Campbell River Mainstem Chinook Enhancement

Prepared for:

Pacific Salmon Commission Southern Fund

2005

Tyee Club of British Columbia/ Campbell River Gravel Committee

Prepared by

S. Anderson, DFO

Executive Summary

The Campbell River chinook salmon are an important component of the commercial and sports fisheries to both the United States and Canada. Campbell River chinook have been enhanced at a facility on the Quinsam River, a major tributary of the Campbell, for over 30 years. With all chinook life history stages within the river supported by a series of habitat restoration projects, a program to increase adult chinook to historical escapements of 4000 was implemented on the mainstem Campbell River. Combining hatchery technology with low tech instream incubation boxes placed in the Campbell upstream of the Quinsam River has resulted in an additional 388,000 fry release. This could potentially contribute nearly 1200 adults, a number of these returning to spawn in the upper river to re-establish this historically important run. The eggs for this project were all otolith marked with a distinct banding pattern during incubation at Quinsam Hatchery allowing for assessment of returning adults. Otolith samples could also be taken from commercial and recreational fisheries, adding important information on timing, distribution, contribution and survival of this chinook stock.

Acknowledgements

This project required the cooperation, communication and technical experience of a number of Department of Fisheries & Oceans Canada personnel. The Tyee Club of British Columbia – Campbell River Gravel Committee would like to acknowledge the expertise provided by all Quinsam Hatchery staff and the Resource Restoration Unit who have greatly contributed to the success of the chinook enhancement project. Thank you to the Pacific Salmon Commission for the financial support necessary to implement this project.

CONTENTS

List of Tables

List of Figures

Introduction

Only 6.5 km long from the impassable Elk Falls to the estuary, the Campbell River has limited area available for spawning and rearing salmon (Fig.1).

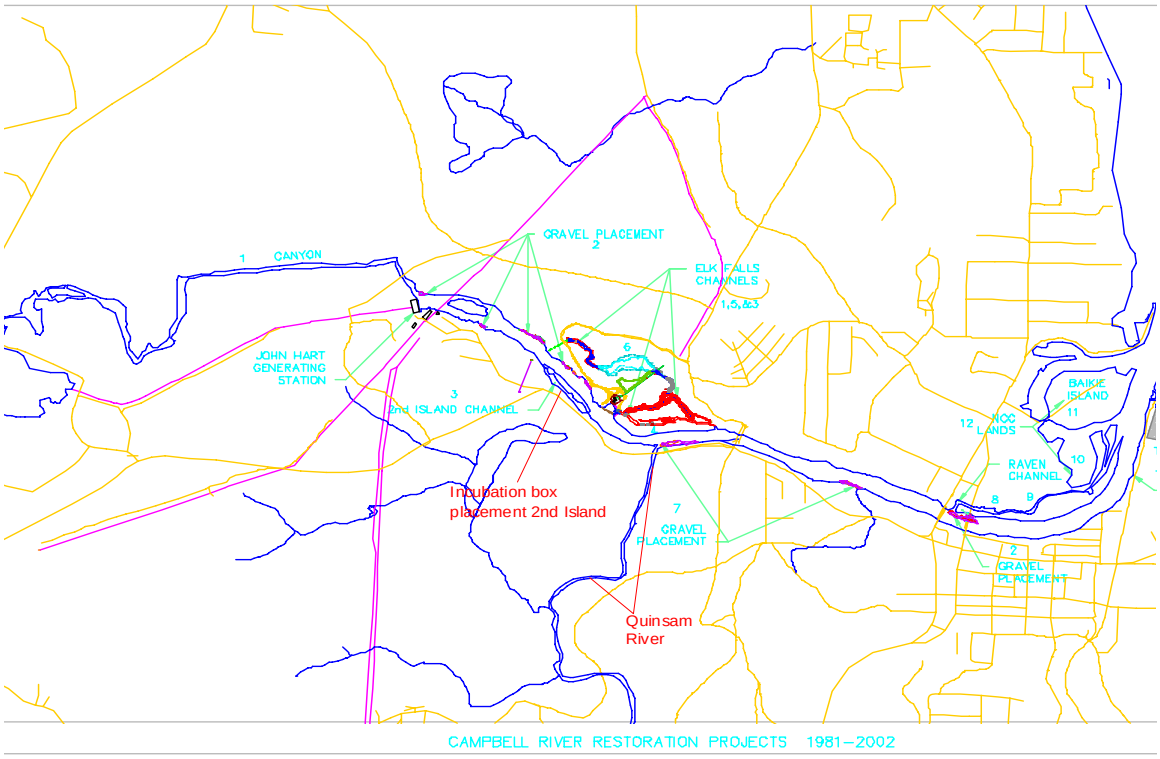

Figure 1. Campbell River with instream incubation box and Quinsam River location (red text), and recent restoration projects.

