Revisiting the Blue Ribbon Panel:
Recommendations on Ocean Acidification

Blue Ribbon Panel "Refresh" Meeting Summary

Friday, March 17, 2017 • 8:30 a.m. to 4:30 p.m.
DoubleTree Hotel • 415 Capitol Way North • Olympia, WA

Meeting attendance (asterisk denotes presenter)

Attendee	Affiliation
Anji Morales	Vulcan, Inc.
Betsy Peabody	Puget Sound Restoration Fund
Bill Dewey*	Taylor Shellfish Farms, Inc.
Bob Schroeter	Washington Association of Conservation Districts
Brad Warren	Global Ocean Health
Chris Davis*	Office of Gov. Jay Inslee
Craig Burley	Washington Department of Fish and Wildlife
Cristiana Figueroa-Kaminsky	Washington Department of Ecology
Dale Beasley	CRCFA/CCF
Dick Sheldon	Coastal Shellfish Grower
Erika McPhee Shaw	Western Washington University
Forrest Howk	The Nature Conservancy
Garrett Dalan*	The Nature Conservancy & Washington Coast Marine Advisory Committee
Greg Pelletier	Washington Department of Ecology
Greig Arnold	Makah Tribal Council
Gus Gates	Surfrider Foundation
Jan Newton*	Washington Ocean Acidification Center
Jay Manning*	Cascadia Law Group
Jennifer Ruesink	University of Washington, Department of Biology
Jessie Turner	Cascadia Law Group
Julie Horowitz	Office of Gov. Jay Inslee
Kelly Susewind	Washington Department of Ecology
Kevin Grant	NOAA Olympic Coast National Marine Sanctuary
Kirsten Feifel	Washington Department of Natural Resources
Kristin Swenddal	Washington Department of Natural Resources
Libby Jewett*	NOAA Ocean Acidification Program
Lisa Anderson-Carnahan	U.S. Environmental Protection Agency
Lisa Graumlich	University of Washington, College of the Environment
Lynn Helbrecht	Washington Department of Fish and Wildlife
Martha Kongsgaard*	Marine Resources Advisory Council (Chair)
Marilyn Sheldon	Coastal Shellfish Grower

Max Kaplan	NOAA Ocean Acidification Program
Meg Chadsey	Washington SeaGrant
Megan Duffy	Washington Department of Natural Resources
Mike Cassinelli	City of Ilwaco
Norm Dicks	Van Ness Feldman, LLP
Parker McCready	University of Washington, School of Oceanography
Paul Dye	Washington SeaGrant
Paul Williams	Suquamish Tribe
Rich Childers	Northwest Straits Commission
Richard Feely	NOAA Pacific Marine Environmental Laboratory
Ron Schultz*	Washington State Conservation Commission
Scott Redman	Puget Sound Partnership
Shallin Busch	NOAA Northwest Fisheries Science Center
Terrie Klinger*	Washington Ocean Acidification Center

Facilitation Team

Angie Thomson, EnviroIssues
Daniel Brody, EnviroIssues
Lauren Dennis, EnviroIssues
Cory Baranski, EnviroIssues

Purpose and objectives

This meeting convened the state's leading ocean acidification thinkers to reevaluate and revise the six focus areas of recommendations from the 2012 Washington State Blue Ribbon Panel on Ocean Acidification (Blue Ribbon Panel). Reevaluation of these focus areas will help ensure Washington state builds on the progress and collaboration over the last several years and continues strategic momentum in addressing the ongoing threat from Washington's changing ocean chemistry. Specifically, the meeting sought to:

1. Provide a high-level overview of the latest scientific knowledge since 2012 that have changed our understanding of ocean acidification and that could impact efforts
2. Review at a high-level what progress has been made to date to fulfill the recommended actions in the 2012 Blue Ribbon Panel
3. Discuss and vet proposals from the MRAC for next steps to fulfill the existing suite of Blue Ribbon Panel recommended actions, as well as any revisions, where appropriate
4. Develop consensus around priorities across the Blue Ribbon Panel's six focus areas to guide activities around ocean acidification for the next five years

In addition to this meeting summary, a report will be developed following the meeting as an addendum to the 2012 report *Ocean Acidification: From Knowledge to Action Washington State Blue Ribbon Panel on Ocean Acidification Washington State's Strategic Response* (the latter which will heretofore be referred to as the "Blue Ribbon Panel report" or "report") to guide priorities going forward. While the highlights of the revisions to the Panel's 2012 recommended actions discussed in the meeting are noted here, the complete set revisions and additions will be reflected in the report.

