Coeur d'Alene Lake Management Plan
Aquatic Vegetation Survey
Rockford Bay Pilot Study

(Photograph by Kathy Hamel from Washington State Department of Ecology, 2001)

Idaho Department of Environmental Quality

January 2011

Coeur d'Alene Lake Management Plan Aquatic Vegetation Survey Rockford Bay Pilot Study

Prepared by

Becki Witherow, Glen Pettit, Glen Rothrock, and Tyson Cline
Idaho Department of Environmental Quality
2110 Ironwood Parkway
Coeur d'Alene, Idaho 83814

January 2011

Executive Summary

In March 2009, the Idaho Department of Environmental Quality and the Coeur d'Alene Tribe finalized the Coeur d'Alene Lake Management Plan (LMP). The overall objective of the plan is to "protect and improve lake water quality by limiting basin-wide nutrient inputs that impair lake water quality conditions, which in turn influence the solubility of mining-related metals contamination contained in lake sediment." An essential component to achieving this objective is to gain an increased understanding of water quality trends through monitoring.

Nutrient dynamics are a key concern in the LMP as increased levels of nitrogen and phosphorus can increase productivity. These increases in productivity can depress hypolimnetic oxygen levels, which may result in the release of toxic heavy metals from lake sediments. Submerged aquatic plants (macrophytes) utilize nitrogen and phosphorus during their growth cycle and may release these nutrients during decay, thus making the study of aquatic plant communities paramount to understanding nutrient dynamics in Coeur d'Alene Lake.

A related issue in Coeur d'Alene Lake is the presence and distribution of the noxious, invasive plant, Eurasian watermilfoil (*Myriophyllum spicatum*). This plant has been found in most of the nearby lakes in Idaho and Washington as well as the southern waters of Coeur d'Alene Lake. Eurasian watermilfoil is a significant treat to the beneficial uses of Coeur d'Alene Lake.

This report outlines a pilot study conducted in Rockford Bay, Coeur d'Alene Lake. The goals of this study were to refine sampling techniques (point intercept, transect, and underwater videography methods), to develop baseline data on plant community structure and plant biomass, and to potentially identify the presence of Eurasian watermilfoil.

The results generated in this study show that Rockford Bay has a moderate to high diversity of submerged aquatic macrophytes typically dominated by *Elodea* species. Comparison of these results to data collected by the Coeur d'Alene Tribe shows that there may be a high degree of annual variability. Spatial variability also plays a role in the community structure. The highest diversity of species tends to be in shallower depths, but the greatest biomass occurs at moderate depths (approximately 12 ft). Plant growth is limited to depths less than 26 ft as it appears that light availability is limited below 26 ft.

Despite the presence of Eurasian watermilfoil in the southern pool of Coeur d'Alene Lake, the noxious plant was not observed in Rockford Bay.

Future studies in on submerged aquatic vegetation will focus on other bays in Coeur d'Alene Lake including, but not limited to, Windy, Mica, Cave, Loff, Powderhorn, Carlin, and Echo Bays. Work will commence during the summer of 2011 and will focus on Eurasian watermilfoil detection, qualitative community structure assessment, biomass determination, and quantification of nutrients stored in plant matter.

Table of Contents

List of Figures

List of Tables

Acronyms and Abbreviations

APHA	American Public Health Association
Cd'A	Coeur d'Alene
IDEQ	Idaho Department of Environmental Quality
EWM	Eurasian watermilfoil (*Myriophyllum spicatum*)
LMP	Lake Management Plan
RPD	relative percent difference
RSD	relative standard deviation
SCUBA	Self Contained Underwater Breathing Apparatus
SVL	Silver Valley Laboratories
Tribe	Coeur d'Alene Tribe
US EPA	United States Environmental Protection Agency
USGS	United States Geological Survey

Introduction

Description of Study Area

Coeur d'Alene Lake, Idaho's second largest lake, is naturally dammed to the north by Pleistocene glacial flood deposits (Breckenridge and Othberg, 1999) (Figure 1). The area of the lake is approximately 32,000 acres with an approximate volume of 2.3 million acre-feet (Woods and Beckwith, 1997). The water surface elevation has been controlled by the Post Falls dam since 1906. The dam lies approximately 10 miles downstream of the lake on the Spokane River, the primary outlet of the lake. Cd'A Lake is primarily fed by the St. Joe and Coeur d'Alene Rivers. During the summer months, the lake level is maintained at 2128 feet and drops to approximately 2121 feet during the winter months. During the winter months, lake level may vary depending on the amount of precipitation and snow pack conditions.

Surrounding the lake is an abundance of past and present mining operations including zinc, silver, and lead (Gillerman and Bennett, 2009). These metals, amongst others, have been evidenced in lake and stream water, sediments, fauna, and flora. The dynamics of these metals in lentic systems are linked to nutrient dynamics including those associated with aquatic plant growth and decay (Jackson, 1998). For example, studies have demonstrated that aquatic macrophytes obtain their nutrients from the sediments in which they are rooted (Bristow and Whitcombe, 1971) and metal concentrations in such plants show a direct relationship with the underlying sediments (Jackson et al., 1991). Furthermore, the decay of annual submerged macrophytes releases substantial quantities of nutrients (e.g. C, N, and P) and metals (e.g. Fe, Mn, and Zn) to the water column (Carpenter, 1980; Jackson et al., 1994b).

The Cd'A Lake drainage basin has been extensively altered by residential and commercial development, and agricultural and silvicultural practices. These activities have created concern over the amount of nutrients entering the lake. The US EPA National Eutrophication Survey conducted in 1975 found the lake to be moderately rich in nutrients (mesotrophic) (US EPA, 1977). Due to efforts to reduce the nutrient inputs to the lake since the 1970s, the lake has since been classified as oligotrophic (low in nutrients) (Woods and Beckwith, 1997). Most recently, it has been shown the nutrient enrichment is on the rise rekindling the concern of nutrient-metal interactions within the lake (Wood and Beckwith, 2008).

Many of the shorelines form steep, rocky drops unsuitable for much rooted aquatic plant growth. The numerous lake bays, however, are generally shallow and gently sloping providing suitable habitat for submerged littoral plants. Previous work by USGS in 1993 on Cd'A Lake found that 22 plant genera were present in the lake, mostly at the shallower southern end (Woods and Beckwith, 1997). Most of the bays with extensive sedimentary deltas had abundant aquatic macrophytes as well. These bays include: Carey, Carlin, Cougar, Kidd Island, Lofts, Mica, Powderhorn, Rockford, 16 to 1, Windy, and the eastern side of Wolf Lodge. Harrison Slough also had abundant macrophytes. Moderate vegetation was found at Bennett, Echo, Fullers, and Turner Bays. In 2005, the Coeur d'Alene Tribe Lake Management Department conducted lake-wide surveys at 28 sites including the aforementioned bays with the exceptions of Bennett, Fullers, and Turner Bays (Tribe, 2006).

