EVOS ANNUAL PROJECT REPORT

Project Number: 040707 and 040703

Project Title: Marine-terrestrial linkages in northern Gulf of Alaska watersheds: Towards monitoring the effects of anadromous marine-derived nutrients on biological production in sockeye salmon systems

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Time Period Covered by Report: October 1, 2003 – September 30, 2004

Date of Report: August 15, 2004

1. **Work Performed**: This was the first year of the project. As such, most of the first season was devoted to sample plan development and data collection. Very little analysis has been done because we are still in the process of collecting this season's data. This report will emphasize the developed study plan, while future annual reports will de-emphasize sampling and provide more analysis and interpretation.

   During February through April, the Alaska Department of Fish and Game (ADF&G) and the University of Alaska Fairbanks (UAF) teleconferenced several times to plan sampling logistics, sample site selections, and data management. Logistically, there are six components to this project: (1) smolt studies, (2) basic limnology sampling, (3) lake productivity measurements, (4) periphyton and phytoplankton sampling, (5) terrestrial sampling, and (6) stable isotope sampling and analysis.

   Smolt Studies

   Smolt studies were conducted at Karluk and Spiridon Lakes (control). At Karluk Lake, smolts were collected and counted using a Canadian fan trap located approximately 2 km downstream from the lake. The site was chosen to coincide with the same project location used from 1999-2003 (ADF&G 2004). The trap was deployed on May 7, 2004 and operated until sockeye salmon smolt counts declined below 100 during one 24-hour period. The trap was pulled from the water on June 26, 2004. A total of 184,687 smolts were enumerated from the trap. Six mark-recapture experiments were performed to estimate the capture probability of the trap (Sagalkin and Honnold 2003). Mean capture probability of the trap was 7%, ranging from a low of 4.5% to a high of 9.9%. Population estimates have not yet been calculated. Smolts were sampled daily (60/day, 5 days per week) for age (scale samples), weight, and length (AWL). Approximately 1,700 smolts were sampled for AWL. All scale samples have been aged, but the data have not been edited or entered into the database.

The smolt project at Spiridon Lake was funded by the Kodiak Regional Aquaculture Association (KRAA). Sockeye smolts were collected at Spiridon using a waterfall bypass system (ADF&G 2004). The bypass system consists of a smolt weir, two Canadian fan traps, two dewatering tanks, one tank for enumeration and sampling, and a pipeline. The system captures 100% of the emigrating smolt. The bypass system was operational on May 6, 2004 and was operated through July 8, 2004. A total of 577,652 smolt were enumerated through the pipeline. Since, all smolts are captured, mark-recapture is unnecessary to estimate total abundance. Rather, total counts are used. During periods of high emigration numbers, numbers are estimated using timed-counts. Approximately 1,500 smolts were sampled for AWL. Scale samples have not been aged. Smolts were collected from Karluk Lake for isotope analysis. Smolts were not collected at Spiridon Lake for isotope analysis. Additional smolts were collected from Frazer Lake for isotope analysis.

Basic Limnology

Tentative sample dates were chosen preseason to coincide with (1) pre-lake stratification (May 1 and June 1); (2) lake stratification and pre-sockeye salmon spawning (July 1, August 1, and August 15); and (3) the influx of carcass derived nutrients (September 1st and 15th, and October 1 and 15th). Specific sample dates were modified inseason to cope with staff scheduling, but the general schedule structure was maintained.

The first samples were collected on April 28th and April 29th. During this sample trip, specific lake and river stations were selected at Spiridon and Karluk Lakes. Lake stations at Spiridon were chosen to coincide with existing sample stations (stations 1 and 2; Figure 1). Samples had not been collected from tributaries feeding Spiridon Lake, so new stations were established. Many of the tributaries feeding Spiridon Lake are small and steep. We chose East Creek and West Creek. Stations at both river sites were approximately 20 m from the mouth and in approximately 2 m of water.

Similarly lake stations at Karluk Lake were chosen to coincide with existing sample stations (stations 2 and 3; Figure 2). Samples had not been collected from tributaries feeding Karluk Lake, so new stations were established. We chose Thumb River and Cottonwood Creek. We chose Thumb River because this river has a large inriver spawning population of sockeye salmon and we chose Cottonwood Creek because it is smaller than Thumb River in terms of depth, width, and numbers of spawning salmon.

Water samples were collected at 1, 5, 10, 15, 20, 25, 30, and 35 m at all lake stations at both lakes on each sample date. Water samples from 50 m have been collected from both stations at Spiridon Lake, but only once from station 3 at Karluk Lake. Two 50 m samples from station 3 at Karluk Lake were inadvertently not collected. D.O., temperature, and light were not measured at river stations due to shallow depth. All river stations had water collected at the surface. Light attenuation was measured using a secchi disk and a photometer. In additional to the D.O., light, and temperature

profiles, a continuous water column profile of conductivity, temperature, depth and fluorescence was obtained at all lake stations and, if water depth permitted, at all river stations using a SBE19 Seacat CTD. Data were gathered during all sampling trips except for the sampling trip in the beginning of August. We are currently in the process of analyzing the raw data.

Both lakes were still completely mixed in May (Figure 3). Likewise, both lakes began to stratify in June and showed further signs of thermocline development in July. Temperature was similar between stations and lakes, although, measurements were not identical. Larger measurement differences were observed for D.O. between stations and between lakes.

To date, 156 water samples have been collected from Karluk and Spiridon Lakes. Water samples are currently being processed from the first three trips. Measurements for the following parameters have been started for all Spiridon and Karluk Lake stations and sample depths: pH, alkalinity, total-phosphorous (TP), filterable reactive phosphorous (FRP), and silicon (si). Total filterable phosphorous (TFP), ammonia, and nitrate+nitrites have not been measured yet. We had planned to outsource samples to measure total kjelhdal nitrogen (TKN), but we have been unable to locate a laboratory with sufficient measurement resolution to process the samples. Chlorophyll *a* and phaeophyton sample measurements are incomplete. UAF and ADF&G have slightly different methods for measuring chlorophyll *a* and phaeophyton. Due to time constraints at the ADF&G laboratory, UAF offered to process the chlorophyll *a* and phaeophyton samples. ADF&G will duplicate the chlorophyll *a* and phaeophyton measurements at the 1-m sample depth. ADF&G duplicated these measurements to compare to the results of the UAF lab and ensure comparability to historical measurements.

Very little synthesis of the data has been done because data for this field season are still being collected, entered, and summarized. While no statistics have been performed on the data, some interesting observations are already apparent:

pH and Alkalinity

pH ranged from a low of 7.1 to a high of 7.7 among all stations and all depths between both lakes. pH tended to be fairly uniform throughout the water column at all lake stations in both lakes (Figures 4 – 7). Likewise, pH tended to decrease from May through July (e.g., Figure 4). pH in the rivers at Spiridon was similar to the pH from the lake stations; however, pH in the rivers at Karluk were dissimilar to the pH from the lake stations (Figures 8 and 9).

Similar to pH, alkalinity had a very limited range (16 to 23 μg/L) among all lake stations and depths, between both lakes (Figures 10 – 13). Unlike pH, alkalinity tended to oscillate between high and low values through the water column. This was true at both lakes, all months sampled, and at all lake stations. (Figures 14 and 15). At both lakes, the highest alkalinity was measured in July and at a river station, but also

in both cases, the high alkalinity was not duplicated at the other river station of the same lake (Figures 14 and 15).

TP

At Spiridon Lake, only station 1 has been analyzed at every depth for TP (Figure 16). Measurement of river station samples is incomplete.

TP varied by depth, station, and month at Karluk Lake (Figure 17-19). This also indicates differences in phosphorus concentrations between lake basins. Concentrations at the 1-m level also demonstrate spatial differences; however, lake stations were more similar to each other for TP than to the river stations (Figure 19).

Silicon

Silicon tended to be uniformly distributed through the water column at Spiridon Lake and demonstrated more variation through the water column at Karluk Lake (Figures 20-25). Concentrations were substantially higher at Spiridon Lake over Karluk Lake (Figures 20-23). Likewise, silicon concentrations from the river stations at Karluk Lake were higher than the concentrations at the lake stations (Figure 25).

Zooplankton

Zooplankton samples are still in the process of being analyzed. To date, the first three samples from Spiridon and Karluk Lake stations have been completed. The only river station deep enough to collect zooplankton samples is station 5 at Karluk Lake; the first three samples from this station have been analyzed.

Composition among all lake stations is similar, and dominated by C*yclops* (Figure 26). However, densities are vastly different between stations at a lake and between lakes. For example, there were an average of approximately 338,000 no./m^3 *Bosmina* at station 3 at Karluk Lake, while no other station at either lake had more than 5,000 no/m^3. Mean length of *Bosmina* and *Cyclops* was similar between stations and lakes (Figure 27).

Zooplankton composition at the river station at Karluk Lake was different from all other lake stations (Figure 28), and densities were low. *Bosmina* were predominant.

Productivity Samples

Productivity measurements were obtained during sampling trips on April 28th, 2004 and June 25th, 2004. During the April sampling trip nitrogen and carbon productivity was determined at Karluk stations 2 and 5 and Spridon stations 1 and 5 from the surface depth only. Mass spectrometric analysis has been completed on these samples but statistical analysis is still under progress. During the June sampling trip productivity was determined at Karluk stations 2 and 5 and Spiridon station 1. We

obtained samples at three light depths (surface, 30%, 1%) from all the lake stations and at the surface from the river station. Analysis of productivity samples from the June sampling trip is in progress. Chlorophyll samples were collected at all productivity depths, in addition to the regular sampling intervals. We will conduct productivity analyses and collect associated chlorophyll and nutrient samples in four future trips (mid-August, early and mid- September, and October). Laboratory analysis of both chlorophyll and nutrient samples is currently in progress.

Periphyton and Phytoplankton Samples

Water samples have been collected from Karluk station 2 and Spiridon station 1 for phytoplankton analysis. Water was collected at 1, 5, 10, 15 and 20m and combined. From this combined sample, an integrated sample was made and subsamples were set aside for pigment analyses (frozen) and phytoplankton speciation (preserved with Lugols). Additionally, the bottom substrate was collected at all from fixed quadrats for periphyton analysis.

Terrestrial Sampling

Pilot studies of terrestrial samples are in progress. Brown bear samples have been obtained through collaboration with ADF&G biologist, Larry VanDaele. Bird samples will be obtained through collaboration with U.S. Fish and Wildlife service. Terrestrial plant and soil samples have been analyzed for stable isotopes, that were obtained from a previous year, and will be compared with those that will be taken this year.

Stable Isotope Sampling and Analysis

Samples have been obtained from all sampling trips for POM (particulate organic matter - phytoplankton) and zooplankton. POM samples were obtained from filtering water taken at all depths at each lake station, and at the river station. Zooplankton samples were obtained from vertical zooplankton hauls at all lake stations, and one Karluk River station. Sockeye smolt samples were obtained from the Karluk Lake smolt trap. Adult sockeye will be sampled from scale collections obtained at the Karluk weir. Collection of terrestrial samples was described above. All samples have been frozen, and will be processed and run in a single batch at the end of the sampling season to ensure maximum consistency.

