Photo 14

Above: Cutting trail to weir site after fire damage

Photo 15

Above: Rebuilding ATV trail to weir site

Photo 16

Above: Rebuilding ATV bridges after fires

Photo 17

Above: Rebuilt ATV bridge

Photo 18

Above: Damage to weir from forest fires

Photo 19

Above: Hot-spots on river bank below weir

Photo 20

Above: Aerial photo of weir with forest fires looking downstream

Photo 21

Above: Aerial photo of weir with forest fires before DIAND conducted a "back-burn"

Photo 22

Above: Aerial photo of weir after DIAND conducted a "back-burn"

Photo 23

Above: Chandindu River valley when Dawson District Fire #11 headed for the Fifteenmile River

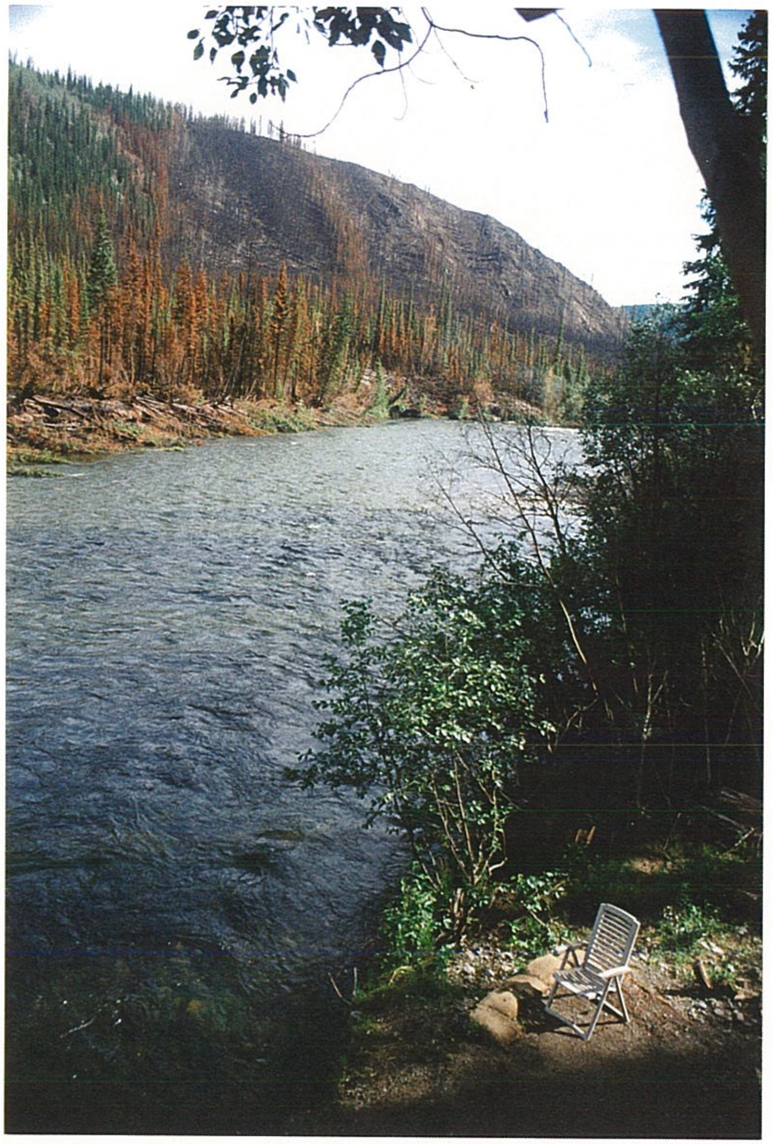
Photo 24

Above: Mike Taylor sampling a chinook salmon on the weir

Photo 25

Above: Chinook salmon recovering after sampling in live pen

Photo 26



Above: Chandindu River valley from weir site after forest fires

6. Weir Operations

The weir was operational from July 16th at 10AM to August 31st at 12AM. The weir was monitored from 8AM to 12AM daily, or 16hrs per day. During this time weir attendants were required to work twelve hour shifts that overlapped (ie: Worker 1, 8AM-8PM; Worker 2, 12PM-12AM) in order to maximize the time when both attendants would be available to sample fish. Workers were required to assist in fish sampling when off duty and many times were awakened in the late or early hours to sample salmon. Weir attendants worked a twelve days on and four days off schedule for the entire period of operations.

