now the only ASC-certified shellfish company in the U.S., has recertified as market conditions shifted. He also shared that a CBS national news segment (which also features Jan Newton and Terrie Klinger) is expected to air in early January.
- Richard (Dick) Feely shared updates on recent research, including a planetary boundaries paper co-authored by Jan Newton, and others in the committee, concluding that ocean acidification has exceeded the global safe operating space, and University of Washington work by Mary Margaret Stowe and Alex Gagnon showing that subsurface acidification in the Salish Sea is occurring nearly twice as fast as surface waters.
 - <https://cicoes.uw.edu/2025/12/03/19th-century-corals-unlock-a-new-understanding-of-ocean-acidification-in-the-california-current-and-salish-sea/>
 - Bill asked whether the more severe conditions in the Salish Sea are primarily anthropogenic. Dick explained that while anthropogenic CO₂ drives surface water acidification, subsurface acidification reflects a combination of anthropogenic CO₂ and biological respiration, potentially enhanced by high productivity and local nutrient inputs, along with declining buffering capacity.

- Dick also shared that he and Jan recently participated in a multi-stressor synthesis effort examining how ocean acidification, hypoxia, and other stressors interact to affect marine systems. This work, led by Frances Chan and Dick, is available through the NANOOS multi-stressors portal and includes both biogeochemical and biological modeling, with applications relevant to species such as Dungeness crab.
 - Population and maternal variation in the sensitivity of Dungeness crab zoea (*Metacarcinus magister*) to elevated CO₂ <https://www.int-res.com/abstracts/meps/v760/meps14854>
 - Jan Newton provided additional guidance on accessing the NANOOS multi-stressor products, noting that users can navigate to the “Products” section of the NANOOS website to find animations, visualizations, and datasets focused primarily on the outer coast, with relevance to Washington waters more broadly.
 - <https://www.nanoos.org/products/multi-stressors/home.php>
- Terrie Klinger and Jan Newton reported continued funding support for WOAC and ongoing monitoring with the Olympic Coast National Marine Sanctuary, including five moorings currently requiring seasonal data retrieval. Funding from the Quileute Tribe, implemented by Jennifer Haagen, will enable two moorings near Makah Bay and Cape Elizabeth to operate in real time, and Simone Alin’s work will improve acidity and pH characterization.
- Terrie and Jan noted that the 35th WOAC cruise was completed this year and discussed uncertainty related to NANOOS funding, which operates on five-year cycles and is awaiting the release of a new proposal opportunity. While bipartisan support remains strong, delays could result in a temporary funding lapse.
- Jan Newton shared that the Global Ocean Acidification Observing Network (GOA-ON) remains strong, with the upcoming Oceans in a High CO₂ World symposium this fall in New Zealand, where WOAC will be represented across multiple sessions. She also reflected on a recent Seattle to San Francisco sailing voyage with University of Washington students, during which imaging flow data were collected for analysis, and noted that student reflections will be shared with the group.
- Terrie Klinger highlighted ongoing graduate student research using molecular techniques to detect harmful algal bloom species, drawing on both current and historical WOAC samples. The student has expanded this work to process samples relevant to Dungeness crab, leveraging WOAC’s eight biological sampling stations throughout the Salish Sea.
- Shallin Busch highlighted recent publications from the Northwest Fisheries Science Center and collaborative work with the University of Washington. She noted that NOAA’s Ocean Acidification Program will issue an internal call for 2027 - 2029 work plans, with the coming year focused on shaping priorities for observation and sensitivity studies. Shallin also referenced recent papers on decapod sensitivity thresholds, population-level responses of Dungeness crab to elevated CO₂, and laboratory comparisons of diploid and triploid oyster performance under multiple stressors.

- Ocean Acidification Thresholds for Decapods Are Unresolved
<https://www.frontiersin.org/journals/marine-science/articles/10.3389/fmars.2024.1449345/full>
- Differential performance of diploid, mated triploid, and induced triploid Pacific oysters under varied environmental conditions: Insights into impacts of temperature, dissolved oxygen, and pCO₂
<https://www.sciencedirect.com/science/article/pii/S0044848625007525>
- Cynthia Catton shared that Helen Berry (Washington Department of Natural Resources) retired at the end of September after many years leading long-term kelp monitoring. Cynthia also highlighted new analyses using DNR's long-term floating kelp dataset to examine responses to the 2014 marine heatwave, including patterns of differential recovery relative to distance from ocean influence.
 - Claar DC, Berry H, Christiaen B (2025) Geographic variability of floating kelp recovery after a marine heatwave event in the Salish Sea and adjacent open coast. PLoS One 20(12): e0336574. <https://doi.org/10.1371/journal.pone.0336574>
- Jennifer Hennessey noted that federal budget uncertainty and continuing resolutions have left some funding decisions unresolved ahead of a January deadline, and shared that Ecology is working with Washington's congressional delegation and has submitted a contingency request through the Governor's budget process.
- Micah Horwith reported vessel challenges driven by extreme conditions but noted successful deep-water sampling near steep bed, producing data relevant to Dungeness crab and geoduck. He thanked Natalie Coleman, Jan Newton, Terrie Klinger, and Simone Alin, and shared that Clean Water Act assessments are increasingly using these datasets.

