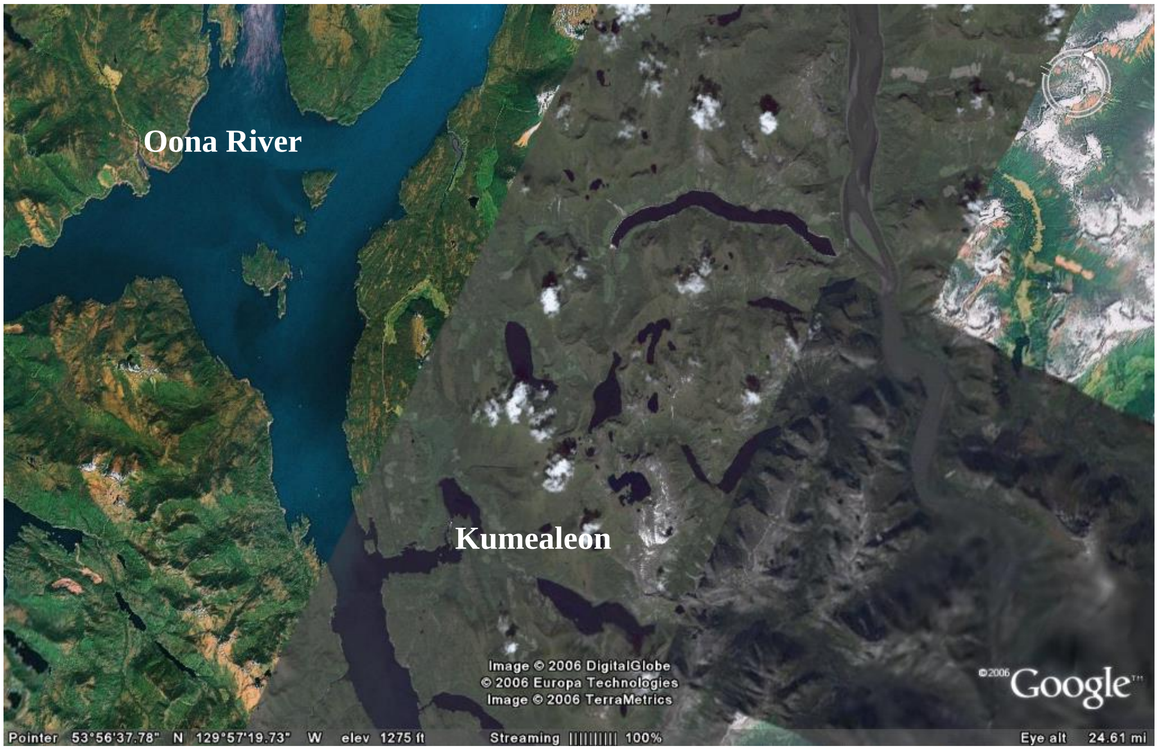
Determining the Trend of Chum Population Dynamics in Area 5 and Measuring the Success of Small Hatcheries for Stock Assistance



Prepared for: Northern Boundary and Transboundary Rivers Restoration and Enhancement Fund

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EXECUTIVE SUMMARY

This study was proposed to address the use of small hatcheries such as the Oona River hatchery to increase chum salmon populations in a depressed system such as the Kumeleon River that had historically larger chum populations according to Fisheries and Oceans Salmon Escapement Data records for Area 5. Habitat measurements were taken within the Kumealeon system in 2006 using standard fisheries techniques for determination of spawning area for chum redds and to aid in quantifying the maximum potential population of chum spawners.

Reviewing historical chum records from the 1950's to the present indicates that there has been a continuous decay in chum populations. This decline can be associated with various activities that effect population declines such as the past logging activity in the Kumealeon watershed, bycatch in the Area 4 sockeye and pink commercial fishery and Area 5 seine pink fishery and the possible effects of climate change whether it is good or bad. Historical records showed that the decadal average in the Kumeleon system for returning chum spawners in the 1950's was 725 and the historical mean from 1950-1989 was 370 with a maximum reported 1500 spawners in the system. The recent records show that the 1990-2001 average was 67 chums with 80 chums reported in the system in 2006.

In 2006 we were able to take approximately 12000 eggs from broodstock takes in the Kumealeon system during the month of August 2006. We achieved a three to one ratio of male to female for genetic integrity for fertilization. Two thousand of these eggs were not mature enough when they were initially selected and this resulted in them being removed from the incubation trays. This left 10000 eggs that were incubated during the winter to the eyed, hatch stage and fry swimup stage. The fry were fed until they reached a weight of between .6 -1.0 gram and 7535 chum fry had their left ventral fin clipped and returned to the Kumealeon system. The fry were returned at two different times to the Kumealeon system once on February 20 2007 and the second release in April 18 2007.

To determine present spawning area (m2) for chum spawners we used specific criteria for measurements according to (Groot and Margolis 1991) such as (a) gravel size (b) velocities of water around redds (c) depth of water (d) nearby pools or LWD for cover. Our measurements based on these criteria showed that the total chum spawning area in the Kumealeon system at this present time was 2166 m2.

The determination of the potential for maximum spawners based on (a) average chum redd size (b) consecutive redds per coupling (c) amount of area needed per coupling demonstrated that the Kumealeon system could accommodate 850 spawners in its present habitat condition. Determination of hatchery success in the future will be conducted on visual surveys of returning spawners that have been clipped in relation to overall returning spawners.

Further habitat rehabilitation of this system would result in a greater net productivity based on an increase in spawning area and thus more chum spawners.

The information from the temperature logger that was put in the Oona River hatchery incubation tank was compared with the temperature logger in the Kumealeon system. The daily temperature data showed a distinct difference in water temperature as the Kumealeon system is a much more warmer than Oona River and therefore results in more accumulated thermal units (ATU's) for faster development of the chum fry. Some of the chum fry from Kumealeon in the Oona River incubation tanks were at the swimup stage in the last part of December and using the data on ATU's from Kumealeon, the wild chum fry would have been out much earlier.

Some of these results have to be investigated more stringently in 2007 for a better understanding of the faster early development in relation to higher temperature, early marine juvenile survival and availability of food sources when they out migrate. This could have a strong bearing on why chum stocks in these areas have a population base that is steadily declining.

INTRODUCTION

There is a continuous downward trend in the observed chum salmon stocks in Area 5 from the 1950's to their present population numbers in the first decade of this new millennium according to the Fisheries Salmon Escapement database. The Oona River Resource Association (ORRA) in partnership with the Stock Assessment Branch of the North Coast Fisheries and Oceans decided it would be a beneficial to investigate the spawning potential of a typical chum bearing system in Area 5 alongside using a small hatchery for increasing chum salmon stocks in this system.

