February 27, 2007

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Re: Request to Add California Ocean Waters to List of Impaired Waters due to Carbon Dioxide Pollution Resulting in Ocean Acidification; Response to "Notice of Public Solicitation of Water Quality Data and Information for 2008 Integrated Report—List of Impaired Waters and Surface Water Quality Assessment [303(d)/305(b)]."

Dear Deborah Neiter,

The Center for Biological Diversity respectfully requests that the Los Angeles Water Quality Control Board recommend that:

> **All ocean waters under Region 4's jurisdiction be included in the state List of Impaired Waters ("303(d) List") under section 303(d) of the Clean Water Act as impaired for pH due to absorption of anthropogenic carbon dioxide pollution.**

Similar requests are concurrently being filed with each Regional Water Quality Control Board with jurisdiction over ocean waters of California. We seek to have all California ocean segments added to the Clean Water Act's 303(d) List as these waters are impaired for pH due to ocean acidification occurring as a result of past, ongoing, and projected absorption of anthropogenic carbon dioxide pollution.

I. INTRODUCTION

California has taken a leading role in confronting the threats posed by global warming resulting from anthropogenic carbon dioxide emissions. Nevertheless, California still ranks as one of the world's top carbon dioxide emitters. Global warming, however, is not the only significant impact of carbon dioxide emissions. In addition to their contribution to global warming, these same carbon dioxide emissions also pose a severe threat to California and the world's oceans.

Approximately half of the carbon dioxide emitted from fossil fuel burning over the past 200 years has been absorbed by the oceans. The absorption of carbon dioxide by the oceans is altering the basic chemistry of seawater, rendering the oceans more acidic. Anthropogenic emissions have already lowered average ocean pH by 0.11 units, with a pH change of 0.5 units projected by the end of the century under current emission trajectories.

The primary known impact of ocean acidification is to impair the process of calcification, by which animals such as mollusks and corals build shells and skeletons. Other calcifying organisms such as many species of phytoplankton and zooplankton will also be harmed by ocean acidification as acidic waters dissolve their protective structures or inhibit growth. These species represent fundamental components of the marine food web. Absent significant reductions in anthropogenic carbon dioxide emissions, ocean acidification will accelerate, ultimately leading to the collapse of oceanic food webs and catastrophic impacts on the oceans, and by extension the global environment.

The ocean waters of California are a major source of biological diversity, productivity, and social and economic activity. Protection of these waters is of the highest interests of the state and its citizens. Ocean acidification is impairing the water quality of California's ocean waters and the beneficial uses of these waters.

While regulation of carbon dioxide as a "pollutant" under the Clear Air Act is currently subject to litigation, there can be no dispute that pH can be regulated as a pollutant under the Clean Water Act. The Environmental Protection Agency ("EPA") lists pH as a "conventional pollutant" in its regulations. 40 C.F.R. § 401.16. Ocean acidification, the lowering of seawater pH resulting from absorption of anthropogenic carbon dioxide emissions, can and must be regulated pursuant to the Clean Water Act.

Because ocean acidification is impairing the water quality of California's ocean waters and the beneficial uses of these waters, and existing regulations are inadequate to prevent continued acidification, these waters meet the listing criteria for inclusion in the 303(d) List as described by the *Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List* ("Water Quality Control Policy"). First, California's ocean waters are on a trend toward declining water quality because of increasing acidity. Second, California's ocean waters fail to meet the water quality standard set forth in California's Ocean Plan to prevent degradation to marine communities.

California's State and Regional Water Quality Control Boards must act immediately to curb the acidification of ocean waters by listing California's ocean segments on the 303(d) List and prioritizing the creation of a Total Maximum Daily Load ("TMDL") for carbon dioxide.

II. CLEAN WATER ACT BACKGROUND

The purpose of the Clean Water Act is to "restore and maintain the chemical, physical and biological integrity of the Nation's waters." 33 U.S.C. § 1251(a). According to the Supreme Court "[T]he Act does not stop at controlling the 'addition' of pollutants,' but deals with 'pollution' generally...which Congress defined to mean 'the manmade or man-induced alteration of the chemical, physical, biological, and radiological integrity of water.'" *S.D. Warren v. Maine Bd. Of Envt'l Protection,* 126 S.Ct. 1843, 1852-53 (2006)

The Clean Water Act requires, inter alia, that states set water quality standards that protect designated uses for water bodies. Each state must develop water quality standards that "specify a water body's 'designated uses' and 'water quality criteria,' taking into account the water's 'use and value for public water supplies, propagation of fish and wildlife, recreational purposes, and agricultural, industrial, and other purposes . . . .' 303(c)(2)." *Pronsolino v. Nastri*, 291 F.3d 1123, 1127 (9th Cir. 2002). These standards are used to set effluent limits and technology standards, and the Act requires compliance with such measures by requiring a permit for the discharge of any pollutant. 33 U.S.C. §§ 1311, 1342.

