Somenos Basin Coho Salmon Summer Habitat Assessment

A project funded by the TD Friends of the Environment Foundation

for:

Somenos Marsh Wildlife Society

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by:

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March 29, 2016

Abstract

During 2015, we continued field investigations on the summer growth and abundance of juvenile Coho Salmon (*Oncorhynchus kisutch*), in the Somenos Basin. As part of this program we continued year-round monitoring of temperature, pH, and dissolved oxygen to assess habitat suitability in Somenos Lake and its three tributary streams; Bings Creek, Averill Creek, and Richards Creek. In summer fish surveys Coho Salmon and other species were sampled monthly with a pole seine at sites in the three tributary streams to Somenos Lake. Temperature was monitored hourly by data loggers located in Somenos Lake and its three tributaries. Temperature, pH and dissolved oxygen were monitored in Somenos Lake by a team of volunteers who collected data on temperature, water clarity, dissolved oxygen and atmospheric conditions at two stations in the lake. In 2015 the surface temperature of Somenos Lake varied from a low of 4.3ºC on January 4th to a high of 28.7ºC on July 3rd. Temperature and oxygen conditions in the lake rendered it unsuitable or even lethal to salmon between mid-May and the end of September. Tributary creek temperatures rarely exceeded 18ºC throughout the monitoring period. Unfortunately their suitability as refuge habitat for salmonids during the summer may have been compromised by low discharge, particularly in Richard's Creek as water from Crofton Lake was held in reserve for the town of Crofton for the entire summer.

Introduction

The Somenos Watershed

Somenos Lake and its tributaries: Averill Creek, Richards Creek and Bings Creek (Figure 1), have long been recognised as spawning and rearing habitat for Pacific Salmon. Coho Salmon ascend the tributaries in relatively large numbers to spawn in the late fall and early winter. As many as 30- 150 spawning adults have been observed in Bings creek, 15 to 30 in Averill Creek, and several dozen to just over 1000 in Richards Creek (Burns 2002). After emergence in the spring, an unknown portion of the salmon fry will move downstream to Somenos Lake during the spring and early summer. Similar behaviour is observed in Mesachie Lake where some Coho Salmon juveniles rear in the lake while others remain in streams around the lake throughout their freshwater residency (Swain and Holtby 1989). Somenos Lake becomes very warm during the summer and also experiences very low oxygen concentration. Therefore, it has been thought that some portion of the juvenile salmonid population must re-ascend the three tributary streams as summer refuge habitat (Burns 1999).

Like other sub-basins of the Cowichan Valley, the Somenos area has been experiencing decreased surface water flow in the recent past. The Canadian Water Survey maintains a gauge near the mouth of Bings Creek. Average monthly discharges in August and September at the station have been declining since 1970 (Figures 2 and 3). Since the turn of the Century August and September discharge is often one third to one half of its range in the 1960s. A forecasting model fitted to the historic trends suggests that by the year 2040 Bings creek may run dry as often as once every four years in August and once every ten years in September,

Figure 2 and 3. This trend is problematic for salmonids seeking summer refuge habitat in four ways:

- less habitat will be available,
- access to refugia from predators may be restricted by limiting juvenile salmonids to mid-channel areas,
- movement within a given creek, or between the lake and the tributary creeks, will be more difficult, and
- lower and slower flowing water is more likely to approach temperatures unfavourable to juvenile salmonid growth,

Given that the three tributaries must provide a cool, oxygenated refuge for juvenile salmon in the summer, the declining trend in summer discharge may be a threat to juvenile salmon survival. Such a situation has previously been identified in portions of Richards Creek, near Somenos Lake. Low summer flow and extraction of water for agricultural use may have caused the lower reaches of Richards Creek to reverse flow. It is thought, this mechanism contributed to a die off of juvenile salmon in 1998 (Burns 2002). In order to prevent such an event from recurring and enhance upstream rearing habitat, summer water flow to Richards Creek has been expanded using stored water from Crofton Lake (Craig 2008). Based on the findings from the 2008 BCCF survey, it was recommended that discharge be maintained at approximately 0.03 m^3/s.

The Role of Cyanobacteria in Somenos Lake

Somenos Lake is also subject to extremely low oxygen concentrations associated with blue-green algae (cyanobaceria) blooms during the warmest months of the summer, Picture 1. This situation arises from the dual action of lower oxygen solubility in warmer water combining with oxygen depletion by heterotrophic bacteria in the lake feeding upon dead blue-green algae (Williams and Radcliffe 2001). The blue-green algae has been observed to grow in highly productive blooms in the summer months since the 1980s. These highly productive phytoplankton are not readily consumed by zooplankton, insects or benthic invertebrates. The rapidly growing and dying blue-green algae are instead consumed by heterotrophic bacteria. It is the resulting respiration by heterotrophic bacteria that depletes oxygen in the lake. This phenomenon has been observed in several other low elevation lakes in and around Southeast Vancouver Island, e.g., St. Mary Lake, Prospect, Langford, Swan, Florence, Glen, Quennell, and Elk Lake (Nordin 2015). The fuel for these blue-green algae

Picture 1: Mats of blue-green algae growing in Somenos Lake during the summer of 2015. Picture courtesy of Barry Hetschko.

blooms is phosphorous that has been put into the lakes by surrounding suburban lawns, agricultural fields and septic tank runoff.

When phosphorous is relatively high concentration relative to nitrogen, blue-green algae, cyanobacteria, can outcompete other phytoplankton species for nutrients. In many lake ecosystems around Southeast Vancouver Island phosphorous loading has been so consistent that the accumulated phosphorous is actually the primary ‘fuel’ powering cyanobacteria blooms (Nordin 2015).

Blue green algae creates poor fish habitat in Somenos Lake in several ways. Firstly, blue green algae are not easily accessible by the zooplankton species which are food for juvenile salmonids. By outcompeting other phytoplankton for resources the cyanobacteria truncate the food web and allow far less energy to be accessible to higher trophic levels. Secondly, cyanobacteria blobs trap more solar radiation in the lake causing temperatures to be higher than they otherwise might have been. Thirdly by increasing temperature the amount o oxygen that can be dissolved in the water column is reduced. Fourthly, as the largely unconsumed cyanobacteria rapidly grow and die they sink through the water column and are ultimately consumed by other bacteria species in deeper waters. This bacterial respiration is what causes the anoxia in near bottom water. In a perverse feedback loop, low oxygen levels liberate compounds containing phosphorous from the lake bottom (the accumulated phosphorous referred to in the preceding paragraph) which further fuels cyanobacterial growth in the lake.

