Maryland Ocean Acidification Action Plan 2020

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Updated: June 2022

Maryland

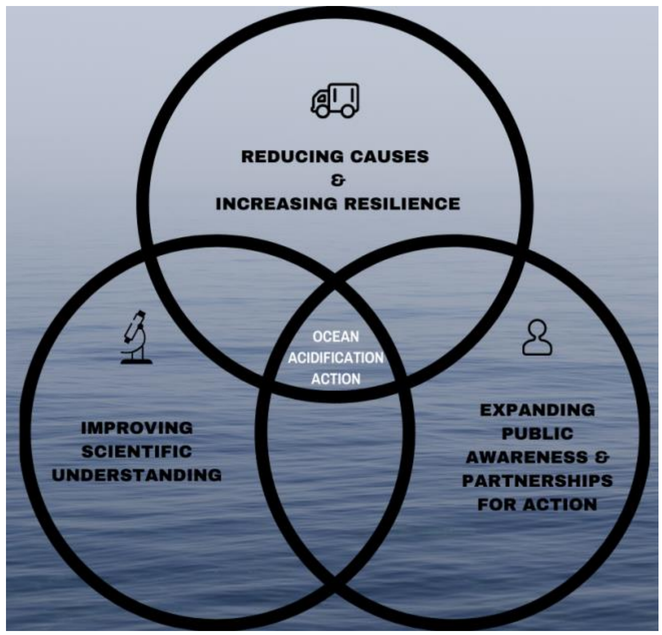
Maryland Ocean Acidification Action Plan 2020

Summary

Maryland recognizes that ocean acidification (OA) is an increasing threat, not only to the open-ocean waters, but also to coastal and inshore waters like the Chesapeake and Atlantic Coastal bays. At stake for Maryland are not only the ecological integrity of our coastal and inshore aquatic ecosystems, prized seafood resources and economic assets, but also a cultural heritage anchored in healthy waters.

Maryland's commitment to being a global leader in combating ocean acidification is reflected in this science-based plan with three components: 1) reducing the causes and increasing resilience, 2) improving scientific understanding and, 3) expanding public awareness and partnerships for action.

The OA Action Plan summarizes what is at stake for the State, socially and economically, and the current understanding of the impacts of OA on natural resources. The Action Plan highlights how Maryland's Greenhouse Gas Reduction Act plan and Chesapeake Bay nutrient reduction strategy form the foundation for reducing two primary causes of acidification: atmospheric CO_2 and excessive nutrient enrichment.



The Action Plan identifies two coordinating bodies within the Maryland Commission on Climate Change (the Commission) that are focused on scientific research and communications. These are the Science and Technology Working Group and the Education, Communications and Outreach Working Group respectively. This coordination framework will help to ensure that progress on the Action Plan is sustained.

Maryland Department of the Environment | Maryland Department of Natural Resources | University of Maryland Center for Environmental Science | OA Alliance International Alliance to Combat Ocean Acidification

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Maryland

Maryland Ocean Acidification Action Plan

Region: State of Maryland, USA

Miles of Coastline: 7,719 mi[1]

Regionally Significant Marine Resources: Maryland is home to the largest and one of the most productive estuaries in the United States – the Chesapeake Bay – as well as the network of Atlantic Coastal Bays and their valuable resources. Coastal waters in Maryland are host to a diverse collection of ecologically and commercially important aquatic species including – but not limited to – the Eastern Oyster, Blue Crab, and Striped Bass. Maryland is home to the Port of Baltimore, one of the largest shipping ports in the North Atlantic, and many coastline parks, residences, industries, and marine activities. Recreational and commercial fishing and hunting are common in Maryland, supporting key cultural resources that include tribal lands and historic fishing communities.

Status of Action Plan: Final

Key statistics on ocean economy: Maryland's Ocean Economy was worth $3.9B and employed 104,064 people in 2016 (USDOC, 2020). The commercial fishing sector in Maryland provides 12,084 jobs, $1.24B in sales, $335M in income, and $504M value added impacts (NOAA Fisheries, 2018). Recreational fishing provides an additional 7,608 jobs, $785M in sales, $327M in income, and $513M in value added impacts (NOAA Fisheries, 2018).

I. What is at Stake for Maryland?

Maryland's Connection to the Chesapeake Bay

Throughout our state's history, the Chesapeake Bay has provided livelihoods, sustenance and recreational opportunities for its citizens, and is deep-rooted in the State's cultural identity and history. As a result, the Chesapeake, as well as the Maryland Coastal Bays, are a focal point of environmental stewardship, with great effort and investment placed in their restoration and preservation.

Chesapeake Bay health has faced many challenges over the past century and a half. Historic overharvesting of oysters between the latter 19th century and the early 20th century produced a steep decline in the wild populations and reef structure (Figure 1), followed by disease impacts starting in the 1960s. Also, by the late 19th century, the Bay watershed had lost nearly 50% of its original forested lands to development and agricultural production. Nutrient additions and runoff to the Bay were in excess, creating over-enriched waters that produced zones of depleted oxygen that are uninhabitable for many

[1] A 2003 Maryland Geological Survey (MGS) study on erosion rates cites 7,719 miles of tidal coastline in Maryland. The estimate is based on air photos flown between 1988 and 1995. The NOAA *Coastline of the US, Maryland* cites 3,190 miles of shoreline, based on a 1961 confirmation of estimates made in 1939-40. As of 2013, the NOAA coastline estimate still had some legal and regulatory standing (DNR, 2013).

organisms. In 1972, Hurricane Agnes produced devastating rains and sediment runoff that decimated soft shell clam, oyster, and submerged aquatic vegetation populations.

