Cyanotech Corporation Conservation Plan for Hawaiian Stilt (*Himantopus mexicanus knudseni*) Annual Report for 2003

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Management Actions

- Netted the 0.69 hectare (ha) nesting habitat and former Ducks Unlimited (DU) pond to exclude stilts from utilizing these areas to nest;
- Operated all raceways at 100% of capacity to prevent stilts from nesting in idle raceways;
- Continued to research and test means and methods of bird deterrents for the facility and reduce the food source attractant in the raceways;
- Requested and received permission from Wildlife Agencies to utilize more aggressive non-lethal hazing methods (i.e. laser, pyrotechnics);
- Initiated and maintained a hazing program utilizing laser, pyrotechnics, Mylar tape, driving roads of facility, and other means of deterrents to discourage stilts from frequenting the facility and nesting;
- Monitored the facility daily for nesting activity, take, and possible entanglement of birds in netting and Mylar tape deterrents;
- Maintained staffing needed to provide daily coverage of hazing and deterrent maintenance.

Summary for Cyanotech Conservation Plan in 2002

On March 18th, 2002 the United States Fish and Wildlife Service (USFWS) issued Cyanotech an Endangered Species Act incidental take permit (No. TE051040-0). On April 3rd, 2002 the Hawaii State Division of Forestry and Wildlife (DOFAW) issued Cyanotech an Endangered Species Enhancement of Survival permit (No. T&E ES-01). The first year that Cyanotech operated with both permits in place was 2002. A meeting was held on December 19th, 2002, with the USFWS, and DOFAW, referred to hereafter as Wildlife Agencies, and Cyanotech representatives to discuss and determine the management actions to be taken in 2003 in regards to the Conservation Plan for Hawaiian Stilts at the Cyanotech Aquaculture Facility (Evans and Uyehara. 2001). In 2002, 48 stilts fledged from the nesting habitat and three chicks, originating from the nesting habitat, were incidentally taken in production raceways. Based on this data and Section 3.4(5)(a)(i) of the Conservation Plan that states "if the total number of fledglings produced in Year 1 is greater than the sum of incidental take in Year 1 plus the incidental take anticipated in Years 2 (2003) and 3 (2004), then management of the Lake as a stilt breeding area may be discontinued upon approval of the Wildlife Agencies," The option to discontinue management of the Lake for Year 2 was discussed and agreed upon by Wildlife Agencies and Cyanotech.

Nesting Habitat

As per the recommendation of the 2002 Annual report for Cyanotech (Waddington, 2002) the 0.69-ha lake (Exhibit 1) was netted to provide physical exclusion to the man-made nesting habitat. A network of one-meter (m) concrete forming stakes, 2.5 centimeter (cm) PVC (polyvinyl chloride) piping, and 1.3cm polypropylene rope was utilized to form the structural base to support the netting above the lake floor. There are 171 vertical support structures for the netting. The netting was secured 2m above the lake floor to allow access for vegetation control and maintenance of the netting and netting support structures. The netting (manufactured by U.S. Netting) is 1.9cm polypropylene mesh and came in has a width of 5.2m. The seams were overlapped 10cm and cable tied to each other as well as to a rope connecting to the PVC pipe. The net was also attached to ropes staked around the perimeter of the nesting habitat where it comes into contact with the embankment. One half-meter strips of 30 millimeter (mm) Mylar tape were tied to the underside of the netting in a "zigzag" pattern of each 5.2m section of netting, to provide a visual reference of the netting. Noting the stilts ability and willingness to move at night, three 90-watt floodlights were installed above the nesting habitat to illuminate the netting and Mylar tape strips in an effort to prevent any entanglement of birds. The floodlights were positioned on the North side of the habitat and operated by a photocell switch turning the lights on at sunset and off at sunrise. Mylar tape was also utilized on the grounds along the top of the nesting habitat to discourage any nesting attempts in these areas adjacent to the habitat. The netting and Mylar tape installations were completed on February 25th, 2003. The installation of the floodlights was completed on March 13th, 2003. Netting was monitored daily to check for entangled birds. To date, there have been no entangled birds in the netting. The netting and netting structure require regular maintenance due to wind, rain, and shifting of concrete stakes due to increase soil moisture levels as a result of rain and runoff. There were no nesting attempts in or adjacent to the nesting habitat.

Production Area

In 1998, a production raceway was converted into a stilt-nesting habitat and became known as the "DU pond". The pond was managed for stilt nesting in 1998 and 1999, but management was discontinued in 2000 due to the inability of the habitat to maintain a self-sustaining invertebrate prey base for stilts. In 2001 and 2002, the pond was used to test the effectiveness of Mylar tape as a deterrent. With no option for nesting in the habitat basin, stilts may again try to utilize the DU pond for nesting and the Mylar tape may not prove to be as an effective deterrent with stilts looking for alternate nest sites. As a result the former DU pond was netted as per recommendation of the 2002 annual report (Exhibit 2). Netting was installed utilizing concrete forming stakes, PVC pipe, and rope. The netting extended from the level of the embankments (approximately 1m) to 1.5m PVC supports on the center berm of the pond. The relatively low level of the netting was not a concern, since no maintenance was anticipated for this pond. Approximately 25% of the pond was netted utilizing the same polypropylene netting on the nesting habitat and the remainder of the pond was covered with shade cloth. The shade cloth is constructed of black knitted plastic and was utilized from stock already on

