Recommendations of the

# Climate Change Working Group

*The over 500 year old, native Hawaiian fishpond, Ko'ie'ie in Maui may be subject to future impacts from climate change such as rising sea levels and increased storm events.*



For the
Sanctuary Advisory Council

Hawaiian Islands Humpback Whale
National Marine Sanctuary

## Need for Action:

Global climate change is believed to affect ocean and atmospheric temperatures, sea water chemistry, and ocean circulation patterns, which in turn, may pose significant threats to marine ecosystems, such as ocean acidification, coral bleaching, invasive species, sea level rise, and extreme weather events. Climate change, as it relates to the Hawaiian Islands Humpback Whale National Marine Sanctuary Management Plan Review, involves three major issues:

1) Potential direct, indirect, and cumulative impacts to humpback whales and their habitat;
2) Broader marine ecosystem impacts within the Hawaiian Archipelago; and
3) "Green" Sanctuary operations.

## Desired Outcome:

As impacts from climate change increase it is important that the Hawaiian Islands Humpback Whale National Marine Sanctuary is prepared to understand and address those issues that have the potential to impact natural and cultural resources under its management purview.

For instance, the impacts of climate change to humpback whales are largely unknown, but could potentially affect aspects of their migration, such as distance and timing. Humpback whale exposure to new diseases is also a possibility, although these would be most likely to manifest in the feeding grounds (IWC 2007). While humpback whales are believed to not feed while in Hawaiian waters, as a primary breeding ground, regular social interactions in Hawaiian waters could increase transmission of disease (Hawaiian Islands Humpback Whale National Marine Sanctuary Condition Report 2010).

Climate change impacts to the marine ecosystem in the Hawaiian Archipelago are also important to understand in order to minimize the impacts to native marine species and habitats, but also to understand the resulting impacts to humans and to mitigate those impacts if possible.

The sanctuary is also looking to minimize its carbon footprint in its day-to-day operations including how it manages its offices and facilities, vehicles, and vessels.

## Recommendations:

In developing recommendations, the Climate Change Working Group incorporated the following overarching considerations:

- Socioeconomic Issues
- Native Hawaiian Traditional Perspectives
- Environmental Impacts
- Community Engagement

**Principle Recommendation**

1) The sanctuary should work to become Climate-Smart Sanctuaries certified which includes developing a peer reviewed Climate Change Site Scenario, a greening program, and developing a specific action plan to address climate change. The sanctuary should complete all Climate-Smart Sanctuaries certification standards with all associated requirements including:

a. A condition report
b. Prepare draft climate change site scenario
c. Implementing greening operations
d. Staff training
e. Engage sites' key stakeholders and advisory council
f. Develop climate change action plan
g. Prepare climate smart sanctuary documentation report

**Other Recommendations**

The following recommendations should be considered in the development of a Climate Change Action Plan, and are related to the three major issues identified above under the following topics:
Research and Monitoring
Education and Outreach
Sanctuary Operations
Native Hawaiian Traditional Perspectives

***Research and Monitoring***

2) The sanctuary should support and collaborate with local and regional efforts to monitor areas in the sanctuary to detect climate change impacts. Monitoring could include changes in salinity, pH, temperature, currents, sea level rise and other measurements that would be indicators of climate change.

3) The sanctuary should become part of the Sentinel Site System to monitor biological resources and the marine environment for ecosystem impacts and changes or large-scale trends, including those from climate change.

4) The sanctuary should support and collaborate with local and regional efforts to monitor humpback whales and other potentially vulnerable species for climate change impacts.

5) The sanctuary should collaborate with local and regional efforts to identify strategies to promote or maximize resiliency of coastal and marine resources.

***Education and Outreach***

6) As part of its Ocean Literacy initiatives, the sanctuary should conduct public education and outreach about potential impacts from climate change to the sanctuary and its resources, community and management response, and examples of how the sanctuary is addressing these issues in its programs and policies.

7) The sanctuary should develop education and outreach programs regarding climate change and sea level rise that includes impacts to the Native Hawaiian community.

***Sanctuary Operations***

8) The sanctuary should develop a greening program where the sanctuary operations and programs are efficiently using energy resources and working to minimize its impacts on the environment.

***Native Hawaiian Traditional Perspectives***

9) The sanctuary should work with Native Hawaiian communities to identify, monitor, and potentially mitigate impacts to low-lying and coastal resources, such as fishponds, lo`i, native plants, aquatic medicinal plants, and other natural and cultural resources.

