Hayden Lake Water Quality Report – 2006

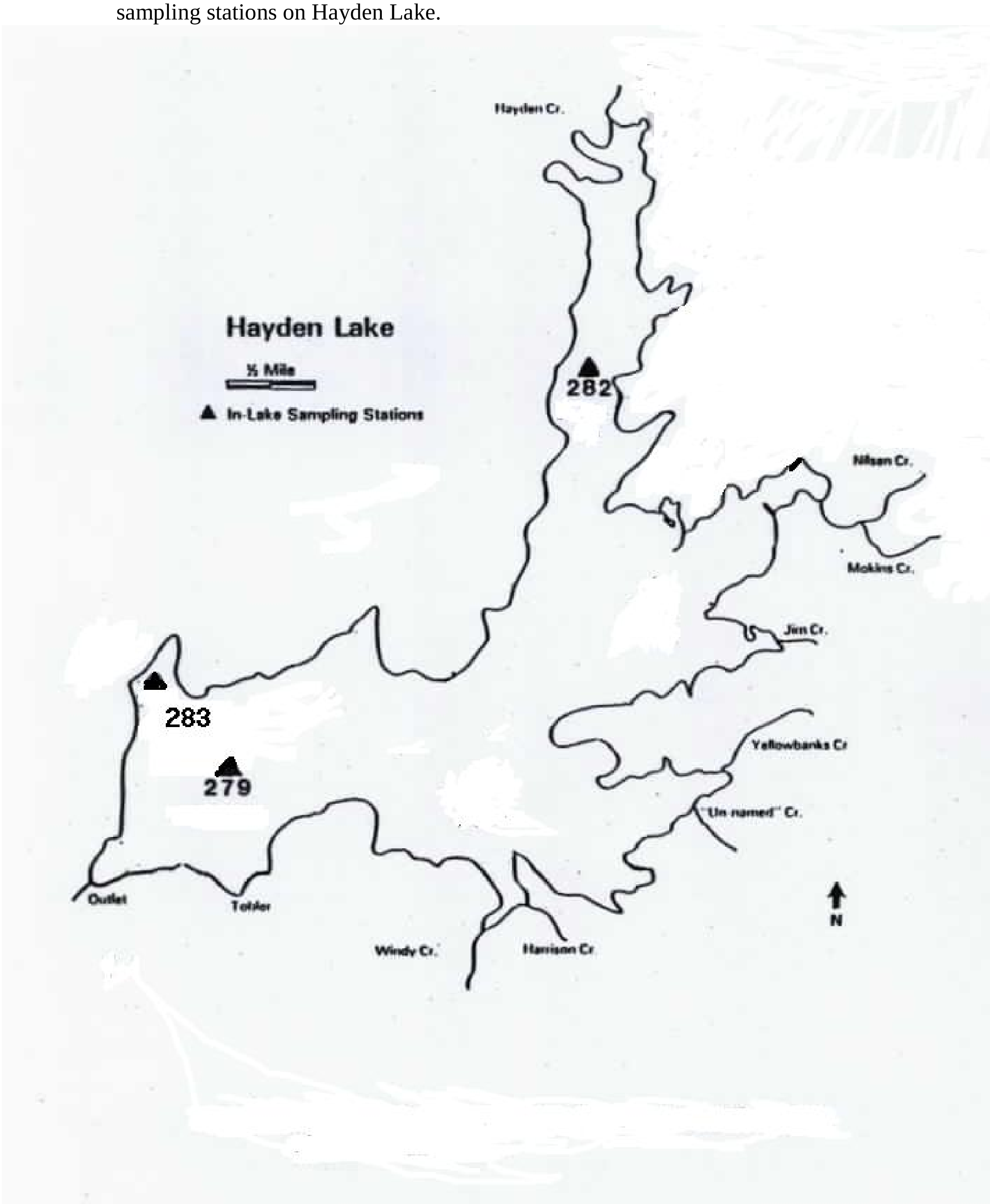
Summary: Based on Mid-Lake, Berven Bay and Northern Arm sampling stations the water quality of Hayden Lake remains good. Lake clarity, total phosphorous, chlorophyll, and dissolved oxygen measurements provided values in the range of high water quality. However, clarity decreased by about 3 feet and total phosphorous has increased slightly from values measured in 2005. Total phosphorous remains above the goal of the Hayden Lake Management Plan and federally required levels determined to fully protect Hayden Lake's water quality. Dissolved oxygen concentrations were well in excess of the minimum allowed by Idaho standards at all locations and strata of the lake. The Forest Service and DEQ were working jointly to measure the amount of phosphorous entering the lake from its primary tributary, Hayden Creek. However, DEQ budget constraints have stopped the collection of the data necessary to make phosphorous load calculations. For the second year, the methodology for continuous real-time chlorophyll florescence data was perfected along transects between the open lake and selected bays. As these measurements are made in subsequent years and compared, a more sensitive measure of the overall health of the lake should emerge. Assessment of the vertical distribution of chlorophyll in the lake's water column has demonstrated the usefulness of chlorophyll florescence data collection along transects during April.