Juvenile Salmonid Habitat Requirements

It is known that water temperatures over 18ºC begin to exclude juvenile Coho Salmon from a given habitat. Exposure to temperatures over 21ºC for extended periods is deleterious to salmon growth and long-term exposure to water over 25ºC is lethal (Carter 2005a). When oxygen concentration in aquatic habitats is lower than 6mg/l production impairment has been observed in Coho, Chinook and Steelhead Salmon and there is a strong risk of lethality when dissolved oxygen is lower than 3mg/l (Carter 2005b).

It is well known by local people that Somenos Lake was a place which supported juvenile salmonids and adult trout throughout the summer months before the persistent appearance of cyanobacteria blooms. Indeed, the institutional memory of these favourable summer conditions can be seen in the large and regular releases of Cutthroat and Rainbow Trout into Somenos Lake throughout 1970s, 1980s, 1990s and 2000s. These trout, along with juvenile salmonids, likely found refuge in cooler deeper portions of the lake. Although surface lake temperatures were historically quite similar to those observed today, the deeper waters were not anoxic as blue-green algae blooms had not yet become a frequent occurrence. The lake was a habitat which provided a food web which provided forage to salmonids as well as a temperature refuge. Therefore the hatchery releases were intended to support a fishery which lasted throughout the year. However, the last 20 years have demonstrated that Somenos Lake is no longer a viable habitat for either juvenile or adult salmonids during the summer.

In order to assess the quality and use of available summer rearing habitat by salmon juveniles, we installed temperature data loggers at several points in the Somenos Basin. Our original proposal also included an intensive seining and trapping program to determine the timing of movement by juvenile salmon between the tributary and lake habitats in the spring, summer, and fall. Due to the funding realised for this project and the delay in obtaining a scientific fish collection permit from the Ministry of Forests, Lands and Natural Resource Operations (MFLNRO - Provincial Government), we were only able to conduct two rounds of trapping in the tributaries; the first in early October and the second in early November. By determining the location and extent of favourable rearing habitat and the timing when juvenile salmon would be attempting to access new habitats, we hoped to inform management options regarding fish passage improvement and the protection of water flow and temperature.

Methods

We reinstalled Onset Hobo temperature data loggers at 2 stations in the Somenos Basin: one in the lake (the 'deep' lake station which is at the point of maximum depth) and 1 in the Bings Creek at an easily accessible site near the intersection of Phillip and Mary Street. The temperature station in the lake was anchored to the bottom at about 7m depth, with a line to a surface float. Data loggers were hung at intervals of 1m from the surface to 6m depth. Observations from 2014 demonstrated that measuring temperatures in all three tributaries was not necessary as there was a very high correlation between the trends and absolute values in all three creeks (Preikshot et al. 2015). The devices were configured to record temperature every 15 minutes and are expected to function for 6 years.

Volunteers used a Wet Pro water analysis kit (wet-pro.ca/) from Cura H_2O (curah2o.com/) to collect data on temperature and dissolved oxygen at a station by Drinkwater Road Dock and the middle of Somenos lake (Figure 4). Training in the proper use of this equipment in the field was provided by Cura H_2O. Data collected by volunteers, also included Secchi Disk depths and atmospheric conditions at the two lake stations. Between mid-May 2015 and the end of September 2015 daily observations of oxygen concentration, temperature, pH, conductivity and total dissolved solids at the Drinkwater Road station, were made at the surface, 1 and 2m depth. During the same period observations of oxygen concentration, temperature, pH, conductivity and total dissolved solids were collected weekly at the deep lake station for the surface, 1, 2, 3, 4, 5, and 6m depth. Observations at both stations were made between 1100 and 1400 hrs.

Fish in stream habitats were obtained by a pole seine 5m wide by 2m deep with a 6mm mesh. The pole seine was operated in pool reaches with one person near the steepest of the two banks and the other in deeper water (or across the stream when possible). The person in deeper water would be a pace in front of the person by the steep bank and the pole seine was moved upstream to the end of the pool. No sample sites exceeded 2m depth. Samples were taken on 17 June, 07 July, 31 July, and 01 September.

One beach seining operation was conducted in the lake on 16 June 2015. The net was 2m deep by 10m long with a mesh of 6 mm. A persistent and potentially toxic blue-green algae bloom in Somenos Lake compelled us to avoid sampling for the remainder of the season.

Results

Trends recorded both in the lake and Bings Creek in 2015 were similar to observation made in 2014, Figures 4 and 5. A six week gap appears in the lake data, due to the disappearance of the Lake data logger array in mid-May. Due to good fortune, temperature data for the period from October 2014 to early may 2015 had been downloaded from the loggers in early May thus preserving the Winter and Spring data. New data loggers were ordered and in place by mid-June. Near-surface peak lake temperature in 2014 was 25.5ºC on the 05th of August and in 2015 was 28.1ºC on 03 July. The near surface temperatures were well over 21º for most of the time from mid-June to the end of August 2016.

In 2015 water temperature in Bings Creek exceeded 18ºC intermittently. As with the lake data the absolute peak temperature in 2015 was higher than that observed in the previous year, Figure 5.

Although the surface temperature in the lake in 2015 was quite higher than 2014, fall turnover occurred on August 31, more than three weeks prior to fall turnover in 2014. As in 2014 this mixing event was coincidental with a significant rainfall. Temperature near the lake bottom remained below 18ºC in the summer of 2016 until the mixing event at the end of August.

Measurements of dissolved oxygen at the Somenos Lake 'deep' station show that very soon after thermal stratification of the lake, in early June, waters below 3m depth were subject to hypoxia and those below 4m depth were subject to anoxia until the turnover event in late August. During the turnover event observations show that the mixing of anoxic water had the effect of lowering dissolved oxygen *throughout* the lake. Figure 6. During even the warmest period of the summer, the top 2m of the lake was well oxygenated (5-11 mg/l). Results from the volunteer water sampling work, from both the lakeside sampling station and 'deep' station are being transcribed to a computer database hosted by the Somenos marsh Wildlife Society and are also periodically uploaded to the Cura H_2O online database (curah2o.com/water-quality/).

