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WATER QUALITY and PLANT GROWTH EVALUATIONS of the FLOATING ISLANDS in LAS VEGAS BAY, LAKE MEAD, NEVADA

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December 2002

INTRODUCTION

Water quality within Las Vegas Bay (Figure 1) is affected by the discharge of treated sewage effluent from the communities within the Las Vegas Valley as well as storm water and groundwater drainage, which enter the bay via Las Vegas Wash. Las Vegas Wash is the only drainage outlet for the valley area, covering 1,600 square miles (4144 km^2); all of the drainage from the valley enters Lake Mead at Las Vegas Bay. Las Vegas Wash once provided further treatment of the discharged wastewater in large shallow wetland ponds along the relatively flat topography. These wetlands or marshlands not only help clean the water but also, provided a rare riparian habitat in the Southern Nevada desert. However, in recent years Las Vegas Wash has increased in flow as well as flooded severely several times resulting in the removal of these important wetlands. Canalizations, continued increase in flows, and increased gradient of Las Vegas Wash has prevented the natural reestablishment of the wetlands. The use, of vegetated floating islands in Las Vegas Bay, was proposed as one method of replacing the water polishing benefits of the lost wetlands.

The objectives of this research are:

1) Determine how effective floating islands are at removing nutrients, and improving water quality within Las Vegas Bay, at the mouth of Las Vegas Wash.

2) It is also the goal of this research to develop floating platforms and islands that are structurally durable.

3) Evaluate the riparian vegetation so that vegetative growth (biomass) can be compared to the nutrient uptake[1].

4) Evaluate plant establishment and different planting techniques.

Information on water quality of Las Vegas Wash was acquired from Bureau of Reclamation Technical Memorandum 8220-98-06.

Another report, Technical Memorandum, 8220-99-03, was a study, performed in 1998, using containers to hold small, vegetated, floating units to evaluate nutrient uptake from water obtained in Las Vegas Bay. It indicated that vegetated floating islands could greatly reduce the nutrients in the water of Las Vegas Bay, especially nitrate and potassium.

[1]The term floating platforms refers to the superstructure that houses and protects the floating islands. The floating platform is composed of the walkway, flotation, the winches, wire rope and lighted beacons. The term floating islands used in this report is the planted portion of the structure.

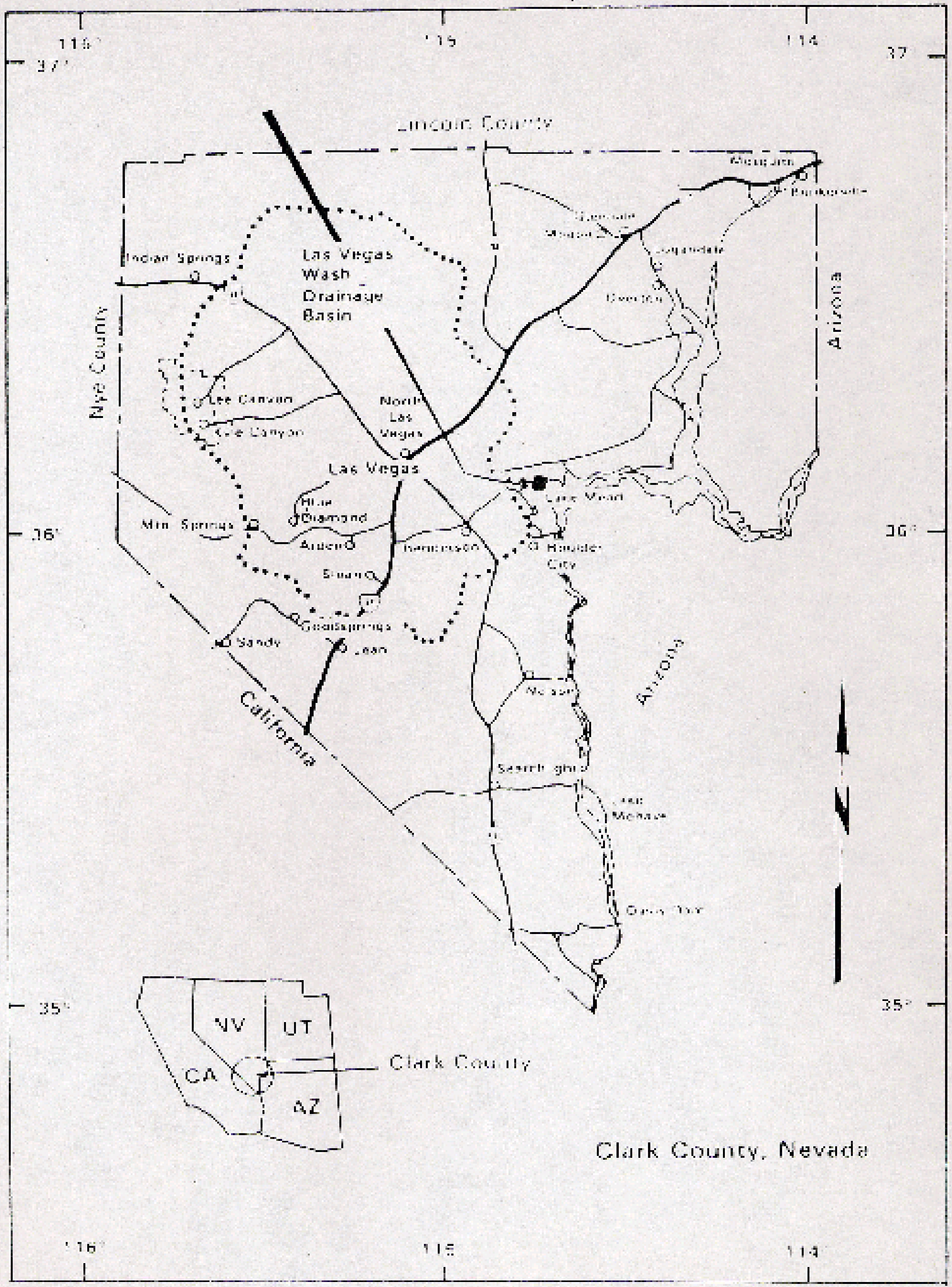


Figure 1. Location map and study area, Clark County, Nevada.

Nitrate was reduced over 80% within the first week of the study, in two separate, month long tests, from approximately 4.52 mg/L to 0.68 mg/L and from 8.22 mg/L to 0.23 mg/L nitrogen (NO_3-N) respectively. Potassium was also reduced approximately 75% by the end of the month long tests. Phosphate levels were low, at the detection limit, and therefore phosphate uptake could not be determined.

Construction of the large-scale floating islands for Las Vegas Bay, and the collection and culturing of the riparian vegetation used to plant these floating wetlands was presented in Bureau of Reclamation Technical Memorandum 8220-01-16.

The two floating platforms, built for this study, are similar to conventional boat docks. Each has 12 slips per platform, to house 12 floating islands in each of the floating platforms. Solid core, polystyrene, blocks; encapsulated in a polyethylene cover, supply flotation.

The outside dimension of each floating platform is 122 feet in length and 26 feet wide giving each of the floating platforms an area of 3,172 square feet. The main walkway, measured 122 feet in length by 4 feet wide, and had sufficient strength for the mounting of four winch stands and four anchoring winches, two at each end of each floating platform. To the main walkways are attached fourteen dock fingers each measuring 2 feet wide by 11 feet in length; seven dock fingers were placed on each side of the main walkway. These fingers are spaced 18 feet apart, providing 12 slips (11feet by 18 feet) per floating platform, in which are fastened 12 floating islands (10 feet by 16 feet). Each slip area formed by two fingers and the main walkway was designed to have a deck load capability of five hundred pounds. This provides a total load capacity of 6,000 pounds per floating platform.

The floating platforms were anchored using four concrete anchors. Each anchor had an approximate weight of 1500 pounds. Four large winches were mounted on each floating platform held the platforms to the anchors via half-inch wire rope. Each winch has a holding capacity of 4000 lbs.

The floating islands were constructed of twelve, high-density polyethylene plastic shipping pallets. These were bolted together with 3/8-inch stock stainless steel hardware. Each pallet measured 48 inches in length by 40 inches in width by 4.75 inches in height. Each pallet had a 3.5-inch space between the top and the bottom surface in which shredded coconut fiber was stuffed. The coconut fiber served as a soil substitute and can last up to five years in water. The twelve attached pallets formed the planting surface of the floating island. Each floating island measured, 10 feet by 16 feet, and has a positive buoyancy of approximately 168 pounds.
After planting the floating islands with emergent vegetation, they were covered with a layer of heavy-duty plastic fence. This fence layer was fastened tight to the pallets holding the coconut fiber and the newly planted vegetation in the pallets, until the vegetation could develop a root system and become self-anchoring.

The majority of the cost ($66,600), for the floating island project was the construction of the two floating platforms, the winches, the winch stands, the anchor lines and anchors. The plastic shipping pallets, used to form the structure of the floating islands, were constructed of virgin high-density polyethylene (HDP). The cost of the pallets was $14,000 for 288 pallets. The coconut fiber total cost was $5,000 for the soil matrix material. The pallets were fastened together using stainless steel hardware, consisting of nylon locking nuts, bolts and washers, this hardware cost $400. Other hardware, plastic fencing and other materials and supplies were $2,700. Therefore, the total cost to build the floating islands was approximately $88,700 or about $23/ft^2 ($250/m^2). If the floating platform was replaced with a floatation pontoon system, thereby eliminating the superstructure and walkways, and pallets were purchased made from recycled HDP rather than those produced from virgin HDP, it is possible that the cost of a similar size structure could be built for approximately $60,000 or about $16/ft^2 ($170/m^2).

The Japanese have constructed several large artificial floating islands, known as Ukishima, on Lake Biwa and Lake Kasumigaura that have improved water quality and clarity (Hoeger 1988, Mueller et al. 1996, Nakamura et al. 1995). Artificial floating islands were constructed in an environmentally deteriorated bay of Lake Kasumigaura, in 1993 at a cost of approximately $37/ft^2 ($400/m^2)[2]. The floating islands had four main functions: water purification, wildlife habitat, shoreline protection and landscape improvement or aesthetic value. The floating islands were planted with six species of plants and had an average standing crop of 5kg/m^2, after two growing seasons. Water quality studies were conducted in enclosed poly sheeting containers, 4mX4m, with a bottom 1.5m beneath the surface. Floating islands within these containers measured 2m x 2m. Phytoplankton was ten times greater within the control compared to the enclosures containing the floating islands or the shaded platform. Wave height was approximately 40% less behind the floating islands. Total nitrogen mg/l was one-third the level of the control area and one half of the shaded test plot. COD was found to be one half of the level found in the control. These artificial floating islands have provided wave protection to the shore, fish and avian habitat, and popular fishing spots. These were all lacking prior to the installation of the floating islands.

Riparian habitat within the Lake Mead National Recreation Area (LMNRA) is scarce and at a premium because of the fluctuating water levels of Lake Mead. Las Vegas Wash is also lacking in riparian vegetation now that it has become canalized. Riparian vegetation that remains within the wash is limited in species diversity, most of which is undesirable for wildlife habitat, and is susceptible to further scouring during flood events. Vegetated floating islands offer a method of maintaining desirable riparian vegetation in a fluctuating water system such as Lake Mead, thus providing habitats for both avian and aquatic species.

[2] The Japanese artificial floating islands used a stainless steel framework, therefore the higher construction cost.

A biological assessment was performed for the project, meeting the requirement of the Endangered Species Act of 1973. As part of this process, the U.S. Fish and Wildlife Service and/or the National Park Service made four requests, these were:

1. Only riparian plant species found within the National Recreation Area were to be used for the planting of the floating islands.

2. The floating islands were not to be placed within a 300-yard (274 m) buffer zone of Blackbird Point (Figure 2). Blackbird point is a known spawning area utilized by Razorback Suckers within Lake Mead.

3. The construction phase of the project should occur outside the known spawning season for Razorback Suckers, typically from February through April.

4. The use of non-treated wood on the walkways was required, to avoid the use of pentachlorophenol and creosote-treated wood in the construction of the floating platforms and islands.

These requests were made to address the concerns for six endangered species found in or near Lake Mead. Species of concern were Razorback Sucker, (Xyrauchen texanus); Peregrine Falcon, (Falcon peregrinus anatum); Bald Eagle, (Haliacetus leucocephaus); Yuma Clapper Rail, (Rallus longirostris yumanensis); Southwestern Willow Flycater, (Empidonax trailii extimus); and Bonytail Chub, (Gila elegans). The specific requirements are listed in Bureau of Reclamation Technical Memorandum 8220-01-16.

METHODS AND MATERIALS

Las Vegas Wash, Plume and Sedimentation

Water depth at the shallow and deep end of each floating platform was measured using a weighted fiberglass reinforced measuring tape. When the study plan, for the water quality monitoring, was being developed in February 2002, the floating islands were in 23 feet to 30 feet (7.0 to 9.1 meters) of water. A reduction in water depth by the middle of June of 2002 was projected to be 13.5 feet (4.1 meters). Therefore, a water depth for the middle of June was predicted to be 9 feet (2.7 meters) at the shallow end and 16 feet (4.9 meters) at the deeper end of the floating platform. The plume from Las Vegas Wash was entering Las Vegas Bay southwest of the floating islands, away from the floating islands, and had been the entire winter. Therefore, siltation was expected to be no more than 2 – 3 feet (0.5 -1m) for the time period between February and June, leaving at a minimum 6 feet (1.8 m) of water in the shallowest areas below the floating platforms. Therefore, it was predicted that sufficient water depth would be available to the end of June 2002, for the floating island water quality studies, without having to move them prior to any of the studies. Siltation was calculated by subtracting the difference in water depths, from one field trip to the next, and adjusting for the different lake level elevations, from one field trip to the next.

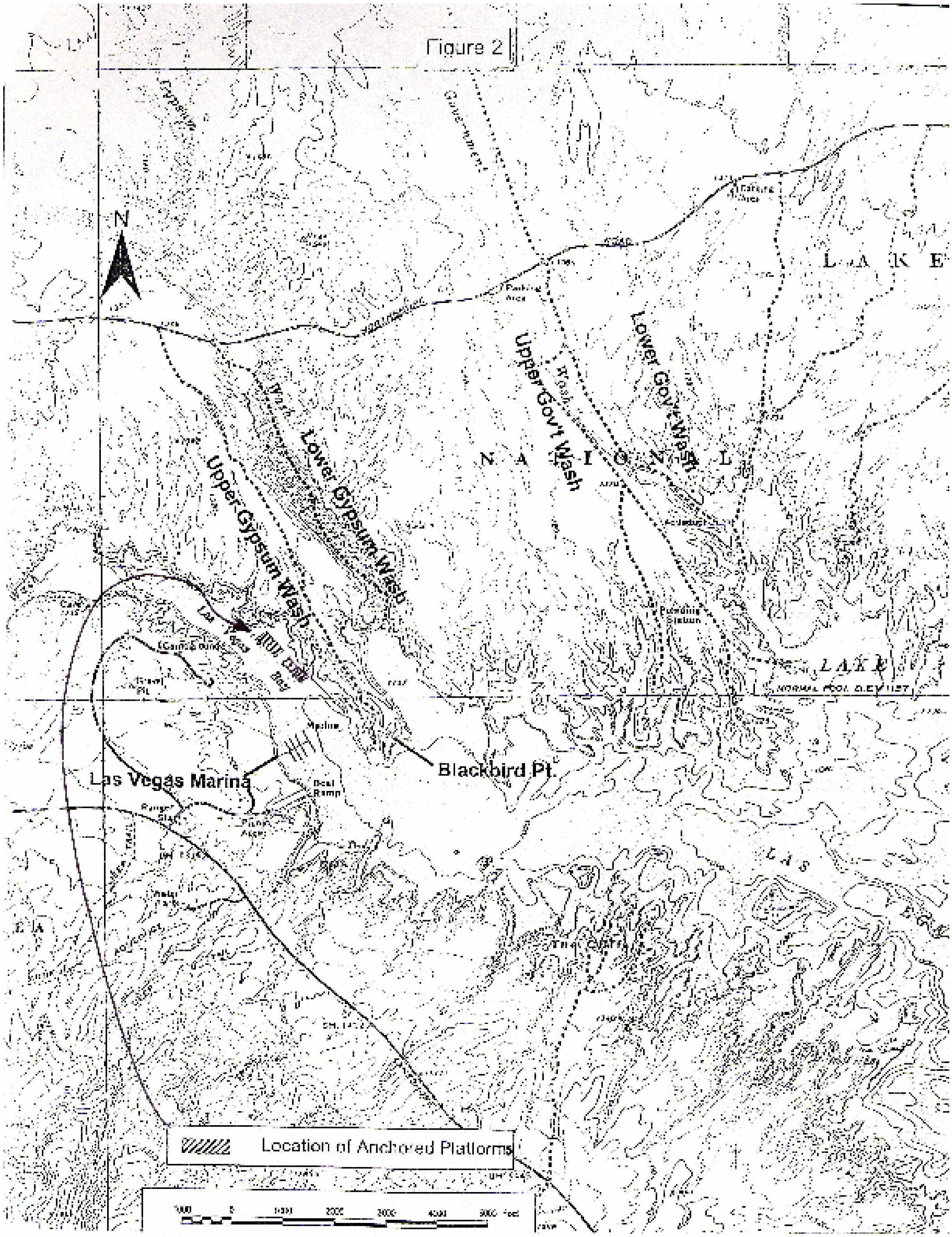


Figure 2
N
Lower Gypsum Wash
Upper Gypsum Wash
Upper Gov't Wash
Lower Gov't Wash
N A T I O N A L
L A K E
LAKE
Las Vegas Marina
Blackbird Pt.
Location of Anchored Platforms

Water Quality

Sampling locations for the May and June tests were the same. Water samples collected for nutrient analysis and physicochemical data were collected upstream of both floating platforms, under each platform in two different areas, to the sides of each of the platforms and downstream of the floating platforms. Figure 3 is a schematic of this sampling scheme, with a designated number, for each of the sampling locations.

A Hydrolab, multi-parameter, water quality meter (Hydrolab Corp., Austin, TX) was used to measure water temperature, dissolved oxygen concentration (DO) both percent oxygen and mg/l, pH, conductivity (EC), turbidity, oxidation-reduction potential (ORP), and total dissolved solids (TDS) of the water within Lake Mead at the point where Las Vegas Wash enters Las Vegas Bay. A Hach, color metric, nitrogen kit (Hach Co., Loveland, CO) was used to determine a crude nitrogen (NO_3 as N) value and to compare it to the nitrate analysis done in the chemistry laboratory and a Hach turbidity meter was used as a comparison to the Hydrolab turbidity readings.

Water clarity was measured using a secchi disk, attached to a calibrated line and a viewing scope to eliminate glare off the surface water. Water depth was measured with a weighted, fiberglass reinforced, measuring tape. Lake Mead Reservoir elevations (Appendix A) were recorded for each of the sampling days so that decrease in lake elevation could be documented as well as used to verify the amount of siltation.

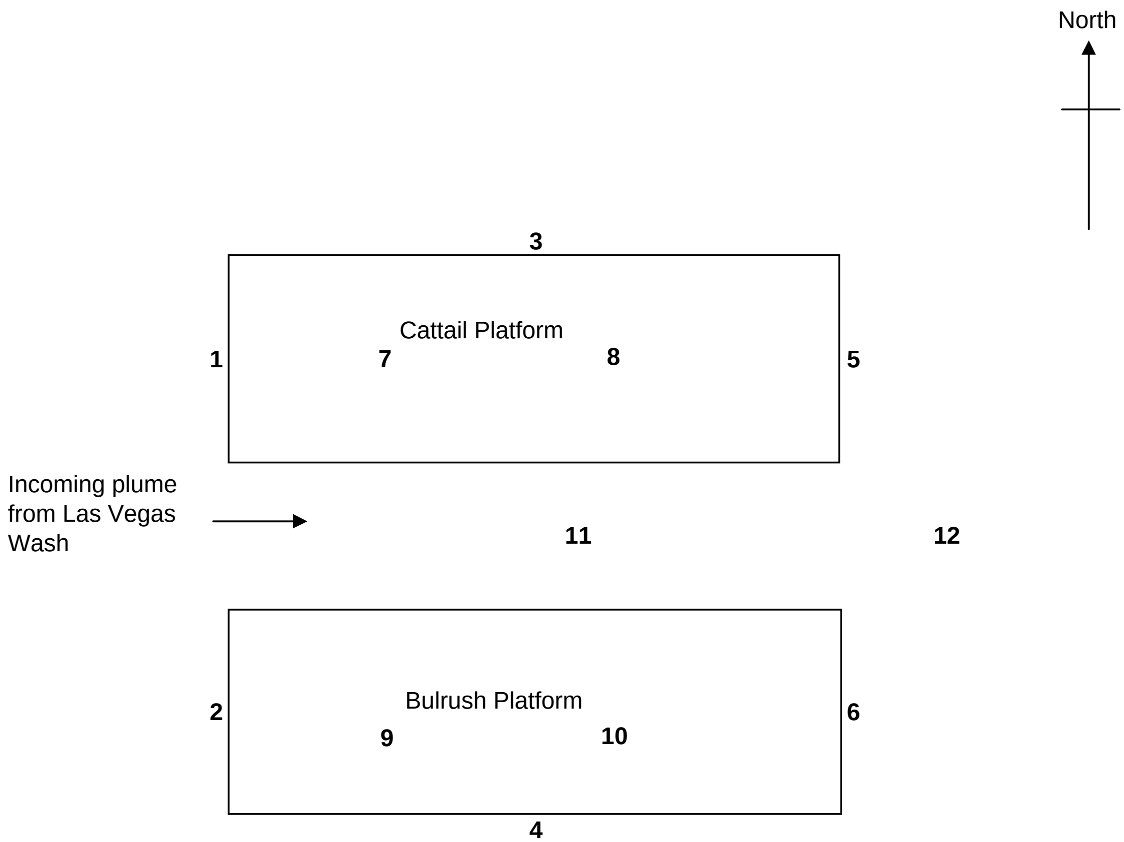
Chlorophyll samples were collected during the May and June test periods to compare the levels of chlorophyll a, b, and c to levels else where within Lake Mead.