Relevant here, the Clean Water Act's section 303(d) requires each state to identify waters for which existing regulations are inadequate to protect water quality—resulting in a "303(d) List." 33 U.S.C. § 1313(d). "Each state shall identify those waters within its boundaries for which the effluent limitations ... are not stringent enough to implement any water quality standard applicable to such waters." 33 U.S.C. § 1313(d)(1)(a). A water body failing to meet any numeric criteria, narrative criteria, waterbody uses, or antidegradation requirements shall be included as a water-quality limited segment on the 303(d) List. 40 C.F.R. § 130.7(b)(3).

For waters identified on the 303(d) List, the states "shall" establish a TMDL for pollutants "at a level necessary to implement the applicable water quality standards." 33 U.S.C. § 1313(d)(1)(C). "A TMDL defines the specified maximum amount of a pollutant which can be discharged or 'loaded' into the water at issue from all combined sources." *Dioxin/Organochlorine Center v. Clarke*, 57 F.3d 1517, 1520 (9th Cir. 1995). The 303(d) List shall include a priority ranking for all listed segments still requiring TMDLs. 40 C.F.R. § 130.7(b)(4). "TMDLs serve as a link in an implementation chain that includes federally-regulated point source controls, state or local plans for point and nonpoint source pollution reduction, and assessment of the impact of such measures on water quality, all to the end of attaining water quality goals for the nation's waters." *Pronsolino,* 291 F.3d at 1129.

Additionally, the EPA oversees California's implementation of section 303(d) of the Clean Water Act and must approve the identified impaired water bodies and TMDLs. 33 U.S.C. § 1313(d)(2). If EPA disapproves of either, then EPA shall identify such waters and establish TMDLs as necessary to ensure water quality standards are met. 33 U.S.C. § 1313(d)(2).

III. OCEAN ACIDIFICATION BACKGROUND

Carbon dioxide pollution is degrading water quality and harming marine ecosystems. The oceans readily absorb carbon dioxide pollution and this causes ocean acidification. Increasing acidity is stripping the oceans of important compounds needed by marine species to build shells and skeletons (Ruttimann 2006). Many sea organisms from phytoplankton to snails and crabs are being harmed as acidic waters dissolve protective structures or inhibit growth. (Ruttimann 2006; WBGU 2006). Other marine organisms, such as fish, experience impaired metabolism as their tissues become more acidic (Pörtner 2004, Royal Society 2005). Adverse impacts on these species will reverberate throughout the marine ecosystem.

A. Seawater Chemistry and Carbon Dioxide

The oceans freely exchange carbon dioxide with the atmosphere. The oceans have already taken up about 50% of the carbon dioxide that humans have produced since the industrial revolution, and already this has lowered the average ocean pH by 0.11 units (Sabine 2004).

Although this number sounds small, it represents a significant change in acidity. The ocean takes up about 22 million tons of carbon dioxide each day (Feely 2006). While preindustrial levels of atmospheric carbon dioxide hovered around 280 ppm (Orr 2005), now they have increased to 380 ppm and if current trends continue they will increase another 50% by 2030 (Turley 2006). These rising carbon dioxide levels are irreversible on human timescales (Kleypas et al. 2006). Over time, the ocean will absorb up to 90% of anthropogenic carbon dioxide released into the atmosphere (Kleypas et al. 2006).

When carbon dioxide is dissolved in seawater it becomes reactive and changes seawater chemistry along with many other physical and biological reactions. When carbon dioxide combines with water, it forms carbonic acid and releases hydrogen ions (Royal Society 2005). These hydrogen ions determine the acidity of the ocean, accounting for the change in pH. The slightly alkaline pH of the ocean is becoming more acidic. The naturally occurring pH values for the ocean were on average 8.16 and as a result of carbon dioxide pollution, the average pH value has dropped to 8.05 (Ruttimann 2006).

Carbon dioxide pollution results in more severe pH changes than experienced in the past 300 million years (Caldeira 2003). Under the business-as-usual scenario of greenhouse gas emissions, carbon dioxide will reach 788 ppm by 2100 and pH will drop another 0.3-0.4 units (Orr 2005). Even under the more modest scenario where carbon dioxide emissions are stabilized, atmospheric carbon dioxide will reach 563 ppm by the end of the century with corresponding ocean acidification.

