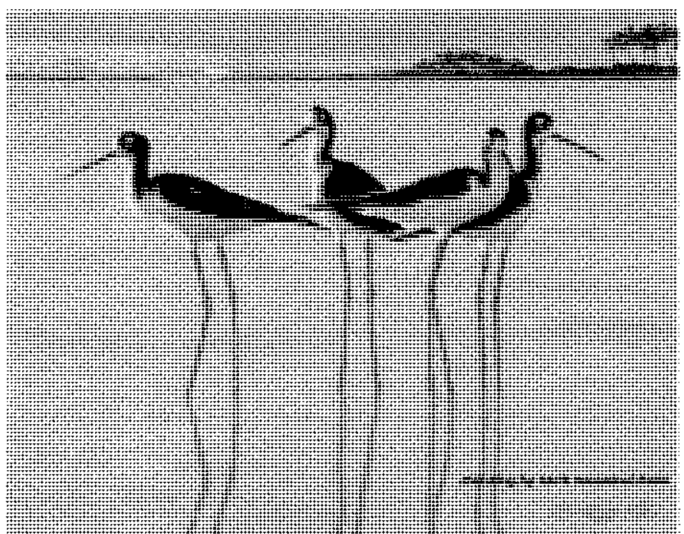
A CONSERVATION PLAN FOR HAWAIIAN STILT AT CYANOTECH AQUACULTURE FACILITY KEAHOLE POINT, HAWAII



December 4, 2001

Prepared for
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Kailua-Kona, Hawaii

Prepared by
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EXECUTIVE SUMMARY

Cyanotech Corporation (Cyanotech) has applied for a permit from the U.S. Fish and Wildlife Service (Fish and Wildlife Service) pursuant to section 10(a)(l)(B) of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531-1544), as amended, and has applied for a license from the Hawaii Department of Land and Natural Resources (DLNR) in accordance with the HRS (Hawaii Revised Statutes) section 195D-4(g) to incidentally take endangered Hawaiian Stilt (*Himantopus mexicanus knudseni*). The incidental take is anticipated to occur as a result of ongoing operations and maintenance activities at Cyanotech's aquaculture facility within the Natural Energy Laboratory of Hawaii (NELHA) along the Kona Coast of the island of Hawaii (Big Island). No other listed, proposed, or candidate species are found in the project area. In support of the permit application, Cyanotech proposes to implement a Conservation Plan as required by section 10(a)(2)(A) of the ESA and the HRS section 195D-21. The proposed permit period is three years.

The primary goal of the Conservation Plan for Hawaiian Stilt at Cyanotech is to eliminate the incidental take of Hawaiian Stilt by eliminating the "attractive nuisance" problem created by the expanse of open-water ponds, invertebrate food resources, and remote nesting areas, which inadvertently attract Hawaiian Stilt to the Cyanotech facility. The Conservation Plan is proposed as a short-term plan to actively pursue non-lethal bird deterrent measures to reduce and eliminate stilt foraging and nesting at the facility. In conjunction, Cyanotech will implement an adaptive mitigation strategy to lure adult stilts into a protected and managed nesting area on-site during the breeding season in order to ensure some reproductive success for the birds attracted to this man-made site, while long-term measures to ultimately eliminate the bird attractions are being developed in the microalgae production ponds.

Cyanotech is located adjacent to the Kona International Airport and the issue of a potential wildlife hazard is a concern. However, the Conservation Plan was developed with the knowledge that the current lack of foraging and breeding sites for stilts on the Big Island makes it difficult to successfully haze Hawaiian Stilts from Cyanotech without adversely impacting the breeding success of the Kona Coast population of Hawaiian Stilts. The Kona Coast population now represents about 10% of the entire population of stilts within the Hawaiian Islands. Therefore, until the invertebrate base and other attractants at the Cyanotech raceways are reduced and other natural habitats are restored or enhanced and managed to provide the extent of foraging and breeding resources found at Cyanotech, significant numbers of Hawaiian Stilts will continue to be attracted to the aquaculture facility.

In the case of Cyanotech, the impacts to Hawaiian Stilts from operation and management of the aquaculture facility have not resulted from any alteration or loss of natural wetland habitat supporting Hawaiian Stilt on the facility. Rather, the aquaculture facility has increased the amount of artificial open-water habitat on the Big Island, which has resulted in the attractive nuisance problem described in this report. Thus, the biological goals of the Conservation Plan are appropriately species-based rather than habitat-based. The strategy includes measures to minimize and mitigate the incidental take of Hawaiian Stilt chicks at Cyanotech.

Specific biological goals of the plan are to:

- Eliminate foraging by adult/subadult Hawaiian Stilts and mortality of Hawaiian Stilt chicks at Cyanotech;
- Eliminate nest site fidelity in unprotected areas of the facility where successful reproduction is not possible, and encourage dispersal to other wetlands and islands where successful reproduction is possible;
- Prevent Hawaiian Stilts from nesting adjacent to runways at the Kona International Airport and reduce nesting adjacent to raceways and lava flats at or near Cyanotech;
- Provide net environmental benefits through development of effective bird deterrents measures to assist in addressing the attractive nuisance and reproductive sink problems associated with many industrial ponds;
- Ensure reproductive success for the Kona Coast population of Hawaiian Stilts by managing a protective breeding area on site to carrying capacity (when the breeding site is being managed);

- Provide a net conservation benefit that contributes to the recovery of Hawaiian Stilt by producing more stilts than is incidentally taken during the permit term.

The Conservation Plan strategy will include:

- exploring options and pursuing solutions to reducing the invertebrate food source from microalgae ponds to limit the number of stilts attracted to the site;
- discouraging stilts from nesting in unsuitable areas by implementing design changes and management practices in the raceway ponds to reduce the attractiveness of the raceways to stilts;
- working with the Fish and Wildlife Service and the DLNR to identify non-lethal methods to detract stilts from using the raceways at Cyanotech;
- dedicating and managing a protected stilt breeding area on site to lure stilts away from the raceways at least during the first breeding season;
- educating Cyanotech employees on the biology and protected status of the Hawaiian Stilt; and
- supporting recovery efforts by providing important biological monitoring data on Hawaiian Stilt on the Big Island.

Implementation of the Conservation Plan represents a viable way to meet the goal of significantly reducing the bird attractant problem at Cyanotech over the long-term by focusing on the root of the problem. Because Cyanotech would be able to concentrate efforts on-site, resources would be dedicated to finding effective bird deterrents that could be of greater value in resolving the attractive nuisance and reproductive sink problems attributed to many artificial wetland sites throughout the main Hawaiian Islands.

The Conservation Plan defines measures to ensure that the elements of the plan are implemented in a timely manner and discusses the possibility of unforeseen events occurring. Funding for the Conservation Plan, alternatives to the proposed plan, and other measures required by the Fish and Wildlife Service and the DLNR are described.

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1.0 INTRODUCTION

1.1 Purpose of the Conservation Plan

Cyanotech Corporation cultivates and harvests microalgae for commercial sale. This microalgae farming operation occurs within man-made, open water ponds along the Kona Coast of the island of Hawaii, Hawaii. The nutrient rich ponds support high-density invertebrate populations, a primary food source for the endangered Hawaiian Stilt (*Himantopus mexicanus knudseni*). Hawaiian Stilts are attracted to and nest within and adjacent to the aquaculture facility. Hawaiian Stilt chicks that hatch at the facility are led by parent stilts to the ponds to feed, where they are suspected either of drowning in the rapidly flowing waters or dying from adverse physiological reactions (e.g., acute dehydration) associated with ingestion of the hypersaline, high-alkaline conditions of the alga medium required for production. Cyanotech's aquaculture operation thus inadvertently attracts stilts to a man-made habitat that is unsuitable for successful stilt reproduction.

The Federal ESA provides for the protection and conservation of fish, wildlife and plants that have been federally listed as threatened or endangered. Activities otherwise prohibited by section 9 of the ESA and subject to the civil and criminal enforcement provisions of section 11 of the ESA may be authorized for Federal entities pursuant to the requirements of section 7 of the ESA and for other persons pursuant to section 10 of the ESA.

Pursuant to section 10(a)(l)(B), the Fish and Wildlife Service may issue permits, under such terms and conditions as the Secretary of the Interior may prescribe, for the taking of any listed species that is incidental to an otherwise lawful activity. Section 10(a)(2)(A) of the ESA requires an applicant for an incidental take permit to submit a "conservation plan" that specifies:

- The impact that will likely result from the specified take;
- The steps the applicant will take to minimize, mitigate and monitor such impacts;
- The level and source of funding that will be available to implement such steps;

- Alternative actions to the take and the reasons those alternatives were not chosen;
- The names of the party or parties involved; and
- Procedures that the applicant will take to deal with unforeseen circumstances.

Chapter 195D, HRS is the State law that complements the Federal ESA and promotes the conservation and recovery of Hawaii's threatened and endangered species and habitats. HRS section 195D-21 provides for the preparation and implementation of Habitat Conservation Plans (HCP) under the Federal ESA and the State Endangered Species Law. HRS section 195D-4 gives the Hawaii Board of the Land and Natural Resources the authority to issue a temporary license as part of a HCP to take an endangered species.

The Fish and Wildlife Service and the DLNR have determined this document to be a "low-effect" Conservation Plan. A low-effect Conservation Plan is one "involving: (1) minor or negligible effects on federally-listed, proposed or candidate species and their habitats ... and (2) minor or negligible effects on other environmental values or resources. 'Low-effect' incidental take permits are those permits that, despite their authorization of some small level of incidental take, individually or cumulatively have a minor or negligible effect on species covered ..." (USFWS/NOAA 1996).

This Conservation Plan has been prepared in accordance with section 10 of the ESA and HRS section 195D-4 in support of the issuance of an incidental take permit and license. The plan is a statutory component of the permit application under Federal and State law to incidentally take Hawaiian Stilt in connection with the ongoing microalgae farming operation at the Cyanotech aquaculture facility.

1.2 Permit Applicant

Cyanotech is the applicant for the incidental take permit. The Cyanotech facility is located within the NELHA, and Cyanotech has a long-term (25-year) lease on the portion of NELHA lands that support the aquaculture facility.

1.3 Project and Site Description

The project site lies within NELHA, a marine research and development area set aside by the State of Hawaii on the Kona Coast, approximately eight miles north of the town of Kailua-Kona on the island of Hawaii (Big Island). The Cyanotech aquaculture plant is located at Keahole Point below Makako Bay, west of the Kona Airport adjacent to other NELHA aquaculture facilities. The Cyanotech facility currently occupies approximately 90 acres of land and includes a series of man-made ponds or "raceway ponds" where the microalgae is grown; office and maintenance buildings; and laboratory, research, and processing buildings. All buildings and raceway ponds were constructed on or out of barren lava; thus, vegetation is sparse to almost non-existent at the aquaculture facility (Exhibit 1).

Individual raceways were formed from crushed lava and are oblong in shape. They vary in length from about 500 to 800 feet and are about 60 feet wide. They are shallow in depth with steep side slopes (1.5:1) and are lined with plastic sheeting. Each raceway includes a narrow, plastic-covered berm down its middle that helps regulate water flow. Similar narrow berms separate individual raceways from one another. Narrow, flat areas of crushed lava or, in a few cases, wider areas of crushed lava separate groups of raceways and serve as roads and passageways for equipment and vehicles (Exhibit 2).

Microalgae is grown and harvested within the raceway ponds, which comprise about 48 acres of open-water habitat within an otherwise barren lava field. To optimize growth of the microalgae, the water depth is kept at approximately 12 inches. The water is hypersaline (30-40 parts per thousand) and alkaline with an average pH between 10.3 and 10.6. Paddle wheels are installed at one end of each raceway to maintain a constant flow of water. Due to the intense, year-round sunlight, the microalgae crop cycle within each raceway pond is only seven days (Exhibit 3). There are 67 raceway ponds at the Cyanotech facility. Within any given day, 2-3 of these ponds are off production for cleaning or harvesting, with 64-65 ponds in full microalgae production.

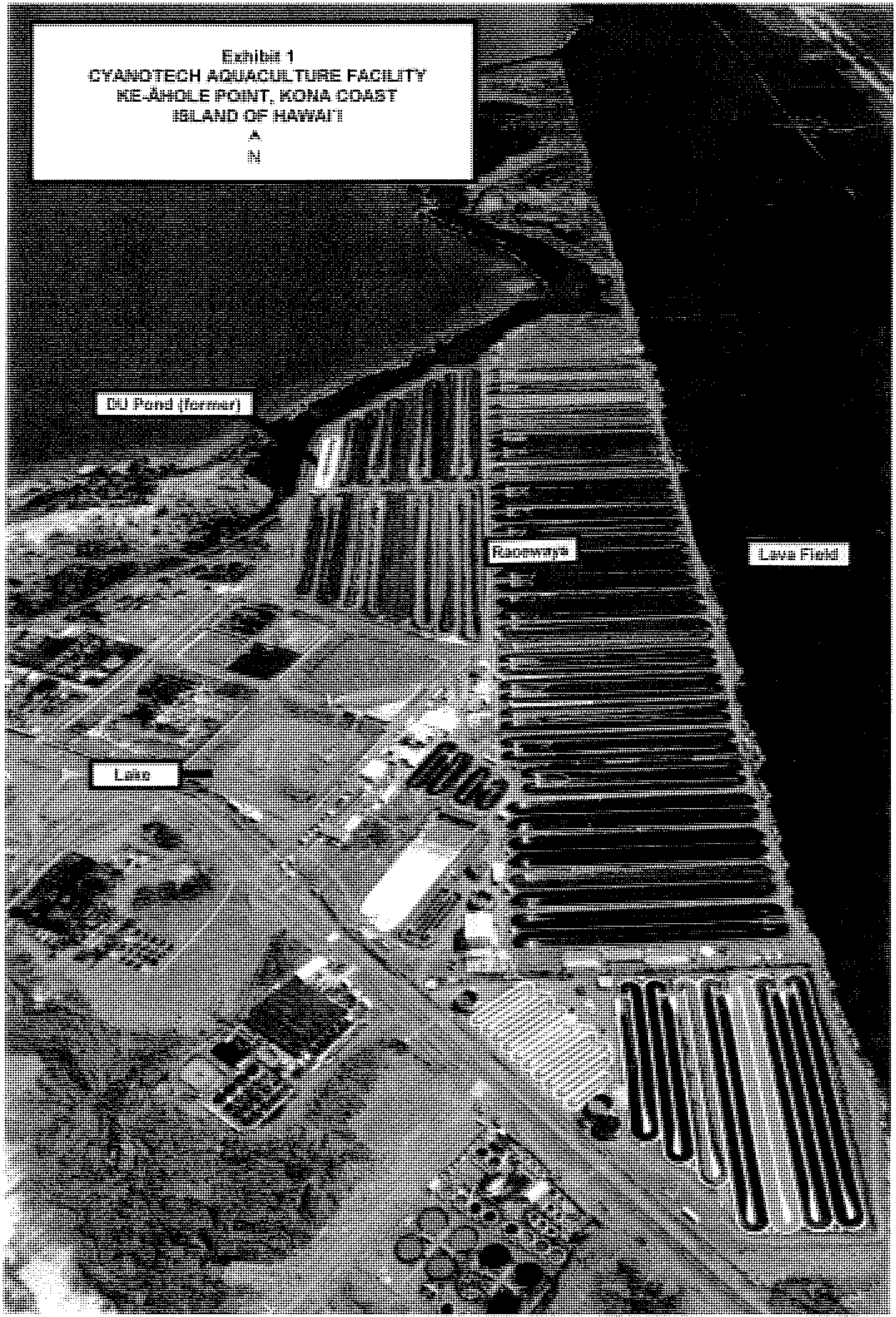

Exhibit 1
CYANOTECH AQUACULTURE FACILITY
KE-ĀHOLE POINT, KONA COAST
ISLAND OF HAWAI'I
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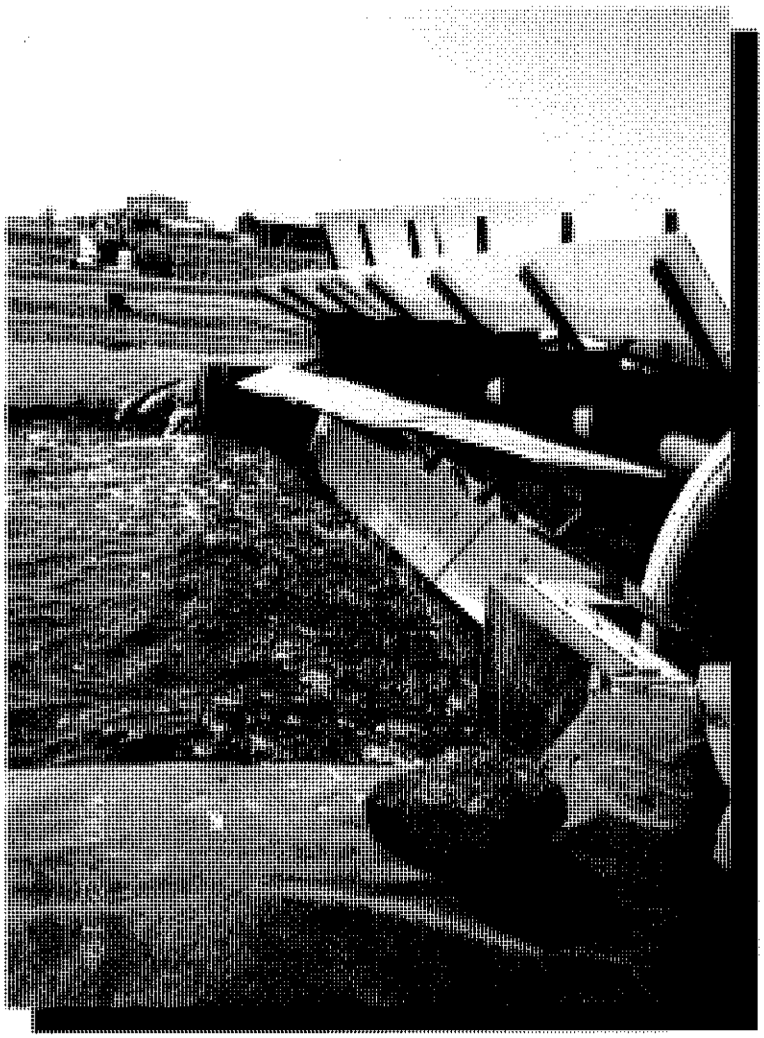
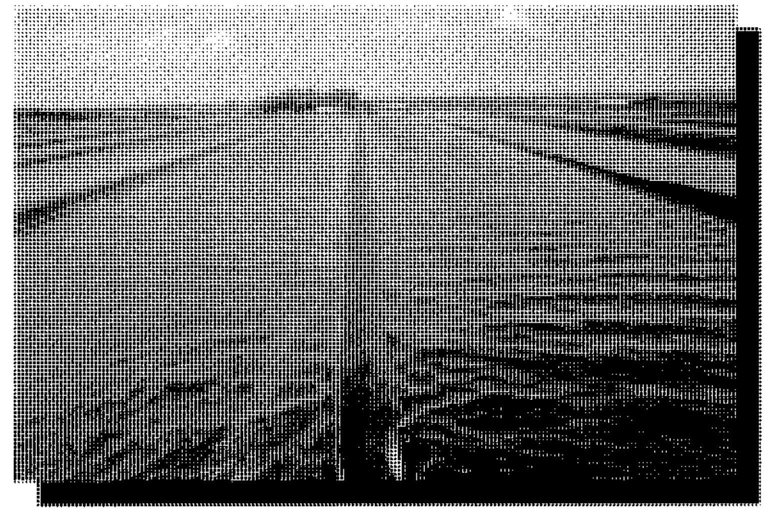
Exhibit 2. Microalgae Ponds and Paddlewheels or "Raceways"





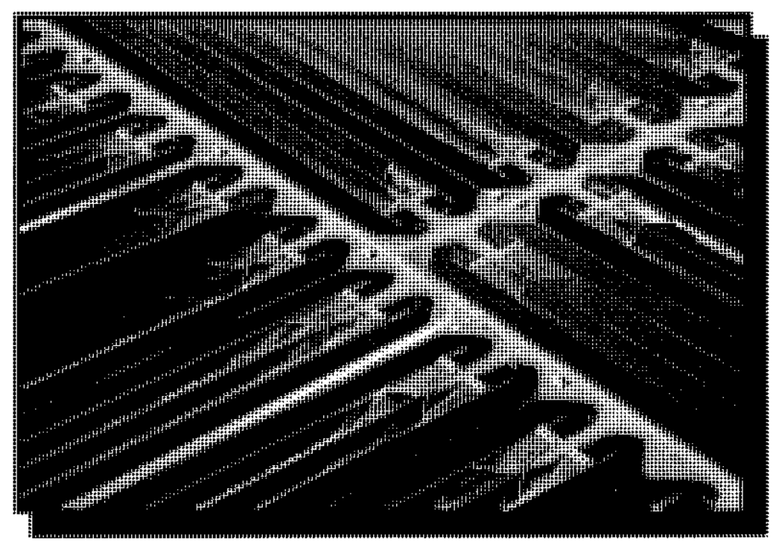
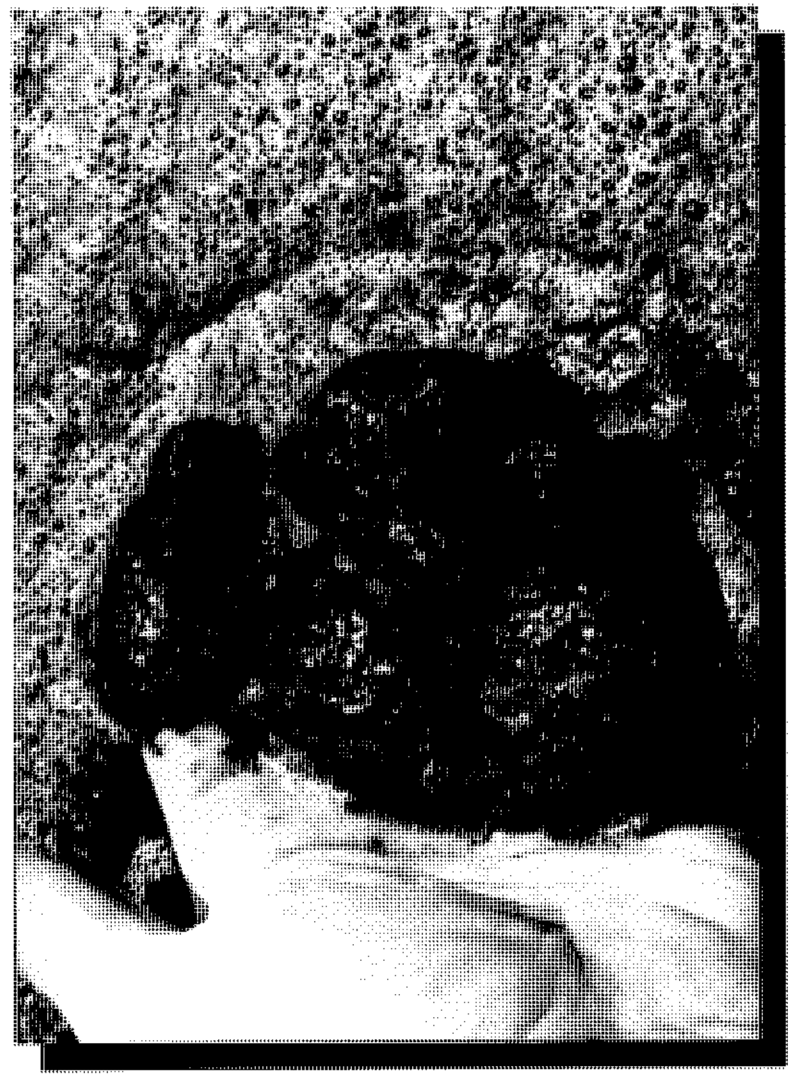


Exhibit 3. Microalgae Production

Nutrient rich algal media before harvest



Spirulina

1.4 Background

Cyanotech completed construction of a 5-acre aquaculture facility and became operational in 1985. The company continued to expand its operation and reached its present 90-acre size in 1996. By 1996, Hawaiian Stilts had discovered the invertebrate-rich raceway ponds. In 1996 and 1997, Cyanotech staff noticed Hawaiian Stilt nests and hatched chicks at the facility (Exhibit 4). A few stilt chicks were found dead in the raceway ponds. No formal records were kept of the number of dead stilt chicks retrieved from the raceway ponds or the number of adult stilts using the facility. Nevertheless, it was assumed that the few chicks observed at Cyanotech died 1) by drowning in the rapidly flowing raceways, 2) from adverse physiological reactions related to ingesting the hypersaline, high-alkaline alga medium or product (e.g., acute dehydration), or 3) a combination of the above factors. Cyanotech staff did not observe predators, and unhatched (non-fertile) eggs were not scavenged.

By 1997, Cyanotech recognized an increasing problem when a record seven Hawaiian Stilt nests were documented at and adjacent to the facility and up to 50 adult stilts were observed to frequent the raceway ponds to forage. The Fish and Wildlife Service was contacted and apprised that the stilts had established a nesting pattern and that a few chicks had hatched and presumably drowned in the ponds.

During a May 27, 1997, Fish and Wildlife Service visit to Cyanotech, a dead stilt chick was retrieved from one of the raceway ponds, and a stilt nest with four eggs was observed on the lava field adjacent to the facility. In a letter dated June 18, 1997, the Fish and Wildlife Service recommended that Cyanotech strive to accommodate the breeding, feeding, and sheltering needs of the birds coincident with the ongoing algae farming operation rather than haze the birds from the project site (See Appendix 1).

In August 1997, under the recommendation of the Fish and Wildlife Service, Cyanotech entered into an agreement with Ducks Unlimited, Incorporated (Ducks Unlimited) to provide a short-term plan to assess and manage the Cyanotech stilt population and,

Exhibit 4. Hawaiian Stilt Incubating on a Nest in the Raceway Area

following this assessment, to provide a long-term plan for managing stilts at the aquaculture facility. This Conservation Plan presents the results of monitoring and management actions undertaken at Cyanotech during the 1998, 1999, and 2000 stilt breeding seasons and includes an assessment of the incidental take that occurred during this period. While the primary purpose of the Ducks Unlimited assessment was to monitor and document stilt activity at Cyanotech, measures to address the incidental take were also investigated. Throughout the assessment period, incidental take of Hawaiian Stilt chicks was reported to the Fish and Wildlife Service (July 2, 1998; March 24, 1999; April 23, 1999; June 1, 1999; June 30, 1999; and June 12, 2000).

In 1998, three adult stilts were found dead on the runway by airport personnel. The incident triggered a Wildlife Hazard Assessment (WHA) pursuant to 14 CFR 139.337, which is currently being conducted at the Kona Airport by the State Department of Transportation (DOT). The WHA is a 12-month study designed to identify wildlife hazards to aircraft operations. The WHA was completed in July 2001 and the report is expected to be finalized by December 2001. According to FAA regulations at 14 CFR 139.337(c), "... at the completion of the WHA, the Federal Aviation Administration (FAA) will determine if a Wildlife Hazard Management Plan is needed to address the wildlife hazards identified in the WHA."

Since 1999, numerous meetings have taken place between the Fish and Wildlife Service, State Division of Forestry and Wildlife, USDA Wildlife Services, FAA, DOT, NELHA, Ducks Unlimited, and Cyanotech to discuss the Conservation Plan, and determine how to address the concerns of the DOT (Appendix 1). Profound differences lie in the conflicting interpretations of the FAA/DOT mandates and the ESA, and the best method to eliminate Hawaiian Stilt usage of the facility. The stakeholders were able to agree on only one concept: The common goal of all parties is to eliminate the attractive nuisance problem at Cyanotech; Cyanotech needs an incidental take permit to legally implement bird deterrent measures for Hawaiian Stilt; and without the permit Cyanotech can not effectively work towards the common goal.

The Conservation Plan describes the short-term management actions that were implemented during the 1998, 1999, 2000 breeding seasons in an attempt to eliminate incidental take at Cyanotech. Results of the monitoring show that it is not possible to accommodate stilt nesting at Cyanotech under the existing operating conditions without incidentally taking Hawaiian Stilt chicks. Thus, the Conservation Plan identifies minimization and mitigation measures to reduce incidental take of Hawaiian Stilt chicks at Cyanotech and contribute to stilt recovery. The goal of the Conservation Plan over the term of the incidental take permit is to eliminate foraging and breeding by Hawaiian Stilts and incidental take of stilt chicks at Cyanotech through evaluation and implementation of effective bird detracting measures.

2.0 HAWAIIAN STILT - BIOLOGICAL CONSIDERATIONS[1]

2.1 Species Account

The Hawaiian Stilt is in the family Recurvirostridae and part of a cosmopolitan superspecies complex comprised of the Black-necked Stilt (*Himantopus mexicanus*) of North and South America, the Black-winged Stilt (*H. himantopus*) of Eurasia and Africa, and the Pied Stilt (*H. leucocephalus*) and the Black Stilt (*H. novaezelandiae*) from Australasia. The Hawaiian Stilt is allied with the Black-necked Stilt and is considered a distinct subspecies by the American Ornithologists' Union (AOU 1998).

The stilt is a slender wading bird, black above (except from for the forehead), white below, and with distinctive long, pink legs (Exhibit 5). Sexes are distinguished by the color of the back feathers (brownish female, black male) as well as by their voice (females having a lower voice). Downy chicks are well camouflaged, tan with black speckling. Immature stilts have a brownish back and white patches on their cheeks (Pratt et al. 1987) and produce a sharp peeping call.

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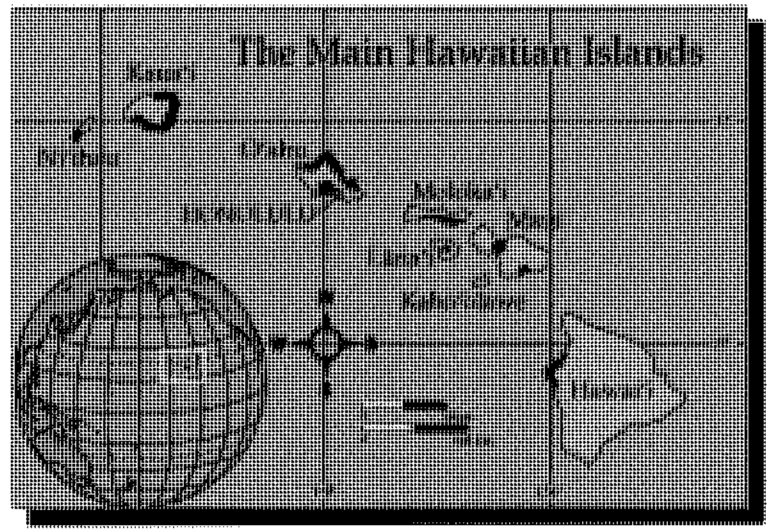
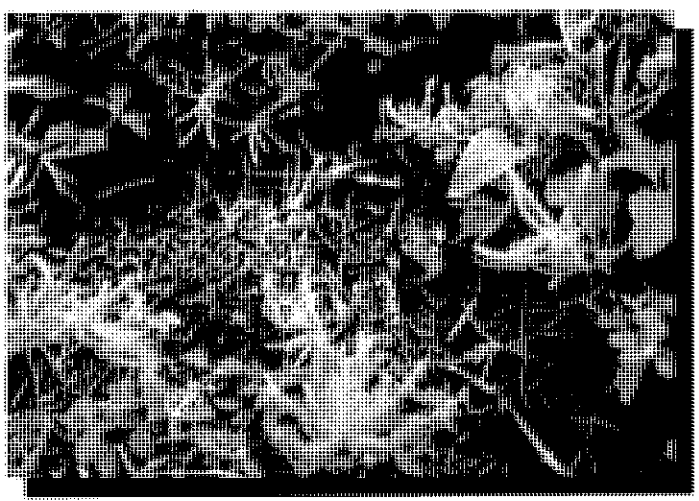
[1]The information in sections 2.1 and 2.2 was taken primarily from the *Recovery Plan for the Hawaiian Waterbirds* (USFWS 1985) and the *Draft Revised Recovery Plan for Hawaiian Waterbirds, Second Revision* (USFWS 1999). Where appropriate, supplemental information has been included based on anecdotal observations by Ducks Unlimited staff.