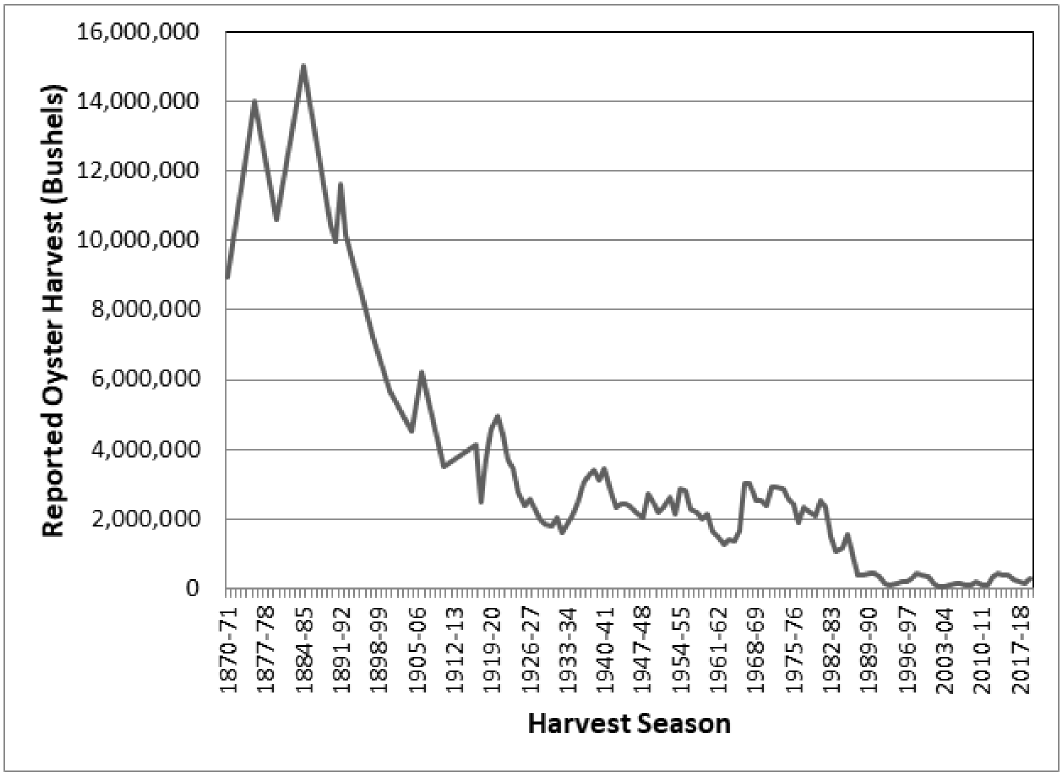

Figure 1 – Maryland oyster harvest (bushels) 1870-71 through 2019-20 for each harvest season (where data is available) as reported by dealer buy tickets. (Maryland Department of Natural Resources, 11/6/2020).

When the degrading health of the Bay became increasingly apparent in the 1960s and 1970s, Congress directed the Environmental Protection Agency (EPA) to conduct a major study of the causes of the Bay's decline. That led to the creation of the well-known federal-state Chesapeake Bay Program (CBP) Partnership, which has provided a framework for decades of science-driven Bay restoration.

Maryland and the CBP partners have the challenge of identifying and managing human induced stresses on the Bay such as nutrient and sediment pollution, habitat disturbance, population increases, warming waters, invasive species and overharvesting, teamed with natural challenges such as disease and environmental variability. Acidification imparts yet another compounding stressor into management equations.

Ocean acidification is a condition where the pH of marine water, which is slightly basic, is lowered towards a more acidic condition. Acidification of Maryland's coastal waters results from two primary causes: increasing nutrient pollution and increasing carbon dioxide in the atmosphere. Increased nutrients cause acidification of deep and shallow waters by stimulating the production of excessive organic matter. That organic matter then decays, consumes oxygen, and produces carbon dioxide which reduces pH, a measure of more acidic waterways. Increased carbon dioxide in the atmosphere associated with fossil fuel combustion is absorbed by water directly, which also reduces pH.

This altered water chemistry can make it more difficult for calcifying aquatic organisms like oyster larvae to create viable shells or maintain adequate growth and reproduction in adult life stages. In important commercial finfish species such as striped bass, studies on comparable species show that acidification may have a complex suite of impacts on physiology, growth, survival, and behavior. Estuaries are dynamic environments, where many organisms have adaptations to cope with varying conditions, but there are still many questions on how acidification might impact the balance of the Bay's ecosystem and habitats, as well as valuable finfish and shellfish resources.