Weir attendants kept a regular maintenance schedule and as a result, kept the weir in top operating condition. Regular maintenance was conducted on hourly intervals in which workers cleaned accumulated debris from the weir and reported water temperature and water level information. Water temperature data was acquired manually from surface water with a digital thermometer and automatically from dataloggers placed on the surface and river-bottom (Table 1). The weir was checked for fish-tightness, scouring, and structural integrity twice daily. In between regular maintenance checks, attendants would observe the river and salmon from an observation tower that was built to address the "shyness" of fish observed in the clear water.

Procedures were established that addressed the fact that all fish migrating through the counting fence were going to be sampled. Great care and respect was demonstrated during fish sampling (Photos 24). Fish entering the live box were captured by triggering the downstream gate, thus trapping them in the live pen. A rope trigger was set up to allow attendants to trip the gate remotely from the observation tower. A board was then placed over the front gate to restrict current and fish were dipnetted from the live box into the sampling tote. Time of capture (Table 2), fish length, sex, and general condition were all recorded. Scale samples and DNA samples were then taken from the fish (photo 24). Fish were released back into the live pen and the upstream gate opened (photo 25). Fish were left in the live pen and allowed to leave on there own recourse to continue their migration upstream. Any fish that stayed too long in the relatively swift current of the live pen was removed and placed into a fish tube. The tubes were then placed in slack water and the fish would leave the tubes upon recovery.

In addition to adult live sampling, juvenile sampling was conducted weekly at several sites near the weir. This fry sampling effort was initiated to assess natural fry sizes and determine optimum target grow-out sizes for outplanting (Tables 3 and 4). Sample sizes are reflected in Table 3 as "Total Fry Captured" and all fry were sampled.

Camp duties were shared among workers. The camp was kept very clean to avoid problems with bears and ran smoothly. Garbage was packed out at every convenience and camp recyclables were washed and removed regularly.

All data collected from the weir has been forwarded to F&OC for consideration. All samples, from Scale and DNA sampling, have been forwarded to F&OC. Results from these samples are not yet available.

7. Take Down and Storage

The weir was disassembled on September 1st and stored neatly on the river bank above the high water mark. Sandbags and stucco wire were also removed from the river and stored above the high water mark. The privy pit and grey water ditch were backfilled. The entire wall tent camp was disassembled and stored on site. A small shed, built in workers off-duty time, was filled with miscellaneous camp materials and secured for the winter.