In addition to changes in pH, carbon dioxide changes the carbon chemistry of the ocean. Seawater is naturally saturated with carbonate ions that are important for marine organisms to build shells and skeletons (WBGU 2006). Calcium carbonate is present in the ocean in two common forms used by organisms for shells and skeletons, calcite and aragonite. Dissolved carbon dioxide reacts with seawater to form carbonic acid, which dissociates to form bicarbonate ions (Turley 2006). The effect lowers pH and decreases the availability of carbonate ions ($CO^{2-}{}_3$) (Kleypas 2006). This is represented by the following equation:

$$CaCO_3+CO_2+H_20 \Leftrightarrow Ca^{2+} + CO^{2-}{}_3+CO_2 + H_20 \Leftrightarrow Ca^{2+}+2HCO^{-}{}_3$$

The ocean acidification that has already occurred, a decline of 0.11 pH, represents a 30% increase in the concentration of hydrogen ions (Royal Society 2005), and a decrease in the carbonate concentration of 10% (Orr 2005). Changes in carbonate saturation extend below the surface throughout the water column (Orr 2005). These changes in saturation make calcium carbonate unavailable for marine organisms to build their protective shells with adverse effects that will spread throughout the ecosystem.

Carbon dioxide pollution into the ocean is causing California's oceans to have a lower pH, increased dissolved carbon dioxide, lower concentration of carbonate ions, and increased bicarbonate ions (Royal Society 2005). The result is that California's oceans have already been seriously degraded by carbon dioxide pollution.

Table 1. Changes to ocean chemistry and pH estimated using the OCMIP3 models calculated from surface ocean measurements and our understanding of ocean chemistry. Note that the concentration of bicarbonate ion (HCO_3^-) and carbonic acid (H_2CO_3) increase with rising atmospheric concentration of CO_2 while carbonate ion (CO_3^{2-}) decreases. The average pH of the surface ocean waters decreases with increasing atmospheric CO_2 concentration. (Assumptions used in model: Total alkalinity = 2324 mol/kg, temperature = 18° C. All other assumptions as per OCMIP3 (Institut Pierre Simon Laplace 2005). Aragonite and calcite saturation calculated as per Mucci & Morse (1990). Physical oceanographic modelling is based on Bryan (1969) and Cox (1984).

	Pre-industrial	Today	2× pre-industrial	3× pre-industrial	4× pre-industrial	5× pre-industrial	6× pre-industrial
Atmospheric concentration of CO_2	280 ppm	380 ppm	560 ppm	840 ppm	1120 ppm	1400 ppm	1680 ppm
H_2CO_3 (mol/kg)	9	13	19	28	38	47	56
HCO_3^- (mol/kg)	1768	1867	1976	2070	2123	2160	2183
CO_3^{2-} (mol/kg)	225	185	141	103	81	67	57
Total dissolved inorganic carbon (mol/kg)	2003	2065	2136	2201	2242	2272	2296
Average pH of surface oceans	8.18	8.07	7.92	7.77	7.65	7.56	7.49
Calcite saturation	5.3	4.4	3.3	2.4	1.9	1.6	1.3
Aragonite saturation	3.4	2.8	2.1	1.6	1.2	1.0	0.9

Source: Royal Society (2005)

B. The Adverse Impacts of Carbon Dioxide Pollution on the Marine Environment

Scientists agree that carbon dioxide pollution is causing ocean acidification with adverse impacts on many marine organisms. Available evidence suggests that the consequences of anthropogenic carbon dioxide accumulation have already begun in surface waters (Pörtner 2005).

One of the most alarming effects of ocean acidification is the impact on the availability of carbonate for calcifying organisms such as mollusks, crustaceans, echinoderms, corals, calcareous algae, foraminifera and some phytoplankton. Nearly all marine species that build shells or skeletons from calcium carbonate that have been studied have shown deterioration when exposed to increasing carbon dioxide levels in seawater (Feely 2006). Estimates suggest that calcification rates will decrease up to 50% by the end of the century (Ruttimann 2006). Snails, sea urchins, starfish, lobster, crabs, oysters, clams, mussels, and scallops all build shells that are vulnerable to ocean acidification. Other marine species may experience physiological effects from acidification including lowered immune response, metabolic decline, and reproductive and respiratory problems (Feely 2006).

1. Calcifying planktonic organisms are adversely affected by ocean acidification.

Plankton, which play a fundamental role in the marine ecosystem, are threatened by ocean acidification. Carbon dioxide uptake by the ocean causes impaired growth and development for calcifying plankton, and acidification dissolves the protective armor of some plankton. Coccolithophorids, foraminifera, and pteropods are the dominant calcifying planktonic organisms and provide an essential role in marine production.

