

DRAFT Ke'e Lagoon and Reef Flat Users Baseline Study (updated September 2006)**

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Abstract

Ke'e Lagoon is a popular Kauai destination for tourist and resident beach-goers and snorkelers. It is part of the Haena State Park, and is located at the end of Route 56 in Haena, Kauai. Also located at the end of the road is the trailhead to the Kalalau Trail, and an ancient Hawaiian Heiau (ancient Hawaiian religious temple). The area has become extremely popular with visiting tourists in the last few years, and this large amount of usage has prompted this study. The study has been done to conclude whether or not the recent human impact is having a detrimental impact on the lagoon and associated reef.

The original survey in 1999 was done in two parts, and in 2006 only one part was updated, the survey of the reef flat, with some added observations about beachgoer behavior. The first survey in

1999 involved counting the number of people using the beach area, and determining the uses that occurred while these people were at the specific beach park area at the end of the road. One of the impacts of primary concern was the effect of humans walking on the reef flat of the area. The second part of the survey was to monitor the lagoon and reef flat area to detect if the human use had a detrimental effect on the marine life and the reef flat itself. In 2006, a partial re-survey of the reef flat area and swim through observations were made to detect if the human use had a detrimental effect on the marine life and the reef flat itself. The complete 2006 survey was not fully completed because of unseasonal huge surf, making it impossible to monitor the reef flat as completely as 1999.

In 1999, the first part of the survey was done with volunteers counting the people using the Ke'e beach area, and what the visitors did while they were there. The studies for this survey were done in June and July of 1999 (and again on June 8, 2006), and contributes to information all ready collected by the Hui Maka'ainana O Makana (the local organization in the area committed to community based management) and the Lima Huli Tropical Botanical Garden.

The total number of visitors to the area has been estimated in 1999 by the DLNR to be over 1700 per day, with 450 using the Kalalau trail (data from Limu Coalition – Dr. Ray Chuan). This leaves the total users of the lagoon area to be at least 1250 per day. Some casual observations were also made of the Ke'e lagoon area by Carl Stepath in August 1999. It appears that the usage is higher during this month (August) of the year. In the updated survey, a June 8, 2006 reef monitoring excursion was conducted by Dr. Stepath, and a number of casual observations were made after this date until July 1, 2006. It appears there was an increase in use of the Ke'e beach area over the last 7 years. In the 1999 study, very few people (mostly local fishermen and other local resident users) were at the end of the road parking lot before 1000. The monitoring was done early in the morning, starting at 0600 on both occasions. In 2006, tourists started showing up at the parking lot at 0700 and the main parking lot was full by 0930, with very few of the users observed appearing to be local residents.

The full parking lot could have been because a number of cars were parked in the parking lot upon my arrival, and they were assumed to belong to Kalalau hikers, and the duration of their stay was not noted. It was also noted on these visits to the end of the road parking lot in 2006 (Ke'e lagoon), that there was a great deal more extra parking than in 1999, and quite a bit more clearing of the forest around the original parking lot had taken place. These trees were not a part of the previous survey, but there was quite a bit of extra parking in the trees that was not there in 1999 (approximately doubling the number of tourist car parking sites). In 1999, the trees parking area had been used almost exclusively by locals, and now all these spots were taken up by tourist vehicles, and it is not obvious where the locals are parking now. This also caused a situation where tourists were using parts of the beach that extended several hundred meters down the beach from the lagoon parking lot during the course of the day. This was not the case in 1999, as it was noted in the study that almost all the tourist use of the Ke'e lagoon area was within 100 meters of the parking lot, so the area of the beach being used by tourists had increased during a similar time period in 1999. Overall there appeared to be much more use of the area by tourists over a longer period of time during the course of a day and much less use of the area by locals during this June-July period, but this was a very small snapshot in time so more research needs to be done to substantiate these observations.