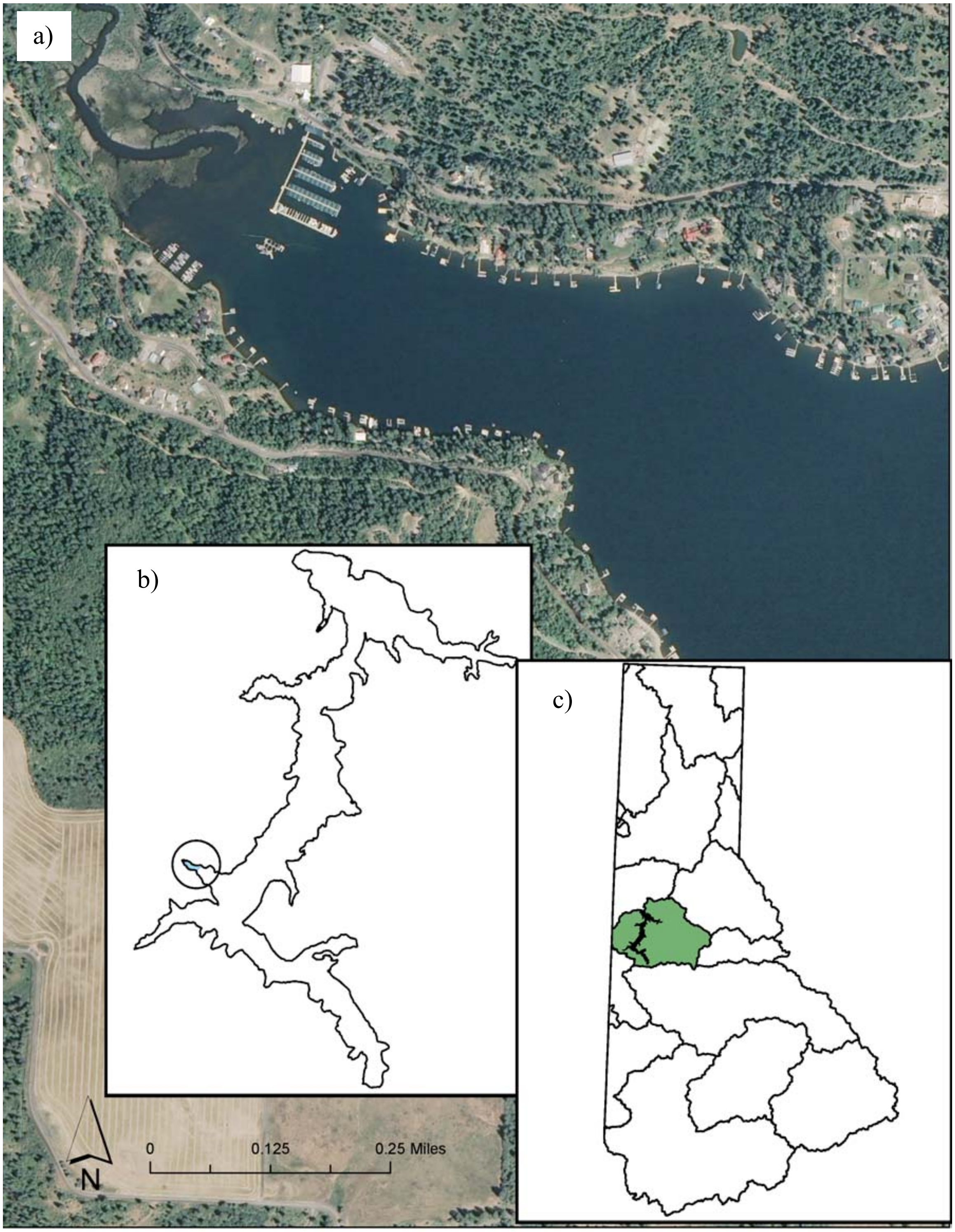

Figure 1. a) Satellite image of Rockford Bay. b) Coeur d'Alene Lake. c) Idaho panhandle region with the Coeur d'Alene Lake watershed in green.

The focus of this IDEQ pilot study was to inventory the rooted aquatic macrophytes of Rockford Bay (Figure 1). Rockford Bay is northwest-southeast trending with a broad, shallow zone near the mouth of Fighting Creek. The flanks of the bay are moderately steep with a high density of lake-front residences and private docks. The bay also houses Black Rock Marina (including fueling facilities) and Shooters Restaurant.

Rockford Bay was chosen given its proximity to the waters studied in the *Lower Lakes Aquatic Vegetation Survey Project* (Tribe, 2007). The bay also has a no-wake zone that provided additional safety for the IDEQ team, particularly during the SCUBA portion of the survey.

Purpose/Objectives

Study Purpose

The primary purpose of a long-term rooted aquatic vegetation survey, as part of LMP studies, is to develop data on submersed aquatic plant distribution and biomass in the northern portion of Coeur d'Alene Lake. This survey expands on previous work conducted on both northern and southern reaches of the lake by the Tribe (Tribe, 2006 and Tribe, 2007). Included as a purpose of this survey work is early identification of Eurasian watermilfoil (EWM), or other noxious aquatic species, that could establish in northern bays. The secondary purpose is to estimate nutrient (primarily phosphorus) release from the existing plant beds into the water column of Coeur d'Alene Lake. The purpose of the 2010 pilot study was for IDEQ staff to develop the methods and protocols needed for annual vegetation surveys.

Study Objectives

Specific objectives of this pilot study were:

1. to establish and refine survey techniques focusing on point-intercept, transect, and underwater video methods.
2. to identify the plant species present in Rockford Bay.
3. to collect samples along transects and quantify the biomass of each plant species in a 18" x 18" quadrat.
4. to identify the presence or absence of EWM.

Materials and Methods

Grid Sampling Methods

Grid sampling (point intercept) methods in general followed those presented in Madsen, 1999. Grid sampling is designed to cover numerous points within a shallow water area for identification of the aquatic plant community present. Site selection for Rockford Bay point intercepts was generated using Hawths Tools, an ArsGIS extension. Hawths Tools uses basic statistical and spatial analysis operations that are commonly required in spatial ecology research. Spacing between points was 75 feet and points were constrained to depths of less than 35 ft. Latitude and longitude were imported into a handheld GPS unit, and sites were located using the waypoint function. Point intercept sampling was conducted on August 3 and 5, 2010 and on September 8, 2010.

Once a sampling point was reached, weighted rake heads tethered to rope were deployed from the starboard and port sides of the bow (two rake tosses per point). The rakes were slowly reeled in, and the plants entangled in the rakes were removed and combined for identification. Species and genus groups were identified referencing two field manuals for aquatic plants of North America and Washington State (Borman et al., 1997, Washington State Department of Ecology, 2001). In all, 35 points received rake tosses (Figure 2).