Exhibit 5. Ae`o or Endangered Hawaiian Stilt
Himantopus mexicanus knudseni

- Population Estimate
  1200 – 1600 (Engilis & Pratt, 1993)
- Habitat fresh, brackish and saltwater mudflats and shallow open water
- Nesting Season – March to August (peak in May)
- Distributed on all main Islands, except Kaho`olawe





The total length of an adult Hawaiian Stilt is about 16 inches. The average weight of an adult is 202.6 g (7.1 oz). The Hawaiian Stilt differs from the Black-necked Stilt by having black extending lower on the forehead as well as around to the sides of the neck and by having a longer bill, tarsus, wing chord, and tail (Coleman 1981).

Stilts use fresh, brackish, and saltwater habitats. Preferred habitats include early successional marshlands interspersed with areas of mudflat or shallow open water; shallowly flooded (< 6 inches), low-growing *Paspalum* or *Batis* flats; and exposed tidal mudflats. Stilts may nest and forage in different wetland sites, and the birds will move between these areas daily.

Feeding habitat consists of shallow water that is fresh, brackish, or saline. Stilts eat a wide variety of aquatic organisms including polychaete worms, crustaceans, aquatic insects, and small fish (Shallenberger 1977). Loafing sites include open mudflats, *Batis* flats, and fresh- or brackish-water ponds.

Stilts nest on mudflats or adjacent to or on low-relief islands within bodies of fresh, brackish, or salt water. Nesting season in Hawaii is March through August with a peak in May and June. Clutch size is 3-4 eggs, and the incubation period is approximately 25 days. The downy, precocial chicks are led by parents to feed in the shallows within 24 hours of hatching. Parental care involves brooding, protection from predators, and selection and aggressive defense of foraging territories. Chicks fledge from four to six weeks of hatching (Coleman 1981, Chang 1990).

2.2 Population Status

Many factors, including indiscriminate hunting, predation by introduced species, and most importantly, the loss of wetland habitat, contributed to the decline of the Hawaiian Stilt. Stilts were historically found on all of the major Hawaiian Islands except Lanai, Kahoolawe, and possibly the Big Island where no sightings of stilts were documented until

1961 (Paton and Scott 1985). Prior to 1961, records of Hawaiian Stilt on the Big Island were limited to three birds collected by S.B. Wilson in the late 1800's and possibly one collected by Collett prior to 1893 (Banko 1979).

Historic population numbers of Hawaiian Stilts are unknown. Munro (1960) suggested that the population had declined to about 200 birds by the early 1940's; however, this may have been an underestimation, since Schwartz and Schwartz (1949) estimated about 1,000 birds in the late 1940's. Population counts from 1960 to 1979 fluctuated from a low of 253 in 1960 to a high of 1,476 in 1977.

Long-term population trends of the Hawaiian Stilt indicate that statewide populations have been relatively stable, or slightly increasing, for the last 20 years (Reed and Oring 1993). Since 1983, statewide surveys have documented 1,000 or more stilts in the islands. Stilts now occur on all of the main Hawaiian Islands except Kahoolawe, but the majority of Hawaiian Stilts are still found on the islands of Oahu, Maui, and Kauai. Engilis and Pratt (1993) estimate the current statewide population to be between 1,200 and 1,600 birds.

Along the Kona Coast of the Big Island, stilt habitat was historically limited to two natural wetlands (Opaeula and Aimakapa ponds) and scattered anchialine pools (Figure 1). The population of Hawaiian Stilts along the Kona Coast remained relatively stable (mean = 24; SD +/- 11 birds) up to about 1996 (Figure 2).

By 1996, a steady increase in the stilt population along the Kona Coast was observed (T. McCafferty pers. comm. 1997), and by 1997, counts as high as 128 stilts had been documented. Because Hawaiian Stilts are capable of interisland movements (Reed et al. 1998b) and are known to quickly colonize newly created wetlands (Pyle 1978, Engilis and Pratt 1993), the 1996-1997 increase is logically correlated to the movement of birds from other islands within the Hawaiian Islands chain to the Big Island in order to take advantage of the new foraging sites following opening of the Kealakehe Wastewater Treatment Plant (WTP) in 1994 and the expansion of operations at Cyanotech from 14 to 67 raceway ponds between 1990 and 1996 (Figure 2). Loss of approximately 200 acres of settling basins on

HAWAIIAN ISLANDS 1:250,000

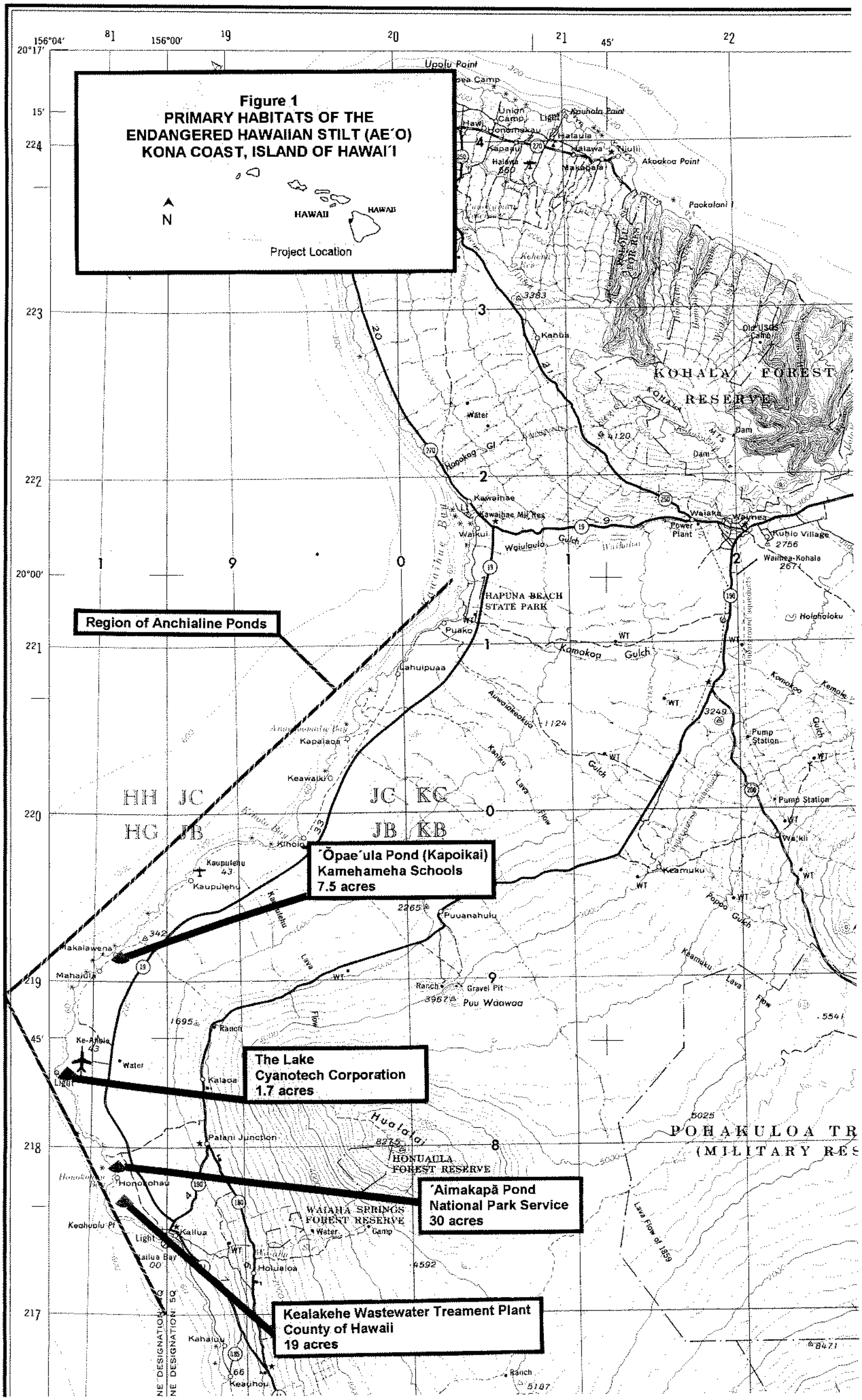
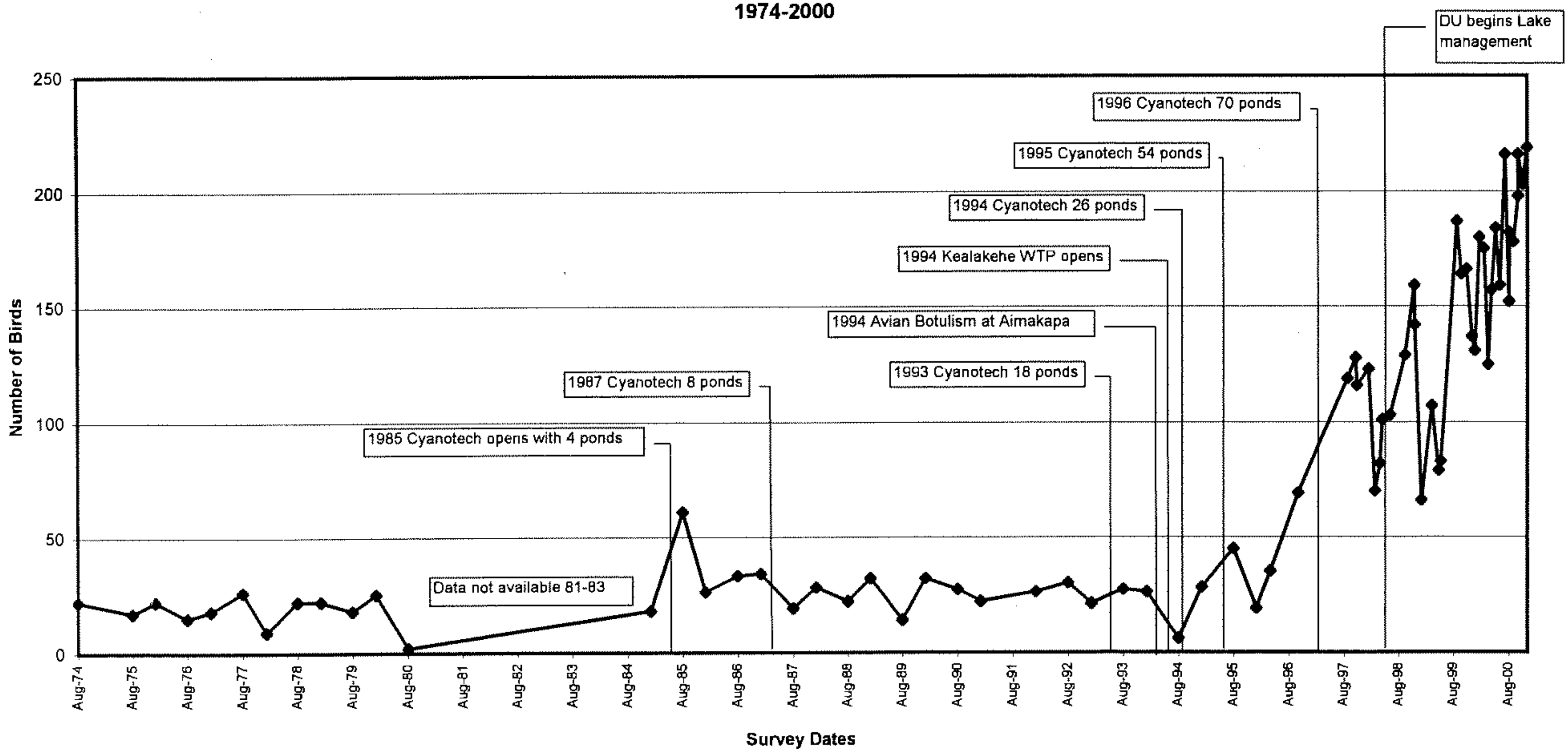


Figure 2: Hawaiian Stilt Population Trend on Kona Coast and Related Events 1974-2000



Waipio Peninsula (closure of Oahu Sugar Company, April 1995) and other declines in agricultural and natural wetlands during that period are believed to have contributed to the influx of Hawaiian Stilts to the Kona Coast.

Observations on the Big Island of banded birds from Maui and Oahu (Reed et al. 1998b; Appendix 2) and similar observations of stilts dispersing to the dry island of Lanai to occupy artificial habitat at the Lanai WTP (Engilis and Pratt 1993) support this theory. It is not suspected that the significant increase in stilt numbers along the Kona Coast could have simply resulted from an increase in stilt reproduction on the Big Island, as no increase in managed (predator-free) or restored habitat coincided with the increase in stilt observations.

For three breeding seasons (1998-2000), predator-free nesting habitat has been managed at Cyanotech in an attempt to prevent Hawaiian Stilts from nesting near raceway ponds where incidental take of stilt chicks is inevitable. During the three breeding seasons 153 stilts were fledged as a result of this management. This increase in birds reflected in the survey data indicates that the number of Hawaiian Stilts along the Kona Coast continues to rise, with a mean of 145 (SD +/- 44) adult and subadult stilts observed during the 1998-2000 survey period (Figure 2).

2.3 Results of Biological Monitoring and Measures to Reduce Take

2.3.1 1998 Breeding Season Monitoring and Pond Management

MANAGEMENT ACTIONS

- Convert a raceway pond into suitable Hawaiian Stilt breeding habitat (DU Pond); manage water levels for optimum stilt breeding conditions;
- Manage water levels in settling basin (Lake) to promote successful stilt reproduction; lure stilts into a protected breeding pond away from hazardous areas;
- Weekly monitoring of stilt breeding activity and incidental take; and
- Monthly census of the Kona Coast stilt population.

Cyanotech Ponds

Prior to the 1998 breeding season, a short-term plan to monitor breeding activity and test measures to reduce take was developed by Ducks Unlimited. The original plan included converting one of the raceway ponds to more suitable stilt nesting habitat. A 0.65-acre raceway pond located in a remote location on the ocean side of the facility was selected for conversion. The raceway pond was taken out of alga production and drained. Crushed lava was used to provide a nesting substrate that would mimic mudflat conditions. The pond was flooded to a shallow depth that left nesting areas exposed. Sludge material was added to the pond intermittently to support establishment of an invertebrate base. Ducks Unlimited was responsible for the design of the pond, and Cyanotech implemented the conversion measures. This converted raceway pond became known at Cyanotech as the "DU Pond" (Exhibit 1 and 6).

A second measure in the short-term plan involved managing water levels to promote stilt nesting at a 1.7-acre basin within the facility. Prior to 1998, the basin was used to contain excess water and sludge material produced during harvest of the microalgae (Exhibit 7). The basin is located immediately adjacent to the parking area and main office building at Cyanotech. Because of its very steep side slopes and the fact that the bottom lies approximately 15 feet below the level of the parking area, this basin can hold large amounts of water. It is therefore known at Cyanotech as the "Lake." Human activity around the Lake during business hours can be considerable; however, the steep side slopes and depth to the Lake bottom decrease the effects of disturbance and add a level of protection important to the site as a stilt nesting area. The Lake had an established invertebrate base and suitable nesting substrate (crushed gravel flats); therefore, no refinements to the design were recommended for the 1998 breeding season.

The third measure implemented included weekly monitoring by Ducks Unlimited biologists of stilt nesting activity and incidental take at and adjacent to Cyanotech. Breeding surveys were conducted throughout the facility at the Lake, DU Pond, raceways, and lava fields. A fourth measure, to gain an understanding of stilt population levels and movement patterns in

Exhibit 6. DU Pond

Exhibit 7. Lake in 1997

relation to Cyanotech, included a monthly census of the primary stilt habitats on the Kona Coast. In addition to the Cyanotech facility, monthly counts were taken at the Kealakehe WTP and when possible at Aimakapa and Opaeula Ponds. At Cyanotech, a mean of 36 (SD = +/- 26) adult stilts were observed in the breeding season, 75 (SD = +/- 39) in the nonbreeding season, with an annual average of 53 (SD = +/- 37) stilts in 1998 (Table 1).

About one week after stilt nesting initiated on the lava fields (see below), Cyanotech employees reported nesting in the Lake. The stilts had located the invertebrate-rich basin and began nesting on the sediments that had accumulated over the years of discharge. In an effort to lure the lava field nesters away from the airport, Cyanotech agreed to manage water levels in the Lake to provide optimum stilt foraging and nesting habitat. Water levels were managed to mimic the early successional marsh conditions preferred by stilts (open mudflats with sparse vegetation, and water depths at 2-6 inches). This measure provided an additional 2 acres (including steep banks) of protected, predator-free stilt nesting habitat at the Cyanotech facility.

Nine successful nests that produced 30 stilt fledglings were documented within the Lake during the peak of the 1998 breeding season. One additional nest found late in the breeding season produced three fledged birds. One nest was also found late in the breeding season at the DU Pond. Four chicks hatched from this nest and remained at the DU Pond until fledging. Five nests were observed on crushed lava between the raceways. All five of these clutches failed (did not hatch, hatched and chicks disappeared, or eggs suspected scavenged).

One additional nest located between raceway ponds hatched four chicks. One of these chicks was found dead near the nest. The nest was constructed on the lip of a steep berm, and it appeared that the chick may have rolled out of the nest and died. The adults tried unsuccessfully to move the remaining three chicks to a raceway pond across from the DU Pond. Cyanotech staff rescued the chicks from the active raceway and moved them the short distance to the DU pond. At the time of the move, no other breeding birds occupied the DU Pond; thus, moving the chicks to the pond did not interfere with other established

Table 1: Hawaiian Stilt Breeding Summary at Cyanotech 1998-2001

	1998	1999	2000	2001
Average monthly count of adult stilts (Cyanotech and Kealakehe Wastewater Treatment Plant)	108	132	182	220
Average monthly count of adult stilts (Cyanotech only)	53	56	84	99
Nesting Pairs @ Cyanotech (Est.)[a]	20	34	61	43
Eggs Salvaged[b]	10	23	0	0
Incidental Take of Chicks	1	29	10	14

1998	LAKE	DU POND	RACEWAYS	LAVA
No. of Nesting Pairs per Site (Est.)[c]	10	1	6	9
No. of Nests	10	1	6	9
No. of Successful Nests (known)	10	1	2	1
Nest Success	100.0%	100.0%	33.3%	11.1%
No. of Eggs[c]	39	4	23 (est.)	33 (est.)
No. of Hatchlings (known)	35	4	8	2
Fledglings Produced	**33**	**5**[d]	**0**	**0**
Hatching Success	89.7%	100.0%	34.7%	6.0%
Fledging Success	**94.3%**	**100.0%**	**0.0%**	**0.0%**
1999	**LAKE**	**DU POND**	**RACEWAYS**	**LAVA**
No. of Nesting Pairs per Site (Est.)[c]	25	5	9	2
No. of Nests	29	5	9[e]	3
No. of Successful Nests (known)	26	4	4	0
Nest Success	89.7%	80.0%	44.4% (est.)	0.0% (est.)
No. of Eggs (Est.)[c]	109	20	30	9
No. of Hatchlings (known)	80	11	12	0
Fledglings Produced	**31**	**0**	**0**	**0**
Hatching Success	73.4%	55.0%	40.0%	0.0%
Fledging Success	**38.8%**	**0.0%**	**0.0%**	**0.0%**
2000	**LAKE**	**DU POND**[f]	**RACEWAYS**	**LAVA**
No. of Nesting Pairs per Site (Est.)[c]	40	6	21	8
No. of Nests	48	8	26	8
No. of Successful Nests (known)	36	4	5	3
Nest Success	75.0%	50.0%	19.2% (est.)	37.5% (est.)
No. of Eggs (Est.)[c]	167	24	92	28
No. of Hatchlings (known)	100	9	14	4
Fledglings Produced	**84**	**0**	**0**	**0**
Hatching Success	59.9%	37.5%	15.2%	14.3%
Fledging Success	**84.0%**	**0.0%**	**0.0%**	**0.0%**
2001	**LAKE**	**DU POND**[g]	**RACEWAYS**	**LAVA**
No. of Nesting Pairs per Site (Est.)[c]	26	0	14	3
No. of Nests	26	0	14	3
No. of Successful Nests	24	0	7	1
Nest Success	92.3%	0.0%	50.0%	33.3%
No. of Eggs (Est.)[c]	81	0	47	11
No. of Hatchlings (known)	65	0	20	1
Fledglings Produced	**41**	**0**	**0**	**0**
Hatching Success	80.2%	0.0%	42.6%	9.1%
Fledging Success	**63.1%**	**0.0%**	**0.0%**	**0.0%**

[ac]Est. no. of nesting pairs at Cyanotech not equal to total est. no. of nesting pairs/site due to intersite movement and renes

[b]Egg salvage discontinued

[c]Includes hatched, infertile, flooded, predated, and abandoned eggs.

[d]Includes 1 fledgling from raceway-hatched brood (see Sec. 2.3.1)

[e]6 of 15 nests were collected by FWS, numbers reflect the 9 uncollected nests.

[f]DU pond was drained and in the process of being returned to production. 8 nests were laid on dry substrate.

[g]DU Pond used as a test site for Mylar. No nests were laid on dry substrate

Successful Nest = at least 1 egg hatched

Nest Success = #successful nests / #nests

Hatching success = #hatchlings / #eggs

Fledging success = #fledglings / #hatchlings stilt territories. Due to the short distance (~ 30 feet), the adults followed and were able to locate the chicks. Once in the DU Pond, the adults did not attempt to move the chicks again; however, only one fledged bird was documented from this clutch.

Total Hawaiian Stilts fledged at Cyanotech ponds during the 1998 breeding season was 38 birds. Thirty-three stilts fledged from the 10 nests in the Lake; 5 fledged from 1 nest and 1 brood placed in the DU Pond; and no birds fledged from the 6 nests in the raceways. Ten out of 10 nests in the Lake successfully hatched and fledged at least 1 bird (Table 1). Twenty-five chicks were banded in the Lake, and re-sighting data at Cyanotech and the Kealakehe WTP have been recorded monthly (Appendix 2).

Lava Fields and Kona International Airport

In 1998, the Hawaiian Stilt breeding season initiated with nine Hawaiian Stilt nests located approximately one quarter of a mile east of the Cyanotech raceway ponds out on the barren lava fields (Exhibit 8). The lava-field nesting sites appear to have been established as early as 1997 based on old nests that were located during the 1998 breeding season. By counting back 25 days (mean incubation period) from the first hatching date, it was determined that the first eggs were laid on the lava fields about one week prior to those in the Lake. The lava nests were monitored and eggs and hatchlings were all predated [presumably by mongooses (*Herpestes auropunctatus*)]. Most of these nests were predated during one incident close to their hatching date. Approximately 2 months following this incident, 4 active nests (with 12 eggs and 2 chicks total) and 1 inactive (no eggs) nest were documented even further away in a northeast direction from the raceway ponds at the edge of the Kona International Airport runway. It is believed that these four nests represented the second nesting attempt by some of the original "lava-nesting" birds (Figure 3).

After 3 adult stilts were found dead on the runway, the Fish and Wildlife Service salvaged 10 eggs and destroyed the 4 nests in an effort to force abandonment of the airport-nesting site. All 10 eggs were checked for fertility (all fertile) and then destroyed. The adult stilts abandoned the airport-nesting site. Following this incident, 4 late nests were documented at

Exhibit 8. Lava Fields and Hawaiian Stilt Nest on Lava Fields

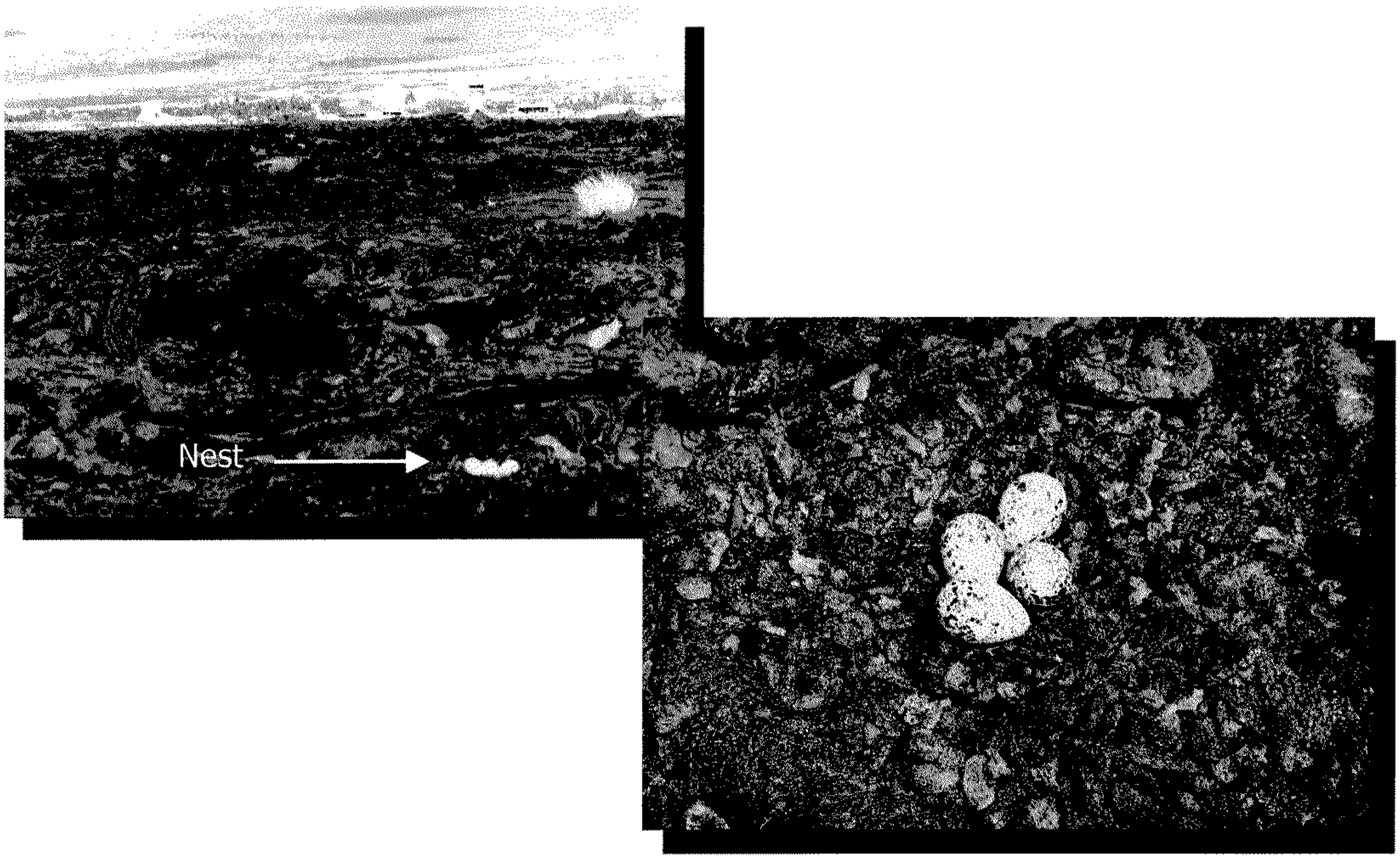
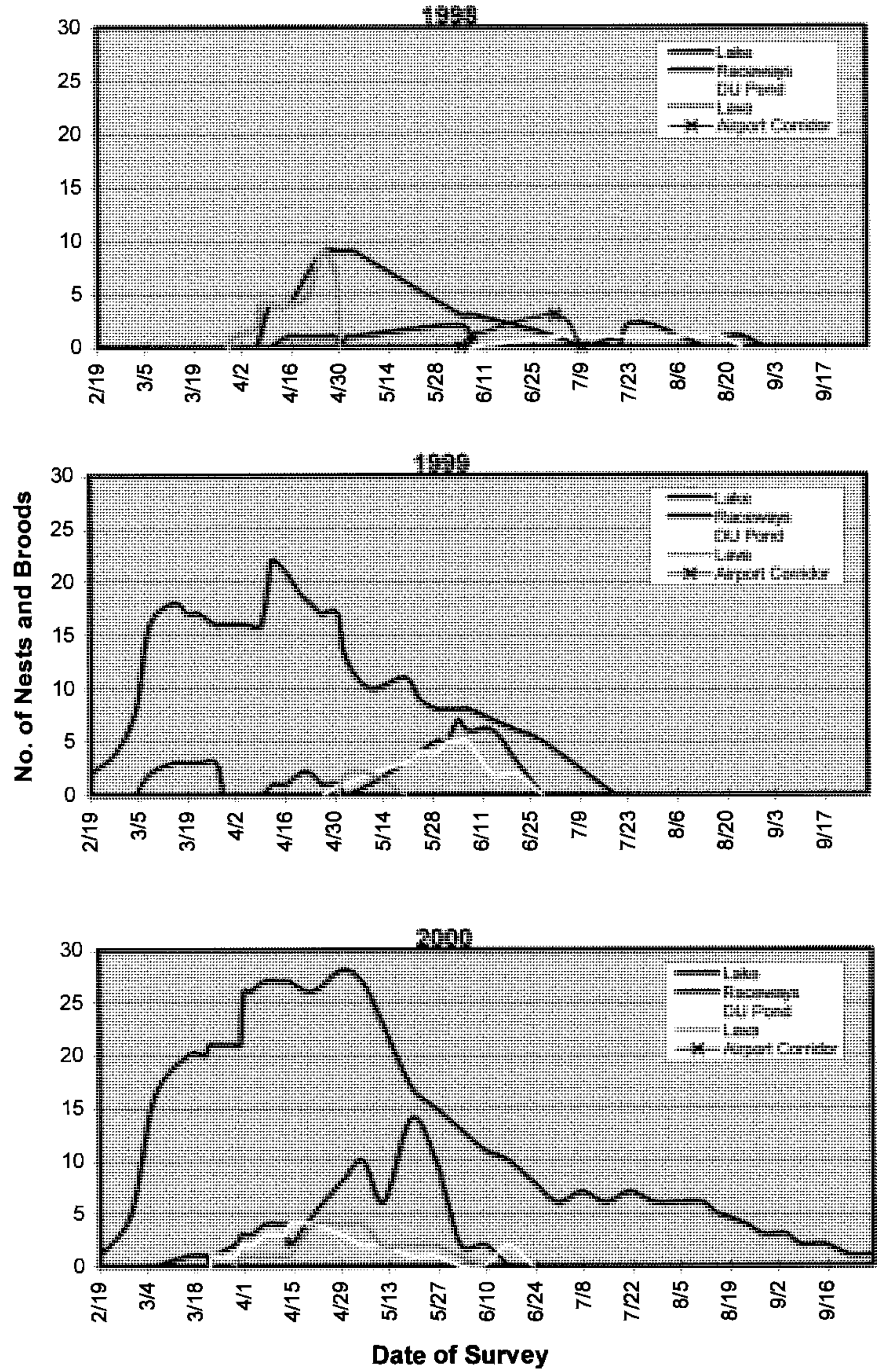


Figure 3: Chronology of Breeding Activity at Cyanotech Breakdown by Site, 1998-2000



Assumptions:
a) clutch laid 25 days before first hatchling
b) chicks fledged after 6 weeks

Cyanotech; a 10th nest at the Lake, a nest within the DU Pond, and 2 nests adjacent to the raceways. These nests may have represented the third nesting attempt by some of the "lava" nesting birds. No stilts fledged from the nine lava field nests (Table 1) or the four nests found adjacent to the airport runway.