The 1999 survey data showed that the peak time for human use during the study period was 4 p.m., with the high level of usage starting at 10 am and lasting until 6:30 p.m. The highest use was sunbathing, with snorkeling and swimming being the important recreational activity of the group. The mean number of people walking on the reef was highest at 1:30 p.m. There did not seem to be any relationship between the tidal stage, and the total number of people at Ke'e, to the number of people walking on the reef. These findings were not calculated in 2006. The observations of the 1999 data collectors concurred that very few of the people using the beach at Ke'e were residents of Kauai, and many of the local inhabitants seemed to be repulsed by the dense population of tourists at this one particular spot. There are supposedly no commercial activities in the area, but commercial kayaking operations were witnessed at the very early morning in the lagoon in 1999. These kayak groups were transiting from the parking lot to the lagoon, and then kayaking down the coast. They did not return to the lagoon after leaving, but no commercial use was seen in 2006.

In 1999, two zones were surveyed and they bordered on each other (one as a control area). The third zone, which was over 500 down the beach from the parking area, was not used because of a shortage of volunteers. There was a tremendous difference in the usage of the two zones, with the tourist population being limited to the impact zone, and more traditional uses occurring farther down the beach. Only a very few tourists seemed to venture out m 100 m from the congested beach area near the parking lot. These findings were not calculated in 2006, but observations seemed to imply that the tourists were using more of the beach and were moving out greater distances from 100m from the parking lot.

The second survey was done in 1999 with quadrats placed randomly on the reef flat area, and the percent reef cover was noted, and this survey was partially replicated in 2006. In 1999, the data indicated there was a significant impact because of the tourists walking on the reef, and the findings in 2006 also significant impact in the reef area closest to the parking lot, and used by a large number of tourists to walk across the reef to the deeper ocean water on the other side. There is quite a number of tourists reef walking to and from the outer edge of the reef to see turtles and other marine life, and according to the 1999 data it appears to be hurting the health of the reef flat area, and this was substantiated by the 2006 data with a significantly lower average of hard coral cover. There is a high amount of foot traffic walking on the reef along this corridor across the reef and this area has a relatively high amount of coral cover, and these corals are thought to be in danger from the inexperienced tourists and their shoes

This reef walking also poses a cultural problem. The local inhabitants are very upset by it. The Hawaiians use the reef for food collection and feel that the walking and suntan oil use in the area has a negative impact on the limu (algae) and marine life that they collect for food off the reef. This was not specifically studied, but the local residents seem to be convinced that it is true.

In 2006, a swim though of the area noted that all the coral was dead along the Kalalau side of the Ke'e channel, going out from the beach. Even though this area had not be monitored in 1999, it had been observed that over half of the *Pocillapora meandrina* coral heads along this side of the channel had been alive. These coral heads were dead in 2006, with no new recruitment noted. This is an apparent problem from nutrient loading appeared to be because of the nearby public toilets, but more study needs to be done to substantiate this idea. All the coral (*Pocillapora meandrina*) was

dead, and this does not seem to be caused by tourists touching the coral in question, they are approximately 3-5 meter deep, and are not in a location where tourists are walking on the reef.

This is a situation where two single studies, at similar times of the year at low low tide, at Ke'e Lagoon provide baseline information for future studies. The data gathered suggests major changes in the management of the area are needed. In order to effectively manage this area, more studies need to be done in the future, over a longer period of time. Improved facilities and management of the area could be facilitated by performing studies of this type for at least every season of the year to determine use patterns and populations for the area.

The area is not near to any major hotel, resort area, metropolitan center. Facilities for the tremendously high usage do not exist, and there is no supervision of people using the area. No lifeguards, no park rangers, no park attendants, limited toilet facilities and extremely restricted parking are a few of the problems that need to be worked out in the future. As the demand on these facilities continues to grow with the increased popularity of Ke'e, and the promotion of tourism, these problems will demand attention.

Introduction

Ke'e Lagoon is located on the Northern part of the island of Kauai, at the end of Route 56 in Haena. It is located at the very beginning to the beautiful Na Pali Coast, and is a very safe protected place to swim and snorkel, except when there is high surf in the winter. The small-protected lagoon is off a beach at the end of the road and is relatively protected from most wave action by a reef.