The Kumealeon system was chosen because it has a small standing chum population, easy access by boat, clarity of water for observing chum populations and in the vicinity of the operating area of the Oona River hatchery for acquiring broodstock. The biologists and fish technicians of ORRA are familiar with the Kumealeon system and are experienced in acquiring broodstock and are knowledgeable in hatchery techniques for the successful incubation of eggs to the fry stage.

The project had five objectives:

1. To take measurements on a chum bearing system in Area 5 for a determination of its spawning potential in area (m2).
2. To enumerate the in migrating adult chum and dead spawners for the duration of their migration into the Kumealeon system. Resident time of the chum spawners was to be determined by the observation of different coloured elastic bands placed on the peduncle of spawners to observe their spatial and temporal movement. Coverage would be every 3 -4 days and coordination with the FAO streamwalker would allow even better coverage.
3. To collect DNA from the chum spawners in the system for building up a DNA bank on chum stocks in Area 5.

4. To collect broodstock from the Kumealeon system and transfer the fertilized eggs into incubation trays in the hatchery at Oona River. These eggs would be monitored for the next six months for disease and water quality to ensure a good egg-fry survival rate.
5. In the early spring, the emergent chums would be held a week to 10 days and then returned back to their natal system. Before they are released they would be fin-cipped in order to differentiate the returning adult chum as wild or enhanced stock.

METHODS

The North Coast has many river systems that have tannic in the water which makes the water dark and it is very difficult to distinguish fish in a system. Kumealeon was chosen as the target river because the water clarity for observing in migrating fish and distinguishing the different species is excellent. It also has good historical records for chum presence and it has a small standing crop of spawners. The system has some damage to its spawning habitat from logging in the past and the estimation of the potential of chum spawners is based on spawning area in its present condition. It is approximately 12 nautical miles from Oona River and there is a good trail (1.5km) from the estuary into the main river system. Access on certain stages of the tide (high slack water) through the rapids allows the use of a small skiff for movement into the lower part of the river that flows into a salt lagoon.

The visual coverage of the system for chum migrants was discussed with the FAO streamwalker Joe Trainer for a determination of the extent of chum movement into the upper reaches in the Kumealeon system. We used a hand held Garmin GPS Map 60CX for plotting and mapping the system for chum spawning areas and for the location of observed redds.

The collection of broodstock we accomplished by the use of small mesh barrier nets on the lower and upper target areas where spawners were visually seen and introducing a 152mm mesh gill net in the middle for capturing the chum spawners. In 2006, there was much fewer pink salmon in the Kumealeon system which made it much easier to catch the chum spawners. The larger mesh nets ensure less stress on any bycatch of pink salmon as they can be released much faster.

We tried to catch at least 3 males to one female for the purpose of genetic integrity. All males after obtaining some milt and immature females were tagged by using different coloured elastic band on their peduncle for determining resident time. There were some modifications done on the elastic bands using small zap straps because we observed that the bands were slipping off the peduncle. We ensured that all fish were in good condition before release. All chums that were caught had a small clip from the operculum for a DNA sample which was put in a vial containing 30% ethanol.

Mature female chums that were captured were stripped of their eggs and the unfertilized eggs were put into separate containers. Milt from the males were taken in small whirlpak or ziplock bags and kept cool in a small cooler and taken back to the Oona River hatchery.

We timed it that no more than 3 hours would elapse from the time we took the first eggs or milt to arriving at the hatchery in Oona River. At the hatchery, the eggs were fertilized using at least a 3:1 ratio of males to females and then the fertilized eggs were transported to the incubation trays. The eggs were washed in a solution of Ovadine (10ml in 10 liters of water) for protection against fungus and bacterial infections

The fertilized eggs were monitored during the winter from the egg to fry swim up stage and a technician was paid some hours each week to monitor water quality and pick any dead eggs from the trays.The fry at swim up stage were fed using a feed timer that distributed Ewos micro feed using a standard formula calibrated to chum juveniles.

There were two release times for the fry as 1667 clipped fry were released on February 20 2007 at an average weight of .6 gram. The second release of 5868 clipped fry was on April 18 2007 and the average weight of the fry was just over 1.0 gram. Release of the fry was done by putting the fry in a large insulated tote filled with water and supplied with an air stone running on 12VDC battery power. The tote was placed in a large skiff and towed to Kumealeon by a larger vessel. The skiff then was taken through the tidal rapids at high slack water to utilize the bigger tides for allowing further movement up the river for release of the fry.

A thermal temperature logger (StowAway Tidbit TB3237) was used at the Oona River hatchery and in the spawning area of Kumealeon for a comparison of the Accumulated Thermal Units (ATU's) for the duration from August 17 2006 until April 18 2007. The data from the tidbit was downloaded using the BoxCar 3.7 for Windows Program.

RESULTS

Determination of Present Spawning Area and Maximum Spawners

Chum spawning area (m2) was based on criteria that included gravel size, water velocity, water depth, amount of fines and cover. Chums utilize the lower reaches that are

