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Tsolum River Biophysical Assessment 2011

A Compilation of two reports:

**Tsolum River Limiting Factors
to Pink Salmon Production**

By Kathy Campbell, RPBio

**Tsolum River Hydrology
and Channel Assessment**

By David Gooding, P.Eng.

With an Introduction by
**Jack Minard, executive director,
Tsolum River Restoration Society**

With Funding and significant In-Kind Assistance from:



**British Columbia
Conservation
Foundation**



**BC Transmission
CORPORATION**

**Gooding
Hydrology**



GEORGIA BASIN / VANCOUVER ISLAND



**Silverbright Pacific
Ecotech**

"A Healthy, Diverse and Productive Tsolum River"

ACKNOWLEDGEMENTS

The TRRS would like to acknowledge the organizations and individuals who helped make this report possible:

Funders of this Project

British Columbia Conservation Foundation
British Columbia Transmission Corporation
Marine Harvest Canada
Living Rivers Georgia Basin/Vancouver Island
Comox Valley Regional District

Corporations

TimberWest Forest Corporation

Expertise and Assistance

British Columbia Institute of Technology
River's Institute
British Columbia Conservation Foundation

Government

Fisheries and Oceans Canada
BC Ministry of Environment
BC Ministry of Natural Resource Operations
Environment Canada
Natural Resources Canada
City of Courtenay
Comox Valley Regional District - Areas A, B and C

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Tsolum River Restoration Society, TimberWest Forest Corp., Fisheries and Oceans Canada, British Columbia Ministry of Environment, British Columbia Ministry of Natural Resources Operations, Pacific Salmon Foundation, Mining Association of British Columbia, Natural Resources Canada, NVI Mines, and Environment Canada.

INTRODUCTION

After 44 years of toxic copper pollution, the Tsolum River has experienced a major improvement in water quality. After several attempts to solve the growing problem, including a partial cap installed in 1988 and 1989, by the year 2000 the Tsolum River was declared “dead”!



1988 – cleaning up the loose material and preparing to cover with gravel

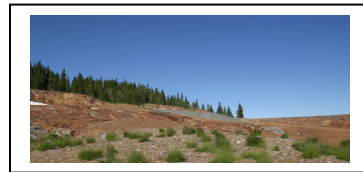


1999 – shows the partial cap installed in 1988/1989

Between 1999 and the present, with the original cap becoming more effective, the successful implementation of the Spectacle Lake Wetland Passive Treatment Project in 2003 and the subsequent complete reclamation of the Mt. Washington Copper Mine Site in 2009 through 2011 water quality is now within healthy and sustainable limits and will support aquatic life again. The Tsolum River Partnership is acknowledged and thanked profoundly for finding the way to accomplish this momentous goal.



Spectacle Lake Wetland 2004



Top: Before
Middle: 2010
Bottom: end of 2011

The following reports by Kathy Campbell, RPBio and David Gooding, P.Eng establish clearly that the next most limiting factor to salmonid production in the Tsolum River after

water quality issues from Acid Mine Drainage (AMD) is unstable substrates loosed into the Tsolum mainstem and tributaries from historical logging (1890 – 1958). This is followed closely and is related to the movement of gravels by extreme flows. High flows move the gravel in winter, destroying fall spawn. Extreme low flows in the late summer reduces rearing habitat to well below what is necessary to sustain coho and trout populations.

Encroaching development in the lower river, agriculture at the centre and private managed forestry in the upper two thirds of the watershed all produce ongoing and significant impacts to the watershed. The TRRS has developed relationships with all sectors and works with them to mitigate, reduce or eliminate these impacts.

Over the 13 years of our presence in the watershed, we have found that there is very little long-term protection for the critical ecosystem drivers that support a healthy ecosystem. Riparian stability, substrate stability, headwater infiltration and other forms of landscape-scale water storage, pool/riffle sequencing and water chemistry are simply not afforded protection per se. The TRRS continues to actively work towards better land use policies with all other environmental organizations in the region and the governments that set these policies. Approaching land use through “salmon friendly” watershed-based policy we believe will result in excellent land use outcomes across the landscape and well into the future.

The TRRS believes that if we can restore and protect these drivers, we will see Tsolum River ecosystems rebuild over time. It is a shared dream that we can dramatically reduce human intervention, and restore and protect these drivers in perpetuity.