2.3.2 1999 Breeding Season Monitoring and Pond Management

MANAGEMENT ACTIONS

- Increase size of nesting mudflats in Lake habitat to accommodate more Hawaiian Stilt breeding pairs;
- Manage water levels in Lake to promote successful stilt reproduction; lure stilts into a protected breeding pond away from hazardous areas;
- Enhance invertebrate food resources in DU Pond to support chicks to fledgling stage;
- Manage water levels in DU Pond for optimum stilt breeding conditions;
- Weekly monitoring of stilt breeding activity and incidental take; and
- Monthly census of Kona Coast stilt population.

The management strategy undertaken during the 1999 breeding season was altered following assessment of the 1998 breeding season results. Since so few nests were constructed in the raceway ponds during 1998, direct harm to stilt chicks was significantly minimized by providing adult stilts more suitable nesting habitat at the Lake and the DU Pond. Nevertheless, indirect effects were not significantly reduced in 1998 as stilts attracted to Cyanotech also attempted to nest in the adjacent lava fields and adjacent to an active airport runway. In an attempt to reduce these indirect effects to stilts and to address the concerns of Natural Energy Laboratory of Hawaii Authority and the DOT for a potential wildlife hazard, a management strategy was designed for 1999 that would attempt to accommodate more nesting pairs within the leased areas of Cyanotech at the Lake and the DU Pond.

Cyanotech Ponds

During 1999, the existing stilt nesting habitat was enhanced in the Lake by enlarging the existing gravel flats from two to three areas, thus increasing the amount of high-ground habitat available for nest building (Exhibit 9). At the DU Pond, the primary factors limiting successful stilt reproduction were determined to be pond size and an inadequate food base to carry chicks to fledging stage. The DU Pond was therefore enhanced by supplementing the pond with excess sludge material and water from the microalgae farming operation in order to promote further establishment of a self-sustaining invertebrate base within the pond. Cyanotech managed the water levels in the Lake and the DU Pond to provide optimum stilt nesting habitat in accordance with recommendations from Ducks Unlimited biologists knowledgeable of the habitat conditions required for maximum stilt production. The Lake and the DU Pond were managed until all stilt chicks in both ponds had fledged.

Total Hawaiian Stilts fledged at Cyanotech ponds during the 1999 breeding season was 31 birds. Thirty-one stilts fledged from the 29 nests in the Lake; no birds fledged from the 5 nests in the DU pond; and no birds fledged from the 15 nests adjacent to the raceway ponds. Twenty-six of the nests in the Lake successfully hatched at least one egg. However, only 14 of the 26 nests successfully fledged at least 1 chick. While 80 chicks hatched, only 38.8% fledged from the nests in the Lake during the 1999 breeding season (Table 1).

The primary factor influencing the low fledging ratio at the Lake during the 1999 breeding season was crowding of the nesting habitat that resulted in an inadequate territory size to support the number of chicks hatched in the colony. Adult stilts moved or attempted to move chicks out of the Lake to foraging habitats within raceway ponds. Chicks that were moved from the Lake to the raceway ponds subsequently died. The chicks are believed to have drowned or succumbed to the saline, high-alkaline conditions of the raceway ponds. Within the Lake and the DU Pond, adult stilts were observed violently attacking chicks that wandered into adjacent territories. Under the very crowded conditions at the Lake during the 1999 breeding season, adverse effects of biological survey work were also documented, as movement of chicks out of the Lake on two occasions followed nest and egg counts and

Exhibit 9. Lake in 1999

banding activities (These activities were halted following the second incident). Twenty chicks were banded during the 1999 breeding season, but only nine of these chicks survived. Re-sighting data for the nine fledglings banded during the 1999 breeding season have been recorded monthly at Cyanotech and the Kealakehe WTP (Appendix 2). At Cyanotech, a mean of 77 (SD = +/- 14) adult stilts were observed in the breeding season, 44 (SD = +/- 48) in the nonbreeding season, with an annual average of 56 (SD = +/- 41) stilts in 1999 (Table 1).

Four of the five nests in the DU Pond successfully hatched at least one egg, but no fledglings were successfully reared at the DU Pond during the 1999 season (Table 1). The primary cause suspected in the loss of the hatched chicks was, again, lack of adequate food resources, because an invertebrate base still had not established within the pond.

Lava Fields and Kona International Airport

As in the previous year, the lava fields between Cyanotech and the airport were monitored for stilt breeding activity. Three lava field nests were documented late in the season at the 1998 colony site, ten weeks after nesting initiated in the Lake. During the 1999 breeding season, no birds fledged from the three lava field nests (Table 1) and no stilts nested adjacent to the airport runways.

2.3.3 2000 Breeding Season Monitoring and Pond Management

MANAGEMENT ACTIONS

- Modify Lake nesting mudflats to accommodate more Hawaiian stilt breeding pairs;
- Manage water levels in Lake to promote successful stilt reproduction; lure stilts into a protected breeding pond away from hazardous areas;
- Discontinue banding and monitoring activities inside the Lake to minimize disturbance to stilt colony; conduct monitoring from outside Lake boundary with a spotting scope
- Discontinue management of DU Pond habitat; return to microalgae production pond;

- Reduce or eliminate gravel berms along edge of raceways to make these nesting sites less desirable;
- Raise the level of human activity in raceway areas to discourage nesting (driving coverage of facility roads);
- Weekly monitoring of stilt breeding activity and incidental take; and
- Monthly census of Kona Coast stilt population.

<u>Cyanotech Ponds</u>

Building on what was learned during the prior two breeding seasons, the management strategy at Cyanotech was again refined. The nesting habitat within the Lake was modified to reduce the effects of crowding and the likelihood that adult stilts would move chicks from the protected Lake habitat to raceway foraging sites. The perimeter berm around each of the two largest nesting islands was removed, the islands were flattened, and one of these islands was divided by cutting a channel through its middle. The berms were pushed down and spread out into the open water areas at irregular intervals. These changes substantially increased the available habitat for nest sites, the amount of foraging edge around the nesting islands, and the number of active territories that could be supported within the Lake for rearing of newly hatched chicks (Exhibit 10). It was determined that the nesting habitat within the Lake was too small to allow for nest searches. Thus, monitoring and data collection were limited to those observations that could be made with a spotting scope.

It was determined that success at the DU Pond was not sufficient to warrant further management. This decision was based on 1) unsuccessful attempts to establish a natural, self-sustaining, invertebrate base within the pond, 2) the location of the pond adjacent to production raceways that could present themselves as an attractive but hazardous foraging site for chicks hatched at the invertebrate-poor DU Pond, 3) the high potential for predation of nests, and 4) the fact that attempts to establish high invertebrate populations at the DU Pond was contrary to efforts at adjacent raceways to reduce invertebrate populations in order to maintain the purity of the alga medium. To force abandonment of the pond as a breeding site for stilts, the DU Pond was drained.

Exhibit 10. Lake 2000 Improvements

A final management action implemented by Cyanotech during the 2000 breeding season was to reduce the area adjacent to raceway ponds where stilts are capable of constructing nests. This measure was accomplished near specific raceways where high nest site fidelity was suggested by monitoring during prior breeding seasons. During the 2000 breeding season, the outer slopes of portions of 23 raceways (~ 9000 feet) were steepened, and the level surface lip of these raceways was reduced or eliminated (Exhibit 11). Additionally, to discourage stilt nesting in raceways and to encourage nesting in the Lake, Cyanotech staff increased the level of human activity by driving on all raceway roads several times per day. This action was based on 1998 and 1999 observations indicating that nesting birds preferred areas of the facility with less human activity.

As in prior years, Cyanotech managed the water levels within the Lake to provide optimum stilt nesting habitat in accordance with recommendations from Ducks Unlimited biologists. The Lake was managed until all stilt chicks within the protected Lake habitat fledged.

The number of Hawaiian Stilts fledged at Cyanotech ponds during the 2000 breeding season was 84 birds. Eighty-four stilts fledged from the 48 nests in the Lake; no birds fledged from the 8 nests in the dry DU Pond; and no birds fledged from the 26 nests adjacent to the raceway ponds. Thirty-six of the nests in the Lake successfully hatched at least 1 egg, and 30 of these nests successfully fledged at least one chick (Table 1). No chicks were banded during the 2000 breeding season. Re-sighting data for the birds banded at Cyanotech and other wetlands have been recorded monthly at Cyanotech and the Kealakehe WTP (Appendix 2). At Cyanotech a mean of 100 (SD = +/- 40) adult stilts were observed in the breeding season, 88 (SD = +/- 46) in the nonbreeding season, with an annual average of 84 (SD = +/- 41) stilts at Cyanotech in 2000 (Table 1).

In 2000, the effects of crowding at the Lake resulted in strong territorial behavior, increased nesting along the bank edges, and a lower nest success (75%) and hatching success (59.9%) than documented in previous years. Contributing to these lower ratios was the rapid encroachment by swollen fingergrass (*Chloris barbata*) and makai (*Bolboschoenus maritimus*) on the nesting islands. The swollen fingergrass dominated the nesting flats

Exhibit 11. Raceway Berm Before and After Modifications

while makai spread in the foraging shallows. The accelerated growth rate was influenced by the import of nutrient-enhanced water, development of a seed bank over the last three years, and a decrease in the elevation of the isle flats. By mid-season (May), the islands contained nearly 50% cover and towards the end (August) 75-85% cover. Although fewer breeding pairs occupied the Lake during the latter half of the season, intense competition was observed over the few nesting sites available. Thus, the decrease in nest and hatching success can be attributed to the abandonment from crowding of four nests and the inadvertent flooding of three nests between May 26 and July 7 (Table 1).

Four of the eight nests in the dry DU Pond (which was in the process of being returned to an active raceway) successfully hatched at least one chick, but no fledglings were successfully reared. Predation is suspected as the cause of at least some of the nest failures because eggs from three nests disappeared prior to their anticipated hatch date. The fate of the final nest is not known.

Lava Fields and Kona International Airport

As in previous years, the lava fields were monitored for stilt breeding activity. Eight nests were documented on the lava fields six weeks after nesting initiated at the Lake. During the 2000 breeding season, no birds fledged from the eight lava field nests (Table 1) and no stilts nested adjacent to the airport runways.

2.4 Incidental Take During the 1998, 1999, and 2000 Breeding Seasons

2.4.1 Incidental Take (1998)

During the 1998 breeding season, it is suspected that a few of the nests constructed between the raceway ponds may have failed due to abandonment caused by the human activity associated with normal operations at the aquaculture facility. Predation is suspected in the loss of at least one raceway nest, and as stated above, one newly hatched chick from a raceway nest was suspected to have rolled out of its nest and died (Table 1). There was no additional documentation of incidental take of Hawaiian Stilt chicks in the raceway ponds (no chick carcasses retrieved from raceway ponds) during the 1998 breeding season.

2.4.2 Incidental Take (1999)

Microalgae production decreased at Cyanotech during the 1999 breeding season, and as a result, there was a marked decrease in the human activity around the raceways. At the same time, there was an increase in the number of adult birds attempting to nest at Cyanotech both in protected (Lake, DU Pond) and hazardous areas (raceways). It is suspected that the effects of crowding in the Lake and the reduced human activity around the raceways resulted in the raceways providing an attractive site for adults to move chicks in their attempt to locate and established suitable foraging territories for newly hatched chicks.

Early in the 1999 breeding season, movement of chicks out of the Lake followed nest searches and banding activities. Thus, it is likely that these activities contributed to at least some of the brood relocations at Cyanotech during the 1999 breeding season. Since the adults continued to move chicks out of the Lake into the raceways once nest search and banding activities were discontinued, crowding of the Lake habitat is still suspected as another factor contributing to the brood relocations and the ultimate incidental take of some of the chicks that are believed to have drowned in the raceway ponds during the 1999 breeding season.

During the 1999 breeding season, 15 nests with 53 eggs were documented adjacent to the raceways. Twenty-nine carcasses (28 chicks and 1 fledgling) were retrieved from raceway ponds (Table 1).

2.4.3 Incidental Take (2000)

By the 2000 breeding season, microalgae production at Cyanotech was back to normal operating levels, which increased human activity around the raceway ponds to 1998 conditions. The modifications made to the islands within the Lake were successful in increasing available nest sites and foraging habitat. Limiting the monitoring and data collection to observations made with a spotting scope was also successful in reducing disturbance within the nesting colony. No movement of newly hatched chicks out of the Lake into raceway ponds was documented, and no incidental take of chicks was related to crowding of the Lake habitat or human disturbance within the nesting colony.

Twenty-six nests with 92 eggs were found adjacent to raceway ponds. Another 8 nests at the dry DU Pond produced 24 eggs. A significant increase in predation accounted for loss of a majority of these eggs, as only 14 hatchlings were ever observed from the raceway nests and only 9 hatchlings were observed at the DU Pond. Ten chick carcasses including two hatchlings from the DU Pond were retrieved dead from raceway ponds during the 2000 breeding season (Table 1).

2.5 Summary Assessment of Breeding Activity, Pond Management, and Incidental Take

The management actions implemented by Cyanotech from 1998, 1999, and 2000 are summarized in Table 2.

Table 2: Summary of Management Actions Implemented by Cyanotech 1998 to 2000

No.	Management Actions	Exhibit	1998	1999	2000
1	Convert a raceway pond into suitable stilt breeding habitat (DU Pond)	6	✓		
2	Manage water levels in DU Pond for optimum stilt breeding conditions	6	✓	✓	
3	Manage water levels in Lake to promote successful stilt reproduction; lure stilts into a protected breeding pond away from hazardous areas	7	✓	✓	✓
4	Weekly monitoring of stilt breeding activity and incidental take	-	✓	✓	✓
5	Monthly census of the Kona Coast stilt population	-	✓	✓	✓
6	Increase the size of the mudflats in Lake habitat to accommodate more stilt breeding pairs	9		✓	
7	Enhance invertebrate food resources in DU Pond to support stilt chicks to fledgling stage	-		✓	
8	Modify the nesting mudflats in the Lake habitat to accommodate more stilt breeding pairs	10			✓
9	Discontinue banding and monitoring activities inside the Lake to minimize disturbance to the stilt colony; conduct monitoring from outside Lake boundary with a spotting scope	-			✓
10	Discontinue management of DU Pond habitat; return pond to microalgae production	-			✓
11	Reduce or eliminate gravel berms along edge of raceways to make these nesting sites less desirable	11			✓
12	Raise the level of human activity in raceway areas to discourage nesting (driving coverage of facility roads)	-			✓

During 1998, it is estimated that about 20 pairs of stilts attempted to breed within and adjacent to Cyanotech. Nesting was documented on the lava fields, Lake, and raceways during the first two weeks of April. Nesting activity was erratic in various sites on and adjacent to the facility through August. During 1998, intense management and monitoring of the Lake to produce optimum stilt nesting habitat was successful in attracting at least half (9-10 pairs) of the stilt breeding population into this protected nesting area (Figure

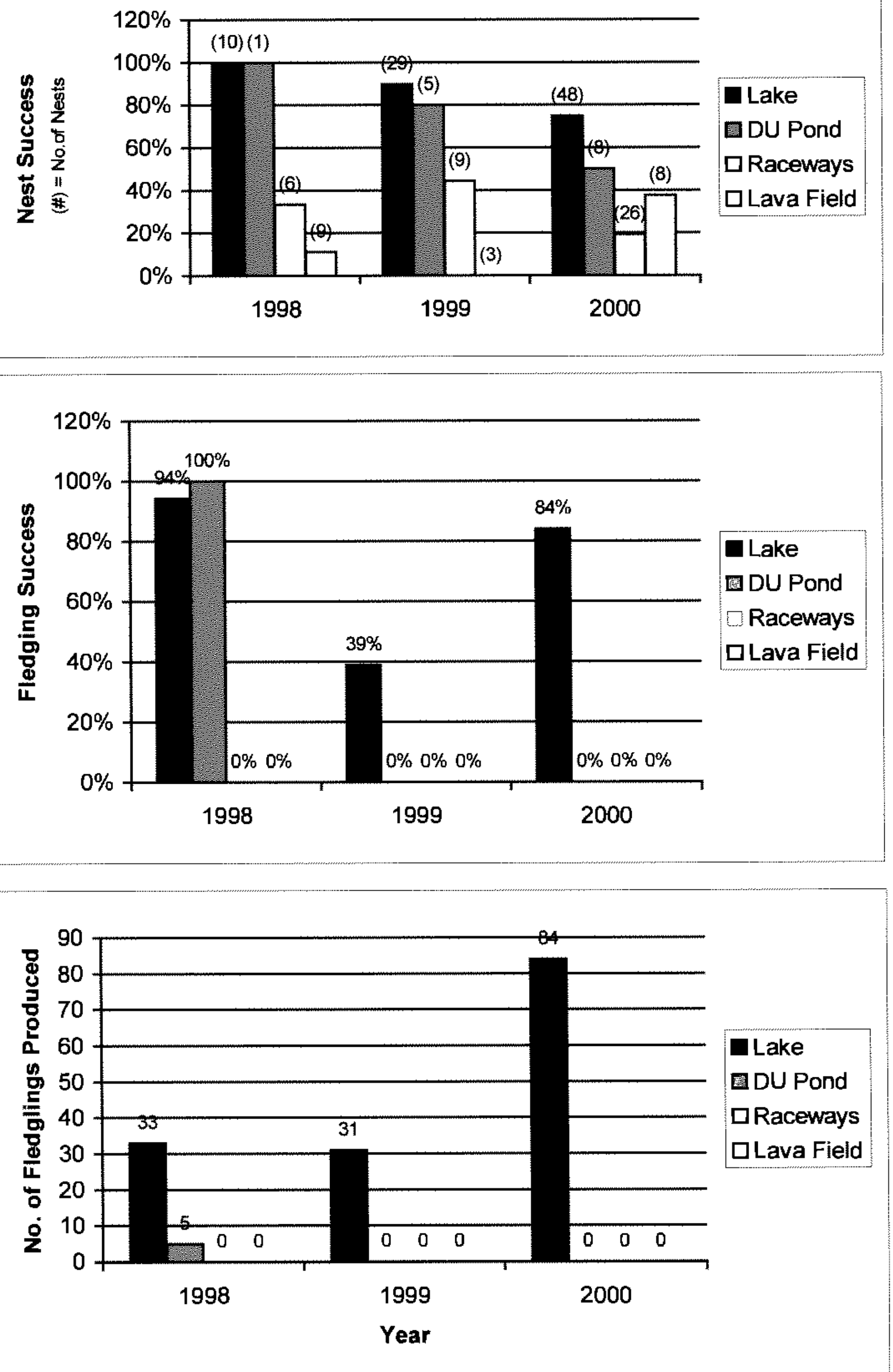
3). Neither crowding nor predation was a factor in management of the Lake, as 100% nest success was achieved, and both hatching (89.7%) and fledging success (94.3%) were very high. The Lake successfully fledged 33 Hawaiian Stilts. Banding activities and nest searches within the colony did not result in any chicks being moved out of the protected Lake habitat.

In its early stages, the DU Pond was considered a success because the pond attracted a nesting pair in its first year. The limited invertebrate base was not perceived as a problem because it was adequate to support the five fledglings produced. With one successful nest in its first year, the DU Pond had a fledgling success rate of 100%. Although a limited amount of nest success was documented in the raceways (33.3%) and lava fields (11.1%), fledging success was zero. The raceway nests and lava nests produced no fledglings (Figure 4). Predation was a significant factor out on the lava, but only limited predation was suspected in the raceways. Incidental take of only one chick was documented.

In 1999, there was an increase in the number of Hawaiian Stilt nesting pairs at Cyanotech, and it is estimated that about 34 pairs of stilts attempted to nest within and adjacent to the site. Egg laying initiated in the Lake in mid-February and in the raceways in early March. Nesting on the lava fields was recorded ten weeks after Lake nesting began, and ceased three weeks later after nests were predated. Intense management of the Lake and DU Pond to produce optimum nesting habitat proved successful in attracting the majority of the stilt breeding population (25 pairs in the Lake, 5 pairs in the DU Pond) to these breeding sites. Breeding was completed in the DU Pond and raceways by the end of June, and the Lake mid-July (Figure 3).

During the peak of breeding activity mid-April, crowding of the protected breeding sites resulted. Overall nest success was reduced to 89.7%, and hatching success reduced to 73.4%. The most dramatic effects resulting from the crowding were the reduced fledging success (38.8%) at the Lake and increased incidental take (28 chicks and 1 fledgling) in the raceways. With the high number of nests crowded into a very small nesting site (< 2

Figure 4: Hawaiian Stilt Reproductive Success at Cyanotech Breakdown by Site 1998-2000



Nest Success = No. of nests that hatched at least one chick / No. of nests

Fledging success = No. of fledglings / No. of hatchlings acres), the birds were much more affected by human disturbance, and banding activities had to be discontinued.

By the end of the 1999 breeding season, it was apparent that there was a significant problem in establishing a natural, self-sustaining invertebrate population at the DU Pond. Although there was an increase in the number of nests and hatchlings produced, the invertebrate base was not adequate to support the hatchlings to fledging stage. Nest success was 80% and hatching success was 55%. However, without an adequate food base, the location of the DU Pond was also a source of concern, as the pond was adjacent to invertebrate-rich (but hazardous) raceways. Fledging success at the DU Pond was reduced to 0% (Figure 4).

Once again in 1999, neither the raceways nor the lava nests produced any fledglings. Although four of nine raceway nests hatched at least one chick (44.4%), fledging success at the raceways and lava fields was zero. Predation of raceway nests again increased, but not significantly from 1998. No nests were documented near the Kona International Airport runway.

During the 2000 breeding season, the estimated number of Hawaiian Stilts nesting in and adjacent to Cyanotech increased to 61 pairs. Reconfiguration of the Lake nesting flats and intense management of water levels proved successful at attracting the majority of the stilt breeding population (40 pairs) to the Lake. Nesting began in the Lake in mid-February, followed by nesting in the raceways in mid-March and lava fields in late March, after the Lake had reached its carrying capacity. Nesting ceased in the raceways after approximately three months, and the in lava fields after two months of nest and brood failure. Successful reproduction continued in the Lake through September (Figure 3).

Crowding of the Lake continued to limit nest success (75%) and hatching success (59.9%), as the carrying capacity of the 1.7-acre Lake with its current configuration and habitat management strategy is estimated to be 20-25 pairs. Rapid encroachment by grasses and sedges contributed to a reduction in the amount of nesting mudflats available during the latter half of the breeding season. Nevertheless, with the changes in the management strategy, fledging success was increased to 84%, and the number of Hawaiian Stilt fledglings recruited into the population was 84.

During the 2000 breeding season, predation of nests within the raceways increased significantly, and nest site fidelity was in evidence at the DU Pond, the raceways, and the lava flats. It was determined that success at the DU Pond was not sufficient to warrant further management. The DU Pond was drained and in the process of being returned to an active raceway; however, during the conversion eight clutches were laid in the dry DU Pond with a nest success of 50% and fledgling success at zero. Some degree of nest success was found in the raceways (19.2%) and lava fields (37.5%); however, fledging success was again 0%. The raceway nests and lava nests produced no fledglings.

Even though limited nest success is apparent in the raceways and lava fields, based on observations, hatchlings survive no more than 3-4 days in these areas. During all three breeding seasons (1998-2000), fledging success in the raceways and lava fields has been recorded at zero. In contrast, the management strategy applied to the Lake between 1998 and 2000 has been successful at luring an estimated 50–74% (Table 1 and Figure 3) of the breeding pairs at Cyanotech into the protected environment and mitigating for any reproductive loss by the stilts nesting in the production areas of the facility. The Lake has experienced a very high nest success, fledging success, and number of fledglings produced in comparison to other wetlands on and off site (Figure 4 and Table 3). Incidental take documented in the raceways was down to 10 chicks in 2000.

During the 1998 breeding season, the Kona Airport reported three adult stilts found dead on the runway and four active nests adjacent to the runway. During the 1999 and 2000 breeding seasons, there were no reports of stilt bird-strikes or stilts nesting adjacent to the Kona Airport runway.

During 2000, two management actions implemented in the raceways, 1) steepening the berms and 2) increasing road activity, were evaluated in reducing nest site fidelity. Only one nest was documented in an area receiving both treatments. Most (25) nests were

Table 3: Hawaiian Stilt Reproductive Success at Various Managed Wetlands

	Aimakapa Pond, Hawaii	Cyanotech Lake, Hawaii[a]	Chevron Oil Refinery, Oahu[a]	Honouliuli Unit, JCNWR, Oahu	Kii Unit, JCNWR, Oahu	Kii Unit, JCNWR, Oahu	Kealia Pond NWR, Maui	Nuupia Ponds, Oahu	Waiawa Unit, JCNWR, Oahu
Time Period	1993-1994 (2 years)	1998-2001 (4 years)	1992-98, 00, 01 (9 years)	1978-1980 (3 years)	1978-1980 (3 years)	1985-1988 (4 years)	1995-2000 (6 years)	1979-1980 (2 years)	1978-1980 (3 years)
No. of nests	34	113	179	66	164	243	307	73	74
No. of successful nests	17	96	no data	no data	no data	137	170	no data	no data
% nest success	50.0%	89.3%	55%[d]	no data	no data	56.4%	54.5%	no data	no data
% hatching success	no data	75.8%	71.4%	53.3%	50.0%	54.0%	no data	40.0%	70.0%
% fledging success	no data	70.0%	68.9%	12.0%	20.6%	24.3%[b]	no data	22.0%	22.5%
No. of fledglings	40	189	291	17	64	9[b]	no data	34	45
Mean fledglings/nest	1.1	1.7	1.64	0.28	0.39	no data	no data	0.52	0.59
Mean fledglings/year	20	47.3	32.3	5.7	21.3	9[b]	no data	17	15
% egg viability[c]	no data	86.1%	no data	no data	no data	no data	no data	no data	no data
Sources	Morin 1998	DU unpubl.	USFWS unpubl.	Coleman 1981	Coleman 1981	Chang 1990	Nishimoto unpl.	Coleman 1981	Coleman 1981

[a]Manmade wetlands intensively managed for Hawaiian stilt reproduction. All other sites are wetland bird sanctuaries managed for multiple species and uses by the National Park Service, U.S. Fish and Wildlife Service, or Marine Corps Base Hawaii.

[b]1988 data only

[c]Cyanotech Lake 1998-2001 and DU Pond 1998-1999 (when managed)

[d]2001 data only

Note: Data summarized from published sources and USFWS and DU files. We believe that reproductive success has increased in recent years at bird sanctuaries Requests have been placed for more recent data and we anticipate filling in the gaps.

Definitions:

successful nest = hatched at least 1 chick

% nest success = # nests that hatched at least 1 chick / total # of nests

% hatching success = # chicks hatched / # of eggs

% fledging success = # of fledglings / # of chicks hatched

% egg viability = # hatchlings / # of eggs incubated to full term documented in untreated areas where only one of the treatments was applied. Nine of these nests were found along raceways with inaccessible roads. The birds moved to raceways with less traffic and/or untreated berms or to the adjacent lava fields. Eight nests were documented in the lava fields between Cyanotech and the airport. One banded bird that has nested unsuccessfully in the same raceway area for two consecutive years (1998 and 1999) was documented in the lava flats in 2000 after that raceway berm was treated. This confirms our earlier assumptions following the 1998 breeding season that a portion of the disturbed raceway-nesters will move towards the airport if other suitable areas are not available.

Due to the limited acreage available at Cyanotech that can be set aside, protected, and managed to produce an optimum-nesting habitat, it is apparent that the number of stilt pairs in the breeding population exceeds the available habitat. Therefore, while the majority of the Cyanotech stilt breeding population has been accommodated in the Lake to nest, the overflow birds have continued to nest adjacent to raceways or out on the barren lava field.

If birds are hazed from Cyanotech, they may continue to nest on the adjacent lava flats where no successful reproduction can occur. Therefore, it is apparent that incidental take of stilt nests and chicks cannot be totally eliminated at Cyanotech in the short-term without causing the indirect loss of reproduction at other sites (adjacent lava flats) along the Kona Coast. Cyanotech is located adjacent to the Kona Airport and the issue of a potential wildlife hazard is a concern. The birds are attracted to the 48 acres of shallow open-water ponds, invertebrate foods, and remote nesting sites on the 90-acre facility. The birds will continue to be attracted to the facility if the attractants are not eliminated prior to or concurrent with other bird deterrent measures.

2.6 Relationship of Cyanotech to Recovery of the Hawaiian Stilt – Source or Sink?

Hawaiian Stilts appear to exist as a metapopulation or a set of metapopulations among islands (Reed et al. 1993) with primary source populations (i.e., most productive populations) located on Oahu, Maui, and Kauai. Because suitable stilt nesting and foraging habitat within natural wetlands on the Big Island has always been limited, the stilt population on the Big Island has historically existed as a "sink" or "satellite" population (i.e., a population dependent upon emigration from source populations).

The recovery goals for Hawaiian Stilts presented in the *Draft Revised Recovery Plan for Hawaiian Waterbirds* (USFWS 1999), however, include the establishment of multiple viable breeding populations on Kauai/Niihau, Oahu, Maui/Molokai, and the Big Island as a criteria for initial downlisting and to support eventual delisting of this subspecies. Implicit in this stated recovery goal is the understanding that viable breeding populations will be established at various protected and managed sites identified in the recovery plan. The natural wetlands at Aimakapa and Opaeula are the only two sites identified in the recovery plan that could support, with future restoration and management efforts, viable breeding populations of Hawaiian Stilts.

Recovery efforts aimed at increasing restoration and management of Hawaii's wetlands are hindered by lack of funding and the time it takes to gain regulatory approvals for work in these sensitive habitats. At the same time, waterbird counts at "artificial wetlands"[2] throughout the main Hawaiian Islands are increasing with wastewater treatment plants on Lanai, Molokai, Oahu, and the Big Island known to support significant populations of Hawaiian Stilts and Hawaiian Coots (*Fulica alai*). Increased restoration, enhancement, and management of protected wetlands designated for waterbirds is critical to the long-term recovery of Hawaiian Stilts. Until restoration efforts can be realized, Hawaiian Stilts and other endangered waterbirds will continue to be attracted to and depend on artificial wetland sites.

Nesting success of waterbirds at artificial wetland sites in Hawaii has not been comprehensively studied to determine whether these areas are source or sink habitats. The mongooses are not established on Lanai, and successful stilt and coot nesting has been observed at the Lanai City WTP. In comparison, monthly waterbird counts by

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[2]The term "artificial wetlands" in the document refers to wastewater treatment plants, aquaculture facilities, and other manmade open-water habitats whose primary purpose is not to attract birds.

Ducks Unlimited at the Kealakehe WTP over a three-year period confirm that a fairly constant number of stilts and coots are supported by the facility. Hawaiian Coots attempt to nest, but nest sites and nesting material (vegetation) are limited. Flooding of nests and predation are also suspected factors in limiting coot reproduction at the Kealakehe WTP. Ducks Unlimited biologists have observed successful reproduction by stilts on one occasion (two fledglings in 2001). Hawaiian Stilts attempt to nest at the facility, but percent hatching and fledging success is very low because egg predation by mongooses is high and newly hatched chicks are preyed upon by a significant resident population of Black-crowned Night-herons (*Nycticorax nycticorax hoactli*).

The overall effect of artificial wetland sites on waterbird recovery has not been adequately assessed. The stilts and coots observed at these sites are responding to adequate (less than optimum) habitat that in the majority of cases is not able to accommodate their annual cycle needs. However, artificial wetlands provide consistent food resources and possibly social opportunities. It is not known how Hawaiian Stilts and Hawaiian Coots pair, and it could be that these nonbreeding aggregations are the mechanism by which pair bonds form (A. Engilis pers. comm. 2000). Nevertheless, it is plausible that these artificial wetlands could reduce the overall reproductive success of Hawaiian waterbird populations by attracting and maintaining adult birds at sites where successful nesting is limited, if not impossible. This situation would be detrimental to recovery efforts and represents a scenario best described as a "reproductive sink." Thus, in order to prevent the Kona Coast from becoming a reproductive sink, recruitment of fledglings back into the overall population must occur.