Introduction: Annual assessment of Hayden Lake's water quality is based on three separate approaches. The water quality is assessed at three stations on the lake: Mid-Lake (279), Berven Bay (283), and the Northern Arm's deep area (282) (Figure 1). Water quality is assessed at these stations based on four measurements. Clarity is the depth to which a fixed object can be seen in the water column. Total phosphorous is the key plant growth nutrient that can cause algae to multiply in the water column. Chlorophyll is a measure of the relative amount of algae growing in the water column. Dissolved oxygen is required by fish and other aquatic life to survive. An increase in phosphorous can cause increasing algae growth, resulting in reduction of the clarity of the water. Dissolved oxygen concentration declines as the algae decay. The second approach is the measurement of the load of total phosphorous entering the lake through its primary tributary, Hayden Creek. The final approach is to assess the key indicator of algae growth (chlorophyll) across transects from the open mid-lake waters into key bays where algal growth is known to occur naturally at higher levels. The change in the chlorophyll concentrations over the years and the nature of that change is the most sensitive measure of the lake's health.

Techniques: Water quality data were collected at the three stations six times during the period from late April to early October. Physical measurements (clarity, temperature dissolved oxygen as well as chlorophyll florescence vertically in the water column) were completed on site, while samples from the upper water column (upper 45 feet) were collected and integrated for chemical analysis of total phosphorous and chlorophyll. The Forest Service measured the discharge of water into the lake from Hayden Creek at a stream gage located near Forest Road 206 Bridge. The DEQ did not measured total phosphorous at a nearby gage, due to budget constraints. The total phosphorous load entering the lake from its largest tributary could have been calculated in pounds per unit time from these data, but the failure to collect phosphorous data has precluded development of this information. The level of chlorophyll was measured in real time based on fluorescence of chlorophyll during mid-

September, during the period when the water column of the lake is most stable. Transect measurements were recorded between the mid-lake area and the upper end of the northern arm (Sportsman's Access), from the mid-lake into Berven Bay and from mid-lake into Windy Bay. All measurements were linked to global position for the most exact comparison to subsequent transects collected in the coming years.

Figure 1: Approximate locations of Mid-Lake (279), Berven Bay (283) and Northern Arm (282) water quality sampling stations on Hayden Lake.



Note: Adapted from Soltero et.al. 1986. Water Quality Assessment of Hayden Lake, Idaho. Eastern Washington University, Department of Biology, Cheney WA 99004. p.10.

2006 Results:

Lake Stations:

The average, maximum and minimum values for clarity, total phosphorous, chlorophyll and dissolved oxygen for the three stations are provided in Table 1.

