YOUTH ACTION RESEARCH IN THE MARINE ENVIRONMENT: A CASE STUDY ANALYSIS OF SELECTED EDUCATION PROJECTS IN HAWAI'I, USA

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ABSTRACT

The marine environment has always been extremely important to the human inhabitants of the Hawaiian Islands. Today, the ocean environment around Hawai'i is no less important, but it is far more threatened. Coastal and urban development, overfishing, introduction of alien species, and other commercial and recreational uses pose serious risks to coastal and marine ecosystems.

There is a recognized need for greater public awareness and understanding of the importance of marine and coastal ecosystems. Involving children actively in the care and management of community resources is an essential factor for long-term societal change in environmental attitudes and behavior. Agencies and organizations in Hawai'i offer a wide range of marine education programs and materials aimed at children. However, there has been little assessment of their overall effectiveness, or analysis of factors that encourage or impede their success. The goal of this research was to begin to address this gap.

The first stage of the research examined the perceptions and attitudes of Hawai'i resource managers and educators toward youth involvement in coastal and marine protection, and to answer the question "What is currently being done and by whom?" The second stage examined in detail three different programs that represent a range of approaches and age levels, and include two public charter schools (one

elementary and one high school) and a nonprofit after-school program that drew youth from four area high schools. The case study research was conducted over the course of the 2001-2002 school year by means of observations, participant-observations, interviews, focus groups, and reviews of written and electronic media.

The case studies were exploratory in nature and differed in their settings, age groups, administration, size, and focus. However, an analysis using the assessment rubric revealed broad patterns common to all three projects. This allowed the development of analytical generalizations that have both theoretical and practical implications for the future of similar programs, both in Hawai'i and elsewhere, and that help identify important questions for future research.

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Born was the coral polyp, born was the coral, came forth
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Born was the sea cucumber, his child the sea cucumber came forth
Born was the sea urchin, the sea urchin (tribe)
Born was the short-spiked sea urchin, came forth
Born was the smooth sea urchin, his child the long-spiked came forth
Born was the ring-shaped sea urchin, his child the thin-spiked came forth
Born was the barnacle, his child the pearl oyster came forth
Born was the mother-of-pearl, his child the oyster came forth
Born was the mussel, his child the hermit crab came forth
Born was the big limpet, his child the small limpet came forth
Born was the cowry, his child the small cowry came forth
Born was the naka shellfish, the rock oyster his child came forth
Born was the drupa shellfish, his child the bitter white shell fish came forth [. . .]

(From the prologue to the Kumulipo Hawaiian creation chant, translated by Martha Warren Beckwith, 1951.)

1.1 The Problem

The marine environment has always been extremely important to the human inhabitants of the Hawaiian Islands. The early Hawaiians depended on the bounty of the sea for most of the protein in their daily diets, and many Hawaiian chants, myths, and legends reflect this focus. Kū'ula, his wife Hina, and their son 'Ai'ai were the gods who controlled the fish in the sea and the different fishing methods throughout the islands, thereby controlling the lives of the people who depended on fishing for their daily sustenance. The fishermen believed that praying to the gods and asking for their help would ensure a good catch (Alameida 1997).

Today, the ocean environment around Hawai'i is no less important, but it is far more threatened. Coastal and urban development, overfishing, introduction of alien species, and other commercial and recreational uses pose serious risks to coastal and marine ecosystems.

We have unique opportunities and challenges for marine and coastal protection in the State of Hawai'i. Our tourism industry provides both a threat to the coastal and marine environment and an opportunity for reaching large numbers of people with important conservation messages. Our cultural diversity offers a wide range of perspectives and possible solutions to problems, but requires the ability to develop cooperation among groups that may have very different interests and outlooks. Our state-based public education system provides a venue for involving large numbers of children and teenagers in marine education and action projects, within the limits imposed by the Department of Education content and performance standards and other restrictions.

It has long been recognized that there is a need for greater awareness and understanding of the importance of our marine and coastal ecosystems among the general public. Many people feel that for long-term change in environmental attitudes and behavior, it is important to involve children and youth actively in the care and management of their community resources.

In an effort to address this need, agencies and organizations in Hawai'i have developed a wide range of education programs and materials aimed at children and youth. These include materials for classroom study, one-time field trips, ongoing student research projects, active outdoor education and adventure-type programs, and environmental monitoring programs. Little research, however, has been done to assess these programs in terms of their scientific accuracy, use of sound pedagogy, long-term sustainability, or their effectiveness at developing environmental understanding and promoting environmentally-sensitive behavior.

The goal of my research project was to begin to address this gap. The first stage of the research examined the perceptions and attitudes of Hawai'i resource managers and educators toward youth involvement in coastal and marine protection. This was accomplished through a series of semi-formal interviews with representatives from federal and state government, nongovernmental organizations, citizen groups, and the tourism industry. Since there is no central listing of all of the marine and coastal education projects in the state, this stage of the research also helped answer the question "What is currently being done and by whom?"

The second stage of the research delved a bit deeper into the issues through a detailed examination of three different programs from a single community. The case studies were chosen from programs that are perceived by the general public as being successful, or that appeared to have a good potential for success based on carefully set criteria. They represent a range of approaches and age levels, and include two public charter schools (one elementary and one high school) and a nonprofit after-school program that drew youth from four area high schools.

The case study research was conducted over the course of the 2001-2002 school year by means of observations, participant-observations, interviews, focus groups, and reviews of written and electronic media. The cases were then analyzed by comparing them to a rubric developed from a detailed review of assessment literature in the fields of science education, environmental education, action research, and community-based resource management.

Complete details of the methodology employed and specific research questions are given in Chapter 3.

1.2 Hawai'i: Coastal Environment and Issues

1.2.1 *The Physical Setting*

Extending more than 2,400 kilometers across the central Pacific Ocean, the Hawaiian archipelago straddles the tropic of Cancer and ranges from 19 to 28 degrees North latitude. The archipelago today consists of 8 main islands – Ni'ihau, Kaua'i, O'ahu, Moloka'i, Lana'i, Kaho'olawe, Maui, and Hawai'i – and 124 small islets, atolls and shoals.

The Hawaiian Islands are volcanic in origin, owing their existence to a geologic "hot spot" in the center of the Pacific Plate. It is believed that the first islands of the chain were formed about 75 to 80 million years ago. Since that time, the Pacific Plate has been moving west northwestward at a rate of about 9-cm per year. New islands are continually being created as the plate passes over the hot spot, while the older islands succumb to the forces of weathering and erosion, eventually becoming underwater seamounts and guyots. The oldest of these, the Emperor Seamounts, are located in the northern Pacific Ocean and stretch from the northwest end of Hawai'i towards Kamchatka.

The current islands get progressively younger as you move down the chain from northwest to southeast. The oldest emergent islands are the atolls of Kure and Midway, dating to about 28 million years BP, and the youngest is the big island of Hawai'i, where volcanism is still active.

1.2.2 *Coastal and Marine Ecosystems*

Because of active geologic forces such as rapid island subsidence, lava flows, and earthquakes, the youngest islands have limited structural reef complexes. Beaches tend to be limited to small pockets in protected bays and coves. Anchialine ponds and tidepools are common. The more mature islands have broad coastal plains, streams, estuaries, more extensive beaches, and well-developed reef systems. The low atolls of the Northwestern Hawaiian Islands are composed of carbonate rock on submerged basalt bases, and have shallow inner lagoons with sandy or muddy sediments, and outer rocky slopes.

Although the main islands are located within the tropics, the moderating effects of cool ocean temperatures and frequent winter storms give the region a subtropical climate. Storm waves coming from both the Arctic and Antarctic regions often batter the coastlines, causing accelerated erosion and reef damage. Due in part to these climate factors, Hawai'i has lower marine species diversity than islands in the equatorial and southern Pacific.

Biodiversity was also affected by Hawai'i's geographic isolation, which limited colonization by many existing species. However, marine organisms have been evolving in the region for the past 80 million years, when the first islands in the chain were formed. Over time, many new species have evolved to fill uncolonized niches, leading to a high rate of endemism. More than 25 percent of Hawai'i's marine organisms are thought to be endemic, the highest recorded percentage of any tropical Pacific archipelago (Maragos 1998). This includes approximately 62 percent of the blennies, 44 percent of damselfish, 40 percent of the parrotfish, 40 percent of the gobies, 25 percent of the angelfish, and 14 percent of the butterflyfish. Among invertebrates, about 25 percent of the sponges, 20 percent of the reef-building corals, and 21percent of the marine snails are considered endemic (Clark and Gulko 1999).

The principal coastal and marine ecosystems of the Hawaiian Islands are described briefly below:

Tidepools and Anchialine Ponds

Tidepools are found along the rocky shores of the younger islands and in areas where sediments are limited or lacking. At high tide, they are connected to the open ocean. Anchialine ponds can be found up to several hundred meters inland in places where porous volcanic rock allows a subterranean connection with the ocean. Salinities in anchialine ponds are similar to the open ocean, although they may have a top film of brackish water because of lower density freshwater input. Anchialine ponds were often used by the early Hawaiians to raise fish and shrimp for food.

Beaches

Most of Hawai'i's beaches are found on the older islands. There is a wide variety of sand including pink sands resulting from the breakdown of iron-rich cinder cones, green sands where olivine crystals have eroded from lava, black sands of tephra particles where lava has entered the ocean, and the classic white sand beaches composed mostly of eroded corals and coralline algae.

Many seabirds and animals such as the endangered Hawaiian monk seal *(Monachus schauinslandi)*, endangered hawksbill sea turtle *(Eretmochelys imbricata)* and threatened green sea turtle *(Chelonia mydas)* use the sand beaches for nesting and/or resting.

In areas where sediments are absent because of wave action, currents, slopes, or lack of offshore sand deposits, beaches are composed of pieces of basalt rock, cemented beach deposits, and coral rubble. A range of organisms such as algae, gastropods, and crustaceans live in this habitat.

Estuaries

Estuarine systems occur where there is a mixing of fresh and saltwater. The federal Clean Water Act defines an estuary as "all or part of the mouth of a river or stream or other body water having unimpaired natural connection with the open sea and within which seawater is measurably diluted with freshwater derived from land drainage" (Environmental Health Center 2000). Three types of estuaries are found in Hawai'i: the large embayment of Pearl Harbor on O'ahu, at the mouths of freshwater streams on the major islands, and in places where groundwater is discharged at some distance offshore. The last type is especially common on Hawai'i Island.

The lower salinities and the input of nutrients and sediments from the freshwater stimulate productivity and sometimes create marsh or mudflat habitats. These habitats are extremely important for many shorebirds including the endangered Hawaiian stilt *(Himantopus mexicanus)* and Hawaiian duck *(Anas wyvilliana)*.

The early Hawaiians often built fishponds in these embayments because the brackish conditions and continuous nutrient replenishment by the tides created an ideal environment for the raising of catadromous fish species such as the striped mullet or 'ama'ama *(Mugil cephalis)*.

Coral Reefs

Hawaiian territorial waters contain more than 80 percent of all the coral reefs currently under United States jurisdiction (Clark and Gulko

1999). These reefs can be classified as one of six types based on their location, level, and type of development: reef communities, patch reefs, fringing reefs, barrier reefs, atolls, and offshore deep reefs.

Reef communities occur in areas where wave action and storm disturbance are common, as well as around very young islands where structural reefs have not yet had time to form. They consist of a loose assemblage of unconnected coral colonies. If these colonies continue to grow and expand their territories, they may form larger areas called *pinnacle reefs*. If the pinnacle reefs grow up to the sea surface and spread out to form shallow reef flats, they are known as *patch reefs*.

Fringing reefs are the most common reef type in Hawai'i and are found close to the shores of most of the main islands to depths of about 50 meters. The longest fringing reef in the Hawaiian Islands runs for 50 km along the southern side of Moloka'i. The island of Hawai'i, because of its young age and continued subsidence, has few true fringing reefs. Along the western side of the island, however, there are a number of young reef structures, known as "apron" reefs, that will eventually mature into fringing reef.

Barrier reefs are generally formed as fringing reef continues to grow and the shoreline continues to erode or the island continues to shrink in size as it subsides. As a result, the reef is farther offshore and there is a relatively protected lagoon between the inner edge of the barrier reef and the island's shoreline. Natural passes in the reef allow water to mix, and create a variety of reef habitats. Species diversity is generally higher here than in a fringing reef. Barrier reefs are known in two places in the Hawaiian Islands - Kāne'ohe Bay on O'ahu and Mānā off northwest Kaua'i.

As a volcanic island erodes and subsides after active volcanism ends, the coral reef surrounding it may continue to grow at a rate equal to or greater than the rate of subsidence, eventually resulting in an *atoll*. An atoll consists of a ring-shaped reef and small carbonate islands surrounding a shallow lagoon. There are six true atolls in the Northwestern Hawaiian Islands – Kure, Midway, Pearl and Hermes, Lisianski, French Frigate Shoals, and Maro Reef. French Frigate Shoals in particular is extremely important for breeding populations of Hawaiian monk seal and green sea turtles, as well as for a variety of birds.

Deep reefs are found encircling all of the main islands between depths of 50 and 200 meters and also occur off submerged banks. These include Penguin Banks southwest of Moloka'i and 30 others in the Northwestern Hawaiian Islands. At these depths, little light is available for photosynthesis. Depth-adapted algae, deep-dwelling fishes, black coral, and other invertebrates are found on the deep reefs. They are also used as foraging grounds by monk seals and sea turtles.

<u>Open Ocean</u>

The open ocean around Hawai'i can be loosely divided into two principal zones – neritic and oceanic. In general, the neritic zone refers to the relatively shallow waters over the continental shelf, while the oceanic zone encompasses the open ocean beyond the shelf break. However, because Hawai'i is an island archipelago, there is no continental shelf and the neritic zone is considered to extend to depths of about 200 meters (Maragos 1998). Being close to land, the neritic zone is affected by terrestrial runoff and sewage discharge. Both zones are home to a wide array of pelagic fish and are important habitat for sea turtles, sea birds, and marine mammals such as the humpback whale and monk seal.

1.2.3 *Environmental Threats*

The unique geologic history and geographic isolation that have made Hawai'i a haven of endemism also make the islands especially vulnerable ecologically. The degradation of Hawaiian ecosystems and the loss of biodiversity began with the arrival of the first Polynesian colonists around 500 AD and the subsequent introduction of other alien species such as pigs and rats. Kirch (1982) estimates that perhaps 80 percent of all lands in Hawai'i below an elevation of 1500 feet had been extensively altered by human use by 1600 AD. Nevertheless, precontact native Hawaiians were intimately associated with their environment and completely dependent on the local ecosystems for their survival. Hawaiian resource management was based on many years of observation, trial and error, and experience handed down through the generations. Sustainable resource management practices were encoded in the cultural and religious constructs of Hawaiian society, and population growth was limited by access to resources.

The present situation is quite different. Today, Hawai'i is a rapidly expanding multicultural society with an economy that is heavily dependent on tourism and the United States military. The population and resource consumption practices of the modern Hawaiian community greatly exceed the historic carrying capacity of the islands and are almost wholly dependent on Pacific Rim imports. The classic "tourist" perception of the Hawaiian environment is based largely on introduced plant species and severely altered landscapes.

According to the U.S. Department of Commerce 2000 census, 1,211,537 people now live in the state of Hawai'i. This reflects a statewide increase of 9.3 percent since 1990, although some counties are growing at a much faster rate. The island of Maui had the most rapid growth at 27.6 percent over the 10-year period, followed by the island of Hawai'i with an increase of 23.6 percent. These numbers reflect only the resident population, and do not include the estimated six million people who visit the state every year.

Along with a growing population, there is an increased demand for housing, energy, freshwater, transportation, and general services, as well as an increased output of solid waste, sewage, and industrial waste, which puts more pressure on coastal and marine ecosystems. The major threats facing Hawai'i's coastal environment are briefly summarized below:

Coastal and Urban Development

Much coastal habitat is lost due to the construction of hotels, residences, shopping malls, and other urban amenities. Building construction and pavement of roads and parking lots leads to a reduction of permeable surface areas. This decreases the ability of the land to absorb rainfall and filter water, allowing more pollutants and sediments to enter the coastal waters. In addition, when vegetation is removed, soils are more prone to erosion and sedimentation is increased. Healthy coastal wetlands play a vital role in cleaning freshwater of pollutants and trapping sediments. Filling of these wetlands also means less habitat for juvenile fish, thereby affecting the composition of marine communities and impacting fisheries.

Streambeds are often altered or channelized during construction, allowing an increased rate of freshwater, sediment, and pollutant discharge to the marine environment. In 1965 and 1987, large areas of corals in Kāne'ohe Bay were killed due to lowered salinities caused by stream flooding during major storms (Gulko et al. 2000).

The physical coastline is altered in numerous ways, including the building and dredging of harbors, marinas, and airports, and the construction of seawalls and groins to protect private property from erosion and storm damage. According to *Hawai'i's State of the Reefs:*

1998, shoreline hardening has resulted in the loss of about 25 miles of beaches on O'ahu, 9 miles on Maui, and 3 to 5 miles on Kaua'i (Clark and Gulko 1999). The change in sand transport due to seawalls and groins can also increase sedimentation in the reef environment and locally deplete the sand habitat needed by many marine organisms.

Nonpoint Source Pollution

On a national level, according to EPA figures, between one- and two-thirds of the pollution in coastal waters comes from nonpoint sources (Environmental Health Center 2000). These sources include runoff from urban and suburban development (e.g., oil, lead, chromium, bacteria, sediments, chemicals and fertilizers), agriculture (fertilizers, pesticides, and sediments), construction and mining (sediments and toxic metals), logging and other land clearing (increased sediments), atmospheric deposition (chemicals, heavy metals, byproducts of fossil fuel consumption), ship hulls (tributyltin), and landfill leaching into groundwater and surface water. The primary sources of nonpoint source pollution in Hawai'i, as well as the United States as a whole, are urban runoff and agriculture.

Elevated nutrient levels from fertilizers can lead to algal blooms, which may deplete dissolved oxygen in the water and decrease sunlight penetration to corals and seagrasses. Insufficient oxygen in the ocean water can kill or restrict the growth of fish and other marine organisms.

Some petrochemicals from urban runoff are converted by ultraviolet radiation and salt water into chemicals toxic to plankton, fish, and coral larvae (Clark and Gulko 1999). Toxins from petrochemicals, pesticides, and heavy metals can also become concentrated in filter feeders such as clams and oysters, and top carnivores such as tuna, making them unsafe for human consumption. In 1991, oyster tissues sampled from the mouth of streams entering Kāne'ohe Bay showed high concentrations of the pesticides dieldrin and chlordane, five years after the use of these chemicals had been banned in Hawai'i (Gulko et al. 2000).

Bacteria from livestock, pets, faulty septic systems, and cesspools also pose a threat to swimmers, boaters, and other water users. The Natural Resources Defense Council reported 70 beach closings in Hawai'i in 1996 due to high pathogen levels in the water. They also noted that the state has limited monitoring of beaches for swimmer safety (Environmental Health Center 2000). Bacteria can also accumulate in the tissues of filter feeding organisms.

Improperly designed and managed construction sites, abandoned agricultural lands, and overgrazing by wild pigs, goats and sheep are also significant causes of sedimentation. In 1996, according to U.S. Fish and Wildlife figures, sediment runoff in Hawai'i was estimated at more than one million tons per year (Clark and Gulko 1999). Sediments increase the water turbidity, smothering corals and leading to decreased penetration of sunlight needed for photosynthesis. Sediment accumulation also decreases the available hard substrate needed for settlement of coral larvae, thereby slowing reef growth and regeneration.

Point Source Pollution

In the United States, there are approximately 2,000 sewage treatment facilities and industrial facilities that annually discharge some 2.3 trillion gallons of effluent into coastal waters (Environmental Health Center 2000). In some still existing older systems, the stormwater systems are combined with sewage treatment systems and are not adequate to handle the waste during periods of heavy rains. In these cases, the system may be bypassed during storm events, leading to direct discharge of wastes into coastal waters.

Point source pollution in Hawai'i comes principally from sewage and aquaculture discharges. The resulting increased nutrient levels may lead to phytoplankton and algae blooms and decreased natural diversity near the source of the discharge. Aquaculture discharge may include hormones that are used in the farming process, and may also result in the introduction of alien species from the facilities into the open ocean.

Marine Debris

Globally, marine debris is an ever-increasing problem. In 1996, more than 275,000 volunteers from 93 countries participated in the Center for Marine Conservation's (CMC) international beach clean up. During the cleanup, the volunteers removed 4,890,914 pounds of coastal debris. Plastics were by far the most abundant material, making up about 61 percent of the trash collected (Environmental Health Center 2000).

Hawai'i accumulates marine debris from both local and international sources. Along with plastics, discarded nets and other fishing gear make up a big part of the debris collected in Hawai'i. In 1998, more than 3,000 kg of nets and related debris were reportedly picked up off O'ahu's beaches and reefs during a three-day community cleanup in Kāne'ohe Bay and Wai'anae (Gulko et al. 2000). In some cases, nets have drifted together into large heavy masses that require special equipment for removal. In 1998 and 1999, in the Northwestern Hawaiian Islands, a multi-agency team lead by the National Marine Fisheries Service removed 39 tons of marine debris. It is estimated, however, that another 4,000 tons of debris remain (Gulko et al. 2000).

Alien Species

In both terrestrial and marine ecosystems, alien species have become an increasingly serious problem in Hawai'i, especially in recent decades. These species may compete with native species for food and space, and often lack predators or other factors that could control their populations. They can change the balance of complex systems such as coral reefs and contribute to the extinction of native species, resulting in lower overall biodiversity.

Introductions may be either accidental or intentional. Alien organisms may be in bilge water or attached to ships' hulls when they enter Hawaiian waters. Other organisms may be introduced when ignorant aquarium owners release fish or other animals, usually purchased from a foreign source, into the ocean.

The mangrove *(Rhizophora mangle* and *Bruguiera gymnorhiza)* is a well-known example of an intentional introduction. It was brought to southern Moloka'i in the early twentieth century to help control sediments entering the ocean from the overgrazed hillsides of the cattle ranches. Mangroves have since spread to the wetlands and mudflats of most of the major islands, often displacing native wetland vegetation.

Other species have been introduced for their potential commercial value. At least 13 species of fish have been introduced, mostly as target species for fishing (Gulko et al. 2000). The bluestripe snapper or ta'ape *(Lutjanus kasmira)*, the blacktail snapper *(Lutjanus fulvus)*, and the peacock grouper *(Cephalopholis argus)* are among the most successful and aggressive fish introductions. These fish are all predators that compete with native species for prey.

Since 1950, at least 19 species of macroalgae have been introduced to the island of O'ahu alone, either intentionally or accidentally. One species, *Kappaphycus alvarezii*, is overgrowing and killing corals in Kāne'ohe Bay (Gulko et al. 2000). *Hypnea musiformis*, which was intentionally introduced from Florida in 1975, has become dominant in the nearshore coastal areas of West Maui (Clark and Gulko 1999). Frequent *Hypnea* blooms form smelly, unpleasant piles on the beaches, necessitating extensive cleanup efforts.

Fisheries

Worldwide, depletion of fish stocks due to overharvest is of serious concern, and Hawai'i is no exception. In a 1997 report, the National Marine Fisheries Service noted that 86 of the 279 fish species studied are classified as overfished, and that overfishing is most severe along the New England and Pacific coasts, including Hawai'i and Guam (Environmental Health Center 2000). The status of many other fish species has not been studied, so there is little data on current stocks and sustainable yields.

Both commercial and recreational fishing are of concern in the Hawaiian Islands. In both cases, catches are often underreported, so it is difficult to get reliable information about actual harvest levels. However, in 1996, a reported 23.1 million pounds of fish and invertebrates worth $52 million were harvested commercially from Hawaiian waters, with 90 percent coming from offshore fisheries (Clark and Gulko 1999), which target pelagic species like tuna and billfish, and bottom species such as snappers and groupers.

Nearshore fishing in reef areas in the main islands is dominated by recreational fishers, which include an estimated one-quarter of Hawai'i's resident population. Long-term catch records indicate an 80 percent decline in nearshore stocks in the past century (Clark and Gulko 1999). This decline is believed to be a result of a number of factors including:

1. Overfishing due to increased human population, improved fishing technology and gear, and a decrease in the knowledge and use of traditional conservation practices.
2. Lack of enforcement of existing regulations and outdated regulations on factors such as minimum size limits.
3. Habitat degradation due to coastal development and pollution.

Hawai'i, unlike the other western coastal states, does not require a marine recreational fishing license; therefore there is little reliable data on actual recreational fish catch. However, there is evidence to suggest that current rates of harvest are already exceeding the sustainable yield of the system, and that the over-exploitation of herbivorous fish might be contributing to increases in certain species of algae (Clark and Gulko 1999).

Fishing out-of-season and the taking of undersized fish and invertebrates are also significant factors in the depletion of nearshore stocks. In a study done in Hanalei Bay on the island of Kaua'i, it was found that less than 30 percent of the bluefin trevally *(Caranx melampygus)* taken were of legal size (Gulko et al. 2000).

Aquarium Fish Collecting

Aquarium fish collecting, especially of rare and endemic species, is big business in Hawai'i. In recent years, the reported value of fish and invertebrates collected annually has ranged from $800,000 to $900,000 (Clark and Gulko 1999). The annual harvest increased from 90,000 fish in 1973 to 422,823 in 1995, and the number of commercial permits rose by 39 percent between 1995 and 1998 (Gulko et al. 2000). About 60 percent of the fish are collected from the west coast of the island of Hawai'i, with most of the rest coming from O'ahu.

Tourism

In 2001, more than 6.3 million tourists visited the Hawaiian Islands. While in the state, these visitors spent in excess of $10 billion, contributing about 18 percent of the Gross State Product and providing employment for 25 percent of the state's residents (Hawaii Tourism Authority 2001). In late 1999, the Hawai'i Tourism Authority awarded a three-year contract, worth $114 million, to the Hawai'i Visitors and Convention Bureau to promote the state as a world-class tourist and business destination. Promotional efforts are underway to increase the number of visitors to the state, the average length of their stay and the amount of money they spend daily, as well as to attract more business conventions, golf tournaments, and other sporting events. This has led to a lawsuit being filed by the Sierra Club, asking that work on the contract be stopped until the state can complete an environmental assessment on the potential impact of increased numbers of tourists.

The Sierra Club lawsuit illustrates that, although tourism is obviously vital to Hawai'i's economy, there are growing concerns about the impact of increasing visitor numbers on the natural environment. More visitors mean increased coastal and urban development, increased demand on resources such as water and electricity, and a corresponding increase in sewage and other wastes.

The negative environmental effects of tourism have long been evident at favorite visitor sites such as Hanauma Bay on the island of O'ahu. Reaching a peak visitorship of some 3 million people per year in the 1980s, the Bay has suffered damage to the corals caused by careless visitors, a disruption to natural food webs through fish feeding, an increase in trash (especially cigarette butts), and water quality concerns from the input of large amounts of sunscreens and tanning oils. In recent years, the area has recovered somewhat due to stricter regulations, including a ban on fish feeding and smoking within the park, and limiting the daily number of visitors by instituting a fee and prohibiting tour bus drop-offs. However, similar problems are increasing in other areas around the state, such as Kahalu'u Beach Park on the island of Hawai'i, which currently has few restrictions.

As tourism continues to increase in economic importance, there is a growing tendency for residents of Hawai'i to focus on the health of the environment mostly in terms of its perceived visual and recreational values, or as an incentive to tourism. The traditional subsistence-based economy, which was strongly bound to an intimate knowledge of the environment for survival, has been replaced by an economy where goods are imported from distant, "invisible" markets. Much of the local population has no knowledge of, and no interest in, the sources of their daily sustenance. This disconnection from direct dependence on the environment for daily life clearly has an effect on the attitudes and actions of the public, resource managers, and education professionals towards environmental understanding and the importance of environmental education.

1.3 Perceptions of Marine Education in Hawai'i

As illustrated in the previous section, extensive scientific research has been conducted, and significant and increasing anthropogenic threats to Hawai'i's marine and coastal ecosystems have been well documented. This section reviews current public perceptions and awareness of environmental problems, and explores the attitudes of local resource managers and educators toward the role of youth education and active involvement in environmental management.

1.3.1 *Public Attitudes*

In 2000, the nonprofit organization Mālama Hawai'i commissioned a survey of public attitudes towards environmental conservation in an attempt to determine the best way to encourage the development of a statewide conservation ethic (Mālama Hawai'i 2001). During a ten-day period in October, 604 Hawai'i residents of O'ahu and neighboring islands were surveyed by telephone to assess their perceptions about, and attitudes towards, environmental conservation issues. Respondents were chosen to be proportionate to age distribution and geographic location.

Key findings of the survey

When asked to name "the most important issues facing Hawai'i today," only 3 percent mentioned the environment as a key issue. Of those 3 percent, more spoke about reef decline and endangered marine life than any other issue. When prompted, 85 percent of the total number of respondents answered affirmatively when asked if they had heard or seen anything about reef decline. However, almost 90 percent of those surveyed felt that Hawai'i's environment was generally healthy. Twenty-six percent of respondents ranked Hawai'i's environment as "very healthy," and a further 63 percent called it "somewhat healthy," indicating that the general public does not see environmental protection as a top priority. Of the top environmental concerns, ocean, marine, and fish issues were mentioned most often (26 percent), followed by development (12 percent), garbage (11 percent), and clean water (9 percent).

Despite the lack of feeling of urgency, 77 percent of those surveyed said that protecting the environment is "very important." Of that number, 51 percent supported increased funding for environmental protection, and 23 percent said they would be willing to volunteer for environmental activities. Of key importance to youth education and involvement in environmental protection was that "involving children in these activities was found to be influential in motivating parents to become more involved in voluntary activities for the environment" (p. 4). In addition, more than 90 percent of those surveyed said that they favor the inclusion of environmental education in the state-mandated curriculum.

1.3.2 *Attitudes of Managers and Educators*

In an attempt to develop a better understanding of the attitudes of resource managers and educators towards youth education and involvement in coastal and marine conservation efforts, and to find out what is currently being done in the State of Hawai'i, I interviewed 41 individuals, representing 35 different agencies and organizations (see Figure 3.1). The respondents included representatives from 3 federal, 12 state, and 2 county government agencies, 12 nongovernmental organizations, 2 schools, 4 for-profit tourism companies, and 1 community volunteer.

The interviews also explored perceived impediments to increasing youth involvement and education programs, educational strategies that were felt to be effective, and opinions about community conditions necessary to foster long-term youth involvement in marine and coastal protection.

Overall Program Goals

The respondents were first asked about the overall goals of their programs. These fell into seven major categories: resource management, public awareness, community capacity-building (including strengthening cultural links), general youth focus programs, formal education, promoting activism, and other. The responses are summarized below (some respondents listed more than one goal):

1. *Resource Management Goals*

    - Build and maintain sustainable fisheries.
    - Better fisheries management in the State of Hawai'i by educating fishermen on biological reasons for changes in the regulations.
    - Manage fisheries and educate the public about sustainable fisheries issues.
    - Protect coral reefs in Hawai'i at current levels, and restore reef ecosystems were feasible.
    - Provide technical assistance to enhance wise management and wise use of the coastal resources of Hawai'i.
    - Encourage and improve marine protected area programs.
    - Recover protected species.
    - Protect the humpback whale and its habitat within Hawaiian waters.
    - Maintain healthy ecosystems.
    - Manage marine resources.
    - Assist state and local officials in obtaining water quality data so that laws can be enforced.
    - Collect credible data on coral reefs for State and other governmental agencies.

2. *Public Awareness Goals*

- Foster awareness, appreciation, and understanding of coastal ecosystems and promote a sense of stewardship.
- Make people aware of the world of water, both salt and fresh.
- Provide information to the general public about conserving and enhancing marine resources and endangered marine species.
- Make youth aware of the complexity of the environment and the need to protect it, and have them learn as much as they can about the entire ecosystem of an area.
- Educate people about water quality and get them involved in hands-on education.
- Promote caring, sharing attitudes towards all living things.

3. *Community Capacity-Building Goals*

- Build a foundation for long-term conservation success by building the needed capacity, motivation, constituency, and resources.
- Build constituency for coral reef protection.
- Promote community development and good community relations.
- Build community and provide cultural activities related to the ocean for children through a community-based and community-run program.
- Promote preservation and practice of Native Hawaiian rights for cultural, spiritual and subsistence purposes, and preserve and restore the habitat and resources.

- Build community leadership.

4. *General Youth Focus Goals*
    - Promote youth aquatics recreation.
    - Conduct general work with teenagers.
    - Build strong kids, strong communities, and strong families.
    - Encourage personal development, skill training, and enhanced self-confidence.

5. *Formal Education System Goals*
    - Provide experiential education about oceans and freshwater systems to university undergraduates.
    - Prepare students for careers in marine science.
    - Conduct an innovative program in ocean studies for high school students, and attract students to careers that would otherwise have been unknown or unavailable to them.
    - Help raise teacher awareness of marine topics.
    - Deliver video programming on science topics to schools.
    - Get marine-related standards into the National Science Standards.

6. *Activism Goals*
    - Encourage the private sector to participate in conservation work.
    - Take immediate conservation action to address urgent priorities such as alien species control.

7. *Other Goals*
    - Conduct aquaculture research and development.

- Educate, entertain, and exhilarate about marine animals.

Coastal & Marine Environmental Issues

All respondents were asked the following question: "In your opinion, what are the main issues relating to the marine and coastal environment that we need to educate people about?" The question was intentionally open-ended in an attempt to gain a better understanding of the priorities and perspectives of the people interviewed, without prompting them to include issues that might not be immediately apparent to them.

The responses can be roughly grouped into four basic themes: fisheries issues, general development issues (including aspects such as sedimentation from deforestation or construction, nonpoint source pollution, habitat destruction, population growth, and tourism), resource management issues other than fisheries, and issues of broader understanding. It is important to keep in mind that whenever we try to categorize things, we create artificial boundaries, and that the responses actually overlap and intertwine among the themes.

Many of those interviewed gave multiple responses to the question. Some were quite general and vague, such as "how to respect the environment" or "the values of stewardship." Others showed a very narrow, local focus, saying that marine debris or invasive alien species was the main problem. The responses also ran the gamut from "too many to count" to an indication that there are no significant problems, or at least none that we can successfully address: "I think we're doing okay as far as conservation efforts. I haven't heard too much of – and yeah, there are kind of problems that are from overfishing – I don't know how we could control that."

Twenty-six respondents talked about issues of general development: coastal or upland development and related pollution, population, and habitat destruction. Tourism, lifestyle issues, and global warming were included under that category as well, because they all relate to development in a broad sense. Twenty people mentioned resource management in general. Fisheries issues (including issues of marine debris such as discarded nets) were high on the agenda, and were mentioned in some way by almost half of the respondents (17).

The responses to the question are summarized below, with numbers indicating how many respondents mentioned a particular issue. Where there is no number after the statement, it was only mentioned by one respondent.

<u>Fisheries Issues</u>

- Over-fishing. (8)
- Destructive fishing techniques. (2)
- General fishing practices and local attitudes. (2)
- Aquarium fish trade. (2)
- Marine debris. (3)

General Development Issues (including sedimentation & other pollution)

- Coastal and upland development. (7)
- Coastal pollution including sedimentation. (7)
- Tourism and its impacts. (5)
- Population. (4)
- Habitat destruction.
- Standard of living and human consumption patterns.
- Global warming.

Resource Management Issues

- Alien or invasive species. (5)
- Increased stewardship of coastal resources. (4)
- Lack of regulations or lack of enforcement of existing laws. (4)
- Endangered species. (3)
- Managing coastal resources (including fisheries) as population grows.
- Multiple uses of resources.
- Impacts of marine-related recreation, including recreational fishing.
- Protecting marine mammals.

Broader Understanding

- Understanding impacts of humans on the coast or ocean and the need for responsible personal actions. (7)

- Respect for the environment and other living things. (3)
- Importance of the ocean in Earth systems; understanding that it is all connected. (2)
- The ocean is seen as a bottomless source of resources and an infinite sink for wastes.
- Making people aware of complexity of the marine environment, especially coral reef ecosystems.
- Knowledge of what an ecosystem is and how it functions.
- Inter-relatedness of various aspects of the environment, including the mauka-makai (mountain-ocean) concept.
- General conservation of resources.
- Linking culture and natural resources to promote the protection of both.
- Understanding that the livelihood of Hawaiians depends on the health of the coastal and terrestrial ecosystems.
- The rate with which resources are disappearing.
- Awareness of what's out there.
- Any human impact.

Importance of Youth Education & Involvement

All of the respondents indicated that youth education and involvement were important in terms of reaching long-term conservation or sustainability goals, and many used words or phrases such as "critical," "extremely important," "key," and "tremendously important."

One respondent gave the opinion that, while it was important for the long-term, she felt that youth education was currently given too much priority and not enough emphasis was being put toward educating adults. Another thought that there is a need to educate adults so that they will realize the importance of youth education and, therefore, give it a higher funding priority. One respondent talked about the importance of a multigenerational approach:

> I think multigenerational [. . .] Because it's no good if, as a child, I come home to you as a parent all excited about what I learned in terms of how we might do better by the ocean or by our land resources and you give me a reaction that shuts me up.

Respondents were also asked why they thought that youth education and involvement were important. The responses to this question are summarized below, and indicate the belief that early development of environmental values is crucial:

- Environmental values (attitudes) need to be instilled when children are young: (13)

> A. So I think it's incumbent on the youth to be able to be educated when they're thinking about it, when they're formulating all their values and so forth in life. I think that's a good time to get people. You know, our values have already been pretty much cast, and so that's why we have a hard time changing policies, I think. So, you know, I think the communities have to rely on the youth.
>
> B. If the youth are not being educated now, then the values, the ethics, and all of the principles behind resource management are not going to be there when they become an adult.

- Adults are not as receptive or enthusiastic as children and youth; they are more resistant to change and can be unwilling to make personal sacrifices for environmental reasons (e.g., paying more for fish): (9)

    A. And you know, in some respects current generations may not be able to cope with all these changing things. They don't cope well with them.

    B. And let's face it, we have a harder time retraining adults than we do training children. They need to understand that what they do impacts, and their attitude toward the coastal resource impacts it. And their attitude will affect the next generation.

- Children are the environmental stewards of the next generation. (6)

- Youth should be aware that they can make a difference now. (3)

- You can reach the adults through the youth: (3)

    A. Through the youth you can reach the parents, and get all people involved. If the youth understands, there's nothing like youth to bring the point home to State and County officials.

    B. [. . .] they [adults] felt that the environment was still relatively healthy. And when asked what would make them do something, one of the only answers that was more universally agreed to than any of the others was if it was something they were doing with their children, or because their children asked them to do something.

- A long time frame is needed for change: (2)

    [. . .] a western approach is typically – the typical decision-making time frame is two years [. . .] so it's something that's gonna take 20, 30, or 40 years, and that doesn't have a rapid enough payoff for most of them [politicians] [. . .] So, I see that if change is gonna happen, it's gonna have to come in one or two generations beyond mine. So I think we have no choice but to focus a lot of attention on the kids.

- Youth need to be aware of the "shifting baseline" concept through a historical perspective of resource abundance and decline: (2)

> So what is happening is that in each subsequent generation you have this idea of the sliding baseline syndrome, that each subsequent generation only becomes familiar with a resource as it was at their first time of contact with it. And so, as they grow older and the resource decreases, they look back on the days like it was when they were young, and how abundant it was compared to what they're seeing today or in the future. The reality though is that when that person was born 20 years ago or 30 years ago, there weren't anywhere near the number of fish in the water there were 100 years ago or 200 years ago, or 500 years ago. And so [. . .] with every subsequent generation, we lose out on knowledge of what a natural system should be like [. . .] So if we can get kids, young kids, to connect up with older people to recognize what the resources were like when those people were young and start to set targets of going back to at least when our <u>kupuna</u> [elders] and others were young as our goal, then we've got a much better chance of not letting it just slip away. 'Cause right now each group of people demands less and less and less.

- There is a lack of adult role models: (2)

> A. So in my experience most of the youth that we deal with, which is a very good cross-section of our community, do not have the model behavior for protecting and conserving the marine coastal environment. Meaning that attitudes are take what you want, pay no attention to limits, sizes of catch, walk on a reef, not understanding coral reef ecology and protection.
>
> B. First educating the adults and then having them educate their children, I think is the most effective.

- If we don't learn how to take care of our resources, we won't survive.

- Greater awareness and understanding when young makes it easier when they reach university level.

Current Youth Education Programs

The agencies and organizations included in the interviews are involved in youth education in a variety of ways, but few are conducting programs that involve the same group of children or youth over a sustained period of time. Those that do long-term projects generally work through charter schools, private schools, or community groups that have a tie to the formal school system.

The following summary of program types is based on programs conducted by the groups interviewed. It makes no claim to be comprehensive or include all marine education projects in Hawai'i, but is probably representative of the most popular types of education programs:

Presentations at schools

These are often done on an "on request" basis, and are usually limited to 1 to 1-1/2 hour time periods. Some are grade-level or whole school presentations; others focus on a single class at a time.

School group tours of facility, on-site school programs, and field trips

These are usually one-time trips that vary from one hour to a half-day in length. They include programs such as aquarium visits, tours of research facilities, reef walks, and tidepool excursions. Some groups provide teachers with pre- and post-trip activity suggestions or curriculum materials.

Teacher workshops

Teacher workshops range from half-day to one-week resident workshops. In some cases, they are jointly sponsored and conducted by several different agencies and organizations. There was a limited number offered by the groups interviewed, and only five different respondents mentioned teacher workshops.

Community Events

Many of the organizations and agencies provide youth-oriented games and activities at community events.

Public Facility Tours & Family Field Trips

Some of the organizations attempt to reach youth through family and general public venues.

Support & Coordination

Three respondents said that their organizations or agencies assist by providing financial, technical, or other information support to groups that provide direct youth education services.

Teacher kits

One group loans out marine education teacher kits with activity notes.

Community-based Education

Two of the groups interviewed work primarily through existing community groups to involve local youth in marine projects.

Future Plans

Five respondents said that they are not doing any youth education or outreach yet, but plan to in the future. In some cases, there are projects in advanced stages of development (curriculum on sustainable fisheries, a school-based monitoring program, and a six-day resident camp program). In other cases, future plans are still more dream than reality:

> A. But, you know, we could eventually branch out to a lot of the charter schools at all levels of education.
>
> B. We've been kind of busy. We haven't been able to put as much effort right now into developing this, but we'd like to get this started, hopefully, by next year.

Other

Other approaches and programs mentioned include:

- E-charter "school-within-a-school" for high school juniors and seniors.
- Hands-on work with projects related to the environment, and with application to classroom activities, with five middle schools in one community.
- Science shows televised from the field, where children can interact via email, and teacher activities are posted on the Internet.
- Ongoing high school research programs (turtles, coral transplant).
- High school students occasionally act as interns.

Successful Educational Strategies

There was a strong consensus among the respondents that fieldwork and hands-on projects were the most successful strategies for youth education: "Experience it. Get people out of the classroom and into the water." The summary of responses shown below indicates that most of the respondents' ideas of effective educational strategies corresponded quite well to current concepts of effective practices as identified in the educational literature:

Experience and Engagement

- First-hand experience interacting directly with the ocean (get out and do). (14)
- Hands-on activities in the classroom or in the field. (11)
- Active engagement; do things so kids are involved and not just watching. (4)
- Give them an opportunity to see things they probably wouldn't see anywhere else. (4)
- Do real work that has meaning in terms of the environment, with projects that students can do over a semester or school year and get an end product. (4)
- Take things kids can touch into the classroom. (3)
- Use an inquiry approach. (2)

- Give students opportunities to work with real research scientists (either in a real setting or through teleconferencing or videoconferencing). (2)
- Have a positive experience with nature. (2)
- Get students to go out and sit and observe.

Importance of teacher or leader style

- Use leaders as mentors.
- Leaders model values of caring, honesty, and responsibility.
- Open and friendly leadership.
- Enthusiastic teachers.
- Show that you are willing to learn from them.
- Teachers or leaders should be relaxed and enjoy themselves.

Relate education to students' lives and interests.

- Integrate education into projects so that they are real and relevant.
- Use case studies of real, current issues.
- Inspire students to care.
- Turn the learning back to the students.
- Make it "cool."

Other Activities or Strategies

- Use educational games. (3)
- Integrate cultural knowledge. (3)
- Employ dramatic messages ("graphic stuff" like dead birds). (2)

- Role-play management issues because it forces students to be more involved and to ask questions if they don't understand.
- Use small group activities.
- Show pictures and use sound recordings.
- Use a variety of techniques to meet different learning styles.
- Broadcast live from underwater.
- Short television spots on particular topics (30 seconds).
- Videos.
- Keep the pace quick and show multiple arrays of things.
- Use interactive sites on the Internet.
- Demonstrations.
- Problem-solving.
- Peer-teaching.
- Relate to historical perspectives.

Family & Community Involvement

- Involve parents with their children.
- Involve kupuna.

General

- Needs to be a long-term, ongoing process, not one-time or even one year.
- Give them an incentive to participate, such as school credit.

- Trust that people can understand the science behind reasons for management changes *(talking mostly about adults).*
- Build children's image and self-esteem.

Unsuccessful Educational Strategies

The unsuccessful strategies listed by the respondents served to reinforce the importance of active involvement, relevance, student interest, and real world connections. Only one respondent said that he didn't agree with letting children decide what they would like to learn. He felt that they would not know what they wanted unless someone showed them. Strategies perceived as unsuccessful include:

- Lecture or talking. (3)
- Forcing or coercing students to be involved.
- Overly academic approaches.
- Too non-personalized, sterilized.
- Limited to classroom, isolated from the real world.
- Rote learning.
- Classroom situation.
- Lack of freedom for expression.
- Piecemeal.
- Drills.
- Letting children tell you what they want to learn.

Limiting Factors to Youth Involvement

There was also a high degree of agreement about the major limiting factors and impediments to involving more youth in the kind of education and action projects that had been identified as important. Lack of financial resources was listed as a prime factor, as well as limited time and difficulties with providing transportation. The transportation issues and some of the time factors were also clearly linked to the lack of financial resources. The other two major areas of concern were liability and safety issues, and Department of Education structure and restrictions. The issues mentioned are summarized below:

Financial Resources (18)

- Lack of financial resources related to money for staff, materials, and related resources:

  A. Resources. I work with a zero budget. As I said, this is a collateral duty for me.

  B. Money.

  C. The amount of money that is spent in Hawai'i on marine-related conservation work and education work is offensive, frankly. It's tragic how little money is being devoted to this in the state.

Time (12)

- Time to prepare and/or implement a project:

  A. Public schools have a very limited amount of time and they're under a lot of pressure to teach the "important subjects," the solids, the math, the English.

  B. As soon as you get the word out that you'll be going to schools, that's what you'll be doing 24/7, because the teachers are so hot for you to come out and talk to the kids.

- Classroom time to take field trips.
- Lack of time on the part of the youth because of competing interests such as sports.

Transportation (7)

- Bus or car transportation to get youth to field sites.
- Boat transportation for water activities.

Liability and safety issues (16)

- Liability coverage for water-based field trips.
- Inadequate water safety training or skills on the part of both youth and teachers.

Department of Education structure and restrictions (16)

- Lack of leeway in state-mandated curriculum (marine education and EE are not included), and difficulty making curriculum changes through the current system.
- Lack of willingness of schools to change; inertia of the system.
- Paperwork that needs to be done for approval: "The DOE as an organization is a bureaucratic nightmare."

