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Dear Mr. Roy Lowe:

Thank you for the opportunity to provide comments as you develop the Comprehensive Conservation Plan for the Oregon Islands National Wildlife Refuge. Defenders of Wildlife is a non-profit, public interest institution with one million members and supporters nationwide, including 15,288 in Oregon. Defenders has been a long-time advocate for the Refuge System and continues to take a special interest in the Refuge System planning process. We published the ***Citizen's Wildlife Refuge Planning Handbook*** to encourage the public to become more involved in refuge planning. Defenders also publishes an annual report on the state of the Refuge System, ***Refuges at Risk***, and this year's report featured the impacts global warming are and will be having on the Oregon Islands National Wildlife Refuge.

We are generally supportive of the current management direction of the refuge. One of the most profound, looming issues facing the refuge is global warming. Through the planning process, the Fish and Wildlife Service (FWS) has an opportunity to assess what is known about global warming and the species and ecosystems that depend on the refuge, what issues need further study, and how this information can be incorporated into management of the refuge. In fact, this assessment is all but required. Interior Secretarial Order 3226, states that

> Each bureau and office of the Department will consider and analyze potential climate change impacts when undertaking long-range planning exercises, when setting priorities for scientific research and investigations, when developing multi-year management plans, and/or when making major decisions regarding the potential utilization of resources under the Department's purview. Departmental activities covered by this Order include, but are not limited to… management plans and activities developed for public lands...

In addition, in May, 2006, Congress passed House Concurrent Resolution 398 "expressing the sense of the Congress that the United States Fish and Wildlife Service should incorporate consideration of global warming and sea-level rise into the comprehensive conservation plans for coastal national wildlife refuges, and for other purposes." The resolution states that:

> (1) the United States Fish and Wildlife Service should incorporate consideration of the effects of global warming and sea-level rise into

the comprehensive conservation plan for each coastal national wildlife refuge;

(2) each such comprehensive conservation plan should address, with respect to the refuge concerned, how global warming and sea-level rise will affect--

(A) the ecological integrity of the refuge;

(B) the distribution, migration patterns, and abundance of fish, wildlife, and plant populations and related habitats of the refuge;

(C) the archaeological and cultural values of the refuge;

(D) such areas within the refuge that are suitable for use as administrative sites or visitor facilities; and

(E) opportunities for compatible wildlife-dependent recreational uses of the refuge; and

(3) the Director of the United Fish and Wildlife Service, in consultation with the United States Geological Survey, should conduct an assessment of the potential impacts of global warming and sea-level rise on coastal national wildlife refuges.

To assist the FWS in the identification of issues to address in the CCP, we have the following comments on how Pacific upwellings are impacted by warming oceans and changing winds, and the effects of global climate change on plankton, fish (rockfish and salmon), sea birds (tufted puffins, auklets and murres), and marine mammals (Steller sea lions, harbor seals, elephant seals, and gray whales). We also include recommendations for management of the refuge based on these findings.

I. The CCP should incorporate information on how Pacific Ocean upwellings are affected by changes in temperature and wind pattern

Rising ocean temperatures off the coast of California have suppressed the upwelling of cold, nutrient-rich, plankton-sustaining waters and altered the food available to fish and birds. Some prey species have declined in number. Others have moved north to cooler, more productive waters and have been replaced by species from the south. Ocean climate shifts have been correlated with North Pacific Ocean ecosystem changes in recent decades (Trites et al 2006).

The Pacific Ocean follows strong and important seasonal changes. The mean sea surface temperature (SST) off the coast of Oregon is approximately 14 degrees Celsius in the summer. During the spring and summer, coastal currents and a southward flow of water develop as northern surface winds blow south along the coast. Upwelling occurs when these currents and upper surface waters bring deep cold ocean water to the surface (Huyer 2001, Lubomudrov 1997). As a result, SST decreases to approximately 9 degrees Celsius in the winter (Oregon Coastal Atlas 2000). During the fall and winter, southwest winds move surface waters towards the north and shore, downwelling occurs, and the water warms once again (Huyer 2001).

El Niños create large interannual variability and can provide insight into how future climate change could affect Pacific Ocean ecosystems. The El Niño Southern Oscillation (ENSO), occurring every 2-7 years, and the positive phase of the Pacific Decadal Oscillation (PDO), which alternates with the negative phase every 20-30 years, are associated with warm, nutrient- poor Pacific waters (Gjerdrum 2003). The strongest El Niños of the century took place in 1982-1983 and 1997-1998. In 1982-1983, the warmth continued long after the tropical signal passed and negatively affected Pacific marine ecosystems. Oregon coastal waters were significantly warmer between July 1997 and September 1998 than 1961-1971 averages (Huyer 2001).