Coccolithophorids are one of the most important calcite producers and studies show that carbon dioxide in seawater reduces calcification of coccolithophorids (Reibesell 2000). Coccolithophorids are one-celled marine plants in the upper layers of the ocean that bloom in large numbers like many phytoplankton. Phytoplankton, such as coccolithophorids, contribute much of the organic material entering the marine food chain and are responsible for about 50%

of the earth's primary production (Royal Society 2005). Coccolithophorids have calcium carbonate structures surrounding them called coccoliths. Studies of coccolithophorids showed that carbon dioxide related changes to seawater caused reduced calcification, malformed coccoliths, and incomplete coccospheres (Riebesell 2000). These phytoplankton not only provide food for other marine organisms but they also influence the global environment by reflecting light from the ocean.

Another example of plankton at risk from ocean acidification are pteropods. Pteropods form their shells from aragonite. Experiments show that the shells of pteropods dissolve as seawater becomes undersaturated with aragonite (Orr 2005). If carbon dioxide pollution continues unabated then large areas of the ocean, especially at higher latitudes, will become undersaturated with aragonite by 2050 (Orr 2005). Krill, whales, salmon, and other fish eat pteropods, and they contribute significantly to marine production. Ocean acidification impedes the calcification of pteropods and even dissolves their protective shells. Not only are pteropods at risk, but also the many organisms that depend on them for food.

Another important planktonic calcifier, foraminifera, experiences reduced shell mass when exposed to elevated carbon dioxide (Kleypas 2006). There is a strong reduction in foraminifera calcification that corresponds to pH decreases (Royal Society 2005).

Calcification is an essential mechanism in the biology and ecology for many marine species. Coccolithophorids, pteropods, and foraminifera are the major planktonic calcifying groups and they all experience adverse biological reactions as a result of ocean acidification. California's oceans are filled with many of these plankton and they play a significant role in the marine food chain.

2. Large calcifying organisms experience reduced calcification due to ocean acidification.

Larger calcifying animals such as corals, crustaceans, echinoderms, and mollusks are also threatened by ocean acidification. These important members of marine ecosystems are vulnerable to ocean acidification because, like calcifying plankton, they are experiencing reduced calcification and erosion of their protective shells.

Experiments revealed that moderate increases in atmospheric carbon dioxide had significant effects on the survival and growth of sea urchins and snails (Shirayama 2005). These adverse effects on echinoderms and gastropods are alarming because they mimicked long-term exposure to carbon dioxide levels that are likely to be reached within decades, 560 ppm (Shirayama 2005). Echinoderms are especially sensitive to ocean acidification because lower pH inhibits the formation of their skeletons which depend on highly soluble calcite precursors (Royal Society 2005, Shirayama 2004). At a pH change of 0.3 units, echinoderms are significantly impacted (Shirayama 2004). Crustacea also are especially vulnerable to sea chemistry changes during molting (Royal Society 2005). Shallow water benthic organisms such as these are among those that will be the first to experience the adverse impacts of the ocean's uptake of carbon dioxide pollution.

Juvenile calcifying organisms are also more vulnerable to pH changes than adults. Most benthic fauna have a planktonic larval phase when they are especially vulnerable to carbonate undersaturation. For example, young sea urchins were smaller and deformed when grown at a lower pH (Haugan 2006, Shirayama 2004). Also, the success of bivalve larvae is greatly reduced by ocean acidification because they experience high mortality while settling, while undersaturation of carbonates weakens their shells (Royal Society 2005).

Due to ocean acidification, within our lifetimes coral reefs may erode faster than they can rebuild (Feely 2006). Coral reefs provide vital functions for marine ecosystems, and studies reveal that coral is extremely vulnerable to ocean acidification (Gattuso 1997). The combined stresses of warmer temperatures, rising sea levels, and ocean acidification are likely to produce major changes to coral reefs in the decades to come (Royal Society 2005). Cold water corals, some of which were recently discovered in California waters, are long lived, slow growing, and fragile. Based on studies of other corals, it is predicted that calcification of cold-water corals will also be reduced by ocean acidification (Royal Society 2005). Some of the cold water coral species in the Pacific calcify and are vulnerable to impacts from anthropogenic carbon dioxide (Guionette 2006, Morgan 2006). Cold water corals may be even more sensitive to reduced carbonate saturation because they already live in conditions less favorable to calcification (Royal Society 2005; Murray 2006). Moreover, because cold water corals depend on calcifying plankton as food, the productivity of coral prey is also compromised by ocean acidification (Morgan 2006).

3. Fitness of other marine animals is compromised by ocean acidification.

Even marine animals that do not calcify are threatened by carbon dioxide increases in their habitat. Changes in the ocean's carbon dioxide concentration result in accumulation of carbon dioxide in the tissues and fluids of fish and other marine animals, called hypercapnia, and increased acidity in the body fluids, called acidosis. These impacts can cause a variety of problems for marine animals including difficulty with acid-base regulation, calcification, growth, respiration, energy turnover, and mode of metabolism (Pörtner 2004).