hand at Cyanotech. Mylar tape was put on the netting and shade cloth to provide a visual reference in an effort to prevent any birds from becoming entangled. Installation of the netting/shade cloth and netting structure for the DU pond was completed on March 6th, 2003. The netting/shade cloth and netting structure require regular maintenance due to wind, rain, and shifting of concrete stakes due to loosely compacted gravel in the embankments of the pond. The netting and shade cloth structure was monitored daily to check for entangled birds. To date, there have been no entangled birds in the netting or shade cloth. There were no nesting attempts in or adjacent to the DU pond or anywhere in the production areas of Cyanotech.

The total cost of netting both the nesting habitat and the DU pond was $10,459. This amount reflects the cost of the netting, the support structures and the labor to erect the net; it does not reflect the on going maintenance of the netting and netting structure. A summary of all hazing and deterrent costs can be found in Table 1.

Hazing, Deterrent Measures and Reduction of Attractants

Appendix IV of the Conservation Plan specifically outlines a three-year action plan for bird deterrent measures at Cyanotech. Some of the outlined research took place prior to the completion of the Conservation Plan and was reported in the Amendment to the Cyanotech Corporation Facility management for Hawaiian stilt (Jan.-Sept. 2002) (Waddington 2003).

During year two, the action plan calls for continued research on the Brine fly (*Ephydra sp.*) life cycle, increased road activity, continued research on bird repellant alternatives and cost, and research on alternative deterrent measures to augment or replace existing measures.

Reduction of Invertebrate Food Source

As in years past the primary invertebrate food source has been the Brine fly. In 2003, Water Boatman (*Trichocorixa reticulata*) also became established in the Spirulina production raceways and provided a food source for the stilts. The Water Boatman has been observed at the facility in the past and has demonstrated seasonal changes in population densities. The highest densities of the Water Boatman ever observed at the facility occurred in the spring of 2003.

Increased Raceway Agitation

In an effort to reduce the invertebrate food source from the raceways, a set of experimental and control raceways were set up in April. Experimental raceways were managed with increased agitation from paddlewheels and by mechanical means (sweeping raceway daily with tractor-mounted brush). To quantify invertebrate densities in the experimental and control raceways 100-liter samples of media were filtered through 44-mesh screen. The invertebrates were washed dried and weighed. Samples were collected at the beginning of the experiment and before each harvest. The

raceways were swept with the tractor mounted brush daily in an effort to disrupt the larval stages of the brine fly. The experiment was comprised of three experimental raceways and three control raceways. The duration of the experiment was one month. No reduction in brine flies or Water Boatman was noted.

Raceway Cleaning

The alternative method of removing the invertebrate food source was to drain the production raceways, allow them to dry, and sweep out the sediment and invertebrates. This systematic process began in mid May. Extra attention was given to raceways as they were dried up to insure that stilt pairs did not try to nest in the idle raceways. Five to six ponds were taken out of production at a time for the cleaning process. This was a time consuming and costly undertaking for the company from labor and equipment cost as well as the lost production of raceways while they were being cleaned. The cleaning process for the raceways was completed, with the exception of one, at the end of August. The labor cost of cleaning the raceways was $20,674. Draining and cleaning the raceways is part of the normal operation and maintenance of Spirulina Production. Raceways have been cleaned on average of once every 12 months. Cyanotech is working on implementing an on going cleaning schedule for the Spirulina raceways that will have each raceway cleaned a minimum of twice per year.

Hazing

As in 2001 and 2002, a hazing program was implemented to increase the amount of activity in the production areas to make these areas less desirable for nesting. Methods included the driving of all the roads in the facility, the use of Mylar tape as a visual deterrent, and the production raceways being maintained at 100% of production capacity from February through the middle May. Driving the roads (six kilometers) via a golf cart has continued four to six times daily from the 2002-nesting season, in an effort to keep stilts from roosting and nesting in these areas. Mylar tape was again utilized through out the facility, during nesting season, to deter stilts from nesting in production areas. A total of $200 was spent to purchase Mylar tape for use during the 2003-nesting season. Maintaining the Mylar tape deterrents was a constant and labor-intensive undertaking.

Other passive deterrents were tested. Plastic effigies of owls (2) were placed around the production area. The effigies were moved daily and positioned from ground level to rooftop (5m). The stilts acted in different to the effigies even moving with in two meters of one effigy positioned on the embankment of a production raceway. Noting the agitated and alarmed reactions stilts have exhibited when they have observed a dead stilt in the water, effigies of dead stilts (Exhibit 3) were fashioned out of polypropylene pond liner material and fitted with small PVC floats to keep them buoyant in the production media. A test was conducted with one effigy in Spirulina production raceway 20 on June 24th, 2003. Thirty-four stilts were congregated in production raceway 20 and the effigy was placed in the pond, allowing the current, created by the paddlewheel, to move the effigy into close proximity of the stilts. Again, the stilts were indifferent to the effigy. There was no recognition of the effigy with vocalizations or change in behaviors. With

the success of other deterrent measures tested earlier, the use of effigies was not further investigated.