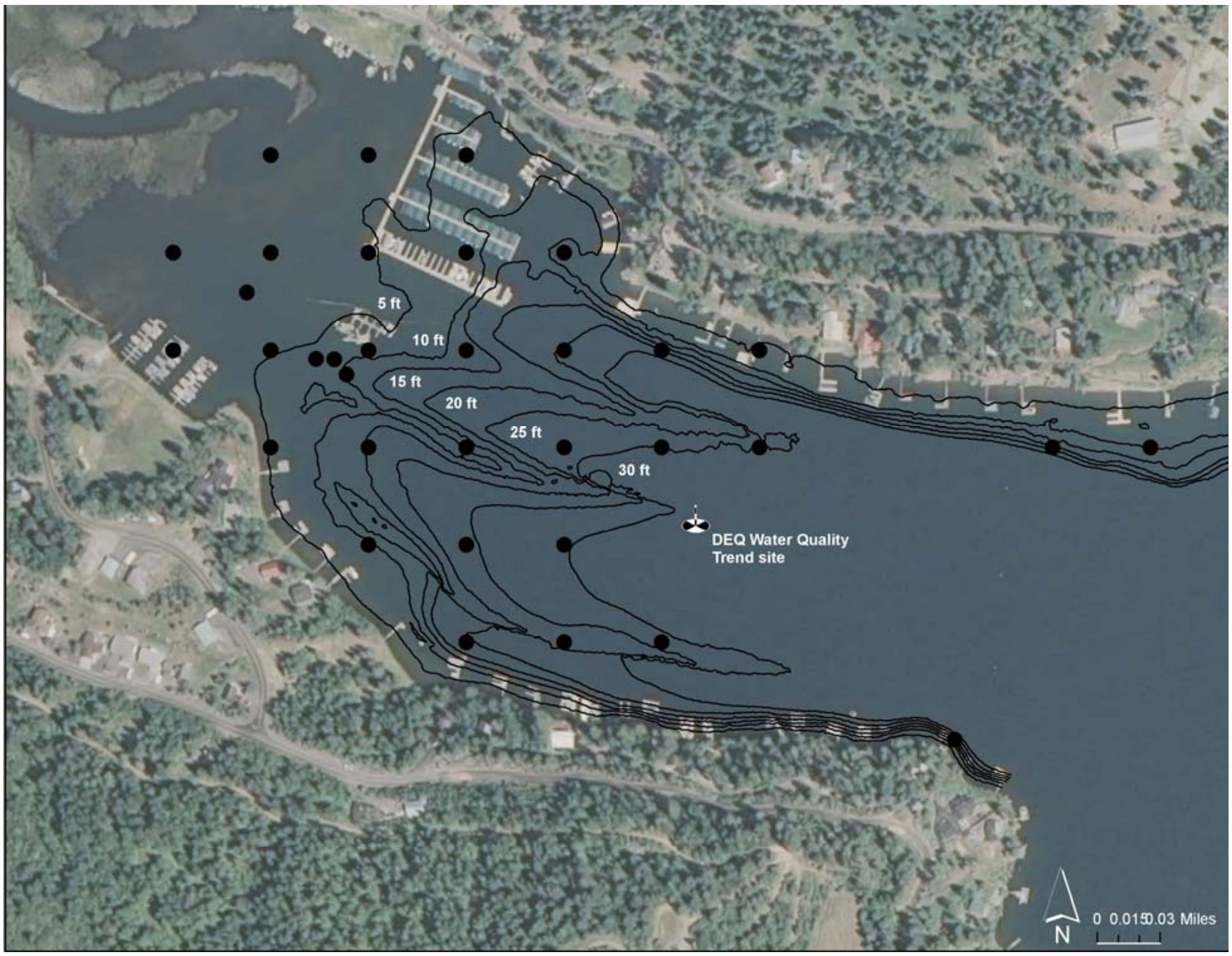

Figure 2. Map of Rockford Bay sampling locations for the point-intercept method (black dots).

Transect Sample Collection Techniques

The transect sampling by SCUBA was conducted on September 21 and 22, 2010. Ideally, the sampling would have been conducted earlier in the year during the maximum annual water temperature (typically around August 15) which coincides with the maximum annual "standing crop" (Tribe, 2006). Because this sampling schedule was during cooler, less ideal conditions, some plants were beginning to senesce.

The transect sampling was a modification of the "line intercept" method as the samples in this study were collected at 3 foot depth increments from 3 – 21 ft (APHA, 1995; Tribe, 2006). Three transects were collected in Rockford Bay based on the bay morphology, ease of access, and diver safety concerns (Figure 3). These transects were oriented approximately perpendicular to the shore line. Using a Humminbird™ depth finder, sampling locations were approximated and marked with a small anchor secured to a numbered buoy and numbered sampling bag (Figure 4a). These markers were threaded along a white rope to allow the divers to effectively move from one location to another. The entire system was secured on both ends by large anchors.

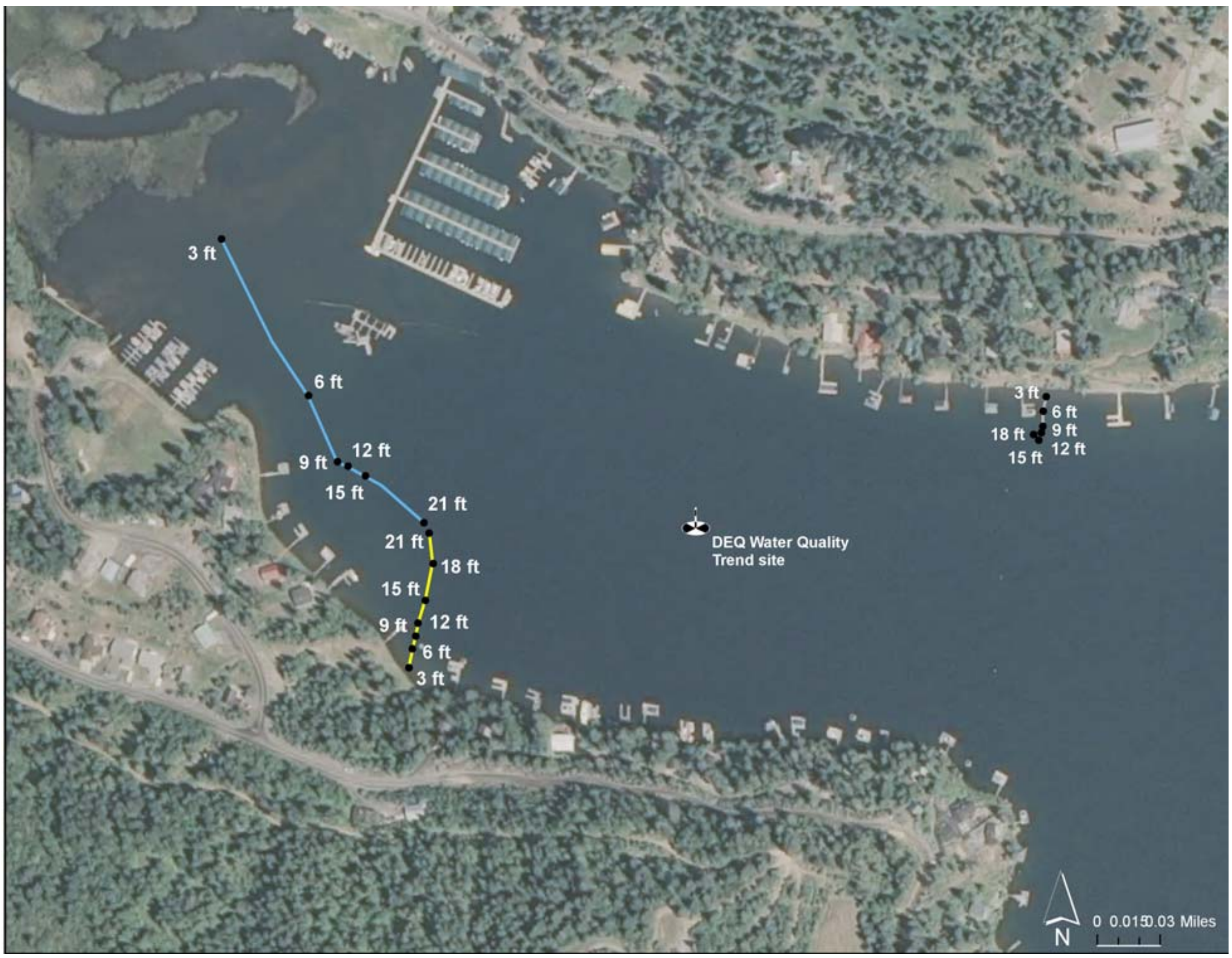

Figure 3. Map of sampling transects. ROCKFORD in light blue, ROCKFORD SOUTH in yellow, ROCKFORD NORTH in gray.

Once the divers were in the water, they were able to refine the sampling locations if and only if the marker was at an incorrect depth according to dive computers. Divers did not reposition the markers for any other reason, and the marker was only moved along the white rope between markers. This was to ensure that the sampling was unbiased and only corrected for depth.

Dive computers used in this study were standard dive computers that only read depth in 1 foot increments. The dive computers were calibrated for altitude, however their accuracy was not determined in the field. Furthermore, the computers were only operational at depths greater than 5 feet, and samples taken at the 3 ft depth interval were estimated. Below 5 feet, the computers were assumed to be accurate to within one foot.

Samples were collected using an 18" x 18" "quadrat" (0.21 m^2): a fixed corner, three-sided frame constructed from PVC pipe (Figure 4**b**). At each sampling location, the quadrat was placed on the lake bottom and any plants contained within the quadrat were pulled from the substrate and placed in a numbered mesh bag. This bag was then secured to the anchor-buoy system to be collected at the end of the sampling period. This system was repeated until all points were collected.

