Comment #29

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Re: Comment Letter – 303(d) List portion of the 2014 and 2016 California Integrated Report

29.01 On behalf of the Center for Biological Diversity (the Center), we submit these comments to the State Water Resources Control Board to request that all available information on ocean acidification be analyzed in the final 303(d) list for the 2014 and 2016 California Integrated Report. As detailed below, the Center has submitted numerous studies indicating that water bodies in California are failing to meet their beneficial uses due to impairments caused by ocean acidification. This increasing acidity is due to atmospheric carbon dioxide deposition and local contributions. The State Water Board is under a legal obligation to examine all available sources of information on pollutants that may lead to an impairment of the state's waters, and has failed to do so in this instance. Ocean acidification must be examined and acknowledged in the 2014 and 2016 Integrated Report.

Legal Background

29.02 California's State Water Board can address ocean acidification in regional waters through the Clean Water Act. California has a duty and authority under the Clean Water Act section 303(d) to solicit and consider ocean acidification data and information during its biennial water quality assessments. EPA has specifically directed states to list waters on the 303(d) impaired waters list that are not meeting water quality standards due to ocean acidification (EPA 2010). Waters identified as impaired by ocean acidification allow local managers to control local sources of pollution, and even address cross-border sources of pollution that contribute to ocean acidification.

EPA's 2010 memorandum instructs that states should list waters not meeting water quality standards, including marine pH water quality standards, and should solicit existing and readily available information on ocean acidification using the current 303(d) listing framework. EPA also recommended that states:

(1) request and gather existing data related to ocean acidification, including temperature, salinity, dissolved oxygen, nitrate, total alkalinity, and pH;
(2) develop assessment methods for evaluating impacts of ocean acidification on marine waters based on existing pH and biological water quality criteria;
(3) track the progress of federal efforts to develop assessment and monitoring methods;
(4) develop bio-assessment methods and/or bio-criteria to reflect ocean acidification impacts;

(5) and include in their Integrated Report methodology a description of how they consider available ocean acidification data and information for assessment decisions.

29.03 In addition to the 2010 memo by EPA directing states to collect ocean acidification water quality data, federal regulations require states to "assemble and evaluate *all* existing and readily available water quality-related data and information to develop the list." 40 C.F.R. § 130.7(b)(5) (emphasis added). The list must include all water bodies that fail to meet "any water quality standard," including numeric criteria, narrative criteria, water body uses, and antidegradation requirements. *Id.* § 130.7(b)(1)(iii) & (b)(3). The Center assisted in that effort by submitting multiple comment letters with relevant ocean acidification data during the comment periods for the 2014 and 2016 303(d) lists.

Because the Center was informed that the Regional Boards had deferred action on ocean acidification to the State Water Resources Control Board, Center comments were sent directly to the State Water Board. Letters were sent on June 11, 2008; February 4, 2009; May 28, 2010; August 27, 2010; and April 16, 2014. On Feb. 5, 2015, the Center submitted additional information and comments on ocean acidification for consideration in the water quality assessment. Based upon the list of comment letters in Appendix L (References Report) of the Staff Report, these comment letters appear to have been received by the State and Regional Boards. However, there was no discussion of the data submitted by the Center; no evidence that the State Board satisfied its duty to "evaluate all existing and readily available water quality-related data and information to develop the list." 40 C.F.R. § 130.7(b)(5).

The State Board may not ignore data before it, nor fail to address relevant information in making its decision regarding which water bodies to include on the 303(d) list. *See Brower v. Evans*, 257 F.3d at 1067 (agency may not "completely fail[] to address some factor consideration of which was essential to making an informed decision"); *Sierra Club v. Hankinson*, 939 F. Supp. 865, 870 (N.D. Ga 1996) ("The Court is further concerned with Georgia's apparent failure to use 'all existing readily available water quality-related data and information . . . such as . . . available EPA databases."). Best available information, as submitted in our letters and summarized below, indicates that certain waters in California should be listed as impaired due to ocean acidification. The State Board must evaluate the data presented by the Center in comment letters, and provide an explanation as to why it was not sufficient for making an impaired waters listing due to ocean acidification. 40 C.F.R. § 130.7(b)(5) (duty to evaluate all existing information).