Resource management agency structures (4)

- Agencies tend to be research-oriented and do not include budgets for education or outreach.
- Lack of collaboration among organizations and agencies.

General support (9)

- Lack of constituency and general support for environmental issues:

  A. Our constituency is primarily saying there's not a problem.

  B. I think the main limiting factor would be people's attitude. It's not a priority.

  C. People just don't take it seriously.

- Lack of understanding on part of state officials.
- Perception that a focus on environmental issues is bad for the state's tourism image.
- Value system of the marine science community: "The value system of a lot of the marine science community is, 'Don't bother me with undergraduates,' or 'Don't bother me with high school students; I've got my research to do.'"
- Hard to find, train, and maintain volunteers.
- Assumption that someone else is doing it or will do it.

Comfort & knowledge levels (7)

- Many teachers and leaders are uncomfortable in the ocean.
- Many teachers don't like teaching science because they don't feel they know how to do it.
- General perception that the ocean is a dangerous place; fear of the unknown.
- Many educators are not ocean-oriented.
- Lack of staff with knowledge.

Other

- Lack of teacher access to resources, techniques, and technical support.
- Lack of awareness of opportunities on part of teachers and youth.
- Not considered as cost-effective as trips to an aquarium or showing a movie.
- Lack of facilities for schools to go to on field trips.
- Difficulties in ensuring scientific rigor and data quality of youth research.
- Bombs (Unexploded ordnances)

To Overcome Limitations

When respondents were asked for their ideas about ways to overcome the perceived limitations, responses were variable. Some had no ideas. Others indicated what should be done, but no one gave specific suggestions on how to do it or who should be responsible. Many felt that more collaboration was needed among the various agencies, organizations, and schools. Others suggested funding options and changes in the science content standards or the structure of the Department of Education. In general, the respondents felt that:

- More outside agencies should work "hand-in-hand" with the DOE and the schools to offer diverse courses that are integrated within the school curriculum or are very affordable outside the curriculum.

- Organizations need to work with youth outside of the classroom or formal school setting.
- There should be more collaboration among agencies and organizations involved in marine and coastal education projects.
- We need to develop a system that enables us to link children to the ocean through formalized programs.
- There should be an attempt to link different programs across the state and encourage communication between students in different parts of the state to compare and contrast what is going on in their respective geographic areas.
- There is a possible niche through high school science teachers who are looking for structured projects.
- More of the community outreach funding from the National Coral Reef Conservation Plan should be channeled through the DOE to promote a broader marine curriculum base in the schools.
- Funding from the coral reef initiative could be used to provide workshops and materials for teachers.
- Teachers need to become more involved.
- A section of the state science curriculum should be devoted to marine science education.
- The State's single school district model should be changed.
- More charter schools should be developed.

Community Conditions that Support Youth Involvement

At the end of the interview, respondents were asked what conditions they would look for in a community if they wanted to be successful in introducing or strengthening marine-related youth programs. The responses centered on community composition and characteristics, individuals within the community, and levels of community education and awareness:

Community Composition and Characteristics (18)

- Community awareness of and interest in the local marine environment. (4)
- Community willingness to take action on their own initiative; track record of activism. (3)
- Discrete area and well-defined community. (2)
- Degree of cultural homogeneity.
- Shared values.
- Intellectually curious community.
- Healthy successful community that has a sense of pride and ownership of their local resources (tenure and control): (2)

> Because we really believe that marine resources are not going to be able to be conserved unless the community itself is healthy and successful, and feels a sense of pride and a sense of ownership of those resources [. . .]

- Existing infrastructure and organization within the community.
- Needs that have been identified by the community.

- Opportunities for community involvement.
- Effective enforcement of current laws.

Individuals (10)

- A few motivated individuals. (4)
- Individuals who can bridge between the community and the organization or agency (influence in the community). (2)
- Individuals who can connect to the youth.
- Support of the kahuna (elders) in the community.
- People who will not let initial limitations or failures stop them.
- Strong familial ties.

Education and Awareness (5)

- A literate population.
- Public awareness of different programs available in the community.
- More people educated at the level of resource management.
- High interest levels on part of the teachers in the public schools.
- Community awareness of the financial costs of sustaining activities.

1.3.3 *Summary*

Both the Mālama Hawai'i public survey and the interviews with resource managers and educators indicated that, in theory, the people of Hawai'i consider youth education and action to be extremely important for long-term protection of the marine and coastal environment. There was consensus that the early development of environmental values is extremely important. There was widespread agreement that children need to be out in the field, gaining direct experience and working on real, meaningful projects, and that there is a need for more direct involvement with the public schools. There was an emphasis on the importance of a multigenerational approach, both for its educational effectiveness and to build greater community support for environmental protection. There was also recognition that more collaboration is needed among resource agencies, nongovernmental environmental organizations, and the formal education system.

In practice, however, there are currently few efforts to involve youth in real ongoing or long-term action projects for the following reasons:

1. Because of DOE regulations, the limitations imposed by the content standards, and liability issues, Hawai'i's regular public schools do not provide an easy venue for youth water-related action projects. Most organizations and agencies seemed to feel that it was easier and more effective to work through public charter schools or private schools.
2. Lack of funds was considered a limiting factor in all venues, whether it was a governmental agency, nongovernmental organization, charter school, community group, or regular public school. This lack of financial resources translated into problems

with staff time, transportation, equipment, and other material resources.

3. There is a perceived need for greater collaboration and communication among the agencies and organizations that are involved in resource protection and education throughout the state.
4. Despite the documentation of significant problems, there is a prevailing attitude in many communities and among the general public that environmental issues are not of great importance because the local environment is seen as being healthy. This may be due, in part, to a lack of scientific literacy and understanding of ecosystem principles among the general public, and the loss of traditional Hawaiian environmental knowledge and resource management skills.

The interviews indicated that the current education system, despite the variety of marine and coastal programs that exist outside the formal education sector, is not providing the scientific literacy, environmental understandings, and emotional connections necessary to precipitate long-term changes in attitude or behavior. What is clearly lacking is a coherent vision or plan for ways to overcome the perceived impediments. The next three sections review the theory and historical background of science education, action research, and environmental education, and explore the practical implications of currently accepted "best practices" as they relate to development, implementation, and assessment of existing and future youth programs in Hawai'i.

1.4 **The Importance of Scientific Literacy**

1.4.1 *Introduction*

A scientifically literate society is one essential facet of effective resource management in modern Western society. In much of Western society, and certainly in Hawai'i today, there is little knowledge or practice of traditional sustainable management of resources. Our management decisions, at least in theory, are generally based on science and "scientific evidence." Without an understanding of the components, interworkings, and complexity of Earth systems and processes, such as energy and nutrient flow through an ecosystem, or the effects of heavy metals or other pollutants on the health of living organisms, we are unlikely to make wise decisions regarding the use and management of the resources. We also need an understanding of principles of scientific uncertainty and the limitations of what science is or is not, and can or cannot do. This is true not only for those who are directly involved in management, but also for the *private citizen* who affects the resource through his or her everyday lifestyle choices, behavior, and voting decisions. In the news, we often hear or read comments to the effect that "Scientists have proven . . ." or "Scientific evidence has not shown conclusively that there is a connection . . ." To the scientifically literate person, statements such as these should raise a warning flag, so that the person will step back and say, "What a minute. I need to find out more before I can accept that."

1.4.2 *Science Education*

Numerous recent studies (American Association for the Advancement of Science 1990, Smith-Sebasto 1997, Stanisstreet and Boyes 1997, Thompson 1997) suggest that a large percentage of American youth has a low level of science literacy, and that it is very difficult to change long-standing scientific misconceptions. In addition, it has been shown in the United States and elsewhere that interest in science tends to decrease as students progress through the formal school years (Barrington and Hendricks 1988, Mattick 2002, Piburn and Baker 1993).

Since the 1980s, in an attempt to address the decline in both scientific literacy and student interest in science, national standards for science education have been proposed by the American Association for the Advancement of Science (1990) and the National Research Council (NRC) (1996). The NRC's *National Science Education Standards* were first released in December 1995, after a four-year preparation period that involved more than 18,000 individuals and 250 science education organizations from around the nation. They consist both of <u>content</u> standards (what students should know and be able to do at a given grade level) and <u>outcome</u> standards (guidelines for assessing student learning of the content). In addition, the *Standards* calls for changes in the way teachers have traditionally taught science, putting a greater emphasis on involving all students in science, addressing student misconceptions, actively engaging students in learning, helping students apply what they learn to real world situations, and developing their abilities to communicate their reasoning to others. All of these changes fit well into an action research model of education, and echo the opinions expressed by resource managers and educators in Hawai'i.

The NRC's content standards are divided into the following eight categories of general knowledge:

- Unifying concepts and processes
- Science as inquiry
- Physical science
- Life science
- Earth and space science
- Science and technology
- Science in personal and social perspective
- History and the nature of science

In addition, more specific content information is detailed for grade level clusters – K-4, 5-8, and 9-12. Specific curriculum decisions, however, have been left to the individual states and school districts (National Research Council 2001).

Many states, including Hawai'i, have also recently revised their state science content standards in an attempt to define what students need to know at each grade level in order to be considered scientifically literate. Hawai'i's science standards are divided into two main categories called "domains." Domain I is concerned mostly with scientific process and Domain II with scientific content. The domains are subdivided into the following "strands" (State of Hawaii Department of Education 1999):

Domain I: How Humans Think While Understanding the Natural World

- Science as Inquiry – promotes the process of asking questions, constructing and testing hypotheses, and communicating results.
- Habits of Mind – looks at developing values such as scientific honesty and curiosity, as well as unifying themes such as systems, change, scale, and models.
- Safety – emphasizes safety skills in scientific inquiry activities.
- Science and Technology in Society – relates technology to science.

Domain II – What We Know Today About the World around Us

- Historical Perspectives – includes ideas of the interdependence of society, technology, and science; and concepts of sustainability.
- Organisms and Development – focuses on developing an understanding about unity, diversity, interdependence, cycles of matter, energy flow, evolution, heredity, cells, and human development.
- Understanding Ourselves and the World around Us – examines human health, learning, and behavior.

- The Physical Environment – looks at physical science concepts about matter and energy.
- Earth Systems and the Universe - relates to an understanding of the universe and our solar system; universal forces such as magnetism, gravity, and electricity; and forces that shaped the Earth.

In addition to the content standards, the Hawai'i Department of Education is also in the process of developing performance standards – ways to determine if students have mastered the content standards. This is an attempt to move away from total reliance on the traditional pen-and-paper type of tests and to increase the accountability of the school toward student achievement.

Educators approach the standards with mixed feelings. Some teachers feel that the standards help focus their teaching, while others think that they are just another energy and time-consuming activity with little practical value. Some are concerned that the standards will change with a change in political leadership. Whatever the individual perspective toward standards, they are a fact of formal education at the K-12 level. If science or environmental action research programs in Hawai'i are going to gain acceptance at the state level, and successfully compete for funding, they must address the state content and performance standards.

Unfortunately, a limiting factor for marine and coastal education and action projects is the lack of emphasis on the ocean environment in both the national and the state science content standards. A 1998 NOAA report pointed out that the only mention of oceans is found in the Earth and Space Science category of the national standards, and that the words "ocean," "sea," "marine," or "water" do not even appear in the index (National Oceanographic and Atmospheric Administration 1998). A similar lack can be noted in the Hawai'i content standards where neither the word "ocean" nor "marine" is included. While many of the standards address general scientific processes that can be applied to the coastal and ocean environment, there is no specific provision for addressing marine concepts and issues.

1.4.3 *Assessing Science Education Program Quality*

Beginning in the early 1990s, the National Center for Improving Science Education (NCISE), an arm of the U.S. Department of Energy National Laboratories, conducted a five-year study to evaluate programs being offered to teachers and students in the United States. More than 50 programs throughout the United States were included in the study (Kaser and Bourexis 1999). By combining the observations and the experience of program directors, teachers, and other staff members with lessons learned from academic research, NCISE identified common characteristics of quality science education programs. Their research explored four different kinds of programs – teacher development, teacher research, student enrichment, and systemic – and looked at elements needed to design, operate, and investigate outcomes of these programs. They call the process "profiling program quality." It is an action research approach to formative evaluation that involves participants in an ongoing critical reflection of the program design and operation. Participants can compare the design and operation of their programs to NCISE's list of quality program components (Figure 3.1), identify strengths and weaknesses, and take action to modify their programs as needed (Kaser and Bourexis 1999).

Figure 1.1 – NCISE Quality Factors

(Summarized from Kaser, 1999)

Teacher Development	Teacher Research	Student Enrichment
Vision for the classroom	Research experience	Program design
Program activities	Teacher assignments	Student selection
Contributions of host org.	Mentor assignments & rules	Preparation
Follow-up	Preparation	Program activities
Teacher leadership & responsibility	Broader host organization experiences	Contributions of host organization
Systemic connections	Systemic connections	Systemic connections
Program administration	Follow up	Follow up
Program evaluation	Program administration	Program evaluation
	Program evaluation	

While NCISE's approach focuses primarily on large-scale programs that involve cooperation among educational and scientific research organizations and institutions, many other educational researchers have concentrated on effective pedagogy. *Science for All Americans: Project 2061* (American Association for the Advancement of Science 1990) summarizes some of the currently accepted key principles of learning and teaching, as shown in Figure 3.2. It can be seen that many of these principles also fit squarely into an action research model, including the focus on inquiry, practice, and reflection, and the emphasis on local relevance and use of students' prior knowledge.

1.5 <u>The Case for Action Research</u>

1.5.1 *Introduction*

Although not a new concept, action research has enjoyed a revival in recent years, and is being applied to everything from community-based resource management, to improvements in education practice and social justice movements. Definitions of action research vary depending on personal philosophies and the goals of the research practitioners, but all definitions have certain elements in common. Action research generally refers to research that is done <u>in the field to solve a practical problem, by those who are directly involved in, or affected by, the problem</u>. Rapoport (1970) sees action research as a type of applied research that directly involves participants in a search for practical solutions to a problem they face, while at the same time contributing to theoretical understanding. Schmuck (1997) says that action research is "reflection and inquiry" by those who wish to improve their own practices. Arhar (2001) defines it as pertaining "to individuals trying to

Figure 1.2

Principles of Effective Science Learning & Teaching

(Summarized from the American Association for the Advancement of Science (1990)

Learning

Students may remember what they are told or what they have read, but their *understanding may be limited.*

Student learning is affected by previous knowledge.

Student learning usually progresses from the concrete to the abstract.

To obtain mastery, students must practice doing what they learn.

Students need constructive feedback and time to reflect, make adjustments, and try again.

Expectations affect student performance.

Teaching

Teaching should be consistent with the nature of scientific inquiry and:

- Start with questions about *things that are familiar to students*
- Engage students actively
- Concentrate on collection and use of evidence
- Provide historical perspectives
- Emphasize clear expression, both oral and written
- Use a team approach (cooperative learning groups)
- Do not separate "knowing" from "finding out" – focus on knowledge and process
- Deemphasize memorization of technical vocabulary.

Science teaching should reflect and encourage scientific values by:

- *Encouraging curiosity*, questioning, and creativity
- Avoiding dogmatism
- Promoting aesthetic appreciation.

Science teaching should attempt to counteract learning anxieties by:

- Building on success
- Emphasizing group learning
- Providing ample opportunities for practice with tools and instruments
- Supporting involvement of women and minorities.

Science teaching should extend beyond school and involve the resources of the larger community.

Science teaching takes time for reflection and practice, and should involve increasing sophistication over time.

monitor and learn from reflection on action and trying to become aware of discrepancies among perceptions, values, and actions. It contains elements of individual and group self-study, and social action" (p. 48).

The practical aim of action research is one of the key factors that distinguishes it from traditional research. Action research is planned and systematic, but it is local in scope and is based on ideas of improving practice, continued personal and professional development, and incorporating multiple perspectives. Traditional research, on the other hand, is concerned with explanation-seeking, knowledge-building, experimentation, and a search for universal truths (Schmuck 1997). In addition, action research makes no claims to objectivity or to being value-neutral, and tends to use qualitative approaches to data collection and analysis. Arhar (2001) adds the following to the list of elements in action research:

- Knowledge, practice, and development are not separated.
- It uses a problem-solving approach to improve social conditions and processes of living in the real world.
- It examines assumptions, beliefs, and actions, and includes self-critique.
- It is geared toward the improvement of the practitioner/researcher as well as toward the practice being researched.
- It is grounded in concepts of constructivism (knowledge developed by experience and reflection).

1.5.2 ***Benefits of Action Research***

Fueyo and Koorland (1997), in discussing the use of action research by teachers in the classroom, note that it empowers teachers to make informed decisions about what aspects of their teaching to change and what to leave alone. In addition, it helps them link prior knowledge to new information, and learn from experience (including their failures). Finally, they learn to ask questions and systematically find answers.

These benefits also apply to the use of action research in community-based resource management, as well as in cases where students are directly involved in real projects in their communities. This will be discussed in more detail later.

1.5.3 ***A Brief History of Action Research***

John Collier

One of the first people to use the term "action research" was John Collier. Active in education and applied anthropology early in his career, he was co-founder of The Home School in New York City, a progressive program that combined work, play, and study. In addition, he worked on numerous community projects in New York that involved field research, teaching, and the development of methods to promote local democracy (Noffke 1997).

While serving as the Commissioner of Indian Affairs from 1933 to 1945, he worked to bring Native American education into communities on the reservations and to refocus the curriculum on local culture, language, and "native self-sufficiency" (Iverson 1978 p.235). In addition, he used an early form of action research in soil conservation work with Native American communities. He felt strongly that the community needed to benefit directly from the research and that outside "experts" should be non-directive in their roles (Noffke 1997).

Throughout his career, Collier was concerned about the potential for action research to be used as a form of social engineering, or social control. His goal was to encourage local, democratic participation of community members in improving their own lives. At the same time, he could see that certain aspects of his work, such as the promotion of bilingual education in Native American schools, could be used to promote the agendas of outside agencies and authorities. If the community were bilingual, then outside policies would be easier to implement and enforce because it would be easier to get information to the community (Noffke 1997). This conflict between promotion of democracy and social engineering through action research continues to be of concern today, especially in the use of action research in classroom settings.

Kurt Lewin

Perhaps one of the names most closely associated with early action research, especially as related to social engineering, is that of Kurt Lewin. A close friend of Collier, and a Jewish refugee from Nazi Germany, Lewin came from a background of social psychology. His work centered on questions of racial and class prejudice, group dynamics, and the concept of action in group settings. He considered democracy and planning as interdependent, so he didn't share Collier's concerns. For Lewin, action research was by nature a form of social engineering; it was inquiry into social actions and the effect of the research at producing improved action (McKernan 1996).

Lewin emphasized the importance of examining and reflecting on the biases, opinions, and prejudices that all people have (Arhar, Holly, and Kasten 2001). Social theory, he felt, had to be practical and tied directly to social action in order to move toward democracy and social justice. His approach of identifying a problem, taking action, observing the results of the action, and eventual development of theory contrasted with the dominant positivistic research paradigm. Like traditional scientific research, it was considered an inductive process and followed the same basic steps. The difference, however, was in the inclusion of democratic, inclusive participation of those affected by the problem. This approach came to be known as the "scientific action research" model – a model that was also used by early education researchers such as John Dewey and Stephen Corey (McKernan 1996).

John Dewey

During the early and mid-twentieth century in the United States, students in most schools were expected to be passive recipients of knowledge that was transmitted by the teacher. The dominant teaching methodology was one of "chalk and talk" – the teacher lectured and wrote things on the board, while the students listened, copied, and memorized. John Dewey, one of the most influential educators of the modern era, felt that the educational process was developmental and that students should be active participants rather than passive subjects. His views reflected the modern worldview because he saw the education process as progressive (starting with simple concepts and progressing to more complexity) and regular (having a predictable sequence to the acquisition of skills, values, and knowledge). Dewey stated his views as a universal theory, saying that children learn better by doing than watching (Arhar, Holly, and Kasten 2001).

While some of Dewey's views were questioned by researchers such as Piaget, whose own research reflected the shifting paradigm from modernity to postmodernity, he made an important contribution to the field of action research in education. He emphasized the gap between teachers and education researchers, and the importance of involving teachers in curriculum research and reform (Noffke 1997). Teachers, he felt, should be skeptical of methodologies coming from outside researchers, and should use the scientific method to test their own ideas in action. In his view, it was the teacher's duty to help students become more socially aware and enable them to participate actively as democratic citizens (Arhar, Holly, and Kasten 2001).

By 1960, John Dewey was advocating an educational ideology that he termed "pragmatism." He argued that knowledge comes from experience and practical efforts, and that it must be used to solve everyday, practical problems. In contrast to the standard European tradition of education, which was based on the reductionist views of the classical Greek philosophers, the pragmatic theory of learning is dynamic, action-oriented, and "situated in the experience of everyday living"(Elliott 1995).

Dewey did not dismiss the importance of culture, and cultural conservatism, in the educational process. Experience shaped by culture and tradition was necessary, he felt, to avoid chaos in our lives; however, it was not enough to deal with future changes, especially in the context of a rapidly changing society. An experimental approach to daily life allows "[. . .] experience to be modified by incorporating new understandings which accommodate the changing conditions of social work" (Elliott 1995 p. 15).

Stephen Corey

A key figure in post-World War II education action research was Stephen Corey from the University of Chicago. Like Dewey and Lewin, Corey believed in a scientific approach to action research; unlike them, he did not feel that democracy was an essential component (Noffke 1997). In his mind, the validity of action research could be measured by "its effects on human welfare" (Corey 1953 p. 17). He emphasized the importance of having cooperative groups carry out the research – this would increase the likelihood that the proposed actions would be feasible and the group committed to making the changes. Working in groups also meant that a wider pool of talent and ideas would be available, individual risk would be limited, and participants would be less likely to feel manipulated by the process (Corey 1953).

Corey's focus also differed from those of earlier researchers in that he was more interested in developing educational knowledge and skills that could help teachers and students adjust to social change, rather than to create change (Noffke 1997).

1.5.4 *Trends in Education Action Research*

In the late 1930s and early 1940s, numerous progressive educators were experimenting with alternative strategies to traditional teaching methodologies. Their work emphasized the importance of field-based research and the involvement at all stages of the research of those affected by the problems.

The Eight Year Study by the Progressive Education Association was one of the early programs that helped legitimize action research as an appropriate methodology. The research question identified in the study was the impact of less rigorous college entrance requirements on the high school curriculum. Changes instituted at the local school level, with the assistance of outside consultants, were considered "experiments," and those directly involved – teachers, school administrators, and students – were responsible for the revision, implementation, and evaluation of the curriculum (Noffke 1997).

A changing political climate in the United States during the 1950s led to a shift from the early action research models of education to more nationally-funded "expert" curriculum. This increased the gap between theory and practice that had been emphasized by Dewey, and helped form the current dominant paradigm of "top-down" research, development and dissemination (RD&D) models (McKernan 1996).

Since the late 1960s, the pendulum has been slowly swinging back toward action research and appears to be gathering momentum. There has been more emphasis on naturalistic and ethnographic inquiry and the use of anthropology to study school cultures through qualitative research (McKernan 1996). Schooling in the United States, at least in theory, is tending more to the postmodern world view, with an emphasis on diversity and individual differences, multiple intelligences, ideas of children's rights, and encouraging parent and community involvement with the school (Arhar, Holly, and Kasten 2001). Many influential educational researchers have been arguing for a greater use of action research methodology in the schools.

Arhar (2001) lists some recent key figures in action research and their special area of influence:

- *Joseph Schwab*, an American curriculum theorist, applied action research to changing curriculum development from a top-down efficiency model to a teacher-developed model with the goal of promoting "critical social consciousness of the impact of power in society" (p. 51).

- *Lawrence Stenhouse*, British director of the Humanities Development Curriculum Project, emphasized the idea that teaching should be based on the teachers' personal research and reflection.
- *John Elliott*, British director of the Ford Teaching Project and the founder of the Classroom Action Research Network (CARN), espouses the concept that education is a moral endeavor that looks for values in practice, and feels that teachers develop theories as they teach.
- *Wilf Carr* and *Stephen Kemmis*, professors of education at the University of North Wales and Deakin University in Australia, coined the term "education action research" and developed a model for "critical-emancipatory action research" based on the concept that the research focus should be on just and democratic forms of education.

1.5.5 *Action Research Philosophies and Theoretical Models*

While the basic philosophy of action research remains focused on problem-solving by those affected by the problems, a number of different models have been developed, reflecting different philosophical outlooks and goals. McKernan (1996) summarizes three principal theoretical models that he terms *scientific*, *practical-deliberative*, and *critical-emancipatory*:

Scientific action research was exemplified by early researchers such as Dewey, Lewin and Corey. It followed the same basic steps as traditional scientific research, except that it included democratic participation of those affected by the problem.

Practical-deliberative action research has the goal of understanding practice and solving immediate problems, which have been identified from a moral perspective. It loses some of the accuracy of measurement and control of the scientific model, but gains by detailed description, increased communication and negotiation, and human interpretation. Some of the key researchers using this model are Stenhouse and Elliott. Elliott, in particular, stresses that practice and research need to be fused, and that the action researcher needs to develop a personal theory through working on practical problems, and that the theoretical understanding should be based on practical action and reflective discourse. Advocates of this model also stress the need for several research cycles to allow time for reflection and deliberative action.

Critical-emancipatory action research has been promoted by Kemmis, Carr, and their colleagues. Their model rejects the positivist belief that knowledge is instrumental in problem solving, claiming that positivist theories seek to explain rather than act. They also criticize positivism for having made scientific thinking completely technical which, they claim, constrains reason. They feel that education curriculum concerns are value-laden and moral rather than completely technical, so the field methodology must stress development of discursive, analytical and conceptual skills. The general process is to create a plan, take action, observe and reflect on the action, then revise the plan and move on to a new cycle of action, observation and reflection. This should be a politically empowering process for the participants, with a focus on social reform.

Mills (2000) uses a simpler approach to the theoretical models, dividing them simply into *critical* and *practical.* Critical action research, in his classification, is based on postmodernism in that it challenges notions of a single truth and the possibility of objectivity. It is:

- Democratic – enabling participation of all.
- Equitable – acknowledging equal worth of all.
- Liberating – emancipatory.
- Enhancing – enabling expression of full human potential.

Practical action research, on the other hand, is based on a more practical "how-to" approach. Practitioners:

- Have decision-making authority.
- Are committed to improvement.
- Are willing to reflect on practices.
- Use systematic approaches to reflect on practices.

- Choose the area of focus and data collection techniques, analyze and interpret the data, and develop and implement action plans.

1.5.6 *Educational Philosophy and Action Research*

From a practical perspective, despite their differences, all of the action research models share a number of elements and themes that have been persistent over time and are relevant to our discussion. The focus on personal relevance, problem-solving, inclusive participation, and participant choice were identified as key elements in science education reform and, as we shall see, are also important in environmental education. Some key points need to be considered, however, when contemplating the use of action research in an educational setting:

Democracy versus social engineering

One recurring theme of concern is the tension between the promotion of democracy and social engineering. Democratic principles are reflected in the focus on emancipatory projects and the participatory nature of action research, which helps equalize relationships in the classrooms. On the other hand, action research is also being used in an attempt to change teachers' and students' attitudes towards research and to promote social and/or environmental action (Noffke 1997). In public school settings, this can be seen as a politicizing process.

Upon further reflection, however, the distinction between the promotion of democracy and social engineering seems somewhat artificial. The promotion of democracy itself can be seen as a facet of social engineering because it is premised on the belief that democracy is the best form of governance. Seen from this perspective, an implicit or explicit social engineering aspect must be recognized in all forms of action research.

Constructivism

The constructivist philosophy holds that individuals construct their own realities out of their personal experiences and validate them through social interactions. This is an ongoing, incremental process that builds on previous knowledge. As people learn and interact with others, they continually add to their knowledge base, make new connections, and modify previously held beliefs. An action research approach to education focuses on this process, rather than on the transmission of specific "facts."

Knowledge versus practice

In traditional teaching, which focuses on the transmission of information from teacher to student, there is often a significant gap between knowledge and practice. Because of its emphasis on field research, the local community, and solving specific day-to-day problems faced by the practitioners, action research attempts to lessen this gap. Learning becomes more of a student-centered activity and the students become more aware of the relevance of their studies and their personal actions to their everyday lives.

Local control

For action research to be successful, practitioners, whether they are teachers or students, need to have some control over the process and the results, and must be able to implement changes they identify as necessary. For teachers, this means that the process must have the support of the administration, other teachers, and parents; for children, projects chosen should be within their abilities and in areas where they actually have the power to make and carry out decisions.

Catalyst for change

Kember (2000) emphasizes that it is often difficult to start an action research project because the topics to be researched must be chosen by the participants themselves, and the process often involves a larger system. Teachers trained in the traditional style of teaching as "knowledge transmission" may find it difficult to change, especially if they don't really believe in student-centered learning or action research and are only participating because of administrative directives. Participants must have a reason to want change their practice – some problem or issue that can serve as a catalyst. This can be illustrated by the development of the environmental education movement, which began to gain momentum in the 1960s and 70s as books such as Rachel Carson's *Silent Spring* helped raise public awareness of increasingly severe environmental degradation.

1.6 **Environmental Education as a Conservation Tool**

1.6.1 ***Historical Overview***

At the United Nations Conference on the Human Environment in Stockholm in 1972, in part because of Sweden's concern over the effects of acid precipitation, heavy metals, and pesticide pollution in the Baltic, world focus was given to the environment and environmental education (EE). June 5 was designated as "World Environment Day," and governments were encouraged to organize activities to promote environmental protection. In addition, the Stockholm conference recommended the establishment of an International Environmental Education Programme (IEEP). The Intergovernmental Conference on Environmental Education was organized two years later and given the mandate to define EE, and identify goals, objectives, and strategies for its development (Vinke 1992). In the mid-1970s, IEEP published a definition stating that environmental education is:

> . . . a permanent process in which individuals gain awareness of their environment and acquire the knowledge, values, skills, experiences, and also the determination which will enable them to act – individually and collectively – to solve present and future environmental problems (Schneider 1992 p. 25).

Despite this broad definition, for many years EE was limited in practice principally to the formal school systems of developed countries. Even in these cases, it was usually not considered as a discipline in its own right; instead, it was woven into the biology curriculum as "nature conservation." Most of the *nongovernmental organizations* (NGOs) working with EE at that time were also oriented toward protection of wildlife and other "nature."

A gradual paradigm shift began in the mid-1980s, as illustrated by a major European initiative. In 1984, at an international meeting of the Office of Economic Co-operation and Development (OECD) member countries, Herbert Moritz, minister of education for Austria, suggested that EE should be a top priority for the future development of education. Two years later, the Centre for Educational Research and Innovation (CERI) of the OECD started the "Environment and School Initiatives" (ENSI) program, which involved the participation of nineteen OECD member countries in an action research project over a period of more than ten years. For this initiative, the concept of "environment" was broadly defined to include not only the natural world, but also the "social, economic, cultural and technological dimensions" (Centre for Educational Research and Innovation 1995 p. 8).

In 1987, the Brundtland Report, presented by the United Nations World Commission on Environment and Development, introduced the concept of "sustainable development." Sustainable development asserts that "the needs of the present should be met without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development 1987). This type of thinking clearly requires a broad, inclusive definition of EE.

In recent years, EE programs have proliferated in both formal and informal education, and in both developed and developing nations. Many governments have officially integrated EE into the formal school system, or have identified it as an important priority for future development, and numerous NGOs have begun major EE initiatives. However, in some cases, formal school integration is merely on paper and, due to lack of resources (both financial and human), quality EE has not yet made it into the classroom.

Many organizations and agencies have also broadened their scope to include socio-economic and cultural factors in promoting environmental protection. This has led to some ideological differences among educators, and the development of a new catch phrase – "education for sustainable development" (ESD). To promoters of this approach, ESD differs from EE because it gives equal weight to environmental, social, and economic factors. ESD is addressed in Chapter 36 of Agenda 21, the action plan from the Rio Earth Summit, and specifically calls for "greater education in developed countries about effects of over-consumption of natural resources" (Paden 2000).

An ESD workplan was drafted by UNESCO and adopted by the United Nations Commission on Sustainable Development (CSD), which was established to monitor nations' progress towards goals set during the Rio summit. The workplan identified seven priorities for action (Paden 2000):

- Clarify and communicate the concept and key messages of ESD.
- Review national education policies and "re-orient" formal education systems.
- Incorporate ESD into sustainable development plans at the national level.
- Educate for sustainable consumption and production patterns in all countries.
- Promote investments in education.
- Identify and share innovative practices.
- Raise public awareness.

National governments and other UN agencies were identified as potential actors in this process, but it was not clear who or what would motivate them to act. A 1998 review by CSD found that only 17 nations had responded to UNESCO's request to address the identified priorities, and that most projects had been small, with inadequate funding and little international support (Paden 2000).

ESD was addressed again at the international level during the Pan European Expert Meeting on Sustainable Development and Environmental Education, held in the Netherlands in January 1999. Douwe Jan Joustra, Program Manager of the Dutch Extra Impulse for Environmental Education, expressed his concern that the theoretical underpinnings of ESD had not been explored sufficiently. At his suggestion, the Dutch Committee for Sustainable Development (NCDO) initiated a plan for an international Internet debate on ESD. Four individuals with varying backgrounds – including an academic researcher in EE, a marketing consultant, an education and communications consultant, and a webmaster - were selected as moderators for the project (Hesselink, van Kempen, and Wals 2000).

The project, called ESDebate, was conducted in five rounds over a period of four months. The first round explored the various conceptions of ESD, the second looked at examples of "good practice," and the third discussed the implications of ESD. The fourth and fifth rounds were kept open for participant suggestions. Fifty participants from twenty-five different countries, mostly with academic or EE backgrounds, participated in the debate. Subsequent evaluation of the program suggested that the lack of involvement of sustainable development experts, and the lack of representatives from corporate and public sectors, biased the results of the study (Hesselink, van Kempen, and Wals 2000). In addition, no consensus was reached on the differences and similarities between EE and ESD. Many educators felt that quality EE programs already address social and economic aspects of the environment, and that ESD was, at best, just another buzzword, and at worst, a way of promoting the "development" part of the equation at the expense of the environment. For the sake of simplicity, I will continue to use the term EE in the following discussions, with the understanding that it is meant to include social, cultural, and economic factors.

1.6.2 *Environmental Education Program Quality*

Despite the limitations noted in the ESDebate project, there was widespread agreement on a number of factors that promoted good education and quality environmental programs. Some of these key factors are:

- EE should focus not only on the formal school system, but also on informal and non-formal learning (e.g., homes, workplaces, recreation areas).
- Studying examples of quality programs and projects increases the chance of new program success.
- The aims of the project need to be clear, concrete and realistic.
- The problem to be solved should be thoroughly analyzed before the education process begins.
- Stakeholders and target groups should be involved at all stages.
- EE should focus on *process* rather than *results*.
- An action-oriented learning approach is most effective.
- To be successful, teachers and trainers need to learn new management and communication skills.

The North American Association for Environmental Education (NAAEE) is the largest EE group in the northern hemisphere, with some 2,500 members representing more than 50 countries. In 1993, NAAEE began the National Project for Excellence in Environmental Education, which led to a published set of guidelines for environmental learning at the K-12 level, guidelines for initial preparation of environmental educators, and a critique of existing EE curriculum materials (North American Association for Environmental Education 1999). The guidelines focus on EE in the context of the formal school system in North America, and highlight four broad skill areas necessary for developing environmental literacy:

1. Questioning and analysis skills.
    - Ability to ask questions and form hypotheses.
    - Skills to gather, organize, interpret, synthesize, and communicate information.
2. Knowledge of environmental processes and systems.
    - The Earth as a physical system.
    - The living environment.
    - Humans and their societies.
    - Environment and society.
3. Skills for understanding and addressing environmental issues.
    - Analyzing and investigating environmental issues.
    - Decision-making and citizenship skills.
4. Personal and civic responsibility.
    - Application of learning.
    - Ability and willingness to act on personal conclusions.

In addition, NAAEE has listed general education principles that the organization feels are important in environmental instruction (North American Association for Environmental Education 1999):

- The learner is an active participant.
- Students' interests should guide instruction, and it should build on previous knowledge and life experience.
- Instruction should enhance students' capacity for independent thinking and effective, responsible action.
- A strong emphasis should be put on developing communication skills.
- Instruction should present a balanced view and incorporate different perspectives.
- Students should have frequent and continuing opportunities to explore and work within their local environment, because this helps lead to a personal commitment to protect it.

As was illustrated in previous sections, these principles closely parallel principles of quality education in both action research and general science education.

1.6.3 *Actors and Audiences*

Despite the many definitions of EE, most researchers and educators agree that it should reach all segments of society. Vinke (1992), in describing EE initiatives of OECD, identifies five principal groups of "actors/audiences" that should be included:

- Government bodies, civil servants and political parties
- Formal education system (teachers and students)
- NGOs (ranging from international to local grassroots)
- Journalists and other media
- Rural and urban communities (including direct resource users)

Clearly, a variety of different approaches are needed to educate this diversity of audiences. In addition, EE must be appropriate to the culture in which it is taking place. It must consider social, economic, and political factors, as well as take into account the existing knowledge of the local population. In discussing experiences of EE in Thailand, Wiltoon Permpongsacharoen (1992) points out that many problems arise because educators fail to ask the appropriate questions before beginning an EE program. He states:

> It is, for example, necessary to ask what the real causes of environmental problems are, where poor people fit in, whether they are responsible for the situation or just victims of it, how they are affected by environmental degradation, and what they think about these problems (p. 190).

He goes on to emphasize the importance of studying indigenous knowledge to understand traditional ways of solving problems, and then building on this knowledge.

1.6.4 ***Approaches to EE***

There are as many different approaches to EE as there are definitions. The reasons for this are obvious if we define EE as "any transfer of environmental knowledge" (Vinke 1992p. 44). In this sense, EE includes everything from long-term action research projects to a 30-second radio or television announcement about recycling.

However, if the goal is to change people's behavior towards their natural environment and lead to long-term protection of resources, EE must move far beyond awareness raising, the development of scientific literacy, and the understanding of ecological principles. As argued by social scientist Roger Hart (1999): "We need programmes based on identification and investigation of problems by residents themselves, with 'action research' as the dominant methodology" (p. 10).

1.7 **Summary**

EE can only be truly effective when the student is a vested participant. One time or occasional participation is not adequate to build the kind of personal knowledge of and relationship to the environment that is necessary to promote real change. An action research approach, based on sound science, and incorporating multiple social and cultural perspectives, offers a potentially effective pathway to direct experience of the local environment and can help serve as a bridge to a broader understanding of the global environment.

Chapter 2 examines the role of action research in community-based resource management, with a particular focus on youth participation. It also reviews the elements needed to create and sustain quality programs, and describes the assessment rubric that was created to evaluate the case study programs.

CHAPTER 2
YOUTH PARTICIPATION AND ACTION RESEARCH IN ENVIRONMENTAL PROTECTION

2.1 Community-Based Resource Management

In recent years, there has been an increased emphasis on involving local residents in the management of natural resources in their communities. Within this movement, there is a wide range of philosophies, definitions, models, and degrees of involvement. Different philosophies are reflected in the variety of names used, including community-based resource management (CBRM), citizen participation, participatory management, co-management, and collaborative management. Levels of citizen involvement can range from a type of "social mobilization," where people are motivated to carry out an agenda that has been predetermined by an outside agency, to true participation, where self-motivated citizens are involved in all steps of the process, from determining the issues and problems to developing and implementing solutions (Hart 1999). Despite the philosophical differences, all of the true participatory models involve some kind of an action research approach, often with a social engineering bias.

The models also share similar underlying assumptions about the benefits of increased local participation. There has been a growing recognition that traditional "top-down" approaches are often ineffective, in part because they don't accurately reflect the needs and priorities of the local resource users. As expressed by Vira and Jeffery (2001), traditional approaches "have limited potential for transforming existing patterns of social interaction and resource use" (p. 1). In participatory management, existing social structures and traditional knowledge of the resource can be used to help identify issues, and design and implement appropriate interventions. Another possible benefit of a participatory approach is that, through the process, local resource users come to understand the relevance of their knowledge and how it can be used for management. As the development of the management plan becomes more participatory, the local users are more likely to continue to participate in the later stages of development and implementation (Walters et al. 1998).

Under certain conditions, community members may be able to adapt their resource management strategies to changing social and physical circumstances without outside interference. This can be difficult, however, given the complex, ambiguous, and often conflicting nature of the ownership, uses, and management responsibilities for most coastal and marine resources. In these cases, collaborative projects have to be created by "purposive action" (Vira and Jeffery 2001). These approaches need to build on existing social organizations, as well as create new ones if needed. Neefjes (2001) notes that this is a long-term effort, as societies generally are slow to adopt new techniques and practices. This has serious implications for program success, especially given the short funding cycles that often characterize these initiatives. It also lends weight to the importance of including children in the process.

In order to discuss community participation, we first need to clarify our concept of "community." This has been argued endlessly in the literature, but most writers accept the idea that a community is dynamic, complex, and variable. For the purposes of resource management, Ostrom (1992) provides a workable definition of community as a group that is characterized by certain shared beliefs and norms, a more-or-less stable membership, and a process of unmediated, complex, long-term interaction. The idea of "shared beliefs," however, does not necessarily mean there is a shared understanding of the exact nature of the resource under consideration, or a common goal for its use and management. In addition, when concerned with resource management, the term community must also refer to a specific place or geographic locale.

To reflect this diversity of opinions, many practitioners use the term "stakeholders" to refer to all individuals, groups, and agencies that affect, or are affected by, policies, decisions, and actions that relate to the resource (Grimble and Wellard 1997). Some, such as Conroy (2001), also divide stakeholders into primary and secondary. Primary stakeholders are those who have a direct, immediate interest in the resource (for example, as a source of livelihood); secondary stakeholders are others such as government agencies that have management responsibility or NGOs that are concerned with environmental protection.

Multiple stakeholders mean multiple opinions about the resource and what constitutes appropriate management. Despite the theoretical democratic nature of the participatory process, all stakeholders do not have equal power. Where interests conflict, an amount of compromise may be necessary. In these cases, those with more power, such as funders, political leaders, local authorities, or wealthy business people are in a privileged position, and their opinions will often carry more weight. To try to address this issue, Rocheleau and Slocum (1995) argue, it is essential to recognize and understand the cultural and social power relationships within the community. These may include issues of class, gender, ethnicity, age, religion, or ideology, as well as other factors. This is an especially important consideration participatory projects involving children.

2.2 **Evaluating CBRM Projects**

Due in part to the nature of funding (e.g., limited funds, short funding cycles) for CBRM projects, evaluation or assessment issues have often been overlooked. In recent years, however, a rising tide of criticism of CBRM projects has led to an increased awareness of the importance of ongoing assessment and usable, valid assessment criteria. In addition, many development professionals have begun to feel the need for an analytical framework, especially since there are often unstated assumptions that "poverty alleviation, empowerment and participation of local 'environmental care' go hand in hand" (Neefjes 2001).

To provide a framework for their CBRM programs, Oxfam and partner organizations have chosen the general goal of "achieving sustainable livelihoods," which they define as "the ability to maintain and improve livelihoods while maintaining or enhancing the global assets and capabilities on which livelihoods depend" (Neefjes 2001). To determine when this goal is met, they have developed the following guidelines:

- Local environmental assets (e.g., land, water, services, economy) are of good and improving quality.
- Poor people have claims and relative control over these assets.
- People have the resiliency to offset risks and cope with changes.
- Changes involve positive contributions to the natural resource base, the human-built environment, and social resources, while being neutral or positive towards other livelihoods.
- Sustainability includes economic, environmental, and social factors.

This framework has an outcomes orientation and does not consider the factors needed to accomplish the desired outcomes. However, numerous case studies have recently looked at factors that should be considered for effective CBRM programs (Harkes 2001, Neefjes 2001, Santhakumar 2001, White, Hale, and Renard 1994), and certain patterns are starting to emerge.

Recent research indicates that the time needed for people to learn the necessary skills to participate successfully in management initiatives is usually a minimum of three to five years (Harkes 2001). Often, because of funding cycles, material interventions are initiated before the local people have the skills to implement or sustain them. Thus, when the project is evaluated, it may be judged to be a failure. In addition, project evaluation often does not consider the intangibles such as personal achievements of the participants or changes in attitudes or perceptions.

Harkes also emphasizes the fact that "success" can be measured on a variety of levels – at the level of the individual, the community, and the project – and that different factors need to be considered at each of these levels. It can also be measured from the perspective of the participants themselves (which she refers to as the "emic" perspective) or from the perspective of outsiders such as government agencies or funders (the "etic" perspective). Often, Harkes argues, the emic perspective is ignored, and project success is measured strictly in terms of outside technical or scientific perspectives. This, she feels, is inadequate for projects that have socio-cultural impacts because it doesn't allow participants or facilitators to gain an adequate understanding of local perceptions and conceptions, or to situate the project within the appropriate socioeconomic, cultural, and environmental contexts. Although she feels that more research should be done in this area, and that new tools for evaluation need to be developed, Harkes suggests a set of possible assessment indicators based on current levels of research (summarized in Figure 2.1). Many of the indicators, especially at the individual level, echo factors that have been identified as important for successful science and environmental education. In addition, at the individual and community levels, they share many commonalties with successful action research.

White, Hale, et al. (1994), summarizing their experiences with Community-Based Coral Reef Management in the Philippines, also point to the need to involve the community in research and documentation of popular knowledge and traditional systems of resource management, and the importance of concentrating on the process rather than just the content and results. They state, "Collaborative management is achieved through a cyclical process of dialogue, action, and reflection; there is a need to value and support the processes themselves without predetermining what results they should lead to" (p. 114). Here again, we see the use of an action research model with the emphasis on dialogue, action, and reflection. Other key factors for success that emerge in their analysis are summarized in Figure 2.2.