HISTORICAL PERSPECTIVE

When the first European settlers arrived in the Comox Valley, they found a “Land of Plenty”: huge timber as far as the eye could see; fish, wildlife and natural foodstuffs to satiate any appetite; and land that could be turned into incredibly rich farmland simply by draining the water. Settlement was inevitable and a large population of aboriginal people who had successfully stewarded these incredible resources for at least 10,000 years were usurped as the land was divided and sold to these newcomers.

Between 1865 and 1965, most swamps were drained, many tributaries and portions of mainstem rivers were altered or outright channelized, and almost every ancient tree in the region was harvested. Roads and ditching laced across the landscape, beginning the process of rapid run off which lowered aquifers and eroded streams. Overfishing and various forms of air, water and land pollution took its toll until visionaries like Rachel Carson began to awaken our society to what we were doing¹. The legacy of this time of outrageous exploitation created British Columbia’s wealth, built our cities and productive farms, and produced the metals and chemicals that powered an explosion of growth. Somewhere in the process however, we lost sight of the fact that nature and natural systems provide that wealth. We still, to this day, wage war on nature. We have not yet learned how to turn our social fabric away from exploitation and towards stewardship and sustainability. This legacy of unfettered exploitation left many problems in the Tsolum River watershed.

¹ (**Rachel Louise Carson** (May 27, 1907 – April 14, 1964) was an American [marine biologist](#) and [nature writer](#) whose writings are credited with advancing the global [environmental movement](#))

There are however, many new and positive initiatives underway and while old habits are hard to break, a new awareness of the fundamental value of nature is beginning to be embraced.

Acid Mine Drainage

In 1969 the Department of Fisheries and Oceans began asking why salmon runs in the Tsolum River were not rebuilding. After the decimation of stocks all over BC from historical logging practices, other rivers in BC were starting to see some rebound thanks to enhancement efforts. Enhancement efforts were undertaken quite earnestly in the Tsolum River but no improvements were observed. Finally in 1985, through the insistence of local people such as Father Charles Brandt of the Comox Valley Branch of the Steelhead Society and others, the cause of the continuing decline was found to be acid mine drainage (AMD) from a copper mine abandoned on the southern slope of Mt. Washington in 1967. Between 1967 and 1985, acid mine drainage accumulated unabated.

Many ideas were considered and rejected because they cost too much and others were rejected because the solution was not without further risks to the environment. Our MLA for the Comox Valley at that time was Karen Sanford. Karen went to bat for a solution to the problem of serious water pollution and kept the issue before the government of the day. Stan Hagen took over the MLA's seat in 1986 and he kept the project alive. A \$1.5 million capping project was given funding by the Province in 1988. Stan Hagen was on the Treasury Board and pushed effectively for the money. Designed and implemented by SRK Consulting it was quickly nicknamed "Murray's Raincoat", for Murray Galbraith who, while working for the BC Ministry of Mines was instrumental in the implementation of the project. The cover was deemed a failure and a waste of taxpayers' money in 1991. The Tsolum languished for a decade in the aftermath.

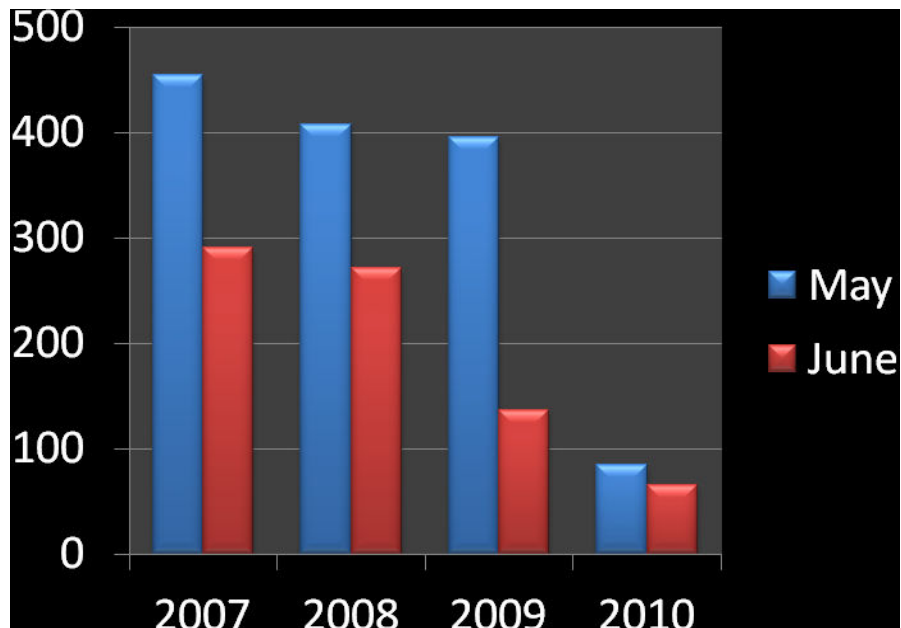
With the formation of the Tsolum River Task Force in 1997 all stakeholders were assembled to discuss what could be done. The Task Force brought the plight of the Tsolum into the public eye again, put pressure on government and industry to take responsibility for the pollution continuing to destroy the river and began to put together a suite of possible solutions. Cost estimates to solve the AMD at that time were in the \$6 - 10 million dollar range and with the 1988/89 failure, there was understandable hesitation.