The observations of pH reflect the remarkable chemical dynamics arising from the summer cyanobacteria bloom. During the period in which cyanobacteria were easily observable in the lake pH was often near 9 and peaked at almost 10 on 01 July 2015, Figure 7. A pH of 10 is similar to that which one might find for borax as used in home cleaning applications. This high pH reflects the removal of carbon from the water column by the blue-green algae. During the period from January to March 2015, the deep waters of the lake appear to have been below the BC provincial water quality guidelines (Water Protection & Sustainability Branch, Ministry of Environment. 2015).

Pole seining in the tributaries yielded Coho Salmon at all four sites sampled. Coho Salmon abundances declined through the summer particularly over the last month, Figure 10 and Table 1. While the juvenile Coho Salmon appeared to grow during the first two month of sampling, those found in September were smaller than those sampled at the end of July, Figure 9 and Table 1.

In the beach seine of the lake on 16 June, 2016 we found over 2500 juvenile and afult Pumpkinseed Sunfish (*Lepomis gibbosus*), just over 400 Peamouth Chub (*Mylocheilus caurinus*) a cople of dozen Brown Bullhead (*Ameiurus nebulosus*) and about 100 American Bullfrogs (*Rana catesbeiana*). The absence of salmon or trout in the lake during the summer mirrors observations made in 2014 (Preikshot et al. 2015). Threespine Stickleback (*Gasterosteus aculeatus*) were not found in the lake in summer 2015, whereas they appeared in lake samples from the summer of 2014.

Discussion

As mentioned in the introduction a survey of Richards Creek (Craig 2008) suggested that releases 0.028 m^3 of water from Crofton lake throughout the summer would enhance available fish habitat while ensuring water storage for domestic use. However, it came to our attention towards the end of the summer that flow in Richards Creek appeared to be much lower than observed in the previous two years. Our supposition had been that this low flow reflected the hot dry conditions that were manifested as very low flows in the Cowichan River. We were advised towards the end of the summer that the Municipality of North Cowichan had, in fact, reduced discharge from Crofton Lake by about 90% from the recommended level. This reduced flow was intended to serve Crofton Lake’s function as a backup water source for the town of Crofton in the event of the Cowichan River running dry before the end of the summer. Given that there was a sharp decline in both abundance and mean length between the end of July and beginning of September there was likely significant mortality of larger juvenile Coho Salmon in the particularly warm summer, given that habitat was likely limited in all three tributary streams. Maintenance of discharge in Richards Creek could have acted to mitigate this die-off in the late summer of 2015.

While Richards Creek is recognised to be the location of most adult Coho Salmon spawning in the basin, both Bings and Averill creek exhibited higher abundances of juvenile Coho salmon (per unit of fishing effort) in our sampling. This discrepancy may be a result of the less habitat being available in Richards Creek as a result of lowered discharge from Crofton Lake.

Another effect of the lowered discharge from Crofton Lake may have been to confound the goal of using higher summer flow in Richards Creek to alleviate anoxia in the lower reaches of Richards Creek, where the habitat is more representative of the conditions found in Somenos Lake. This would be the dredged habitat from the north end of Somenos Lake to the Herd Road Bridge. The lower reaches of Richards Creek therefore may have acted as a barrier to the movement of juvenile salmon back into Richards Creek at the onset of summer and could prevent the fish from reaching summer refuge habitat in upper Richards Creek.

Our results demonstrate that Somenos Lake continues to be unviable as summer rearing habitat for juvenile salmonids. For the period between early June and early September, the surface water was sufficiently warm (>20ºC) that it would likely have caused juvenile salmonids to actively avoid it (Carter 2005a). Although deeper lake water was sufficiently cool for salmonids during this period, the dissolved oxygen concentration was so low that it would have caused any salmonids present to perish (Carter 2005b). Stream habitat was sufficiently cool during the summer that it would have fostered survival and growth of juvenile salmonids (Carter 2005a). We caught salmonids at all tributary habitats throughout the summer demonstrating their affinity for these sites. Therefore, the drastic decline in length and number of Coho Salmon juveniles throughout the Somenos Basin in the late summer was likely a function of reduced foraging habitat area rather than temperature. It is well established that juvenile Coho Salmon are highly competitive for foraging habitat in stream environments (Swain and Holtby 1989). Smaller habitat area may also have the effect of increasing predation by animals such as Mergansers, Great Blue Herons, and River Otters (Sandercock 1991).

The very high pH observed in near surface water of the lake is a source of some concern. At the high pH levels observed in Somenos Lake during the summer of 2015 the chemistry of ammonia would likely have been toxic to many of the fish (Horne and Goldman 1994).

The high pH near the surface and anoxia near the bottom of the lake are two limitations to the restoration of the Lake as suitable summer habitat for Trout and Salmon. The source of this problem is recognised as the persistent cyanobacteria blooms that occur each summer fuelled by high phosphorous levels in the lake bed. One solution commonly used is deep-water aeration which binds phosphorous to compounds in the lake bed. Several years of aeration can potentially allow the phosphorous to be isolated from the lake water by sedimentation thus rendering the fuel for the cyanobacteria bloom inaccessible. This approach is being used in Elk Lake (Nordin 2015).

Unfortunately aeration is unlikely to serve in Somenos Lake as it is too shallow. However a potential remedy to this situation may be found in recent studies in Alberta (Orihel et al. 2016) which suggest that addition of iron to lakes can significantly reduce the incidence and strength of blue green algae blooms. Phosphorous becomes bound to the iron and is removed from the water column by sedimentation. Investigations of this approach may be useful in Somenos lake as it would be a cost-effective means of reducing the amount of cyanobacteria in the lake and recreating the characteristics of historic summer lake conditions.