Water samples were collected in 500-ml Nalgene bottles for nutrient determinations of nitrate nitrogen ($N0_3$-N), ammonia nitrogen (NH_3-N), potassium (K), and total suspended solids (TSS). These samples were placed in an insulated cooler, and packed in ice until they could be delivered to the analytical laboratory in Boulder City. Water samples were analyzed, for nutrients, by the Lower Colorado Region Laboratory, U.S. Bureau of Reclamation, (Appendix B and C), according to Standard Methods for the Examination of Water and Wastewater, 18th ed., American Public Health Association (APHA, 1992). Phosphate ($P0_4$) was not collected because it had been determined that incoming levels were low, approximately 0.04mg/l or less (Technical Memorandum No. #8220-99-03). Although the phosphate loading is high over time, phosphate limits set by the Environmental Protection Agency for the three-wastewater treatment plants on Las Vegas Wash have resulted in low release concentrations for a given sample time and therefore, not a good indicator of nutrient uptake by the riparian plants on the floating islands[3]. The first water quality test occurred from May 15, 2002 to May 21, 2002. A static water test was planned for this first sampling period in which the floating platforms were to be enclosed by

[3]Nutrient information on Las Vegas Wash and Las Vegas Bay from Dr. James F. LaBounty, Southern Nevada Water Authority and James J.Sartoris and Richard A. Roline, U.S. Bureau of Reclamation.

Figure 3.

Water sampling and monitoring stations and their number designations.



placing a heavy-duty plastic sheet around the perimeter of the floating platforms. However, because of the swiftness of the incoming flow (greater than 0.5 feet per second), as well as, the close proximity of the encroaching delta, the plastic curtain could not be deployed during the first scheduled test. Therefore, a flowing water study was initiated to determine if a zone of lower nutrient concentration could be identified beneath the riparian vegetation of the floating islands, compared to the nutrient concentrations around the perimeter of the floating islands.

The floating platforms had to be moved several times before the second water quality-sampling period could commence on June 5, 2002 to June 11, 2002. These platform moves were accomplished by winching the platforms away from the incoming plume of Las Vegas Wash or by the placing of additional anchors and towing the floating platforms to the new locations. A plastic curtain was used to completely enclose the bulrush platform during the June water quality test. However, because of the current of the incoming Las Vegas Wash water, the lightness of the plastic sheeting, and the air captured within the plastic sheeting, the weighting system prepared by the Lower Colorado Region was not sufficient to sink the bottom edge of the plastic sheet. Additional weight had to be secured to the bottom edge of the plastic sheet to form a positive seal with the bottom sediments and to position the sheet in the desired location. The water level was low, allowing the curtain to extend completely to the bottom of the lake, as well as, rise approximately 18 inches above the water surface, preventing wave action from lapping water into the interior of the enclosure. Also, because of the large amount of silt carried by the plume, the bottom perimeter of the plastic curtain formed a positive sealed with the bottom substrate within a few hours and no dye test was needed to confirm that the bottom edge of the plastic curtain was following the bottom contours. It took three days to set the single enclosure in place. Because of the problems setting the first enclosure around the bulrush platform, a second enclosure was not set around the cattail platform. Instead, it was decided that the cattail platform would serve as a control to be compared to the enclosed platform. Although the platforms are referred to as cattail or bulrush, because these species were initially segregated, the two platforms had become somewhat homogeneous after 12 to 16 months of growth.

Vegetation

Vegetation for planting the twenty-four floating islands was located and collected within the Lake Mead National Recreation Area at the Overton Wildlife Management Area. This area was the main source of vegetative stock, as well as seed and tuber collections, although a small amount of vegetation was collected along Las Vegas Wash downstream of the Northshore Road Bridge. The plant species collected included: Southern Cattails (Typha domingensis), Hardstem Bulrush (Schoenoplectus acutus), Olney's Bulrush (Schoenoplectus americanus), Common Three-square Bulrush (Schoenoplectus pungens), River Bulrush (Bolboschoenus fluviatilis), Saltmarsh Bulrush (Bolboschoenus maritimus) and Creeping Spikerush (Eleocharis palustris). Schoenoplectus and Bolboschoenus are the newer genus taxonomic names, formerly known as the genus Scirpus, members of the family Cyperaceae (Smith, 1995).

Plant Establishment

All of the floating islands were planted between January 17, 2001 and May 17, 2001. The floating islands were evaluated visually for percent coverage several times during the first growing season. Four floating islands were replanted using plant stocks from the other floating islands and one island that didn't get constructed in 2001 was built and planted during the winter and spring of 2002. The four islands were replanted because a beaver, Castor canadensis, and waterfowl damaged these islands during the winter of 2001-2002. Visual, percent coverage, evaluations for each complete island were made once again in 2002 prior to and after the water quality monitoring of the floating islands. In addition, 22 of the 24 islands were evaluated for; percent coverage using a randomly placed quarter meter square quadrat, culm length, and culm diameter at 15 cm above the island structure, and fresh and dry biomass was also collected.

Floating Island Structural Durability

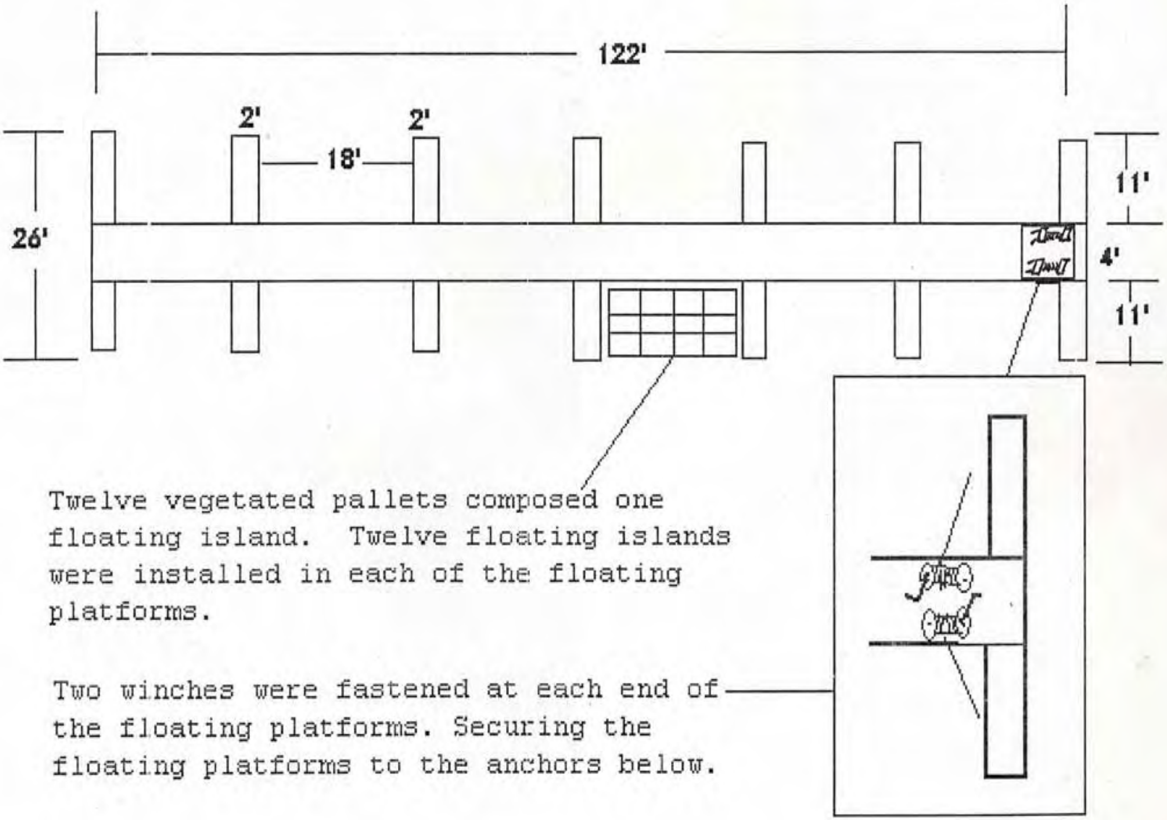
The floating platform superstructure and the floating islands were inspected for general wear and durability throughout the study. This included the winches and anchor lines as well as the hardware used to assemble to floating platforms and islands general maintenance was performed as needed.

The two floating platform superstructures were built by a contractor and are similar to a conventional boat dock. There are 12 slips in each platform, which house 12 floating islands. These floating platforms also provide an easy and expedient method for the removal and addition of floating islands without dismantling the entire structure, should certain islands designs fail or become overgrown and need replacing. Four of the floating islands were removed, towed to shore for replanting during the winter of 2001-2002 testing this design concept.

The floating platforms are constructed of galvanized angle steel, welded into a truss frame. The truss frame height is 12 inches and a freeboard height of 19 inches was measured before the floating islands were attached to the floating platforms. The floating platforms provide the structural strength to the superstructure, independent of the decking and the attached floating islands. The decking covering the truss framework is constructed of 2 inches by 6 inches untreated pine. Flotation is supplied by solid core polystyrene blocks encapsulated in a polyethylene cover and is known in the industry as flotation billets. The floatation is attached to the steel truss structure supporting it approximately one foot above the water surface.

The outside dimension of each floating platform is 122 feet (37.1m) in length and 26 feet (7.9m) wide, giving each of the floating platforms an area of 3,172 square feet. The main walkway, measured 122 feet in length by 4 feet wide, and had sufficient strength for the mounting of four winch stands and four anchoring winches, two at each end of each floating platform. To the main walkways are attached fourteen dock fingers each measuring 2 feet (0.6m) by 11 feet (2.1m); seven dock fingers were placed on each side of the main walkway. These fingers are spaced 18 feet apart, providing 12 slips per dock, in which are fastened 12 floating islands, as depicted in the enclosed drawing (Figure 4). Each slip area formed by two fingers and the main walkway was designed to have a load capability of five hundred pounds. This provides a total

Figure 4. Two floating platforms were constructed. Each had a length of 122 feet and a width of 26 feet. The main walkway was 4 feet wide and side finger walkways were 2 feet wide.



load capacity of 6,000 pounds (2721.6 kg) per floating platform. Figure 5 shows a view of the floating platforms in Las Vegas Bay from the campground during the winter of 2001 before planting and a later view of the floating platforms with the established floating islands, summer, 2002.

The anchors used to hold the floating platforms in place were composed of four concrete aggregate blocks weighing approximately 1,000 pounds (453.6 kg) each. Galvanized steel rope, 1/2 inch (12 mm) in diameter was fastened to the anchors using a two-foot length of chain and two cable clamps.

Four large winches were mounted on each floating platform. Each winch has a holding capacity of 4000 lbs (1814 kg). During strong winds and wave fetch caused by wind, movement can be felt but the platforms are still quite stable and walking is easily accomplished.

The floating islands were constructed of twelve, high-density polyethylene plastic shipping pallets. These were bolted together with 3/8-inch (9 mm) stock stainless steel hardware; one bolt, two washers, and one nylon insert nut were used at each connection point. Each pallet measured 48 inches (1.2 m) in length by 40 inches (1 m) in width by 4.75 inches (12.1 cm) in height. Each pallet had a 3.5-inch (8.9 cm) space between the top and the bottom surface of the pallet in which shredded coconut fiber was stuffed. The twelve attached pallets formed a planting surface, 10 feet (3.0 m) by 16 feet (4.9 m). The twelve pallets that compose a floating island have a positive buoyancy of approximately 168 pounds (76.2 kg). After planting the floating islands with emergent vegetation they were then covered with a layer of heavy-duty plastic fence having a mess opening size of 1.75 inches (42.7mm) by 1.75 inches (42.7). This fence layer helped to hold the coconut fiber and the newly planted vegetation in the pallets, until the vegetation roots could anchor the plants to the plastic grid of the pallets. A second layer of the same fence material was then fastened to the floating island forming a two-foot high fence around the perimeter and over the top of each island. This fence cover prevented waterfowl and other wildlife from eating, removing or trampling the vegetation before it established.

RESULTS AND DISCUSSION

Las Vegas Wash, Plume and Sedimentation

Water depths at the start of the first six-day monitoring period (5/15/02 to 5/21/0) were 11' 2" (3.4m) to 19' 10" (6.0m) from the shallow end to the deep end of the cattail platform and 15' 6" (4.7m) to 22' 10" (7.0) from the shallow end to the deep end of the bulrush platform. This depth seemed ideal for the fitting of the membrane curtain around the perimeter of the floating islands. However, the direction of the incoming plume from Las Vegas Wash had changed and was now flowing directly at the floating islands as well as to the west of them Table 1 and 2.

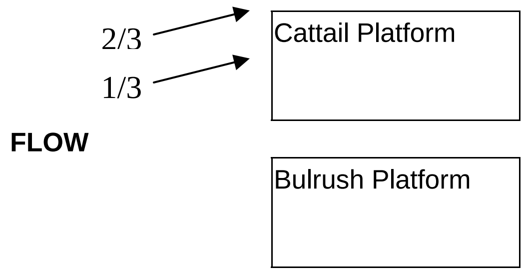
This incoming plume flow continued to meander, almost on a daily basis, transporting large amounts of silt. In addition to the redistributing of the silt load, the dropping of the lake elevation, the Nevada Department of Transportation was working on the wash below North Shore Road Bridge, Highway 147. This activity sluiced even more silt and debris down

Figure 5.
View of the floating platforms in Las Vegas Bay in the winter of 2001 before planting.

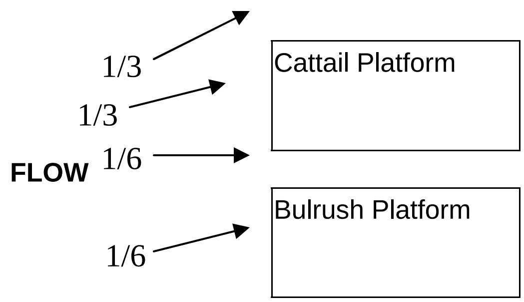
Summer of 2002 showing established cattails and bulrush.

Table 1.

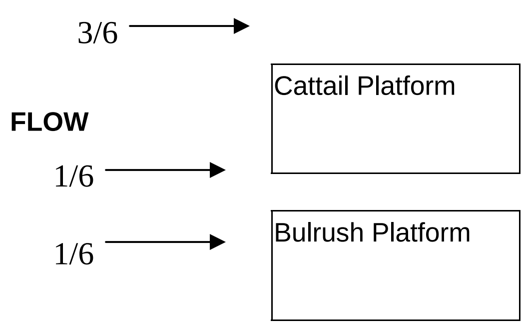
Las Vegas Wash Flow Conditions Coming Into Lake Mead During May, 2002



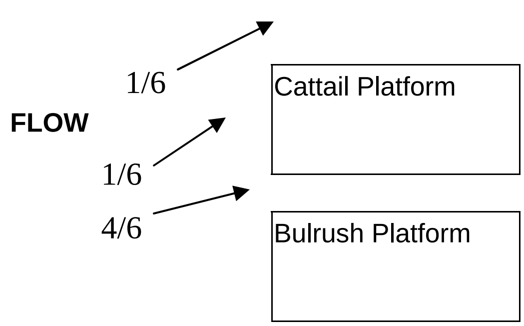
5/15/2002
1/3 flow at Cattail platform,
2/3 flow west of Cattail platform



5/17/2002
1/3 flow west of cattail platform,
1/3 flow at the cattail platform,
1/6 between cattail and
bulrush platform, and 1/6 flow
at bulrush platform.



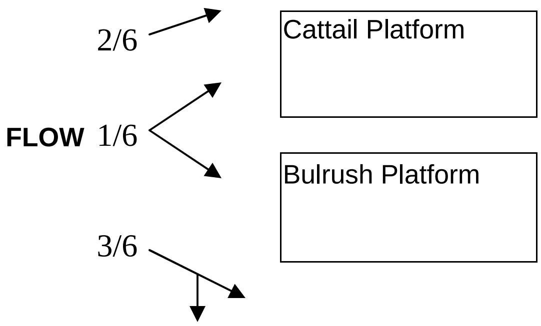
5/19/2002
3/6 west of cattail platform,
1/6 between cattail and
bulrush platform,
1/6 at bulrush platform,
1/6 east of bulrush platform.



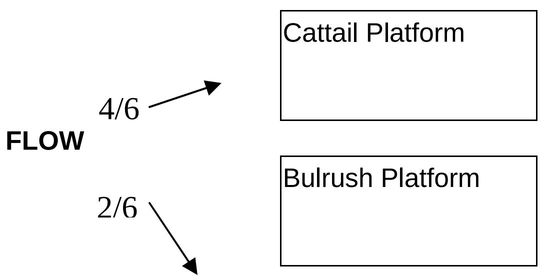
5/21/2002
1/6 west of cattail platform,
1/6 at cattail platform,
4/6 at sw corner of bulrush

Table 2.

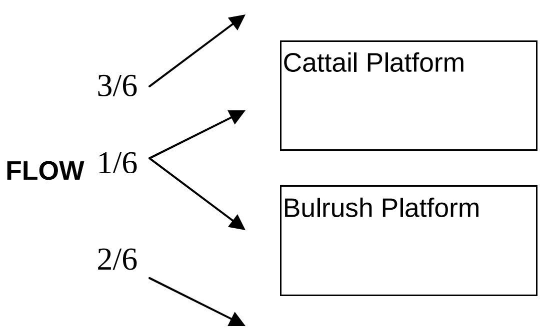
Las Vegas Wash Flow Conditions Coming Into Lake Mead During June, 2002



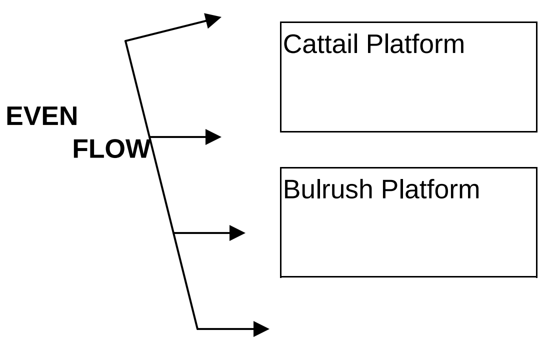
6/05/2002
2/6 flow west of cattail platform,
1/6 flow at cattail &
bulrush platforms,
3/6 flow east and south of
bulrush platforms.



6/07/2002
4/6 flow at cattail platform
2/6 flow east of bulrush platform



6/09/2002
3/6 flow west of cattail platform
1/6 flow at cattail and bulrush
2/6 flow east of bulrush platform.



6/11/22
even flow west, east and at
the cattail and bulrush platforms

the wash into Las Vegas. This debris was redeposited upon and around the floating islands as the velocity of the incoming plume slowed. This flow and debris made installation of the membrane curtain, during the May test, impossible. Siltation and water depth was monitored each sampling day during the May monitoring test (5/15/02, 5/17/02, 5/19/02, 5/21/02) and every sampling day during the June monitoring test (6/5/02, 6/7/02, 6/9/02, 6/11/02), as well as two days in between the two monitoring periods (5/23/02 and 6/3/02).

Maximum silt depositions of 19.5 inches (495mm) per day were recorded between May 17, and May 19, 2002 at the upstream end of the cattail platform (Table 3). Mean silt depositions at the upstream end of the floating platforms were 14.5 inches (368mm) and 10.2 inches (259mm) per day for the cattail and bulrush platforms respectively, during the May monitoring period and mean silt depositions of 7 inches (178mm) to 3.5 (89mm) inches per day for the cattail and bulrush platforms respectively, during the June monitoring. The total amount of siltation within Las Vegas Bay between May 15, 2002 and June 11, 2002 is impossible to determine because the floating platforms were winched into deeper water four times between the middle of May and the middle of June, and therefore, the platforms were in different locations within the bay during this period. However, the original location of the floating platforms on May 15, 2002 was a mud flat by June 11, 2002 indicating a deposition of 15 (4.6m) to 12 feet (3.7m) in less than one month. This takes into account the loss of 3.76 feet (1.1m) of lake elevation during this same time period.