One stilt fledgling was observed and presumably fledged at Opaeula Pond during the 1998 breeding season and two fledglings in 2001; and it is likely that a few stilts produced fledglings at other wetlands along the Kona Coast in 1998, 1999, and 2000 (Aimakapa and Hualalai wetlands). However, at these sites, nesting habitat is limited, stilt nests are susceptible to predation, and water levels cannot be controlled to produce optimum foraging habitat to support chicks through the fledging stage. Based on these factors and the banding and re-sighting data, the 153 stilts fledged at Cyanotech represent the majority of the Hawaiian Stilt production on the Big Island over the last three breeding seasons. While limited data at other wetlands is readily available for comparison, the average number of fledglings produced at Cyanotech per year exceeds that recorded at other managed wetlands in the Hawaiian Islands (Table 3).

A comparison of the overall population numbers of Hawaiian Stilts along the Kona Coast over the past three breeding seasons with the estimated number of nesting pairs at Cyanotech during the same period establishes Cyanotech as a significant breeding site for stilt on the Big Island. The estimated number of breeding pairs at Cyanotech has increased from 20 to 61 pairs in the last three years (Table 1), which possibly establishes the Big Island as an important source population of Hawaiian Stilts for the first time in recorded history.

Since Hawaiian Stilts typically breed after year two (Coleman 1981), with only two records of Hawaiian stilts breeding at year one (Robinson et al. 1999; Ducks Unlimited unpubl.), the increase in pair bonds from 1998 to 1999 was not likely related to increased stilt production on the Big Island. In 1999, banding data showed that only one 1998 Cyanotech fledgling formed a pair bond. The observed increase in paired stilts from 1998 to 1999 was likely the result of 1) some of the initial 1997 immigrated birds reaching reproductive age in 1999, 2) an increase in available nesting habitat at the Lake, or 3) a combination of the above two factors. By year 2000, however, fledglings produced at Cyanotech in 1998 reached reproductive age. Banding data showed that at least six of the chicks banded in 1998 nested at Cyanotech in 2000. Thus, the significant increase in nesting pairs during the 2000 breeding season can be at least partially attributed to the reproductive success at Cyanotech in 1998.

Within the main Hawaiian Islands many of the larger natural wetlands are protected, but few of these areas are either naturally suited for stilts or actively managed for maximum stilt production. Due to degraded hydrology and invasive species, and a need for restoration, many of these wetlands in their present condition have reached the carrying capacity of the habitat for successful stilt reproduction. Available habitat appears to be key to Hawaiian Stilts because habitat limits carrying capacity (Reed et al. 1998a). Population viability analysis of the Hawaiian Stilt suggests that not enough habitat exists in Hawaii to achieve the recovery goal of a minimum population size of 2,000 birds (Reed et al. 1998a).

Therefore, it is plausible that the Hawaiian Stilt population as it now exists on the Big Island includes a large number of breeding birds that would not have otherwise located suitable nesting habitat and successfully reproduced on other islands within the chain. Moreover, if the stilts nesting in the Cyanotech raceways were not able to find suitable habitat to fledge chicks elsewhere, then the hatchling mortality in the raceways conceivably would not represent a net reproductive loss for Hawaiian Stilt population statewide; and if the stilts nesting in the Cyanotech Lake were not able to locate suitable breeding habitat elsewhere, then the increased stilt population on the Big Island and the overall reproductive success in evidence at Cyanotech, likely represent a net increase in the overall population numbers of the subspecies.

Recently, two males banded on the Big Island (Aimakapa 1994; Cyanotech 1998) were sighted on Maui at Kealia Pond National Wildlife Refuge (NWR) (USFWS unpubl.) prior to breeding at Cyanotech. The first male bred successfully at Cyanotech's Lake in 1998 and 1999, and unsuccessfully in 2000. The second male is believed to have bred unsuccessfully at Cyanotech's raceways in 2001. During the past three breeding seasons, at least 12 of 25 fledglings banded at Cyanotech in 1998 have returned to breed successfully and unsuccessfully as well, in both the Lake and raceway ponds, confirming recruitment back into the population and supporting the assumption of natal philopatry and the lack of suitable breeding habitat at Cyanotech and elsewhere.

In metapopulations, individuals that enter the breeding pool can have a strong impact on local populations, unlike those that merely move and do not breed (Reed et al. 1994). Population viability analysis indicates that Hawaiian Stilts are capable of rapid population growth under favorable conditions (Reed et al. 1998a). The reproductive success achieved at the less than 2-acre site at Cyanotech (148 fledglings over 3 years) supports this analysis and provides evidence that Cyanotech, as currently managed, is not a reproductive sink for Hawaiian Stilts.

In summary, the current management and operation of the Cyanotech aquaculture facility attracts Hawaiian Stilts and affects their foraging and breeding habits. Hawaiian Stilts are provided expanded foraging opportunities while achieving a level of reproductive success that exceeds all other wetland sites along the Kona Coast and provides some evidence that the Big Island now exists as an important source population for stilts. This expanded foraging habitat and reproductive success results in the loss of some stilt chicks in Cyanotech raceways. Nevertheless, the past efforts of Cyanotech to protect and manage the Lake as a Hawaiian Stilt foraging and nesting habitat in order to offset the incidental take of Hawaiian Stilts in raceway ponds represents a net conservation benefit to the subspecies as a whole.

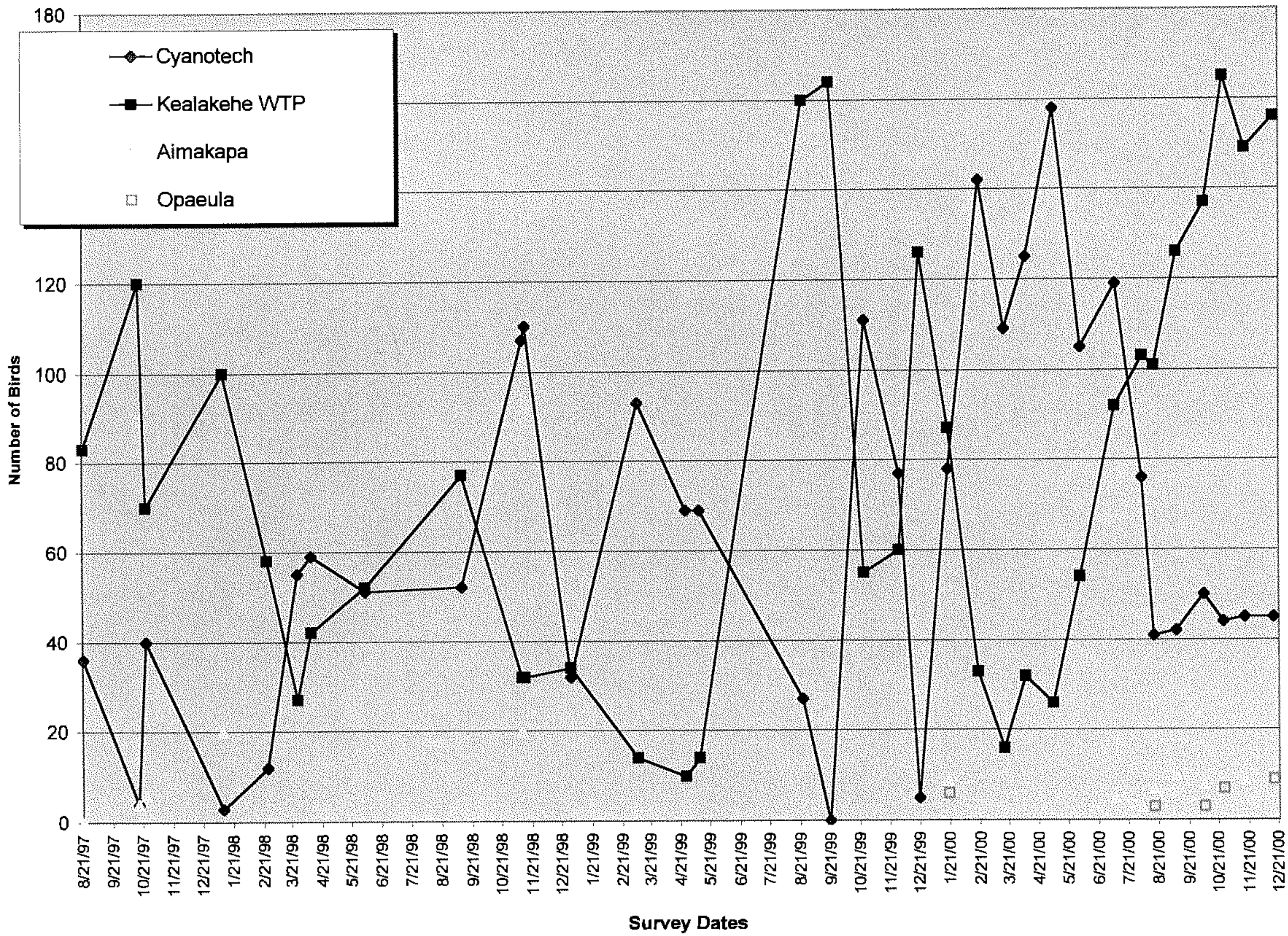
2.7 Potential for and Assessment of Future Incidental Take

2.7.1 Direct Effects

Cyanotech and the nearby Kealakehe WTP support the majority of the Hawaiian Stilt population along the Kona Coast. The birds move freely between these areas (Figure 5) and have acclimated to the varying levels of human activity at these sites. While the birds may be temporarily disturbed during some operations at Cyanotech (e.g., cleaning, draining, and harvesting ponds), incidental take of adult Hawaiian Stilts has not been observed or directly attributed to the operations and maintenance activities at the aquaculture facility.

Loss of Hawaiian Stilt eggs and chicks at Cyanotech is anticipated during the permit term. Based on the limited natural, stilt-breeding habitat available along the Kona Coast and the amount of habitat currently available at Cyanotech, it is anticipated that the facility will continue to attract the majority of the Kona Coast breeding population of Hawaiian Stilts until effective bird deterrents can be found and alternate breeding sites in the Hawaiian Islands are restored and managed.

Figure 5: Hawaiian Stilt PopulationTrend on the Kona Coast Breakdown by Location 1997-2000



Emergency maintenance in Lake and routine maintenance in raceways
Maximum take estimation: none or very few eggs or chicks during the permit term

Within the Lake, no disturbance of Hawaiian Stilts is anticipated. The biological monitor will conduct surveys from outside the bermed area once per week with a spotting scope. Nest searches were discontinued in 1999 due to adverse impacts on breeding success. Emergency activities (e.g., waterline repair), although very rare, may require Cyanotech staff to work inside the bermed areas of the Lake where active nests and chicks may be located. Stilt eggs and chicks are cryptic, Cyanotech employees conducting these activities could accidentally crush eggs. Any accidental crushing of eggs during emergency maintenance in the Lake or routine maintenance in the raceways would represent incidental take of the species. However since 1998, Cyanotech has educated its employees on the sensitivity of the Lake, as well as nest detection in the raceways. No Hawaiian Stilt eggs or chicks have been lost in this manner during the four years of monitoring incidental take, and therefore none or very few eggs or chicks are anticipated to be lost during the permit term.

Bird deterrents in raceways
Maximum take estimation: moderate disturbance of up to 30 pairs of adult stilts per year, take of 1 – 2 nests (4-8 eggs) per year, and take of 1 fledgling, 2 adults, during the permit term (authorized as a minimization measure)

The primary biological goal of the Conservation Plan is to eliminate incidental take of Hawaiian Stilt chicks at Cyanotech. Based on four years of monitoring data, to be successful at achieving this goal, adult foraging and nesting must also be eliminated within the raceways, and nest site fidelity as well. Elimination of bird attractions in combination with bird deterrents is essential. Although stilt production in the Lake exceeds the low number of chicks perishing in the raceways by more than 350 percent, the raceways alone continue to present a reproductive sink problem for Hawaiian Stilt that must be resolved for the plan to be successful. As long as the raceways attract foraging and nesting stilts, stilts will continue to feed and attempt to breed, and there will be site fidelity and chick mortality.

Again, the intent of bird deterrents is to reduce foraging, nesting, and promote abandonment of hazardous raceway nesting sites, and encourage dispersal to other wetlands where successful breeding is possible. Adults observed in early nest-building activities would be hazed from the site by deterrent methods described in Appendix 4. Because the routine bird deterrent measures proposed are non-harmful and designed to be preventative in nature, death or injury to adult and subadult birds is expected to be zero, and nest abandonment from implementation of deterrent measures is anticipated to be zero, or one to two nests per year maximum. Under the worst-case scenario, incidental take of one adult and two juvenile stilts over the permit term may result from more rigorous hazing measures such as lasers or predator call devices that may be used in Year 3 (see section 3.7). Moderate disturbance of up to 30 pairs of adult stilts is anticipated to reduce nesting and chick mortality near raceways. Attempts to modify breeding behavior through bird deterrents may also represent incidental take under the ESA.

The proposed non-lethal bird deterrent measures (e.g., increased driving on roads, Mylar tape) are intended to modify stilt behavior by disrupting breeding and are thus important for meeting the permit requirement to minimize incidental take (loss of chicks/eggs) and the primary goal of the Conservation Plan to eliminate this type of incidental take. Non-lethal bird deterrent measures will help eliminate the number of birds attracted to the facility in the long-term, and in the short-term will deter adults from nesting in areas where successful reproduction is not possible. Furthermore, nest site fidelity may be reduced and stilts may disperse to other wetlands and other islands where successful reproduction is possible. The information gained will provide net environmental benefits through development of effective bird deterrent measures to assist in addressing the attractive nuisance and reproductive sink problems associated with other industrial sites.

Chicks hatched in unprotected areas of the facility
Maximum take estimation: 20-25 chicks per year

Hawaiian Stilt populations fluctuate in relation to rainfall patterns, with reproductive attempts higher in some years than others (Engilis and Pratt 1993). Thus, it is not possible to predict the exact number of breeding pairs that will attempt to nest at Cyanotech each year or an exact amount of incidental take that will result from these nesting attempts. Nevertheless, based on current survey information, it is estimated that between 45-65 stilt breeding pairs will attempt to nest in protected and unprotected sites.

Unprotected areas at the facility where stilt nests have been documented include the areas along the top and sides of the raceway berms and on gravel roads. Chicks hatched in unprotected areas may be particularly susceptible as vehicles moving between the raceways could crush them. Chicks hatched in unprotected areas are likely to be led by parent stilts into raceway ponds where they will not survive. Suspected causes of death are either drowning or physiological reactions to the microalgal medium. Such injury or mortality is considered incidental take of the species.

Using the highest estimate of 65 stilt breeding pairs, a 36.7% average nest success rate within raceways over the last four years (Table 1), an average clutch size of 3.6 eggs per nest (Coleman 1981), and an egg viability of 86.1% (1998–2001 average of Cyanotech's managed habitats) (Table 3), approximately 74 stilt chicks per year could be incidentally taken (chicks hatched in raceways that perish in ponds or on roads) if the Conservation Plan is not implemented (no Lake management, no bird deterrent measures). This estimate does not account for natural chick mortality and ongoing predation of chicks, nor additional loss of chicks from Hawaiian Stilt pairs that would attempt to renest after initial nest failure. At a National Wildlife Refuge on Oahu, Chang (1990) found that 46% of the chick mortalities occurred within the first 10 days of hatching.

It is anticipated that implementing the minimization measures outlined in the Conservation Plan will reduce the amount of this incidental take to less than 15 to 20 chicks or eggs per year, and under the worst-case scenario no more than 20 to 25. However, even under normal conditions, not all of these hatchlings would be expected to survive and be recruited back into the population, as evidenced by the 0.934 fledglings per brood ratio calculated for the Hawaiian Stilt (Robinson et al. 1999). This estimate for incidental take is based on the number of stilts incidentally taken per year from 1998 to 2001: mean = 14; median = 12; range 1 – 29; during four years of active Lake management with no bird deterrent program in place. In 1999, due to crowding and disturbance in the Lake a higher number of chicks (29) were incidentally taken than in any other year (Table 1). Chicks were walked by parents out of the Lake to unprotected areas and perished. Factors contributing to this increased take have been rectified and are not anticipated to occur again (See sections 2.3 and 2.4 for discussion).

Additionally, raceway hatchling numbers were estimated using actual (1998-2001) and hypothetical (four-year weighted means) datasets for nest success, average clutch size, and egg viability with considerations to natural mortality, ongoing predation, and chick movement from the adjacent lava fields to the raceways. All numbers were calculated from raceway monitoring data except for egg viability. This rate was calculated from Cyanotech's managed habitats (Lake, DU Pond) because the data required for egg viability in the raceways or other unmanaged wetlands were not available. Therefore, the egg viability applied to the estimation of raceway hatchlings is likely to be higher than the actual.

This estimate for potential incidental take, using the actual raceway monitoring data showed a mean of 13, median of 12, and range of 7–22 during 4 years of active Lake management with no bird deterrent program in place. Hypothetical examples to assess raceway hatchlings using a mean (36.7%), low (19.2%), and high (50%) nest success from 1998 to 2001 yielded respective means of 13, 17, and 18 hatched. A small number of estimates (16) for potential raceway hatchlings was derived from actual and hypothetical datasets ranging from 1 to 39. Of the 16 calculations, 14 (88%) estimated 22 chicks or less, and 12 (75%) fell between 3 and 15 (Appendix 3).

Appendix 3 has been included at the request of the Fish and Wildlife Service and the DLNR to assess incidental take in the raceways. The calculations in Appendix 3 are not meant to be used as a prediction tool, but as one way to assess incidental take at the end of the breeding season. There are several interacting variables that will affect the outcome of incidental take. Variables such as the success of bird deterrent measures, predator populations, hatching success of lava nests, infertility, inexperienced breeders, number of microalgae ponds in production, and weather patterns, among others cannot be quantified with any level of confidence at this time. None of these variables have been accounted for in the incidental take calculations. With the new management regime of bird deterrent measures to prevent nesting in the raceways and break the reproductive sink cycle, incidental take is expected to decrease from previous years.

In summary, it is highly unlikely that any chicks hatched in the unprotected nesting sites at Cyanotech would survive to fledging. Eggs abandoned as a result of human disturbance, and crushing of eggs and chicks attributed to emergency maintenance in the Lake or normal operations and maintenance of raceways, and death or injury directly related to bird deterrents represent incidental take of the species. Loss of Hawaiian Stilts that can be attributed to natural causes (e.g., predation, diseases, parasites) or complications not linked to the Cyanotech operation (e.g., band injuries, contaminants) do not represent incidental take of the species for Cyanotech.

During the 2000 breeding season, one adult stilt and two fledglings were recovered from three separate raceway ponds on two separate dates. These birds were transported to the National Wildlife Health Center for examination. The adult stilt was fairly decomposed and found unsuitable for necropsy. Nothing unusual was revealed in the gross necropsy of the fledglings, and tests for avian botulism were negative. The histopathology reports were inconclusive and the causes of death unable to be determined. There was no apparent link to the microalgae production.

The actual incidental take under the Conservation Plan will most likely be lower than this estimated amount. This is because, under the Conservation Plan Lake management will be conducted in the same manner as in previous years, however the implementation of bird deterrent measures is fully expected to decrease the number of foraging adults and prevent stilts from laying eggs, thereby decreasing the number of pairs, nests, and incidental take of chicks in the raceways.

2.7.2 Indirect Effects

2.7.2.1 Types of Indirect Effects

Hawaiian Stilt nests are generally constructed in or near wetlands so that movement of chicks after hatch is limited to short distances. In one instance on Oahu, adults with three-day old chicks were moved 0.3 miles from the nest to a less crowded foraging site (Reed et al. 1994). At this same location on Oahu during two nonconsecutive breeding seasons, adult stilts nested within a gravel parking area separated from the nearest body of water by a road and a 20-foot high berm. Chicks that hatched from these nests were moved by their parents across the road and over the berm to a created wetland, which was the established nesting site for the majority of the breeding stilts at this location. Crowding at the created wetland is suspected as the reason that some of the adult pairs established the upland-nesting site in the gravel parking lot.

A similar circumstance is occurring on the lava fields adjacent to Cyanotech. However, the level of human disturbance around the Cyanotech ponds, rather than crowding of the primary nesting site, is suspected as the reason that the stilts established a nesting colony so far away from the foraging sites. Between incubation periods, adult stilts with nests out in the lava fields were observed flying to the Cyanotech ponds to feed. It is reasonable to believe, therefore, that adults would attempt to move chicks hatched from the lava-field nesting site to the Cyanotech ponds.

The lava-field nesting sites appear to have been established as early as 1997 based on old nests that were located during the 1998 breeding season. Nest site fidelity by Hawaiian Stilts has been documented on Oahu. Therefore, even with the managed and protected nesting site at the Lake, it is reasonable to anticipate that a portion of the breeding population may continue to nest at established lava-field nesting sites. As was documented during the past three breeding seasons, all nests constructed out in the lava fields will likely fail due to predation. The recent lava fields are characteristic rugged terrain, include innumerable crevices and deep ravines, and support rats and mongooses. Therefore, in the event that eggs successfully hatch from nests out in the lava field, it is inconceivable that the chicks could survive the move across the lava to the Cyanotech ponds. Furthermore, any chicks successfully moved from lava nesting sites to the Cyanotech ponds would likely perish in the raceways. Chicks in past years are suspected of drowning or dying from adverse physiological reactions to the alga medium.

While a portion of the birds may attempt to renest at other wetland sites or within the Lake when space becomes available later in the breeding season, the loss of the nests out in the lava fields is viewed as an indirect adverse effect related to the construction and operation of the aquaculture facility. Loss of these nests is not considered incidental take as defined under the ESA. Nevertheless, with implementation of this Conservation Plan, it is hoped that the established nesting sites out in the lava fields will eventually be abandoned for more favorable nesting sites through eventual dispersal to natural wetland sites on the Big Island or other wetlands off island.

Likewise, the Kona International Airport bird strike issue is also indirectly related to Cyanotech's migroalgae operation. The stilt nesting attempts adjacent to the runway resulted because stilts were attracted to the expanse of foraging habitat provided by the aquaculture facility. Again, it is the intent of the Conservation Plan to discourage stilts from attempting to nest within the lava fields adjacent to the airport by encouraging nesting within the Lake at Cyanotech in the first year and other wetland habitats off-site, while reducing the overall stilt population attracted to Cyanotech in the long-term.

2.7.2.2 Addressing the Potential of a Wildlife Hazard

The 1998 Hawaiian Stilt breeding season began with nine nests located on the lava fields between Cyanotech and the Kona International Airport. The lava fields are the property of the Kona Airport. These nests were predated closed to their hatching date. Approximately two months later, four active nests were documented further away from Cyanotech on the airport safety corridor west of and adjacent to the runway. It is believed that these four nests represented the second nesting attempt by the lava-field colony. Three adult stilts were found dead on the runway by airport personnel. There were no eyewitnesses to the impact. The Fish and Wildlife Service salvaged these nests to force abandonment of this hazardous nesting site. Following this incident, four late nests were documented at Cyanotech including one at the DU Pond, two in the raceways, and one in the Lake. These nests may have represented the third nesting attempt by some of the birds of the lava-field colony.

About one week after stilt nesting initiated on the lava fields, Cyanotech employees reported nesting in a 1.7-acre settling basin used to discharge recycled water and excess sludge material from microalgae ponds. The stilts had located the invertebrate-rich basin and began nesting on the sediments that had accumulated over the years of discharge. In an effort to lure the lava-field nesters away from the airport, Cyanotech agreed to manage water levels to reduce scattered nesting on the lava fields and adjacent to the airport, and to draw the stilts into a protected site, giving them a chance to breed successfully (Figure 3).

In an attempt to reduce these indirect effects to stilts and to address the concerns of the DOT for potential bird strikes, a management strategy was designed for 1999 and 2000 that would attempt to accommodate more nesting pairs within the leased areas of Cyanotech at protected breeding sites. Since 1998, incidental take of Hawaiian Stilt chicks has been minimized but has not been eliminated. Hawaiian Stilt reproduction on-site has been successful, and there have been no additional reports of adult stilt mortality at the Kona Airport. Details are provided in sections 2.3 and 2.4 of the Conservation Plan.

A Wildlife Hazards Assessment (WHA) is currently being conducted at the Kona Airport by the DOT pursuant to 14 CFR 139.337. The ecological study is the first of eight being conducted at airports in the Hawaiian Islands. The WHA is a 12-month study designed to identify wildlife hazards to aircraft operations. The WHA was completed in July 2001 and the report is expected to be finalized by December 2001. According to FAA regulations at 14 CFR 139.337(c), "... at the completion of the WHA, the Federal Aviation Administration (FAA) will determine if a Wildlife Hazard Management Plan is needed to address the wildlife hazards identified in the WHA."

Since 1999, numerous meetings have taken place between the Fish and Wildlife Service, State Division of Forestry and Wildlife, USDA Wildlife Services, FAA, DOT, NELHA, Ducks Unlimited, and Cyanotech to discuss the bird strike issue at the Kona Airport, and determine how to address the concerns of the DOT in this Conservation Plan (Appendix 1). A general consensus has not been reached. The overarching goal of the Conservation Plan is to eliminate the attractive nuisance problem at Cyanotech. Accomplishing this goal, and meeting the biological goals required for an incidental take permit as well as the requirements of the DOT, in an economically-feasible manner, have become a conundrum.

The profound differences lie in the conflicting interpretations of the FAA/DOT mandates, the ESA, and HRS 195D and the best method to eliminate Hawaiian Stilt usage of the facility. In addition, a thorough assessment of the actual wildlife hazard has not been completed. The Conservation Plan has been re-drafted numerous times, in an attempt to find a workable solution acceptable to all of the stakeholders. In 2001, in consultation with federal and state wildlife and airport officials, the management strategy was again modified from accommodation of Hawaiian Stilts at Cyanotech to elimination of the attractions of the facility through implementation of effective bird deterrent measures, in an effort to eliminate Hawaiian Stilt use, incidental take, and the indirect effects discussed above.

With the approval of the Fish and Wildlife Service and the DLNR, Cyanotech is already taking steps to decrease the food source and potential stilt nesting areas in the raceways. An aggressive hazing program has been called for by the DOT to eliminate Hawaiian Stilt presence at Cyanotech immediately. However, this activity was identified by the Fish and Wildlife Service as intentional take of Hawaiian Stilt, an action for which neither Cyanotech nor the DOT currently hold a permit. Current levels of moderate disturbance around the raceways have resulted in some movement of birds back to the lava fields at the Kona Airport. The airport administrators were advised of the possible increase in bird movements towards the airport with aggressive hazing measures. Hence, the reasoning behind the original strategy to lure birds away from the airport property to the Lake breeding pond, and the current emphasis to address the root of the problem by reducing bird attractions over the long-term.

In the short-term, if some birds are expected to move towards the lava fields, airport and adjacent properties with the increase in bird deterrent measures proposed, then it is essential for the Kona Airport, NELHA, and Cyanotech to be prepared to work cooperatively to implement non-lethal bird deterrent measures at the Cyanotech facility as well as on adjacent properties. The stakeholders were able to agree on only one concept: The common goal of all parties is to eliminate the attractive nuisance problem at Cyanotech; Cyanotech needs an incidental take permit to legally implement bird deterrent measures for Hawaiian Stilt; and without the permit Cyanotech can not effectively work towards the common goal. The objective to eliminate incidental take by eliminating stilt use can only be realized when Cyanotech, NELHA, the Fish and Wildlife Service, DLNR, and DOT take cooperative and proactive measures in concert.

3.0 HAWAIIAN STILT CONSERVATION PLAN

3.1 Scope of the Plan

The Conservation Plan for Hawaiian Stilt at Cyanotech is proposed as a short-term plan to guarantee some reproductive success for the breeding population of Hawaiian Stilts along the Kona Coast that is attracted to this man-made site (due to the limited number of natural breeding and foraging sites existing within the Hawaiian Islands) while actively pursuing non-lethal bird deterrent measures to reduce and eventually eliminate the number of birds attracted to the facility in the long-term. The strategy includes measures to minimize the incidental take of stilt eggs, chicks, subadults, and adults and measures to mitigate any incidental take of Hawaiian Stilts at Cyanotech, in a manner that provides a net conservation benefit to Hawaiian Stilts. The period of time for which the incidental take permit is sought is three years.

The Conservation Plan was developed with the knowledge that the current lack of foraging and breeding sites for stilts on the Big Island makes it difficult to successfully haze Hawaiian Stilts from Cyanotech without adversely impacting the breeding success of the Kona Coast population of Hawaiian Stilts. The Kona Coast population now represents about 10% of the entire population of stilts within the Hawaiian Islands. Surveys from 1998-2000 in Kona show that the majority of stilts forage at Cyanotech and the Kealakehe WTP, and that nearly all successful stilt reproduction occurs at Cyanotech (Figure 5). Therefore, until the invertebrate base and other attractants at the Cyanotech raceways are reduced and other natural habitats are restored or enhanced and managed to provide the extent of foraging and breeding resources found at Cyanotech, significant numbers of Hawaiian Stilts will continue to be attracted to the aquaculture facility.

This Conservation Plan is not intended to replace or reduce actions by resource agencies to develop a more comprehensive, long-term strategy for developing alternate, suitable habitat for Hawaiian Stilts on the Big Island or at other locations throughout the main Hawaiian Islands. It is the intent of the Conservation Plan to provide a sound impetus for the resource agencies to address the urgent need for habitat restoration and management of Hawaiian Stilt by supporting conservation actions that complement the minimization and mitigation plans described above. The Conservation Plan creates an opportunity to integrate public and private habitat protection programs to support one another. Coordination between Fish and Wildlife Service Refuges and State sanctuaries to manage to accommodate displaced breeders during the permit term is imperative. Section 6 grants designed specifically to support Conservation Plan goals can be acquired for habitat improvements or land acquisitions to benefit Hawaiian Stilt.

Increased restoration, enhancement, and management (e.g., restore hydrology, remove vegetation, control predators) of protected wetlands designated for waterbirds is critical to the long-term recovery of Hawaiian Stilts. Examples of ongoing efforts include, but are not limited to: predator control and restoration planning at Aimakapa Pond (National Park Service and Ducks Unlimited) and Opaeula Pond (Kamehameha Schools, Ducks Unlimited, Fish and Wildlife Service, Natural Resources Conservation Service); enhancement and monitoring at Kealia Pond NWR on Maui (Fish and Wildlife Service, Ducks Unlimited, U.S. Geological Survey), enhancement and management of Ohiapilo Pond on Molokai (County of Maui, Ducks Unlimited); and restoration and management of Pouhala Marsh on Oahu (State of Hawaii, City and County of Honolulu, Ducks Unlimited, Fish and Wildlife Service).

This Conservation Plan applies to all lands leased by the Cyanotech Corporation for its microalgae farming operation along the Kona Coast of the Big Island. The incidental take permit is sought for incidental take of Hawaiian Stilt eggs and chicks that occurs at Cyanotech in association with all ongoing operations and maintenance activities at the facility. Incidental take of adult and subadult stilts is requested in association with experimental deterrent measures.

3.2 Biological Goals

Within the Habitat Conservation Planning process, biological goals and objectives of conservation plans may be either habitat or species based. Habitat based goals are expressed in terms of amount and/or quality of habitat. Species-based goals are expressed in terms specific to individuals or populations of the species covered in the conservation plan (USFWS/NOAA 2000).

The impacts to Hawaiian Stilts from operation and management of the Cyanotech aquaculture facility do not result from any alteration or loss of natural wetland habitat supporting Hawaiian Stilt. Rather, the aquaculture facility has increased the amount of artificial open-water habitat on the Big Island, which has resulted in the attractive nuisance problem described in this report. The raceway ponds at Cyanotech have had the unintentional effect of attracting endangered Hawaiian Stilt. The birds located the expanse of open water on their own. Thus, the biological goals of the Conservation Plan are appropriately species-based rather than habitat-based.