An animal's ability to transport oxygen is reduced by pH changes (Pörtner 2005). Water breathing animals have a limited capacity to compensate for changes in the acidity (Haugan 2006). For example, fish that take up oxygen and respire carbon dioxide through their gills are vulnerable because decreased pH can affect the respiratory gas exchange (Royal Society 2005). Changes in metabolic rate are caused by the changes in pH, carbonates, and carbon dioxide in marine animals (Haugan 2006).

Squid, for example, show a very high sensitivity to pH because of their energy intensive manner of swimming (Royal Society 2005). Because of their energy demand, even under a moderate 0.15 pH change squid have reduced capacity to carry oxygen and higher carbon dioxide pressures are likely to be lethal (Pörtner 2004). Even species more tolerant to pH changes experience decreased metabolism from increased carbon dioxide in the water (Pörtner 2004). For example, as much as 50% mortality was observed in copepods after only six days of exposure to waters with a pH level 0.2 units below the control (Pörtner 2005).

In fish, pH also affects circulation. When fish are exposed to high concentrations of carbon dioxide in seawater cardiac failure causes mortality (Ishimatsu 2004). At lower concentrations sublethal effects can be expected that can seriously compromise the fitness of fish. Juvenile and larval stages of fish were found to be even more vulnerable (Ishimatsu 2004).

Increased concentration of carbon dioxide not only produces pH changes that affect animals, but also the internal accumulation of carbon dioxide in the body of the organism adversely impacts many marine species (Haugan 2006). Marine animals are likely to have difficulty reducing carbon dioxide in their bodies with consequent effects on development and reproduction (Turley 2006). Hypercapnia can cause decreased protein synthesis which results in reduced growth and reproduction (Haugan 2006). This effect has been observed in mollusks, crustaceans, and fish (Haugan 2006).

Experiments with elevated carbon dioxide levels have revealed numerous adverse effects on the productivity of a variety of marine organisms (WBGU 2006). Changes were noted in the "productivity of algae, metabolic rates of zooplankton and fish, oxygen supply of squid, reproduction in clams, nitrification by microorganisms, and the uptake of metals" (WBGU 2006; see also Pörtner 2005). Other effects could include decreased motility, inhibition of feeding, reduced growth, reduced recruitment, respiratory distress, decrease in population size, increased susceptibility to infection, shell dissolution, destruction of chemosensory systems, and even mortality (Turley 2006; Royal Society 2005).

Impacts to marine organisms are not confined to the laboratory. Experiments with deep sea injection of carbon dioxide in central California waters killed benthic meiofauna such as nematode worms and amoeba (Barry 2005). Researchers also predict that the long-term hypercapnic conditions caused by absorption of atmospheric carbon dioxide will produce similar physiological stresses for marine organisms (Barry 2005).

Additionally, studies have shown that reproduction can be seriously compromised with pH changes. Studies have found loss of sperm motility for Pacific oysters, decreases in egg production by copepods, decreased hatching of egg sacs for gastropod mollusks, and impacts on reproductive success for silver sea bream and sea urchins (Royal Society 2005).

In sum, ocean acidification can have many adverse effects on marine animals that can reduce their fitness and survival (Royal Society 2005). Many marine animals have low thresholds for long-term carbon dioxide exposure (Pörtner 2005). Studies demonstrate that many marine species are threatened with population declines and changes in species composition due to the decreased fitness of individuals and compromised reproductive success that is occurring or will result from ocean acidification.

4. Ocean acidification impacts entire ecosystems.

Changes caused by ocean acidification such as reduced calcification can compromise the fitness and survival of some species resulting in changes in abundance and diversity of species in marine communities (Royal Society 2005, Kleypas 2006). These shifts can lead to even greater ecosystem responses that will alter ecosystem productivity, nutrient availability, and carbon cycling (Kleypas 2006).

Declining populations of species that are unable to adjust to ocean acidification will cause major changes in interactions among species in marine ecosystems. For example, the shift from coccolithophores to diatoms in the plankton community can cause a restructuring of the ecosystem at all trophic levels (Royal Society 2005). Additionally, a decrease in pteropod abundance can also increase predation of juvenile fish (Royal Society 2005). Changes to the carbonate chemistry and reduced calcification by plankton will change the amount of sinking and settling to deeper waters, which may reduce delivery of food to deeper waters and benthic organisms (Haugan 2006).