The TRRS has worked tirelessly towards a complete covering of the site. By 1998, water quality samples showed vast improvement and "Murray's Raincoat" had begun to become effective. It is agreed that the 1989 partial cap became effective as the interstitial spaces in the gravel plugged up with detritus, dust and other particulate matter. Over the peak flows of 1987/88 we see a 50% reduction in cu loading in the Tsolum! In 2001, we see the largest run of pink salmon return to the Tsolum since 1953!

In 2003, the Tsolum River Partnership was formed and implemented a Passive Wetland Project that effectively reduced pollution by a further 50%. With improvements underway and stocks looking as though they could be rebuilding worries began to surface about the Wetland Project's effective ability to sequester toxic copper. As it had become evident that improvements were revitalizing the potential of the river, concerns arose that those gains could slip as the wetland ceased to work. The potential of losing the gains galvanized a real effort on the part of the Partnership to get a complete site reclamation underway.

With a grant of \$50,000.00 from the BC Ministry of Environment work began in earnest to decide what to do. With the findings from this original grant embarked on the road to a complete reclamation project with an engineered bitumen seal and soil cover had begun.

The rest, as they say, is history. As soon as the bitumen seal installation was completed in 2010, water quality continued to improve. An extensive monitoring regime is in place and is providing continual data that is showing excellent results and strong improvement in water quality. The results have reduced highs of over 35 parts per billion of toxic copper leachate in river water to well within sustainable parameters and within the 11 parts per billion maximum set by the Partnership.



Pyrrhotite Creek copper loadings kg/month

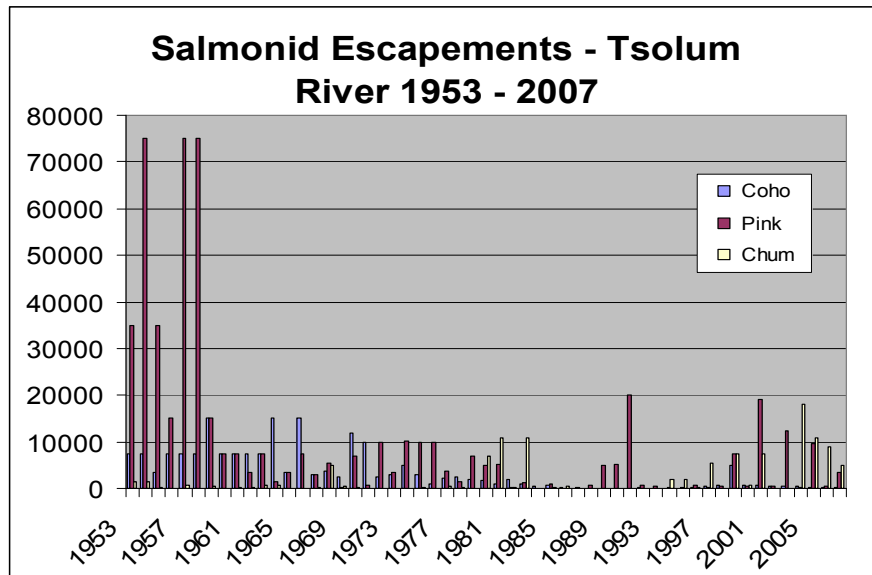
Declining Stocks

The graph below clearly shows the decline in stocks by 1959, five years before any copper mining occurred on Mt. Washington. It is agreed that historical logging practices were largely responsible for these declines along with urban and agricultural development and overfishing. Similar declines can be seen in all watersheds in BC that were clearcut with little environmental awareness.