Invasive Pumpkinseed Sunfish proved to be shockingly abundant in our lake sample. If the relative abundances from our net are indicative of the Lake in general we can infer that almost 90% of fish biomass in Somenos Lake in the summer is invasive. This ratio of invasive biomass would be even greater if one was to also consider the contribution of American Bullfrogs. This state of affairs is likely aided by the ability of bullfrogs to avoid effects of anoxia as they can breathe air.

Peamouth Chub continue to be abundant at both the Averill and Bings creek sites as well as in the lake. This biology of this species is poorly understood but of great significance in terms of the biodiversity of the Somenos Basin. As it happens Peamouth Chub is only found in three watersheds on Vancouver Island; Kennedy Lake, Nanaimo River and Somenos Lake. It has been suggested that while the Kennedy lake population was caused by human activity the colonisation of the Nanaimo and Somenos systems occurred when fish from the Fraser River became entrained in a freshet and were transported across Georgia Strait (Clark and McInerny 1974). The length of time that Peamouth Chub have been in Somenos Lake is thus poorly understood and they may merit consideration for protection due to their uniqueness and the threats to their habitat in Somenos Lake.

An invasive plant species called Parrot Feather was observed in Somenos Creek near the end of summer 2015. Although this was outside our study area the phenomenon is of potential importance to Salmonids in that it may represent a barrier to downstream movement of age one Coho and Steelhead salmon during their migration to the sea. Parrot feather grew in such thick mats that waterfowl were observed by the author to be able to walk upon it in the middle of the creek channel, Picture 2. Removal of this plant may already not be possible. At the very least a priority of ecosystem management in the Somenos basin should be the prevention Parrot Feather's establishment of in the tributary Creek habitats. The arrival of parrot Feather in the tributary creeks may severely degrade the already highly compromised salmon refugia there.

Picture 2: A group of Coots walks upon dense Parrot Feather growth in Somenos Creek in the late summer of 2015. Picture courtesy of Barry Hetschko.

Conclusions and Recommendations

Juvenile salmon appear to continue to use the tributaries of the Somenos basin as summer rearing habitat although the quality of this habitat may have been degraded in the summer of 2015 by a combination of hot dry conditions and water management policies for Crofton Lake. Potential movement of juvenile salmonids between the lake and upper Richards Creek may be restricted by the conditions of lower Richards Creek. Allowing juvenile salmon to access cooler creek habitats in the summer is necessary to avoid die-offs in warm low oxygen waters found in the Lake during the period from July to September. Addressing this concern is of particular importance due to the trends in summer discharges we forecast for the creeks in the Somenos wastershed.

An important goal of our project remains the determination of the timing of movement by juvenile salmon between lake and tributary habitats. Sampling in the future should be expanded to the spring and fall and potentially be expanded to consider the movement of age 1 Coho Salmon to the Ocean during the spring of their second year of life. Consideration may also be given to mark and recapture experiments to determine the proportion of the population of juvenile Coho Salmon that remains in stream versus those which may move to the lake at some time in their first year of life.

Management options which should be considered to ensure the availability of creek habitat to salmonids during the summer include:

- assurance of sufficient discharge in tributary creeks including the release of water from Crofton lake and the monitoring of water licences in Bings and Averill Creek to avoid causing harm to fish and fish habitat,
- facilitation of fish passage at creek mouths where flow can be spread out over marshy habitat;
- improving fish passage in culverts to ensure that fish are able to access tributary streams from Somenos Lake, e.g., installing “baffles” to slow the water in the Averill Creek culvert as suggested by Burns (2002);
- habitat improvements in the lower reaches of Richards Creek which could increase available summer habitat and enhance fish passage;
- enhancement of riparian vegetation to ensure shading and cooler water temperature in tributary creeks.
- consideration of an iron-phosphorous amelioration study for Somenos Lake to reduce the size and duration of cyanobacteria blooms
- removal of Parrot Feather in Somenos Creek and prevention of its expansion to the Somenos wastershed above the lake

This project was successful in creating a partnership between professional researchers and a team of community volunteers. The result of this partnership was the creation of a locally based monitoring plan that can assess habitat quality in the Somenos basin and will help identify future research priorities and management options. The participants in this project would like to express their thanks to the TD Friends of the Environment Foundation for providing the grant support that made our research possible.