Literature Cited

ADF&G. 2004. Salmon research operational plans for the Kodiak Area, 2004. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 4K04-22, Kodiak.

Sagalkin, N.H. and S.G. Honnold. 2003. Evaluation of sockeye salmon smolt population estimate bias from single-site mark recapture experiments. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 4K03-40, Kodiak.

2. **Future Work**: Work planned for the upcoming year should not be substantially different from the proposal. We have had difficulty finding a laboratory to analyze TKN with sufficient resolution and it is likely that this parameter will be dropped; however, we feel that measurements of nitrate+nitrite and ammonia should provide sufficient resolution of nitrogen. Flight costs were higher than anticipated because of the time it took to collect all the samples, so we have discussed omitting the final sample. However, it appears that the budget will be sufficient for this fiscal year to perform all necessary tasks.

3. **Coordination/Collaboration**: This project involves extensive coordination and collaboration. Smolt data from the Spiridon smolt project have been collected and are in the process of being analyzed. Flights to Spiridon Lake were shared when possible to reduce costs. The Karluk escapement weir is still in place; total counts for the early and late sockeye salmon runs have been collected. Adult catch sampling has taken place and scales are currently being aged. Aged scales will be used in conjunction with age-marker analysis to reconstruct the Karluk Lake sockeye salmon run. Flights to re-supply the Karluk smolt research project were shared with the Frazer Lake fish pass project to reduce costs. We will integrate the results of this project with the paleoecological work of the EVOS/GEM project "Reconstructing Sockeye Populations in the Gulf of Alaska over the last Several Thousand Years (D. Mann, B.Finney, PIs).

4. **Community Involvement/TEK & Resource Management Applications**: The ADF&G presented the project design to the Kodiak National Wildlife Refuge Staff, the Kodiak Regional Salmon Planning Team, and the U.S. Coast Guard for review and comment. The results of these consultations were considered prior to finalizing the operational plans and implementing the field project. Data collected will also be shared with these groups through copies of this annual report. The ADF&G gave preference to local residents, including qualified residents of the Villages of Karluk, when hiring sampling crews. The study sites were located in areas of high recreational use and frequent interaction with the public occurred. Employees were encouraged to provide accurate information to the public regarding the goals and objectives of the project. The results from this project have management implications regarding the effect to which fisheries may influence the overall productivity of watersheds. The results from this project will provide information critical in

developing a monitoring program to detect annual changes in levels of marine nutrients in watersheds.

5. **Information Transfer**: This project is currently in the first year of gathering data. No reports have been written, and no presentations have been made. The ADF&G is developing a limnology database to integrate the current data with historical data and facilitate future data requests.

6. **Budget**: As indicated in the 'Future Work' section, flight costs were higher than expected because of the underestimated amount of time required to collect all of the samples. However, due to collaborative cost-sharing, total costs for 2004 budget will be less than expected. To assist with future expenditures in 2005 and 2006 it would be very beneficial if extra monies not spent in the 2004 budget could be rolled over to a subsequent year.

Report Prepared By: Nick Sagalkin, Bruce Finney, and Steve Honnold

Project Web Site Address:
ww.cf.adfg.state.ak.us/region4/finfish/salmon/kodiak/gem_res.php

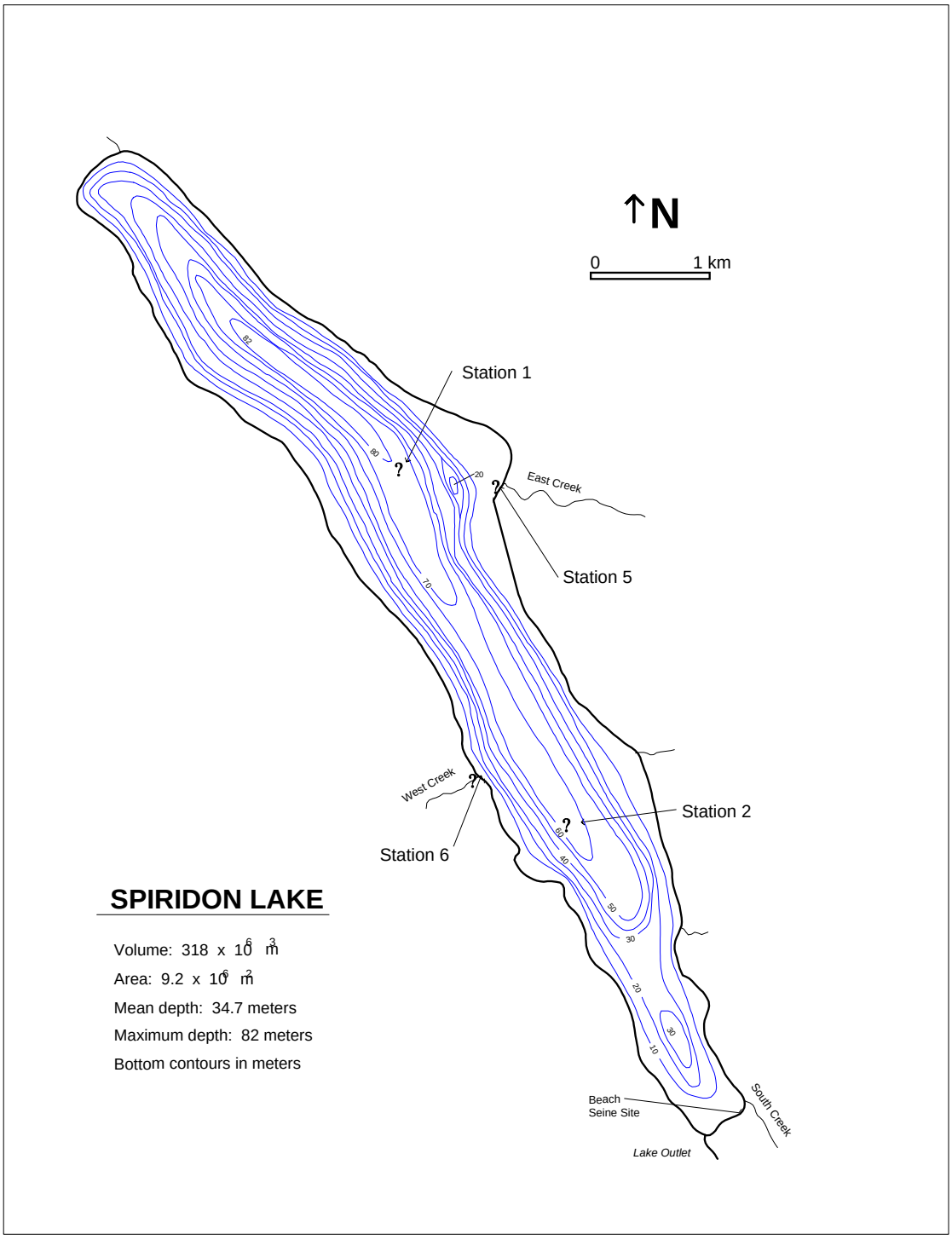

Figure 1. Bathymetric map of Spiridon Lake indicating sample stations.

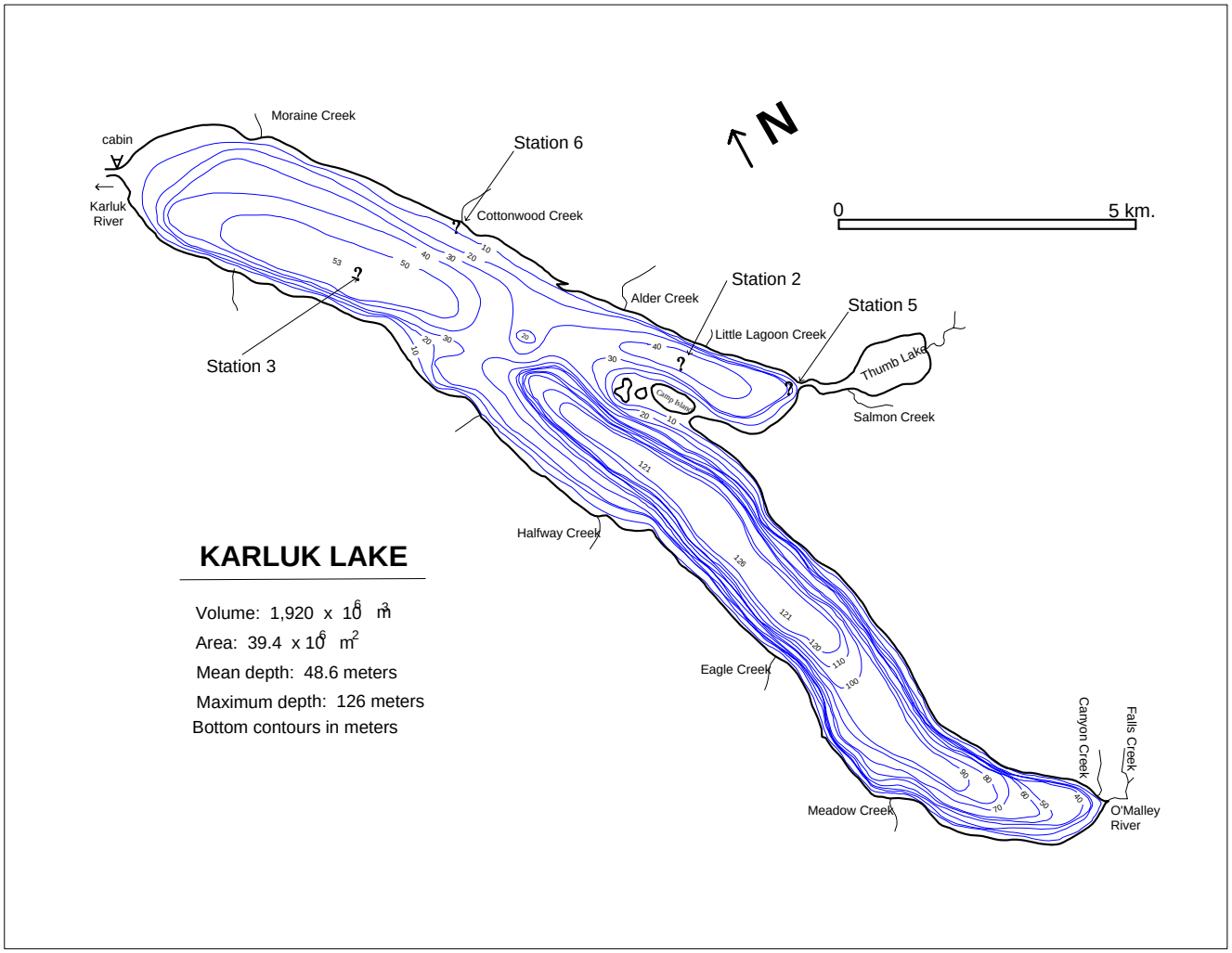

Figure 2. Bathymetric map of Karluk Lake indicating sample stations.

