APPENDIX D

The cost of inaction

Failure to take action will reduce management options and trigger more severe ecological harm

Marine ecosystems, and the industries that depend on them, face growing risks of widespread harm that will become increasingly difficult to reverse as rising CO_2 emissions intensify ocean acidification and hypoxia (OAH). Thus, the cost of inaction on OAH, in the form of reduced management options and wider ecological changes, will rise over time. Scientists are working to understand where and when OAH's aggregate impacts will cross thresholds, or "tipping points," where ecosystems switch to significantly degraded or altered states from which recovery becomes increasingly unlikely. Scientists also are continuing to evaluate what actions West Coast managers can take now to slow the progression of OAH and mitigate its most ecologically and economically threatening impacts.

The full scope of ecological changes ahead is not yet well understood or described, and, as with any area of scientific projection, understanding will come qualified by caveats about scientific and statistical uncertainty. While skeptics might argue that West Coast managers should wait to take action until these uncertainties are resolved, the Panel strongly disagrees with that assessment. OAH science allows researchers to link various observational and modeling data to develop reasoned, informed projections that can help bound expectations about what the world might look like in 1 year, in 10 years, in 50 years. These projections will change as scientific understanding of OAH improves, but the general trends are clear.

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Science supports the decision to act now to start addressing OAH

The Panel's rationale for why West Coast managers should take action now includes:

1. Larger and more rapid changes in ocean chemistry lie ahead.

Continued atmospheric CO_2 emissions will alter the chemistry of coastal waters in ways that will fundamentally make it more difficult to support ecosystems and the benefits that they provide to humans today. These changes in ocean chemistry are not projected to occur in a simple incremental fashion, as non-linearities in the carbonate system amplify the impacts of future rise in seawater CO_2 content. Larger and more rapid changes can also arise from processes associated with climate change and nutrient inputs that enhance inorganic carbon loading and the intensity of ocean hypoxia.

2. The risk of crossing biological and ecological thresholds will increase as OAH stress intensifies.

In addition to non-linear changes in ocean chemistry, scientists also expect impacts on marine life populations and ecological communities will rise non-linearly as the intensification of OAH stress exceeds the physiological tolerance of an increasingly large suite of species that interact within coastal food webs.

3. Predictive power will decrease as the effects of OAH move deeper into uncharted territory.

As the West Coast moves away from presently observable states of ocean chemistry and ecology, it will become harder for scientists to predict with confidence how ecological systems will be affected by OAH. Thus, West Coast managers will benefit from slowing OAH's impacts, as it will help to preserve access to the best-constrained assessments of risks and options.

4. Degraded systems may become less resilient to OAH stress.

Emerging science suggests that as ecosystems become degraded by OAH and other stressors, they become less resilient and less able to withstand increased OAH stress going forward. This suggests that taking actions now to prevent the loss of resilience can lessen the impacts of OAH in the future.

5. Reversing OAH degradation later will involve greater effort and/or longer lag times.

Preventing declines in populations or ecosystems is often more tractable and less costly than reversing declines once they have occurred. For example, challenges in rebuilding fish populations once genetic diversity is lost, or restoring habitats once they have shifted into a less desired state, illustrate the difficulty of reversing ecological degradation. By allowing more changes to manifest before taking management action, OAH effects may become more difficult and perhaps impossible to reverse.

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This report was produced by the West Coast Ocean Acidification and Hypoxia Science Panel (the Panel), working in partnership with the California Ocean Science Trust. The Panel was convened by the Ocean Science Trust at the request of the California Ocean Protection Council in 2013, working in collaboration with ocean management counterparts in Oregon, Washington, and British Columbia. Ocean Science Trust and the Oregon Institute for Natural Resources served as the link between the Panel and government decision-makers. The information provided reflects the best scientific thinking of the Panel. More information on the Panel can be found at www.westcoastOAH.org. Cover image: Bob Wick / Bureau of Land Management / Creative Commons License; circle inset (Tessa Hill): Tomales Bay Oyster Co.; circle inset (fish on reef) - Joe Hoyt / Cordell Bank NMS.