2.3 Children's Participation

It is especially important to recognize power issues in participatory projects with children. Although varying somewhat by culture, children obviously do not have the same power as adults. This can have several ramifications for children's participatory projects. First, it is easy for adults, often unwittingly, to use their power to direct the children's

Figure 2.1

Possible Assessment Indicators for CBRM Projects

(from Harkes, 2001)

Individual indicators:

Involvement in	Project design Decision-making Management Defining boundaries Rule development
Capability to	Express opinions Make decisions Prioritize decisions Participate in meetings Write proposals Speak in public Work in committees
Control over	Process Resources People's own lives
Access to	Knowledge Meetings Resources
Skills to	Manage a project Solve problems Repair and maintain technical equipment
Change in	Awareness Sense of responsibility Generating new ideas Willingness to deviate from customs & community values Willingness to take risks

Community indicators:

Communication	Commitment of stakeholders Recognition of stakeholders Understanding between groups of stakeholders Expression of different viewpoints Level of open disagreement
Representation *(Equity)*	Various stakeholders Various social groups Women Socially marginalized groups
Collaboration	Between individuals Between neighborhood groups Between different social groups
Trust between	Staff members Staff and government Staff and project beneficiaries
Support of	Higher government levels Local leaders NGOs Project staff Village-based organizations

Project indicators:

Material output	Size of yields Size of protected areas Occurrences of destructive practices
Human involvement	Number of participants Frequency of meetings Frequency of trainings Size of network
Project benefits	Division of benefits Economic opportunities Health Income Education
Management	Institution designed & active Management plan & regulations designed & implemented Enforcement structure in place Conflict management strategy in place Leadership
Participation	Type & dimension

Figure 2.2

CBRM/Participation Success Factors

(from White, et al., 1994)

Involvement of the community in:

- Research and documentation of popular knowledge and traditional systems of resource management.
- Definition and establishment of legal instruments to formalize community responsibilities and rights.
- Promotion of community participation, representation, planning, and decision making.
- Building community institutions and public awareness through organization, training, financing, legal counsel, and technical assistance

Transparency of process & content of assistance

Accountability

Participation of those who will be affected by action (Inclusion of all stakeholders)

Level of control by participants

Flexibility and commitment

Concentration on process

Institution building

Decentralized and integrated solutions – range of stakeholders and consideration of variety of impacts

Respect for diversity

Clear objectives and issues; careful identification of issues

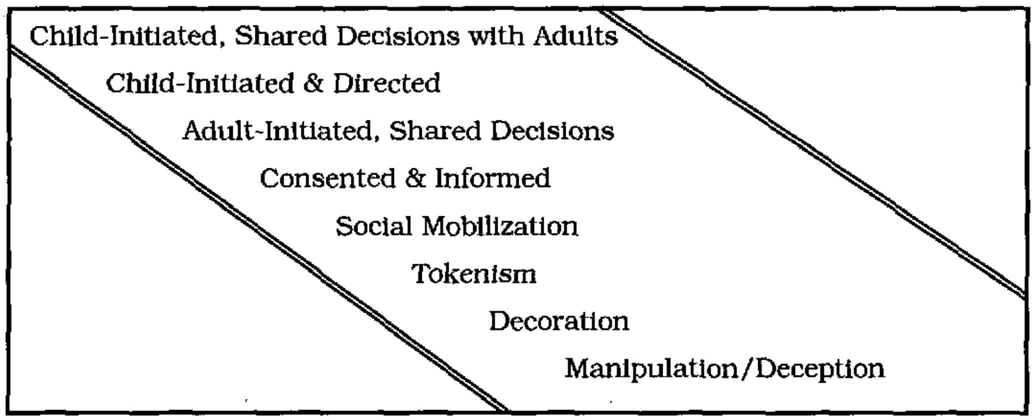
Feedback of results to sustain & increase community participation

Development of trust between all participants

Sufficient time for projects to evolve

projects to their own ends. At one extreme, this can lead to deliberate deception or manipulation of the children. Hart (1999) has adapted the ladder of participation metaphor developed by Arnstein (1979) to describe what he sees as the different levels of children's participation (Figure 2.3):

Figure 2.3 – Ladder of Children's Participation (from Hart 1999)



<u>*Manipulation or deception*</u>

In manipulation, adults consciously use children to express their own messages. Using children's artwork out of context, without the understanding or consent of the children, to convey a message that may not have been what the children intended, is an example of manipulation. Deception refers to attempts by adults to deny their involvement in the children's work. Perhaps the classic example is a science fair project that was planned and carried out primarily by a parent, but is submitted as the child's own work.

Decoration

When children are prompted by adults to participate in a demonstration or wear clothing advocating a certain cause, but have not had a chance to develop an understanding of the cause or any chance to participate in the development of the demonstration, this can be seen as an example of decoration.

Tokenism

Hart points out that tokenism is one of the more pervasive and potentially damaging levels of children's participation. Usually the adults involved sincerely believe that they are listening to the children and giving them a voice in the project and decisions but, in reality, the adults have determined what the project will be and often even the way the students will present it. As Hart says, "To involve them as tokens will impress the press and politicians and may entertain many audiences, but children learn from such experiences only that democratic participation is a sham" (p. 42).

Social Mobilization (Assigned but informed)

In social mobilization, the project is conceived, developed and directed by adults. If the students are fully informed about the issue and the reasons for the project, they may become very enthusiastic and take a degree of ownership in it. This is often the case in projects where children are used to educate others in the community about an issue they have been studying. Social mobilization projects can be very effective as a first step in teaching children to reflect critically on what they are learning and to help them develop important communication skills. However, they are top-down projects and their impact is usually short-term. Unless they are followed by higher level participatory projects, they may also convey the message to the children that their perspectives are not really important (Hart 1999).

Consulted and Informed

This level refers to projects that are designed and run by adults, but where children have been consulted at the different stages during the process, and their opinions taken seriously.

Adult-Initiated, Shared Decisions with Children

At this level children should be involved in some way at all stages of the project, from initial planning to implementation. At the least, they need to understand the reasons behind decisions that they might not have a voice in, and there should be some aspects of the process that they have control over. This is an important level, because it helps children develop a sense of competence and a gives them a feeling of empowerment.

Child-Initiated and Child-Directed

These projects are harder to find, and are often not recognized or encouraged by adults. Usually they are recreational in nature, with children forming things like clubs or informal sports teams. Often they can be noted in children's play, especially when children are working with materials that allow for cooperative group interaction, such as sand, water, and building materials.

Child-Initiated, Shared Decisions with Adults

The highest rung on Hart's ladder is represented by projects that are initiated and carried out by children, but where the children have enough confidence and trust to ask voluntarily for the active participation of adults.

One caution with the ladder metaphor is that it may promote the idea that projects on a higher rung are always somehow "better." This is not necessarily the case. Different levels of participation may be appropriate depending on the specific circumstances, such as age, maturity, culture, and the nature of the project. As children develop – physically, intellectually, and socially – they need different levels of guidance and support. Participation skills are learned, and adult-imposed structure is necessary in early stages of the learning process. Duckworth (1987) made an essential point when she wrote, "Making new connections depends on knowing enough about something in the first place to provide a basis for thinking of other things to do – of other questions to ask – that demand more complex connections in order to make sense" (p. 14).

Good self-esteem and a sense of cultural identity are also important aspects of successful children's participation projects. Identity development is a social process, varying by culture, that is connected to a child's developing understanding of his or her social world. Self-understanding and understanding of the social world influence each other in a reciprocal manner. Based on research done mostly in a Western context, Hart (1999) has noted the following differences between children from age 8 to 11 and adolescents that should be considered in development of participatory projects:

Children

- Are enthusiastic, outward looking, and industrious.
- Are in the process of forging independent identities.
- Use groups as work places to gain competence and begin to develop independence.
- Need adult support for their plans and to help them guard against failure.
- Need adult help learn to deal with failure.
- Should work on authentic projects with adequate adult supervision.

Adolescents

- Are inward looking and philosophical.
- Are constantly testing identity constructions.

- Use groups as a stage for a trial run of identity.
- Need projects that provide opportunities for comparing and contrasting their self-identity with others' views of them.
- Need opportunities to develop a positive group culture.
- Should have freedom to develop their own culture within appropriate limits.

2.4 **Education and CBRM**

It is generally agreed that education is an important component of community-based resource protection efforts. In the introduction to his paper, "Living coastal resources of Southeast Asia: Management through continuing education by institutions of higher learning," Chou (1994) comments that "[. . .] among traditional users of coastal resources, education has been shown by resource scientists to be effective in making the users realize that improperly managed coastal habitats cannot provide sustained benefits over a long term." He goes on to emphasize the importance of reaching all segments of society over a long-term period, noting however that current decision makers may not be the most important people to target for education efforts because they are often more concerned with short-term financial gains and development priorities. He feels that groups such as school children and the general public are often more receptive to environmental messages and, if properly motivated, they can be effective in pressuring politicians and resource managers to act in more environmentally sensitive ways.

Bago and Velasquez (1992) illustrated the importance of systematic, long-term involvement with EE in their discussion of an environmental education and awareness-raising project in the Philippines. Beginning in 1987, and continuing over the next three years, the Philippine NGO Lingkod Tao-Kalikasan Foundation (LTK) held a series of three-day workshops throughout the country, at various regional, provincial, town and village levels. The purpose of the workshops was to raise awareness of the 1987 "Philippine Charter for Nature," which promotes the concepts of community-based sustainable development and active participation by citizens in protecting the natural resource base for their livelihoods. The workshops targeted representatives of the Catholic Church, government officials (at all levels), teachers, NGOs, and other citizens' groups.

In a mid-term evaluation of the program, LTK found a very positive response to the workshops. The main criticism by workshop participants, however, was that they needed to learn more problem-solving skills and strategies, and did not receive those in the training. Bago and Velasquez (1992) noted that, "Due to time constraints the EOS project does not provide the participants with problem-solving skills to adequately cope with environmental concerns" (p. 182). These are skills that need to be developed over time, and can be more easily accomplished if we begin working with the children, using a participatory action research approach.

Hart (1999) reinforces this idea:

> [. . .] children need to be investigating their own communities in ways that will heighten their awareness of the need for a people-centered approach to development. At the same time, through their community research and action, children will develop a sense of shared responsibility and skills that will enable them to continue to participate as adults and to recognize the importance of their participation in local, national, and even global environmental decisions (p. 8).

The ENSI project of OECD, mentioned in the previous chapter, illustrates these principles in action. The stated goal of the project was to improve the quality of the environment by having teachers and students work in their local communities. Four guiding principles were identified: personal experience in the environment, the use of interdisciplinary learning and research, appropriate social action, and development of a sense of personal responsibility toward the environment (Pettigrew and Somekh 1994).

ENSI was based on the principles of action research in the formal school setting at three different levels – student learning, teacher learning, and support staff learning. The following groups of skills were identified as desired outcomes (Posch 1994):

- *Cognitive* – an understanding of relevant issues and relationships; the "big picture."

- *Interpersonal* – empathy with the feelings of others, positive regard for others, and the ability to provide support to others.
- *Self-monitoring* – learning from reflections on experience, eliciting feedback, setting realistic goals, and knowing what risks to take.
- *Impacting* – influencing others through networking, goal-sharing, and political awareness.

The ENSI experience indicated, however, that undertaking successful environmental and community-based action research projects with children or youth is not simple. Many factors affected the success, or lack of success, in different countries, as well as in individual schools. Varying levels of political control and cultural factors were noted as creating important differences among the programs. Other limiting factors included the difficulty of dealing with controversial topics and issues of values within the formal school setting. There were also fears among the teachers that their efforts would be seen as attempts at political manipulation or indoctrination of the students (Centre for Educational Research and Innovation 1995).

As the project progressed, teachers began to question many widely held beliefs and methodological practices. As Elliott (1995) points out:

> Facilitators of action research, especially those located in academic institutions of higher education, are often prone to methodological dogmatism in their relations to teachers. They tend to impose on teachers methodological requirements which promote and legitimate the latter's intellectual dependence on outside expertise. These

> requirements stem from research traditions which dissociate social inquiry from social practice, and social researchers from social practitioners (p. 36).

This comment illustrates that, despite all the research and literature on action research philosophy and methodology, there continues to be a significant gap between what Argyris and Schon (1978) call "espoused theory" and "theory in use."

Wells (2001) comments that sustaining action research projects is never easy, especially in cases where change is politically rather than educationally motivated. He noted that during the ten-year life of the "Developing Inquiring Communities in Education Project" (DICEP), an action research initiative in Ontario, Canada, two different K-12 curricula were introduced in the province. The second curriculum was introduced only two years after the first, following the election of a political party that espoused "common sense" and reduced taxation. The new curriculum, in direct contrast to recent research findings of "best practice," was instituted without any consultation with teachers, focused on breadth rather than depth of coverage, and had an emphasis on standardized testing.

2.5 But is it "Good?" - Assessing Program Quality

The ENSI experience highlighted an ongoing concern among educators and program evaluators worldwide. How do we judge a "quality" program? If environmental education and action research are "values-driven" and long-term results of programs dealing with children are not visible for years (if ever), what criteria can we use to decide if a given program is worth the time, money, and effort to sustain?

Successful marine and coastal action research projects for youth need to draw from several disciplines. First, it is important to have a solid understanding of the science behind the issues, so we must determine what promotes quality science education. Second, we must include aspects of environmental education that go beyond pure scientific understanding – such as factors involving human interaction with the natural environment, economic and social elements, behavioral change, and the broader aspects of "values." Third, we turn to the action research literature to determine the factors needed to involve young people successfully in this type of endeavor. Finally, we need to consider the general realm of citizen participation and community-based resource management to help turn the understandings into action. Fortunately, as noted previously, extensive research has been carried out in all of these areas. A comparative analysis and synthesis of this research revealed certain common factors among the disciplines, and highlighted specific key elements of each. This allowed the creation of the rubric that was used to assess the case studies in this research, and which could be applied to similar programs elsewhere. This synthesis is included as Appendix A, and is summarized in Figure 2.4.

Five main categories of concern were identified: program logic, program administration, program design and implementation, program content, and evaluation and assessment. Each of the categories contains a number of elements that should be considered when assessing existing programs or designing new ones. The categories are not mutually exclusive – most of the elements listed in all categories could also be considered aspects of program design, and should be included in the initial program planning. The rubric is not intended to be used as a simple, reductionist checklist; rather, it can help guide observations or analysis.

A few other cautions should be noted in using the rubric. First of all, it is not exhaustive. It would have been an impossible task to review all existing literature and include all possible factors. I have tried to examine a fairly comprehensive list and develop a representative sample. In addition, the terminology for similar concepts varies considerably among the different disciplines, and even among different authors within a single discipline. In some cases, the differences in terminology may indicate subtle differences in theoretical understanding or philosophy. Finally, it is important to remember that much of what appears in the evaluation literature is based on the experience and opinions of "experts" in the field, and is therefore subjective and possibly biased toward the personal beliefs of the researchers.

In developing the rubric, my goal was to identify broad similarities that could be used as a framework to measure actual or potential program effectiveness. Every program will be a bit different in its focus, and the specific indicators need to be adjusted to fit. In addition, as noted by Kaser and Bourexis (1999), programs develop over time and it would be unfair to judge a program without taking that factor into account. The rubric is best used as a formative evaluation tool that can help identify both a program's strengths and its areas of concern.

The rubric elements are briefly described below in the context of their application to youth programs that deal with marine and coastal resource protection and/or management issues:

Program Logic

The program logic answers the question – What do we want to accomplish with this program? This includes an examination of the overall vision of the people developing and administering the program, the needs that the participants want to address, and the specific goals.

1. *Vision & Aims*

There should be a certain level of shared vision and shared aims among the participants. This does not mean that all have to agree on all facets of the program; however, there needs to be a degree of consensus concerning the overall nature of the project. In youth programs, the participants may include teachers or youth leaders, school or organization/agency administrators, scientific researchers, parents, children, and other community members.

2. *Goals*

It is important to have clearly defined and understood goals, with clear, achievable objectives. The age, culture, and maturity levels of the youth involved need to be considered when establishing the goals and objectives.

3. *Needs*

The program should be based on needs that have been identified by the participants, including the children.

<u>*Program Administration*</u>

Program administration refers to the overall program structure and logistical issues such as staffing, infrastructure (e.g., buildings and materials), long-range planning, and funding.

1. *Governance & Management Structure*

Governance and management structure, including roles, responsibility, and accountability, need to be clearly defined and functional. For school programs, everyone involved – administration, teachers, students, and parents - should understand and comply with his or her role within the program.

2. *Planning*

To ensure continuity, programs need to have a strategic plan that considers both short- and long-term objectives, including funding issues.

3. *Support*

The program should have the support of the relevant governing bodies (e.g., state government, school district), local organizations, students, parents, and the community at large.

4. *Relationships*

Good working relationships and a feeling of trust should be established among participants and collaborating groups or individuals.

5. *Capacity-building*

There should be regular professional development for teachers and facilitators and ongoing capacity building and training for all participants to help develop important skills and understandings.

6. *Resources & Infrastructure*

Availability of and access to necessary facilities and resources, including financial resources, is critical.

Program Design & Implementation

Program design looks at aspects of planning and preparation that are done before the program actually begins. As mentioned earlier, most aspects of the other categories are really facets of the program design and should also be considered from the beginning of the design process.

In program implementation, the focus is on how the project is actually being carried out – does it accurately reflect the original vision and design? If not, what changes were made and why? Does it address currently accepted standards of "best practice?"

1. *Inclusive Participation*

The program should encourage the participation of all stakeholders (including children) at all stages of the process, and should actively consider factors such as gender, culture, and abilities.

2. *Collaboration*

There should be collaboration among appropriate individuals, other programs, agencies, and organizations. The nature and goals of the program will dictate the exact nature of the collaboration.

3. *Best Practice*

The program design should review and incorporate applicable ideas of current "best practice" in terms of social understanding, scientific accuracy, and use of appropriate scientific procedures.

4. *Relevance/Student Direction*

The focus should be on problems or issues that are of relevance to the participants. In the case of youth programs, this means that their interests should guide the initial research.

5. *Prior Knowledge*

Prior knowledge and experience affect learning, behavior, and attitude, and programs should be designed to incorporate a constructivist approach that starts from the current level(s) of the children's understanding.

6. *Real World Setting*

The greatest impacts occur when research is related to real problems and issues, and action is situated in the local environment.

7. *Control*

For effective action research and action projects, participants need to have a measure of control over the process and resources, including decision-making authority and the ability to make changes. This is especially important when choosing appropriate projects for children's participation.

8. *Problem Assessment*

Before beginning a program or project, participants should identify the issues, and thoroughly assess the problem to be addressed.

9. *Critical Analysis*

The program and activities should provide participants with the tools and skills necessary to analyze information for accuracy, bias, and underlying messages.

10. *"Real" Research*

Participants should be involved in research that uses the tools, methods, and processes of scientists and social scientists.

11. *Procedural Accuracy*

The program should emphasize the importance of accuracy in data collection and analysis, so that results will be convincing to scientists, resource managers, and the community at large.

12. *Technology & Methodology*

The program should use appropriate technology and incorporate state-of-the-art science methodologies.

13. *Technical Assistance*

Scientists, technicians, and other community members should work actively with the youth to address the identified problem.

14. *Uncertainty*

Projects should demonstrate that research has uncertainties, and that methodologies, aims, and problem definition may shift as research proceeds.

15. *Active Participation*

Activities should involve all learners as active participants.

16. *Team Approach*

Group learning should be emphasized and participants should work as a team to solve problems.

17. *Skill Building*

Project activities should provide opportunities for participants to develop skills such as the ability to ask questions; form hypotheses; and gather, organize, interpret, synthesize, and communicate information.

18. *Communication*

There should be a strong emphasis on development of communication skills so that participants can express their opinions, participate in meetings, write proposals, communicate the results of their research, and work with others.

19. *Process Focus*

Knowledge should not be separated from the process used to "find out," and results should be assessed accordingly.

20. *Problem-Solving*

A problem-solving approach will help participants develop skills that can be transferred to other aspects of their lives and to solving other environmental or social problems.

21. *Practice*

Participants need to practice doing what they learn, and apply their learning to real situations.

22. *Time & Opportunity*

The program should allow both time and opportunity for participants to explore the environment, become familiar with the issues, and practice using the appropriate research tools and techniques.

Several research cycles are needed to allow sufficient time for reflection, action, evaluation, and improvement.

23. *End Results*

The activities should have definable and useful end products for the participants. This will increase their feeling that what they have done really matters and that they can have a positive impact. Attention should also be paid to ways of disseminating the results.

24. *Personal Development*

The program should be structured to encourage development of self-confidence, self-esteem, and a sense of cultural or community identity.

25. *Valuing Diversity*

The activities and instructional strategies should be appropriate for participants' backgrounds, abilities, and individual learning styles, and should present a balanced viewpoint that incorporates multiple perspectives.

26. *Open-Mindedness*

Program activities should encourage curiosity, questioning and creativity, and should promote a change in awareness.

27. *Trust*

The learning environment should be safe and supportive, so that participants can develop a sense of trust in each other.

28. *Risk-Taking*

The development of open mindedness and trust should encourage participants to develop a greater willingness to take intellectual and social risks.

29. *Support of Teachers/Facilitators*

The children or youth need an appropriate level of support from the teachers or facilitators. The amount and nature of the support will be dependent on the participants' age, abilities, and experience, and may include direct instruction, material support, or more indirect help in refining research questions and methodologies, etc.

<u>Program Content</u>

The general trend in science education in the United States today is toward depth, rather than breadth, of coverage, with a greater focus on process skills than on content (National Science Resources Center 1997). Nevertheless, unless programs also incorporate accurate scientific information and an emphasis on knowledge construction, student products may end up being, in the words of one teacher, visually appealing but "embarrassingly often, almost content-free" (Hume 2001).

1. *Current Scientific Understanding & Accuracy*

Scientists and technicians should help develop program content, and it should include accurate, currently accepted scientific understanding.

2. *Standards*

For school programs, the curriculum and materials should be aligned with, or complementary to, national and state curriculum standards.

3. *Broad Concepts*

The activities should provide background and opportunities for participants to develop knowledge of important scientific concepts, and an understanding of relevant issues and relationships, both "scientific" and social.

4. *Systems Processes*

The program should help participants develop an understanding of important processes and interactions in physical, life, and Earth sciences, and of the interrelationships of humans, society, and environment.

Program Evaluation & Assessment

Wulf and Schave (1984), writing about educational evaluation in the 1980s, noted that people often develop really good projects, bring them to the point of testing in the classroom or field setting, and then the funding runs out and the project dies. The project never realizes its potential effectiveness because it was never evaluated and disseminated for greater use. Today, with the emphasis on action research and development of process skills, continual assessment and evaluation (both formative and summative) are essential to program success.

1. *Reflection*

All participants should have the opportunity to discuss and reflect on their actions and make changes based on their experiences. They should be encouraged to engage in a critical examination of their assumptions and beliefs.

2. *Feedback*

All participants (teachers, leaders, mentors, and youth) should receive regular feedback from other participants, both during and after the program experience.

3. *Evaluative Monitoring*

Regular evaluative monitoring should take place during the program. This may be done through the processes of reflection and feedback.

4. *Impact Assessment*

Pre- and post-program assessments can help determine the impact of the program on the participants, and in turn, guide future program direction.

5. *Use of Evaluation*

Program administrators should use evaluation results in a constructive way to guide future improvements.

Figure 2.4
Youth Program Assessment Components

Program Logic	Vision & aims Goals Needs	Design & Implementation	Inclusive participation Collaboration Best practice Relevance/student-direction Prior knowledge Real world setting Control Problem assessment Critical analysis "Real" research Procedural accuracy Technology & methodology Technical assistance Uncertainty Active participation Team approach Skill-building Communication Process focus Problem-solving Practice Time & opportunity End results Personal development Valuing diversity Open-mindedness Trust Risk-taking Support of teachers/facilitators
Administration	Governance & mgmt. Planning Support Relationships Capacity-building Resources & infrastructure		
Program Content	Current scientific understanding & accuracy Standards Broad concepts Systems processes		
Assessment	Reflection Feedback Evaluative Monitoring Impact Assessment Use of Evaluation		

CHAPTER 3
RESEARCH METHODOLOGY

3.1 <u>Research Design</u>

This research project was conducted using a mostly qualitative, multiple-case study approach. Validity was enhanced through use of techniques of triangulation (multiple sources of evidence gathered through observation, interviews, and surveys of a variety of stakeholders), peer review, and feedback from key people in the cases being studied. Analytical generalizations were made among the programs to compare what appear to be the key factors in a program's success or failure – pedagogical, political, societal, or cultural factors, individual personalities, etc.

3.1.1 *Why Case Studies?*

There are many possible designs that can be used for educational program evaluation. Weiss (1998) and Yin (1994) agree that case studies are an appropriate design when one is attempting to establish causal links, to relate theory to practice, or to explore situations where outcomes are not clear, or do not occur for a long time period. Case studies can be especially valuable in answering "how" or 'why" questions. In their "naturalistic" approach to evaluation, Lincoln and Guba (1986) emphasize that the socially-constructed nature of multiple realities necessitates a holistic, rather than a reductionist, approach to their study. If we accept the idea that there are multiple realities that are socially constructed, rather than universal "truths," the advantages of the case study methodology for this research, which delves deeply into a specific social context, become apparent.

Yin (1994) also discusses the advantages and disadvantages of using a single-case or multiple-case approach. Single-case studies can be used effectively to illustrate how an already strongly developed theory works in practice or in cases where the researcher is studying a unique or extreme case. However, in general, validity (or credibility in the terminology of Lincoln & Guba) will be increased by use of a multiple-case approach. If two or more cases support the same theory, but do not support other equally plausible theories, you can claim replication. This replication may be either *literal*, where both cases give the results predicted by the theory, or *theoretical*, if a case gives opposite results but for reasons predicted by the theory. Lincoln and Guba (1986) remind us that although case studies can only develop "working hypotheses" that relate to a given and specific context, they can be used to generate plausible inferences about patterns and relationships. As noted previously, there has been little in-depth research into youth environmental action programs. Therefore, my research project was exploratory in nature, with the purpose of beginning to identify patterns, relationships, and questions for future investigation.

3.1.2 ***Reliability and Validity Concerns***

Gilbert (2001)notes that there is an inherent conflict between *reliability* and *validity* in social science research. In traditional positivistic research, validity is defined as the degree to which the research measures the concepts it is designed to measure. Lincoln and Guba (1986) use the word *credibility* as a parallel term in naturalistic research or evaluation. Reliability (or *dependability* in Lincoln & Guba's terms) is the extent to which you will get the same results each time you do the same investigation using the same methods. A focus on quantifiable measures and indicators that can be analyzed statistically generally yields more reliable results, but a lot of the richness and contextual nuances will be lost. Human behavior is dependent on specific context, so in-depth studies that delve deeply into these factors should have greater validity.

Because it is impossible to replicate a case study exactly, Yin (1994) suggests multiple cases be considered multiple experiments, rather than replicates of a single experiment. Using this approach, the case studies can be compared using techniques of *analytical generalization*, rather than *statistical generalization*. Analytical generalizations compare the empirical data from a case study to a theory-based template to see how well it fits. Validity of analytical generalizations can be increased by using what Lincoln & Guba (1986) term "thick descriptions" – providing a detailed narrative of the specific context of the case study so that those reading it can determine how applicable it is to their own specific case or situation.

In the context of this research project, analytical generalizations were made by comparing the cases to the theoretical template, or assessment rubric, described in Chapter 2.

3.1.3 *Sampling Strategy Considerations*

The strategy used in choosing subjects for study is extremely important, because whatever strategy is chosen will impose limitations on the study. In case study research, Weiss (1998) and Babbie (1992) agree that use of representative or probability sampling techniques is generally not appropriate. The following sampling strategies are common in qualitative research, and were used in my research:

Theoretical sampling (Glaser and Strauss 1967)

This strategy has also been called *purposive* or *judgmental* (Babbie 1992) and *quality* (Weiss 1998) sampling. Cases are selected that will contribute to maximum theoretical development. These may be cases that seem to be working the way the theory predicts they should, or cases that don't seem to work the way the theory predicts.

Snowball sampling (Arber 2001)

This sampling procedure is often used when there is no easily accessible list of the total population you want to study. Using this technique, the researcher talks with one or more members of the population, and asks them for suggestions of others to include in the sample. The advantage of the technique is that it may lead to a wide web of people who would not otherwise be included in the population. The limiting factor is that it will only identify people who are in some way connected to the network.

Sampling for maximum diversity (Yin 1994)

For exploratory case studies and theory generation, this strategy uses a wide diversity to help identify subjects and issues for further examination.

3.2 **Research Questions**

3.2.2 ***Stage 1***

The first stage of my research helped establish the landscape within which marine and coastal education is currently taking place in Hawai'i, and identified suitable programs for the case study research. Because there is no comprehensive list of programs of this nature, snowball sampling strategy was used to identify the principal organizations, agencies, and individuals involved in marine and coastal resource management and education in the state. Semi-structured interviews were then conducted with 41 resource managers and educators from 35 identified groups. Figure 3.1 lists the organizations and agencies included in the initial survey. The interviews averaged about 45 minutes in length and focused on answering on the following questions:

1) What types of youth education, action programs, and curricula are currently being implemented in the two states and by whom?
2) In the opinions of resource managers and educators, how important is youth education and youth involvement in meeting long-term resource protection goals and why?
3) What are some of the major impediments to youth involvement in resource management and protection initiatives as perceived by managers and educators?
4) Which types of youth programs are perceived as being successful and why?

3.2.2 *Stage 2*

After specific programs were identified for the case studies, the second stage of the research examined each of the cases in more detail. The principal research questions in the case studies were (the relationships of the questions to the assessment rubric are shown in italicized parentheses):

1) What is the program intended to accomplish? Did any particular environmental issues prompt the development of the project? *(program logic)*

2) What agencies, groups, or individuals were responsible for initiating the project? Did the idea originate from within the local community or from an outside organization? *(program design & administration)*

3) What process was followed in program planning and implementation? *(program design & implementation)*

4) What factors (socio-cultural, economic, political, pedagogical) helped or hindered the development and implementation process? *(all components)*

5) What evidence exists that the program is making a difference? *(program assessment)*

6) What intellectual tools and resources do youth need in order to become actively involved in environmental protection? *(answered through review of research literature and development of rubric)* Which programs provide those tools? *(program design, implementation, and content)*

7) Based on the case studies, what factors appear to influence the success or failure of youth involvement in environmental protection efforts? *(synthesis of all components)*

3.3 **Site and Case Selection Process**

As a result of the first stage of the research, a coastal community on one of the main islands was chosen for more detailed study. Within the community, three different programs were selected for the in-depth case studies. The three programs represent a range of approaches and age levels, including programs in two public charter schools (one elementary and one high school level) and a nonprofit after-school program that drew youth from four area high schools.

The region and the cases were chosen using a theoretical sampling strategy based on the following criteria:

1) The programs appear to be based on information that is commonly accepted as accurate by the scientific community.
2) The programs appear to have a solid pedagogical and methodological foundation including at least three of the following:
   a) a systematic approach that is incremental and developmental.
   b) use of developmentally appropriate materials and activities.
   c) use of a student-centered, inquiry-based educational methodology.
   d) inclusion of a realistic action research component.
3) The programs are being integrated in some way into the formal school system and have been approved by the relevant government authorities.
4) The programs involve the local community (community members outside the formal school system, NGOs, etc.), marine scientists, or resource management agencies.

5) The programs are relatively new, and will be ongoing over a period of at least a year.

6) The programs have potential for use as models that could be adapted for use in other communities.

3.4 **Data Collection**

A variety of data collection techniques, summarized below, was used in the two stages of the research:

3.4.1 ***Stage 1***

Semi-formal Interviews

Semi-formal interviews, ranging between 40 minutes and 1-1/2 hours in length, were held with 41 program managers, researchers, and educators (including key state department of education personnel) on O'ahu, Maui, and Hawai'i. The interviews all followed a similar format, starting with the questions shown as Appendix B. Depending on the answers to the beginning questions, each interview then took a direction specific to the interests of the parties involved. All interviews were recorded, and the tapes transcribed verbatim.

Website and Printed Material Review

Other sources of data included websites and printed material such as publicity brochures, newsletters, and annual reports.

3.4.2 ***Stage 2***

Observation/Participant Observation

Observation and participant-observation techniques were used over the course of one school year (early October 2001 through May 2002) with each of the selected case studies. The number and duration of the observation periods, and the degree of observer participation, varied depending on the nature and timing of the specific program. This is discussed in more detail in the individual case study descriptions.

The observations were qualitative in nature, with descriptive and reflective notes being recorded on paper in separate columns using a format modified from Creswell (1998). After each observation session, the handwritten notes were reviewed, then entered on the computer, and any additional reflections added. No attempt was made to record specific quantitative data such as the amount of time spent on a particular activity or the number of repetitions of a given behavior. Instead, the observations focused on broad key behavioral indicators that had been determined in advance (Appendix C) as being important to answer the research questions.

Focus Groups, Semi-formal, & Informal Interviews

For each of the case studies, two focus groups were conducted with the educators or youth leaders who were in charge of the program. One took place near the beginning of the study and a follow-up was held at the end of the school year. The initial focus groups looked at the genesis of the program, the leaders' goals and plans for implementation of the program, their perceptions of important environmental issues and the role of their students in addressing the issues, and their opinions on successful education strategies and potential limiting factors. The second focus group served as a self-evaluation of the program by the teachers or leaders – How well did the program match their initial expectations? What worked well and what didn't? Why? What changes will they make in the future as a result of this year's experience?

Similar focus groups were held with students in the two high school level programs. In the initial focus groups, students were asked for their opinions about their community and the local marine environment (both positive and negative aspects). They were also asked why they chose to participate in the program and what they hoped to get out of it. During the second focus group session, the students were asked what they had learned during the program, whether or not the program met their expectations, what they liked and didn't like about the program, and what changes they would recommend for the future.

All focus group sessions were tape recorded, and the tapes transcribed verbatim. Starting questions for the teacher/leader and the student focus groups are shown in Appendices D and E.

Due to time restrictions, there was no initial focus group for students in the elementary school program. At the end of the year, however, the individual teachers in the elementary school program conducted evaluatory focus groups with the students in their project groups. This is described in more detail in that case study.

Semi-formal interviews were also conducted with other adults who were involved with the projects at various levels. These included school principals, scientist mentors, resource agency managers, student teachers, and parent volunteers. Throughout the year, informal conversations and discussions were held with students and individual teachers/leaders when opportunities arose.

Meetings

Data collection also included attendance at a variety of special program planning meetings and regular teacher staff meetings.

Review of Websites, Printed Material, and Student Work

Depending on the specific case, other sources of data included websites; printed material such as publicity brochures, newsletters, and teachers' lesson plans; and student-generated work such as tests and reports. These are discussed in more detail in the specific case descriptions.

3.5 Analytical Procedures

As in most case study research, the data analysis process was to a large extent iterative; i.e., it evolved and was refined as the research progressed and new questions were generated. After each of the observation sessions, interviews, and focus groups, the tape-recorded notes were transcribed and reviewed. This often led to follow-up questions and a slight refocusing of further observations.

A coding scheme, consisting of 5 major thematic categories and a total of 47 sub-categories, was developed from the elements noted in the assessment rubric described in Chapter 2. The elements were also keyed to the major research questions. For each of the cases, observation, interview, focus group, and meeting notes, as well as written materials, were then analyzed and compared to the codes to see how they fit the various components.

During a review of the notes, some patterns emerged that didn't fit neatly into any of the categories. These were generally in more subjective areas such as teacher bias (possibly unconscious), that might be reflected in the vocabulary used or the leading questions asked of the students. Where noted, these patterns have been described in the case studies, with the caveat that they are subjective interpretations on the researcher's part.

3.6 Possible Limitations of the Study

The study was conducted by a single researcher. Due to a background in environmental and science education, I am a proponent of the social-constructivist paradigm of learning, and am aware that this orientation may lead to a certain bias in the study. I have tried to minimize this bias by an extensive literature review, accurate transcriptions of taped material, detailed and accurate descriptions of my observations, and the use of the assessment rubric. The teachers and leaders of each of the case study programs were also given the opportunity to review and comment on the draft descriptions.

In addition, the study was limited to a very short time frame (eight months) during a year that, in many respects, may not be representative. The terrorist attacks of September 11 occurred at the beginning of the school year. This had a profound impact on the residents of Hawai'i, both because of an economic decline due to a drop in tourism and in a deeper, more fundamental psychological sense. It is impossible to know how this may have affected student and teacher attitudes during the year. Even in "normal" circumstances, there may be specific factors or isolated events that positively or negatively affect a program in any given year. Again, I have tried to address this through detailed contextual descriptions of each case.

The following case studies are not intended to be program evaluations in the formal sense. Their value, I believe, lies in the focus on the process of program planning and implementation, the identification of factors which (in these particular cases) seemed to enhance or impede chances of program success, and the perceptions of the key actors involved. As with any case study, the results are context-specific, and the reader needs to consider this carefully when determining their applicability to his or her own situation.

3.7 **Case Studies: The Community Setting**

The case study area is located on one of the main Hawaiian Islands. In 1996, the economy of the island was based on five main sectors: service industries, related primarily to tourism; retail and wholesale businesses; county, state, and federal government; construction and manufacturing; and agriculture. Tourism and tourist-related industries provide the community's economic backbone, with almost 1.3 million tourists visiting the island in 1997 (Division of Business 1999).

The chosen case studies are all located in the coastal zone. They include programs at two public charter schools (one high school and one elementary) and an after-school program run by a local nonprofit organization. The names of the school and organizations have been changed to protect their anonymity.

3.8 **A Note on Charter Schools**

Charter schools are nonsectarian public schools, based on specific state laws, which have more freedom of governance and operation than most public schools. This allows communities to determine their own school management strategies, curriculum priorities, and teaching methodologies.

Although the concept dates back to reform efforts of the 1970s, the first actual state-approved "charter school" was not established until 1991, when Minnesota passed a charter school law. By 1999, 36 states had passed similar laws, and more than 1,700 charter schools were in operation in 34 states (uscharterschools.org 2002).

In Hawai'i, charter schools are officially known as "new century charter schools," reflecting wording from Act 62, which was signed into law on May 27, 1999. Act 62 constituted the third revision of the original 1994 charter school law that allowed the establishment of "student-centered schools" in Hawai'i. The new law requires that charter schools in Hawai'i be free to all students, have a nondiscriminatory admission policy, and comply with all statewide performance standards. The law allows an existing public school to convert the whole school, or a particular program within the school, to charter status, and also permits the establishment of new charter schools. In return for increased accountability by complying with state standards, they are free from other state statutory and regulatory requirements affecting public schools. Funding amounts are determined by the legislative auditor, and charter schools are supposed to get per pupil funding equivalent to that of the regular public schools (Hawaii Association of Charter Schools 2000). In the first year after Act 62 took effect, 25 charter schools opened their doors in Hawai'i, including the two that are featured in the following case studies.

Figure 3.1

Organizations & Agencies Interviewed

Federal Government

Hawaiian Islands Humpback Whale National Marine Sanctuary
National Marine Fisheries Service Laboratories
Western Pacific Regional Fishery Management Council

State Government

Division of Aquatic Resources – Hawai'i
Division of Aquatic Resources – Maui
Division of Aquatic Resources - O'ahu
Hawai'i Institute of Marine Biology
Hawai'i Sea Grant
Hawai'i State Department of Education
Hawai'i State Department of Education Teleschool Program
Kaho'olawe Island Reserve Commission
Maui Community College Marine Science Program
University of Hawai'i – Hilo Marine Biology Program
University of Hawai'i Marine Options Program
Waikiki Aquarium (University of Hawai'i)

County Government

Richardson Ocean Park
Hanauma Bay Education Program

Nongovernmental Organizations & Citizen Groups

Hawai'i Audubon Society Pacific Fisheries Coalition
Hawai'i Nature Center
Kona Family YMCA
Kula Nai'a Foundation
National Marine Educators' Association
Oceanic Institute
Pacific Whale Foundation
Queen Lili'u-o-ka-lani Children's Center
Reef Check
Sierra Club Water Sentinel Program
The Nature Conservancy
Waimea Family YMCA

Schools

West Hawai'i Explorations Academy
Hawai'i Preparatory Academy

For Profit & Tourism Companies

Dive Makai
Dolphin Quest
Maui Ocean Center
Sea Life Park

Other

Community volunteer

CHAPTER 4
SUNSET SCHOOL OCEAN PROGRAM

Sunset is a public charter school for students in grades 3 through 5. Because of personal interest in the environment and environmental issues, the teachers chose to design their curriculum around a different biome each year. They decided to begin with a study of the ocean because of its relevance to the children's lives. Over the course of the 2001-2002 school year, the students spent their daily afternoon "project time" learning about different aspects of the ocean environment.

4.1 **Methodology and Information Gathering**

During the Sunset case study, I observed 43 separate classroom sessions, totaling about 41 hours, over a period of approximately 8 months. Most of these observations were during the afternoon "project time" because that was when there was the greatest focus on the ocean environment. At the start of the year, the students had been randomly divided into five groups for the project time. To obtain an overall picture of how the program functioned, I chose to focus my observations on one of those groups as they rotated through the various teachers and units of study. During the "Inquiry" sessions, which are described in more detail below, the students were divided by interest groups, and I made short visits to the various classrooms to observe each of the groups.

At first, my role was strictly that of an outside observer. As time went on and both teachers and students became accustomed to my presence, I became more of a participant-observer. Students would ask me questions about the marine topics they were studying and the teachers would discuss the curriculum and ask if I had ideas or suggestions for activities. At the request of the teachers, I also presented several slide programs about coral reef ecology and issues, and led one classroom activity about animal adaptations.

In addition to the classroom observations, I attended seven of the weekly teacher curriculum meetings (usually from 1 to 1-1/2 hours in length), and reviewed the school website, some of the teachers' written lesson plans, and samples of student work including unit pre- and post-tests. I held two focus groups with the teachers – one near the beginning of the school year to explore overall goals and expectations, and one at the end to assess the year's achievements.

At the end of the year, to get the students' perspectives, each of the teachers conducted an assessment focus group session with the students in her group. This will be discussed in detail later.

4.2 **Student Population and Parent Involvement**

Sunset has a year-round open enrollment period, with a cutoff date of April 1 for the following school year. They accept applications from parents of students going into grades 3, 4, or 5, and give preference to students from the local school district. After April 1, if there are more spaces than applicants, they accept all those who have applied. If there are more applicants than space, they use a lottery system to determine acceptance.

Special education students are also accepted into the school after consultation with their parents. At present, however, the Hawai'i State Department of Education policy allows parents to enroll their children in the regular local public school and receive special education (SPED) services, or to attend a charter or private school and decline SPED service.

According to the school director, the student population comes from a wide range of socioeconomic and cultural backgrounds and represents typical school demographics for the local area. However, because parents have to take the initiative to apply to the school, it seems fair to say that the students tend to come from families that place a higher than average priority on education. After the first year, the director compared her experience at Sunset with her 31 years in the regular public school system, stating:

> Participation at meetings and events is extremely high compared to regular public school. We always had about 90 to 95 percent parent participation compared to less than 50 percent at the regular public school. We had a large number of volunteers who helped in a variety of ways throughout the year. At our Mahalo (Thank you) Dinner, we recognized 30 different individuals for sustained volunteerism at the school. In addition, we had about 40 more parents who participated in single events like field trips or sharing a talent or lesson with students. Out of 90 parents, we had approximately 70 who were active during the day hours.

> Night events, as I said, were well attended by 95 to 98 percent.

4.3 **Background, Vision, and Goals**

Sunset School opened its doors in September of 2001 with 93 students in grades three through five. The school was initiated by five teachers from the regular public school system who were, in the words of one, "[. . .] eating lunch together, moaning and groaning [. . .]" about the problems they were facing as teachers. They were all frustrated by the current school structure, which gave them little leeway to change things such as curriculum, teaching styles, or scheduling in ways that they felt would be in the best interests of the children. After about six years of informal discussions, the teachers decided to take the plunge and apply for charter school funding.

Their overall vision was to create a school that would allow them the freedom to tap into the particular strengths of each teacher, and to work as a team in all aspects of curriculum development, scheduling and teaching. They felt that it was important to include regular meeting times during the school day in order to continue building as a team and to provide opportunities for reflection, discussion, review, and revision of their progress. Without actually articulating it, the teachers chose an action research model for the development of the school.

The teachers agreed that their major educational goal was to help the children develop skills that would allow them to become independent learners and to take more responsibility for their own learning. When designing the program at the beginning of the school year, the teachers emphasized the use of eight strategies to work towards that goal. These strategies came from a combination of the teachers' experience (which ranged from 5 years to 32 years) and a review of national evaluations of curriculum materials and programs promoting "best practices" in science education.

Smaller class sizes

Class sizes ranged from 17 to 19 students. Smaller class sizes, the teachers felt, would allow them to devote more attention to the students' individual needs and interests.

Division of teacher responsibility

In contrast to the normal self-contained classroom, where a single teacher is responsible for teaching all subjects, the teachers chose to divide the subjects by their individual interests and strengths. All five taught reading and math classes in the mornings, but the afternoon sessions were divided, with two teachers focusing on science, two on social studies, and one on computer technology. As one of the teachers expressed it:

> We wanted the kids to be able to go to someone whose real expertise and passion was that subject area, because we felt that would deliver deep curriculum, and the motivation to learn that kind of curriculum, instead of one person trying to do that for all subject areas.

Multi-age grouping

Instead of working in grade-level classes, the students were randomly placed in multi-age groups. During the morning reading and mathematics sessions, fourth and fifth graders were mixed together, while third graders had their own classes. For the afternoon ocean study project time, all three grade levels were combined in each group.

Multi-age groups, the teachers felt, would provide more flexibility and promote peer mentoring among the children. About six weeks after the school year had begun, they were still enthusiastic about the strategy, but admitted that it was challenging to carry out.

For reading and mathematics, their original philosophy had been to move the children up as their ability levels changed. However, they found it difficult to coordinate this movement, and became concerned about some possible impacts of the system:

> When we first envisioned the school, we thought third graders, fourth graders, and fifth graders would just be grouped according to their ability in math and language. Then we started to think about what the social ramifications would be like for a fifth grader with mostly third graders. So then we decided that we wouldn't do that, we would group them fourth and fifth grade together, and third grade would be added when they're older. But still, we struggle all the time how we're going to move this third grader up, how we're going to move this fourth grader down because they're not able to do the work. They're not making it. So that is a struggle for us. I don't think we've solved it yet.

Among the drawbacks during the project time, when the three grade levels were combined, they noted that it was a bit harder to plan their lessons because they had to address a wider range of skill levels:

> Sometimes the lessons are a little too challenging for our youngest students. But again, it's the exposure, so we try to adjust by thinking that for the youngest students [. . .] they have the exposure that they'll be able to use in subsequent years. They don't have to learn everything, because they are younger, but the exposure is giving them a challenge."

From a pedagogical viewpoint, they all agreed that the multi-age grouping was beneficial:

> While it can be a drawback at times, it really fosters discussion. It makes kids think about things they might not have otherwise thought of. I think it allows, sometimes, younger children or less skilled children to be introduced to topics that may not be presented to them if they were in a group that was all of their own skill level or their own age group, because the teacher might not think it would be appropriate, and it would probably be impossible if you didn't have some higher skilled children in there to help. And then for the higher skilled kids it allows a lot more range of topics too.

Among the other positive features, the teachers believed that the grouping improved social relationships between the children by developing an atmosphere of 'ohana (extended family) in the school, and erasing sharp distinctions between the grade levels. It could also promote higher expectations without individual pressure.

Problem-based learning

The teachers felt that one of the most successful educational strategies would be a focus on "real issues that are around them right now." They considered environmental issues a priority and decided to focus on a different biome each year, beginning with the ocean biome. The students were already familiar with many aspects of the ocean environment, the teachers reasoned, so they could build on this background knowledge. In addition, relating the first year's curriculum to a familiar local biome would help build a platform for future years' study: "When they go into another biome that may not be as familiar, they'll have a process and some content that they can build on from there, versus us starting with, say, the Arctic tundra that they have no background knowledge about."

When asked what they considered the most important local marine and coastal issues that the children should be aware of, the teachers named overuse of the coral reef by divers and snorkelers, collection of tropical fish, coastal development, and overfishing.

One teacher expressed her concern about the students' lack of general environmental understanding: "Because we live on an island and the kids spend, I would say, about 90 percent of their free time at the ocean, it is important for them to be aware of the impact that they have on it. I don't think they're aware that they do impact it."

Another teacher was drawn to the approach because she felt that the students need a better understanding of their environment in order to make good decisions in the future: "The kids, although they can't make the decisions now, will make the decisions in the future, and maybe they can help their parents make good decisions about what we do in our environment."

A third teacher agreed with her:

> As for me, it's letting kids have the knowledge to be able to make their own decisions about what they feel is proper or not. And they're young yet, but I think if we can continue with that focus of giving them the knowledge in different areas and having them come up with their own conclusions, that's a powerful learning tool for them, because that's what we all have to do as adults.