The mainstem of the Campbell River has historically been an important area for chinook salmon spawning, however, since the construction of John Hart dam in 1947 natural gravel recruitment to the Campbell River had virtually ceased. Over the past 6 decades, periodic high flow events resulted in the remaining gravel bed being scoured, leaving the river armoured with large cobbles and boulders, with very little material suitable for salmonid spawning (Burt & Burns 1995). The establishment of a more natural hydrograph on the Campbell (CRIFMS, 1997, and BCHydro Water Use Planning draft) and habitat restoration has vastly improved the historically important spawning, rearing and estuarine transition habitats (Burt 2004). With all chinook life history stages within the river now supported, a program to get adult chinook returning to the upper river could be implemented. Based on historical escapements and the projected habitat capacity of the Campbell River a target of 2000 pairs of chinook was established (CRIFMS, 1997).

The Campbell chinook, have been enhanced at a facility on the Quinsam River, a major tributary of the Campbell, for over 30 years and according to coded wire tag information from Quinsam Hatchery releases, are an important component of the United States and Canadian commercial and sports fisheries. In 1973, the new Quinsam

Hatchery began collecting Chinook brood stock from pools in the Campbell River estuary (the Quinsam River did not have a significant Chinook run). As reference, the Quinsam River confluence is downstream of nearly 3.5km of under-seeded habitat in the upper Campbell River. This mainstem area above the Quinsam is historically, a very high quality and desirable spawning area for large Chinook, and is a priority objective to return adults to this area, (shared by DFO and the local community).

Escapements to the Campbell River (last 5 years) have averaged around 1000. Use of low tech enhancement, through placement of instream incubation boxes in the Campbell upstream of the Quinsam River, with a capacity of close to 400,000 eggs potentially provides nearly 1200 adults (based on recent fry to adult survival of area chinook of 0.3% G. Bonnell, DFO OHEB pers comment). Returns will be distributed mostly as 3, 4 and 5 year olds, adding to fisheries and escapements in 2008-2010. The eyed eggs placed in the incubation boxes have been thermally otolith marked distinct from the Quinsam production marks and can therefore be assessed during adult dead pitches, part of the Key Streams sampling by DFO Stock Assessment Division. Determining the contribution to escapement provides an indicator of the success of the program. Any future program initiated for otolith sampling on commercial or recreational chinook catches could also provide information on contribution of this program. Increased productivity of the Campbell will be reflected in increased fishing opportunities throughout their migration routes.

Methods

The aluminium fabricated cassette incubators have been used by DFO staff in a number of sites in the area, and have undergone a number of modifications to the design to accommodate varying conditions and experience. The incubators are fairly sensitive to variations in flow, (recommendation is 8-13cm/second), and as such have generally been placed in well protected areas or in controlled flow channels. For this project the incubators were to be placed in a side-channel on the Campbell River that is subject to changes in the mainstem river flow. Further adaptations were required to change the lid design, allow for a debris deflector and to reduce the flow through the incubators if high river flows were encountered. Previous versions of the incubators had a one piece lid (approx 1.5m x 2.1m) that slid off horizontally. This design was very awkward to work with, so for this project, the lid was changed to a hinge design that allowed each of the four compartments to be opened individually (Fig 2.). The trash rack on the upstream side of the incubator was also changed to allow it to be angled toward the flow if debris accumulation was found to be a problem. Pins secured the trash rack to the frame in its normal configuration. Removing one pin allowed the placement of a small additional section on one side to angle the trash rack, allowing any debris to be deflected rather than accumulate and block the flow through the incubators. The final modification was to weld in an additional slot behind the trash rack to accommodate a section of perforated aluminium screen to reduce water velocity if conditions required (Fig 3.). Each box has 4 modules that hold 6 ‘trays’ each. Each tray consists of two 0.6m square window screens (fly screen) clipped together on all four sides using pieces of split plastic tubing or vinyl channel pieces.