## Process or Methodology:

The Climate Change Working Group (CCWG) was established by the Sanctuary Advisory Council for the Hawaiian Islands Humpback Whale National Marine Sanctuary during its December 15, 2010 meeting, for the purpose of developing recommendations to the Sanctuary Advisory Council (SAC) on actions that the sanctuary could incorporate into its management plan review process regarding climate change issues and impacts to sanctuary resources.

The Climate Change Working Group met eight times, mostly through Go-to-Meeting in addition to in-person meetings, to consider the issues and develop their recommendations. This included reviewing public comments received during the scoping period related to climate change. Additional information was provided to the working group through technical experts who presented information or provided answers to specific questions. The working group utilized this information to form the basis of their recommendations.

**Appendices:** **A) Contributing Members**
**B) Contributing Technical Experts**
**C) Background Information**
**D) References**

## A) Members:

Working Group Chair: Eric Kingma, Western Pacific Fishery Management Council SAC representative
Working Group Vice-chair: Marnie Meyer, State of Hawaii Office of Planning SAC representative
Bill Friedl, Former SAC Chair
Elizabeth Kumabe, UH Sea Grant College Program, SAC representative
Gordon LaBedz, Conservation SAC representative - alternate (Surfrider)
Keeaumoku Kapu, Kuleana Kuikahi
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Staff Lead: Paul Wong

## B) Contributing Technical Experts:

Charles Young, NOAA Pacific Islands Fisheries Science Center, Coral Reef Ecosystem Division
Dolan Eversole, UH Sea Grant College Program, Coastal Storms Program
Elizabeth Moore, NOAA Office of National Marine Sanctuaries
Dr. Jeff Polovina, NOAA Pacific Islands Fisheries Science Center, Oceanography Division
Trisha Kehaulani Watson, Chair of SAC Native Hawaiian Working Group

## C) Sources of Information—Summary of Background Documents:

Global Climate Change

According to Doney et al. (in press), humans influence climate primarily through fossil fuel, industrial, agricultural, and other land-use emissions that alter atmospheric composition. Long-lived, heat-trapping greenhouse gases (CO2, CH4, N2O, tropospheric ozone, and chlorofluorocarbons) warm the planet's surface globally, whereas shorter-lived aerosols can either warm or cool regionally. Through a series of positive feedback loops such as increased water vapor, atmospheric warming is also amplified. Best estimates of projected global mean surface temperature increase over the twenty-first-century range from approximately 1.8°C to 4.0°C, depending on emission scenario (Solomon et al. 2007). Fossil-fuel CO2 emissions for the past decade have been at the high-end of

Intergovernmental Panel on Climate Change (IPCC) scenarios, and attributed to rapid economic growth in developing countries (Le Quéré et al. 2009). Moreover, the climate system exhibits considerable inertia, and temperatures will likely continue to increase decades to centuries after greenhouse gas levels stabilize.

Climate and CO2 changes influence many levels of ocean biological organization and function. Direct temperature and chemical effects alter organism physiology and behavior, leading to population-level impacts such as poleward shifts in spatial ranges as well as changes in population size, population growth rates, and seasonal variation (Doney et al. in press).

Community-level impacts of climate change stem from altered physiology that translates to changing interactions among species such as competition, grazing, predation, and disease dynamics. Together with local climate-driven invasion and extinction, these processes result in altered community structure and diversity, including emergence of novel ecosystems (Doney et al. in press).

No ecosystem is unaffected by the diverse effects of rising CO2 levels. The effects of climate change are particularly striking for the poles and the tropics, because of the sensitivity of polar ecosystems to sea-ice retreat and poleward species migration as well as the sensitivity of coral-algal symbiosis to minor increases in temperature. Ocean acidification may hasten the decline of tropical coral ecosystems (Doney et al. in press).

The following provides information on potential impacts to coastal and marine resources in the Hawaii Archipelago from climate change.

Humpback Whales

*Habitat availability*
Humpback whale migration, feeding, resting, and calving site selection may be influenced by factors such as ocean currents and water temperature. Any changes in these factors could affect humpback whale population recovery by rendering currently used habitat areas unsuitable or undesirable (Hawaiian Islands Humpback Whale National Marine Sanctuary Condition Report 2010).