Focus Areas from the 2012 Blue Ribbon Panel

In 2012, the Blue Ribbon Panel recommended strategies and actions over six focus areas, recognizing the need for action across a range of disciplines to reduce the impacts of ocean acidification. The six focus areas are:

1. **Invest in Washington's Ability to Monitor and Investigate the Causes and Effects of Ocean Acidification.** Investing in ocean acidification research and monitoring will provide the necessary scientific support for developing, implementing, and evaluating effective responses to ocean acidification.
2. **Inform, Educate and Engage Stakeholders, the Public, and Decision Makers in Addressing Ocean Acidification.** Increasing understanding of ocean acidification and its consequences among policy leaders, interested organizations, and the public is essential to implementing appropriate response measures.
3. **Reduce Local Land-Based Contributions to Ocean Acidification.** Reducing inputs of nutrients and organic carbon from local sources will decrease acidity in Washington's marine waters that are impacted by these local sources and thereby decease the effects of ocean acidification on local marine species.
4. **Increase Our Ability to Adapt to and Remediate the Impacts of Ocean Acidification.** We need to use a wide range of approaches to adapt to and remediate the impacts of ocean acidification in order to limit future losses of shellfish resources.
5. **Reduce Emissions of Carbon Dioxide.** Emissions of carbon diocese must be significantly reduced to prevent irreversible harm to marine organisms and coastal ecosystems. Meanwhile the real and present consequences of acidification require that we act not to reduce, manage, and adapt to impacts of acidification.
6. **Maintain a Sustainable and Coordinated Focus on Ocean Acidification.** The state's effectiveness in addressing the impacts of changing ocean chemistry on our marine ecosystems and coastal communities requires sustained leadership and support by the Governor and other state officials and a coordinating mechanism to facilitate implementation of the Panel's recommendations.

Welcome and introductions

Martha Kongsgaard (Marine Resources Advisory Council Chair) opened the meeting and thanked attendees for their participation and for working together to build on the progress and collaboration over the last several years.

Setting the stage

Jay Manning (Cascadia Law Group, Co-Chair of the 2012 Blue Ribbon Panel) shared background and history of the formation of the 2012 Blue Ribbon Panel, noting that:

- The Blue Ribbon Panel was a work group for a challenging topic, with great diversity among its members.

- In 2012, Bill Dewey shared his story of nearly losing all larval oysters over two years from a small change in the pH of the water. Upon hearing his story, Governor Christine Gregoire launched the Washington Shellfish Initiative.
- The Panel was made of twenty-three members, including nine expert scientists, providing a scientific basis for decision-making. The panel focused on the economical aspect of ocean acidification, a key aspect to its legislative success.
- The Blue Ribbon Panel was the first of its kind, working to address ocean acidification and setting an example for other states to follow, such as Maine, Maryland and Florida.
- The role of the Marine Resources Advisory Council continues to be important for continuing to address ocean acidification.

Process before arriving at the Blue Ribbon Panel "Refresh"

Angie Thomson (EnviroIssues, MRAC Facilitator) gave an overview of the process over the previous several months to prepare for the Blue Ribbon Panel "Refresh" meeting. Ad hoc committees met to discuss highlights in progress in ocean acidification efforts over the last five years, proposed revisions to existing recommended actions, and proposed new recommended actions for each focus area. Highlights of these ad hoc committee discussions were included in meeting presentations and guided the discussions throughout the day.

Advancements in our scientific understanding

Jan Newton and Terrie Klinger (Washington Ocean Acidification Center, or WOAC) reviewed the questions that drove the Blue Ribbon Panel process, shared the latest scientific knowledge since 2012 that has changed our understanding of ocean acidification, and provided perspective on what questions still remain.

Introductory comments:

- It is critical to understand ocean acidification-relevant science that is specific to Washington waters and species.
- The success of the last Blue Ribbon Panel process was the result of scientists, managers and policymakers collaborating to identify current knowledge gaps and recommended actions.

Major ocean acidification questions that drove the 2012 process:

- What is the status of ocean acidification in Washington's waters?
- How important are local drivers to the acidification signal?
- How do Washington's species respond to acidifying conditions?
- How do Washington's marine ecosystems respond to acidifying conditions?

Key takeaways regarding the status of ocean acidification from the past five years:

- Humans are affecting ocean acidification in Washington. Human-generated carbon dioxide from the atmosphere is increasing ocean acidification substantially in surface waters. The signal from human-generated carbon dioxide in outer Washington coastal waters has been measured and contributes 30-50% of the total load (human plus biological contributions) in surface waters and approximately 20% in deep waters (Feely, et al. 2016).

- There is strong variation in ocean acidification variables over depth, season and location (WOAC, DNR and Ecology data).
- Puget Sound, particularly South Hood Canal, has the highest seawater carbon dioxide concentration recorded along the west coast (Alin, NOAA).
- Atmospheric carbon dioxide levels are enhanced and increasing faster in Puget Sound versus the offshore coast and global average (Alin, et al., 2015).