Figure 2. Instream cassette incubator - modified lid design

Figure 3. Screen modification for high velocity events – prior to final lid design (see Fig 2)

Incubation boxes were installed in early September 2005 during scheduled low flows on the Campbell. A crew of 6 transported and cabled the box frames into a site along the shore on the right bank of Second Island Side channel (Fig. 4). The site was chosen just downstream of a large 1m diameter log embedded in the channel bank and angled into the channel providing protection to the boxes at higher flows. A gas-powered rock drill with an extension bit was used to drive the duck-bill anchoring system into the substrate. Depths and velocities in and around the boxes were monitored as the discharge in the Campbell River increased over the fall spawning period and were found to be within the range required.

Figure 4. Incubators sited in Second Island looking upstream- September 2005

Target flows through the generating station at John Hart for the time frame the eggs would be in the incubation boxes ranged between 80-125cms (BCHydro WUP proposal (Table 1).

Table 1. Campbell River Water Use Plan Recommended Flow Strategy for spawning and incubation period –draft.

Date	Low *cms	Target cms	High cms	Actual
July 20 - Sept 14	28	40	126	
Sept 15 – Sept 21	28	40	126	
Sept 22 – Oct 14	28	100	104	
Oct 15 – Nov 15	80	122	126	
Nov 16 – Dec 31	80	106	126	
Jan 1 – Jan 31	80	122	126	266 cms Jan 2-17
Feb 1- Feb 28	80	106	126	
Mar 1 – Apr 14	60	100	104	

*****Cms cubic meters per second

With the support and cooperation of the staff at the Quinsam River Salmon Hatchery an additional 70 pairs of chinook were captured from the main broodstock seining pool on the Quinsam River in early October. The hatchery beach seine for most of their chinook brood from behind a floating fence about 1km upstream of the Campbell-Quinsam confluence (Fig 5). Adults were transferred by transport tank truck to Quinsam Hatchery adult holding ponds (Fig 6.). Chinook were sorted daily with ripe females taken and green returned to holding. The 70 pairs were added to the regular production at Quinsam to provide the extra 400,000 eggs required for this project.

Figure 5. Broodstock seine on Quinsam River

Figure 6. Adult transport to Quinsam Hatchery

Hatchery practice follows genetics guidelines of a 1 to1 male to female ratio (Fig 7). Fertilization was followed by Ovadine disinfection of eggs within 24 hours. Formalin (Parasite-S) treatment for fungus control commenced 4 days after fertilization and continued twice weekly until just after inventory (eyed stage of development). During incubation eggs are picked to remove the dead at least three times after the eyed stage, survival was over 96%. Eggs were incubated from the onset on Quinsam River water, as opposed to the warmer Cold Creek groundwater, to delay development and provide for more natural emergence timing. The two water sources, with distinct temperature differences, allows for thermal otolith marking. Mixing the two water supplies provides the required 2C change in temperature, applied for 24 hours that produces each band. In this project the banding pattern is applied before hatch, allowing marking before the eggs were transferred to the incubation boxes on the Campbell River.

Figure 7. Chinook eggtake at Quinsam

Eggs were out-planted about 1 week before hatch, the first week of January 2006, which coincided with BCHydro having to implement a 140cms spill through the dam due to high reservoir inflows, more than doubling the flows in the Campbell River (total 266cms). Velocities were once again checked and found to be within the acceptable

range. The log upstream of the boxes protected the boxes from some of the higher flows, with the faster water running over top of the boxes, not impacting flows through the area where the eggs would be placed (the boxes are less than 0.5m high). Transfer day was January 5th with close to 400,000 eggs at 476 ATUs loaded into 48 trays. Loading rate for each tray was 3.1kg, about 8000 eggs (Fig. 8).

Figure 8. Loading of trays at Quinsam Hatchery (January 2006)

A crew of 9 was required, 5 loading and transporting the trays of eggs from Quinsam Hatchery to the site (5km) and 4 more at the site in dry suits loading the boxes (Fig 9 & 10). Mild, damp weather allowed transfer without concern for the eggs drying, freezing or being shocked by extreme changes in temperature. Eggs were weighed from Atkins cells into the trays, placed in the box modules then into the bed of a pickup for transport.