The primary goal of the Conservation Plan for Hawaiian Stilt at Cyanotech is to eliminate the incidental take of Hawaiian Stilt by eliminating the attractive nuisance problem at Cyanotech. A secondary goal of the plan is to implement a short-term strategy to lure adult stilts away from production ponds and lava fields into a protected and managed nesting area during the first breeding season. This should ensure that Cyanotech does not become a reproductive sink during the permit term in which long-term measures to reduce and ultimately eliminate Hawaiian Stilt foraging and nesting at Cyanotech are being implemented. The Conservation Plan proposes an integrated and adaptive management approach to resolving the attractive nuisance problem at Cyanotech that strives to address the concerns of all the parties involved, and the protection of the endangered Hawaiian Stilt.

Specific biological goals of the plan are to:

- Eliminate foraging by adult/subadult Hawaiian Stilts and mortality of Hawaiian Stilt chicks at Cyanotech;
- Eliminate nest site fidelity in unprotected areas of the facility where successful reproduction is not possible, and encourage dispersal to other wetlands and islands where successful reproduction is possible;
- Prevent Hawaiian Stilts from nesting adjacent to runways at the Kona International Airport and reduce nesting adjacent to raceways and lava flats at or near Cyanotech;
- Provide net environmental benefits through development of effective bird deterrents measures to assist in addressing the attractive nuisance and reproductive sink problems associated with many industrial ponds;
- Ensure reproductive success for the Kona Coast population of Hawaiian Stilts by managing a protective breeding area on site to carrying capacity (when the breeding site is being managed);
- Provide a net conservation benefit that contributes to the recovery of Hawaiian Stilt by producing more stilts than is incidentally taken during the permit term.

For specific information on the methods and measurements to be used to accomplish biological goals see section 3.4 Success Criteria.

3.3 Minimization and Mitigation Measures

Cyanotech will appoint a biological monitor approved by the Fish and Wildlife Service and the State Division of Forestry and Wildlife (collectively, "Wildlife Agencies") to oversee the following minimization and mitigation measures of the Conservation Plan.

3.3.1 Minimization Measures

Measures aimed at reducing incidental take over the term of the permit are:

1) Cyanotech will aggressively explore options and pursue solutions to reduce or eliminate the invertebrate food source from its ponds in order to limit the number of stilts attracted to the site. Cyanotech will implement a three-year action plan to evaluate bird deterrent measures at the Cyanotech raceway ponds (See Appendix 4).
2) During the first year, Cyanotech will reconfigure the raceway ponds to steepen the outer slopes and eliminate the level surface lip of individual raceway ponds where stilt nesting occurs. This measure will reduce the gravel area adjacent to raceway ponds where stilts

are capable of constructing nests and promote abandonment of sites where nest site fidelity has been established near specific raceway ponds.

3) Cyanotech employees will use bird deterrents to keep adult stilts from raceway ponds. The bird deterrent measures used will be limited to driving or walking on raceway roads several unset times per day to increase the level of human activity, and placing preventative devices (e.g., Mylar tape) in areas where nest building activities are observed.

4) Bird deterrent measures will be introduced to only a limited number of raceway ponds at a time such that the entire population of Hawaiian Stilts currently sustained by the raceway ponds is not affected by a loss of adequate foraging habitat.

5) Cyanotech will immediately halt use of any bird deterrent or hazing method that results in the incidental take of adult or subadult stilt until an evaluation of the incident can be conducted by the Wildlife Agencies and Cyanotech is advised on how to proceed.

6) The former DU Pond will either a) be returned to an active microalgae production pond or b) used as a test site for a deterrent measure (e.g., netting) in order to force stilts to abandon this former breeding site.

7) The Lake will be managed in accordance with recommendations from a biologist knowledgeable of the wetland habitat conditions required for optimum stilt breeding habitat. The Lake will be managed to lure birds away from the raceways and lava fields into a protected breeding site in accordance with the guidelines in section 3.3.2.

8) The biological monitor will use best professional judgment when determining whether to access the Lake during the breeding season to collect data necessary to determine reproductive success. Due to adverse effects of monitoring suspected from crowded conditions within the Lake, monitoring activities will be limited to observations that can be determined with a spotting scope, once per week.

9) Cyanotech employees conducting emergency maintenance (e.g., waterline repair, trash retrieval during high winds) in the Lake during the breeding season will be instructed to take extra precautions to prevent accidental crushing of eggs or chicks and to limit time spent within the interior of the Lake to the shortest duration possible. The frequency of emergency maintenance work of this nature is anticipated to be no more than once per breeding season.

10) Aside from conducting normal operations, employees will be instructed to keep activities adjacent to the Lake to a minimum during the breeding season (e.g., no social gatherings or unnecessary activities along the Lake bank in view of breeding birds).

11) Cyanotech will continue to educate its employees on the continuing activities to protect and conserve endangered Hawaiian Stilts at Cyanotech and on the behavioral cues for breeding stilts. Employees will be advised to continue aquaculture activities with

caution if stilts are exhibiting these behaviors and to provide the biological monitor with any nest, egg, or chick sighting data within three days of any observations.

12) Any additional raceways constructed by Cyanotech will incorporate bird deterrent measures and designs that will eliminate factors drawing Hawaiian Stilts to the facility. Future expansion of the Cyanotech facility is contingent upon market conditions, financial resources, and environmental resources. There are no immediate plans for development.

13) Cyanotech will work with the Wildlife Agencies on identifying additional bird deterrents that may be used as a long-term strategy for reducing incidental take of Hawaiian Stilts at Cyanotech and other future aquaculture facilities planned within NELHA. If a bird deterrent technique requires special training, Cyanotech personnel will seek that training prior to use.

3.3.2 Mitigation Measures

Cyanotech will manage the 1.7-acre Lake to provide optimum breeding habitat for Hawaiian Stilt:

1) Cyanotech will conduct maintenance of aggressive weeds in the Lake to maximize available nesting mudflats and foraging shallows. Additional pipelines will be installed to production ponds to allow for alternate discharge sites (other than the Lake) and to prevent inundation of active nests. All maintenance will be conducted during the nonbreeding season to avoid unnecessary activities in the protected breeding area.

2) Prior to the breeding season (mid-January), the Lake will be flooded. Cyanotech will manage water levels in the Lake to provide optimum stilt nesting habitat. The Lake will be managed to lure birds away from the raceways and lava fields into a protected breeding site. The Lake will be managed until all stilt chicks within the Lake have fledged.

3) During the breeding season of the Hawaiian Stilt, the Lake will be managed in accordance with recommendations from a biologist knowledgeable of the wetland habitat conditions required for optimum stilt breeding habitat and to attain the biological goals set forth in section 3.2. Once initiated, management of the Lake as a stilt breeding area will not be discontinued prior to the end of the current breeding season.

4) After the breeding season (approximately August), the Lake will be drained and maintained with no standing water to encourage stilt dispersal to other wetlands and islands. Stilt intra- and inter-island movements will promote genetic diversity and reduce the probability of chance events affecting larger concentrations of stilts. The Lake will remain dry throughout the nonbreeding season.

5) To the extent possible, Cyanotech will strive to maintain the aquaculture facility predator-free by disallowing free-roaming cats and dogs at the site. Office and other building and construction areas will be kept free of litter and debris that provides shelter or food for rats, mongooses, and feral dogs and cats. A predator control program will be implemented for the Lake using traps and/or diphacinone bait stations, if the biological monitor determines that predator control is necessary to prevent chick mortality (i.e., the biological monitor documents loss of eggs/chicks in the Lake due to mongooses and/or rats).

Although Lake management is described under the Mitigation Measures section 3.3.2, the Lake breeding pond would be managed to a serve a dual purpose: (1) Minimization of incidental take of Stilt chicks by luring breeding stilts away from raceways and lava fields adjacent to Kona Airport and (2) Mitigation for incidental take of stilt chicks by providing a protected area for Hawaiian Stilts to reproduce successfully.

Lake management may be discontinued after Year 1 or Year 2 of the permit term and Cyanotech would surrender or transfer its interest in the basin to a third party. The Executive Director of NELHA has indicated that there are several other tenants interested in taking over the lease, and has offered to support and expedite the transfer. The new lessee will be required to use the basin in a manner that does not attract birds. The funds saved from the lease of the Lake may be redirected to additional on-site minimization efforts.

3.4 Success Criteria

This Conservation Plan will be considered a success if:

1) An effective, environmentally safe deterrent for significantly reducing or eliminating Hawaiian Stilt use of raceway ponds at Cyanotech is identified. The deterrent will be deemed effective only if harm (injury or death) of adult and subadult Hawaiian Stilt can be maintained to an insignificant level (near zero).

2) Foraging and nesting by Hawaiian Stilts at Cyanotech is significantly reduced or eliminated so that incidental take of Hawaiian Stilt chicks is eliminated or reduced to less than five per year.

3) The majority of adult Hawaiian Stilts have dispersed from Cyanotech to other wetland sites on the Big Island and on other islands (e.g., Maui, Molokai, and Oahu) where successful reproduction is probable.

4) When the Lake is being managed to ensure that some reproductive output is realized from the stilts attracted to Cyanotech, the mitigation strategy will be deemed a success if, averaged over the three-year permit period (or number of years the Lake is managed), the number of Hawaiian Stilt breeding pairs supported by the Lake is greater than or equal to 20 pairs, which is comparable to the estimated carrying capacity of the Lake at 20-25 pairs; and

5) The total number of Hawaiian Stilts fledged by Cyanotech in the Lake is greater than the total number of Hawaiian Stilt eggs, chicks, fledglings, and adults incidentally taken during the course of the three-year permit term.

<u>After Lake Management in Year 1:</u>

a) Excess stilt production (= total number of fledglings – total number of birds incidentally taken) in Year 1 can be used to offset incidental take in Years 2 and 3;

   (i) If the total number of fledglings produced in Year 1 is greater than the sum of the incidental take in Year 1 plus the incidental take anticipated in Years 2 and 3, then management of the Lake as a stilt breeding area may be discontinued upon approval of the Wildlife Agencies;

   (ii) If the total number of fledglings produced in Year 1 is <u>not</u> greater than the sum of the incidental take in Year 1 plus the incidental take anticipated in Years 2 and 3, then Cyanotech will manage the Lake in Year 2;

<u>After Lake Management in Year 2:</u>

b) Excess stilt production in Years 1 and 2 can be used to offset the incidental take in Years 1 and 2 plus the incidental take in Year 3;

   (i) If the total number of fledglings produced in Year 1 and 2 is greater than the sum of the incidental take in Years 1 and 2 plus the incidental take anticipated in Year 3, then management of the Lake as a stilt breeding area may be discontinued upon approval of the Wildlife Agencies;

   (ii) If the total number of fledglings produced in Year 1 and 2 is <u>not</u> greater than the sum of the incidental take in Years 1 and 2 plus the incidental take anticipated in Year 3, then Cyanotech will manage the Lake in Year 3.

From the 1998 to 2000 breeding season, Cyanotech has fledged 3.5 times more Hawaiian Stilts into the population than it has incidentally taken chicks as shown in Table 1. Furthermore, in any two given years, Cyanotech has produced more stilts in two years than it has incidentally taken in three. A conservative example would be to combine the two lowest years of production and compare it to the total number of birds incidentally taken for three years. (Total incidental take for 1998, 1999, and 2000 = 40; total Hawaiian Stilts fledged in only 1998 and 1999 = 69).

The decision to discontinue Lake management will be made during the annual consultation and review between Cyanotech and the Wildlife Agencies. This decision will be based primarily on the guidelines above, and those presented in sections 3.5(9) and (10) and 3.7.

3.5 Monitoring and Reporting

The following measures will be implemented as a part of the Conservation Plan in order to maintain an accurate census of Hawaiian Stilts at the project site, monitor and report on the level and impact of the incidental take, and monitor and evaluate fulfillment of the mitigation and minimization requirements and success of the Conservation Plan.

1) The Hawaiian Stilt population will be surveyed at Cyanotech at least once monthly during the non-breeding season. Number of adult and subadult stilts at Cyanotech will be documented and band combinations recorded, where possible.

2) Hawaiian Stilt nesting activity will be monitored at Cyanotech at least once per week beginning no later than February of each year and will continue through the breeding season until all stilt chicks have fledged. Hatching and fledging success of Hawaiian Stilts at Cyanotech will be determined, if possible. If crowded conditions at the Lake make it impossible to accurately census nests, at a minimum, the number of fledged birds will be reported. Nesting attempts by birds fledged and banded at Cyanotech will be documented, where possible.

3) Surveys for incidental take of Hawaiian Stilt will be conducted at least twice per week during the breeding season, and once per week or as needed during the non-breeding season. Efforts will be made to determine nest and chick fates through monitoring and thorough searches of the adjacent areas. To determine the amount of incidental take, and the number of eggs and chicks lost due to natural causes (predation, abandoned, addled, flooded, infertile), the bio-monitor will record:

- Nest building activity
- Number of eggs laid
- Date eggs were laid
- Estimated incubation period
- Hatching date
- Number of hatchlings
- Fate or suspected fate of eggs and chicks

4) No incidental take is anticipated with non-harmful bird deterrents proposed. If new deterrents are tested that could possibly harm a stilt, monitoring will be increased as appropriate. Additionally, Cyanotech maintenance and operations staff will assist with the monitoring on a daily basis. Injured stilts and carcasses will be brought to the attention of the biological monitor right away. The bio- monitor will record:

- Date of collection
- Time
- Location
- Age of bird
- Suspected origin
- Suspected cause of death
- Other pertinent data

5) If incidental take occurs, the recovery data will be given to the Wildlife Agencies at the end of the week that it occurs. All stilt remains will be collected and submitted to the Fish and Wildlife Service or State Division of Forestry and Wildlife for necropsy and/or scientific preservation. Cause of mortality will be determined if possible. The biological monitor will responsible for the proper handling, storage, and shipment protocols for all biological material collected on the facility.

6) If at anytime, the biological monitor determines that the minimization measures, as described in section 3.3.1, are resulting in an increasing number of stilts attempting to nest in the lava fields, the biological monitor will inform the Wildlife Agencies. The biological monitor will notify the Wildlife Agencies and the Kona Airport Manager if stilt breeding activity is detected adjacent to the airport runway.

7) An annual report will be submitted to the Wildlife Agencies within 60 days of the end of the breeding season. The report will include information on the:

   a) management actions taken by Cyanotech during the stilt breeding season;

   b) reproductive success of Hawaiian Stilts at Cyanotech;

   c) observed nesting attempts at established lava-field nesting sites;

   d) the amount of any incidental take associated with operations and maintenance of the aquaculture facility throughout the entire year, and the suspected causes of the incidental take;

   e) average monthly stilt counts at Cyanotech during breeding and non-breeding seasons;

f) a description of the deterrent methods evaluated including the number of raceway ponds tested and an assessment of the effectiveness of each deterrent; and

g) a plan of action for the upcoming breeding season, including recommendations for changes based on monitoring results.

8) With reasonable advance notification, Cyanotech will allow access to the facilities by the Wildlife Agencies for the purposes of ensuring compliance and providing technical assistance with this Conservation Plan.

9) Consultation between Cyanotech and the Wildlife Agencies will be ongoing throughout the year during the course of the permit term. A consultation and review, between Cyanotech and the Wildlife Agencies, will take place at a minimum of once per year to evaluate the fulfillment of the mitigation and minimization requirements and success of the Conservation Plan (e.g., success of deterrents, adaptive management) and to set priorities for the upcoming year.

10) If after the second year of the permit term, bird deterrents are determined by the Wildlife Agencies to be unsuccessful, consultation between Cyanotech and the Wildlife Agencies will be initiated to plan an alternative course of action (e.g., extend the permit, investigate other mitigation) prior to the end of the permit term.

3.6 Funding

Cyanotech will be responsible for accomplishing and funding the minimization and mitigation measures, and monitoring responsibilities outlined in the Conservation Plan. Costs for implementing the Conservation Plan are as follows:

Biological Monitoring and Reporting	$ 15,000
Purchase and Installation of Bird Deterrents	5,000*
Labor for Berm Reconstruction and other Bird Deterrents	22,000
Lake Lease	24,000
Lake Maintenance	3,000
Lake Water Management	2,500
Lake Predator Control (if necessary)	1,000
TOTAL PER YEAR	**$ 72,500**

*Funds allocated for deterrents as follows: Year 1 $7500, Year 2 $5000, Year 3 $2500; an average of $5000 per year.

All costs listed above will be provided by Cyanotech are budgeted as cash contributions to the implementation of the Conservation Plan. A considerable amount of Cyanotech staff time and resources has already been invested in the initial investigation, management strategy, monitoring and reporting, meetings and site visits with stakeholders, and preparation and numerous revisions of the Conservation Plan. We estimate an investment of $232,145 in out-of-pocket expenses (does not include in-kind services of managerial staff time) spent from August 1997 to present, an average of $58,056 per year.

3.7 Adaptive Management

The adaptive management strategy used to assess the extent of the attractive nuisance problem at the aquaculture facility and to deal with the changing circumstances that occurred as a result of the concerted effort by Cyanotech, under the advice of the Wildlife Agencies, to eliminate the incidental take and to accommodate the needs of the species into the daily operations and maintenance of the facility is described in section 2.3 of this plan. Assessing the results of the management and subsequent monitoring efforts was critical in understanding the potential scope of the problem on the Big Island and the explosive effect that such intense management can have on Hawaiian Stilt recovery as a whole.

Even with the knowledge gained over the past three breeding seasons, it is evident that an adaptive management strategy will be needed as the Conservation Plan advocates new biological goals aimed at reducing rather than maintaining Hawaiian Stilts at the aquaculture facility. Guiding principles of this adaptive management strategy are as follows:

a) The results of the annual monitoring reports will be evaluated by the Wildlife Agencies to determine if the bird deterrents are effective to the point that incidental take of stilt eggs, chicks, subadults, and adults is no longer an issue, and to determine whether management of the Lake can be discontinued.

b) Mitigation requirements may be discontinued prior to the end of the permit period and the requirement to meet the biological goals relative to stilt production may be relaxed if bird deterrents are found to be effective prior to termination of the permit. Another factor to consider is the progress of Hawaiian Stilt habitat improvement projects on the Big Island, Maui Nui, and Oahu being conducted at the Fish and Wildlife Service Refuges, State wildlife sanctuaries, and entities other than Cyanotech, and the potential for these sites to provide alternate breeding grounds in upcoming seasons.

c) If the results of the biological monitoring indicate that the bird deterrent measures are not producing the desired effect (reduced stilt populations at Cyanotech, in particular during the nonbreeding season), the mitigation strategy may be changed to investigate more rigorous hazing methods.

d) If the results of the biological monitoring indicate that reducing the foraging habitat provided by Cyanotech is having a greater overall negative effect on the Hawaiian Stilt population than the anticipated level of take observed at the facility in past years, Cyanotech will reconsider the goals of the Conservation Plan in accordance with the assurances provided in Chapter Five.

4.0 CHANGED CIRCUMSTANCES

"Changed circumstances" means changes in circumstances affecting the Hawaiian Stilt or the geographic area covered by the Conservation Plan that can reasonably be anticipated by Cyanotech Corporation and that can reasonably be planned for in the Conservation Plan (e.g., the listing of a new species, or a fire or other natural catastrophic event in areas prone to such event). Changed circumstances are not Unforeseen Circumstances.

The only changed circumstance identified in this Conservation Plan is an outbreak of avian botulism. Avian botulism results from the ingestion of toxin produced by the bacterium, *Clostridium botulinum*. Not enough is known about avian botulism to precisely identify the factors leading to an outbreak. Bacterial growth and various environmental conditions may favor toxin production in wetlands. When an outbreak does occur it is usually perpetuated by the following bird-maggot cycle (Locke and Friend 1987):

> *toxins are produced in a decaying animal carcass - maggots concentrate toxins - additional birds eat the toxin-laden maggots - death of more birds and more toxin production perpetuates the outbreak.*

An outbreak of avian botulism occurred at Aimakapa in 1994. Botulism was also documented during the summer of 1997 and 2001 on Maui at the Kanaha Pond Wildlife Sanctuary and Kealia Pond NWR in the summer and fall of 2000 and 2001. The main clue to botulism is sick birds. Birds affected will display ataxia (loss of muscle control) and will have difficulty standing and holding their heads upright. Because the bacterium that causes botulism is found naturally in the environment and stilts travel between wetlands, the site of the outbreak cannot always be determined. If there are any signs of birds with botulism at Cyanotech, the measures outlined in Appendix 5 will be initiated immediately.

Cyanotech Corporation will give notice to the Wildlife Agencies within seven days after learning that any of the changed circumstances listed in the Conservation Plan has occurred. As soon as practicable thereafter, but no later than 15 days after learning of the changed circumstances, Cyanotech Corporation will modify its activities in the manner described in the Conservation Plan to the extent necessary to mitigate the effects of the changed circumstances on Hawaiian Stilt and will report to the Wildlife Agencies on their actions. Cyanotech Corporation will make such modification without awaiting notice from the Wildlife Agencies.

If the Wildlife Agencies determine that changed circumstances have occurred and that Cyanotech Corporation has not responded in accordance with the Conservation Plan, the Wildlife Agencies will so notify Cyanotech Corporation and will direct them to make the required changes. Within 15 days after receiving such notice, Cyanotech Corporation will make the required changes and report to the Wildlife Agencies on its actions. Such changes are provided for in the Conservation Plan and hence do not constitute unforeseen circumstances or require amendment of the permit or the Conservation Plan.

5.0 UNFORSEEN CIRCUMSTANCES

Cyanotech Corporation and the Wildlife Agencies acknowledge that, even with provisions for monitoring, minimizing, and mitigating impacts to the Hawaiian Stilt, circumstances may arise that were not fully anticipated by the Conservation Plan and which may result in a substantial and adverse change in the status of the Hawaiian Stilt. When either party becomes aware of circumstances, which may adversely affect the Hawaiian Stilt or Cyanotech's ability to implement this plan, the party identifying the circumstance will notify the other within three days. Cyanotech and the Wildlife Agencies will meet to review the data, discuss findings, and identify possible protective measures within one week following notification of any unforeseen circumstance.

In negotiating "unforeseen circumstances" provisions for HCPs, the Wildlife Agencies shall not require the commitment of additional land or financial compensation beyond the level that was otherwise adequately afforded for the Hawaiian Stilt under this Conservation Plan, provided that the terms of the Plan are being properly carried out. Moreover, the Wildlife Agencies will not seek and Cyanotech Corporation will not be required to provide any other form of mitigation, except where extraordinary circumstances exist.

If extraordinary circumstances warrant the requirement of additional mitigation while Cyanotech Corporation is in compliance with the Conservation Plan, such mitigation will maintain the original terms of the plan to the maximum extent possible. Further, any such changes will be limited to modifications that can be accomplished within the current extent of the ponds at the Cyanotech facility. Additional mitigation requirements will not involve the payment or expenditure of additional funds beyond specified in the Conservation Plan or apply to lands available for development or land management under the original terms of the plan without the consent of the Cyanotech Corporation.

6.0 PERMIT AMENDMENTS

6.1 Minor Modifications

Informal amendments are permissible without amending the underlying section 10(a)(1)(B) permit provided that the changes do not 1) cause a net adverse effect on the Hawaiian Stilt that is significantly different from the effects considered in the original plan and issued permit or 2) result in a failure to meet the performance measures of the permit.

Examples of minor modifications to the Conservation Plan are changes in the design or management of the protected nesting site and changes in survey frequency or monitoring procedures. The Conservation Plan may be informally amended by written notification to the Fish and Wildlife Service's Pacific Islands Office and the DLNR in Honolulu, Hawaii.

6.2 Formal Amendments

Formal amendments to the Conservation Plan are required based on changes that would produce a net adverse effect on the Hawaiian Stilt greater than those considered in the development of the Conservation Plan. Formal permit amendments require written notification to the Wildlife Agencies and the same justification and supporting information for compliance with a standard incidental take permit application, including conservation planning requirements and compliance with issuance criteria.

Examples of events that would require formal amendments to the Conservation Plan would include attraction to the project site of other listed species that may be subject to incidental take, incidental take of Hawaiian Stilts above the level authorized in the section 10(a)(1)(B) permit, or failure of Cyanotech Corporation to fulfill the mitigation requirements as outlined in the Conservation Plan.

When the Wildlife Agencies or Cyanotech Corporation believes that a formal amendment to the Conservation Plan is required, consultation with the Wildlife Agencies will include the Fish and Wildlife Service's Regional and Pacific Islands Offices and the DLNR. Cyanotech will prepare the appropriate documentation for submission to the Wildlife Agencies. The documentation will include a description of the event or activity and an assessment of its impacts. The amendment will describe changes to the mitigation measures to ensure that the Hawaiian Stilt and any other species covered by the Conservation Plan are appropriately protected.

7.0 PERMIT RENEWAL OR EXTENSION

The permit may be renewed or extended with the approval of the Fish and Wildlife Service and the Department of Land and Natural Resources. The request to renew or extend the permit must be submitted in writing by the permittee and reference the permit number; certify that all statements and information in the original application are still correct or include a list of changes; and provide specific information concerning what take has occurred under the existing permit and what portions of the project are still to be completed. The request must be made to the Fish and Wildlife Service's Regional and Pacific Islands Offices and the DLNR at least 60 days prior to the permit's expiration date. The permit shall remain valid while the renewal or extension is being processed. The renewal or extension may be approved in writing by the Regional Director of the Fish and Wildlife Service and the Chairperson of the Board of Land and Natural Resources. Changes to the Conservation Plan that would result in a net adverse effect on the Hawaiian Stilt will be handled in accordance with section 6.2.

8.0 OTHER MEASURES

Section 10(a)(2)(A)(iv) of the ESA states that a Conservation Plan must specify other measures that the Director may require as being necessary or appropriate for purposes of the plan. When conservation plans involve multiple parties, the Fish and Wildlife Service may require that an Implementing Agreement be drafted and signed by each party to the Conservation Plan. The Fish and Wildlife Service also requires that a monitoring program be developed and implemented to ensure that mitigation success criteria are met. A monitoring program for the Conservation Plan has been developed that describes the data to be collected, the frequency of monitoring, and the reporting procedures and schedules. The monitoring program is described in section 3.5 of this plan. A biologist approved by the Wildlife Agencies will perform the monitoring.

The Wildlife Agencies have determined this document to be a "low-effect" Conservation Plan with negligible or minor effects on listed species, whereby an Implementation Agreement is not required.

9.0 ALTERNATIVES CONSIDERED

9.1 No Action Alternative

Under a no action scenario, microalgae farming would occur at Cyanotech with no management of on-site habitat or bird deterrent measures. Adult birds would be attracted to the invertebrate-rich ponds for foraging and consequently would nest adjacent to active raceway ponds and on adjacent lava flats, potentially including the lava flats immediately adjacent to the Kona International Airport runways. Hawaiian Stilt chicks would die in raceway ponds and active nests would likely be destroyed or abandoned due to human disturbance factors associated with normal operations of the aquaculture facility. Predation and rugged terrain would prevent nest success on adjacent lava flats. No successful reproduction of birds attracted to the project area would occur. Thus, the aquaculture facility would function as a reproductive sink for Hawaiian Stilts, and there would be little to no contribution to the recovery of Hawaiian Stilt. This alternative was not selected because it would not meet the issuance criteria for an incidental take permit, and Cyanotech Corporation would be at risk for prosecution for violating the take prohibitions of the ESA and State law HRS section 195D.

9.2 Long-term Management Off Site

Under this alternative, Cyanotech Corporation would contribute funds to 1) implement restoration, enhancement, and management actions at Aimakapa Pond, Opaeula Pond, or other off-site wetlands or 2) create a protected and managed stilt habitat adjacent to the Kealakehe WTP. The Lake would be dried out or leased to another entity. The size of the restoration area or created pond would determine the reproductive output of the new habitat, but the management would be designed to at least equal or exceed the mean number of fledglings produced per nest at natural wetlands within the main Hawaiian Islands. Once the habitat restoration is complete, this scenario would result in an increase in the Kona Coast population of Hawaiian Stilt and contribute to the recovery of the species. Based on the amount of time it has taken to complete other large wetlands restoration projects in Hawaii, it is anticipated that this alternative would take between 5 and 10 years to implement, which extends beyond the term of this permit. The new habitat would require a long-term management and monitoring commitment.

Under this scenario, incidental take of Hawaiian Stilts would not be minimized at Cyanotech, as some birds would continue to forage and subsequently nest at the raceways and on the adjacent lava flats with zero reproductive success. This alternative was not selected because it would not meet the goal of significantly reducing the bird attractant problem at Cyanotech over the long-term. Because incidental take on site would continue to occur, perhaps in perpetuity, a long-term permit with much greater financial obligations would be required. Because financial resources would be required to support off-site management, fewer resources could be dedicated to researching effective bird deterrents that could be of greater value in resolving the reproductive sink problem attributed to artificial wetland sites. This alternative is likely to be cost prohibitive and thus not economically feasible for Cyanotech Corporation.

9.3 Haze/Fee Alternative

Under the haze alternative, Hawaiian Stilts would be hazed from Cyanotech using noise or other human-induced deterrents. In order to successfully implement this scenario, it would be necessary to continually haze stilts from Cyanotech 365 days per year, 24 hours per day. Even if hazing could be implemented in this manner, it is unlikely that all birds would abandon the invertebrate-dense ponds for less than optimum foraging sites on the Big Island or other islands within the chain. Direct mortality of adult stilts would likely be avoided, and the incidental take of Hawaiian Stilt chicks from hazardous conditions in raceway ponds would be significantly reduced. Increased nesting, however, would occur on adjacent lava flats where predation and rugged terrain would result in zero reproductive success. More importantly, implementing this scenario would increase the potential for bird strikes to occur, as birds hazed from Cyanotech may once again use nesting sites adjacent to active runways. Because some birds would still remain in the area, the aquaculture facility would function as a reproductive sink, and there would be little to no contribution to the recovery of Hawaiian Stilt. Since incidental take would not be completely avoided, at least some mitigation commitment would be required to meet the permit issuance criteria. An option for mitigation to offset the reproductive loss under this scenario would be for Cyanotech Corporation to contribute funds to the management of Hawaiian Stilts at other wetlands off-site. Payment of mitigation management fees could be dedicated to wetland restoration or management projects which would contribute to the recovery of the Hawaiian Stilt.

This alternative was not selected because physically hazing birds from a site has not proven effective as a long-term solution. Hazing as the chief management tool, is viewed as a perpetual treatment of the problem, rather than the solution. Moreover, the primary indirect effect associated with hazing (i.e., failed reproduction at lava nesting sites) is in essence no different from the incidental take attributed to raceway mortality. This alternative would not meet the goal of significantly reducing the bird attractant problem at Cyanotech over the long-term. Because incidental take would continue to occur, perhaps in perpetuity, a long-term permit with much greater financial obligations would be required. Because financial resources would be required to continually haze Hawaiian Stilts, fewer resources could be dedicated to support off-site management and researching effective bird deterrents that could be of greater value in resolving the reproductive sink problem attributed to artificial wetland sites. This alternative may meet the issuance criteria for an incidental take permit and is an alternative to be given consideration in the event that an effective exclusion method cannot be identified within the term of the issued permit.

9.4 Integrated Management Approach

This alternative would implement a short-term management plan to integrate the best elements of alternatives 9.3 and 9.5 at Cyanotech, to reduce and offset the incidental take of stilt eggs and chicks while long-term strategies to exclude the population of stilts at Cyanotech can be evaluated and implemented. Under this scenario, Cyanotech would aggressively explore options and pursue solutions to reducing the invertebrate food source from its ponds in order to reduce the number of stilts attracted to the site and eliminate the attractive nuisance problem. Non-lethal bird deterrents would be investigated and used on raceway ponds with the intent of finding an effective method to exclude stilts from the ponds. Nest site fidelity in the raceway ponds would be discouraged and incidental take minimized by bird deterrents in these unprotected and hazardous sites.