Key biological takeaways from the past five years:

- On commercial species:
    - Early life stages of Dungeness crab show sensitivities to pH that could lead to population declines (Miller et al., 2016).
    - Adult Olympia oysters show sensitivity to low pH, reducing their reproductive potential. Larvae show some tolerance to low pH (Friedman and Wippel, UW, in progress).
- On plankton and other species:
    - Larval krill development and survival are sensitive to low pH levels that are currently observed (McLaskey et al., 2016).
    - Species diversity of forams is decreasing, and shell dissolution is increasing (Martin and Nesbitt, 2015).
    - Pteropod shell dissolution is evident off the Washington coast and severe within the Salish Sea (Bednarsek et al., UW & NOAA). Pteropods may be useful as indicators of ocean acidification; may also be true for benthic forams (Bednarsek et al., 2017).
    - Copepods may play a key role in affecting trophic interactions under acidification conditions (Busch et al., 2013).
    - Native and non-native seagrass species appear to have the capacity to effect short-term changes in seawater carbonate chemistry via photosynthesis (Miller et al., 2017).
    - Numerical models suggest that in Washington waters, epibenthic invertebrates (crabs, shrimps, benthic grazers and detritivores, bivalves) will show strong negative responses to ocean acidification. Some demersal fish species, sharks and species such as Dungeness crab could be subject to strong indirect effects of ocean acidification because they consume species known to be sensitive to changing pH (Marshall et al., 2017).

Key adaptation and management takeaways from the past five years:

- Shellfish hatcheries and growing area operations are benefiting from online real-time monitoring data.
- Shellfish hatcheries are implementing effective adaptation measures using seawater modification.
- Source attribution modeling is currently underway and will be used to show where local contributions are increasing acidifying conditions.
- Forecast modeling is now available online for surface waters of the outer coast and soon for the Salish Sea, as seen with LiveOcean from NANOOS.

Key questions that still need to be addressed further:
The following questions have initial evidence to suggest the need for continued research efforts to increase understanding of the effects of ocean acidification.

- How do changes in seawater buffering affect the regional ocean acidification signal now and in the future?
    - The upwelled water off the coast is old, reducing buffering capacity. This means carbon dioxide levels change faster in Washington than in other bodies of water.
- How important are local drivers to the acidification signal?
    - Much of the Salish Sea is under-saturated in aragonite during several months of the year, not limited to winter.
    - Local nutrient loadings generally increase surface water aragonite saturation (due to biological productivity) and decrease bottom water saturation (due to remineralization). This is particularly notable in terminal bays and inlets.
    - The Salish Sea carbonate system is sensitive to organic carbon in freshwater loadings.
- How does ocean acidification interact with other stressors (e.g., temperature, hypoxia, salinity) to affect the marine ecosystem?
    - The importance of ocean acidification compared to other stressors will vary by species, leading to varying impacts to species interactions and ecosystem function.
    - Lab experiments are used to test sensitivity to multiple stressors.
    - Modeling is used to project potential ecosystem changes.
- How does ocean acidification influence harmful algal blooms?
    - Harmful algae can grow faster and become more toxic under ocean acidification conditions.
    - Field experiments can help determine impact in Washington waters.
- How do Washington's species respond to acidifying conditions?
    - Laboratory studies show negative responses among fish and shellfish.
    - Field studies are required to assess ecological implications and will help determine species responses in the environment.
    - Time-series data from resource agencies and others are critical to understanding ecological responses.

Discussion:
Participants discussed the following points about current scientific understanding of ocean acidification:

- **South Hood Canal sequesters a large amount of carbon dioxide** and also has lowest pH water.
- **Most biological research in Washington state suggests negative consequences of ocean acidification,** including work on Coho salmon, Dungeness crab, and Olympia oysters. Planktonic species are the base of the food chain, which will have implications for the whole ecosystem.
- **It will be valuable to expand ocean acidification research to other bodies of water beyond Puget Sound for comparison.** Research should continue in other Washington waters, such as Willapa Bay. Efforts should also focus on how the impacts in Washington state can relate to changing conditions in other parts of the country.
- **Carbon dioxide contribution is both local and global.** Several groups are currently working to identify the relationship between ocean acidification and local land-based contributions of nutrients.

Monitoring and Investigations

Libby Jewett (National Oceanic and Atmospheric Administration [NOAA] Ocean Acidification Program) reviewed progress over the last five years, proposed actions over the next five years, and potential revisions to the Blue Ribbon Panel's recommended actions related to monitoring and investigations (see the 2012 Blue Ribbon Panel report Chapter 7 – Invest in Washington's Ability to Monitor and Investigate the Effects of Ocean Acidification).

Introductory comments:

- Investing in the capacity to monitor and investigate the effects of ocean acidification is central to building the necessary scientific foundation to make good management decisions. Progress has been made, but there are key gaps in knowledge that require additional research in order to understand the effects of ocean acidification on Washington waters.
- State efforts are going to be more important going forward, in anticipation of reduced federal funding for ocean acidification and environmental work.
- NOAA's Ocean Acidification Program's approach to fulfilling its ocean acidification mission ("to better prepare society to respond to changing ocean conditions and resources by expanding understanding of ocean acidification, through interdisciplinary partnerships, nationally and internationally") is parallel and complimentary to the Washington state approach, making for a beneficial partnership.

