Fraser Basin Council

Cultus Lake Aquatic Stewardship Strategy (CLASS)

March 6, 2012

> 5 - Year Report,
Oct. 2007 to March 2012.

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For the Cultus Lake Aquatic Stewards

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1926 Cultus Creek watercolour by A.Archibald, courtesty of L. Kirkness

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are needed to see this picture.

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Executive Summary

Cultus Lake is one of the most valuable places for its beauty, for wildlife, fish and for the shared human interest since time immemorial.

This Lake has become a popular destination where human impacts must be managed to ensure a safe and healthy future for fish and for human beings. The economy of 3 million visitors (FVRD 2010) requires a healthy lake. Economic multipliers are valued at $27 million and the time has come to export nutrients from the Cultus Lake watershed. We must manage the human impacts so ecosystem services continue to make this one of the best places in the Fraser Valley.

Since October 2007, the Cultus Lake Aquatic Stewards have addressed lake water quality by "building community" around the issues, bringing awareness and necessary actions. Facilitated by the Fraser Basin Council, all interests and sectors were brought together, each in their own way, to take action benefiting the Lake. The strategy is to bring together the science and the people; to build community around the issue of caring for Cultus Lake. The appendices in this report reflect both the science and the social work to make the necessary changes. We found out that information by itself, does not make decisions. Therefore, the process must be designed to move the human heart to action.

Achievements include: 1. Gathering information, 2. Building community and 3. Stimulating new scientific research to understand nutrient impact. Specifics include: Issues Workshop, Oral History Project, Literature Review, Caring For Cultus booklet, Cultus Lake 3 dimensional map, Cultus Pygmy Sculpin Workshop, Lake Levels, Sewerage Com'ty, Cultus Lake User Survey 2010 and partnering with new science regarding Nutrient Mass Balance, also known as the Scoop On Poop.
New work is emerging with Species At Risk, i.e., Cultus Lake is the only place in the world that is home to the Cultus Pygmy Sculpin. The CLASS network partners are also addressing predator control, milfoil, sockeye recovery, species at risk, invasive plants (milfoil and iris), mitigating resource extraction sediment flows, and supported dialogue with local governments, neighbours and First Nations.

Lake care issues have included: human impacts with nutrient loading from septic tanks and lawn fertilizers, hydrocarbons, bird nutrients, resource extraction impacts, lake levels, sedimentation/turbidity and invasive aquatic plants.
Cultus Lake is home for 19 species of fish, including the COSEWIC[1] listed populations of Cultus Sockeye and for the SARA[2] listed Cultus Pygmy Sculpin. It is expected that if the Lake is healthy for fish that is will be good for people, too.

[1] Committee On The Status Of Endangered Wildlife in Canada

None of this work would have been possible without the residents, volunteers, agencies and funders. Funders over 5 years include the Fraser Basin Council, Fisheries and Oceans Canada, BC Min. of Environment, Fraser Salmon Watershed Program, Canadian Wildlife Federation, Vancity Savings and Credit Union, Cultus Lake Parks Board and the Fraser Valley Regional District. Thank you to all.

There is more lake-caring work to come.
We invite you to engage with Caring For Cultus Lake. The volunteer website is http://cultusstewards.shawbiz.ca/

[2] Species At Risk Act (of Canada)

List of Acronyms

ABCD	Asset-based Community Development
ATV	All terrain vehicle
BCMOE	BC Ministry of the Environment
BCTS	BC Timber Sales
C2C	Community To Community Dialogue, funded by UBCM
CFD	Chilliwack Forest District
CLASS	Cultus Lake Aquatic Stewardship Strategy (group)
CLPB	Cultus Lake Parks Board
CLRA	Cultus Lake Residents Association
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CW	Chilliwack
CWF	Canadian Wildlife Federation
DFO	Dept. of Fisheries and Oceans Canada
DO	Dissolved oxygen
FBC	Fraser Basin Council
FNs	First Nations
FSWP	Fraser Salmon Watershed Program
FVIPC	Fraser Valley Invasive Plant Council
FVRD	Fraser Valley Regional District
FVWC	Fraser Valley Watersheds Coalition
LBRA	Lindell Beach Residents Association
MFLNRO	BC Ministry of Forests, Lands and Natural Resource Operations
NGOs	Non-governmental organizations
PSF	Pacific Salmon Foundation
RJ	Restorative Justice
SARA	Species At Risk Act
SN	Sto:lo Nation
STC	Sto:lo Tribal Council
TEK	Traditional Ecological Knowledge
TOR	Terms of Reference
UBCM	Union of BC Municipalities

About Cultus Lake

Situated about 80 kilometers east of Vancouver, Cultus Lake (and its creeks) is part of the larger Chilliwack River Watershed, and along with the Vedder Canal drains into the Fraser River, the world's largest un-dammed salmon bearing river. It is a warm lake and is a very popular recreation destination for fishing, water skiing, canoeing and hiking. The Lake is 7 km long and up to 1.5 km wide, about

650 hectares. Cultus Lake is in Sto:lo[3] territory (also known as S'ólh Téméxw) and home to the Chihl-kway-uhk people and Soowahlie First Nation. Sockeye salmon have spawned in this lake since it was formed hundreds of years ago.

The name Cultus comes from the coastal trade language known as Chinook Jargon. The fact that is holds a Chinook name is significant and shows that this water-body has been known for hundreds of years by many peoples. The name translation, commonly given in English, is "bad or worthless" but Elders remind us that Cultus is a powerful place to be respected. Cultus means "don't fool with it. Don't take it lightly. Respect the power and follow spiritual protocols otherwise its goodness will be depleted. The lake would become worthless. It would become *cultus*." This understanding may have come about from the known history and oral tradition about how this lake was formed.

Approximately 800 years ago, there was a new landslide that blocked the former water body, creek and drainage of this valley. The filling waters formed the newer Cultus Lake we know today. Local survivors re-told the story, and this information was carried forward through the oral tradition of the generations.[4] Today geological surveys confirm some of the oral tradition. Recent experience during high rainfall events still result in gravel and debris slides off the Vedder Mountain on the west side. The mountain is not so stable.
"Soo-welz-a" means where the waters have come together to form the lake. This name sticks today in the form of Sweltzer as in the creek.

Cultus Traditional Stories*:*

"Power became used up it became worthless. It became cultus."
"The lake has super natural beings called Stalacums, " explained Cultural Advisor, Sonny McHalsie, at the CLASS/Soowahlie longhouse gathering held at Yakweakwioose. "These stalacums must be respected. We learn to live along side of them and they get to know us. We have learned how to get along. It can be tough for new people."
"Some of the creeks and waterways are home to the two-headed serpent. That is why they have that meandering shape made by the serpent. Cultus Lake used to be a training place for medicine men. These shalams spent time at Cultus and received their power. One time, two shalams in training went out on the lake. One went down into the lake on a rope saying to the other, that when he tugs on the rope to haul him back up. When he was hauled up, he was just a skeleton. His flesh had been eaten up or "melted away." One of the stalacums is like a giant maggot. It eats up."
"When canoe pulling, keep your eyes on the horizon. Don't look down into the water."

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[3] http://en.wikipedia.org/wiki/Sto:lo_people - for more info.
[4] Settler society calls this TEK or Traditional Ecological Knowledge.

The First Songs of the Land[5]

It was in 1911, on Cultus Main Beach, that Skowkale Hereditary Chief William K'HHalserten Sepass (1841-1943) dictated the Sepass Poems – The Ancient Songs of Y-Ail-Mihth.[6] These songs are as significant in this territory as is the Genesis chapter of the Bible or the Vedic text of India. This epic collection of ancient aboriginal poems translated from the original Halq'emeylem (Coast Salish) language into English took place at Cultus between 1911 and 1915. The poems tell the story of the beginning of the world and the legends of Xa:ls (K'HHals), the great Transformer who walked this earth in the distant past to put things right. Today, there are reminders of Xa:ls throughout Sto:lo territory, and throughout all the lands of the Salish people of BC and Washington State. (e.g., Xa:ytem, the Hatzic Rock in Mission, Siwash Rock at Stanley Park, Lightening Rock at Kilgard, the white rock at White Rock beach, Mount Cheam and 197 more of these transformer sites).

Transition to the Modern World

In his lifetime, Chief Sepass witnessed the arrival of European settlers to the Fraser Valley and Cultus area, the Goldrush and 'Steamboat' eras, the arrival of the first Christian missionaries, the establishment of the Indian Residential Schools, the International Boundary Survey, the mapping of Indian reserve lands, the first automobiles, telephones and two world wars. As a young man, he witnessed the devastation of his people – including many members of his own family, from smallpox, influenza, measles, tuberculosis and many other diseases. As an older man, he witnessed the demise of his people's language, culture and history.7

The Beautiful Lake

Cultus Lake is famous for its natural beauty and sockeye salmon. As these most valued qualities are under pressure, it is the intent of the Cultus Lake Aquatic Stewardship Strategy to address the future of this lake's well being. When surveyed[8] (2010), the public responded by saying they love this lake for its

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[5] First Songs of this Land is coined by Lori Paul from Spiderlodge Studio.
[6] http://www.longhousepublishing.com/SponsorPkg.pdf
[7] By permission, Ann Mohs, (republished) Sepass Poems, Longhouse Publishing copyright 2009, Sepass Family.
[8] Cultus Lake User Survey Report is available on http://cultusstewards.shawbiz.ca/

accessibility, proximity to Greater Vancouver, warm swimming temperatures, lovely beaches, park amenities and sense of community.

Cultus Lake is a small, deep lake with steep sides nestled in the edge of the Cascade Mountains. Over ten thousand years ago, the receding glacier had deposited gravels and a glacial moraine at the south end of the lake, known as the Columbia Valley. These gravels are very porous. The Valley has a small portion on the American side of the border and is known for agricultural production surrounded by forest and forest harvests. Cultus Lake is in Sto:lo territory and has many jurisdictional bodies that include: BC Parks, Defense Canada, Fraser Valley Regional District, BC Ministry of Tourism, City of Chilliwack through the Cultus Lake Parks Board, and resource extraction activities such as forestry and gravel extraction that fall under the appropriate provincial and federal ministries. Under the Municipal Gov't Act, it is known as Electoral Area E of the Fraser Valley Regional District and it holds the highest (measured at one third) assessments compared to the other 6 electoral areas.

The lake has diverse communities that live on or near it: Lindell Beach, Columbia Valley, Soowahlie First Nation, Cultus Lake Community, and new development proposals. Current resident population of Electoral Area E (which includes the Chilliwack River Valley) is about 3,500 people.

In 1932, the management of the north end of Cultus Lake was designated to the City of Chilliwack. Chilliwack established the Cultus Lake Parks Board that operates the Cultus Lake Park to this day. Prior to 1932, between 1924 and 1932, a joint committee of the City of Chilliwack and Township of Chilliwack operated the park but this proved to be an onerous task for the councilors for the two municipal governments.

At the other end of the lake the Cultus Lake Provincial Park was established after 1948. The 2,561-hectare Cultus Lake Provincial Park is almost evenly divided between the northwest and southeast sides of Cultus Lake. The northwest portion is mostly in its natural state with the visitor-oriented facilities confined to the south-east portion. The Provincial Park has four campgrounds with a total of 298 campsites, and a large day-use area. Cultus Lake Provincial Park and the Cultus Lake Park have a combined 1,363 campsites/cabins and leases.

About 1901, logging operations have removed some of the old-growth cedars that once surrounded the lake. The 1930s saw increased logging activities as harvesting edged up the mountainsides on both sides of the lake. There was a sawmill and log-sort at Cultus Lake.

In the current era, this lake is getting "loved to death". FVRD traffic counts show more than three million visitors per year in 2010. Most of these are repeat visitors based on the same 130,000 people but they stay long enough to flush the toilet

at least once. Human impacts in the form of nutrients percolating through porous gravels are now measured by scientists through lake core sampling data.

Fisheries and Oceans scientists analyzing the lake core samples, clearly say that the lake is moving towards eutrophication. This means the water is becoming richer in mineral and organic nutrients that promote a proliferation of plant life, especially algae, which reduces the dissolved oxygen content and often causes the extinction of other organisms. The lake is changing. The causes for this process are becoming more understood with the science measuring and researching the increase of human impacts.

Caring for the lake and respecting these waters has long been taught in First Nations communities. The relationship of the Sto:lo people to the lake extends far back in time. Trade routes were well established between the Sto:lo and their southern cousins in what later became Washington State. At one time, a village was located adjacent to Sweltzer Creek and Main Beach but this village was largely abandoned by the 1860s probably because of the loss of population caused by introduced diseases. Nevertheless, the relationship of the Sto:lo to the lake was recognized by the Crown when in 1863, reserve boundaries were established in the Chilliwack area. The Soowahlie boundaries included portions of Cultus Lake. The boundaries however were re-drawn in 1867 and this section of Cultus Lake was omitted from the Soowahlie Reserve. The modern day treaty process is addressing this issue but it remains to be resolved.

At Cultus Lake, in 1958 Berns Mussell, Albert Douglas, and Sam Jimmie invited Chief Richard Malloway to join them in starting up the canoe races and Indian Days in the first week of June, that still take place to this day.

During the 2008 Oral History Project “old-timers” spoke about the sense of community and the wonderful dances held at the Pavilion. They spoke about how popular Cultus Lake had become for Vancouver visitors seeking to escape the city and the ever-present news of World War II. The Cultus community contributed to the war effort and during the last years of WWII, teens at Cultus even developed the Cultus Submarine group. When the war was over, the 1950s saw increased prosperity and family recreation. Cultus became even more popular. The volume of settlement families in the area warranted the building of the Cultus Lake Community School. It was opened in 1953, operating to this day by School Dist. 33 Chilliwack. It has 150 students from grades 1 to 6.

By 1955 power boating traffic increased and it is suspected that invasive Eurasian milfoil arrived at this time. Cultus Lake became the main summer recreational destination in this area. After World War II, many of the summer cottages were winterized and a year round population began calling Cultus Lake home. Many of these older cottages have now been replaced with architecturally designed homes in recent years. Today 1,000 people live within the 65-acre boundary of Cultus Lake Park.

The Cultus Lake community offers waterslides, two golf courses, bumper boats, canoe, boat and jet-ski rentals, marina, miniature golf, restaurants, Laundromat, stores, gas station, church camps, provincial and local campgrounds and summer weekly market. In 2004, a B-rated, sci-fi movie called Snakehead Terror was made at Cultus Lake.

At the same time the south shore hosts the community of Lindell Beach and the newer Cultus Cottages. Southbound, beyond the Lake is the Columbia Valley community that reaches to the USA border. The Columbia Valley has many farms including livestock production, berry production, a winery and specialty crops like garlic or lavender.

Cultus Lake and surrounding area is one of the most loved and beautiful places in BC. In order to keep it healthy and beautiful the future depends on what we do now. At this point in writing the Cultus Lake Aquatic Stewards realize that we collectively need to address the nutrient load, causing eutrophication.

This document is a snapshot in time of the things we know now and is meant to provide information for management decisions towards a better future for Cultus Lake itself.

Xólhmet te mekw'stám ít kwelát.[9]
We have to look after everything that looks after, and sustains, us.

[9] Understood in the Halq'eméylem language of the Sto:lo people.

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

“Cultus Creek” now known as Sweltzer, watercolour by A. Archibald in 1926.
Courtesy of L. Kirkness.