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Figures and Tables

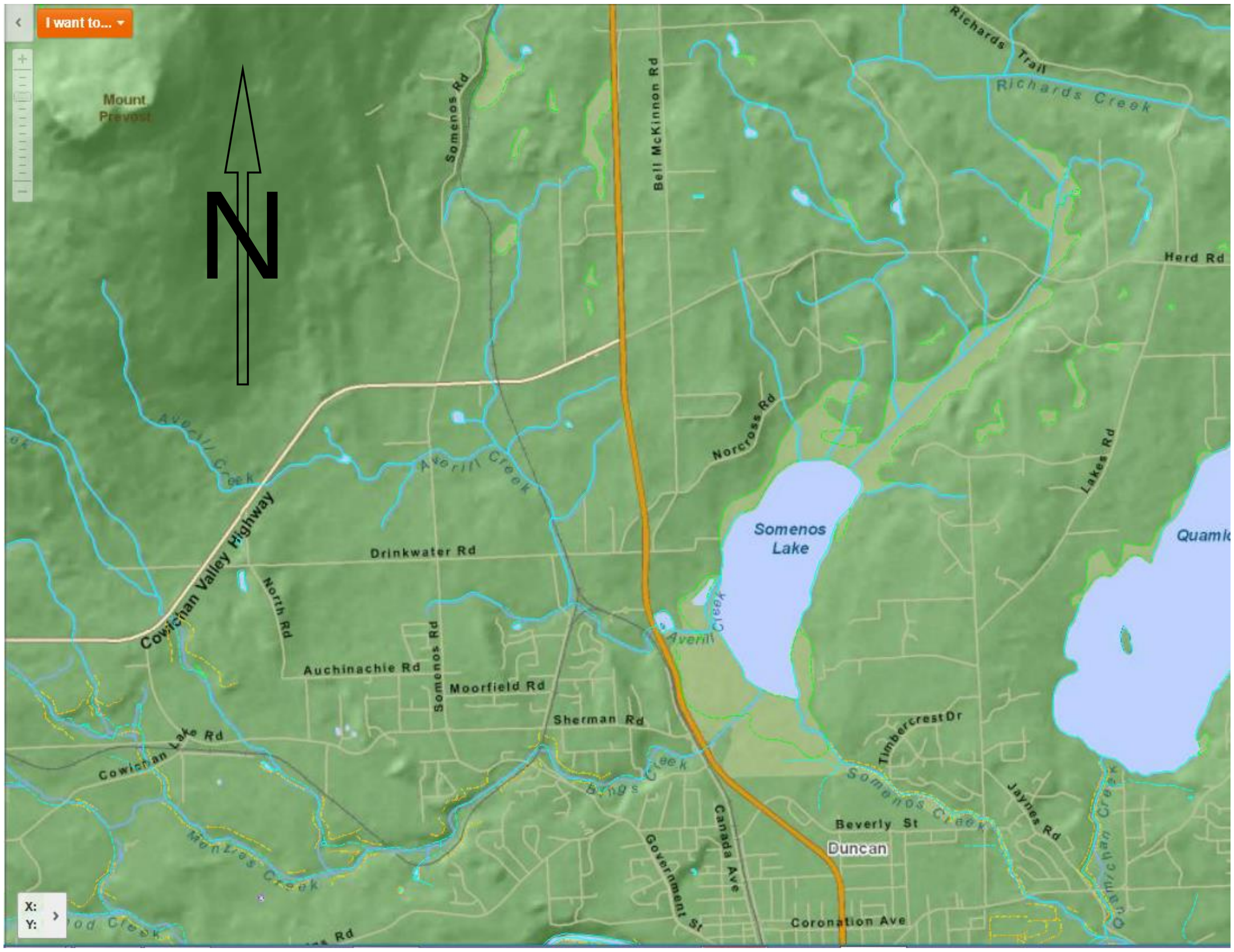

Figure 1: The Somenos basin in the Cowichan Valley, southeast coast of Vancouver Island and sampling sites used in this study. The map was developed courtesy of the British Columbia Ministry of Environment Habitat Wizard web GIS system (www.env.gov.bc.ca/habwiz/).

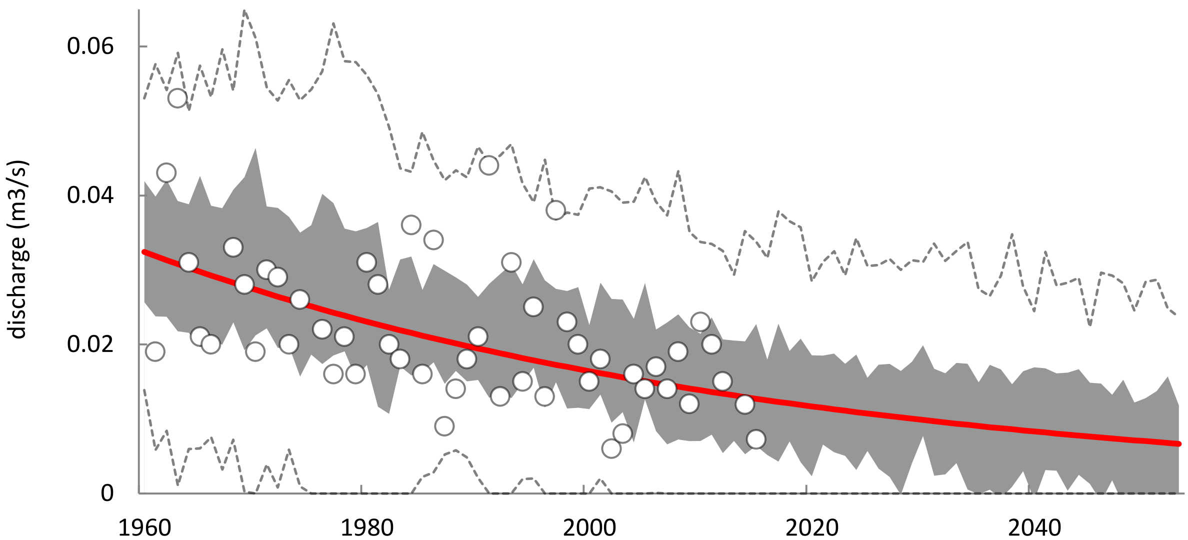

Figure 2: Mean August discharge (circles) in Bings Creek, 1960-2015 (Environment Canada data from wateroffice.ec.gc.ca/). The red line shows modelled mean August discharge with a logistic regression fitted to historic data. This model was used to generate hindcasts and forecasts of mean August discharge from 1960 to 2050 by modelling potential annual variability as a function of the difference between observed discharge data and modelled hindcast data. The gray line shows the ±50% confidence interval and the dotted lines show the ±95% confidence intervals after 100 simulations.