Most of the ocean's biological activity happens near the surface waters, and ocean acidification will have substantial effects on organisms and habitats in those areas. Impacts on surface waters will cycle down to affect deep-ocean communities. Changes in acidity occur more quickly near the surface where most marine organisms occur, but deep-ocean species may be more sensitive to pH changes (Caldeira 2003).

Changes in pH also affect the availability of marine nutrients that are essential for marine production (Turley 2006). Changes in nutrients such as phosphorus and nitrogen could cause eutrophication (Turley 2006). The aggregation of these changes may have potentially devastating effects on marine communities.

Other effects of climate change are also likely to combine synergistically with ocean acidification, intensifying the adverse affects on marine communities. For example, ocean temperatures are already changing, while runoff from more storms may alter salinity. The combined impact of all of these changes will influence the productivity, interactions, and distribution of many phytoplankton and zooplankton, resulting in impacts on the rest of the food chain (Haugan 2006). Ocean acidification can increase organisms' sensitivities to such environmental extremes (Pörtner 2005). For example, decreased metabolism can result in narrowing the thermal tolerance of an organism (Haugan 2006).

Due to the specific habitat tolerances of many species, some species may become imperiled from the impacts of high concentrations of carbon dioxide. Additionally, many threatened and endangered species depend on California's ocean ecosystem and are extremely vulnerable to changes in marine habitat. Ocean acidification jeopardizes the continued existence of some of these species. For example, ocean acidification may dissolve the shell of the endangered white abalone or inhibit shell formation and growth. Also, there are numerous threatened and endangered species such as blue, humpback, and fin whales, and sea otters that prey on calcifying species. Declining fitness of fish due to acidification could not only impact depleted fish populations, but also already imperiled fish-eating species such as the California least tern, California brown pelican, marbled murrelet, Steller sea lion, and Guadalupe fur seal. Similarly, impacts to squid, among the most sensitive of marine species to changes in pH, would likely impact squid-eating species such as sperm whales.

These ecosystem responses will have serious effects on California's ocean biodiversity and productivity. While the worst effects of ocean acidification are forecasted for the future, other impacts are already underway. Changes in pH are a significant threat in marine habitats. At present, the water quality of California's ocean waters is declining due to carbon dioxide pollution, putting entire marine communities at risk.

IV. CALIFORNIA'S OCEAN WATERS ARE IMPAIRED AND MUST BE ADDED TO THE 303(D) LIST

All segments of California's ocean waters must be included on the State's 303(d) List because current measures are not stringent enough to prevent ocean acidification and achieve water quality standards. 33 U.S.C. § 1313(d). The Clean Water Act requires that California protect the water quality for designated uses of its waters. California's Ocean Plan defines the designated uses of ocean waters:

> The beneficial uses of the ocean waters of the State that shall be protected include industrial water supply; water contact and non-contact recreation, including aesthetic enjoyment; navigation; commercial and sport fishing; mariculture; preservation an enhancement of designated Areas of Special Biological Significance (ASBS); rare and endangered species; marine habitat; fish migration; fish spawning and shellfish harvesting.

California Ocean Plan at 3 (2005).

The beneficial uses of California's oceans are threatened by ocean acidification. For example, many marine species are vulnerable to ocean acidification, which can impair the ocean's marine resources and economic activities dependent on these resources such as fishing, mariculture, and shellfish harvesting. Habitat for imperiled species, and their spawning, migration, and forage may be impaired. Even under conservative estimates of future carbon dioxide emissions, scientists predict chemical changes that threaten the ability of marine life to adapt to the acidifying ocean (Orr 2005). All these impacts would severely impair Californians' aesthetic and recreational enjoyment of the ocean waters and sea life they contain.

California's ocean waters meet one or more of the 303(d) listing factors enumerated in California's Water Quality Control Policy ("WQCP"). First, California's ocean waters are experiencing a trend of declining water quality for pH. Second, ocean acidification is causing degradation of marine communities. For these reasons, which are described in detail below and supported by the attached scientific evidence, California's ocean should be placed on the 303(d) List as impaired for pH as a result of anthropogenic carbon dioxide emissions.

A. California's Oceans Are on a Trajectory for Declining Water Quality

The Clean Water Act and California's antidegradation policy prohibits any degradation of water bodies that are currently meeting water quality standards. The increasing acidification of the ocean requires that California's ocean waters be added to the 303(d) List.

A water segment shall be placed on the section 303(d) list if the water segment exhibits concentrations of pollutants or water body conditions for any listing factor that shows a trend of declining water quality standards attainment.

WQCP §. 3.10 (2004). As this listing criterion fulfills the Clean Water Act's antidegradation requirements, a water body must be listed if it has declining water quality even if water quality objectives are not exceeded. WQCP § 3.10.

EPA identifies pH as a conventional pollutant. 40 C.F.R. § 401.16.