During Year 1, while the long-term measures to ultimately eliminate Hawaiian Stilt foraging and nesting are being implemented, the Lake within Cyanotech would be managed to lure adult stilts into a protected and managed nesting area, away from production ponds and lava fields to ensure that some reproductive output is maintained by the significant number of stilts attracted to the artificial foraging sites at Cyanotech. After the first breeding season, the Lake would be maintained dry to encourage stilt dispersal to other wetlands along the Kona Coast and to off-island wetlands within the main Hawaiian Islands. During Years 2 and 3, Lake management would be discontinued and a portion of the funds saved from Lake management redirected to additional on-site minimization efforts and off-site mitigation to replace both of those functions formerly provided by Lake management. Approximately $12,000 per year would be reallocated to increase on-site minimization efforts to implement the most effective bird deterrent measures developed during the first year to continue to reduce attractiveness of the Cyanotech facility to Hawaiian Stilts. As mitigation for incidental take, a cash or in-kind contribution of a maximum of $12,000 per year would be dedicated to off-site wetland habitat improvements to directly or indirectly contribute to the long-term recovery of Hawaiian Stilt. Mitigation requirements would be discontinued or relaxed prior to the end of the permit period if minimization measures prove successful at significantly reducing incidental take.

This alternative was not selected because it may not meet the issuance criteria due to the unconditional closure of the Lake after Year 1. Although Lake management has not proven to be the most effective at minimization, it may be the most practical means of mitigation in the short-term. The past three years have shown that flexibility and adaptive management are a necessary components of a plan with many interacting and unpredictable variables and key to resolving this attractive nuisance problem.

9.5 Conservation Plan – Adaptive Management On Site

This alternative would implement short-term management at Cyanotech to reduce and offset the incidental take of stilt eggs and chicks while long-term strategies to exclude the population of stilts at Cyanotech can be evaluated and approved for use by the Wildlife Agencies. Under this scenario, Cyanotech would aggressively explore options and pursue solutions to reducing the invertebrate food source from its ponds in order to limit the number of stilts attracted to the site. Nest site fidelity in the raceway ponds would be discouraged and minimized by deterring birds in these unprotected and hazardous sites. Non-lethal bird deterrents such as netting and biodegradable repellents would be investigated and used on raceway ponds with the intent of finding an effective method to exclude stilts from the ponds. The Cyanotech Lake would be managed during the stilt breeding season to ensure that recruitment of fledged birds into the overall population is maintained by the significant number of stilts attracted to the artificial foraging sites at Cyanotech and the Kealakehe WTP. The Lake would be maintained dry in the nonbreeding season to encourage stilt dispersal to other wetlands.

Implementing this alternative would minimize the incidental take of Hawaiian Stilts at Cyanotech. Some birds would continue to nest on adjacent lava flats where nests would be predated and no successful reproduction is possible. However, the Lake would be managed at carrying capacity to lure stilts from hazardous areas to a protected area. Based on past breeding success with management of the Lake, it is anticipated that between 20 and 30 stilt fledglings would be produced per year even if bird deterrents prove effective at reducing the overall population of stilts at Cyanotech. Recruitment of fledged birds into the overall Hawaiian Stilt population is anticipated as at least some fledged birds are anticipated to disperse to other islands within the chain, providing for genetic diversity and contributing to species recovery. Management of the Lake as a stilt breeding area may be discontinued prior to the end of the permit period, after Year 1 or after Year 2, and the requirement to meet the biological goals of the on-site mitigation may be relaxed if Cyanotech fledges more Hawaiian Stilts than it would incidentally take (actual plus projected) during the permit term, and bird deterrents are found to be effective.

This alternative would allow Cyanotech to gain credit for the number of Hawaiian Stilt fledglings produced to offset the three-year mitigation requirement after one or two years. Implementation of this alternative presents a viable way to meet the goal of significantly reducing the bird attractant problem at Cyanotech over the long-term by focusing on solutions to the sources of the problem. Cyanotech would be able to concentrate efforts on site, and resources would be dedicated to finding effective bird deterrents. This alternative would likely meet the issuance criteria.

Actions taken by Cyanotech during the past three breeding seasons have shown that implementing the Conservation Plan can minimize stilt breeding activity in hazardous areas and contribute to Hawaiian Stilt recovery goals. Implementation of a long-term exclusion plan is not feasible at this time. Implementation of this integrated and adaptive Conservation Plan in conjunction with issuance of an incidental take permit is therefore the preferred alternative. This alternative is more fully described in Chapter Three.

10.0 DEFINITIONS

"Artificial wetlands" - in this document refers to wastewater treatment plants, aquaculture facilities, and other manmade open-water habitats whose primary purpose is not to attract birds.

Conservation Plan - Under section 10(a)(2)(A) of the ESA, a planning document that is a mandatory component of an incidental take permit application, also known as a Habitat Conservation Plan or HCP.

Deter – To keep or discourage from doing something by instilling fear, anxiety, or doubt (Neufeldt and Guralnik 1988).

Endangered Species – "…any species [including subspecies or qualifying distinct population segment] which is danger of extinction throughout all or a significant portion of its range." [Section 3(6) of ESA]'

Endangered Species Act (ESA) of 1973, as amended – 16 U.S.C. 1513-1543; Federal legislation that provides means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, and provides a program for the conservation of such endangered and threatened species.

Habitat – The location where a particular taxon of plant or animal lives and its surroundings, both living and non-living; the term includes the presence of a group of particular environmental conditions surrounding an organism including air, water, soil, mineral elements, moisture, temperature, and topography.

Habitat Conservation Plan (HCP) – See "conservation plan." A planning document to mitigate alteration or loss of natural habitat supporting a listed species.

"Harm" – Defined in regulations implementing the ESA promulgated by the Department of the Interior as an act "which actually kills or injures" listed wildlife; harm may include "significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering." (50 CFR 17.3)

"Harass" – Defined in regulations implementing the ESA promulgated by the Department of the Interior as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, and sheltering." (50 CFR 17.3)

"Haze" – To punish or harass by forcing to do hard, unnecessary work; to initiate or discipline by forcing to do ridiculous, humiliating, or painful things (Neufeldt and Guralnik 1988).

Implementing Agreement – An agreement that legally binds the permittee to the requirements and responsibilities of a conservation and section 10 permit. It may assign the responsibility for planning, approving, and implementing the mitigation measures under the HCP.

Incidental take - Take of any federally listed wildlife species that is incidental to, but not the purpose of, otherwise lawful activities (see definition for "take") [ESA section 10(a)(1)(B)].

Incidental take permit – A permit that exempts a permittee from the take prohibition of section 9 of the ESA issued by the FWS pursuant to section 10(a)(1)(B) of the ESA.

Listed species – Species including subspecies and distinct vertebrate populations, of the fish, wildlife, or plants, listed as either endangered or threatened under section 4 of the ESA.

"Low-effect HCPs" – Those involving: (1) minor or negligible effects on federally listed, proposed, or candidate species and their habitats covered under the HCP; and (2) minor or negligible effects on other environmental values or resources. "Low-effect" incidental take permits are those permits that despite their authorization of some small level of incidental take, individually or cumulatively have a minor or negligible effect on species covered.

Mitigation – Under NEPA regulations, to moderate, reduce or alleviate the impacts of a proposed activity, including: a) avoiding the impact by not taking a certain action or parts of an action; b) minimizing impacts by limiting the degree or magnitude of the action; c) rectifying the impact by repairing, rehabilitating or restoring the affected environment; d) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; e) compensating for the impact by replacing or providing substitute resources or environments (40 CFR 1508.20).

National Environmental Policy Act (NEPA) – Federal legislation establishing national policy that environmental impacts will be evaluated as an integral part of any major Federal action. Requires the preparation of an EIS (Environmental Impact Statement) for all major Federal actions significantly affecting the quality of the human environment (42 U.S.C. 4321-4327).

"Net conservation benefit" – "...contribute either directly or indirectly, to the recovery of the covered species. This contribution to recovery will vary and may not be permanent...Conservation benefits from SHAs [Safe Harbor Agreements] include, but are not limited to, reduction of habitat fragmentation rate; the maintenance, restoration, or enhancement of habitats; increase in habitat connectivity; maintenance or increase of population number or distribution; reduction of the effects of catastrophic events; establishments of buffers for protected areas; and establishment of areas to test and develop new an innovative conservations strategies." (FR 32723, June 17, 1999; definition under federal Safe Harbor Agreements; no definition available under the State law)

"Recovery" – The number of individuals of the protected species has increased to the point that the measures provided under this ESA are no longer needed.

Take – Under section 3(18) of the ESA, "... to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" with respect to federally listed endangered species of wildlife. Federal regulations provide the same taking prohibitions for threatened wildlife species [50 CFR 17.31(a)].

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APPENDICES

Appendix 1. Correspondence

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Ecoregion
300 Ala Moana Boulevard, Room 3108
Box 50088
Honolulu, Hawaii 96850

June 18, 1997

Dr. Gerald R. Cysewski
Hawaiian Ocean Science and Technology Park
73-4460 Queen Kaahumanu Highway #102
Kailua-Kona, Hawaii 96740

Dear Dr. Cysewski:

I apologize for the delay in sending this letter. My travel schedule and other duties have been particularly hectic since we met on May 27.

I appreciate your time and effort involved in showing me and my colleagues your production operation at Cyanotech. We all understand that your ponds and raceways have had the unintentional effect of attracting endangered Hawaiian stilts to your project site. Having seen the operation and discussed the matter with my colleagues, I believe that appropriate safeguards should be implemented in order to ensure that the breeding, feeding and sheltering needs of these birds are met coincident with your algae farming operations. I would much prefer attempting to work with the Hawaiian stilt issue than the other alternative, which would be to haze the birds away or otherwise discourage them from your project site.

Since we are now between breeding seasons for the stilts, I urge you to contact Mr. Andrew (Andy) Engilis of Ducks Unlimited in California (916-852-2000). Andy and I have discussed your circumstance, and I believe that his organization is best suited to provide the biological expertise prior to next breeding season that will ensure your project activities and Hawaiian stilt biological requirements are reasonably compatible.

Thanks again for your hospitality on May 27. Please do not hesitate to call if I can be of further assistance.

Sincerely,

Robert P. Smith

Robert P. Smith
Pacific Islands Manager

cc: Andy Engilis
Jeff Burgett
Mike Silbernagle
Michael Buck

NATURAL ENERGY LABORATORY OF HAWAII AUTHORITY

Natural Energy Laboratory of Hawaii & Hawaii Ocean Science and Technology Park

March 12, 1999

To: NELHA Board of Directors

From: Jim Frazier
Executive Director

Subject: Condition of Liability: Endangered Hawaiian Stilt

Cyanotech Corp. invited NELHA to a meeting with Ducks Unlimited. This was a follow-up session to review a conservation plan (working draft) for Hawaiian Stilts at Cyanotech, Kona, Hawaii. The plan is Cyanotech's approach to deal with federal regulations on an endangered species. When it was recognized that a population of the birds was being established in the raceways and in pond # 4, a management program needed to be established.

NELHA, DLNR and DOT are named in the conservation plan based on the ownership of the land. Ducks Unlimited states that the ownership encumbers the state agencies as liable partners with Cyanotech in this issue. My concerns are with the objectives and mission of this organization in managing and mitigating this condition. From the discussion the two DOT representatives (Gene Marimatsu and Bob Kawamoto) agree with these concerns for developing a greater habitat and population. The location of the airport and the safety of the population it serves would dictate that a nesting, rearing and studying program not be in pond #4 but an alternative site should instead be sought.

The sewage treatment area is much more suited to develop the environment now being formed in Pond #4. Ducks Unlimited, with their ability to move programs like the stilt conservation plan could be effective in seeking and developing an alternate site. Efforts should be made to seek and reach parties defined as the County of Hawaii, the National Fish & Wildlife Service and DLNR to locate this population to the most appropriate surroundings. NELHA is not prepared to have Cyanotech's consultant take the proposed management strategy when sound alternatives are available. From the definition given by the consultant Pond #4 is not the sole or even best environment to set a 10-year study project on the species.

Cyanotech Corp. created the attraction by allowing the leased pond to have a small amount of water on the floor. This became the attraction, as the raceways are really no different than the ponds at the treatment plant. It is now incumbent upon Cyanotech to energetically pursue the development of a logical and workable alternative. To accept a long-term study program from season to season is the researchers' goal and not in the best interest of the NELHA or DOT Airport. The State agencies are in a position to assist with developing an action plan for the alternative site but cannot endorse further development of the plan as proposed.

cc: Frank Kamahele-DOTA
Charlene Unoki-DLNR
Guy Archer-AG

73-4460 Queen Kaahumanu Hwy., #101 • Kailua-Kona, Hawaii 96740

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NATURAL ENERGY LABORATORY OF HAWAII AUTHORITY

Natural Energy Laboratory of Hawaii & Hawaii Ocean Science and Technology Park

18 March 1999

Mr. Gerald Cysewski, President
Cyanotech Corporation
73-4460 Queen Kaahumanu Hwy,
Kailua-Kona, HI 96740

Dear Gerry:

Thank you for inviting me to meet with you and Ducks Unlimited, Inc. to discuss the Hawaiian Stilt situation.

Gerry, the lease agreement between Cyanotech Corporation and NELHA clearly specifies that leased lands are restricted to uses authorized by NELHA and the State of Hawaii. All other uses must be requested for approval prior to implementation. The management plan solicited by Cyanotech Corporation and proposed by Ducks Unlimited, Inc. is not accepted nor approved by NELHA or other representatives (i.e., Department of Transportation – Airports Division or Department of Land and Natural Resources). Until such time that such authorization and approval is sought and granted, neither NELHA nor the State of Hawaii accepts responsibility for any financial or other commitment connected with the situation which was belatedly brought to this office's attention.

We are greatly concerned about the situation and highly motivated to ensure that the interests of NELHA, the State of Hawaii, Cyanotech, and other NELHA tenants, as well as, the Hawaiian Stilt population, are fully considered in determining resolution. As discussed at the meeting however, it does not appear that all options have been considered for mitigating the matter.

For your perusal, accompanying is a copy of my note to the NELHA Board of Directors outlining specific concerns. My staff and I will work with Cyanotech and Ducks Unlimited, Inc. to assist with developing an action plan however, are not prepared to endorse further development of the plan currently being proposed.

Sincerely,

James A. Frazier

James A. Frazier
Executive Director

cc: Guy Archer, State of Hawaii Deputy Attorney General
Frank Kamahele, State of Hawaii Department of Transportation/Airports
Charlene Unoki, State of Hawaii Department of Land & Natural Resources

BENJAMIN J. CAYETANO
GOVERNOR

KAZU HAYASHIDA
DIRECTOR

DEPUTY DIRECTORS
BRIAN K. MINAAI
GLENN M. OKIMOTO

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
AIRPORTS DIVISION
400 RODGERS BOULEVARD, SUITE 700
HONOLULU, HAWAII 96819-1880

IN REPLY REFER TO:

AIR-P
99.0354

June 9, 1999

RECEIVED
JUN 14
NELHA

Mr. Jim Frazier
Executive Director
Natural Energy Laboratory of Hawaii Authority
73-4460 Queen Kaahumanu Highway, #101
Kailua-Kona, Hawaii 96740

Dear Mr. Frazier:

Subject: Conservation Plan for Endangered Hawaiian Stilts at Cyanotech, Kona, Hawaii

We are opposed to the development of a conservation plan for Hawaiian stilts at Cyanotech, Kona, Hawaii. We are opposed to any activity which will be a potential bird attractant. We are concerned that aircraft approaching or departing Kona International Airport at Keahole may be susceptible to potential bird strikes since the proposed area for development is less than one mile from the runway. The establishment of a population of birds in close proximity of the airport is in violation of the attached Federal Aviation Administration (FAA) Advisory Circular No. 150/5200-33, Hazardous Wildlife Attractants On or Near Airports.

NATURAL ENERGY LABORATORY OF HAWAII AUTHORITY

Natural Energy Laboratory of Hawaii & Hawaii Ocean Science and Technology Park

14 June 1999

Mr. Gerry Cysewski, President
Cyanotech Corporation
73-4460 Queen Kaahumanu, #102
Kailua-Kona, HI 96740

Dear Gerry:

Subject: Conservation Plan for Endangered Hawaiian Stilts at Cyanotech, Kona, Hawaii

Please see the accompanying copy of a letter from Jerry M. Matsuda, P.E., Airports Administrator for the State of Hawaii Department of Transportation (DOT), Airports Division. In his letter, Mr. Matsuda advises of the DOT's position on the subject of development of a conservation plan for endangered Hawaiian Stilts at Keahole Point (specifically naming Cyanotech). A copy of the circular no. 150/5200-33, Hazardous Wildlife Attractants On or Near Airports issued by the Federal Aviation Administration (FAA) noted in Mr. Matsuda's letter is also provided herewith.

If you have any questions or concerns, please do not hesitate to contact me (or any of the individuals named in Mr. Matsuda's letter).

Sincerely,

Jacqui L. Hoover
for James A. Frazier
Executive Director

c: John Corbin, Chair - NELHA Board of Directors
Frank Kamahele, Hawaii Airports District Manager
Jerry M. Matsuda, Airports Administrator – DOTA

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U.S. Department of Transportation

Federal Aviation Administration

Advisory Circular

Subject: HAZARDOUS WILDLIFE ATTRACTANTS ON OR NEAR AIRPORTS

Date: 5/1/97

Initiated by: AAS-310 and APP-600

AC No: 150/5200-33

Change:

1. **PURPOSE.** This advisory circular (AC) provides guidance on locating certain land uses having the potential to attract hazardous wildlife to or in the vicinity of public-use airports. It also provides guidance concerning the placement of new airport development projects (including airport construction, expansion, and renovation) pertaining to aircraft movement in the vicinity of hazardous wildlife attractants. Appendix 1 provides definitions of terms used in this AC.

2. **APPLICATION.** The standards, practices, and suggestions contained in this AC are recommended by the Federal Aviation Administration (FAA) for use by the operators and sponsors of all public-use airports. In addition, the standards, practices, and suggestions contained in this AC are recommended by the FAA as guidance for land use planners, operators, and developers of projects, facilities, and activities on or near airports.

3. **BACKGROUND.** Populations of many species of wildlife have increased markedly in the last few years. Some of these species are able to adapt to human-made environments, such as exist on and around airports. The increase in wildlife populations, the use of larger turbine engines, the increased use of twin-engine aircraft, and the increase in air-traffic, all combine to increase the risk, frequency, and potential severity of wildlife-aircraft collisions.

Most public-use airports have large tracts of open, unimproved land that are desirable for added margins of safety and noise mitigation. These areas can present potential hazards to aviation because they often attract hazardous wildlife. During the past century, wildlife-aircraft strikes have resulted in the loss of hundreds of lives world-wide, as well as billions of dollars worth of aircraft damage. Hazardous wildlife attractants near airports could jeopardize future airport expansion because of safety considerations.

DAVID L. BENNETT
Director, Office of Airport Safety and Standards

SECTION 1. HAZARDOUS WILDLIFE ATTRACTANTS ON OR NEAR AIRPORTS.

1-1. TYPES OF HAZARDOUS WILDLIFE ATTRACTANTS ON OR NEAR AIRPORTS. Human-made or natural areas, such as poorly-drained areas, retention ponds, roosting habitats on buildings, landscaping, putrescible-waste disposal operations, wastewater treatment plants, agricultural or aquacultural activities, surface mining, or wetlands, may be used by wildlife for escape, feeding, loafing, or reproduction. Wildlife use of areas within an airport's approach or departure airspace, aircraft movement areas, loading ramps, or aircraft parking areas may cause conditions hazardous to aircraft safety.

All species of wildlife can pose a threat to aircraft safety. However, some species are more commonly involved in aircraft strikes than others. Table 1 lists the wildlife groups commonly reported as being involved in damaging strikes to U.S. aircraft from 1993 to 1995.

Table 1. Wildlife Groups Involved in Damaging Strikes to Civilian Aircraft, USA, 1993-1995.

Wildlife Groups	Percent involvement in reported damaging strikes
Gulls	28
Waterfowl	28
Raptors	11
Doves	6
Vultures	5
Blackbirds-Starlings	5
Corvids	3
Wading birds	3
Deer	11
Canids	1

1-2. LAND USE PRACTICES. Land use practices that attract or sustain hazardous wildlife populations on or near airports can significantly increase the potential for wildlife-aircraft collisions. FAA recommends against land use practices, within the siting criteria stated in 1-3, that attract or sustain populations of hazardous wildlife within the vicinity of airports or cause movement of hazardous wildlife onto, into, or across the approach or departure airspace, aircraft movement area, loading ramps, or aircraft parking area of airports.

Airport operators, sponsors, planners, and land use developers should consider whether proposed land uses, including new airport development projects, would increase the wildlife hazard. Caution should be exercised to ensure that land use practices on or near airports do not enhance the attractiveness of the area to hazardous wildlife.

1-3. SITING CRITERIA. FAA recommends separations when siting any of the wildlife attractants mentioned in Section 2 or when planning new airport development projects to accommodate aircraft movement. The distance between an airport's aircraft movement areas, loading ramps, or aircraft parking areas and the wildlife attractant should be as follows:

a. Airports serving piston-powered aircraft. A distance of 5,000 feet is recommended.

b. Airports serving turbine-powered aircraft. A distance of 10,000 feet is recommended.

c. Approach or Departure airspace. A distance of 5 statute miles is recommended, if the wildlife attractant may cause hazardous wildlife movement into or across the approach or departure airspace.

SECTION 2. LAND USES THAT ARE INCOMPATIBLE WITH SAFE AIRPORT OPERATIONS.

2-1. GENERAL. The wildlife species and the size of the populations attracted to the airport environment are highly variable and may depend on several factors, including land-use practices on or near the airport. It is important to identify those land use practices in the airport area that attract hazardous wildlife. This section discusses land use practices known to threaten aviation safety.

2-2. PUTRESCIBLE-WASTE DISPOSAL OPERATIONS. Putrescible-waste disposal operations are known to attract large numbers of wildlife that are hazardous to aircraft. Because of this, these operations, when located within the separations identified in the sitting criteria in 1-3 are considered incompatible with safe airport operations.

FAA recommends against locating putrescible-waste disposal operations inside the separations identified in the siting criteria mentioned above. FAA also recommends against new airport development projects that would increase the number of aircraft operations or that would accommodate larger or faster aircraft, near putrescible-waste disposal operations located within the separations identified in the siting criteria in 1-3.

2-3. WASTEWATER TREATMENT FACILITIES. Wastewater treatment facilities and associated settling ponds often attract large numbers of wildlife that can pose a threat to aircraft safety when they are located on or near an airport.

a. New wastewater treatment facilities. FAA recommends against the construction of new wastewater treatment facilities or associated settling ponds within the separations identified in the siting criteria in 1-3. During the siting analysis for wastewater treatment facilities, the potential to attract hazardous wildlife should be considered if an airport is in the vicinity of a proposed site. Airport operators should voice their opposition to such sitings. In addition, they should consider the existence of wastewater treatment facilities when evaluating proposed sites for new airport development projects and avoid such sites when practicable.

b. Existing wastewater treatment facilities. FAA recommends correcting any wildlife hazards arising from existing wastewater treatment facilities located on or near airports without delay, using appropriate wildlife hazard mitigation techniques. Accordingly, measures to minimize hazardous wildlife attraction should be developed in consultation with a wildlife damage management biologist. FAA recommends that wastewater treatment facility operators incorporate appropriate wildlife hazard mitigation techniques into their operating practices. Airport operators also should encourage those operators to incorporate these mitigation techniques in their operating practices.

c. Artificial marshes. Waste-water treatment facilities may create artificial marshes and use submergent and emergent aquatic vegetation as natural filters. These artificial marshes may be used by some species of flocking birds, such as blackbirds and waterfowl, for breeding or roosting activities. FAA recommends against establishing artificial marshes within the separations identified in the siting criteria stated in 1-3.

d. Wastewater discharge and sludge disposal. FAA recommends against the discharge of wastewater or sludge on airport property. Regular spraying of wastewater or sludge disposal on unpaved areas may improve soil moisture and quality. The resultant turf growth requires more frequent mowing, which in turn may mutilate or flush insects or small animals and produce straw. The maimed or flushed organisms and the straw can attract hazardous wildlife and jeopardize aviation safety. In addition, the improved turf may attract grazing wildlife such as deer and geese.

Problems may also occur when discharges saturate unpaved airport areas. The resultant soft, muddy conditions can severely restrict or prevent emergency vehicles from reaching accident sites in a timely manner.

e. Underwater waste discharges. The underwater discharge of any food waste, e.g., fish processing offal, that could attract scavenging wildlife is not recommended within the separations identified in the siting criteria in 1-3.

2-4. WETLANDS.

a. Wetlands on or near Airports.

(1) Existing Airports. Normally, wetlands are attractive to many wildlife species. Airport operators with wetlands located on or nearby airport property should be alert to any wildlife use or habitat changes in these areas that could affect safe aircraft operations.

(2) Airport Development. When practicable, the FAA recommends siting new airports using the separations identified in the siting criteria in 1-3. Where alternative sites are not practicable or when expanding existing airports in or near wetlands, the wildlife hazards should be evaluated and minimized through a wildlife management plan prepared by a wildlife damage management biologist, in consultation with the U.S. Fish and Wildlife Service (USFWS) and the U.S. Army Corps of Engineers (COE).

NOTE: If questions exist as to whether or not an area would qualify as a wetland, contact the U.S. Army COE, the Natural Resource Conservation Service, or a wetland consultant certified to delineate wetlands.

b. Wetland mitigation. Mitigation may be necessary when unavoidable wetland disturbances result from new airport development projects. Wetland mitigation should be designed so it does not create a wildlife hazard.

(1) FAA recommends that wetland mitigation projects that may attract hazardous wildlife be sited outside of the separations identified in the siting criteria in 1-3. Wetland mitigation banks meeting these siting criteria offer an ecologically sound approach to mitigation in these situations.

(2) Exceptions to locating mitigation activities outside the separations identified in the siting criteria in 1-3 may be considered if the affected wetlands provide unique ecological functions, such as critical habitat for threatened or endangered species or ground water recharge. Such mitigation must be compatible with safe airport operations. Enhancing such mitigation areas to attract hazardous wildlife should be avoided. On-site mitigation plans may be reviewed by the FAA to determine compatibility with safe airport operations.

(3) Wetland mitigation projects that are needed to protect unique wetland functions (see 2-4.b.(2)), and that must be located in the siting criteria in 1-3 should be identified and evaluated by a wildlife damage management biologist before implementing the mitigation. A wildlife damage management plan should be developed to reduce the wildlife hazards.

NOTE: AC 150/5000-3, *Address List for Regional Airports Division and Airports District/Field Offices*, provides information on the location of these offices.

2-5. DREDGE SPOIL CONTAINMENT AREAS.

FAA recommends against locating dredge spoil containment areas within the separations identified in the siting criteria in 1-3, if the spoil contains material that would attract hazardous wildlife.

SECTION 3. LAND USES THAT MAY BE COMPATIBLE WITH SAFE AIRPORT OPERATIONS.

3-1. GENERAL. Even though they may, under certain circumstances, attract hazardous wildlife, the land use practices discussed in this section have flexibility regarding their location or operation and may even be under the airport operator's or sponsor's control. In general, the FAA does not consider the activities discussed below as hazardous to aviation if there is no apparent attraction to hazardous wildlife, or wildlife hazard mitigation techniques are implemented to deal effectively with any wildlife hazard that may arise.

3-2. ENCLOSED WASTE FACILITIES. Enclosed trash transfer stations or enclosed waste handling facilities that receive garbage indoors; process it via compaction, incineration, or similar manner; and remove all residue by enclosed vehicles, generally would be compatible, from a wildlife perspective, with safe airport operations, provided they are not located on airport property or within the runway protection zone (RPZ). No putrescible-waste should be handled or stored outside at any time, for any reason, or in a partially enclosed structure accessible to hazardous wildlife.

Partially enclosed operations that accept putrescible-waste are considered to be incompatible with safe airport operations. FAA recommends these operations occur outside the separations identified in the siting criteria in 1-3.

3-3. RECYCLING CENTERS. Recycling centers that accept previously sorted, non-food items such as glass, newspaper, cardboard, or aluminum are, in most cases, not attractive to hazardous wildlife.

3-4. COMPOSTING OPERATIONS ON AIRPORTS. FAA recommends against locating composting operations on airports. However, when they are located on an airport, composting operations should not be located closer than the greater of the following distances: 1,200 feet from any aircraft movement area, loading ramp, or aircraft parking space; or the distance called for by airport design requirements. This spacing is intended to prevent material, personnel, or equipment from penetrating any Obstacle Free Area (OFA), Obstacle Free Zone (OFZ), Threshold Siting Surface (TSS), or Clearway (see AC 150/5300-13, *Airport Design*). On-airport disposal of compost by-products is not recommended for the reasons stated in 2-3.d.

a. Composition of material handled. Components of the compost should never include any municipal solid waste. Non-food waste such as leaves, lawn clippings, branches, and twigs generally are not considered a wildlife attractant. Sewage sludge, wood-chips, and similar material are not municipal solid wastes and may be used as compost bulking agents.

b. Monitoring on-airport composting operations. If composting operations are to be located on airport property, FAA recommends that the airport operator monitor composting operations to ensure that steam or thermal rise does not affect air traffic in any way. Discarded leaf disposal bags or other debris must not be allowed to blow onto any active airport area. Also, the airport operator should reserve the right to stop any operation that creates unsafe, undesirable, or incompatible conditions at the airport.

3-5. ASH DISPOSAL. Fly ash from resource recovery facilities that are fired by municipal solid waste, coal, or wood, is generally considered not to be a wildlife attractant because it contains no putrescible matter. FAA generally does not consider landfills accepting only fly ash to be wildlife attractants, if those landfills: are maintained in an orderly manner; admit no putrescible-waste of any kind; and are not co-located with other disposal operations.

Since varying degrees of waste consumption are associated with general incineration, FAA classifies the ash from general incinerators as a regular waste disposal by-product and, therefore, a hazardous wildlife attractant.

3-6. CONSTRUCTION AND DEMOLITION (C&D) DEBRIS LANDFILLS. C&D debris (Class IV) landfills have visual and operational characteristics similar to putrescible-waste disposal sites. When co-located with putrescible-waste disposal operations, the probability of hazardous wildlife attraction to C&D landfills increases because of the similarities between these disposal activities.

FAA generally does not consider C&D landfills to be hazardous wildlife attractants, if those landfills: are maintained in an orderly manner; admit no putrescible-waste of any kind; and are not co-located with other disposal operations.

3-7. WATER DETENTION OR RETENTION PONDS. The movement of storm water away from runways, taxiways, and aprons is a normal function on most airports and is necessary for safe aircraft operations. Detention ponds hold storm water for short periods, while retention ponds hold water indefinitely. Both types of ponds control runoff, protect water quality, and can attract hazardous wildlife. Retention ponds are more attractive to hazardous wildlife than detention ponds because they provide a more reliable water source.

To facilitate hazardous wildlife control, FAA recommends using steep-sided, narrow, linearly-shaped, rip-rap lined, water detention basins rather than retention basins. When possible, these ponds should be placed away from aircraft movement areas to minimize aircraft-wildlife interactions. All vegetation in or around detention or retention basins that provide food or cover for hazardous wildlife should be eliminated.

If soil conditions and other requirements allow, FAA encourages the use of underground storm water infiltration systems, such as French drains or buried rock fields, because they are less attractive to wildlife.

3-8. LANDSCAPING. Wildlife attraction to landscaping may vary by geographic location. FAA recommends that airport operators approach landscaping with caution and confine it to airport areas not associated with aircraft movements. All landscaping plans should be reviewed by a wildlife damage management biologist. Landscaped areas should be monitored on a continuing basis for the presence of hazardous wildlife. If hazardous wildlife is detected, corrective actions should be implemented immediately.