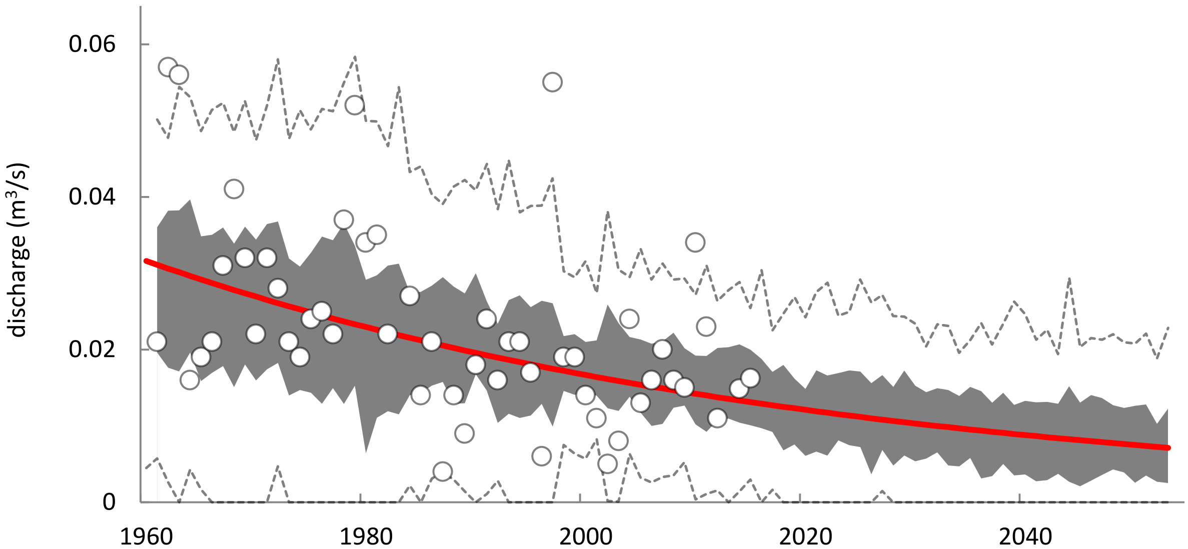

Figure 3: Mean September discharge (circles) in Bings Creek, 1960-2015 (Environment Canada data from wateroffice.ec.gc.ca/). The red line shows modelled mean September discharge with a logistic regression fitted to historic data. This model was used to generate hindcasts and forecasts of mean September discharge from 1960 to 2050 by modelling potential annual variability as a function of the difference between observed discharge data and modelled hindcast data. The gray line shows the ±50% confidence interval and the dotted lines show the ±95% confidence intervals after 100 simulations.

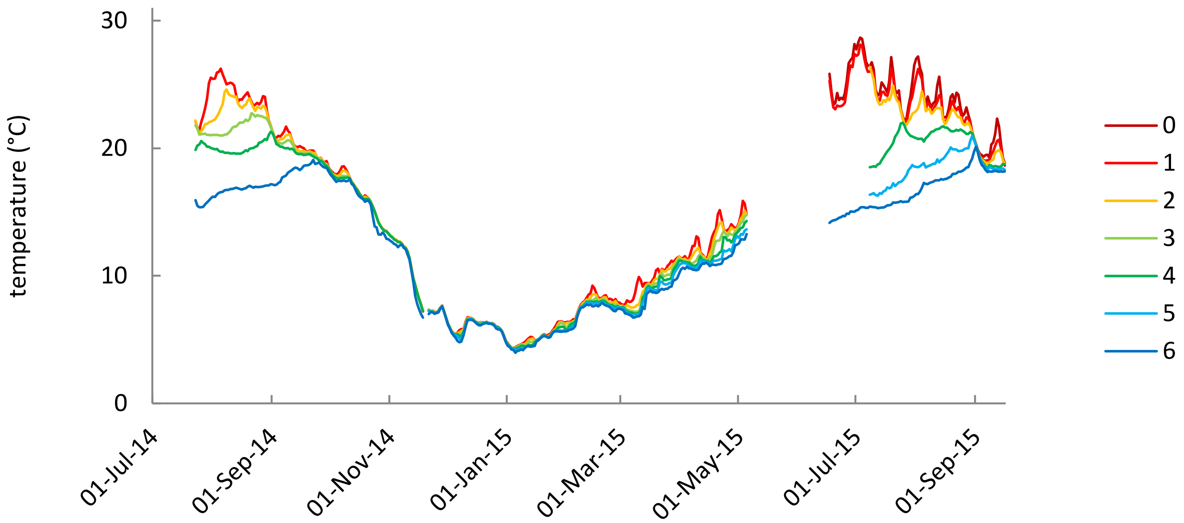

Figure 4: Average daily temperatures measured at the Somenos Lake station, July 2014-September, 2015 at 0m (surface) to 6m depth. Note the missing data for early May to mid-June due to the disappearance of the temperature data logger array.

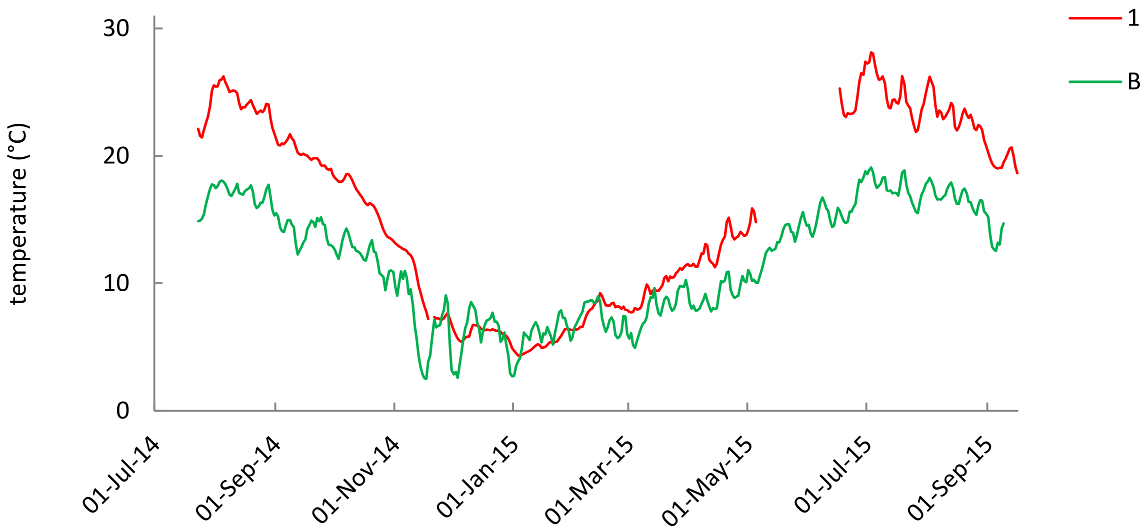

Figure 5 Average daily temperatures measured in Bings Creek (green line) versus temperature recorded a 1m depth (red line) in Somenos Lake, July 2014-September 2015.