About the Cultus Lake Aquatic Stewards

In October 2007, Dave Barnes phoned Marion Robinson to explore ways to help Cultus Lake. The first workshop was held with 32 people and their input was collated to form the Issues and Topics document (Appendix 1) of which subsequently the network of the Cultus Lake Aquatic Stewardship Strategy was formed. The Terms of Reference are in Appendix 2.
This network, known by the acronym CLASS, meets every month except August and December and includes:
Cultus Community Association, Lindell Beach Ratepayers, Columbia Valley residents, Cultus Lake Parks Board, BC Cultus Lake Park, Citizens On Patrol, FVRD Planning, FVRD Engineering, FVRD Electoral Area Representatives, Fisheries and Oceans Canada (scientists, regulators and community advisor), The Fraser River Salmon Table, The Fraser Valley Salmon Society, The Sport Fishing Advisory Board, the Fraser Valley Watersheds Coalition, The Chilliwack School District, SD #33 Work Experience, Dept. National Defense, Soowahlie First Nation, Sto:lo Tribal Council, Chihlkwayuhk Tribal Society, residents, volunteers, businesses, forestry and gravel operations and more extended networks and friends. Still invited is the BCMOE Lakes Water Quality branch. “It takes a community network to save a lake…” 2010 team picture below.

CLASS Vision Statement:
Cultus Lake is a diverse productive lake ecosystem, offering recreational opportunity that is healthy, safe and enjoyable for all with respect and stewardship of the biological, ecological, spiritual, cultural and aesthetic values of this ecosystem.

The CLASS Strategy

CLASS is a network, not a society, association or even a coalition. Networks enable the input form agencies that cannot be a member of one group or another as is required if CLASS were a society. Networks include more participants. CLASS policy is to be a model of the non-adversarial approach, always building community around the issue. See Appendix "How to Save Salmon"

The strategy is to build cooperation and coordination by bringing agencies and individuals together. This requires a values-based approach that remains inclusive, engaging and seeks rapport with all participants. See Principles Of Operating in Appendix 2 and Building Relations in the last appendices.

Strategy for Working Together[10] *to benefit the Lake:*

			
Inform	**Influence**	**Involve**	**Collaborate**
Build awareness by providing information, TEK, and science	Foster knowledge and understanding by exchanging information both ways and building relations.	Build support and commitment through dialogue and exchanging ideas, both ways, share "ownership" Build community.	Seek shared understanding, common purpose, doing collective action, striving for consensus. Save Cultus Lake.

CLASS knows that information by itself does not make decisions. Therefore it is necessary to build community around the issue. This is done in many ways where groups reach out to groups and the network is grown by making the space to have the deeper conversations. It is through the human relationship that change takes place. It is the sense of connection and belonging that motive people to do their part. Attached are appendices about some of these processes.

[10] Adapted from the work of Ann Landry of Parks Canada.

About the Projects

The efforts in addressing lake care started with gathering information, sharing knowledge and assessing gaps. By connecting with the scientific community we have together come to understand what the lake requires as a system and what the community can do in subject areas. The following is a list by year of actions undertaken. There are many more actions from each involved person. This list is just the beginning of a network fanning out from those that care about Cultus Lake.

2007
Formation of the CLASS Network

- Outreach and gathering of interests
- October Issues and Topics Workshop
- Establishment of CLASS, Terms of Reference

2008
Information gathering

- Oral History Project to learn about historic baselines of how this lake used to be.[11] We learned about the abundant presence of fresh water clams before 1970 and how recreational management used to use copper sulphate to mitigate snails carrying "swimmer's itch."
- Literature Review of 72 scientific documents to learn what is known and what are the gaps.[12] (See Appendix 3 for list)
- 3 Dimensional map of the Cultus Lake Watershed[13]
- First Nations Traditional Ecological Knowledge (TEK)

2009
Starting Actions

- Increasing partnerships with key stakeholders, built funding relationships
- Wrote proposals
- Increased outreach
- Took part in events: June Pikeminnow Derby
- Facilitated community dinner in the Yakweakwioose Longhouse
- Began to understand nutrient loading issues
- Initiated funding relationships (and nearly swamped a boat full of dignitaries as they all rushed forward to look at milfoil)

2010

- Delivered FSWP Cultus Project

[11] This report is in the Chilliwack Museum and Archives.
[12] The discs are available from FVRD's Watershed Planner.
[13] Housed at the Cultus Lake Parks Boardroom and brought out to events.

- Cultus Lake User Survey completed
- Volunteer milfoil report
- Provided no-drip fuel spouts for boater's jerry cans.
- Scientific reporting updates re Cultus Sockeye workshop Dec.16
- Facilitated community dinner in the Yakweakwioose Longhouse
- Took part in events: June Pikeminnow Derby
- Presented to media, Cultus Com'ty Association, CLPB and others
- Established web-site
- Realized that human nutrient load is probably the invisible killer.
- Wrote proposals

2011

- Launched 2-year Nutrient Mass Balance (The Scoop On Poop) in partnership with DFO scientists, thank you to FSWP and CWF.
- Established sub-committee re sewerage options, thank you to VanCity.
- Addressed lake level issues by building working relations.
- Facilitated local gov't relations via Soowahlie C2C
- Held Circles to build lake caring communities[14]
- Hosted the Cultus Pygmy Sculpin workshop
- Organized dialogue with neighbouring elected officials
- Initiated Sewerage planning, information and actions
- Events: June Pikeminnow Derby, March Longhouse dinner.
- Hosted 3 tours with visiting Indonesian Group and local NGOs Funders, and First Nations. Also Alexandra Morton.
- Wrote proposals, made presentations, media releases.

2012

- Continued partnering with science on Nutrients
- Public outreach about the Cultus Pygmy Sculpin (pending funding)
- Facilitated working relations with local gov't (Soowhalie C2C)
- Continued work re nutrient export via sewerage options (Vancity)
- Initiate public outreach re SARA species (pending funding)
- Forest Practices and watersheds (with Doug Wahl)
- Problem solving, planning and funding options.
- more

[14] See Appendix 7: Building Relations

CLASS Resources 2007-2012

	Organization	In-kind	Other Value (time, space, and help)	Cash
2007	Fraser Basin Council		• DFO space, • Recording sec'ty, • CLPB space, hall • Use of CLPB address • Time of attendance of all CLASS participants every month and sub-com'ty work • Provision of knowledge, expertise and TEK • Refreshments • Caring For Cultus Booklets • Cultus 3 D map • SD work experience • Regulatory help • FVRD staff • Traffic count • Etc.	5,000 expressed in unfunded labour
2008	Fraser Basin Council			12,000 in unfunded labour
	MLA Barry Penner via FVRD re milfoil	10,000		
2009	Fraser Basin Council			18,000 in unfunded labour and know-how.
2010	Fraser Basin Council and Pacific Salmon Foundation through the Fraser Salmon Watershed Program			39,899. (11K allocated)
2011	Fraser Basin Council and the Pacific Salmon Foundation through the Fraser Salmon Watershed Program, Fisheries and Oceans Canada, Canadian Wildlife Federation, Vancity Savings and Credit Union	108,700		74,225. (46K allocated to research)

2012	Fraser Basin Council, Fisheries and Oceans Canada, Canadian Wildlife Federation and Vancity Savings Credit Union, Pending: Habitat Stewardship Program with FVRD and Cultus Lake Parks Board.	110,500	Calculated at 20 K for time X5 2K/year space X5 2K/year lghs X4 5K booklet 2K map 5 K Traffic Cnt. 20 K misc.	50,195 (27K allocated to research)
2013	Fraser Basin Council, Fisheries and Oceans Canada, Canadian Wildlife Federation and Vancity Savings Credit Union, Pending: Habitat Stewardship Program with FVRD and Cultus Lake Parks Board.	TBA		20,000 is confirmed, while 65,000 from all sources is pending (April) Half of 65K will be allocated.
Total		247,300.00	150,000.00	284,319.00
Total Value	Oct. 2007 to March 2012	681,619.00 (pending HSP portion)		

CLASS granting contributions and funding partners, in the order of contact:
Fraser Basin Council and Fisheries and Oceans Canada
FVRD via BCMOE with MLA Barry Penner
Pacific Salmon Foundation
Fraser Salmon Watershed Program
Canadian Wildlife Federation
Vancity Savings and Credit Union
Pending the HSP application, the Cultus Lake Parks Board and FVRD will be funders.

Other investments and contributions towards the benefit of Cultus Lake include

- DFO mandate at the Cultus Lab, estimated at 300K per year
- FVRD infrastructure and engineering.
- FVRD OCP process (2011-12) and planning.
- Operation and maintenance of 2 parks.
- Provincial and Federal Ministry mandates.
- UBCM Com'ty to Com'ty dialogues.

Below is the CLASS activities and general calendar. Not visible is the behind-the-scenes, values-based, community building activity that increases cohesion and better communication.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
CLASS Meet	Meet	Meet	Meet	Meet	Meet	Meet	-	Meet	Meet	Meet	-
Winter fishery					Pikeminnow Derby						Winter fishery
		Long House Dinner			Canoe races						
	CPS Workshop	C2C			Cultus survey			Cultus survey			Salmon update
Present to CLPB	FBC board	Report	Start new fiscal		FBC board			Plan, budget next yr	FBC board		
Winter pred. control			Summer activities								Winter pred. control
Year-round scientific field season.											

Project Stories

Oral histories

To understand the base-lines about how this lake used to be, with the help of Ron Denman at the Chilliwack Museum and Bruce Clark, we organized the Oral History Project bringing together the oldest people in this watershed. The event was held in 2008 at the Cultus Hall with 43 participants. Stories were solicited in working groups on subject areas. We learned about the “good old days” with dancing in the Pavillion but important to this project, we learned that the waters used to have abundant fresh water clams! We learned that it used to be a management practise to reduce swimmer’s itch by killing snails with bluestone (toxic copper sulfate). The loss of clams could be symbolic as one of the horrible man-made changes. Oral history also shows that milfoil came as power boating increased. We learned that all mitigative efforts have only made more colonies. We began to understand the scale and scope of human impacts in the Cultus watershed.

Literature Review

Knowing where to start, we had to understand what has been studied and where the gaps are. The community saw this as a milfoil problem but we came to understand the invasive aquatic plants as a symptom, not a cause. There were many symptoms (outlined in the Topics and Issues document) and the literature review helped us understand more about the science. In addition to the Fraser Basin Council, MLA Barry Penner provided the resources to engage a local biology graduate. The literature review consists of 72 documents available from Watershed Planning at the FVRD. We learned that there were some documents by Ken Shortreed about nutrients.

Caring For Cultus Booklet

To provide useful information for residents and visitors to Cultus Lake, the DFO community advisor provided a major role. Mark Johnson and his team put

together a wonderful booklet that was provided to land owners by the Fraser Valley Conservancy as well as being available on the Cultus Lake Parks Board website. This template is now being used by other lake care folks as far away as Alaska.

Cultus Lake 3 D Map

CLASS welcomed the contribution of a 3D map from a retired Coquitlam-based architect and local students and DFO. It is housed at the Cultus Lake Parks Board room and brought out for special occasions like the longhouse dinner in 2011.

Invasive Plants

The Cultus watershed has become home for many invasive plant species. They include giant knotweed, tansy, ivy, morning glory, giant hogweed and many more. Most disturbed soils become weed sites. The Fraser Valley Invasive Plant Council[15] has conducted tours at Cultus to show the invasive plants. Invasive plants cost the ecosystem. Despite their attractive appearance, invasive plants are one of the five most significant causes of biodiversity loss and change to ecosystem functions, as reported by the Millennium Ecosystem Assessment.[16] They carry potential negative impacts to the economy, environment, and society; therefore, preventative planning and careful budgeting are required. Help is available from the Fraser Valley Invasive Plant Council and the BC Invasives web-site is http://www.bcinvasives.ca/
Aquatic invasive species include Eurasian Milfoil, which has colonized the littoral area of Cultus Lake. At the same time yellow flag iris is growing in Sweltzer Creek and needs to be managed.

Milfoil

Invasive aquatic plants have long been a concern to residents and park managers. Earlier efforts of mitigation did not reduce the milfoil. It made it worse. Every tiniest little piece would float away and create new colonies.
Some actions include:

- Milfoil assessments have been done, the last one in 2004.
- Milfoil growth pattern research was conducted by the class of Connie Williams at Chilliwack High-school.
- In other places, like Christina Lake, they are finding an indigenous weevil that eats milfoil; so far, not found at Cultus Lake.
- CLPB has a fund earmarked for milfoil.

[15] http://fraservalleyweeds.com/
[16] http://bcinvasiveplants.com see feature article: Economic impacts.

- Scientists are asking whether milfoil is benign or if it changes water quality. More science needed.
- Milfoil harbours predator fish species.
- Milfoil grows in former salmon spawning beds and salmon are having to spawn in deeper water.
- Questions remain as to when the littoral areas of Cultus Lake will be all grown out with milfoil and its role regarding Species At Risk.
- It is proposed to do a comparable (to 2004) milfoil assessment and a technical workshop, also considering SARA species.

Update on Salmon Stocks

DFO and CLASS hosted workshop held Dec. 16, 2010, we learned about captive brood stocks from Dr. Ruth Withler and how even the smolts (baby salmon) need to toughen up in the natural environment for the success of future salmon.

Cultus Pygmy Sculpin

See Appendix 6: Cultus Lake's Very Own Fish
The CPS (or PS for short), is unique to Cultus Lake.
Patricia Woodruff conducted a valuable study so we can learn more about this fish. In partnership with CLASS, DFO held a CPS workshop in Feb. 2011. DFO will release the Recovery Action Plan in May 2012.

Cultus Lake User Survey 2010

So many people use Cultus Lake. What do we know about where they come from, how often, and what age groups enjoy this lake. At the same time do they know about environmental actions and are they willing to do their part? The Cultus Lake Survey funded by the Fraser Salmon Watershed Program was designed by CLASS and intercept surveys were conducted in June and September 2010. We learned that of all the lake users, 66% were swimmers, 27% power-boaters, 34% non-power boaters with most of the newest visitors - not power-boaters. We found out that most people strongly supported environmental actions while only half had heard about the Cultus Pygmy Sculpin. The study informs the CLASS work of public outreach and may help the business community recognize the increase in non-power boating. The study is on the Cultus Stewards website.

Nutrient Mass Balance (The Scoop On Poop)

Understanding and resolving the nutrient loading issue at Cultus Lake is one of the most critical things to save this lake. CLASS and scientists came together as

the understanding for nutrient loading needed to be researched. Based on the lake core sampling work of Dr. Dan Selbie (unpubl. 2010), he explained about human impacts over time. See Appendix 3: The Case For Cultus Lake. This 2-year research work in 2011 to 2013 is funded by the Fraser Salmon Watershed Program, DFO and Canadian Wildlife Federation. Nutrient mass balance will be measured for 2 years from all in-flow lake sources (completed in 2013). This scientific information makes the case to export nutrients to save the lake from further eutrophication. If the lake becomes completely eutrophied – all other investments in salmon and SARA species research, recovery become mute, as does the economy of 3 million visitors and property values. This may be a short paragraph but essentially all the CLASS work is about community building and outreach towards saving Cultus Lake.

Sewerage Options

Knowing that nutrient loading is the critical issue, CLASS and the Fraser Basin Council are looking at ways to export nutrients from Cultus Lake. At the same time the FVRD are undertaking engineering studies at both, the north end and the south end of the lake. Together this information will provide decision-makers with options. This project of sewerage options called Caring For Cultus is funded by Vancity in 2011-2013.

Lake Levels

Submitted by Gordon Spencer of Lindell Beach:
The level of Cultus Lake is artificially maintained through a weir at the mouth of Sweltzer Creek, which is maintained by the Cultus Lake Park Board under a provincial water license. The level of the lake is raised during the summer months to allow for recreational activities and allowed to drop to natural levels during the winter months. Over the past decade the weir has been allowed to remain at higher than allowed levels for various reasons and also allowed to remain in longer than allowed.

The result was the Lindell Beach end of the lake often flooded during winter storms, creating a hardship for residents. Two more serious problems were also encountered:
1. The churning of the lake and the high water served to scour the beach, potentially disrupting the spawning grounds of the Cultus Lake salmon;
2. The flooding negatively impacted the operation of septic systems of cottages on the beachfront. Although use of these cottages is limited over the winter, the potential for a problem remains.

