Enclosure 2: EPA Request for Public Comment on Ocean Acidification Impacts in Oregon Marine Waters

REQUEST FOR PUBLIC COMMENT ON OCEAN ACIDIFICATION IMPACTS IN OREGON MARINE WATERS

Background: EPA is seeking Public Comment on Data and Information

Separate from the public comments that EPA requests on water segments now proposed for listing, EPA is also requesting public comment on the studies and information developed by the National Oceanic and Atmospheric Administration (NOAA), University of Washington (UW) and others, which describe potential aquatic life impacts off Oregon's coast. The studies and information are listed below. These materials are subject to copyright protections, so EPA is providing links to them in the reference section below, but will not be providing copies of the documents themselves. Over the years, EPA has assembled a significant amount of information on ocean acidification (OA) that focused mainly on studies conducted in laboratories, related issues at hatcheries, and chemical and biological data, most of which were collected outside Oregon state waters. More recently, EPA reviewed numerous additional studies published in the time period extending from 2012 through 2016. Most relevant to determining whether Oregon state waters may be impaired for the purposes of the Clean Water Act would be the studies conducted in State waters (or nearby adjacent coastal waters) and studies of aquatic life populations in those same waters.

EPA's current request invites public comment on the below cited literature, which may be relevant to Clean Water Act decisions about impaired Oregon marine waters, and also solicits any additional existing and readily available water quality-related data collected in Oregon state marine waters, related to acidification of those coastal waters. The aquatic life studies listed below pertain to locations off the Oregon Coast, but outside state waters (which extend three miles seaward from shore). EPA is considering these studies, and whether or not the information presented in the studies is representative of Oregon state waters, but is also inviting the public to submit any other data or information potentially related to acidification within coastal Oregon state waters potentially related to ocean acidification.

Specifically, EPA is seeking public comment regarding whether these studies and information may be representative of conditions in Oregon's coastal waters with relation to the designated aquatic life uses and associated narrative criteria found at OAR 340-41-007(1) and (11). Those narrative criteria provide:

> (1) Notwithstanding the water quality standards contained in this Division, the highest and best practicable treatment and/or control of wastes, activities, and flows must in every case be provided so as to maintain dissolved oxygen and overall water quality at the highest possible levels and water temperatures, coliform bacteria concentrations, dissolved chemical substances, toxic materials, radioactivity, turbidities, color, odor, and other deleterious factors at the lowest possible levels.
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> (11) The creation of tastes or odors or toxic or other conditions that are deleterious to fish or other aquatic life or affect the potability of drinking water or the palatability of fish or shellfish may not be allowed . . . .

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EPA is Seeking Public Comment on Specific Data and Information

Numerous lab and field studies have shown impacts to shellfish from corrosive conditions. Mollusks (such as mussels, clams, and oysters) have been shown to be sensitive to ocean acidification, and both early life stages and adults have shown reduced calcification, growth, and survival when exposed to corrosive conditions (e.g., aragonite saturation less than 1) (Waldbusser *et al.*, 2014.) Laboratory studies have shown that oyster larvae experience conditions detrimental to their development and growth at an aragonite saturation level of 1.5 and below (Waldbusser *et al*., 2014). Laboratory studies by Miller *et al.*, 2016, demonstrate impacts on early stages of Dungeness crabs, including delays in hatching at a pH of 7.1, and significantly reduced zoeal survival at a pH of 7.5 and below. Busch *et al.*, 2014, conducted laboratory experiments that indicate pteropod shell dissolution increases as aragonite saturation state decreases. Some of the conditions simulated in these studies are being recorded off the coast of Oregon, as well as in Oregon state waters.

EPA reviewed NOAA data (Feely *et al.,* 2014a; Feely *et al.*, 2014b; Feely *et al*., 2015) and found the data demonstrate an aragonite saturation state of less than 1, which is corrosive to pteropods, in 73% of observations in Oregon state waters. Oregon does not, however, have a numeric water quality standard for aragonite, so in order to determine an impairment, the impact of the presence of corrosive waters on the aquatic life designated use must be assessed.

In 2014, Bednarsek *et al*. published a widely publicized study on the shell dissolution of pteropods off the coast of Washington, Oregon, and California. Pteropods are an important prey group for ecologically and economically important fish, bird, and whale diets (Bednarsek *et al*., 2014). For Oregon, the pteropod samples were collected at stations ranging from 6.5 miles to 85 miles from the Oregon shoreline (i.e., all outside the three-mile limit of Oregon state coastal waters). The stations with the highest proportion of individuals exhibiting signs of dissolution are located closest to shore (see graphs below.)