Water Quality

May Nutrient Analysis:

During the May monitoring, a zone of lower nutrient concentration, mean nitrate (NO_3 - N), was observed as the water flowed immediately under, surface sample, both the cattail and bulrush floating platforms, 10.07 ppm to 5.83 ppm and 6.23 ppm to 4.68 ppm respectively (Table 4). This decrease was also seen in the mean ammonia (NH_3 - N), 0.02 ppm to 0.01 ppm (Table 5); the mean potassium (K), 19.5 ppm to 13.0 ppm (Table 6); and the mean total suspended solids (TSS), 452 ppm to 44 ppm (Table 7); immediately under the cattail floating platform, however, like phosphate, the ammonia was low in concentration and therefore is not an accurate indicator of nutrient removal (Table 5). A decrease in the TSS immediately under the bulrush, floating platform was also observed showing a similar trend to the TSS surface samples of the cattail platform (Table 6). However, this graduated lowering of concentration did not hold true for the surface samples of ammonia or potassium immediately under the bulrush platform (Tables 5 and Table 7), as was observed under the cattail platform. A decrease in NO_3-N and NH_3-N, K, and TSS was also seen 4.9 feet (1.5m) below the cattail platform. At 4.9 feet (1.5m) under the bulrush platform none of the nutrients sampled followed a decreasing concentration with direction of flow pattern (Table 4,5,6, and 7and appendix B). It is believed that the bulrush roots and rhizomes did not reach beyond a meter below the floating islands and therefore did not affect the nutrient concentration substantially at 4.9 feet (1.5m) below the surface. Also, the nutrient concentrations below the cattail islands were higher in concentration than below the bulrush islands more often, which corresponds to the higher incoming flow conditions toward the cattail

Table 3.

Silt And Gravel Accumulation During Water Quality Sampling May 15-23, 2002 and June 5-11, 2002.

		Depth at Cattail Islands				Depth at Bulrush Islands			
	Mead ele.	Upstream	Siltation	Downstream	Siltation	Upstream	Siltation	Downstream	Siltation
5/15/2002	1165.33	134"		238"		186"		274"	
	-4"		19"/2 days		6"/2 days		12"/2 days		3"/2 days
5/17/2002	1164.97	111"		228"		170"		267"	
	-3"		39"/2 days		18"/2 days		29"/2 days		2"/2 days
5/19/2002	1164.71	69"		207"		138"		262"	
"No Values"	Islands winched away from plume as much as possible using older anchors and lines (5/20/02)								
5/21/2002	1164.32	66"		188"		170"		260"	
"No Values"	Islands winched away from plume using new anchors and lines (5/22/02)								
5/23/2002	1163.84	206"		229"		257"		270"	
	-19"		48"/12 days		35"/12 days		53"/12 days		21"/12 days
6/3/2002	1162.24	139"		175"		185"		230"	
"No Values"	Islands winched away from plume before starting June study (6/3/02)								
6/3/2002	1162.24	154"		107"		201"		237"	
"No Values"	New location for floating platforms set by the marina (6/4/02)								
6/5/2002	1162.00	192"		204"		191"		233"	
	-4"		2"/2 days		0"/2 days		6"/2 days		-2"/2 days
6/7/2002	1161.68	186"		200"		181"		231"	
	0"		13"/2 days		2"/2 days		13"/2 days		1"/2 days
6/9/2002	1161.74	173"		198"		194"		230"	
	-2"		27"/2 days		5"/2 days		2"/2 days		-1"/ 2 days
6/11/2002	1161.57	144"		191"		190"		233"	

Both islands were attached to one end of a rock on shore and and to anchors on the other end.
The islands were then winched as close to shore as possible before being moved to West Gypsum Bay.

Table 4. **Nitrogen as NO3-N, May 2002**

Station Code	15-May NO3 as N (ppm)	17-May NO3 as N (ppm)	19-May NO3 as N (ppm)	21-May NO3 as N (ppm)
#1	8.04	8.70	7.94	15.59
#1	11.53	10.63	11.10	14.16
#2	8.54	6.81	6.28	3.28
#2	9.63	5.62	8.22	3.00
#3	7.92	5.59	7.50	5.52
#3	9.32	7.36	7.30	9.47
#4	9.41	4.59	5.74	3.38
#4	10.49	5.41	5.84	3.47
#5	7.24	4.11	7.48	4.47
#5	9.26	7.21	8.04	4.78
#6	6.16	3.63	5.76	3.20
#6	9.67	5.48	5.72	5.51
#7	7.31	4.76	7.52	9.11
#7	10.48	7.17	7.41	9.31
#8	5.65	4.31	7.49	7.82
#8	10.38	7.05	7.83	7.66
#9	7.99	4.51	6.88	3.69
#9	9.30	5.50	8.39	2.79
#10	6.78	4.00	5.61	3.42
#10	9.40	5.72	6.09	6.42
#11	8.64	4.15	5.75	5.65
#11	10.98	5.07	7.51	8.22
#12	na	na	5.87	5.64
#12	na	na	6.03	7.70

Surface Sample, Cattail Platform

Station Code	15-May NO3 as N (ppm)	17-May NO3 as N (ppm)	19-May NO3 as N (ppm)	21-May NO3 as N (ppm)	Mean (ppm)	Direction of Flow
#1	8.04	8.70	7.94	15.59	10.07	
#7	7.31	4.76	7.52	9.11	7.18	
#8	5.65	4.31	7.49	7.82	6.32	
#5	7.24	4.11	7.48	4.47	5.83	↓

1.5 Meter Sample, Cattail Platform

Station Code	15-May NO3 as N (ppm)	17-May NO3 as N (ppm)	19-May NO3 as N (ppm)	21-May NO3 as N (ppm)	Mean (ppm)	Direction of Flow
#1	11.53	10.63	11.10	14.16	11.86	
#7	10.48	7.17	7.41	9.31	8.59	
#8	10.38	7.05	7.83	7.66	8.23	
#5	9.26	7.21	8.04	4.78	7.32	↓

Surface Sample, Bulrush Platform

Station Code	15-May NO3 as N (ppm)	17-May NO3 as N (ppm)	19-May NO3 as N (ppm)	21-May NO3 as N (ppm)	Mean (ppm)	Direction of Flow
#2	8.54	6.81	6.28	3.28	6.23	
#9	7.99	4.51	6.88	3.69	5.77	
#10	6.78	4.00	5.61	3.42	4.95	
#6	6.16	3.63	5.76	3.20	4.68	↓

1.5 Meter Sample, Bulrush Platform

Station Code	15-May NO3 as N (ppm)	17-May NO3 as N (ppm)	19-May NO3 as N (ppm)	21-May NO3 as N (ppm)	Mean (ppm)	Direction of Flow
#2	9.63	5.62	8.22	3.00	6.62	
#9	9.30	5.50	8.39	2.79	6.49	
#10	9.40	5.72	6.09	6.42	6.90	
#6	9.67	5.48	5.72	5.51	6.59	↓

Table 5. **Nitogen as NH3-N, May 2002**

Station Code	15-May NH_3 as N (ppm)	17-May NH_3 as N (ppm)	19-May NH_3 as N (ppm)	21-May NH_3 as N (ppm)
#1	0.05	0.17	0.15	0.41
#1	0.14	0.21	0.24	0.36
#2	0.05	0.07	0.05	0.08
#2	0.07	0.06	0.12	0.07
#3	< 0.04	0.05	0.10	0.14
#3	0.12	0.12	0.11	0.26
#4	< 0.04	< 0.04	0.04	0.07
#4	0.12	< 0.04	< 0.04	0.07
#5	< 0.04	< 0.04	0.09	0.11
#5	0.09	0.12	0.13	0.11
#6	< 0.04	< 0.04	< 0.04	0.08
#6	0.07	0.05	< 0.04	0.14
#7	< 0.04	< 0.04	0.10	0.26
#7	0.12	0.12	0.10	0.26
#8	< 0.04	< 0.04	0.10	0.20
#8	0.12	0.11	0.12	0.20
#9	< 0.04	< 0.04	0.05	0.08
#9	0.07	0.05	0.09	0.07
#10	< 0.04	< 0.04	< 0.04	0.07
#10	0.08	0.06	0.04	0.14
#11	< 0.04	< 0.04	< 0.04	0.15
#11	0.13	0.05	0.07	0.23
#12	na	na	0.04	0.14
#12	na	na	0.04	0.18

Surface Sample, Cattail Platform

Station Code	15-May NH_3 as N (ppm)	17-May NH_3 as N (ppm)	19-May NH_3 as N (ppm)	21-May NH_3 as N (ppm)	Mean (ppm)	Direction of Flow
#1	0.05	0.17	0.15	0.41	0.20	
#7	< 0.04	< 0.04	0.10	0.26	0.18	
#8	< 0.04	< 0.04	0.10	0.20	0.15	
#5	< 0.04	< 0.04	0.09	0.11	0.10	↓

1.5 Meter Sample, Cattail Platform

Station Code	15-May NH_3 as N (ppm)	17-May NH_3 as N (ppm)	19-May NH_3 as N (ppm)	21-May NH_3 as N (ppm)	Mean (ppm)	Direction of Flow
#1	0.14	0.21	0.24	0.36	0.24	
#7	0.12	0.12	0.10	0.26	0.15	
#8	0.12	0.11	0.12	0.20	0.13	
#5	0.09	0.12	0.13	0.11	0.11	↓

Surface Sample, Bulrush Platform

Station Code	15-May NH_3 as N (ppm)	17-May NH_3 as N (ppm)	19-May NH_3 as N (ppm)	21-May NH_3 as N (ppm)	Mean (ppm)	Direction of Flow
#2	0.05	0.07	0.05	0.08	0.06	
#9	< 0.04	< 0.04	0.05	0.08	0.07	
#10	< 0.04	< 0.04	< 0.04	0.07	0.07	
#6	< 0.04	< 0.04	< 0.04	0.08	0.08	↓

1.5 Meter Sample, Bulrush Platform

Station Code	15-May NH_3 as N (ppm)	17-May NH_3 as N (ppm)	19-May NH_3 as N (ppm)	21-May NH_3 as N (ppm)	Mean (ppm) (ppm)	Direction of Flow
#2	0.07	0.06	0.12	0.07	0.08	
#9	0.07	0.05	0.09	0.07	0.07	
#10	0.08	0.06	0.04	0.14	0.08	
#6	0.07	0.05	< 0.04	0.14	0.09	↓

Table 6. **Potassium, May 2002**

Station Code	15-May K (ppm)	17-May K (ppm)	19-May K (ppm)	21-May K (ppm)
#1	17.1	18.7	16.9	25.3
#1	20.7	22.8	21.7	22.5
#2	16.5	16.2	13.6	8.2
#2	18.2	13.6	16.2	8.3
#3	16.8	16.2	15.5	11.8
#3	18.3	12.2	15.8	17.6
#4	18.4	12.2	12.6	8.7
#4	20.5	13.5	13.1	8.9
#5	14.6	11.3	15.8	10.2
#5	19.4	16.0	17.1	10.4
#6	14.0	10.4	13.0	8.8
#6	17.7	13.6	13.2	12.3
#7	15.5	12.5	16.2	17.3
#7	20.8	16.2	15.9	17.4
#8	12.6	11.7	16.1	14.7
#8	19.9	15.6	16.6	14.8
#9	16.3	12.0	14.5	9.3
#9	18.1	13.7	16.5	8.3
#10	14.8	11.3	12.9	8.7
#10	18.4	13.8	13.7	13.0
#11	18.4	11.4	13.1	12.1
#11	21.2	13.2	15.3	15.5
#12	na	na	13.2	11.4
#12	na	na	13.7	14.2

Surface Sample, Cattail Platform

Station Code	15-May K (ppm)	17-May K (ppm)	19-May K (ppm)	21-May K (ppm)	Mean (ppm)	Direction of Flow
#1	17.1	18.7	16.9	25.3	19.5	
#7	15.5	12.5	16.2	17.3	15.4	
#8	12.6	11.7	16.1	14.7	13.8	
#5	14.6	11.3	15.8	10.2	13.0	↓

1.5 Meter Sample, Cattail Platform

Station Code	15-May K (ppm)	17-May K (ppm)	19-May K (ppm)	21-May K (ppm)	Mean (ppm)	Direction of Flow
#1	20.7	22.8	21.7	22.5	21.9	
#7	20.8	16.2	15.9	17.4	17.5	
#8	19.9	15.6	16.6	14.8	16.7	
#5	19.4	16.0	17.1	10.4	15.7	↓

Surface Sample, Bulrush Platform

Station Code	15-May K (ppm)	17-May K (ppm)	19-May K (ppm)	21-May K (ppm)	Mean (ppm)	Direction of Flow
#2	16.5	16.2	13.6	8.2	13.6	
#9	16.3	12.0	14.5	9.3	13.0	
#10	14.8	11.3	12.9	8.7	11.9	
#6	17.7	13.6	13.2	12.3	14.2	↓

1.5 Meter Sample, Bulrush Platform

Station Code	15-May K (ppm)	17-May K (ppm)	19-May K (ppm)	21-May K (ppm)	Mean (ppm)	Direction of Flow
#2	18.2	13.6	16.2	8.3	14.1	
#9	18.1	13.7	16.5	8.3	14.1	
#10	18.4	13.8	13.7	13.0	14.7	
#6	17.7	13.6	13.2	12.3	14.2	↓

Table 7. **Total Suspended Solids, May 2002**

Station Code	15-May TSS (ppm)	17-May TSS (ppm)	19-May TSS (ppm)	21-May TSS (ppm)
#1	57	417	100	1234
#1	61	655	628	599
#2	15	397	137	9
#2	22	26	385	11
#3	37	27	88	63
#3	216	82	90	101
#4	47	13	67	10
#4	26	13	85	10
#5	31	11	91	41
#5	158	46	278	40
#6	19	10	42	10
#6	34	12	39	165
#7	54	19	111	147
#7	132	211	85	105
#8	24	13	124	55
#8	92	44	183	96
#9	23	12	196	81
#9	27	22	412	14
#10	22	11	61	16
#10	28	15	144	211
#11	51	10	55	48
#11	27	17	249	78
#12	na	na	50	48
#12	na	na	56	129

Surface Sample, Cattail Platform

Station Code	15-May TSS (ppm)	17-May TSS (ppm)	19-May TSS (ppm)	21-May TSS (ppm)	Mean (ppm)	Direction of Flow
#1	57	417	100	1234	452.1	↓
#7	54	19	111	147	82.7	
#8	24	13	124	55	54.2	
#5	31	11	91	41	43.5	

1.5 Meter Sample, Cattail Platform

Station Code	15-May TSS (ppm)	17-May TSS (ppm)	19-May TSS (ppm)	21-May TSS (ppm)	Mean (ppm)	Direction of Flow
#1	61	655	628	599	485.7	↓
#7	132	211	85	105	133.1	
#8	92	44	183	96	103.8	
#5	158	46	278	40	130.3	

Surface Sample, Bulrush Platform

Station Code	15-May TSS (ppm)	17-May TSS (ppm)	19-May TSS (ppm)	21-May TSS (ppm)	Mean (ppm)	Direction of Flow
#2	15	397	137	9	139.6	↓
#9	23	12	196	81	77.9	
#10	22	11	61	16	27.7	
#6	19	10	42	10	20.5	

1.5 Meter Sample, Bulrush Platform

Station Code	15-May TSS (ppm)	17-May TSS (ppm)	19-May TSS (ppm)	21-May TSS (ppm)	Mean (ppm)	Direction of Flow
#2	22	26	385	11	110.9	↓
#9	27	22	412	14	118.7	
#10	28	15	144	211	99.5	
#6	34	12	39	165	62.4	

islands for most of the May test (Table 1). It is helpful to use Figure 3 and Tables 1 and 2, along with the nutrient analysis and the water quality information to understand the sampling locations and the direction of flow as well as the shifting of the in coming plume during the May and June tests because conditions changed every sampling date.

June Nutrient Analysis:
During the June study, the decrease in nitrogen (NO3-N) 7.62 ppm to 6.41 ppm and total suspended solids (TSS) 135 ppm to 30 ppm was not so obvious, as it was during the May analysis, but reduction in these nutrient levels was still seen in the samples taken immediately below the cattail islands (Table 8 and 9)[4]. No obvious reduction in the other nutrients, nitrogen as ammonia ($N\text{-}NH_3$) and potassium (K) could be discerned (Table 10 and 11).

An enclosure was setup around the bulrush platform in June, to evaluate the nutrient uptake potential of the wetland plants under static water conditions. Sample stations #9 and #10, within the enclosed area, showed an increase in nitrogen (NO_3 - N), ammonia (NH_3 -N), and potassium K for both the surface and 1.5m samples (Table 8, 10, 11 and appendix B) rather than a decrease in nutrient levels as in the flowing water evaluations. It is speculated that these increased nutrient levels are in response to nutrients being released from the newly deposited sand and silt brought in by Las Vegas Wash and deposited beneath the bulrush platform just prior to being enclosed with a plastic curtain. Information from Reclamation Technical Memorandum No. 8220-10-02 “Analysis of Sediments from the Las Vegas Bay Delta” (Table 5) showed that NH_3-N and NO_3-N, as well as phosphate, were released during sediment equilibration tests. A blue-green alga bloom that has been prevalent at Lake Mead during the passed two years or input of avian guano by the birds using the floating islands could also explain this increase in nutrients within the enclosure. Although, there were very few birds present during the water quality sampling periods in both May and June, those present were mostly small songbirds or grackles and no rain occurred during either evaluation that would have flushed bird guano into the enclosure. It is also unlikely that blue-green algae would increase nutrient levels within four days.

Water chemistry data was gathered, with the portable Hydrolab unit, each time a water sampling was made. On two occasions the Hydrolab unit malfunctioned, May 21, 2002 and June 11, 2002, therefore, there are only partial data sets for these dates. Data on the May and June water quality are presented in appendix D. Water temperatures during the May and June sampling periods ranged from 23 to 27 ^{o}C on the surface and 22 to 28^{o} C at 4.9 feet (1.5m). In general, water temperatures were consistent from the surface down to 1.5 meters.

Dissolved oxygen levels ranged between 9 mg/l to supersaturated levels of 14-17 mg/l during the

[4] Total suspended solids for the June study were estimated from turbidity values using a Hach photometric turbidity meter.

Table 8. **Nitrogen as NO3-N, June 2002**

Station Code	05-June NO3 as N (ppm)	07-June NO3 as N (ppm)	09-June NO3 as N (ppm)	11-June NO3 as N (ppm)
#1	9.33	9.21	6.49	5.47
#1	9.22	9.39	9.51	5.96
#2	6.04	7.66	7.35	4.72
#2	6.23	7.86	7.29	5.14
#3	6.22	8.57	7.01	4.11
#3	8.20	10.27	9.77	7.66
#4	5.67	7.36	7.32	4.16
#4	6.38	7.62	7.27	4.11
#5	6.29	8.83	6.98	3.55
#5	10.14	11.24	7.74	5.83
#6	7.16	7.82	7.68	4.07
#6	8.08	8.86	7.92	4.92
#7	6.57	7.62	6.61	3.16
#7	9.86	10.14	9.89	4.19
#8	6.17	8.55	6.90	3.19
#8	10.09	9.69	8.09	6.05
#9	6.77	7.91	9.33	7.33
#9	7.03	8.20	9.86	7.87
#10	6.73	7.79	9.88	8.96
#10	7.00	8.25	9.86	9.33
#11	6.16	8.60	7.24	4.90
#11	8.08	8.67	8.25	9.24
#12	na	na	na	na
#12	na	na	na	na

Surface Sample, Cattail Platform

Station Code	05-June NO3 as N (ppm)	07-June NO3 as N (ppm)	09-June NO3 as N (ppm)	11-June NO3 as N (ppm)	Mean (ppm)	Direction of Flow
#1	9.33	9.21	6.49	5.47	7.62	
#7	6.57	7.62	6.61	3.16	5.99	
#8	6.17	8.55	6.90	3.19	6.20	
#5	6.29	8.83	6.98	3.55	6.41	↓

1.5 Meter Sample, Cattail Platform

Station Code	05-June NO3 as N (ppm)	07-June NO3 as N (ppm)	09-June NO3 as N (ppm)	11-June NO3 as N (ppm)	Mean (ppm)	Direction of Flow
#1	9.22	9.39	9.51	5.96	8.52	
#7	9.86	10.14	9.89	4.19	8.52	
#8	10.09	9.69	8.09	6.05	8.48	
#5	10.14	11.24	7.74	5.83	8.74	↓

Surface Sample, Bulrush Platform

Station Code	05-June NO3 as N (ppm)	07-June NO3 as N (ppm)	09-June NO3 as N (ppm)	11-June NO3 as N (ppm)	Mean (ppm)	Direction of Flow
#2	6.04	7.66	7.35	4.72	6.44	
#9	6.77	7.91	9.33	7.33	7.83 enclosure	
#10	6.73	7.79	9.88	8.96	8.34 enclosure	
#6	7.16	7.82	7.68	4.07	6.68	↓

1.5 Meter Sample, Bulrush Platform

Station Code	05-June NO3 as N (ppm)	07-June NO3 as N (ppm)	09-June NO3 as N (ppm)	11-June NO3 as N (ppm)	Mean (ppm)	Direction of Flow
#2	6.23	7.86	7.29	5.14	6.63	
#9	7.03	8.20	9.86	7.87	8.24 enclosure	
#10	7.00	8.25	9.86	9.33	8.61 enclosure	
#6	8.08	8.86	7.92	4.92	7.44	↓