3-9. GOLF COURSES. Golf courses may be beneficial to airports because they provide open space that can be used for noise mitigation or by aircraft during an emergency. On-airport golf courses may also be a concurrent use that provides income to the airport.

Because of operational and monetary benefits, golf courses are often deemed compatible land uses on or near airports. However, waterfowl (especially Canada geese) and some species of gulls are attracted to the large, grassy areas and open water found on most golf courses. Because waterfowl and gulls occur throughout the U.S., FAA recommends that airport operators exercise caution and consult with a wildlife damage management biologist when considering proposals for golf course construction or expansion on or near airports. Golf courses should be monitored on a continuing basis for the presence of hazardous wildlife. If hazardous wildlife is detected, corrective actions should be implemented immediately.

3-10. AGRICULTURAL CROPS. As noted above, airport operators often promote revenue-generating activities to supplement an airport's financial viability. A common concurrent use is agricultural crop production. Such use may create potential hazards to aircraft by attracting wildlife. Any proposed on-airport agricultural operations should be reviewed by a wildlife damage management biologist. FAA generally does not object to agricultural crop production on airports when: wildlife hazards are not predicted; the guidelines for the airport areas specified in 3-10.a-f. are observed; and the agricultural operation is closely monitored by the airport operator or sponsor to ensure that hazardous wildlife are not attracted.

NOTE: If wildlife becomes a problem due to on-airport agricultural operations, FAA recommends undertaking the remedial actions described in 3-10.f.

a. Agricultural activities adjacent to runways. To ensure safe, efficient aircraft operations, FAA recommends that no agricultural activities be conducted in the Runway Safety Area (RSA), OFA, and the OFZ (see AC 150/5300-13).

b. Agricultural activities in areas requiring minimum object clearances. Restricting agricultural operations to areas outside the RSA, OFA, OFZ, and Runway Visibility Zone (RVZ) (see AC 150/5300-13) will normally provide the minimum object clearances required by FAA's airport design standards. FAA recommends that farming operations not be permitted within areas critical to the proper operation of localizers, glide slope indicators, or other visual or electronic navigational aids. Determinations of minimal areas that must be kept free of farming operations should be made on a case-by-case basis. If navigational aids are present, farm leases for on-airport agricultural activities should be coordinated with FAA's Airway Facilities Division, in accordance with FAA Order 6750.16, *Siting Criteria for Instrument Landing Systems.*

NOTE: Crop restriction lines conforming to the dimensions set forth in Table 2 will normally provide the minimum object clearance required by

FAA airport design standards. The presence of navigational aids may require expansion of the restricted area.

c. Agricultural activities within an airport's approach areas. The RSA, OFA, and OFZ all extend beyond the runway shoulder and into the approach area by varying distances. The OFA normally extends the farthest and is usually the controlling surface. However, for some runways, the TSS (see AC 150/5300-13, Appendix 2) may be more controlling than the OFA. The TSS may not be penetrated by any object. The minimum distances shown in Table 2 are intended to prevent penetration of the OFA, OFZ, or TSS by crops or farm machinery.

NOTE: Threshold Siting standards should not be confused with the approach areas described in Title 14, Code of Federal Regulations, Part 77, (14 CFR 77), *Objects Affecting Navigable Airspace.*

d. Agricultural activities between intersecting runways. FAA recommends that no agricultural activities be permitted within the RVZ. If the terrain is sufficiently below the runway elevation, some types of crops and equipment may be acceptable. Specific determinations of what is permissible in this area requires topographical data. For example, if the terrain within the RVZ is level with the runway ends, farm machinery or crops may interfere with a pilot's line-of-sight in the RVZ.

e. Agricultural activities in areas adjacent to taxiways and aprons. Farming activities should not be permitted within a taxiway's OFA. The outer portions of aprons are frequently used as a taxilane and farming operations should not be permitted within the OFA. Farming operations should not be permitted between runways and parallel taxiways.

f. Remedial actions for problematic agricultural activities. If a problem with hazardous wildlife develops, FAA recommends that a professional wildlife damage management biologist be contacted and an on-site inspection be conducted. The biologist should be requested to determine the source of the hazardous wildlife attraction and suggest remedial action. Regardless of the source of the attraction, prompt remedial actions to protect aviation safety are recommended. The remedial actions may range from choosing another crop or farming technique to complete termination of the agricultural operation.

Whenever on-airport agricultural operations are stopped due to wildlife hazards or annual harvest, FAA recommends plowing under all crop residue and harrowing the surface area smooth. This will reduce or eliminate the area's attractiveness to foraging wildlife. FAA recommends that this requirement be written into all on-airport farm use contracts and clearly understood by the lessee.

Table 2. Minimum Distances Between Certain Airport Features And Any On-Airport Agriculture Crops.

Aircraft Approach Category And Design Group [1]	Distance In Feet From Runway Centerline To Crop		Distance In Feet From Runway End To Crop		Distance In Feet From Centerline Of Taxiway To Crop	Distance In Feet From Edge Of Apron To Crop
	Visual & ≥ ¾ mile	< ¾ mile	Visual & ≥ ¾ mile	< ¾ mile		
Category A & B Aircraft						
Group I	200 [2]	400	300[3]	600	45	40
Group II	250	400	400[3]	600	66	58
Group III	400	400	600	800	93	81
Group IV	400	400	1,000	1,000	130	113
Category C, D & E Aircraft						
Group I	530[3]	575[3]	1,000	1,000	45	40
Group II	530[3]	575[3]	1,000	1,000	66	58
Group III	530[3]	575[3]	1,000	1,000	93	81
Group IV	530[3]	575[3]	1,000	1,000	130	113
Group V	530[3]	575[3]	1,000	1,000	160	138
Group VI	530[3]	575[3]	1,000	1,000	193	167

1. Design Groups are based on wing span, and Category depends on approach speed of the aircraft.

Group I:	Wing span up to 49 ft.	Category A:	Speed less than 91 knots
Group II:	Wing span 49ft. up to 78 ft.	Category B:	Speed 91 knots up to 120 knots
Group III:	Wing span 79 ft. up to 117 ft.	Category C:	Speed 121 knots up to 140 knots
Group IV:	Wing span 118 ft. up to 170 ft.	Category D:	Speed 141 knots up to 165 knots
Group V:	Wing span 171 ft. up to 213 ft.	Category E:	Speed 166 knots or more
Group VI:	Wing span 214 ft. up to 261 ft.		

2. If the runway will only serve small airplanes (12,500 lb. And under) in Design Group I, this dimension may be reduced to 125 feet; however, this dimension should be increased where necessary to accommodate visual navigational aids that may be installed. For example farming operations should not be allowed within 25 feet of a Precision Approach Path Indicator (PAPI) light box.

3. These dimensions reflect the TSS as defined in AC 150/5300-13, Appendix 2. The TSS cannot be penetrated by any object. Under these conditions, the TSS is more restrictive than the OFA, and the dimensions shown here are to prevent penetration of the TSS by crops and farm machinery.

SECTION 4. NOTIFICATION OF FAA ABOUT HAZARDOUS WILDLIFE ATTRACTANTS ON OR NEAR AN AIRPORT.

4-1. GENERAL. Airport operators, land developers, and owners should notify the FAA in writing of known or reasonably foreseeable land use practices on or near airports that either attract or may attract hazardous wildlife. This section discusses those notification procedures.

4-2. NOTIFICATION REQUIREMENTS FOR WASTE DISPOSAL SITE OPERATIONS. The Environmental Protection Agency (EPA) requires any operator proposing a new or expanded waste disposal operation within 5 statute miles of a runway end to notify the appropriate FAA Regional Airports Division Office and the airport operator of the proposal (40 CFR 258, *Criteria for Municipal Solid Waste Landfills*, section 258.10, *Airport Safety*). The EPA also requires owners or operators of new municipal solid waste landfill (MSWLF) units, or lateral expansions of existing MSWLF units that are located within 10,000 feet of any airport runway end used by turbojet aircraft or within 5,000 feet of any airport runway end used only by piston-type aircraft, to demonstrate successfully that such units are not hazards to aircraft.

a. Timing of Notification. When new or expanded MSWLFs are being proposed near airports, MSWLF operators should notify the airport operator and the FAA of this as early as possible pursuant to 40 CFR Part 258. Airport operators should encourage the MSWLF operators to provide notification as early as possible.

NOTE: AC 150/5000-3 provides information on these FAA offices.

b. Putrescible-Waste Facilities. In their effort to satisfy the EPA requirement, some putrescible-waste facility proponents may offer to undertake experimental measures to demonstrate that their proposed facility will not be a hazard to aircraft. To date, the ability to sustain a reduction in the numbers of hazardous wildlife to levels that existed before a putrescible-waste landfill began operating has not been successfully demonstrated. For this reason, demonstrations of experimental wildlife control measures should not be conducted in active aircraft operations areas.

c. Other Waste Facilities. To claim successfully that a waste handling facility sited within the separations identified in the siting criteria in 1-3 does not attract hazardous wildlife and does not threaten aviation, the developer must establish convincingly that the facility will not handle putrescible material other than that as outlined in 3-2. FAA requests that waste site developers provide a copy of an official permit request verifying that the facility will not handle putrescible material other than that as outlined in 3-2. FAA will use this information to determine if the facility will be a hazard to aviation.

4-3. NOTIFYING FAA ABOUT OTHER WILDLIFE ATTRACTANTS. While U. S. EPA regulations require landfill owners to provide notification, no similar regulations require notifying FAA about changes in other land use practices that can create hazardous wildlife attractants. Although it is not required by regulation, FAA requests those proposing land use changes such as those discussed in 2-3, 2-4, and 2-5 to provide similar notice to the FAA as early in the development process as possible. Airport operators that become aware of such proposed development in the vicinity of their airports should also notify the FAA. The notification process gives the FAA an opportunity to evaluate the effect of a particular land use change on aviation safety.

The land use operator or project proponent may use FAA Form 7460-1, *Notice of Proposed Construction or Alteration*, or other suitable documents to notify the appropriate FAA Regional Airports Division Office.

It is helpful if the notification includes a 15-minute quadrangle map of the area identifying the location of the proposed activity. The land use operator or project proponent should also forward specific details of the proposed land use change or operational change or expansion. In the case of solid waste landfills, the information should include the type of waste to be handled, how the waste will be processed, and final disposal methods.

4-5. FAA REVIEW OF PROPOSED LAND USE CHANGES.

a. The FAA discourages the development of facilities discussed in section 2 that will be located within the 5,000/10,000-foot criteria in 1-3.

b. For projects which are located outside the 5,000/10,000-foot criteria, but within 5 statute miles of the airport's aircraft movement areas, loading ramps, or aircraft parking areas, FAA may review development plans, proposed land use changes, operational changes, or wetland mitigation plans to determine if such changes present potential wildlife hazards to aircraft operations. Sensitive airport areas will be identified as those that lie under or next to approach or departure airspace. This brief examination should be sufficient to determine if further investigation is warranted.

c. Where further study has been conducted by a wildlife damage management biologist to evaluate a site's compatibility with airport operations, the FAA will use the study results to make its determination.

d. FAA will discourage the development of any excepted sites (see Section 3) within the criteria specified in 1-3 if a study shows that the area supports hazardous wildlife species.

4-6. AIRPORT OPERATORS. Airport operators should be aware of proposed land use changes, or modification of existing land uses, that could create hazardous wildlife attractants within the separations identified in the siting criteria in 1-3. Particular attention should be given to proposed land uses involving creation or expansion of waste water treatment facilities, development of wetland mitigation sites, or development or expansion of dredge spoil containment areas.

a. AIP-funded airports. FAA recommends that operators of AIP-funded airports, to the extent practicable, oppose off-airport land use changes or practices (within the separations identified in the siting criteria in 1-3) that may attract hazardous wildlife. Failure to do so could place the airport operator or sponsor in noncompliance with applicable grant assurances. FAA recommends against the placement of airport development projects pertaining to aircraft movement in the vicinity of hazardous wildlife attractants. Airport operators, sponsors, and planners should identify wildlife attractants and any associated wildlife hazards during any planning process for new airport development projects.

b. Additional coordination. If, after the initial review by FAA, questions remain about the existence of a wildlife hazard near an airport, the airport operator or sponsor should consult a wildlife damage management biologist. Such questions may be triggered by a history of wildlife strikes at the airport or the proximity of the airport to a wildlife refuge, body of water, or similar feature known to attract wildlife.

c. Specialized assistance. If the services of a wildlife damage management biologist are required, FAA recommends that land use developers or the airport operator contact the appropriate state director of the United States Department of Agriculture/Animal Damage Control (USDA/ADC), or a consultant specializing in wildlife damage management. Telephone numbers for the respective USDA/ADC state offices may be obtained by contacting USDA/ADC's Operational Support Staff, 4700 River Road, Unit 87, Riverdale, MD, 20737-1234, Telephone (301) 734-7921, Fax (301) 734-5157. The ADC biologist or consultant should be requested to identify and quantify wildlife common to the area and evaluate the potential wildlife hazards.

d. Notifying airmen. If an existing land use practice creates a wildlife hazard, and the land use practice or wildlife hazard cannot be immediately eliminated, the airport operator should issue a Notice to Airmen (NOTAM) and encourage the land owner or manager to take steps to control the wildlife hazard and minimize further attraction.

APPENDIX 1. DEFINITIONS OF TERMS USED IN THIS ADVISORY CIRCULAR.

1. GENERAL. This appendix provides definitions of terms used throughout this AC.

a. Aircraft movement area. The runways, taxiways, and other areas of an airport which are used for taxiing or hover taxiing, air taxiing, takeoff, and landing of aircraft exclusive of loading ramps and aircraft parking areas.

b. Airport operator. The operator (private or public) or sponsor of a public use airport.

c. Approach or departure airspace. The airspace, within 5 statute miles of an airport, through which aircraft move during landing or takeoff.

d. Concurrent use. Aeronautical property used for compatible non-aviation purposes while at the same time serving the primary purpose for which it was acquired; and the use is clearly beneficial to the airport. The concurrent use should generate revenue to be used for airport purposes (see Order 5190.6A, *Airport Compliance Requirements*, sect. 5h).

e. Fly ash. The fine, sand-like residue resulting from the complete incineration of an organic fuel source. Fly ash typically results from the combustion of coal or waste used to operate a power generating plant.

f. Hazardous wildlife. Wildlife species that are commonly associated with wildlife-aircraft strike problems, are capable of causing structural damage to airport facilities, or act as attractants to other wildlife that pose a wildlife-aircraft strike hazard.

g. Piston-use airport. Any airport that would primarily serve FIXED-WING, piston-powered aircraft. Incidental use of the airport by turbine-powered, FIXED-WING aircraft would not affect this designation. However, such aircraft should not be based at the airport.

h. Public-use airport. Any publicly owned airport or a privately-owned airport used or intended to be used for public purposes.

i. Putrescible material. Rotting organic material.

j. Putrescible-waste disposal operation. Landfills, garbage dumps, underwater waste discharges, or similar facilities where activities include processing, burying, storing, or otherwise disposing of putrescible material, trash, and refuse.

k. Runway protection zone (RPZ). An area off the runway end to enhance the protection of people and property on the ground (see AC 150/5300-13). The dimensions of this zone vary with the design aircraft, type of operation, and visibility minimum.

l. Sewage sludge. The de-watered effluent resulting from secondary or tertiary treatment of municipal sewage and/or industrial wastes, including sewage sludge as referenced in U.S. EPA's *Effluent Guidelines and Standards*, 40 C.F.R. Part 401.

m. Shoulder. An area adjacent to the edge of paved runways, taxiways, or aprons providing a transition between the pavement and the adjacent surface, support for aircraft running off the pavement, enhanced drainage, and blast protection (see AC 150/5300-13).

n. Turbine-powered aircraft. Aircraft powered by turbine engines including turbojets and turboprops but excluding turbo-shaft rotary-wing aircraft.

o. Turbine-use airport. Any airport that ROUTINELY serves FIXED-WING turbine-powered aircraft.

p. Wastewater treatment facility. Any devices and/or systems used to store, treat, recycle, or reclaim municipal sewage or liquid industrial wastes, including Publicly Owned Treatment Works (POTW), as defined by Section 212 of the Federal Water Pollution Control Act (P.L. 92-500) as amended by the Clean Water Act of 1977 (P.L. 95-576) and the Water Quality Act of 1987 (P.L. 100-4). This definition includes any pretreatment involving the reduction of the amount of pollutants, the elimination of pollutants, or the alteration of the nature of pollutant properties in wastewater prior to or in lieu of discharging or otherwise introducing such pollutants into a POTW. (See 40 C.F. R. Section 403.3 (o), (p), & (q)).

q. Wildlife. Any wild animal, including without limitation any wild mammal, bird, reptile, fish, amphibian, mollusk, crustacean, arthropod, coelenterate, or other invertebrate, including any part, product, egg, or offspring there of (50 CFR 10.12, *Taking, Possession, Transportation, Sale, Purchase, Barter, Exportation, and Importation of Wildlife and Plants*). As used in this AC, WILDLIFE includes feral animals and domestic animals while out of the control of their owners (14 CFR 139.3, *Certification and Operations: Land Airports Serving CAB-Certificated Scheduled Air Carriers Operating Large Aircraft (Other Than Helicopters)*).

r. Wildlife attractants. Any human-made structure, land use practice, or human-made or natural geographic feature, that can attract or sustain hazardous wildlife within the landing or departure airspace, aircraft movement area, loading ramps, or aircraft parking areas of an airport. These attractants can include but are not limited to architectural features, landscaping, waste disposal sites, wastewater treatment facilities, agricultural or aquacultural activities, surface mining, or wetlands.

s. Wildlife hazard. A potential for a damaging aircraft collision with wildlife on or near an airport (14 CFR 139.3).

2. RESERVED.

BENJAMIN J. CAYETANO
GOVERNOR

BRIAN K. MINAAI
DIRECTOR

DEPUTY DIRECTORS
GLENN M. OKIMOTO
JADINE Y. URASAKI

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813-5097

IN REPLY REFER TO:
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March 1, 2001

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Mr. James A. Frazier
Executive Director
Natural Energy Laboratory of Hawaii Authority
73-4460 Queen Kaahumanu Highway, #101
Kailua-Kona, Hawaii 96740-2632

Approved by: ______________

Exc. Dir. ______________

Dear Mr. Frazier:

We have reviewed the draft Habitat Conservation Plan (HCP) for Cyanotech Corporation. The draft HCP continues to treat our aviation safety concerns in a casual manner and ignores our opposition to the use of the artificial marsh as a wildlife attractant.

We have repeatedly informed you of our concerns and opposition of Cyanotech's actions which pose a wildlife hazard to aircraft operations at Kona International Airport at Keahole. Cyanotech's actions are contrary to the Federal Aviation Administration Advisory Circular No. 150/5200-33 that recommends against establishing artificial marshes within 10,000 feet of an airport that serves turbine-powered aircraft. This Advisory Circular was transmitted to you with our correspondence dated June 9, 1999. You are also in violation of General Lease No. S-4717 between State of Hawaii Board of Land and Natural Resources and the Natural Energy Laboratory of Hawaii, Section 13-C which states, "any activity on the land or along the adjacent coast that would interfere with or be a hazard to the flight of aircraft over the land or to and from the Airport or interfere with air navigation and communication facilities serving the airport is prohibited." The use of an artificial marsh to attract Hawaiian Stilts and other birds within the airport environs is not a viable mitigation measure because it violates existing agreements and creates a wildlife hazard. Additionally, we are aware that suitable off-site mitigation measures are available that would not compromise aviation safety. We suggest that immediate measures be taken to enforce the provisions of the lease agreement and that Cyanotech be made to reduce or eliminate the attraction to Hawaiian Stilts and other birds.

Please have your staff contact Lynette Kawaoka, Planner of the Airports Division, at (808) 838-8812 to clarify any questions you may have.

Very truly yours,

BRIAN K. MINAAI
Director of Transportation

c: Department of Land and Natural Resources
Federal Aviation Administration
U.S. Department of Agriculture Wildlife Services

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
AIRPORTS DIVISION
400 RODGERS BOULEVARD, SUITE 700
HONOLULU, HAWAII 96819-1880

BRIAN K. MINAAI
DIRECTOR

DEPUTY DIRECTORS
GLENN M. OKIMOTO
JADINE Y. URASAKI

March 1, 2001

IN REPLY REFER TO:
AIR-P
01.0097

Dr. Gerald Cysewski
President
Cyanotech Corporation
73-4460 Queen Kaahumanu Highway
Kailua-Kona, Hawaii 96740

Dear Dr. Cysewski:

Subject: Draft Habitat Conservation Plan

We have reviewed the draft Habitat Conservation Plan (HCP) for Cyanotech Corporation. The draft HCP continues to treat our aviation safety concerns in a casual manner and ignores our opposition to the use of the artificial marsh as a wildlife attractant.

The wildlife hazards to aircraft operations at Kona International Airport at Keahole have been created as a direct result of your actions. The number of birds using your facility has increased over the years and the artificial marsh seems to have exacerbated the stilt problem by not only increasing incidental take, but also increasing nesting along raceways. By allowing this activity to continue, you may be exposing yourself to potential liability if an adverse aircraft incident results from the bird attraction. Your actions are contrary to Federal Aviation Administration guidance (AC No. 150/5200-33) that recommends against establishing artificial marshes within 10,000 feet of an airport that serves turbine-powered aircraft. You are also in violation of General Lease No. S-4717 between the State of Hawaii Board of Land and Natural Resources and the Natural Energy Laboratory of Hawaii, Section 13-C which states, "any activity on the land or along the adjacent coast that would interfere with or be a hazard to the flight of aircraft over the land or to and from the Airport or interfere with air navigation and communication facilities serving the airport is prohibited." The use of an artificial marsh to attract Hawaiian Stilts and other birds within the airport environs is not a viable mitigation measure because it violates existing agreements and creates a wildlife hazard. Additionally, we are aware that suitable off-site mitigation measures are available that would not compromise aviation safety. Therefore, you should implement aggressive measures to eliminate the attraction to Hawaiian Stilts and other birds and you should consider suitable off-site mitigation measures that would not threaten aviation safety. We suggest that you work with Mr. Mike Pitzler, U.S. Department of Agriculture, Wildlife Services, to develop mitigation measures to achieve that end.

Please have your staff contact Lynette Kawaoka, Planner, at 838-8812 to clarify any questions you may have. Thank you for your assistance in this matter.

Sincerely,

Jerry M. Matsuda

JERRY M. MATSUDA, P.E.
Airports Administrator

c: Department of Land and Natural Resources
Natural Energy Laboratory of Hawaii Authority
U.S. Fish and Wildlife Services
U.S. Department of Agriculture Wildlife Services
Federal Aviation Administration

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BENJAMIN J. CAYETANO
GOVERNOR

LEADING HAWAII INTO THE NEW MILLENNIUM
1959 2000+

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
AIRPORTS DIVISION
400 RODGERS BOULEVARD, SUITE 700
HONOLULU, HAWAII 96819-1880

MAR 2001
RECEIVED

BRIAN K. MINAAI
DIRECTOR

DEPUTY DIRECTORS
GLENN M. OKIMOTO
JADINE Y. URASAKI

March 1, 2001

IN REPLY REFER TO:

AIR-P
01.0100

Dr. Paul Henson
Field Supervisor
U.S. Department of the Interior
Fish and Wildlife Services
P.O. Box 50088
Honolulu, Hawaii 96850-0001

Dear Dr. Henson:

We have reviewed the draft Habitat Conservation Plan (HCP) for Cyanotech Corporation. The draft HCP continues to treat our aviation safety concerns in a casual manner and ignores our opposition to the use of the artificial marsh as a wildlife attractant.

We have repeatedly informed you of our concerns and opposition of Cyanotech's actions which pose a wildlife hazard to aircraft operations at Kona International Airport at Keahole. Cyanotech's actions are contrary to the Federal Aviation Administration Advisory Circular No. 150/5200-33, Hazardous Wildlife Attractants On or Near Airports, that recommends against establishing artificial marshes within 10,000 feet of an airport that serves turbine-powered aircraft. Additionally, Cyanotech's actions are in violation of General Lease No. S-4717, between the State of Hawaii Board of Land and Natural Resources and the Natural Energy Laboratory of Hawaii, Section 13-C which states, "any activity on the land or along the adjacent coast that would interfere with or be a hazard to the flight of aircraft over the land or to and from the Airport or interfere with air navigation and communication facilities serving the airport is prohibited." The use of an artificial marsh to attract Hawaiian Stilts and other birds within the airport environs is not a viable mitigation measure because it violates existing agreements and creates a wildlife hazard. Additionally, we are aware that suitable off-site mitigation measures are available that would not compromise aviation safety. We suggest that immediate measures be taken to enforce the provisions of the lease agreement and that Cyanotech be made to reduce or eliminate the attraction to Hawaiian Stilts and other birds. We suggest that you work with Mr. Mike Pitzler, U.S. Department of Agriculture, Wildlife Services to develop mitigation measures to achieve that end.

Please contact Lynette Kawaoka, Planner, at (808) 838-8812 to clarify any questions you may have.

Sincerely,

Jerry M. Matsuda

JERRY M. MATSUDA, P.E.
Airports Administrator

c: Department of Land and Natural Resourses
Federal Aviation Administration
U.S. Department of Agriculture Wildlife Services

HAWAII OCEAN SCIENCE & TECHNOLOGY (HOST) PARK

and the Natural Energy Laboratory of Hawaii

Administered by the Natural Energy Laboratory of Hawaii Authority (NELHA), State of Hawaii

March 14, 2001

Mr. Brian K. Minaai, Director
Department of Transportation
869 Punchbowl Street
Honolulu, Hawaii 96813-5097

NELHA FILE COPY

Dear Mr. Minaai:

We have received your letter to James Frazier of March 1, 2001 expressing your Department's concerns about the population of endangered Hawaiian stilts that has developed on the property leased by NELHA tenant Cyanotech.

James Frazier retired from NELHA in November, 2000, and I am now serving as Executive Director. I look forward to cooperating with the Department of Transportation, both as a "sister" agency of the State and as a neighbor. Not only is NELHA adjacent to the Kona International Airport at Keahole, we are located on a site fronting the Queen Kaahumanu Highway and we have significant interaction with your Harbors Division through activities at Kawaihae Harbor.

As you are aware, NELHA and Cyanotech have worked for several years to address the problems created when Hawaiian stilts chose to inhabit Cyanotech's microalgal raceways. We have attempted to address the conflicting legal requirements of both the Endangered Species Act as administered by the U.S. Fish and Wildlife Service and the State Department of Land and Natural Resources and the Federal Aviation Act administered by the FAA and your Department. We are disturbed to learn of your conclusion that the DRAFT Habitat Conservation Plan prepared by Cyanotech consultant Ducks Unlimited Inc. does not adequately address the aviation concerns represented by your department, and we intend to work quickly to rectify that situation. I have already talked with Lynnette Kawaoka of your department and assured her of our intention to deal with this issue as promptly as possible.

As a newcomer to this position, I am eager to address this and all other issues crucial to NELHA's success. I must, however, work through the history of this problem before I can develop an appropriate mitigation strategy. As part of that process, I am also forwarding your letter and our records on this issue to our Deputy Attorney General, John Chang, and requesting that he review the information and recommend appropriate action for NELHA.

I assure you that NELHA will make every effort to address your concerns as promptly as possible. We will work with the Department of the Attorney General to develop within one month an appropriate response and a formal action plan for your consideration.

We look forward to maintaining a cooperative working relationship with the Department of Transportation, and we request your forbearance while we develop a strategy for dealing with this serious problem.

Sincerely,

Jeff L. Smith
Executive Director

73-4460 Queen Kaahumanu Hwy., #101, Kailua-Kona, Hawaii USA 96740-2632

HAWAII OCEAN SCIENCE & TECHNOLOGY (HOST) PARK

and the Natural Energy Laboratory of Hawaii

Administered by the Natural Energy Laboratory of Hawaii Authority (NELHA), State of Hawaii

March 14, 2001

Mr. John W. K. Chang, Esq.
State of Hawaii, Department of the Attorney General
Commerce and Economic Development Division
Hale Auhau, 425 Queen Street
Honolulu, HI 96813

NELHA FILE COPY

Dear John,

As I mentioned to you on the phone yesterday, NELHA has received a strongly worded letter from the Department of Transportation regarding the status of endangered Hawaiian stilts nesting on the property of NELHA tenant, Cyanotech. I view this as a very serious issue, and I want to develop an appropriate strategy for dealing with it as soon as possible.

I attach a copy of the subject letter from D.O.T. as well as the DRAFT Habitat Conservation Plan prepared recently by Cyanotech's consultant, Ducks Unlimited Inc. This document was developed in an effort to comply with mandates of the Endangered Species Act, as administered by the U.S. Fish and Wildlife Service in cooperation with the State Department of Land and Natural Resources. My interim response to D.O.T. is also attached for your information.

I also attach the agenda and notes from a meeting held last November in Honolulu that was attended by representatives of most of the concerned agencies. Dr. Tom Daniel, who represented NELHA at that meeting, prepared these notes. The attached attendance list for that meeting indicates the range of agencies represented. Note that the Department of Transportation Airports Division has contracted with the U.S. Department of Agriculture Wildlife Services Division for evaluation of wildlife hazards at all Hawaii airports, including Kona International Airport at Keahole.

It appears to us that NELHA should take a strong role in developing a rapid solution to this problem. Previous policy has been to defer to Cyanotech as the tenant that must deal with the problem. As pointed out in the D.O.T. letter, however, NELHA has responsibility for our tenants' actions. Cyanotech has worked diligently to comply with the mandates of the USFWS and DLNR, but these are clearly contrary to the concerns of D.O.T. and the FAA.

The preferred long-term solution, as indicated in the Draft HCP, is to develop alternative habitats elsewhere and then make the existing artificial habitat at Keahole unattractive so that the birds will leave. The Endangered Species Act will not allow hazing the birds from their present location until alternative habitat is available. The most viable alternative habitat is that at `Aimakapā Pond in the Kaloko-Honokohau National Historic Park. This pond has significantly greater surface area, and thus more potential for alternative habitat, than the alternative ponds at Makalawena to the North of Keahole. It is our understanding that the National Park Service intends eventually to restore this pond to its former state, in which it was the major nesting habitat for the stilts. It appears that the needed restoration has been delayed in favor of other ongoing activities of preparing the park for public use.

The `Aimakapā pond area of the National Park is approximately 2 miles south of the runway, and there is a question of whether that is sufficiently distant to satisfy FAA concerns. The smaller Ōpae`ula pond at Makalwena is approximately the same distance north of the runway, so there is no clearly preferable alternative habitat. Another alternative being proposed by a community group involves development of an artificial wetland using the effluent from the Honokohau sewage treatment plant south of Honokohau Harbor. This has great potential as a solution to many problems, but it will be a large, expensive and long-term project. It will also be only a few thousand feet further from the runway, probably not enough to allay FAA concerns.

These last two paragraphs are included to help you understand what looks like the preferred plan for approaching this problem. It will require that we expedite significantly the National Park Service's restoration of `Aimakapā pond and convince the various agencies that this action will indeed provide the most expeditious solution to the problem.

We solicit your review of this issue and solicit your recommendations as to how NELHA should proceed. Please contact me if you need further information or discussion of the issues.