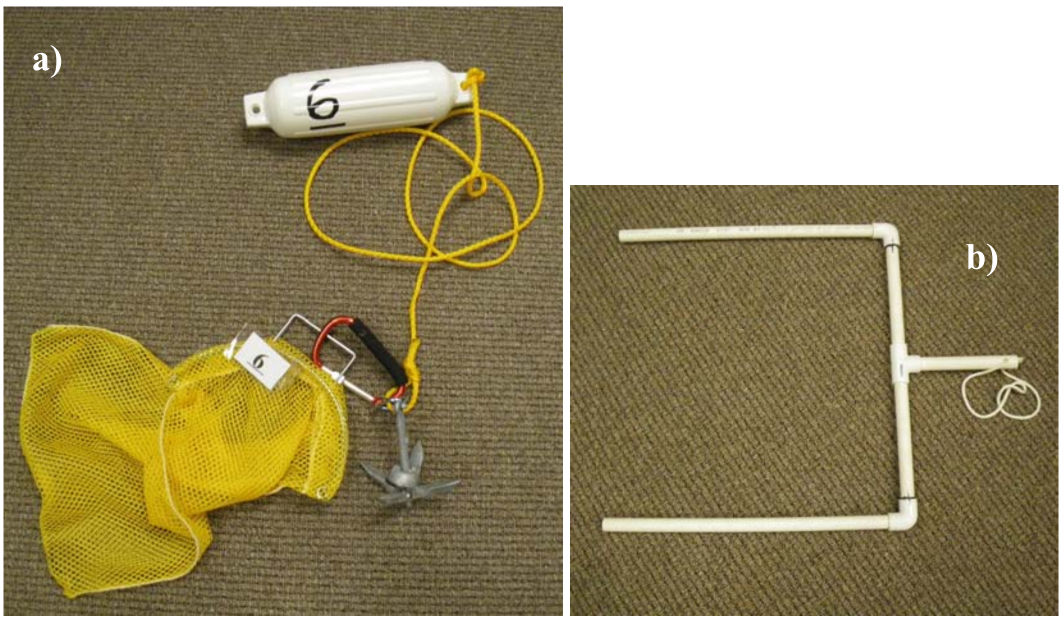

Figure 4. a) Sample collection bag, anchor, and buoy system. **b)** 18" x 18" sampling quadrat.

Once the sample bagging was completed by the divers, the team marked all of the buoys with GPS and collected the samples. On the boat, the mesh bags containing samples were rinsed in lake water until the rinsate appeared clear and were swung/shaken to remove excess water. Samples were transferred to a labeled plastic bag and chilled until sorting at IDEQ's laboratory.

Transect Sample Sorting Techniques

All samples were sorted at the IDEQ laboratory in Coeur d'Alene within 3 days of collection. The contents of each bag were spread out on a clean workbench to separate the individual plants as much as possible. Upon identification, individual plants were separated by hand and placed in piles. Once the entire sample was separated according to genus/species, the genus/species samples were placed in either small, medium, or large brown paper bags labeled with a permanent marker.

Chara and *Nitella* were often intertwined and difficult to separate and/or identify, so these macro-algae were lumped together as a subsample.

After sorting and bagging, the paper bags containing the samples were left open and allowed to air dry in the IDEQ mobile laboratory. This location was chosen because of space constraints and because the warm environment would accelerate drying. After one day it was found that the larger samples were not drying quickly, leading to possible mold growth. To accelerate drying, these large samples were spread out in clean plastic trays and turned by hand daily. The samples were dried for seven days and submitted to Silver Valley Laboratories (SVL, Coeur d'Alene) in brown paper bags secured with one standard staple. All subsample bags were recorded on a chain-of-custody form which was kept on file at SVL and IDEQ.

Laboratory Analysis

SVL used a modification of SM10400-D-3-a to determine dry weight biomass. The air dried plant samples in paper bags were dried in a forced-air oven at 105 °C for 20 to 24 hours. The samples were cooled in a desiccator and weighed.

Quality Assurance and Quality Control

Prior to weighing plant samples, four bags of each size (small, medium, large) were submitted to SVL for determination of initial dry weight and oven dried weight. Comparison of weights from the bag groups was used to assess the variability in bag weight (Table 1). This variability is described as the relative standard deviation (RSD),

$$RSD = \frac{\sqrt{\frac{1}{N-1}\sum_{i=1}^{N}\left(x_i - \bar{x}\right)^2}}{\bar{x}}$$

where $\{x_1, x_2, \ldots x_N\}$ are the measured weights of the bags, $\bar{x}$ is the mean value of the weights, and N is the number of bag weights. The mean oven dry weight of the appropriate bag size (Table 1) was used as tare for subtraction from the oven dried plant subsamples.

Table 1. Measured weights, mean weights, and relative standard deviations of selected paper bags used in this study.

Size	Initial Weight (g)	Dry Weight (g)
Small	11.3	10.6
	11.4	10.6
	10.3	10.5
	11.4	10.6
Mean	*11.1*	*10.6*
RSD	*4.8%*	*0.5%*
Medium	36.2	33.8
	36.2	33.8
	36.2	33.8
	35.7	33.6
Mean	*36.1*	*33.9*
RSD	*0.7%*	*0.3%*
Large	63.9	59.0
	65.8	60.3
	63.2	58.0
	64.4	59.3
Mean	*64.3*	*59.3*
RSD	*1.7%*	*2.0%*

During the lab process of oven drying the bagged plant subsamples, 10% of the subsamples were re-dried, cooled, and reweighed to test the precision of the drying and weighing process (Table 2). The comparison of the initial and duplicate weights are represented by the relative percent difference (RPD),

$$RPD = \left| \frac{(original \quad result - duplicate \quad result)}{(original \quad result + duplicate \quad result)/2} \times 100\% \right|$$

The acceptable RPD limit set by SVL is 10%, and all duplicate results fell well below that limit.

Table 2. Selected sample weights, duplicate weights, and relative percent differences.

Duplicate Result (g)	Sample Result (g)	RPD (%)
117.6	116.9	0.6
193.4	194.3	0.5
215.2	215.6	0.2
55.12	55.24	0.2
80.36	81.40	1.3
82.78	84.33	1.9

Digital Video

To gain a better qualitative understanding of the macrophyte community structure, one diver was equipped with a JVC HD Everio underwater video camera (Model GZ-HD320). Once the transect was in place, the diver videoed the length of the transect before the other divers collected samples. This activity qualitatively illustrated the diversity and density of submerged macrophytes.

Results

Plant Community Structure – Grid Method

In total, 35 grid points were sampled with rake tosses. For one point, data were erroneously not recorded. Point depths ranged from 3-34 ft. The deepest depth where plants were found was 26 ft. There were 28 points 26 ft and shallower, and at 3 of these depths, plants were absent. In at least one case, plants were absent because of a rocky substrate. Six points ranged from 27-34 ft with no plants found.

Routine LMP water quality sampling was conducted in Rockford Bay for 2010 (Figure 2), with a station depth of 10.2 m (33 ft). On June 9, the 1% light level (Photosynthetically Active Radiation, or PAR) was recorded at 23 ft, while on July 20 and August 20, PAR near the bottom was slightly greater than 1%. Thus, light could be a growth limiting factor beyond approximately 26 ft. Also, for plants sampled between 3-6 ft in summer months, these are areas where lake sediments are not underwater during winter months because of lake draw-down.

In Rockford Bay, at least 11 genus/species of rooted aquatic macrophytes were identified (Table 3). This number may be slightly higher given that some of these categories included genus groups such as undifferentiated thin-leafed pondweeds (*Potamogeton* sp.), and possible multiple species of *Elodea*. In addition, 2 macro-algae were identified: *Chara* sp. and *Nitella* sp. In two sampling locations, filamentous algae were noted. Eurasian watermilfoil (*Myriophyllum spicatum*) was not found in any samples.