Many watersheds across the Province experienced similar significant reductions in abundance of salmonids by the mid-fifties. DFO began to support and build hatcheries across the province, new logging regulations were written, and education programs and community led enhancement and restorations were implemented by the early sixties. By the mid-eighties, some rebound in salmonid abundance became the norm in watersheds where this work had been undertaken. The Tsolum, even with numerous and significant activities undertaken, failed to rebound and stocks continued to decline. By 1983, it was apparent that restoration activities were not working. Creating the Wolf Lake storage, experimenting with pink enhancement between 1969 through 1976, building a hatchery facility on Headquarters Creek, outplanting spawning adults from the nearby Puntledge Hatchery and outplanting coho and pink fry were all fruitless. Everyone was asking why. It was not until November 1984 that the world heard about the Acid Mine Drainage pollution.

From 1969 to 1981, the enhancement efforts performed by DFO resulted in some increases in pink salmon immigration. 1989, 1990 and 1991 saw a vastly reduced commercial fishery on pink salmon, no major flood events during incubation in the

Tsolum River and excellent out and immigration timings and temperatures. Coho numbers continued to decline and chum were very variable.



Pinks again began to show better in odd years with the beginning of the TRRS Pink Sustainability Project and the rearing of pink salmon at the Tsolum Facility. The TRRS released 500,000 fry in 1999 and in 2000 we saw the first returns. Odd year pinks appeared to be doing better than even year even though 1,000,000 fry were released every year.

Coho have been reduced to mere remnant numbers with the last run of any size occurring in 1999 and chum, although appearing to build through 1998 – 2007, have since declined as well. In 2010, escapement numbers were; Coho, 1000, Chum 1500, pinks 900. Coho show a remarkable return while chum continued to decline. These returns are in concert with coast-wide trends and are beginning to show that toxic copper is not chasing away those fish that attempt to return to the Tsolum. With the dramatic return of water quality we should now see returns that follow coast-wide trends.

Water Quantity

By 1999, it had been established by the Tsolum River Task Force that, after the Acid Mine Drainage (AMD), the next most limiting factor to fish production in the Tsolum River watershed was extreme low flows². This is painfully obvious during the low flow period from late August to the first rains of the fall as we see portions of the mainstem and many tributaries dry to the point where wetted widths become untenable to rear coho and trout, water temperatures rise to as high as 32 degrees Celsius³ and a significant loss of rearing fry, smolts and parr occurs annually. It was from these observations the assumption was made that water quantity was the next most limiting factor.

In 1999, in an effort to alleviate low water issues, at least in the mainstem and in Headquarters Creek, the small dam that had been installed at the outfall of Wolf Lake into Headquarters Creek in 1951 was repaired to eliminate leakage and raised to impound more water in Wolf Lake. A proper weir control, staff gauges and a protective line of floating logs were installed at the same time.

² Campbell, K “The State of the Tsolum Report” April 1999

³ TRRS, 1999 Pond Study

With thanks to James Craig of the British Columbia Conservation Foundation (BCCF), a more definitive release schedule was researched and monitored. A study of the area of Wolf Lake that is drawn down in use of this stored water was undertaken and a “rule curve” was designed to guide releases. With funding from BCCF and the Pacific Salmon Foundation, another study looked at other storage potential throughout the watershed.⁴

Up until this time, there was little coordination between Hatchery staff and the Tsolum River Task Force or Restoration Society. The most dramatic of these non-coordinated events was in 1997 when two excavators were in the lower Tsolum Mainstem performing bank stabilization works placing rip rap. Without rainfall (or any warning) water began to rise around these machines. The machines had to leave the river and abandon the remainder of the work. Several days later, it was discovered that the rise in water was due to the opening of the weir by DFO staff a few days earlier with no coordination or communication planning.