Blue Ribbon Panel recommended strategies:

In 2012, the Blue Ribbon Panel recommended four guiding strategies for monitoring and investigations to move from knowledge to action, including:

- Understand the status and trends in Washington's marine waters (Strategy 7.1)
- Quantify the relative contribution of different acidifying factors (Strategy 7.2)
- Understand the biological responses of local species (Strategy 7.3)
- Identify the real-time snapshots, short-term forecasts, and long-term predictions of corrosive seawater conditions (Strategy 7.4)

Highlights in progress over the last five years:

Over the past five years, Washington has made significant progress in addressing the Blue Ribbon Panel's monitoring and investigations recommended actions. Some accomplishments include:

- Establishment of an ocean acidification monitoring network taking chemical and biological measurements to examine temporal trends and spatial coverage. This network leverages existing networks and partnerships.
- Development of mathematical models for aragonite saturation, pH and source influence of local versus global carbon and nitrogen.
- Development of predictive models on local ocean acidification conditions.
- Lab and field studies on local species, including Dungeness crab, Olympia oysters, and pteropods with a focus on economic and ecological importance.
- Networking of partners (government agencies and research programs, tribal groups, shellfish industry, and universities) through the WOAC to further monitoring and investigation efforts.

These groups conduct efforts that contribute to the knowledge of the effects of ocean acidification in Washington waters, such as:

- University of Washington and Northwest Association of Networked Ocean Observing Systems (NANOOS) buoys with NOAA Ocean Acidification sensors to monitor atmospheric carbon dioxide in Hood Canal.
- NOAA cruises to survey aragonite saturation along the Washington coast.
- Adaptation of data analysis to online tools for partner use.
- WOAC's plankton monitoring program to identify trends in biological response to changing ocean conditions.
- The Pacific Coast Collaborative / Integrated Ocean Acidification and Hypoxia Monitoring Task Force was created to improve monitoring capacity along the Washington and British Columbia coast through an integrated monitoring network.
- Groups such as the University of Washington and NANOOS have developed forecast models for ocean conditions along the cast and within Puget Sound.

Proposed efforts to focus on monitoring and investigation over the next five years:
The Monitoring and Investigations ad hoc committee proposed the following efforts to focus on going forward:

- Continue monitoring efforts and expand the network of partnerships.
- Capitalize on other existing datasets and monitoring efforts.
- Continue to refine predictive relationships and models in both space and time.
- Complete the source emission model.
- Help get predictive ocean acidification models into the hands of end users.
- Expand lab studies on biological responses to other commercially and ecologically-important local species, including finfish.
- Look at ocean conditions at both Washington and regional scales.

Proposed additions to the recommended actions:
The ad hoc committee proposed the following action be added to Strategy 7.1:

- *7.1.4: Coordinate at the state level to capitalize on existing data and monitoring efforts.* In recognizing that there are rich data sets that provide a wealth of information on species decline and other trends, the purpose of this new action would be to further encourage coordinated efforts in data-sharing. This would leverage the state's investments in monitoring and data collection, and could provide additional insights on ocean acidification effects.

Discussion
Participants discussed proposed revisions to the Blue Ribbon Panel recommended actions for monitoring and investigations:

- **Funding for monitoring and investigations work is limited,** so steps should be taken to identify overlapping programs to make better management decisions for the efficient allocation of resources.
- **Participants supported the need for coordinated data set sharing and co-located observational resources (the new action 7.1.4)**. For example, the Washington Department of Fish and Wildlife is working on data sets from the 1970s that may be of value to other national and local groups.

Going forward, there should be a focused effort to develop technology to make data collection and sharing more efficient. Data sharing will help support an integrated monitoring modeling research effort. Coordinated data sharing and co-locating observational resources will be reflected as a new strategy for monitoring and investigations in the Blue Ribbon Panel Report.

- **Current ocean acidification research is primarily focused within the Puget Sound, and there is a gap in research within areas such as Willapa Bay on the Washington coast.** Future MRAC meetings should address how to encourage collaboration between stakeholders to integrate research on the Washington coast into current scientific investigations.

Education and Outreach

Betsy Peabody (Puget Sound Restoration Fund) reviewed progress over the last five years, proposed actions over the next five years, and potential revisions to the Blue Ribbon Panel's recommended actions related to education and outreach (see the 2012 Blue Ribbon Panel Report Chapter 8 – Inform, Educate and Engage Stakeholders, the Public, and Decision Makers in Addressing Ocean Acidification).

Introductory comments:

- Education and outreach connects Washingtonians to the problem and impacts of ocean acidification and empowers citizens and businesses to help develop and implement solutions.