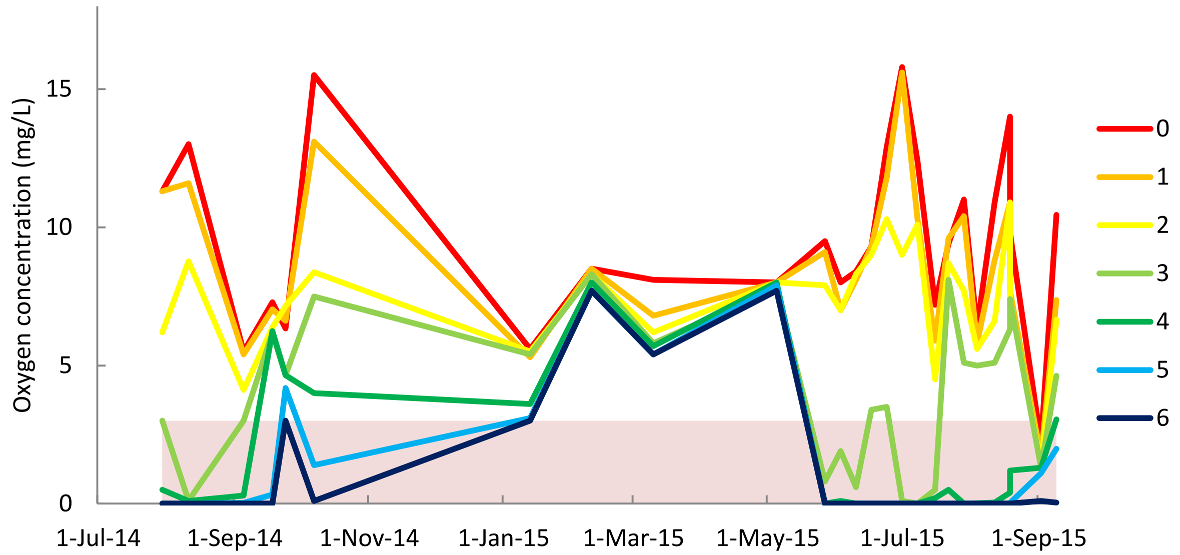

Figure 6: Observations of dissolved oxygen made at the Somenos Lake ‘deep’ station between July 2014 and September 2015. Measurements were taken at the surface, (0m) and at each meter interval to 6m depth. The red area indicates oxygen concentrations which are harmful or fatal to juvenile salmonids Carter 2005b.

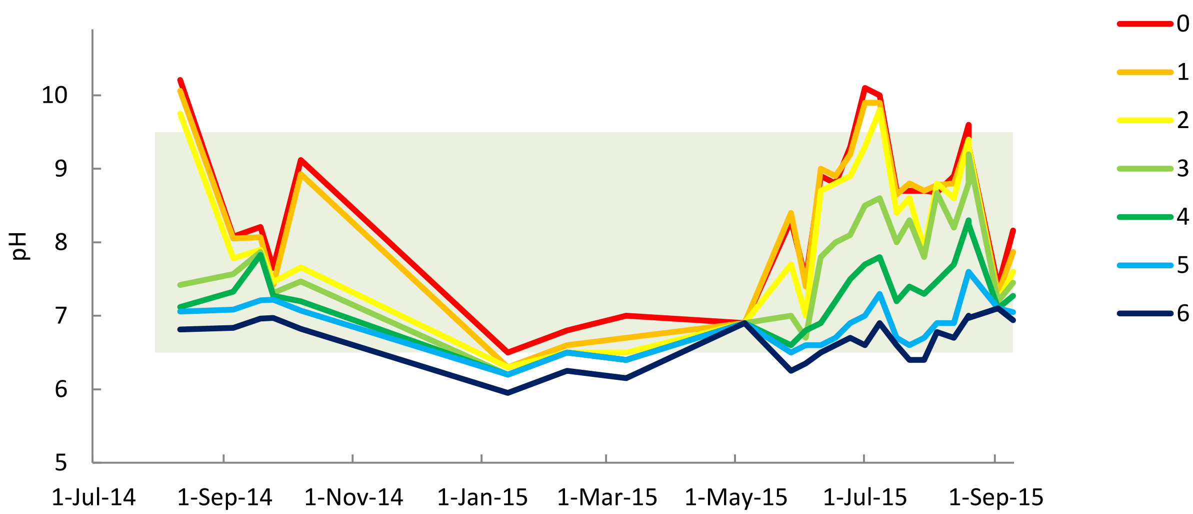

Figure 7: Observations of pH made at the Somenos Lake ‘deep’ station between July 2014 and September 2015. Measurements were taken at the surface, (0m) and at each meter interval to 6m depth. The green area indicates the range deemed as acceptable for sustaining fish populations (Water Protection & Sustainability Branch Ministry of Environment 2015)

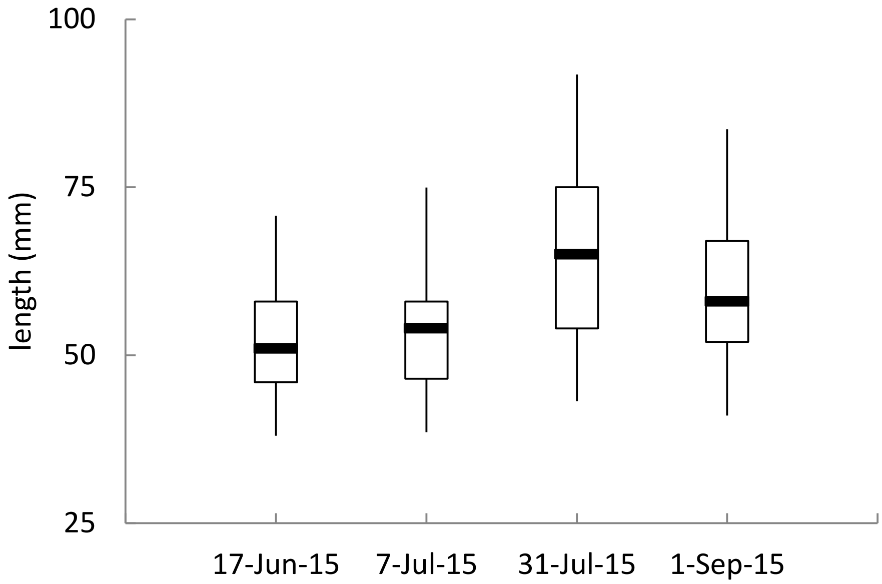

Figure 8: Mean fork lengths (bars) with ±50% (bars) and ±95% (whiskers) confidence intervals for juvenile Coho salmon at the four creek sampling stations during the summer of 2016.