<u>Science support</u>

29.04 The best available science supports that ocean acidification is already affecting coastal waters of California by impairing the capacity of organisms to produce shells and skeletons, altering food webs, and affecting the dynamic of entire ecosystems such as kelp forests, salt marshes, and oysters beds (Cooley & Doney 2009; Cheung et al. 2009, 2010; Brown et al. 2014; Ekstrom et al. 2015; Chan et al. 2016; Seijo et al. 2016; Swezey et al. 2017). Small increases in water acidity can substantially reduce the ability of marine organisms to growth, reproduce and survive. Shelled mollusks such as oysters and pteropods are especially at risk because they are vulnerable to rapid decalcification, dissolution, and mortality (Barton et al. 2012; Gazeau et al. 2013; Hettinger et al. 2013). Shelled mollusks such as oysters are keystone species in coastal areas that provide great economic value and ecosystems services such as water filtration, coastal protection, and habitat (Newell 2004) and they are at risk due to corrosive waters. Ocean acidification has already affected oyster populations in estuarine waters of the U.S. Pacific Northwest (Barton et al. 2012, 2015; Timmins-Schiffman et al. 2012). Ocean acidification is also already affecting important shelled organisms such as pelagic pteropods (Ohman et al. 2009; Bednaršek et al. 2014, 2016, 2017; Bednaršek & Ohman 2015). Pteropods are small sea snails that use the aragonite form of calcium carbonate to secrete their spiral shells (Bednaršek et al. 2012) and are important food for salmon, forage fish, and even whales. Pteropods may be the best indicator for water impairment due to their striking vulnerability to ocean acidification because their delicate aragonite shells (Comeau et al. 2012; Bednaršek et al. 2012, 2017; Stanford's Woods Institute for the Environment et al. 2016; Weisberg et al. 2016). Changes in their abundance and survivorship of these organisms can result in cascading effects that ripple through the food web affecting other marine organisms from fishes to whales.

California's coastal waters are vulnerable to ocean acidification because coastal upwelling and ocean currents are increasingly carrying more anthropogenic CO_2 to the region (Chan et al. 2016). Coastal upwelling along the California coast brings deep water rich in CO_2 and low in dissolved oxygen to the continental shelf driving chemical conditions that affect marine life (Feely et al. 2004, 2008; Hauri et al. 2009; Feely et al. 2009; Gruber et al. 2012; Hauri et al. 2013; Bednaršek et al. 2014). Recent declines in aragonite saturation states due to anthropogenic ocean acidification have been compounded by changes in the circulation of the California Current System (Feely et al. 2012), likely connected to climate change (Bakun 1990; Snyder et al. 2003; Sydeman et al. 2014). Thus, California coastal waters are relatively more acidic than other coastal waters in the continental United States, and it is expected that the effects of ocean acidification will become more severe overtime as waters become more acidic with increasing climate change (Bakun 1990; Snyder et al. 2003; Sydeman et al. 2014). Scientists have already observed waters corrosive to sea life reached nearshore shallower areas along the northern California coast (Feely et al. 2008, 2016). Models predict that by the mid-century, surface coastal waters in this region would remain undersaturated during the entire summer upwelling season and more than half of nearshore waters throughout the entire year (Gruber et al. 2012; Hauri et al. 2013).

Along the California coast, ocean acidification interacts with natural and anthropogenic processes that further reduce pH and carbonate saturation state (Feely et al. 2008; Salisbury et al. 2008; Hauri et al. 2009, 2013; Takeshita et al. 2015; Feely et al. 2017). Surface waters already show undersaturation with respect to aragonite due to anthropogenic ocean acidification independently of upwelling pulses, which lead to harsh chemical conditions to vulnerable marine organisms, including areas where pH is lower than 0.2 units from what occurs naturally (Feely et al. 2008, 2016, 2017). In fact, coastal and estuarine waters today are already seasonally undersaturated with respect to aragonite (Feely et al. 2010, 2016, 2017), and models predict that undersaturation will spread to more broader coastal areas and for longer periods (Feely et al. 2009; Hauri et al. 2013). Studies also show that under ocean acidification conditions, contamination effects, chemical toxicity, and heavy metal pollution can be more severe. In more acidic waters, sediments become more toxic as they easily bounds to heavy metals making them more available and thus more toxic for aquatic life (Roberts et al. 2013). For example, ocean acidification increases the toxicity effects of copper in some marine invertebrates (Campbell & Mangan 2014; Lewis et al. 2016). Thus, some coastal waters are certainly failing to attain adequate water quality standards including, numeric criteria, narrative criteria, water body uses, and antidegradation criteria. Waters must be listed even if only one water quality standard is not achieved.