Blue Ribbon Panel recommended strategies:
In 2012, the Blue Ribbon Panel recommended two guiding strategies to improve understanding of ocean acidification and engage stakeholders in solutions, including:

- Share information showing that ocean acidification is a real and recognized problem in Washington state (Strategy 8.1).
- Increase ocean acidification literacy (Strategy 8.2).

Highlights in progress over the last five years:
Over the past five years, Washington has made significant progress in addressing the Blue Ribbon Panel's education and outreach recommended actions. Some accomplishments include:

- Organization of several forums and events that have generated ongoing conversations about ocean acidification.
- Governor Inslee has embraced the need to address ocean acidification, serving as an ally for education and outreach.
- Development of a clearinghouse of ocean acidification education curriculum.

Proposed efforts to focus on education and outreach over the next five years:
The Education and Outreach ad hoc committee proposed the following efforts to focus on going forward:

- Develop an outreach strategy and supporting key messages to help tell the ocean acidification story.
- Emphasize specific actions individuals and communities can take to address ocean acidification.
- Increase engagement of the fishing and crabbing industries, forest landowners and agriculture.

- Continue holding ocean acidification events, highlighting the problem and its impacts and engaging people and businesses in solutions.
- Review significant barriers to getting ocean acidification curricula taught in classrooms and identify an array of solutions.

Proposed additions to the recommended actions:
The Education and Outreach ad hoc committee proposed the following action be added to Strategy 8.1:

- *8.1.6: Develop and periodically update an ocean acidification outreach strategy and an annual list of key messages and key findings.* In recognition of the need for a broader outreach strategy to support telling the ocean acidification story, this strategy could highlight potential tactics and resources for ocean acidification communicators to use in engaging various stakeholder communities. This strategy addresses the need for accurate key messages to effectively communicate:
    - How ocean acidification is affecting jobs and resources in Washington state.
    - How the ocean relates to our health, coastal economies and well-being.
    - The consequences of rapid change for marine life in Washington.

To support the new action 8.1.6, the ad hoc committee proposed the following strategies and actions be added to other chapters to integrate outreach within the other focus areas of the Blue Ribbon Panel recommendations:

- Chapter 5 – Local Land-Based Contributions
    - *Strategy 5.3: Share significant findings and progress on local land-based contributions actions.*
        - *Action 5.3.1: Identify and share key findings from local land-based contributions actions with ocean acidification communicators to support outreach efforts designed to raise public awareness of ocean acidification.*
- Chapter 6 – Adaptation and Remediation
    - *Strategy 6.4: Share significant findings and progress on adaptation and remediation actions.*
        - *Action 6.4.1: Identify and share key findings from adaptation and remediation actions with ocean acidification communicators to support outreach efforts designed to raise public awareness of ocean acidification.*
- Chapter 7 – Monitoring and Investigations
    - *Strategy 7.6: Share significant findings and progress on monitoring and investigations actions.*
        - *Action 7.6.1: Identify and share key findings from monitoring and investigations actions with ocean acidification communicators to support outreach efforts designed to raise public awareness of ocean acidification.*

Discussion:
Participants discussed proposed revisions to the Blue Ribbon Panel recommended actions for education and outreach:

- **Communication, education, and outreach rely on the work being done by other groups and identify how to be more effective and systematic in communicating that work.** By themselves,

education and outreach actions have been challenging to gain funding for; it may be more effective to begin thinking about them as integrated into the other focus areas.
    - It would be helpful to have an annual summary of new information and findings from each committee area to then make available to share.
    - The biannual symposium, hosted by the Washington Ocean Acidification Center, is one venue for communicating updates and new information in science. It would be helpful to have summaries from each presenter. WOAC has no specific funding for outreach, however SeaGrant can leverage the symposium to be a better outreach opportunity. This would require funding for SeaGrant staff to carry out the necessary work.
- **Education and outreach can be used to share new tools and resources with managers and the public.** Web or in-person trainings for new tools, coupled with a feedback process, would help with development and implementation of these tools.
- **Participants agreed on the need to bring in new groups, including forestry and agriculture,** to support ocean acidification education and outreach and come up with solutions.
    - Engaging forestry groups will be particularly valuable as MRAC moves towards a focus on carbon policy. It is important these groups are not perceived as a target. The focus should be on stewardship of the land and watersheds that play key roles in ocean management. One participant noted that three of the top ten carbon-storing national forests are in Washington state.
- **It is important to capture and communicate that ocean acidification work is moving forward and making significant progress.** People are starting to see this work as a dynamic effort. It was noted that information relevant to specific communities should be made available. For example, the food web dynamic is central to many local communities. Learning how Coho and Dungeness crab are affected can help bring attention to the issue.
- **Participants acknowledged that understanding the baseline of public literacy of ocean acidification is necessary** before developing an annual communication strategy and regular work assessments. Funding priorities should include a public opinion survey. Survey turnover time may be shorter by working together to create a template. Concern was raised that an annual update is not enough to provide useful information as soon as it is developed.