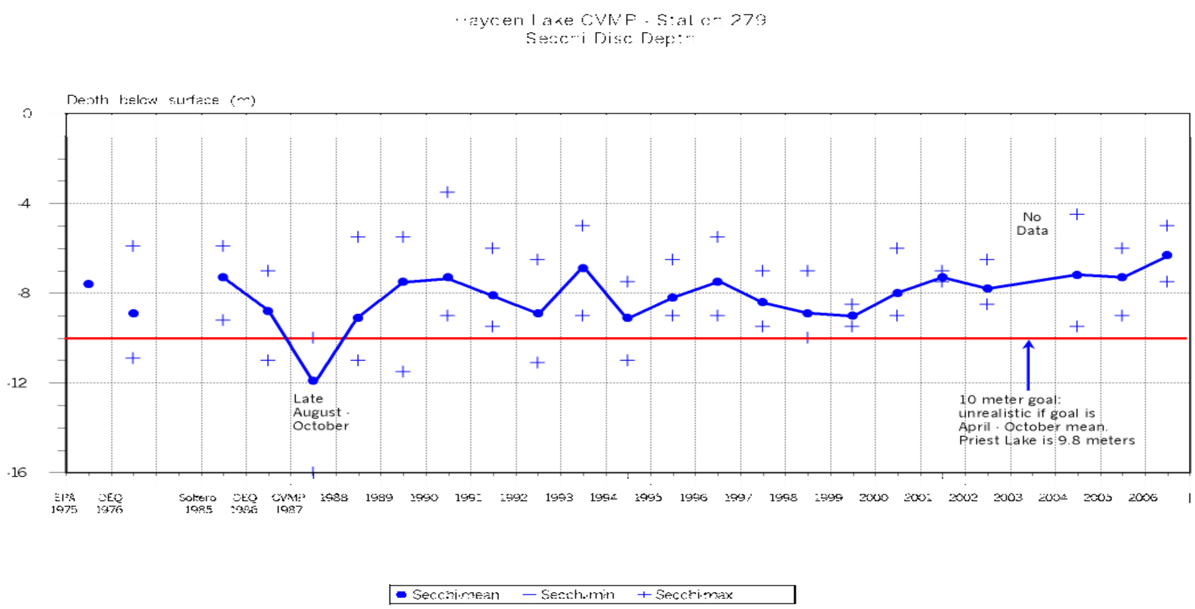
Table 1: Average, maximum and minimum clarity, total phosphorous, chlorophyll a and dissolved oxygen for the Mid-Lake, Berven Bay and Northern Arm Stations of Hayden Lake.

Water Quality Parameter	Mid-Lake (279)			Berven Bay (283)			Northern Arm (282)		
	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min
Clarity (feet)	20.7	24.6	16.4	20.3	26.2	13.1	20.7	23.0	18.0
Total Phosphorous (ug/L)	7.6	9.0	6.0	6.4	8.0	5.0	7.4	9.0	6.0
Chlorophyll a (ug/L)	1.5	2.3	0.5	1.4	1.9	0.5	1.7	2.0	1.0
Dissolved Oxygen (upper column) (mg/L)	9.6	11.7	8.5	9.4	11.3	8.5	9.4	11.4	8.4
Dissolved Oxygen (lower column) (mg/L)	9.9	11.1	8.5	11.8*	13.0*	8.7*	10.5	12.4	7.0

Note: ug/L – micrograms per liter of water or parts per billion; mg/L – milligrams per liter of water or parts per million; * - near bottom, because station too shallow for stratified upper, warm water and lower cold water.

The averages for the three key measurements, clarity, total phosphorous and chlorophyll for the mid –lake station are plotted with averages from previous years in figures 2 – 4.

Figure 2: Average, maximum and minimum clarity measured as Secchi depth in meters from 1985 to 2006.



Note: 1 meter equals 3.28 feet.

Figure 3: Average, maximum and minimum total phosphorous measured as micrograms per liter (parts per billion) from 1985 to 2006.