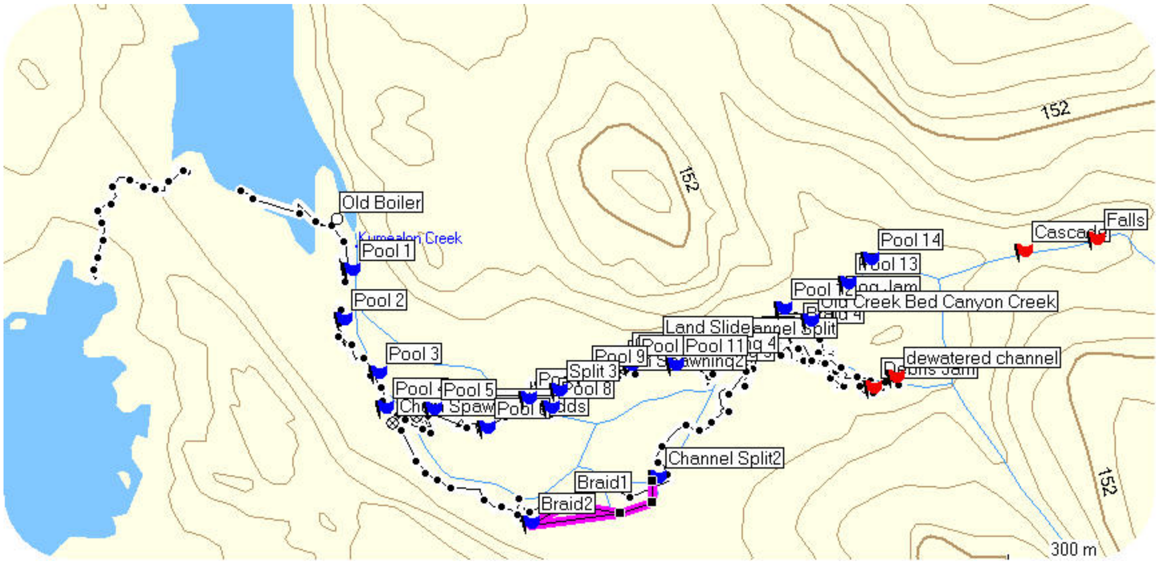

Fig 1. Kumealeon Overview from the old Boiler up to the Cascade Falls

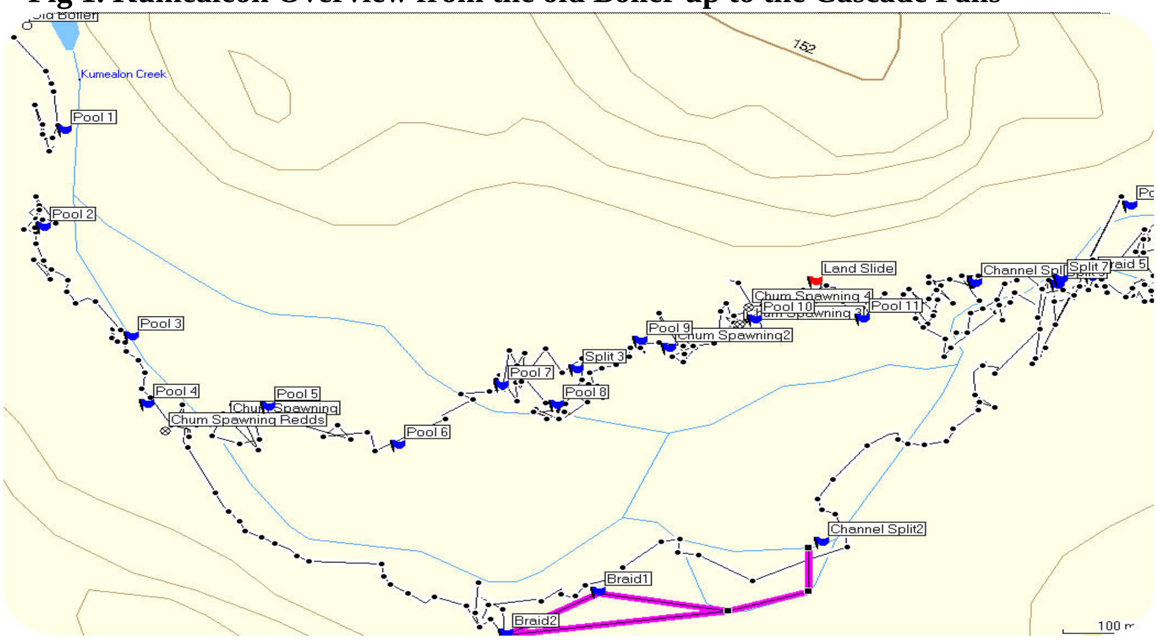

Fig 2. Lower Kumealeon Reaches showing Pools and Braided Areas

influenced by the larger tides and they do not prefer areas of high gradient.

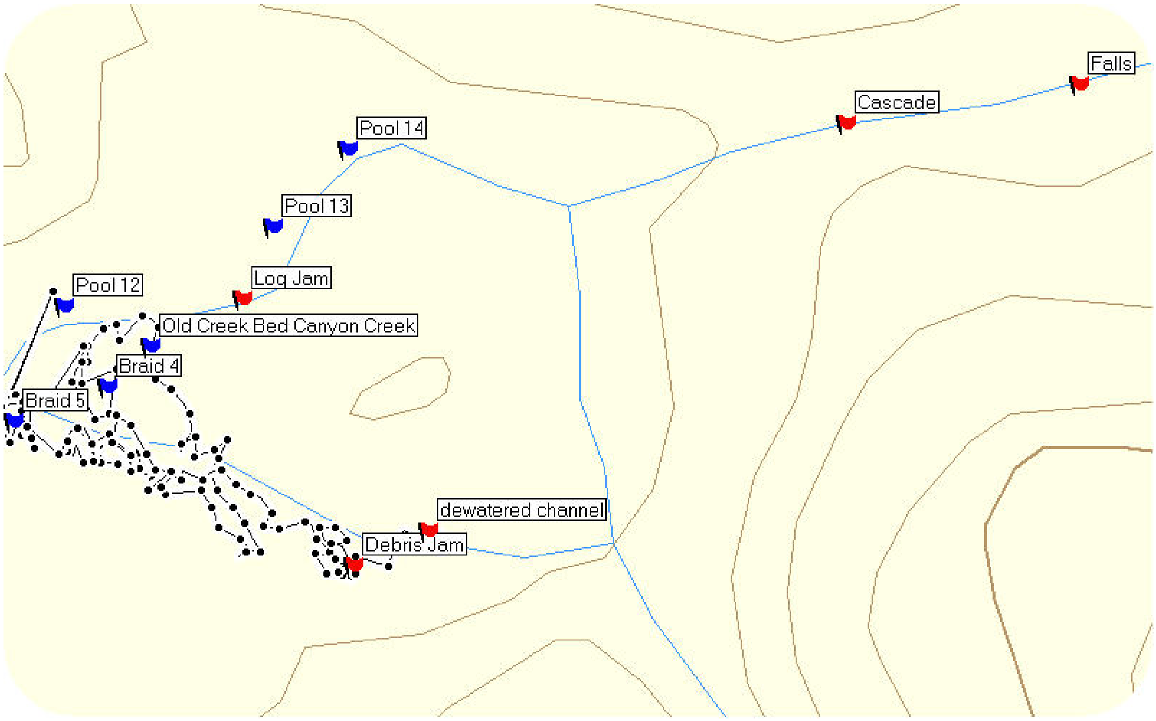

Fig 3.Upper Kumealeon towards the Canyon Creek and up to the Cascades

One hundred and three specimens of gravel were measured which resulted in an average diameter of 3.4 cm +/- 2.7 cm. Fifty-six different areas within the lower reaches were selected using the above criteria for quantifying square area of potential spawning grounds for chums. The total spawning area based on above criteria was 2166 m2 and the average size of each area was 39.44 m2.