Table 9. **Total Suspended Solids, June 2002**

Station Code	05-June TSS (ppm)	07-June TSS (ppm)	09-June TSS (ppm)	11-June TSS (ppm)
#1	456	36	39	11
#1	419	39	12	70
#2	16	25	17	15
#2	22	25	15	68
#3	38	27	13	13
#3	170	41	58	126
#4	20	23	13	13
#4	26	23	17	9
#5	71	28	15	5
#5	429	99	26	40
#6	41	25	17	15
#6	68	36	27	57
#7	99	26	13	6
#7	459	68	68	25
#8	60	99	26	40
#8	502	70	27	68
#9	22	15	17	175
#9	20	17	25	117
#10	32	22	17	457
#10	30	15	27	na
#11	34	27	15	13
#11	68	35	27	126
#12	na	na	na	40
#12	na	na	na	457

Surface Sample, Cattail Platform

Station Code	05-June TSS (ppm)	07-June TSS (ppm)	09-June TSS (ppm)	11-June TSS (ppm)	Mean (ppm)	Direction of Flow
#1	456	36	39	11	135.4	
#7	99	26	13	6	36.1	
#8	60	99	26	40	56.4	
#5	71	28	15	5	29.8	

1.5 Meter Sample, Cattail Platform

Station Code	05-June TSS (ppm)	07-June TSS (ppm)	09-June TSS (ppm)	11-June TSS (ppm)	Mean (ppm)	Direction of Flow
#1	419	39	12	70	135.0	
#7	459	68	68	25	155.0	
#8	502	70	27	68	166.7	
#5	429	99	26	40	148.6	

Surface Sample, Bulrush Platform

Station Code	05-June TSS (ppm)	07-June TSS (ppm)	09-June TSS (ppm)	11-June TSS (ppm)	Mean (ppm)	Direction of Flow
#2	16	25	17	15	18.4	
#9	22	15	17	175	57.3	enclosure
#10	32	22	17	457	131.9	enclosure
#6	41	25	17	15	24.5	

1.5 Meter Sample, Bulrush Platform

Station Code	05-June TSS (ppm)	07-June TSS (ppm)	09-June TSS (ppm)	11-June TSS (ppm)	Mean (ppm)	Direction of Flow
#2	22	25	15	68	32.4	
#9	20	17	25	117	44.7	enclosure
#10	30	15	27	na	24.1	enclosure
#6	68	36	27	57	47.0	

Table 10. **Nitogen as NH3-N, June 2002**

Station Code	05-June NH$_3$ as N (ppm)	07-June NH$_3$ as N (ppm)	09-June NH$_3$ as N (ppm)	11-June NH$_3$ as N (ppm)
#1	0.16	0.09	0.06	< 0.04
#1	0.14	0.11	0.13	0.06
#2	< 0.04	< 0.04	0.08	< 0.04
#2	0.04	< 0.04	0.08	< 0.04
#3	< 0.04	0.04	0.07	< 0.04
#3	0.07	0.14	0.16	0.09
#4	< 0.04	< 0.04	0.09	< 0.04
#4	< 0.04	< 0.04	0.09	< 0.04
#5	< 0.04	0.07	0.06	< 0.04
#5	0.20	0.20	0.09	< 0.04
#6	0.05	0.04	0.08	< 0.04
#6	0.06	0.08	0.10	< 0.04
#7	0.04	0.05	0.07	< 0.04
#7	0.16	0.05	0.15	< 0.04
#8	0.04	0.12	0.07	< 0.04
#8	0.16	0.12	0.10	0.05
#9	0.07	0.23	0.13	0.09
#9	0.09	0.19	0.15	0.10
#10	0.06	0.32	0.16	0.12
#10	0.08	0.26	0.15	0.12
#11	< 0.04	0.07	0.08	< 0.04
#11	0.08	0.04	0.10	0.14
#12	na	na	na	na
#12	na	na	na	na

Surface Sample, Cattail Platform

Station Code	05-June NH$_3$ as N (ppm)	07-June NH$_3$ as N (ppm)	09-June NH$_3$ as N (ppm)	11-June NH$_3$ as N (ppm)	Mean (ppm)	Direction of Flow
#1	0.16	0.09	0.06	< 0.04	0.10	
#7	0.04	0.05	0.07	< 0.04	0.05	
#8	0.04	0.12	0.07	< 0.04	0.08	
#5	< 0.04	0.07	0.06	< 0.04	0.06	

1.5 Meter Sample, Cattail Platform

Station Code	05-June NH$_3$ as N (ppm)	07-June NH$_3$ as N (ppm)	09-June NH$_3$ as N (ppm)	11-June NH$_3$ as N (ppm)	Mean (ppm)	Direction of Flow
#1	0.14	0.11	0.13	0.06	0.11	
#7	0.16	0.05	0.15	< 0.04	0.12	
#8	0.16	0.12	0.10	0.05	0.11	
#5	0.20	0.20	0.09	< 0.04	0.16	

Surface Sample, Bulrush Platform

Station Code	05-June NH$_3$ as N (ppm)	07-June NH$_3$ as N (ppm)	09-June NH$_3$ as N (ppm)	11-June NH$_3$ as N (ppm)	Mean (ppm)	Direction of Flow
#2	< 0.04	< 0.04	0.08	< 0.04	0.08	
#9	0.07	0.23	0.13	0.09	0.13	enclosure
#10	0.06	0.32	0.16	0.12	0.16	enclosure
#6	0.05	0.04	0.08	< 0.04	0.06	

1.5 Meter Sample, Bulrush Platform

Station Code	05-June NH$_3$ as N (ppm)	07-June NH$_3$ as N (ppm)	09-June NH$_3$ as N (ppm)	11-June NH$_3$ as N (ppm)	Mean (ppm) (ppm)	Direction of Flow
#2	0.04	< 0.04	0.08	< 0.04	0.06	
#9	0.09	0.19	0.15	0.10	0.13	enclosure
#10	0.08	0.26	0.15	0.12	0.15	enclosure
#6	0.06	0.08	0.10	< 0.04	0.08	

Table 11. **Potassium, June 2002**

Station Code	05-June K (ppm)	07-June K (ppm)	09-June K (ppm)	11-June K (ppm)
#1	14.4	16.8	13.2	9.0
#1	19.1	17.5	17.0	13.2
#2	13.3	15.2	15.5	11.3
#2	13.8	15.3	15.5	11.9
#3	13.7	16.3	13.7	10.4
#3	16.8	19.2	18.0	15.0
#4	13.0	15.5	15.4	10.5
#4	14.0	15.6	15.4	10.4
#5	14.0	17.0	14.9	9.8
#5	20.7	20.1	15.9	12.9
#6	15.1	16.4	16.4	10.5
#6	16.5	17.6	16.0	11.7
#7	14.5	15.2	13.3	9.5
#7	20.1	18.8	18.3	10.7
#8	14.0	17.2	14.7	9.5
#8	20.5	19.1	15.8	13.2
#9	14.3	17.3	17.8	14.8
#9	14.3	17.3	17.8	14.8
#10	14.4	17.8	18.5	17.1
#10	15.1	17.8	18.4	17.5
#11	13.9	17.4	15.4	11.7
#11	16.4	17.6	16.4	17.4
#12	na	na	na	na
#12	na	na	na	na

Surface Sample, Cattail Platform

Station Code	05-June K (ppm)	07-June K (ppm)	09-June K (ppm)	11-June K (ppm)	Mean (ppm)	Direction of Flow
#1	14.4	16.8	13.2	9.0	13.4	↓
#7	14.5	15.2	13.3	9.5	13.1	
#8	14.0	17.2	14.7	9.5	13.8	
#5	14.0	17.0	14.9	9.8	13.9	

1.5 Meter Sample, Cattail Platform

Station Code	05-June K (ppm)	07-June K (ppm)	09-June K (ppm)	11-June K (ppm)	Mean (ppm)	Direction of Flow
#1	19.1	17.5	17.0	13.2	16.7	↓
#7	20.1	18.8	18.3	10.7	17.0	
#8	20.5	19.1	15.8	13.2	17.2	
#5	20.7	20.1	15.9	12.9	17.4	

Surface Sample, Bulrush Platform

Station Code	05-June K (ppm)	07-June K (ppm)	09-June K (ppm)	11-June K (ppm)	Mean (ppm)	Direction of Flow
#2	13.3	15.2	15.5	11.3	13.8	↓
#9	14.3	17.3	17.8	14.8	16.1	enclosure
#10	14.4	17.8	18.5	17.1	17.0	enclosure
#6	15.1	16.4	16.4	10.5	14.61	

1.5 Meter Sample, Bulrush Platform

Station Code	05-June K (ppm)	07-June K (ppm)	09-June K (ppm)	11-June K (ppm)	Mean (ppm)	Direction of Flow
#2	13.8	15.3	15.5	11.9	14.1	↓
#9	14.3	17.3	17.8	14.8	16.1	enclosure
#10	15.1	17.8	18.4	17.5	17.2	enclosure
#6	16.5	17.6	16.0	11.7	15.5	

May sampling. The dissolved oxygen levels ranged from 7 mg/l to 16 mg/l during the June sampling outside of the enclosure that was wrapped around the bulrush platform. Within the enclosed platform, dissolved oxygen levels were lower, within two days the oxygen levels dropped into the 3-6 mg/l ranges. Oxygen levels remained at these low levels until the enclosure started to tear, letting fresh water enter the enclosure area (Rose et al. 1996).

The pH of both studies varied from 7.5 to 9.0 throughout the May and June. Levels within the enclosed platform in June represent some of the lower values of this range 7.5 to 8.2.

Conductivity in the study area ranged from 1,000 to 2,320FS/cm. The 2,320FS/cm was a single high value approximately 500F higher than the next lower value. Slightly higher levels were seen within the enclosure four days into the static water test (1895 and 1943FS/cm). Although the values recorded within Las Vegas Bay are high compared to the rest of the lake, they were lower than the 1840FS/cm to 3000FS/cm range of the treated wastewater that was used to culture the wetlands plants the previous year. No visual effects of the high conductivity were observed in the bulrushes or the cattails on the floating islands. High conductivity proved to be a limiting factor for the optimum growth of the wetlands plants at the culture pond using treated wastewater (Bower et al.1957). High conductivity can stunt plant growth and can cause bulrush to change in color from a dark Hunter green to a gray green.

The chlorophyll data found in appendix E was not sampled at all of the sampling sites used for the nutrient and water quality analysis and not on every sampling date and therefore could not be correlated to the increase in nutrients within the enclosed bulrush platform in June. Chlorophyll values were the highest on May 15, 2002 when the study first began. Large amounts of algae and debris had been packed around the floating platforms and the platforms had not been moved or disturbed by our boating and sampling activities. There were less debris and surface algae around the floating islands after this initial start date.

Vegetation

Other species that established on the floating islands on their own included: Rabbitfoot grass (Polypogon monspeliensis), Common Reed (Phragmites australis), Saltcedar (Tamarix ramosissima), Barnyard grass (Echinochloa crus-galli), Umbrella sedge (Cyperus laevigatus), Wormbane (Eclipta alba), Saltmarsh Fleabane (Pluchea odornata), Dock (Rumex crispus) and Cocklebur (Xanthium strumarium), Duckweed (Lemna minor), Water Fern (Azolla caroliniana), Seepwillow (Baccharis sp.).   Some of these invasive plants: Common Reed, Umbrella Sedge, Wormbane and the Saltmarsh Fleabane have presented some weed problems; however, the Wormbane and the Saltmarsh Fleabane were crowded out after the first or second year of growth by the Cattails and Bulrushes. These invasive plants were most prevalent on the floating islands that are newly planted, seeded or replanted. The Common Reed appears to be the one species that may prove to be the most bothersome and needs to be controlled mechanically or chemically.

Plant Establishment
All of the floating islands established during the first growing season with an approximate 47 and 60 percent aerial coverage for cattails and bulrush respectively (Figure 6, October 2001). However, four of the floating islands were replanted during the spring of 2002. A pair of beaver had fed heavily, on the vegetation of some of the islands during the winter (2001-2002), mostly on cattail rhizomes and roots and since the vegetation was not actively growing, the floating islands were impacted. Some of the cattails were so heavily fed upon that the plants had no roots or rhizomes causing the culms to lodge or drop through the plastic pallets, leaving large voids within some of the floating islands. Figure 7, shows a beaver below the walkway of the bulrush platform. It remains to be seen if the floating islands can establish to a degree that they can handle winter-feeding by the beaver and not be adversely impacted by the following spring. Also, in a few areas waterfowl had smashed down the plastic fencing and formed two or three areas used for loafing, requiring the need for fixing and replanting. Because the floating islands were wrapped with the heavy plastic fencing during the initial planting, the coconut fiber remained in place fairly well. However, there were still many areas devoid of coconut fiber were the roots and rhizomes of the vegetation had not grown into. These areas were not restuffed with coconut fiber, and it is assumed that the spreading vegetation will eventually colonize them. These areas allow for the release of hydraulic pressures from under the islands during periods of large wave activity. The percent coverage, by July 2002, was very similar to the coverage in October 2001 although the plants were much taller in stature the second growing season. Siltation, and numerous platform moves had taken a toll on the vegetation during the 2002-growing season as indicated by the reduction in percent coverage from the May 2002 to July 2002.

A quarter meter square quadrat was used to more carefully evaluated the percent coverage of the vegetation on the floating islands as well as, collect culm length and diameter, and biomass weight data. Twenty-two samples, one from each floating island was collected, minus the missing cattail island that sank on May 20, 2002 and the bulrush island (number 8) that was seeded rather than planted with vegetative sprigs or tubers. Because of the time involved in quadrat sampling, approximately six samples per day, and the destructiveness of the collection of the quadrat samples, only one sample per floating island was taken. The mean percent coverage using the quadrat to evaluate the eleven cattail and eleven bulrush islands, in July 2002, was 25 and 57 percent, respectively (Figure 8). This is similar to the visual percent coverage of 44 and 60 percent evaluated visually for the same July 2002 evaluation.

Appendix F contains information on the ten culm diameters, ten culm lengths for each species found within the quadrat as well as the total fresh and dry weight biomass and the percent coverage for all of the species within each quadrat. Selection of the quadrat locations was random, however only ten culms of each species were selected to measure the culm diameter and culm length because of the amount of time needed to count, measure and weigh all of the culms within each quadrat was limited. Also because the sampling was destructive, only one quadrat per island was done. Each floating island was sectioned into a grid of twenty-eight possible quadrat locations. One location for each island was then randomly selected for sampling.

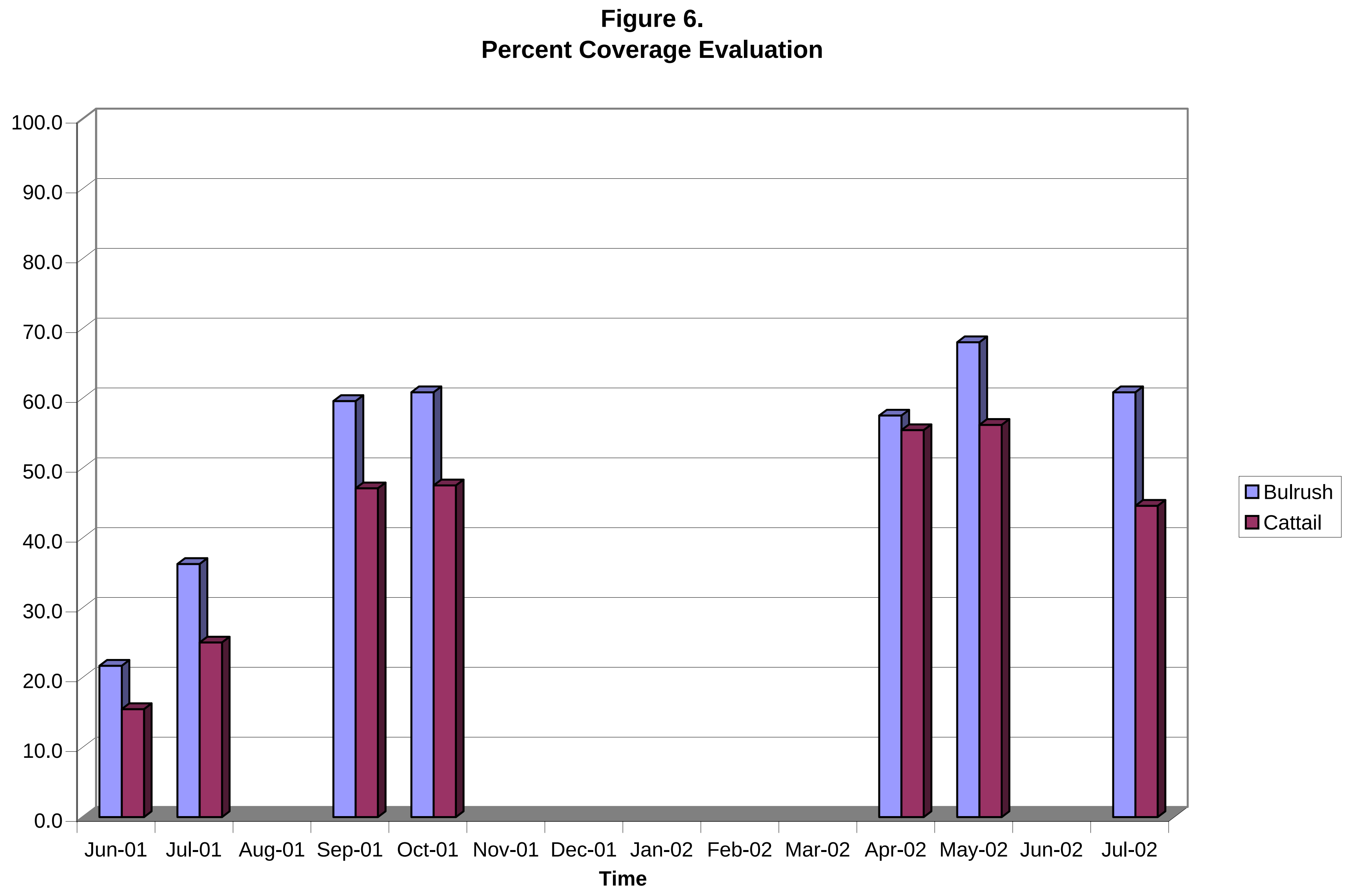
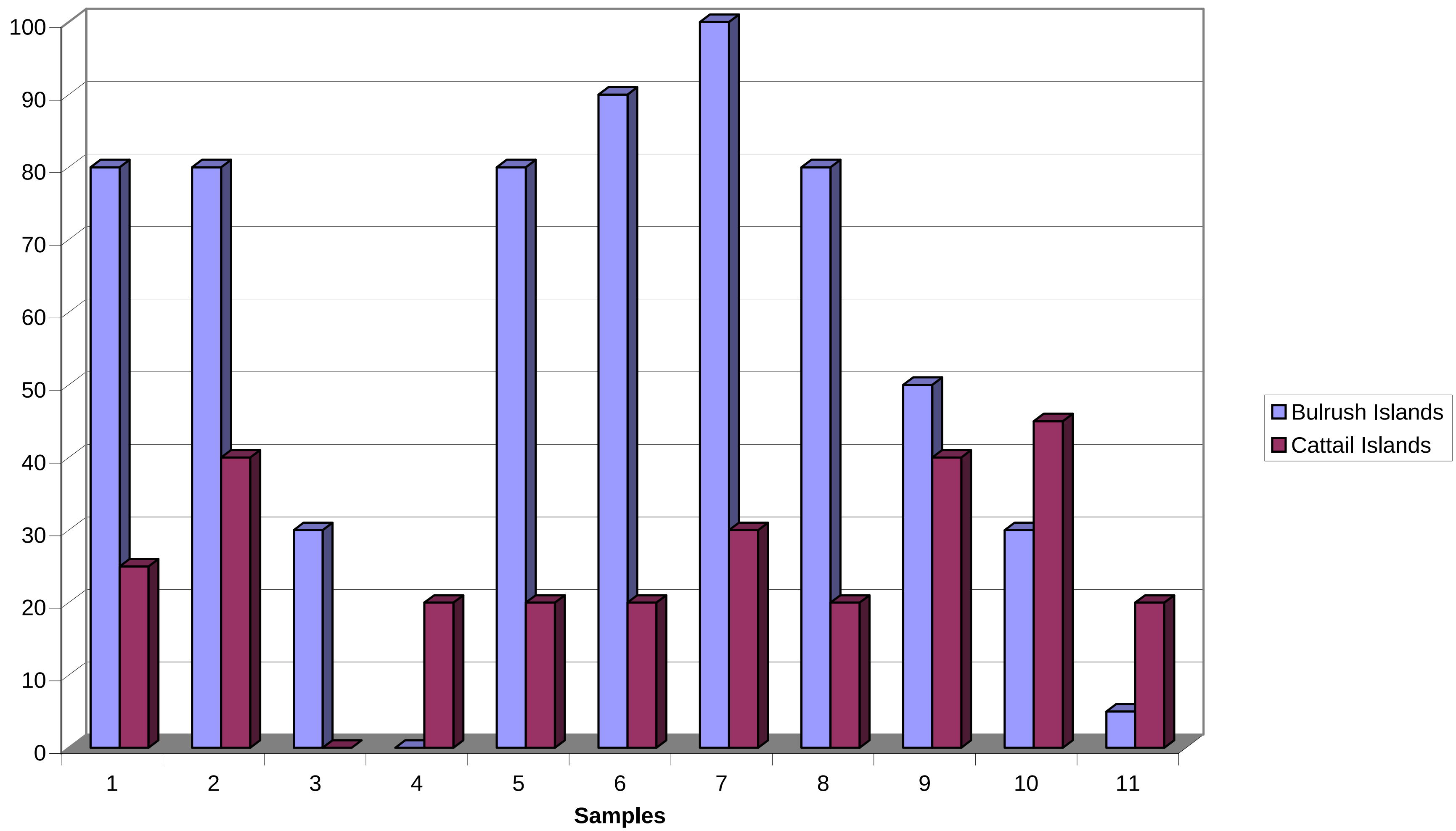


Figure 6.
Percent Coverage Evaluation
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Jun-01
Jul-01
Aug-01
Sep-01
Oct-01
Nov-01
Dec-01
Jan-02
Feb-02
Mar-02
Apr-02
May-02
Jun-02
Jul-02
Time
Bulrush
Cattail

Figure 7. One of two beaver now residing at the floating islands.