November 2007 saw the beginning of an Augmentation Advisory Committee who held their first meeting on February 11, 2008. From this meeting several actions were determined;

- established 35 Cubic Feet per second (CFS) or 10% of Mean Annual Discharge (MAD) as the target we need to achieve, based on provincial standards in ECVI water allocation plans
- more study of discharges that allow pink salmon immigration
- compare the actual figures to the target contemplated
- Identify defensible targets for rearing flows
- Examine relationship of historical storage releases and WSC hydrometric record at the Rees Bridge.
- determine the actual amount of storage physically accessible behind the Wolf Lake Dam, versus what is acceptable to use, and what has been used recently
- look into other water storage locations throughout the watershed

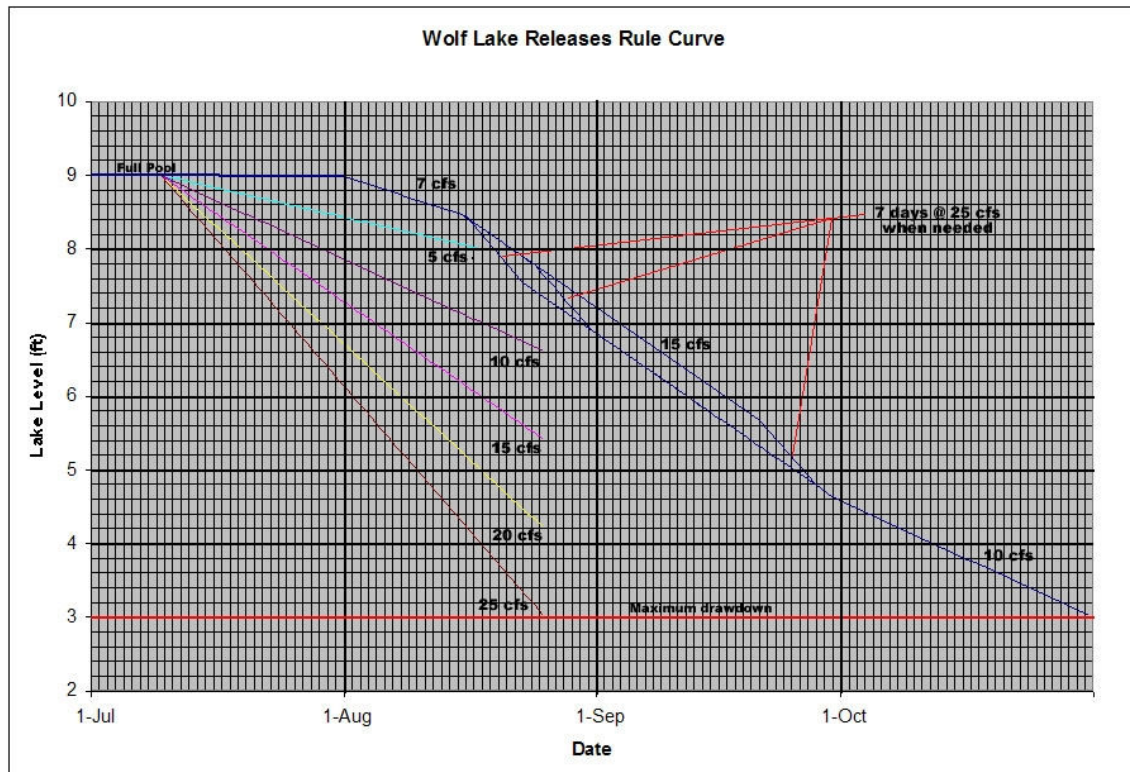
This group includes James Craig of the BCCF, Margaret Wright of DFO, Scott Silvestri of the BC Ministry of Forests, Lands and Natural Resource Operations, Dave Gooding, a hydrologist retained by the TRRS and Darcy Miller and Brian Munro of the Puntledge Hatchery. The last meeting of this group took place on February 15, 2011. Several decisions were made and action items identified:

Objectives for the Wolf Lake storage and release strategy were increased to include ecosystem and multi-species considerations vs. pink migration alone. A decision was confirmed to move the water release start date to mid-July in order to mitigate the extreme lows in late July observed in recent years, utilize more storage at the front end of the augmentation period and avoid having underutilized storage at the end of the summer.

Another decision was to establish a minimum acceptable lake level and a contingency for extreme drought. The minimum level, nicknamed the “Rimmer” level after Mr. Skip Rimmer, a lakes biologist with the Province who did much of the early work on using the Wolf Lake storage, allows 6 feet of drawdown below full storage level. A drawdown below this level is thought to result in impacts to shoal habitat and resident species of fish. The license for 3,200-acre feet equates to a potential 8.4 feet of drawdown

⁴ Gooding, D “TSOLUM RIVER Flow Augmentation In the Tsolum Watershed” December 2007

(Gooding 2008). In very dry years (i.e., 1:10 year droughts or worse), an extra foot of storage may be used to maintain downstream fish habitat in the Tsolum.