The Table below shows a matrix using established parameters from Groot and Margolis and tabulation of our data

Total Chum Spawning (m2)	**2167**
Chum Redd Size (m2)	**1.7**
Number Consecutive Redds per Coupling	**3**
Total Amount of Spawning Area Needed per male/female coupling	**5.1**
Total Amount of Couples w/o Superimposition	**425**
Total Maximum No Potential Chum Spawners Over System	**850**

Table 1. Estimation of Chum Spawning Area and Potential Spawners

Monitoring of Chum In Migration and Acquiring Broodstock

The movement of chums into the Kumealeon system begins in late July and spawning usually is over by the first part of September. The acquisition of broodstock is much easier in the beginning of their in migration as you do not have to worry about the bycatch of pinks. In 2006, we conferred with the Fisheries and Oceans stream walker about coordinating walking of the system for maximum coverage of chum movement. We were not very successful in the determination of resident time as we had problems with the rubber bands falling off the caudal peduncle. This year we will incorporate a zap strap with the rubber band so they don't fall off and we can monitor their movement more effectively.

It was very easy to catch the male chums for milt but finding the females was much more difficult and many of the females were spawned out and one of the females we took too early as she was still immature. The total number of eggs that we took in 2006 was approximately 12000 with 2000 of these eggs being immature that we had to discard.

Incubation of Chum Eggs and Development Time for Eyed Stage, Hatch Stage and Swim up stage.

The chum eggs were fertilized at the hatchery with a 3:1 ratio using a matrix for mixing the milt and the eggs to ensure better success for fertilization. This was demonstrated by Rob Dams (Community Advisor for FAO) and Brian Spilsted (Stock Assessment Biologist for North Coast FAO) who accompanied us on some of our broodstock takes. The eggs were also treated with Ovadine for any infections and for preventing fungal growth.

All the chum eggs from broodstock takes were deposited in the incubation trays from early August to late August. The first part of the eyed stage was in middle of September and the hatch stage was in the vicinity of October 9th 2007. The swim up stage for the earliest chums was in middle of December.

Salmon species	**To Eyed Stage(ATU's)**	**To Hatched Stage (ATU's)**	**To Swim Up Stage (ATU's)**
Coho	217-237	448-475	777-829
Chum	***217-250***	***498-546***	***845-1126***
Chinook	242-258	512-526	825-1029
Pink	224-257	545-662	868-1034
Sockeye	236-257	614-694	943-1088

Table 2. Average Accumulated Thermal Units (ATU's) for Developmental Stages of the Different Salmonids. From the Morten Creek Salmon Enhancement Program

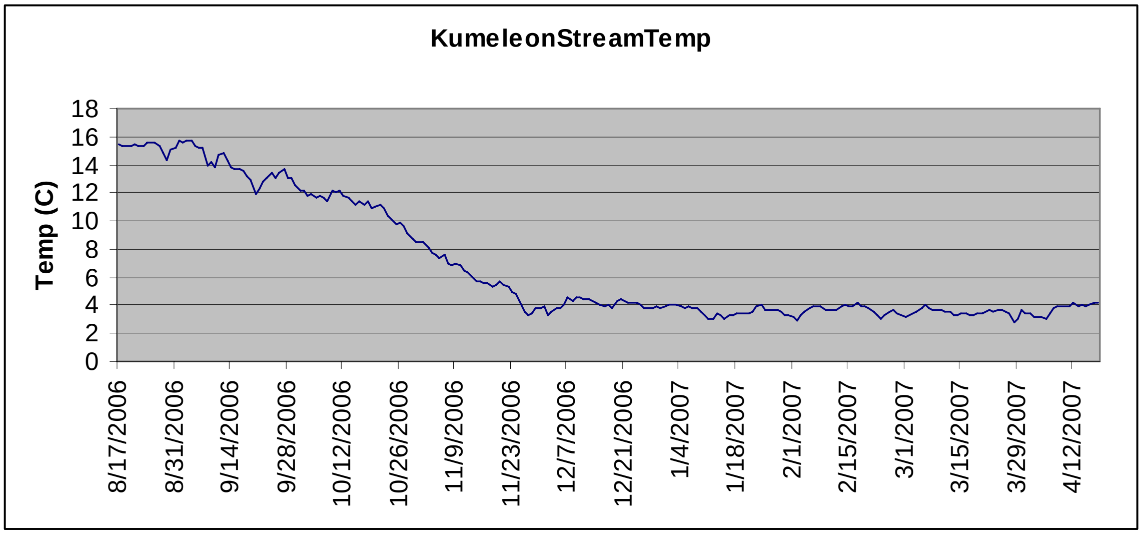

Fig 4. Average Daily Temperature of Kumealeon Stream from Aug 17 2006 to April 4 2007

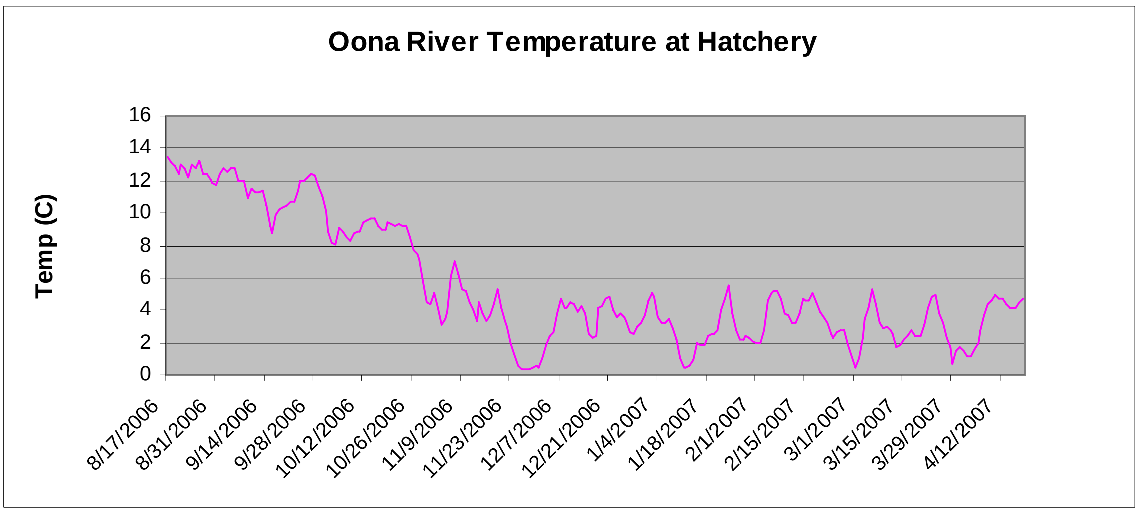

Fig 5. Average Daily Temperature of Oona River from Aug 17 2006 to April 4 2007

Figure 4 and Figure 5 show the average daily temperatures recorded on the temperature loggers in both the Kumealeon and Oona River.

DISCUSSION

This was the first year of a study that will investigate the use of small hatcheries in doing stock assistance for chum salmon on the North Coast of British Columbia. The preliminary study of 2006 showed that there are some necessary questions that have to be investigated by using a small scale approach to understand why these chum salmon streams in Area 5 are slowing losing their population base when compared with the historical records of the 1950's and onward in the Fisheries and Oceans Salmon Escapement Database.