This issue was brought forward to CLASS meetings and discussed at several meetings. A recommendation ws made to put together a working group of

representatives from the responsible agencies to see if the problem could be resolved. The Lindell Beach Residents Association too the lead and following the advice of CLASS members put a working group together.

Following several meetings between the CLPB, Lindell Beach Residents Association, DFO and the FVRD, an agreement was struck in October that will see the boards in the weir put in place no earlier than March 15th and removed no later than Sept. 15th. The results have been positive and immediate - the level of the lake was at least 20cm lower than in past years, and flooding was non-existent even though we had some significant storms over the winter.

The lake level committee will meet twice yearly - spring and fall, to ensure the lake is being maintained at agreed levels, and to address other issues such as blockages in Sweltzer Creek that might influence the natural level of the lake. This has been a problem on the lake and for the Lindell Beach residents for a number of years. We are grateful to CLASS for exploring this issue and coming to the aid of our community.

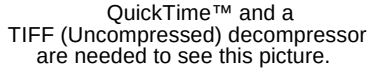
Community To Community Dialogues

Groups and agencies have different ways of relating to each other. Good relations are necessary for doing business. Some groups connect very well but others are adversarial. From the perspective of Conflict As Opportunity[17], we can take that energy and transform the conflict. At least we have energy and not apathy to work with. We don't have to agree on topics but it is good to have ways to communicate and ways to relate to each other. The FBC and CLASS have brought some dialogue[18] together with First Nations, local government, regional government and resource extraction industries. Outcomes have been positive and CLASS welcomes the interest and new participation brought to the table. Five dialogue sessions were funded by UBCM and FBC.

Longhouse Gatherings

CLASS has come to understand the value of "setting the table" and inviting the community to share, learn and report out on Caring For Cultus Lake. "On this site, on this very ground, people have been speaking this way to each other for thousands of years," explained Chief Otis Jasper. Supported by Elders Frank and Mary Malloway, up to 120 people come together to talk about Cultus Lake. It was the 4th longhouse gathering in March 2012. Picture is below.

[17] Conflict As Opportunity as brought to us by Justice Barry Stuart (ret.) and the Center For Restorative Justice, SFU.
[18] See Appendix 9 about Debate vs Dialogue



The Way Forward

As of March, 2012, the Cultus Stewards and the Fraser Basin Council with support of their funders, have worked to put in place both the science and the community connection. The Nutrient Mass Balance project will be completed in March 2013. It is our hope that decision-makers understand and choose to export nutrients out of this watershed. Our hearts are warmed by the generous response of funders and community members. It takes a community to save a lake. Thank you to all and keep on going!

Lake Water Quality

Understanding what the lake, itself, needs is a learning curve for many people. As CLASS grew community around understanding the lake, a number of lake science topics became common knowledge.

See Appendix about a Primer on Cultus Lake.

In 2008, the Cultus Lake Aquatic Stewards held an Oral History Project to learn from our most senior citizens about how the lake used to be. We learned that the lake was clear and visible all the way down, that it had old or old secondary forests around it and an abundance of fresh water clams. “The returning salmon were so plentiful you could walk on them.”

Baseline evidence and Traditional Ecological Knowledge shows that Cultus Lake was a healthy lake before the 1940s. To keep reasonable Lake water quality, the following subject areas need to be addressed and managed:

Negative Cultus Lake impacts from human sources include:

1. Nutrient loading from human sources[19]
    a. 3 million visitors per year, flushing the toilet. The nutrients[20] accumulate in the porous ground no matter how good the septic systems are working. The nutrients percolate into the water. We need to export nutrients to save this lake. In 2012 there is no hook-up to the City of Chilliwack sewage treatment system.
    b. Lawn and field fertilizers both in the form of commercial granules or animal waste. Less is better.
    c. Gulls feeding elsewhere roost at Cultus Lake leaving nutrients and plastics.
    d. Resident geese. (Fecal material is visibly annoying but not the same threat as the volume from 3 million human flushes.)
2. Sediment and debris flows from forest and mining resources extraction.
3. Human alteration of riparian areas. Perfect lawns with perfect sandy beaches lacking rocks, woody debris, and native plants are not good for fish nor the lake environment. Let’s keep the beaches we have, but not increase humanly-altered foreshore areas. See Caring For Cultus booklet.[21]
4. Humans have brought invasive plants like Eurasian Milfoil.[22]
5. Solid waste (garbage) on lake bottom (as being pulled out by volunteer divers)
6. Increased sediment and turbidity of the water both from humans (boating) and natural wave actions. Some of this sediment comes from land use activities having flowed into the lake over time. At the same time, turbidity results from eutrophication and the increase of algae.
7. Hydrocarbons impacts – is a CLASS new agenda item. We need more science around this issue.

[19] See Appendix 3, The Case For Cultus Lake.
[20] See Appendices about Nutrients
[21] See 2nd from bottom on CL Parks Board website: http://www.cultuslake.bc.ca
[22] See Appendix and http://www.invasiveplantcouncilbc.ca/

Ecosystem Services[23]

Humankind benefits from a multitude of resources and processes that are supplied by natural ecosystems. Collectively, these benefits are known as *ecosystem services* and include products like clean drinking water and processes such as the decomposition of wastes. While scientists and environmentalists have discussed ecosystem services for decades, these services were popularized and their definitions formalized by the United Nations 2005 Millennium Ecosystem Assessment (MEA), a four-year study involving more than 1,300 scientists worldwide.[24] This grouped ecosystem services into four broad categories: *provisioning*, such as the production of food and water; *regulating*, such as the control of climate and disease; *supporting*, such as nutrient cycles and crop pollination; and *cultural*, such as spiritual and recreational benefits.

As human populations grow, so do the resource demands imposed on ecosystems and the impacts of our global footprint. Natural resources are not invulnerable and infinitely available. The environmental impacts of human actions, are becoming more apparent – air and water quality are increasingly compromised, oceans are being overfished, pests and diseases are extending beyond their historical boundaries, and deforestation is exacerbating flooding downstream. It has been reported that approximately 40-50% of Earth's ice-free land surface has been heavily transformed or degraded by anthropogenic (human) activities, 66% of marine fisheries are either over-exploited or at their limit, atmospheric CO_2 has increased more than 30% since the advent of industrialization, and nearly 25% of Earth's bird species have gone extinct in the last two thousand years.[25] Society is increasingly becoming aware that ecosystem services are not only limited, but also that they are threatened by human activities. The need to better consider long-term ecosystem health and its role in enabling human habitation and economic activity is urgent. To help inform decision-makers, many ecosystem services are being assigned economic values, often based on the cost of replacement with anthropogenic alternatives. The ongoing challenge of prescribing economic value to nature, for example through biodiversity banking, is prompting trans-disciplinary shifts in how we recognize and manage the environment, social responsibility, business opportunities, and our future as a species. The microcosm of this reality is at Cultus Lake.

Experts currently recognize four categories of ecosystem services.[26] The following lists represent samples of each:

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[23] http://en.wikipedia.org/wiki/Ecosystem_services

[24] Millennium Ecosystem Assessment (MEA). 2005. Ecosystems and Human Well-Being: Synthesis. Island Press, Washington. 155pp.

[25] Vitousek, P.M., J. Lubchenco, H.A. Mooney, J. Melillo. 1997. Human domination of Earth's ecosystems. Science 277: 494-499.

[26] Same as footnote 13.

1. Provisioning services
• food (fish and game), wild foods, and spices
• water for all needs from drinking water, habitat to irrigation
• minerals (including diatomite)
• pharmaceuticals, biochemicals, and industrial products
• energy (hydropower, biomass fuels)

2. Regulating services
• carbon sequestration and climate regulation
• waste decomposition and detoxification
• purification of water and air
• crop pollination
• pest and disease control

3. Supporting services
• nutrient dispersal and cycling
• seed dispersal
• Primary production

4. Cultural services
• cultural, intellectual and spiritual values
• Traditional uses
• recreational experiences (including ecotourism)
• scientific discovery

Understanding of ecosystem services requires a strong foundation in ecology, which describes the underlying principles and interactions of organisms and the environment. Since the scales at which these entities interact can vary from microbes to landscapes, milliseconds to millions of years, one of the greatest remaining challenges is the descriptive characterization of energy and material flow between them. For example, the area of a forest floor, the detritus upon it, the microorganisms in the soil and characteristics of the soil itself will all contribute to the abilities of that forest for providing ecosystem services like carbon sequestration, water purification, and erosion prevention to other areas within the watershed. Note that it is often possible for multiple services to be bundled together and when benefits of targeted objectives are secured, there may also be ancillary benefits – the same forest may provide habitat for other organisms as well as human recreation, which are also ecosystem services.

Cultus Lake and the Cultus Lake watershed provide extensive ecosystem services.

Economic Perspective

It is because of high value in ecosystem services that visitors flock to Cultus Lake. Thus the economies received are from the direct benefit of access to a good Lake. This is measured in traffic counts at the FVRD at 3 million visitors per

year. Many of these visitors are the same repeat visitors but one can estimate that at least ten dollars is spent per person per visit, the spin-off economy starts at the nine million dollar mark.

If one considers the direct economies of services (fuel, vehicles, food, entertainment, recreation, sports, consumables) then perhaps thirty dollars per person is spent, making the starting estimate at an economy of twenty seven million dollars. If we include fixed assets like properties, land value, infrastructure along with the intangibles of proximity to large urban populations, easy lake access and the other reasons Cultus Lake users responded in the Cultus Lake User Survey 2010, (available on www.cultusstewards.shawbiz.ca), then the economies generated from Cultus Lake are in the hundreds of millions of dollars.

This economy cannot exist without the intact ecosystem. The single largest impact is nutrient loading from human sources. The solution is to export the nutrients via sewer pipe out of the valley or treatment that removes nitrogen and phosphorous. This removal of N and P would still need to be exported. At the time of this writing the FVRD is undergoing research and review of sewerage options.

Problem Solving

Upon seeing the scientific data, many readers will say “it’s a no brainer” to know that we must export and remove nutrients.[27] How this will be achieved requires some problem solving. Issues that come up are cost, funding mechanisms, private-public partnerships and how to understand the cost benefit over the long term beyond the 25-year window.

Framing the message[28] so we can all understand is key. Here is an example of a mental frame:

Can we afford 19 cents per person to save this lake?

Rationale: Here is an example estimate of the cost idea:
Say that the cost of the pipe option to hook up with city sewage treatment costs $10 million. If you amortized 10 million over 25 years, 10 year term, at 3% that would cost $47,324 per month or $567,900 per year. Divide that by 3 million visitors per year, comes out to 19 cents per person. Then the issue may not be so much about cost but about how we pay for it.

Then the problem solving is about funding mechanisms or how to collect from the visitor volume or other revenue models that may include other funding partners

[27] See Appendix 3 about The Case For Cultus Lake.
[28] Words elicit images. These images can fit your thinking (mental frame) and provide a way forward rather than getting hung up on something that is seems insurmountable.

like private (developers) or federal funders. At the same time there are new opportunities of doing business with First Nation neighbours and as participants in CLASS.

CLASS invites the infrastructure authorities to explore funding solutions with our network of those that have expertise in this area.

Concerns raised:

Another thought about on-site treatment vs the pipe hook-up to the City:
Other jurisdictions have expressed that if there is a sewage treatment plant, it is cost effective not to duplicate yet another plant as the capital investments are already made. Also consider the cost of maintenance over time. For example one smaller on-site plant costs 75K per year to maintain while the pipe with flow-regime meters may cost 25K per year. The saving of 50K over 20 years actually could have paid for the pipe-hook up in the first place?

Does tertiary treatment remove nitrogen and phosphorous?
Tertiary treatment can be used to remove most the remaining suspended organic matter from the effluent before it is discharged to a watercourse. Tertiary treatment is effected by sand filters, mechanical filtration or by passing the effluent through a constructed wetland such as a reed bed or grass plot. Most tertiary systems do not take out water-soluble nitrates nor address phosphorus accumulation over time. These nutrients are usually removed by harvesting the crop that had the huge up-take thus resulting in nutrient export. Therefore investing in an on-site tertiary treatment plant may meet human safety regulatory standards but it does not protect the lake with nutrient export.

Nutrient removal at a proposed plant

Wastewater may contain high levels of the nutrients nitrogen and phosphorus. Excessive release to the environment can lead to a build up of nutrients, called eutrophication, which can in turn encourage the overgrowth of weeds, algae, and cyanobacteria (blue-green algae). This may cause an algal bloom, a rapid growth in the population of algae. The algae numbers are unsustainable and eventually most of them die. The decomposition of the algae by bacteria uses up so much of the oxygen in the water that most or all of the animals die, which creates more organic matter for the bacteria to decompose. In addition to causing deoxygenation, some algal species produce toxins that contaminate drinking water supplies. Different treatment processes are required to remove nitrogen and phosphorus.

Nitrogen removal

The removal of nitrogen is effected through the biological oxidation of nitrogen from ammonia to nitrate (nitrification), followed by denitrification, the reduction of nitrate to nitrogen gas. Nitrogen gas is released to the atmosphere and thus

removed from the water.

Nitrification itself is a two-step aerobic process, each step facilitated by a different type of bacteria. The oxidation of ammonia (NH_3) to nitrite (NO_2^-) is most often facilitated by *Nitrosomonas* spp. (nitroso referring to the formation of a nitroso functional group). Nitrite oxidation to nitrate (NO_3^-), though traditionally believed to be facilitated by *Nitrobacter* spp. (nitro referring the formation of a nitro functional group), is now known to be facilitated in the environment almost exclusively by *Nitrospira* spp.

Denitrification requires anoxic conditions to encourage the appropriate biological communities to form. It is facilitated by a wide diversity of bacteria. Sand filters, lagooning and reed beds can all be used to reduce nitrogen, but the activated sludge process (if designed well) can do the job the most easily.[6]:17-18 Since denitrification is the reduction of nitrate to dinitrogen gas, an electron donor is needed. This can be, depending on the wastewater, organic matter (from faeces), sulfide, or an added donor like methanol. The sludge in the anoxic tanks (denitrification tanks) must be mixed well (mixture of recirculated mixed liquor, return activated sludge [RAS], and raw influent) e.g. by using submersible mixers in order to achieve the desired denitrification.

Sometimes the conversion of toxic ammonia to nitrate alone is referred to as tertiary treatment.

Many sewage treatment plants use centrifugal pumps to transfer the nitrified mixed liquor from the aeration zone to the anoxic zone for denitrification. These pumps are often referred to as *Internal Mixed Liquor Recycle* (IMLR) pumps.

Phosphorus removal

Each person excretes between 200 and 1000 grams of phosphorus annually. Studies of United States sewage in the late 1960s estimated mean per capita contributions of 500 grams in urine and feces, 1000 grams in synthetic detergents, and lesser variable amounts used as corrosion and scale control chemicals in water supplies.[16] Source control via alternative detergent formulations has subsequently reduced the largest contribution, but the content of urine and feces will remain unchanged. Phosphorus removal is important as it is a limiting nutrient for algae growth in many fresh water systems. (For a description of the negative effects of algae, *see* Nutrient removal). It is also particularly important for water reuse systems where high phosphorus concentrations may lead to fouling of downstream equipment such as reverse osmosis.

Phosphorus can be removed biologically in a process called enhanced biological phosphorus removal. In this process, specific bacteria, called polyphosphate accumulating organisms (PAOs), are selectively enriched and accumulate large quantities of phosphorus within their cells (up to 20 percent of their mass). When the biomass enriched in these bacteria is separated from the treated water, these biosolids have a high fertilizer value.

Phosphorus removal can also be achieved by chemical precipitation, usually with salts of iron (e.g. ferric chloride), aluminum (e.g. alum), or lime.[6]:18 This may lead to excessive sludge production as hydroxides precipitates and the added chemicals can be expensive. Chemical phosphorus removal requires significantly smaller equipment footprint than biological removal, is easier to operate and is often more reliable than biological phosphorus removal. Another method for phosphorus removal is to use granular laterite.