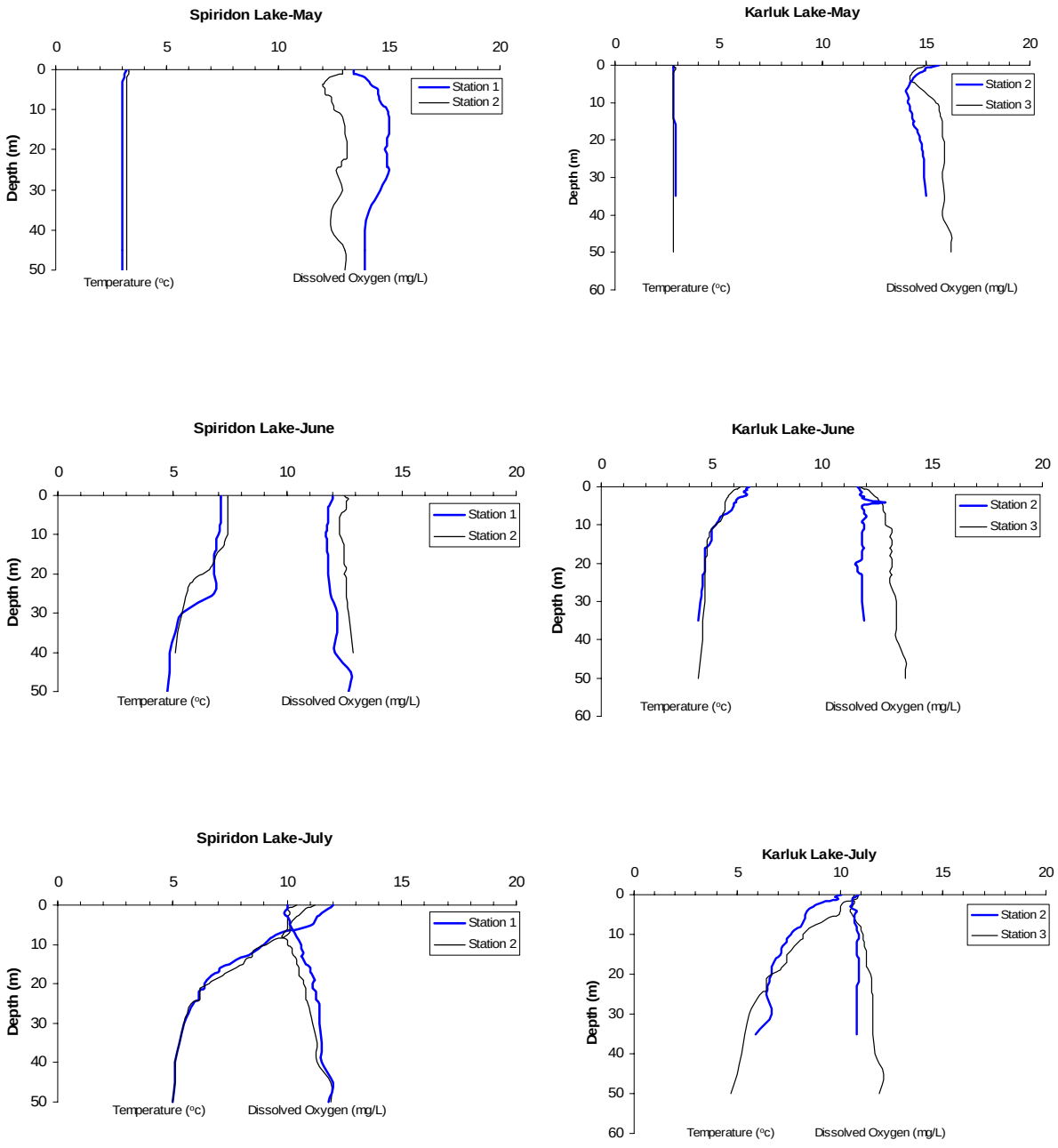

Figure 3. Temperature (^{o}c) and dissolved oxygen (mg/L) profiles from Spiridon Lake station 1 and 2 and from Karluk Lake station 2 and 3, May – July, 2004

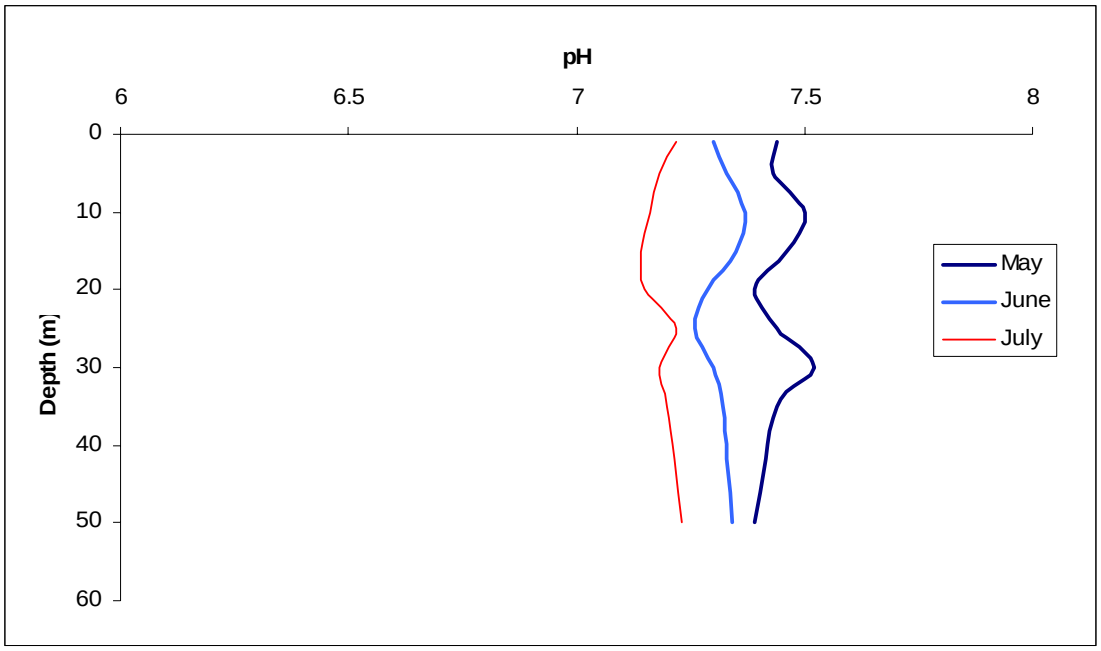

Figure 4. pH profile from Spiridon Lake station 1, 2004.

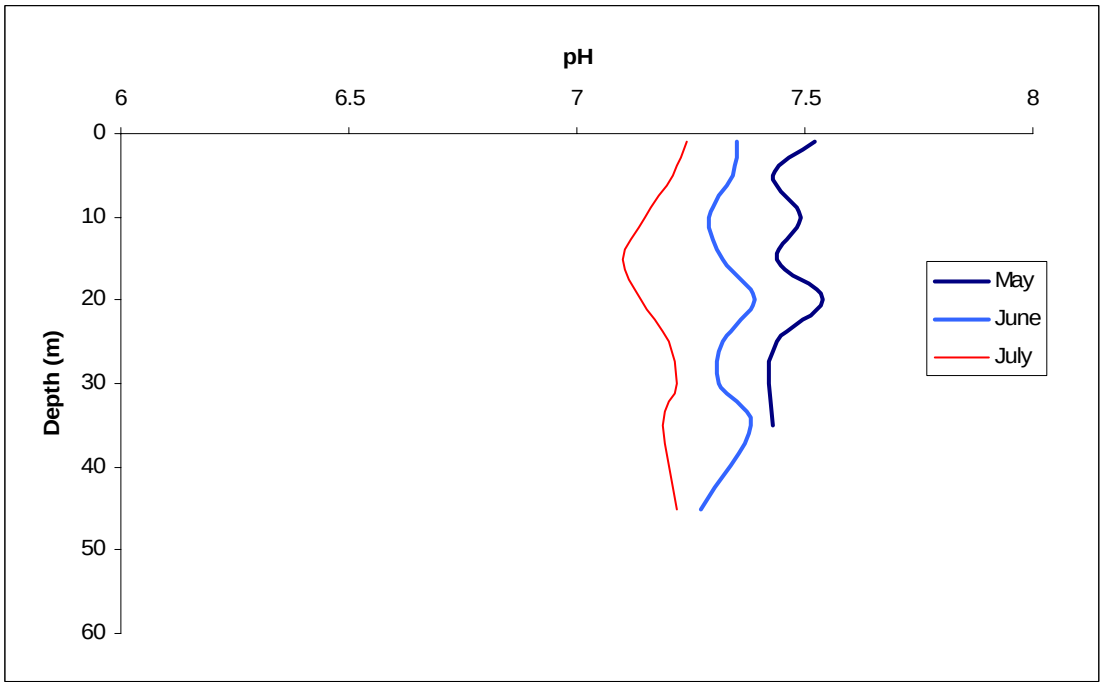

Figure 5. pH profile from Spiridon Lake station 2, 2004.

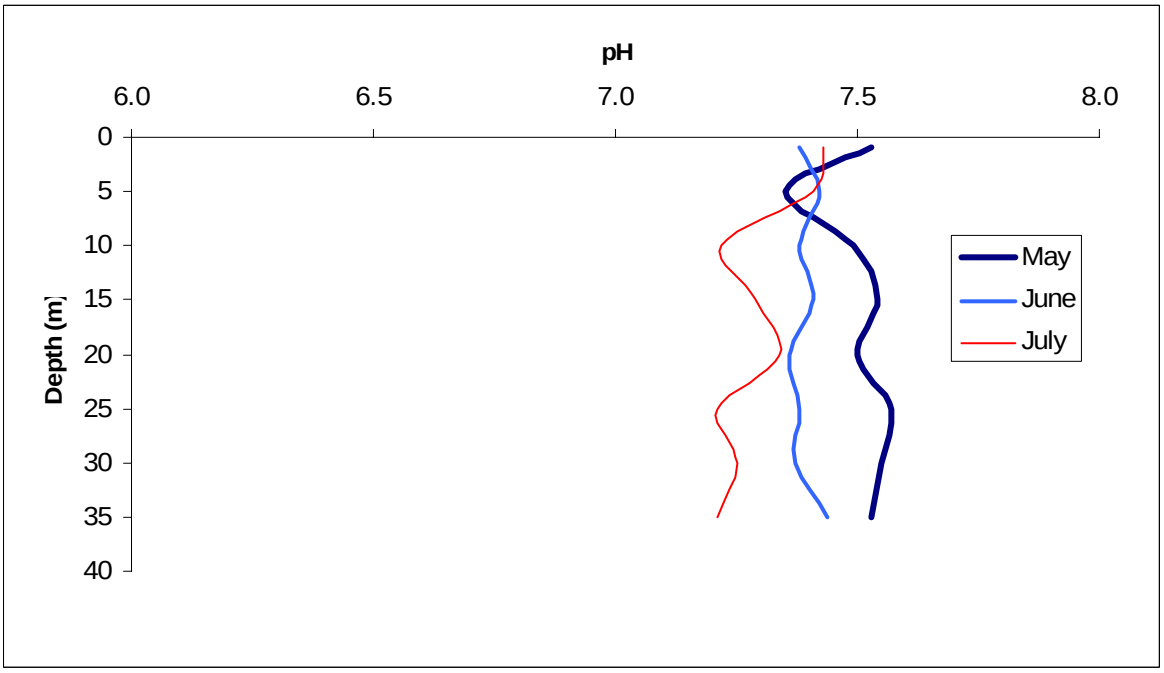

Figure 6. pH profile from Karluk Lake station 2, 2004.