Large SST changes off the Western United States have occurred during the past 80 years and the frequency of warm events has increased since 1977 (McGowan 1998). Increased SST reduces the upper water layer's density, raises the amount of work required to elevate deep isopycnals (a surface of constant water density), decreases the depths from which water is mixed, stirred, or upwelled, and delays the delivery of nutrients to the surface layer. As a result, ecosystems that rely on coastal upwellings suffer; plant nutrient rates, natural zooplankton, kelp, vertebrates, and possibly saline decline, and the benthic, intertidal community structure shifts (Korso et al 2006, McGowan 1998).

For the first time ever recorded, the onset of 2005 spring conditions occurred 50 days late off Newport, Oregon, leaving surface waters over the Oregon shelf warm for an extra seven weeks until mid- July. The upwelling of deep cold water occurred by May 24th, but the outer shelf gave no indication until two months later on July 13, 2005. Scientists believe this unexpected two month delay between the arrival of the late spring transition and the final surfacing of the upwelled water in mid- July could be correlated with surface wind stress and heating and should be studied further (Korso et al 2006).

More frequent Pacific El-Niño- like conditions are predicted as greenhouse gas concentrations increase in the atmosphere (Timmermann et al 1999). It is essential to understand how and why oceans change and how entire ecosystems will respond in order for the FWS to effectively prepare for climate change (Huyer 2001, McGowan 1998).

II. The CCP should incorporate information on how zooplankton are affected by changes in temperature and wind pattern

Plankton blooms when spring wind and water currents saturate the sea surface with nutrients from deep within the ocean depths. As the water moves south during upwelling, nutrients are recycled and zooplankton thrives. Zooplankton, such as euphausiids (shrimp-like krill), eat phytoplankton and form the basis of the Pacific Ocean's food web. Zooplankton biomass and the abundance of larval fish declined between 1958 and 1960 coinciding with a warming trend of the California current. In 1977 the California zooplankton population declined by greater than 70% and has never recovered, potentially due to reduced upwelling driven by warming SST (McGowan et al 1998).

Plankton abundance is determined by climate-driven variations in water transport from the north. If the water circulation is forceful, zooplankton abundance increases and if the circulation is weak, there is less zooplankton (McGowan et al 1998). An increase in SST reduces the upper water layer's density. As a result, the depths from which water is mixed, stirred, or upwelled becomes shallower and plant nutrient rates and zooplankton decline (McGowan et al 1998).

Almost all of the predicted climate change effects on the Oregon Islands can be linked back to change in cold to warm zooplankton species or a decrease in overall zooplankton in the Pacific Ocean.

III. The CCP should incorporate information on how fish are affected by changes in temperature and wind pattern

Rockfish

An absence of krill afflicts entire food chains since the prey fish that many other species rely on for survival consume zooplankton. In 1975 during a central California Current cool phase, rockfish were highly abundant, but after the 1976-1977 warm phase regime shift, rockfish declined. They continued to decline, hitting extreme lows in the 1990s. A cool regime returned in 2001 leading rockfish populations to rebound to numbers similar to those in the 1970's (Miller et al 2004). Global warming is expected to increase the frequency and severity of warm phases, negatively affecting rockfish abundance.

Salmon

The Oregon coho salmon population dropped in the 1990's and hit the extreme low of 14,000 in 1997, a 99% decline from historic levels. They started a slow recovery in 2000, and peaked in 2002 with an estimated 200,000 individuals. Despite the 2002 increase, coho salmon have been on the decline again since 2003 and federal scientists predict that they will continue this path. The recent removal of Oregon coho salmon's federal endangered species protection by the National Marine Fisheries Service could further their decline (Earth Share of Oregon 2006).

According to a variety of studies, changes in climate and ocean conditions, especially during the first year of life, play a critical role in the survival and abundance of salmon. A 2003 study reports that Oregon coho salmon had a higher marine survival rate when SST was cooler the winter prior to smolt or during the winter following smolt migration, possibly because of either improved feeding conditions or reduced predation (Logerwell et al 2003). One can extrapolate that warmer temperatures could correspond with lower coho survival. In addition, a later transition between winter downwelling and spring upwelling led to poor coho survival, while lower spring SST increased coho survival because nutrients were easily transported from below the surface (Logerwell et al 2003).