Figure 8.
Percent Coverage Quadrat Samples
August 2002



Although the two platforms were originally planted with either cattails or bulrush, some islands had a mix of both species. After two growing seasons the platforms are becoming more diverse in species composition, several quadrat samples had three to six species present. However, cattails are still the predominant species on the cattail platform and Olney's Bulrush is the dominant species on the bulrush platform. Olney's is much larger than the other bulrush species and therefore, produces the most biomass. Because of its size, Olney's is crowding and shading out more of the other smaller bulrushes with each subsequent growing seasons. Volunteer species have also become prevalent on some of the floating islands, with Phragmites leading the list of these species. Cattails make up the majority of the biomass on the floating islands. Cattails are the largest species on the floating islands both in height and culm base diameter (measured 15cm above the island base), followed by Olney's bulrush. Cattails in excess of 11 feet (340cm) high and with culm diameters as wide as 2.5 inches (6.7cm) and Olney's up to 8 feet (240cm) tall with half inch (13mm) culm widths were collected as part of quadrat samples. Fresh weight biomass measured from within the quarter meter square quadrats, ranged from two quadrats containing no biomass to one with 11.58 pounds (5,252 gm) of biomass. The mean fresh and dry weight biomass for the cattail islands was 5.24 pounds (2,376 gm) and 1.40 pounds (635 gm) respectively, and 3.90 pounds (1770 gm) and 0.65 pounds (297 gm), fresh and dry weight respectively for the bulrush islands.

These standing crop weights, 9.5 kg/m^2 and 7kg/m^2 for cattails and bulrush are larger than those identified by the Japanese on some of their floating islands (5kg/m^2) however both cattails and Olney's bulrush are larger species and contain more water than the species of reed used by the Japanese and therefore appear similar when species physiology is considered.

Floating Island Structural Durability

The floating platforms, super structure, have been in place for more than two years and show only minor wear and most of this wear is in the pine decking which was not painted or treated. A fair amount of wood debris has accumulated under the platforms but appears not to be a problem. Some of this wood was brought to the floating platforms by the beaver and they have started dragging wood upon one of the floating islands to construct a lodge.

The weight of the anchors has been reduced from 1,500 pounds (680 kg) to 1,000 pounds (453.6 kg) as well as the number of anchors has been reduced from four to two for each floating platform. Because of the large amount of siltation within the delta both of these measures, did not compromise the safety of the anchoring system. In addition, because the floating platforms were being moved every few months and sometimes every few weeks 1/2-inch (12mm) diameter wire rope was used to replace the original 5/8-inch (15mm) diameter wire rope. Some of the wire rope has to be abandoned with each move and the wire ropes had very little time to fray or deteriorate, as a cost savings, the smaller diameter wire rope is being used.

The plastic pallets have worked well; however, they are beginning to show a few problems. Some of the stainless steel hardware has pulled through the plastic pallets. Most of this was due to the pulling or shoving of the floating island on the shore during the replanting of these islands. Also, because of the tremendous amount of silt deposition on top of the floating islands, estimated to be more than 500 pounds (227 kg) for some of the islands, some have become very swaybacked. Because of this silt deposition, at least six floating islands need repairing. These islands droop as much as three or four feet below the water surface in the middle. Therefore, the vegetation in the middle of these islands is being drowned or at least harmed by the deeper water depth. The swayback islands have also made replacement of the four corner rope ties for each floating island more difficult. The corner of the island has to be lifted with the help of a comealong winch to remove the tension on the old rope and held up while a new rope is fastened to the corner of the floating island and the eye bolts on the floating platform walkways. The attachment ropes for the floating islands have to be replaced yearly and this amounts to a considerable amount of time, with 96 ropes holding the floating islands to the floating platforms.

The coconut fiber is no longer needed in most of the floating islands. The roots and rhizomes have woven into the plastic pallets to the extent that in many areas the pallet is not visible. In other areas however the coconut fiber has washed away leaving voids in the plastic pallets in which the lake water below the floating islands can be seen. It is believed that plant rhizomes will eventually find these voids and send up new plant sprigs, which will fill these voids. The bird netting that was installed to hold the coconut fiber in place has also become interwoven with roots and rhizomes making much of the netting, nonessential.

The bird netting that was lofted above the floating islands to prevent the birds from using the floating islands is no longer needed in most cases. Most of this netting has been pushed down into the vegetative thatch, although this netting may still be providing some support to the bulrush and cattails preventing them from lodging during high wind events. The beavers have also ripped large holes in many areas of the bird netting. These are no longer being repaired because most of the floating islands have established well.

SUMMARY AND CONCLUSIONS

Las Vegas Wash, Plume and Sedimentation

Sedimentation was more severe than had been predicted for the study period of May and June. This was attributed to construction activities by the Nevada Department of Transportation below the North Shore Road Bridge on Highway 147, the decreasing lake elevation as well as the redistribution of the bed load within the Las Vegas Wash Delta/Las Vegas Bay interface. A maximum silt deposition of 19.5 inches (487mm) per day was recorded during the first monitoring period (May15-21, 2002). Silt deposition and loss of lake elevation became so extreme that the floating platforms had to be moved during the May test and prior to and immediately after the June test. One of the twelve floating islands on the cattail platform became so laden with silt that it sank (May 20, 2002). Many other islands on both the cattail and bulrush platforms were damaged by the silt load and are very swaybacked. It is estimated that several islands have accumulated five hundred pounds of silt or more. Many appear to be negatively buoyant and might sink if not attached to the superstructure of the floating platform.

Water Quality
A zone of lower nutrient concentration was identified immediately under the cattail platform with the reduction of NO_3-N, NH_3-N, K, and TSS and with a reduction of NO_3-N and TSS immediately under the bulrush platform. This lowering of nutrients was seen as a gradient with the highest concentration occurring upstream of the platforms and decreasing as the water flowed under the platforms toward the downstream end of the platforms.

May Test
The zone of lower nutrient concentration was also detected at 4.9 feet (1.5 m) below the cattail platform for NO_3-N, NH_3-N, and K. No nutrient reduction could be detected below the bulrush platform at 4.9 feet (1.5 m). This was probably due to the shorter length roots of the bulrush compared to the cattail roots.

June Test
Immediately under the cattail platform a zone of lower nutrient concentration was seen once again for NO_3-N and TSS. However, at 4.9 feet (1.5m) meters below the floating cattail platform, this lowering of nutrients was not detectable.

In the static water area, within the enclosure, which was placed around the bulrush platform, the nutrient level of NO_3-N, NH_3-N, and K all increased, both immediately under the platform and at 4.9 feet (1.5 m) (sample stations #9 and #10). The TSS increased immediately below the floating platform but not at 4.9 feet (1.5 m). The reason for the increase in nutrient levels is still unclear. It is possible that the increase in nutrient levels came from the sand and silt beneath the islands. These sediments were freshly deposited just prior to enclosing the bulrush platform and nutrients are released from these soil types during sediment equilibration studies. Also, because of the sparse number of birds using the floating islands during this time and lack of rain during the sampling periods, when the enclosure was in place, it is not likely that the increase in nutrients is due to bird guano accumulations or flushing into the enclosure.

Vegetation and Plant Establishment
There are at least eighteen species of plants on the floating islands. Common reed is very aggressive and should be controlled to prevent it from out competing the bulrush and cattails. Aerial coverage of the islands is still relatively low, ranging from 25% to 57% for the cattail and bulrush respectively using visual estimates, and 44% to 60% for the cattail and bulrush islands respectively when measured with quarter meter square quadrat. Plant diversity continues to increase. One-quarter meter square quadrat contained six species of plants and many quadrat samples contained three or more species. The vegetative canopy of the cattails have risen to eleven feet high and eight feet high in areas containing Olney's Bulrush. The beavers continue to damage the floating islands; damage to the vegetation appears to be minimal during the period when the vegetation is actively growing. It remains to be seen how much damage the beavers will do during the winter when the plants are dormant. However, damage to the structure caused by beaver continues to increase. This includes chewing on the walkways, plastic pallets and ropes, as well as pulling wood and mud onto the floating islands.

Floating Island Structural Durability
The floating platforms have been moved to West Gypsum Bay and return to more anchors and heavier weights may be in order depending on the amount of silt that is projected to be deposited upon the anchors as well as the bottom substrate where the floating platforms are now relocated. It has been determined that the 1,000 pound (453.6 kg) anchors can be lifted using the winches on the walkways and it is therefore, possible to move the floating islands with the aid of two boats, providing that the anchors are not covered over by silt.

Attachment ropes for the floating islands have to be replaced yearly and these now hold a tremendous amount of weight not only because of the increasing amount of vegetation on the floating islands but also because of the silt that has been deposited upon them.

The plastic pallets appear to be reaching their limit to support the floating islands and maybe bending due to the increased silt and biomass loads they are supporting, some of the floating islands are very swaybacked. Some of the stainless steel hardware has pulled through the pallets, it is believed that wave action and several moves of the floating islands are causing the bolts to eat their way through the plastic pallets, however close inspection of this has not been possible because the pallets are submerged under water and covered by vegetation.
The bird netting that covers the floating islands is no longer needed and some has been removed during the vegetation coverage evaluations so that the quarter meter square quadrat could be placed in position during sampling. An easily removable method needs to be developed so that the bird netting can be raised, lowered or removed easily. After the bulrush and cattails established it appears that this netting is no longer needed and could be removed although it might still be providing some support in area where it has not been pushed down upon the floating islands.

RECOMMENDATIONS

The use of vegetated floating islands, on a fluctuating reservoir has posed many challenges to the engineer of these structures. Used in areas where siltation does not cover the anchors the winches on the floating platforms can be used to lift the anchors as needed without costly equipment or contractors. Therefore, it becomes a fairly easy task to maneuver the floating platforms into new locations as needed dependent upon the rise or fall of the fluctuating lake levels. It appears from the water quality data presented in this study that using floating islands, to remove nutrients from the water, does work. Further water polishing is obtainable, although it was not possible to determine how well the floating islands removed nutrients, compared to natural wetlands mainly because they had to be moved several times during the study. The floating islands provided wildlife habitat above and below the floating islands for numerous fish, bird and amphibians. In these floating island studies, beavers and invasive plants are presenting biological problems.

Engineering problems are still presenting challenges to the successful use of floating islands.

Although many of these obstacles have been solved during this project, such as moving them as needed, some improvements or changes still need to be made.

Listed below are some recommendations and problems that still need to be solved:

1) Some kind of hanger or fastener needs to be developed to make attachment and replacement of the ropes holding the floating islands to the floating platforms quicker and less frequent.

2) A larger mesh size screen, mounted higher above the vegetation would help prevent the wetland plants from lodging during windstorms. This appears to be more important as the vegetation grows taller with each new growing season

3) Silt deposited on the floating islands needs to be removed, by washing, vibration or some other means. If the removal of the silt proves to be impractical, these islands need to be replaced or replanted.

4) Beaver have produced noticeable damage to the floating islands during the winter of 2001-2002. There is now a pair of beaver on the floating islands. If these beavers mate and produce offspring, the destruction to the vegetation and islands, as well as the structure of the floating platforms, will be to great and removal of the beavers will be necessary.

5) Common reed needs to be controlled on the floating islands, so that species diversity can be maintained. Common Reed may prove to be an excellent plant for removing nutrients from the water, however, it appears to be the most aggressive species on the floating islands and it is beginning to displace other more wildlife desirable species.

6) A soft connecting system might be more effective for fastening the pallets together rather than using the stainless steel hardware to fasten the pallets together. This would allow the islands to flex more in high wave situations and eliminate areas of wear between the hardware and the plastic pallets.

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Appendix A

Lake Mead Reservoir Elevations

ACCUMULATIONS FOR MAY 2002

ACCUM. DAY	GLEN CANYON CFS	GLEN CANYON ACCUM. A.F.	LAKE MEAD ELEV.	HOOVER DAM HOOVER RELEASE CFS	HOOVER RELEASE A.F.	HOOVER RELEASE ACCUM.	HOOVER GROSS GEN	HOOVER RATE KWH/AF	LAKE MOJAVE ELEV	DAVIS DAM DAVIS RELEASE CFS	DAVIS RELEASE A.F.	DAVIS RELEASE ACCUM.	DAVIS GROSS GEN	MWD DIVER. AT INTAKE A.F.	MWD DIVER. AT INTAKE ACCUM.	LAKE HAVASU ELEV	PARKER DAM PARKER RELEASE CFS	PARKER RELEASE A.F.	PARKER RELEASE ACCUM.	PARKER GROSS GEN.	C.A.P. DIVER. A.F.	C.A.P. DIVER. A.F.
1	10100	20033	1167.41	16413	32556	32556	14846	456	642.21	19050	37789	37789	4742	3348	3348	448.29	12950	25680	25680	1692	5937	5937
2	10400	40661	1167.28	18482	36659	69215	16648	454	642.03	19660	38997	76786	4879	3445	6793	448.60	11610	23020	48700	1529	5958	11895
3	10800	62083	1167.11	19287	38255	107470	17479	457	642.15	17400	34511	111297	4325	3503	10296	448.86	11660	23128	71828	1539	5740	17635
4	9900	81719	1167.00	15887	31512	138982	14303	454	642.01	17230	34181	145478	4278	3517	13813	448.88	12400	24602	96430	1634	5972	23607
5	9400	100364	1166.90	16069	31872	170853	14511	455	641.98	16130	32002	177480	4004	3523	17336	448.72	13170	26126	122556	1741	6895	30502
6	10600	121388	1166.77	17853	35411	206265	16171	457	641.99	17120	33958	211438	4248	3517	20852	448.50	13460	26692	149248	1767	5825	36327
7	10400	142017	1166.58	21124	41899	248164	14303	341	642.21	17090	33906	245344	4228	3497	24349	448.35	13960	27692	176940	1831	5970	42298
8	10400	162645	1166.42	18460	36615	284780	16609	454	642.30	17100	33922	279266	4254	3479	27828	448.30	13450	26682	203622	1762	5768	48065
9	10400	183273	1166.21	22328	44287	329067	20273	458	642.53	17780	35267	314533	4422	3481	31309	448.34	12010	23822	227444	1566	5841	53907
10	10400	203901	1166.02	19676	39027	368095	17836	457	642.56	18930	37555	352088	4715	3459	34768	448.37	12960	25714	253158	1685	5950	59857
11	9700	223140	1166.01	10670	21164	389258	9265	438	641.99	18160	36027	388115	4523	3453	38221	448.42	13980	27730	280888	1816	5964	65821
12	9300	241587	1165.89	16885	33492	422750	15168	453	641.93	18180	36051	424166	4507	3491	41712	448.33	13170	26116	307004	1719	6889	72710
13	10400	262215	1165.73	20779	41215	463965	18839	457	642.06	18300	36303	460469	4543	3505	45217	448.37	13330	26438	333442	1742	5669	78379
14	10400	282843	1165.52	20781	41219	505185	18763	455	642.20	18190	36081	496550	4521	3517	48734	448.40	12990	25760	359202	1701	5808	84186
15	10400	303471	1165.33	20078	39823	545008	18115	455	642.23	18180	36061	532611	4506	3511	52245	448.49	12560	24912	384114	1637	5710	89897
16	10500	324297	1165.13	21850	43339	588347	19708	455	642.50	17530	34769	567380	4346	3499	55743	448.89	9340	18524	402638	1234	5786	95683
17	10300	344727	1164.97	19414	38507	626855	17535	455	642.58	17110	33934	601314	4254	3471	59215	448.84	12870	25530	428168	1692	5948	101631
18	10100	364760	1164.85	17496	34703	661558	15782	455	642.69	16260	32248	633562	4019	3473	62688	448.76	12740	25262	453430	1667	5939	107570
19	9300	383207	1164.71	15645	31032	692590	14051	453	642.56	16570	32862	666424	4124	3471	66159	448.59	12780	25342	478772	1678	6889	114458
20	10000	403041	1164.58	18809	37307	729897	17147	460	642.62	16850	33414	699838	4201	3558	69717	448.54	12810	25412	504184	1680	5929	120387
21	10300	423471	1164.32	21600	42843	772741	19708	460	642.85	17870	35439	735277	4459	3507	73224	448.38	13490	26760	530944	1767	5810	126196
22	10300	443901	1164.07	24159	47919	820660	22045	460	643.38	17070	33864	769141	4271	3550	76774	448.37	12450	24690	555634	1628	5766	131962
23	10100	463934	1163.84	23078	45775	866435	20957	458	643.76	16480	32690	801831	4124	3388	80162	448.74	8770	17400	573034	1163	5736	137698
24	7900	479603	1163.65	22058	43751	910187	20121	460	644.11	17130	33974	835805	4303	3995	84157	448.87	10750	21322	594356	1424	5823	143522
25	7900	495273	1163.49	18394	36483	946670	16574	454	644.07	17490	34695	870500	4387	3941	88098	448.91	11170	22152	616508	1467	5798	149320
26	8000	511140	1163.38	14032	27832	974502	12602	453	643.81	17960	35619	906119	4506	3933	92031	448.98	11550	22912	639420	1522	6893	156212
27	7900	526810	1163.24	16341	32412	1006913	14693	453	643.80	16000	31732	937851	3979	3967	95998	448.90	12400	24588	664008	1627	6597	162809
28	7900	542479	1162.99	23909	47423	1054336	21613	456	644.31	15790	31328	969179	3947	3356	99354	448.61	14610	28974	692982	1837	5865	168674
29	7900	558149	1162.74	22885	45391	1099728	20565	453	644.63	17410	34535	1003714	4366	3425	102779	448.41	13320	26426	719408	1726	5857	174532
30	8000	574016	1162.55	18597	36887	1136615	16646	451	644.65	18250	36195	1039909	4583	3435	106215	448.68	9550	18946	738354	1262	5845	180377
31	8000	589884	1162.39	16807	33336	1169951	14905	447	644.36	18630	36955	1076864	4689	3451	109666	448.77	12600	24996	763350	1656	5845	186222
TOTAL							527781						135253							50391		

BUREAU OF RECLAMATION
LOWER COLORADO REGION
BOULDER CITY, NEVADA
AVAILABLE RESERVOIR ELEVATIONS AND CONTENTS FOR MAY 2002

	LAKE MEAD	LAKE MOHAVE	LAKE HAVASU	SENATOR WASH
MAX CONTENT IN A.F.	27380000	1809800	619400	7576
MAX ELEV. IN FEET	1229.0	647.0	450.0	240.0