Local Land-Based Contributions

Garrett Dalan (The Nature Conservancy & Washington Coast Marine Advisory Committee) reviewed progress over the last five years, proposed actions over the next five years, and potential revisions to the Blue Ribbon Panel's recommended actions related to local land-based contributions (see the 2012 Blue Ribbon Panel report Chapter 5 – Reduce Local Land-Based Contributions to Ocean Acidification).

Introductory comments:

- The Blue Ribbon Panel recognized the need to take local actions now in order to address the continued acidification of Washington's marine waters. Relying on emissions reductions alone is not enough to address the problem.
- Local land-based pollutants are likely to exacerbate acidification and enter the marine environment from single (point) or diffused (nonpoint) sources. A forthcoming model from the Department of Ecology (Ecology) will provide greater insights into these dynamics.

- Many sophisticated water quality programs are in place around the state to reduce nutrient loading. Despite these programs, marine nutrient levels continue to be a significant problem.

Blue Ribbon Panel recommended strategies:
In 2012, the Blue Ribbon Panel recommended two guiding strategies to move forward on nutrient and carbon reduction, including:

- Strengthen and augment existing pollutant reduction actions to reduce nutrients and organic carbon (Strategy 5.1).
- Impose stringent controls to reduce and limit nutrients and organic carbon from sources that are contributing significantly to acidification of Washington's marine waters (Strategy 5.2).

Highlights in progress over the last five years:
Over the past five years, local land-based contributions groups have made significant progress in addressing the Blue Ribbon Panel's recommended actions. Some accomplishments include:

- In October 2016, the Center for Ocean Solutions with EPA hosted a meeting on how to apply the Clean Water Act to pH-impaired marine waters and 303(d) water quality criteria related to ocean acidification.
- Washington Department of Ecology's nonpoint source control plan references ocean acidification work.
- The agricultural community now has access to funds from the Conservation Commission to incorporate ocean acidification actions and best management practices.
- Ecology has made progress on a rule to ban sewage discharge from boats into Puget Sound.
- Ecology has made significant progress in developing a local sources attribution model.

Proposed efforts to focus on local land-based contributions over the next five years:
The Local Land-Based Contributions ad hoc committee proposed the following efforts to focus on going forward:

- Continue working with the agricultural community to answer ocean acidification information needs.
- Target projects together to maximize limited resources and enhance results.
- Continue identifying opportunities to better incorporate ocean acidification into planning efforts.
- Continue research efforts to better understand the natural vs. anthropogenic biological impacts from ocean acidification.

Proposed additions to the recommended actions:
The ad hoc committee proposed the following action be added to Strategy 5.2:

- *5.2.3: If determined necessary based on scientific data, establish new programs to reduce nutrient, sediment, and organic carbon loading from nonpoint sources.* If the results of the source model determine nutrient sources are contributing to local acidification, this action supports the formation of new programs to minimize local source contributions to marine waters. This action is also in recognition that the contribution of local sources is likely to differ by geography and that certain areas might require more concentrated or targeted efforts to reduce pollutants.

Discussion:
Participants discussed proposed revisions to the Blue Ribbon Panel recommended actions for local land-based contributions:

- **Washington water quality criteria, based on criteria developed in California, should be expanded to include aragonite saturation.** Participants agreed collaboration on this expansion with California would be beneficial.
- **There are few regional sewage treatment plants that strip nutrients from waste.** If it is determined nutrient input is a contributing issue, there will have to be a systematic change of operations.
- **Participants noted there may be a gap in how green wastewater management plays a role in managing nutrient input.**
- **Local sources modeling data is expected for release in summer 2017.** This data will provide an overall idea of nutrient input into Washington marine waters.

Adaptation and Remediation

Bill Dewey (Taylor Shellfish Farms) reviewed progress over the last five years, proposed actions over the next five years, and potential revisions to the Blue Ribbon Panel's recommended actions related to adaptation and remediation (see the 2012 Blue Ribbon Panel report Chapter 6 – Increase Our Ability to Adapt to and Remediate the Impacts of Ocean Acidification).

Introductory comments:

- Adaptation and remediation work can help ensure continued viability of species and ecosystems while providing resource managers information on how to adjust to changing conditions and restore or enhance resilience.

Blue Ribbon Panel recommended strategies:
In 2012, the Blue Ribbon Panel recommended three guiding strategies to adapt to and remediate the impacts of ocean acidification in order to limit future losses of shellfish and other key marine resources, including:

- Remediate seawater chemistry (Strategy 6.1).
- Increase the capacity of resource managers and the shellfish industry to adapt to ocean acidification (Strategy 6.2).
- Enhance resilience of native and cultivated shellfish populations and ecosystems on which they depend (Strategy 6.3).