In 1982-1983, one of the most dramatic El Niño years, the average weight of Coho salmon in Oregon fisheries was the lowest on record (McGowan 1998). Between 1992 and 1998, low coho survival was associated with warm coastal SST (Logerwell et al 2003). Logerwell et al hypothesized that their prediction for 1999 salmon numbers was higher than the actual observed amount because subarctic zooplankton was unable to rebound from the low abundances that previously occurred in warmer El Niño years. Although lower than predicted, the situation reversed itself in 1999, supplying more evidence that temperatures can severely influence Oregon coho salmon survival (Logerwell et al 2003). When the Pacific Ocean temperatures decreased in 1999, zooplankton species changed and baitfish (smelt, anchovy, herring and sardine) increased (Emmett et al 1999). Emmett et al (1999) proposed that baitfish abundance can positively affect salmon survival by acting as 'alternative prey' and decreasing salmon predation rates.

IV. The CCP should incorporate information on how sea birds are affected by changes in temperature and wind pattern

An estimated 1.2 million sea birds nest on the Oregon Islands, more than on the Washington and California coasts combined. Dramatic declines have been noted in pigeon guillemots, common murres, and two species of cormorants. These seabirds share the same primary food source- the declining, nonmigratory rockfish.

Common Murres

Approximately 700,000 common murres nest on the Oregon Islands, nearly two-thirds of the total nesting population south of Alaska. Last year a radically different weather pattern during the breeding season resulted in the largest ever die-off of the common murre, the refuge's most populous seabird resident.

Although the principal prey item of the common murre is juvenile rockfish and their diet patterns correlate with rockfish abundance, studies show that adult common murres will switch from one prey to another depending on availability (Ainley et al 1996). One study suggests that murres rely on euphausiids during the pre-breeding period and then switch to juvenile rock fish later in the year when the fish reach sufficient size (Ainley et al 1996). Both rockfish and euphausiids may both suffer declines as SST rises, but adult murres may be able to adapt to changes in prey availability. For example, the use of rockfish by adult murres dramatically declined after 1989. In the 1980s' after the 1967-1977 PDO warm shift, rockfish numbers decreased, murre foraging habitat moved towards the coast, and anchovies became a more common food. The use of rockfish then rebounded in 2001, a few years after the cool regime, with 2002 numbers close to those during the cool 1970s (Ainley et al 1996, Miller et al 2004). Close correlations between the birds' use of rockfish and El Niño, La Niña, and intra-decadal climate patterns (such as PDO) make climate "a compelling explanation" to the observed variability in prey (Miller et al 2004).

Murre chicks may not adapt as well to changes in prey availability. Unlike adults' diverse diets, nestling murres must be fed prey that is less than 40mm (Manuwal et al 2002). If euphausiids and juvenile fish decrease, parents may not find adequate food for their young.

Although common murres prey upon euphausiids and juvenile rockfish, both not fished by humans, possible commercial future exploitation of adult rockfish and their alternate prey, herring and anchovies, could be detrimental for murres (Ainley et al 1996).

Cassin's Auklet

Although studies of Cassin's auklets have not been completed on the Oregon Islands, many have been carried out on California's Farallon Islands. This population of auklets is unlikely to adapt to a sudden loss of its main food source, krill, and has dropped 75 percent. In fact, 2006 is the second year in a row that almost none of the 20,000 nesting pairs raised a healthy chick. Researchers on the Farallon Islands agree that the decline of krill and Cassin's auklets corresponds with a 3-5 degree increase in California ocean temperatures (Wohlsen 2006).

A study on the Southeast Farallon Island concluded that upwelling and SST play a part in the availability of krill during the auklet chick- rearing time period. Auklets in the study were able to adapt to changing ocean conditions and prey availability by modifying their time of breeding, but when ocean conditions worsened subsequent to breeding, auklets could not adapt, and nestling growth and productivity deteriorated (Abraham et al 2004).

If Cassin's auklets responded negatively on the Farallon Islands to climate- driven prey variability, they are likely to respond the same way on the Oregon Islands.

Tufted Puffins

A study conducted on Triangle Island, a small Pacific island north of Vancouver Island, British Columbia, suggests that warm SST corresponded with earlier tufted puffin breeding, advanced hatching dates, and decreased fledgling success and growth rates (Gjerdrum et al 2003). When average breeding- season SST exceeded 9.9 degrees Celsius, puffin fledgling growth rates dropped to virtually zero, implying that fledglings are particularly sensitive to higher SST (Gjerdrum et al 2003). Changes in SST likely caused prey species to become poorly distributed and harder to find as they escaped the warmth and emigrated to deeper water (Gjerdrum et al 2003).

