

## **Environmental Indicators for Hawai'i**

This section of the report provides an overview of broad-based environmental indicators for Hawai'i. The following section helps to inform Hau'oli Mau Loa Foundation about common metrics to track environmental health over time.

Environmental indicators can be used to explain complicated conditions or processes with a single, or less complicated, measure. The usefulness of indicators is manifold; the ability to represent complexities with a single, straightforward measure allows for an enormous degree of simplification, both in measurement and understanding. As such, indicators sometimes fail to accurately describe complex phenomena (Dale and Beyeler, 2003). It is important to recognize then that the usefulness of indicators is limited to whether they validly represent the environmental state or change in which they are purposed. If so, then they serve as a tool for understanding the current state of the environment and inferring trends over time.

### ***Environmental Pressure***

Measures of population and resource consumption provide overarching indicators of environmental pressure. That is, the degree to which human beings are over-stepping the natural carrying capacity of the planet. In a sense, these indicators of environmental pressure provide signs for the broader condition of the environment.

### ***Population***

Population is perhaps the quintessential indication of human pressure on the environment. Even if per-capita pressure on the environment is reduced through social and technological means, the overall health of the planet continues to decline as population increases. According to a recent report entitled "Indicators of Environmental Health," the population of Hawai'i has grown from 1.1 million in 1995 to 1.3 million in 2009 and is expected to reach 1.72 million by 2020 (Hawaii Department of Health, 2010).

### ***Waste***

The average person in Hawai'i produces about twice the waste per resident than on the continental U.S.—9.2 pounds per person per day in 2008 compared with a national average of 4.5 pounds per person per day (Hawaii Department of Health, 2010). Hawai'i's waste profile is likely substantially higher than the U.S. average because of the production of waste by tourists. Nonetheless, the numbers show that Hawai'i residents and visitors produce a comparatively large amount of waste.

## ***Water***

The use of fresh water is an important indicator of the health of the state's fresh water supply. The yearly volume of fresh water in Hawai'i for public consumption is primarily used by the county of Honolulu, about 66% of the yearly total of 80,247 million gallons for 2008 (Hawai'i Department of Business, Economic Development and Tourism, 2009). This number has consistently risen through the years. Keeping the state's water usage consistent, or perhaps decreasing it, will be important considering the threats to fresh water that climate change presents.

## ***Energy***

Another measure of environmental pressure exerted by the population is energy use. Nearly 90% of the state's energy is derived from the combustion of petroleum. The release of greenhouse gas emissions is a critical environmental concern, especially considering the predicted impacts of global climate change. For this reason, understanding how Hawai'i contributes to the problem, as well as assessing areas where progress has and can be made is important. Emissions have risen by about 5% from 1990 to 2005, or by 1.14 million metric tons in CO2 equivalent (Hawai'i Department of Health, 2010).

### **A. Status of the Terrestrial Environment**

There are a number of indicators that can be used to judge the condition of the terrestrial environment. A natural separation occurs in measuring and reporting indicators between the health of the land itself and the health of the species that occupy it (although clearly intrinsically linked).

## ***Land Use and Agriculture***

The classification of land throughout Hawai'i, and accordingly its use, is an important measure of the health of the land. The statewide zoning system classifies land as urban, rural, agricultural, or conservation with allowable uses dictated by these labels (Hawai'i Land Use Commission, 2010). Substantial changes have occurred in the designation of land throughout the state over time. Between 1969 and 2006, Hawai'i lost 35,456 acres of conservation lands and 25,651 acres of agricultural lands, while gaining 57,500 acres of urban area and 4,495 acres of rural area during the same period (Hawaii Department of Business, Economic Development and Tourism, 2009).

## ***Land-Based Pollutants***

The number of chemical and oil spills in the state is another indicator of terrestrial ecosystem health. Representing not only a direct indication of harmful inputs, but to a certain extent care for and concern over the environment, this measure is important because it directly affects the plants and animals that occupy the terrestrial environment. Accordingly, in 2009, there were fifty-six and sixty-two terrestrial oil and chemical spills respectively (Hawaii Department of Health, 2010).

## ***Native Flora & Fauna***

Considering the unique Hawaiian habitat, that status of the over 21,000 different species, almost 9,000 of which are endemic, that inhabit the environment is an important indicator of the overall system (Eldridge and Miller, 1994). Hawai'i has the greatest number of threatened or endangered species in the United States. According to recent figures, there are a total of 333 species in Hawai'i listed as threatened or endangered (U.S. Fish and Wildlife Service, 2010). While Hawai'i is considered a haven for biodiversity, it is also a haven of endangered species.