Figure 9. Loaded trays in modules at Second Island

Figure 10. Technicians opening incubators to place egg tray modules (high flows, January 2006)

Safety measures were implemented with personnel stationed on the river bank, extra ropes secured; throw bags and personal floatation devices available. The modified box design, with the removable tray modules and the sectioned lid made placing the eggs during high flows much easier than would have been possible with the early box models. Flow velocities were again check after placement, and visual observations confirmed the eggs were not being pushed to the back of the tray.

Campbell mainstem flows were ramped down to target discharge (125cms) within 10 days of egg placement. Velocities around the boxes were again monitored and the boxes opened to determine flow through and if hatch had occurred. January 20th observations indicated 99% hatch. Monitoring continued during the development to swim up stage to ensure no debris blockages and to check survivals. Temperature loggers were downloaded periodically to track expected development.

In order to get a good look at the developing fry one of the trays was opened March 30th and a sample placed in a plastic container to determine the amount of yolk sac remaining. Swim up was estimated to be in about 10 days. A crew was organized for release on April 6, 2006. Each module was removed from the boxes, taken up or downstream along the shore of Second Island side channel and each tray released (Fig 11,12). An average of 50 dead per tray was estimated. Chinook fry immediately dispersed along the boulders and wood debris along the shore (Fig. 13). A sample of 10 fish was retained from each box to send for otolith sampling. The empty trays will be removed for washing, disinfection, repair and storage for use in the 2006 brood chinook project.

Figure 11. Crew releasing chinook in Second Island side channel

Figure 12. Releasing individual tray -8000 fry

Figure 13. Released chinook fry April 2005

Results

Modifications to the boxes prior to placement were found to be very effective in situ. The lid configuration and modules for the trays made it much easier to load, monitor and release. The site placement of the boxes proved to be very good, with the flow never exceeding box design even with a fairly significant spill in early January for a total flow of 266cms. The extra precautions built into the boxes were not required at the flows encountered, but could still be valuable in future years if flows are even higher. The target brood numbers, eggs, loading targets and release numbers were all met (Table 2).

Table 2. Campbell River Chinook project balances

Females	Eggs green	Eggs eyed	Egg Survival	Eggs planted	ATUs	Fry released	ATUs release	Incubation box survival
70	420,000	403,200	96%	*391,000	476	388,00	898	99%

* Surviving eggs in excess of box loading requirements were placed in an incubation box in a left bank side channel on the Campbell.

Otolith marking was applied during the eyed stage a total of 7 bands applied over two separate periods. The incubation temperature was increased by 2 degrees by mixing water supplies (eggs were incubated on colder water supply), for 24 hours for each band, returned to normal incubation for 48 hours before the next band was applied. The two sections, 3 bands followed by 4 bands, were separated by a 96 hour period (Table 3).

Table 3. Chinook otolith marking of Campbell River enhancement project

Brood Yr	**Species**	**Stage**	**Number marked**	**Mark applied**	**Release samples taken**
2005	Chinook	Eyed eggs	420,000	1:1.3/2.4	Yes (not yet read)

Discussion

The Campbell River is an impounded system, with BCHydro controlling the flow to the river through its generating stations and spill through the John Hart dam. The flow management strategy developed over the past 10 years provides for a more natural hydrograph to the mainstem river downstream. The majority of target flow goes through penstocks to the generating station (maximum =122cms) with 3.5cms through the dam to feed the river. BCHydro communicates with DFO to inform them of any updates and expected changes to discharge due to changing in water levels in the upper watershed reservoirs. This allowed project staff to monitor the boxes to ensure flows were within safe incubating conditions, and make changes before eggs were placed. High sediment loads can effect the survival of eggs in the incubation boxes, reducing oxygen levels and coating the screens reducing survivals. The Campbell River is a very clean water system with very little sediment load as most of the water comes from the reservoirs, providing ideal conditions for the operation of this type of incubation box. The close proximity to Quinsam River Salmon Hatchery also provided the opportunity for technicians to closely monitor the site and development of the chinook. The incubation boxes were more expensive than the estimate as we recognized that modifications were necessary to be prepared for the higher flow conditions that were possible in Second Island side channel. Previous projects using this type of incubation box were sited in controlled flow locations. Since this was a prototype design it took more labour and material to complete than originally anticipated. The end result performed very well and future applications of this type of incubation box will likely incorporate these improvements.