“Coral/algal reefs are the largest structures on earth built by plant and animal growth...Corals are usually thought of as the builders of tropical reefs. Although corals are major contributors, stony or coralline algae usually surpass other organisms as the main frame-builders in shallow, surge-swept areas. In fact, the outer-most margin of a reef may harbor few corals. Instead, there may be a ridge of encrusting algae called the “algal ridge” where the greatest force of the waves is concentrated. The encrusting growth of coralline algae binds together the solid and loose fragments of limestone which collect on a reef. Seaweeds are usually the most conspicuous occupants on rock and rubble surfaces of reef flats. Inshore, where water circulation is sluggish, fleshy seaweeds are most common. Where water movement is more vigorous near the reef edge, pastel-colored stony algae (especially Porolithon spp.) are characteristic.” AECOS, Inc., 1979.

“Considered by marine scientists to be the ocean's version of the rain forests, coral reefs house some of the oldest and most biologically diverse ecosystems on the planet.” Yeomans, M., 1999.

This entire Ke'e lagoon area is part of the Haena State Park, and is managed by the Hawaii Department of Land and Natural Resources. There is no marine protected area here, and no lifeguards or supervisory personnel to manage the thousands of people that visit the area every day.

The Ke'e area consists of a parking lot at the end of Route 56, with six portable toilets, a shower and a beautiful sandy lagoon wedged between the fringing reef and the mountainous Na Pali. There is no camping in the area, and no facilities such as picnic tables, food or snorkel concessions.

The reefs are very important to the area, and have been used by the local inhabitants for many centuries. "Reef flats provide shelter for many organisms collected for food, including edible seaweeds (limu), mollusks (octopus or he'e), long-spined sea urchins (wana), sea cucumbers (loli), and fishes... Some organisms (for example, the spaghetti worm, Lanice conchilega) have been collected for use in medical research." AECOS, Inc., 1979.

The reefs are also an important economic resource. These reefs provide sand for the beautiful white beaches, protection from storms, food to eat, a home for millions of little organisms, and are a wonderful snorkel grounds. A hotel owner in Belize says, "Our business is completely dependent on the health of the reef...That's primarily why people come here." Yeomans, M., 1999.

Methodology

The surveying was done from June 1 to August 15, 1999. The human use survey data report is from the dates of July 3, 7 and 11, 1999. A copy of the survey form is attached (Ha'ena Marine Use Pattern Survey). Only zones #1 and #2 were used because of the number of volunteers available. Zone 1 was the impact area at Ke'e lagoon and Zone 2 was approximately 200 meters down the beach. Volunteers were selected from the community and Hui, and did the actual counting and entry onto the survey forms. This data set is not large enough to establish anything more than baseline information and more data needs to be collected.

The reef impact work in 1999 was done by diving the reef numerous times, and doing transects on the reef flat (1999 and 2006). The dives were to gather information about the area and make observations, while the transects were to distinguish human impact of walking on the reef flat itself. The reef flat transects were done in two areas, an impact area and a control area. A total of fifteen 10 m transects were set out in both of the areas. Five of these transects were randomly selected in each area and then five points were randomly selected on each transect line. So, five transect lines were selected in each area, and a total of twenty-five 1sq. m quadrats were used to compute percent coverage of coral, algae, and other substrate in each area. See the 1999 report for an outline of the coverage. The quadrat surveying was done at low tide, while the reef was exposed. In 2006 five randomly selected transect lines were chosen in areas A and B, and a total of twenty-five 1sq. m quadrats were used to compute percent coverage of coral, algae, and other substrate in each area. The quadrat surveying was done at low low tide, while the reef was exposed.

The impact area was so designated because it was close to the swimming lagoon and parking lot, so was the area with the major concentration of people. This area close to the parking lot and in front of the small swimming lagoon is noted as Point A. The major flow of people across the reef is from this area to a small indentation in the reef. When people are walking on the reef, the main concentration seems to be in a corridor from the beach to this small reef indentation to enter the ocean and view turtles and fish along the reef edge in deeper water. This is the major impact area as noted in the 1999 and 2006 reports. This information has been gathered by observation, and was used to divide the study site. This impact area was studied by percent cover and compared to the control area to the right of the line. Thus these two areas of reef flat were studied, next the results were compared.