The recorded number of chum salmon that was estimated by both this project's crew and the FAO Streamwalker was 80 chum. Observation of the chums in the system showed a greater percentage of males than females. It was difficult to find enough females for broodstock as there were plenty of males around in the system. There was very few pinks in the system in the earlier part of August (2006 was probably one of the lowest pink runs in the past few decades) and there was a lot of bear activity which probably resulted in a higher mortality on the chums since there were less pinks around.

The 10,000 eggs that were put originally into the incubation trays at the Oona River hatchery resulted in approximately 7435 clipped fish released back into the Kumealeon system. This represents a 74% survival rate from egg to a released fry. These fry were released at just .6 grams on the first release which is about double what the wild chum smolts would weigh when they out migrated and just over 1.0 grams on the second release.

Predictions for the wild salmon production would be based on approximately 25 female spawners in the Kumealeon system in 2006 (this would not include the 7 spawners we took for broodstock). Our estimation of the number of eggs on average for female chums in Kumealeon was approximately 2500 eggs and using standard estimation from Salo (1991) for egg to fry survival rates for chum at 1% to 22% and a median of 11% and fry to adult at 0.3 to 3.2 % with a median at 1.75%. Using these parameters the calcuated number of expected wild spawners back to the Kumealeon system would be 116 spawners. The expected enhanced spawners based on the same fry to adult survival rate for the clipped returned fry would be 127 spawners.

The measurement of spawning area that would be suitable for chum spawners was calculated conservatively at 2167 m2. Using information from reference sources such as (Groot and Margolis 1991) we were able to quantify the number of potential spawners at 850 with the present condition of the Kumealeon watershed. This watershed has a history of logging activity and it is evident by the amount of dewatered and braided areas. Habitat restoration would improve the amount of spawning area but our estimation shows that there is enough potential spawning area for improving the chum base population by small scale stock assistance using the Oona River hatchery.

The temperature loggers in both Kumealeon and Oona River show a striking difference in temperature regimes between the two systems. The temperature logger was put in the main river in Kumealeon (August 17th to April 4th) at a low depth so that it would be always submerged even at low flows. The temperature logger in Oona River was in the main river from August 17 2006 to Sept 19 2006 and then moved into the incubation tank from Sept 20th to April 18th. The comparison of the two systems for temperature during the same period is shown in Figure 6. The graph shows that the Kumealeon system is a much warmer system and that there is a gradual slope with very little spiking which is attributed to the buffering action of the large lake at its headwaters. The Oona system is not a lake fed system and results in more spiking in its temperature profile.

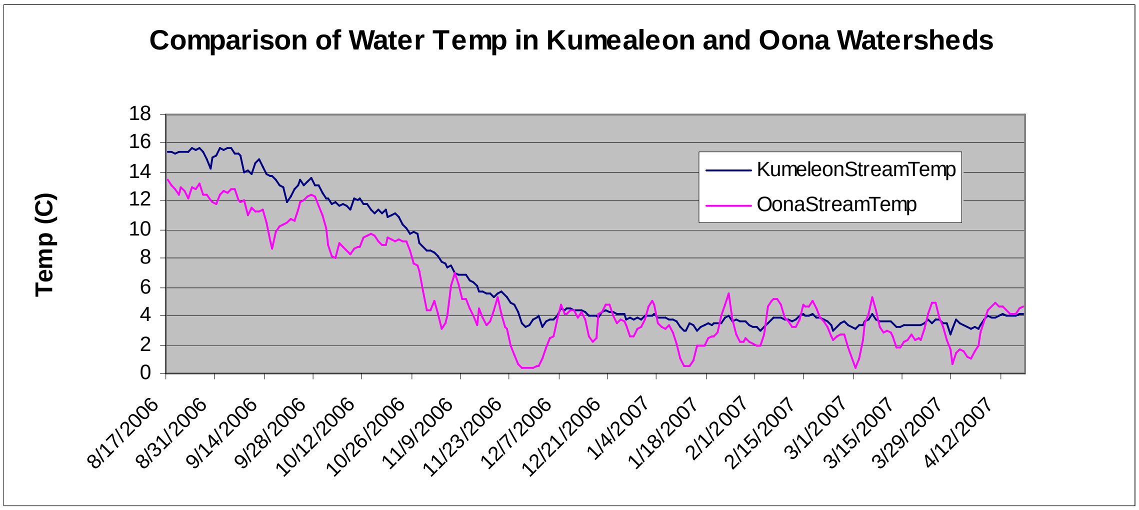

Fig 6 Comparison of Water Temperature in Kumealeon and Oona River Watersheds from August 17 2006 to April 12 2007.

The daily temperatures for both Kumealeon and Oona River are shown in Table 3. An average of these temperatures from the beginning of the broodstock takes around Aug 17 2006 to the first observation of the chum fry swimup stage at the Oona River hatchery on December 15th 2006 was taken to be used as a value in John Jensen's Salmon Incubation Model. The averaged temperature for this period for Kumealeon was 10.11 degrees C and for Oona the averaged temperature was 7.81 degrees C. The results from running the model are shown in Table 2 and the predicted dates for the first fry swimup was November 28th 2006 for Kumealeon and for Oona River it was December 17th 2006.

RECOMMENDATIONS AND CONCLUSIONS

The project is funded for 2007-2008 and the same methodology for the project will be employed as was done in 2006-2007. The data collected in this project highlights some concern about the correlation of the high ATU's with a much earlier anticipated swimup stage for the wild stocks in Kumealeon. What impact this would have in their early juvenile marine survival and the association of available food sources at this time should be investigated. We will try to do more work in the future on determining the relationship of chum fry outmigration in the Kumealeon system using the ATU's as a predictive model.

One of the recommendations for project in 2007/2008 is to have temperature loggers not only in the main part of the river but also to have a temperature logger in the gravel. This is necessary to see the amount of variation between the temperature where the eggs are in the redds and compare it to the temperature readouts from the logger in the river flow. There can be a wide variation in temperature between the main river flow and the temperature in the gravel (personal communication Bruce Shepherd, Habitat Chief North Coast FAO) Shepherd et. Al. (1986).This will also be done in Oona River for placing a temperature logger in the main flow and another temperature logger in the incubation tank for the dual purpose of comparison and redundancy.

We would like to seek some extra funding in the future for investigating the out migration of chum smolts for their timing in relation to prediction of the outmigration based on the recorded ATU's. It will be important to investigate the chum fry usage of the estuary and also to sample some of these smolts for doing stomach analysis to see what they are feeding on while they reside in the estuary. Plankton tows and other benthic sampling should be done to associate the availability of food sources for what may be present in their diet.