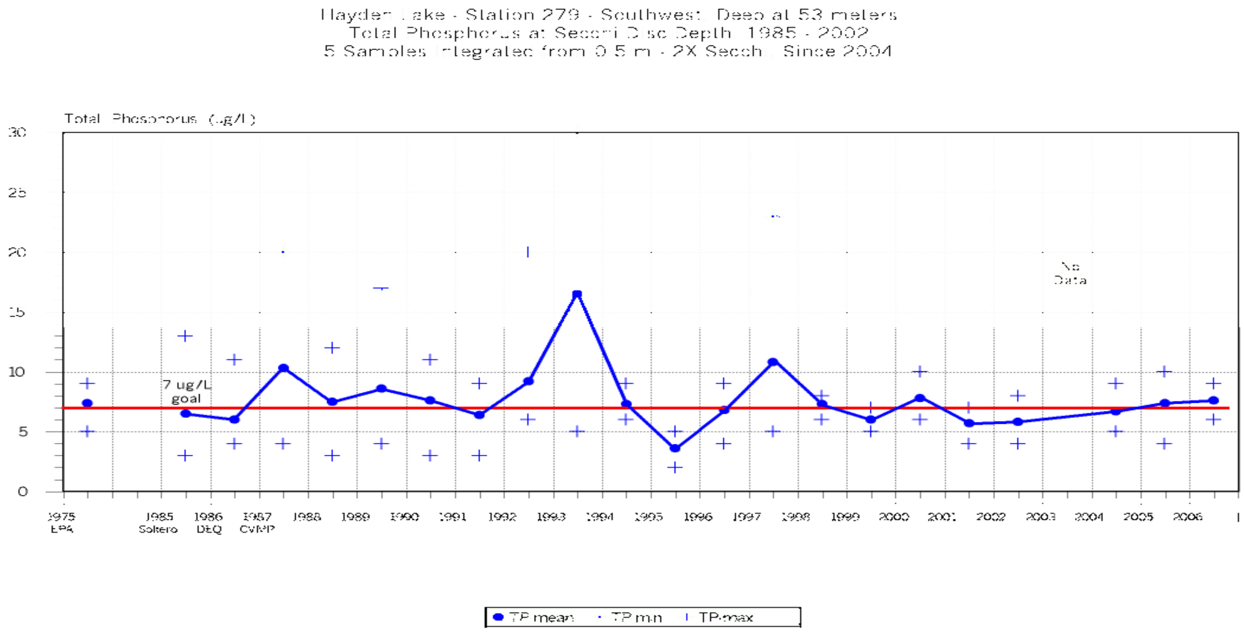
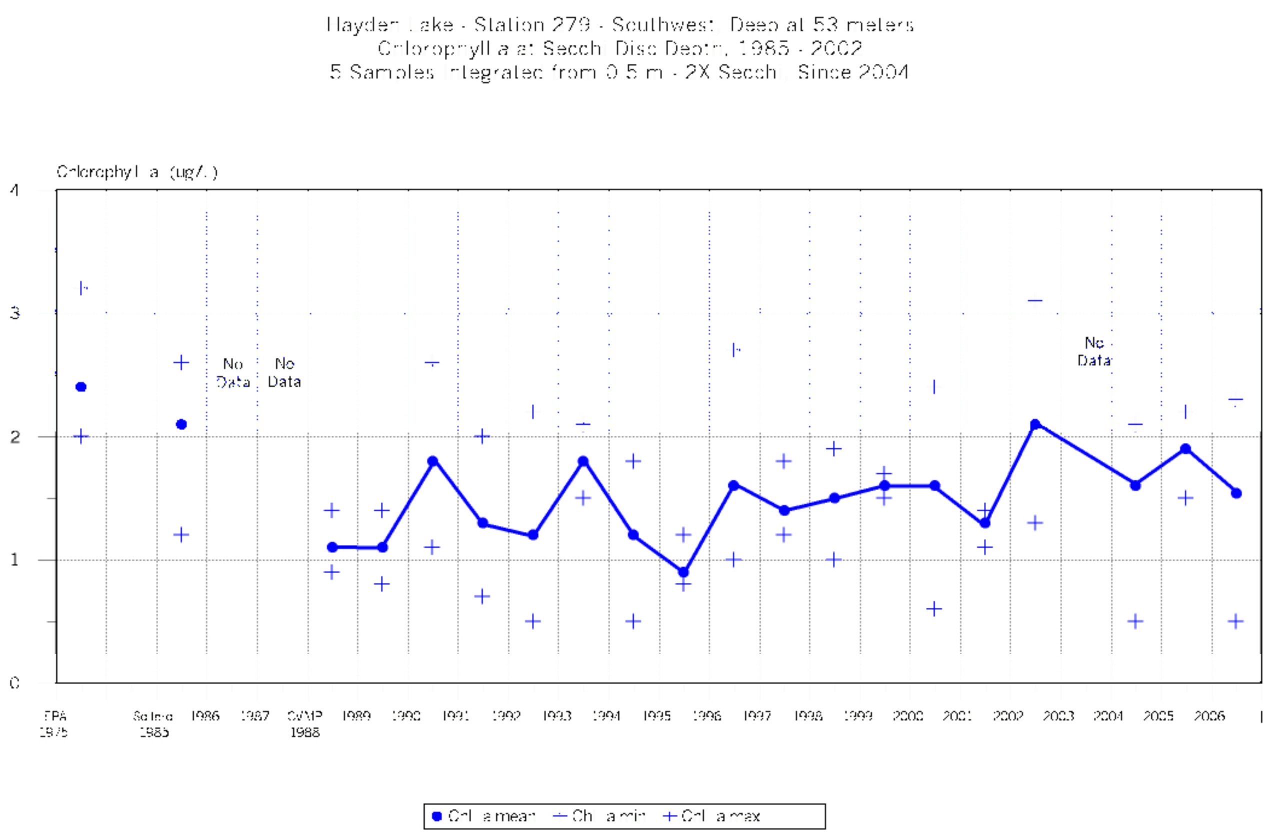