Maryland's Fisheries and Coastal Economy

Marine resources, particularly oysters, blue crabs, and striped bass, contribute 2.1% of the State's annual GDP (USDOC, 2020). Communities in Maryland depend economically, and identify culturally, with the harvesting and processing of natural resources. Oyster aquaculture is a growing industry in Maryland, which is also home to the largest oyster hatchery on the East Coast of the United States. In Maryland, the number of harvested bushels of aquaculture oysters grew from about 3,000 in 2012 to nearly 55,000 in 2019. In 2017, oyster aquaculture alone was credited with adding nearly $8M to Maryland's economy (van Senten, J., et al., 2019). Dockside aquaculture values in 2019 accounted for $4.4M in sales. The Maryland wild oyster fishery landed 270,011 bushels between 2019-2020 with a dockside value of $12.2M (Figure 2). Commercial crab harvests of 33.1M lbs brought a dockside value of $54.7M in 2019.

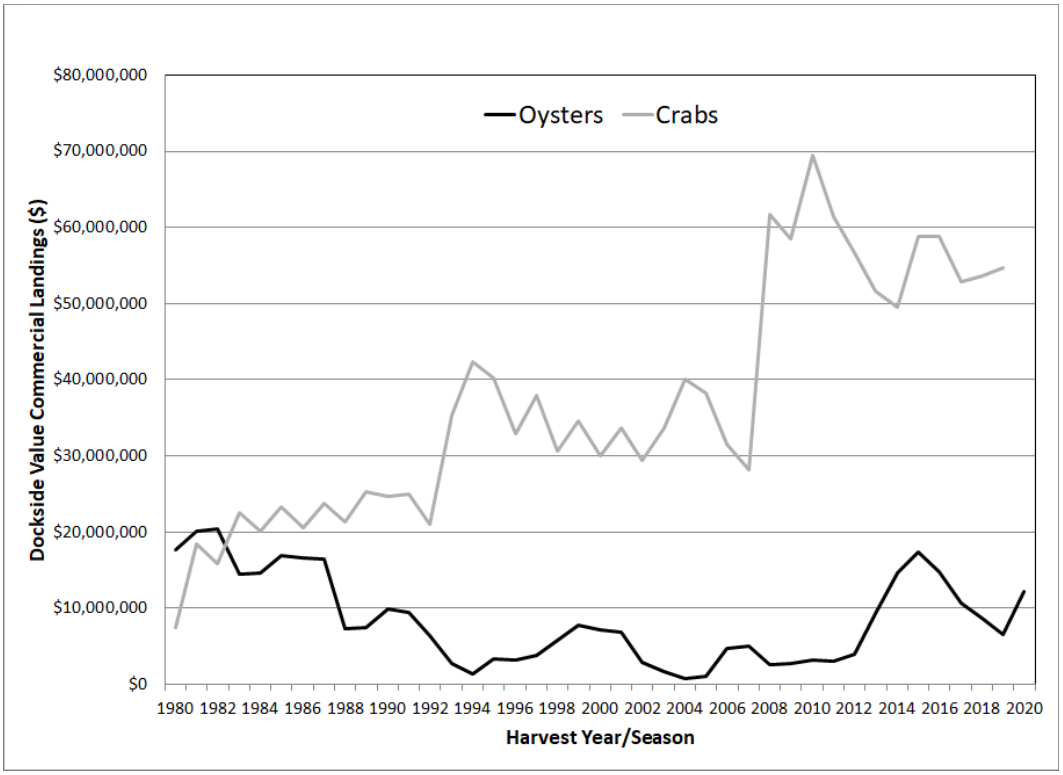

Figure 2- Dockside value of the commercial harvest of oysters and crabs in Maryland, by harvest year for crabs and harvest season for oysters (e.g. 1980 = 1979-80 harvest season). (Maryland DNR, 11/9/2020).

Given the value and importance of Maryland fisheries, restoring degraded habitat and water quality will reduce risk and vulnerability to local economies, and preserve the iconic cultural heritage of the Bay region.

Maryland Investments in the Environment

For more than 40 years, Maryland has worked with farmers, industry, and local jurisdictions to reduce nutrient pollution to the Chesapeake Bay. Since 1985, this work has resulted in an estimated decrease of nearly 37 million pounds in the average annual nitrogen pollution loading rate, reducing nutrient-related stress and re-building a resilient ecosystem.

Since 2000, Maryland has spent approximately $11B on Chesapeake Bay restoration activities, $4.7B of which has been appropriated within the last five years (JCR 2019). This includes funding for activities that reduce nutrient and sediment inputs to the Bay (e.g., cover crops and wastewater treatment plant upgrades), activities that support improving our understanding of the Bay (e.g., monitoring, education, outreach), and activities that prevent or minimize future degradation of the Bay (e.g., land conservation).

Maryland has met federally mandated milestones for nutrient reduction through the efforts of private citizens, farmers, businesses, communities, nongovernmental organizations (NGOs), local governments, State agencies and federal government partners to install Best Management Practices (BMPs), which lower pollution inputs throughout the Bay. Plans are in place for Maryland to meet its share of the remaining nitrogen and phosphorus pollution reduction targets for the Chesapeake Bay by 2025. In addition to improving low dissolved oxygen zones and submerged vegetation, these nutrient reduction actions also help to mitigate ocean acidification.

Several in-water restoration investments provide noteworthy examples of success. Ten Chesapeake Bay tributaries have been undergoing oyster reef restoration since 2011, five by Maryland and five by Virginia. This initiative is one of the largest oyster restoration projects in the world. Between 2011 and 2021, 856 acres of oyster reef, out of a planned 1,282, have been restored in Maryland at a cost of $65.05M (CBP, May 2021). Ocean acidification poses a risk to this investment, given the sensitivities of oysters to acidification, especially the larvae produced in these restored reefs.