Once removed, phosphorus, in the form of a phosphate-rich sludge, may be stored in a land fill or resold for use in fertilizer.

Appendices

Appendix 1: Issues and Topics

2007 First Workshop to achieve a starting point.

Issues and Topics: Initiating The Cultus Lake Aquatic Stewardship Strategy

In attendance were 32 representatives from all sectors: 4 orders of government (including First Nations), Non-governmental organizations, and residents. From the brainstorm collection of sticky notes of the CLASS meeting held on Oct. 12, 2007, the topics included:

Topics of interest include:

- Inherent lake value
    - Beauty
    - Natural ecosystem
    - Spiritual values.
- Water temperature
    - Cold water recharge areas
    - Shading of waterways
- Water quality

    - Lake water habitat
    - Drinking water
    - Pollution
- Species at Risk
    - Cultus Pigmy Sculpin
    - Cultus sockeye
    - Painted Turtle and others
- Fish and fish habitat
    - Cultus sockeye recovery project
    - Interest of Commercial Salmon Fishers/ Salmon Table
    - Predator management
    - Species At Risk
- Nutrient Management concerns
    - Human waste in porous ground, estimated
        - > 500,000 campers/season
        - >1,000,000 day use visitors
        - > 1,500,000 visitors /season
        - Seagulls – 10 -20,000 birds roost on lake every night in fall/winter
        - Septic tank nutrient bio-accumulation
- Recreational use
    - Impacts to ecosystem
    - Population volume management
    - Human safety
    - Cost/benefit to the region
- Invasive species
    - Eurasian Milfoil
        - Need to be managed. Soowahlie and CLPB willingness to provide labour.
    - Invasive plants: ivy, knotweed, yellow iris, etc. (concern to Sweltzer Cr.)
- Cultural and heritage values.
    - Archaeology supports oral tradition of long time settlement.
    - Called Swee-ehl-chah or Tsowallie by local First Nations. Cultus is a Chinook trade-language word derived from the Salish word Kul, meaning "bad" or “be careful not to go there, deplete power”.
    - Soowahlie First Nation territory.
    - Dictation site of the Sepass Poems.
- Public interest and engagement
    - Citizens groups, Stewardship groups, First Nations
    - How to get involved. Define the necessary approach.
    - Outreach and awareness.
- Governance, jurisdictions and management.
    - Regulatory requirements to manage issues.
    - Local, regional, and crown authorities.
        - Tools like the OCP

    - Resource extraction, forestry, agriculture.
    - Fiduciary responsibilities
    - Budget allocations
- Natural disasters
    - Fires, slides or flood
        - Access cut-off as well.
- Development
    - Watershed tipping point?
    - How much impact can the system take?
    - Need for septic or city sewer hook-up?
    - Sediment and pollution issues.
- Research needs
    - Literature review, list and analysis.
    - Oral history collection, establish base-lines.
    - History
    - Many questions to answer.
        - I.e., What is the milfoil impact on fish and fish habitat? Therefore, can invasive plants have the same management as indigenous plants?
        - What is real number of lake users and visitors?
        - How many toilets are flushed in this watershed?
        - What conditions worsen milfoil?
        - Who and how do we ensure monitoring?
        - How do we measure the action costs/benefits?

Strategic considerations:

1. To manage agency and public apathy
    - Identify short term wins while maintaining a long term action plan
2. Include traditional and scientific knowledge.
3. Do Terms of Reference: what, why, who, when, where, how in 2 pages.
    - Committee and sub-committees
    - Principles of operating
4. Identify jurisdictions and fiduciary responsibly. Ie which Ministries have to do with Lakes Water Quality.
    - Strategically find ways to be inclusive.
    - Build relationships.
5. Do Resource strategy = people and funding
6. Do Public awareness campaign and outreach.
7. Build community around Caring for Cultus Lake.
8. Do Asset-Based-Community Development.
9. Keep going. Never give up.

Appendix 2: CLASS Terms of Reference and Principles of Operating

Cultus Lake Aquatic Stewardship Strategy
T E R M S O F R E F E R E N C E

Draft 1: September 20, 2007, Amended Feb.27, 2008. Amended Sept. 30, 09. Amended Apr.15, 2011.

Name*:** ***Cultus Lake Aquatic Stewardship Strategy (CLASS)

Purpose*:** ***To preserve and enhance water quality and habitat of Cultus Lake for the benefit of aquatic and watershed ecosystems

- In this significant fish bearing but human impacted, stressed, lake system
- as a model for Lower Mainland lakes and waterways with
- consideration to public safety.

We will do this by:

- Building relationships and working with stakeholder groups.
- Including a human strategy that includes nutrient management issues, invasive plants, aquatic SARA species, water temperature and other lake water quality impacts.
- Education of residents and visitors.

Vision statement:

Cultus Lake is a diverse productive lake ecosystem, offering recreational opportunity that is healthy, safe and enjoyable for all with respect and stewardship of the biological, ecological, spiritual, cultural and aesthetic values of this ecosystem.

Structure:

Committee: The stakeholder committee is made of all interested parties. The approach is inclusive with regular meetings to be determined by the chairperson.

Technical Committee: The larger Stakeholder Committee will need help with Science-based and Traditional Knowledge to improve decision-making and works with the scientific community.

Steering Committee: The smaller steering committee undertakes the homework in advance of the Stakeholder meeting. Meetings to be determined as needed.

Other Committees: As deemed necessary.

Decision Making: Decisions will be made on consensus. Each participant can endorse, live-with-it or block the decision. The group works with the "blocks" to find out what they need to come to consensus.
Timeline: Schedules to be determined by the group. Fiscal year end is March 31st.

***Protocols*:**

- Communications: External communications will be conducted through appointed spokes-people. This way we can deliver the same message.
- Records are to be kept by the office at Cultus Lake Lab (or Cultus Lake Park Board) until determined otherwise. Mailing address is c/o CLPB.

Participant Roles and Responsibilities:

- Each participant is responsible to his/her organization (or network for communication). If unable to participate, please send someone else.

Principals of Operation:

1. Recognition: There must be recognition of existing agreements and obligations in all decision-making.
2. Exercising Caution: Caution must be exercised when shaping decisions to avoid making irreversible mistakes.
3. Transition Takes Time: Lake water quality is a journey that requires constant feedback, learning and adjustment. In the short-term, the elements of sustainability may not always be in balance.
4. Mutual dependence: Land, water, air and all living organisms including humans are integral parts of the ecosystem. Biodiversity must be conserved.
5. Accountability: Each of us is responsible for the social, economic and environmental consequences of our decisions and accountable for our actions.
6. Integration: Consideration of social economic and environmental costs and benefits must be an integral part of our decision-making.
7. Adaptive Approaches: Plans and activities must be adaptable and able to flex with new knowledge, monitoring and adaptive management.
8. Coordinated and Cooperative Efforts: This is needed as no one person can be the hero of any water system. We all need to help and do our part.
9. Open and Informed Decision Making: Open decision-making depends on the best available information.
10. Managing Uncertainty: A lack of certainty should not prevent decisive actions for sustainability.

CLASS Policy

- Non-adversarial approach, (human values-based)
- Using education and outreach; building relationship and building community around the lake care issues.

Appendix 3: The Case for Cultus Lake

The decline in Cultus Lake sockeye salmon has been attributed to several external factors including over-exploitation in mixed-stock fisheries, poor marine survivals, and parasite-induced pre-spawn mortality (CSRT 2009). With depressed spawning numbers, and hatchery supplementation measures underway (but being scaled back), habitat quality becomes very important to the persistence of Cultus Lake sockeye salmon (CSRT 2009).

Water quality in Cultus Lake is degraded relative to historical baselines, and available limnological (Shortreed 2007) and paleolimnological evidence (D.T. Selbie et al. DFO *unpubl.*) indicate the ecosystem has responded substantially to anthropogenic nutrient loading over the 20th century (Fig. 1).

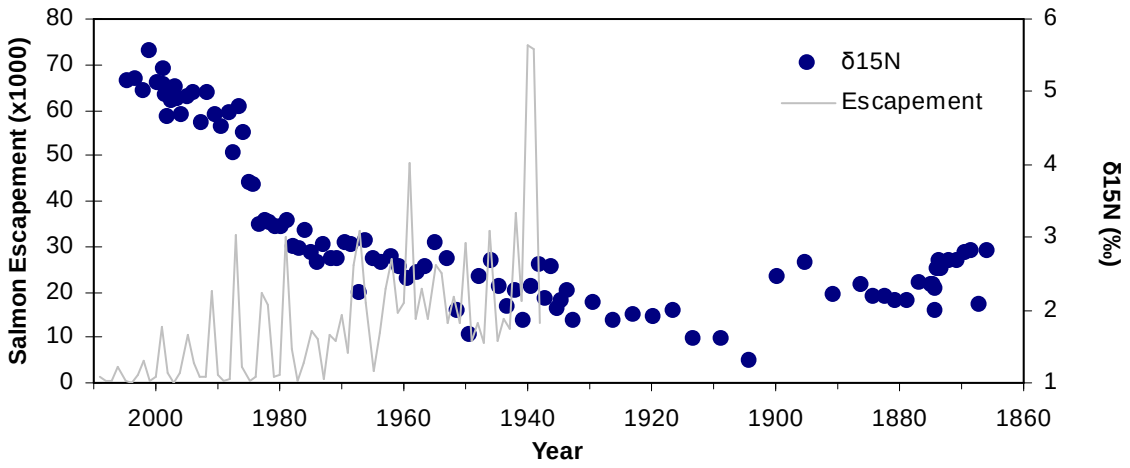

Fig. 1: The proportion of heavy nitrogen ($\delta^{15}N$) in Cultus Lake sediments over the past. ca. 150 years. Increased $\delta^{15}N$ in sockeye salmon nursery lakes is largely related to sockeye returns and catchment nutrient sources (Selbie et al. 2009). As Cultus Lake sockeye salmon have declined over this period (grey line), and human occupation of the watershed has increased, the most plausible explanation is increasing nutrient loading from anthropogenic (e.g. sewage effluent, agricultural runoff) and possibly waterfowl (e.g. Canada goose and gull guano) sources. D.T. Selbie et al. DFO *unpubl.*

Consequently, Cultus Lake currently has unusually high nitrogen (N) and phosphorus (P) concentrations, and the highest photosynthetic rates of any sockeye salmon nursery lake in the Fraser drainage (Shorteed 2007; CSRT 2009). Surface water temperatures have increased since the early 20th century

(Ricker 1937), with summer temperatures often exceeding those lethal for sockeye salmon (Fig. 2).

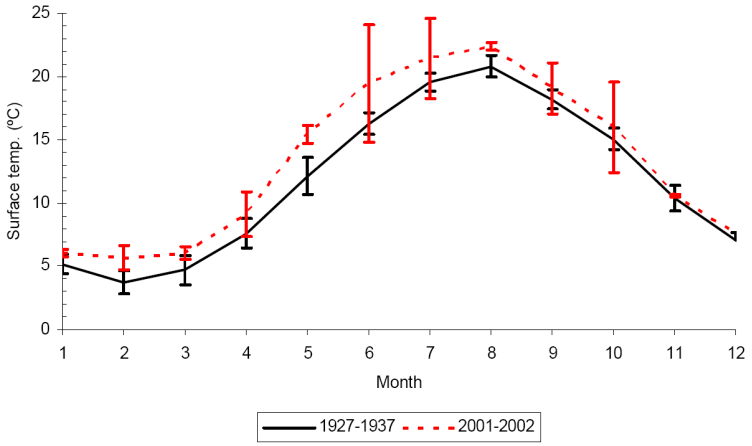

Fig. 2: A comparison of monthly mean surface temperatures in Cultus Lake, BC between 1927-1935 and 2001-2002. Error bars indicate ±2 SE. Spring and summer surface temperatures have warmed appreciably over the 20th century. Modified from Shortreed (2007).

Light penetration and deepwater (hypolimnetic) dissolved oxygen (DO) levels have also decreased in Cultus Lake over the same period (Fig. 3), with the most plausible explanation for these trends an increase in lake productivity coupled with decomposition of organic matter (e.g. algae, invasive Eurasian watermilfoil (*Myriophyllum spicatum*; Shortreed 2007). This is supported by markedly increased algal production following ca. 1950 in the Cultus Lake sedimentary record, which corresponds to intensive development and increasing use of the watershed (Fig. 4).

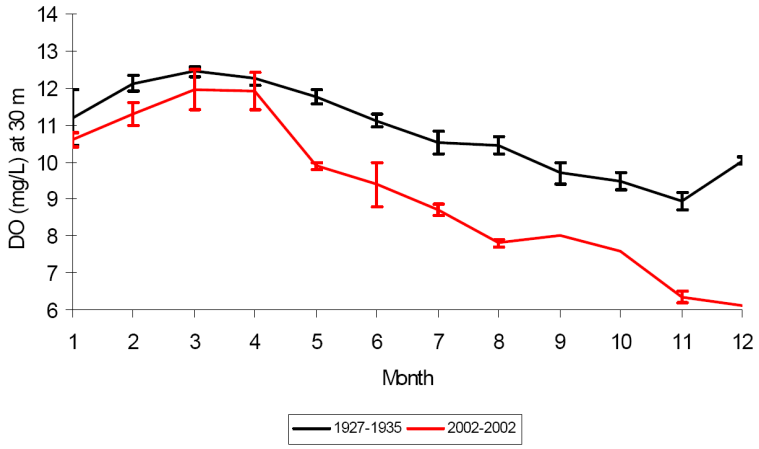

Fig. 3: Comparison of monthly mean deepwater (hypolimnetic, 30m) dissolved oxygen (DO) concentrations in Cultus Lake, BC between 1927-1935 and 2002. Error bars indicate ±2 SE. A more rapidly declining trend in modern deepwater oxygen levels is evident during the stratified period, most likely related to increased organic matter loading from increased algal and macrophyte production. Modified from Shortreed (2007).

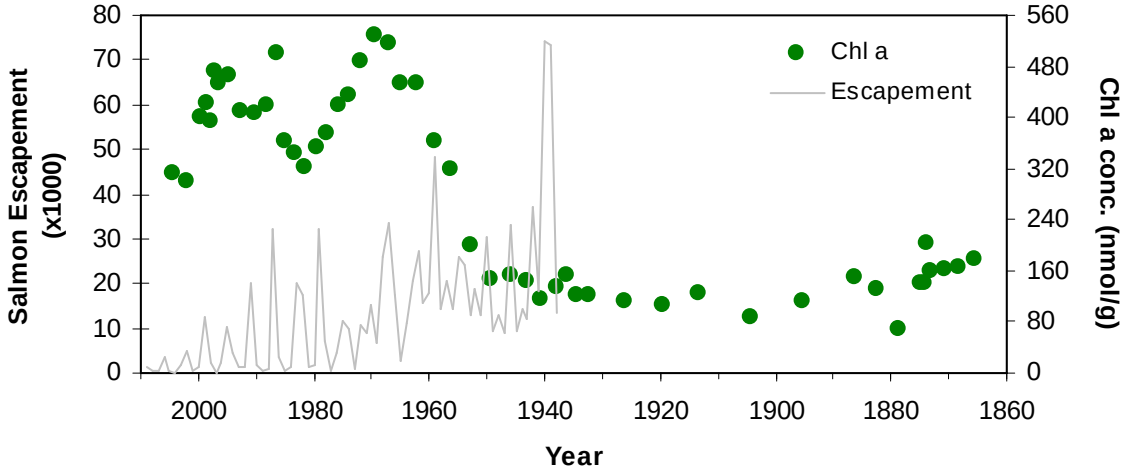

Fig. 4: The concentration of chlorophyll *a* (ubiquitous algal pigment) in Cultus Lake sediments over the past ca. 150 years. The substantial increases in chl *a* following ca. 1950 indicates an increase in overall algal productivity in Cultus Lake that was coincident with the increases in heavy nitrogen ($\delta^{15}N$; Fig. 1). Together, these trends most likely indicate responses to cultural eutrophication of Cultus Lake resulting from increased antropogenic nutrient loading in the watershed. D.T. Selbie et al. DFO *unpubl.*

While DO remains above hypoxic levels for sockeye salmon throughout most of the hypolimnion during stratification, a worrying trend has been observed at the sediment-water interface. Oxygen declines have been more pronounced in the water < 1m above the sediments in the late-summer and fall (M. Bradford and D.T.Selbie, DFO *unpubl.*). If DO depletion increases to anoxic levels near the sediments as a result of further nutrient loading, primary production, and organic matter decomposition, severe consequences for Cultus Lake and its sockeye

population may occur. Anoxia at the sediment-water interface changes phosphorus solubility, leading to enhanced releases from the sediments (internal loading), which is then distributed throughout the water column during mixing (Wetzel 2001). This internal loading is a positive-feedback mechanism that increases lake nutrients and primary productivity (algae and plants), and further reduces deepwater oxygen (Wetzel 2001; Kalff 2002).