The categories looked for in the percent cover on these transect line were turf algae (Turf), coralling encrusting algae (Crust), macro algae (Macro), coral (Coral), sand (Sand) and rubble, and bare substrate or basalt rock (Bare Substrate). The amount of Bare Substrate was negligible

Reef Monitoring Results

The area studied is in a very high surf area for most of the year. The summer months are the only time that the area gets any relief from the pounding surf, so that is when the monitoring was done. “The main factors affecting life on the bottom of this environment of rough and shifting sand are wave energy and bottom topography.” PUSPP/CZM, Aug 1978.

Some of the macro-algae found on reef flat included: *Galaxaura rugosa*, *Asparagopsis taxiformis* (limu kohu), *Hydrolithon reinboldii*, *Porolithon onkodes*, *Coralina* sp., *Centroceras clavulatum*, *Pterocladia capillacea*, *Sporolithon erythraeum*, *Hydrolithon breviclavium*, *Amansia glomerata* and *Padina* (sp.). “Due to strong tolerance to sunlight and desiccation and its crustose nature it is extremely successful in occupying high wave energy habitats. *P. onkodes* performs a critical role in the formation and maintenance of the biotic reefs of Hawaii by providing an actively growing reef rim, allowing consolidation and cementation of reef material to occur in protected shoreward areas...” Tissot, 1999. Limu kohu was found in very limited quantities in the control area and none in the impact area, but it mainly blooms in the spring and should be checked at that time. The local people on the reef this time of year are looking for octopus and va’wai’i’ole (sp?).

The corals found on the reef flat included, but are not limited to, *Pocillapora meandrina*, *Montipora patula*, *Montipora capitata* (formerly *M. verrucosa*), *Montipora flabellata* and *Porites lobata*. There were several bleached corals, but this is likely due to the heat of the sun at low tide. (Jokiel, in conversation, 1999)

The reef flat monitoring was done at Ke’e reef flat at low tide on Tuesday, August 10, 1999, Wednesday, August 11, 1999, and Thursday, June 8, 2006. The reef flat was divided into two sections that included the impact area and the control area. When the data from the two sections was compared, it became obvious that there is a significant difference in the two areas. The area of particular concern is coral cover, and the average was 4.76% in the impact area and 8.92% in the control area in 1999; and the average was 5.73% in the tourist impact area and 7.51% in the control area in 2006. This is a significant difference and was not expected to be so large, even though, it did appear to decrease in 2006. To establish a statistically valid sampling, more work needs to be done and more data collected. However, a difference has been established and this difference has been substantiated with a second monitoring event 7 years later in 2006. It is hard to definitely say that this difference is due to human impact because of the limitations of this study, but this certainly seems to be the case. The area of most concern is the corridor between the beach and the outer reef, where the highest percentages of tourists travel across the reef. At this time there is no control or supervision of the people crossing the reef in this area with coral cover, and this situation has not changed since 1999.

For more information about an assessment of Ke'e Beach biological resources and fish populations please consult the 1999 report (Stepath, 1999).

Conclusions

The beach and reef area at Ke'e lagoon is a very unique area. It has a beautiful white sand beach; an aquamarine colored safe swimming and snorkeling lagoon, and is surrounded by some of the best natural beauty in the world.

It is no wonder so many tourists flock to the site and use Ke'e beach at the end of the road. Over the years this use has continued to increase because of the increase popularity and promotion of the area in tourist magazines. These tourists are not staying at a nearby hotel or resort and are not paying for any of the facilities at the park. It is all being paid for by the State tax dollars of local residents who are not using the beach park area very much. Some shift of the funding responsibilities seems to be necessary.

There has been a tremendous amount of resources spent for the promotion of tourism, and for some reason very little has been spent on the infrastructure of park facilities such as Ke'e lagoon. These facilities still need improvement, and need to be managed in a way that will protect it for future generations.

These visitors are not staying at any local hotels (there are none), and appear to be finding out about Ke'e from travel books, magazines, videos and bus tours. They come and appear to stay between one and two hours, so there is a continual changing of the people there. This information was gathered by interviewing some of the visitors and observation, so it can not be substantiated quantitatively.