She added that it was important to encourage the children to believe that they could make a difference:

> And if you believe that you're going to work toward something where you can make a difference, you will do the work that it takes to help meet whatever goal that you have. But if you are never involved, even as an adult, there are a lot of adults that feel that "I don't need to go to that meeting on overfishing, because I'm just one more person. They don't need to hear from me." [. . .] So you want to help cultivate that awareness that they can make a difference and that it's important that they become involved because if you are not involved, then things won't necessarily happen.

The teachers all agreed that, when using environmental issues for problem-based learning, it was important to present all sides of an issue and promote open-mindedness among the students:

> We're trying to teach process skills, not teach opinion, but to show them that, if there's a controversial issue, there's always two sides and what is your job? Your job is to listen to both sides and then get the facts, weigh those facts and then, based on your experience or what you think, you make the judgment. Not everyone will come up with the same conclusions.

One teacher noted, "We have a lot of parents that this is how they make their living, going out and fishing or collecting or whatever. And you know, you have to be sensitive and not say that what daddy does to make his living is wrong."

Another expanded on this idea:

> To me, anytime there's a controversial issue about your environment, you have to look at it as objectively as you can for the long-term good of the community, and that's difficult to do when your livelihood depends on it. I think if you don't start having the kids realize they have to look at the issues from all sides, they start getting caught up in the emotional issue and then you don't necessarily always make the best decision.

To foster the development of knowledgeable voters and decision-makers, they felt it was important for students to be exposed to the issues when young and to acquire background knowledge, information, critical thinking skills, and process skills that would allow them to weigh all the factors and make an intelligent decision about a particular issue.

Student-centered and student-directed

The teachers also believed that it was important for students to take ownership of their own learning. As one expressed it, "This is their school. They can come to decisions about what they want to do." To achieve this aim, they developed a number of strategies, including the creation of special interest clubs based on the children's own ideas and suggestions. Students were also expected to participate in regular school maintenance chores such as inspecting the bathrooms for cleanliness, picking up trash, watering the plants, and wiping down the picnic tables. Six weeks into the school year, the teachers saw a positive trend. "At the beginning, we had to remind them of their jobs. Now they remind us - 'I have to go sweep. I have to go pick all these things up.'"

During the ocean study project time, the teachers decided to use student-generated questions and projects as much as possible. They saw their role as facilitators to help guide student learning by providing needed materials, asking questions to help the children focus their study, and allowing them to discuss and test their ideas. This proved to be more challenging than they had expected. Again, about six weeks into the year, one teacher commented that it was difficult to get the students to come up with questions because they didn't know how. She continued:

> Some of the kids, this is their fifth year in the public school system. They're used to the kind of teacher-directed "This is what you'll do tonight;" "Write your homework," whatever [. . .] The teacher gives everything, and the kids have a real hard time when we say "What do you want to learn?"

All agreed, however, that it was becoming easier as the year progressed. "They're getting it," said one teacher. "The kids are excited." "The parents are excited," added another.

"Inquiry" time

In addition to the ocean-theme project classes, the teachers decided that the students would engage in periodic "Inquiry" projects. During this time, the children would have a free choice of subject and would develop their own questions for inquiry, which they could work on either individually or in small groups. The purpose of the Inquiry projects was to capitalize on the students' own interests to promote their curiosity, imagination, and creativity. At the same time, the inquiry process would help them build skills in devising research questions, forming hypotheses and theories, making predictions, collecting and analyzing information, and recording and presenting results. It would also help the children realize that, as stated in the school's written curriculum overview, "authorities can be wrong and that any question is reasonable."

Emphasis on communication skills

The staff felt that development of communication skills, ranging from casual conversation to formal presentations of data using a variety of media, was extremely important in all subject areas. In particular, they wanted the students to learn to use the language and terminology of science correctly, and to find ways to relate science to other aspects of their school learning.

Assessment

The teachers realized that the children's communication skills were also an important component in an ongoing assessment process. Teachers could assess the extent of prior knowledge from the questions that the students asked, and chart student progress by asking them to communicate what they had learned.

Other planned assessment strategies included teacher observations of the students as they worked, pre- and post-tests for project units, and the use of computer simulations, journals, and project binders.

4.4 **The Ocean Study**

4.4.1 ***Structure and Instructional Strategy***

The staff decided to structure the year's study by dividing the ocean biome into zones extending from the land outward – beach and tidepools, coral reefs, the open ocean, and the deep sea. During a five-week period, the study would focus on one of the ocean zones and the groups would rotate through the teachers, spending one week of daily afternoon "project time" sessions with each teacher. During this time, two of the teachers would focus on science relating to the zone being studied, two on social studies, and one would incorporate computer technology and skills. The afternoon project time sessions were 1-1/4 hours in length, with the exception of Wednesdays when they were cut to 45 minutes because of early school dismissal.

During weekly curriculum meetings, the teachers determined a general breakdown of content to be covered in the succeeding rotation, and negotiated who would teach which content area. Each teacher then developed her own lesson plans for that content.

Each five-week rotation was to be followed by one week of "Inquiry." During this time, the students were expected to develop their own inquiry questions (on any topic), research the question, and present the results to their classmates. For the Inquiry time, the student groups were based on similarities in their choice of topics and each teacher facilitated one or more groups. The students were allowed to conduct their inquiries individually or in pairs or small groups.

Midway through the second five-week unit, it was becoming clear to the teachers that the system was not working as well as they had hoped. During a curriculum-planning meeting, one teacher expressed her opinion that the one-week rotations were too short and did not allow for enough depth of coverage of the basic concepts. The students were unable to come up with inquiry questions that related to the subject being studied, she argued, because they didn't have enough background knowledge. She suggested that they extend the time with each teacher from one week to two, so that the entire unit would take ten weeks instead of five. The Inquiry sessions would then be extended from one week to two, allowing the students time to research their questions in more depth.

Not all of the teachers agreed with this view; one felt that the time was already adequate to address the subject in enough depth, stating that she had learned early on that she wasn't going to be able to cover everything in the time allotted. After a period of discussion, however, they agreed to try the proposed new schedule of a ten-week project unit, followed by two weeks of Inquiry. They continued to follow the new schedule for the remainder of the school year.

4.4.2 *The Ocean Project in Action*

I began my classroom observations near the end of the first five-week unit, and followed one group of students (Group 5) through the rest of that rotation. I continued to focus on that particular group of students for the rest of the year. The description of the first unit is based on what was reported to me by the teachers, a review of the written material given to the students by the teachers, and my own observations of the final week of the unit.

Beach & Tidepool

The first unit focused on the beach and tidepool zones. At the beginning the unit, the entire student population went on a field trip, with half of the students walking to a small local tidepool, and the other half traveling by bus to a beach and tidepool area in a nearby national historical park. At the site, the students were divided into four smaller groups for tidepool explorations. Assisted by parents as well as by the teachers, each student had to choose one tidepool animal, observe it and describe its behavior. In addition, the students were given a worksheet entitled "Sharing the Beach." They were instructed to look for evidence of ways in which humans had affected the beach environment, and record their observations under one of four categories: things they saw, heard, smelled, and felt that were caused by people. Back in the classroom after the fieldtrip, they discussed their observations.

Science

Over the next week, one of the science teachers (KL) had her students work in pairs to research and write a report on a tidepool animal of their choice. The following week, after completing their research, the students rotated to another teacher (MT) where they created a tidepool mural. With the assistance of a part-time art teacher, PR, who painted the tidepool background, each student worked independently to create an artistic representation of his or her animal. PR told them that they could use any medium or combination of media they wished to make the animal, and gave them suggestions, such as paint, collage, papier-mâché, etc.

MT instructed the students to find a picture of the animal in a book or on the Internet before beginning the art project. Six students immediately rushed to the computers lining the wall of the classroom. Since there were only five computers, MT directed some of the others towards books. As the students settled down to work, PR and MT walked around the room observing and talking with the individual students.

The students were given two days to complete the artwork. On the third day, they gave oral presentations to the rest of the class. Before starting the presentations, MT told all the students to get paper and pencils, and prepare to take notes on the presentations. They were instructed to record their name, the student presenter's name, the animal name, what they liked about the presentation, and what they learned from it. MT reminded them that the goal was to listen and learn from others, not to think about their own presentations.

During the student presentations, about half of the class was fidgeting and looking bored. Some were drawing or writing, and one boy was spreading glue over his hand. After the first presentation, MT reviewed what the other students were supposed to be doing (taking notes). As the presentations continued, the students became more interested and focused, and began to ask questions of the student presenter. For example, Arthur talked about hermit crabs and gave facts about what they eat, where they live, how they produce eggs, and the size of the crabs at hatching. The children were especially fascinated by the hermit crab diet, and Arthur was asked to repeat some of the information several times, so they could write it down. They appeared quite comfortable with correcting each other if they felt the information was wrong – when Karen called a green sea turtle a mammal, her partner corrected her and said that it was actually a reptile.

After the class had ended, MT commented to me that normally she would spend a lot more time on the presentations, but that they did not have enough time in the schedule to allow for it.

<u>Technology</u>

During the week in the technology class, the students were introduced to basic Internet skills. The school's computer room has enough work stations for every student, with 15 desktop computers, three laptops, and two printers, as well as a large television monitor.

When introducing the students to Internet search skills, the school director (GN), who was substituting for the regular classroom teacher, explained the process while demonstrating on the television monitor. She gave each student a worksheet titled "Tide Pool Quest," and reviewed the directions before the students dispersed to the computers and began working. They were instructed to use an on-line dictionary to find the definitions of words related to tidepool animals, use a search engine to do a topic search on echinoderms, then use Google Image Search and

Microsoft Office Design Gallery to find a picture of a mollusc, and compare the difference between the two image sites.

The worksheet also instructed the students to use Yahooligans for a category search, and find some information on hermit crab claws. Other activities included a review and comparison of two Webquest sites, and a tidepool learning activity based on the school's own "Learning Zone" site.

This assignment appeared to be very challenging for many of the students. The vocabulary was quite advanced, containing words such as invertebrate, arthropod, and echinoderm. GN had to define many of the words for some of the students, and there were more questions than she had time to answer. Two or three student hands were up at all times.

Coral Reefs

The five-week tidepool study was followed by a week of 'Inquiry' after which the focus shifted to the coral reef, again for a five-week period.

Science

Group 5 began their study of coral reefs with one of the science teachers (KL). After reminding them that they were spending the year studying the ocean, working their way out from the shore to the deep ocean, KL asked them what zone they thought would come after the tidepool. Guesses included the coast and the surf zone, and KL prompted the students to get the response she was looking for.

KL then passed out a paper asking the students to list three things that they know about the coral reef, and answer the question "What would you like to know about it?" Some of the students filled the paper out immediately, but others appeared to have difficulty. It seemed to be especially difficult for some of them to think of things they would like to know, and several students asked KL if the questions they wrote down were okay. After collecting the papers, KL read some of the students' responses to the rest of the class.

KL told the students that they were going to make models of coral polyps, and passed out a worksheet with pictures. She asked one student to read the description of the coral polyp, while she drew it on the board. KL then reviewed the directions for making a coral polyp out of clay and demonstrated as she read. She passed out balls of clay to the students and instructed them to make their own polyps. The bell rang, indicating the end of the period, but the students all kept working. As the students finished, they brought their models up to KL who placed them on a shelf.

When the students returned the following day, KL called them over to a corner of the room where there was a sofa, a couple of soft chairs, and a carpet. She said that she wanted to read them something from a book on coral reefs. As she read, she stopped frequently to explain the more difficult words or concepts. She also told them a story about taking a piece of coral and killing it when she was younger and "didn't know any better." She passed around a couple of pieces of coral skeleton and a magnifying glass so that the students could examine them closely. While the coral was being passed around, the students were chattering excitedly about their personal experiences with snorkeling and swimming. KL listened attentively to what the children said, giving the impression that she could learn from them as well.

The students returned to their desks and KL put on an overhead projection showing a coral planula. She asked the students to pronounce the word, and then showed them the stages of coral settlement, growth, and reproduction by budding and spawning. After she finished the review, she passed out an unlabeled sheet with the pictures of the coral cycle and asked the students to label and color them.

Later in the week, the students reviewed the vocabulary they had learned and were introduced to the concept of symbiosis. One day they watched a video about a Caribbean reef system, and were instructed to record at least four animals that they saw living in the reef. They were allowed to record the information either in words or by drawing it, and had to note where it was seen in the reef system. After watching the video for about ten minutes, the students were given a paper with an outline of a coral reef and instructed to color the picture and draw the animals they had seen in the appropriate area of the reef.

KL put the video back on while the students were working – some students stopped drawing to watch; others ignored it altogether. As the video continued, most students began to focus more on their drawing and less on the video. There was a lot of discussion and talking among the students, but it seemed to be mostly about the work they were doing.

After about ten more minutes, KL asked the students to share what they had drawn. Overall, the students were very eager to share their work with their classmates. Several students raised their hands and read their list of animals. One student included a hammerhead shark in his drawing, which had not appeared in the video. Another drew a whale, which had been shown in a different part of the video.

Social Studies

During the second week of the coral reef study, the group moved to the room of one of the social studies teachers (JB). JB had chosen to focus on environmental issues affecting coral reefs, covering tourist behavior while snorkeling (stepping on corals, feeding fish, and improper use of sunscreen), aquarium fish collecting, and coastal development. She started the week by having an aquarium fish collector come in to show a video and talk about the fish collection industry.

The following day, JB wrote "fish collector" on the board. She chose one student, handed him a pair of swim fins, and said that he would represent a fish collector. She said she was going to give them some facts and opinions about "Kimo" – he didn't speak good English and he was married with two children. She showed the students pictures of the fish that he collects. Then she wrote on the board while continuing to talk – he is supporting his family, he pays rent, he is hardworking. He keeps the fish in big tanks under his house. She listed a problem – he can only collect from certain areas because of government regulations – and then read a list of local areas that are closed to fish collecting. She asked the students to copy what she had written on the board.

She then erased the board and said, "This is what the environmentalists would say," noting that fish collecting was "disturbing nature." She asked, "Can anybody think of any other bad things about fish collecting?" One student mentioned pollution from the boat, but the other students had few ideas, and the teacher prompted them to get responses such as "feeding the fish to attract them would change the balance." The lack of responses may have indicated that the students did not understand the issues well enough to comment on them.

JB gave the students some statistics about the density of certain species of fish in collecting areas versus protected areas, and added that nobody has been able to breed these fish species in tanks. She also asked the students how easy it would be to cheat and take fish from a forbidden area. (She started by asking them how many of them thought they could get away with cheating in school if they really wanted to. Most of them said that they could.)

She then told them that they were going to have a debate of the "environmentalists" versus the "tourists" about whether or not snorkeling should be allowed on the reef. She closed her eyes and counted to ten, while the students chose which side they wanted to take. Initially, eight students chose the "tourist" position, and ten supported the "environmentalists". The teams had to take turns – only one student from each side could speak in each round. After a few minutes, she stopped the debate and allowed the students to change sides if they wished. All but five switched to the tourist side.

During the debate, the students kept repeating the same things over and over: "How do you know it's our fault?" from the "tourists", and "'Cause there used to be more fish," from the "environmentalists". By the time the period ended, there was too much noise and confusion for JB to wrap up the lesson, so she said they would continue the discussion on the following day.

After the class, three students talked with JB about the issue and she told them that the previous project group had come up with a proposed solution - to educate the tourists to be responsible snorkelers.

It appeared that JB had wanted the students to come up with certain answers during the debate so that it would lead her into the next activity.

Two days later, the students were again doing debates. This time, the issue was whether or not native Hawaiians should be allowed to build homes on the coast. Again, the students were asked to choose sides for the debate – the "environmentalists" versus the "Hawaiians". As in the previous debate, the same basic comments were repeated several times – "You stole our land" (Hawaiians) and "You'll cause runoff if you build there" (environmentalists). The focus of the debate seemed to shift more toward Hawaiian cultural issues, and cultural stereotypes were noticeable in some of the children's comments. One boy (environmentalist) kept repeating, "Why don't you just get a job so that you can pay for your housing just like everybody else?" Another student (Hawaiian) said, "The ocean was clean and there were lots of fish until you <u>haoles</u> (white people) got here." Some of the comments also indicated that the students didn't understand the complexity of the environmental issues involved – one said, "If you get a job you can buy your food at the supermarket and then you won't need to catch the fish and upset the balance of nature."

After allowing the students a couple of chances to switch sides if they wished, JB pointed out that they were only saying <u>what</u> they wanted, not <u>why</u> they wanted it. She explained that they were learning to see things from diverse perspectives, and gave the students a new debate question. This question was whether to allow tourists to snorkel with no rules, or to prohibit snorkeling altogether for tourists. Only one student chose the no snorkeling side.

After a short period of debating, JB asked the students why they thought snorkeling should be allowed. The students responded that money from tourism is important and that tourists want to have fun. JB said that there is a compromise – we can educate the tourists on how to care for the reef. She told them that they were going to create a brochure or flyer to do this.

She had the students brainstorm what information they could put in their brochure. Their responses were: Keep the beach clean; don't take coral or shells from the water; don't step on or touch the coral; don't feed the fish; wait at least fifteen minutes after putting sunscreen on.

JB then told the students that their challenge for the rest of the week was to design part of a brochure or flyer to present this information. She said that when all five groups were done, she would choose the best parts from the five classes and combine them to make a brochure. She handed out paper and asked the students to work independently to outline their ideas and develop a rough draft of the brochure. The students went back to their desks and started working. Some discussed ideas with each other, while others began to write or draw immediately. Meanwhile, JB went around the room and talked with individual students, giving very specific suggestions to some of them.

Technology

For the third week of the unit, the students were with the technology teacher (RF). On the preceding weekend, RF had gone to a local beach and collected trash, then printed a list of everything she had found. She gave copies of the list to the students and asked them to develop a system to categorize the trash. They were given a piece of construction paper, scissors, and glue, and instructed to write their category headings on the construction paper, then cut and paste the words under the proper headings.

After the students completed the cut-and-paste activity, they were shown how to put the data into a spreadsheet on the computer and generate printed charts and graphs.

On the final day of the rotation, the students worked on the computers, answering questions about their charts and graphs. They were given three questions: "What do your charts tell you?" "What information do they convey?" "Based on this information, what do I think needs to be done?" As each student finished, he or she would print the answers and bring them up to RF who reviewed them, principally for grammar and spelling. She also asked them occasional questions about their suggestions for action, and sometimes suggested that they revise their answers.

When talking with RF after the class, she told me that she would have preferred to have the students go to the beach and collect their own trash for the activity, but there was not enough time to do that.

Science

For the third week of the unit, the students rotated to another science teacher (MT). MT reminded them that this was the start of the second half of the coral reef unit, so she wanted to begin by asking them what they already knew about corals. They would then discuss what kinds of things could kill corals. One student asked, "If you feed fish, will that affect the coral?" MT replied that it was a very good question, and they would discuss it later. She then proceeded to ask them what they knew.

The students began calling out responses: Corals are animals; individuals are called polyps; they live in colonies; fresh water kills them; they can be more than one color; other animals live there; there is interdependence among coral reef animals.

One student protested that they had done this in KL's class before starting the unit. MT asked them if any of their initial assumptions had been wrong, and all of the students said "No." She then asked if they had learned anything in KL's class. Most of the students said yes, but four replied that they had not learned anything. Another student mentioned zooxanthellae, and MT reviewed why corals need sunlight using a question and answer technique. The student responses indicated that they knew that plants need sunlight to make food, but they did not appear to have a detailed understanding of the process of photosynthesis. MT reviewed mechanisms of coral reproduction and asked the students to name the three basic body parts of a coral polyp.

MT then asked the students how corals are killed. The students' responses included freshwater runoff, dynamite, people stepping on corals, erosion, hurricanes and storms, earthquakes, tsunamis, and people building buildings. When a student mentioned lava, MT asked him if he knew a place where lava has killed coral, and the students discussed this for a while, comparing their own experiences. Another student listed gasoline as a factor, and MT asked how gasoline could get into the ocean. The students responded that it was spilled; people go to the beach and their cars have gas leaks; and oil spills from boats. None of them mentioned runoff from the land or storm drains.

The next day, MT gave the students a handout listing ways that Hawaiian corals are damaged, and asked them to put it in their science binders. She also gave them a black and white drawing of a landscape with hills, agricultural fields, coastal development, and ocean with coral reef. The scene also had a snorkeler, a spear fisher, a boat with its anchor on the reef, and construction equipment. MT gave the students colored pencils and told them to choose one color to indicate all the things shown in the picture that are "bad" for the reef, then color the rest of the picture using any colors they wanted. She wrote the instructions on the board, and the students started working. When MT noticed that one boy was adding other things that could damage the reef to his picture, she complemented him on being creative, and suggested to the rest of the class that they might want to do it as well.

The activity didn't engage most of the students for very long, and after five or ten minutes they began to fool around with each other. MT commented to me that she had just looked at a student's project binder and realized that another teacher had already covered this in her class. She thought it was the other science teacher, but discovered some time later that it was one of the social studies teachers.

Later in the week, MT asked me to do a slide presentation on coral reefs. KL also brought her class in to see the presentation, so the room was crowded with 35 students. During the presentation, I focused on locations of coral reefs around the world, reef zones, and various invertebrates and fish found in a coral reef ecosystem. The presentation lasted for the entire period because the students were actively engaged and kept asking questions. They were not afraid to ask for clarification if they did not understand a word, and several wanted any new word written on the board so they could spell it properly.

On the final day of the rotation, MT reviewed some of the ways that coral reefs are damaged and what the students could do to help with conservation. She then asked me to do a slide presentation about damage to reefs and conservation efforts. After the slide show, which lasted about one-half hour, MT told the students that, as a culminating activity at the end of the unit, all of the groups would hold a mock trial about a coastal development project. She asked for volunteers to participate in the trial, and then gave the students time to organize the coral reef section of their project binders and to draw a cover picture for it.

While the students were working, MT walked around the room checking to see if they had everything organized. Some students were looking through books on coral reefs and came over several times to show me pictures and ask questions about them. Dynamite damage to reefs seemed to be of particular interest, and the students were trying to find a picture of it.

<u>Social Studies</u>

Group 5 spent the last week of the unit with the second social studies teacher (SD). SD told me that she didn't see a way to work the coral reef into her unit of study because, to meet the state syllabus requirements, she needed to cover American History for the fifth graders. She chose to focus on the history of indigenous people of the northwestern United States, and to bring the ocean theme in through a look at issues surrounding traditional whaling.

On the final day of the unit, SD told the students that they were going to have a debate. She reminded them that, although they had been studying the history of the Northwest Indians, they needed to remember that there are still indigenous people living there today. She said she was going to read a newspaper article about a controversy and ask them to decide which side they supported.

Before starting to read, SD asked the students what they knew about whaling and used a question/answer technique to get responses. One boy said that he had learned in third grade that the Chinese or Japanese wanted to come over here and take our whales because they didn't have any of their own left. SD responded that she didn't think that was true any more.

SD told the students that the article was from May 1999, and concerned the Makah Indians from Washington State, who wanted to be allowed to start whaling again. She asked the students to write down either "I think the Makah should be able to continue whaling because . . ." or "I don't think the Makah should be able to continue whaling because . . ." and give their reasons. The students began writing. Some discussed their ideas with others, but most worked alone.

After reading a short section, SD asked the students one by one for their opinions. Two students supported the Makah whaling, one said only in certain areas, and nine were against the whaling under any circumstances. The most frequently cited reason against was that the whales would become extinct. Another was that the beach would be littered with bones.

SD said that she would now read the whole article, which was a description of a whale harvest, and that they should draw a two-column chart labeled "Makah" and "environmentalists". She illustrated by drawing the chart on the board. She said that the article talks about these two groups, and instructed the students to listen to and record the arguments for each side. She proceeded to read the article aloud, stopping periodically to make sure the students understood the harder words. She also discussed what it means to take an animal off the endangered species list.

After reading the article, SD asked the students to help her fill out the chart on the board with the reasons for each group's position. She asked them to raise their hands and wait to be called on. As the students responded, SD did not record their comments literally; instead she paraphrased the responses. When the students mentioned the concerns of the commercial whale watch boat operators, SD wrote them down under the "environmentalist" heading.

After the list was complete, SD asked the students to pick a side for the debate, either "Makah" or "environmentalist". Five students chose the side of the Makah; the other thirteen chose the environmental side. She asked the "environmentalists" to start, and said that she would give a point to each side if their argument made sense. She also said that the responses had to address the point brought up by the opposing side, not something completely different.

The focus of the debate was mostly economic: "The tourists won't come if there is whaling," and "People will lose jobs." SD moderated the debate and asked students to clarify their ideas by using phrases such as "Your point is . . .?" After a few rounds, she asked all of the students to try to take the opposite side for a short while. She then asked them to go back to their desks and write a paragraph with their opinion and the reasons for it. They could take a position for, against, or unsure as long as they could state their reasons. She also noted that in five different classes, three times more students took the side of the Makah.

The students sat down and began writing. One asked if one sentence could be called a paragraph, and another asked if she could just make a list of the reasons. Both times SD answered no. The students were unable to finish the assignment in the remaining time, so they were instructed to take it home and finish it that evening.

Coral Reef Unit Wrap Up

The teachers decided to have the students hold a mock trial as a culminating activity for the coral reef unit. The "environmentalists" were suing the "builders" who wanted to build houses on the beach. Students were asked to volunteer to take on various roles – judge, attorneys, witnesses, and jury – and were given time to prepare their positions. The rest of the students served as the audience. The "trial" was held on an outdoor stage, with the audience on bleachers, and was moderated by a parent who was also an actual judge.

The trial started with opening statements from both sides. The "environmentalists" began by giving the perspective of the tourism industry, stating that if the builders proceed they will kill the coral and then there will be no more tourists. The "attorney" for the builders said that the builders would not kill the coral; they would be respectful and put down gravel instead of dirt so there would be no runoff. The student "bailiff" swore in the first "witness", and the builders' lawyer asked why they had brought the builders to court. The witness responded that the builders are killing the coral. The lawyer reminded her that, in the opening statement, the builders said that they would not destroy the coral. The witness responded, "What if they do?"

Next, the lawyer asked her if she saw the coral being destroyed. She replied yes, and he asked her when she saw it. She replied that she saw it when she went snorkeling. When the lawyer asked her what she saw, she mentioned dead fish and broken coral. He asked her how she knew it was caused by the builders and she said that she saw them.

Another witness was sworn in, representing a tourist from Florida. The environmentalists' lawyer asked her why she came to Hawai'i, and she responded that she wanted to see the coral and the fish. The lawyer said, "But the builders are destroying the coral – will you still come?" She replied no. The other lawyer asked her if she came just to see coral, and not to visit family. She said she had no family here. The lawyer said, "So you pay a lot of money just to see the coral." She agreed.

The next witness was a poor single parent with six children, who had found an affordable house (one the builders wanted to construct) and would not be able to have it if the builders lose the case. The environmentalists' lawyer asked her where she lives now (by the beach) and how she feeds her children if she has no money. Next he asked her if houses are affordable on the beach. She said she doesn't live in a house, but just on the beach. The lawyer said that they wanted to stop the builders from building on the beach. The witness replied that the builders said they weren't going to damage the reef. The lawyer said that the builders were lying. This kind of dialogue went on for some time until a teacher told the other lawyer to object.

Another witness was sworn in. The prosecuting side talked about the problems they would have with runoff if the builders proceeded. The witness said that the builders would use gravel. A debate ensued between the witness and the lawyer about whether or not gravel would prevent runoff.

In the closing statements, the environmentalists said that coral covers 10 percent of the ocean, and that building would kill corals and fish. The builders said that they won't kill the coral and will provide jobs and affordable housing.

The student "judge," reading from a script, told the "jury" that they must use evidence and facts based on the law of burden of proof. The adult moderator tried to explain what this meant, and read the rules for that the jury had to follow.

The 15 student jurors retreated to SD's classroom to discuss the case. SD and JB served as teacher facilitators. At the beginning of their deliberations, several students stated that they felt the "poor" witness was a "set-up" on the part of the builders to sway the jury. The jurors then took a vote to determine how many thought the builders were "guilty." Only one student said "not guilty." SD asked the student to explain her reasons, but the student refused. When the other students asked for her reasons, she said that the builders were "trying to make things better." JB asked a few students to take the other side for a while to help the student present her argument.

The argument stalled. Four students kept discussing the issue, using phrases like "The builders are lying," and "It's a set-up." The other students began fooling around. At the end of the process, the final vote was 14 to 1 against the "builders". The jury returned to the stage and announced their verdict in favor of the "environmentalists". The judge then asked the audience to raise their hands if they agreed with the jury, and the case was decided against the "builders".

Open Ocean

The Open Ocean unit began after the Christmas and New Year holidays, and was the first unit on the new ten-week rotation schedule.

At a curriculum meeting in late November, the teachers began discussing what they wanted to cover in the unit, and how the content would be divided among them. SD said that she would like to focus on navigation. KL, who was interested in astronomy, said she might focus on Hawaiian navigation. She also mentioned the possibility of teaching about plate tectonics and mapping of the ocean floor. JB said that she hadn't yet decided what she would teach. RF said that the students had been working on spreadsheets and graphing in the technology section, but she wasn't sure of the best focus for the open ocean unit. The school director, GN, suggested that RF introduce the students to Hyperstudio so they could use it for their presentations in other classes.

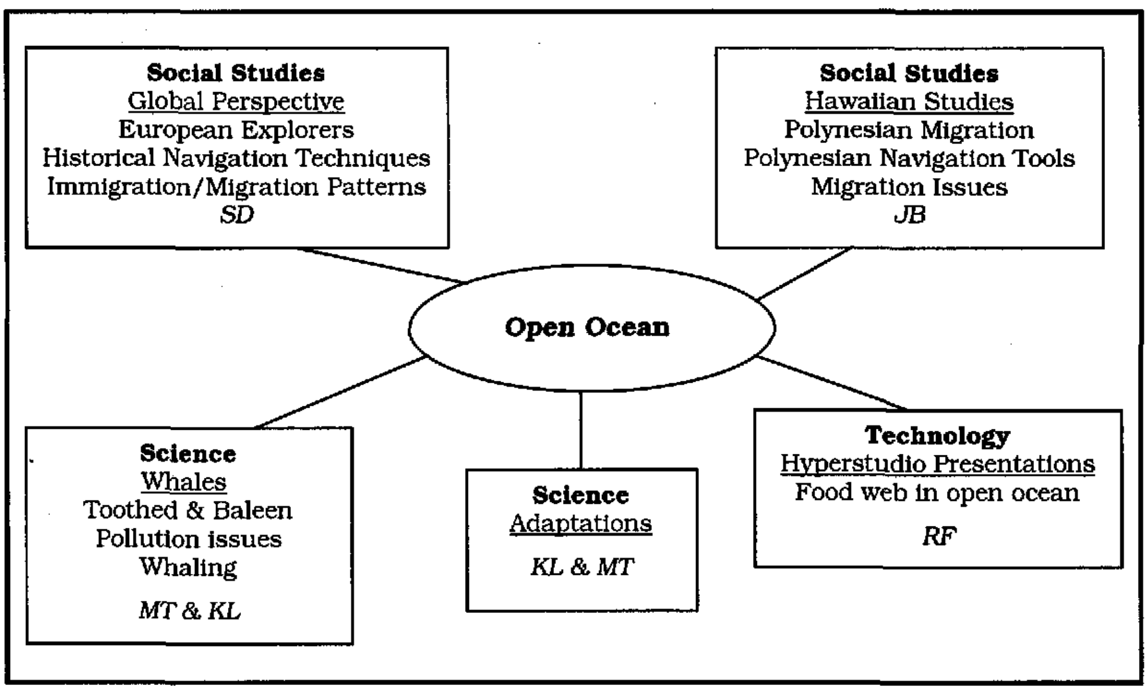
SD asked how they could get their classes to be more hands-on, and GN replied that she would talk to the local 4-H coordinator for suggestions. MT pointed out that the science focus would be on the surface layers of the open ocean, meaning the area where photosynthesis takes place. She and KL talked about spending one week on photosynthesis, one on food chains and webs, and one on local issues such as fisheries and whales. Other suggestions included a whale watch trip and an astronomical evening as part of the unit.

At the following week's curriculum meeting, the teachers continued their negotiations about the unit, and decided that JB and MT would teach science, SD would do navigation, KL would cover Hawaiian navigation, and RF would teach Hyperstudio and have the students prepare presentations on photosynthesis. They also decided that they would have both a whale watch and an astronomy evening as culminating activities.

During this meeting, the teachers did not come to an agreement about the specific content that each one would cover in her section. JB said that she was definitely not going to teach photosynthesis for science, but had not decided what she would do instead. MT mentioned the communication failure during the coral reef unit, and pointed out that it was important that they coordinate better so that they know what has been covered when a particular group of students comes to their class.

At that point, the focus of the meeting shifted to other concerns such as the development of a standard assessment rubric for Inquiry time, and the logistics of a parent survey that was being conducted. The teachers continued to discuss their curriculum plans informally over the following weeks, finally arriving at the breakdown shown in Figure 4.1. The two science teachers decided to structure things differently, alternating units. KL would teach adaptations to three of the groups, and work on whales with the other two groups. MT would teach whales to three groups, and adaptations to the other two.

Figure 4.1 – The Open Ocean Unit



Implementation of this unit was complicated by the fact that MT left the school halfway through, and a new teacher (CH) was hired to replace her. CH had five years of experience as a classroom teacher, but had always worked in a self-contained classroom and had never dealt with multi-age groups in the same class. In addition, she did not know the students the way the other teachers did and did not know what they had learned during the first part of the unit.

Social Studies

On the first day after the Christmas break, Group 5 entered SD's classroom. She called them all up to the carpeted floor area in the corner of the room and explained the new rotation schedule.

SD began her lesson by saying they were going to discuss why people choose to move. She asked them if any of them had ever moved from another state or country. Several students raised their hands and she asked them where they had moved from and why. As they responded, she started a list of reasons on the board – jobs, family, climate, etc. SD then asked them why there is often news about people coming into the United States, and explained that it was often because of tyrannical rulers, lack of freedom, or discriminatory treatment. She said that they would be talking about this a lot in the next two weeks.

SD began to read aloud from *Molly's Pilgrim*, a book by Barbara Cohen, about the problems faced by a Jewish girl whose family immigrated to the United States from Russia. She stopped part way through the story and asked the students to tell her two reasons that were given in the story about why Molly's family had moved. (One of the reasons that Molly's family moved, according to the book, was that Jewish girls were not allowed to go to school in Russia. SD did not talk to the students about the time period represented in the book, or how the factors portrayed in the book might have changed over time.) After she finished the book, she told the students that she had read it to remind them that people are still moving to the United State and to other countries.

She then passed out one-page short stories to the students and asked them to work in pairs to read the story and make a list of the characters involved and why they had moved. While the students were working, SD wrote "push" and "pull" on the board, and told the students that she was going to give them new meanings for the words: "When we talk about people who immigrate, we talk about push and pull factors." She asked the students to report on the names of the characters in their stories and to list the push and pull factors. Other students were warned to listen because they would have to complete an assignment about it.

After the students finished reporting on their stories, SD gave them an assignment. They could either pretend they were a character from one of the stories or make up their own character, but they had to write a letter to a friend about why they were choosing to move, giving both "push" and "pull" factors. They did not have time to finish this during class time, so they were instructed to do it as homework.

Over the next few days, the class discussed why people move and looked at historical reasons for European exploration, including the spice trade. On the third day of the unit, after reviewing where various spices come from and why they were considered important in food preservation, SD had the students work in pairs to conduct an experiment. She gave each pair a piece of aluminum foil to make into a bowl, and a raw potato that she had cut in half.

On the previous day, the students had copied the directions for the experiment and written down a hypothesis. Their task was to decide which spice might work best to keep a raw potato from spoiling. Some students had brought in their own spices; others used spices provided by the teacher. One group wanted to test more than one spice, so SD suggested that they cut their potato into four pieces.

After the students had prepared their potatoes, SD said they needed to talk about data collection. She pointed out that some students wanted to try more than one spice, and asked them why. One boy said that he wanted to see which spice would keep the potato best for the longest time. SD asked how they would collect data to determine this, and another student suggested a graph.

SD told them that one piece of information they needed to record was the day. She listed five days and dates in a column on the board, then asked what other data they needed to record. A student said, "What the potato looks like." SD asked, "Which potato?" and he replied "Both." SD drew columns on the board and labeled them for the two potatoes. She then said that they would do observations about touch, smell, and look, and asked them for samples of words that could be used to describe these features.

SD instructed the students to turn their experiment sheets over, create a data sheet on the back side, and fill in that day's observations. Some students seemed confused about why they had to record that day's observations since "nothing has happened yet."

As the students were creating their data sheets and conducting their observations, SD went around checking and discussing problems with their experimental designs (e.g., one pair didn't label their potatoes and couldn't remember which spices they had used). When the student pairs were finished, she called on them to put their potatoes on the bookshelf and go to the carpeted area in the corner. If a student had not done everything that had been requested, she would point out, "You need to do one more thing before I can call on you," and ask the student to figure it out.

After the students were all assembled on the carpet, SD reviewed a game they had played on a previous day. The game illustrated that different countries had different financial resources, and that those with more resources could send out more explorers. She said that they were going to make "explorer wheels". To do this, they would watch a video and listen for four pieces of information – the date of the exploration, the expedition sponsor, the explorer's goal, and his actual accomplishments. She started an animated video about Christopher Columbus, stopping it periodically to review key points and make sure the students understood. Class time was over before the video was done, so SD said they would continue the next day.

When the students returned the following day, SD reviewed the potato experiment and told them that they were to observe and describe the appearance, smell, and feel of their potatoes. After observing, they were to review their hypothesis and think about whether it should be changed. She went around the room and talked with each pair of students about their observations. Many of the students also checked out other students' potatoes.

SD reminded the students that she wanted them to be very careful with their observations and descriptions. They should not just say that the potato "looks rotten" or "yucky," but should describe it with words such as "black" or "soft." She also re-emphasized the importance of labeling in a scientific experiment.

After the students had finished their observations, SD used a questioning technique to review the section of video they had watched the previous day. When the video was over, SD reminded the students that Christopher Columbus did not succeed in discovering India, but said that he was important because people now knew that there was land in between Europe and Asia.

SD told the students that they were going to report on various explorers by creating "explorer wheels". She demonstrated, showing them a completed wheel, consisting of two circles of posterboard that were connected in the center by a metal fastener. The top circle was the title page, and had a wedge-shaped piece cut out so that one quarter of the bottom circle was visible. The bottom wheel was divided into quarters, and the students were to divide their reports into four sections – dates, sponsor, goal, and discovery – and write one on each section of the wheel.

She called five students up to the carpet area, then paired the reminder of the students at the desks. She gave each student the materials to make a wheel, and gave each pair a plastic-coated information sheet about an explorer. The students were allowed to use a highlighter pen on the plastic to mark the pertinent information before writing their reports on the posterboard wheel.

After the students at the desks started working, SD went over to the remaining five students and gave them very specific directions, such as what to write and how to spell the words. She read the explorer information aloud, paragraph by paragraph, stopping frequently to question the students and make sure they understood. When I spoke with her later about this, she told me that these were students who had problems reading and writing, or following directions, or were ones who had trouble working with others. The other students were all working quietly at their desks.

On the next-to-the-last day of the rotation, SD wrote a list of three tasks for the students to do in the next two days: 1. Finish your explorer's wheel. 2. Do the potato experiment. 3. Do the explorer crossword.

She had brought in cooked potatoes for an extension of the potato-spice experiment. Before giving the students the boiled potatoes, she asked them to take out their science experiment, turn it over, and draw a new data chart on the back. Then she said, "Before you get a potato, you have to come up with a new hypothesis. Now that the potato is cooked, do you think the same thing will happen?" She gave them time to write their hypotheses, then passed out the potatoes. The students spent the remainder of the class working on the three tasks, while SD helped individual students assemble their explorer wheels.

On the following day, SD asked how many students were surprised at the appearance of their potato. Most of them raised their hands. She asked what surprised them about the potato, and they responded that it looked different from the raw potato. She asked them to look at their observation data from day two of the raw potato experiment and compare it to day two of the cooked potato. The students commented that the cooked potato looked better, so SD asked them why. One student said that there was less moisture in the cooked potato. Another said that cooking might help preserve the potato because heat kills germs. SD did not follow up on the students' reasoning or give her opinion about their ideas. She instructed them to make their observations for the day, and told them that they could take the potatoes home to continue the experiment if they wished.

After completing their observations, the students were called over to the carpet area and SD reviewed what they had studied over the last two weeks. She reviewed the use of the compass as a tool and reminded them that they had learned about longitude and latitude earlier in the year. She then told them that there was another tool the explorers used for navigation and asked them if they knew what it was. Several students said "the stars," and SD asked how the stars could be used for navigation. One girl replied that the North Star is always in the north.

SD asked them how else stars could be used in navigation. The same girl said "the Big Dipper and Orion's belt." SD asked what those are called and another student replied "constellations." SD asked what a constellation is, and used a question/answer technique to arrive at the definition that constellations are patterns formed by the arrangement of stars. SD told the students that she was going to give them a star map for January and then went back to one student's comment about constellations: "They have stories about them." She read a story about Taurus in Greek mythology, and a girl asked her if all the people in the story are real. SD replied that they are myths, which are stories that some people believe in.

After the students got their sky maps, SD put a copy of the map on the overhead projector and showed them Ursa Minor, Polaris, Orion, Cassiopeia, and Pegasus. As she pointed out the constellations, the students traced them onto their maps.

SD then told them that they were going to build models of a tool called a sextant, or astrolabe, that was used by sailors for navigation. She gave each student written directions and passed out materials, then reviewed the directions step-by-step as she constructed a model. The model consisted of a semicircle of posterboard with a drinking straw taped to the flat edge. A string weighted with a washer was attached to the center of the straw, and the curved edge of the posterboard was marked off in degrees.

As SD was passing out the string, several students complained that their straws were broken. SD ignored their complaints and told them that they must be problem-solvers; she would help them with the hard stuff but not the easy stuff. Some of the students taped the drinking straw to the curved edge of the posterboard, even after SD had demonstrated the correct way to make the model. When the students had completed the basic model, SD reviewed the number of degrees in a circle, and had the students label the curved edge starting with 0° in the center to 90° at one end.

SD demonstrated how to use the sextants and instructed the students to choose an object in the room to serve as the North Star. After sighting the "North Star" through the straw, they were to take a reading by seeing where the string hung on the numbers. This, she said, would be their latitude. After getting a reading, the students were instructed to go closer (sail towards) their "star" and take another reading to see if the latitude was different. SD asked them why the reading was different, but did not spend much time discussing the reasons.

Because it was the last day of the rotation, the students were instructed to write a paper of what they had learned during the past two weeks before they were excused.

Science

For the next section of the unit, the students moved to KL's room where their first assignment was to complete a pretest by answering the question "What is adaptation?," then draw a picture of an ocean animal's adaptation and explain it. Finally, they were instructed to look up the word "adaptation" in a dictionary and copy the definition.

For the next activity, KL had put a series of posters of marine fishes of Hawai'i (pelagic fishes, bottom fishes, and sharks) on the classroom walls. The students were instructed to walk around and look at the posters, and choose two fish that showed similar adaptations in terms of their color, mouth, and shape. Working in pairs, the students drew pictures of their chosen fish and then presented their work to the rest of the class, explaining the reasons behind their choices.

The following day, KL gave the students an outline drawing of different ocean zones (sublittoral, bathyal, and abyssal) and discussed the different environmental conditions in each zone. On day three, she reviewed the ocean zone drawing and the concept of adaptations. She told the students that she would be away for the rest of the week and they would have a substitute teacher, so she wanted to talk about what they would do while she was gone. She said they would watch a video and would have to list 10 to 15 different adaptations that they saw in the video. This would be followed by a week-long project, where the students would invent their own fish, list at least five adaptations, and explain how the adaptations helped the fish. After reviewing the grading criteria for the project, she dismissed the class.

When the students came in the following day, the substitute teacher reviewed the assignment and started the video "Blue Planet: Seas of Life." The section of the video the students watched focused on the Arctic and Antarctic regions, rather than the open ocean. (I discussed this with KL when she returned, and she told me that she had left the video at the open ocean segment, but someone had mistakenly rewound it.) After the first 15 minutes, many students began to get restless, squirming and talking, but the teacher kept the video on for about 40 minutes longer.

After stopping the video, the teacher asked the students to define "adaptation". Several students gave examples, but no one gave a definition of the word. Many of the student responses indicated that they still did not understand the concept. One said it was "something that can go from one place to another." Another mentioned a "seal moved by a polar bear." The substitute teacher did not correct students when their responses were inaccurate and did not discuss the meaning of the word.

She gave the students the last eight minutes of the class to finish writing a list of the adaptations they saw in the video.

On Friday, the substitute teacher handed out papers with a picture of a blue marlin. Below the picture were a list of possible adaptations of different fish (under the categories of mouth, body shape, coloration, and reproduction), the advantage of each adaptation, and examples of fish that showed the different adaptations. The vocabulary used was quite advanced, including words such as elongate, dispersed, and live bearers, but the teacher did not review the words with the students.

The teacher told the students to get their project binders and asked one student to read the instructions for the "create-a-fish" project. She passed out blank drawing paper to the students. Some started drawing immediately, but most of the others were talking. Two girls were just sitting, staring into space. No one even looked at the marlin paper, although one boy asked, "So we're supposed to draw a marlin?" Another student went and got a picture book on sharks and started looking through it. The teacher wandered around the room while the students worked, speaking with students who were acting inappropriately and asking occasional questions. At the end of the class, she collected the pictures and dismissed the students.

When KL returned on the following Monday, she reviewed the students' lists of adaptations from the video. She then told them that she wanted them to take the pictures they had drawn of an imaginary fish and list at least five adaptations and what they are for. As she passed their pictures out, she showed them to the rest of the class and commented enthusiastically on each one.

KL then left for a meeting and the school director, GN, took over. There was a fairly high noise level as the students discussed their pictures with each other, but most of the conversation seemed to be related to the assignment. GN went around the room discussing the students' work with them. After the students had been working for ten minutes, GN stopped them to read two different examples of student work. One used short phrases to describe the adaptations and their advantages; the other used complete sentences. She asked the other students to name the adaptation described, then to say why it was important, then she asked them to look at their own papers and make sure they had all the information.

KL returned and said that she wanted to share some of the students' work with the others. She read some of the papers aloud and gave her own suggestions on adaptations they could include. As she read the papers, the other students continued writing or talking with each other.

KL reminded the students that they needed to finish their pictures that day, and that they were studying the open ocean so they should indicate that in their pictures. The students continued working on their pictures until the end of the class. As they finished, they brought the pictures to KL for her approval. If she approved, KL collected the picture and dismissed the student.

During the last two days of the rotation, the students did oral presentations of their work. KL instructed them to put their papers away if they weren't presenting on that day, and said that while one student was presenting, the others were to write down two of the adaptations and advantages mentioned by the student presenter. At the conclusion of each presentation, KL asked the other students what adaptations had been mentioned. The students had apparently listened to each other because they gave accurate responses.

After class, KL told me that she wasn't really happy with the way the activity worked because it seemed more like a language arts activity than science. Only two of the students had written papers that dealt with adaptations that might have a scientific basis. She also agreed that the students didn't seem to understand the different environmental conditions of the various ocean zones. Most of the students chose to put their fish in the shallow water of the reef rather than the open ocean, and almost all of them said their fish was "adapted to live in all zones."