Maryland has also invested in the recovery of submerged aquatic vegetation (SAV) habitats. Active efforts to improve water clarity through the reduction of sediment runoff (Lefcheck et al., 2018) and direct SAV planting efforts have resulted in the state achieving 44% of the 79,800 acre SAV recovery goal set for 2025 (MD DNR, July 2021; Figure 3). While SAV has been identified as an essential habitat for many key Bay species, SAV beds have also been shown to remove carbon dioxide, enhance calcification, and sequester carbon, thus serving as a buffer against acidification.

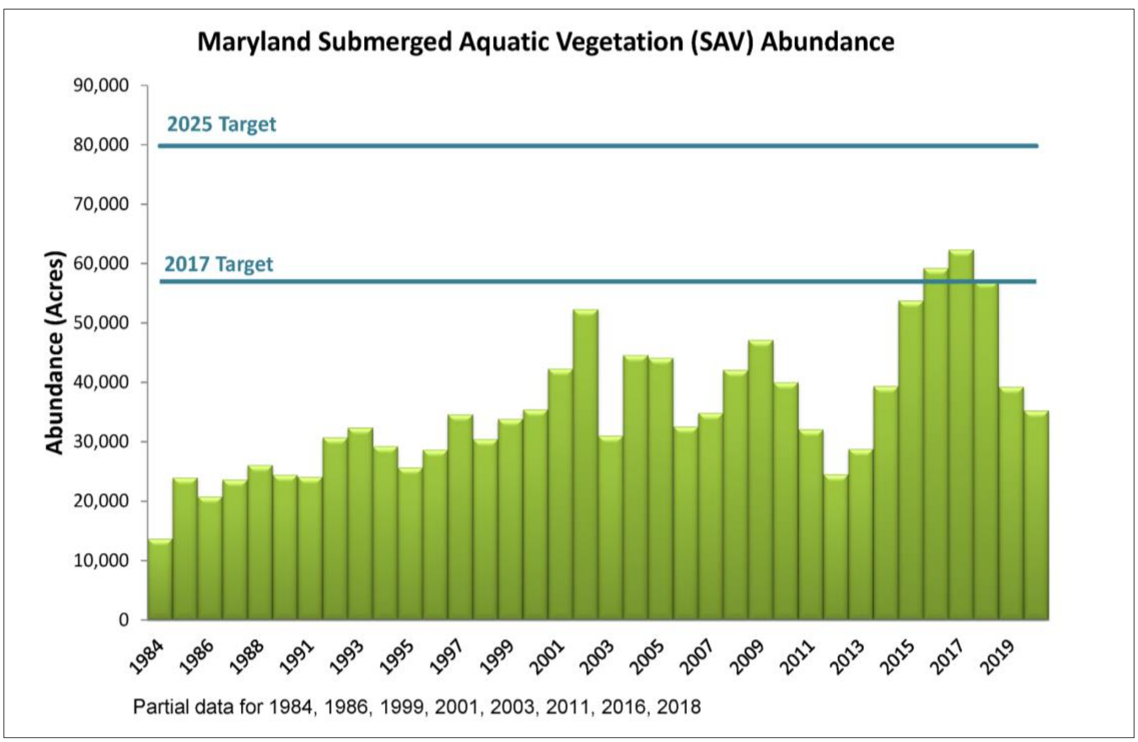

Figure 3 - Abundance in acres of submerged aquatic vegetation in the Maryland portion of the Chesapeake Bay (1984-2019) as detected by the Virginia Institute of Marine Science (VIMS). Bay grass abundance can fluctuate greatly, with high rainfall and stream flows in 2018 and 2019 resulting in reduced habitat conditions and underwater grass abundance decline. (Maryland DNR, 5/2022).

Existing Ocean Acidification Concerns in Maryland

In 2015, the Maryland Ocean Acidification Task Force (the Task Force) published a report detailing possible ocean acidification impacts in the Chesapeake Bay. Concerns identified by the Task Force cover the three aquatic environments of the open-ocean, coastal waters, and inshore waters like the Chesapeake Bay. The concerns include the following:

- In open ocean waters, increases in atmospheric CO_2 concentrations are causing acidification effects similar to those occurring in most of the world's oceans.
- In Maryland's near-shore ocean environments, physical oceanographic processes, such as mixing, may be having additional impact, but as yet are not fully understood.
- In the Chesapeake Bay and parts of the Coastal Bays, acidification, eutrophication-induced hypoxia, and increased temperatures and/or freshwater inputs may have compounding effects on aquatic organisms.
- Acidification may cause a range of impacts to fish and shellfish and their prey. Reduced reproductive success, more susceptibility to disease and predation, reduced growth due to increased energy expenditures, and increased mortality are all potential concerns.

Through decades of building environmental awareness and education, citizens understand the threats that face the bays and coastal waters and the need for science driven solutions. In this regard, Maryland is a fertile ground for a plan to study and mitigate coastal acidification.