The Cultus Sockeye Recovery Team (2009) identified that the thermal structure of Cultus Lake creates a precarious balance relative to sockeye fry food supply (deep primary and secondary production) that allows young fish to avoid lethal water temperatures while retaining access to food. They also noted that reduced light penetration in Cultus Lake may disrupt this balance (CSRT 2009). Nutrient loading (e.g. sewage effluent, agricultural and golf course runoff) is thus of principal concern to future sockeye production in Cultus Lake, given the potential for phytoplankton blooms (biological turbidity) that could decrease light penetration and food availability at depth. Moreover, increased algal and invasive milfoil productivity would enhance deepwater organic matter sedimentation and decomposition resulting in further oxygen depletion and degradation of remnant deepwater nursery habitat in Cultus Lake (i.e. a temperature-oxygen habitat squeeze).

Given predicted future climate warming (IPCC 2007), deepwater habitat is likely to be critical to the persistence of this endangered stock. As such, abatement of anthropogenic nutrient loading to Cultus Lake is likely essential to preventing further water quality and habitat deterioration. The Cultus Lake watershed has several conspicuous point sources for nutrient loading including golf courses, near-shore septic systems, fertilized lawns and agriculture (Shortreed 2007, CSRT 2009). Additional diffuse sources likely include landscape overflows, bird guano and groundwater discharge (Zubel 2000).

Shortreed (2007) identified enhanced nutrient loading to Cultus Lake via two main tributaries (Frosst and Spring creeks) that pass through golf courses and residential areas serviced by septic systems. While this study identified the likely “hot-spots” for nutrient loading, Cultus Lake receives discharge from 10 main tributary creeks draining very different land cover types (e.g. agrarian, residential, undisturbed parkland).

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Appendix 4: Map of Cultus Lake

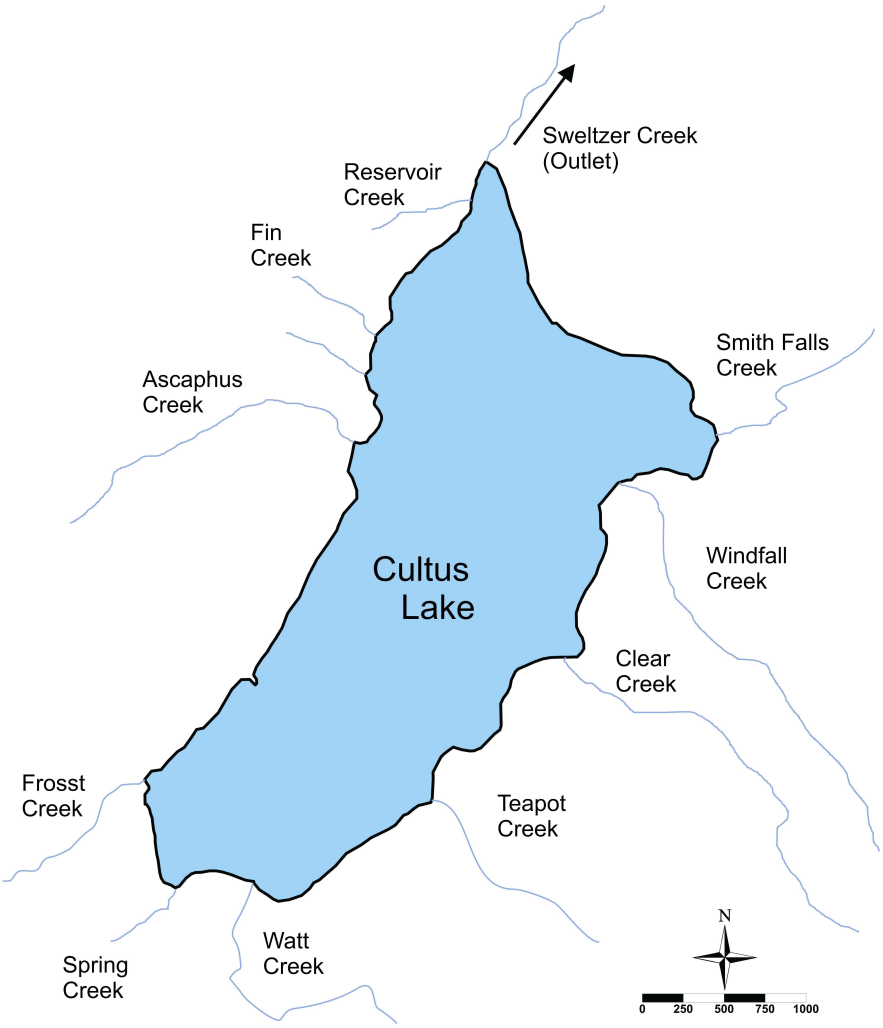


Fig. 5: Map outlining the major tributaries and the outlet of Cultus Lake, BC. Frosst and Spring creeks drain residential, agricultural and forested areas (Shortreed 2007), while all other creeks principally drain forested parkland. Sweltzer Creek is the outlet for Cultus Lake.

Appendix 5: Primer on Lake Science and Terminologies Used

What differentiates lakes?

Like fingerprints or snowflakes, every lake is unique. There are many characteristics that make lakes individual gems in the landscape. Here we explore some of the most important ways in which lakes vary. The characteristics highlighted say something about the water quality, species that live in a lake, and what happens underwater. Lakes, ponds, reservoirs, rivers, and streams are all important aquatic ecosystems.

Lakes vs. Ponds

Both lakes and ponds are standing or slow-moving bodies of water. There are no official or scientific differences between lakes and ponds. Lakes are larger than ponds, but size is relative. What would be considered a pond in one region might be considered a lake in another. In general, water bodies that are considered lakes in dry areas would only be considered ponds in regions with abundant water resources where there are more (and larger) bodies of water. Despite the lack of official characteristics, there are several questions that are used to generally distinguish ponds from lakes:

- Does light reach the bottom of the deepest point of the water body?
- Does the water body get large waves (i.e. larger than 1ft/30cm in height)?
- Is the water body relatively uniform in temperature?

If these questions can be answered with a “yes,” the water body is likely a pond and not a lake.[29]

By this definition, Cultus is definitely a lake.

Lake Stratification

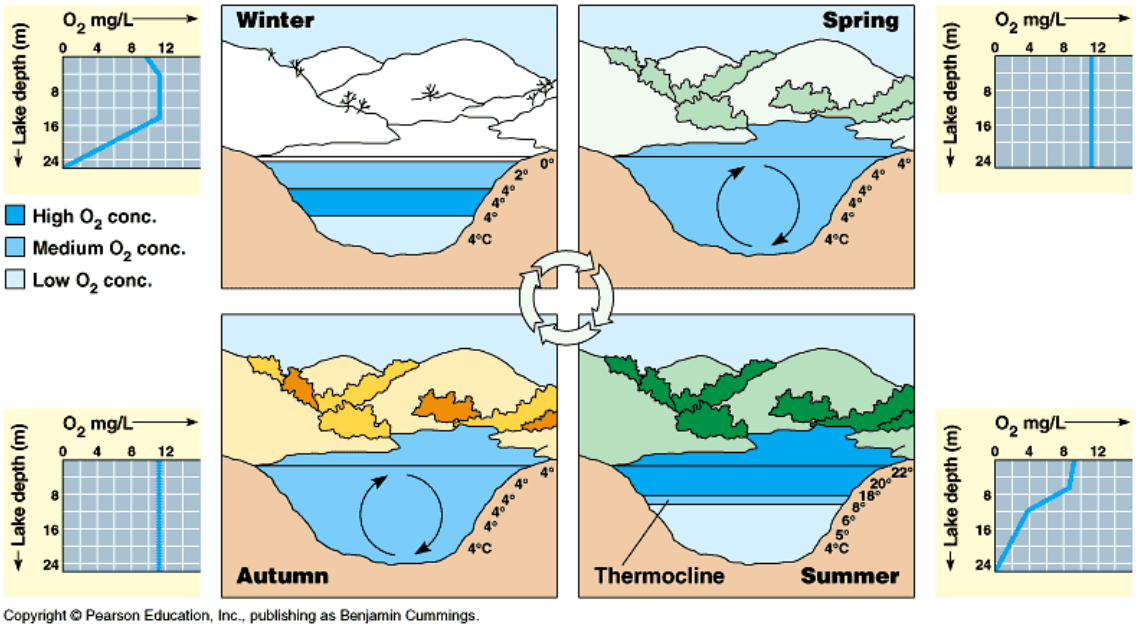
Cultus Lake is a highly productive body of water that undergoes thermal stratification over the summer. Most of the productivity takes place in the warmer

[29] Bronmark C. and H. Lars-Anders. 2004. Biology of Lakes and Ponds. Second ed. New York.

surface layer, which is called the Epilimnion. This layer contains a large concentration of photosynthetic organisms such as green algae, blue-green algae, and yellowish organisms known as diatoms. These also provide food for abundant zooplankton, which are the major food source for the food chain of the 19 fish species in the lake. In more recent time where measurements show that Cultus Lake is warmer in the summer than it was historically, the fish needing to stay cold to survive, may not be where the layer of “food bugs” are nor where there is enough oxygen. Due to changing conditions, the fish are getting squeezed.

I

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.



Temperature stratification occurs in Cultus Lake in summer. Sunlight heats the upper layers of water as far as it penetrates; the deeper water remains cold. As depth increases, the separation point of the warmer upper water form the lower colder water is noticeable as the **thermocline**; the thermocline is a narrow vertical zone between the warmer and colder waters where a rapid temperature change occurs. The distribution of plants and animals within a pond or lake also shows stratification based on water depth and distance from the shore. The **littoral zone** is shallow, well-lighted, warm water close to shore. Characterised by the presence of rooted (including milfoil) and floating vegetation, a diverse attached algae community, and a very diverse animal fauna including suspension feeders (clams, now fewer than in 1970), herbivorous grazers (snails), and herbivorous and carnivorous insects, crustaceans, fishes, and amphibians. Some reptiles, waterfowl, and mammals also frequent this zone.

The **limnetic** zone is the open, well-lighted waters away from the shore. Occupants of this zone include phytoplankton (algae and cyanobacteria) which are photosynthetic, zooplankton (rotifers and small crustaceans) that grazes on phytoplankton, and small fish that feed on the zooplankton. Occasional visitors to this zone are large fish, turtles, snakes, and piscivorous birds. The **profundal** zone is the deep, aphotic zone lying beneath the limnetic zone. This is an area of

decomposition where detritus (dead organic matter that drifts from above) is broken down. Water temperature is usually cold and oxygen is low due to cellular respiration of decomposers; mineral nutrients are usually plentiful due to decomposition of detritus. Waters of the profundal zone usually do not mix with surface waters due to density differences related to temperature. Mixing of these layers usually occurs twice each year in temperate lakes and ponds; this results in oxygen entering the profundal zone and nutrients being cycled into the limnetic zone.[30]

What is water quality?
Water quality is a general term that refers to a general description about the properties of a water body. Lakes that have a high water quality possess properties that make it a high valued resource to society and nature.

Commonly, water quality is assessed through the use of many different methods ranging from simple test kits measuring things such as pH (acidity) to much more complex electronic sensor platforms that can measure a wide variety of parameters over a long time at a high frequency. For each parameter, the quality of the water is generally reported with reference to a specific standard, to allow the quantitative measurement of that factor to be stated as a qualitative statement about the body of water. Often, standards are set by governing organizations, such as Environment Canada and Fisheries and Oceans Canada.

Lake Water Quality Indicators

What are the impacts of key stressors such as nutrients, bacteria, watershed & lakeshore land-use and development, resource extraction? Which ones accumulate over time? Which ones are hard to "see"?

Scientists commonly measure the following list to assess lake water quality:

Trophic Indicators (trophic has to do with nutrients)
Lake profiles (pH, conductivity, temperature and dissolved oxygen)
Water quality chemistry and nutrient concentrations
Chlorophyll *a*, Secchi disk depth, turbidity, and color

[30] kentsimmons.uwinnipeg.ca/ 16cm05/1116/16biomes.htm

Ecological Integrity Indicators

Sediment diatoms
Phytoplankton
Zooplankton
Shoreline physical habitat conditions
Macroinvertebrates (bugs)
Fish community diversity (and predator balance)

Recreational Indicators

Pathogen indicator (enterococci bacteria)
Algal toxin (microcystins)
Sediment mercury
Hydrocarbons

These are variables measured over time in order to detect trends, which could indicate changes to the ecosystem health.

Limnology

Limnology is a discipline that concerns the study of in-land waters (both saline and fresh), specifically lakes, ponds and rivers (both natural and manmade), including their biological, physical, chemical, and hydrological aspects.

Aquatic ecosystems

... consist of entire drainage basins: the nutrient and organic-matter content of drainage from the catchment area is modified in each of the terrestrial, stream, and wetland-littoral components, as well as in the lake or reservoir per se. Productivity is generally low to intermediate in the terrestrial components, highest in the wetland interface region between land and water, and lowest in the open-water portion of the lake. (See below: Lakes- zonation, Littoral zone, Macrophytes and Production).

Benthos

... originating from the Greek word for "bottom", is now nearly uniformly applied to animals associated with substrata. Benthic is the adjective used about things at the bottom of the lake.

Trophic State

Trophic is an adjective used to describe the state of a lake. The word comes from the Greek, pertaining to nutrition or nutritive processes.

At Cultus we use the words "becoming more eutrophic." This means increasing nutrient loading.

Lakes are often classified as **oligotrophic** or **eutrophic**, depending on the amount of organic matter produced. Oligotrophic lakes are deep, nutrient-poor lakes in which the phytoplankton is not very productive. The water is usually clear; the profundal zone has a high oxygen concentration since little detritus is produced in the limnetic zone to be decomposed. Eutrophic lakes are shallow, nutrient-rich lakes with very productive phytoplankton. The waters are usually murky due to large phytoplankton populations and the large amounts of detritus being decomposed may result in oxygen depletion in the profundal zone during summer.[31]
Oligotrophic lakes may develop into eutrophic lakes over time. If runoff from surrounding terrestrial habitats brings in mineral nutrients and sediments. Human activities increase the nutrient content of runoff due to septic, lawn and agricultural fertilizers; municipal wastes dumped near lakes dramatically enriches the nitrogen and phosphorus concentrations which increases phytoplankton and plant growth. Algal blooms and increased plant growth results in more detritus and can lead to oxygen depletion due to increased decomposition. It also changes the clarity of the water. More nutrients = more algaes = less light = murky water.

Background:[32]
Einar Naumann, a German scientist, developed what we now think of as trophic state terminology, using terms that Weber (1907, as cited in Hutchinson 1969) used to classify the nutrient content of bogs. According to Weber, ***oligotrophic*** bogs were raised bogs where the nutrients had leached out, while ***eutrophic*** bogs were sunken, and nutrients accumulated in them. Thus the idea that oligotrophic means "poorly-fed" and eutrophic means "well-fed" originated from the nutrient condition of bogs, not lakes (Hutchinson 1969).