These are some of the areas that should be investigated for understanding the population dynamics of this system and how this may apply to other chum bearing systems in Area 5. There may be a strong relationship with the higher temperature in this system and the association with increased early development, its effect on juvenile survival rate and the overall reduction in adult chum populations in these areas.

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TIME TO DEVELOPMENTAL STAGE FOR KUMEALEON

SPECIES: Chum
STAGE NUMBER: 25
DESCRIPTION: 25: MAWW, Emergence, or Ponding
INCUBATION TEMPERATURE: 10.11°C
TIME TO STAGE (HR): 2501.4
TIME TO STAGE (DAYS): 104.2
ACCUMULATED C-DAYS (ATUS): 1053.7

TIME TO DEVELOPMENTAL STAGE FOR OONA RIVER

SPECIES: Chum
STAGE NUMBER: 25
DESCRIPTION: 25: MAWW, Emergence, or Ponding
INCUBATION TEMPERATURE: 7.81°C
TIME TO STAGE (HR): 2950.3
TIME TO STAGE (DAYS): 122.9
ACCUMULATED C-DAYS (ATUS): 960.1

Table 3 Model Readouts from John Jensen's Salmon Incubation Program.

TEMPERATURE LOGGER READOUTS AND ATU'S

Date	Kumealeon AvergageTemp	Kumealeon ATU's	Oona AvgTemp	Oona ATU's	DailyTemp Differences
8/17/2006	15.44	15.44	13.45	13.45	1.99
8/18/2006	15.37	30.81	13.13	26.58	2.24
8/19/2006	15.29	46.1	12.86	39.44	2.43
8/20/2006	15.36	61.46	12.47	51.91	2.89
8/21/2006	15.44	76.9	12.98	64.89	2.46
8/22/2006	15.39	92.29	12.75	77.64	2.64
8/23/2006	15.37	107.66	12.2	89.84	3.17
8/24/2006	15.62	123.28	12.98	102.82	2.64
8/25/2006	15.57	138.85	12.82	115.64	2.75
8/26/2006	15.65	154.5	13.21	128.85	2.44
8/27/2006	15.37	169.87	12.39	141.24	2.98
8/28/2006	14.87	184.74	12.43	153.67	2.44
8/29/2006	14.3	199.04	12.04	165.71	2.26
8/30/2006	15.05	214.09	11.86	177.57	3.19
8/31/2006	15.15	229.24	11.77	189.34	3.38
9/1/2006	15.73	244.97	12.38	201.72	3.35
9/2/2006	15.6	260.57	12.75	214.47	2.85
9/3/2006	15.71	276.28	12.59	227.06	3.12
9/4/2006	15.7	291.98	12.76	239.82	2.94
9/5/2006	15.33	307.31	12.83	252.65	2.5
9/6/2006	15.26	322.57	12.02	264.67	3.24
9/7/2006	15.18	337.75	11.95	276.62	3.23
9/8/2006	13.95	351.7	11.98	288.60	1.97
9/9/2006	14.16	365.86	10.96	299.56	3.2
9/10/2006	13.83	379.69	11.51	311.07	2.32
9/11/2006	14.68	394.37	11.3	322.37	3.38
9/12/2006	14.84	409.21	11.27	333.64	3.57
9/13/2006	14.31	423.52	11.38	345.02	2.93
9/14/2006	13.88	437.4	10.49	355.51	3.39
9/15/2006	13.7	451.1	9.24	364.75	4.46
9/16/2006	13.72	464.82	8.74	373.49	4.98
9/17/2006	13.51	478.33	9.87	383.36	3.64
9/18/2006	13.13	491.46	10.22	393.58	2.91
9/19/2006	12.92	504.38	10.35	403.93	2.57
9/20/2006	11.86	516.24	10.52	414.45	1.34
9/21/2006	12.33	528.57	10.685	425.14	1.645
9/22/2006	12.85	541.42	10.65	435.79	2.2
9/23/2006	13.08	554.5	11.3825	447.17	1.6975
9/24/2006	13.47	567.97	11.925	459.09	1.545
9/25/2006	13.03	581	12.005	471.10	1.025
9/26/2006	13.39	594.39	12.245	483.34	1.145
9/27/2006	13.65	608.04	12.4	495.74	1.25
9/28/2006	13.11	621.15	12.2775	508.02	0.8325
9/29/2006	13.03	634.18	11.655	519.68	1.375
9/30/2006	12.51	646.69	11.0375	530.71	1.4725
10/1/2006	12.23	658.92	10.145	540.86	2.085

Date	Kumealeon AvergageTemp	Kumealeon ATU's	Oona AvgTemp	Oona ATU's	DailyTemp Differences
10/4/2006	11.92	694.8	8.05	565.94	3.87
10/5/2006	11.69	706.49	9.095	575.03	2.595
10/6/2006	11.74	718.23	8.8225	583.85	2.9175
10/7/2006	11.61	729.84	8.515	592.37	3.095
10/8/2006	11.38	741.22	8.28	600.65	3.1
10/9/2006	12.15	753.37	8.7075	609.36	3.4425
10/10/2006	12.05	765.42	8.86	618.22	3.19
10/11/2006	12.15	777.57	8.8625	627.08	3.2875
10/12/2006	11.82	789.39	9.405	636.48	2.415
10/13/2006	11.72	801.11	9.56	646.04	2.16
10/14/2006	11.41	812.52	9.6775	655.72	1.7325
10/15/2006	11.18	823.7	9.64	665.36	1.54
10/16/2006	11.4	835.1	9.2475	674.61	2.1525
10/17/2006	11.12	846.22	8.9775	683.59	2.1425
10/18/2006	11.43	857.65	8.9775	692.56	2.4525
10/19/2006	10.92	868.57	9.4025	701.97	1.5175
10/20/2006	11.05	879.62	9.2875	711.25	1.7625
10/21/2006	11.2	890.82	9.25	720.50	1.95
10/22/2006	10.87	901.69	9.2875	729.79	1.5825
10/23/2006	10.35	912.04	9.21	739.00	1.14
10/24/2006	10.12	922.16	9.2475	748.25	0.8725
10/25/2006	9.76	931.92	8.5525	756.80	1.2075
10/26/2006	9.89	941.81	7.66	764.46	2.23
10/27/2006	9.69	951.5	7.505	771.97	2.185
10/28/2006	9.1	960.6	7.155	779.12	1.945
10/29/2006	8.8	969.4	5.715	784.84	3.085
10/30/2006	8.53	977.93	4.4575	789.29	4.0725
10/31/2006	8.51	986.44	4.4175	793.71	4.0925
11/1/2006	8.48	994.92	5.0875	798.80	3.3925
11/2/2006	8.14	1003.06	4.1075	802.91	4.0325
11/3/2006	7.79	1010.85	3.09	806.00	4.7
11/4/2006	7.61	1018.46	3.48	809.48	4.13
11/5/2006	7.38	1025.84	3.95	813.43	3.43
11/6/2006	7.56	1033.4	6.065	819.49	1.495
11/7/2006	6.94	1040.34	7	826.49	-0.06
11/8/2006	6.84	1047.18	6.18	832.67	0.66
11/9/2006	6.91	1054.09	5.24	837.91	1.67
11/10/2006	6.87	1060.96	5.125	843.04	1.745
11/11/2006	6.48	1067.44	4.5375	847.57	1.9425
11/12/2006	6.3	1073.74	4.0675	851.64	2.2325
11/13/2006	6.14	1079.88	3.365	855.01	2.775
11/14/2006	5.7	1085.58	4.5	859.51	1.2
11/15/2006	5.65	1091.23	3.83	863.34	1.82
11/16/2006	5.59	1096.82	3.3275	866.66	2.2625
11/17/2006	5.62	1102.44	3.675	870.34	1.945
11/18/2006	5.29	1107.73	4.38	874.72	0.91
11/19/2006	5.51	1113.24	5.245	879.96	0.265
11/20/2006	5.67	1118.91	4.185	884.15	1.485