29.05 Beyond reviewing the information submitted by the Center, California must also evaluate pH and other monitoring data that is readily available and seek out additional ocean acidification data from state, federal, and academic research institutions. EPA's 2010 memo and Integrated Report Guidance discussed several sources, including the NOAA data (EPA 2010: 7-9; EPA Guidance 30-31). The following are additional sources from which the state water board can obtain and evaluate data from:

- Central and Northern California Ocean Observation System Data Portal
- Bodega Ocean Observing Node
- NOAA Pacific Marine Environmental Laboratory Carbon Program
- National Estuarine Research Reserve System
- Oregon State University, College of Earth, Ocean and Atmospheric Sciences
- Ocean Observatories Initiative
- NOAA National Ocean Data Center
- National Data Buoy Center
- University of Washington's Oceanic Remote Chemical Analyzer (ORCA) Group
- Northwest Association of Networked Ocean Observing Systems (NANOOS)
- Integrated Ocean Observing System
- Global Ocean Acidification Observing Network

California should obtain and evaluate data on all relevant parameters of ocean acidification that are available from these and other sources including it its own water quality database. Coastal and estuarine ocean acidification parameters were not considered in the this Integral Report. Thus, California should seek, analyze, and discuss data on water quality parameters relevant to ocean acidification.

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References

Bakun A. 1990. Global Climate Change and Intensification of Coastal Ocean Upwelling. Science **247**:198–201.

Barton A et al. 2015. Impacts of Coastal Acidification on the Pacific Northwest Shellfish Industry and Adaptation Strategies Implemented in Response. Oceanography **25**:146–159.

Barton A, Hales B, Waldbusser GG, Langdon C, Feely RA. 2012. The Pacific oyster, Crassostrea gigas, shows negative correlation to naturally elevated carbon dioxide levels: Implications for near-term ocean acidification effects. Limnology and Oceanography **57**:698–710.

Bednaršek N, Feely RA, Reum JCP, Peterson B, Menkel J, Alin SR, Hales B. 2014. Limacina helicina shell dissolution as an indicator of declining habitat suitability owing to ocean acidification in the California Current Ecosystem. Proceedings of the Royal Society of London B: Biological Sciences **281**:20140123. Available from http://rspb.royalsocietypublishing.org/content/281/1785/20140123 (accessed September 6, 2015).

Bednaršek N, Harvey CJ, Kaplan IC, Feely RA, Možina J. 2016. Pteropods on the Edge: Cumulative Effects of Ocean Acidification, Warming, and Deoxygenation. Progress in Oceanography. Available from http://linkinghub.elsevier.com/retrieve/pii/S0079661115300112 (accessed April 25, 2016).

Bednaršek N, Klinger T, Harvey CJ, Weisberg S, McCabe RM, Feely RA, Newton J, Tolimieri N. 2017. New ocean, new needs: Application of pteropod shell dissolution as a biological indicator for marine resource management. Ecological Indicators **76**:240–244.

Bednaršek N, Ohman M. 2015. Changes in pteropod distributions and shell dissolution across a frontal system in the California Current System. Marine Ecology Progress Series **523**:93–103. Available from http://www.int-res.com/abstracts/meps/v523/p93-103/ (accessed September 6, 2015).

Bednaršek N, Tarling GA, Bakker DC, Fielding S, Cohen A, Kuzirian A, McCorkle D, Lézé B, Montagna R. 2012. Description and quantification of pteropod shell dissolution: a sensitive bioindicator of ocean acidification. Global Change Biology **18**:2378–2388.