Figure 4: Average, maximum and minimum chlorophyll a measured as micrograms per liter (parts per billion) from 1985 to 2006.



Hayden Creek Phosphorous Loading:

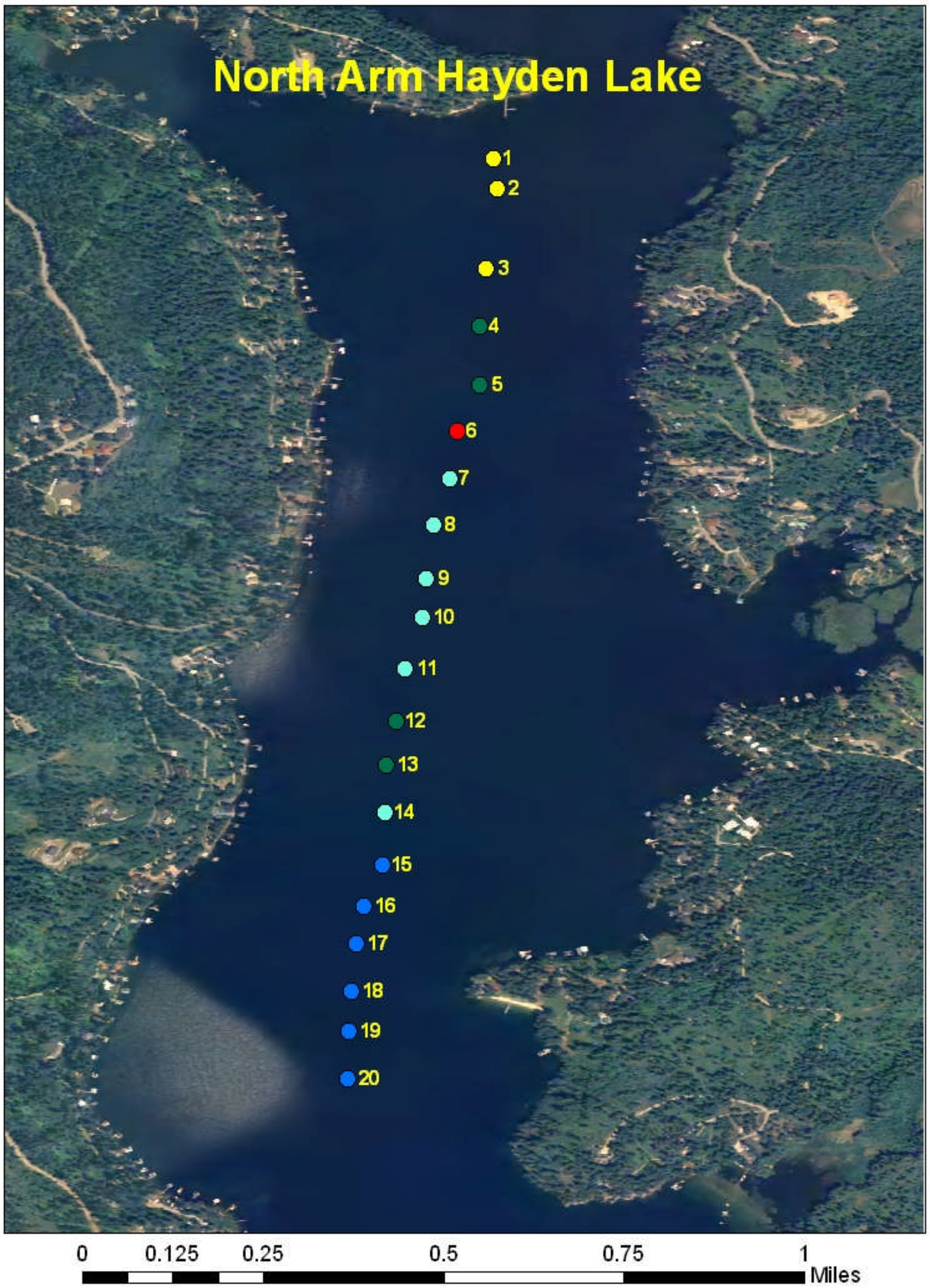
Data on discharge and phosphorous content of Hayden Creek were collected by the Forest Service and DEQ from spring 2005 to fall 2005. These data have not been compiled nor have phosphorous loads to the lake been calculated. Although the Forest Service has continued to collect stream discharge data during 2006, DEQ has not collected total phosphorous samples due to budget limitations. Without the total phosphorous data the phosphorous load entering Hayden Lake from its largest tributary cannot be calculated.