II. Policy Framework for OA Action Plan

Origin of Maryland's Ocean Acidification Action Plan

In 2019, Maryland became a member of the International Ocean Acidification Alliance. By joining the OA Alliance, Maryland has endorsed the Call to Action (IACOA, 2016) and committed to broadly support the five goals within the Call, as reflected in this Action Plan. This Action Plan was developed and adopted under the leadership of the secretaries of the Maryland Departments of Environment and Natural Resources in partnership with the University of Maryland Center for Environmental Science (UMCES). The plan also relies heavily on the guidance of the International Ocean Acidification Alliance and the foundational work of Maryland's original Ocean Acidification Task Force.

Maryland's Ocean Acidification Action Plan Framework

This Ocean Acidification Action Plan depends on other initiatives that focus on reducing the causes of Ocean Acidification, including:

- **Maryland's 2015 Ocean Acidification Task Force Report:** Developed as a partnership between state government, academia, and industry, the report records scientific background, concerns and offers important recommendations, the most primary of which are cited in this Action Plan.
- **Maryland's Chesapeake Bay Watershed Implementation Plan**: Initiated to reduce nutrient loads and take other actions with ocean acidification mitigation benefits, this plan has helped lead the restoration of Bay grasses and limiting the generation of oxygen consuming and CO_2 producing materials.
- **Maryland's Greenhouse Gas Reduction Act Plan (GGRA)**: Supported by the Maryland Commission on Climate Change (MCCC)[2]MDE prepares and publishes GGRA plans to advance greenhouse gas emissions reductions and encourage carbon sequestration through the protection, management, and restoration of forests, agricultural soils and blue carbon ecosystems[3]. MDE also publishes an updated inventory of statewide greenhouse gas emissions and removals in a three-year cycle.

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[2] The Maryland Commission on Climate Change was first established by executive order in 2007, then codified by law in 2015.

[3] Blue carbon ecosystems are defined as coastal wetland ecosystems with manageable and atmospherically significant carbon stocks and fluxes.

Maryland

III. Priority Action Areas

Maryland's priority action areas build on the recommendations of Maryland's Ocean Acidification Task Force report of 2015 (Figure 4).

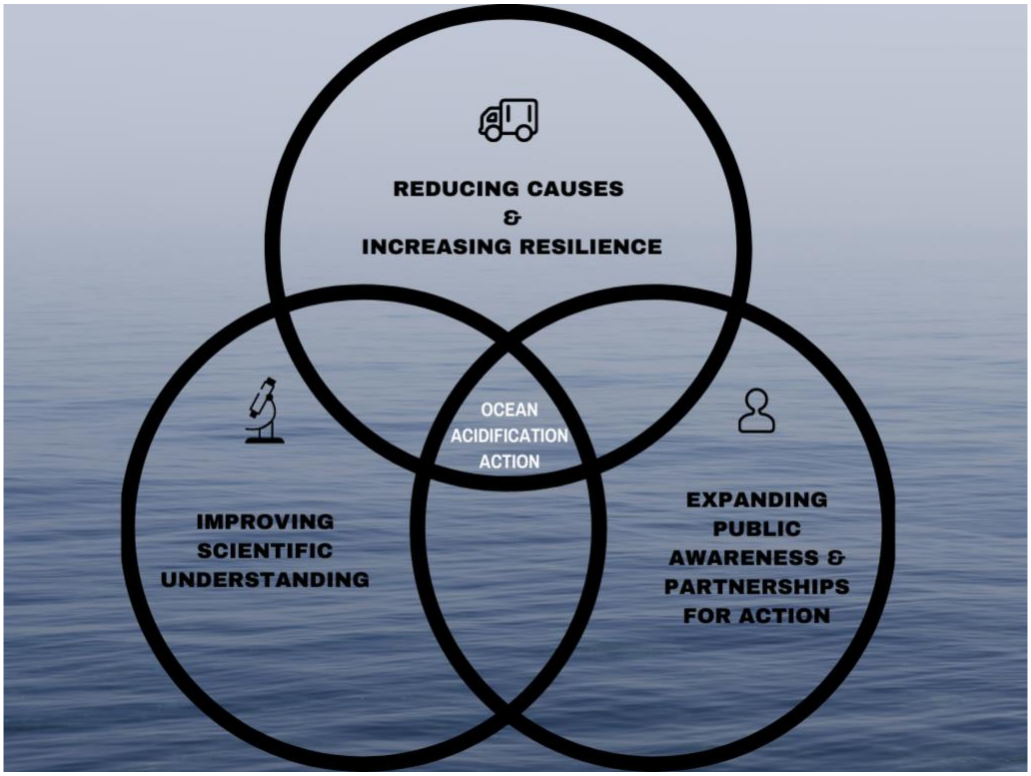

Figure 4 – Three key components of Maryland's Ocean Acidification Action Plan

Three Key Components of Maryland's Ocean Acidification Action Plan

1. **Reducing Causes & Increasing Resilience:** Take actions to prevent or slow the causes of ocean acidification by reducing atmospheric emissions of CO_2, reducing inputs of land-based pollutants, and other measures. Assist coastal communities, industries, and marine ecosystems in building resilience to increasing acidity in marine waters.
2. **Improving Scientific Understanding:** Improve understanding within the region, using existing monitoring programs to guide research about the chemistry and ecosystem impacts. Continuing the use of science to develop practical strategies to address acidification.
3. **Expanding Public Awareness & Partnerships for Action:** Highlight the link between OA and efforts to reduce greenhouse gas and nutrient pollution. Collaboration of experts with partnerships must be sustained to combat OA. Use existing communication entities to support broader awareness of acidification.