Highlights in progress over the last five years:
Over the past five years, Washington state made significant progress in addressing the Blue Ribbon Panel's adaptation and remediation recommended actions. Some accomplishments include:

- Opened the Kenneth K. Chew Center for Shellfish Research and Restoration conservation hatchery.
- Developed new hatchery treatment methods for mitigating corrosive conditions.
- Progressed key research on pteropods as a bioindicator for ocean acidification.

- Began testing the use of vegetation-based systems for remediation.
- Conducted ongoing water quality monitoring at shellfish hatcheries and facilities across the state.
- Developed a strategy to increase eelgrass by 20% in Puget Sound by 2020.
- Restored 60 acres of native oyster habitat in Puget Sound.
- Began research on ocean acidification impacts to gene expression.

Proposed efforts to focus on adaptation and remediation over the next five years:
The Adaptation and Remediation ad hoc committee proposed the following efforts to focus on going forward:

- Develop implementable projects that use vegetation-based systems for remediation.
- Identify local opportunities to retain and use shell material in key marine areas.
- Investigate feed formulations for ocean acidification resistance.
- Continue ongoing work, including:
    - Developing new monitoring and treatment methods.
    - Developing ocean acidification indicators and working to incorporate thresholds into action.
    - Restoration efforts and conservation hatchery operations.
    - Genetic research.
    - Eelgrass and kelp restoration.
    - Identification of refuge sites.

Proposed additions to the recommended actions:
The ad hoc committee proposed the following actions be added to Strategy 6.1:

- *6.1.4: Identify and support research and implementation of activities to increase the marine ecosystem's ability to capture and store carbon from atmospheric sources.* The marine ecosystem can sequester carbon dioxide in vegetation and sediments. Capitalizing on this function may help reduce acidifying conditions.
- *6.1.5: In watersheds where models show land-based pollution contributes to local acidification, implement seaweed recycling programs between local shellfish farms and terrestrial farms.* Local seaweed recycling could be used to buffer corrosive conditions in ocean acidification hotspots created by local land-based pollution sources. This action supports the creation of financial incentives for farmers, both terrestrial and in the shellfish industry.

The committee proposed the following action be added to Strategy 6.2:

- *6.2.5: Investigate the relationship between ocean acidification resistance in larval shellfish and feed quantity and quality, to assess the potential to strengthen young shellfish through adjusted feeding regimes.* Recent research has suggested that feed quantity and quality may influence the capacity of shellfish larvae and calcifying zooplankton to survive and grow under stress from ocean acidification and other adverse environmental conditions. Careful study of the effects of feed regimes on growth, survival, and physiological responses to these stresses may lead to adaptation strategies that are practical and useful in shellfish aquaculture and, possibly, in efforts to protect and restore fish that feed on zooplankton during their early lives.

The committee proposed the following actions be added to Strategy 6.3:

- *6.3.6: Identify and protect intertidal and nearshore habitats that support organisms vulnerable to ocean acidification and those that mitigate ocean acidification impacts.* This action integrates habitat restoration and protection into mitigation and adaptation efforts.
- *6.3.7: Review and evaluate current regulations governing the culture and harvest of aquatic vegetation and develop recommendations for regulatory changes, if needed.* Existing regulations governing harvest and interaction with aquatic vegetation may impede development of adaptation practices, given that research has shown photosynthesizing marine vegetation may locally remediate low pH waters, potentially conferring some protection from ocean acidification to both wild and cultured shellfish and other calcifiers.

Discussion:
Participants discussed proposed revisions to the Blue Ribbon Panel recommended actions for adaptation and remediation:

- **There is a focused effort to restore and protect eelgrass, however recreational harvest is also allowed.** Regulations may need to change to make forward progress. California has similar laws in place and may be a good resource to consult.
- **Success stories of adaptation to ocean acidification should be framed and packaged to communicate outward.** The media covered hatchery failures from ocean acidification, but efforts should be made to share the successful work being done. Participants agreed it would be beneficial to quantify this success as a return on investment. Monitoring equipment in hatcheries will be helpful for identifying the economic impact.

Reduce Emissions of Carbon Dioxide

Chris Davis (Office of Governor Jay Inslee) reviewed progress over the last five years, proposed actions over the next five years, and potential revisions to the Blue Ribbon Panel's recommended actions related to carbon emission reduction (see the 2012 Blue Ribbon Panel report Chapter 4 – Reduce Emissions of Carbon Dioxide).

Introductory comments:

- There is not an MRAC ad hoc committee for this focus area.
- In addition to the understanding that atmospheric carbon dioxide is the largest contributor to acidifying conditions, local emissions of carbon dioxide, nitrous oxides, and sulfur oxides may also be enhancing acidification in local waters, particularly around urbanized areas of Puget Sound.
- Industry has succeeded in instilling doubt about the scientific consensus on humans driving climate change, and less than half of Americans understand there is scientific consensus. However, 82% of Americans think we can and should "fix" climate warming and 75% want carbon dioxide regulated as a pollutant, including majorities in every congressional district in the country.
- From Washington state's emission profile, 45% of carbon emission comes from transportation.