Gjerdrum et al (2003) expect climate changes to cause dramatic effects on Pacific marine life, making Triangle Island, in particular, an unsuitable breeding ground. Since tufted puffins are a long-lived species that are not likely to show population declines until it is too late, it is especially important to start research now to see if the Oregon Island populations will be impacted like the ones on Triangle Island. Gjerdrum et al (2003) recommend more research to better-test the hypothesis that puffins will not switch to a new prey species if primary prey disappear.

V. The CCP should incorporate information on how marine mammals are affected by changes in temperature and wind pattern

Steller Sea Lions

An estimated 800 threatened Steller sea lion pups are born on the Oregon Islands NWR each year, more than on any other site south of Alaska.

Steller sea lions are split into two categories: The Western Stock (includes Western Gulf of Alaska and Aleutian Islands) and the Eastern Stock (includes Eastern Gulf of Alaska and Western US). The western population declined by more than 80% between the 1970s and early 1990s, but may be stabilizing. Following a decrease in levels early this century, the Eastern population seems to be recovering (NSF 2005).

One hypothesis for the western stock's decline is that their diets shifted to lower quality food as the result of cool to warm Northern Pacific Ocean climate change (Fritz et al 2005). This change in water temperature and currents influenced Steller sea lions' quality prey species' numbers and abundance; less nutritious prey became more abundant and more nutritious prey became less abundant. Steller sea lions accommodated these changes by shifting to a less nutritious diet and scientists contribute nutritional stress to their decline (Fritz 2005). Decreased nutrition leads to less healthy individuals, which can lead to decreased birth and increased death rates (NSF 2005). Compared to adults, juveniles are especially susceptible to less nutritious food since they have higher metabolic rates compared to the size of their stomachs and may not be able to consume the necessary amount of food (NSF 2005).

While a dietary shift to less nutritious food can not solely be blamed for the drastic declines in western Steller sea lions, scientists have noted that western climate- induced ocean changes occurred simultaneously with pronounced sea lion declines. Similarly, the greatest abundance of Steller sea lions occurred during the Little Ice Age, while the end of the Little Ice Age coincides with a population reduction (NSF 2005). It is important to recognize that cooler temperatures favor Steller sea lions while warmer temperatures do not.

Additional research is required where the Eastern Steller sea lions forage since it is likely that the Eastern population will react the same way to changes in ocean temperatures and currents.

Harbor Seals

Harbor seals have been thriving in Oregon since the passing of the Marine Mammal Protection Act in the 1970's and The National Marine Fisheries Service report that their populations are increasing at a rate of about 7% per year since then. There are approximately 10,000 harbor seals off the coast of Oregon, making them the most abundant pinniped found in Oregon's coastal and marine waters (Brown et al 2005).

Scientists hypothesize that the Farallon Islands in California experienced an increased harbor seal population during El Niño because warmer temperatures forced the seals to leave traditional areas of shallower waters in search of food in cooler, deeper water (Sydeman et al 1999). Additionally, Brown et al (1983) noted that harbor seals in Oregon moved from coastal to more estuarine regions in search of food during poor foraging conditions. These examples illustrate that population count numbers need to be scrutinized so differences in immigration numbers and internal population additions can be looked at separately (Sydeman et al 1999).

Unlike many of the other species discussed, harbor seals may not suffer extreme population losses due to climate change because they are opportunistic feeders, seem to migrate towards cooler locations, and will prey on a variety of benthic and epibenthic fish, including anchovy, smelt, herring, flatfish, cottids, gadids, sculpins, rockfish, sand lance, salmonids, and cephalopods (NMFS 1997).

Elephant Seals

In 1993, Northern elephant seals started giving birth at Shell Island, Cape Arago, Oregon Islands NWR, the world's northernmost Northern elephant seal pupping site and the only place in Oregon that elephant seals regularly visit. Surprisingly, Shell Island, which often floods during storms, is not an ideal pupping site since pup survival is primarily dependent on the weather (Hodder 1998). Unfortunately, elephant seals may be relying on areas such as Cape Arago as they continue to migrate to the cooler north.

Quality breeding habitat may already be limiting the Northern elephant seal breeding population on South Farallon Islands' Sand Flat Beach. The 1983 El Niño storms washed away a majority of the sand and there have been substantial declines in breeding females at that location ever since (Sydeman et al 1999). If increased storms caused elephant seal problems in California, there is reason to believe that climate change could also cause many Oregon Island pups to perish, especially since Shell Island has a tendency to flood.

Elephant seals are negatively affected by decreases in nutritious prey as well (McMahon 2005). One study suggests that elephant seal pup weaning masses are important to their survival (McMahon 2005). If krill numbers continue to decline, nursing elephant seal females will not be able to access appropriate foods and the pups may fall victim.