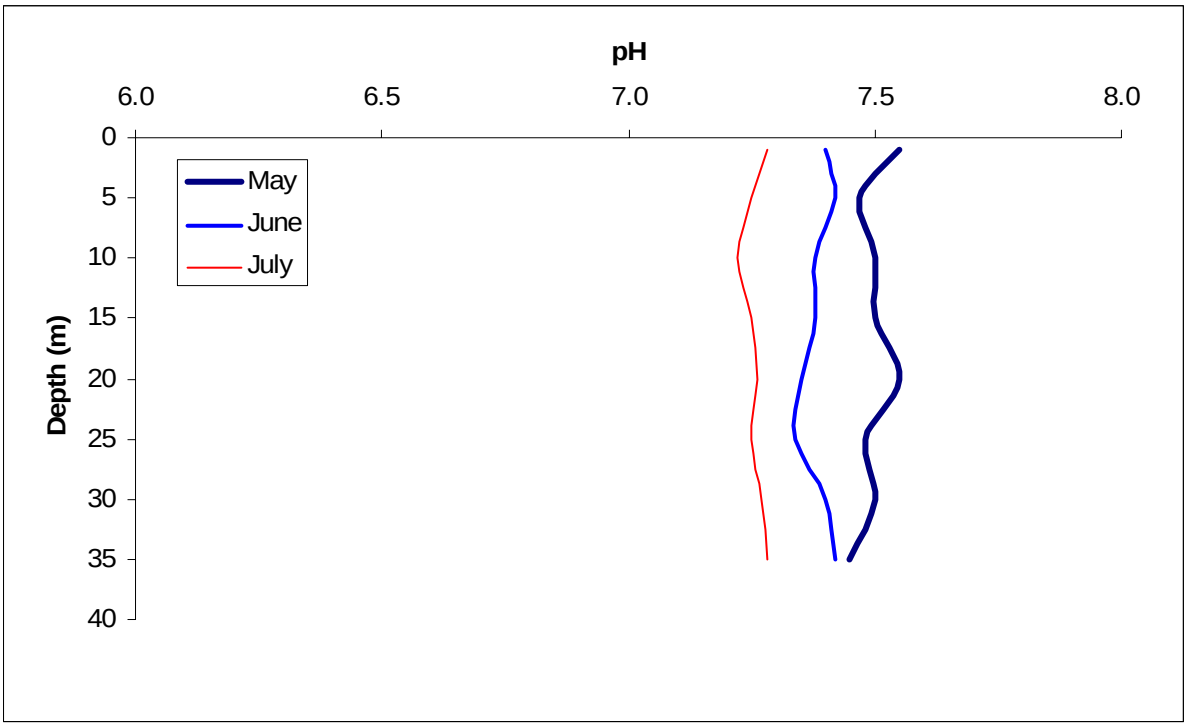

Figure 7. pH profile from Karluk Lake station 3, 2004.

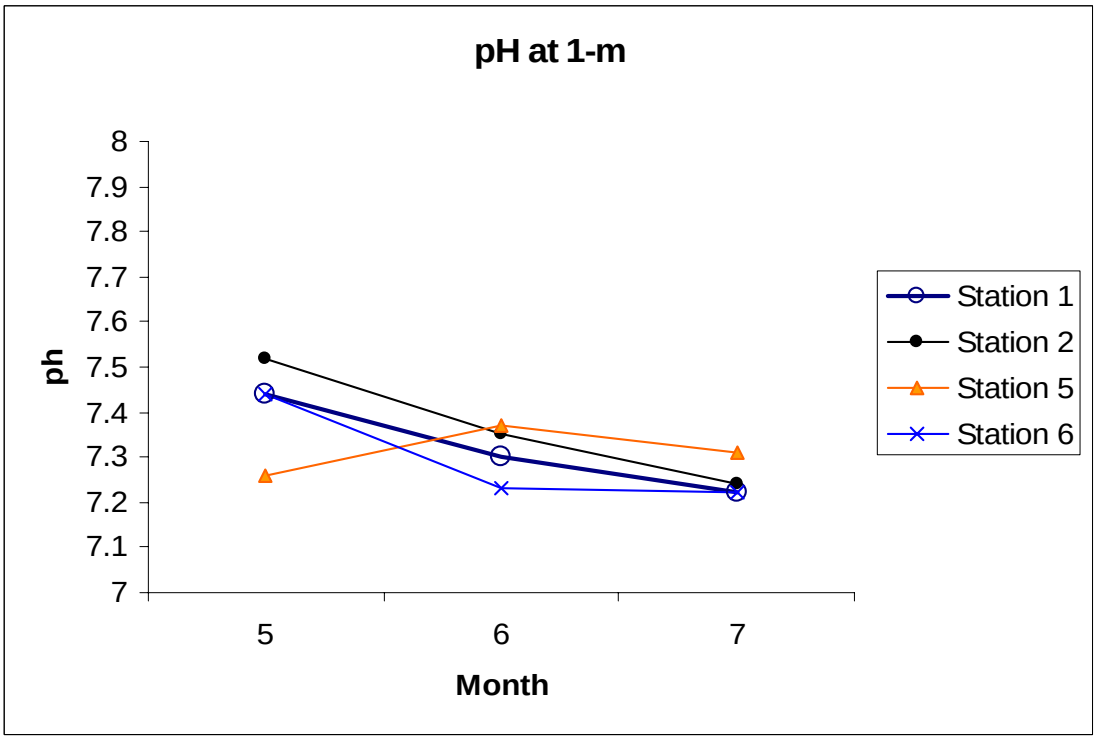

Figure 8. pH at 1-m from lake stations 1 and 2 compared to pH from river stations 5 and 6, Spiridon Lake, 2004

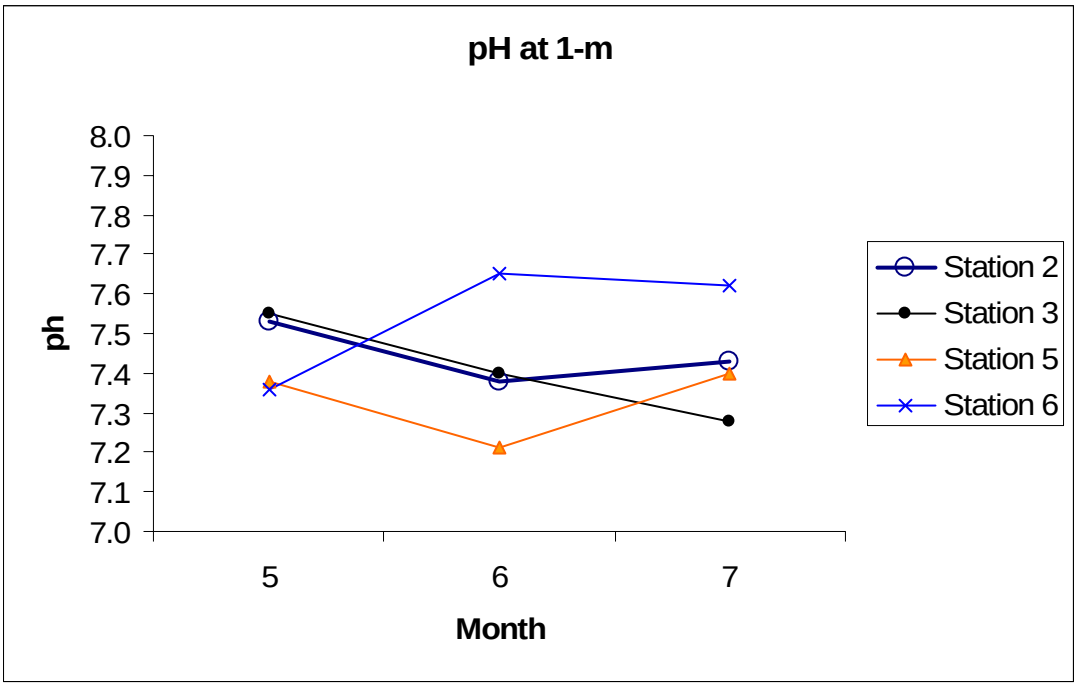

Figure 9. pH at 1-m from lake stations 2 and 3 compared to pH from river stations 5 and 6, Karluk Lake, 2004.

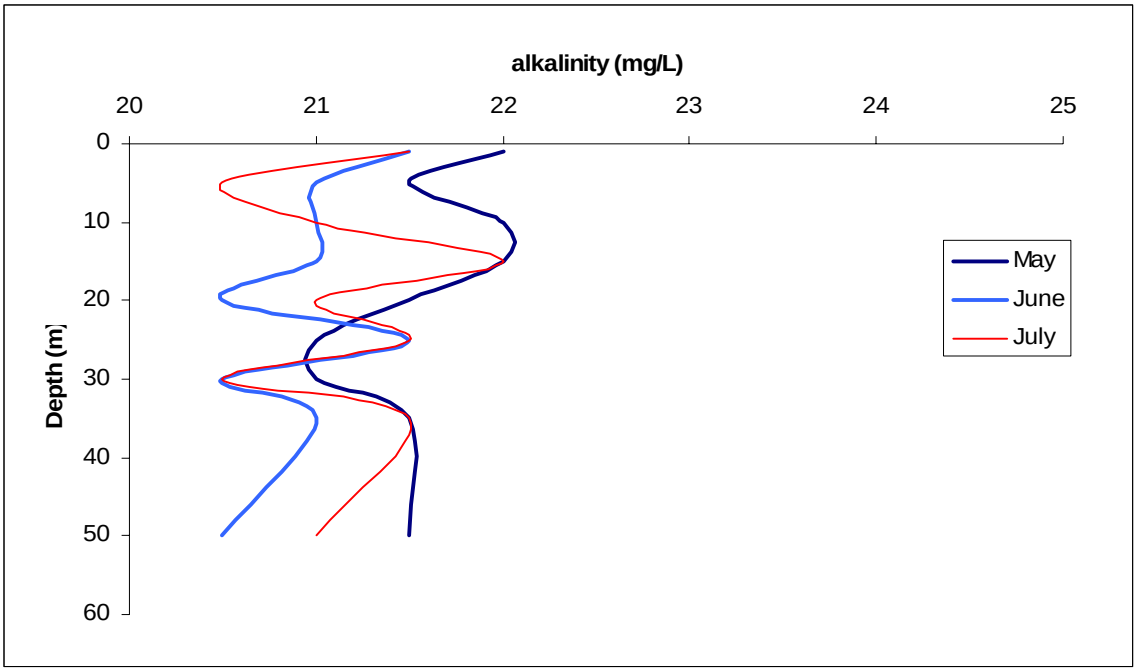

Figure 10. Alkalinity profile from Spiridon Lake station 1, 2004.