2011 will serve as an experimental year for a revised operating procedure by evaluating releases on a weekly basis and adjusting according to lake level. Some key operational points:

- Water level recorders are to be maintained
- Puntledge Hatchery staff will continue to visit the dam once per week during the summer
- Opening and closing of the gate valve at the outlet is staged over a few days (i.e., significant changes to be “ramped”)
- Beaver activity at dam is causing problems
 - Puntledge Hatchery staff and TRRS volunteers will scope out options
- The trash rack requires modification so that it is easier to remove debris at high lake levels - debris in gate valve can prevent full closure and result in the storage not being full at the beginning of the release season
- Develop, if possible, electronic real time remote monitoring to detect beaver or other blockages and prevent significant low flow occurrences
- Advocate for timely flow measurements and correction factors on the WSC website so DFO can optimize Tsolum flow/Wolf storage management
- Revise and review operating procedures annually
- TRRS to observe pink salmon behaviours at different low flow scenarios

The Puntledge Hatchery staff, the TRRS, James Craig of BCCF and Margaret Wright of DFO continue to track, discuss and refine the use of the Wolf Lake storage.

Stock Enhancement

The TRRS was formed in September 1998 to become the business arm of the Task Force and developed the first strategic plan for the river. The State of the Tsolum was produced and it looked like action would begin. One of the first projects of the newly formed TRRS was to begin enhancing pink populations. It was decided at a strategic planning session in 1999 that only pink salmon would be enhanced to attempt to raise nutrient levels in order to support other species. It is known that pink salmon have high nutrient levels per gram of body weight, their carcasses decomposing would replenish lost nutrients and the abandoned and unused Tsolum Facility could be utilized. The TRRS discussed and determined that enhancing pink salmon for nutrients would be a good idea. Other species were considered for enhancement, primarily steelhead and coho, but restoring lost habitat to support remnant stocks emerged as the strategic course of action to be undertaken by the TRRS.

Bill McClean, an Operations Biologist with the Vancouver Island Major Hatchery team, established that pink salmon were not only in decline but that the water quality issues from the AMD caused pink salmon to “avoid” the river, further exacerbating this decline. Bill went on to explain how important the nutrients from large numbers of pink salmon carcasses were to the health of the Tsolum River and with any improvements in water quality efforts to rebuild pink stocks would be critically important. A small DFO facility located on Headquarters Creek was therefore re-opened by the TRRS in 1998 with 500,000 fry being released in 1999.

A brief overview assessment, funded by the Urban Salmon Habitat Program of the mainstem and tributary confluences was undertaken in 2001 from June through November. From this project, the TRRS initiated the Pink Sustainability Project (PSP) in 2001 that has been operating since.

This early assessment looked at barriers, obstructions, flows, erosion sites, spawning areas, holding pool habitat and water withdrawals from the lowest flows of the year to the highest. It was undertaken to better understand what obstacles, beyond toxic copper levels, might inhibit a healthy run of pink salmon in the Tsolum. It was determined during this assessment that low flows only impact pinks during the earliest part of their immigration period in late July and early August. Usually by late August or early September there is ample water for pinks to migrate well upstream. There have been a couple of very dry years where it was well into October before flows were high enough to encourage pink salmon but we were able to utilize stored water from Wolf Lake to assist.

This year (2011) will see the 13th year of pink enhancement with some 12.5 million fry released to date. In 2011 the hatchery fry were transported by truck to the Rees Bridge in order to bypass the Rotary Screw Trap allowing us to completely separate wild fish from hatchery stock in our out migration research.



Volunteers releasing one million fry downstream of the Rotary Screw Trap

Stock Assessment

Since the inception of the PSP pinks have been assessed each year with concerted Stream Inspection Log counts completed in 2001, 2007 and 2009 and stream walk estimates completed for each of the other years. In 2004, with funding from TimberWest and the Pacific Salmon Foundation, a small four-foot rotary screw trap was manufactured and delivered to the TRRS.