Date	Kumealeon AvergageTemp	Kumealeon ATU's	Oona AvgTemp	Oona ATU's	DailyTemp Differences
11/23/2006	4.9	1134.53	1.9325	892.42	2.9675
11/24/2006	4.82	1139.35	1.295	893.71	3.525
11/25/2006	4.28	1143.63	0.6175	894.33	3.6625
11/26/2006	3.55	1147.18	0.33	894.66	3.22
11/27/2006	3.3	1150.48	0.33	894.99	2.97
11/28/2006	3.42	1153.9	0.33	895.32	3.09
11/29/2006	3.81	1157.71	0.45	895.77	3.36
11/30/2006	3.83	1161.54	0.5325	896.30	3.2975
12/1/2006	3.99	1165.53	0.49	896.79	3.5
12/2/2006	3.3	1168.83	1.0175	897.81	2.2825
12/3/2006	3.61	1172.44	1.8125	899.62	1.7975
12/4/2006	3.79	1176.23	2.455	902.08	1.335
12/5/2006	3.76	1179.99	2.65	904.73	1.11
12/6/2006	4.05	1184.04	3.7925	908.52	0.2575
12/7/2006	4.51	1188.55	4.775	913.30	-0.265
12/8/2006	4.36	1192.91	4.185	917.48	0.175
12/9/2006	4.57	1197.48	4.145	921.63	0.425
12/10/2006	4.54	1202.02	4.46	926.09	0.08
12/11/2006	4.43	1206.45	4.3825	930.47	0.0475
12/12/2006	4.39	1210.84	3.8725	934.34	0.5175
12/13/2006	4.36	1215.2	4.22	938.56	0.14
12/14/2006	4.23	1219.43	3.7925	942.35	0.4375
12/15/2006	4.04	1223.47	2.5725	944.93	1.4675
12/16/2006	3.99	1227.46	2.255	947.18	1.735
12/17/2006	4.04	1231.5	2.415	949.60	1.625
12/18/2006	3.86	1235.36	4.105	953.70	-0.245
12/19/2006	4.28	1239.64	4.26	957.96	0.02
12/20/2006	4.39	1244.03	4.7725	962.73	-0.3825
12/21/2006	4.33	1248.36	4.8125	967.55	-0.4825
12/22/2006	4.23	1252.59	3.99	971.54	0.24
12/23/2006	4.12	1256.71	3.5225	975.06	0.5975
12/24/2006	4.15	1260.86	3.795	978.85	0.355
12/25/2006	4.1	1264.96	3.6	982.45	0.5
12/26/2006	3.76	1268.72	3.3275	985.78	0.4325
12/27/2006	3.84	1272.56	2.61	988.39	1.23
12/28/2006	3.81	1276.37	2.5325	990.92	1.2775
12/29/2006	3.89	1280.26	3.05	993.97	0.84
12/30/2006	3.81	1284.07	3.21	997.18	0.6
12/31/2006	3.97	1288.04	3.7175	1000.90	0.2525
1/1/2007	4	1292.04	4.655	1005.56	-0.655
1/2/2007	4.04	1296.08	5.085	1010.64	-1.045
1/3/2007	4.1	1300.18	4.8525	1015.49	-0.7525
1/4/2007	3.87	1304.05	3.5225	1019.02	0.3475
1/5/2007	3.84	1307.89	3.25	1022.27	0.59
1/6/2007	3.87	1311.76	3.17	1025.44	0.7
1/7/2007	3.79	1315.55	3.405	1028.84	0.385
1/8/2007	3.79	1319.34	2.89	1031.73	0.9
1/9/2007	3.61	1322.95	2.1325	1033.86	1.4775