DAY	TOTAL SYSTEM STORAGE**	TOTAL AVAILABLE SPACE	HOOVER ELEVATION FEET	HOOVER CONTENT 1000A.F.	HOOVER RELEASE ft3/s	DAVIS ELEVATION FEET	DAVIS CONTENT 1000A.F.	DAVIS RELEASE ft3/s	PARKER ELEVATION FEET	PARKER CONTENT 1000A.F.	PARKER RELEASE ft3/s	SENATOR WASH ELEVATION FEET	SENATOR WASH CONTENT A.F.	SENATOR WASH PUMPED ft3/s	SENATOR WASH RELEASE ft3/s
1	42326.8	18556.3	1167.41	18529	16400	642.21	1677.1	19100	448.29	585.5	12900	236.75	7954	303	0
2	42295.5	18587.5	1167.28	18513	18500	642.03	1672.3	19700	448.60	591.7	11600	237.97	8389	375	0
3	42272.2	18610.9	1167.11	18492	19300	642.15	1675.5	17400	448.86	596.6	11700	238.08	8430	160	0
4	42244.1	18638.9	1167.00	18478	15900	642.01	1671.8	17200	448.88	597.0	12400	238.09	8433	139	0
5	42216.7	18666.4	1166.90	18466	16100	641.98	1670.8	16100	448.72	593.9	13200	238.06	8422	124	0
6	42181.0	18702.0	1166.77	18449	17900	641.99	1671.0	17100	448.50	589.5	13500	238.04	8415	132	0
7	42148.8	18734.2	1166.58	18426	21100	642.21	1677.1	17100	448.35	586.9	14000	238.09	8433	133	0
8	42114.9	18768.2	1166.42	18406	18500	642.30	1679.5	17100	448.30	585.8	13500	237.98	8393	99	0
9	42086.9	18796.2	1166.21	18380	22300	642.53	1685.8	17800	448.34	586.7	12000	238.04	8415	132	0
10	42054.1	18829.0	1166.02	18356	19700	642.56	1686.6	18900	448.37	587.2	13000	238.06	8422	124	0
11	42025.7	18857.4	1166.01	18355	10700	641.99	1671.0	18200	448.42	588.2	14000	238.08	8430	121	0
12	42003.1	18880.0	1165.89	18341	16900	641.93	1669.6	18200	448.33	586.4	13200	239.92	9114	470	0
13	41974.4	18908.6	1165.73	18321	20800	642.06	1672.9	18300	448.37	587.1	13300	240.17	9209	169	0
14	41939.1	18943.9	1165.52	18295	20800	642.20	1676.8	18200	448.40	587.8	13000	240.02	9152	99	0
15	41907.3	18975.8	1165.33	18272	20100	642.23	1677.7	18200	448.49	589.5	12600	239.99	9140	118	0
16	41896.0	18987.1	1165.13	18248	21900	642.50	1685.1	17500	448.89	597.3	9340	240.08	9174	136	0
17	41860.7	19022.4	1164.97	18228	19400	642.58	1687.3	17100	448.84	596.3	12900	240.06	9167	116	0
18	41836.8	19046.2	1164.85	18214	17500	642.69	1690.2	16300	448.76	594.7	12700	240.10	9182	122	0
19	41804.7	19078.3	1164.71	18197	15600	642.56	1686.6	16600	448.59	591.4	12800	240.03	9155	108	0
20	41767.7	19115.4	1164.58	18181	18800	642.62	1688.4	16800	448.54	590.5	12800	240.04	9159	117	0
21	41719.1	19163.9	1164.32	18149	21600	642.85	1694.6	17900	448.38	587.3	13500	240.10	9182	127	0
22	41687.5	19195.5	1164.07	18119	24200	643.38	1709.1	17100	448.37	587.2	12400	240.03	9155	95	0
23	41664.5	19218.5	1163.84	18091	23100	643.76	1719.6	16500	448.74	594.4	8770	239.97	9133	105	0
24	41645.7	19237.4	1163.65	18068	22100	644.11	1729.2	17100	448.87	596.8	10700	241.94	9900	506	0
25	41616.0	19267.0	1163.49	18048	18400	644.07	1728.1	17500	448.91	597.7	11200	241.99	9919	135	0
26	41586.7	19296.3	1163.38	18035	14000	643.81	1720.9	18000	448.98	599.0	11600	241.91	9888	116	0
27	41565.2	19317.9	1163.24	18018	16300	643.80	1720.7	16000	448.90	597.5	12400	241.98	9915	135	0
28	41542.0	19341.0	1162.99	17988	23900	644.31	1734.8	15800	448.61	591.8	14600	241.87	9872	94	0
29	41517.4	19365.7	1162.74	17958	22900	644.63	1743.7	17400	448.41	588.0	13300	241.31	9651	0	0
30	41496.5	19386.5	1162.55	17935	18600	644.65	1744.2	18200	448.68	593.2	9550	240.68	9405	0	0
31	41469.1	19413.9	1162.39	17915	16800	644.36	1736.1	18600	448.77	595.0	12600	241.90	9884	353	0
TOTAL					590100			543000			385060			4963	0
AVE.					19040			17520			12420			160	0
AC FT					1170000			1077000			764000			9844	0

** INCLUDES FONTENELLE AND CRYSTAL RESERVOIRS

BUREAU OF RECLAMATION
LOWER COLORADO REGION
BOULDER CITY, NEVADA
COLORADO RIVER STORAGE PROJECT DATA (operational) FOR MAY 2002

		LAKE POWELL MAX. STORAGE 24320000 AF MAX. ELEV. 3700.0 FEET			FLAMING GORGE MAX. STORAGE 3749000 AF MAX. ELEV. 6040.0 FEET			NAVAJO MAX. STORAGE 1696000 AF MAX. ELEV. 6085.0 FEET			BLUE MESA MAX. STORAGE 829500 AF MAX. ELEV. 7519.4 FEET			MORROW POINT MAX. STORAGE 117025 AF MAX. ELEV. 7160.0 FEET		
DATE	COMPUTED INFLOW FT3/S	ELEVATION (FEET)	CONTENT (1000 AF)	RELEASE FT3/S	ELEVATION (FEET)	CONTENT (1000 AF)	RELEASE FT3/	ELEVATION (FEET)	CONTENT (1000 AF)	RELEASE FT3/S	ELEVATION (FEET)	CONTENT (1000 AF)	RELEASE FT3/S	ELEVATION (FEET)	CONTENT (1000 AF)	RELEASE FT3/S
1	7100	3645.80	16699	10100	6015.34	2820	800	6050.01	1230	910	7479.46	502.1	1210	7151.83	110.5	1260
2	3300	3645.69	16685	10400	6015.32	2820	800	6049.85	1220	910	7479.28	500.8	1220	7152.18	110.8	1200
3	7300	3645.63	16678	10800	6015.30	2820	800	6049.67	1220	910	7478.95	498.4	1770	7153.92	112.2	1200
4	6400	3645.57	16671	9900	6015.28	2820	800	6049.52	1220	910	7478.91	498.1	650	7152.98	111.4	1100
5	5400	3645.51	16663	9400	6015.26	2820	800	6049.36	1220	910	7479.03	498.9	0	7149.67	108.8	1400
6	5100	3645.42	16652	10600	6015.24	2810	800	6049.19	1220	910	7478.84	497.6	1230	7149.83	108.9	1270
7	6900	3645.36	16645	10400	6015.22	2810	800	6049.03	1210	910	7478.67	496.3	1200	7150.00	109.1	1230
8	4900	3645.27	16634	10400	6015.22	2810	810	6048.86	1210	860	7478.63	496.1	1010	7149.79	108.9	1190
9	7900	3645.23	16629	10400	6015.24	2810	810	6048.71	1210	860	7478.37	494.2	1550	7150.80	109.7	1240
10	7400	3645.18	16623	10400	6015.26	2820	810	6048.53	1210	860	7478.08	492.1	1560	7151.82	110.5	1240
11	5700	3645.11	16615	9700	6015.29	2820	800	6048.35	1210	860	7477.90	490.8	1310	7152.50	111.0	1110
12	7800	3645.09	16612	9300	6015.34	2820	810	6048.23	1200	860	7477.93	491.0	800	7151.43	110.2	1260
13	5900	3645.01	16603	10400	6015.37	2820	800	6048.11	1200	860	7477.72	489.5	1260	7151.48	110.2	1310
14	4900	3644.92	16592	10400	6015.42	2820	800	6047.96	1200	860	7477.51	488.0	1330	7151.91	110.6	1240
15	5900	3644.85	16583	10400	6015.48	2820	800	6047.81	1200	860	7477.45	487.6	1020	7151.35	110.1	1280
16	10500	3644.85	16583	10500	6015.54	2830	800	6047.66	1200	860	7477.31	486.6	1380	7152.10	110.7	1160
17	3200	3644.73	16569	10300	6015.59	2830	800	6047.51	1200	860	7477.19	485.7	1290	7152.54	111.1	1190
18	6100	3644.67	16561	10100	6015.60	2830	1250	6047.38	1200	860	7477.03	484.6	1480	7154.01	112.2	990
19	7800	3644.64	16558	9300	6015.55	2830	2460	6047.27	1190	860	7477.14	485.4	790	7153.49	111.8	1090
20	2400	3644.52	16543	10000	6015.42	2820	3640	6047.15	1190	860	7477.07	484.9	1320	7154.10	112.3	1160
21	4800	3644.43	16532	10300	6015.26	2820	3990	6046.96	1190	860	7477.05	484.7	1300	7155.04	113.0	1020
22	6800	3644.37	16525	10300	6015.09	2810	4010	6046.82	1190	860	7477.10	485.1	880	7155.81	113.7	650
23	7600	3644.33	16520	10100	6014.91	2800	4020	6046.67	1190	770	7477.01	484.4	1310	7156.37	114.1	1160
24	7900	3644.33	16520	7900	6014.73	2800	4020	6046.54	1190	760	7476.90	483.7	1270	7158.18	115.6	610
25	6900	3644.31	16518	7900	6014.57	2790	4010	6046.41	1180	760	7476.79	482.9	1190	7158.95	116.2	930
26	6500	3644.29	16515	8000	6014.41	2790	4020	6046.30	1180	760	7476.82	483.1	710	7158.35	115.7	1020
27	10400	3644.33	16520	7900	6014.27	2780	3610	6046.17	1180	760	7476.78	482.8	920	7156.94	114.6	1560
28	10900	3644.38	16526	7900	6014.14	2780	3240	6046.00	1180	760	7476.67	482.0	1330	7157.41	114.9	1200
29	11900	3644.44	16534	7900	6014.02	2770	3070	6045.83	1180	760	7476.62	481.7	1110	7157.01	114.6	1340
30	8500	3644.45	16535	8000	6013.93	2770	2430	6045.66	1180	760	7476.59	481.4	1190	7156.79	114.4	1350
31	8500	3644.46	16536	8000	6013.86	2770	2030	6045.50	1170	760	7476.52	481.0	1470	7157.58	115.1	1230
TOT	212600			297400			59440			26120			36060			36190
AVE	6858			9590			1920			840			1160			1170
A F	421700			590000			118000			51800			71500			71800

GLEN CANYON TO HOOVER DAM LOSSES

MAY 2002

DATE	GLEN RELEASE CFS	HOOVER RELEASE CFS	LAKE MEAD STORAGE 1000 AF	STORAGE CHANGE 1000 AF	LAKE MEAD PUMPING CFS	LAKE MEAD EVAPORATION CFS	CHANGE BANK STORAGE CFS	LOSS CFS	ACCUMUL. A.F.	INFLOW CFS
1	10100	16400	18529	-10	521	1055	-328	-2213	-4389	12600
2	10400	18500	18513	-16	521	1055	-524	-1081	-6532	11500
3	10800	19300	18492	-21	521	1055	-688	494	-5551	9600
4	9900	15900	18478	-14	521	1055	-459	449	-4661	9960
5	9400	16100	18466	-12	521	1055	-393	-420	-5493	11200
6	10600	17900	18449	-17	521	1055	-557	-413	-6311	10300
7	10400	21100	18426	-23	521	1055	-754	-947	-8189	10300
8	10400	18500	18406	-20	521	1055	-655	1285	-5639	9340
9	10400	22300	18380	-26	521	1055	-852	496	-4655	9920
10	10400	19700	18356	-24	521	1055	-786	2013	-662	8390
11	9700	10700	18355	-1	521	1055	-33	-1361	-3361	11700
12	9300	16900	18341	-14	521	1055	-459	-518	-4389	11000
13	10400	20800	18321	-20	521	1055	-655	-1941	-8238	11600
14	10400	20800	18295	-26	521	1055	-852	908	-6438	8420
15	10400	20100	18272	-23	521	1055	-754	1052	-4352	9330
16	10500	21900	18248	-24	521	1055	-786	-238	-4823	10600
17	10300	19400	18228	-20	521	1055	-655	143	-4539	10200
18	10100	17500	18214	-14	521	1055	-459	-1058	-6638	11600
19	9300	15600	18197	-17	521	1055	-557	2238	-2199	8050
20	10000	18800	18181	-16	521	1055	-524	-1720	-5611	11800
21	10300	21600	18149	-32	521	1055	-1049	3282	898	5990
22	10300	24200	18119	-30	521	1055	-983	350	1593	9670
23	10100	23100	18091	-28	521	1055	-918	701	2983	9640
24	7900	22100	18068	-23	521	1055	-754	-1003	993	11300
25	7900	18400	18048	-20	521	1055	-655	900	2778	9240
26	8000	14000	18035	-13	521	1055	-426	-688	1413	8600
27	7900	16300	18018	-17	521	1055	-557	-815	-203	8750
28	7900	23900	17988	-30	521	1055	-983	-1414	-3007	9370
29	7900	22900	17958	-30	521	1055	-983	-420	-3840	8370
30	8000	18600	17935	-23	521	1055	-754	109	-3623	7830
31	8000	16800	17915	-20	521	1055	-655	311	-3007	7640
TOTAL	297500	589850			16151	32705			-3007	303900

Appendix B

May Nutrient Analysis

UNITED STATES BUREAU OF RECLAMATION
LOWER COLORADO REGIONAL LABORATORY

FLOATING WETLANDS: COMPLETE REPORT

Samples Received: 05/15/02
Date Analyzed: 05/22/02

Lab No.	Station Code	Depth (m)	TSS (ppm)	K (ppm)	O-PO4 as P (ppm)	NO3 as N (ppm)	NH_3 as N (ppm)
020944	#1	0	57	17.1	< 0.02	8.04	0.05
020945	#1	3	61	20.7	< 0.02	11.53	0.14
020946	#2	0	15	16.5	< 0.02	8.54	0.05
020947	#2	3	22	18.2	< 0.02	9.63	0.07
020948	#3	0	37	16.8	< 0.02	7.92	< 0.04
020949	#3	3	216	18.3	< 0.02	9.32	0.12
020950	#4	0	47	18.4	< 0.02	9.41	< 0.04
020951	#4	3	26	20.5	< 0.02	10.49	0.12
020952	#5	0	31	14.6	< 0.02	7.24	< 0.04
020953	#5	3	158	19.4	0.02	9.26	0.09
020954	#6	0	19	14.0	0.02	6.16	< 0.04
020955	#6	3	34	17.7	0.02	9.67	0.07
020956	#7	0	54	15.5	< 0.02	7.31	< 0.04
020957	#7	3	132	20.8	< 0.02	10.48	0.12
020958	#8	0	24	12.6	< 0.02	5.65	< 0.04
020959	#8	3	92	19.9	< 0.02	10.38	0.12
020960	#9	0	23	16.3	< 0.02	7.99	< 0.04
020961	#9	3	27	18.1	< 0.02	9.30	0.07
020962	#10	0	22	14.8	< 0.02	6.78	< 0.04
020963	#10	3	28	18.4	< 0.02	9.40	0.08
020964	#11	0	51	18.4	< 0.02	8.64	< 0.04
020965	#11	3	27	21.2	< 0.02	10.98	0.13

UNITED STATES BUREAU OF RECLAMATION
LOWER COLORADO REGIONAL LABORATORY

FLOATING WETLANDS: COMPLETE REPORT

Samples Received: 05/17/02
Date Analyzed: 05/24/02

Lab No.	**Station Code**	**Depth** (m)	**TSS** (ppm)	**K** (ppm)	**O-PO4 as P** (ppm)	**NO3 as N** (ppm)	**NH_3 as N** (ppm)
020966	#1	0	417	18.7	0.03	8.70	0.17
020967	#1	3	655	22.8	0.04	10.63	0.21
020968	#2	0	397	16.2	< 0.02	6.81	0.07
020969	#2	3	26	13.6	< 0.02	5.62	0.06
020970	#3	0	27	16.2	< 0.02	5.59	0.05
020971	#3	3	82	12.2	< 0.02	7.36	0.12
020972	#4	0	13	12.2	< 0.02	4.59	< 0.04
020973	#4	3	13	13.5	< 0.02	5.41	< 0.04
020974	#5	0	11	11.3	< 0.02	4.11	< 0.04
020975	#5	3	46	16.0	< 0.02	7.21	0.12
020976	#6	0	10	10.4	< 0.02	3.63	< 0.04
020977	#6	3	12	13.6	< 0.02	5.48	0.05
020978	#7	0	19	12.5	< 0.02	4.76	< 0.04
020979	#7	3	211	16.2	< 0.02	7.17	0.12
020980	#8	0	13	11.7	< 0.02	4.31	< 0.04
020981	#8	3	44	15.6	< 0.02	7.05	0.11
020982	#9	0	12	12.0	< 0.02	4.51	< 0.04
020983	#9	3	22	13.7	< 0.02	5.50	0.05
020984	#10	0	11	11.3	< 0.02	4.00	< 0.04
020985	#10	3	15	13.8	< 0.02	5.72	0.06
020986	#11	0	10	11.4	< 0.02	4.15	< 0.04
020987	#11	3	17	13.2	< 0.02	5.07	0.05

UNITED STATES BUREAU OF RECLAMATION
LOWER COLORADO REGIONAL LABORATORY

FLOATING WETLANDS: COMPLETE REPORT

Samples Received: 05/19/02
Date Analyzed: 05/24/02

Lab **No.**	**Station** **Code**	**Depth** (m)	**TSS** (ppm)	**K** (ppm)	**O-PO4 as P** (ppm)	**NO3 as N** (ppm)	**NH_3 as N** (ppm)
020988	#1	0	100	16.9	< 0.02	7.94	0.15
020989	#1	1.5	628	21.7	< 0.02	11.10	0.24
020990	#2	0	137	13.6	< 0.02	6.28	0.05
020991	#2	1.5	385	16.2	< 0.02	8.22	0.12
020992	#3	0	88	15.5	< 0.02	7.50	0.10
020993	#3	1.5	90	15.8	< 0.02	7.30	0.11
020994	#4	0	67	12.6	< 0.02	5.74	0.04
020995	#4	1.5	85	13.1	< 0.02	5.84	< 0.04
020996	#5	0	91	15.8	< 0.02	7.48	0.09
020997	#5	1.5	278	17.1	< 0.02	8.04	0.13
020998	#6	0	42	13.0	< 0.02	5.76	< 0.04
020999	#6	1.5	39	13.2	< 0.02	5.72	< 0.04
021000	#7	0	111	16.2	< 0.02	7.52	0.10
021001	#7	1.5	85	15.9	< 0.02	7.41	0.10
021002	#8	0	124	16.1	< 0.02	7.49	0.10
021003	#8	1.5	183	16.6	< 0.02	7.83	0.12
021004	#9	0	196	14.5	< 0.02	6.88	0.05
021005	#9	1.5	412	16.5	< 0.02	8.39	0.09
021006	#10	0	61	12.9	< 0.02	5.61	< 0.04
021007	#10	1.5	144	13.7	< 0.02	6.09	0.04
021008	#11	0	55	13.1	< 0.02	5.75	< 0.04
021009	#11	1.5	249	15.3	< 0.02	7.51	0.07
021010	#12	0	50	13.2	< 0.02	5.87	0.04
021011	#12	1.5	56	13.7	< 0.02	6.03	0.04

UNITED STATES BUREAU OF RECLAMATION
LOWER COLORADO REGIONAL LABORATORY

FLOATING WETLANDS: COMPLETE REPORT

Samples Received: 05/21/02
Date Analyzed: 05/31/02

Lab No.	Station Code	Depth (m)	TSS (ppm)	K (ppm)	NO3 as N (ppm)	NH_3 as N (ppm)
021013	#1	0	1234	25.3	15.59	0.41
021014	#1	1.5	599	22.5	14.16	0.36
021015	#2	0	9	8.2	3.28	0.08
021016	#2	1.5	11	8.3	3.00	0.07
021017	#3	0	63	11.8	5.52	0.14
021018	#3	1.5	101	17.6	9.47	0.26
021019	#4	0	10	8.7	3.38	0.07
021020	#4	1.5	10	8.9	3.47	0.07
021021	#5	0	41	10.2	4.47	0.11
021022	#5	1.5	40	10.4	4.78	0.11
021023	#6	0	10	8.8	3.20	0.08
021024	#6	1.5	165	12.3	5.51	0.14
021025	#7	0	147	17.3	9.11	0.26
021026	#7	1.5	105	17.4	9.31	0.26
021027	#8	0	55	14.7	7.82	0.20
021028	#8	1.5	96	14.8	7.66	0.20
021029	#9	0	81	9.3	3.69	0.08
021030	#9	1.5	14	8.3	2.79	0.07
021031	#10	0	16	8.7	3.42	0.07
021032	#10	1.5	211	13.0	6.42	0.14
021033	#11	0	48	12.1	5.65	0.15
021034	#11	1.5	78	15.5	8.22	0.23
021035	#12	0	48	11.4	5.64	0.14
021036	#12	1.5	129	14.2	7.70	0.18

Appendix C

June Nutrient Analysis

UNITED STATES BUREAU OF RECLAMATION
LOWER COLORADO REGIONAL LABORATORY

FLOATING WETLANDS: COMPLETE REPORT

Samples Received: 06/05/02
Date Analyzed: 06/28/02

Lab No.	Station Code	Depth (m)	TSS (ppm)	K (ppm)	NO3 as N (ppm)	NH_3 as N (ppm)
021274	#1	0	456	14.4	9.33	0.16
021275	#1	1.5	419	19.1	9.22	0.14
021276	#2	0	16	13.3	6.04	< 0.04
021277	#2	1.5	22	13.8	6.23	0.04
021278	#3	0	38	13.7	6.22	< 0.04
021279	#3	1.5	170	16.8	8.20	0.07
021280	#4	0	20	13.0	5.67	< 0.04
021281	#4	1.5	26	14.0	6.38	< 0.04
021282	#5	0	71	14.0	6.29	< 0.04
021283	#5	1.5	429	20.7	10.14	0.20
021284	#6	0	41	15.1	7.16	0.05
021285	#6	1.5	68	16.5	8.08	0.06
021286	#7	0	99	14.5	6.57	0.04
021287	#7	1.5	459	20.1	9.86	0.16
021288	#8	0	60	14.0	6.17	0.04
021289	#8	1.5	502	20.5	10.09	0.16
021290	#9	0	22	14.3	6.77	0.07
021291	#9	1.5	20	14.8	7.03	0.09
021292	#10	0	32	14.4	6.73	0.06
021293	#10	1.5	30	15.1	7.00	0.08
021294	#11	0	34	13.9	6.16	< 0.04
021295	#11	1.5	68	16.4	8.08	0.08