Table 1 - Temperature Profiles

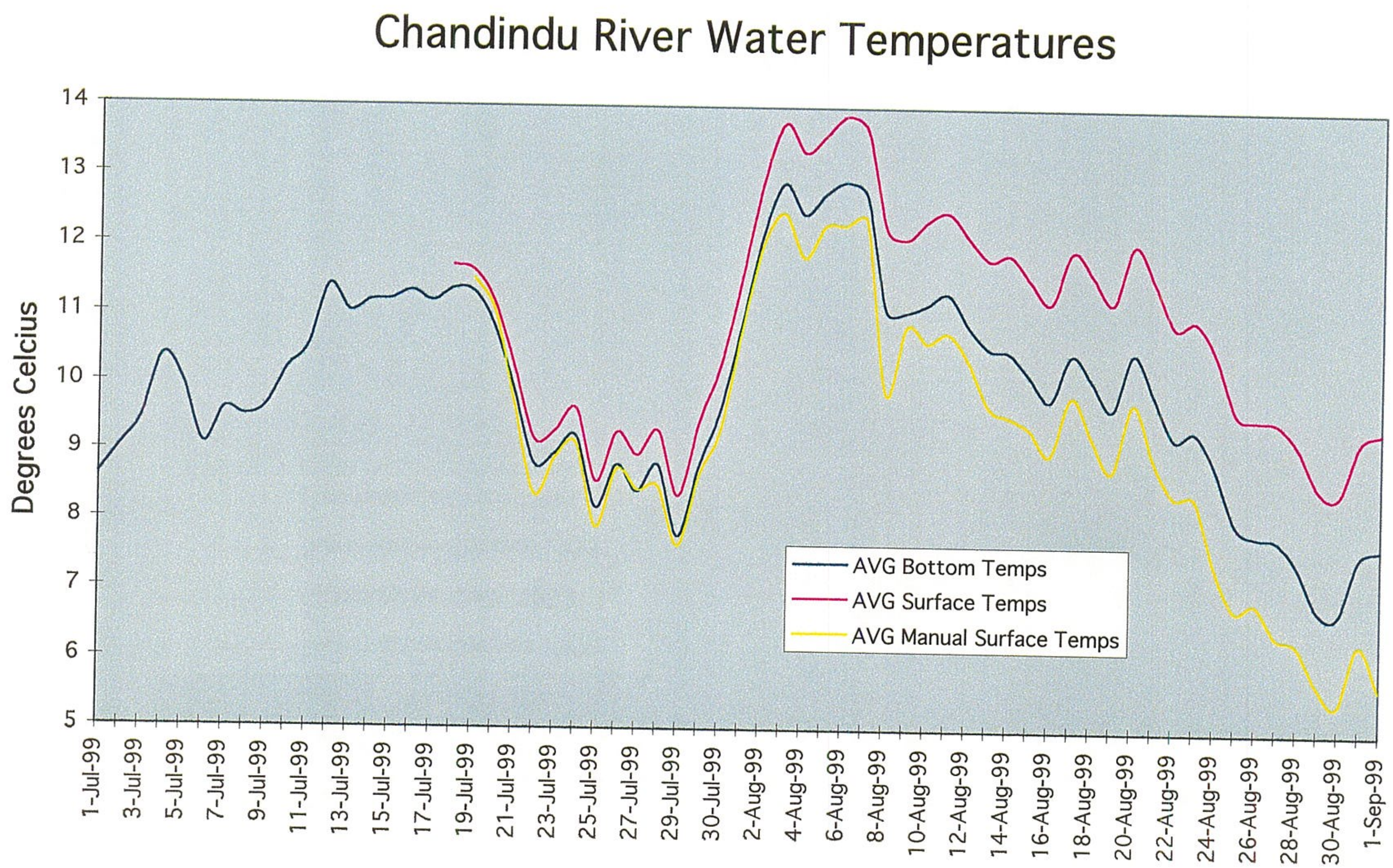
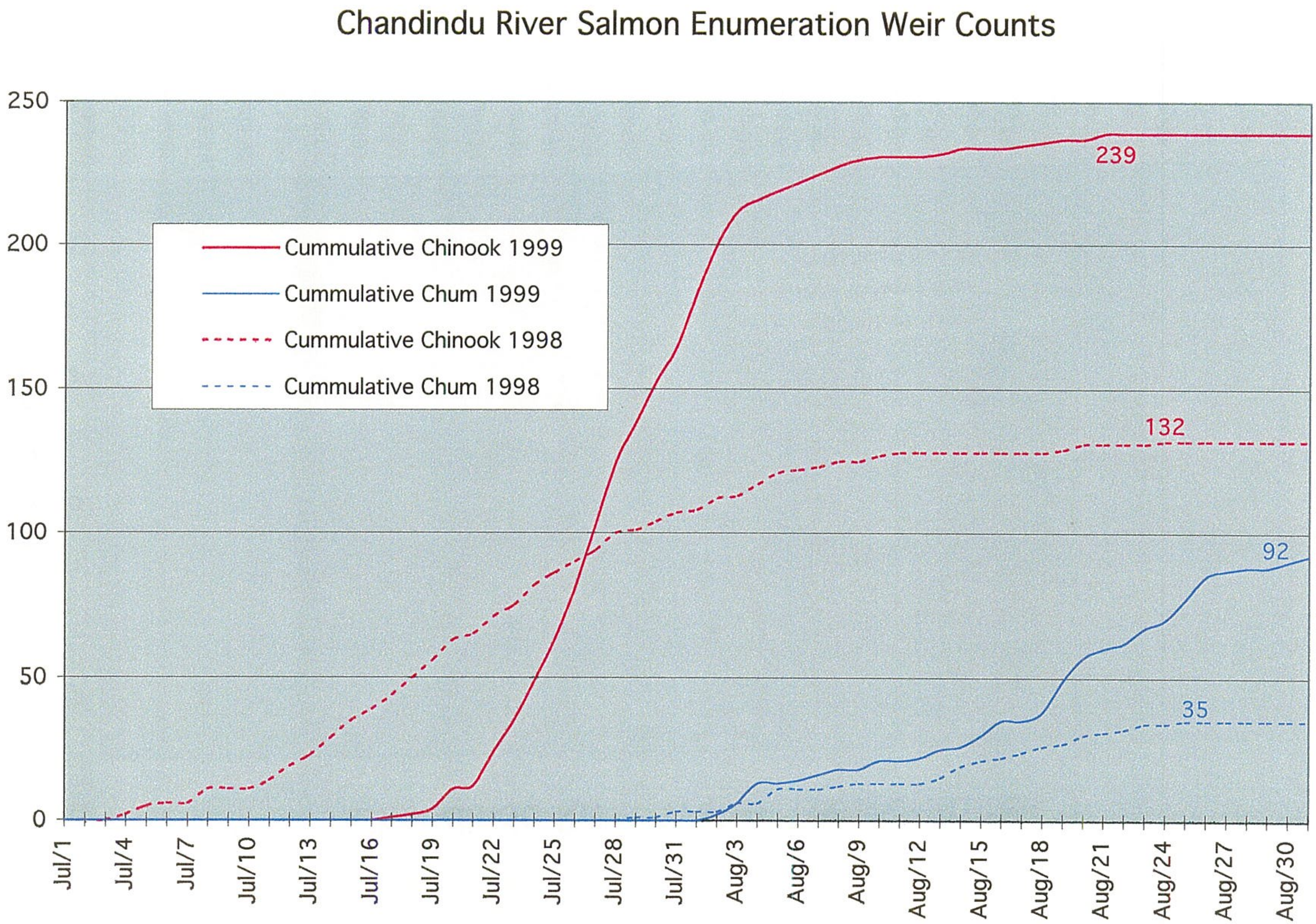