During the December 19th, 2002 meeting with Wildlife Agencies, the possibility of utilizing more aggressive non-lethal deterrents (i.e. laser, pyrotechnic shells, and other non lethal hazing actions) were discussed, and later formally requested in a letter dated February 18th, 2003. Although hazing efforts reduced the amount of nesting activity in production areas in 2002, it did not reduce the total number of stilts frequenting the facility. The total number of stilts at the facility after the 2002-breeding season continued to exceed 100 during weekly counts. Therefore, more aggressive non-lethal hazing methods were considered, per the Conservation Plan (Section 3.7 c). After receiving permission to utilize laser and pyrotechnics from Wildlife Agencies, research began into purchasing these devices.

Laser: An "Avian Dissuader", a laser deterrent device (Exhibit 4), manufactured by Sea Technology Inc., was purchased at a cost of $900.00 and testing began March 13th, 2003. The laser is a pistol type design and operates on the "point and shoot" basis. The laser beam is aimed at the ground or embankments of ponds close to the stilts or the stilts' body and the red dot of light frightens the stilts and causes them to move from the area. The beam is adjustable from 3 to 30 cm and has a manufacturer's claimed effective range of 500 m. According to manufacturer's directions, the laser is most effective at sunrise and sunset. Morning surveys of stilts (Figure 1) on the facility were taken one half hour before sunrise and then hazing using the laser would begin if stilts were present at the facility. A survey of stilts was also conducted (Figure 1) one half hour before sunset and hazing with the laser would begin if stilts were present at the facility. An ITT PVS-14, generation III, night vision monocular was used during the pre-sunrise and post-sunset surveys and hazing activities to provide more accurate data and more effective hazing. The laser was never directed at individuals, automobiles, boats, aircraft or the airport at anytime. Both the airport operations center and the Natural Energy Laboratory of Hawaii Authority security were notified before any active hazing activities were conducted.

Consultation of Laser and Pyrotechnic Use with Kona International Airport

On May 1st, 2003, Airport District Engineer David Hein was notified about the hazing efforts utilizing pyrotechnics as a deterrent at Cyanotech, to see if there would be any concerns or objections considering the proximity of the facility to the airport. The use of the laser was also mentioned, but the main emphasis of this communication was to express concern of the visual flashes and sounds that the pyrotechnics would be producing in regards to airport security. Mr. Hein responded "Kona International Airport and the Federal Department of Homeland Security officials have no objection to the use of pyrotechnic shells or lasers to control wildlife at Cyanotech as long as the Kona Airport Operations Center is notified prior to any use." Mr. Hein also mentioned that the use of the use laser might require a Federal Aviation Administration (FAA) permit, due to the proximity of the hazing efforts to the airport. Initial research into this possibility was conducted prior to the laser being purchased, and it was found that the FAA does require permits for use on airport property (USDA 2001) but makes no mention of

properties in close proximity, or adjacent to airports. As a result of these findings the laser was purchased and put into use. On May 28th, 2003 FAA Airport Certification/Safety Inspector Mack Humphrey, in Honolulu, informed Cyanotech that a permit for the laser is not needed in this situation.

The first week of testing the surveys and hazing were conducted morning and evening every day for one week. After the first week, morning surveys and hazing, if stilts were observed, were conducted everyday for the remainder of the stilt-nesting season (March 20 through September 13th, 2003) and evening surveys and hazing were conducted every Tuesday and Friday. During the non-breeding season, morning surveys and hazing was conducted five days a week (Tuesday-Saturday), and evening surveys and hazing efforts were conducted on Tuesday and Friday.

Pyrotechnics

The use of pyrotechnics was delayed due to the inability to locate a pyrotechnic dealer able and willing to ship the devices to Hawaii. Scare-Away pyrotechnics were finally ordered from Reed-Joseph International Company and arrived in mid April. The system (Exhibit 5) consisted of a 15mm launcher, a small pistol to launch the shells and 6mm blanks that ignite the shells. The initial cost of the pyrotechnic system was $283.00. The blanks are the same that are used in starter pistols. There are two types of shells used with this system, "Screamer Sirens" and "Bird Bangers". The Screamer Siren shells, according to the manufacture, travel 50 to 75m making a siren-like sound as it flies. The Bird Banger shells travel 35 to 50m down range before exploding. Before use, the Hawaii County fire and police departments were contacted to see if applicable permits would be required for the use of this type of device. The Hawaii County fire department classifies this type of device as a flare-gun and no permitting from the fire department was needed. However, the police department classifies the launcher as a firearm and it was registered as so with the County police department. This also required that the user be registered with the police department and currently I am the only registered user of the launcher. To use the launcher, the hammer is cocked back; a blank inserted into the rear of the launcher and the fuse end of a shell is inserted into the muzzle. The muzzle length is short, 1.5cm, and as a result aiming the projectile is less than accurate. The main concern was to prevent the remnants of spent shells from falling into the production raceways and potentially fouling or damaging harvest lines and harvest pumps. Effort is given to try to have the spent shells land in the roads along the production raceways and not in them. The use of pyrotechnics began on the evening of May 6th, 2003.