Social Studies

Group 5 spent the following two weeks in JB's class focusing on Polynesian voyaging. For the study, JB divided the class into four teams representing four island groups: Fiji, New Zealand, Easter Island, and the Marshall Islands. (She told them that the Marshall Islands was not part of Polynesia, but that she included it because it was interesting.) She had created a simulation game by drawing a map and putting it up on a bulletin board. Each student team made a model sailing canoe out of aluminum foil and paper. The position of their canoe was represented on the map by a colored dot, and they had to earn points to move their canoes along a route on the map. Points were gained by sharing research about their island group, Jeopardy-style questions asked by JB, and random "fate cards". JB also used the game points to maintain classroom control. One student was repeatedly noisy, so her team lost four points and was moved back on the board.

At the beginning of the fourth class period, JB asked each team if they had anything to share. One girl had brought in some old Hawaiian wooden percussion instruments. JB asked if anyone knew how to play them and said she would give them game points if they demonstrated. A boy tried to play the instruments, although he admitted that he had no idea how to do it, and JB gave his team one point. Another girl showed the class a gourd that she was planning to make into an ipu (gourd drum). One of the girls from the Marshall Islands team showed the class a map and discussed how the islanders had been moved for nuclear testing. The other students asked her several questions. Finally, another girl from the Marshall Island team read a report she had written on Hawaiian canoe making. None of the boys in the class had prepared anything to share.

When the students had finished sharing, JB asked them to get the maps from their folders and find New Zealand. She told them that New Zealand forms part of the Polynesian triangle, and that Maoris are people who live in New Zealand. She then lectured about the three islands of New Zealand, writing the key words on the board, while the students took notes. She attempted to show them the location, but the wall map was broken and she was unable to pull it down, and there was no globe in the room. She finally asked them to look for Chatham Island on their personal maps, then showed them pictures of traditional houses. She also discussed the process of tattooing, and talked about how the moa (a large flightless bird) was hunted to extinction. During her lecture, most of the children were sitting on the floor at the front of the room and appeared very interested. Near the back of the room one girl had her head down and appeared to be sleeping, and another was drawing.

The students regrouped as teams, and JB played a Jeopardy-style game to review the things they had been studying. After the game, she pulled "fate" cards out of a hat, where teams could earn points based on random events.

Science

By the time Group 5 had reached the second science portion of the unit, MT had left and been replaced by CH. CH told the students that they were going to work in groups and make papier-mâché whale models. She said that they would need at least four balls of paper to stuff their models, then showed them some models made by a previous class and asked how they could be improved. She pointed out that the proportions could be better, and the colors more accurate.

She asked each group to show her the picture they were going to follow while making their models and passed out the newspaper so the students could begin. At this point, three boys began arguing with each other and complaining to CH. She tried to talk it through with them and finally sent one boy outside to "cool down."

Over the next week, the students continued to work on their models. During that time, they also watched a video on whales and one on pollution, and CH gave lectures on issues such as fishing nets, whaling, and competition for food. Subsequently, the students were asked to choose an issue pertaining to either whales or dolphins and propose a solution. They then had two days to create a brochure or a television program to discuss the issue and their proposed solution.

On the Thursday before the end of the rotation, CH asked the students how many of them had come up with some solutions to the problems and issues they had discussed in class. Without waiting for their responses, she said that they had come up with some of the same solutions as a local nonprofit conservation group and passed out an information sheet entitled "Environmental Issues Affecting Marine Mammals." She read the introduction from the information sheet, and asked the students to take turns reading aloud.

She gave the students highlighter pens and asked them to continue reading about the four issues presented in the paper. After reading, they were to highlight the most important sentence in each issue, as well as what they felt was the best solution presented. Some students highlighted the whole paragraph, instead of one sentence, so CH asked them to revise it. When they were finished, CH instructed them to put the papers in their project binders and spend the remainder of the class preparing for the following day's presentations. While the students were preparing, CH walked around and discussed their presentations with them.

Twenty minutes before the end of the class, she stopped them and asked if anyone was ready to present that day since they might not have enough time for everyone on the following day. Three boys decided to present and did a "news report" on whale hunting, commenting that there was a big discussion going on "between the United States and Alaska."

On Friday, CH reviewed some of the videotaped presentations that had been done by other classes. She gave the students presentation suggestions and clarified her expectations saying that the script should be written, practiced, and read as written, not ad-libbed. She criticized earlier groups' performances, saying that they were good for having been done in a very short time, but that they would be better if they had been planned in more detail.

Two groups of students had prepared Hyperstudio presentations, so CH divided the rest of the class in half and they watched the presentations on the computers. One focused on the grey whale and pollution; the other was a general presentation of whales and environmental protection. The presentations demonstrated that the students understood how to use Hyperstudio, but it was unclear how much they understood about the issues because their presentations included very little content.

One student had written a letter to Chicken of the Sea asking them what was meant by "dolphin-safe," and showed the class the response she had received. She then interviewed two other students about hunting whales, and discarding nets in the water. A spirited debate ensued when one student asked what the difference was between killing cows and killing whales. After a few minutes, CH stopped the students and told them she would like them to debate in a more formal way, looking at cows versus whales. "Who feels that killing whales is something completely different?" she asked. She split them into two groups and reviewed the rules of debating – one speaker at a time, show respect for the other viewpoint.

One student started the debate by stating that whales are endangered and cows are not. The other team countered that whales are no longer on the endangered species list, and that they had evolved from land mammals. The whale-protector team responded that people own cows, but whales are not owned by anyone. At this point, the class time ended and the students were dismissed.

<u>Culminating Activity</u>

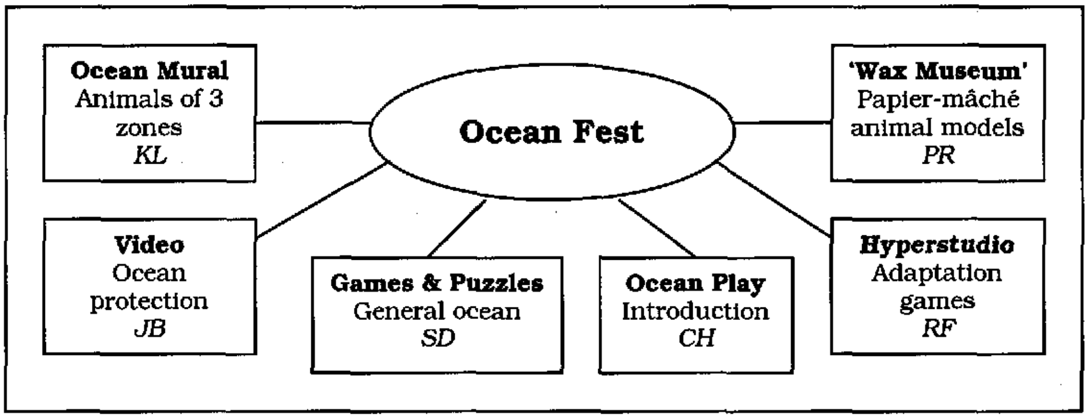
During a curriculum meeting at the end of February, SD pointed out that due to the change in schedule (switching from a five-week to a ten-week unit), there would only be four weeks of classes remaining by the time they had finished the open ocean unit and done the following two-week Inquiry session. After some discussion, the teachers decided that they did not have enough time to do a unit on the abyssal zone as originally planned, and elected to spend the last month on a culminating activity that would help the students review what they had learned during the year. They tossed ideas around, including making an ocean model in a swimming pool, doing an ocean-related play, or creating a mural.

GN pointed out that the culminating activity should demonstrate what the students had learned, rather than teach them new material. RF suggested that the final two-week Inquiry could be used to have the students develop a way to teach something about the ocean to younger children, and that they could invite the first and second graders from the adjoining public school to participate. GN recommended that the teachers choose the concepts for the final student activity, because she felt that the children would need help with the structure.

Nothing definite was decided at the meeting, and the teachers continued to think about it and discuss it over the succeeding month. The final decision was to begin the wrap-up activity after the Inquiry period, and have the students prepare an "Ocean Fest" program. Second and third graders from the neighboring school were invited to attend during two days, and an evening session was planned for parents. Each teacher chose an activity based on her interests, and the students were assigned to one of the groups (Figure 4.2).

The student project groups were reorganized for this final period. During this time, I made periodic short visits to each of the classes to see what they were doing.

Figure 4.2 – The Ocean Fest



On the first day of the Ocean Fest, about 50 students arrived from the adjoining public school and took seats on the bleachers at the back of the school. GN welcomed them and told them that the Sunset students had spent the year studying the ocean and wanted to share what they had learned.

CH announced that they would start with a stage play based on the book *"Surf Gecko to the Rescue."* The students had all written individual adaptations of the book, and CH had compiled them into a single script. The students had then painted backdrops and gathered props and costumes. The students performed the play, which had a simple environmental message about not littering or harassing turtles or other animals. After the play, GN divided the audience into groups to rotate through the other rooms and activities.

In KL's class, the students had created an ocean mural. KL had purchased two large pieces of canvas and asked a parent who was an artist to paint a background scene that extended from a tidepool to the open ocean. The artist outlined certain animals in the different zones to give the students some guidance, and the students then painted their own animals on the mural. KL also brought in her sewing machine and had the students make stuffed animals based on the research that they had done earlier in the year. Each of the animals was either attached to the mural in the appropriate ocean zone, or a hole was cut so that the student could stand behind the mural and put a hand through with a sock puppet animal. During the presentations, the students all stood behind their mural. One student introduced the mural and then, starting in the tidepool zone and moving outward, each student moved his or her animal and narrated some facts about it. After all the students had spoken, a student asked the audience where each of the animals had been seen and asked them to put a Velcro sign on the spot. This proved a bit confusing, because many of the "animals" had moved around quite a lot during the presentation. At the end of the mural presentation, another student described the ocean protection display they had created about litter.

JB's class had made a series of videos – one on tidepools and tidepool protection, one on aquarium fish collecting where the students talked about writing letters asking local businesses not to keep saltwater aquaria, and one showing the students giving their brochure on protection of the corals to tourists at a nearby beach park.

PR had helped the students create a "wax" museum of papier-mâché models based on organisms they had studied during the year. The students stood at tables behind their models and described them as the audience moved around the room. The audience movement through the room was a bit disorganized and chaotic, but the students knew their material quite well and gave very detailed information about the animals.

SD's class had created a series of simple board games, word searches, crosswords, and puzzles. The audience was divided into small groups at clusters of tables and had an opportunity to play the games.

In RF's class, the students had developed a series of computer games about the ocean. RF had each of the students introduce his game to the audience, then the visiting students were split up to play the games. Unfortunately, the introductions took a considerable amount of time, and little time was left to play the games.

This program was repeated on the following day for more visiting students, and again in the evening for the parents.

4.5 **Year in Review – Teachers' Perspectives**

4.5.1 ***Program strengths***

When reflecting on the implementation of the program over the course of the year, the teachers identified the following as areas of strength:

Personal Development

During the year-end focus group, the teachers were asked to rate the overall success of the school year on a scale of 1 to 10, with 10 being wildly successful and 1 being a total disaster. KL rated it a 10, and all the other teachers agreed on a score of 8. When asked for a reason for the rating, one replied:

> I think the students – the growth we've seen in the kids [. . .] Everything we thought they might not be able to do, they did it. They went beyond our expectations. It's amazing; they've become very independent learners. Not all of them – we have some that have struggled quite a bit, but a lot of them have become very independent learners. They take responsibility. That's one thing I am really proud of – they take responsibility for their learning.

Another teacher mentioned her own personal growth during the year as a positive feature:

> I didn't know what I was doing, very well, in the beginning and so I grew a lot. I used to hate the first three days [of Inquiry], and then I just hated the first two days, and by the end I just hated the first day because it is such a challenge as a teacher to take 18 kids, all on different topics, and be a facilitator [. . .] I feel very comfortable with it now, but it still scares me on the first day to see all those eyes on me.

Shared Vision, Open-Mindedness, & Atmosphere of Trust

At a November curriculum meeting, JB commented that she had had a completely different vision of what the school would be like. She said that she had pictured the students having more long-term, hands-on projects such as keeping an aquarium and studying fish behavior or developing a garden project. MT agreed, adding that she would like to get the students out into the community more.

During this meeting, and some of the others, differences of opinion about the vision for the school would surface, and there was occasional friction between some of the teachers, but they generally reached a compromise. At the end of the year JB commented:

> I remember thinking that we all thought the same way, and then I started working with you guys and everybody was so different, and it blew me away [. . .] I thought we'd all agree on everything and I'm finding out, gosh, there's a whole lot of stuff we didn't agree on. And we worked it out.

She added, "I wouldn't teach if I couldn't teach here. And I would not ever, I couldn't, go back to the old way."

The other teachers agreed with her, adding that a critical factor in their success was the atmosphere of trust that they had developed, saying, "People have to feel safe to say what they think." Another added, "We agreed to disagree. And everybody was willing to speak up, and that's really critical." They felt that it was extremely important to deal with problems and issues as they arose, and not, as one phrased it, "go to your room and pout."

By the year's end, they felt that their hard work had paid off: "I think the vision that we started with is beginning to unfold. I mean, at first I didn't think we would be able to have these meetings that we do in the middle of the day; I could not visualize that it would work. But it did." They saw the regular meetings as an essential component of a successful program: "I think because of meeting together, we have goals for next year – things that we would like to improve on [. . .] A lot of it has come from the kids, some has come from the parents, and some of it has come from us just sitting here going 'maybe next year.'"

Program Structure & Division of Teaching Responsibility

Their self-imposed structure and the division of teaching responsibility allowed them to give equal time to various subject areas. SD said:

> I know when I taught self-contained, because I love history, I would be teaching history, history, history, and then I'd go "Oh my gosh, report card time – I'd better do a quick week of science." And then I'd get back into history again, because that is what I love. In this curriculum, they have a balance, I think, of all those areas continually throughout the year.

In addition, because they taught the same science and social studies units five times with the different groups of students, lesson planning took less preparation, so they had more time to focus on developing and incorporating math and language arts units. KL commented:

> I've never taught an hour and fifteen minutes of math every day. Something else would always come in – but I have an hour and fifteen minutes of math a day. I have two hours of language arts [. . .] And then there are the interest groups, the project groups, and inquiry on top of that. It's amazing how much they get in a day.

Multi-Age Grouping

In the teachers' perspective, the benefits of the multi-age grouping outweighed the disadvantages. Children had more opportunities for growth, because the teachers were not "kept in a little box that says I'm only going to deliver curriculum that is appropriate for an eight-year old [. . .] We were able to aim high and let the kids absorb as much as they could and be challenged that way." Age and grade level distinctions became blurred in the classroom, so the students were not as limited by conscious or unconscious expectations based on their age. The multi-age system also valued the different background experiences and prior knowledge individual students brought to the classroom, and encouraged them to learn from each other, as well as fostering the development of valuable social skills.

Opportunities for Students

The structure of the school also allowed for a wide variety of activities and opportunities for the students: "There was drama, there was music, there was enrichment. Everything you could imagine – there was even a garden, there were salt-water tanks. For every child that had an interest, there was something for that child." In addition, the students were excited about learning and were eager to get to school each day, not only because of the variety of activities, but also because they were developing an in-depth understanding of a particular theme.

Communication Skills

All of the Ocean Study and the Inquiry projects culminated with student presentations, giving the students ample opportunities to improve their communication skills. They were encouraged to explore different ways of presenting information such as building models, using display boards, doing Hyperstudio presentations, and role-playing. At first, most of the students chose to use a flat display on a board, but later they began to branch out. After an anti-smoking project:

> [. . .] some of them made buttons for kids to wear; we have a sign on our door; they made posters; they made bumper stickers. They had a variety of ways of getting their message out and I think we're going to see more of that because the kids are beginning to see what the possibilities are.

The teachers agreed that the first year was difficult because the students had just come from a regular school environment where they were not used to having the options. In addition, they realized that they had to modify their teaching styles: "I was used to just doing the one-dimensional 'get up in front of the class and do a speech.' So we've really grown too."

Student-Direction

Because the students were given significant freedom of choice to pursue their individual interests, they took more of an ownership in the school. This kept the teachers from dropping sections of the program such as Inquiry when the going got tough. One said, "I think we would have let some things go, had not the children said 'What about this?' and 'Don't forget that.'" Another added, "I think our school has really involved the kids a lot – a lot more than I ever knew we could. Now that they have that choice, they're not ever going to let it go."

The main strength of the Inquiry time was that the students loved being able to ask their own questions and conduct their own research: "By the fourth round, they were already thinking ahead and they could hardly wait. They started talking ahead of time, they were collecting things, they were so motivated because this was what they were going to get to do."

Student Empowerment

Two of the teachers said that the students felt a greater sense of empowerment as a result of the year's program. JB said, "I think a lot of the kids have really learned that they can make a difference." KL agreed with her saying, "Even with the smoking issue – they feel like they can make a difference. And they feel like they are."

4.5.2 *Areas of Concern & Plans for Improvement*

Not everything worked out as planned, and the teachers identified the following as areas of concern:

Time & Opportunity

Although they had agreed on the general structure of the year's study, and the need to integrate and coordinate their units with each other, they discovered that it was not always easy to put it into practice. Because the school was new, they spent a lot of time on logistical issues such as hiring support staff, purchasing materials, and determining the best way to communicate with parents. Despite their weekly curriculum meetings, they often found themselves scrambling to get their lesson plans together in time. In addition, one teacher commented, "I don't think we envisioned exactly how that would all work anyway. So now that we've lived through it, we can integrate it a bit more."

Time was also a factor for student projects. Because of the division of teaching and the rotation schedule, it was sometimes difficult to allow enough time for children who worked at a slower pace to complete their projects. SD recalled the dilemma she faced when the students were making papier-mâché whales. One of her students was working very slowly, and it was apparent he would not be done by the end of the rotation period. "So trying to find a balance between letting John work at his own pace, which is what we're supposed to be doing and allowing for here, and knowing that this has to be done because you're moving on and you're not going to be in this environment again, was tough for me."

Inquiry

Inquiry projects also suffered from lack of time. Even after the teachers changed the rotation schedule to allow a two-week block for Inquiry, they felt it was not enough time to help the students form appropriate questions, collect needed resources, conduct the inquiry, and present the results.

Although the teachers saw great improvements in the students' approach to the inquiry process over the year, they were still concerned about the students' abilities to frame appropriate questions. They admitted that they themselves were not entirely comfortable with the distinction between inquiry and conventional research. RF said, "I still struggle with that, like 'Is this an inquiry question? This doesn't seem like an inquiry question; this seems like a research project. How can I guide this child towards an inquiry question?'" She added, "A lot of times I can identify that it's not true inquiry, but then I have a hard time turning that [a student's question] into an inquiry experience."

To improve the inquiry process, they decided that they needed to give the students more guidance, and to devote more time in the inquiry cycle to the formation of the questions. One suggestion was that, after the students frame their initial questions, the teachers would meet together, discuss all of the questions, and brainstorm ways to turn them into questions suitable for the inquiry process. They would then go back to the students with ideas and suggestions, and give them more time to refine their questions. In addition, they felt that they needed professional development classes to improve their own skills in inquiry-based learning.

Student development level and personal experience were also areas of concern in the Inquiry projects. In the coming year, the staff plan to look at ways to help facilitate the development of the necessary skills: "In a normal school, kids wouldn't get to what we're doing until fifth grade, and we're expecting third graders to jump right in [. . .] we need to adjust our inquiry lessons to help those younger kids who haven't had the same number of experiences."

Active Participation of All Students

Although there were a wide variety of activities that addressed a range of learning styles, JB said she had discovered that the school was probably not appropriate for every child. It worked well for those students who were motivated and emotionally ready to become independent learners, but some children needed a more consistent structure than the current school design provided. She pointed out that nine or ten of the students were not ready to do inquiry because they couldn't work independently. In some cases, she felt this was due to age and experience level; in other cases, it was lack of motivation on the part of the student.

Administration - Funding

Charter school funding was one of the teachers' main concerns. They had received a three-year start-up grant from the federal government, and were supposed to receive operating costs from the state government under the same basis as regular public schools. At the start of the school year, they learned that the budgets had been re-adjusted and they would receive about $1400 less per student than anticipated. One teacher said, "The operating funds are much less than we anticipated they would be – not even enough to pay our salaries. So, I think the only conclusion you can make from that is that it is an attempt to stop charter schools." Another added that the state had to continue to fund them if they fulfill their charter, but that the amount of money they were currently receiving would make it impossible to continue the school indefinitely.

4.6 **Year in Review – Students' Perspectives**

During the last two weeks of school, each of the teachers conducted a focus group session with the students in her group. Each group consisted of 16 to 18 students, and all teachers asked the same five questions:

1. What were the best things about project time?

2. What were the worst things about project time?
3. What did you learn about the ocean?
4. What are the main threats to the ocean environment?
5. What can you personally do to help protect the ocean?

I was present at all five sessions and tape-recorded the students' responses, then transcribed the tapes verbatim. It is worth noting that the responses of the different groups of students differed significantly. Part of the difference probably reflected the teacher's individual style. Even though all of the teachers asked the same questions, they had different ways of leading the students through the process. Some asked the questions exactly as written and made no comments on the students' answers; others asked the questions, then rephrased them, and tried to help the students clarify their answers by rewording the student's answer and asking "Is this what you meant?" In addition, each group's answers took a different focus depending on the first student's response and the specific classroom dynamics. In some groups, the students focused on generalities; in other cases they discussed very specific classroom sessions and activities.

4.6.1 *Best things about project time*

<u>*Hands-On Activities*</u>

Twenty-seven students mentioned hands-on activities in response to the question about what they liked best. It didn't appear that the subject matter was an important factor in the enjoyment of the hands-on experience, as illustrated by the following discussion (Different students are indicated by initials):

> A. When we got the waxed paper and raced with Q-tips and water. It's like we had waxed paper and we had toothpicks and then you put a little drop of water and you dragged the toothpick where the water is and it would follow the toothpick.

(The teacher asked if that was an experiment and what they were trying to find out.)

> A. If . . . I don't know. It's like if you got waxed paper and you put a drop of water on waxed paper and stick a toothpick inside the water and drag it, the water will follow it. Then you put the waxed paper on a piece of paper that was like a maze and you'd get to race.
>
> B. The purpose of it was to see if water molecules stick together.
>
> C. When we got to try and make a compass by rubbing a needle on top of a magnet and then dropping it in water and then it turns toward the north.
>
> D. When we got to experiment with making an egg drop and we were putting eggs inside of our like box or bottle and see if the egg would crack when you dropped it off the building.
>
> E. When we got to make boats and like race around the board with them and you could get extra points if you bring stuff in.
>
> F. When we got to do the mural of whales and dolphins.
>
> G. I'd have to say my favorite part would be the egg drop too, but second favorite would be when we made the whales with papier-mâché from newspaper. That was fun.

Freedom of Choice

One group of students talked a lot about the fact that they had a choice of what to study or what project to do and how to do it, saying things like, "We get taught inquiry and pick our own questions and what we want to study about," and "The teachers don't have to get the site [Internet] for you; you can get the information yourself."

Because of this choice, one student commented, "We never needed to be assigned any work." Another added, "We never got assigned anything boring; that made us more dedicated to it, so we would do it in our own time instead of having you force us."

Variety

The students also liked the variety of activities and the fact that they got to work with different groups of students at different times. After a group had shared some of their favorite activities, one student said, "I think the best thing about project time is that we get to do a whole lot of different activities." In another group, A commented, "You get to learn one topic like open ocean in lots of different ways – like science, you can do experiments, make plays." B said, "It's like a different way of learning it – a group [. . .]" "You're with different people all the time," added C.

Learning New Things

Some of the students mentioned learning specific things as the best part of the project time. One said, "I liked project time because I learned how waves are formed." When the teacher asked him why that was good, he replied, "Because I like to surf and I didn't really know how waves are formed." Others mentioned making a salt-water fish tank, finding out why sharks don't swim backwards, and "learning about different things, like nets and boats and other things, not just the basic ocean." One girl said that she is already looking forward to next year, when she can learn about the rainforest.

Teacher Style and Support

Comments about the teachers included, "You taught us in a fun way," and "The teachers would never argue with you." The students used descriptors like "good," "nice," and "fun," and one girl commented, "There's less people than in regular classes, so you get more attention."

4.6.2 ***Worst things about project time***

Writing

Overall, the students had far less to say when asked what things they didn't like. The one thing students in all of the groups mentioned, however, was that they dislike writing.

Frustration

A number of students expressed frustration with their inability to find information or come up with appropriate questions when trying to conduct their own research. "Like when you don't know what to do and you're done with all your work on the first and then you don't have another question," said one. "And when you don't have enough information and you can't find more" added another.

Lack of Choice

Although none of the students in the third focus group mentioned freedom of choice when talking about the things they liked best, lack of choice came out in the discussion of what they didn't like:

> A. Some of the project groups in one class – she gave us a plan that we had to follow. We couldn't go and find out stuff for ourselves, so I didn't really like that kind of thing.
>
> B. Like if the whole class did something, then you would have to do it. Like the teachers decided - that was when most of the class didn't like to do it. We didn't want to do it but we had to.

Teacher Style

There was some discussion about teaching styles that they didn't like – some teachers gave long lectures and left the students with little time to do their research or finish their projects. Others gave too much homework, or asked them to write a lot.

4.6.3 ***What they learned about the ocean***

When asked what they had learned about the ocean during the year, the students' responses fell in two broad categories. Two of the groups spoke mostly about environmental issues, and the other three focused on content knowledge.

Environmental Issues

Pollution was the most frequently mentioned issue (8), followed by fish collecting (4), whaling (3), and fishing boats and nets (3). In some cases, the students' comments were merely factual, "Nets to catch tuna are killing dolphins, whales, and turtles;" in other cases, they were judgmental, "About how bad people catch tropical fish and take the air out and then sell them." Some also indicated misconceptions, "I learned that if you kill one polyp on the top of a piece of coral, eventually the coral is gonna die. If you kill one little polyp, the whole structure, the whole piece of coral, the colony is gonna die."

Content Knowledge

Some of the student's comments indicated that they had a basic understanding of systems principles such as the water cycle:

> A. The ocean is the most important thing in the world and it keeps us alive. 'Cause the water evaporates to the clouds, then it comes to the mountains, then it rains.
>
> B. And that water keeps us alive because we drink water, and what he said was true because we drink from the water cycle.
>
> C. And the rain grows food.
>
> A. Without the ocean, you wouldn't be alive right now.

Many of the comments showed that the students remembered what they had studied, but did not give a clear indication of how well they understood the material:

> A. What sorts of things live in the ocean.

B. Animals and how they adapt.

C. Like the different depths of the ocean. What's living there and stuff.

D. We learned about the cycle of the tropical fish and a way to protect the ocean.

Some comments showed that students remembered certain facts that they found interesting:

A. Life is being found under the ocean near volcanic sea vents.

B. For coral to grow you need sunlight, and if you block the sunlight you can't have coral grow.

C. We learned that sea cucumbers clean the sand. (Lots of giggling and discussion) Yeah, and then the sea cucumber was pooping out all this stuff. (More giggling)

D. I learned that there can be some very creepy fish down where it's really black. They're just plain creepy. Like lights coming out of their head, like big mouths, tiny little bodies [. . .]

One group of students got sidetracked into a detailed discussion of a student's inquiry project on whales:

A. [I learned] that whales have a different way of milking their young. A way of nursing. Like a humpback whale – their milk just shoots out and the baby just gets close cause their mouth, they can just open up.

B. It just shoots out?

C. Yeah, cause it's so thick.

A. A regular woman's milk – it's 40 times richer. So if you drink like a cup you gain like maybe 10 to 20 pounds. Twenty to 40 times richer than regular milk.

C. They can gain at least 200 pounds in a week.

A. See that's why the babies need to get so big so fast – 'cause they need the blubber to keep them warm. They need to get lots of blubber so they can float up easier and to keep them warm.

D. That whales can hold their breaths up to . . .

E. An hour.

D. Yeah, some of them can hold their breath up to an hour.

A. Because their blood veins are zigzag and their heart beats slower than ours.

B. They shut everything down except their lungs and their heart.

D. Our veins are straight so we don't have enough air.

A. And another thing, you know their heart beats like ten times per minute ordinarily? They slow it down to four times a minute.

4.6.4 *Main threats to the ocean environment*

The question about the main threats to the ocean environment engendered more responses and discussion than any of the other questions:

Pollution

The most common responses dealt with pollution (mentioned by 36 students). They spoke about oil spills and leaks from boats, litter (six-pack rings, balloons, medical waste, fireworks), runoff (especially of chemicals from golf courses), and sunscreen from swimmers and snorkelers.

Fishing

Nineteen students said that fishing was a threat, especially because of dolphin bycatch in the tuna fishing industry, longliners, overfishing, and discarded drift nets. The drift net issue raised a lot of discussion, and some disagreement, among one group of students:

> A. Nets are good because fishermen love nets.
>
> B. Nets aren't good!
>
> A. Like throwing drift nets. Fish love to go under there because there's algae. And then the fishermen come and then there's all these mahi mahi and marlin and ahi, and they all go over there and have like a big huge fight. In the village there's one and about 15 boats come in to one little small net. So some rubbish is kind of good – it helps people get money.

(RF said that she didn't understand his point.)

> A. The point is like if they don't pick up the drift nets, they don't kill fish really, it's just a home for fish. So sometimes it's kind of good. It gives the fishermen a better chance of getting more money.
>
> B. So it's a good thing for people.

RF asked if it is a good thing for animals. One student said no; the other said yes because they make homes. More amicable discussion ensued, but no consensus was reached.

Tourism

Fourteen students said that tourists were one of the main threats because, as one said, "[. . .] they come and they don't know the science; they just go ahead and when they do they step all over the coral and then things that live there. They're ruining the animals' homes." Others mentioned tourists collecting shells and coral, touching the turtles, getting sunscreen in the water, and feeding the fish: "When the tourists come, they feed the fish and a few years from now if they stop feeding it, the fish will rely on the people to feed them and the fish will probably die off because they lost all their skills."

Other

Coastal construction (runoff and use of dynamite to build harbors) was mentioned by seven students, fish collecting by three, and whaling by two.

4.6.5 ***Personal action to help protect the ocean***

When the students were asked what they personally could do to help protect the ocean, their responses fell into two main categories: making other people aware and picking up litter.

Awareness-building

Thirty-six students said that they could help protect the ocean by making people more aware of the environment and things that damage it. Suggested actions included:

- Talking to people if they saw them littering, walking on the coral, feeding fish, or harassing fish or turtles.
- Creating brochures or flyers about the various issues and giving them out to people.

- Putting up signs about littering or fish feeding at beach parks.
- Creating an Internet web site about threats to the ocean.
- Making movies or commercials.

Litter & Recycling

Sixteen students mentioned that they could pick up litter, either while at the beach or by forming special litter parties with their friends, and another three said they could help by not littering themselves. Four students suggested recycling as a way of protecting the ocean.

Political Action

Three students suggested writing letters to the government asking for funding for patrol boats, funding for litter removal, and to pass laws to protect the ocean. One student said he could ask his mother to write a letter.

Consumer Action

Two students mentioned contacting the tuna companies about using fishing methods that were "dolphin-safe". One said, "You could get a bunch of friends and call whichever company doesn't have the 'Save the dolphins' sticker on it and say you just lost two customers and maybe they'll change their minds."

Other

Other ideas included using only natural fertilizers on plants at home, cutting up six-pack rings, and waiting 15 minutes after putting sunscreen on before going in the water.

4.7 Year in Review – Observer's Perspective

After reviewing the observation notes, meeting notes, interview and focus group notes, and written materials, I compared the school's ocean study program with the assessment rubric. The following comments reflect my own interpretations of the events observed:

4.7.1 *Program logic*

There appeared to be a high degree of shared vision among the school staff. Despite occasional friction on specific issues, the teachers worked out differences of opinion through their respect for each other, their regular meeting times, and informal discussions. They ended the year agreeing that their original vision was well founded, and most of their instructional strategies appropriate. It will be interesting to see how this will carry on through time, since two of the original staff have left and been replaced by new staff who were not part of original design process.

4.7.2 ***Administration***

<u>Relationships</u>

As noted above, there were good relationships among the various staff, including support staff and volunteers, and everyone, including the students, appeared to have a clear understanding of their roles. The system was quite informal and the staff often shared duties.

Relationships with parents were also good. According to a parent survey done about two-thirds of the way through the year, based on 64 responses, 62 parents were happy with the communication between the school and home. In addition, the school director estimated that 90 to 95 percent of the parents participated in school events in some way during the year.

<u>Governance, Management, Resources, & Infrastructure</u>

There were two critical administrative issues facing the school at the end of their first year. These issues will need to be addressed for future planning and long-term success:

- State-level political and funding issues dealing with Charter schools had still not been settled.
- The school is situated in buildings belonging to an adjoining public school, and there appeared to be some friction between the two schools regarding use of the library, the cafeteria, and other facilities and services.

Capacity-building

The teachers identified a need for more professional development, especially in the area of inquiry-based learning. Ongoing professional development in science content is also important, especially since one of the teachers with a strong science background has left the school, and neither of the two new teachers is particularly strong in science.

4.7.3 ***Program implementation***

Participation, Open-mindedness, Trust, Risk-taking

The variety of activities provided, and the instructional strategies used, allowed for active participation by all of the children. In addition, the school developed a culture of support and trust, which helped give all students the confidence to express their viewpoints, and encouraged them to branch out in their explorations and learning. During student presentations, other students were encouraged to ask questions of the presenter, and good student-led discussions often occurred.

Valuing Diversity

The students seemed to accept each other's differences and opinions. Even during some of the teacher-led debates, such as the "Hawaiians" versus the "environmentalists", the students did not necessarily choose their positions based on their own ethnic backgrounds.

Relevance, Student-Direction, & Use of Prior Knowledge

The ocean theme was well chosen to be relevant to the students and to build on their prior knowledge. In general, each teacher started her unit of instruction by determining the students' level of prior knowledge, either through a pre-test or by using a question-answer technique. In addition, they encouraged the students to talk about their personal experiences with the ocean.

Student-direction was used to a certain extent in the ocean study (e.g., students were given several options for ways to present information), although the content and most of the activities were developed and directed by the teacher. During the Inquiry time, the students were given the freedom to form their own questions, do the research, and decide on the best way to present the information.

In at least one case, however, an Inquiry project exemplified Hart's (1999) "tokenism" level of children's participation. For a follow-up project, after the students had studied the impact of local aquarium fish collecting, the teacher had the students write letters to express their concerns about fish collecting, which she sent to local businesses that maintained salt-water aquaria. The teacher outlined what she wanted included in the letter by posting the following guidelines on the board:

> *Paragraph 1* – name, age, school, and 1 thing about yourself.
>
> *Paragraph 2* – You have been studying the coral reef and the impact of humans on the reef. You have read information,

> watched videos, listened to speakers expressing different points of view about the reef (perspective). You've had debates and held a trial.
>
> *Paragraph 3* – As a result you want to express your concern about collecting tropical fish from our reef. Reasons – rare, can't reproduce in captivity.

In this case, the teacher had decided that the students (mostly third graders) were too young to pursue an independent inquiry, so she directed the project. The students chose to participate in the project (it was not required), but were not given the option of how to present their information or to whom they would present it.

Real World Setting

The ocean is very real to the students – they see it every day and spend a lot of their free time playing in or near it. Many of their parents are involved in industries such as fishing or tourism that depend on the ocean. In that sense, the ocean study took place in a real world setting. Most of the instruction, however, took place in the classroom rather than outdoors. The initial tidepool visit was the only field trip taken by the entire student body, although two of the teachers took small groups out after school when they were working on particular Inquiry projects and when they were preparing for the Ocean Fest.

Neither the planned whale watch nor the astronomy night took place. According to the teachers, this was mainly because of lack of time and money. Because this was their first year of operation, as noted earlier, the teachers were extremely busy trying to establish the school structure and prepare their initial lesson plans. The cost of buses for field trips ($180 per bus per day) was another limiting factor.

Time & Opportunity

The school structure allowed more time for science and social studies than would be found in most regular public schools. Often however, given the breadth of the ocean theme, there was not enough time to cover a particular subject in depth. This was in part due to the schedule of the rotations - a teacher would only have a student for one to two weeks, and then would not have that student in her project group again for another five to ten weeks. This made it very difficult to follow up with students who were working at a slower pace. It could also make it difficult to allow students to pursue interesting things that came up in class. The student-generated debate about the difference between killing whales and killing cows began during the final ten minutes of the last class of the rotation, and the students were not together again with same teacher to continue it.

In addition, especially before the teachers changed the rotation schedule from five to ten weeks, some of the lessons were somewhat rushed, and did not allow enough time for students to explore and understand more complex issues in depth. This lack of understanding was noticeable in some of the student debates about environmental issues, and in some of the student presentations, as described below:

KL's class had been studying whales during the previous two weeks, and were going to share what they had learned with CH's class. They began setting up their props, getting into costumes, and arranging desks, working independently without much direction from KL. The students had been instructed to create either a brochure or a television commercial about protecting whales. KL told the other class that they were the live studio audience and should follow the cue cards shown by a student (to clap, cheer, boo, etc.). The presentations included:

- An interview with a "chef" who had decided to use less seafood because "catching fish is competing with the whales' food source." He stated that he would serve more roast beef and less fish.
- A news report on garbage in the ocean, mentioning oil, soda cans, toy truck tires, and small nets. The reporter said that we should make laws and fine people who violate them, and that we should also use more renewable energy sources.
- A report on nets and tuna fishing. The students suggested putting beepers on the nets to keep dolphins and other animals that use sonar away from the nets.

- An interview with a "professional fisherman." The interviewer asked the fisherman if he knew how many fish died because of lost nets. The fisherman replied that he didn't know and he didn't care.
- A skit about a whale watch cruise with a tourist who wanted to go up close to the whales. The boat operator wouldn't take him because he would get fined.
- A scene where a person was throwing rocks at a turtle and received a fine. The student who introduced the skit said they needed to protect "turtles and other marine mammals."
- An incomprehensible skit about killing whales. One boy said, "People are mostly killing whales and this is why they shouldn't kill whales." The gist of the skit seemed to be that the whale could submerge and pull the boat down with it. The students ended the skit by saying, "Don't kill whales for food, just kill fish."
- A video made by a student's father. The video began background music and shots of waves and rocks, then showed the student picking up trash at the shore and a "Don't Litter" sign.
- A display board on marine pollution. The student emphasized that you should use paper products instead of plastic, but listed a Styrofoam cup as paper. KL corrected the student's mistake.

After the class, KL told me that she had deliberately designed her lesson plan to give students a problem to solve, but the presentations showed her that many of the students just didn't "get" some of the things she had presented in class. She said that she tried to present all sides of the whaling issue in a non-biased way, and admitted that some of the students didn't really seem to understand the issues they were talking about in their presentations.

Problem Solving & Control

As seen in the above example, some of the problem-solving activities presented to the students were based on issues that were too complex for the students to understand, given their developmental levels and the amount of time that could be devoted to the study. In addition, issues such as whaling are outside of the students' control – other than helping people become aware, there is little they can do about whaling.

In many cases, the teachers used debates to foster thinking about environmental issues and solutions. Debates can help students develop critical analysis skills by encouraging them to think about the reasons behind their viewpoints. By expressing their viewpoints, the students also improve their communication skills. However, the classical debate structure does not value diversity, promote trust, or encourage open-mindedness because it indicates that there are only two, incompatible, viewpoints. It does not focus on consensus building or problem solving except in a win-lose way.

During the classroom debates, the students were often debating issues that were either too complex for their level of understanding or background knowledge (e.g., whaling), artificially simplified (e.g., either/or, all-or-nothing situations such as no rules for snorkeling versus total prohibition), or situations over which they had no control. In addition, the word "environmentalist" was always used in opposition to the other viewpoint – environmentalists vs. fish collectors, environmentalists vs. developers, environmentalists vs. tourists, environmentalists vs. Native Hawaiians, and environmentalists vs. whalers. The concept of an "environmentalist" was not sufficiently explored or defined, and little attention was given to the fact that fishermen, developers, or others can also be environmentalists.

I felt that some of the debates were also arranged less to let the students explore the issues, and more to achieve a pre-determined end on the teacher's part. In these cases, the teacher appeared (perhaps unconsciously) to want the students to come up with certain ideas, and used leading or prompting questions and phrases to achieve that end. In some cases, a teacher would also paraphrase or reword student responses when recording them on the board, again appearing to want to lead the students in a particular direction.

"Real" Research, Methodology, & Procedural Accuracy

Over the course of the year, the students did little actual experimental research directly related to the ocean topic. They did do a variety of simple experiments (e.g., potato and spice experiment, testing paper towels for absorbency, making compasses, and making water filters) that were connected to the topic in some way. Some of the teachers indicated that they would like to do more in the future, and would like to focus on longer-term projects such as keeping a fish tank and using it to study fish behavior. The reasons they expressed for not including more experiments this year were lack of time, lack of materials, and their own uncertainties of how to do it.

In the experiments that I observed, the teachers were very good at presenting the basic scientific method to the students, and discussing the importance of accuracy in labeling, observations, and descriptions during scientific experiments.

Technology

The students had good instruction in the use of computer technology, and a lot of opportunity to apply what they had learned. The computer room had sufficient computers for each student in a class, and each of the other classrooms had five computers, all of which were linked to the Internet. During the year, the students worked on Internet search techniques, use of spreadsheets, graphing, and a variety of presentation programs including Hyperstudio.

A lack of keyboarding skills and knowledge of basic word processing techniques appeared to frustrate some students. One student erased three complete sentences because he forgot one letter at the beginning. Several made comments that they would rather hand-write their information because it took too long to find the right letters on the keyboard.

The students relied heavily on the Internet for their research and Inquiry projects. One question that arises is how to help students develop skills in identifying bias and inaccurate or misleading information when doing research, especially using the Internet, and I think this is something that should be addressed in the future.

End Results

The Ocean Fest at the end of the year gave the students a good opportunity to use the knowledge and understanding they had gained. Presenting their achievements to younger students reinforced the idea that what they had learned mattered, that it was important, and that they could actually help others.

4.7.4 ***Program content***

Current Scientific Understanding & Accuracy

The teachers appeared to have spent a considerable amount of time researching their subject, and most of the information presented was accurate. By their own admission, however, several of them did not feel completely comfortable with their level of understanding in science, and inaccurate statements or misconceptions expressed by students were sometimes not corrected. In response to the question "What did you learn about the ocean?" during the year-end student focus groups, one student said he had learned about "The ozone layer. It's making the icebergs in the Antarctic melt." The teacher said that she hadn't known that and thanked him for teaching her something new.

In another example, a teacher made enthusiastic comments and gave students a lot of positive feedback on their fish adaptation drawings, but did not focus on the quality of the work as it related to the assignment. One student's imaginary fish adaptation was "a beak for catching fish." "Like a parrotfish," responded another student, and the teacher agreed, rather than pointing out that parrotfish use their beak-like mouths for scraping algae off corals and not for catching fish.

The lack of science knowledge was especially evident during the Inquiry sessions, because the students were allowed to choose any subject they wanted to research. This made it almost impossible for the teachers to know if the information the students were presenting was accurate without doing a great deal of research themselves. During one inquiry, two girls were making food dyes from a recipe that they got from the Internet. The teacher had brought them supplies including red cabbage, onion skins, and vinegar, and the girls were experimenting. The recipe called for hot water, and they were trying it with cold water. When asked why it might need hot water, one of the girls said that it was so the onion skins would "melt." She repeated this later to the teacher, who didn't question her about it even though the other girl kept asking, "How can onion skins melt?"

Broad Concepts & Systems Processes

Comments made during the year-end student focus groups and the student presentations during the Ocean Fest indicated that many of the students had a basic understanding of concepts such as ocean zones, factors needed for coral growth, the water cycle, and possible impacts of land use on the ocean environment. Most of them knew the word "adaptation," but it was not clear how many of them really understood what it meant in the context of marine organisms. Most of them could talk about a specific marine organism in some detail because of their independent research projects.

Other

In some cases, I feel that the students received mixed messages because of contrast between what they were taught in class and what was modeled. Throughout the study, there was a strong focus on the danger of plastics in the environment, and at least one girl did a presentation about plastics for the other students. However, at an afternoon assembly right after her presentation, the teachers passed out ice pops encased in plastic as awards to students. When I discussed this with GN, she agreed that it was a contradiction, but pointed out that they had made the choice partly because of the hot climate, and partly because of economics.

Although there was a considerable amount of discussion with the students about alternative materials to use that might be less of a direct threat to the marine environment, there was little focus on the idea of conserving resources by examining lifestyles and make conscious choices to use less. This was reflected in the students' suggestions for personal action, where four students mentioned recycling and a couple discussed the environmental impacts of paper versus plastic, but no one mentioned the idea of consuming less.

4.7.5 ***Program Assessment***

Teachers

Over the course of the year, the teachers engaged in continual reflection about what was working well and what wasn't. During their daily meetings they gave each other feedback, and made modifications as they felt they were needed.

Students

The teachers admitted that student assessment was an area that they need to work on in the coming year. Although student report cards were based on the state standards, each teacher developed her own way to assess the students' work. During one of the curriculum meetings this was discussed, and the teachers decided they should share their assessment strategies with each other and should involve the students in creating assessment rubrics. GN pointed out that their goal as a team was to develop some quality assessment tools, so that they wouldn't have to reinvent them next year.

Much of the assessment was based on the teachers' observations of the students while they were working, and the quality of students' presentations at the end of a rotation or Inquiry period. For example, a proposed rubric for Inquiry required students to demonstrate appropriate information-gathering techniques, and looked at the time the student was on-task during the Inquiry, the variety of resources used in the research, the product created, and an oral or written summary of the information learned.

In addition, some of the teachers asked the students to fill out summary forms at the end of their Inquiry projects, reporting on their initial question, how and why the question might have changed, how they found the information to answer the question, and what the answer was. This technique helped the students engage in reflection about their research.

Although the teachers created pre- and post-tests for the different units, not all of them used the tests. Some gave pre-tests but not post-tests, and some used neither. When writing the tests, the teachers had not thoroughly considered how the data would be analyzed and used, and many of the students did not appear to take the tests very seriously. In one class, when asked to write as much as they could remember, some students questioned if they would be graded on it. One girl said, "I don't remember anything!" Most students only wrote a few words and said they were done. After they handed in the test, they then moved to the corner of the room to play some Hawaiian games. PR, who was substituting that day, told me that the students wanted to play the games and were focused on that, not the test.

I reviewed all of the pre- and post-tests that were done for the coral reef unit. Many of the post-tests had misconceptions or errors in them, but it appeared that the teachers had not given the students feedback on the post-tests or corrected their mistakes. Lack of writing skills may also have affected the students' responses, so the tests may not have accurately reflected the students' level of knowledge. In addition, the questions were broad and open-ended, making it additionally difficult to assess student understanding of the topic.

Parents

Two parent conferences were held during the course of the year. These conferences actively involved the students in presenting things they had learned to their parents. The parents were also kept informed of school events through a monthly newsletter that was sent home with the students.

Near the end of the year, the school conducted a written survey to assess parent satisfaction. In the survey, which was returned by 62 parents (~70 percent return rate), 61 said they would recommend the school to others, one said no. Forty-seven said that the school experience had resulted in positive changes for their child, while four felt that their children were already well-prepared so changes weren't as evident. The main improvements noted by parents were increased self-motivation, higher interest in learning, improved academics, lack of boredom, more self-confidence, more responsible, enjoyed school more, were more organized, and had an improved attitude toward school. Sixty-two of the parents were happy with the level of communication between school and home, two were not.