Blue Ribbon Panel recommended strategies:
In 2012, the Blue Ribbon Panel recommended one guiding strategy for Washington to continue to lead in the adoption of policies and practices that address the multiple risks posed by carbon dioxide accumulation in the atmosphere, including:

- Take action to reduce global, national, and local emissions of carbon dioxide (Strategy 4.1).

Highlights in progress over the last five years:
Over the past five years, Washington has made significant progress in addressing the Blue Ribbon Panel's carbon emissions recommended actions. Some accomplishments include:

- Created Carbon Emissions Reductions Taskforce (2014).
- Proposed carbon emission limit legislation (2015, 2017).
- Established tax incentives for electric vehicles (2014).
- Signed legislation to eliminate coal fired electricity (2015).
- Established Clean Energy Fund with $80 million (2013).
- Ecology revised the state's greenhouse gas emission reduction limits to be more aggressive (2016).
- Clean Air Rule began requiring large emitters to gradually reduce over time (2017).
- Participation at COP22, making the connection between climate change and the oceans (2016).

Proposed efforts to focus on reducing carbon emissions over the next five years:
Chris noted that the Governor's Office is focusing on the following efforts moving forward:

- Continue working to strengthen carbon limits and price.
- Defend and enforce Ecology's Clean Air Rule.
- Galvanize states and cities to greater ambition.
- Provide North American leadership.

Discussion:
Participants discussed proposed revisions to the Blue Ribbon Panel recommended actions for carbon emission reduction:

- **The Clean Air Rule has faced some challenges and could use more diverse voices.** There is a need to make it as effective and useful as possible.
- **MRAC has historically focused on aspects of ocean acidification other than carbon**, a commonly divisive topic. Going forward, MRAC should determine how and when to make a statement about carbon.
- **Participants agreed to form an ad hoc committee focusing specifically on carbon emission recommended actions.** This group will discuss and strategize on specific next steps the ocean acidification community can focus on in the next five years.

Maintain a Sustainable and Coordinated Focus

Martha Kongsgaard reviewed progress over the last five years, proposed actions over the next five years, and potential revisions to the Blue Ribbon Panel's recommended actions related to maintaining a sustainable and coordinated focus on ocean acidification (see the 2012 Blue Ribbon Panel report Chapter 9 – Maintain a Sustainable and Coordinated Focus on Ocean Acidification).

Introductory comments:

- MRAC's effectiveness in addressing the impacts of changing ocean chemistry on our marine ecosystems and coastal communities requires sustained leadership and support by the Governor and other state officials and partners across the ocean acidification landscape.

Blue Ribbon Panel recommended strategies:

In 2012, the Blue Ribbon Panel recommended key actions to facilitate Washington state's effectiveness in addressing ocean acidification, including:

- Ensure effective and efficient multi-agency coordination and collaboration (Strategy 9.1).

Highlights in progress over the last five years:

Over the past five years, Washington has made significant progress in addressing the Blue Ribbon Panel's recommended actions on coordination and collaboration. Some accomplishments include:

- Establishment of MRAC and creation of a partnership of ocean acidification leaders across the state.
- Establishment of the Washington Ocean Acidification Center (WOAC).
- Coordination with partners working at multiple scales, including the OA Hypoxia Panel, Pacific Coast Collaborative, the OA Alliance and others.

Proposed efforts to focus on coordination and collaboration over the next five years:

Martha proposed the following efforts to focus on going forward:

- Continued collaboration through MRAC
- Operations and research support through WOAC
- Coordination with other regional, domestic, and international groups

Proposed additions to the recommended actions:

MRAC participants proposed the following action be added to Strategy 9.1:

- *9.1.3: Coordinate Washington's efforts to address ocean acidification with those of other regional, domestic, and international groups.* As MRAC has solidified its role as a leader in the ocean acidification conversation, it has become apparent MRAC has value to bring at larger scales beyond Washington state. This action formalizes the commitment to continued engagement.

Discussion:

Participants discussed proposed revisions to the Blue Ribbon Panel recommended actions for maintaining a sustainable and coordinated focus on ocean acidification. The following additional points were discussed:

- Julie Horowitz, Office of Gov. Jay Inslee, announced the **UN Sustainable Development Goal 14 (Oceans) Conference** will be held in June 2017 in New York, and proposed draft language codifying Washington state's voluntary commitment to addressing ocean acidification. Participants supported the commitment language.

Next Steps

As action items, EnviroIssues will:

- Develop Blue Ribbon Panel "Refresh" report as addendum to 2012 report, incorporating the revisions to existing Blue Ribbon Panel recommended actions as well as the new recommended actions, as discussed in the meeting.
- Follow-up with MRAC members on the formation of a new carbon ad hoc committee.

Martha Kongsgaard thanked everyone for their participation and adjourned the meeting.