UNITED STATES BUREAU OF RECLAMATION
LOWER COLORADO REGIONAL LABORATORY

FLOATING WETLANDS: COMPLETE REPORT

Samples Received: 06/07/02
Date Analyzed: 06/28/02

Lab No.	**Station Code**	**Depth** (m)	**K** (ppm)	**NO3 as N** (ppm)	**NH_3 as N** (ppm)
021296	#1	0	16.8	9.21	0.09
021297	#1	1.5	17.5	9.39	0.11
021298	#2	0	15.2	7.66	< 0.04
021299	#2	1.5	15.3	7.86	< 0.04
021300	#3	0	16.3	8.57	0.04
021301	#3	1.5	19.2	10.27	0.14
021302	#4	0	15.5	7.36	< 0.04
021303	#4	1.5	15.6	7.62	< 0.04
021304	#5	0	17.0	8.83	0.07
021305	#5	1.5	20.1	11.24	0.20
021306	#6	0	16.4	7.82	0.04
021307	#6	1.5	17.6	8.86	0.08
021308	#7	0	15.2	7.62	0.05
021309	#7	1.5	18.8	10.14	0.05
021310	#8	0	17.2	8.55	0.12
021311	#8	1.5	19.1	9.69	0.12
021312	#9	0	17.3	7.91	0.23
021313	#9	1.5	16.3	8.20	0.19
021314	#10	0	17.8	7.79	0.32
021315	#10	1.5	17.8	8.25	0.26
021316	#11	0	17.4	8.60	0.07
021317	#11	1.5	17.6	8.67	0.04

UNITED STATES BUREAU OF RECLAMATION
LOWER COLORADO REGIONAL LABORATORY

FLOATING WETLANDS: COMPLETE REPORT

Samples Received: 06/09/02
Date Analyzed: 06/28/02

Lab No.	**Station Code**	**Depth** (m)	**K** (ppm)	**NO3 as N** (ppm)	**NH_3 as N** (ppm)
021318	#1	0	13.2	6.49	0.06
021319	#1	1.5	17.0	9.51	0.13
021320	#2	0	15.5	7.35	0.08
021321	#2	1.5	15.5	7.29	0.08
021322	#3	0	13.7	7.01	0.07
021323	#3	1.5	18.0	9.77	0.16
021324	#4	0	15.4	7.32	0.09
021325	#4	1.5	15.4	7.27	0.09
021326	#5	0	14.9	6.98	0.06
021327	#5	1.5	15.9	7.74	0.09
021328	#6	0	16.4	7.68	0.08
021329	#6	1.5	16.0	7.92	0.10
021330	#7	0	13.3	6.61	0.07
021331	#7	1.5	18.3	9.89	0.15
021332	#8	0	14.7	6.90	0.07
021333	#8	1.5	15.8	8.09	0.10
021334	#9	0	17.8	9.33	0.13
021335	#9	1.5	18.4	9.86	0.15
021336	#10	0	18.5	9.88	0.16
021337	#10	1.5	18.4	9.86	0.15
021338	#11	0	15.4	7.24	0.08
021339	#11	1.5	16.4	8.25	0.10

UNITED STATES BUREAU OF RECLAMATION
LOWER COLORADO REGIONAL LABORATORY

FLOATING WETLANDS: COMPLETE REPORT

Samples Received: 06/11/02
Date Analyzed: 07/01/02

Lab No.	**Station Code**	**Depth** (m)	**K** (ppm)	**NO3 as N** (ppm)	**NH_3 as N** (ppm)
021378	#1	0	9.0	5.47	< 0.04
021379	#1	1.5	13.2	5.96	0.06
021380	#2	0	11.3	4.72	< 0.04
021381	#2	1.5	11.9	5.14	< 0.04
021382	#3	0	10.4	4.11	< 0.04
021383	#3	1.5	15.0	7.66	0.09
021384	#4	0	10.5	4.16	< 0.04
021385	#4	1.5	10.4	4.11	< 0.04
021386	#5	0	9.8	3.55	< 0.04
021387	#5	1.5	12.9	5.83	< 0.04
021388	#6	0	10.5	4.07	< 0.04
021389	#6	1.5	11.7	4.92	< 0.04
021390	#7	0	9.5	3.16	< 0.04
021391	#7	1.5	10.7	4.19	< 0.04
021392	#8	0	9.5	3.19	< 0.04
021393	#8	1.5	13.2	6.05	0.05
021394	#9	0	14.8	7.33	0.09
021395	#9	1.5	15.5	7.87	0.10
021396	#10	0	17.1	8.96	0.12
021397	#10	1.5	17.5	9.33	0.12
021398	#11	0	11.7	4.90	< 0.04
021399	#11	1.5	17.4	9.24	0.14

Appendix D

May and June Water Quality Analysis

May Surface Water Quality

	Surface	Volts	Temp.	DO%	DO	Turb(Hach	Depth	pH	Cond.	ORP	Nitrogen
5/15/2002	#1	7.7	25.17	192.1	15.65	7.5 (34)	surface	8.61	1283	279	6
	#7	7.7	25.92	200	17	40.4	surface	8.8	1216	263	
	#8	7.7	25.17	200	16.85	32 (24)	surface	8.76	1083	264	6
	#5	7.7	25.04	200	17.08	25.2	surface	8.77	1134	282	
	#2	8.1	23.06	123.3	10.5	17.9(17)	surface	8.12	1301	322	4
	#9	8.1	23.78	151.1	12.69	23	surface	8.5	1266	297	
	#10	8	23.78	171.9	14.47	13.2 (14)	surface	8.61	1215	293	3
	#6	8	23.69	172	14.45	12.4	surface	8.66	1143	294	
	#3	7.7	25.99	200	16.88	93.8(32)		8.7	1349	278	6
	#4	7.6	26.02	200	16.72	47.2		8.62	1386	265	
	#11	7.6	26.17	200	17.65	54.5		8.64	1354	264	
	#12										
	Surface	Volts	Temp.	DO%	DO	Turbidity	Depth	pH	Cond.	ORP	
5/17/2002	#1	7.5	23.25	119.5	10.15	266.1	surface	8.22	1376	271	
	#7	7.5	23.17	124.8	10.63	7.7	surface	8.44	1062	280	
	#8	7.5	23.12	126.7	10.78	6.0 (9)	surface	8.44	1043	268	3
	#5	7.5	23.21	142.1	12.06	0.9	surface	8.46	1019	268	
	#2	7.5	24	152.7	12.82	78.6		8.47	1159	268	
	#9	7.5	23.75	146.6	12.36	4.2		8.53	1064	266	
	#10	7.5	23.54	139.6	11.84	3.9		8.51	1018	267	
	#6	7.5	23.5	143.5	12.21	2.8		8.53	1001	262	
	#3	7.5	23.03	124.7	10.72	10.8 (18)		8.36	1064	270	4
	#4	7.6	23.73	152.8	12.84	0 (9)		8.45	1061	268	4
	#11	7.6	22.98	128.6	10.88	19.4 (10)		8.35	1022	226	1
	#12					0					
	Surface	Volts	Temp.	DO%	DO	Turbidity	Depth	pH	Cond.	ORP	
5/19/2002	#1	7.5	24.73	115.7	9.61	131.5		8.17	1683	267	
	#7	7.4	24.55	121.8	10.1	78.2		8.25	1594	267	
	#8	7.4	24.57	126.4	10.48	100.1		8.28	1601	268	
	#5	7.4	24.52	122.8	10.2	78.4		8.27	1604	261	
	#2	7.4	23.78	127	10.73	106.6	surf	8.3	1479	276	
	#9	7.3	23.84	123	10.35	143.2		8.23	1559	276	
	#10	7.3	23.73	126.8	10.59	25.3		8.33	1384	273	
	#6	7.3	23.76	124.3	10.61	23.6		8.31	1395	274	
	#3	7.5	24.29	132	10.57	38		8.21	1536	281	
	#4	7.3	23.79	134.2	11.34	27.8		8.32	13.85	274	
	#11	7.4	23.81	133.2	11.19	17.4	surf	8.33	1399	275	
	#12	7.5	23.01	150.1	12.03	15.4		8.32	1436	277	
	Surface	Volts	Temp.	DO%	DO	Turbidity	Depth	pH	Cond.	ORP	
5/21/2002	#1		19.7		6.15			8.9	2320		
	#7		18.5		6.26			8.96	1850		
	#8		18.39		5.95			9	1740		
	#5		17.47		5.82			8.98	1435		
	#2										
	#9										
	#10										
	#6										
	#3		17.7		6			8.97	1485		
	#4										
	#11										
	#12										

May 1.5 Meters Water Quality

	Depth	Volts	Temp.	DO%	DO	Turb(Hach	Depth	pH	Cond.	ORP	Secchi	bottom	Nitrogen
5/15/2002	#1	7.7	23.66	155.9	12.67	86.9 (41)	3m	8.21	1478	284	22cm	11' 2"	8
	#7	7.7	25.18	184.6	15.01	167.2	3m	8.46	1486	268	17cm	15' 6"	
	#8	7.7	25.35	200	16.71	213.4 (49)	3m	8.53	1408	267	25cm	18' 3"	6
	#5	7.7	25.29	200	16.37	159.6	3m	8.55	1368	284	26cm	19' 10"	
	#2	8.1	22.68	118	9.82	33.9(25)	3m	8.06	1366	321	90cm	15' 6"	6
	#9	8.1	22.77	38.2	11.69	28.7	3m	8.28	1334	302	50cm	19' 11"	
	#10	8	22.82	132.5	11.21	26.9 (21)	3m	8.29	1327	300	10cm	21' 7"	7
	#6	8	22.88	174	12.46	28.4	3m	8.31	1320	301	40cm	22' 10"	
	#3	7.7	25.38	191.8	15.45	203 (86)	3m	8.53	1392	274	25cm	17' 11"	6
	#4	7.6	25.36	195.6	15.98	41.7	3m	8.51	1387	267	20cm	18' 8"	
	#11	7.6	25.2	200	15.77	44	3m	8.3	1491	268	18cm	22' 10"	
	#12												
	Depth	Volts	Temp.	DO%	DO	Turbidity	Depth	pH	Cond.	ORP	Secchi	bottom	
5/17/2002	#1	7.5	23.45	109.7	9.23	440.4	3m	8.18	1487	270	20	9' 3"	
	#7	7.5	22.91	116.6	9.97	117.5	3m	8.33	1208	281	30	15' 3"	
	#8	7.5	22.84	124.6	1067	21.9 (24)	3m	8.36	1132	272	45	17' 4"	5
	#5	7.5	22.77	120.3	10.19	33.3	3m	8.29	1196	273	40	19" 0"	
	#2	7.5	23.53	140.8	11.74	8.7	3m	8.39	1140	268	20	14' 2"	
	#9	7.5	23.52	142.4	12.04	9	3m	8.45	1133	268	65	18' 4"	
	#10	7.5	23.46	145.2	12.27	7.7	3m	8.44	1132	270	40	21' 1"	
	#6	7.5	23.42	147.3	12.52	7.3	3m	8.54	1105	265	60	22' 3"	
	#3	7.5	22.71	112.8	9.7	41.4 (41)	3m	8.25	1239	273	40cm	16' 2"	
	#4	7.5	23.5	143.5	12.04	6.5 (10)	3m	8.46	1106	268	80	18' 10"	
	#11	7.6	23.01	126.9	10.83	5.1 (14)	3m	8.32	1082	275	90cm	22' 4"	1
	#12												
	Depth	Volts	Temp.	DO%	DO	Turbidity	Depth	pH	Cond.	ORP			
5/19/2002	#1	7.4	25.73	102.8	8.26	500	1.5	8.15	2054	262	20cm	5' 9"	
	#7	7.4	24.6	121.4	10.11	96.5	1.5	8.28	1610	262	22	11' 5"	
	#8	7.4	24.56	128.6	10.68	96.7	1.5	8.26	1589	265	18	15' 4"	
	#5	7.4	24.52	121.4	10.08	80.4	1.5	8.28	1598	261	25	17' 3"	
	#2	7.3	23.01	123.6	10.33	173.7	1.5	8.23	1550	275	27	11' 6"	
	#9	7.3	23.74	127.3	10.52	164.8	1.5	8.24	1561	275	21	17' 5"	
	#10	7.3	23.73	126	10.69	44.3		8.33	1401	273	31	20' 1"	
	#6	7.3	23.78	127.8	10.77	62.3	1.5	8.31	1426	274	36	21' 10"	
	#3	7.5	24.47	123.2	10.2	22.2	1.5	8.21	1571	279	29	15' 3"	
	#4	7.4	23.79	129.4	10.94	34.6	1.5	8.34	1387	275	32	18' 0"	
	#11	7.4	23.82	131.9	11.1	42.8	1.5	8.33	1411	275	41	18' 5"	
	#12	7.5	23.97	124.3	10.49	38.2	1.5	8.32	1444	277	36	21' 4"	
	Depth	Volts	Temp.	DO%	DO	Turbidity	Depth	pH	Cond.	ORP			
5/21/2002	#1		19.64		6.03		1.5	8.91	2250		5	5' 6"	
	#7		18.68		5.79		1.5	8.95	1970		15	10' 1"	
	#8		18		5.92		1.5	8.98	1690		22	13' 1 "	
	#5		17.64		5.82		1.5	8.97	1470		34	15' 8"	
	#2										73	14' 2"	
	#9										59	18' 9"	
	#10										60	20' 11"	
	#6										68	21' 8"	
	#3		18.18		5.83		1.5	8.92	1780		21	12' 7"	
	#4										73	19' 2"	
	#11										29	14' 4"	
	#12										33	20' 4"	

June Surface Water Quality

	Surface	Volts	Temp.	DO%	DO	(Hach) turbidity	Depth	pH	Cond.	TDS	
6/5/2002	#1	7.5	27.08	184.4	12.26	(88)		8.44	1852	1.146	
	#7	7.5	27.74	200.0	14.14	(41)		8.54	1649	1.026	
	#8	7.5	27.71	200.0	14.65	(30)		8.62	1530	0.987	
	#5	7.4	28.76	200.0	16.25	(35)		8.78	1486	0.995	
	#2	7.5	25.24	151.1	10.96	(13)	surface	8.19	1478	0.951	
	#9	7.5	25.26	129.1	9.59	(13)		7.97	1540	0.986	enclosure
	#10	7.5	25.17	131.7	9.71	(12)		8.07	1539	0.985	enclosure
	#6	7.5	25.38	140.3	10.35	(23)		8.13	1671	0.931	
missed	#3					(24)					
	#4	7.5	27.20	200.0	15.93	(16)		8.70	1451	0.931	
	#11	7.5	26.93	200.0	16.05	(22)		8.46	1658	0.963	
	#12										

	Surface	Volts	Temp.	DO%	DO	(Hach) turbidity	Depth	pH	Cond.	TDS	
6/7/2002	#1	7.3	26.73	117.1	9.25	0.7 (24)		8.27	1755	1.125	
	#7	7.4	26.69	113.7	9.08	1.1 (16)		8.24	1753	1.113	
	#8	7.4	26.79	116.3	9.21	0.4 (23)		8.25	1745	1.120	
	#5	7.4	26.46	115.9	9.23	1.4 (21)	surface	8.15	1840	1.186	
	#2	7.3	27.05	128.5	10.06	0.0 (15)		8.41	1645	1.052	
	#9	7.3	27.22	47.8	3.88	0.0 (11)		7.54	1751	1.119	enclosure
	#10	7.3	27.25	40.3	3.20	0.0 (13)		7.47	1757	1.124	enclosure
	#6	7.3	26.91	122.8	9.73	0.0 (15)		8.33	1698	1.088	
	#3	7.4	26.80	121.3	9.73	0.5 (18)		8.28	1751	1.118	
	#4	7.4	27.16	137.5	11.02	0 (14)		8.42	1624	1.041	
	#11	7.4	26.92	128.7	10.37	0.1 (19)		8.35	1724	1.102	
	#12										

	Surface	Volts	Temp.	DO%	DO	(Hach) turbidity	Depth	pH	Cond.	TDS	
6/9/2002	#1	7.3	24.31	106.0	8.60	(25)		8.58	1660	1.064	
	#7	7.3	24.22	102.7	8.49	(10)		8.57	1615	1.035	
	#8	7.3	24.14	97.2	8.09	(11)		8.51	1641	1.050	
	#5	7.3	24.21	101.0	8.40	(11)	surface	8.54	1680	1.075	
	#2	7.4	24.23	99.7	8.50	0.0(12)	surface	8.52	1726	1.106	
	#9	7.4	24.05	74.7	6.13	(12)		8.23	1895	1.202	enclosure
	#10	7.3	23.85	70.3	5.80	(12)		8.23	1943	1.248	enclosure
	#6	7.3	24.11	97.0	8.04	(12)		8.52	1770	1.134	
	#3	7.3	24.29	104.2	8.64	(10)		8.54	1692	1.081	
	#4	7.3	24.29	101.0	8.37	(10)		8.52	1726	1.106	
	#11	7.3	24.28	104.4	8.64	(11)		8.53	1719	1.099	
	#12										

	Surface						
6/11/2002	#1	No Hydrolab Available			(7)		
	#7				(4)		
	#8				(8)		
	#5				(3)		
	#2				(11)		
	#9				(66)		enclosure
	#10				(90)		enclosure
	#6				(11)		
	#3				(10)		
	#4				(10)		
	#11				(27)		
	#12						

June 1.5 Meters Water Quality

						(Hach)							
6/5/2002	Depth	Volts	Temp.	DO%	DO	turbidity	Depth	pH	Cond.	TDS	Secchi	bottom	
	#1	7.5	27.77	175.8	12.10	(88)	1.5	8.34	1894	1.228	10	14' 0"	
	#7	7.5	28.21	164.5	11.55	(90)	1.5	8.30	1974	1.272	13	15' 8"	
	#8	7.5	28.27	169.3	11.86	(93)	1.5	8.33	19.69	1.261	21	16' 0"	
	#5	7.4	28.31	166.8	11.90	(90)	1.5	8.34	1995	1.275	15	16" 0"	
	#2	7.5	25.14	141.4	10.41	(12)	1.5	8.09	1575	1.010	42	15' 11"	
	#9	7.5	25.14	120.3	9.04	(12)	1.5	7.90	1568	1.004	45	17' 10"	enclosure
	#10	7.5	25.11	127.7	9.47	(13)	1.5	7.99	1563	1.001	35	18' 10"	enclosure
	#6	7.5	25.33	141.8	10.49	(34)	1.5	8.13	1669	1.022	35	19' 5"	
	#3					(64)					32	14' 4"	
	#4	7.5	26.30	180.5	12.72	(28)	1.5	8.40	1541	1.022	44	18' 8"	
	#11	7.5	26.68	185.2	13.42	(36)	1.5	8.35	1702	1.097	32	18' 6"	
	#12												

						(Hach)							
	Depth	Volts	Temp.	DO%	DO	turbidity	Depth	pH	Cond.	TDS	Secchi	bottom	
6/7/2002	#1	7.3	26.36	108.9	8.70	4.6 (25)	1.5	8.11	1899	1.219	34	15' 6"	
	#7	7.4	26.19	106.4	8.35	5.4 (35)	1.5	8.13	1899	1.226	20	16' 2"	
	#8	7.4	26.22	107.7	8.71	5.1 (38)	1.5	8.12	1902	1.219	23	16' 8"	
	#5	7.4	25.98	102.9	8.35	4.4 (49)	1.5	8.04	1929	1.238	26	16' 8"	
	#2	7.3	27.04	127.7	10.09	0.0 (15)	1.5	8.41	1647	1.057	40	15' 1"	
	#9	7.3	27.00	76.4	6.11	0.0 (12)	1.5	7.89	1737	1.112	41	17' 7"	enclosure
	#10	7.3	26.87	67.9	5.26	0.0 (11)	1.5	7.77	1806	1.155	35	18' 7"	enclosure
	#6	7.3	26.81	116.7	9.30	0.6 (24)	1.5	8.30	1744	1.118	45	19' 3"	
	#3	7.4	26.30	106.2	8.52	1.6 (28)	1.5	8.12	1889	1.202	36	16' 5"	
	#4	7.3	27.02	129.2	10.19	0 (14)	1.5	8.37	1641	1.051	53	17' 10"	
	#11	7.4	26.83	124.1	10.26	1.3 (24)	1.5	8.29	1739	1.112	40	18' 2"	
	#12												