It appears that if local residents see a lot of people at a beach, they will go somewhere else; while conversely, tourists will go to a beach if they see a lot of people there. This makes Ke'e very crowded, but with very few local people on the beach.

The nearest hotel is about 10 miles away, so the area is not set up for such high use. When one looks across the area and sees the crowds it feels as if it is at a resort. This beach is one of the remotest on the island, but is very accessible by automobile, and the visitors seem to like the majestic beauty of the surroundings.

It is very difficult to study and area for such a short period of time, and be able to draw any substantial conclusions. "Despite the ecological and economic importance of coral reefs, we have a poor understanding of how this ecosystem responds to human activities..." Hodgson, 1999. Because of the complexity of the coastal marine ecosystems and seasonal variations, it is very difficult to isolate specific impacts. Since this is the first continued study of its type in the Ke'e area it should to be considered important, with more study needed in the future.

The coral reef flat data does appear to show harm to the corals on the reef due to the human impact of the tourists in the Ke'e Lagoon area. Humans are impacting the reef area. Because of the limited scope of this study, and the great number of parameters involved, it is very difficult to measure the exact effect. There are differences in the reef flat area as presented in this paper. These include differences in the beach use, differences in the fish populations, differences in coral cover and differences in the customary uses of the native peoples. "Because of easy access and generally calm waters, reef areas are heavily used.... No doubt certain reef flats are adversely affected by the numbers of people visiting during favorable low tides." AECOS, Inc., 1979.

The reef flat has coral cover in the areas that are not laid bare at low tide. These areas are on the reef flat between the beach and the outer exposed reef area. Because of the location of these coral areas, the tourist foot traffic poses a danger to the coral when people walk to the outer portion of the reef. The tourists transit right through this coral area on their way to dive off the outer portion of the reef, and this poses a threat of damaging or killing the small amount of living coral that does exist at Ke'e reef. The tourists do not really know the habitat, and periodically step on living coral and crush it. As the tourist numbers increase and the area remains unsupervised the threat to these corals will increase. Walking on the reef should be prohibited for tourists.

The main problem is cultural and (subsistence) by the Hawaiian people who reside in the watershed area (Ahupua'a). These people are very concerned by the daily intrusion by thousands of people a day into their beachfront space. A place that they have been fishing and gathering for centuries. These tourists unintentionally intrude into the reef area that is nearly sacred to these Hawaiian people. They feel that they can not go to places that they traditionally have gone all their lives, and that the visitors are trampling and collecting from the reef area that has been their fishing and gathering grounds, their refrigerator. The Hawaiians use the reef for food collection and feel that the walking and suntan oil use in the area has a negative impact on the limu (algae) and marine life that they collect for food off the reef [i.e. *Asparagopsis taxiformis* (*limu kohu*)]. Although this was not specifically studied it could be in the future.

Recommendations

- 1) It appears to be very important to make Ke'e a marine protected area for subsistence and sustainable fisheries management. "Important parts of the sea must be set aside in marine reserves and safeguarded from as many threats as possible, because future generations deserve to inherit some portion of the natural ecosystems that exist today. Marine reserves provide protection from the harmful effects of overfishing... Marine reserves provide an excellent opportunity for public education... Marine reserves would be expected to increase economic activities that depend on healthy natural resources... Marine reserves can be effectively enforced." Fujita, 1999
- 2) It is necessary to improve restroom facilities, and make sure that the sewage is treated before going into the ocean. The portable toilets are good in the respect that they remove the excrement from the area, whereas a septic system would release it into the immediate ocean environment. The extremely high use of the area by visitors makes it important to clean up the unsightly and unpleasant situation there now.

- 3) Redesign park so that parking is next to park entrance.
- 4) Hire staff to monitor park, while managing and controlling people. These people could educate visitors about the reef and cultural significance of the surrounding area.
- 5) Begin environmental education programs for visitors. Pamphlets could be designed to distribute to the visitors, so they would learn about the qualities of the reef and the rest of the area.
- 6) Charge admission for tourists to pay for improvements and staffing. “On Bonaire, one successful marine park – financed wholly by divers’ fees – has been in operation for 20 years.” Yeomans, M., 1999.
- 7) Work with residents to incorporate community based management.
- 8) Study the effect of suntan lotion on the reef and other marine organisms in the area.