Date	Kumealeon AvergageTemp	Kumealeon ATU's	Oona AvgTemp	Oona ATU's	DailyTemp Differences
1/12/2007	2.98	1332.18	0.49	1035.90	2.49
1/13/2007	3.45	1335.63	0.5325	1036.43	2.9175
1/14/2007	3.32	1338.95	0.9375	1037.37	2.3825
1/15/2007	3.03	1341.98	1.93	1039.30	1.1
1/16/2007	3.27	1345.25	1.89	1041.19	1.38
1/17/2007	3.35	1348.6	1.89	1043.08	1.46
1/18/2007	3.47	1352.07	2.4125	1045.49	1.0575
1/19/2007	3.4	1355.47	2.57	1048.06	0.83
1/20/2007	3.48	1358.95	2.57	1050.63	0.91
1/21/2007	3.48	1362.43	2.81	1053.44	0.67
1/22/2007	3.55	1365.98	4.0675	1057.51	-0.5175
1/23/2007	3.89	1369.87	4.775	1062.28	-0.885
1/24/2007	4	1373.87	5.56	1067.84	-1.56
1/25/2007	3.68	1377.55	3.7925	1071.63	-0.1125
1/26/2007	3.7	1381.25	2.77	1074.40	0.93
1/27/2007	3.66	1384.91	2.1775	1076.58	1.4825
1/28/2007	3.63	1388.54	2.1725	1078.75	1.4575
1/29/2007	3.58	1392.12	2.4125	1081.17	1.1675
1/30/2007	3.32	1395.44	2.25	1083.42	1.07
1/31/2007	3.3	1398.74	2.0925	1085.51	1.2075
2/1/2007	3.22	1401.96	1.97	1087.48	1.25
2/2/2007	2.93	1404.89	1.97	1089.45	0.96
2/3/2007	3.29	1408.18	2.7675	1092.22	0.5225
2/4/2007	3.5	1411.68	4.615	1096.83	-1.115
2/5/2007	3.81	1415.49	5.05	1101.88	-1.24
2/6/2007	3.91	1419.4	5.205	1107.09	-1.295
2/7/2007	3.94	1423.34	5.1225	1112.21	-1.1825
2/8/2007	3.87	1427.21	4.7725	1116.98	-0.9025
2/9/2007	3.73	1430.94	3.8325	1120.81	-0.1025
2/10/2007	3.73	1434.67	3.6775	1124.49	0.0525
2/11/2007	3.68	1438.35	3.21	1127.70	0.47
2/12/2007	3.73	1442.08	3.245	1130.95	0.485
2/13/2007	3.97	1446.05	3.755	1134.70	0.215
2/14/2007	4.09	1450.14	4.7725	1139.47	-0.6825
2/15/2007	3.97	1454.11	4.6175	1144.09	-0.6475
2/16/2007	3.99	1458.1	4.6575	1148.75	-0.6675
2/17/2007	4.18	1462.28	5.0875	1153.84	-0.9075
2/18/2007	3.94	1466.22	4.5	1158.34	-0.56
2/19/2007	3.87	1470.09	3.8725	1162.21	-0.0025
2/20/2007	3.79	1473.88	3.5975	1165.81	0.1925
2/21/2007	3.58	1477.46	3.21	1169.02	0.37
2/22/2007	3.32	1480.78	2.53	1171.55	0.79
2/23/2007	2.98	1483.76	2.335	1173.88	0.645
2/24/2007	3.27	1487.03	2.65	1176.53	0.62
2/25/2007	3.53	1490.56	2.73	1179.26	0.8
2/26/2007	3.68	1494.24	2.73	1181.99	0.95
2/27/2007	3.37	1497.61	1.8125	1183.80	1.5575
3/1/2007	3.11	1500.72	0.41	1184.21	2.7

Date	Kumealeon AvergageTemp	Kumealeon ATU's	Oona AvgTemp	Oona ATU's	DailyTemp Differences
3/4/2007	3.61	1511.1	3.48	1191.04	0.13
3/5/2007	3.76	1514.86	4.185	1195.23	-0.425
3/6/2007	4.1	1518.96	5.325	1200.55	-1.225
3/7/2007	3.79	1522.75	4.34	1204.89	-0.55
3/8/2007	3.68	1526.43	3.21	1208.10	0.47
3/9/2007	3.63	1530.06	2.85	1210.95	0.78
3/10/2007	3.66	1533.72	3.01	1213.96	0.65
3/11/2007	3.61	1537.33	2.81	1216.77	0.8
3/12/2007	3.53	1540.86	2.5325	1219.31	0.9975
3/13/2007	3.29	1544.15	1.7725	1221.08	1.5175
3/14/2007	3.27	1547.42	1.855	1222.93	1.415
3/15/2007	3.37	1550.79	2.1725	1225.11	1.1975
3/16/2007	3.39	1554.18	2.3725	1227.48	1.0175
3/17/2007	3.32	1557.5	2.73	1230.21	0.59
3/18/2007	3.32	1560.82	2.3725	1232.58	0.9475
3/19/2007	3.42	1564.24	2.4525	1235.03	0.9675
3/20/2007	3.42	1567.66	2.3725	1237.41	1.0475
3/21/2007	3.53	1571.19	3.1275	1240.53	0.4025
3/22/2007	3.71	1574.9	4.185	1244.72	-0.475
3/23/2007	3.51	1578.41	4.89	1249.61	-1.38
3/24/2007	3.71	1582.12	4.93	1254.54	-1.22
3/25/2007	3.71	1585.83	3.8325	1258.37	-0.1225
3/26/2007	3.52	1589.35	3.2075	1261.58	0.3125
3/27/2007	3.47	1592.82	2.335	1263.91	1.135
3/28/2007	2.77	1595.59	1.7325	1265.65	1.0375
3/29/2007	3.08	1598.67	0.695	1266.34	2.385
3/30/2007	3.73	1602.4	1.455	1267.80	2.275
3/31/2007	3.48	1605.88	1.735	1269.53	1.745
4/1/2007	3.4	1609.28	1.495	1271.03	1.905
4/2/2007	3.18	1612.46	1.175	1272.20	2.005
4/3/2007	3.16	1615.62	1.095	1273.30	2.065
4/4/2007	3.22	1618.84	1.615	1274.91	1.605
4/5/2007	3.08	1621.92	1.97	1276.88	1.11
4/6/2007	3.37	1625.29	2.81	1279.69	0.56
4/7/2007	3.81	1629.1	3.6375	1283.33	0.1725
4/8/2007	3.97	1633.07	4.42	1287.75	-0.45
4/9/2007	3.94	1637.01	4.655	1292.40	-0.715
4/10/2007	3.94	1640.95	4.9675	1297.37	-1.0275
4/11/2007	3.99	1644.94	4.695	1302.07	-0.705
4/12/2007	4.14	1649.08	4.695	1306.76	-0.555
4/13/2007	3.99	1653.07	4.34	1311.10	-0.35
4/14/2007	4.05	1657.12	4.1825	1315.28	-0.1325
4/15/2007	3.97	1661.09	4.14	1319.42	-0.17
4/16/2007	4.07	1665.16	4.145	1323.57	-0.075
4/17/2007	4.2	1669.36	4.4975	1328.07	-0.2975
4/18/2007	4.18	1673.54	4.6925	1332.76	-0.5125

Table 2 Readouts from Temperature Tidbits in Kumealeon and Oona River and the Accumulated Thermal Units (ATU's)

FINANCIAL SUMMARY FOR PROJECT

This is the summary of the project expenditures for the 2006-2007 ORRA project. **Determining the Trend of Chum Population Dynamics in Area 5 and Measuring the Success of Small Hatcheries for Stock Assistance.**

Final contract financial agreement

Contract Services	**$7,825.00**
Wages	$16,136.00
Mercs at 14%	$2,259.04
Total Wages	**$18,395.04**
Expenses	**$1,292.00**
Travel	**$500.00**
Project subtotal	**$28,012.04**
Administration at 5%	$1,400.60
Total Project	**$29,412.64**

Actual financial spending

Revenue from Northern Boundry Fund/chum project		**$29,412.64**
Expenses		
Contract Services		$8,926.00
Wages		$15,918.48
Mercs		$1,072.85
WCB		$341.94
Expenses	1121.78	$1,255.25
gas/travel		$498.10
ad min		$1,400.00
TOTAL EXPENSES		**$29,412.62**
Balance		**$0.02**

Signature Administrator/Financial Officer

-- Date -----------------------