## ***Streams and Watersheds***

The condition of the state's watersheds is another important indicator of overall environmental quality. Data from 2006 on the number of impaired streams in Hawai'i serve as a source for indications of the health of the fresh water ecosystems throughout the state. Statewide, 19% of streams (70 of 376) were considered impaired in 2004 and 25% (93 of 376) impaired in 2006 (Hawaii Department of Health, 2010). Unfortunately, all Hawaiian Islands saw an increase in the number of impaired streams between 2004 and 2006.

## **B. Status of the Marine Environment**

As an integral part of the broader Hawaiian environment, the marine ecosystem is critically important to the state. Importantly, the activities on land directly impact the near-shore marine environment. Like the terrestrial environment, the marine system can be discussed in terms of the water itself and the life that inhabits it, though they are intricately linked.

## ***Beaches and Coastal Waters***

Skirting the boundary between the terrestrial and marine environments are the state's beaches. The health of the state's beaches is most at risk from poor sewage management. There were a total of 310 beach days posted in 2009, essentially warnings about the potential health effects of using the area, all of which were attributable to sewage events (Hawaii Department of Health, 2010). In 2006, approximately 40% of the coastal waters in Hawai'i were at some point considered impaired, based on measurements of pollutants that exceed the standards set by the Clean Water Act for each intended use (Hawaii Department of Health, 2010).

## ***Coral Reefs***

The status of the state's coral reefs is a very important measure of near-shore marine health because of the connections between the reefs and the rest of the marine ecosystem. Bleaching events in Hawai'i in 1996 and 2002 wreaked havoc on the marine ecosystems of the main and Northwest Hawaiian Islands, respectively (Hawaii Coral Reef Assessment and Monitoring Program, 2008).

## ***Marine Pollutants***

Chemical and oil spills occurring within the marine environment of Hawai'i are critical given the process of bio-accumulation that occurs within these ecosystems. This is a critical issue given the fishing industry in the state, both for local consumption and export. Though progress was made in the realm of oil spills, there was an increase in chemical spills between 2008 and 2009.

## ***Invasive Species***

The number of invasive species inhabiting the marine ecosystem is an excellent indicator of the overall quality of the environment. Just as invasive species are a significant problem for the terrestrial environment, the same can be said for the marine environment. According to one source, in 1999 there were a total of 23,150 different marine species, 5,047 of which are not indigenous to the state (Bishop Museum, 2002). This means that approximately 20% of the marine species in Hawai'i are non-native.

## ***Fisheries and No-Take Zones***

Fishery yields can indicate the health of the marine ecosystem in two different ways. First, the level of the yield represents the available quantity of fish. Conversely, it represents the level of pressure being exerted by the fishing industry (often given by an indicator of “effort” or number of vessels). According to the *Hawai'i Data Book*, “Forestry, Fisheries and Mining” section, there have been significant increases in fishery yields over the past years (Hawaii Department of Business, Economic Development and Tourism, 2009).

The number of Marine Protected Areas, or more accurately Marine Life Conservation Districts (MLCD's) in Hawai'i, is an excellent indicator of the level of marine conservation and protection occurring by the government. Currently, there are thirteen different MLCD Systems in operation throughout Hawai'i (Hawaii Division of Aquatic Resources, 2010).

## **C. Climate Change Indicators**

There are a number of indicators that serve as evidence for climate change. These figures generally serve as either measurements of the causes or of the effects of the phenomenon, providing evidence for its current state and predictions of its future level or extent. Those indicators that represent drivers of climate change have already been mentioned earlier, in relation to environmental pressures, and will not be addressed again here.

### ***Temperature and Greenhouse Gas Emissions***

Using temperature as an indicator for the effects of climate change is far and away the most direct measure. Tracking changes in average global temperature as well as local temperatures allows for both generalized and specific discussion of climate change. According to the IPCC (2007, p. 5), as of 2007, eleven of the last twelve years (1995-2006) ranked as the hottest in modern measurement.

Carbon Dioxide (CO<sub>2</sub>) levels are also an important indicator for climate change, given its role in driving the change itself. There is strong evidence that CO<sub>2</sub> levels are rapidly increasing, from pre-industrial levels of 280 parts per million (ppm) to 379 ppm in 2005 (IPCC, 2007). Additional evidence indicates that CO<sub>2</sub> accumulation is occurring at increasing rates.

### ***Sea Level Rise***

Sea level rise also serves as an indicator of climate change, and though local net increases in sea level may vary from global averages, it is still an important measure of overall change.

According to the IPCC (2007), global sea level has been rising at increasing rates, about 1.8 mm per year over the last 45 years, but 3.1 mm per year over the last ten years. This is expected to accelerate, exacerbated by both increasing thermal expansion and glacier melting. Given the predictions of various sources, and taking into account the potential for uncertainty, it is not unreasonable to assume a sea level rise in Hawai'i of approximately one meter by the year 2100 (Fletcher, 2009).

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While indicators are often an imperfect measure of the state of the environment, they nonetheless provide considerable insight into both creating a baseline of environmental conditions as well as trends over time.

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