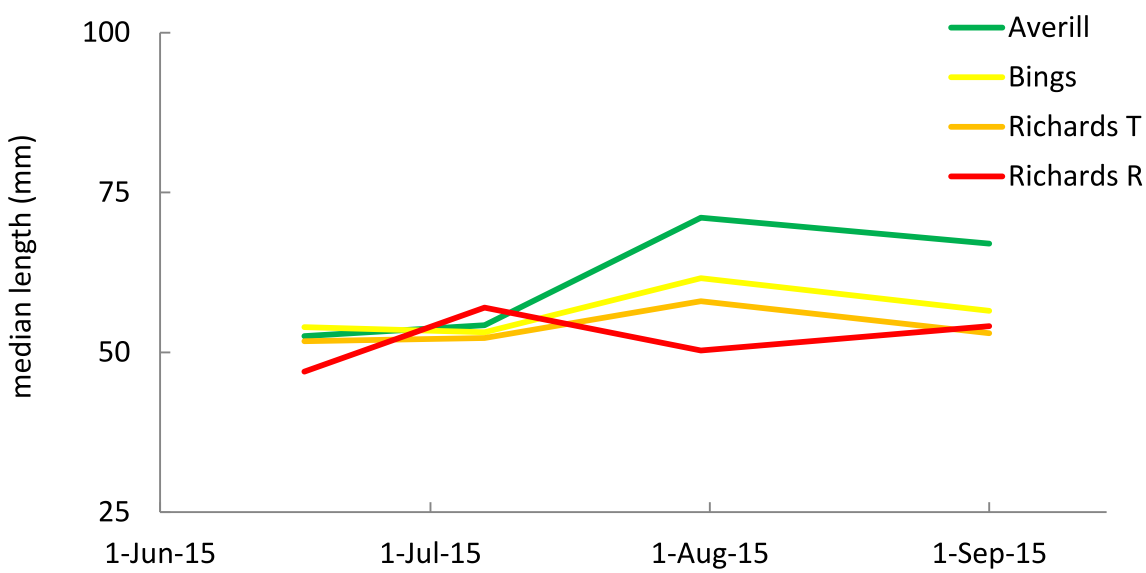

Figure 9: Trends in mean fork lengths for juvenile Coho Salmon observed in each of the four creek sampling sites during the summer of 2015.

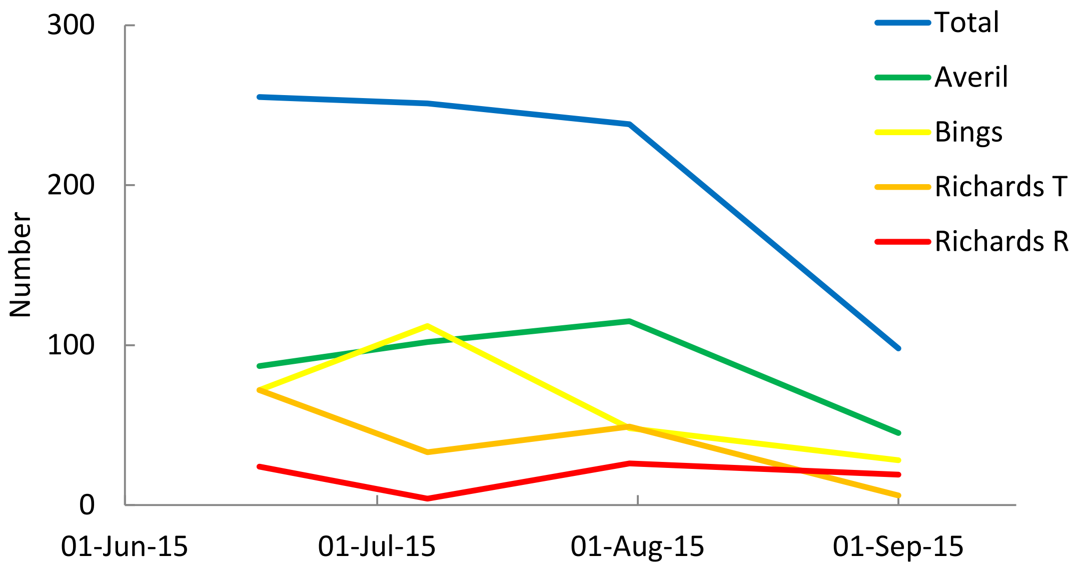

Figure 10: Trends in catches of Coho Salmon at each of the four creek sampling sites during the summer of 2015)

Table1: Total Catch (number) and mean lengths (mm) for fish species caught at Rice Road (Rice R) and Richards Trail (Rich T) on Richards Creek, Averill Creek near the Trans Canada Trail and Bings Creek near the intersection of Phillip and Mary Street on 17 June, 07 July, 31 July and 01 September 2015.

	Catch				**Mean Length**			
	Rice R	Rich T	Averill	Bings	Rice R	Rich T	Averill	Bings
17-Jun-15								
Coho	24	72	87	72	47.9	52.2	52.5	54.1
Cutthroat		2				101.0		
Rainbow								
Peamouth			17	4			64.5	63.5
Sculpin								
Stickleback				9				57.7
07-Jul-15								
Coho	4	33	102	112	51.7	57.8	71.2	61.7
Cutthroat	1	2			190.0	155.9		
Rainbow	2	3						
Peamouth			2	2			62.8	74.6
Sculpin			1				44.0	
Stickleback				1				35.3
31-Jul-15								
Coho	26	49	115	48	62.7	52.4	54.5	52.7
Cutthroat	1	8			230.0	112.5		
Rainbow					90.0	103.3		
Peamouth			3	5			57.2	62.0
Sculpin			1				47.0	
Stickleback				25				52.7
01-Sep-15								
Coho	19	6	45	28	54.5	52.8	66.7	56.4
Cutthroat	2	1	1		192.5	40.0		
Rainbow	5							
Peamouth			3	1			70.0	
Sculpin			1				50.0	
Stickleback			3	67			29.3	33.8

Table 2: Total catch (number) and mean lengths (mm) of fish caught during the Summer beach seine event in Somenos Lake on 16 June 2015. Lengths were not take for American Bullfrogs.

	Peamouth Chub	Bullhead Catfish	Pumpkinseed adult	Pumpkinseed juvenile	American Bullfrog
catch	405	24	1257	1272	99
mean length	64.7	73.0	114.6	52.8	