This equipment has allowed the TRRS to compare out migration against counts and estimates of immigration. This process has supplemented our knowledge of stock abundance but has not provided definitive data. The Rotary Trap went through several changes in location before its current location was established. The objective was to find a locale that allowed shallow fishing for pink and chum when the river had higher flows and deeper fishing at lower flows for coho and trout. The current location appears to be working and a project to stabilize the banks provides an opportunity to “fix” this location.

Other factors have skewed the data as well; flood events, extreme low flows during early spring and enormous differences in immigration numbers.

We have made several swims of the river and over the years, we are hearing from residents and observing that cutthroat trout are thriving. This is not corroborated however by RST data. We are quite certain from our observations that Cutthroat have improved, are stable, and fear we are not fishing them effectively with the RST. It is thought that cutthroat utilize the lower portion of the water column and manage to avoid the two foot depth at which the RST fishes. We continue to have interesting numbers of rainbow trout and do believe there is a remnant steelhead population hanging on in the Tsolum River. Pink and Chum are in concert with immigration in that high immigration numbers can turn into high outmigration. As you will see however, in Gooding’s Hydrology report (attached), the Tsolum River can get a very good run of pinks but have very low outmigration due to a flood event during incubation, which mobilizes loose substrates.

RECOVERY PLANNING

Habitat damaged by human activity has reduced the productivity of all salmon and trout species in the Tsolum watershed. The Tsolum River once supported large populations of steelhead, resident rainbow trout, sea-run cutthroat trout, as well as coho, pink and chum salmon. Now that minesite remediation has controlled copper levels, the TRRS can now design an organized, prioritized recovery plan that restores fish and wildlife productivity.

Unstable Substrates

Twenty or more unstable gravel bars are responsible for significant egg and alevin losses when flows exceed 49 CMS for 10 days or more⁵. Any recovery planning will have to start here. TRRS research shows two possible methods to improve this loose substrate. One method is to carefully mine gravel out of the river in a way that creates a narrower, deeper channel with pools. The second method involves heavy bioengineering. It is suspected at this point that we will use a combination of methods.

⁵ Gooding, D “Tsolum River Biophysical Assessment Hydrology and Channel Assessment” January 2010

Extreme Flows

Continuing to refine the use of stored water from Wolf Lake or increasing the storage in the lake by raising the dam are real possibilities to augment low flows in the lower half of the Tsolum River main channel. Other locations to develop winter storage for summer releases have been identified. The barriers to moving forward on these include ownership of the water licenses and the liabilities involved when a dam and storage are contemplated.

Opening up substrate accumulations at confluences with tributaries would assist pink salmon into tributaries such as Dove and Murex Creeks at lower flows. There are many smaller streams that could benefit from headwater restorations that improve storage and release scenarios.

Habitat Assessments

TRRS volunteers and our partners have completed many habitat restoration projects; however, no comprehensive habitat assessments have been completed in the Tsolum River watershed. A baseline study of existing habitat and riparian function based on modern GIS techniques would provide both a tool upon which to base priorities but also track the effectiveness of our work over time. The TRRS has applied for funding to support this GIS based tool.

Public Awareness, Education and Engagement

Landowners along the river have expressed great interest in the ongoing improvement and as we move forward, we will provide a vehicle for landowner and resident participation.

Planning and Funding

Ken Ashley reflects the thinking of the TRRS when he writes, "In terms of next steps, and how the Rivers Institute at BCIT could assist the TRRS in restoring the Tsolum River watershed, I believe a defensible approach would be to provide targeted funding to obtain some deficient background information so that TRRS can develop a holistic multi-species watershed restoration program."⁶

This comment supports the formation of a GIS-based assessment tool that collects the "deficient background information" needed to build a plan to restore the ecological functioning of the Tsolum River.

We see this tool, which we have called "The Tsolum River Legacy Project," as the starting point of an exciting and important globally significant restoration of a previously damaged ecological system. If it had not been for a community that did not give up in the face of serious obstacles, we might have seen the Tsolum written off. Now, because of these passionate people it is possible to achieve a dream and assist other communities all over the world find their way forward as we share our learning.

The two following Assessment Reports deepen our understanding of the limiting factors and begin to show the way forward to a plan that prioritizes our activities, is holistic and achievable.

Jack Minard, executive director
Tsolum River Restoration Society

A Healthy, Diverse and Productive Tsolum River"

⁶ Email dated May 2010 from Ken Ashley, BCIT to Marc Angelo, BCRI