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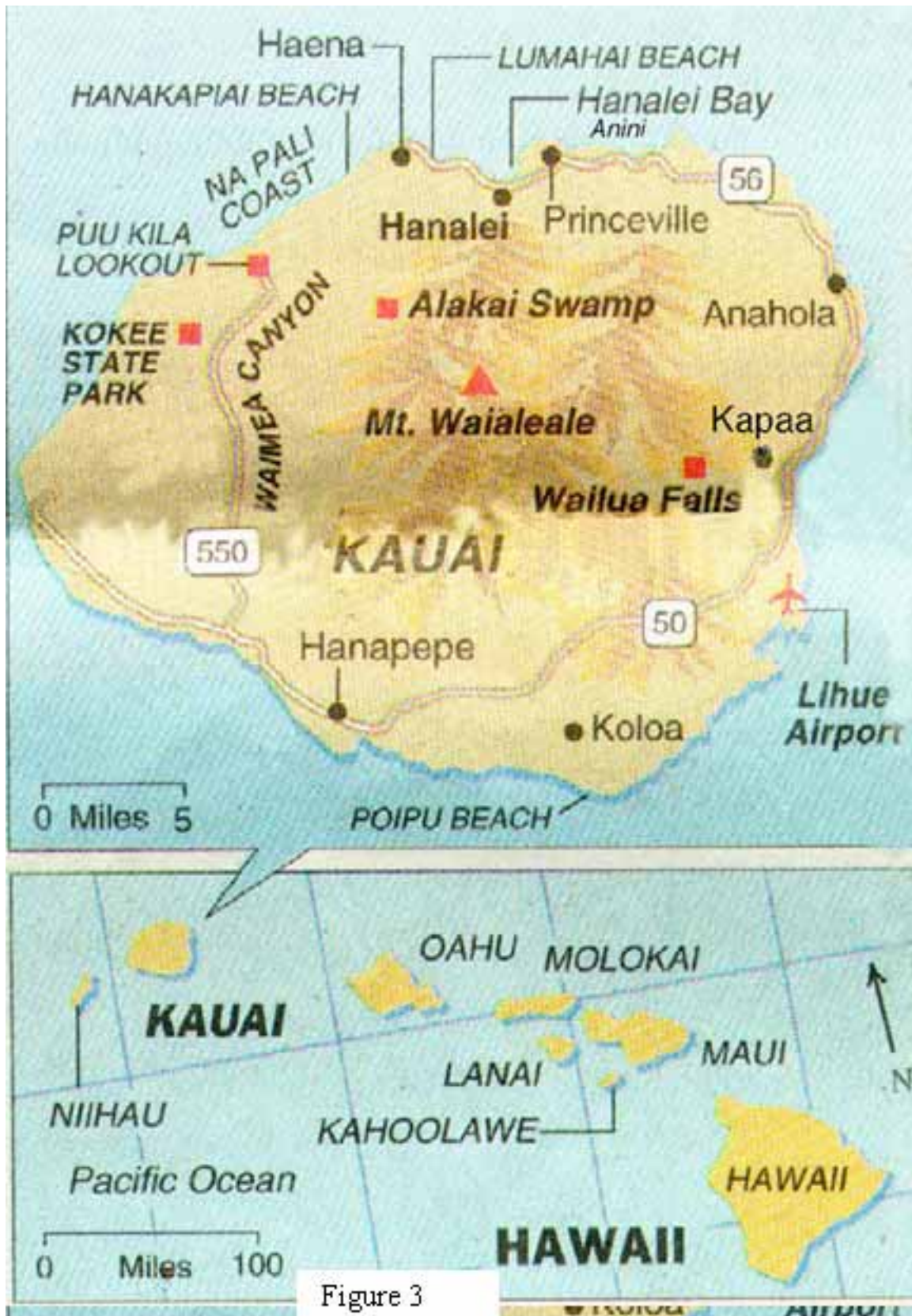


Figure 3



Figure 4

Impact
12
05
17
09
07



Figure 5

Control
20
15
03
19
12

Figure 3