4.8 **Conclusion**

Sunset School's ocean study illustrated the benefits and difficulties of a whole school approach to marine and coastal education and action projects at the elementary school level. Overall, the program was very successful in its first year, and both teachers and students finished the year feeling satisfied with what they had accomplished, and looking forward to the following year.

Among the program's main strengths were the commonality of the vision and the camaraderie among the staff, the enthusiasm of the students at being given choices and their subsequent feelings of ownership, the dedication of the entire year to the study of a single theme which allowed the teachers and students to explore a topic in more depth and build on previous knowledge, and the atmosphere of trust and respect among both students and staff.

Areas of concern included funding and political issues related to charter schools in Hawai'i, the time and logistical factors of getting students involved in hands-on research in the field, the complexity of some of the environmental issues addressed, the accuracy of some of the science content, and the difficulties in helping students develop appropriate questions for inquiry-based learning.

Some questions remain - To what extent will the students take individual action based on what they have learned? Will it carry over into other aspects of their lives in the future? During the year-end focus groups, the students expressed many ideas for action. However, when they were asked the question "What can you do personally to help protect the ocean?" their responses were always "You could . . ." rather than "I could . . ." or "I will . . ." This would be an interesting and valuable arena for future research.

Note:

In a follow-up communication with the teachers, after the beginning of the 2002-2003 school year, I learned that they have already begun to address some of the concerns noted above. They have restructured the project groups so that younger third graders will work with the same project teacher for the entire year. This will allow the teacher to guide them more directly as they learn to do research and begin framing questions for inquiry. To allow time for more in-depth examination of issues and concepts related to the current year's theme of the rainforest biome, and more integration of subjects, they have also changed the rotation schedule. The students will now remain with a single teacher for a four-week block and study the plants, animals, people, economy, and environmental issues affecting a particular region, before rotating to another teacher to study another region.

CHAPTER 5
MAKAI HIGH SCHOOL MARINE PROGRAMS

Makai High School is a public charter high school that encourages students to use a hands-on, research-based approach to study real problems. Due to the school's location along the coast, there is a strong emphasis on coastal and marine-related projects. Some of these are large group projects, and many students do individual or small group research projects. This case study focuses on three of the larger group projects – a reef survey program, a survey/education program of snorkeler behavior at a local beach park, and a marine peer-teaching project.

5.1 Methodology and Information Gathering

For the Makai case study, I made 17 separate visits, totaling 21.5 hours. I began as an outside observer, and later shifted to more of a participant-observer role when I was asked by a local marine educator (GS) to help the students with science research methodology.

In addition to the observations, I attended five teacher meetings dealing with curriculum and general school concerns, and conducted semi-structured interviews with the school director, two student teachers, and three scientist mentors. I conducted two focus groups, one near the beginning of the school year and one at the end, with the four teachers who were involved with marine projects. I also conducted four focus groups - two near the beginning of the year and two at the end - with students in the three marine projects chosen for the case study. A total of 12 students participated in the first two focus groups, and 9 participated in the wrap-up groups. In addition, I held informal conversations with students and teachers throughout the course of the year, and attended two student "evidence folder" presentations. Finally, I reviewed the school web site and written assessment materials.

5.2 **Background and School Philosophy**

Makai is a small open-air high school located right on the coast. There are no classrooms, and students meet in a central, partially shaded area with bleachers and picnic tables. Surrounding the central area stand a garage with electric vehicles in various states of disrepair, an array of greenhouses, and several fish tanks. These are the students' research project areas. A small one-room building houses about a dozen computers for student use, and a corner office area for the school's administrative assistant. Another small building serves as an office for the school director, and a workplace for the teachers.

Makai was initiated in 1994 with three staff members as a "school within a school" program of a nearby public high school. The originator and moving force behind the program was AB, now the school's director:

> When I first came down here in 1988 or so, I looked around and thought what a great, marvelous place for science students – high school science students – to have an opportunity to work with laboratory scientists and working on the research that was going on. There was original, important, ongoing research here that was not beyond the level of a smart high school student. And there was a need for some of the people down here who were working to get

> assistance. Altogether it looked like a great package, an opportunity for students to come down here and work.

He admitted, however, that vision was one thing and practical reality another. After he and two others had struggled for some months, they hired an independent consultant to help develop an overall concept and related curriculum for the program. They agreed that students should be able to work on projects that were of interest to them, and have the freedom to pursue "real projects with real outcomes." The staff also chose to focus on a limited set of skills that they felt were extremely important for the students' personal development: communication skills, technology skills, teamwork, and problem solving.

For the first three years after the school opened in 1994, there were 3 teachers and about 50 students. All of the original teachers were science teachers, and they decided they needed a language arts person. With the hiring of a fourth teacher in 1997, the school's enrollment was increased to 85.

In 1999, the staff decided to apply for charter school funding to become a stand-alone school. To a large extent, this decision was financial. The local high school population was decreasing because another school had opened in the area, and the program was in danger of being dropped. The charter was accepted and Makai became a charter school in 2000.

5.3 **The Vision Today**

The school's program design still reflects the original philosophy of involving students in real research projects that they have chosen themselves, and giving them the freedom to develop the projects. As expressed by KN, when starting a semester of student-teaching, the strategies give the students an intrinsic motivation to succeed:

> The teaching strategies here are real science [. . .] One of the things I like about this school was when I saw that they expected the students to question; they expected students to find an interest that was their own and to build science foundation knowledge from that interest.

BG, another student-teacher, agreed, adding, "A lot of it is because the students picked, developed, and implemented their project, and so it's totally student-driven." He went on to point out that the teachers would not "go chasing students down" to make sure they had completed their work. KN added:

> They're going to say, "Look, it's up to you. And it's a large part of this school that they are going to let you sink as well as swim here. If you want to swim great, we'll help you swim. If you want to sink, we're not going to hold you up." They're making the students responsible for what happens, rather than making the teacher responsible for the student's success or failure.

The teachers who worked with the marine projects expressed similar viewpoints, emphasizing the importance of flexibility of teaching strategies, student choice, hands-on experience, getting out in the field, and reality-based projects.

The teachers also felt that it was extremely important to involve students in conservation projects, not only because it would instill a conservation ethic that would carry over into adulthood, but also because it will affect future generations: "They'll also pass on that ethic as well as the practice to their children, and what you're setting up is multiple generations of people who are conservation-conscious and active in trying to support the sustained growth of the whole ecosystem."

5.4 **Student Perspectives**

I conducted the initial set of student focus groups about two months into the school year. About half of the students who participated in the focus groups were in their first year at the school; the rest had attended for one or more years previously. During the focus group sessions, I asked the students about their perspectives on marine and coastal environmental issues and solutions, why they decided to attend Makai and what they thought of the school, and why they were involved in specific projects.

5.4.1 *Environmental issues*

When asked to identify the main coastal or marine problems in the local community, most students concentrated on pesticide and fertilizer runoff from golf courses, increasingly limited public access to beaches due to continued construction of hotels, the impact of tourists on the coral reef, and litter. After they had discussed these problems for a while, I asked them if they could think of any other issues:

> A. Not over here.
>
> B. In California you have like major storms that mess it up and stuff. That's all I can think of.
>
> C. Other types of pollution. I don't know.

One student mentioned aquarium fish collecting and overfishing due to commercialization of sport fishing, and another said he had never been anywhere else but didn't know what the problems were in Hawai'i.

In both focus groups, the discussion kept coming back to a comparison with the mainland United States, especially California. The students felt that there were very few environmental problems in Hawai'i compared to other places, and that their local community cared more:

> This area kind of differs from many areas like California where they build up right on the coast. You have a lot of coastal erosion. There's none of that over here. There's not as much pollution; the community cares a lot more about the coastal region than it does in other places, like other communities in California or the East Coast.

Other than the idea that the marine environment near the mainland was more polluted, the students had little to say when asked about global issues. Only two students expressed opinions, mentioning global warming, garbage dumping in the ocean, commercial fishing, and destructive fish collecting techniques. The students showed little detailed understanding of the problems:

> A. Did they mention garbage dumping?

> B. Yeah, I don't know if they do that here or what.
>
> A. I don't know, but I know they do it in big cities.

When talking about fish collecting, a student said:

> In the tropical areas, it's not just overcollecting of fish, but how they collect fish – they use cyanide for fishing and that's not good for corals and they put it in the water and it's not good for anything. And they use stun bombs and they blow up the coral and, I don't know, it stuns the fish and that's not good either. It pollutes the water and stuff.

5.4.2 *Ways to address problems*

In response to the question, "What do you think can or should be done to solve some of these problems?" the students emphasized picking up litter and educating people by posting signs at beaches and talking to others about the importance of not stepping on the reef or taking coral or sand.

5.4.3 *Perspectives on the school*

The main reasons the students gave for choosing to attend Makai rather than the regular public high school were:

- The freedom of choice to work on their own projects:

> Having your own project. You care about your project and you really want to learn about it, and you want to teach it if you know about it. And it gets you really motivated about attending this school.

- The wide range of project options available:

> There is such an opportunity down here. Whatever you could possibly think of to learn or do with the environment, you could do here and have total support for it.

- The chance to learn more about the environment:

  > I think bringing the environment into the school really helps. It gets you involved and makes you want to get interactive. It makes you more aware of what's going on.

- The hands-on, field aspect of the projects:

  > It's hands-on. You actually get to go to the beach and see what you're learning about instead of just reading it from a book.

- The opportunity to take responsibility for their own work:

  > A. You have responsibilities here and you have to take them.
  >
  > B. You don't have teachers saying 'Do your work,' because you're doing the work yourself. It's not that it's easier, it's that you want to do it. It's low key when it comes to teachers.
  >
  > C. It's kind of like college.

The focus group students all agreed that there were problems with unmotivated or untrustworthy students, and that the problems were especially bad this year. Because of a few students, they said, they were losing the trust and freedom they had come to expect from the teachers: "They trusted us so much. We could go down to the beach on our own. We could go like a bunch of places and they'd trust us to come back and we always do. But then people started blowing it."

Part of the problem, the students felt, was that some people were attracted to the school for the wrong reasons: "From other people, they hear that this school is really easy, so they come here expecting that, and it can be really easy, but you're going to fail. You're not going to get anything done." Another student agreed, adding, "I failed my first quarter, because I didn't understand. This quarter I'm getting 'A's and I go to all my classes."

In addition, the "problem" students hindered other students in their project work:

> In order to start off a project, you have to propose it first and get it accepted. And there are a lot of people that will like join the project just because they are supposed to be in a project. And they don't even do anything, just like take up space.

5.4.4 *Students' project choices*

The students chose to participate in the reef survey, the snorkeler education project, and/or the peer teaching project for the following reasons:

- For their own interest and learning.
- To educate others about the marine environment.
- To improve their public speaking skills.
- To help protect the environment.
- To gain work experience.
- Because they like working with children.

5.5 Reef Survey Project

5.5.1 *Rationale & project background*

GS, the local marine educator, initiated the school's reef survey program in 1997 as an extension of a community volunteer monitoring program. The community volunteer project developed protocols for gathering key data such as fish species, coral cover, and coral damage that the Division of Aquatic Resources had identified as important for future management decisions.

The Makai reef survey project was carried out by snorkeling at a local beach park. GS had identified two areas within the bay for repeated surveying, and had placed permanent pins to mark the ends of the transect area. At the beginning of the school year, GS conducted a series of sessions on identification of marine organisms for the students who wanted to participate in the project. The students were tested on their recognition of 27 common species of fish and six different corals before they began surveying. They also had to be checked off on water safety skills before they were allowed to participate.

5.5.2 *Reef survey in action*

I began my observations near the end of October, after the students had been trained in fish and coral identification. During my first visit, JD, the teacher facilitating the reef survey, conducted a review session before the exam in the school's computer lab/all purpose room. Eight students were working on the computers and various conversations were going on when the reef survey students came in for the review. The noise level was high, and continued to be high throughout the succeeding review session. Other students and staff were continually entering and leaving the room.

Two students asked JD why they needed to be able to identify fish and corals for the project. JD replied that the point of the project was to record what fish and corals were found along their transect lines.

JD began a slide show to review the fish, asking the students which fish were shown in each slide and giving them tips about key features for identification. She also gave both the common and the Hawaiian name for each fish. After talking about the fish, JD moved on to the corals, again showing slides for identification. Some students were unsure of how to distinguish lobe coral *(P. lobata)* from Evermann's coral *(P. evermanni)*, and the students and teacher discussed this for a while, but didn't arrive at a clear distinction. One student questioned why it was important to know the difference between the two coral species: "How does it affect the ecosystem?" JD responded, "In science we have to try to be accurate." The same student argued that they shouldn't have to be tested on their identification skills, saying, "I think you should take it on faith that we know this stuff." Discussion about the difference between lobe and Evermann's coral continued, and students gradually wandered out of the room.

The following Tuesday, thirteen students and two teachers (JD and MK) arrived at the local beach park to begin their projects. This group included students from two other projects (snorkeler behavior, which was supervised by MK, and a turtle research project) as well as the reef survey. A few students were planning to participate in both the reef survey and the snorkeler behavior project, and some were not yet sure which projects they wanted to work on.

Confusion reigned as the students began to unload their supplies from the bus. After some discussion, it appeared that someone had discarded the transect lines, so they would not be able to do the reef transects. In addition, they had forgotten to bring clipboards to put their data sheets on and no one had brought stopwatches for the students doing the snorkeler behavior research. The turtle project was under the supervision of another teacher who was not there, so MK agreed to stay on shore to help those students with their survey.

JD passed out a pencil and data sheet to each pair of students involved in the reef survey project. She told them that they could not do a survey that day because they had no transect lines, but that they could snorkel and practice their fish and coral identification. She instructed the students to be out of the water by 11:30 a.m., and let them go. One student was instructed to act as lifeguard (the beach park also had a county lifeguard on duty).

Most of the students entered the water immediately, but two girls said they were unsure if they could distinguish live coral from rock. JD offered to go out with them and help. Both girls appeared quite nervous about entering the water, and it came out in conversation that one of them had never been snorkeling before and the other had only gone once before. Shortly after the girls had put their snorkeling gear on and started swimming, another student came up to us and said that he didn't know where his buddy was. JD told him to join our group. We then proceeded to swim out to the reef and JD pointed out different types of corals to the students.

After all of the students had returned to the beach, they began to pack up their supplies and return to the bus. I asked JD if they were going to review what they had seen. She told me that, because the project was student-driven, they didn't hold formal meetings to discuss their progress or results, but that project groups met every Thursday so that the teachers could sign the students' progress reports.

On Thursday, I returned to the school to attend the reef survey project meeting, which was being held in the lab/all purpose room. JD was reviewing and signing individual progress reports for both the reef survey and peer teaching projects, while other students sat around talking and waiting for their reports to be signed.

JD told the students that she would like to go to another area for the next reef survey, but that there was no lifeguard there so she would need one student to serve as lifeguard. She discussed the near drowning of a man at the beach park the previous Tuesday, and reminded the students about the importance of staying with their buddies.

After signing all of the progress reports, she went to find a tide calendar to schedule the next trip. At that point, a student came in and reported that there were seven dead fish in the quarantine tank, so JD left to check on the problem, ending the project group session.

Two weeks later, at 10:30 a.m., the students returned to the local beach park to do their survey. Of the fifteen students who attended, seven were planning to do the reef survey, six would be participating in a survey of sea urchins, and two planned to do both. JD said that the choice to bring all of the students was a logistical one. The reef survey was going to be done in the morning, and the urchin survey in the afternoon at a different beach on the other side of town. She felt that it would take too much time to return to the school after the reef survey to pick up the other students.

JD explained the survey methods to the students, saying that they were to work in pairs and swim the transect line twice (up and back) counting and recording the fish they saw along the line. They were then to swim the line a third time and record what species of corals were directly below the line. The students asked a lot of questions about the fish survey, and expressed a concern about their ability to identify the fish correctly. Two students had brought clipboards to record their data; the others said that they didn't need them.

JD reminded the students that they needed to get in the water if they wanted to get credit for the day. The surf was up and conditions were fairly rough, so she instructed the students who were not participating in the reef survey to stay near the shore. Because of the conditions, the rest of us walked along the rocky shore to a place where the water was deep enough to snorkel. Two girls decided not to continue because it was too rough.

JD swam out to the survey area and looked for the pins to attach the transect line. She couldn't find them, so she and a student tied the line loosely to a rock, then extended it more-or-less parallel to the shore. JD held the far end of the line while six of the students swam along it. Because of the current and the waves, the line was floating and swaying as the students collected their data.

After returning to shore at 11:30, everyone got on the bus and went into town for lunch, then continued on to the other beach for the urchin survey.

I next observed the reef survey project in January after the winter holidays. This time I met the group at the school rather than the beach park. Three groups of students were involved: the urchin survey, the reef survey, and the snorkeler behavior group. The trip was scheduled to leave the school at 9:15 a.m., right after the morning announcements.

There was considerable confusion about who was going on the trips and which teachers would supervise. JD, who normally supervised both the urchin and the reef surveys, was absent so another teacher, TR, agreed to assist, although he was not usually involved in the marine projects. It was finally decided that all of the students would go together in the bus, and that they would do the urchin survey first, then continue on after lunch to the usual beach park for the reef survey and snorkeler behavior projects.

The bus arrived at the beach park at noon for the afternoon session. The weather was cloudy and chilly, and the students complained about the clouds and the cold and said that they really didn't want to go into the water. MK told the students that they could have until 12:45 to rest before beginning their work.

Only one student (Mark) chose to do the snorkel survey. He told me that he didn't want to use the transect line because JD wasn't there to set it up, so he was going to "eyeball it" and swim an imaginary line. MK paired him up with the student who usually served as lifeguard. I went along with them to see what they were doing.

Mark swam out a short distance into the bay, then stopped and began recording all of the fish that he saw. The fish at the beach park are used to being fed by tourists, and we were soon surrounded. Mark chose two rocks to swim between to conduct his survey. As we began swimming, the fish surrounding us swam along, keeping pace with our speed. Mark continued recording the same fish over and over as they swam along with us. I asked him about the purpose of the survey and what was done with the data he was recording. He told me that he was using it for his own research paper, and that it was also given to the Division of Aquatic Resources for their database.

After fifteen minutes, we returned to the shore and the group went back to the school.

Two weeks later, now almost seven months into the school year, I again went out to the beach park to observe the reef survey and snorkeler behavior projects. This time, four students were there to do the reef survey. They got their waterproof data sheets out of the supply box and found that they had not been cleaned since the survey the previous week. One student said that she couldn't erase her data off the sheet because she had not yet copied it down. She also asked JD if she (JD) was collecting and compiling the data. JD responded that it was the individual student's responsibility to compile his or her own data for the research paper.

A half-hour after arriving at the beach park, the students were ready to go in the water. I swam out with JD and one student to string the transect line. The other students waited on the beach until this was done. Twenty minutes later, the other students swam out and recorded the fish they saw. After fifteen minutes of data collecting, they returned to shore, and we removed the transect line. I asked JD why the students didn't take the responsibility for putting out and taking in the transect line. She replied that this is the first year that she has had to do it and that, overall, this year's students were very apathetic.

5.6 Snorkeler Behavior Education Project

5.6.1 *Rationale & project background*

Since January 2001, Makai students have been working with GS to conduct research on snorkeler behavior, and to educate visitors at a county-owned beach park. During the period from January to May 2001, the students had collected data on snorkeler behavior, recording the frequency and duration with which snorkelers touched, stepped on, or stood on live coral. After a period of initial data collection, the students set up displays and gave talks to prospective snorkelers at the park, explaining about the importance of coral and proper snorkeling etiquette. They followed this by attempting to monitor and collect data about the snorkelers' behavior when they went back in the water after hearing the students' presentations.

I observed the project during its second year of operation. The supervising teacher, MK, was new to the project. The year began with two groups of students – those who had done it the previous year formed one group, and the new students were a separate group. Shortly after the start of the school year, however, all but one of the returning students dropped the project.

During the year, the students went out to the beach park a total of thirteen times. On their first trip, they practiced data collection. During the following five visits, they recorded data about visitor behavior. On the last seven trips, they put up a display, gave educational presentations to the visitors, and attempted to gather data on the snorkeling behavior of the same visitors after the presentations. Most of the trips were combined with the reef survey project group, and several students participated in both. I was present as an observer on seven of the trips – the initial practice session, two during the initial data collection phase, and four of the educational presentations.

A total of ten students took part in the project, but not all of them came on every trip. Only one student was using the data collected for a research paper; the others participated for reasons that ranged from getting credit for community service to just wanting to be out of school for the morning.

5.6.2 *Snorkeler behavior project in action*

The program start was delayed until December because of a combination of scheduling problems, weather, and lack of visuals and T-shirts for the student presenters. GS, who was supplying the photographs for the display boards, was out of the country during the autumn, and there was also a question of how to pay for the T-shirts.

On their second data collection trip, in late January, the snorkeler behavior group reached the beach park at noon. The weather was cold and cloudy, and there were only four to eight snorkelers in the water at any given time. The students complained about the weather, and said they were *tired and cold and really didn't want to go swimming*. They also pointed out that six or seven students with data sheets in hand, following four or five snorkelers, would be a bit obvious. Finally, two boys decided to go in, and spent fifteen minutes observing and recording data. The other students waited on the beach.

During the three succeeding visits, three to four students participated in data collection. Their observation periods ranged from 15 minutes to one hour, with each student spending an average of 35 minutes per observation. The student who was doing her research paper about the project only participated in the first data collection session, spending a total of 30 minutes in the water.

In early March, the students were ready to begin their educational presentations. Ten students arrived at the beach park at 10:15 a.m. They put up a banner advertising their project, and set up four cardboard display boards on picnic tables in the covered pavilion. MK told me that GS was unable to come that day, so the students would just do practice presentations, and not collect data. She talked with them about what they were going to do and how to do it – e.g., how to introduce themselves to the visitors and get them interested, and what information they would include in their presentations. MK told them that, last year, the students went out on the beach to talk with visitors and suggest that they visit the display. She also asked two students to go to the snorkel rental stand and ask the vendors to inform their customers about their presentations.

As people began to drift over to the display boards, usually one or two at a time, one student recorded the number of people and another student showed the visitors the pictures on the display boards and talked about them. During the one-hour session, a total of 31 adults and 4 children visited the display.

The photos showed corals that could be seen at the beach park, some of the fish and invertebrates, a comparison of healthy and damaged corals, good snorkeler etiquette, and students doing survey work. In general, the message the students gave about proper snorkeling etiquette was very clear. However, their explanations dealing with coral reef biology or reef ecosystems were very general in nature, and some of their information was incorrect or misleading. One boy said that Christmas tree worms *(Spirobranchus giganteus)* grow "on top of" the coral, and called them "urchins." Another said that coral polyps "stack themselves on top of each other," while a third said that it is okay to take dead coral out of the water for a souvenir. This trend continued at later sessions. I heard one student describe red pencil urchins *(Heterocentrotus mammillatus)* as having "big thick legs." Another said that Christmas tree worms feed on coral.

Of the ten students present, three or four were involved with visitors at any given time, while the others sat on a nearby picnic table talking with each other. Near the end of the hour, MK asked a few of the students if they had noticed any problems that should be addressed in their Thursday meeting. Three of the students suggested that they needed to decide who was going to do what. In addition, they mentioned the problem they had with the display boards blowing over, and discussed possible ways to redesign the boards to prevent the problem. As they prepared to leave, MK and I took down the display banner, without the assistance of the students.

Three days later, MK and six students returned to the beach park, arriving at 10:10 a.m. GS came with a new promotional banner, and she and MK discussed the best way to present the program while the students sat around talking with each other for about ten minutes. MK and two students then put the banner up, while the four other students set up the display boards. During the previous session, they had identified a problem with how to put the boards up so that they would stay in place, but they had not yet dealt with it.

The display boards fell down, so the students moved them from the picnic bench to the top of the table. MK had brought string and started tying the boards to the table. GS asked a student to help.

Two students put rubber bands on red heart-shaped keychains that said, "I love coral." GS wanted the students to attach a keychain to the snorkel of every person who listened to their presentation. She said that this would make it easier for other students to follow them around and observe their behavior when they went into the water after the presentation. Unfortunately, however, although nineteen adults and two children received the keychains, none of them went back into the water afterwards.

I came back for another observation about one month later. To deal with the problem of the wind knocking over the display panels, the students had set the boards up in a different orientation. The display was still in the covered pavilion, but at a 90-degree angle to the previous setup. The display was hard to see from a distance because it was between two tables and three students were sitting on the table in front of it.

MK asked two girls to go over to the snorkel rental concession and let them know about the program. One student volunteered to record the number of people who visited the display, and another four girls agreed to go snorkeling and collect data after visitors had been "trained". They went out and sat on the beach. MK sent the other students out to recruit "trainees".

During the first twenty minutes, only three people visited the display, so MK moved the boards to the usual table facing the water. More people came by, including five different people at one time, but only one student was doing any explaining. Finally, the girl serving as the recorder came over and started to assist him, while the remaining two girls sat talking on the picnic table. MK went over to the girls and asked them to help.

During the session, a total of 22 adults and 4 children visited the display but, again, none of them went back into the water afterwards, so no follow-up data was collected.

After the session, MK told me that she had forgotten to bring the key chains. She also said that the students had decided more than a month ago that they needed to put captions under the pictures on the display, but they had not yet done so. Since they were going to set the display up the following day for a special Earth Day celebration at the park, MK said that she was going to do the captions herself that night. She also said that only one student was willing to come on Saturday for the Earth Day program. She persuaded two other students from the previous year's program to help by offering them "points" for volunteer service.

I did my last observation of this program in late May. Seven students attended – four were going to teach, and the other three were to do post-teaching observations and data collection. It was a relatively slow day at the beach park and only thirteen people visited the display. Finally, one couple had heart tags tied onto their snorkels and went into the water. Two students followed them to observe. As they were entering the water, the man turned to one of the girls and asked her a question about the program, making it difficult for the girls to observe the couple without their awareness. This was the only day that the students managed to get any follow-up data for the project.

5.7 Peer-teaching program

5.7.1 *Rationale & project background*

The peer-teaching program is one of the oldest and largest marine programs at Makai. In 1995, when the funding that had supported educational tours at the host research facility was cut, GS approached JD, and asked if Makai students would be interested in conducting tours to present their research and promote marine conservation to elementary school students. During the 2001-2002 school year, approximately 45 Makai students participated in the program, hosting more than 2,000 visitors. Most of the tour groups were elementary schools from around the state, but the Makai students also presented programs to senior citizen groups and occasional school groups from the mainland United States.

I observed three separate peer-teaching presentations during the year. The exact number and type of stations, the size of the visiting groups, and the presentation lengths varied throughout the year. In general, programs lasted from one to one-and-a-half hours, and groups rotated through ten to fourteen stations during that time. The program described below is a composite from the three observations.

5.7.2 *Peer-teaching in action*

When the group arrived, they were seated on the bleachers in the central area. JD introduced the school, welcomed the visiting students, and told them a little bit about the work of the Makai students. She also talked about the research laboratory, and described the resources available at the facility such as ample sunlight; clean, unpolluted surface ocean water; and deep cold water. She told them that the cold water was pumped up from the ocean depths and used for agriculture and aquaculture. While JD was speaking, some Makai students stood around the bleacher area talking loudly with each other.

After the introduction, JD asked the elementary teachers to divide their students into ten groups, and said that the groups would be doing four-minute rotations through different stations.

At the first station, the student presenter talked about Maine lobsters. He showed the children a rubber lobster, then a live one, and pointed out the body parts. He then showed them a slipper lobster and told them what it eats. The children were given an opportunity to touch the lobsters.

The second stop was an artificial tidepool containing a variety of sea urchins. The Makai student showed the children a rock-boring urchin *(Echinometra mathaei)*, let them touch it, and told them that these urchins "bore holes into the rocks with their feet." Another student showed them a collector urchin *(Tripneustes gratilla)* and mentioned that these urchins had "grass and stuff" on their bodies. They then showed the children a display case of mounted echinoderms.

At the "shark pit," which was still empty, the students talked about their plans for the future. One student held up a display poster showing different species of sharks, and talked about the cost of black-tip sharks and how they are shipped. She mentioned that people kill sharks to get their fins to make soup and that the soup is very expensive. She also said that they had had a hammerhead shark in the tank during the previous year, but that it had died.

The visiting group moved on to the touch tank, which contained nudibranchs, algae, cowries, and sea cucumbers, as well as an empty textile cone shell *(Conus textile)*. The children were allowed to touch all of the animals in the tank. The presenting student told them that they shouldn't touch a cone shell if they find a live one.

At the coral tank, a student explained that she was working on research on how to grow coral. She showed the children how to tell the difference between live and dead coral, and told them that they should not touch or step on live coral because they would damage it. She also pointed out that the water in the coral tank was pumped directly from the ocean, so there were now other invertebrates and small fish living in it as well.

Two students were working on a clown fish breeding project. They showed the children the clown fish that had been bred and raised in their tanks, and talked about sex changes in fish. One child asked how fish change sex, but the student presenter didn't answer the question. She went on to tell them that there had been about 500 eggs, but that only 8 survived.

The visiting group moved on to the aquaculture tank where the high school students are breeding moi *(Polydactylus sexfilis)*. Two students were working at this station. One gave the children a very detailed explanation of the project, while the other student asked him clarifying questions such as "What does 'murky' mean?" if the words seemed too difficult for third graders. Another Makai student told the children, ". . . bacteria makes algae if you don't clean the tank."

The next station was a demonstration solar panel. The Makai students talked about how a solar panel works. The panel was hooked up to a motor, and the children were allowed to start and stop the motor by covering or uncovering the panel.

The electric car at the following station was a great hit with the elementary students. A Makai student explained how it worked, and the children were given the opportunity to sit in a partially completed car.

At the reef tank, another student told the children how large the tank was and the number of gallons of water the tank contained. Since this was the last station of the program, he then told them that they could "wander around" until they were called for the wrap-up.

At the end of the program, the children were called back to the bleachers to watch a puppet show about a turtle that got a plastic six-pack ring caught around its neck. As one Makai student read the story, other students used puppets to act out the story. The other animals that were the turtle's friend were unable to remove the ring, and finally one of the children in the audience was asked to help. The children were then asked what they could do to help protect the ocean, and they responded that they should not throw trash into the ocean.

5.8 <u>**Year in Review – Teachers' Perspectives**</u>

In the wrap-up focus group, the teachers expressed mixed feelings about the overall success of the year. On a 1 to 10 scale, with 10 being the highest success, one teacher rated the year a 2, while the other three teachers agreed on a 5 or 6. As one teacher expressed it:

> I'd give it around a 6. We've had a great success with a lot of the kids. There have been some things that have fallen through the cracks, but we've made plans to address them, which to me makes it a success in that we recognize a problem and start doing something about it.

With the change from a one-year special program to a four-year charter school had come new challenges for the staff. Not only did they now have to include all of the core subjects, such as social studies, mathematics, and language arts, in their program; they also needed more students to make the school financially viable. In two years, the student body increased from 85 to 135, and the staff from 4 to 15. "We're having growing pains," admitted AB:

> We're offering classes, which we tried very hard not to do because they cut across the integrative curriculum and the concept of having projects. They're forcing us back into the traditional high school model where you have classes [. . .] And that very heavily impacts being able to get the projects done.

A long-time teacher agreed:

> Because of the huge expansion, you know the dynamics changed. We did lose a lot of the small school atmosphere. And most people would say that 135 is still a small school, but because we're not all sitting together, and the kids are still doing a lot of independent stuff, it's really hard to foster that on even that small a scale."

In order to reach their goal of 120 students for the 2001-2002 school year, the staff did some intensive last minute recruiting. "In July, a month before we started, we had 76 students and we needed 120. We recruited really hard, and when we did that we had students signing up for not the right reasons," said AB. They also made the decision to open the school to ninth graders. This brought its own related set of problems. The school has a loose structure, where teachers are available to assist those students who want help but do not continually check up on them to make sure they are doing the work. Some of the new students were not prepared for, or were unwilling to take, this level of responsibility. According to AB:

> We got a group of maybe six or eight that were not appropriately placed in this program, and I think they detract enormously [. . .] it can radically change the complexion, the makeup of the campus [. . .] And that culture is difficult to break, but I think we can. We have in the past.

The teachers agreed that, overall, one of the greatest difficulties stemmed from the fact that they had accepted a number of younger students into the program, and that they didn't have much experience working with that age group.

Some of the staff felt that the main cause of the problem was the way in which they were recruiting students. As one of the student teachers said:

> We tend to target most of the special ed students and people like that. And, although I think this kind of school is really good for them – because hands-on projects are really good – I also believe that those students generally speaking need much more structure, and they need consequences because

> that's what they understand. They're beyond the intrinsic motivation. They've already been burnt by the educational system or whatever has gotten them to where they're at. And so to expect them to be intrinsically motivated is a big joke – it's not going to happen [. . .] We target those people accidentally because it's an alternative school.

She went on to give her opinion that, if the school is going to keep to its original philosophy, they should be targeting the "higher end" of GT (Gifted & Talented) alternative students, because those are the ones that are going to be intrinsically motivated.

The staff also felt that money and time had been major limiting factors. Because of the reallocation of funding for charter schools, their budget had been cut by about 45 percent. The funding cut meant that they had less money for project supplies and equipment, but the teachers felt that the greatest impact was on their time: "We need the money so that we can have the time to do things in an efficient manner. That's every teacher's problem – it's not money, it's time."

Time was a factor in other ways as well. Because of the switch to charter school status, the school needed to broaden their course offerings. AB noted, "Our staff has been overwhelmed with trying to redo the curriculum and all the pieces that go with it. And because of that they are working more on developing classes and not as much on supporting projects." This, he felt, had an impact on students' attitudes toward their projects.

In addition to the change in the structure of instruction in the school, AB said, the philosophy behind the school was very different for some of the new teachers who had come from more traditional school settings or straight from university teacher-training programs. Although the staff agreed with the broad vision and the philosophy, some found it difficult to implement:

> We have new staff who have not grown out of the philosophies in which they were initiated, and so we're struggling with how we're going to get back to the initial concept. I think everybody is in agreement that we should be there. It's just a question of how to get there with the kind of curriculum we're currently running.

One area of staff disagreement concerned the importance of traditional grading of student performance. "My concept of education precludes the notion that you force people to do things for a grade," AB said. He added:

> The staff is not in complete agreement, in fact, they go from a spectrum of "Grades are king," to my view, which is that we should look to find activities and experiments and projects that students will want to do, and get motivated by, not because there is a grade at the end of the tunnel, but because they want to do it.

One of the student teachers emphasized that, despite some differences in vision, staff teamwork was still a major strength of the school: "The staff tends to work much better collaboratively than I have seen in other schools. And you're not isolated. There's much more support and teamwork amongst the staff. And they model that for the students." This teamwork, she felt, was beneficial to students in many ways:

> Here if a student doesn't understand the math, they can go to another teacher without the initial teacher feeling upset about it or offended or anything. And the other teacher can explain it to them. So they generally go to several teachers until they find one that they understand. And that's a good advantage.

5.8.1 ***Project Strengths***

During the final focus group, the teachers also discussed the design and implementation of the three marine projects covered in this case study. They identified the following as the strengths of the projects over the past year:

Reef survey

There were three or four dedicated students who stayed with the program through the year. They had the time and opportunity to take more trips to the reef, and collected more data than they had in the previous year.

Snorkeler education program

The number of student participants was good, and the students had a good understanding of the subject matter and were interested in passing that understanding on to visitors. MK said the students were more motivated than they had been the previous year:

> I didn't have to keep chasing them. Last year I remember, at the end of the year, chasing the kids from behind the boards to the front of the boards. This year, at least, most of them

> stood around the boards and looked available. And their willingness to go around and gather people to come and hear them talk.

She also felt that the information about the reef that students were presenting was generally accurate:

> I've had a lot of situations where the people they were "teaching" knew quite a bit [. . .] And they'd let the kids teach them and they'd come to me and tell me, "You know, your kids know their stuff." I had that happen on maybe two or three occasions this year. So I felt pretty confident that the kids knew what they were talking about for the most part.

Peer-teaching program

JD said that the number of other schools participating in the peer-teaching program was good, and they had a total of about 2,000 visitors. She also felt that the students presenting the program were good communicators.

5.8.2 *Areas of Concern*

The teachers also talked about what they perceived as project weaknesses or areas of concern:

Reef survey

From JD's perspective, the main problem with the reef survey had been the lack of student interest and motivation. Although twelve students signed on to the program at the beginning of the year, only three or four stuck with it, and she wasn't sure why the others lost interest. "You'd think taking kids to the beach and snorkeling would be enough to get them motivated. But it just isn't – for some reason, this year's been different." Part of the problem, she felt, was that the students didn't realize it was going to be hard work. Although they are told that it is a survey project, and that they will have to swim a transect line and record data, they don't know how physically demanding it can be: "Obviously, they're not into the physical activity part. They'd rather talk to the lifeguards on the beach instead of getting in the water."

To address the problem of identifying the right students for the project in the future, she said that she may need to be more honest with the students about the demands of the project, and tell them that they will have to participate under all weather conditions unless the surf is too high.

Snorkeler education project

Organization was an area that could be improved in the snorkeler education project, according to MK. The students had things pretty well organized by the end of the year, but there were initial problems deciding who was going on each trip, gathering the needed equipment, and locating things like the students' T-shirts.

Data collection for the second stage of the project (finding out how snorkelers were interacting with the reef after listening to the students' presentations) was also a problem, and the students collected almost no follow-up data. Part of the problem, MK felt, was the new school schedule. During the previous year, the students would spend the entire day at the beach park doing presentations and collecting follow-up data. This year, due to the addition of math and other classes to the curriculum, the students were limited to the morning hours. MK has ideas for improving that part of the project in the coming year: "One is getting floating poster boards and have the kids in the water and [. . .] teach them while they're in the water. And then have kids on the side observing to see if the people that we taught do what we asked them not to do."

The final area of concern noted by MK was that most of the students participated in the project to earn community service points for their assessment, or because they were generally interested in reef conservation. Only one student was doing her research paper on the snorkeler education project, with limited success. "She's so young, she doesn't quite get, I think, the concept of what we were trying to do. And that's pretty obvious in her research paper." MK felt that if more students focused their research papers on the project, they would put more emphasis on the data collection aspect.

Peer-teaching project

In some ways, JD felt that the students involved in the peer-teaching project showed less initiative than in previous years. She commented that none of them were interested in designing a project T-shirt or developing curriculum or materials to give to the visiting schools.

In addition, the students did not create any visual displays to accompany their presentations. "Every year I get beautiful display boards and this year, for some reason, they just weren't into making display boards. Every station is supposed to have some sort of visual display and that didn't happen this year."

To improve the project in the coming year, JD decided that she would design T-shirts for the students to wear, and try to find time to develop some curriculum materials for the visiting schools. She identified her lack of time as a major limiting factor:

> The main problem is that I can't focus on just this project. If I could get a group together, I'd like to revise the puppet show and improve that. Get background music [. . .] And, just develop more curriculum for the schools. They would like us to take it on the road, and I can't do that because I'm spread so thin.

5.9 Year in Review – Students' Perspectives

Nine students participated in the final focus group sessions. I asked them what they felt were the best and worst things about the projects, how the projects could be improved in the future, and what they had learned from doing the projects. All of the students who participated in the final focus groups had worked on two or more of the projects, so the projects tended to meld together in their responses.

5.9.1 *Best Things*

When asked to name the best things about the projects, most of the students' responses related to the teaching aspect of the snorkeler education and the peer-teaching projects:

> A. It's cool to teach the kids about things that they don't know. It's fun. Giving information that they don't know.
>
> B. Probably talking to the kids, stuff about reef conservation, things that are a pride to our community.
>
> C. I really liked teaching people and informing them about reefs and the ecosystems and trying to instill in them the need for conservation [. . .] I expected people to be more knowledgeable but all these people didn't know what coral was and the ones that did know what coral was, in a round-about way, didn't know how to recognize it. They thought it was rock and stuff like that. So it was really cool being able to teach them and people were really learning a lot.

In addition to teaching, three students said that they liked learning more about coral reefs and fish through their projects, although one girl was not sure how that knowledge would benefit her: "I can name a lot of fish now that I could never have named if it wasn't for the reef survey. And I don't know if that's good or bad. Like I don't know what that's gonna get me in life, but hey, it's pretty cool."

One student liked the peer teaching program because it was an easy way to meet many of the school requirements: "Just in one tour you can get your community service, you can get your points, and you get a lot of stuff done." Another student said he liked the reef survey program because the training had given him the skills to get a summer job as a narrator on a tour boat. Another liked the chance to go to the beach and get in the water once a week, acknowledging also that he learned useful things about coral reefs and he liked teaching others.

5.9.2 *Worst Things*

The students were much more vocal when asked what they had not liked about the projects. Foremost among the responses were boredom and burnout, especially with the peer teaching program.

> A. I got really burnt out at the end of this year because it's just a lot of tours over and over. And you're saying the exact same things, so it's easy to just get burnt out on the project.
>
> B. I don't like the repetition of it, I guess. I get bored after a while, so it's kind of old after having to say the same things over and over again.

Another student said that he burned out on the teaching project because he wasn't used to working with really young children, and that it was difficult to control them and get them to pay attention to what he was saying. Other criticisms of the peer-teaching project were that some students weren't reliable and didn't show up to do scheduled tours, and that others were using profanity in the presence of elementary students.

One of the students working on the reef survey also mentioned burnout as a major factor. He had been frustrated by the fact that they didn't go out to collect data on a regular basis, and that the project was, in his words, "messed up." As he put it, "A lot of people were dragging their feet on it, because they were bored or just stopped being interested after the first semester, or not even going out and collecting data." He also noted that the data was not always recorded correctly, and that there were too many variables to get reliable data.

The reef survey students also cited the lack of responsibility taken by other students as a problem:

> A. You also need to know that they are going in the ocean. So, some people will be not even in the mood to go in at all – either the water's too cold or too rough or just whatever.
>
> B. They want to go, but when they get down there they don't want to get in the water.
>
> A. And that's a responsibility too, like bring their snorkel gear and stuff. But other than that . . .
>
> B. It goes back to being a good student or a crappy student.

The comments on the snorkeler education project were similar to the feedback on other two projects. Students didn't like having to do the organizational work and preparation, and they were frustrated with other students who didn't do their share of work. In addition, two students admitted that they liked teaching, but did not like research or data collection.

5.9.3 *Ways to Improve Projects*

After the students had spent some time talking about all of the problems they had encountered with the projects, I asked them where they would put the responsibility for the problems and for dealing with the problems. This question started a spirited discussion:

> A. Advisors. They told us . . . it's not really ourselves. You know, we can only go out once a week – we have classes. We have class work that we have to do in the afternoons, so we can only go out for like half a day. The teachers are busy during this time, so we can't really go out. We have to have a supervisor when we go out. It's not all student-oriented. We have to have someone looking after us, so it's not our fault that we can't go out and take this data.
>
> B. But the problems that we face when we're out there, like being rainy and not enough people out there and stuff . . .
>
> C. I lay the blame on myself because I was not responsible.
>
> B. Responsibility is a key thing.
>
> D. I think it's students – and I think it's half and half – teachers and the students. Students have a responsibility level to even show up when we do go out. And when we are able to go out, the teachers have to also have plans.
>
> B. There's students that don't take enough responsibility. And the teachers do as much as they can according to their schedules.
>
> A. Students might be a little more into it if the teachers were a little more into it.

The students didn't appear to be reaching a consensus on this point, so I asked them what suggestions they had for improving the projects they had worked on.

One student who had worked on the peer teaching project said that it should be better organized: "Last year we did have some more organization going, and I think it would be better to do that again. We had poster boards and you had to write reports and stuff like that."

The other main suggestion for improving the peer teaching project was to have students learn about each other's research projects, and rotate through the stations rather than presenting the same information over and over. One student suggested creating guided scripts for each of the presentations, rather than relying on impromptu talks.

The same suggestion for a guided script was raised for the snorkeler education project. Two students said that the physical layout of the display boards could be improved, so that the students wouldn't get in each other's way when they were doing presentations. Others disagreed, saying that the boards worked fine the way they were.

None of the students mentioned the problem of getting follow-up data on snorkeler behavior, so I asked them how they could redesign that part of the project. This created another spirited discussion, with the students finally agreeing that it was a matter of timing and that there was nothing they could do to solve the problem.

5.9.4 *What they had learned*

Most of the students said that they had learned how to be better public speakers and were more comfortable with talking to a variety of people, especially young children. Two students mentioned that they understood their own research projects better because they had to figure out how to explain it to others.

The students who had worked on the reef survey and the snorkeler education project said that they had learned more about corals and coral reef ecosystems. However, when questioned in more detail about some of their comments, it appeared that they were confused about some basic concepts, even though they had spent the year studying and teaching about coral reefs:

> A. There's a lot of natural threats, like coral bleaching and big storms.
>
> B. Well, yeah, there's also like El Niño and whatnot, because of the surf and the water temperatures, so like coral can survive only up to a certain temperature. And water, with El Niño, temperatures are increasing and decreasing and that has an effect.
>
> RESEARCHER. *So, what is El Niño?*
>
> A. The weather; global warming and all that stuff.
>
> C. Global warming causes it.
>
> B. Isn't El Niño a storm with huge amounts of rain and wind?
>
> A. No, no, El Niño is like the year that the weather was bad or something.
>
> C. Well, I know there was a big storm here 3 years ago, I think, and a lot of the corals are damaged because of the surf and whatnot.
>
> A. Global warming will eventually have an effect. I think the pollution will eventually, besides, increase in temperature and with the increase in temperature in the waters, comes an increase in the bacterial growth and, they're saying it might actually happen. But then there's like major problems that could happen with like any sudden increase or gradual increase in temperature.

RESEARCHER. Such as? What kind of problems?

A. Corals might not be able to . . . I don't know if corals would grow more in like the warmer waters, but then there'd be like bacteria that would grow in the warmer water from a certain amount of pollution. Like say there's a certain amount of pollution in this coastal area, and the temperature of the water can regulate a certain amount. And then with the warmer waters, it can no longer regulate, and has an opposite effect and warmth makes bacteria grow. So then there might be bacteria in the fish. People can't eat their fish any more and it might kill the polyps in the coral.

RESEARCHER. What causes coral bleaching?

B. Too much sun and too warm a waters. That's what they think but they can't prove it.

RESEARCHER. What actually is coral bleaching?

B: When the coral dies, essentially.

A. Not just the coral.

RESEARCHER. Can anybody tell me what the mechanism is – why it turns white?

D. The polyps die.

E. I don't know about the white part, but the zooxanthelle - this is when it like turns another color, when the zooxanthelle is getting a particular thing out of the water, like, in its food, it's picking out certain enzymes or something like that and that's what turns it the different colors. The bleaching I always thought, but I've never really been positive, I didn't hear too much about it, I thought it was just when it was dead.

B. Yeah, when the polyps die and there's no life left in it.

D. The crown-of-thorns go over it and then they eat it. When it just dies it goes white.

B. The skeleton is white and then, what makes it colored is all the polyps and the life in it.

E. And what it eats, right? What it eats comes out and that's what changes it to its color. I guess you can kind of liken it to, we turn really, really pale when we're dead.