Generally, species diversity decreased with increasing depth with the most genus/species groups occurring in depths between 3 and 5 ft. The most genus/species positively identified in a sample was 9 (at 3.2 ft). For one site at 10 ft, 6 genus/species were identified. Beyond 10 ft depth, no more than 5 genus/species were collected. A complete listing of point-intercept presence/ absence results is presented in Table A1.

Table 3. Genus/species codes and names for the vegetation identified in Rockford Bay rake tosses.

Species Code	Full Species Name (Common Name)
Cha	*Chara* species (muskgrass, macro-algae)
Csp?[a]	*Callitriche* species (starwort)
Esp	*Elodea* species (water weed)
Iso?[a]	*Isotes* species (quillworts)
Nit	*Nitella* species (brittlewart, macro-algae)
PA	*Potamogeton amplifolius* (big-leaf pondweed)
PE	*Potamogeton epihydrous* (ribbon-leaf pondweed)
PP	*Potamogeton praelongis* (white-stemmed pondweed)
PRi	*Potamogeton richardsonii* (Richardson's pondweed)
Psp	*Potamogeton* species (thin-leafed pondweeds)
PZ[b]	*Potamogeton zosterformis* (flat-stemmed pondweed)
RA	*Ranunculus aquatilis* (white water buttercup)
Ssp?[a]	*Sagitaria* species (arrowhead)
FA	Filamentous algae

?[a] = genera where identification is uncertain at this point
b = PZ in rake tosses may be same as PF (*Potamogeton friesii*) identified within qudrats

Dominant Species in Rake Tosses

Elodea sp. was the most common plant group identified in Rockford Bay. It was present in 23 point-intercept samples, and clearly the dominant species group in 6 of those samples (Table A1). Undifferentiated thin-leafed pondweeds, *Potamogeton* sp., were present in 17 point-intercept samples and dominant in 5. In 96% of the samples where thin-leafed pondweeds were identified, *Elodea* sp. was also present in the sample.

The macro-algae *Chara* and *Nitella* were present in 11 and 12 of the point-intercept samples, respectively. They were equally dominant at one point-intercept location, ROCK 006, at a depth of 5 ft. Two other plants were commonly present, *Potamogeton richardsonii* (n = 11 samples), and *Ranunculus aquatilis* (n = 9 samples). Surprisingly, *Potamogeton robbinsii* (fern-leafed pondweed) was not collected in rake tosses, or transect quadrats. This is a fairly common plant in north Idaho lakes including Coeur d'Alene Lake (Tribe, 2006). Examination of the underwater video coverage did however clearly show pockets of fern-leafed pondweed within Rockford Bay.

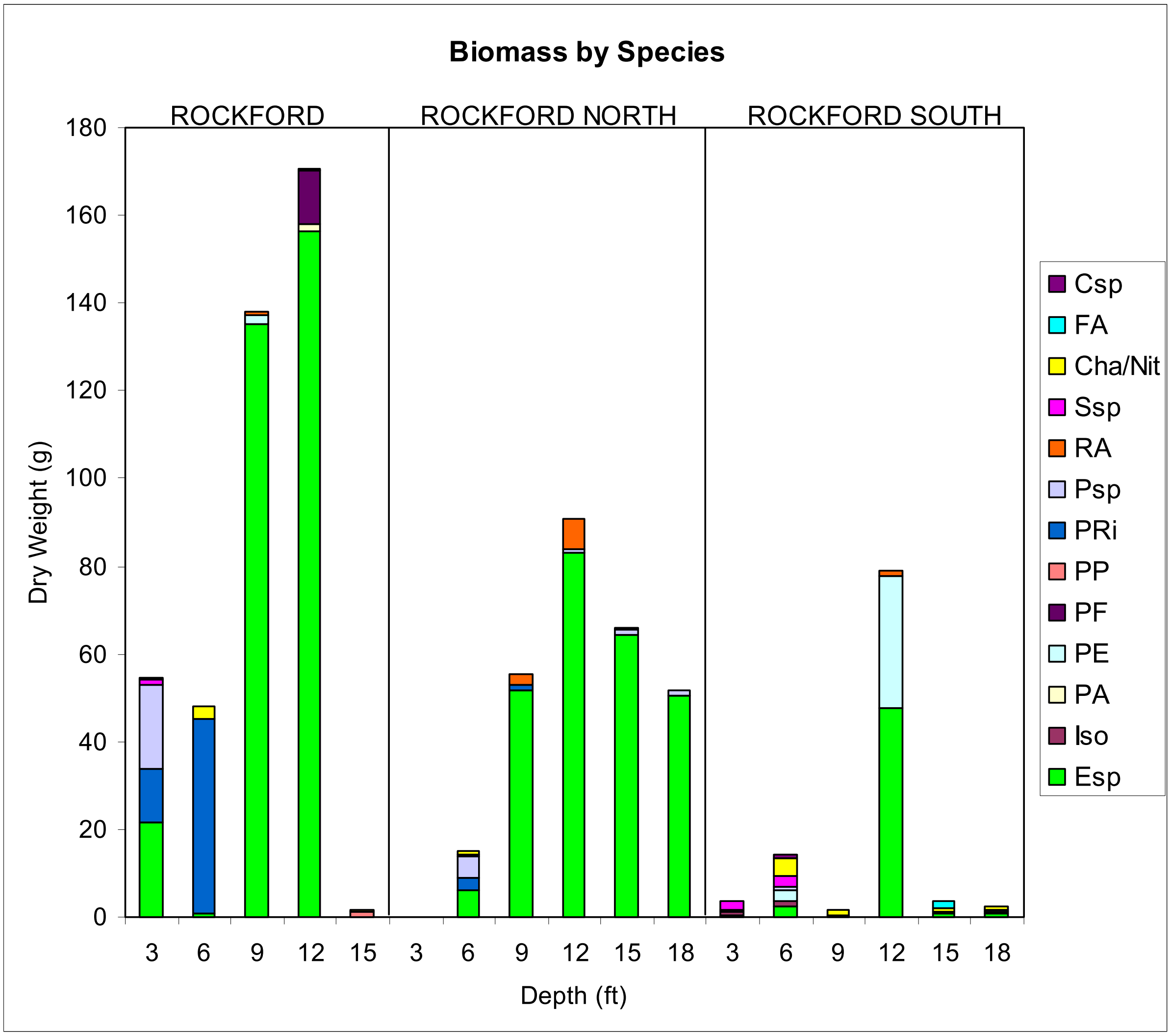

Figure 5. Dry weight biomass of species in 0.21 m^2 quadrats used in Rockford Bay transects.

Biomass Results in Quadrats

A total of seventeen 0.21 m^2 quadrats were sampled, and one sample, ROCKFORD NORTH 3 ft, had no plants (Table 5). *Elodea* sp. was present in 15 out of 17 transect samples and had the highest oven dried weight in 10 of those samples (Figure 5). Of the 17 transect samples, 8 had thin-leafed pondweeds present, however, Psp was never the dominant plant group in a sample. PRi had the most biomass in one transect sample: ROCKFORD 6ft. *Sagitaria* sp. (with ID uncertain at this point) was the dominant plant by biomass at ROCKFORD SOUTH 3ft.

The macro-algae *Chara* sp. and *Nitella* sp. were present in 8 transect points and represented 73% of the biomass at one location, ROCKFORD SOUTH 9ft. These macro-algae were the dominant species (31%) at ROCKFORD SOUTH 6ft. One sample, ROCKFORD SOUTH 15ft, had a dominance of filamentous algae, however all other samples were practically absent of filamentous algae.