Science update: Razor clams

Amelia Ritger (University of California, Santa Barbara) presented findings from a coast-wide study examining shell integrity in Pacific razor clams. The research was co-designed with Tribal partners following observations by coastal Tribal harvesters that razor clam shells were becoming more brittle in recent years.

- Shell thickness and strength vary significantly across geographic locations, reflecting an environmental mosaic rather than a simple latitudinal gradient.
- Razor clam shells collected from several Washington beaches exhibited reduced thickness and strength compared to historical samples, consistent with observations from Tribal and recreational harvesters.
- Analysis suggests that multiple factors, including ocean acidification, food availability, temperature, and oxygen conditions, likely interact to influence shell integrity.
- Laboratory experiments conducted in collaboration with Fisheries and Oceans Canada represent the first successful multi-stressor experiments on Pacific razor clams, examining combined effects of acidification and marine heatwaves.

Q and A:

- Bill Dewey asked whether razor clams have been studied at the larval stage, noting strong ocean acidification impacts observed in Pacific oyster larvae. Larval razor clams have not yet been studied but would be an important focus for future research.
- Dick Feely asked about razor clam shell mineralogy. Razor clams use both calcite and aragonite, making them sensitive to changes in carbonate chemistry.
- Senator Keith Wagoner asked whether the experiment would continue and whether razor clams from Puget Sound could be included; Amelia clarified that the completed experiment was conducted by Fisheries and Oceans Canada using Vancouver Island clams, represents the first successful multi-stressor razor clam experiment, and noted that razor clams are not common in Puget Sound.
- Bill Dewey emphasized the economic importance of razor clam fisheries and suggested that larval-stage studies could be a strong candidate for future funding.
 - Terrie Klinger noted that WOAC has actively sought researchers to pursue larval razor clam studies, and Jan Newton added that a recent request for proposals did not receive any applicants.
 - Another attendee shared that a group is beginning related research, and Jan Newton noted she could follow up to explore potential collaboration.

Science update: Manila clams

Mackenzie Gaverty (NOAA Fisheries) presented results from a recently published study evaluating parental priming as a potential tool to enhance Manila clam resilience to ocean acidification.

- Broodstock exposed to controlled low-pH conditions during OA priming were not negatively impacted.
- Larvae from primed parents showed improved survival, growth, and shell development under acidified conditions, though acidification remained stressful overall.
- Subtle shifts in maternal RNA may reveal part of the mechanism of successful broodstock priming.

Q&A:

- Betsy Peabody asked whether exposure to ocean acidification conditions could trigger spawning in bivalves. While all clams were spawned under ambient conditions, stress exposure may influence fecundity and warrants further study.
- Betsy Peabody asked whether parental priming is currently used in commercial hatcheries; Bill Dewey responded that it is not currently practiced and would be of interest to explore, particularly given differences in calcium carbonate mineralogy among species.
- Bill asked how aragonite saturation levels factored into the experiment. The aragonite saturation was below 1 during treatments and that future studies could include additional treatments reflecting hatchery-controlled conditions.

- Terrie Klinger asked whether the observed priming response is heritable. While effects across generations were observed, they do not reflect DNA sequence changes and may involve epigenetic mechanisms.
- Terrie also asked whether epigenetic markers were examined. Additional analyses are underway using archived samples supported by WOAC funding.
- Jennifer Hennessey asked how ocean acidification conditions were regulated in the experiment. The pH was controlled using CO₂ dosing.
- The “little neck” clams performed poorly under hatchery conditions, which highlights species-specific responses.

Science update: Dungeness crab

Aaron Dufault (Washington Department of Fish and Wildlife) summarized Puget Sound Dungeness crab co-management, including the 3-S framework (size, sex, season), test fisheries, and harvest monitoring. He noted a persistent north–south productivity gradient, with continued closures in Deep South Sound (Marine Area 13) and parts of southern Hood Canal due to low abundance and limited reproductive capacity. Puget Sound-wide populations remain relatively stable, and co-managers are expanding data tools to better inform preseason quotas, molt timing, and in-season management.

Emily Buckner (Pacific Northwest Crab Research Group) presented results from collaborative research on Dungeness crab recruitment and growth. Findings show that larval abundance is highest in the central and northern Salish Sea, recruitment varies annually, and differences in larval size reflect environmental conditions rather than genetics, indicating strong population connectivity. Warmer temperatures are associated with smaller larvae and potentially delayed entry into the fishery, and ongoing work is evaluating whether seasonal closures align with peak molt timing.

OA Alliance

The OA Alliance partnered with LUMA Storytelling to produce *Changing Waters: Time for Action on Ocean Acidification*, a short film highlighting global responses to ocean acidification from government leaders, Indigenous communities, the seafood industry, and scientists, filmed in Washington State, Colombia, and Fiji.

The film, which features MRAC members, was screened to the group and will be more widely available in early 2026.

<https://www.oaalliance.org/oaalliance-short-film>

Next steps

- MRAC will next meet virtually in March 2026.