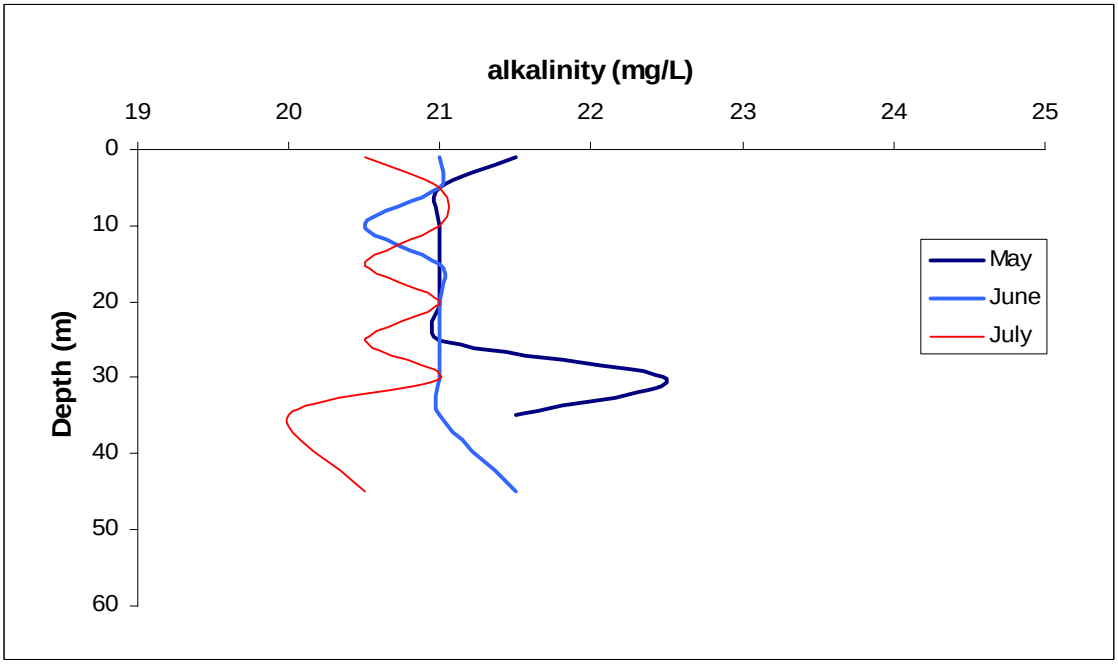

Figure 11. Alkalinity profile from Spiridon Lake station 2, 2004.

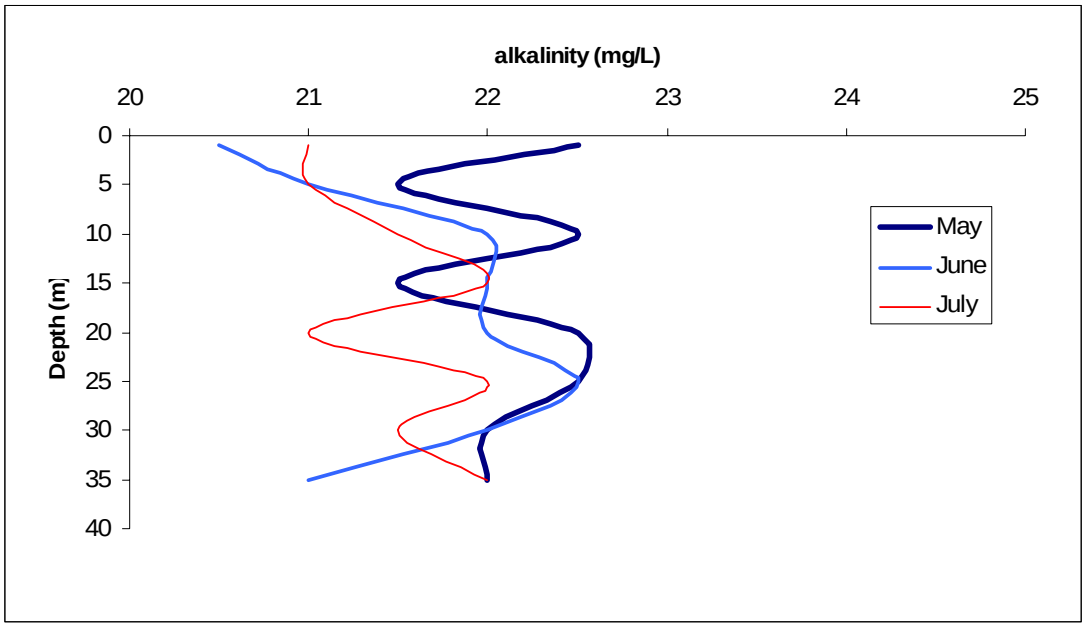

Figure 12. Alkalinity profile from Karluk Lake station 2, 2004.

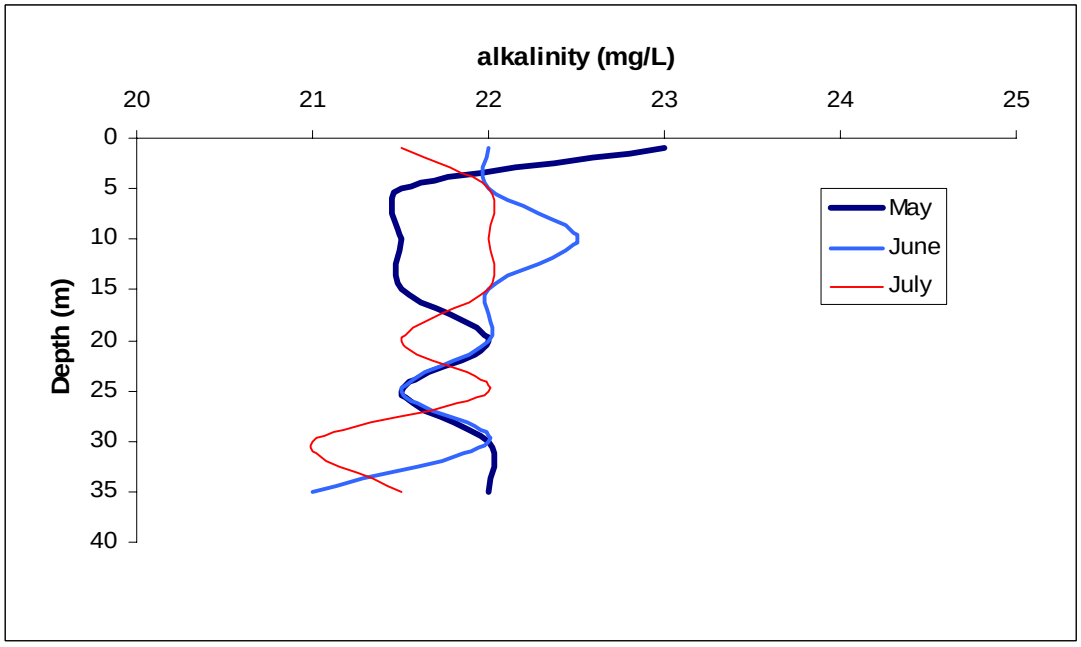

Figure 13. Alkalinity profile from Karluk Lake station 3, 2004.

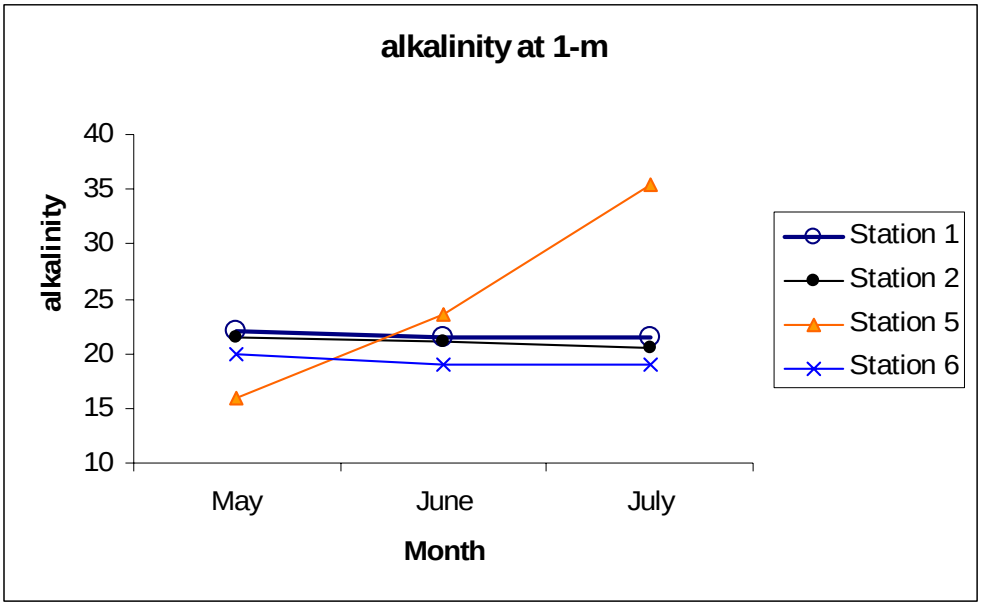

Figure 14. Alkalinity at 1-m from lake stations 1 and 2 compared to alkalinity from river stations 5 and 6, Spiridon Lake, 2004.

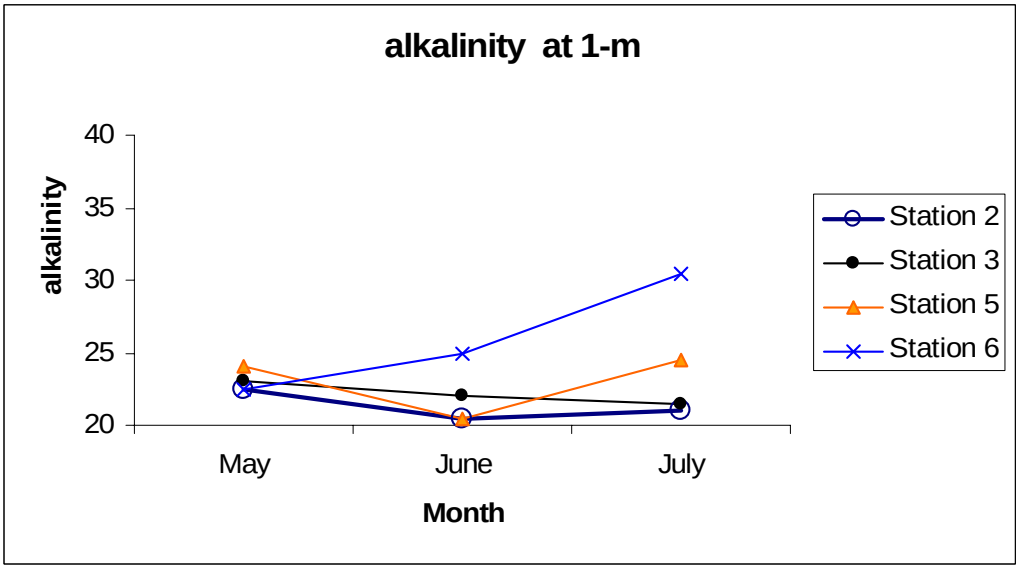

Figure 15. Alkalinity at 1-m from lake stations 2 and 3 compared to alkalinity from river stations 5 and 6, Karluk Lake, 2004.