Maryland

Reducing Causes & Increasing Resilience

Reducing Causes: Maryland's Action Plan to combat the causes of ocean acidification is led by two focused strategies: Reducing greenhouse gases (GHG) and reducing nutrient inputs to the Chesapeake and Coastal Bays.

Atmospheric carbon dioxide is a key driver of acidification, accounting for about half the occurrence of reduced pH in the Chesapeake Bay; in deeper waters, nutrient pollution accounts for the other half (Shen, C. et al. 2020; Su, J., et al. 2020). Therefore, reducing atmospheric CO_2 through carbon emission reductions and sequestration is essential to alleviating acidification. In 2021, MDE released a climate action plan required by the Greenhouse Gas Reduction Act (GGRA). The 2030 GGRA Plan provides a strategic direction for many sectors, which are working to reduce carbon dioxide and other greenhouse gasses (carbon dioxide equivalents – $C0_2$e) (Figure 5).

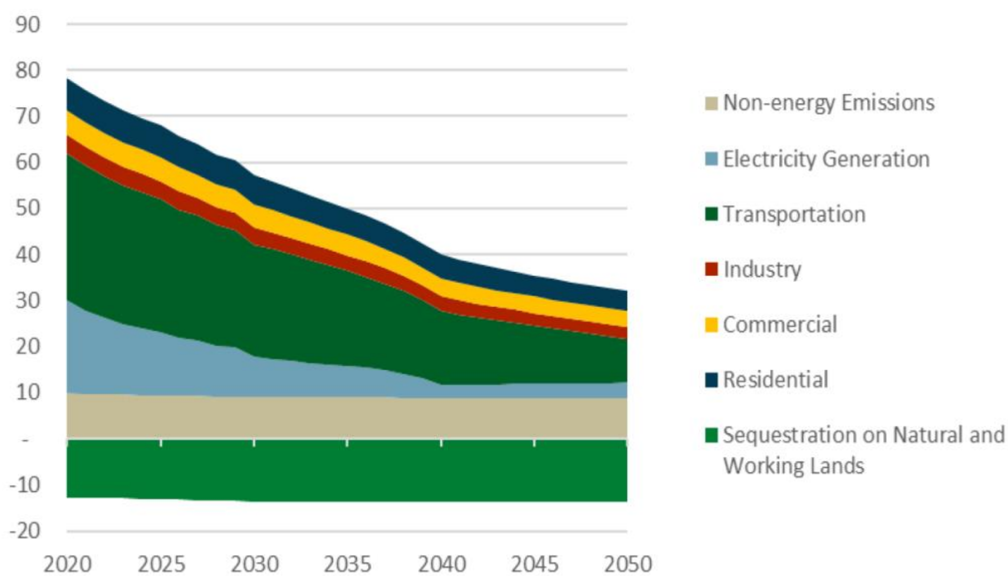

Figure 5 - Carbon dioxide equivalent reductions and removals from key sectors in Maryland's Greenhouse Gas Reduction Act Plan will help slow coastal acidification.

In addition, the GGRA plan includes strategies that sequester carbon. The agricultural sector, which manages about 2 million acres of cropland in Maryland, plays an important role in sequestration (USDA). Maryland's cover crop incentive program, which provides a cost share to farmers to plant cover crops, helps to sequester carbon, in addition to taking up nitrogen, holding soils in place and making soils healthier and thus more resilient to climate change stressors. This farming practice benefits both CO_2 reductions and nutrient reductions, and so helps to control coastal acidification. The 2030 plan also supports the protection and restoration of blue carbon ecosystems, which have benefits for both CO_2 reductions and potential buffering of coastal acidification (Su et al. 2020). Under the Climate Solutions Now Act of 2022, Maryland now has the most ambitious GHG reduction target of any state in the nation. MDE will submit a final GHG reduction plan in December 2023 that plots a path to a 60% reduction in GHG reductions by 2031 from 2006 levels.

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Maryland's other important plan for reducing the causes of ocean acidification has been its Chesapeake Bay Nutrient Reduction Strategies. In Maryland's latest strategy, the 2019 Phase III Watershed Implementation Plan (WIP) (MDE, August 2020), significant attention is given to the anticipated effects of climate change. Further considerations of climate change are addressed in plan enhancements adopted in a 2022 Addendum to Maryland's WIP. The overall 2025 nitrogen target is 44.7 million pounds per year of total nitrogen and phosphorus target is 3.68 million pounds per year of total phosphorus.

Maryland's Phase III WIP strategy includes new insight about best management practices (BMPs) that have co-benefits of carbon sequestration and nutrient reduction. Multiple interests are served when investing in an action that simultaneously achieves both mitigation and adaptation objectives. This insight has positive implications for garnering the support of decision makers who must prioritize limited financial resources.

Increasing Resilience: Resilience to OA will be targeted in a manner that maximizes environmental results in consideration of the greatest social and economic benefit. Areas of special concern include wild oyster reefs and sanctuaries, the oyster aquaculture industry, blue crabs, striped bass, and vulnerable elements of the ecosystem food chain. Targeting will also account for geographic considerations. For instance, evidence is emerging that it is possible to boost resilience to acidification in localized areas. One approach is to increase the amount of aquatic plants, which buffer acidification. Public and private SAV restoration efforts in Maryland inherently provide acid buffering benefits. Recent research, conducted in the upper Chesapeake Bay area known as the Susquehanna Flats, suggests that sea grasses may also contribute to larger scale acid neutralization (Borunda, A. 2020, Su et al. 2020). Maryland is protecting those sea grasses and other valuable ecological assets to restore the Bay, combat climate and mitigate OA. As aquatic plants provide only one source of natural buffering and their effects may be location-specific, other efforts that involve direct restoration interventions to alleviate acidification will be explored.