At present, California's ocean segments are on a trajectory of declining attainment of water quality standards for pH. California's water quality standard for the ocean states, "the pH shall not be changed at any time more than 0.2 units from that which occurs naturally." California Ocean Plan 6 (2005).[1]

Applying the existing Ocean Plan standard for pH, all California ocean waters must be included on the 303(d) List because they are experiencing degradation. As described above, dissolved carbon dioxide lowers the pH of seawater and acidifies the ocean. Surface ocean pH has already declined by 0.11 units on average from preindustrial values (Caldeira 2003). The naturally occurring pH values for the ocean were on average 8.16 and as a result of carbon dioxide pollution, the average pH value has dropped to 8.05 (Ruttimann 2006). This is a significant change in water quality since each step is a tenfold change in acidity.

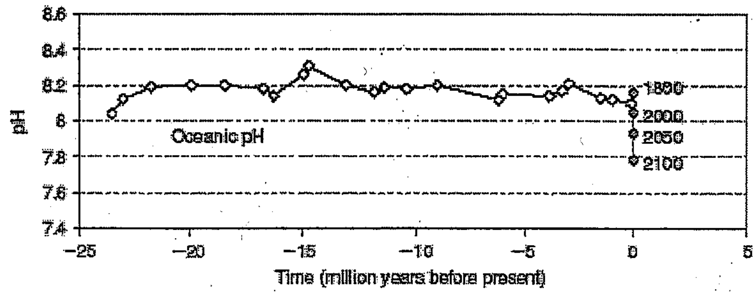

Figure 8.2 Past (white diamonds, data from Pearson and Palmer, 2000) and contemporary variability of marine pH (grey diamonds with dates). Future predictions are model derived values based on IPCC mean scenarios.

Source: Turley 2006

The ongoing acidification of the ocean is the most severe change in ocean pH in several million years (Turley 2006). These changes are occurring at about 100 times the rate of changes seen naturally in geological history. Natural changes occur more slowly with a greater

[1] This standard allowing for a 0.2 unit change from naturally occurring pH is inadequate to fully protect water quality from ocean acidification. The standard assumes localized pH changes that would dilute on a larger scale, but widespread carbon dioxide absorption amounting to a 0.2 pH change will have devastating effects on California's marine life. Therefore, the Center for Biological Diversity is submitting a proposal to the State Water Quality Control Board to modify this water quality standard accordingly to better protect California's ocean waters from ocean acidification. Nevertheless, even under the 0.2 unit standard in the current Ocean Plan, California's ocean waters still meet the criteria for listing on the 303(d) list.

opportunity for the impacts of pH changes to be lessened (Royal Society 2005). A further decline of another 0.09 units will exceed California's water quality standards allowing for a maximum pH change of 0.2.

Meanwhile, human activities continue to release carbon dioxide, and the ocean is continuing to absorb such pollution. With the oceans absorbing about 22 millions of carbon dioxide each day (Feely 2006), seawater pH will continue to decrease. Assuming current trends of greenhouse gas emissions, the global average pH of seawater will drop another 0.3-0.4 units (Orr 2005). Having already absorbed half of anthropogenic carbon dioxide, scientists predict that the oceans will absorb up to 90% (Kleypas et al. 2006). Unabated, carbon dioxide pollution will degrade seawater quality beyond California's water quality standards. By the end of this century, absent significant reductions in carbon dioxide emissions, this will result in a pH change up to 0.5 units (Royal Society 2005).

California is among the largest producers of carbon dioxide pollution. Contributing about 492 million metric tons of greenhouse gases each year, California is the nation's second largest emitter of greenhouse gases and the world's 12th largest contributor (CED 2006). Carbon dioxide accounts for 84% of those emissions, much of which is quickly absorbed into the surface layers of the ocean. California's population is expected to increase from 35 million today to 55 million by 2050. Absent significant per-capita reductions in current carbon dioxide emission rates, California's emissions are likely to increase.

Increasing carbon dioxide in the atmosphere will lead to further ocean acidification.