Results of Laser and Pyrotechnic Use

The use of pyrotechnics has been very successful with the stilts becoming conditioned to the point of only three to four shells needing to be fired before the majority if not all stilts present at the facility leave. The use of both the laser and pyrotechnics on the Tuesday evenings during the nesting season was successful enough that the use of pyrotechnics was not needed in the mornings. While the use of either the laser or the pyrotechnics alone was sufficient to deter the stilts from nesting at the facility the combination of both

hazing methods seemed to be most useful. The use pyrotechnics would cause the stilts to take flight, where the laser could be used to single out individuals to keep them from returning to the raceways.

Property Outside of Cyanotech Boundaries (Lava Fields of Keahole International Airport)

The lava field adjacent to the Cyanotech facility, where stilts had nested in previous years, was monitored weekly for nesting activity. Surveys were conducted every Sunday through the nesting season. A Nikon 20x60 Fieldscope and Zeiss 10x40 binoculars were used to survey the lava field. In addition to weekly surveys daily observations of stilt movements at and around the facility helped determine if stilts were frequenting the lava field. There was only one instance where stilts were observed in the lava field. On February 26th, 2003, two stilts were observed flying out and landing near the fence line in the field. No other observations or nesting attempts were documented for the lava field.

Stilt Counts, Nesting, and Incidental Take

Stilt counts are conducted weekly through out the year (Figure 2). A mean of 16.35 (Standard error = $\pm$ 7.07) adult stilts were observed at Cyanotech during 2003 nesting season weekly surveys (March-August), compared to 104.19 (Standard error = $\pm$ 8.75) for the 2002-nesting season. A mean of 83.96 (Standard error=$\pm$ 9.87) adult stilts were observed at Cyanotech during the non-nesting season weekly surveys (September 2002-Febuary 2003) compared to 113 (Standard error = $\pm$ 7.83) for September 2001- February 2002. The stilt counts for September 2002- February 2003 do not reflect any additional hazing measures other than driving the roads of the facility four to six times daily.

There were no nesting attempts on the Cyanotech facility or in the lava fields of Keahole International Airport.

As per the Conservation Plan, surveying for incidental take was conducted twice per week during the nesting season and once per week during non-nesting season. However, monitoring for injured or dead stilts is conducted daily as part of normal operations of the production raceways. Surveying the raceways for debris is conducted daily in an effort to protect the mechanical and harvest systems of the production raceways. Surveying the raceways visually first thing in the morning before the paddlewheels are turned on has proven to be the most effective method of identifying and recovering debris and stilts from the raceways. Visual observations are also made while the driving the production area to deter stilts from utilizing the facility to nest or roost.

There were four stilt mortalities recovered at Cyanotech this year. Two sets of remains recovered were found outside of production raceways and were comprised of only partial remains. Two sets of remains recovered from production raceways (one from Spirulina and one from Astaxanthin raceways) (Exhibit 6). None of the remains were in good enough condition for necropsy. Each time remains were recovered, they were bagged, labeled, put in a freezer and the Wildlife Agencies were notified. After consulting with

USFWS regarding the circumstances of the mortalities, the two sets of remains recovered from the raceways do constitute take. The total amount of incidental take at Cyanotech was two. Cyanotech's current incidental take permit allows for up to 30 incidences of take per year.

Recommendations and Request

Continue to identify and research deterrent measures for the facility. Even with the effectiveness of the netting, Mylar tape, laser and pyrotechnics, stilts are still frequenting the facility. There has been an increasing trend in the numbers of stilts observed at the facility following the nesting season (Figure 2). New and additional deterrent measures need to be identified and tested to try and reduce the numbers of stilts frequenting the facility, especially during the non-nesting season.

Cyanotech request recommendations from Wildlife Agencies on the need for continued hazing of stilts during non-nesting season, noting that after hazing efforts start, stilts leave the facility flying approximately two kilometers to a small complex of anchialine ponds (area known as Pine Trees) at the south end of Keahole International Airport. The stilts then return to Cyanotech with in 30 to 40 minutes of the hazing and additional hazing efforts at that time result in the stilts moving around the facility, but not leaving.

Since sweeping the raceways to disrupt the life cycle of the invertebrates was not effective, new methodologies to reduce the invertebrate food source need to be identified and tested.

The netting and netting support structures need to be inspected and reinforced where necessary to insure the integrity and effectiveness of the netting of both the nesting habitat and the former DU pond.

It is recommended that Cyanotech operate at 100% of production capacity during the stilt-nesting season (Feb.-Aug.). If this is not possible, idle raceways should be filled with seawater to prevent stilts from nesting in the idle raceways.

It is recommended that Cyanotech consider all reasonable measures to improve the ability to recover stilt carcasses in a condition suitable for necropsy and for the purpose of documenting incidental take.

Cyanotech requests that the Wildlife Agencies continue to work cooperatively with the Cyanotech staff to provide technical assistance on policy and conservation issues, as well as biological expertise (e.g., permit compliance, adaptive management, bird deterrents, etc.).