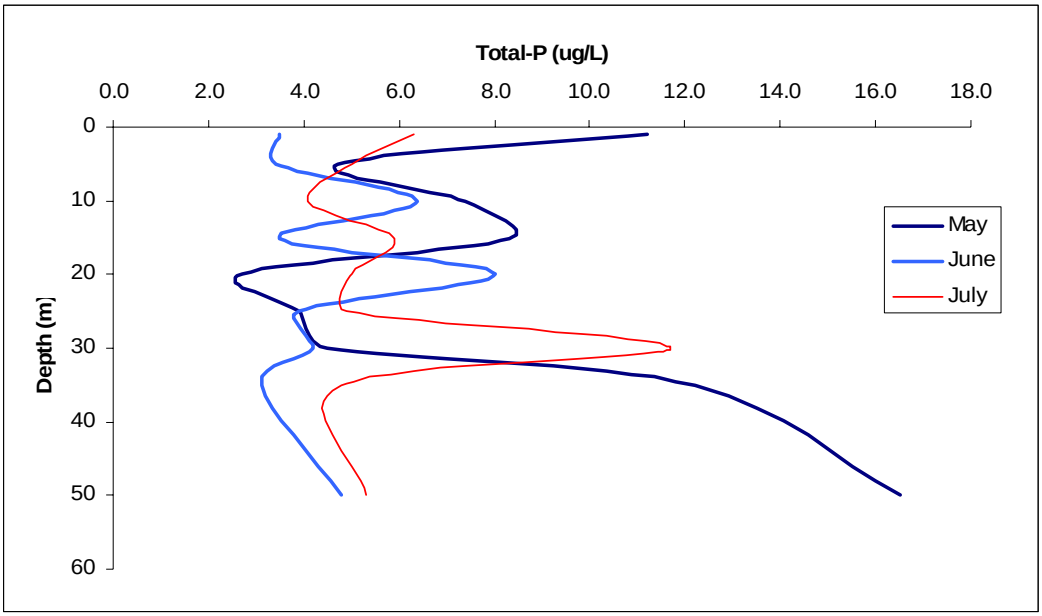

Figure 16. Total phosphorus profile from Spiridon Lake station 1, 2004.

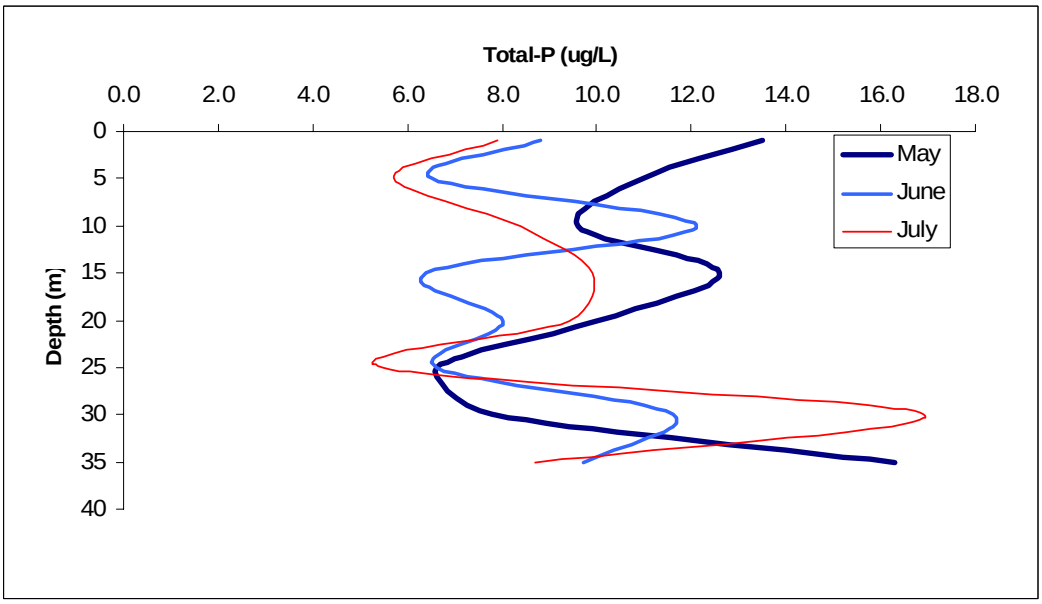

Figure 17. Total phosphorus profile from Karluk Lake station 2, 2004.

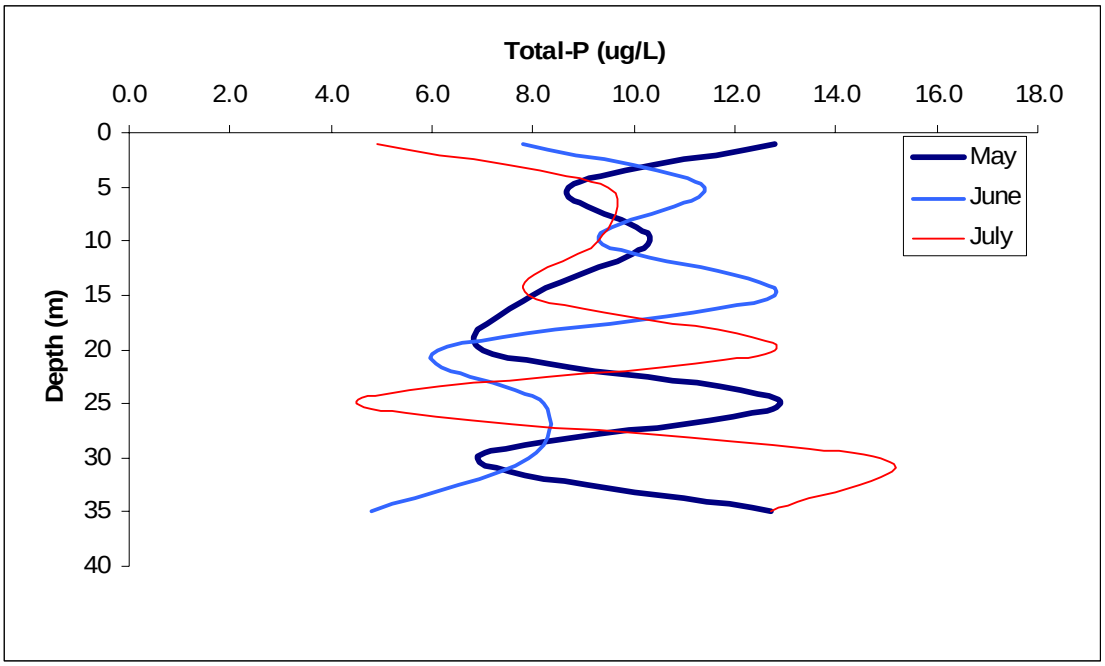

Figure 18. Total phosphorus profile from Karluk Lake station 3, 2004.

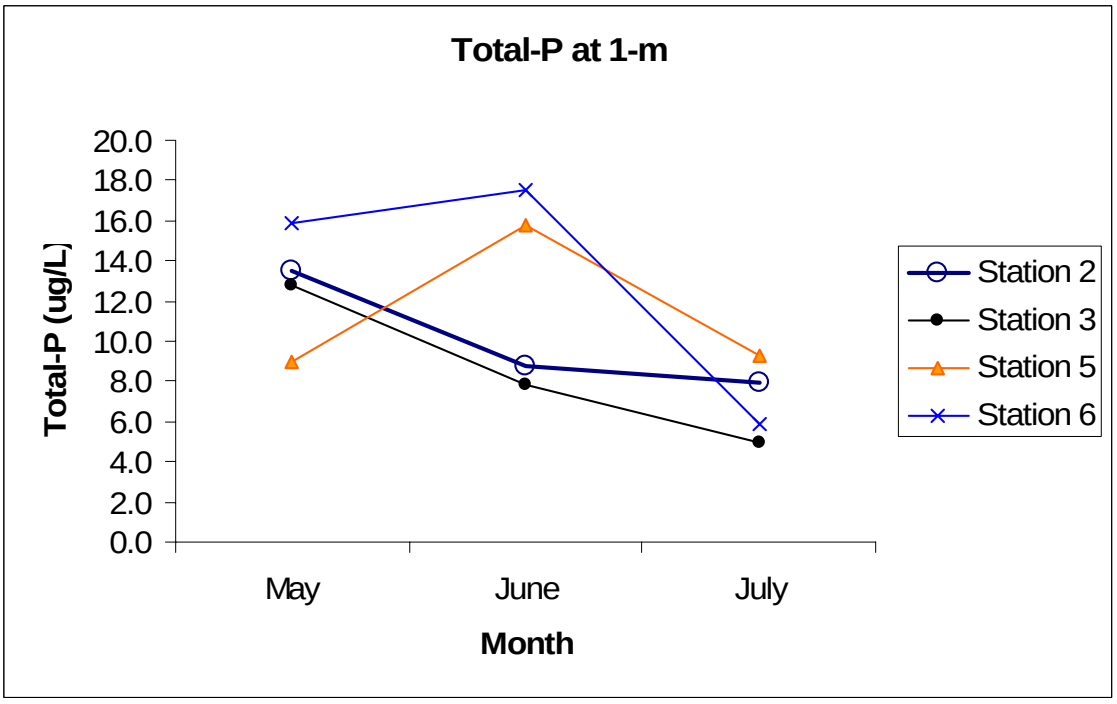

Figure 19. Total phosphorus at 1-m from lake stations 2 and 3 compared to TP from river stations 5 and 6, Karluk Lake, 2004.

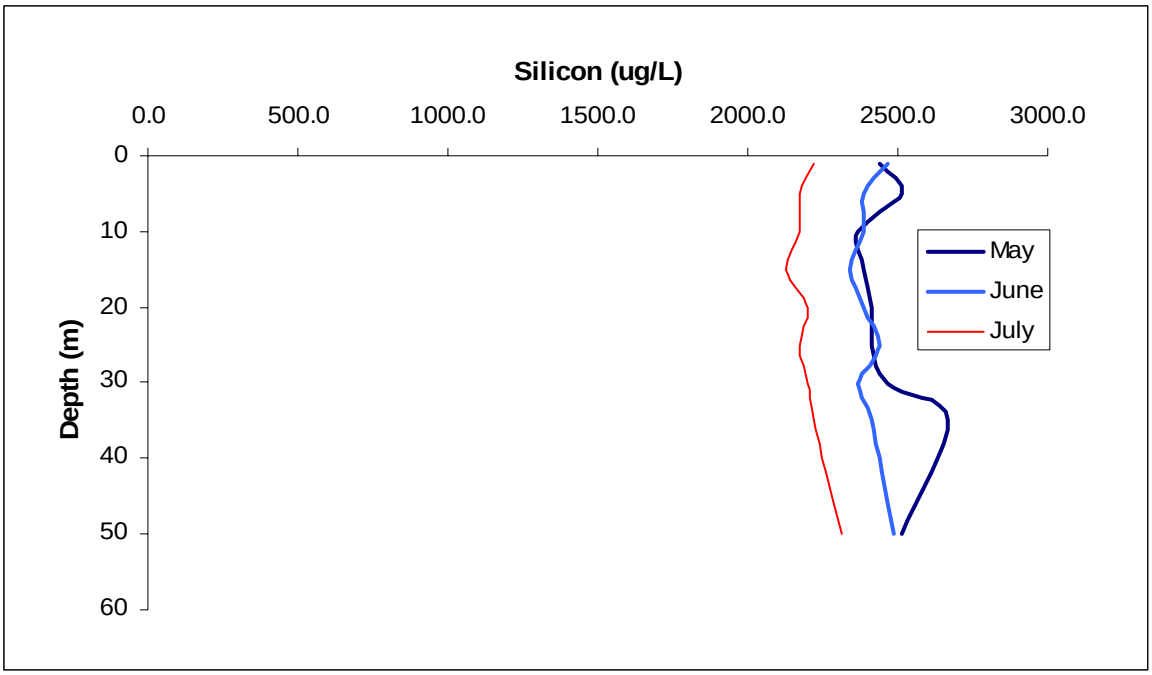

Figure 20. Silicon profile from Spiridon Lake station 1, 2004.