The sample with the highest biomass was at ROCKFORD 12 ft with 816.9 g/m^2. The lowest biomass with plants present was at ROCKFORD 15 ft with 8.5 g/m^2. The mid-bay transect (ROCKFORD) had the highest total biomass followed by ROCKFORD NORTH on the south-facing slope of the bay. In all transects, the sample with the highest biomass was at 12 ft and generally decreased with both increasing and decreasing depth (Figure 6). Biomass results for all quadrats sampled are presented in Table A2.

For the total set of quadrats, mean biomass was 224.3 g/m^2 with a high standard deviation of 242.7 g/m^2 (n = 17).

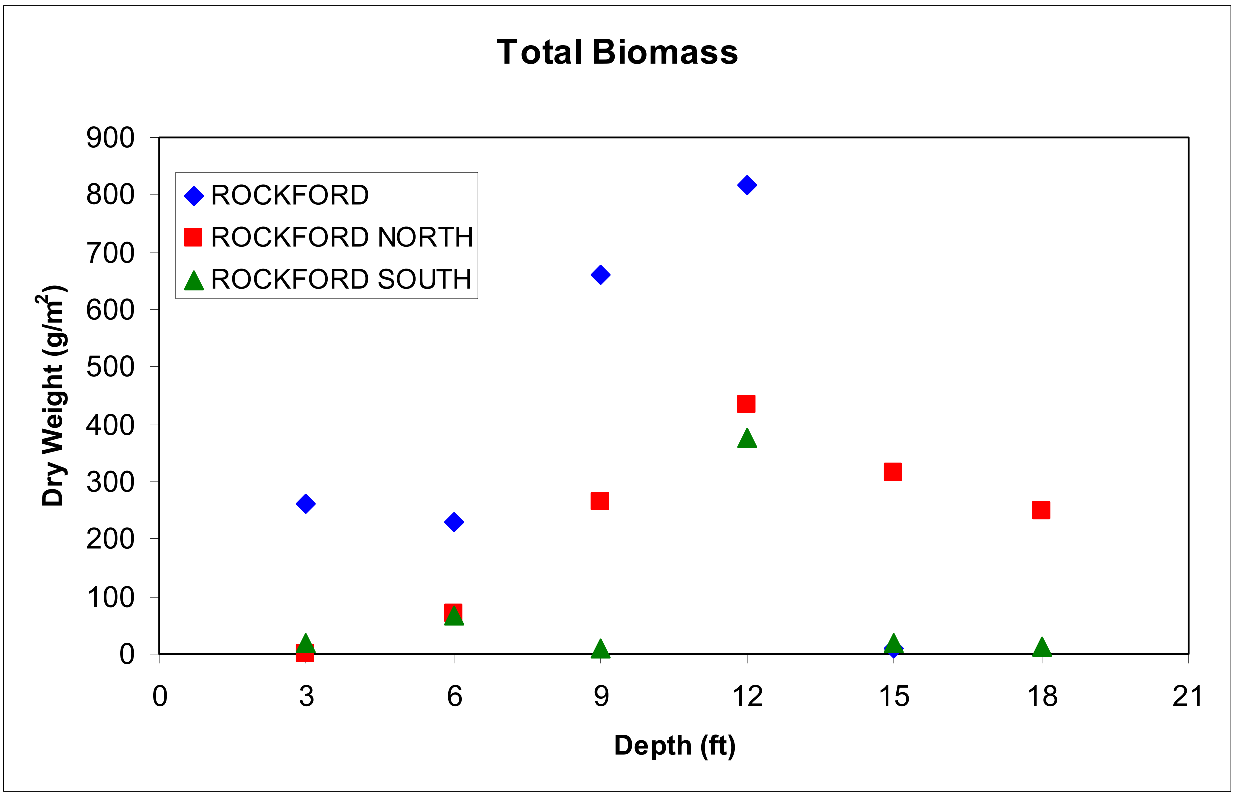

Figure 6. Total dry weight biomass for Rockford Bay transect samples.

Discussion

Grid Results Versus Transect Results

There was a slight difference in the species present in the rake-toss (grid) results versus the transect results. There are several explanations that may account for this discrepancy. Firstly, the samples themselves may have been misidentified. For example, it appears that the same plant species was identified as *Potamogeton fresii* (PF) in the quadrat collection method (with distinct winter buds present), and *Potamogeton zosterformis* (PZ) in the grid-collection method (no apparent winter buds). Secondly, spacing of the teeth in the rakes used to collect samples may have permitted thin-leaved or immature plants to pass through the rake itself. Thirdly, the collection of transect samples created dense plumes of sediment making it difficult to see smaller plants in the quadrat. Although the differences in the species represented in the two sample collection methods were slight, these sources of error must be taken into consideration.

Emergent Macrophytes

Summer pool elevation is 2128 ft above sea level from approximately Memorial Day to Labor Day, and during the winter months it is slowly lowered approximately 7-8 ft at the Post Falls dam. Given these fluctuations in lake level, much of Rockford Bay goes through a seasonal drying period which may evidence itself in the presence of emergent macrophytes such as *Sagitaria* sp. at depths up to 8 ft.

Comparisons to Other Studies

Results from the 2005 *Baseline Coeur d'Alene Lake Aquatic Vegetation Survey* conducted by the Coeur d'Alene Tribe indicated that the highest biomass of a genus/species in Rockford Bay was from an Esp sample collected at 6 ft (115.8 g/m^2) (Tribe, 2006). The highest biomass from a genus/species during the entire study was 331.6 g/m^2 from an Esp sample collected at 9 ft at the southern end of Coeur d'Alene Lake. These data are much lower than the maximum biomass recorded during this 2010 IDEQ study: 748.2 g/m^2 from an Esp sample at 12 ft (Table A2).

The mean and median biomass produced by Esp in Rockford Bay during the earlier Tribe study was 31.6 and 4.1 g/m^2, respectively (Table 4, considering only samples with Esp present, n=4) (Tribe, 2006). These data are substantially lower than the mean and median Esp biomass in the IDEQ study: 198.6 and 102.7 g/m^2 respectively (only samples with Esp present, n=15). This may indicate that the bay-wide *Elodea* crop was generally less during the September 2005 sampling than the September 2010 sampling. There are two caveats for this comparison however: 1) the Tribe conducted a single transect in Rockford Bay while IDEQ conducted 3 transects, and 2) there were two DEQ samples of dense Esp where Psp was very difficult to separate from this mass, and Esp includes some Psp weight (Table A2).

During the September 2005 sampling, PRi biomass density was also lower than that observed during the 2010 survey (Table 4). The genus/species groups Csp?, PA, PE, PP, and RA were only observed during 2010 and apparently not collected in September 2005; PA and RA were however sampled in 2005 on the northern tip of Rockford Bay. PF, Psp, and Ssp biomass densities were higher during September 2005, and Iso? was approximately the same.

Table 4. Mean and median biomass density (g/m^2) for the IDEQ 2010 study and for the 2005 Coeur d'Alene Tribe study (Tribe, 2006) in Rockford Bay.

	Csp?[a]	**Esp**	**Iso?[a]**	**PA**	**PE**	**PF[b]**	**PP**	**PRi**	**Psp**	**RA**	**Ssp?[a]**	**Cha/ Nit**	**FA**
IDEQ study													
n	1	15	2	1	3	3	1	4	8	6	4	8	1
mean	2.7	198.6	3.4	7.5	55.4	21.0	5.4	72.5	17.3	10.0	7.2	7.3	7.2
median	2.7	102.7	3.4	7.5	12.6	2.7	5.4	35.7	4.4	5.1	8.1	4.0	7.2
Tribe study													
n	0	4	1	0	0	2	0	4	5	0	2	6	0
mean	--	31.6	2.5	--	--	36.7	--	46.4	33.2	--	13.0	8.5	--
median	--	4.1	2.5	--	--	36.7	--	38.0	39.2	--	13.0	8.2	--

?[a] = Csp? (*Callitriche* sp.), Iso? (*Isotes* sp.), and Ssp? (*Sagitaria* sp.) are plants with uncertain ID.
b = PF, *Potamogeton friesii*, was not identified in grid method and may have been the plant identified as PZ, *Potamogeton zosterformis*, in rake tosses.