Literature Cited

Evans, K. and Uyehara, K. 2001. A Conservation Plan for Hawaiian Stilt at Cyanotech Aquaculture Facility Keahole Point, Hawaii.

Waddington, J.S. 2002. Cyanotech Corporation facility management for Hawaiian Stilt (*Himantopus mexicanus knudseni*) (Jan.-Sept. 2002).

Waddington, J.S. 2003. Amendment to the Cyanotech Corporation Facility management for Hawaiian stilt (*Himantopus mexicanus knudseni*) (Jan.-Sept 2002).

United States Department of Agriculture. 2001. Use of Lasers in Avian Dispersal.

Acknowledgements

U.S. Fish and Wildlife Service
Hawaii State Division of Forestry and Wildlife
Ducks Unlimited Inc.
Natural Energy Laboratory of Hawaii Authority
Federal Aviation Administration
Keahole International Airport Operations Department
Cyanotech Corporation

EXHIBIT 1 Netted Nesting Habitat

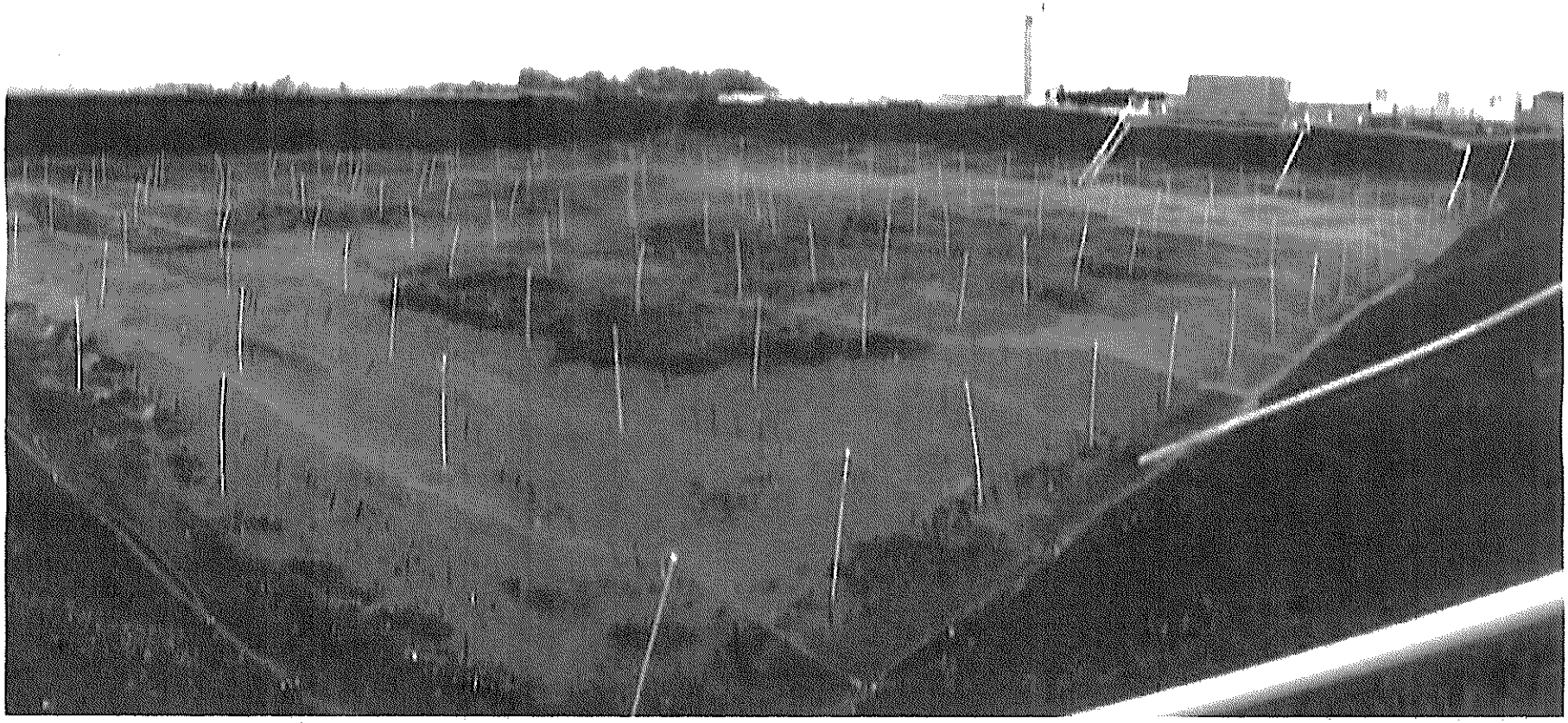


EXHIBIT 2 Netted DU Pond

EXHIBIT 3 Stilt Effigies

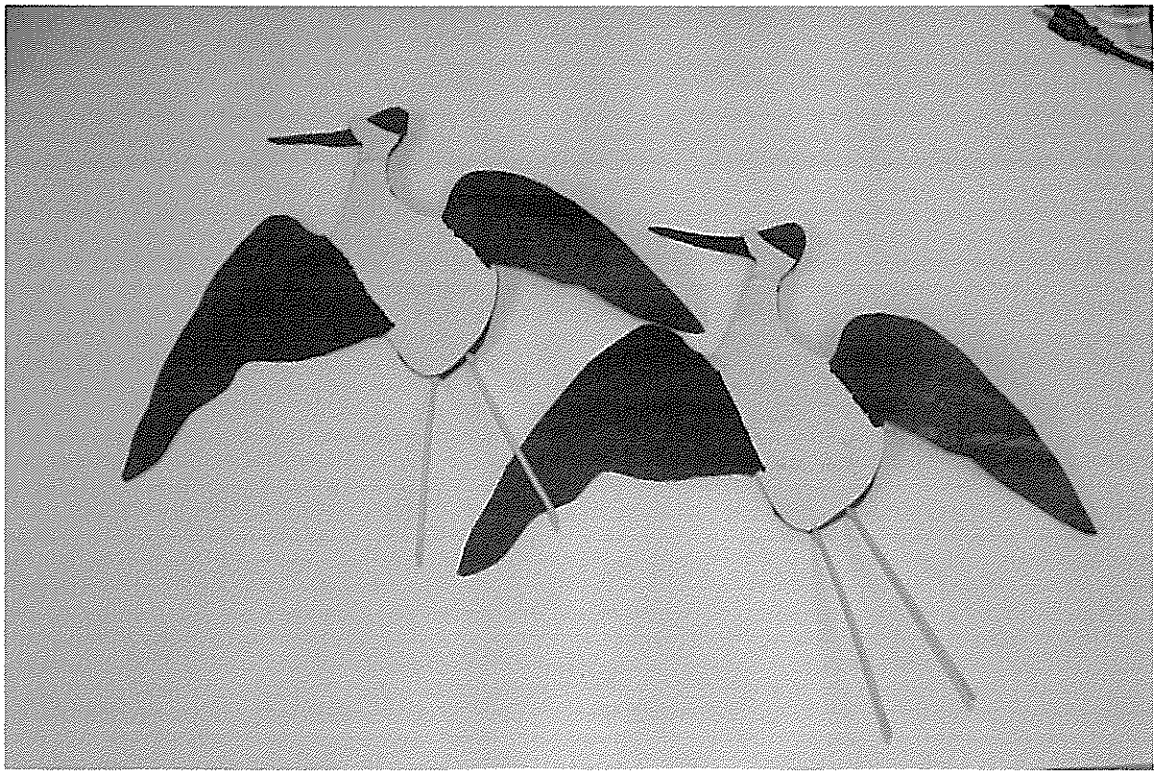


EXHIBIT 4 Avian Dissuader Laser