Naumann used the terms, but not necessarily Weber's concept, in classifying lakes. He based his original trophic classification on the "quantitative production of phytoplankton" (Naumann 1929). Oligotrophic lakes were those with low production, "never leading to a coloring or even a clouding of the water." In eutrophic lakes, production attains very high values, "the water being, for the most part, very strongly clouded or even completely coloured."

Naumann related these trophic lake types to the physical and chemical factors that affect production. These factors included temperature (with which he divided the world into Arctic and Alpine, Temperate, and Tropical zones), light, and chemical factors (calcium, humic content, nitrogen and phosphorus, iron, pH, oxygen, and carbon dioxide). He divided the possible range of values for each of these factors, which he called milieu-spectra, into low (*oligotypus*), medium

[31] kentsimmons.uwinnipeg.ca/ 16cm05/1116/16biomes.htm
[32] From http://www.secchidipin.org/trophic_state.htm

Trophic lake types suggested by Naumann

Lake Type	Characteristics
	(*mesotypus*) and high (*polytpus*) “size-classes” or groups. For example, an oligotrophic lake might have oligotypus values of N and P and oligo or mesotypus levels of humus (Naumann 1929). Each of Naumann’s original lake types may have been based on a measure of production, but he combined the measure of production with a description of the factor (or factors) that were related to that production. However, he emphasized that **trophic classification was based on production, not the factor determining that production**. He considered nitrogen and phosphorus to be the primary determinants of production. Nitrogen and phosphorus are nutrients. These nutrients feed the smallest plants that are important to the food chain. A good food chain leads to a lake that is high in fish production. Cultus lake is high in production. More about the stressors later.
Oligotrophy	Lakes with low production associated with low nitrogen and phosphorus
Eutrophy	Lakes type with high production, associated with high nitrogen and phosphorus
Acidotrophy	Lake type with low production, with pH values less than 5.5
Alkalitrophy	Lake type with low production, associated with high calcium concentrations
Argillotrophy	Lake type with low production, associated with high clay turbidity
Siderotrophy	Lake type with low production, associated with high iron content
Dystrophy	Lake type with low production, associated with high humic color

Today trophic state terms such as oligotrophy and eutrophy are still commonly used, and terms such as dystrophy and argillotrophy can occasionally be found in the literature. Unfortunately, the original meanings of the terms have become

blurred and a variety of definitions and underlying philosophies are attached to the trophic state terms. Some of these definitions bear little resemblance to the original concept.

Cultus Lake is becoming more culturally eutrophic. In this case, culturally means man-made.
The term eutrophication is synonymous with increased growth of the biota of lakes, and that the rate of increasing productivity is accelerated over that rate which would have occurred in the absence of perturbations to the system. The measurable criterion of accelerated productivity is an increased quantity of carbon assimilated by algae and larger plants per given area.

Under a large majority of lake conditions, the most important nutrient factors causing the shift from a lesser to a more productive state are phosphorus and nitrogen. Typical plant organic matter of aquatic algae and macrophytes contains phosphorus, nitrogen, and carbon in approximately the ratios:

1P : 7N : 40C per 100 dry weight or

1P : 7N : 40C per 500 wet weight.

If one of the three elements is limiting and all other elements are present in excess of physical needs, phosphorus can theoretically generate 500 times its weight in living algae, nitrogen 71 (500:7) times, and carbon 12 (500:40) times.[33]

Production and Productivity

Production refers to new organic matter formed over a period of time plus losses to respiration, excretion, secretion, mortality, grazing, and predation. All living organisms obtain the energy of life by combustion of organic matter. Autotrophs (like plants) capture solar energy radiating through air or water and store (`fix') captured energy as environmental redox potential (E_h) between the photosynthetic products, oxygen and organic matter. Autotrophs essentially "make their own fuel" in a process called synthesis or production per the following equation which is the reverse of respiration:

$_nCO_2 + {}_nH_2X \rightarrow (CH_2O) + X$
Reduction $_nCO_2 \rightarrow {}_n(CH_2O)$
Oxidation $_nH_2X \rightarrow {}_nX$

The "photosynthetic process" (phototrophy) is also an oxidation-reduction reaction, but uses solar energy to reduce CO_2 to organic matter. In photosynthesis, X is oxygen and water is oxidized to oxygen. Photosynthesis is

[33] http://lakes.chebucto.org/glossary.html

not the only process which produces organic matter. Chemolithotrophy synthesizes organic matter in the absence of light, and where for example X is sulfur, hydrogen sulfide is oxidized. Organisms which do not produce their own fuel are dependent on organic matter produced by autotrophs (heterotrophs).

Productivity usually refers to an average rate of production over a distinct period of time (e.g. day, year).

- Estimates of primary productivity by photosynthesis can be obtained directly by following changes in oxygen production or rates of inorganic carbon assimilation.

- Secondary productivity by invertebrates and vertebrates is difficult to estimate because of complex trophic relationships, changes in diet during the organism's life history, and animal mobility. Productivity measurements of animals are based on changes in numbers, biomass, and growth rates.

- The ratio of productivity to biomass (P/B ratio) estimates the turnover rates of energy flow relative to biomass; P/B values generally decrease with increasing trophic level.

- A population is a defined assemblage of individuals of one species.

- A group of interacting populations forms a community.

- Functionally similar organisms can be grouped into trophic levels based on similarities in patterns of food production and consumption. Energy is transferred and nutrients are cycled within an overall ecosystem trophic structure.

Cultus Lake is a lake with very high productivity.

Lakes- zonation

The lake is separated into the open-water pelagial zone and the littoral zone, the latter consisting of the bottom of the lake basin colonized by macrovegetation. The sediments free of vegetation that lie below the pelagial zone are referred to as the profundal zone. The littoriprofundal zone is the transitional area of the sediments occupied by scattered benthic algae. At Cultus Lake exhibits a significant vertical stratification in light penetration and water temperature. Light is rapidly absorbed by the water and micro-organisms in the water resulting in a rapid decrease in light intensity as depth increases. This divides the lake into two layers: the **photic zone** in the upper layer where light is sufficient for photosynthesis; the lower **aphotic** zone receives little light and no

photosynthesis occurs.

Littoral zone

... is an interface zone between the land of the drainage basin and the open water of lakes. Most lakes of the world are relatively small in area and shallow. In such lakes, the littoral flora contributes significantly to the productivity, and may regulate metabolism of the entire lake ecosystem.

Wetland and littoral regions of freshwater ecosystems are commonly intensely metabolically active owing to the presence of aquatic macrophytes. Phytoplankton productivity is generally lower I littoral zones containing stands of aquatic macrophytes largely from a competition for nutrients (including carbon) by submersed macrophytes, and by a reduction of light by macrophyte foliage.

Macrophytes

Macro means big and phyte means plant. The term aquatic macrophyte generally refers to the macroscopic forms of aquatic vegetation, and encompasses macro-algae (e.g. the alga Cladophora, the stoneworts such as Chara), the few species

of mosses and ferns adapted to the aquatic habitat, as well as true angiosperms. Four groups of aquatic macrophytes can be distinguished as follows:

- Emergent macrophytes grow on water-saturated or submersed soils from where the water table is about 0.5m below the soil surface (supralittoral) to where the sediment is covered with approximately 1.5m of water (upper littoral).
- Floating-leaved macrophytes are rooted in submersed sediments in the middle littoral zone (water depths of approximately 0.5m to 3m), and possess either floating or slightly aerial leaves.
- Submersed macrophytes occur at all depths within the photic zone. Vascular angiosperms occur only to about 10m (1 atm hydrostatic pressure) within the lower littoral (infralittoral), and nonvascular macrophytes (e.g. macroalgae) occur to the lower limit of the photic zone (littoriprofundal).

Freely floating macrophytes are not rooted to the substratum; they float freely on or in the water and are usually restricted to nonturbulent, protected areas.

Phytoplankton

The phytoplankton consist of the assemblage of small plants having no or very limited powers of locomotion; they are therefore more or less subject to distribution by water movements. Certain planktonic algae move by means of flagella, or possess various mechanisms that alter their buoyancy. However, most algae are slightly denser than water, and sink, or sediment from, the water. Phytoplankton are largely restricted to lentic ("standing") waters and large rivers with relatively low current velocities. (See also Periphyton, Metaphyton and Zooplankton).

Composition of the Algae of Phytoplanktonic Associations:

ALGAE CLASSES

Blue-green algae	Cyanophyta or Myxophyceae
Green algae	Chlorophyta
Yellow-green algae	Xanthophyceae
Golden-brown algae	Chrysophyceae
Diatoms	Bacillariophyceae
Cryptomonads	Cryptomonadineae
Dinoflagellates	Dinophyceae
Euglenoids	Euglenophyceae
Brown algae	Phaeophyta
Red algae	Rhodophyta

Zooplankton

Animals of fresh waters are extremely diverse, and include representatives of nearly all phyla. The zooplankton include animals suspended in water with limited powers of locomotion. Like phytoplankton, they are usually denser than water, and constantly sink by gravity to lower depths. The distinction between suspended zooplankton having limited powers of locomotion, and animals capable of swimming independently of turbulence-the latter referred to as nekton-is often diffuse. Freshwater zooplankton are dominated by four major groups of animals: protozoa, rotifers, and two subclasses of the Crustacea, the cladocerans and copepods.

- Protozoa: have limited locomotion, but the rotifers, cladoceran and copepod microcrustaceans, and certain immature insect larvae often move extensively in quiescent water. Many pelagial protozoa (5-300 µm) are meroplanktonic, in that only a portion, usually in the summer, of their life cycle is planktonic. These forms spend the rest of their life cycle in the sediments, often encysted throughout the winter period. Many protozoans feed on bacteria-sized particles (most cells <2µm), and thereby utilize a size class of bacteria and detritus generally not utilized by large zooplankton.
- Rotifers: Although most rotifers (150µm-1mm) are sessile and are associated with the littoral zone, some are completely planktonic; these species can form major components of the zooplankton. Most rotifers are nonpredatory, and omnivorously feed on bacteria, small algae, and detrital particulate organic matter. Most food particles eaten are small (<12µm in diameter).
- Cladocerans: Most cladoceran zooplankton are small (0.2 to 3.0 mm) and have a distinct head; the body is covered by a bivalve carapace. Locomotion is accomplished mainly by means of the large second antennae.
- Copepods: Planktonic copepods (2-4 mm) consist of two major groups, the calanoids and the cyclopoids. These two groups are separated on the basis of body structure, length of antennae, and legs.
- Trophic abundance:
    - In **oligotrophic** systems, concentrations of edible algae are lower, so zooplankton concentrations are also lower. Perhaps as important, there is a shift in dominance to copepods which have lower per capita filtering rates and excrete faecal pellets rather than dissolved nitrogen and phosphorus. All these factors contribute to reduced coupling at this interface.
    - In **mesotrophic** systems, edible and nutritious algae are in higher concentrations than in more nutrient-poor waters, and the

proportion of these algae is greater than in more eutrophic systems. In these intermediate systems there are also sufficient concentrations of cladoceran herbivores. A number of species in the genus Daphnia have particularly high per capita filtering rates. Cladocerans also regenerate nitrogen and phosphorus in the soluble available forms. This enhances phytoplankton productivity, speeds nutrient cycling, and tightens coupling between these trophic levels.

- Ciliated protozoans and rotifers become more important in the zooplankton among **eutrophic**, subtropical lakes. As lakes become more eutrophic**,** a greater proportion of the phytoplankton biomass and productivity often results from large algae (mostly colonial or filamentous). The larger algae interfere with food collection to a greater extent in larger cladocerans causing reduced growth and fecundity than in smaller cladoceran species that feed on small particles.

- Predation by fishes and size selectivity: Planktivorous fish can be important in regulating the abundance and size structure of zooplankton populations. Prey are visually selected in most cases, on an individual basis, although the gill rakers of certain fish collect some zooplankton as water passes through the mouth and across the gills. Planktivorous fish select large zooplankters and can eliminate large cladocerans from lakes. When size selection by fish is not in effect, and when large zooplankters are present, smaller-sized zooplankton are generally not found to co-occur with the larger forms. The cause is likely a result of size-selective predation of smaller zooplankton by invertebrates (copepods, phantom midge larvae, and predaceous Cladocera).

Lakes- Toxic and Potentially Hazardous Substances

It is recognized that along with an increased trophic response, other harmful effects of certain substances are part of the overall problem of man-made (cultural) eutrophication. Some of these substances such as trace elements were always present in low quantities in aquatic systems supplied in the basic natural load, but with accelerated eutrophication, the increased amounts supplied, accumulated and recycled in the aquatic system cause problems. Other substances, mainly organic compounds of an anthropogenic nature, originating from pesticides, paints and other chemicals, also enter into water courses and add to the problem. These substances are usually found in very low concentrations in water but they can accumulate in animal tissues and persist in a water body.

Trace Elements: Mercury, lead, arsenic, cadmium, selenium, copper, zinc,

chromium, and vanadium could cause serious local problems near point sources of industrial releases. The additive and synergistic effects of the mixture of heavy metals can further increase the hazard to aquatic life. Mercury and lead rank highest with respect to real or anticipated environmental hazard in Canadian lakes. Both of these elements can be converted by the process of methylation by microorganisms into methyl mercury and methyl lead, which are strong human nerve poisons. [Mercury can come from atmospheric deposition like from acid rain in northern Ontarion]

Organic Compounds: Organochlorine pesticides such as DDT, Aldrin-dieldrin, chlordene, polychlorinated biphenyls (PCBs) are extremely persistent chemicals and have the ability to bioaccumulate. These substances are known to cause reproductive failure in fish-eating birds, either by failure of eggs to hatch or by the production of non-viable offspring.

Microorganisms: Pathogenic organisms can enter water systems from direct sewage discharge, sewer overflows and septic system failures. Depending on the size of the water body, they can cause health hazards in nearshore regions or they can affect the whole water body.

Limnology and demophoric growth (demohoric is Greek for demos – population and phora – production, about resources consumed and waste generated.)

In broad terms, limnology is the study of the functional relationships and productivity of freshwater communities as they are affected by their physical, chemical, and biotic environment, and includes standing (lentic) and running (lotic) waters.

A fundamental feature of the earth is an abundance of water, which covers 71% of its surface to an average depth of 3800 meters. Over 99% of the immense mount of water of the biosphere occurs in the oceans and polar ice deposits. The turnover time of this water is very long. Most of the remaining water occurs in freshwater lakes; its renewal time is much shorter than in marine systems.

Finite freshwater resources are being exploited and degraded at an alarming rate by the activities of humankind (Wetzel 1983).

Demands upon surface and groundwater supplies result from both population growth and expanding utilization and consumption in technological growth. This growth in utilization of freshwater and other finite environmental resources is termed demophora.

Unless the demands of exponential demophoric growth upon fresh waters are rapidly controlled, a freshwater crisis is imminent. The severity of the freshwater crisis will exceed that of past and contemporary resource-utilization problems.

The crisis is already apparent and will become acute early in the 21st century.[34]

[34] http://lakes.chebucto.org/glossary.html

Appendix 6: Cultus' Very Own Fish

The Cultus Pygmy Sculpin

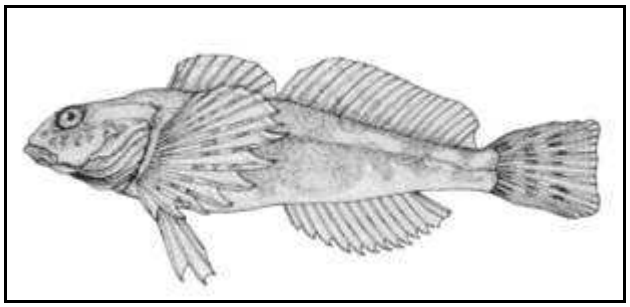
Nowhere else in the world can you find the Cultus Pygmy Sculpin. This little fish is a SARA listed species, (Species At Risk Act).