Brown MB, Edwards MS, Kim KY. 2014. Effects of climate change on the physiology of giant kelp, Macrocystis pyrifera, and grazing by purple urchin, Strongylocentrotus purpuratus. Algae **29**:203–215.

Campbell A, Mangan S. 2014. Ocean Acidification Increases Copper Toxicity to the Early Life History Stages of the Polychaete Arenicola marina in Artificial Seawater. Environmental science & ….

Cao L, Caldeira K. 2008. Atmospheric CO_2 stabilization and ocean acidification. Geophysical Research Letters **35**. Available from http://doi.wiley.com/10.1029/2008GL035072 (accessed October 24, 2015).

Chan F et al. 2016. The West Coast Ocean Acidification and Hypoxia Science Panel: Major Findings, Recommendations, and ctions. Page 40. California Ocean Science Trust, Oakland, California. Available from http://westcoastoah.org/wp-content/uploads/2016/04/OAH-Panel-Key-Findings-Recommendations-and-Actions-4.4.16-FINAL.pdf.

Cheung WWL, Lam VWY, Sarmiento JL, Kearney K, Watson R, Pauly D. 2009. Projecting global marine biodiversity impacts under climate change scenarios. Fish and Fisheries **10**:235–251.

Cheung WWL, Lam VWY, Sarmiento JL, Kearney K, Watson R, Zeller D, Pauly D. 2010. Large-scale redistribution of maximum fisheries catch potential in the global ocean under climate change. Global Change Biology **16**:24–35.

Comeau S, Gattuso J-P, Nisumaa A-M, Orr J. 2012. Impact of aragonite saturation state changes on migratory pteropods. Proceedings of the Royal Society of London B: Biological Sciences **279**:732–738.

Cooley SR, Doney SC. 2009. Anticipating ocean acidification's economic consequences for commercial fisheries. Environmental Research Letters **4**:024007.

Ekstrom JA et al. 2015. Vulnerability and adaptation of US shellfisheries to ocean acidification. Nature Climate Change **5**:207–214.

EPA. 2010. Integrated reporting and listing decisions related to ocean acidification. Page 16. Memorandum. US Environmental Protection Agency, Washington DC.

Feely R, Alin S, Carter B, Bednarsek N. 2017. Determination of the Anthropogenic Carbon Signal in the Coastal Upwelling Region Along the Washington-Oregon-California Continental Margin. Salish Sea Ecosystem Conference. Available from http://cedar.wwu.edu/ssec/2016ssec/climate_change_ocean_acidification/37.

Feely R, Doney S, Cooley S. 2009. Ocean Acidification: Present Conditions and Future Changes in a High-CO2 World. Oceanography **22**:36–47.

Feely RA et al. 2016. Chemical and biological impacts of ocean acidification along the west coast of North America. Estuarine, Coastal and Shelf Science **183**:260–270.

Feely RA, Alin SR, Newton J, Sabine CL, Warner M, Devol A, Krembs C, Maloy C. 2010. The combined effects of ocean acidification, mixing, and respiration on pH and carbonate saturation in an urbanized estuary. Estuarine, Coastal and Shelf Science **88**:442–449.

Feely RA, Sabine CL, Byrne RH, Millero FJ, Dickson AG, Wanninkhof R, Murata A, Miller LA, Greeley D. 2012. Decadal changes in the aragonite and calcite saturation state of the Pacific Ocean. Global Biogeochemical Cycles **26**:GB3001.

Feely RA, Sabine CL, Hernandez-Ayon JM, Ianson D, Hales B. 2008. Evidence for upwelling of corrosive "acidified" water onto the continental shelf. Science **320**:1490–1492.

Feely RA, Sabine CL, Lee K, Berelson W, Kleypas J, Fabry VJ, Millero FJ. 2004. Impact of anthropogenic CO2 on the CaCO3 system in the oceans. Science **305**:362–366.

Gazeau F, Parker LM, Comeau S, Gattuso J-P, O'Connor WA, Martin S, Pörtner H-O, Ross PM. 2013. Impacts of ocean acidification on marine shelled molluscs. Marine Biology **160**:2207–2245.