Increase Scientific Understanding

Solutions for OA will be driven by two major research areas: Increasing resilience in natural ecosystem dynamics and reducing causes. Research will be targeted to prevent ecological breakdowns and to build resilience in support of the environment, the economy, culture and equity.

Research of Natural Ecosystems: Ecosystem monitoring and modeling will examine the complex relationship between species impacted by acidification and overall health and resilience of the marine and estuarine system. Oysters are of particular concern due to their known vulnerability to OA at early life stages, as well as possible compromises OA may pose to growth and reproduction in adults. Impacts to other commercially valuable Bay species such as striped bass, as well as ecologically important forage fish, are less known, but OA has been shown to alter spawning behavior and migration, affect larval growth and survival, and influence predator-prey interactions in species outside the region. Research should highlight OA impacts on various life stages of key Bay species, and the interaction of OA with multiple stressors (temperature, low oxygen). Because hatcheries are crucial to oyster restoration, the oyster public fishery industry, and oyster aquaculture, studying the OA impacts on hatchery production is an important area of research.

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Extensive state water monitoring networks exist in Maryland, and are operated by DNR and MDE, with supporting efforts from federal, academic and NGO partners. Applying advances in monitoring technologies will improve monitoring reliability and affordability. Past efforts in the Chesapeake Bay demonstrate strong cooperation between research and management communities to guide monitoring in support of positive restoration and protection outcomes.

DNR conducts water quality monitoring to assess the habitat for living resources, identify trends, guide management actions, and determine progress toward nutrient reduction goals via a roughly 35-year sampling effort at long-term fixed station monitoring sites throughout the Chesapeake and Coastal Bays. DNR also conducts temporally and spatially intensive water quality monitoring efforts in shallow water habitats as well as the assessment of harmful algal blooms. Each DNR program collects pH data, millions of records to date, that have been used to assess acidification trends in Chesapeake Bay (Waldbusser et al., 2011). DNR has maintained specialized continuous water quality monitoring efforts within oyster restoration and sanctuary areas such as Harris Creek and the Tred Avon River, and will pursue monitoring opportunities at future restoration sites.

MDE maintains a vast monitoring network specifically targeted on water quality parameters for shellfish growing areas. These networks have extensive records of pH, water temperature and other variables, but have not historically included all of the necessary parameters to study long-term changes in acidification of state waters. MDE has sensors for measuring pCO_2 that could be used for this monitoring.

MDE and DNR will collaborate with colleagues from the University of Maryland to assess monitoring opportunities for the main stem of the Chesapeake Bay and representative tributaries. Monitoring options will be evaluated in coordination with the EPA Chesapeake Bay Program and the State of Virginia with the goal of identifying a mutually beneficial carbonate system monitoring strategy in which to invest.

Research of Methods for Reducing Causes: One component of mitigation research will be improving cost-effective ways to reduce the causes of OA. This research will align with Maryland's GGRA and Chesapeake Bay Phase III WIP. Opportunities for co-beneficial actions, like natural buffers that both reduce nutrient loads and sequester carbon, are important areas of investigation. Maryland is recognized for its preferred use of living shorelines as a coastal erosion solution. Additionally, the State is developing financing methods, both public and private, to support mitigation approaches.

Maryland is exploring the co-beneficial intersection of methods for reducing causes and building resilience to acidification. An example is localized shoreline and shallow water systems that sequester carbon and nutrients while also neutralizing acidification. Aquaculture facilities and oyster reef habitat areas are logical locations for investigating these methods.

OA Research and Monitoring Coordinating Body: Maryland recognizes that sustained action necessitates embedding those actions within strong institutions. To this end, at the direction of the Maryland Commission on Climate Change (MCCC), the Science and Technical Working Group will serve as a coordinating body for the Ocean Acidification Action Plan in consultation with the Adaptation and Resiliency Working Group. The OA coordinating body will help synthesize appropriate information about ocean acidification and communicate important scientific outcomes with partners. When appropriate the body will provide guidance to help with decision making.

Expanding Public Awareness & Partnerships for Action

Expanding Public Awareness: The Education and Outreach workgroup (ECO)[4] of the MCCC will support the Climate Commission with communications tools for OA. ECO will consider the following:

- **Key Audiences:** Maryland's communications strategy will focus on potentially impacted parties, decision makers and influencers.
- **Institutional Grounding of the Communications Strategy:** The MCCC will oversee the OA Communications Strategy with its ECO workgroup. Beginning in 2021, the MCCC Annual Report will more explicitly include ocean acidification highlights on communications that are outcome-oriented.
- **Communications Evaluation:** ECO members include communications professionals who will develop and evaluate the effectiveness of OA communications.