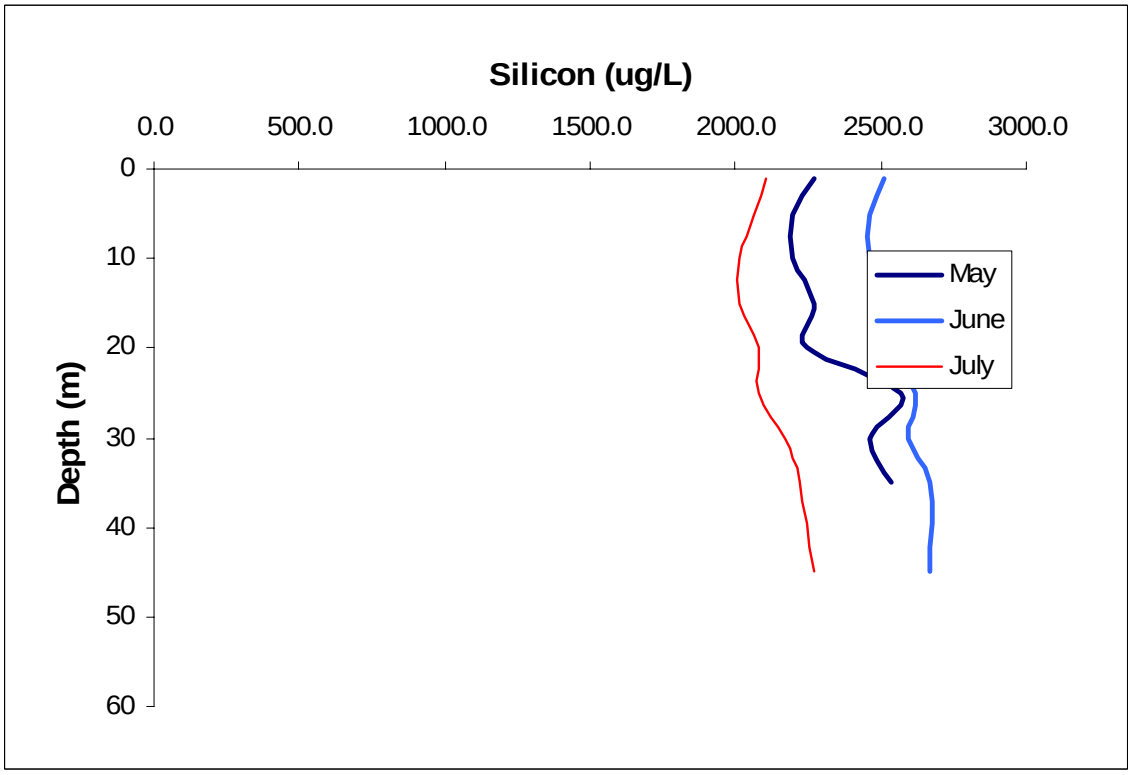

Figure 21. Silicon profile from Spiridon Lake station 2, 2004.

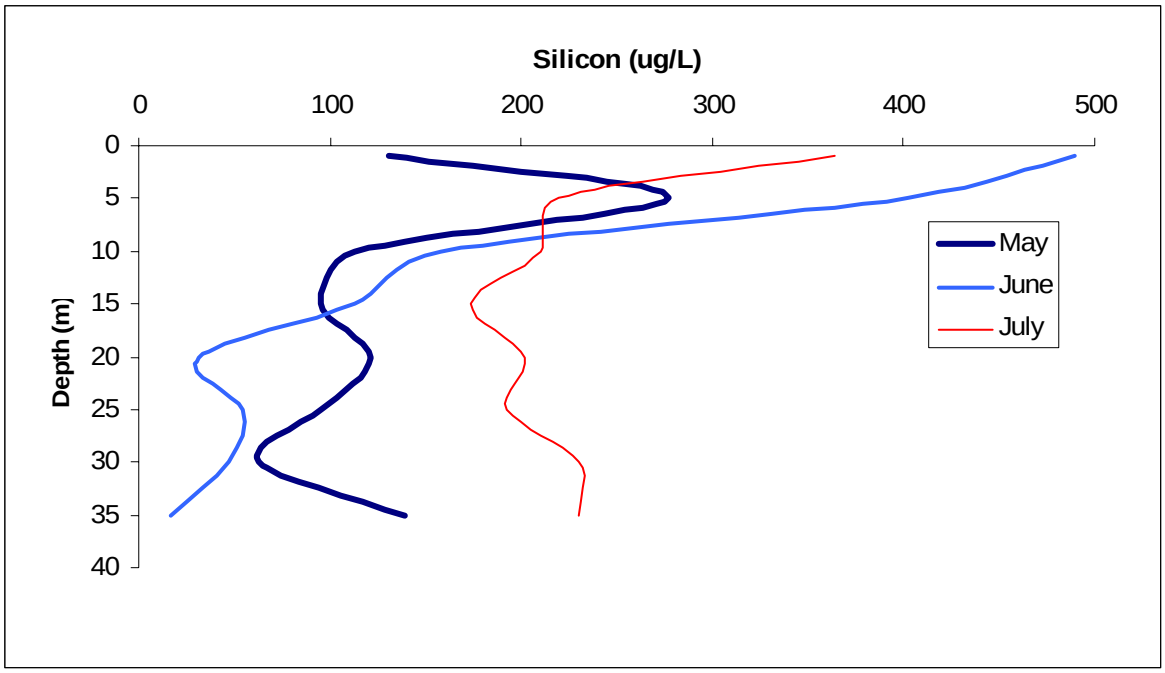

Figure 22. Silicon profile from Karluk Lake station 2, 2004.

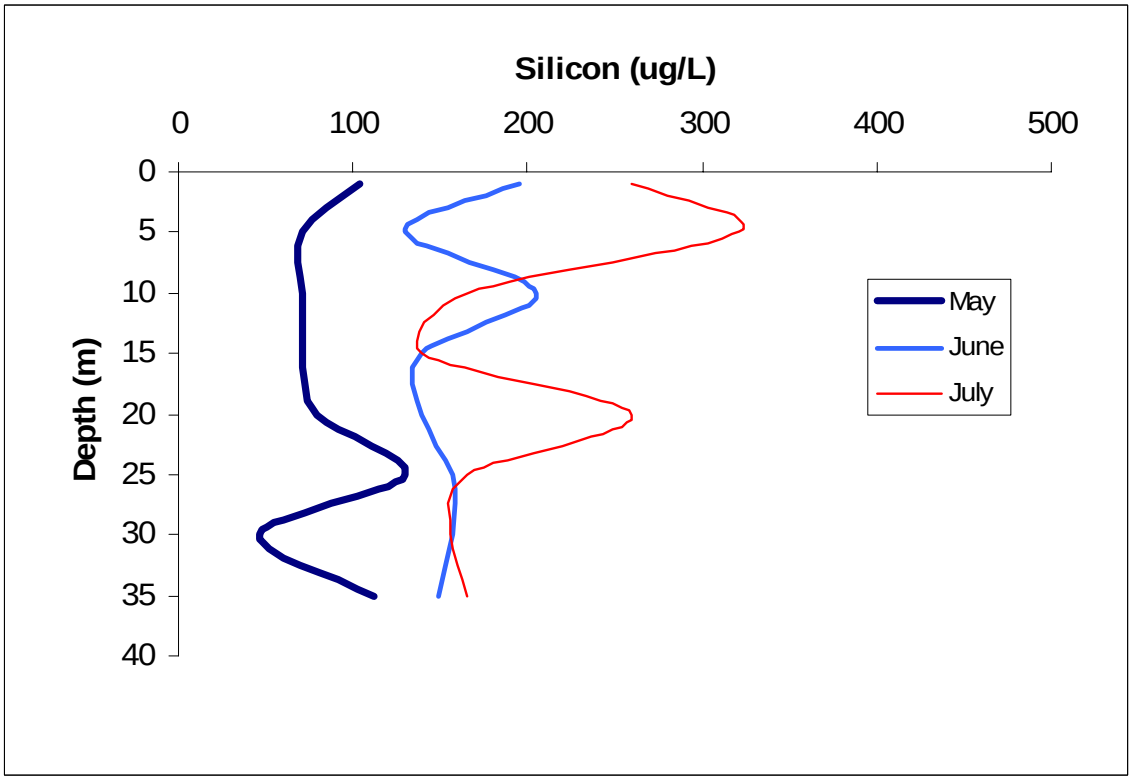

Figure 23. Silicon profile from Karluk Lake station 3, 2004.

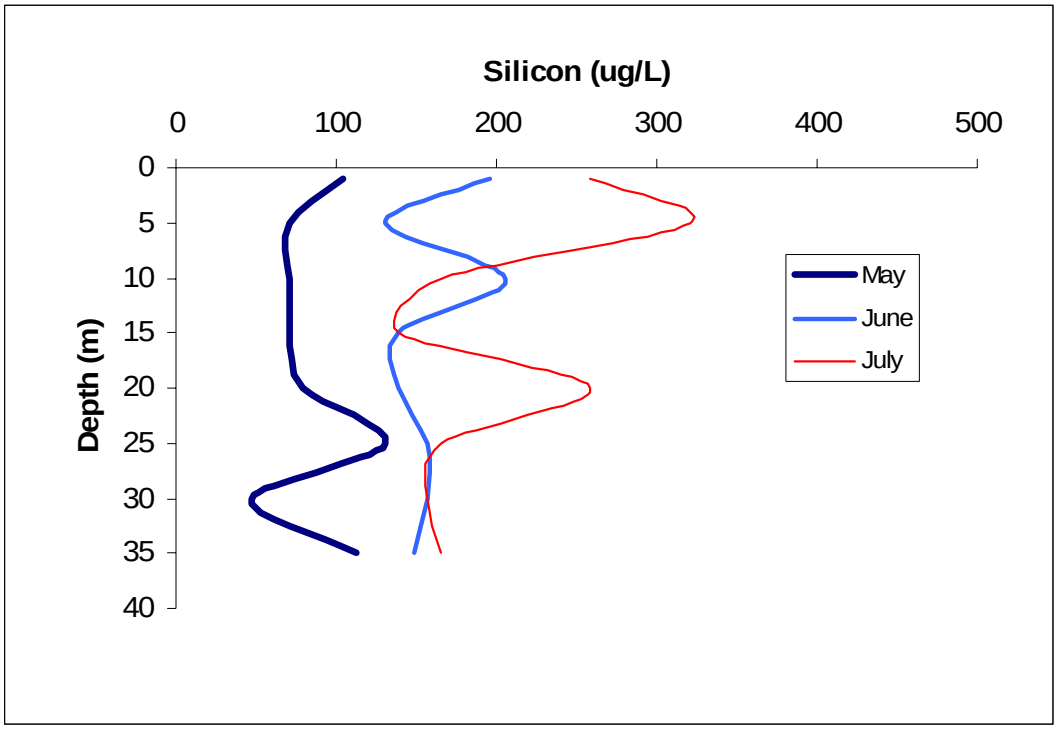

Figure 24. Silicon at 1-m from lake stations 1 and 2 compared to silicon from river stations 5 and 6, Spiridon Lake, 2004.