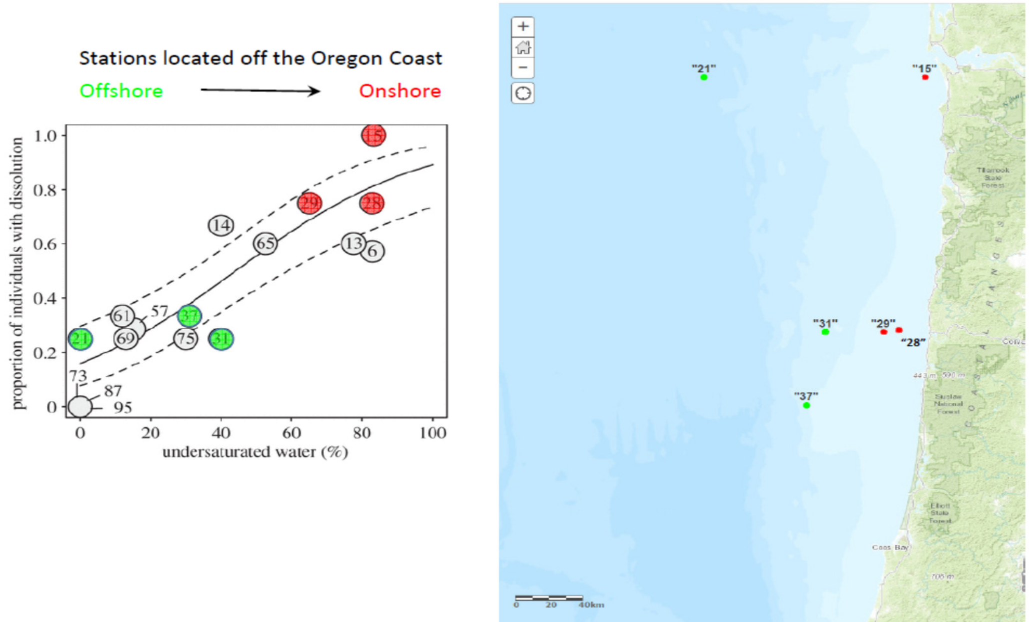

Figure 3 from Bednarsek *et al*. (2014) highlighting data points offshore of Oregon. Right panel shows 2011 sampling locations offshore of Oregon.

The 2014 Bednarsek study found that 24% of offshore pteropods and 53% of onshore pteropods (delineated by the 200 meter isobaths) had severe dissolution damage, and the authors estimated that the incidence of severe pteropod shell dissolution owing to anthropogenic OA has doubled since pre-industrial times in near shore habitats across the study area and is on track to triple by 2050. Harris *et al.*, 2013, explained that coastal upwelling zones, located closer to shore, may be more vulnerable to enhanced acidification. Upwelling causes low aragonite saturation state waters to be forced to the surface, while the aragonite saturation state is further suppressed by anthropogenic CO_2 and freshwater inputs. The sampling locations in these studies were also located outside the three-mile state water boundary, however.

Additionally, unpublished data from Bill Peterson (NOAA, NW Fisheries Science Center,) show a decline in pteropod populations at a station located 9.1 km (5.65miles) from the Oregon shore (Peterson, 2014.) There are studies linking such declines to increases in shell dissolution (Mackas and Galbraith, 2012; Bednarsek *et al.*, 20016; Lischka *et al.,* 2011.) Bednarsek *et al.*, 2016 (submitted) documents increased pteropod mortality with increased dissolution. Recent studies by both Bednarsek *et al.,* 2016, and Lischka *et* al., 2011, document the cumulative effects of decreased pH, deoxygenation and increased ocean temperatures, which negatively affected survival of pteropods. Mackas and Galbraith (2012) examined several time series, one collected since 1979, and observed declines in pteropod populations of one species on the continental shelf of Vancouver Island correspond with demonstrated high occurrences of severe shell dissolution, although a definitive link has not been made. Two other pteropod species exhibited different trends, however, so no sustained and consistent downward trend in total pteropod abundance/biomass has been recorded. (Mackas and Galbraith, 2012.)

Waldbusser *et al.*, 2015, demonstrate how OA acts as a multi-stressor on bivalve larvae. Saturation state effects on shell formation carry over into later life stages, where pH or CO_2 effects can further exacerbate initial OA effects. Again, the sampling locations in these studies are outside Oregon state waters, or are conducted in laboratories; however, given the patterns and trends they represent, of increasing shell dissolution in the presence of aragonite saturation states less than 1, which are present in Oregon state waters, these data suggest that there may be impairments of aquatic life present within Oregon waters.

EPA is Seeking Additional Data and Information from the Public

Please submit any additional data or information specifically related to potential aquatic life impairments in coastal Oregon state waters to EPA by the close of this comment period, which is open from December 22, 2016 to February 6, 2017. Comments can be sent to Jill Fullagar at Fullagar.jill@epa.gov and should include the subject line "OR 2012 comment period." All decision documents and supporting information related to this action can be found on EPA's website at: https://www.epa.gov/tmdl/partial-approvalpartial-disapproval-oregon-2012-303d-list . EPA will evaluate any new data and information received and make an attainment determination as to whether Oregon's coastal waters are attaining applicable water quality standards. If EPA determines that impairment listings are appropriate in light of any new data and information that is received, EPA will identify such listings as proposed additions to the list, and take public comment consistent with the requirements of 40 C.F.R. 130.7(d)(2). Otherwise, EPA will approve Oregon's decision not to list those segments following the close of this comment period.

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