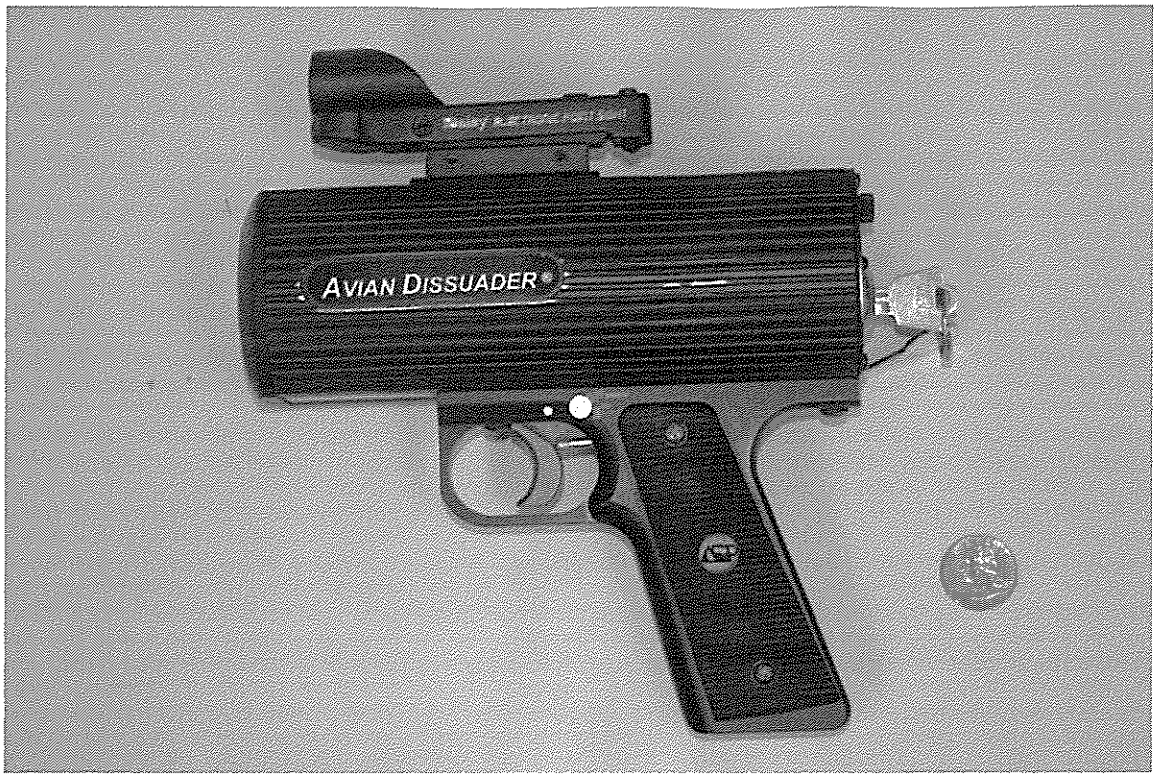


EXHIBIT 5 Pyrotechnic System

Exhibit 6

Stilt Mortality Recovery Map

1. January 14,2003 outside Spirulina raceway 26.
2. March 11,2003 in Spirulina raceway 19.
3. May 2,2003 outside Spirulina raceway 68.
4. September 17,2003 in Astaxanthin raceway 14.

Figure 1 Cyanotech Corporation 2003 Hawaiian Stilt Laser and Pyrotechnic Trials Morning, Evening and Weekly Counts

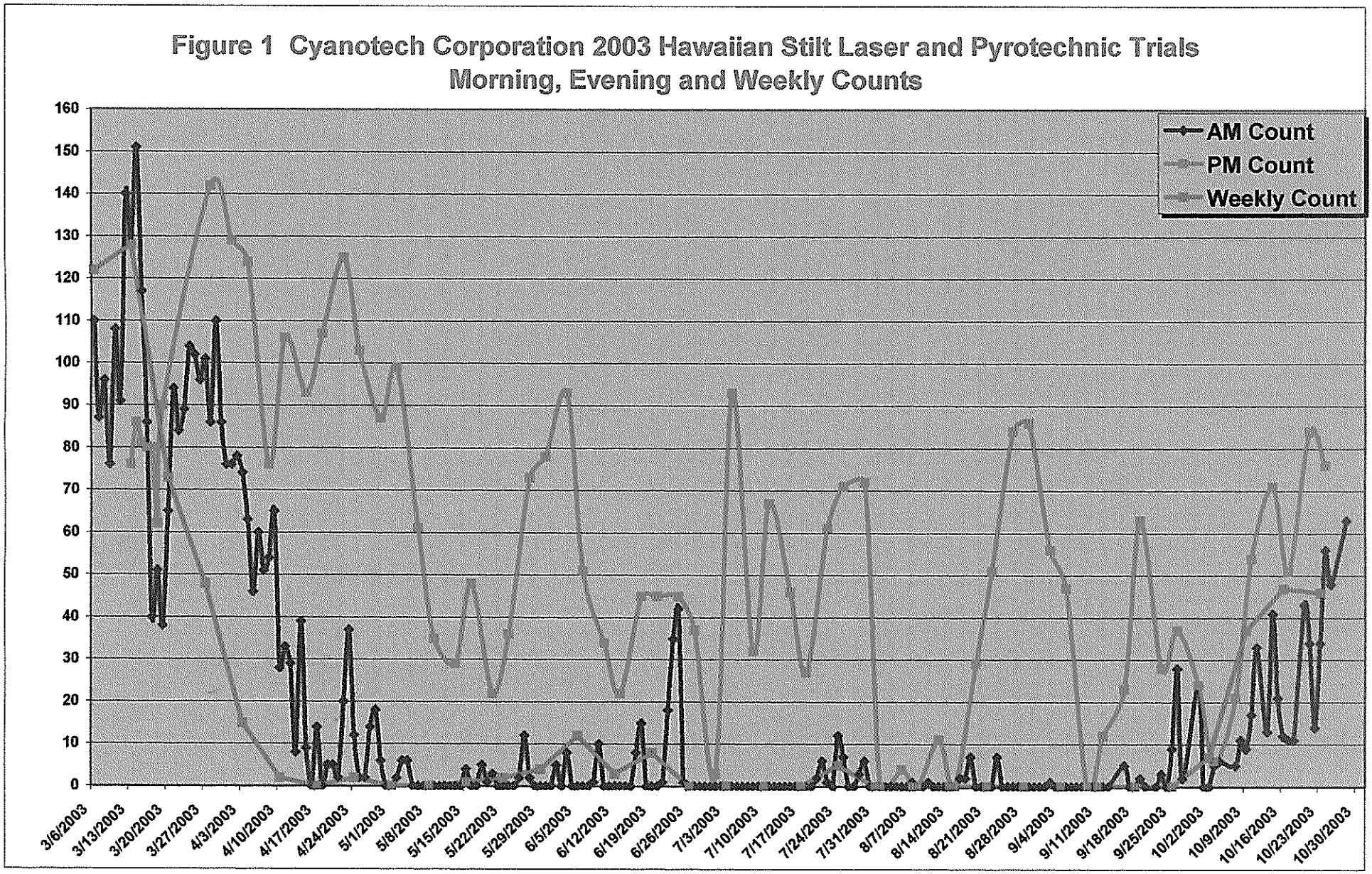
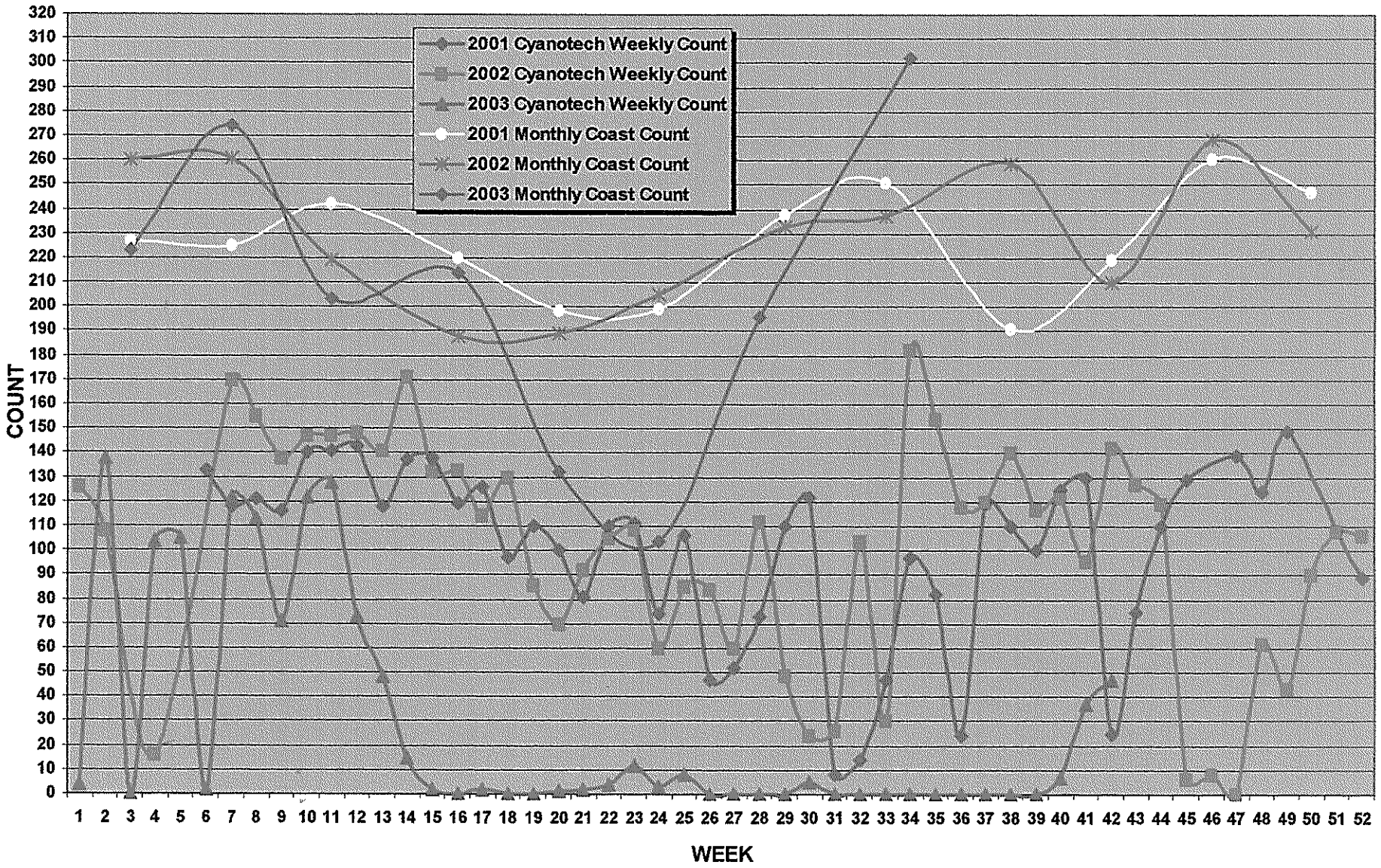