Gray Whales

Visitors come to the Oregon Islands every year to witness gray whales' annual migrations. Gray whale populations, nearly extinct in the 1850's, seem to be flourishing; calves migrating along the West Coast increased by 8% since 2005 (Latifi 2006). Gray whales access their Arctic benthic food during periods when ice is less abundant and less likely to block nutritious food. It is especially important that pregnant adult females fatten up on small crustaceans and other small animals in the ocean's sediment prior to migration since they eat little during their migrations south. One study found that years with low calf production were associated with Arctic feeding seasons that were shortened due to extensive seasonal ice and suboptimal available nutrition (Perryman et al 2002). On the surface, it seems that less Arctic ice could lead to more accessible food and increased gray whale reproduction and survival.

Although warm- cold Arctic cycles are normal and do not necessarily reflect global warming, Wayne Perryman, A NOAA biologist, reports that gray whales are presently feeding further north than they were in the 1980s due to warmer Arctic temperatures and less overall ice (Rodgers 2006). Despite the fact that plankton-eating gray whale populations are increasing, global warming and diminished ocean upwellings could eventually decrease nutritious plankton and impair the whales' chances of survival (Dedina 2000).

VI. Recommendations

Defenders urges the FWS to include the above information in the description of the refuge's resources and resource challenges within the CCP and in the "affected environment" section of the accompanying environmental impact statement. In addition, we have the following recommendations to be included in the CCP.

<u>The refuge should conduct research and monitoring and encourage partners (universities, other government agencies) to conduct research on the ongoing and emerging ecosystem changes wrought by global warming</u>.

Though there is overwhelming scientific consensus that the earth is warming and that the primary cause of this warming is human-caused increases in greenhouse gas emissions, much less is understood about the complex effects global warming will have on ecosystems and wildlife. We believe the National Wildlife Refuge System, and Oregon Islands NWR in particular, should develop a comprehensive research and monitoring program to function as an early warning system for climate-induced changes. As the steward of the majority of coastal rocks and islands along the Pacific Coast of the United States, the FWS has a unique role and opportunity to integrate research and monitoring throughout the Pacific coastal ecosystem, with a particular focus on nesting sea birds and marine mammals. Change detected at Oregon Islands NWR may not be enough to inform management decisions. A comprehensive program throughout refuges along the Pacific coast will be able to discern population level changes in abundance or distribution. The FWS should work closely with other owners and managers of coastal habitat on the Pacific, particularly the National Park

Service and the Bureau of Land Management. This will help fulfill the FWS requirement "to monitor the status and trends of fish, wildlife, and plants in each refuge" (16 U.S.C. §668dd).

The refuge should develop management actions to cope with climate-driven change.

Through the planning process, the FWS is required to identify and describe:

- Significant problems that may adversely affect the ecological integrity or wilderness characteristics and the actions necessary to correct or mitigate the problems; and
- Significant problems that may adversely affect the populations and habitats of fish, wildlife, and plants (including candidate, threatened, and endangered species) and the actions necessary to correct or mitigate the problems.

(602 FW 3, *Service Manual*). We hope this letter helps the FWS identify the significant problems affecting the refuge as a result of global warming. These problems are extremely complex, and involve interactions throughout the refuge ecosystem and food chain. Understanding climate-driven changes in real-time will be essential to allow the FWS to adapt management strategies to conserve the wildlife resources the refuge was established to protect. The FWS should incorporate adaptive management strategies based on research and monitoring into the CCP that will help alleviate the effects of global warming.

The refuge should include information about the effects of global warming on the refuge ecosystem in its environmental education and interpretation programs.

Tens of thousands of visitors enjoy wildlife watching, environmental education and interpretation at the Oregon Islands NWR. Environmental education and interpretation are priority public uses of the refuge system and when compatible, support the refuge system's mission by building public understanding and support for wildlife conservation. According to the FWS General Guidelines for Wildlife Dependent Recdreation (605 FW 1, *Service Manual*), recreational uses should provide "an opportunity to make visitors aware of resource issues, management plans, and how the refuge contributes to the Refuge System and Service mission." As described above, global warming is one of the largest resource issues facing the refuge. It is incumbent upon the FWS to ensure the public is informed about the climate-driven changes occurring to the wildlife they have come to enjoy and learn about at Oregon Islands NWR. The FWS should develop brochures, interpretive panels, websites, and education and interpretation programs that include the vulnerabilities of the refuge's resources to climate change.

We hope our comments have been helpful in the development of the Oregon Island NWR CCP and we look forward to participating in the planning process.

Sincerely,

Noah Matson

Noah Matson
Director, Federal Lands Program

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