RESEARCHER. Any comments from the rest of you about coral bleaching, what it is? What causes it to turn white?

E. But that's just a thought, I don't know what it is.

D. I think it's the polyps, though.

5.10 <u>**Year in Review – Observer's Perspective**</u>

After reviewing the observation notes, interview and focus group transcripts, and written materials, I compared the three projects in this case study with the assessment rubric. The following analysis reflects only those specific programs, and may not be representative of other projects at the school or individual students' research projects.

5.10.1 ***Program logic***

Since its inception, the school has had a very strong educational philosophy that student projects should be initiated and run by the students. The teachers are there to assist where needed, but it is the responsibility of the students to make sure the work gets done. It is based on the belief that if students are allowed to decide what and how they want to learn, they will have an intrinsic motivation to succeed and will not be as dependent on a reward/punishment system such as traditional grading.

Not all of the staff appeared to share this vision, at least not to the same degree. This may reflect some of the "growing pains" mentioned by

AB, when he talked about the disagreement among the staff over the importance of grading, and may improve as the staff spends more time working together.

In addition, although all of the staff questioned said that there were more problems this year, and that the school culture had changed significantly, there was disagreement as to the reasons. Some teachers felt that the principal cause of the problem was lack of funding for project support, while others thought it was lack of time because they now had to teach regular classes in addition to facilitating student projects. All agreed that the increased number of students was an important contributing factor, but some attributed the problems to the overall immaturity of the ninth graders, and others said that the school was recruiting the "wrong" type of students. The school has a local reputation among students as being an easy way to get through high school, and because it is a public charter school, the school can not discriminate or refuse to admit students who apply.

5.10.2 *Administration*

Governance, Management, and Resources

For long-term stability and success, the political and funding issues of public charter schools in Hawai'i need to be resolved. According to AB, the school was only able to operate on their current budget because of a surplus from the previous year, and they need to keep student enrollment at 120 or more in order to maintain the same staff numbers. These issues contributed significantly to many of the problems the school was dealing with during the observation period.

Relationships

Relationships among the staff, and between staff and students, appeared to be generally good. The atmosphere was relaxed and informal, and students and teachers interacted freely.

Relationships with researchers and mentors were more problematic. I interviewed three different people who had served or were serving as scientist mentors on various student projects. Although two or the three continue to serve as mentors, all of them expressed certain frustrations. Two major issues were identified – lack of quality control in the data collected by the students, and lack of follow-through with projects. One mentor said that, although she has worked with the students for several years, she had not used their data since the first year because the quality is not high enough. To get usable data, she felt, the instruction methods and the teachers' expectations would have to change. Another mentor said that high school students were capable of collecting data of a reasonable quality, and that some of the students did do good work. It depended entirely, he said, on the individual student's motivation.

The third mentor said that she no longer worked with the students because they did not take any initiative, showed little interest in the project, and expected her to do all the work. Another mentor reinforced this, saying "I guess I was a little disappointed at times that a project they [the students] were supposed to have chosen, it ended up they didn't seem to care much about it. They really just wanted to get out of school as fast as they could." He added:

> And some of those kids who wanted to do it, sort of - once they found out it involved keeping check on things and being fairly responsible – they kind of dropped the ball, some of them. Not all of them. You know, it really kind of got me down because I thought "Wow, this is a really neat kid; they're really smart and they can do all this stuff." And then they'd just sort of leave a big mess and not keep on.

Some of the problems noted above may stem from differences in philosophy and goals between teachers and researchers. The teachers are concerned with the overall education process and the personal development of their students, while the researchers are looking for quality data and a reliable product. This is an important consideration for all programs that try to involve students in collaborative research or environmental action programs with outside organizations or agencies, and it deserves further research.

Planning

The informality of the school structure contributed to a fairly high degree of disorganization when it came to planning. During one of the staff meetings, the discussion centered on grading policies. The school has a multi-faceted assessment process where student grades are based on a daily journal, one or more research papers, literary critiques, a computer skill checklist, community service activities, and a weekly binder. The weekly binder contains time management sheets, weekly project reviews, weekly module reviews (showing how the student has participated in activities that help support the school, such as vehicle repair or managing the tool room), and activity points (for other activities such as poetry groups or art projects that don't relate to either their research projects or school support). These are all combined in a portfolio that each student prepares and presents as evidence of his or her work over the course of each school quarter.

The staff meeting discussions showed that the staff was uncertain or in disagreement about some of the grading policies, including what constituted acceptable evidence for the portfolios. Some of the teachers felt that writing done by students for their history classes should be acceptable as a replacement for daily journal entries; others disagreed. As the discussion continued without reaching a resolution, and teachers wandered in and out of the room, one teacher commented, "No wonder the kids are so confused."

This disagreement over grading was evidently not a new problem, because it was mentioned by a mentor who had worked with the school four years previously. As he pointed out, the grading philosophy reflected the individual teacher's expectations, which in turn affected student performance:

> There's one teacher I really respected down there who is real hard on the kids. And another teacher who's saying was "It's all good." That was his favorite saying. He's not there anymore. So anything they did was fine. And it kind of like set the tone there, so it contributed to kids not necessarily trying their hardest. Where some of his kids would get high grades on something, and some kids who were assigned to other teachers would get low grades on reports that were fairly similar. So they weren't happy about that either. "Oh, man, he gave me an F." "Miss gave me an A." Something like that. All the teachers were kind of different.

The disorganization extended beyond grading issues. At a staff meeting in late February, one teacher noted that the planned parent open house was not on the calendar for the coming week. AB asked the teachers which ones would be present for the open house, and it became apparent no organization had yet been done. The teachers spent the next fifteen minutes discussing what time the program should be held. Further discussion revealed that no one knew if invitations had been sent to the parents or not, even though the open house was less than a week away.

The overall lack of organization and follow-through at the staff level may have been a contributing factor to the lack of organization evident in many of the student projects.

5.10.3 ***Program design and implementation***

<u>*Relevance, Active Participation, & Student-direction*</u>

In theory, the marine projects I observed were relevant to the students. Although none of them were student-initiated, the students had chosen to participate because they were interested in the project. This was true for a number of the students. Others, however, took part because they were required to do some kind of project, and the marine projects gave them the chance to go to the beach for the day. As JD put it when reviewing one program, "I had some key people on there that I could trust their information. There was about three or four really good kids [out of a total of eight]. Some of the other ones were just along for the ride – literally – and lunch." This reinforced my observations of the other projects. Approximately half of the students actively participated in project work during the field sessions; the others spent most of their time talking with each other, sitting on the beach, or playing in the tidepools.

On several occasions, there were noticeable gaps between the teachers' stated philosophy and their actions. According to the teachers, the projects were supposed to be student-directed and student-managed. However, JD put out and removed the transect line for the reef survey instead of leaving it to the students, but said that she doesn't have formal meetings with the students to discuss their data because the project is student-driven. MK wrote and typed the captions for the snorkeler education displays because the students were unwilling to do it. When talking about the peer teaching program, JD said:

> I was bummed because I wanted a T-shirt design. I've had that happen. I've had kids come up with a project T-shirt because I wanted them all to wear it. But nobody got it – would design a T-shirt. So I think I'm just going to have to do it myself for next year.

Student Motivation

Despite the school philosophy that students will be self-motivated if they are allowed to work on projects of their own choosing, most of the students appeared to be motivated more by the points they could earn. When the reef survey students complained that they had not been able to get out often enough to survey and collect data, I asked them if they could have done it on their own on the weekends. All of them agreed that they could have done that, but one student asked, "Hey, do we get points if we go by ourselves?" In another example, when the snorkeler education project was asked to come to the beach park on a Saturday to take part in a special Earth Day program, MK told me that she had to offer the students extra points before any of them would agree to help. The teachers had also offered points to students who were willing to participate in the focus groups for this case study research.

The noted lack of motivation may reflect, in part, the nature of the projects chosen for the case study. The fact that the projects were not student-initiated may have attracted some of the less interested or motivated students because they did not have to make the effort to propose and design their own project. For these students, the chance to spend time at the beach was probably a major motivating factor.

Real-World Setting & "Real" Research

One of the program's strengths was that most of the student projects took place in a real-world setting, and were focused on actual problems. The beach park where the students were doing their reef survey and snorkeler education work is one of the most heavily used beaches in Hawai'i, and the students could see the impacts first hand.

In addition, the reef survey and snorkeler education projects were "real" research because they were done in collaboration with agencies that were interested in getting the students' data for ongoing research projects. This was a powerful motivating factor for many of the students.

Procedural Accuracy

This is an area where there is room for improvement. As noted in the project descriptions, students often reached the research site without the necessary equipment such as transect lines or data sheets. The surveying procedures used also reflected a lack of concern for detail. Although there are fixed transect pins in the bay where the students were doing the reef survey, only one pin was used because no one ever managed to locate the second pin. The students were supposed to do repeat surveys of the same transect, but no one ever used a compass to determine the direction of the line from the single pin to make sure that they were surveying the same area. The transect line was also often loose and swaying in the current. At least one student was collecting data without using a transect line at all, choosing instead to "eyeball it."

Collaboration & Technical Assistance

The school receives a significant amount of technical assistance from individuals and agency personnel who act as student mentors. This is an extremely important component of the program that should be expanded. Two of the mentors interviewed expressed the view that many of the problems with procedural accuracy could be addressed if mentors spent a more extended time in the field working directly with the students.

End Results

The projects had a fairly strong focus on end results. The students who worked on the peer-teaching project had the opportunity to share their research and their knowledge with some 2,000 people. In the snorkeler research/education project, the students collected data for a larger agency project and shared their learning with others through the teaching aspect. The original intent of the reef survey project was to collect data for an agency project. The data is not currently being used by the agency because of quality control issues, but if those issues were resolved, the students' research could be of real benefit to the agency.

Time & Opportunity

Both teachers and students identified lack of time and opportunity as a limiting factor. Due in large part to the implementation of structured classes such as math and history, the schedule could not be as flexible as it had been in previous years. This, combined with the limitations imposed by tides and weather, meant that the students could not go out to the beach park as often or for as a long a period as they would have liked.

The teachers' time was also more limited because of preparation time for the structured classes, and dealing with issues such as restructuring the curriculum, applying for accreditation, and writing grant proposals for project funding.

Team Approach

All of the case study projects used a team approach, with mixed success. As the students pointed out, they worked well together if the entire group was motivated, but all of the projects were hampered by certain students who either did no work or actively hindered the work by fooling around and distracting others.

Control

All of the students had a fair amount of control over their projects. If they decided that they did not like the project, they could drop it without incurring any penalties. If they felt that the project should be done differently, they could discuss it with the rest of the students in the group and make a suggestion to the teacher advisor. The final decision, however, remained with the teacher. One student noted, "We all would recommend something to the advisor, and then it's up to her whether or not it actually would happen."

In the day-to-day running of the school, the students' input was limited to a token involvement. The school has a student council that reports to one of the teachers. The teacher then passes the students' ideas on to the rest of the staff, but the students are not involved in decision-making in a substantive way. As one of the student-teachers expressed it, "I think to make them really involved they should be sitting in the meetings so that they can brainstorm with us, rather than just give us their opinions and we decide whether we like them or not. That's not the same thing as participating."

Personal Development & Communication Skills

As illustrated by both students' and teachers' comments, the projects appeared to help students develop better communication and other personal skills. Students said that they felt more confident around other people, they were better public speakers, and they had a greater feeling that they could make a difference when it came to environmental problems. Several students commented that they had gained valuable experience that would help them get jobs or do better when they go to a university. One girl said that she had overcome her fear of the water by participating in the snorkeler research/education project.

Trust

Students who had attended the school in previous years said that one of the things they liked best was that the teachers trusted them to be responsible and gave them a lot of freedom. They acknowledged that inappropriate behavior by some students had made more restrictions necessary over the past year, but they resented it. Three girls told me that they feel less motivated themselves as a result. They were no longer concerned with doing quality work, and simply wanted to pass their courses. This general attitude seemed widespread through the school, affecting both the students' and the teachers' attitudes and behavior.

Support of Teachers/Facilitators

The problems of the past year impelled the teachers to rethink their roles as facilitators. Many students failed their courses and caused problems for other students because they were unable or unwilling to manage their time and take personal responsibility for their learning. To address this issue, the staff has decided to try a more structured approach for the next year. The approach will be based on a three-tier system, where all students begin in structured classes and gradually earn the right to work in a more unsupervised, student-directed manner.

If implemented as planned, this should go a long ways towards addressing the problem.

Research has shown that teachers' expectations also affect student performance (Huberman 1997, Kaser and Bourexis 1999). In some instances, the teachers facilitating the projects appeared to have low expectations of the students. One teacher commented that the students were incapable of field-mapping a tidepool because "their attention spans are too short." Of another project, she said, "It's an [agency] project so we have to be accountable and you can't really rely on the kids to be accountable for that sort of thing."

One of the mentors expressed her opinion that many of the problems with accurate data collection and project follow-through stemmed from the low expectations of the director and the teachers. She also felt that the school needs a director who is more of a disciplinarian. The lack of discipline, she felt, transfers to the teachers and then to the students.

5.10.4 ***Program content***

Through their individual and group research projects, the students are exposed to a wide range of science and environmental concepts and processes. However, what they actually learn is extremely variable, depending on the students' motivations, and their abilities to conduct research, read and analyze written information, and ask appropriate questions. In many instances, students gave misleading or incorrect information when doing presentations. The overall program could benefit by putting a stronger focus on helping students understand and use accurate research methodology and data collection techniques, working more closely with them on the interpretation of their results, and providing continued feedback to them about their educational presentations.

5.10.5 ***Program assessment***

As discussed earlier, assessment is both a strength and an area of concern. The system is complex, and attempts to consider multiple learning styles by using a variety of assessment techniques. The journal writing requirement encourages students to reflect on what they are learning and how they are affected by their school experiences. The inclusion of community service and an expectation that students will help with maintenance and support of the school helps carry the school experience out of the realm of the purely academic, and supports the idea that students have a responsibility to the larger community.

The concern comes from the lack of consistency with which the grading system is applied, which varies considerably from one teacher to another, and the general confusion of the staff over what is expected from the students. In various staff meetings, teachers have expressed their concern about these issues and are planning to address assessment in their new, more structured system.

5.11 **Conclusion**

Overall, the loosely structured, student-directed, and project-based nature of the Makai program can be very effective for those students who have the maturity, self-motivation and self-discipline to work independently. At its best, a program of this nature can meet most of the criteria noted in the assessment rubric. At worst, it becomes merely a way for students to pass the time until they are old enough to leave school.

The key to success appears to lie primarily in the interest and motivation of the individual student. Project-based learning can also be very effective for unmotivated students who are having trouble in traditional school settings, but those students need a different framework that is more structured and includes more direct teacher guidance. The three-tiered structure system planned for the coming year may help address the issue of students who need additional guidance.

As part of the restructuring, the overall school vision needs to be discussed, analyzed, and agreed upon by all staff to narrow the gap between theory and practice. There is a need for frequent and continued reflection on the part of both students and teachers, and a willingness to engage critical examination of personal assumptions, beliefs, and actions. In addition, if the staff decides to continue with the concept of a student-directed school and student-run programs, the students should be included in a more substantive way in planning and implementing the school structure.

CHAPTER 6
MARINE-WISE

Marine-Wise is a voluntary after-school marine science program for secondary students that is run by a local nonprofit organization. The program's goal is to involve students from community schools directly in marine research through a variety of research-based fieldtrips and follow-up work in a computer lab. The following case study research was conducted from October 2001 to June 2002 during the program's third year of operation.

6.1 Methodology and Information Gathering

I spent a total of 6.5 hours observing the program in action, reviewed printed material about the program, and attended five organizational meetings with the program directors and other community members. In addition, I conducted pre- and post-program interviews with the directors, and a focus group interview with three of the students who were involved in the program. I also held informal conversations and discussions with the directors and students throughout the year.

6.2 Background, Vision, and Goals

Marine-Wise is the brainchild of two marine mammal researchers. In 1990, SL and PT formed a nonprofit foundation to promote continued scientific research, education, and conservation efforts relating to Hawaiian spinner dolphins. The foundation's stated goals are:

- To conduct and coordinate research on wild populations of whales and dolphins.
- To work with educators and community members by serving as an education resource and by providing courses and internship opportunities for high school students, community members and undergraduate marine science students.
- To promote awareness of the importance of a healthy marine ecosystem.
- To serve an advisory function to Federal and State agencies regarding marine conservation issues.

In 1999, SL and PT were approached by the 21^{st} Century Learning Center at a local elementary school and asked if they would develop a program to take high school students on marine-related fieldtrips. SL and PT were interested in the concept, but noted that the Center's general focus was on sports and related after-school recreational activities. As SL said, "They wanted us to just take kids on trips, go do coastline trips, that kind of thing. And we said, 'Well, we don't want to do that. We want to do something that ties into more ongoing research. We don't want to just take kids on fieldtrips.'" After deliberation about their specific objectives, SL and PT decided that their program would provide opportunities for:

- Rigorous marine science education for students in grades 8-12.

- Technology training for students and teachers.
- Community participation in marine science research projects.
- Leadership development for students in grades 8-12.

The 21st Century Learning Grant gave them $2,000 per year for three years to offset costs of the program. SL and PT volunteered their time to organize and run the program, and the students paid $10 per week for fieldtrip transportation. The elementary school provided classroom space and access to their computer lab, while the local YMCA donated the use of their van for fieldtrips and provided liability coverage for the students.

Twelve students took part in the program during the first year of operation, meeting weekly for three-hour sessions from early October 1999 through May 2000. The program consisted of a combination of classroom sessions, marine-related field trips (including visits to aquaculture facilities and Hawaiian fishponds, whale watching trips, attendance at a marine ornamentals conference, and a trip on a tourist submarine), and several research-oriented trips such as a whale count, tidepool survey, and snorkel reef transects, where the students had the opportunity for hands-on work.

During the second year, the program was shorter, running from January through March, and was centered on humpback whale research that was being conducted by a consortium of researchers who come to the island for the winter calving season. As part of their research, the scientists set up a shore station to track and record the positions of humpback whales during daylight hours over a period of six to eight weeks. Eight Marine-Wise students helped with this research by serving as data recorders at the shore station.

6.3 <u>**Marine-Wise in Action**</u>

In early October 2001, SL and PT met with the principal of the local elementary school and FR, a teacher from a nearby high school, to discuss the Marine-Wise schedule and possible activities for the coming year. PT said that he would like to start the year by having students work on a coastal water quality testing project. A discussion followed about what parameters to measure. SL said that she would also like to have the students do some initial ecosystem mapping of coastal habitats, and they talked about the possibility of comparing water quality in anchialine ponds, the ocean, and areas of freshwater input to the ocean.

PT mentioned that they were thinking about running cables to put out an underwater video camera for monitoring, and FR, who works extensively with video technology, suggested the use of wireless cameras. The group discussed the possible involvement of a community association in a wealthy coastal residential area, agreeing that the chair of the association would be a good support person to help them find residents willing to have the cables run across their property. FR also said that he is trying to get a map server on their website so that his students can input information directly into a Geographic Information System (GIS).

This led into a discussion about the difficulties of doing research with high school students. FR felt that the hardest part was getting students to be critical of the data that they collect. In his opinion, based on his own teaching experience, the students don't understand the need to calibrate the probes when doing water quality tests, or the general need for accuracy in data collection. This led back into the discussion about what water quality parameters could be measured by the Marine-Wise students. Testing for coliform bacteria was discussed, and the group came to the consensus that this would be too difficult for elementary students, but that high school students were capable of testing at a presence/absence level.

PT asked the group's opinion about what kind of software to use for the ecosystem mapping. FR recommended Arc View, but PT said that he would prefer Excel because it was simpler to use.

SL mentioned the possibility that the Marine-Wise students could serve as mentors and peer-teachers for fourth graders at the elementary school.

She also noted that they had lost their tie with one of the area high schools because the lead teacher there had left the school. As a result, she said, there was no student interest in the program from that school this year. She said that she was going to focus her efforts on finding students from another local high school. FR pointed out that they needed more than student interest; they had to get teachers to commit to the program as well. He also suggested finding some funding to pay the students through a community work experience program, but gave no specifics about how to do this.

I met with SL again two weeks later to find out how the program was progressing. She said that they had changed the starting date from October 10, as originally planned, to November 14. Their goal was to involve ten to twelve students, but although she had sent flyers to the four schools that had participated in the program the previous year, and had put an advertisement in the local newspaper, no students had signed up. SL wasn't sure why there had been no interest, but noted that a teacher at one of the high schools had dropped the program because she wasn't getting the support of her school administration. SL didn't think that the $10 weekly fee they were asking was a limiting factor, and said that they don't charge students who can't afford it. In the past, she felt, the fee had been important. Those who didn't pay were more apt to drop out because they didn't take the program as seriously.

6.3.1 ***First student orientation***

On November 14, the first meeting of the Marine-Wise students was scheduled for 3:00 p.m. at the local elementary school. SL and PT arrived at the school at 3:15 and told me that only one student had called and expressed interest in the program, and that they didn't know why the interest was so low. SL also said that eight students from a nearby charter school had committed to the program, and were supposed to attend that day. Shortly before the meeting, however, their teacher had called and said the students couldn't make it, but that he would attend and then pass the information on to the students.

Shortly after 3:15, two students arrived and we walked over to the computer lab for the orientation. PT told the students that they would be doing "marine environmental monitoring" during the fall semester, and handed out a program description. They would map a section of shoreline and near-shore waters, and monitor water quality using "wireless network technologies and other techniques." For the water quality monitoring, PT and SL had decided to have the students measure salinity, chloride concentration, and water temperature, and to study the distribution of snails along the shoreline as an indirect salinity indicator.

SL broke in at this point to explain the "big picture." This section of shoreline, she explained, was undergoing rapid development. There is no sewage treatment plant in the community, and individual homes were dependent on leachfields. The community association had funded a water quality study, and the Marine-Wise students were going to assist with this study by looking at freshwater input into the ocean near the development. SL also told the students that they wanted to teach them how to use the scientific method and let them try some accepted methods for taking certain standard measurements.

PT then talked about the instruments and equipment they would be using to take the measurements. These included GPS (Global Positioning System) and GIS (Geographic Information System) for the shoreline mapping, a refractometer for testing salinity, a standard chloride test kit for determining chloride concentrations, and a thermometer for recording water temperatures.

SL told the students about the underwater camera and the reef monitoring that they hoped to do in the spring, and also mentioned the humpback whale studies they would conduct during the winter months. She told the students that, in the spring, they might have the opportunity to work on projects based on their own interests.

PT brought the focus back to the water quality testing. He said that they would be using snails as indicator species because invertebrates have no way to regulate their internal salinity. Because of this, he said, different species will be found in waters of different salinity and can be used to indicate areas of freshwater input. He went on to describe the humpback whale studies that would start in February, noting that the exact timing would depend on when the whales actually arrive. During this study, the students would learn how to use a theodolite to pinpoint and map the exact locations of the whales.

SL told them that four whale researchers would probably be coming from the mainland United States during this period, and that they would probably take a couple of boat trips so that the students could see the difference between observing whales from shore and from the water. She then began to talk about the plans for a coral reef fish survey in the spring, and asked if the students were comfortable in the water and with mask and snorkel. Both students answered in the affirmative.

SL and PT both pointed out that all of their projects are long-term and are collecting real, useful data. At this point, PT asked the students for their impressions. One student, a 17-year old from an area charter high school, indicated that none of this was new to him, but that he was interested. The other student was a 14-year old freshman from a regular public high school, who said that she didn't know much about this kind of research.

SL mentioned that there was a $40 per month transportation fee, but that they won't turn students away if they can't pay. What they were looking for, she said, was commitment. She also told them that they were required to join the local YMCA, which cost $10 per year, in order to get the needed liability insurance.

SL talked about the flexibility of the timing for the whale studies in the winter, before going back to the logistics of the water quality-monitoring project. She said that they had two meetings scheduled before Christmas. On the last Wednesday in November, they would take a fieldtrip to the study area to get some initial data. The following week they would meet in the computer lab to input their data.

Before ending the meeting, they discussed transportation issues. The public school student said that she would have trouble getting to the meeting place by 3:00 p.m. because of the bus schedule. Her school got out at 1:00 p.m. on Wednesdays, but the students needed to wait at the school until 2:30 p.m. for the bus. This meant that she couldn't get to the meeting place until about 4:15 p.m. SL said that she would check into the problem and try to figure something out.

Just before the group dispersed, the teacher from the charter school called and said that he had forgotten about the meeting. SL and PT agreed to meet with him at his school that Friday.

6.3.2 *Meeting with the charter school teacher*

At the beginning of the meeting, the charter school teacher (BK) described the school, saying that it is a K-12 public charter school for Hawaiian students. There are about 80 students in grades 6 through 12, and they work together in multi-age groups. He expressed his desire to focus on the use of real-time online data. The school has a computer lab, he said, and the students are heavily involved in its use.

SL asked him if he could do follow-up work in class to complement the Marine-Wise fieldwork. He was somewhat dubious, but said it might be possible, depending on where the students were on their "other stuff." SL told him they were facing two logistical issues with the Marine-Wise program – the cost of transportation to the field sites (students at this charter school were mostly from low-income families), and the problem with the bus schedule at one of the regular public high schools. BK asked if the bus schedule was the real reason they didn't get more than one student from that high school, or if there were some other factors. He also said that his school, being a charter school, was currently having financial problems so the cost of transportation was a major impediment. SL responded that they might be able to use the YMCA van so that the only expense would be for gasoline.

BK said that the school had some funding available for career focus programs, and that if they could move the Marine-Wise program to Friday mornings, he could probably get more students involved and find the money for transportation. SL and PT agreed that this could be a good opportunity, and that they could start it in February with the whale program. BK responded that there would probably be more support in his school for the water quality monitoring program. He also said that their program changes on a quarterly basis, with the next quarter running from January 14 to March 22, and the final quarter from April 15 to June 14, so they wouldn't be able to make any changes until January.

The three discussed the possibility of alternating whale studies and monitoring during the winter quarter. SL felt that it would be better to do whales during the winter and monitoring in the spring. For the whale studies, the students could be split into two groups. During each session, half of the students would work at the field station, and the other half in the computer lab.

The problem for the current quarter, however, was finding the money to pay for gas for the YMCA van so that interested students could participate in the after school program. BK said that even if they only had a small group and didn't meet as frequently as every week, it would still be a valuable experience for the students because they could become familiar with the equipment and the data collection protocols. They agreed to follow through with the two scheduled meetings before the Christmas holidays, although they delayed the first field trip by one more week.

PT said they had not yet decided exactly where they would collect their water quality data, because the community association wanted the entire coastline monitored. BK said they should make a "to do" list, and they decided that SL and PT would check on the YMCA van, send information about the whale research to BK, and get the equipment for the field trip. BK agreed to ask about free YMCA memberships for low-income students, and have the students fill out the liability waivers. He also said that ten students had expressed interest in participating in the program, with five of them "probably serious."

6.3.3 *The first field trip*

PT and one student (the girl from the public high school who had attended the first orientation session) arrived at the community boat ramp at 3:20 p.m. on the day of the first fieldtrip. PT explained to the student that they would be looking at water salinity, and said that light is refracted when it goes from air to water, so they would measure the salinity using an instrument called a refractometer. He gave her the data sheet and asked her to be the recorder. He reviewed the data they would record - cloud cover (estimated by eighths, e.g., 1/8 covered by clouds, etc.), sea state, (which he told her was a three and that they would discuss it later); swell size (again he gave her the figure); and location.

PT used a hand-held GPS unit to determine the latitude and longitude, and said to the student "You know about latitude and longitude, right?" When she nodded yes, he then took a water sample with an eyedropper and put it in the refractometer. He showed her how to use it and asked her to read the scale. She had initial difficulty reading it, but figured it out after a few tries. Next, PT said they would test for chloride, but then decided to take the water temperature first. He took the temperature and asked the student to record it.

At 3:40, BK arrived with two students from the charter school, and PT began to explain the refractometer again. BK interrupted and had the students introduce themselves. He then gave a short, very general lecture about the relationship of sodium chloride molecules to water molecules in a saltwater solution.

PT attempted to demonstrate the chloride test, but it didn't work. He filled the bottle with silver nitrate after putting in the water and the reagent, but there was no color change. Finally, they decided to give up on the chloride test and moved to another site to collect more data.

BK asked PT what other data, besides salinity and temperature, they would be measuring. PT replied that, for the moment, that was all because they were looking for areas of freshwater intrusion. BK and PT discussed the importance of choice of sample locations, but did not involve the students in the discussion, and the students did not take the initiative to participate.

At the next site, PT asked the students where they would expect the most freshwater to be found – in close to shore or out farther. One student replied that there would be more freshwater out farther. When

BK asked her why she thought this, she replied that Uncle Kapono had told her that. BK agreed that there could be strong freshwater springs off shore but pointed out that, in general, the freshwater influence will come from the land.

PT told the students that two different species of snails could also be used as salinity indicators, because one species lives in freshwater and the other in saltwater. He said he did not know the names of the species, nor could he identify them at this point.

At this and the next two sites, PT had the students take the salinity and temperature readings, while he used the GPS to determine the latitude and longitude. At each site, they took two readings – one close to shore, and one farther out off the rocks. At first, they only took one sample at each location. I asked if they were going to do replications to increase the reliability of the data. BK agreed that it would be a good idea, so they took three samples at each location at the last two sites.

At the end of the trip, BK said that he would do some follow-up work with his students in class, and that they would meet at the computer lab on the following Wednesday afternoon.

6.3.4 *The computer lab session*

On the following Wednesday, BK and his two students arrived at the computer lab at 4:20 p.m., despite the previously agreed upon starting time of 3:30. The girl from the public high school did not attend.

BK again asked PT about the possibility of changing the program to Friday mornings so that more of his students could participate. He also asked about the ideal number of students for the program. PT said that four students per time slot would be ideal for the winter whale study, and they agreed that they could involve eight students if they rotated shore duty with lab duty. They agreed that ten would be the maximum allowable number. In PT's opinion, if there were more than ten, the students would start socializing and not concentrate on working.

Using a lecture style, PT reviewed latitude and longitude with the students. He asked them to find Hawai'i on the globe and determine the latitude and longitude. He presented both the decimal form of expression, as commonly shown on GPS units, and the use of degrees, minutes, and seconds. BK asked if the decimal form was a true decimal, or was based on 60, but PT was unable to define it clearly.

PT explained to the students that they were going to enter the salinity data they had collected the previous week on an Excel spreadsheet. He asked them if they wanted to try to set up their own spreadsheet system. They said that they did and began to work independently. Meanwhile, BK discussed methods with PT and decided to try to create a spreadsheet of his own.

The students began manually calculating the average values of their replications and entering that into the spreadsheet. PT showed them how to use Excel to determine an average value, and pointed out that they couldn't put both words and numbers in the same cells if they wanted to do calculations. He called them over to see what he was doing on his spreadsheet, but he hadn't completely figured out his own system yet. BK recommended that the students try to design their own spreadsheets and print a graph from the data before looking at PT's. The students each did the spreadsheet in a slightly different manner, although they discussed it with each other.

BK and PT discussed whether it would be easier to design the spreadsheet first and then the data collection sheet (BK's opinion), or design the data sheet first (PT's opinion). No consensus was reached.

Both students chose bar graphs to display their data, and BK asked them if the graphs made it easier to understand the data. They answered that the graphs did not help. PT called them over to his computer and explained what he had done. He showed them how to do averages and standard deviations, but did not explain the purpose of a standard deviation. With BK, the students discussed different types of graphs and their uses.

At 5:15, SL came in and started talking with BK about her concerns about what was happening with the Rural Initiative Grant process, and the session ended. BK asked what the students should do as a follow-up, but PT gave no suggestions. They discussed how many more times they could take water quality data before the start of the whale season, and determined that there was no time for more fieldwork. BK recommended that they split the group in half (assuming a larger group in the Friday morning time period), and work on both whales and water quality. SL suggested that, after the whale season, some of the students might want to focus on a dolphin study.

6.3.5 *Second student orientation*

In mid-January, the Marine-Wise program met for the first time since the computer lab session. The meeting was intended to be an orientation session for several new students from one of the public high schools. However, only one home-school student and an 85-year old volunteer attended. PT said that there had been some changes to the program. They had dropped the water quality monitoring program and would be concentrating on the whale research. The main goal, he said, was to count the whales and determine the regional winter population. By using a theodolite and a stopwatch, researchers can pinpoint the location and sighting times of the whales. If they have repeated sightings of the same whale, they can develop a track and determine the whale's speed. They also planned to do some behavioral observations, and look at the impact of tourist and fishing boats on the whales. PT said that they might have a hydrophone that would allow them to listen to the whales and get more information about their vocal patterns. He said that they also hoped to work with a super-computing center and use wireless technology to access the Internet from the shore station.

PT said that the Marine-Wise students would work at the shore station for four-hour blocks on Wednesday afternoons. The sighting observations and the theodolite readings would be done by adult researchers, while the students would assist by entering the data on the computer, taking detailed written notes, and marking the whales' positions on a magnet board. He explained that the whales come to Hawai'i to breed and calf, and mentioned that they have the longest migration of any mammal.

The student asked if they would be doing any photo identification of whales. PT responded that they couldn't because they didn't have the proper permits or access to a boat. He went on to explain that the whales come to Hawai'i to calve because of the warmer water. They leave Alaska in October and return in April, and the females don't eat at all during this period. The student asked several questions – Do the whales go back to the same place every year? Where else do they go besides Hawai'i? – and appeared quite interested in the program. At the end of the meeting, however, she said that she would be going to Switzerland for a couple of months starting in early March, so she didn't know if she could participate.

6.3.6 *Follow-up organizational meeting*

The following day, PT and SL met with a former local educator (RF) and a representative of the super-computing center to discuss problems and future plans. The meeting began with a discussion of why the Hawaiian charter school had dropped their involvement with the program. Apparently, BK had proposed that Marine-Wise be added to the school's Friday morning community involvement programs, but the administration had not approved the plan. He had told SL that he didn't know why it wasn't approved, but suspected that it was because of transportation costs.

RF suggested that they consider working with a grade eight class in a nearby middle school, but the meeting focus then changed to ways to incorporate wireless technology into science education programs. The super-computing center was developing a grant proposal for National Science Foundation (NSF) funding, and wanted feedback from PT and SL. SL asked if they were targeting only high schools in their proposal and said that they should include elementary schools as well. She also said that she was working on grant proposals for Marine-Wise and that they would like to coordinate it with the super-computing center's proposal. SL noted that she and PT were trying to obtain grants at three levels – for adult community education programs, for their own research, and for Marine-Wise, with Marine-Wise as the lowest priority.

The discussion moved on to impediments to the water quality monitoring project. RF pointed out that there was sufficient money available for the project, because the community consisted of wealthy homeowners who wanted to protect their property values, but that the community association lacked organization. SL agreed, citing lack of community organization as the main limiting factor to the Marine-Wise involvement in water quality monitoring.

SL also talked about other plans for the Marine-Wise program, including the proposed reef fish survey. Another possibility for Marine-Wise, she felt, would be to conduct a pilot-project one-week summer resident course for a small number of high school students, then apply for a larger grant to expand the program. She went on to say that, in her opinion, the school interface was lacking and that an after-school program doesn't work. Money is needed, she said, to pay a person to go into the schools on a regular basis and work with the students during school time. At this point, the meeting disintegrated into a series of random discussions.

6.3.7 *The whale observations*

In the end, three students participated in the whale research over a period of about eight weeks. They were all girls who had participated in the project the previous year. One girl came weekly, except for the weeks when observations were cancelled due to high winds. The other two students were more sporadic in their participation. None of the students who had come to orientation meetings or to the two water quality sessions took part.

The whale shore station was situated on a bluff overlooking a broad expanse of ocean. During a typical session, one scientist with binoculars stood scanning the horizon looking for pods of whales. As she called out a sighting, another researcher pinpointed their location using the theodolite. As they called out their information, PT entered the data on a laptop computer, one student took handwritten notes, and the other student located the pod on a magnetic board using numbered magnets. The researchers also tried to record the number of animals in each pod and whether or not they were active at the surface.

Each scan lasted for fifteen minutes. After it ended, everyone pointed out whales they had seen and discussed their observations. The researchers would frequently refer to the student who was taking notes to ask her which pod was last sighted at a certain location or similar questions. Between scans, the researchers reviewed the data sheets and asked questions of the students to make sure the data had been entered correctly.

With the end of the whale season, the Marine-Wise program ceased to function. There were no follow-up or review sessions with the students who had participated.

6.4 **Students' Perceptions**

Because of the late start of program, and the number of false starts, I was only able to interview the three girls who participated in the whale research. As mentioned earlier, all of them had done it during the previous year, and one had participated both years. This year, they were involved only in the whale research and did not all attend at the same time. The initial focus group was held at the end of January just before the start of the current year's whale research. No final group sessions were held, so no wrap-up focus group was done. The time factor of the study made it impossible to follow up with the individual students.

6.4.1 *Marine environment*

I started the focus group by asking the students what they felt were the best things in their local marine environment. All three felt that a lot of people respect the ocean because it's part of their everyday life, and that the ocean around Hawai'i is fairly healthy and well cared for. This opinion was based mostly on a visual assessment. As one student said, "Most of the places I've been I can see the water pretty clear, so I think it's pretty well taken care of."

When asked about the major local environmental problems affecting the ocean, all three mentioned pollution, especially trash and litter. One talked about runoff from coastal construction, and another noted damage to reefs from tourists who "don't know enough about it to take care of it." On a global level, they mentioned oil spills, abandoned fishing nets, overfishing, and Navy testing of "underwater equipment and microphones and stuff." The student who said overfishing was a problem elaborated on her perspective:

> Because I think most of the food comes from the ocean and like, if the land goes bare and stuff like that where farmers can't farm or anything, they'll have to turn to the ocean for fish and stuff like that. So if they don't realize that they have to protect the ocean for later on, then when later on comes, there will be a disaster.

Two of them indicated a feeling of powerlessness when it came to global issues. One said, "Some situations are noncontrollable; you can't do anything about it no matter how hard we try. It's just beyond our reach." Another added, "What can be done is probably being done at the moment." The third student felt that education programs helped a little because people then could understand "just what's really going on with the ocean and how it's affecting us."

When encouraged to think of actions that they could take personally, the students felt that they could pick up trash and educate others. Two of the students expressed this in the third person. One said, "Sometimes like for community work a couple of students go down to the beach and pick up litter and stuff." The other added, "Once or twice a school year – maybe three times – they [National Honor Society students at her school] go down to the beach and just clean it completely of trash." The third student framed her reply as a personal action:

> Well, one thing I could do is, like any time I go to the beach and I see litter, it's like, goes straight into the trash can. And, like, tell people – like if I see somebody like, oh, no, that's wrong; you should do this. Or like tell my friends or other people in the community that I know, about things that they could do to help protect and make the ocean cleaner.

When I asked her if she actually did these things, she replied, "Whenever I go to the beach, which is hardly ever."

6.4.2 *Motivation to Participate*

For all three students, the main factor that motivated them to become involved in Marine-Wise was the opportunity to learn more about the ocean environment. One girl was a high school senior who planned to study marine science at the University of Hawai'i in Hilo the following year. The other two had not decided on careers, but said they were just interested in the ocean, especially the marine mammals. As one expressed it:

> The ocean is just part of, the biggest majority of, our planet. And you just gotta wonder what's out there, and you have to know something about it. I mean, part of our everyday life is something that will always be there. Even if we're gone, it's gonna always be there. And you just wanna know about it.

6.4.3 *Best and Worst Things about the Program*

From the girls' perspectives, the best things about the program in the past had been the boat trips and the whale watch trips. The student who was planning a career in marine biology said that, for her, the best part was actually seeing the whales and having the opportunity to work with real scientists. The girl who had participated in the program during the first year also said that she like doing research about fish: "We learned about their habitat, and what their purpose was, and how big they were, how many species were in that family, or how many types in that family. We learned about their different names, a bunch of neat things."

On the negative side, the students said that the shore station, while interesting, was hot and tiring, and that data recording became repetitive and boring. "I mean, recording information is great and all but I just want to learn more about anything and everything," said one.

The issue of student choice also came up:

> I wanted to do a bit more research and stuff. Not like school research where the paper's due by this date or whatever [. . .] but on our own too, like we can research exactly what we want to know about. And then once we know about that and we're satisfied, then we can move onto another subject.

Other things all the students agreed on were that they would like more boat trips, and would like to go diving or snorkeling to conduct reef studies.

6.5 Year in Review – Facilitators' Perspectives

SL and PT agreed that the past year had not been an overwhelming success for the Marine-Wise program. The enrollment had dropped from twelve students over a nine-month period in the first year, to three students who participated in the whale study over six to eight-weeks during the most recent year.

They felt, however, that they had been successful in narrowing their goals to three focus areas for future programs – water quality monitoring, whale research, and reef fish surveys - and had identified agencies and organizations with which they could collaborate. SL said:

> I think that's something that takes time – you can't figure that out ahead of time. You know it's like, you go around and you talk to about twenty different people, all of who say they've got this neat program, when you don't actually see what they're doing. It turns out they actually aren't really doing anything yet.

She went on to add that, when dealing with community-based monitoring or other environmental science, it was important to identify and work with on-going projects that have long-running potential.

6.5.1 ***Time & Opportunity***

Time and opportunity were of key importance for a successful program in other ways as well. The facilitators identified having a stable group of youth as crucial, and compared the first year of the program to the most recent year:

> PT (speaking of the first year). We did classroom activities, we did dry runs of transects on land and then we took them out in the water and we actually did it in the water several times. And over time, they kind of learned what was expected of them as far as collecting data and actually did them [the transects] in reality.
>
> SL: I think you need a year. You need to have the same group of kids for a year, throughout the course of the

> year, or you can't accomplish those kinds of goals. You can't get the kids up to speed technique-wise and understand the science behind it well enough to have an end product, where they've collected some real data. Or even, like PT said, if you don't have the data set, you have a skill set.

6.5.2 *Collaboration with Schools*

The main weakness of the past year, they felt, was their link with the schools. Getting and keeping students involved depended heavily on the commitment and follow-through of individual classroom teachers: "Basically, we decided we were going to try to build the bridges at the school level, because the weakness with just doing a hands-on program is that the kids don't get any curriculum." This year, one of the supporting teachers had left a school they had been working with, and none of the other teachers showed any interest. Another high school had a new principal who refused to talk with them about the program, and the logistics of the bus schedule made it difficult for students from that school to attend the Wednesday afternoon sessions.

6.5.3 *Resources & Infrastructure*

Lack of financial resources was also a major limiting factor for the program. PT put it bluntly: "You need money. You need somebody to put their wallet where their mouth is. And until that happens – we've been volunteering our time and we've gotten paid very little to do this. And you can only stretch yourself so far for so long."

6.5.4 ***Future Plans***

At the time of the wrap-up focus group, future plans for the Marine-Wise program were undecided. SL and PT were discussing the possibility of involving a few students in their spinner dolphin research during the summer. A small amount of money was available through the 21st Century Learning Center to pay the students minimum wage as part-time interns. Three students had expressed interest in the possibility and SL and PT were hoping to find more interested students through the community center. As for the fall, they had made no decisions about whether or not the program would continue.

6.6 **Year in Review – Observer's Perspective**

After reviewing the observation notes, interview and focus group transcripts, and written materials, I compared the Ocean Explorers program with the assessment rubric. The following reflects my own interpretation of events, and is based only on the third year of the program's operation.

6.6.1 ***Program Logic***

Vision & Goals

SL and PT appeared to share an overall vision and a passion for their program – that of involving youth in real marine research, and giving them opportunities to develop research skills. However, the disorganization and lack of focus at various meetings indicated that there was a lack of common vision and goals among the potential collaborators. Many of the people they met with seem more focused on future possible technological aspects of the program (e.g., underwater cameras with video streaming capabilities, wireless technology), than on educational opportunities. The meetings did not stay focused on how to involve the students more during the current year, or how to deal with the limitations of scheduling and transportation issues.

6.6.2 *Administration*

<u>*Governance, management, & planning*</u>

The program was run by two volunteers who had a lot of other concerns. Neither had a full-time job or a steady source of income, so they were extremely busy with temporary jobs such as substitute teaching, teaching courses at the local community college, and working at service jobs, in addition to caring for their two young children. Much of their time was also spent working on grant proposals to support their own research, and to develop adult education programs, as well to find continued funding for Marine-Wise. In fact, SL told me that Marine-Wise was the lowest of the three priorities.

Because of this, short-term planning for the program was somewhat disorganized. Notices to newspapers often went out late, and follow-up with the schools was sporadic, which may have contributed to the problem of getting enough youth in program. As seen in the wrap-up focus group, the facilitators had no definite long-term plans, and indicated that they were getting frustrated and burned out by the ongoing funding problems, and the difficulties with finding a committed group of students.

Resources & Infrastructure

As noted earlier, the program had very few resources, and depended on their relationships with other organizations for facilities, equipment, and supplies. Their financial resources were limited to $2000 per year from the 21st Century Learning Grant, and the $10 weekly fee charged to the students. The facilitators did all their planning and program preparation from their home.

Relationships

SL and PT had developed some very good relationships within the community that made their program feasible. Their link with the local YMCA allowed them use of a van to transport the students to fieldtrip sites and gave them liability coverage for water activities. These are extremely important factors that were identified by many resource managers and educators as major limitations to youth involvement in marine and coastal projects. The local elementary school, which administered the 21st Century Learning Center, allowed them to use their high-quality computer lab. Their relationships with other schools (the source of students for the program) were more problematic, and depended mostly on individual teachers.

6.6.3 *Program Design & Implementation*

Inclusive participation/student direction

Youth were not involved in the program planning stages, nor were they given options as to what they would like to pursue once in the program. Their interests did not guide the program, although the three girls who participated in the whale research did so because it was interesting to them. All three said, however, that they would like to do more snorkeling and learn about coral reefs, and one student mentioned that she would like to determine her own research focus. The program facilitators had indicated that they intended to allow the students more freedom of choice during the spring, but the program faded out in March at the end of the whale research.

Collaboration

The whale research project was done in collaboration with scientific researchers. Other individuals, agencies, and organizations were also involved in numerous planning meetings, but did not provide hands-on support during the program.

Technology & methodology/real science/real world setting

The whale research project was a real, ongoing research project where the students had the opportunity to work with top researchers and were introduced to proper technology and sound scientific methodology. However, the students functioned strictly as technicians, and did not get the opportunity to do any research of their own. The water quality monitoring program did not continue long enough to be assessed for these characteristics.

Active participation/team approach

The three girls who worked on the whale research all participated actively in the program, and the students were a real part of the research team during the project. There was no attempt, however, to develop a group cohesion or culture among the students in the program. This may have been primarily because the program was limited to the whale research and did not include many of the activities originally planned.

6.6.4 ***Program Content***

The bulk of the program content was limited to whale research, which reflected current scientific understanding and was accurate. There was little focus on broad concepts or systems processes in that part of the program. If the program had functioned as originally designed, and the students had been able to spend equal time on water quality monitoring, whale research, and reef fish surveys, the program may have reflected a more balanced environmental perspective.

6.6.5 ***Assessment***

Little assessment was done. The facilitators discussed and reflected on their experiences, and made changes based on what they perceived as problems during the year. However, there was no evaluative monitoring of the program or outside feedback from students or collaborators, and no attempt at impact assessment.