Partnerships for Action: Maryland is an active partner in several organizations aimed to understand and take action on ocean acidification. The State is committed to protecting its coastal environments and the social and economic benefits they provide. Due to the interconnected nature of the Chesapeake Bay and the regional importance of Maryland's Coastal Bays, Ocean City and Assateague Island State Park and National Seashore, Maryland's work to protect the environment has been inherently interstate.

Several state representatives from Maryland's natural resource management and academic institutions participate in the Mid-Atlantic Coastal Acidification Network (MACAN). MACAN is a regional platform aimed to develop research and local adaptation strategies for the mid-Atlantic region, co-coordinated by the Mid-Atlantic Regional Council on the Ocean (MARCO) and the Mid-Atlantic Regional Association Coastal Ocean Observing System (MARACOOS).

Maryland has a long history of working with the Chesapeake Bay Program Partnership (CBPP), which is recognized internationally for its leadership on complex regional aquatic ecosystem management. This partnership brings together vast technical resources in combination with a governance framework that operates at the highest level of decision making among state and federal governments. In doing so, it represents an effective science-based framework for action that will support Maryland's OA Action Plan.

The US Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), the US Environmental Protection Agency (EPA), the US Department of Agriculture (USDA), the US Department of Interior, and the US Geological Survey (USGS) are important federal partners. Maryland will draw upon these and numerous other partnerships to enable the success of this Plan.

Maryland also participates as an Executive Committee member of the International Alliance to Combat Ocean Acidification (OA Alliance). Maryland will continue partnering with fellow OA Alliance members to elevate urgency and ambition for climate action, integrate ocean actions across climate commitments and frameworks, and translate ocean acidification knowledge into policy actions and investments.

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[4] ECO assists with the Commission's public outreach and meetings on climate change as well as educating Marylanders on what the State is doing to address climate change causes and impacts. Members represent State agencies, private sector, academia and non-governmental organizations.

Maryland continues to be invested in efforts to mitigate climate impacts; in fact, the State leads the nation in reducing CO_2 emissions while growing GDP (Saha and Jaeger, 2020).

IV. Challenges and Measures of Success

Challenges Encountered Drafting the OA Action Plan

An innate challenge that comes with the creation of a Maryland Ocean Acidification Action Plan is the recognition that this is not merely a statewide issue, but is also influenced by processes at the watershed, regional, national, and global scale. The Chesapeake Bay watershed consists of six states and the District of Columbia; coordinating those multiple jurisdictions is a challenge. It is important for all states in the watershed and region to collaborate to foster conservation and restoration investment and action. Each state faces its own social, economic and political challenges in tackling environmental issues. With challenges comes opportunity; cooperation by states provides value-added benefits. For example, Virginia's water quality monitoring programs align with Maryland's, making assessment of the Chesapeake Bay ecosystem more accurate and comprehensive.

Measures of Success of the Three Key Components of the Plan

Reducing Causes & Increasing Resilience

- Maryland will have achieved its core Chesapeake Bay nutrient reduction commitments by 2025 and will be on a path to make additional reductions that account for anticipated impacts of climate change.
- Maryland anticipates it will be at least 85% towards its original "40 by 2030" greenhouse gas reduction goal by 2025.
- Maryland will meet its 2025 restoration target of 79,800 SAV acres and be on track to meeting its share of the Bay-wide ultimate goal of 185,000 acres.

Improve Scientific Understanding

By 2025 Maryland will have completed the near-term actions identified in an *Ocean Acidification Research and Monitoring Action Plan* developed as a commitment of this OA Action Plan. These near-term actions will:

- Put in motion monitoring strategies to resolve key questions about OA,
- Identify additional targeted adaptation and resilience opportunities, and
- Determine whether additional targeted actions are viable for reducing the causes of OA.

Expanding Public Awareness & Partnerships for Action

The MCCC ECO workgroup is charged with assembling and directing resources to realize the following outcomes within five years:

- Effective platforms of information sharing and outreach will have been identified and created. Ocean acidification will be a commonly understood concern by Maryland's general public. Survey data will demonstrate that a large segment of Maryland's population understands and supports the key goals of Maryland's OA Action Plan.

- Vulnerable communities, central influencers and principal decision makers will be informed about key messages concerning ocean acidification.
- Maryland will have institutionalized governance of the OA Action Plan into an existing structure that supports leadership oversight and decision making.

V. How Does OA Action Support Maryland's Existing International and Domestic Climate Commitments?

By going on record with commitments to combat ocean acidification, this Action Plan further affirms Maryland's international and domestic leadership on mitigating the causes of climate change and building resilience to buffer its impacts. Institutionalizing the science and communications of this OA Action Plan will have positive effects beyond ocean acidification because it bolsters existing plans and emphasizes the integration of environmental restoration and climate mitigation.

Maryland's two major strategies for reducing atmospheric CO_2 and reducing nutrient over-enrichment of coastal waters are affirmed by more explicitly connecting them to ocean acidification. In addition to the direct benefits of these strategies, the linkage highlights common interests among parties that have not routinely joined forces. Such a coalition will help overcome the dilemma that knowledge of solutions alone is insufficient for solving problems that confront resistance from the status quo. Opportunities that move beyond the existing mitigation approaches should be considered in the future.

Coordinating with the Maryland Commission on Climate Change will help sustain the Plan commitments. In return, this topic can bring new energy and urgency to the Commission's mission of leading Maryland in its efforts to mitigate the causes of and build resilience to climate change.

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