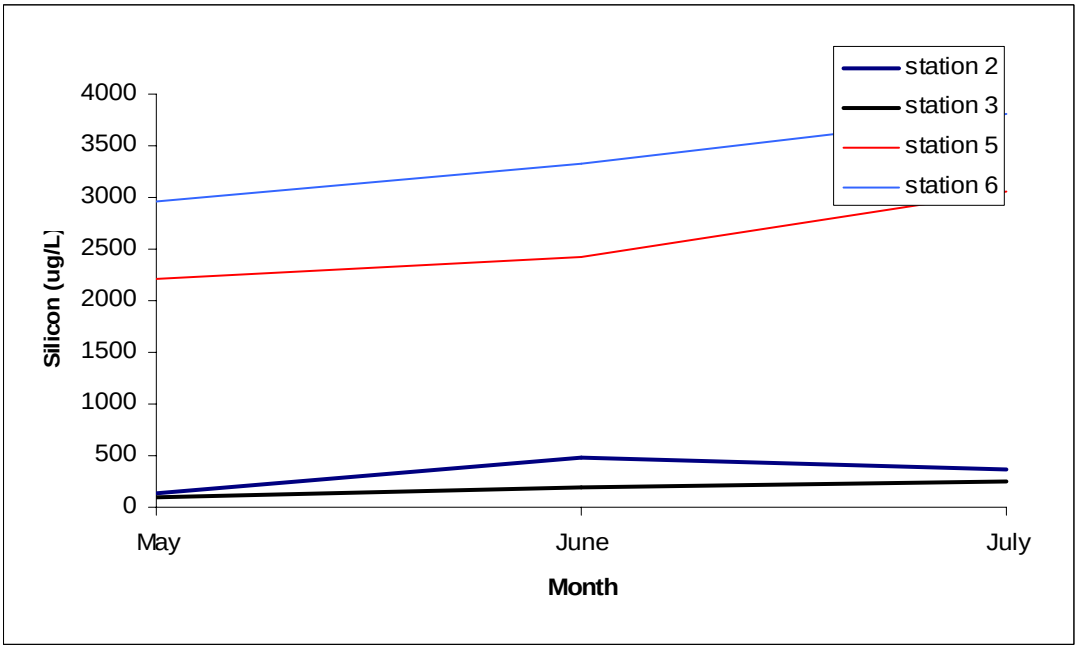

Figure 25. Silicon at 1-m from lake stations 2 and 3 compared to silicon from river stations 5 and 6, Karluk Lake, 2004.

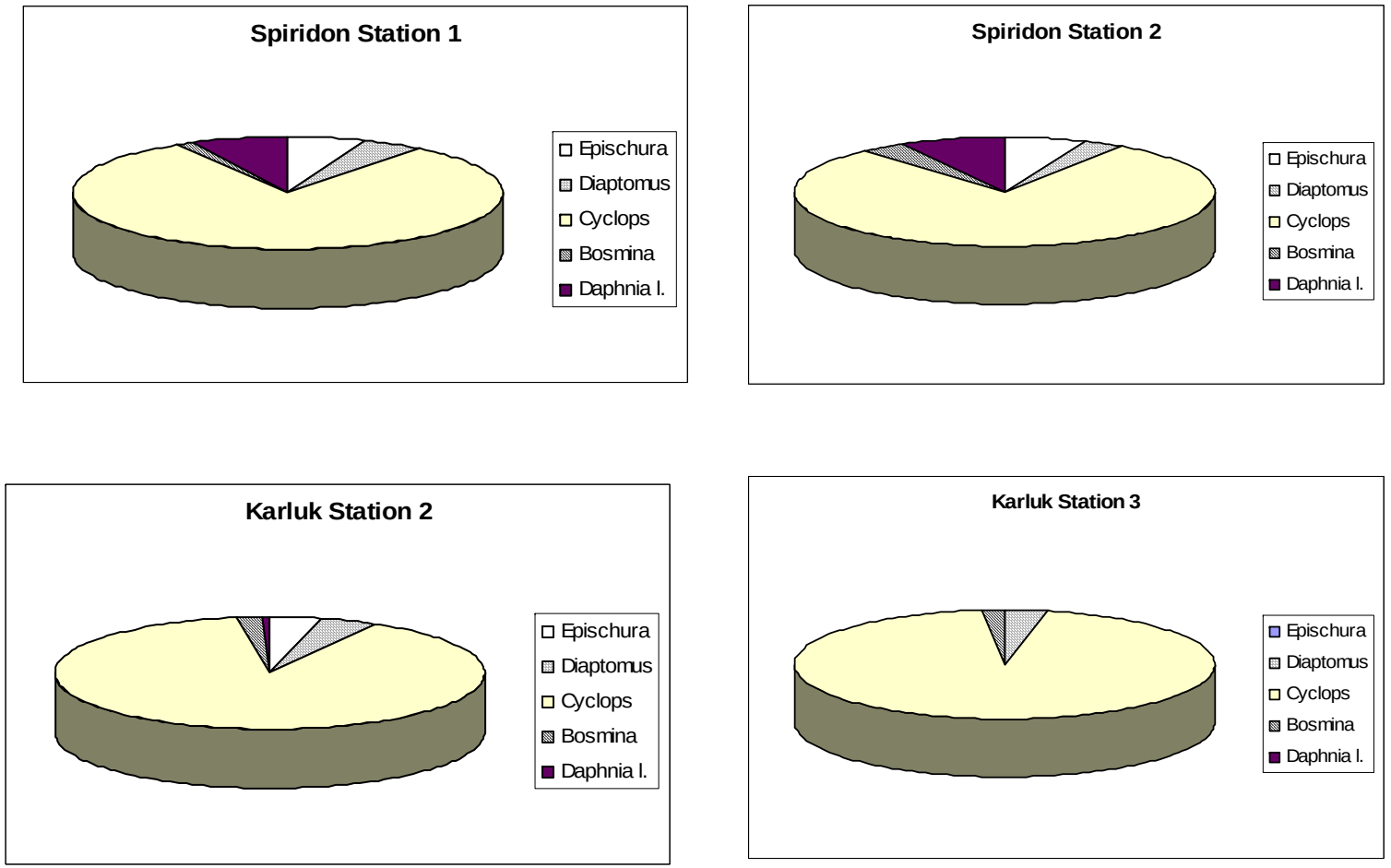

Figure 26. Zooplankton species composition from Spiridon and Karluk Lakes, lake stations, 2004.

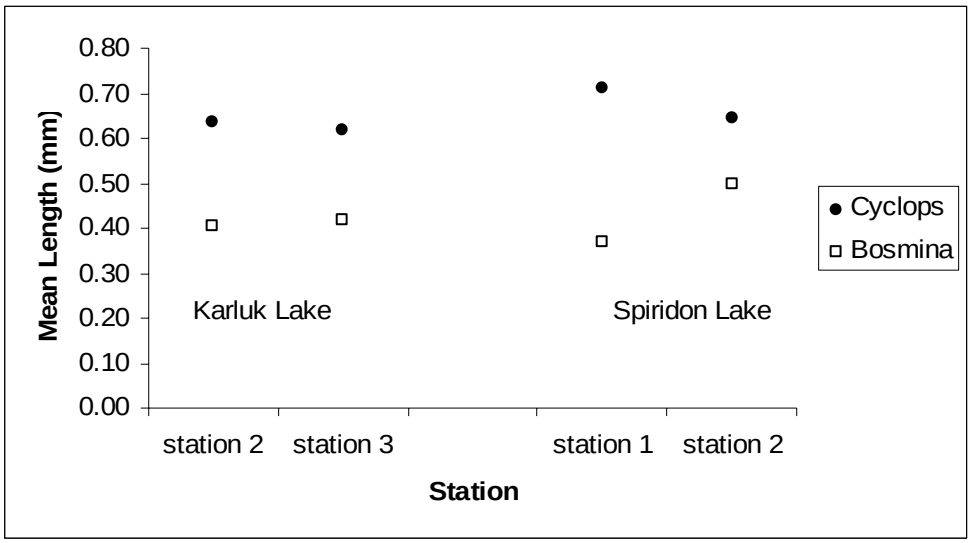

Figure 27. Mean length of *Cyclops* and *Bosmina* from lake stations at Karluk and Spiridon Lakes.

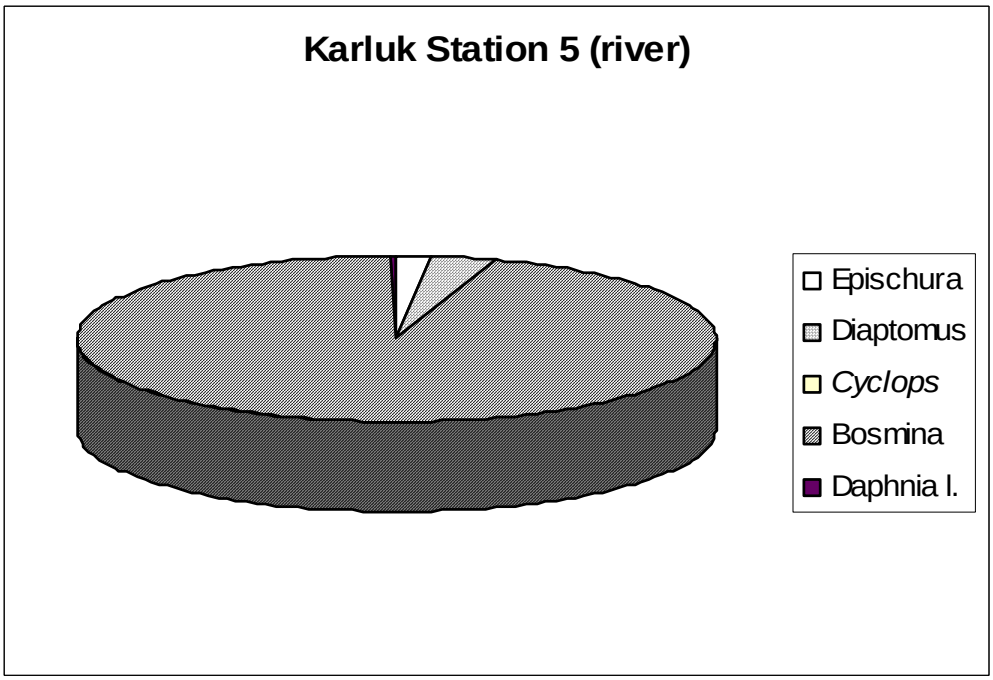

Figure 28. Zooplankton species composition from the Karluk Lakes river station, 2004.