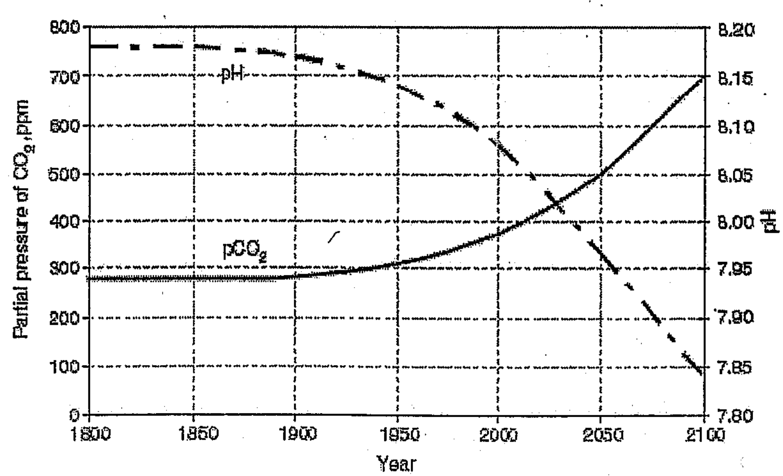

Figure 8.1 The past and projected change in atmospheric CO_2 and seawater pH assuming anthropogenic emissions are maintained at current predictions (redrawn from Zeebe and Wolf-Gladrow 2001).

Source: Turley 2006

As described above, and documented in the scientific literature submitted with this request, carbon dioxide absorption into the ocean is causing California's ocean waters to have a lower pH, increased dissolved carbon dioxide, lower concentration of carbonate ions, and increased bicarbonate ions (Royal Society 2005). The result is that California's ocean waters have already been degraded by carbon dioxide pollution. California's ocean waters are on a trajectory toward nonattainment of water quality standards and therefore should be added to the 303(d) List.

B. Ocean Acidification Is Impairing Marine Communities

California's ocean waters should also be placed on the 303(d) List because they exceed the narrative water quality criteria for biological characteristics described in California's Ocean Plan. The Ocean Plan provides that "[m]arine communities, including vertebrate, invertebrate, and plant species, shall not be degraded." Ocean Plan at 10.

California's Water Quality Control Policy ("WQCP") explicitly states that a water segment that "exhibits adverse biological response" such as "reduction in growth, reduction in reproductive capacity, abnormal development, histopathological abnormalities, and other adverse conditions" should be placed on the list. WQCP § 3.8. A segment should also be listed "if the water segment exhibits significant degradation in biological populations and/or communities" as evidenced by declining species diversity or individuals in a species. WQCP § 3.9.

As described above, the impacts of ocean acidification on marine organisms, and ultimately, marine communities are significant, diverse, and will greatly increase in severity over time. There is no scientific dispute that anthropogenic atmospheric carbon dioxide is causing ocean acidification and that such acidification will have adverse impacts on many marine organisms. Available evidence suggests that the adverse consequences of anthropogenic carbon dioxide accumulation are already being felt in surface waters (Pörtner 2005).

Ocean acidification is adversely affecting calcifying planktonic organisms such as coccolithophorids, foraminifera, and pteropods, larger calcifying organisms such as crustaceans, echinoderms, corals, and mollusks, non-calcifying organisms such as fish and squid, and such adverse affects will reverberate though the marine ecosystem to marine mammals, seabirds and ultimately human communities reliant upon ocean resources. In short, ocean acidification caused by anthropogenic carbon dioxide is causing degradation of California's marine communities in breach of the water quality standards. As such, California's ocean waters should be added to the 303(d) List as impaired for pH from absorption of anthropogenic atmospheric carbon dioxide.

V. CONCLUSION

While the worst effects of ocean acidification are forecasted for the future, the adverse changes to California's ocean waters from ocean acidification are already underway. These changes will, if not addressed, have serious, and likely catastrophic effects on California's ocean biodiversity, productivity, and ultimately, economy.

All segments of California's ocean waters must be added to the Clean Water Act's 303(d) List as impaired for pH from absorption of anthropogenic atmospheric carbon dioxide. Such listing is necessary because anthropogenic carbon dioxide pollution is degrading water quality and impairing the ocean's designated uses. California's specific listing criteria are met because these ocean waters are on a trajectory of declining water quality, and because ocean acidification is degrading California's marine communities.

California's ocean waters are among the most productive, diverse, and ecologically and economically important of any ocean waters in the United States and the world. Ocean acidification threatens the fundamental health of these waters and all species dependent upon them. These waters can only be protected if prompt and decisive action is taken to reduce ocean acidification by reducing anthropogenic atmospheric carbon dioxide emissions.

The goals of the Clean Water Act and California's Ocean Plan can only be met by taking steps to slow ocean acidification. The changing pH of the ocean and associated impacts on marine resources are unlike any that have been experienced on this earth for millions of years. California must take actions now to abate carbon dioxide pollution by listing California's ocean segments as impaired on the 303(d) List and establishing a TMDL for carbon dioxide.

In conclusion, the Los Angeles Water Quality Control Board must recommend to the State Water Resources Control Board that all ocean segments within its region be added to the 303(d) List as impaired for pH from absorption of anthropogenic atmospheric carbon dioxide.

Respectfully submitted,

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VI. SOURCES

For supporting documents listed below, please see the attached articles submitted with this letter.

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