Projected labour costs in the budget were low, an increase to agency staff wages and the inclusion of the GST in the total cost was not accounted for in the original application (1 year before implementation of the project).

Broodstock capture was accomplished as scheduled with crews achieving the target of 70 additional pairs of chinook. Expected fecundities of 6000 per female were met and incubation, marking and transport of eggs went smoothly. The higher than expected flows to the Campbell during box loading made it a bit of a challenge, experienced field personnel were key to the success.

In the original application we had hoped to be able to take eggs from throughout the timing of the run. The logistics of otolith marking too many different egg takes dates to give a broad section of the timing of the run was determined to be far too complicated and labour intensive. As well with the Campbell River mainstem flow coming from deep in the reservoir the water is warmer throughout the incubation period, causing an earlier emergence than would be found on a natural river flow. It was decided that later egg take dates kept on the colder water source at the hatchery would allow the eggs to develop and emerge later in the spring, a more natural timing, when more food would be available to the fry, improving survival.

Survivals to release were very good with greater than 99% of the loaded eggs being released as fry (388,000). Recent marine survivals of unfed chinook releases have been quite low, expected to be in the range of 0.2-0.4%. This would increase the Campbell adult contribution to catch and escapement by 800 – 1600, (spread over 3- 6 year old age classes), with adults returning in 2008-2011. The majority of these fish will be returning as 4 and 5 year olds. Sampling adults and analyzing otoliths from dead pitch, and potentially from commercial and recreational fisheries, would provide data on distribution, contribution and survivals.

Conclusion

The Campbell River mainstem chinook project using low technology enhancement techniques was accomplished as projected with only a few minor changes from the original application. This project is actually a combination of high tech and low tech enhancement. Combining the enhancement facility at Quinsam Hatchery, the experienced personnel and established fish culture techniques, with instream incubation presents an ideal opportunity to increase the productivity of the mainstem Campbell River. The capture of brood stock, very high incubation survivals and the otolith marking would not be possible without the opportunity to partner with a major fish culture facility. The performance of the modified incubation boxes was excellent, even with the less than ideal conditions experienced. Having identified the potential difficulties, and having the ability to closely monitor and modify if necessary, added to the success of the project. Achieving 99% survival from the incubation boxes in this setting was very rewarding, future projects, whether on the Campbell or elsewhere will benefit from this experience.

Recommendations

1. Continue the program of chinook egg plants for a period of at least 5 years to establish returns on all brood cycles
2. Identify opportunities, and funding sources to sample recreational and commercial catches to determine contribution, distribution, timing and survivals.

References

Burt, David. 2004. Restoration of the Lower Campbell River, A Review of Projects to 2003 and a Plan for Future Works, Prepared for Campbell River Gravel Committee, Department of Fisheries & Oceans Canada, Ministry of Water, Land and Air Protection. 96p.

Burt, David & T. Burns 1995. Assessment of Salmonid Habitat in the Lower Campbell River. BCHydro Environmental Affairs, Southpoint Drive, Burnaby, BC, Canada.

Campbell River Hydro/Fisheries Advisory Committee. 1997. Campbell River Interim Flow Management Strategy. Available from BCHydro 10 John Hart Road Campbell River, BC. 51p.