Gruber N, Hauri C, Lachkar Z, Loher D, Frölicher TL, Plattner G-K. 2012. Rapid Progression of Ocean Acidification in the California Current System. Science **337**:220–223.

Hauri C, Gruber N, Plattner G-K, Alin S, Feely RA, Hales B, Wheeler PA. 2009. Ocean Acidification in the California Current System. Oceanography. Available from http://agris.fao.org/agris-search/search.do?recordID=DJ2012089494 (accessed March 8, 2016).

Hauri C, Gruber N, Vogt M, Doney SC, Feely RA, Lachkar Z, Leinweber A, McDonnell AMP, Munnich M, Plattner G-K. 2013. Spatiotemporal variability and long-term trends of ocean acidification in the California Current System. Biogeosciences **10**:193–216.

Hettinger A, Sanford E, Hill TM, Hosfelt JD, Russell AD, Gaylord B. 2013. The influence of food supply on the response of Olympia oyster larvae to ocean acidification. Biogeosciences **10**:6629–6638.

Lewis C, Ellis RP, Vernon E, Elliot K, Newbatt S, Wilson RW. 2016. Ocean acidification increases copper toxicity differentially in two key marine invertebrates with distinct acid-base responses. Scientific Reports **6**. Available from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4761931/ (accessed March 25, 2016).

Newell RI. 2004. Ecosystem influences of natural and cultivated populations of suspension-feeding bivalve molluscs: a review. Journal of Shellfish Research **23**:51–62.

Ohman MD, Lavaniegos BE, Townsend AW. 2009. Multi-decadal variations in calcareous holozooplankton in the California Current System: Thecosome pteropods, heteropods, and foraminifera. Geophysical Research Letters **36**:L18608.

Salisbury J, Green M, Hunt C, Campbell J. 2008. Coastal Acidification by Rivers:A Threat to Shellfish? Eos, Transactions American Geophysical Union **89**:513–513.

Seijo JC, Villanueva-Poot R, Charles A. 2016. Bioeconomics of ocean acidification effects on fisheries targeting calcifier species: A decision theory approach. Fisheries Research **176**:1–14.

Snyder MA, Sloan LC, Diffenbaugh NS, Bell JL. 2003. Future climate change and upwelling in the California Current. Geophysical Research Letters **30**:1823.

Stanford's Woods Institute for the Environment, California Ocean Protection Council, Center for Ocean Solutions, Southern California Coastal Water Research Project. 2016. Ocean Acidification: Setting Water Quality Goals: Uncommon Dialogue. Page 21. Stanford University, Stanford University. Available from http://www.opc.ca.gov/webmaster/_media_library/2017/01/OA_Uncommon_Dialogue.pdf.

Swezey DS, Bean JR, Ninokawa AT, Hill TM, Gaylord B, Sanford E. 2017. Interactive effects of temperature, food and skeletal mineralogy mediate biological responses to ocean acidification in a widely distributed bryozoan. Proc. R. Soc. B **284**:20162349.

Sydeman WJ, García-Reyes M, Schoeman DS, Rykaczewski RR, Thompson SA, Black BA, Bograd SJ. 2014. Climate change and wind intensification in coastal upwelling ecosystems. Science **345**:77–80.

Takeshita Y, Frieder CA, Martz TR, Ballard JR, Feely RA, Kram S, Nam S, Navarro MO, Price NN, Smith JE. 2015. Including high-frequency variability in coastal ocean acidification projections. Biogeosciences **12**:5853–5870.

Timmins-Schiffman E, O'Donnell MJ, Friedman CS, Roberts SB. 2012. Elevated pCO2 causes developmental delay in early larval Pacific oysters, Crassostrea gigas. Marine Biology **160**:1973–1982.

Weisberg SB, Bednaršek N, Feely RA, Chan F, Boehm AB, Sutula M, Ruesink JL, Hales B, Largier JL, Newton JA. 2016. Water quality criteria for an acidifying ocean: Challenges and opportunities for improvement. Ocean & Coastal Management **126**:31–41.