						(Hach)							
	Depth	Volts	Temp.	DO%	DO	turbidity	Depth	pH	Cond.	TDS	Secchi	bottom	
6/9/2002	#1	7.3	24.00	91.4	7.68	(8)	1.5	8.45	1721	1.104	45	14' 5"	
	#7	7.3	24.07	93.5	7.79	(36)	1.5	8.45	1906	1.227	48	15' 7"	
	#8	7.3	23.95	95.3	7.94	(18)	1.5	8.43	1931	1.260	42	16' 6"	
	#5	7.3	23.97	94.9	7.89	(17)	1.5	8.45	1880	1.214	42	16' 6"	
	#2	7.3	24.20	96.4	8.04	0.0 (11)	1.5	8.49	1768	1.108	30	16' 1"	
	#9	7.4	24.01	73.5	6.05	(15)	1.5	8.20	1942	1.238	34	17' 10'	enclosure
	#10	7.2	24.06	64.7	5.37	(18)	1.5	8.13	1951	1.256	34	18' 8"	enclosure
	#6	7.3	24.01	94.9	8.00	(19)	1.5	8.49	1807	1.157	38	19' 2"	
	#3	7.3	24.07	96.3	8.00	(33)	1.5	8.44	1890	1.196	38	16' 2"	
	#4	7.3	24.28	97.7	8.04	(12)	1.5	8.51	1735	1.109	42	15' 5"	
	#11	7.3	23.89	95.7	8.10	(18)	1.5	8.49	1812	1.164	38	18' 2"	
	#12												

	Surface												
6/11/2002	#1	No Hydrolab Available				(40)					45	12' 0"	
	#7					(15)					38	14' 6"	
	#8					(35)					42	15' 8"	
	#5					(27)					45	15' 11"	
	#2					(36)					40	15' 10"	
	#9					(50)					18	17' 6"	enclosure
	#10					(178)					15	19' 0"	enclosure
	#6					(32)					45	19' 5"	
	#3					(54)					45	15' 8"	
	#4					(6)					45	18' 0"	
	#11					(90)					42	17' 7"	
	#12												

Appendix E

May and June Chlorophyll Analysis

Floating Wetlands Chlorophyll Analysis
collected: May 15 through June 11, 2002

Date Received	Chlorophyll a Concentration (mg/m3)		Chlorophyll b Concentration (mg/m3)		Chlorophyll c Concentration (mg/m3)		Location
5/15/2002	84.30		23.88		3.51		1-surface
5/15/2002	103.13		26.50		4.18		2-surface
5/15/2002	56.89		14.79		2.99		3-surface
5/15/2002	80.84		21.90		3.53		4-surface
5/15/2002	40.41		9.88		2.16		8-surface
5/15/2002	69.39		18.20		2.88		10-surface
5/17/2002	5.89	19.14	1.31	1.31	1.13	1.13	3-surface
5/17/2002	7.75	25.18	0.68	0.68	1.04	1.04	4-surface
5/17/2002	6.98	22.69	1.05	1.05	0.92	0.92	11surface
5/17/2002	13.69	44.48	3.51	3.51	1.13	1.13	8-surface
5/17/2002	13.05	42.41	2.93	2.93	1.02	1.02	8-3 meters
5/17/2002	3.39	11.02	0.54	0.54	0.59	0.59	10-surface
5/17/2002	21.39	69.52	5.56	5.56	1.29	1.29	10-3 meters
5/19/2002	14.81	48.13	4.39	4.39	1.42	1.42	11-surface
5/19/2002	13.64	44.33	4.12	4.12	1.24	1.24	11-1.5 meters
5/19/2002	11.64	37.84	3.62	3.62	1.05	1.05	8-surface
5/19/2002	10.35	33.63	2.93	2.93	0.94	0.94	8-1.5 meters
5/19/2002	15.18	49.34	4.85	4.85	1.01	1.01	10-surface
5/19/2002	14.84	48.24	4.70	4.70	1.14	1.14	10-1.5 meters
5/21/2002	1.15	3.74	0.29	0.29	0.32	0.32	11-surface
5/21/2002	1.29	4.19	0.32	0.32	0.23	0.23	11-1.5 meters
5/21/2002	1.58	5.12	0.44	0.44	0.42	0.42	8-surface
5/21/2002	1.46	4.76	0.32	0.32	0.32	0.32	8-1.5 meters
5/21/2002	1.96	6.36	0.49	0.49	0.42	0.42	10-surface
5/21/2002	1.83	5.94	0.34	0.34	0.48		10-1.5 meters
6/5/2002	20.58	66.90	6.46	6.46	1.24	1.24	2-surface
6/5/2002	11.58	37.64	3.56	3.56	0.77	0.77	2-1.5 meters
6/5/2002	28.57	92.85	9.38	9.38	1.56	1.56	11-surface
6/5/2002	13.34	43.34	4.46	4.46	0.88	0.88	11-1.5 meters
6/5/2002	sample lost	na	na	na	na	na	8-surface
6/5/2002	20.70	67.29	6.54	6.54	1.06	1.06	8-1.5 meters
6/11/2002	21.30	69.22	5.43	5.43	1.05	1.05	7-surface
6/11/2002	7.23	23.48	1.83	1.83	0.47	0.47	7-1.5 meters
6/11/2002	16.20	52.64	4.42	4.42	1.14	1.14	11-surface
6/11/2002	8.93	29.04	2.40	2.40	0.68	0.68	11-1.5 meters
6/11/2002	9.28	30.17	2.42	2.42	0.60	0.60	10-surface
6/11/2002	7.49	24.33	1.84	1.84	0.56	0.56	10-1.5 meters

Appendix F

Plant Growth Indicators From Quarter Meter Square Quadrat Sampling

Plant Growth- culm diameter, culm length, fresh weight biomass, dry weight biomass from quarter meter square quadrates
Cattail Platform

Island	Species	Culm Diameter mm													
1	Cattail		40	12	14	17	22	19	14	10	22	19	Mean Diameter mm	fresh wt.	5252 g
			15	16	15	17	18	14	18	17	21	27	18	dry wt.	1579.3 g
		Culm Length cm												%coverage	25%
			169	201	179	182	175	153	196	181	161	180	Mean Length cm		
			185	170	245	228	167	198	175	148	159	178	182		
Island	Species	Culm Diameter mm													
2	Phragmite		5	7	8	7	6	5	8	6	3	5	Mean Diameter mm	fresh wt.	1678 g
			5	7	6	6	6	7	4	8	4	6	6	dry wt.	578.6 g
		Culm Length cm												%coverage	40%
			199	164	200	203	173	170	155	160	188	121	Mean Length cm		
			186	187	203	183	190	173	198	175	98	109	169		
	Species														
	Hardstem	Culm Diameter mm													
			7	6	9	7	7	6	5	5	7	5	Mean Diameter mm		
			13	9	10	9	7						7		
		Culm Length cm													
			171	182	194	140	105	174	181	148	150	100	Mean Length cm		
			194	188	143	183	151						157		
	Species														
	Cattail	Culm Diameter mm													
			17	16	10	14	12	18	11				Mean Diameter mm		
													14		
		Culm Length cm													
			141	145	115	124	128	163	109				Mean Length cm		
													131		
Island	Species	Culm Diameter mm													
3	none		0										Mean Diameter mm	fresh wt.	
													0	dry wt.	
		Culm Length cm												%coverage	0
			0										Mean Length cm		
													0		
Island	Species	Culm Diameter mm													
4	Wormbane		6	3	4	2	7	5	3	4	3	5	Mean Diameter mm	fresh wt.	180 g
			4	4	4	3	3	3	3				4	dry wt.	26.6 g
		Culm Length cm												%coverage	20%
			20	27	21	24	36	19	31	58	39	26	Mean Length cm		
			27	53	29	31	23	32	37				31		
	Species														
	Rabbit Ft.	Culm Diameter mm													
			1	1	1	1	1	1	1				Mean Diameter mm		
													1		
		Culm Length cm													
			29	32	27	21	37	36	30				Mean Length cm		
													30		
Island	Species	Culm Diameter mm													
5	Olney's		13	9	8	12	12	13	16	11	12	13	Mean Diameter mm	fresh wt.	2076 g
			8	10	13	10	9	6	10	9	10	12	10.9	dry wt.	457.3 g
		Culm Length cm												%coverage	20%
			216	175	177	125	111	192	154	193	216	172	Mean Length cm		
			124	190	213	211	147	215	208	202	222	205	179		
	Species														
	Cattails	Culm Diameter mm													
			19	10	11	9	12	18	13	9	17	14	Mean Diameter mm		
			7	12	10	16	14	9					13		
		Culm Length cm													
			174	148	143	146	146	164	136	162	115	136	Mean Length cm		
													151		
			172	145	161	197	139	139							
Island	Species	Culm Diameter mm													
6	Cattail		18	16	12	21	11	18	15	18	13	14	Mean Diameter mm	fresh wt.	1784 g
			11	10	15	16	16	11					15	dry wt.	499.1 g
														%coverage	20%
		Culm Length cm											Mean Length cm		
			156	135	160	181	172	178	148	256	189	174	174		
			154	173	166	199	151	189							
Island	"No island not done"														
7															
Island	Species	Culm Diameter mm													
8	Cattail		34	21	19	20	16	39	20	20	35	16	Mean Diameter mm	fresh wt.	4566 g
			17	23	17	23	15	22	20	17			22	dry wt.	1318.2 g
														%coverage	30%
		Culm Length cm											Mean Length cm		
			345	220	212	210	160	340	185	188	272	175	219		
			198	202	195	200	230	195	195	219					
Island	Species	Culm Diameter mm													
9	Olney's		10	8	7	5	9	6	6	7	6	5	Mean Diameter mm	fresh wt.	850 g
			7	8	5	8	9	8	5	8	5	5	7	dry wt.	182.2 g
														%coverage	20%
		Culm Length cm											Mean Length cm		
			181	170	173	216	197	170	158	240	183	180	188		
			178	185	193	199	177	180	189	219	144	213			

Island	Species	Culm Diameter mm												
10	Wormbane	8	5	6	5	8	7	6	4	5	4	Mean Diameter mm	fresh wt.	2698 g
		6	6	7	4	5	6	8	6	4	3	6	dry wt.	421.9 g
													%coverage	40%
		Culm Length cm										Mean Length cm		
		74	106	146	164	183	189	105	140	191	144	137		
		133	161	119	74	161	99	161	110	164	123			
	Species	Culm Diameter mm												
	Cattail	43	53	40	58	53						Mean Diameter mm		
												49		
		Culm Length cm										Mean Length cm		
		323	249	278	242	163						251		
	Species	Culm Diameter mm												
	Three Sq.	3	3	3	3	3	3	1	2	3	4	Mean Diameter mm		
		3	4	3	2							3		
		Culm Length cm										Mean Length cm		
		85	146	123	104	141	147	130	123	136	81	117		
		136	112	119	60									
Island	Species	Culm Diameter mm												
11	Cattail	33	13	23	36	51	16	45	12	24	28	Mean Diameter mm	fresh wt.	4566 g
		30	45	67	28	41						33	dry wt.	1318.2 g
													%coverage	45%
		Culm Length cm										Mean Length cm		
		132	114	188	221	211	180	124	157	178	183	171		
		163	183	229	188	107								
	Species	Culm Diameter mm										Mean Diameter mm		
	Three Sq.	3	3	3	3	4	2	2	2	2	2	3		
		3	2	2	3	1	1	2	2	2	2			
												Mean Length cm		
		Culm Length cm										75		
		66	94	76	76	89	58	71	66	81	51			
		84	58	91	28	51	58	74	71	64	43			
	Species	Culm Diameter mm										Mean Diameter mm		
	Phrag.	3	3									3		
												Mean Length cm		
		Culm Length cm										98		
		102	94											
Island	Species	Culm Diameter mm												
12	Phrag.	5	7	6	5	4	5	6	4	5	6	Mean Diameter mm	fresh wt.	2486
		5	5	2	2	3						5	dry wt.	606.1 g
													%coverage	20%
		Culm Length cm										Mean Length cm		
		18	57	111	191	230	82	148	216	230	228	152		
		211	240	137	71	111								
	Species	Culm Diameter mm										Mean Diameter mm		
	Cattail	19	24	15	22	16	40	17	22	52	47	27		
		26												
		Culm Length cm										Mean Length cm		
		332	185	177	223	250	170	141	167	170	124	191		
		160												

Bulrush Platform

Island	Species	Culm Diameter mm												
1	Olney's	7	9	9	8	8	7	6	6	8	10	Mean Diameter mm	fresh wt.	3052
		8	5	10	7	9	10	11	9	6	7	8	dry wt.	1190.3 g
		Culm Length cm											%coverage	80%
		188	60	161	178	183	190	167	184	160	143	Mean Length cm		
		121	153	40	176	206	134	187	160	180	159	157		
	Species	Culm Diameter mm												
	Phag.	6	2	5	5	4	6	2	3	3	6	Mean Diameter mm		
		5	5	4	4							4		
		Culm Length cm												
		103	71	33	136	104	90	112	117	100	96	Mean Length cm		
		140	65	155	170							107		
Island	Species	Culm Diameter mm												
2	Phrag.	5	3	2	2	2	6	4	4	5	5	Mean Diameter mm	fresh wt.	1740
		3	2	3	3	4	5	6	4	4	4	4	dry wt.	451.8 g
		Culm Length cm											%coverage	80%
		176	174	147	150	140	161	163	164	40	164	Mean Length cm		
		200	162	123	130	137	171	165	164	122	125	149		
	Species	Culm Diameter mm												
	Maritimus	5	6	4	6	6	4	4	3	4	5	Mean Diameter mm		
		3	6	4	5	4	4	5	4	4	3	4		
		Culm Length cm												
		121	125	141	113	162	128	105	114	169	132	Mean Length cm		
		100	143	122	108	98	134	110	86	139	91	122		
	Species	Culm Diameter mm												
	Hardstem	6	9	11	10	10	5	10	6	5	7	Mean Diameter mm		
		5										8		
		Culm Length cm												
		164	169	184	193	165	130	198	107	108	91	Mean Length cm		
		160										152		
Island	Species	Culm Diameter mm												
3	Three Sq.	4	3	4	4	3	3	3	5	4	2	Mean Diameter mm	fresh wt.	618 g
		2	2	3	3	2	2	1	1	3	2	3	dry wt.	142.3 g
		Culm Length cm											%coverage	30%
		142	103	70	85	103	72	74	86	65	73	Mean Length cm		
		89	118	104	73	123	108	80	137	118	90	96		
	Species	Culm Diameter mm												
	Flea Bane	5	6	7	6	3	5	5	2			Mean Diameter mm		
												5		
		Culm Length cm												
		56	52	35	50	42	61	26	40			Mean Length cm		
												45		
	Species	Culm Diameter mm												
	Cyperus	5	4	5	5							Mean Diameter mm		
												5		
		Culm Length cm												
		43	85	70	40							Mean Length cm		
												60		
	Species	Culm Diameter mm												
	Olney's	6										Mean Diameter mm		
												6		
		Culm Length cm												
		62										Mean Length cm		
												62		
	Species	Culm Diameter mm												
	Phrag.	4	3	3								Mean Diameter mm		
												3		
		Culm Length cm												
		134	101	115								Mean Length cm		
												117		
Island	Species	Culm Diameter mm												
4	no vegetation		0									Mean Diameter mm	fresh wt.	0
												0	dry wt.	0
		Culm Length cm											%coverage	0%
			0									Mean Length cm		
												0		
Island	Species	Culm Diameter mm												
5	Olney's	6	7	8	9	9	6	10	9	8	8	Mean Diameter mm	fresh wt.	1150
		8	6	6	10	7	8	7	7	10	5	8	dry wt.	280.7 g
		Culm Length cm											%coverage	80%
		164	184	183	211	104	184	172	183	166	191	Mean Length cm		
		79	170	103	179	166	205	173	191	198	132	167		

Island	Species	Culm Diameter mm												
6	Cattails	48	56	46	49	37	36	18	28	17	22	Mean Diameter mm	fresh wt.	618 g
		25	19	16	16	13						30	dry wt.	142.3 g
		Culm Length cm											%coverage	30%
		295	291	272	240	240	235	190	242	184	191			
		176	304	246	169	155						229		
	Species	Culm Diameter mm												
	Hard Stem	11	8	7	6	9	7	5	8	5	5	Mean Diameter mm	fresh wt.	4780 g
		5	7	6	9	5	9	11	14	7	4	7	dry wt.	1103.5 g
		Culm Length cm											%coverage	90%
		216	212	216	189	177	161	149	148	148	143	Mean Length cm		
		40	72	49	154	185	135	128	148	162	149	149		
	Species	Culm Diameter mm												
	Spike R.	1	2	1	2	1	2	2	2	1	1	Mean Diameter mm		
		1	2	1	2	1	2	1	2	2	1	2		
		Culm Length cm												
		116	113	108	107	104	103	95	95	93	89	Mean Length cm		
		85	83	86	87	73	73	69	69	65	57	89		
	Species	Culm Diameter mm												
	Olney's	12	11									Mean Diameter mm		
												12		
		Culm Length cm												
		183	125									Mean Length cm		
												154		
	Species	Culm Diameter mm												
	Phrag.	3	3	3	3	2						Mean Diameter mm		
												3		
		Culm Length cm												
		163	113	173	161	122						Mean Length cm		
												146		
	Species	Culm Diameter mm												
	Wormbane	2	8	5	2							Mean Diameter mm		
												4		
		Culm Length cm												
		100	152	94	86							Mean Length cm		
												108		
Island	Species	Culm Diameter mm												
7	Olney's	9	7	6	10	6	9	9	9	7	7	Mean Diameter mm	fresh wt.	1726
		7	7	7	6	8	7	7	4	4	8	7	dry wt.	340.0 g
		Culm Length cm											%coverage	100%
		16	157	64	180	156	151	70	166	113	100	Mean Length cm		
		168	190	103	140	151	131	77	133	127	135	126		
Island	Species	Culm Diameter mm												
8	Not done=Seeded platform											Mean Diameter mm	fresh wt.	
												#DIV/0!	dry wt.	
		Culm Length cm											%coverage	
												Mean Length cm		
												#DIV/0!		
Island	Species	Culm Diameter mm												
9	Cattail	60	34	47	24	23	20					Mean Diameter mm	fresh wt.	2560
												35	dry wt.	858.6 g
		Culm Length cm											%coverage	80%
		293	219	219	224	204	200					Mean Length cm		
												227		
	Species	Culm Diameter mm												
	Olney's	7	7	5	4	6	7	7	3	4	3	Mean Diameter mm		
		7	8	6	7	4	5	8	10	5	7	6		
		Culm Length cm												
		196	178	204	145	81	146	93	153	189	180	Mean Length cm		
		98	116	149	146	187	178	186	201	180	119	156		

Island	Species	Culm Diameter mm												
10	Maritimus	3	3	4	3	4	4	3	2	2	2	Mean Diameter mm	fresh wt.	726
		2	7	7	9	6	5	6	5	5	5	4	dry wt.	177.9 g
		Culm Length cm											%coverage	50%
		74	70	73	66	81	101	90	120	102	87	Mean Length cm		
		96	80	67	72	78	107	93	120	76	87	87		
	Species	Culm Diameter mm												
	Olney's	10	9	12	12	10	9	10	11	11	11	Mean Diameter mm		
		12	9	10	10	8	9					10		
		Culm Length cm												
		139	67	169	88	156	103	116	134	168	132	Mean Length cm		
		165	143	167	159	197	120					139		
	Species	Culm Diameter mm												
	Wormbane	7	9	9	4	4						Mean Diameter mm		
												7		
		Culm Length cm												
		57	37	79	66	100						Mean Length cm		
												68		
	Species	Culm Diameter mm												
	Cattail	12										Mean Diameter mm		
												12		
		Culm Length cm												
		122										Mean Length cm		
												122		
	Species	Culm Diameter mm												
	Hardstem	7										Mean Diameter mm		
												7		
		Culm Length cm												
		43										Mean Length cm		
												43		

Island	Species	Culm Diameter mm												
11	Cattail	40	35	22	27	20	33	22				Mean Diameter mm	fresh wt.	2140
												28	dry wt.	368.0 g
		Culm Length cm											%coverage	30%
		315	321	260	134	316	152	139				Mean Length cm		
												234		
	Species	Culm Diameter mm												
	Hardstem	4	6	11	7	3						Mean Diameter mm		
												6		
		Culm Length cm												
		222	173	144	149	89						Mean Length cm		
												155		
	Species	Culm Diameter mm												
	Wormbane	8	6	9	5	3	8	4	7	6	6	Mean Diameter mm		
		5	4	6	8	6	4					6		
		Culm Length cm												
		159	152	141	149	152	140	140	111	162	89	Mean Length cm		
		145	153	98	97	114	58					129		
	Species	Culm Diameter mm												
	Tamarisk	3										Mean Diameter mm		
												3		
		Culm Length cm												
		83										Mean Length cm		
												83		

Island	Species	Culm Diameter mm												
12	Cattail	50	72	48	13	8						Mean Diameter mm	fresh wt.	980
												38	dry wt.	142.3 g
		Culm Length cm											%coverage	5%
		291	254	57	327	97						Mean Length cm		
												205		
	Species	Culm Diameter mm												
	Hardstem	11										Mean Diameter mm		
												11		
		Culm Length cm												
		148										Mean Length cm		
												148		