Appendix I Financial statement

Project Expenditure Form

Page 1 of 2

Name of Project: Campbell River Mainstem Chinook Enhancement

ELIGIBLE COSTS

Labour
Wages & Salaries

Position	# of crew	# of work days	hrs per day	rate per hour incl GST	BUDGET Total (PSC + In-kind + cash)	OTHER FUNDING In-Kind & Cash	CONTRIBUTION FUNDING PSC Amount	
Supervision Quinsam Hatchery/ DFO	1	15	7.5	35.00	3,938	3,938		
Administration Quinsam Hatchery	1	5	7.5	30.00	1,125	1,125		
Broodstock/ Eggtake Crew	8	1.5	7.5	26.03	2,340		2,340	
Eggtake and Incubation Crew	2	12	2.5	26.03	1,562		1,562	
Thermal marking labour	1	14	4	30.00	1,680	1,680		7 bands for marking increase time required
Installation crew	4	1	3.5	26.03	364		364	
Additional modifications	2	2	7.5	35.00	1,050	1,050		
Loading transport	5	0.5	7.5	26.03	488		488	
Loading transport	4	0.5	7.5	35.00	525	525		
Monitoring	2	16	3	26.03	2,499		2,499	
Release crew	6	1	4	26.03	625		625	
Clean up	1	2	7.5	26.03	390		390	
							5,584	Sept - Dec Labour costs
Reporting	1	1.5	6.25	26.03	244		244	
Reporting	1	3	7.5	35.00	788	788		
							2,929	Jan - May Labour costs
	30	75			-			
Person Days (# of crew x work days)		390		sub total	17,618	# 9,105	8,513	

Labour - Employer Costs (percent of wages subtotal amount) included in labour wages above.

rate 0% sub total

Subcontractors & Consultants

	# of crew	# of work days	hrs per day	rate per hour		
Insurance if applicable	rate	0%				
				sub total		

Volunteer Labour

	# of crew	# of work days	hrs per day			
Skilled	2	3	7.5	30.00	1,350	1,350
Un-skilled						
Insurance if applicable	rate	0%				

sub total	1,350	#	1,350		
Total Labour Costs	18,968	#	10,455	8,513	

Site / Project Costs	**Detail (use additional page for details if needed)**					
Travel (do not include to & from work)						
Small Tools & Equipment	cables, clamps duckbills, shovels, aluminium, pain	500		217		
Site Supplies & Materials	trays $800, formalin, ovadine, CO2	1,500		749		
Equipment Rental	rock drill with bits and fuel one day	200				
Work & Safety Gear	Waders, Life jackets, throw bags, drysuit repairs	2,000	1,500	1,240		
Safety Training & Supplies	Swift water training DFO/hatchery staff trained					
Repairs & Maintenace						
Permits						
Technical Monitoring	Temperature logger, DO meter, flow meter	2,000	2,000			
Other site costs						
	Total Site / Project Costs	6,200	3,500	2,206		

ELIGIBLE COSTS				BUDGET		OTHER FUNDING	CONTRIBUTION FUNDING
Training (e.g Swiftwater, bear aware, electrofishing, etc).				Total (PSC + In-kind + cash)		In-Kind & Cash	PSC Amount
Name of course	# of crew	# of days					
Swiftwater (hatchery staff trained)	8	3		3,000		3,000	
Bear aware (hatchery staff trained)	8	1		1,600		1,600	
Snorkel, PADI (hatchery staff trained)	2	1		600		600	
			Total Training Costs	5,200	#	5,200	

Overhead / Indirect Costs (not to exceed 20% of PSC Amount)				
Office space, including utilities, etc.	1,000	1,000		
Insurance				
Office supplies	fieldbooks, paper, bindings	100	100	
Telephone & long Distance		100	100	
Photocopies & printing	reports	100	100	
Other overhead costs				
	Total Overhead Costs	1,300	#	1,300	-

Capital Costs / Assets **Detail (use additional page for details if needed)**

Assets are things of value that have an initial cost of $250 CAN or more and which can be readily misappropriated for personal use or gain or

which are not, or will not be, fully consumed during the term of the project.					
incubation boxes, fabricated aluminum 2 @ $1300 each		2,568			2,568
	Total Capital Costs	2,568			2,568
	Project Total Costs	34,236	#	20,455	13,287
	Funds Received				12,000
	Balance required				1,287
	Projected Approved Cost to PSC				13,328

Budget Summary

(PSC + in-kind + cash)

Unspent 41

		PSC
Total Labour Costs	18,968	8,513
Total Site / Project Costs	6,200	2,206
Total Training Costs	5,200	
Total Overhead Costs	1,300	
Total Capital Costs	2,568	2,568
Project Total	34,236	13,287

I certify that the amounts included in this Project Expenditure were incurred as reported for the Campbell River Chinook Enhancement Project as funded by the Pacific Salmon Commission

Angela Pagani
Financial
Administrator
DFO Quinsam
Hatchery

Page 2 of 2