These patterns may indicate that growing conditions were more favorable for a predominantly PRi-PF-Psp-(Esp) community during the summer of 2005, and current conditions in Rockford Bay favor a more diverse community but one that is dominated by Esp. To assess the degree of variability in these changing conditions, long-term monitoring is necessary.

Furthermore, the mechanisms for these differences are unclear. Future directions of this study will include examining the external drivers on plant growth such as nutrient availability and uptake, climatic conditions, and water clarity.

Eurasian Watermilfoil

The noxious, invasive plant, Eurasian watermilfoil (*Myriophyllum spicatum*) has been found in most of the nearby Idaho and Washington lakes and has indeed been observed and documented in the southern pool of Coeur d'Alene Lake (Tribe, 2006 and 2007). The plant is known to be introduced to uninfested waters by plant fragments often carried on boats and boat trailers. EWM out-competes native species by rapidly forming dense mats which block sunlight from slower-growing and shorter species. This plant presents a significant threat to fish and wildlife habitats and may entangle swimmers.

EWM has been documented and is treated for in Harrison Slough approximately 8 miles southeast of Rockford Bay (Tribe, 2006). We hypothesize that EWM migration will most likely be seen in bays closest to current infestations, near boat ramps, or in areas with heavy motorized boat traffic. During this study we saw no EWM in Rockford Bay. It may be possible that EWM has not migrated into the northern pool of Coeur d'Alene Lake, however further research is necessary to conclude this.

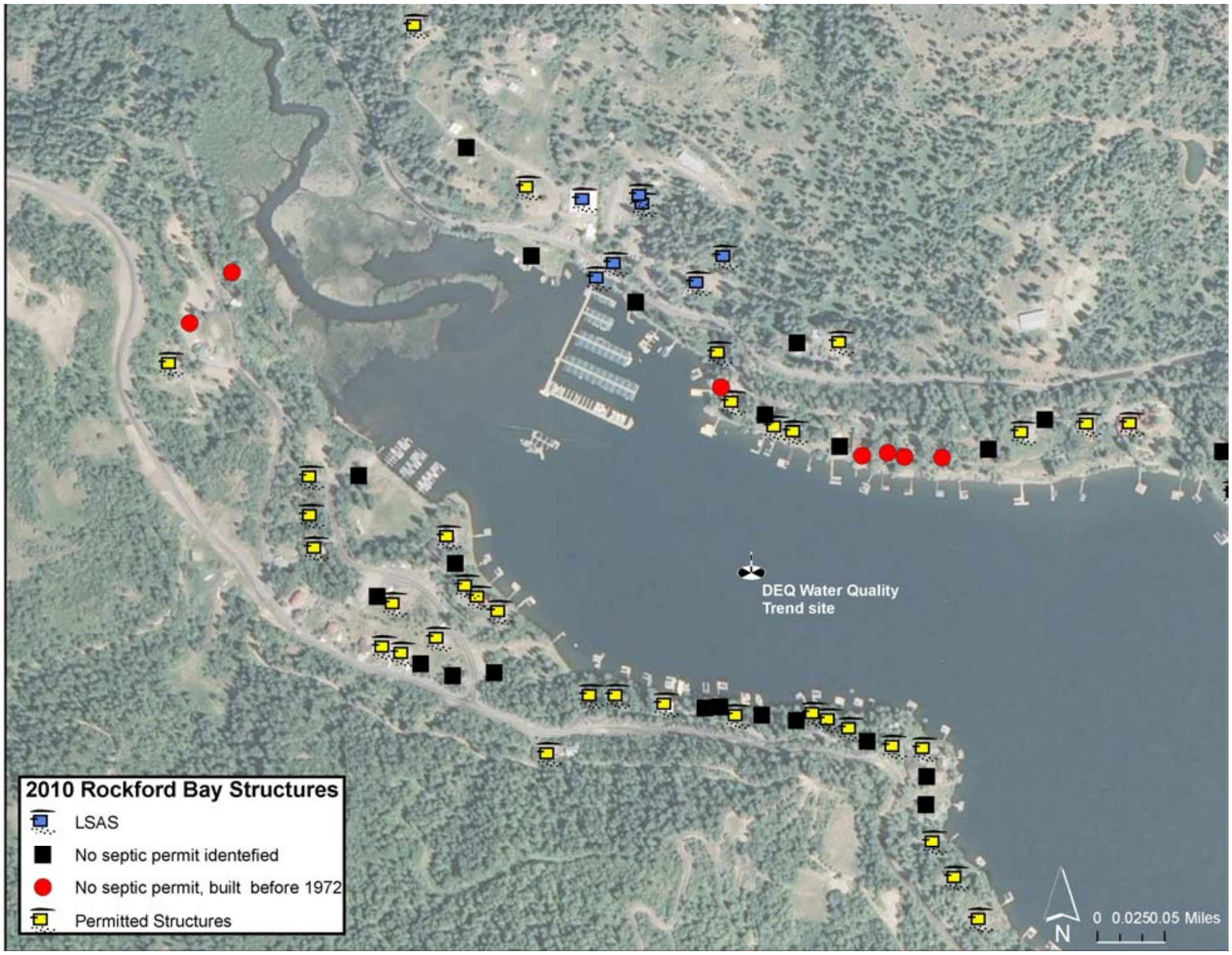

Figure 7. Map of wastewater facilities within Rockford Bay as determined in 2009.

Conclusions and Future Studies

Overall, Rockford Bay appears to have a moderate to high diversity of submerged aquatic macrophytes as shown in this 2010 survey and a previous 2005 study (Tribe, 2006). It appears that specific assemblages of genus/species groups vary from year to year. The biomass represented by genus/species groups varies annually as well. The environmental drivers for this variation are unclear, and more research will elucidate the relationships between internal and external factors and plant community structure. For example, IDEQ will explore the possibility of subsurface wastewater impact within shallow bays. Subsurface wastewater, which is high in nitrate concentration, may stimulate rooted plant growth if it seeps into lake sediments. A joint project by IDEQ, the Tribe, and Panhandle Health District was conducted in 2007-08 to identify and map the various subsurface wastewater systems around the perimeter of Cd'A Lake (Figure 7).

This IDEQ 2010 work was a pilot study to refine sampling techniques and strategies. Further work will incorporate results from other bays, specifically: Windy, Mica, Cave, Loff, Powderhorn, Carlin, and Echo Bays. IDEQ will begin sampling these bays during the summer of

2011 utilizing the point-intercept (rake toss), transect (quadrat), and underwater videography techniques outlined in this document.

Future laboratory work will include biomass assessment and phosphorous and nitrogen quantification of plant species. These data will be used to calculate nutrient storage of aquatic macrophytes in Coeur d'Alene Lake bays.

References

APHA (American Public Health Association). 1995. Standard methods for the examination of water and wastewater. 19th Edition. Washington, D.C.

Breckenridge, R.M., and K.L. Othberg. 1999. Surficial geologic map of the Coeur d'Alene quadrangle, Kootenai County, Idaho. Idaho Geological Survey, Pub I.D. SGM-7, Moscow, ID. 1 pp.

Borman, S., Korth, R., and J. Temte. 1997. Through the looking glass: a field guide to aquatic plants. University of Wisconsin Press, Madison, WI. 256 pp.

Bristow, J.M. and N. Whitcombe. 1971. The role of roots in the nutrition of aquatic vascular plants. American Journal of Botany. 58, 8-13.

Carpenter, S.R. 1980. Enrichment of Lake Wingra, Wisconsin by submersed macrophyte decay. Ecology. 61. 1145-1155.