Chlorophyll Florescence Transects:

During late August and September, the water column of the lake is stratified between warm water on the surface and cold water at depth. During this period precipitation is at a minimum and for this reason, discharge into the lake is at a low point. Weather is typically warm, calm and stable. The result of these conditions is a stable water column in the lake, allowing the most repeatable results from year to year as possible. During this period (September 14th), transects were made from near Sportsman's Access down the northern arm to the mid-lake area off Chicken Point, from Berven Bay to the mid-lake area off Berven Bay, and from Windy Bay to the mid-lake area off Windy Point. Along these transects, the relative fluorescence of chlorophyll was measured in real time and the data was linked to the global position at which it was collected. It is expected that chlorophyll concentration, as measured as its fluorescence property will increase in more nutrient rich areas of the lake. A gradient of chlorophyll florescence was found as expected across the northern arm of Hayden Lake (Figure 5). Points in red and yellow have the highest fluorescence signal, while those in green and light blue have a moderate signal and those in dark blue the lowest signal and therefore the lowest relative chlorophyll concentrations. Only low chlorophyll florescence signals (blue) were detected through the Berven and Windy Bays transects.

Chlorophyll fluorescence transects were collected during September 2005 for Berven Bay and the northern arm. These data were collected with the same technique and were geo-referenced with a global positioning unit. Although the measurements were collected at more frequent intervals, geo-referencing permits their direct comparison to the September 2006 transects. Global Information System (GIS) support from DEQ to process this data is well behind other priorities. Similar transect data collected over the years could indicate any changing condition in the lake for better or for worse as it develops. These data would allow for a timely response to deteriorating water quality conditions.

Figure 5: Chlorophyll fluorescence of the water column at individual locations on a transect between the Sportsman's Access Bay and mid-lake area off Chicken Point.



Chlorophyll Concentration Dynamics in the Water Column:

Chlorophyll fluorescence was collected through the vertical water column at each lake station during each sampling event. Although fluorescence provides relative data, the chlorophyll and therefore the algae distribution in the water column are revealed by these data. The distribution of chlorophyll in the water column on a specific date and location is demonstrated by Figure 6. The chlorophyll abundance peaks at 13 meters in the water column. The depth of maximum chlorophyll concentration for this station is charted by the date between Late April and early October in Figure 7. Chlorophyll maximum sinks in the water column as the year progresses.

Figure 6: Distribution of chlorophyll in the water column at station 279 on May 26 2006.