No Beauty Contest

The Cultus pygmy sculpin is about 5 cm (~2in) long and kind of looks like a larva or a juvenile sculpin. The fish runs brown to grey on top, has dark blotches and is more or less white on the bottom. Spawning males are darker coloured and boast an orange band on the first dorsal fin. The species has a large head, heavy body and a variety of fins.

Due to its limited range and isolation, the Cultus pygmy sculpin is highly vulnerable to change. The introduction of non-native species to Cultus Lake in particular may pose a threat. The sculpin also has native predators, most notably the Dolly Varden (Salvelinus malma) or the Bull Trout (I can't tell the difference, even if they are), which also lives in the lake's deep waters.

Picture courtesy of Sylvia Letay, BC Ministry of Environment



Picture courtesy of Dr. Rolph Schluter, Dept. of Zoology, UBC.

What's being done:
The Cultus pygmy sculpin is protected under the federal Species at Risk Act (SARA). A recovery strategy is completed and action plan will be released in May, 2012. DFO staff have presented to CLASS to talk about the Recovery Strategy and with their technical team.

Why worry about an ugly little fish?
If this little fish can't make it due to human impacts, neither will the lake stay healthy, nor the humans or the property values. It is all connected. The economies of hosting 3 million visitors per year plus the quality of life for residents depends on healthy, wonderful lake water and lake habitat.

What can you do?
The Cultus pygmy sculpin will get the protection it needs only if all of us work together to reduce threats. Reducing man-made threats will also benefit common interests of land value, healthy shorelines and salmon. You are invited to do your best to reduce these threats wherever possible to better protect the sculpin's critical habitat. Get involved with the Cultus Lake Aquatic Stewards that meet on the last Weds of every month at either the Lab or Parks Board.

More on doing:

The Action Plan Workshop and Technical Workshop was held on Feb. 23, 2011, in cooperation with CLASS, to brainstorm ideas for the recovery actions of the Cultus Pygmy Sculpin. CLASS participants, residents and business owners participated. The final report will be released in May, 2012.

- with help from Eric Chiang, DFO Species At Risk Planner

Appendix 7: About Nutrients, Water and Fish-breathing.

Submitted to the Cultus resident's newsletter.
Cultus Lake Aquatic Stewards Update May, 2011

Water is precious. Fresh, available drinking water on earth is the tiniest amount, yet we contaminate over 3 million toilet flushes per year in the Cultus Lake watershed. Scientists have recently undertaken lake core samples to show human impacts over the last 50 and 100 years. Cultus Lake is moving towards eutrophication. That means that too much nutrient is hurting the lake. A degraded lake will degrade Cultus economies. It is time to research nutrient impacts and options for Cultus Lake.
To this end, the Cultus Lake Aquatic Stewards with the Fraser Basin Council and fisheries and Oceans Canada have taken on a project called Nutrient Mass Balance, otherwise known as the Scoop On Poop. Scientists will measure where and now much nutrient is entering the lake.
At the same time, Vancity is helping FBC research solutions for sewerage options in the Cultus area. Even when excellent septic systems and group septics, called sewers, are used – the nutrients still stay in the watershed on porous, glacial gravels that leach into the lake. At some point we need to get the nutrients out of the Cultus Lake area.

Nutrients in the lake grow plants that use up the dissolved oxygen that fish need. The oxygen (O2) taken up by fish is oxygen gas dissolved in the water. An example of other gases dissolved in water is carbon dioxide that imparts little

bubbles in your carbonated beverage. When the water is warmed up, it cannot hold the dissolved gas (so don't forget to aerate the water you boiled to get the chlorine out for your fish tank). Warm lake water, increased nutrient and reduced oxygen is lethal to Cultus fish.

Out of all the water on Earth, only 2.75 percent is fresh water, including 2.05 percent frozen in glaciers, 0.68 percent as groundwater and 0.011 percent of it as surface water in lakes and rivers. Freshwater lakes, most notably Lake Baikal in Russia and the Great Lakes in North America, contain seven-eighths of this fresh surface water. Swamps have most of the balance with only a small amount in rivers, most notably the Amazon River. The atmosphere contains 0.04% water. In areas with no fresh water on the ground surface, fresh water derived from precipitation may, because of its lower density, overlie saline ground water in lenses or layers. Most of the world's fresh water is frozen in ice sheets.
This 3 million figure is interpreted from the FVRD visitor count.
Nutrients are what plants love to feed on. Fertilizer sacks post the numbers in percentages as 6-0-0 for lawns and 12-12-12 for roses. These numbers represent nitrogen, phosphate and potash (potassium) called N, P, and K. Human waste and manure also are nutrients and too much nutrient grows invasive plants, algae and hurts lake systems. The Shuwap Lake had a 50 km algae bloom on it in 2008 and Mara Lake last year. See www.swoa.ca under water quality.

How Fish Breath

From Prof. Hoff: "*Actually, by percent, there is more oxygen in air than can dissolve in water. That being true, why can't fish out of water survive? Among other things, it is because the fish gill tissues are thin membranes that allow oxygen-bearing water to move between the layers and enable oxygen to diffuse into the fish's bloodstream. When the fish is removed from water, the surface tension of water draws the layers into contact with each other. This greatly reduces the gill surface area accessible to oxygen bearing water -- under such circumstances, the gill tissue has only two sides. Thus, the fish suffocates because its breathing apparatus has been tremendously compromised by the adherence of the gill layers. This accounts for the practice of catch-and-release fishermen who (in preparation for the release) sometimes hold a fish in the water while moving it back and forth. The purpose of this procedure is to create a turbulent flow of water around the gills, thereby encouraging the gill layers to separate from each other and enable the traumatized fish to regain its ability to breathe."*

Fine sediments from clay slides make it very difficult for fish to breath. Humans suffocate the same way if they have no filter to breath the air in a fierce sand storm. (Camels close their nostrils down where the hairs act as a filter). Newly hatched fish die from fine sediments plugging up their gills. In Cultus Lake the only way in and out is through the Sweltzer Creek. It is very important to keep the Sweltzer operating well without any sediments and without intrusion from invasive plants.

Appendix 7: Building Relations

Building Relations
Towards A Better Cultus Lake Habitat Resource

“Restorative Justice” Thinking and the Cultus Lake Watershed.

This appendix was provided for those coming to Circle over harms done. It is meant to provide information and stimulate further dialogue about restorative practices with industry and aquatic stewards at Cultus Lake.

Introduction

“The longest human journey is from the head to the heart,” explained Art Solomon, Ojibway Elder.

Understanding that human hearts move human hands, some of us prefer not to use the words "Restorative Justice" (RJ) as it implies criminal justice when this RJ thinking is all about valuing the relationships. Relationship is the catalyst for positive change.

Relationship is the part called "How we do it" while we undertake the "What we do" or the content. Even though Restorative Justice can apply to many things like repeat non-compliance cases - for this paper, you are invited to think about RJ for relationship-building within the Cultus Lake Aquatic Stewards (CLASS) and the gravel industry operators. You are invited to think about **where we need improved relationships and how it can apply to neighbourly relations at Cultus Lake**.

Origins of Restorative Thinking: Often we use the terms Restorative Justice (RJ) when we talk about a continuum of restorative practices ranging from just coming together to build community all the way to dealing with criminal offenses. The shift from punitive to restorative understanding stems from the core questions being asked. Is our perspective, "Who dunnit and what do they deserve?" or "Who has been harmed and what do they need?"[35] In the event of harm having been done, what outcomes do we seek? Gone are the frontier days when any one of us can carry on without consideration for the other. Shall we inflict more harmful relations or what do we really want? Harms can be viewed as unpleasant behaviours among those involved. Harms can be where we have not always been "our best selves" in our intentions. Have you ever had a bad day at work, or a bad day as a result of your stewardship or gravel work? **Which working relationships could use some improvement?**

Harm to the Relationship

Justice As Sanctuary: The "Justice" part of "Restorative Justice" puts the emphasis on repairing the harms caused. Harms are understood as a violation to the relationship, whether it is a bad feeling between individuals, between groups or between governance structures. In the case of a criminal offence, harm is viewed not simply as a violation of the law and an offence against the Crown; it is seen as a transgression of the relationships between those that have committed harms, those that feel harmed and the community, including the harm done to the environment.

Restorative Justice Continuum

Who else is thinking restoratively? In BC today there are many layers and levels of Restorative Justice delivery, from the coursework at the SFU Center For Restorative Justice[36] to your child's school RJ program, a good example of community delivery includes the Community For Justice Initiatives[37] in Langley.

[35] Howard Zehr. 1990. Changing Lenses. Waterloo, Ontario, Herald Press.
[36] http://www.sfu.ca/cfrj/about.html
[37] http://www.cjibc.org/

Restorative Justice is taking place through 65 provincial[38] and 32 Aboriginal Com'ty Accountability Panels[39], some municipal programs and some authorities write about or provide an RJ service. Just knowing that there are so many working in this field of restorative processes is encouraging. Yet, other than learning the theories, none of these groups seem to be a cultural match for those involved with or managing Cultus Lake issues.

How do we turn knowledge into skills?
Although we agree with Albert Einstein's criticism regarding doing the same thing over and over again and expecting different results, the best thing we can do differently is to shift our understanding towards restorative thinking and build better relationships by undertaking the actual experience. Marion Robinson recommends having the conversation to build the working relationship with Cultus Stewards and with the gravel operator. We start with conversations to learn/explore what is essentially called Circle Work.

Restorative thinking is multi-disciplinary and multi-dimensional. It goes beyond the single incident left to those dealing with a harm having been done. "RJ is growing in many dimensions and threads can be seen in a better way of doing things - whether it's Caesar Milan[40] training people, or Justice Murray Sinclair[41] on How to Be a Good Lawyer, Dr. Gabor Mate[42] on Brain Development, or Dr. Joe Solanto[43] on Trauma-affected Society," says Larry Moore of Heartspeak Productions.[44]

Some processes are more restorative than others.[45]
"The opportunity is to build a better way of doing things through our values and by building relationships," explains Dr. Elizabeth Elliott. In her book,[46] she says "I learned that the problems were much deeper than a flawed criminal justice system [or a flawed government] and that our work needed to begin in our relationships with each other and the natural world and, most importantly, with ourselves. She goes on to say that "RJ cannot be actualized solely within the criminal justice system. It must be a new paradigm for responding to harm with its own philosophical and theoretical framework. Facilitating this shift requires a rethinking of the assumptions around punishment and justice, placing emphasis instead on values and relationships. If we can achieve this

[38] http://www.pssg.gov.bc.ca/crimeprevention/justice/index.htm
[39] http://www.pssg.gov.bc.ca/crimeprevention/justice/docs/CAPInformationPackage.pdf
[40] Caesar Milan, The Dog Whisperer as seen on NGC on TV or Youtube "rehabilitates dogs and trains people." The term is coined from natural horsemanship and horse whispering. The need is to train people to come to themselves, to get "real."
[41] http://www.youtube.com/watch?v=1LoXRW8_R9o
[42] http://www.youtube.com/watch?v=BpHiFqXCYKc
[43] http://www.youtube.com/watch?v=OMCfOXrVbQo
[44] http://www.heartspeakproductions.ca/
[45] RJ in this context does not apply to the Voluntary Penalty System for non-compliant fishers. That would be like doing an RJ process for every "speeding ticket" and really doesn't apply.
[46] Elizabeth Elliott. 2011. Security With Care, Restorative Justice and Healthy Societies. Fernwood Publishing, Halifax and Winnipeg.

change, we can build a healthier, more ethical and more democratic society." Imagine people valuing fish and the fishery as an extension of their healthy relationship, their responsibility to their earth and linked with previous generations and those generations yet to come.

Why undertake restoring & improving relations with those involved at Cultus Lake?

- It's the first step on doing things differently. (If we all rush to court, the outcomes will be the same, harms will aggregate and nothing will change.)
- It can bring clarity to misinformation.
- It gives every participant a chance to be heard.
- It is cost effective,
- It is culturally appropriate,
- It is built from the inside out, creating ownership and good ways of extending our relations to each other that is amplified in ecological care.
- Communities and the management-community are able to expand their roles and responsibilities towards a sustainable Cultus Lake,
- They become better able to address some of the underlying causes of harm and losses,
- Nobody is left out of the process,
- It is safe to ask questions,
- The social bonds of the gravel and stewardship community are strengthened,
- Communities are able to demonstrate positive impacts, sense of inclusion and thereby mitigating future harms.
- The RJ experience is not intellectual and connects us in a deeper way.
- Communities can work alongside justice system personnel and save resources necessary for more immediate attention – like when disenfranchised people burn log booms in the river. [In Sierra Leone, suffering from massive war crimes, they spent $3 million to prosecute 9 men while the communities moving forward with healing processes receive nothing. At the same time the communities have resolved hundreds of criminal cases.[47] Restorative communities can do this.]
- Relationship building is key to the future of Cultus Lake. It may be the "missing piece."

How do we build the relationships with each other?

Restorative Justice is not a formula nor is it mechanical. Institutions are there to support and not lead the participants in their process. Even the principles of The National Round Table and the Environment expressed the value of the participant driven process (PDF). The quality of the outcomes is determined by the degree of engagement of those

[47] "Collectively, we will find a way out."—*John Caulker, Executive Director, Fambul Tok International.* Google or Youtube: Fambul Tok.

participants most affected. Restorative processes are meaningful when they are between people not when they are an institutional program. “People have spirit and institutions don’t,” explained a local First Nations staff person, “we will come when this is meaningful. Right now we’ll just wait and see if the process comes from the human heart or not. If it remains within the bureaucratic or legal culture then it isn’t really built on our relationships and cannot, therefore, have the good outcomes.”

Beyond principles, RJ is an approach based on values. Howard Zehr, Professor at Eastern Mennonite University, defines RJ as a more or less cohesive set of human values. When we come together from our values, it promotes accountability, healing and closure. It makes more human what can be a de-humanizing process.

Values commonly associated with RJ include: safety, respect, compassion, authenticity, truth, caring, honesty, grace, human-ness, dignity, balance, listening, balance responsibility, kindness and that participation is voluntary.
In the watershed, the victim is often the fish, the environment or it can be the feelings left in the community from someone else’s management decisions. Sometimes management authorities feel like they are between a rock and a hard place. Industry feels targeted by what they call misinformation. “You don’t need a victim and an offender to have a good restorative process,” explained Dr. Dave Gustafson[48] from Com’ty Justice Initiatives, BC. “The act of bringing people together and providing a meaningful circle, in itself, builds community that improves the work of folks working in watershed.” *See Appendix 1 for full page comment.*[49]
“Trust the Circle Process,” advises Justice Barry Stuart, “the Process is the Product.” “Sometimes the best way to deal with complex issues, like watershed management, is to get down into the human reasons people make the decisions that they do and the ways that interests bump up against each other at a grassroots, human level. Circle values and Forum Theatre is a great vehicle for accomplishing this task,” says David Diamond of Headlines Theatre.

Build the Bridge Before You Need It.
Don’t wait until the rainy season and when stressful moments arrive. Start now by coming together to experience Talking Circles. Ask someone skilled and currently active in circle-keeping to “circle-keep” your group. “It is important that they are currently active, have a home circle and do their own core work,” explained Robert Seto, AVP Facilitator, “consider Alternative To Violence (AVP) exercises to energize and deepen the process and use Forum Theatre techniques like Rainbow Of Desire (Us and Them Project[50]) to gain insight and understanding.” Subsequently, the Circle can design the

[48] Dave is speaking metaphorically about Restorative Justice on Tributary Steams http://www.youtube.com/watch?v=_GLsyk8cLY8
[49] By permission, personal communications with Marion Robinson, March 28, 2011.
[50] Us and Them is an Inquiry initiated by Headlines Theatre to explore why we (society) create people that become “the other.” Using the Augusto Boal approach, Rainbow of Desire, a series of

process and explore further RJ applications (beyond it's own relationship-building), for example, on how to deal with issues as they come up. "Be uncomplicated. Simply hold Circles without a mountain of paper culture to go with it," suggests one Elder.