Gillerman, V.S., and E.H. Bennett. 2009. Idaho mining and exploration, 2008. Idaho Geological Survey, Staff Report 09-5, Moscow, ID. 17 pp.

Jackson, L.J. 1998. Paradigms of metal accumulation in rooted vascular plants. The Science of the Total Environment. 219, 223-231.

Jackson, L.J., Rasmussen, J.B. Peters, R. H., and J. Kalff. 1991. Empirical relationships between the element composition of aquatic macrophytes and their underlying sediments. Biogeochemistry. 12, 71-86.

Jackson, L.J., Rasmussen J.B., and J. Kalff. 1994b. A mass-balance analysis of trace metals in two weedbeds. Water, air and Soil Pollution. 75, 107-119.

Madsen, J.D. 1999. Point intercept and line intercept methods for aquatic plant management. Aquatic Plant Control Technical Notes Collection (TN APCRP-M1-02). U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Tribe (Coeur d'Alene Tribe). 2006. Project completion report for the baseline Coeur d'Alene Lake aquatic vegetation survey. Prepared for Avista Utilities by the Coeur d'Alene Tribe Lake Management Department, Plummer, ID. 71 pp.

Tribe (Coeur d'Alene Tribe). 2007. Project completion report for the Lower Lakes aquatic vegetation survey project. Prepared for the Basin Environmental Improvement Project Commission by the Coeur d'Alene Tribe Lake Management Department, Plummer, ID. 90 pp.

USEPA (U.S. Environmental Protection Agency). 1977. Report on Coeur d'Alene Lake, Benewah and Kootenai Counties, Idaho. National Eutrophication Survey Working Paper No. 778, Washington, DC. 20 pp.

Washington State Department of Ecology. 2001. An aquatic plant identification manual. Publication 01-10-032. 195 pp.

Woods, P.A., and M.A. Beckwith. 1997. Nutrient and trace element enrichment of Coeur d'Alene Lake, Idaho. U.S. Geological Survey Water Supply Paper 2485, Boise, ID. 93 pp.

Wood, M.S. and M.A. Beckwith. 2008. Coeur d'Alene Lake, Idaho: insights gained from limnological studies of 1991-92 and 2004-06. U.S. Geological Survey, Scientific Report 2008-5168, Boise, ID. 40 pp.

Appendix A

Field Data from the Point-Intercept and Transect Quadrat Sampling Methods

(page intentionally left blank)

Table A1. Presence/absence of rooted aquatic plants identified in rake tosses for the point intercept method in Rockford Bay, 2010

		Genus/Species Codes – see Table 3 for plant names														
Point ID	**Depth (ft)**	**Cha**	**Csp?[a]**	**Esp**	**Iso?[a]**	**Nit**	**PA**	**PE**	**PP**	**PRi**	**Psp**	**PZ**	**RA**	**Ssp[a]?**	**FA**	**Notes**
ROCK 001	3.2	P	P	P	P	P				P	P		P	P		
ROCK 002	6.5	P		P						P						
ROCK 003	9.2	P		P						P	P					
ROCK 004	11.7	P		P						P			P		P	
ROCK 005	3	P	P	**X**	P	P				P	**X**					
ROCK 006	5	**X**	P		P	**X**				P	P					
ROCK 007	8			**X**				P				P				
ROCK 008	3		P	P	P					P	P			P		
ROCK 009	4		P	P	P	P					P		P	P		
ROCK 010	5-6			P							**X**			P		
ROCK 011	5-6			**X**							**X**					
ROCK 012	nd	--	--	--	--	--	--	--	--	--	--	--	--	--	--	sampled but not recorded?
ROCK 013	5	P		P		P		P		P	P			P		
ROCK 014	5	P		P						P	**X**			P		
ROCK 015	13			P		P				P	P	P				
ROCK 016	18			P							**X**	P				
ROCK 017	24			P		P										Sparse
ROCK 018	15			**X**		P					P					
ROCK 019	18			P		P							P			
ROCK 020	9	P		P		P		P					P		P	
ROCK 021	19	P							**X**							
ROCK 022	24															No plants present
ROCK 023	27															No plants present
ROCK 024	32															No plants present
ROCK 025	34															No plants present

Table A1 - continued

Point ID	Depth (ft)	Cha	Csp?[a]	Esp	Iso?[a]	Nit	PA	PE	PP	PRi	Psp	PZ	RA	Ssp[a]?	FA	Notes
ROCK 026	26			**X**						P	P		P			
ROCK 027	10	P		P							P		**X**			
ROCK 028	15			**X**							P		P			
ROCK 029	10			P		P	P	P			P		P			
ROCK 030	23															No plants present
ROCK 031	30															No plants present
ROCK 032	23			P		P										
ROCK 033	29															No plants present
ROCK 034	30															No plants present
ROCK 035	20															No plants present--rocky
Genus/Species Summary																
	Depth (ft)	**Cha**	**Csp?[a]**	**Esp**	**Iso?[a]**	**Nit**	**PA**	**PE**	**PP**	**PRi**	**Psp**	**PZ**	**RA**	**Ssp[a]?**	**FA**	Notes
Presence Count		11	5	23	5	12	1	4	1	11	17	3	9	6	2	
Dominant Count		1	0	6	0	1	0	0	1	0	5	0	1	0	0	

Genus/Species Codes – see Table 3 for plant names

?[a] = Csp? (*Callitriche* sp.), Iso? (*Isotes* sp.), and Ssp? (*Sagitaria* sp.) are plants with uncertain identification at this point
P = Present by rake toss method
X = Dominant plant by rake toss method

Table A2. Dry weight biomass (g/m^2) of rooted aquatic plants collected within 0.21 m^2 quadrats along 3 transects in Rockford Bay, September 2010

Genus/Species Codes – see Table 3 for plant names															
Transect identifier	**Depth (ft)**	**Csp?**	**Cha/Nit**	**Esp**	**FA**	**Iso?**	**PA**	**PE**	**PF**	**PP**	**PRi**	**Psp**	**RA**	**Ssp?**	**Total (g/m^2)**
ROCKFORD	3	--	3.0	102.7	--	--	--	--	--	--	58.7	91.6	--	5.8	261.8
	6	--	13.9	3.2	--	--	--	--	--	--	213.0	--	--	--	230.1
	9	--	--	646.4[a]	--	--	--	9.9	--	--	--	--	3.6	--	659.9
	12	--	--	748.3	--	--	7.5	--	58.1	--	--	--	3.0	--	816.9
	15	--	3.0	--	--	--	--	--	--	5.4	--	--	--	--	8.4
ROCKFORD NORTH	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	6	--	3.3	29.6	--	--	--	--	--	--	12.6	23.6	--	2.5	71.7
	9	--	--	248.4	--	--	--	--	--	--	5.6	--	11.2	--	265.2
	12	--	--	397.7	--	--	--	--	--	--	--	3.4	32.7	--	433.7
	15	--	--	308.5	--	--	--	--	--	--	--	4.4	3.0	--	315.9
	18	--	--	241.9[a]	--	--	--	--	--	--	--	6.3	--	--	248.1
ROCKFORD SOUTH	3	--	--	2.8	--	2.5	--	--	--	--	--	2.8	--	10.2	18.4
	6	2.7	21.1	12.4	--	4.2	--	12.6	--	--	--	4.5	--	10.2	67.7
	9	--	6.3	2.3	--	--	--	--	--	--	--	--	--	--	8.6
	12	--	--	227.9	--	--	--	143.7	--	--	--	--	6.5	--	378.0
	15	--	4.6	3.4	7.2	--	--	--	2.3	--	--	--	--	--	17.6
	18	--	2.7	3.6	--	--	--	--	2.7	--	--	2.2	--	--	11.2

a = samples where Psp was very difficult to separate from dense Esp. Weight of Esp may include some Psp.