6.7 Conclusion

The Marine-Wise program illustrated the difficulties of designing and implementing a successful, effective small-scale marine education/research project on a very limited budget. The program facilitators were working with limited time and few financial resources, which affected their ability to plan and implement the program effectively. The program did not have the wholesale support of the local school system and it was difficult to recruit youth into the program. The lack of student-direction and choice of activities may also have contributed to the difficulties of keeping students interested and involved in the program.

Given the lack of resources and support, it was a tribute to the passion and dedication of the facilitators that the program was able to function as successfully as it did for three years.

CHAPTER 7
LESSONS LEARNED: SUMMARY AND CONCLUSIONS

The primary goal of this research project was the development and testing of a practical assessment tool for youth environmental education and action programs that is grounded in a solid theoretical framework. The framework was developed from a synthesis of research into program quality in the fields of science education, environmental education, action research, and community-based resource management, and was tested by applying it in three separate case studies. The research was exploratory in nature, with the goal of beginning to identify patterns, relationships, and questions for future investigations. This is an inherently holistic approach that does not lend itself easily to linear exposition, but a review of some of the key elements of each of the contributing disciplines may help clarify the theoretical understandings and illuminate the case study results.

Case studies, by their very nature, are snapshots taken in a specific place and time. They can give us valuable insights into processes and human perceptions, but they do not provide universal truths. The documented case studies examined programs that were different in their settings (charter schools and after-school programs), age groups (elementary students and high school students), administration (school and NGO), size (from more than 90 participants to a group of 3), and focus (from a broad study the ocean biome to a narrow focus on humpback whales). Despite the differences, an analysis of the case studies using the assessment rubric revealed broad patterns that were common to all three projects. This allowed the development of some analytical generalizations that have both practical and theoretical implications for the future of similar youth programs in Hawai'i and elsewhere.

7.1 **Practical Implications**

Within the site- and time-specific contexts of the case studies in this research, a number of themes emerged that may be of practical interest for program developers, resource managers, and educators who wish to start or maintain environmental action research projects with children or youth:

- *The role of individuals cannot be overemphasized.*

In all three case studies, the programs were initiated and implemented because of the vision of one person or a small group of people. The elementary charter school was initiated by a small group of dedicated teachers who shared a similar vision. The high school program came about because an individual saw a valuable opportunity and acted on his vision. The after-school program was developed by two marine researchers who were asked to conduct a marine-related field trips.

The programs were also heavily dependent on other individuals for sustainability and effectiveness. The after-school program relied on individual teachers to advertise their program and recruit students. In the past year, after a particular teacher left one school, they did not get any student involvement from that school. At another school, they had no success in promoting the program to the school principal, and recruited only one student who participated in two sessions before dropping out. The organizers and facilitators were beginning to suffer from burn-out, largely due to their inability to recruit and retain youth participants, and it is questionable whether the program will continue at all in the future.

The selection of appropriately motivated youth participants, or the appropriate structuring of the program to address the developmental and/or motivation levels of the youth involved, was equally important. This was especially true at the high-school age where the programs were more loosely structured, but was also noted by the teachers in the elementary school program. Unmotivated participants, or those who were motivated for reasons having nothing to do with interest in the projects, were detrimental to the program and distracting to other participants. This was particularly evident in the charter high school projects, and reflects observations made by Hume (2001) who stressed her experiences as a teacher, noting that individual responsibility needs to be combined with collective responsibility and involvement for successful collaborative building of knowledge.

This dependence on individuals makes the sustainability of programs problematic unless they can be institutionalized in some way. The previously discussed restrictions imposed by the DOE structure, and the lack of emphasis on the marine environment in the state-mandated syllabus, make it difficult to accomplish this in the current public school setting, so alternative avenues such as increased cooperation with community groups, nongovernmental organizations, and management agencies should be explored.

- *Projects do not function in isolation.*

Although individuals were of critical importance, many outside factors also affected the success of the programs. The two charter schools were dealing with funding issues, which took substantial amounts of the teachers' time, and limited the material resources available to support the marine programs. Issues of student discipline, the state accreditation process, and the need to teach specific classes such as mathematics and history in order to meet state-mandated standards also affected the charter high school programs. All of these factors impacted the overall vision and philosophy of the school, as well as the available time and the morale of both teachers and students.

Support from higher levels, such as the DOE or the local schools, is extremely important. The charter schools felt that their very existence was threatened at the state level, engendering doubt and anxiety. The after-school program had trouble recruiting youth into the program, in part because there was little support from the local schools at the administrative levels.

To increase the chances of success, outside factors that may affect a program should be identified in as much detail as possible and addressed in the very early stages of program planning and design. After the program is operational, there should be continual monitoring and reassessment of these factors so that modifications can be made as needed.

- *Resource management agencies and researchers need to be involved.*

There needs to be more direct, substantive involvement on the part of resource management agencies and researchers. With careful planning, youth programs can be tied into the stated goals of the agency or organization. For example, groups that list resource management as their primary goal could involve youth in direct data collection and monitoring activities, as well as help teachers develop sound scientific education materials and programs about issues such as fish reproduction or principles of marine ecosystems. This would ultimately benefit the agency, as well as the environment, because future resource users would have a better understanding of the reasons behind management regulations and be more likely to make environmentally-sustainable decisions.

With the involvement of researchers and management agencies in cooperative research projects with youth, there comes a responsibility on the part of the teachers or other youth leaders to structure and conduct the programs in such a way that the managers and researchers don't feel they are wasting their time. The overall goal of teachers may be to educate students in a broad sense, but the researchers and managers need good quality, scientifically-accurate, usable data. This is an area that has been highly problematic in the past, and was clearly illustrated in the case study of the charter high school. Many teachers have limited knowledge of, and experience with, scientific research. These problems could be minimized if:

- Teachers set high expectations and standards for their students.
- Researchers and managers helped teachers gain content knowledge and research skills.
- Researchers spent more time in direct, hands-on involvement and guidance of the youth while they are designing research projects, and collecting, recording, and analyzing their data.

Most researchers and resource management agencies have limited budgets with which to pursue youth education, and it is generally not a stated priority. However, it could be considered an opportunity for them to raise their public profile and promote increased awareness of the importance of their work, and help justify future funding for research.

This could, in turn, affect public perceptions of environmental issues and lead to increased funding opportunities through more educated voters. As a number of the respondents pointed out in the initial interviews, you can often reach the parents through their children.

In addition to improving the quality and credibility of student-collected data, collaboration with other agencies or organizations can help overcome some of the other perceived limitations. For example, in the initial interviews with resource managers, researchers, and educators, liability was identified as being a major obstacle to youth involvement in marine programs. The after-school program solved this by getting insurance coverage through their linkage with the local YMCA.

- *Youth need adult guidance and facilitation.*

There is consensus in the research literature that student choice and student direction of projects are important motivating factors. This was reinforced by student comments in the focus groups of all three case studies. What appeared to be equally important, however, was the appropriate level of guidance and support by the teachers or adult facilitators. At the elementary school level, the children found it difficult to frame an appropriate question for inquiry without initial teacher direction. In the charter high school, project quality was severely impacted because of lack of teacher supervision and direction, especially in terms of accurate research methodology, data collection, and data analysis.

- *Teacher expectations affect student attitude and performance.*

As noted in the research literature, teacher expectations are extremely important factors in student attitude and performance (American Association for the Advancement of Science 1990). Teachers or leaders should set high standards and expectations of student performance that are appropriate to the children's development levels and experience. This was illustrated in the case studies of both the elementary charter school, where the teachers noted that the students were challenged but exceeded their expectations, and the charter high school where many of the teachers had low expectations of the students and the students performed accordingly.

- *A focus on key scientific concepts and accuracy is important.*

There is a current trend in science education to emphasize science process and downplay the importance of accurate science content, and this was seen in the two charter school case studies. The main reason given for this change of focus is that our scientific knowledge is growing rapidly, and it is impossible for a person to understand all facets of science. In addition, scientific understanding changes over time so that what we learn today may not be "right" tomorrow. Some people also comment that content is not important because children will never remember facts they are taught. I feel, however, that these are dangerous assumptions. It is impossible to know what children will consider important and remember in the future. In addition, an important facet of science education is the construction of a solid foundation on which to build future knowledge and promote continued inquiry. A person needs to have a base knowledge of currently accepted scientific theories in order to question intelligently and analyze issues critically.

- *Time is critical for sustained change.*

There appeared to be very little difference of perspective between high school and elementary students in terms of ways they believed they could help protect the environment. In all of the youth focus groups, students talked about two personal actions they felt they could take – picking up trash and educating others. On Hart's (1999) ladder of children's participation, these actions both fall on the lower rungs of tokenism or social mobilization rather than at higher levels of self-directed participation. The United States has had a strong anti-litter campaign for at least 40 years, so it is perhaps not surprising that picking up trash was the first suggestion of almost all of the students. It is also a simple and easily implemented activity that provides an immediate feeling of gratification. It does little, however, to address root causes of the problems or to help students gain a deeper understanding of more complex issues.

The level of knowledge and understanding of global marine problems also appeared about equal between the elementary students at the end of one year of study, and the high school students. If anything, the elementary students expressed more awareness of global issues than did the high school students. This supports the concepts of the importance of long-term involvement that builds over time. If third graders have this level of understanding now, after a single year of study, with sustained involvement over the years they could be functioning at a much higher level by the time they reach high school.

- *There is a need for increased understanding of personal impacts.*

In the student focus groups and informal discussion with teachers and students, there was almost no mention of the impact of personal lifestyle choices, such as resource consumption patterns, on environmental protection. There was an emphasis on local, discrete behavior patterns such as not stepping on coral or harassing marine life, and telling other people not to do these things, but no discussion of issues such as the impact of personal automobile use or consumer choices. Teachers and students talked about recycling and using paper instead of plastic bags or picnic supplies, but did not explore ways to consume less. A consideration of possible environmental and social impacts (both local and global) of our daily decisions and behaviors should be incorporated, at levels appropriate to the age of the children, into all environmental education programs.

- *Willingness to change is essential.*

As discussed earlier, unless participants are willing to engage in continued reflection, critical analysis, and change, programs have little chance of long-term success. Without this process of action, reflection, and modification, programs are subject to stagnation and loss of effectiveness over time. Even programs that were extremely successful in the past may need modifications in logic, design, and/or implementation to adapt to changing external conditions.

With the high school charter school program, the teachers indicated that the problems were caused by the students involved, the lack of funding, and the time restrictions imposed by the need to meet state-mandated standards. While all of these factors undoubtedly had a significant impact, the teachers appeared to engage in little reflection about the possible effects of their personal attitudes on the program. Most of the students also blamed outside factors such as teachers and other students for their own lack of enthusiasm and involvement.

In the case of the elementary charter school, the teachers met daily to talk with each other. They continually discussed their failures and successes, and made several modifications to their program to address problems they identified. Overall, this led to a higher degree of shared vision and purpose, and a greater sense of satisfaction, among those teachers and their students than was seen in the other case studies.

A disposition to engage in continual self-critical examination of our assumptions, beliefs, and behaviors, and the ability and willingness to change and adapt as needed, are important on the individual level as well as at the program level. The development of this disposition may be the single most important factor in the holistic education of the individual and his or her evolution from childhood perceptions and actions to the capacity for a truly adult level of participation and responsible action.

7.2 **Theoretical Implications**

In the social sciences, theories are roughly analogous to models, such as computer-based climate models, that are used in the biological and physical sciences. They are extremely simplified reflections, not of reality, but of one possible version of reality given a specific set of circumstances, and they do not accurately reflect the incredible complexity of a real system. They can, however, serve as a valuable starting point for practical analysis, and provide a framework for understanding and a rationale for change.

Action research theory and methodology underpin successful youth environmental projects. The importance of continual, repeated cycles of personal and group action, observation, critical reflection, and revision in any education or action project cannot be overemphasized. It is through this process that internalization of learning takes place, allowing for the changes in attitude and practice that are needed for successful long-term environmental conservation. This ties in well with social constructivist learning theory, which is based on the concept that we make sense of our world by constructing understanding from our prior knowledge and our experiences, and normalizing our concepts through social interactions with others.

Action research, environmental education and constructivist learning theories also emphasize the importance of conducting research in naturalistic settings and allowing time for several cycles of observation, action, and reflection. In a practical sense, this means that much of the education should move outside the classroom on a regular basis. Projects should be relatively long-term and should systematically build on prior knowledge that gains in sophistication as children move through personal developmental stages. To accomplish this through the formal education system requires a major change in philosophical outlook at both the administrative and teaching levels, as well as a significant restructuring of many school practices.

Our current education system is still rooted in the philosophies of the Industrial Revolution, when traditional public schooling developed largely for the purpose of creating a disciplined force of assembly line workers, while simultaneously creating a market for the factory-produced products. Similar to an assembly line, traditional schooling in Western society tends to be mechanistic and standardized, with the goal of mass-producing identical products (i.e., school graduates). As noted by Priesnitz (2000), our public schools continue to provide an ideal venue to ensure this pervasive "culture of consumers" (p. 281).

Charter schools and other alternative programs, such as those profiled in these case studies, are attempting to break the traditional mold and implement new philosophies and practices. However, most of our current generation of teachers, education officials, youth leaders, scientific researchers, and resource managers were themselves trained through a traditional teacher-centered style, where education was seen as the transmission of information and "facts" handed down from a central authority figure. They may see the logic behind constructivist learning and action research, and agree with the approach in principle, but it is very difficult to change long-term beliefs and actual behavior. As illustrated by the case studies, this gap between theoretical understanding and daily practice continues to be pervasive. It becomes especially problematic when the programs are tied to larger systems, such as government agencies and education departments, that have a great deal of bureaucratic inertia and are mired in a morass of regulations that make it difficult to involve children in extensive fieldwork because of issues of priorities, finance, time, and liability.

Current theories in science education, environmental education, and action research also emphasize the importance of *process* over *results*. Programs should be based on democratic principles of active, inclusive participation; cooperation; open communication; and shared decision-making at all levels from administration to students. This is difficult to do in most schools because of the historical, traditional top-down approach to education. In addition, a recent and growing focus on state-mandated outcomes-based standards, and teacher accountability for meeting the standards (i.e., results), increases this difficulty by limiting flexibility in the public school setting, including that of charter schools. Despite the fact that charter schools have significantly more freedom of operation than regular public schools, they are still required to address state standards. This present outcomes-based approach to education also encompasses an inherent contradiction between concepts of science and learning as a continually changing process, and a need to demonstrate that students have achieved predetermined outcomes for accountability purposes.

Both action research studies and environmental education research have indicated that a catalyst, such as an environmental crisis (or at least the *perception* of a crisis), is needed to stimulate people into taking action and changing their practices. The continuing degradation of ecosystems in Hawai'i has been well documented by scientific researchers, but the public still does not perceive the environment as a high priority because it *appears* to be healthy. This argues for a need for researchers to take a more active role in education to bring an understanding of the environmental threats and their potential impacts to the forefront of public awareness.

Community-based resource management is also premised on an action research model that emphasizes the importance of public participation in issue analysis, development and implementation of a management plan, and continued resource monitoring. Ideally, it is a democratic, collaborative process that involves all stakeholders on a more-or-less equal basis, does not begin with predetermined results, and where stakeholders have a degree of control over the process and results. In reality, there is little true community-based resource management in Hawai'i and, therefore, little opportunity for children to be involved in a true participatory sense. Although there are some exceptions, most resources are managed through central government agencies (federal, state, or county), and public participation is limited to political activism, input of opinions at agency-run public meetings, or participation in periodic volunteer projects such as beach cleanups.

Our dependence on centralized agencies to dictate both education and resource management policy reflects a broader abdication of personal responsibility for our lives. As a society, we are becoming increasingly disconnected from the natural environment, and the visible links between the health of local and global ecosystems and the quality of our lives are becoming progressively less obvious. Our food, clothing, housing products, and other material goods are shipped in from all parts of the world. More and more, we interact with the natural world through television, computers, and other electronic media. As a result, we *know* far more about our world and *understand* far less, at least in an emotional sense. If environmental education is going to be effective as a conservation tool, it is necessary to go beyond intellectual understanding to engage the emotions and make the issues personal.

While scientific understanding is essential, it is not enough, in and of itself, to lead to the development of personal environmental stewardship ethics. Education methodologies such as conducting laboratory experiments, solving simulated problems, using role plays, and working with computer imagery and data bases are valuable tools for making students aware of issues, giving them opportunities to use the "scientific method", and teaching processes of cooperative group work and problem analysis. However, unless children have the opportunity to interact directly with the environment and work on problems where they can not only propose a solution, but also actually attempt to carry it out, it remains an intellectual exercise.

The scale of the problems to be addressed and the developmental levels of the children involved need to be carefully considered when designing the program to allow for real problem-solving opportunities, a reasonable chance of success, and development of a sense of ownership and personal control. An often-cited problem in environmental education projects involving children is that children feel that the problems they are asked to address are beyond the scope of their control. Unless children are given ample opportunities to discover that they *can* make a difference in a real, rather than token, sense, and that their perspectives and ideas are important, this feeling of powerlessness can carry over into adulthood, where it is often disguised as cynicism. These adults are less willing to vote, participate in public meetings, or do volunteer work because they are disillusioned, don't trust the system, and don't think that their input is of any significance. This tendency towards cynicism was noticeable even among students as young as those in the elementary school case study.

Within the current system, there are opportunities for youth involvement and participation in a number of aspects of scientific research, resource monitoring, and local ecosystem restoration. Here, however, the distinction between *process* and *outcomes* becomes even more problematic. Overall education goals focus on the development of the whole person (the process of learning), while scientific research and resource monitoring are premised on the collection and analysis of accurate data (the outcomes). Through careful program design and implementation, these two apparently disparate concepts can be reconciled, at least in part, by linking students' research and action opportunities closely to the performance outcomes mandated in the state education standards.

To accomplish this goal, there need to be close, ongoing partnerships and collaborations among researchers, resource management agencies, education administrators, curriculum writers, teachers, students, and members of the local community. All of the managers and researchers interviewed in the initial survey said that youth education and involvement was important in order to meet long-range resource protection and scientific competence goals. However, in most cases, their direct involvement with youth education was limited to occasional school visits, hosting tours to their facilities, or periodic teacher workshops. These can all be valuable additions to the education process, but do not sufficiently address the need for the sustained, active youth involvement in a real-world setting that is needed for sustained change.

One way to address this issue is to reorient our thinking about schools and education, and their role within the community. Schools can, and should, be thought of as valuable community resources that lend themselves to concepts and methods of community-based resource management. Stakeholders in the process should include youth, parents, teachers, administrators, scientific researchers, resource managers, businesses, and others, because all members of the wider community benefit from improved management of the resource. As expressed by Peterson (2000), "To be successful, public education has to dissolve its old identity as a separate, contained institution within the society and evolve into a new identity with branches and roots engaging the whole community" (p. 235). The notion of "school" as a building where children go to be "taught," should be replaced by the broader concept of a "learning community," which includes all stakeholders and stresses the relational aspects of learning - i.e., the importance of the individual's place within the larger society, and his or her responsibility to it. The learning community concept requires a shift in focus from "teaching" to that of "learning."

The phrase "learning community" also implies reciprocal relationships rather than a one way flow of knowledge. All members of the community are at once both learners and teachers; they both give to and receive from the community. As children (and adults) learn, they also give to the community by becoming more involved in community activities, more connected to the community and more caring. Learning becomes embedded as a lifelong activity, rather than being perceived as something that is done only within the context of the formal school system.

The concept of learning communities has become much more prevalent in the educational literature of recent years. Home schools, charter schools, and other alternative schools are referring to themselves as learning communities, and stressing the relational nature of individuals within the community. There are many definitions and many models of learning communities, ranging from a narrow view of the learning community as a curriculum restructuring effort that links academic disciplines, teachers, and students under a common theme, to broader ideas of the community as a collaborative group with a common purpose (MacGregor 2000). Most of the models, however, place the school squarely as the central focus of the community, and few, if any, include scientists or researcher managers as integral parts of the learning community. For sustainable and sustained conservation efforts, we need to broaden our vision of the learning community.

Along with membership in the learning community, as with membership in any other organization, comes an attendant responsibility to the other members of the community and to the well-being of the community as a whole. If research scientists and resource managers consider themselves members of this greater learning community – and as such, both learners and teachers – their involvement with youth programs and activities becomes an essential component of the system. It is a long accepted tradition that scientists have a responsibility to publish the results of their research and make it accessible to the rest of the scientific community. When scientists and resource managers consider themselves part of a larger learning community, this responsibility becomes extended to the general public, including the youth. Scientists and managers have access to knowledge, tools, and understandings that are not easily accessible to the non-specialist, but which are extremely important to the sustainable, long-term conservation of natural ecosystems.

Although these ideas are based on research conducted in a developed country within a Western context, I believe that the extended learning community concept could be applied successfully at the village level in developing nations as well. In most villages, the school is an even more central feature of the community than it is in Hawaiian towns and cities. This is an aspect that has been largely ignored in most CBRM development programs. The difficulty lies in convincing the funding agencies and the higher managerial echelons of its importance.

Many argue that we need policy, laws, monitoring, and enforcement for effective management, not education or emotional attachment. While I agree that these factors are extremely important, especially in the short term, I firmly believe that it is the youth of today who will determine those policies and laws, and dictate whether or not they are enforced in the future. This will depend largely on how and what children learn while they are young, and how they perceive themselves and their responsibilities in relation to their local and global communities. We ignore these long-term perspectives at our peril.

7.3 **Future Research Opportunities**

One of the greatest potential values of exploratory case studies lies in their ability to encourage us to reflect and ask more questions. Based on the case study research documented here, many questions arise that warrant future investigation. Among the other important issues that could be explored further are:

- Ways to incorporate marine and coastal education into the national and state-mandated curricula.
- Strategies to limit liability issues related to student field trips and projects.
- The effectiveness of youth marine education and action projects in changing people's long-term behavior and environmental attitudes.

- The impact of children's involvement on parents' behavior and voting patterns.
- The importance of multigenerational approaches to resource protection and the development of environmental ethics.

7.4 **Concluding Thoughts**

The widespread concerns over basic scientific literacy and the relative ignorance among the general public of the nature, scope, and personal and societal relevance of environmental impacts, ranging from local to global levels, suggest a basic, systemic flaw in a public education system that is still dominated by the scientific reductionist paradigm. We need to restructure our concepts of both education and community, using a systems approach, where we identify not only how individual components relate to our goals, but also how the many and varied components within the system relate to each other. In the words of Benjamin and Hanes (2000), this "does not mean thinking that a large chasm can be jumped with a series of small steps" (p. 169).

Major paradigm shifts are always slow, and this one will be no exception. But it can happen, and it needs to happen. As evidenced by the rapidly burgeoning literature dealing with concepts of learning communities and futures perspectives, more and more people are becoming disillusioned with our present system of education and our current perceptions of community. Starting on a small scale, with openminded people who are willing to take risks and try new approaches, we can develop model learning communities and programs that can serve as inspiration to others. Attempts to develop innovative, student-directed programs that are personally-relevant and practically-oriented have increased dramatically over the past decade, and that trend is likely to continue. The growing emphasis on environmental monitoring, involving community members and using new technologies, provides numerous opportunities for student involvement throughout the K-12 range. For this to be feasible, there is a need for closer integration of resource management agencies and researchers with the public and private educational system, and a public commitment to provide the needed resources.

Ideally, policy makers, administrators, teachers, students, and parents should be vested partners in the process of education reform. Schools must develop partnerships with local and state agencies, resource managers, NGOs, and researchers, and make effective use of local opportunities and resource capital to ensure broad support, access to current information and technologies, and continued success. Scientific researchers, resource management agencies, and nongovernmental organizations must acknowledge the importance of youth education and involvement in a substantive way and be willing to share some of their time, expertise, and other resources. The learning communities concept, combined with action research methodologies, offers a practical and workable approach.

APPENDICES

APPENDIX A
ASSESSMENT RUBRIC

	Science Education	Action Research	CBRM/ Participation	EE/ESD
		Program Logic		
Vision & Aims	Shared stakeholder vision.	Shared stakeholder aims.	Shared beliefs & norms; shared stakeholder aims.	
Goals	Goals clearly defined & understood by all.			Clear, concrete, realistic aims; attainable outcomes.
Needs	Program is based on needs identified by major education stakeholders.	Focus is on problems identified by practitioners.	Focus is on problems identified by practitioners.	
		Program Administration		
Governance & Management Structure	Clearly defined governance & management structure (roles, responsibility, accountability).		Definition & establishment of legal instruments to formalize community rights & responsibilities.	
Planning	Strategic plan for short- and long-term implementation.			
Support	Support of program by school structures & governance.		Support of government, local leaders, NGOs, project staff, & village-based organizations.	
Relationships	Establishment of good working relationships & trust among partners.		Building community institutions & public awareness through organization, training, financing, legal counsel, & technical assistance.	
Capacity-building	Regular professional development & ongoing assistance.		Capacity-building of participants.	Training of facilitators in key competencies; deeper understanding of issues.
Resources & Infrastructure	Availability of needed facilities & resources, including financial.		Access to knowledge, meetings, & resources.	

Program design				
Inclusive Participation	Teachers, administrators, & scientists involved in program design & implementation.	Collaborative – stakeholders as co-investigators.	Participation of all stakeholders in the process.	Interdisciplinary team; involve stakeholders & target groups.
Collaboration	Program interacts, collaborates & networks with other programs, local school districts, & universities.		Collaboration between individuals, agencies, neighborhood groups, and different social groups.	
Best Practice	Program designed to reflect research findings & knowledge of best practice.	Exercise rigorous scientific principles of procedure.		Studying examples of quality programs & projects increases chance of new program success.
Relevance	Start with questions about things that are relevant to students.	Focus on problems of immediate concern to practitioners.	Relevant issues are the driving force for community involvement.	Student interests should guide instruction.
Prior Knowledge	Student learning is affected by prior knowledge.	Grounded in concepts of constructivism (knowledge developed by experience & reflection).	Begin with research & documentation of popular knowledge and traditional systems of management.	Build on previous knowledge & experience.
Real World Setting	Extend beyond the school & involve the larger community (connection to the real world).	Research conducted in setting where problem is encountered.	Research conducted in setting where problem is encountered.	Allow frequent & continuing opportunities to explore & work within local environment.
Control		Participants have decision-making & action authority.	Participants have control over process & resources, and the ability to make changes.	Student projects are focused on areas where students have some control.
Usefulness	Attention to dissemination of study results.	Importance of shareability & utility of results.		Influencing others through networking, goal-sharing, & political awareness.

Program Implementation				
Problem Assessment			Use of pre-assessment tools such as Participatory Rural Assessment PRA) or Participatory Learning & Action; careful identification of issues.	Thorough analysis of problem to be solved before beginning.
"Real" Research	Activities involve students in actual science using tools, methods, & processes of scientists.	Stakeholders participate in research & implementation of identified solutions.	Stakeholders participate in research & implementation of identified solutions.	
Procedural Accuracy		Exercise rigorous scientific principles of procedure.	Emphasize scientific accuracy in data collection to be convincing to scientists & resource managers.	
Technology & Methodology	Include frontier science & use of state-of-the-art tools & methodologies.		Use of appropriate technology for monitoring changes in resource.	
Technical Assistance	Scientists, technicians, etc. work with students to solve real or simulated problems and serve as role models.			
Uncertainty	Activities demonstrate that research has unknown outcomes, uncertainties & loose ends.	Problem, aims, & methodology may shift as inquiry proceeds.		
Active Participation	Student-directed.	Collaborative – stakeholders as co-investigators.	Involve all stakeholders to ensure politically neutral process.	Learner is an active participant.
Team Approach	Use a team approach & emphasize group learning.	Practitioners work as team to solve problem.	Collaboration between individuals, neighborhood groups, & different social groups.	

Skill Building	Activities provide opportunities for developing skills, & "habits of mind."			Ability to ask questions, form hypotheses, develop skills to gather, organize, interpret, synthesize, & communicate information.
Communication	Emphasize clear expression, both oral & written.		Participants need ability to express opinions, participate in meetings, write proposals, speak in public, & work in committees.	Should have a strong emphasis on developing communication skills.
Process Focus	Not separate "knowing" from "finding out;" focus on both knowledge & process.	Knowledge, practice, & development are not separated.	Concentration on process.	Focus on process rather than results.
Problem Solving	Use of problem-solving approach.	Uses problem-solving approach to improve social conditions & processes in the real world.	Participants need skills to solve problems and make decisions.	Need skills for understanding & addressing environmental issues.
Practice	Students must practice doing what they learn.	Increase link between knowledge & practice.	Participate in implementation of identified solutions.	Application of learning; ability & willingness to act.
Time & Opportunity	Provide ample opportunities for practice with tools & instruments.	Need for several research cycles to allow time for reflection & deliberative action.	Allow sufficient time for projects to evolve.	Allow frequent & continuing opportunities to explore & work within local environment.
End Results	Activities have definable end-products for students (e.g. projects & presentations).	Practitioners are committed to improvement of practice & implement knowledge gained through process.	Projects should show measurable gains for stakeholders.	
Personal Development	Build individual self-confidence & interpersonal skills.		Promote self-esteem & sense of cultural or community identity.	
Valuing Diversity	Activities & instructional strategies appropriate for individual student's gender & cultural background.		Respect for diversity.	Should present a balanced view & incorporate different perspectives.

Open Mindedness	Encourages curiosity, questioning, & creativity.		Promote change in awareness, generating new ideas.	
Trust	Learning environment is safe & supportive; students develop trust.		Development of trust by all participants.	
Risk Taking	Willingness of all partners to take risks.		Promote willingness to deviate from customs & community values, and willingness to take risks.	
		Program Content		
Current Scientific Understanding	Scientists, technicians, etc. assist in developing program content. Content reflects accurate, current scientific understanding.			
Standards	For school programs, curriculum & materials aligned with or complementary to national & state standards.			
Broad Concepts	Activities provide opportunities for development of knowledge of important science concepts.			Focus on understanding of relevant issues & relationships.
Systems Processes	Unifying concepts & processes in physical science, life science, earth & space science. technology, science in social & personal perspective, & history & nature of science.			Knowledge of environmental processes & systems, including physical earth, living environment, humans & societies, environment & society.

Program Evaluation & Assessment				
Reflection	Partners engage in regular reflection & make changes based on data.	Evaluative – reflective. Dialogue/discourse based – discussion & reflection on discussion critical. Examines assumptions, beliefs & actions, and includes self-critique.	Cyclical process of dialogue, action, reflection.	Investment in time for reflection needed; learning from reflection on experience.
Feedback	Include assessment of students' work in order to give them feedback. Students, teachers, & mentors have opportunities to provide input & feedback during & after the experience.		Feedback of results to sustain & increase community participation.	Elicit feedback.
Evaluative Monitoring	Regular evaluative monitoring takes place during the program.	Critique is grounded in social practice.		
Impact Assessment	Pre- & post-program assessments gather information about impact on students.		Develop analytical impact indicators for planned & unplanned changes.	
Use of Evaluation	Program administrators use evaluation results to make changes.			

APPENDIX B
PROGRAM MANAGER INTERVIEW QUESTIONS

1. What are the overall goals of your program?

2. In your opinion, what are the main issues relating to the marine and coastal environment that we should be educating people about?

3. In your opinion, how important are youth education and involvement in meeting your long-term resource protection goals?

4. In your opinion, how can education help achieve marine or coastal resource protection?

5. What are the main limiting factors to youth involvement (or more involvement) in the program?

6. What kinds of educational or action projects do you do with pre-college youth?

(Questions 7 –14 are only asked if the response to question 6 indicates that there are youth education or action projects)

7. What prompted the initiation of these education projects?

8. Who started the project?

9. In your opinion, what are the most successful educational strategies you have tried?

10. Why were they successful?

11. What were the least successful strategies, and why?

12. What plans do you have for overcoming these limitations?

13. What conditions within the community support youth education and involvement in your project?

14. In your opinion, what is the general community opinion toward the education and involvement of local youth in the project?

APPENDIX C
KEY BEHAVIORAL INDICATORS

1. In what ways are the youth actively involved in the planning of the project (e.g. – determining questions to investigate, methods to use, etc.)?

2. How actively and in what ways do youth participate in the project?

3. How much enthusiasm do the participants show? (within the cultural context)

4. Are certain groups being excluded or marginalized from participation? If so, which ones?

5. How effective is the adult support system for the youth? (e.g. – supervision, help where needed, etc.)

6. From where does the key leadership for the project appear to come?

7. What scientific content is being presented to and used by the youth, and how accurate is it?

8. Do the program content and implementation appear to value diversity and open-mindedness?

9. What tangible results are apparent from the project?

10. What factors appear to limit or encourage program success?

APPENDIX D
LEADER/TEACHER INTERVIEW AND FOCUS GROUP QUESTIONS

At the beginning of the year

1. What kind of educational or action work do you do with children or youth?
2. Who started the project and why?
3. What are the overall goals of your project?
4. In your opinion, what are the most successful educational strategies you have tried?
5. Why were they successful?
6. What were the least successful strategies, and why?
7. What conditions within the community support youth education and involvement in this project?
8. What are the main limiting factors to youth involvement in the project?
9. What plans do you have for overcoming these limitations?
10. What kinds of support (materials, training, etc.) would help you the most in your efforts to educate youth, or to involve them more in action research projects?
11. How can this kind of education help children or youth in their own personal development?
12. How effective do you think the project is in terms of helping reach short-term resource protection goals? What about long-term?

At the end of the year

1. How would you rate the success of the program over the past year?
2. Why would you give it this rating?
3. What were the strengths of the program and why were they strengths?
4. What were the weakness and why?
5. Will you be doing the program again next year? If not, why not?
6. What will you change in future programs?

APPENDIX E
YOUTH PARTICIPANT FOCUS GROUP QUESTIONS

Pre-program

1. What do you think are the best things about your community?

2. In your opinion, what are the main problems (environmental or social) in your community?

3. Why do you think these problems are important?

4. What do you think can or should be done to solve each of these problems?

5. What kinds of things can you do personally to help solve the problems?

6. Why did you choose to become involved in this project? *(referring to the environmental education/action project being studied)*

7. What other kinds of projects would you like to be involved in?

Post-program

1. How would you rate your overall experience in the program? In other words, how did it compare to what you expected?

2. What were the best things about the project?

3. What were the worst things about it?

4. If you were to do it again, what would you change?

5. What have you learned from the program?

LITERATURE CITED

Alameida, R. K. 1997. *Nā Mo'olelo Hawai'i o ka Wā Kahiko: Stories of Old Hawai'i.* Honolulu: The Bess Press.

American Association for the Advancement of Science. 1990. *Science for All Americans: Project 2061.* New York: Oxford University Press.

Arber, S. 2001. "Designing samples.," in *Researching Social Life.* Edited by N. Gilbert, pp. 58-82. London: Sage Publications.

Argyris, C., and D. Schon. 1978. *Organisational Learning: A Theory-of-Action Perspective.* Reading, MA: Addison Wesley Longman.

Arhar, J. M., M. L. Holly, and W. C. Kasten. 2001. *Action Research for Teachers: Traveling the Yellow Brick Road.* Upper Saddle River, New Jersey: Prentice-Hall, Inc.

Arnstein, S. R. 1979. Eight rungs on the ladder of citizen participation. *Journal of the American Institute of Planners.*

Babbie, E. 1992. *The Practice of Social Research.* Belmont, California: Wadsworth Publishing Company.

Bago, A. L., and A. Velasquez. 1992. "A case of environmental education and awareness raising in the Philippines," in *Environmental Education: An Approach to Sustainable Development.* Edited by H. Schneider. Paris: Organization for Economic Co-operation and Development.

Barrington, B. L., and B. Hendricks. 1988. Attitudes towards science and science knowledge of intellectually gifted and average students in third, seventh, and eleventh grades. *Journal of Research in Science Teaching* 25:679-687.

Benjamin, R., and S. Hanes. 2000. "Transforming public education: sustaining the roots of American ideals, our economy, and our environment," in *Education for a Sustainable Future: A Paradigm of Hope for the 21st Century.* Edited by K. A. Wheeler and A. P. Bijur, pp. 161-197. New York: Kluwer Academic/Plenum Publishers.

Centre for Educational Research and Innovation. 1995. *Environmental Learning for the 21st Century.* Paris: Organization for Economic Co-operation and Development.

Chou, L. M. 1994. Living coastal resources of Southeast Asia: Management through continuing education by institutions of higher learning. *Aquatic Conservation: Freshwater and Marine Ecosystems* 4:179-184.

Clark, A. M., and D. Gulko. 1999. *Hawaii's State of the Reefs Report, 1998.* State of Hawai'i Department of Land and Natural Resources.

Conroy, C., M. Abha, A. Rai, N. M. Singh, and M.-K. Chan. 2001. "Conflicts affecting participatory forest management: their nature and implications," in *Analytical Issues in Participatory Natural Resource Management.* Edited by B. Vira and R. Jeffery, pp. 165-184. New York: Palgrave.

Corey, S. M. 1953. *Action Research to Improve School Practice.* New York: Teachers College.

Creswell, J. W. 1998. *Qualitative Inquiry and Research Design: Choosing Among Five Traditions.* Thousand Oaks, California: Sage Publications.

Division of Business, E. D., & Tourism,. 1999. "Social and economic trends during the past decade: Hawai'i County," vol. 2002: DBEDT.

Duckworth, E. 1987. *"The Having of Wonderful Ideas" and Other Essays on Teaching and Learning.* New York: Teachers College Press.

Elliott, J. 1995. "Reconstructing the environmental education curriculum: teachers' perspectives," in *Environmental Learning for the 21st Century*, pp. 13-29. Paris: Organization for Economic Co-operation and Development.

Environmental Health Center. 2000. *Coastal Challenges: A Guide to Coastal and Marine Issues.* Washington, DC: National Safety Council.

Fueyo, V., and M. A. Koorland. 1997. Teacher as researcher: A synonym for professionalism. *Journal of Teacher Education* 48:336-344.

Gilbert, N. Editor. 2001. *Researching Social Life.* London: Sage Publications.

Glaser, B. G., and A. L. Strauss. 1967. *The Discovery of Grounded Theory.* Chicago, Illinois: Aldine.

Grimble, R., and K. Wellard. 1997. Stakeholder methodologies in natural resource management: a review of principles, contexts, experiences and opportunities. *Agricultural Systems* 55:173-193.

Gulko, D., J. E. Maragos, A. Friedlander, C. Hunter, and R. Brainard. 2000. "Status of coral reefs in the Hawaiian archipelago," in *Status of Coral Reefs of the World: 2000.* Edited by C. Wilkinson, pp. 219 - 238. Cape Ferguson, Queensland: Australian Institute of Marine Science.

Harkes, I. 2001. "Project Success: Different Perspectives, Different Measurements," in *Analytical Issues in Participatory Natural Management.* Edited by B. Vira and R. Jeffery, pp. 128-143. New York: Palgrave.

Hart, R. A. 1999. *Children's Participation: The Theory and Practice of Involving Young Citizens in Community Development and Environmental Care.* London: Earthscan Publications Limited.

Hawaii Association of Charter Schools. 2000. "Historical perspective: Hawaii charter schools fact sheet," vol. 2002.

Hawaii Tourism Authority. 2001. "2001 Annual Report to the Hawaii State Legislature," vol. 2002.

Hesselink, F., P. P. van Kempen, and A. Wals. Editors. 2000. *ESDebate: International Debate on Education for Sustainable Development.* Cambridge, UK: IUCN Commission on Education and Communication.

Huberman, M. 1997. "Assessing the implementation of innovations in mathematics and science education," in *Bold Ventures: Patterns Among Innovations in Science and Mathematics Education,* vol. 1. Edited by S. A. Raizen and E. D. Britton, pp. 155-199. Dordrecht, The Netherlands: Kluwer Academic Publishing.

Hume, K. 2001. "Seeing shades of gray: developing a knowledge-building community through science," in *Action, Talk & Text: Learning & Teaching Through Inquiry.* Edited by G. Wells, pp. 99-117. New York: Teachers College Press.

Iverson, K. 1978. Progressive education for Native American: Washington ideology and Navajo reservation implementation. *Review Journal of Philosophy and Social Science* 3:231-255.

Kaser, J. S., and P. S. Bourexis. 1999. *Enhancing Program Quality in Science and Mathematics.* Thousand Oaks, CA: Corwin Press, Inc.

Kember, D. 2000. *Action Learning and Action Research.* London: Kogan Page Limited.

Kirch, P. V. 1982. The impact of prehistoric Polynesians on the Hawaiian ecosystems. *Pacific Science* 36:1-14.

Lincoln, Y. S., and E. G. Guba. 1986. "But is it rigorous? Trustworthiness and authenticity in naturalistic evaluation.," in *Naturalistic Evaluation,* vol. 30, *New Directions for Program Evaluation.* Edited by D. D. Williams, pp. 73-84. San Francisco, California: Jossey-Bass.

MacGregor, J. 2000. "Learning communities: vehicles for learning community and sustainability," in *Education for a Sustainable Future: A Paradigm of Hope for the 21st Century.* Edited by K. A. Wheeler and A. P. Bijur, pp. 199-214. New York: Kluwer Academic/Plenum Publishers.

Mālama Hawai'i. 2001. *Public attitudes toward environmental conservation: Results of a telephone survey and focus groups. Summary of findings.*

Maragos, J. E. 1998. "Marine Ecosystems," in *Atlas of Hawai'i,* Third edition. Edited by S. P. Juvik and J. O. Juvik, pp. 111-120. Honolulu: University of Hawai'i Press.

Mattick, L. 2002. *What is known about student interest in science and when and why do students turn away from the subject?* University of Queensland.

McKernan, J. 1996. *Curriculum Action Research: A Handbook of Methods and Resources for the Reflective Practitioner,* Second edition. London: Kogan Page Limited.

Mills, G. E. 2000. *Action Research: A Guide for the Teacher Researcher.* Upper Saddle River, New Jersey: Prentice-Hall, Inc.

National Oceanographic and Atmospheric Administration. 1998. "1998 Year of the Ocean - Marine Education, U.S.A.: An Overview," vol. 2001.

National Research Council. 1996. *National Science Education Standards.* Washington, D.C.: National Academy Press.

—. 2001. *Investigating the Influence of Standards: A Framework for Research in Mathematics, Science, and Technology Education.* Center for Education, Division of Behavioral and Social Sciences and Education, National Research Council.

National Science Resources Center. 1997. *Science for All Children: A Guide to Improving Science Education in Your School District.* Washington, D.C.: National Academy Press.

Neefjes, K. 2001. "Learning from participatory environmental impact assessment of community-centered development: the Oxfam experience," in *Analytical Issues in Participatory Natural Resource Management.* Edited by B. Vira and R. Jeffery, pp. 111-127. New York: Palgrave.

Noffke, S. E. 1997. "Themes and tensions in US action research: towards historical analysis," in *International Action Research: A Casebook for Educational Reform.* Edited by S. Hollingsworth, pp. 337. London: The Falmer Press.

North American Association for Environmental Education. 1999. *Excellence in Environmental Education - Guidelines for Learning (K-12).* Rock Spring, Georgia: North American Association for Environmental Education.

Ostrom, E. 1992. Community and the endogenous solution of commons problems. *Journal of Theoretical Politics* 4:343-351.

Paden, M. 2000. "Education for sustainable development: small is beautiful," in *Human Nature*, vol. 5, pp. 1.

Permpongsacharoen, W. 1992. Alternatives from the Thai environmental movement. *Nature and Resources* 28:4-13.

Peterson, L. 2000. "Understanding sustainable communities," in *Education for a Sustainable Future: A Paradigm of Hope for the 21st Century.* Edited by K. A. Wheeler and A. P. Bijur, pp. 221-236. New York: Kluwer Academic/Plenum Publishers.

Pettigrew, M., and B. Somekh. 1994. "Introduction," in *Evaluating Innovation in Environmental Education.* Edited by OECD, pp. 11-17. Paris: Organization for Economic Co-operation and Development.

Piburn, M. D., and D. R. Baker. 1993. If I were the teacher. . . Qualitative study of attitude toward science. *Science Education* 77:393-406.

Posch, P. 1994. "The study "Environment and Schools Initiatives": phase one," in *Evaluating Innovation in Environmental Education*. Edited by OECD, pp. 21-29. Paris: Organization for Economic Co-operation and Development.

Priesnitz, W. 2000. "Education can lead the way to a sustainable society," in *Creating Learning Communities: Models, Resources, and New Ways of Thinking about Teaching and Learning*. Edited by R. Miller, pp. 279-284. Brandon, VT: The Foundation for Educational Renewal, Inc.

Rapoport, R. N. 1970. Three dilemmas in action research. *Human Relations* 23:499.

Rocheleau, D., and R. Slocum. 1995. "Participation in context: key questions," in *Power, Process and Participation: Tools for Change*. Edited by R. Slocum, L. Wichhart, D. Rocheleau, and B. Thomas-Slayter, pp. 17-30: Intermediate Technology Publications.

Santhakumar, V. 2001. "Analysing failed participation from the perspective of new institutional economics: Evidence from Kerala," in *Analytical Issues in Participatory Natural Resource Management*. Edited by B. Vira and R. Jeffery, pp. 208-222. New York: Palgrave.

Schmuck, R. A. 1997. *Practical Action Research for Change*. Arlington Heights, Illinois: IRI/SkyLight Training and Publishing, Inc.

Schneider, H. Editor. 1992. *Environmental Education: An Approach to Sustainable Development*. Paris: Organization for Economic Co-operation and Development.

Smith-Sebasto, N. J. 1997. "Education for Ecological Literacy," in *Environmental Education for the 21st Century: International and Interdisciplinary Perspectives*. Edited by P. J. Thompson, pp. 279-288. New York: Peter Lang Publishing, Inc.

Stanisstreet, M., and E. Boyes. 1997. "Vehicles: Metaphors for Environmental Education," in *Environmental Education for the 21st Century: International and Interdisciplinary Perspectives*. Edited by P. J. Thompson, pp. 301-310. New York: Peter Lang Publishing, Inc.

State of Hawaii Department of Education. 1999. *Science Content Standards*.

Thompson, P. J. Editor. 1997. *Environmental Education for the 21st Century: International and Interdisciplinary Perspectives.* New York: Peter Lang Publishing, Inc.

uscharterschools.org. 2002. "Overview of charter schools.," vol. 2002.

Vinke, J. 1992. "Actors and approaches in environmental education in developing countries," in *Environmental Education: An Approach to Sustainable Development.* Edited by H. Schneider. Paris: Organization for Economic Co-operation and Development.

Vira, B., and R. Jeffery. Editors. 2001. *Analytical Issues in Participatory Natural Resource Management.* New York: PALGRAVE.

Walters, J., J. E. Maragos, S. Siar, and A. White. 1998. *Participatory Coastal Resource Assessment.*

Weiss, C. H. 1998. *Evaluation.* Upper Saddle River, New Jersey: Prentice-Hall, Inc.

Wells, G. 2001. "The development of a community of inquirers," in *Action, Talk & Text: Learning and Teaching Through Inquiry.* Edited by G. Wells, pp. 1-22. New York: Teachers College Press.

White, A., L. Z. Hale, and Y. Renard. Editors. 1994. *Collaborative and Community-based Management of Coral Reefs: Lessons from Experience.* West Hartford, Connecticut: Kumarian Press.

World Commission on Environment and Development. 1987. *Our Common Future.* Oxford University Press.

Wulf, K. M., and B. Schave. 1984. *Curriculum Design: A Handbook for Educators.* Palo Alto, California: Scott, Foresman, & Co.

Yin, R. K. 1994. *Case Study Research: Design and Methods.* Beverly Hills, California: Sage Publications.