Positively Changing Cultus Lake Care One Circle At a Time

"There is lots of talking about doing the talking," observed Grand Chief and Elder, Rose Charlie. You can talk, or read a book, about swimming and you may get some knowledge. When you get in the water you actually develop the skill about learning to swim. "Swimming" in Restorative Justice means **a place to practice positive healthy relationships**. Restoring or improving things doesn't happen in isolation. Change doesn't happen without connections. Community doesn't happen without others. The *experience* of knowing you have been helpful, insightful and contributive can only happen in the *experience*.

"We can attend classrooms and accumulate some RJ knowledge but the intellectual stuff is not very useful when we meet with deeper challenges in our communities," said a First Nations Elder, " when we act from our values, we are true every time. If we have cohesion to each other - and value relationship rather than objects & numbers we are heading in the right direction. Improving relations with industry and stewards will improve the resource."

A Talking Circle starts with clarifying relationship values. The getting acquainted stage starts with the circle-keeper explaining the process, doing an opening to start the circle and then having all involved contribute a value. Speaking about the values and making a commitment to them is the easy part. That's the part like reading a book about swimming. When you get to the parts of the Circle that involve building relationships and addressing the issues, you are having a healthy relationship. Time and time again people step up and operate from a deep place of respect and understanding. Circles can hold what we cannot carry by ourselves.
We have seen folks expressing themselves and feeling heard, taking ownership of harms done, and taking part in deep listening. The Circle is *a space apart*. It's a place where we make room for difficult conversations in *a good way*.[51] People leave Circle different from when they arrive. We all become transformed. We can all positively transform the Fishery and ourselves.

An Overview of Circles[52]

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community sessions are being offered. Marion Robinson has been trained by Headlines Theatre and will be undertaking local sessions.

[51] First Nations understanding – "You can't get to a good place in a bad way," says Harold Gatensby.

[52] Kay Pranis. 2005. The Good Little Book of Circle Processes: A New / Old approach to Peacemaking. Published by Good Books, USA.

A Circle is a way for bringing people together in which:

- Everyone is respected
- Everyone gets a chance to talk without interruption
- Participants explain themselves by telling their own stories
- Everyone is equal; no person is more important than anyone else
- Spiritual and emotional aspects of individual experience are welcomed.

Circles are useful when people:

- Need to make better decisions together
- Have a disagreement
- Need to address and experience that resulted in harm to someone
- Want to work together as a team
- Wish to celebrate
- Wish to share difficulties
- Want to learn from each other

Circle is a container strong enough to hold:

- Anger
- Frustration
- Joy
- Pain
- Truth
- Conflict
- Diverse world views
- Intense feelings
- Silence
- Paradox

About the Nature of This Work

Often when we set out to undertake something our only thoughts are about delivering the content and not about the best process. To bring together the visionaries with the action-folks we need to be more on one page so we can "jump to substance" together. Those folks doing the jumping need to have made the deeper connection with values. If these values are punitive, adversarial or shame-based there will not be the intended good outcome.[53] Within restorative thinking, the values guide the action. Values are human and not institutional. Therefore institutionalizing the process of Restorative Justice is misguided. John McKnight, author and facilitator, says "the institutions provide service, people provide care." Local caring and engagement actions supported by institutions will improve the resource. This work may be the higher octave for both the lake caring community and the economies that sustain it.

[53] "Can't get to a good place in a bad way," is a restorative principle.

Recommended Reading in Restorative Practises:

Security With Care, Restorative Justice and Healthy Societies by Elizabeth Elliott. 2011, Fernwood Publishing. Available from the publisher at http://www.fernwoodpublishing.ca/Security-With-Care/

Peacemaking Circles, From Crime To Community, Kay Pranis, Barry Stuart and Mark Wedge. 2003. Living Justice Press.

Community, The Structure of Belonging. Peter Block. 2008. Berrett-Kohler Publishers.

Conflict Across Cultures, A Unique Experience of Bridging Differences. Michelle LeBaron and Venashiri Pillay. 2006. International Press, Nicholas Brealy Publishing.

Any of the Little Books Of Justice & Peacebuilding ($5 each) from Good Books Publishers at 800-762-7171 or http://www.GoodBooks.com

Food For Thought:

How do groups get anything done? See Clay Shirky on Institutions vs Collaboration. http://www.youtube.com/watch?v=sPQViNNOAkw

Why shaming anyone doesn't work: Psychological Foundations of Restorative Justice with Dr. Donald Nathason from disc 5 of Tributary Streams used at SFU Crim 315 as a textbook. http://www.youtube.com/watch?v=CZr5hSW65Vo

Thoughts from Dave:

Dr. Dave Gustafson, a globally respected, long-time restorative practitioner and educator, is fond of sharing stories, insights, challenges and lessons learned from his earlier days working in the fishing industry on the BC coast and then in salmon resource development in communities such as Babine Lake, Meziadin River and others.
When asked about his thoughts regarding Restorative Justice and the Fishery in the Lower Mainland, bringing these two worlds together, Dave responded with the following:

A tremendous amount can be learned just by observing how nature takes care of things, when we park our arrogance and assumptions long enough to sit at her feet and learn her ways. As humans, we are desperately dependant on nature and interconnected with one another. We can learn vital things from one another, too, when we are prepared to sit, for even a time, humbly at one another's feet, listening to and acknowledging what others have learned through their own experience. That happens to be the beauty of dialogue processes, such as

Circles: talking, conflict resolution, dialogue and healing circles to name a few. There, tremendous opportunities can open up to us - far beyond the bare essentials of the positions being voiced - if we can only be still long enough to learn what is at the heart of each matter, each issue, each person's perspective, so as to honour and include it rather than debate and reject it. Too often we narrow and constrict our processes, believing, for example, that we need an identified 'victim' and an identified 'offender' in order to convene a truly restorative process. Where resource issues are concerned, failing to build relationships among those who steward, who protect and who harvest those fragile resources usually means that the resource itself suffers. In the fishery, this can mean that the real victim is the fish, the watershed or the environment where those stocks live and are nurtured.

In over 30 years of bringing people together to dialogue for all sorts of reasons, I've learned this: the very act of preparing people to communicate effectively with one another, and then the convening of meaningful circle or other processes in which they can meet and truly dialogue, in itself builds community. Communities have - and tend to take - responsibility for the environments in which they live and are nurtured. It is no 'stretch' to suggest that building relationships of mutual interest and respect can go a long way toward protecting stocks, protecting (and even reclaiming) environments, improving watersheds and ensuring sustainability. Like the life-cycle of the salmon themselves, these processes, in order to fulfill their potential and their destiny, need to go 'full circle.' And, when they are allowed to do so, the 'harvest' can be rich and plentiful.

Appendix 8: "How To Build Community To Save Salmon"

"How to Build Community to Save Salmon"

Thoughts from the Cultus Lake Stewards, April 16, 2011
on the occasion of Alexandra Morton's visit.

When we come together and understand what needs to be done we also identify a unified approach about HOW this work can get done. These pages are about the HOW part of caring for the lake, home to Cultus populations of sockeye salmon.

"The longest human journey is from the head to the heart," explained Art Solomon,[54] Ojibway Elder. "Realizing that human hearts move human hands, we build community with all that come forward to care for Cultus Lake. We choose the non-adversarial, inclusive approach. It keeps the doors open and communication flowing. We can't afford not to work with all sectors, all agencies and all individuals to do the right thing. There is room for all of us," explained Marion Robinson.

[54] Art Solomon, 1913-1997, was a compassionate Canadian of French and Ojibway heritage working with the most marginalized populations. He was an author, poet and educator.

The Cultus Lake Aquatic Stewardship Strategy is to be inclusive, non-adversarial and provide education combined with outreach.

Community Engagement and Collaborative Leadership

When watershed challenges seem insurmountable, many decision-makers focus on other things instead. Cultus Lake issues have not had overwhelming support in the last few years due to a number of circumstances. For example, at Cultus Lake, money and effort have gone into milfoil eradication to no avail. This invasive plant keeps growing. At the same time sockeye salmon numbers have been down (except for 2010) and the DFO Salmon Recovery Plan has remained in draft form while the lab team works diligently. Cultus sockeye (COSWIC listed) were not granted SARA status and many resources, therefore, do not qualify for Cultus Lake. Some watershed stewards are working on predator control, and keeping the dialogue alive regarding invasive plant management. At the same time there are excellent scientists in DFO and at the Cultus lab. So where is the opportunity? The opportunity is in building the lake-caring community to move forward together with the science. Scientific lake core samples show increased nutrients (eutrophication) that could come from the 3 million visitors to this little 650-hectare lake. It is the community response that will make the difference to removing nutrient-point-sources so this lake can live and support salmon and aquatic SARA species. “What is good for the fish, is also good for humans and property values,” explained a participant, “a smelly, green algae bloom would ruin the local economy of 3 million visitors to the lake.”

The world as we have known it, is in the midst of a fundamental change. As a result many of the existing systems within business, government and other sectors are no longer working well. In Cultus Lake, the community has responded creatively to these challenges. Learning from other lake efforts, the Cultus community moved forward with a bottom-up model rather than top-down approach. The community took the opportunity to move beyond the old “residual” role of compensating for gaps in government service to occupy a more central place in watershed care. The community now actively works with the role of government. One recent example is of Cultus citizens keeping an eye on the Vedder Mountain where sedimentation can occur in high rainfall events. (Kudos to the Forest sector’s quick response to citizen concern. This has prevented some fish deaths.)

Relationship with people is the key. It is in communities that energy is tapped, innovations are launched and citizenship can be expressed through active community engagement to save salmon habitat.

The Non-Adversarial Approach

Sometimes, even without thinking, we create an ownership or a territorialism where others can't come forward to help even if we say we want them. Globally we look to Gandhi or Mandela to remind us of our behaviours as seen in our "ways of being." Local Aboriginal Elders also talk to us about "ways of being" and how we conduct ourselves. Ways of being are rooted in the values we hold. These values are universal as no one at Cultus would not want to act in fairness, respect, trust, honesty, care, and with integrity and consideration for others. The human values we hold can be seen more in how we conduct ourselves than in what we say. The Cultus Lake Aquatic Stewards have chosen to conduct themselves in ways that build community, include others and get along with different points of view. "Just because we believe in watersheds doesn't mean we would attack others that are not there yet in understanding what the lake needs," says a senior Cultus resident. "Be patient with those that don't understand. Let them discover their way of being with caring for Cultus Lake and with caring for all things that take care of us," said Ernie Victor, (Sto:lo) Cheam Band Councilor.

Education

Reaching out to bring the understanding of what Cultus Lake needs, as a living body, to everyone, is a process we refer to as education. As every person involved with the CLASS group has interconnections in a multitude of groups and agencies, we are growing the network, momentum and care for Cultus Lake. We do this in a more personal way of two people connecting with two more people. This network includes residents, ratepayers, schools, 4 orders of government and staff, First Nations, forest sector, gravel pit operators, youth, seniors, NGOs, research scientists and the business community.

How we do this:

- Work together; use people power,
- Use a values-based approach where relations and social cohesion are high,
- Use science, factual information, get help to interpret data,
- Be relevant to the audience. Find ways to include them,
- Use the asset-based approach to community development (ABCD),
- Work with media, internet and personal contact to get the message out,
- Build community and continue relentless outreach and inclusion,
- Consult oldest long-time residents to establish ecological base-line as to how this watershed was in the past.
- Help others see themselves in this work so it doesn't become separated into "us and them" (and it doesn't land on one person to do all the work).
- Establish healthy patterns of behaviour and continuity[55] towards watershed work.

Carrots and Sticks

[55] As explained by Chief Mark Wedge, http://www.youtube.com/watch?v=eKjE8EtsF84

Lake caring communities work at the front end of the justice spectrum. Traditional teaching means we don't tell others what to do but we model what we want to see, while the criminal justice system and the court system in Canada, (Fish Act) punishes offenders once the deed has been done. This will not bring back to life – the fish nor the necessary human ability to relate. As offences are against the Crown, both the victim and the offender are removed from direct accountability while the justice industry (lawyers) works it out. Justice Barry Stuart (now retired) reminds us that court is what we use when all else has failed: when community is not present, when the relationships are gone and folks have lost the connection to their values. He sees court processes as the ultimate failure. Shifting the thinking from "Who dunnit and what do they deserve?" To "Who has been harmed and what do they need?"[56] can help us shift our human relations to the higher octave of what it takes to save the salmon. We all have a responsibility.

Turning our knowledge into skills to benefit salmon

The Cultus Lake Aquatic Stewards have been meeting every month since October, 2007. Achievements to date include

- Establishing the Cultus network, ratifying a Terms of Reference,
- Workshopping Issues & Topics,
- Rediscovering historic base-lines with the Oral History Project,
- Completing a literature review of 72 scientific documents,
- Recognizing other contributions and efforts, (Salmon Table)
- Complimenting the work with the human aspect of sustainability,
- Finding our how the Lake is used, public outreach, (Cultus Lake User Survey)
- Setting future work priorities with science and community and
- Moving forward with Nutrient Mass Balance (the Scoop on Poop).

Other CLASS participants are also working on salmon recovery, predator control, invasive plant management, science & research, SARA listed species recovery, river clean-up, lake levels, safety and governance.

By our fruits, they will know us. Matt. 7.20.

Although we agree with Albert Einstein's criticism regarding doing the same thing over and over again and expecting different results, the best thing we can do differently is to shift our understanding towards restorative justice thinking and the building of caring communities, relationships and actions based on human values.
Cultus Lake Aquatic Stewards work together to deliver a multi-pronged approach through science, education and building community with the focus on lake care. Every individual, in turn, is connected to a larger community whether it's First Nations, local, provincial or federal government, NGOs, community groups or otherwise. The Stewards

[56] Howard Zehr. 1990. Changing Lenses. Herald Press.

are *a network* rather than a society, association or coalition. Being *a network* allows some participants to act as advisory, particularly those agencies that cannot be a "member" of any group. For example, even at the provincial level there is a fund from harms done that goes back to environmental actions but the province can't be a society member. Every little bit helps and many pebbles make a mountain.
People come to Cultus Lake and are motivated by its natural beauty and environmental qualities.[57] Some Cultus visitors[58] and residents have been connected to this special place for generations. They identify with this little lake surrounded by trees and hills and want to keep it intact for generations to come. If those that love this lake, come back in many years from now, will it still be that special place? We realize that the future depends on what we do now.

To conclude, salmon will be saved when we all do our part, whether we do it with our consumer dollars, or within the connection to each other as British Columbians. Being conscious of what is good for fish, is good for humans, too. The world is too small to ruin this place so we can move to another place. There is no such "other place."
The only thing that can turn this around is the relational action to engage other humans.[59] Relationship is the catalyst for change. Our ability to relate to and connect with our actions saves salmon. This relation-ality, as coined by Shawn Atleo (National Chief) to self and others extends to the environment. Building our healthy-fish identity, building the caring community, one circle at a time, benefits our future and future of salmon.

[57] Cultus Lake User Survey 2010.
[58] FVRD measures 3 million visitors per year.
[59] Adapted from Sandra Bloom. 1997. Creating Sanctuary. Routledge.

Appendix 9: Debate vs Dialogue

Debate Versus Dialogue

Debate	Dialogue
Assuming there is a right answer and you have it.	Assuming that many people have pieces of the answer and that together they can craft a solution.
Combative: participants attempt to prove the other side wrong.	Collaborative: participants work together toward common understanding.
About winning	About exploring common ground
Listening to find flaws and make counter-arguments	Listening to understand, find meaning and agreement
Defending assumptions as truth	Revealing assumptions for re-evaluation
Critiquing the other side's position	Re-examining all positions
Defending one's own views against those of others	Admitting that other's thinking can improve on one's own.
Searching for flaws and weaknesses in other positions	Searching for strengths and value in others' positions
Seeking a conclusion or vote that ratifies your position	Discovering new options, not seeking closure as the prime goal.

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