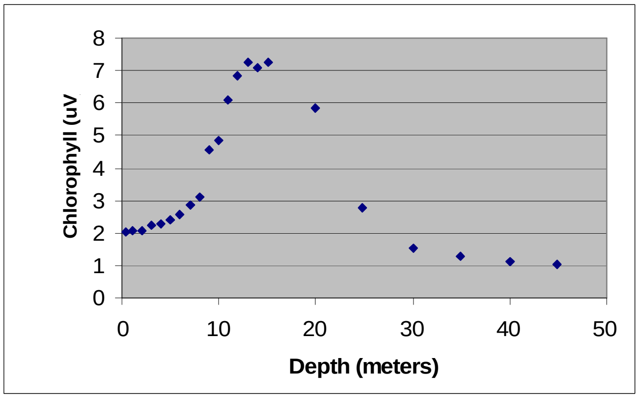
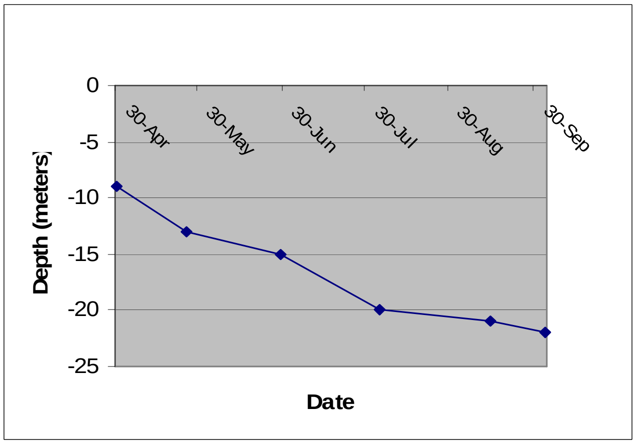


Figure 7: Depth of chlorophyll maximum concentration as a function of date.



Discussion: Based on the Hayden Lake monitoring station data collected during 2006, the lakes clarity remains high with peak values of 7.5 meters or 24.6 feet. Clarity was approximately a three feet less than during 2005. This result is most likely due to the larger volume of water entering the lake in water year 2006 and the resulting increase in sediment and phosphorous. Spring algae growth caused low clarity measurements during early sampling events (April-June). Total phosphorous concentrations increased during 2006 between 0.2 – 1.4 micrograms per liter over the 2005 values dependent on the station. The largest increase was in the northern arm station closest to the lake largest tributary, Hayden Creek. Chlorophyll levels at the mid-lake, Berven Bay and Northern Arm stations are typical of a lake with low available phosphorous concentrations and low algae growth. Total phosphorous concentrations remain above the goal for the lake set by the lake management plan and federally required levels determined to fully protect water quality. The ten year average has not met the 7 ug/L total phosphorous goal. Dissolved oxygen throughout the water column at all sampled locations was well above the minimum state standard of 6 mg/L.

Water quality station data do not measure the amount of phosphorous entering the lake. The Forest Service and DEQ were collecting the data that would make these estimates possible on a yearly basis. However, this effort has been stalled by budget restraints on total phosphorous sampling in Hayden Creek.

Water quality station data are not the most sensitive indicator of changes occurring in the lake water quality. Since bays, and especially the Northern Arm of Hayden Lake that was a marsh prior to construction of the outlet dike, have higher algae growth (Figure 5), a change in the level of algae growth along the transect from the mid-lake area towards Sportsman's Access will be a sensitive indicator of the improvement or decline of lake water quality. A second year of relative algae growth data collection (chlorophyll fluorescence) in real time and at known global position was completed. These data have not been fully processed for interpretation. Additional collection of these data will be required in successive years to scientifically assess any change in water quality status.

Chlorophyll fluorescence results from water column profiles (Figure 6) indicate that the maximum chlorophyll concentration is sinking in the lake as the spring and summer seasons progress (Figure 7). This pattern is quite typical of lakes of high clarity that are low in growth nutrients (phosphorous), like Hayden Lake. The floating diatom algae grow quickly in biomass early in the spring using the nutrients made available by the high runoff from the watershed. This burst of productivity ends and the algae begin to age and descend through the water column. The maximum chlorophyll fluorescence tracks this descent through the seasons. Knowledge of the behavior of the algal productivity provides two insights useful into the interpretation of the chlorophyll fluorescence transect data. If the fluorescence signal moves out towards the open water of the lake from a bay from year to year when measurements are made in September, algal growth other than the spring diatom algae growth is occurring in response to increased plant growth nutrients. The September measurement should provide an early warning of adverse water quality trends that would increase, if not countered. The result also suggests that chlorophyll fluorescence transect data collected in the spring, when the floating diatom algae are near the surface would provide insight into water quality trends in the lake associated with the level and plant growth nutrient quality of runoff from the watershed.

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