*Food availability*
Changes to climate and oceanographic processes may also lead to decreased productivity and different patterns of prey distribution and availability. Such changes would certainly affect the feeding grounds of dependent predators such as humpback whales. While humpback whales do not feed in Hawaiian waters, preliminary evidence suggests that some baleen whales may migrate further poleward in order to find the food resources they require. This could result in either longer migrations, with subsequent energetic and timing consequences, or a shift in breeding grounds to shorten the transit (Simmonds 2009).

*Increasing diseases*
Changes in climate could potentially expose humpback whales to new or resurging diseases, although these would be most likely to manifest in the feeding grounds. Currently, most of the concern about emerging or resurging cetacean diseases associated with climate change has focused on their feeding grounds, as some scientists around the world have indeed noticed increases in diseases in those habitats that may be associated with climate change (IWC 2007). While humpback whales fast during their season in Hawaiian waters, as a breeding ground, this is where any increase in sexually transmitted diseases could manifest themselves (Hawaiian Islands Humpback Whale National Marine Sanctuary Condition Report 2010).

<u>Coral Reefs</u>

*Coral bleaching*
Sea surface temperatures in Hawaii have been steadily rising over the past several decades (Vecchi & Soden 2007; Jokiel & Brown 2004). Some low-resolution models have predicted temperature to rise in the summer months by at least 1˚C by the year 2100 (Vecchi & Soden 2007). Other low-resolution models have predicted no change in maximum sea surface temperature outside of the present rage 24-29 ˚C (Guinotte et al. 2003). Several periods of anomalously high temperature have been found to induce coral bleaching in Hawaii (Jokiel and Coles 1990).

*Ocean acidification*
Calcifying organisms in Hawaiian waters are susceptible to the impacts of ocean acidification. Low-resolution modeling has predicted the aragonite saturation state in the Hawaiian Islands to decrease to marginal levels between 2040-2049 and remain until 2069 (Guinotte et al. 2003), which may slow the rate of calcification.

Several studies have simulated future $CO_2$ levels and tested the impacts on Hawaiian marine organisms. At levels of $CO_2$ projected to occur within the 21$^{st}$ century, acidified seawater was found to decrease the coral calcification rate and linear extension rate of the coral *Montipora capitata*, but was not found to affect the quantity of gametes produced or spawned (Jokiel et al. 2008). Coral larvae were found able to recruit, though the effect on the settlement rate was unable to be tested. Additionally, encrusting crustose coralline algal (CCA) percent cover and growth was found to decrease with an increase in fleshy algal percent cover (Kuffner et al. 2008). Rhodoliths (CCA) were found to dissolve under these acidic conditions. Crustose coralline algae and coral form the structural basis and cohesion for carbonate reefs and a loss in growth and decrease in mass can drastically change the dynamics of a coral reef ecosystem.

Fisheries

Climate induced changes in fish prey may alter tuna migration patterns from the Western Pacific to the Eastern Pacific (Polovina 1996). The seasonal north-south movements of many large pelagics appear to track the similar peak migration of primary productivity. Using remotely-sensed chlorophyll[1] concentrations from satellite observations, Polovina et al. (2008) found that over the past decade, primary productivity in the North Pacific Subtropical Transition Zone has declined an average of 1.5% per year, and a 3% per year decline occurring at the southern limit of the transition zone. The expansion of the low chlorophyll waters is consistent with global warming scenarios based on increased vertical temperature stratification of the world's oceans in the mid-latitudes. Expanding oligotrophic[2] portions of large subtropical gyres, will in time lead to a reduction in chlorophyll density and carrying capacity in these oceanic features, which will impact the abundance of pelagic fish species.

Beaches and Nearshore Areas

*Sea Level Rise*
Global sea level is predicted to rise by 2.5 – 6.2 ft by the year 2100 (Vermeer & Rahmstorf 2009). Sea level rise can induce coastal erosion, which can decrease the quality of coastal resources and impact water quality in nearshore areas.

*Precipitation*
Precipitation in Hawaii is predicted to decrease by 5-10% in the wet season and increase by 5% in the dry season (Timm & Diaz 2009). A change in precipitation could affect brackish water habitats in coastal wetlands.

## D) Sources of Information--References:

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[1] Chlorophyll is the green pigment found in phytoplankton that absorbs light energy to initiate the process of photosynthesis.
[2] Meaning waters where relatively little plant life or nutrients occur, but are rich in dissolved oxygen.

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