Figure 2 Hawaiian Stilt Weekly and Monthly Counts for Cyanotech and the Kona Coast



This chart represents the weekly Hawaiian Stilt counts at Cyanotech Aquaculture Facility. The monthly Kona Coast counts of Hawaiian stilts are total counts for six study sites and the Cyanotech facility. The six study sites were: Kealakehe wastewater treatment plant, Honokohau reef, Aimakapa pond, Kaloko pond, Opaeula pond and Kukio fishponds. This study was conducted by and data presented as a courtesy by Ducks Unlimited Inc. The monthly Kona coast wetland study ended in August of 2003. The data for 2001 January- July was from the USDA-APHIS-Wildlife Services report: A Wildlife Hazard Assessment for the Kona International Airport, Kailua-Kona, Hawaii September 2000- August 2001, by Todd A. Felix.

TABLE 1

Cost for Cyanotech deterrents, hazing, and reduction of invertebrate food source in 2003

Pyrotechnics system	**283.00**
Avian Dissuader Laser	**900.00**
Netting and labor for Nesting Habitat and DU Pond	**10459.00**
Mylar Tape	**200.00**
Effigies	**40.00**
Labor for Hazing and deterrent maintenance	**18000.00**
Labor for cleaning and removing invertebrate food source in Spirulina raceways	**20674.00**
Total	**50556.00**