Sincerely,

Jeff L. Smith
Executive Director

Attachments:

1) DRAFT: *A Conservation Plan for Hawaiian Stilt at Cyanotech Aquaculture Facility, Keahole Point, Hawaii.* Prepared for Cyanotech Corporation by Ducks Unlimited, Inc., January 2001.
2) Letter AIR-P 01.0099, dated 3/1/01, to James A Frazier from Brian K. Minaai, Director of Transportation
3) Response, dated 3/14/01, to Brian K. Minaai from Jeff L. Smith
4) Agenda from meeting of 11/21/00
5) Notes on meeting of 11/21/00
6) Attendance list from meeting of 11/21/00

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Ecoregion
300 Ala Moana Boulevard, Room 3-122
Box 50088
Honolulu, Hawaii 96850

APR 12 2001

Mr. Jerry Matsuda, P.E.
Airports Administrator
Department of Transportation
Airports Division
400 Rodgers Boulevard, Suite 700
Honolulu, HI 96819-1880

Dear Mr. Matsuda:

We appreciate your March 1, 2001, letter regarding the draft Conservation Plan (HCP) for the Hawaiian Stilt at Cyanotech Aquaculture Facility (Cyanotech), Keahole Point, Hawaii. Please be assured that the U.S. Fish and Wildlife Service (Service) does not treat the issue of aircraft safety in a casual manner, nor have we ignored your concerns. In fact, the Service is no longer recommending that Cyanotech accommodate Hawaiian stilts (stilt) at the aquaculture facility, and instead is supporting a plan to develop deterrents and implement hazing.

As you know, the Cyanotech Aquaculture Facility attracts stilts that forage at the facility year-round and attempt to breed at the raceways and the lava field between Cyanotech and the Kona Airport. Stilt chicks that hatch adjacent to the raceways are led by parent stilts to feed in microalgae ponds where they are suspected of drowning or dying from adverse physiological reactions to the microalgae medium. This constitutes "take" of a species protected by the Endangered Species Act (ESA). Section 9 of the ESA prohibits "take" of listed species.

The Service initially suggested that Cyanotech try to accommodate the stilts by creating a suitable nesting area at the facility away from the raceways, lava field, and airport. For a variety of reasons, including Department of Transportation's (DOT) objection to this approach, the Service is no longer encouraging Cyanotech to accommodate stilts at the facility. The focus now is to eliminate the attraction of the facility through deterrents and hazing. Deterrents and hazing, however, cannot be implemented until Cyanotech obtains the necessary Federal and State incidental take permits.

Under Section 10 of the ESA the Service may authorize the take through issuance of an incidental take permit, provided the landowner develops a conservation plan that will, among other things, minimize and mitigate the impacts of the take, ensure adequate funding to implement the conservation plan, and not appreciably reduce the likelihood of survival and recovery of the species in the wild (50 CFR 17.22 (b)(2)(i)).

The goal of the HCP is to eliminate the attraction of the Cyanotech facility to stilts. However, as proposed in the HCP, Cyanotech will continue to provide suitable nesting habitat on site while effective deterrent methods are developed. This is expected to reduce the amount of incidental take and draw birds away from the airport during the breeding season. This habitat will be phased out and eventually eliminated. It is important to understand that this temporary accommodation for nesting stilts is not only intended to provide mitigation, but also to reduce take and attract stilts away from the lava field and airport runway.

In the past, the Service and DOT have worked together cooperatively with other stakeholders (e.g. Federal Aviation Administration, Department of Land and Natural Resources) to resolve similar issues requiring a balance between concerns for aviation safety and survival and recovery of species protected by the ESA and the Migratory Bird Treaty Act. The success of the solutions developed resulted from a clear identification of the actual wildlife hazard, understanding of the biology and behavior of the wildlife species, and the ability to implement proposed solutions.

I look forward to working together to achieve our mutual goal of deterring stilts from foraging and nesting at Cyanotech. If you have any questions or concerns, please contact Fish and Wildlife Biologist James Kwon or Annie Marshall, at 808/541-3441.

Sincerely,

Paul Henson
Field Supervisor
Ecological Services

cc: Cyanotech Corporation
Natural Energy Laboratory of Hawaii
Department of Land and Natural Resources-DOFAW
Federal Aviation Administration
U.S. Department of Agriculture Wildlife Services

APPENDIX 2: HAWAIIAN STILT BAND RE-SIGHTINGS 1998-2000 AT CYANOTECH AND KWTP

Band		1998												1999						
No.	Colors	21-Apr	25-Apr	5-May	19-May	20-May	27-May	4-Jun	1-Jul	20-Jul	18-Aug	10-Sep	3-Nov	4-Feb	8-Mar	15-Mar	19-Mar	22-Mar	29-Mar	5-Apr
1	BB/RA				b							C			K	C				C
2	BW/RA				b							C			C	C	C	C		C
3	BY/RA				b								C					C	C	C
4	BG/RA					b						C			C			C		C
5	GB/RA					b						C		C			C			
6	GG/RA					b														
7	GR/RA					b								C						C
8	GW/RA					b					C	C	C	C	C		C			C
9	OB/RA					b						C	C	C	K		C	C		
10	OG/RA					b					C	C					C	C	C*	
11	OO/RA					b						C	C	C	K		C	C		C
12	OR/RA					b						C				C	C	C		C
13	WB/RA					b						C	C		K		C		C	C
14	WG/RA					b					C	C	C		K				C	
15	WO/RA					b						C	C	C	K			C		C
16	WR/RA					b										C		C		
17	BO/RA						b						C				C	C		
18	OW/RA						b			C			C	C					C	C
19	OY/RA						b			C		C	C	C	C	C	C	C	C	
20	WW/RA						b			C		C	C	C	C	C			C	C
21	WY/RA						b			C		C	C	C	C			C		C
22	YB/RA							b				C		C	K		C		C	C
23	YW/RA							b		C		C	C	C	C	C		C		C
24	YG/RA								b					C	K	C	C		C	C
25	YO/RA								b				C	C	C		C	C	C	C
26	YR/RA																			
27	YY/RA																			
28	RW/RA																			
29	BB/WA																			
30	BG/WA																			
31	GB/WA																			
32	GY/WA																			
33	OG/WA																			
34	OO/WA																			
35	BA/WW (BI)	C		C						C				C*		C		C	C	C
36	BA/BB (BI)		C	C				K										C		C
37	BY/AR (OA)			C																
38	AB/GB (MA)							K												
39	BA/RW (BI)											C	C			C		C		C
40	WA/BR (MA)							K												
41	R/BA (OA?)	C													C	C		C		
42	OO/AO																	C		
43	A only on left																		C	C

Note: Birds with RA or WA on right leg banded at Cyanotech. Deceased chicks banded in 1999 - RB/RA, RG/RA, RO/RA, BO/WA, BR/WA, BW/WA, GR/WA, GO/WA, GG/WA, GW/WA, OB/WA.

Banding Site: BI=Big Isle; OA=Oahu; MA=Maui; b=banding date; C=sighted at Cyanotech; K=sighted at KWTP; d=deceased

APPENDIX 2: HAWAIIAN STILT BAND RE-SIGHTINGS 1998-2000 AT CYANOTECH AND KWTP

Band No.	Colors	1999 12-Apr	13-Apr	20-Apr	26-Apr	1-May	3-May	7-May	10-May	14-May	20-May	24-May	29-May	1-Jun	4-Jun	8-Jun	14-Jun	21-Jun	28-Jun	23-Aug
1	BB/RA				C							C								
2	BW/RA						C		C			C								
3	BY/RA				C							C				C				
4	BG/RA						C		C		C	C		C		C	C			
5	GB/RA				C											C				K
6	GG/RA																			
7	GR/RA											C				C				
8	GW/RA		C		C				C/K			C					C			K
9	OB/RA				C															
10	OG/RA		C	C	C		C		K											
11	OO/RA			C												C				K
12	OR/RA	C									C						C			K
13	WB/RA																C			
14	WG/RA			C	C							C					C			
15	WO/RA				C		C													
16	WR/RA		C		C											C	C			
17	BO/RA	C	C									C				C		C		
18	OW/RA																			
19	OY/RA		C		C		C		C											
20	WW/RA				C											C				
21	WY/RA		C						C											
22	YB/RA		C		C															
23	YW/RA		C				C									C				
24	YG/RA				C															K
25	YO/RA			C	C															
26	YR/RA	b				C	C	C	C		C	C	C	C		C				
27	YY/RA	b				C	C	C	C		C	C	C	C	C	C				
28	RW/RA	b		C		C			C											
29	BB/WA			b																
30	BG/WA			b																K
31	GB/WA			b		C	C	C	C		C	C								
32	GY/WA				b	C	C	C	C		C	C								
33	OG/WA				b	C	C	C	C		C	C*								
34	OO/WA				b	C	C	C	C		C	C*								
35	BA/WW (BI)	C	C	C	C				C		C	C		C		C	C	C	C	C
36	BA/BB (BI)											C		C		C	C	C		
37	BY/AR (OA)																			
38	AB/GB (MA)																			
39	BA/RW (BI)	C		C	C		C				C	C*								
40	WA/BR (MA)																			
41	R/BA (OA?)						C		C		C	C		C		C	C	C	C	
42	OO/AO																			
43	A only on left		C									C						C		

Banding Site: BI=Big Isle; OA=Oahu; MA=Maui; b=banding date; C=sighted at Cyanotech; K=sighted at KWTP; d=deceased

APPENDIX 2: HAWAIIAN STILT BAND RE-SIGHTINGS 1998-2000 AT CYANOTECH AND KWTP

Band		1999				2000														
No.	Colors	20-Sep	25-Oct	30-Nov	20-Dec	19-Jan	21-Jan	4-Feb	19-Feb	28-Feb	6-Mar	16-Mar	22-Mar	23-Mar	1-Apr	7-Apr	14-Apr	21-Apr	29-Apr	5-May
1	BB/RA	K		C						C	C			C				C		
2	BW/RA	K		C	K						C	C				C				
3	BY/RA																			
4	BG/RA	K		C					C	C					C	C	C			C
5	GB/RA		K	K		K			K			K								
6	GG/RA																			
7	GR/RA				K						C									
8	GW/RA	K			K	C		C	K	C						C			C	C
9	OB/RA	K		K			C				C					C				C
10	OG/RA	K		C					K	C	C	C								
11	OO/RA								C		C	C			C	C	C	C	C	C
12	OR/RA	K		K	K				C	C		C		C	C	C	C	C	C	C
13	WB/RA			C	K	K	C	C	C		C							C		
14	WG/RA			C		C		C		C						C				
15	WO/RA					K				C	C	C								
16	WR/RA	K		C			C	C	C		C		C	C	C	C	C	C		C
17	BO/RA	K								C										
18	OW/RA						C			C	C			C	C	C	C	C	C	C
19	OY/RA		C		K		C		K						C		C	C		C
20	WW/RA	K	C		K			C								K			C	C
21	WY/RA				K	C		C	C		C		C	C	C	C	C	C	C	C
22	YB/RA	K	C	K			C				C	C								
23	YW/RA				K			C	C		C				C	C	C	C		C
24	YG/RA	K	C				C													
25	YO/RA	K	C	C			C												C	
26	YR/RA	K	K	C	K				C							C		C	C	
27	YY/RA	K				C		C		C	C				C					
28	RW/RA																			
29	BB/WA																			
30	BG/WA																			
31	GB/WA	K	C/K				C	C			C	C				K			C	
32	GY/WA																			
33	OG/WA			C								K								K
34	OO/WA			C								K				K				K
35	BA/WW (BI)			C	K				C	C	C				C	C			C	
36	BA/BB (BI)	K		K					C					C		C	C			
37	BY/AR (OA)																			
38	AB/GB (MA)																			
39	BA/RW (BI)		K	C							C	C		C	C	C		C	C	C
40	WA/BR (MA)																			
41	R/BA (OA?)	K	C	C			C		C	C		C	C		C	C	C	C	C	C
42	OO/AO																			
43	A only on left	K	C			K											C	C	C	

Banding Site: BI=Big Isle; OA=Oahu; MA=Maui; b=banding date; C=sighted at Cyanotech; K=sighted at KWTP; d=deceased

APPENDIX 2: HAWAIIAN STILT BAND RE-SIGHTINGS 1998-2000 AT CYANOTECH AND KWTP

Band No.	Colors	2000 11-May	19-May	26-May	29-May	2-Jun	9-Jun	16-Jun	23-Jun	30-Jun	7-Jul	14-Jul	21-Jul	28-Jul	4-Aug	11-Aug	15-Aug	16-Aug	23-Aug	28-Aug
1	BB/RA		C	C		C					K							K		
2	BW/RA										K				C			K		
3	BY/RA		C			C					K	C			K			K		
4	BG/RA	C																		
5	GB/RA																			
6	GG/RA																			
7	GR/RA																			
8	GW/RA		C	C			C					C			K					
9	OB/RA	C	C	C		C	C	C	C	C	C	C	C		C					
10	OG/RA																			
11	OO/RA	C									K									
12	OR/RA										K				K			K		
13	WB/RA	C				K		C			C	C								
14	WG/RA																			
15	WO/RA	C	C	C		K					K				K					
16	WR/RA																			
17	BO/RA																			
18	OW/RA			C		C		C				C	C							
19	OY/RA				d															
20	WW/RA																			
21	WY/RA			C		K			C			C	C	C	C	C				
22	YB/RA					K									C			K		
23	YW/RA			C		C					K									
24	YG/RA																			
25	YO/RA																			
26	YR/RA										K									
27	YY/RA																			
28	RW/RA																			
29	BB/WA																			
30	BG/WA																			
31	GB/WA																			
32	GY/WA																			
33	OG/WA																			
34	OO/WA		C			K														
35	BA/WW (BI)																			
36	BA/BB (BI)		C					C												
37	BY/AR (OA)																			
38	AB/GB (MA)																			
39	BA/RW (BI)	C	C	C		C	C	C	C	C	C	C	C	C	C		C		C	C
40	WA/BR (MA)																			
41	R/BA (OA?)	C	C	C		C	C	C	C	C	C	C	C	C						
42	OO/AO																			
43	A only on left			C			C	C												

Banding Site: BI=Big Isle; OA=Oahu; MA=Maui; b=banding date; C=sighted at Cyanotech; K=sighted at KWTP; d=deceased

APPENDIX 2: HAWAIIAN STILT BAND RE-SIGHTINGS 1998-2000 AT CYANOTECH AND KWTP

Band		2000									
No.	Colors	1-Sep	4-Sep	8-Sep	15-Sep	22-Sep	6-Oct	16-Oct	26-Oct	17-Nov	6-Dec
1	BB/RA										
2	BW/RA			K						K	
3	BY/RA										
4	BG/RA										
5	GB/RA										
6	GG/RA										
7	GR/RA										
8	GW/RA			K			K		C		C
9	OB/RA			C	C	C	C				C
10	OG/RA										
11	OO/RA										
12	OR/RA			K			K			K	
13	WB/RA			K					C		
14	WG/RA										C
15	WO/RA			K							C
16	WR/RA									K	
17	BO/RA										
18	OW/RA			K			K				
19	OY/RA										
20	WW/RA										
21	WY/RA										
22	YB/RA			K							
23	YW/RA									K	
24	YG/RA										
25	YO/RA										
26	YR/RA										
27	YY/RA						C		K		
28	RW/RA										
29	BB/WA										
30	BG/WA										
31	GB/WA			K							
32	GY/WA										
33	OG/WA			K						K	
34	OO/WA									K	
35	BA/WW (BI)										
36	BA/BB (BI)			C			K				
37	BY/AR (OA)										
38	AB/GB (MA)										
39	BA/RW (BI)	C	C		C	C	C	C		K	
40	WA/BR (MA)										
41	R/BA (OA?)						K				
42	OO/AO										
43	A only on left										

Banding Site: BI=Big Isle; OA=Oahu; MA=Maui; b=banding date; C=sighted at Cyanotech; K=sighted at KWTP; d=deceased

APPENDIX 3: Assessment of Incidental Take using Raceway-Hatched Chicks

Est. No. of Raceway Hatchlings Only												Assessment of Incidental Take Chicks Hatched in RWs Only		
Raceway (RW) Data Only									Actual Data			Hypothetical Data		
	Actual No. of Nests	Nest Success (%)				Average No. of Eggs of Successful Nests		Egg Viability		Adjusted[b]		Nest Success (%) 1998-2001		
									Take[a]	Take		36.7 (Mean)	19.2 (Low)	50.0 (High)
Year	(N_A)	Actual (NS_A)	Mean (NS_M)	Low (NS_L)	High (NS_H)	Actual (E_A)	Mean (E_M)	(EV)	Reported	Reported	$N_ANS_AE_AEV$	$N_ANS_ME_MEV$	$N_ANS_LE_MEV$	$N_ANS_HE_MEV$
1998	6	33.3	36.7	19.2	50	4	3.5	86.1	1	1	7	7	3	9
1999	9	44.4	36.7	19.2	50	3	3.5	86.1	29	10	10	10	5	14
2000	26	19.2	36.7	19.2	50	3.2	3.5	86.1	10	5	14	29	15	39
2001	14	50	36.7	19.2	50	3.7	3.5	86.1	14	10	22	15	8	21
								Mean	14	7	13	15	8	21
								Median	12	8	12	13	7	18
								Range	1-29	1-10	7-22	7-29	3-15	9-39

[a]Includes chicks hatched in RWs, Lava, Lake and of Unknown origin
1998 (1 RWs); 1999 (29 hatchlings=10 RWs, 12 Lake, 7 Unknown);
2000 (10 hatchlings=5 RWs, 3 Lava, 2 Unknown);
2001 (14 hatchlings=10 RWs, 1 Lava, 3 Unknown).
[b]Adjusted to present raceway hatched chicks only for comparison.

Est. No. of RW Hatchlings Only = (Actual No. of RW Nests)(% RW Nest Success)(Avg. No. of Eggs of Succ. RW Nests)(Egg Viability)

Est. No. of RW Hatchlings Only = $N_ANS_XE_XEV$

Less 30-50% est. chick mortality from natural causes or ongoing predation (Chang 1990)

Plus 30-50% est. chick movement from lava or uknown origin to raceways

see Table 1 and 3 for raw data and definitions

APPENDIX 4

Preliminary Three-year Action Plan for Bird Deterrent Measures at Cyanotech

The intent of this Action Plan is to provide general parameters for the research and application of bird deterrent measures at Cyanotech. Methods, experimental design, monitoring, criteria for determining effectiveness, and timeline for implementation with annual cost estimates are outlined. This plan will be refined and deterrents summary updated within the first six months of the permit term.

GOALS AND OBJECTIVES

- Test and implement non-lethal methods to eliminate bird attractants (e.g., aquatic insects, open water, gravel berms, remoteness) in the raceways;
- The implementation cost of this action plan is economically feasible for Cyanotech Corporation;
- The bird deterrent measures do not reduce microalgae productivity due to biochemical or operational limitations;
- The bird deterrent measures are environmentally sound and do not compromise the integrity of the microalgae products;
- Eliminate or reduce Hawaiian Stilt foraging and breeding activity on site over a three-year period down to an insignificant amount; and
- Reduction in the overall numbers of Hawaiian Stilts attracted to the Cyanotech microalgae facility.

INCREMENTAL STRATEGY

Multiple bird deterrent measures will be tested and, if viable, applied to additional raceway ponds. Monitoring and evaluation by the biological monitor is necessary to determine if deterrent measures are successful, not successful, or in need of modification. Annual consultation with the Wildlife Agencies at the end of each breeding season is necessary to evaluate bird deterrents and modify this action plan year-to-year based on the monitoring results of the previous season. Ongoing adaptive management is a critical component of this action plan.

Microalgae are the fastest growing plants known and are capable of accelerated growth rates under certain conditions that include water, carbon dioxide, nutrients, aeration, and intense sunlight. The bird deterrent measures must be cost effective and low maintenance so that they do not inhibit microalgae operations. Screening devices must allow for full sunlight and ventilation so that they do not reduce microalgae productivity. Any deterrent measure applied directly to the algal media is required to be safe for human consumption and must not reduce product purity. The microalgae products are manufactured primarily for human consumption and regulated by the State Department of Health and the U.S. Food and Drug Administration.

The following strategies will be adopted for the trial and implementation of the deterrent measures in the raceway ponds (See Plan Section 2.1 Species Account for biological justifications):

A. Removal of food resources attracting Hawaiian Stilts (primarily Ephydrid shoreflies)
B. Removal of gravel berms and favorable nesting substrates
C. Reduction in remote undisturbed areas suitable for nesting
D. Prevent Hawaiian Stilts from being attracted to shallow, calm, open-water areas using non-harmful visual, audible, or mechanical methods.

DESCRIPTIONS OF DETERRENT MEASURES AND ESTIMATED COSTS (costs for equipment and supplies only):

1. **Increase Spirulina harvest from 50 to 70%:** Currently Cyanotech harvests the Spirulina microalgae media down to 50% of the pond approximately once per week. At that time, more alga media is added and the production cycle continues until the next harvest. Cyanotech will increase that harvest to 70% of the pond. An increase in the amount of Spirulina harvested is anticipated to reduce the number of invertebrates associated with the media by limiting reproductive capacity. The life cycle of the Ephydra fly is approximately 14 days.
   Estimated Costs Year 1: $2,000

2. **Bacillus thuringiensis (Bti) Treatment of Ephydra larvae**: Cyanotech will investigate Bti to biologically control the Ephydra fly larvae prior to adult emergence. The Bti application will follow label specifications. This form of bio-control poses no known threat to human health, and is one of the methods that should not compromise the integrity of the natural Spirulina product. Bti will be applied in coordination with harvesting methods described in #1 to maximize effectiveness.
   Estimated Costs Year 1: $1,000

3. **Review of existing research on the Ephydra life cycle:** Review literature relevant to the long-term reduction of Ephydrid populations through biological and mechanical control methods (e.g., design of a more effective "filth" screening system). Request technical assistance from the Biological Resources Division and Fish and Wildlife Service entomologists, other agencies, or Ephydrid specialists. Application of recent research on site when appropriate.
   Estimated Costs year 1 and 2: $500/year

4. **Reduction or removal of gravel berms**: During the first year of the permit term, Cyanotech will reconfigure the gravel berms along the edge of the raceway ponds to steepen the outer slopes and reduce or eliminate the level surface lip where stilt nesting occurs. This measure will make the berms less desirable to nesting stilts, reduce the area adjacent to the raceways where stilts are capable of constructing nests, and promote abandonment of unsuitable nest sites.
   Estimated Costs Year 1: $500

5. **Increase road activity**: Cyanotech employees will deter adult stilts from raceways. The deterrent method used will be limited to driving and walking on raceway roads several times per day to increase the level of human activity adjacent to the production ponds, and placing preventative devices such as Mylar tape, in areas where nest building activities are observed.
Estimated Costs Year 1 to 3: $500/year

6. **Research raceway netting alternatives and costs**: Explore feasibility of non-lethal, specially-designed and engineered netting or other exclusion devices to reduce the open water bird attractant, and to discourage or exclude stilts from foraging and nesting in raceway areas. Cyanotech will work with vendors and resource agencies to assess designs, effectiveness, ordering procedures, installation, maintenance, and costs.
Estimated Costs Year 1: $1,500

7. **Research bird repellent alternatives and costs**: Explore feasibility of non-lethal, biodegradable bird repellents to be used in and around the raceways to deter stilts from foraging and breeding. Cyanotech will work with resource agencies and vendors to assess effectiveness, ordering procedures, application, costs, and potential harm to microalgae products.
Estimated Costs Year 1 and 2: $500/year

8. **Research alternative deterrent measures to augment or replace measures above**: Cyanotech will pursue research of additional deterrent measures contingent upon viability of measures discussed above.
Estimated Costs Year 1 to 3: $1,000/year

9. **Implement raceway netting trial**: If task #6 is determined to be feasible, netting of 1-2 ponds in a remote location will be done on a trial basis to evaluate effectiveness and cost of future netting of additional ponds.
Estimated Costs Year 2: $2,500

10. **Implement bird repellent trial**: If task #7 is determined to be feasible, application of repellents to 5–10 ponds will be done on a trial basis to determine effectiveness and cost of future repellent treatment to additional ponds.
Estimated Costs Year 3: $1,000

EVALUATION AND REPORTING

Ongoing monitoring and evaluation of each deterrent measure is an integral part of the adaptive management strategy. The response of the Hawaiian Stilt and data on microalgae productivity will be the determinatives of the overall effectiveness of each deterrent.

1. Waterbird Response

   A monthly census of waterbirds present on the facility will be conducted throughout the permit. Counts will be broken down by species and location (Lake, raceways, lava fields). Hawaiian Stilt band re-sighting data will be recorded to track bird movements. Hawaiian Stilts will be aged during counts whenever possible. Breeding activity will be monitored on a weekly basis to determine reproductive success and incidental take (See Plan Section 3.5 for details). The biological monitor may increase the length of time, coverage, and frequency of surveys, for deterrents that may result in bird injury or mortality.

2. Microalgae Productivity

   The microalgae will be monitored closely to assess the effectiveness of deterrents in relation to microalgae productivity. The optical density of the microalgae will be measured in both treated and untreated ponds daily, five days per week, to monitor microalgae growth and productivity.

3. Reporting

   A description of the deterrent methods evaluated including the number of raceway ponds tested and an assessment of the effectiveness of each deterrent will be included in the annual report to the Wildlife Agencies.

CRITERIA FOR DETERMINING EFFECTIVENESS OF PLAN

- An effective, environmentally-sound, economically-feasible deterrent for significantly reducing or eliminating Hawaiian Stilt use of the raceway ponds is discovered;
- Harm (injury or death) of adult and subadult Hawaiian Stilt can be maintained to an insignificant level (near zero);
- The majority of Hawaiian Stilts have dispersed from Cyanotech to other natural wetland sites on the Big Island and other main islands where successful reproduction is probable;
- An incremental reduction in the number of active stilt nests in the raceways each year. By year three of the permit term, the number of active stilt nests in the raceways is reduced to less than or equal to 10 percent of the number of nests documented in the year 2000 (26 nests in year 2000; 10% = 3 nests).

DETERRENTS EXPLORED

Several devices to prevent or exclude birds from accessing raceways ponds have been explored since 1997, three are discussed here:

a) Netting -- Installation of a synthetic mesh to cover the 70-acre expanse of open water to prevent stilts from foraging and nesting in raceways was explored. Preliminary calculations to purchase netting came out to a large initial investment of $900,000 - 950,000. This amount did not include special designs, installation, or annual maintenance costs. Lower cost nets are available; however to be effective, Cyanotech nets are required to be UV, salt, alkali, and wind tolerant and allow for the full sunlight and ventilation necessary for optimum microalgae production. Unless specifically designed for easy mechanical removal, the nets would impede microalgae harvest, pond maintenance operations, and emergency repairs. Netting of all the production ponds is not economically nor operationally feasible at this time. However, specially-designed nets would prevent adult stilt foraging and nesting thereby reducing incidental take of stilt chicks and will be re-evaluated in smaller areas as part of a long-term solution.

b) Fencing -- Installation of a six-inch high fence to exclude stilt chicks from feeding and perishing in raceways was suggested in 1997. The installation of approximately 36,375 feet of fenceline around pond clusters would block chicks from entering raceways but would not minimize incidental take. Because the fence would not exclude adults, breeding stilts would continue to forage in the raceways and attempt to breed in adjacent areas. Hatchlings would attempt to access water and perish on roadways and at the edge of raceways which is no different from the incidental take attributed to mortality in the ponds. Furthermore, a fence barrier poses operational challenges by restricting access of heavy equipment during maintenance activities. The perimeter fence is not a viable alternative and is not being considered at this time.

c) Mylar tape – Mylar tape was tested to prevent stilts from establishing nesting territories in undesirable areas. Mylar is the synthetic material that silvery greeting balloons are made of. Mylar tape, 0.5 and 1.2-inch wide, was strung across the former DU Pond at 10 and 20 foot intervals prior to the 2001 breeding season. So far, the Mylar has been successful at preventing stilt nesting in small areas. However, Mylar is extremely labor intensive due to its short life span in this environment. The intense sunlight, salty air, and gusty winds limit its usefulness to three weeks. Mylar tape can break off and fly into the microalgae ponds, and potentially do serious damage to pumps and paddle wheels. Mylar may be useful when applied with other deterrent measures, in small areas that can be inspected daily.

Please make copy for each Island Team

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MCMXCII

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THIS FAX HAS ___ PAGES INCLUDING THIS PAGE DATE:________

TO:______________________

FROM (CHECK ONE):

☐ THIERRY M. WORK, DVM (WILDLIFE DISEASE SPECIALIST)

☐ BOB RAMEYER (BIOLOGICAL TECHNICIAN)

☐ OTHER______________________________

SUBJECT:__________________

To: ☐ Kealia Pond NWR; ☐ Kauai NWR; ☐ Oahu NWR; ☐ DOFAW-Kauai (Telfer); ☐ DOFAW Maui (Ueoka); ☐ DOFAW Oahu (Conry); ☐ DOFAW-Hawaii (Bachman); ☐ Kaloko NP (Kuailani).

BOTULISM ALERT!!

As some of you may know, Kanaha Pond in Maui is experiencing a suspected botulism outbreak. We are attempting to confirm this. In the interim, I encourage all of you to keep an eye out for similar outbreaks since this is the time of year where we commonly encounter Botulism in Hawaiian waterfowl. This alert also serves as a refresher of how to recognize botulism and manage it.

BOTULISM-is a natural toxin produced by a bacterium in pond soil. Although the bacteria are probably present year-round, it takes the convergence of unique environmental conditions for the bacteria to produce toxin. The exact nature of these environmental conditions remains a mystery.

Once botulism toxin is produced, it is ingested and concentrated by invertebrates in the pond. These invertebrates are ingested by birds who succumb to the toxin. Avian botulism is not transmissible to humans; the botulism toxin affecting humans is different than that affecting birds.

HOW TO DEAL WITH BOTULISM

Because we do not know the environmental conditions that cause botulism outbreaks, our best defense is early detection and management.

1. BE VIGILANT

Botulism can occur in any area with standing fresh or brackish water frequented by waterfowl. Botulism is typically detected through observation of sick birds or sudden appearance of bird carcasses.

Typical clinical signs in birds include inability to use legs or wings, inability to hold head up or loss of fear of humans

If your pond is not experiencing bird mortalities, I recommend surveying ponds at least once to twice a week. If your pond is experiencing bird mortality, surveys should be done daily.

Ideally, the entire pond should be examined. If the area is too large or manpower is limiting, concentrate on the following areas of the pond:

☞ Places where birds typically aggregate.
☞ Edges where vegetation meets pond water (sick birds will seek cool areas, such as brush, to hide and try to recuperate).
☞ Areas of pond that are downwind or down current where carcasses may be aggregated.

2. BE PROACTIVE

Botulism is best addressed when detected early. If you suspect botulism in your pond, take the following action:

☞ Inform your local State of Hawaii Dept. Fish and Wildlife (DOFAW) Biologist.

☞ On a daily basis, remove dead birds and fish from the pond. This will help mitigate mortalities for two reasons:

- Protein from the carcasses is used by bacteria to make toxin.
- Carcasses breed fly maggots which concentrate toxin. Birds become poisoned when they ingest maggots.

☞ Keep a tally of what dies each day. This allows you to determine whether things are getting better or worse. For birds that are fresh dead, place the carcass in a plastic bag with date of collection and store frozen or ship to the Honolulu Field Station (**call first**). The carcass can be used to confirm presence of botulism.

ACKNOWLEDGMENTS

This Conservation Plan was prepared by Karen Evans (former Regional Biologist of Hawaii) and Kim Uyehara of Ducks Unlimited and data collection included Anthony J. McCafferty and J. Scott Waddington. The document was improved with the comments of Andrew Engilis, Jr., Sharon E. Reilly, Thomas J. Dwyer, Jennifer Crummer, and Gerald R. Cysewski. The plan has been modified based on the comments of the Fish and Wildlife Service and the DLNR. Photos provided by Jeff Burgett of the Fish and Wildlife Service, Ducks Unlimited, and Cyanotech Corporation. A heartfelt thank you to island artist Herbert Kawainui Kane for permission to re-print the painting entitled *Hawaiian Stilts (Ae'o)* on the cover.

Named after the Kukulu-ae'o, performers who walked on stilts during ancient Hawaiian ceremonies, the ae'o (Hawaiian stilt) gracefully stalks the shallows of remote lagoons and ponds in Hawaii.

Herb Kawainui Kane