Table 2 - Cumulative Timing



In 1999, the chinook salmon (king) run was below other years in terms of population size, and late in terms of their arrival to the Yukon. Data suggests that the 1999 chinook run was 57% below the recent 6 year cycle average (93-98) and it was July 14th before the beginning of the run was declared by F&OC (JTC, Oct 27-29, 1999). Low overall salmon runs are not completely uncommon in the Canadian portion of the Yukon River (Cox et al., 1997). In 1999, the total Canadian commercial chinook catch was the second lowest catch recorded since 1978. Low overall numbers aside, many more salmon were counted on the Chandindu River than were in 1998. Low run sizes during salmon enumeration on the Chandindu River in years 1998 and 1999 unfortunately compromises our ability to get a clear idea of how many salmon typically migrate to the Chandindu River. Nineteen ninety-nine was, for both chinook and chum salmon populations, a poor year. Data gathered in this weir study has been considered in light of the low returning populations of salmon. Fortunately regarding run timing, the late returning salmon coincided with the forest fires in the area that delayed the start of the weir project.

On June 19th a presentation to the Tombstone Steering Committee was made by project personnel. The Tombstone Steering Committee was tasked with determining the final boundaries for the Tombstone Territorial Park, agreed to in the Tr'on dëk Hwech'in Final Agreement. Study areas of the park included much of the headwaters of the Chandindu and North Klondike Rivers. The presentation was successful in influencing the committee's decision regarding the final park boundaries. The presentation illustrated the importance of Chandindu River salmon resources and focused on the proponents' background research and their restoration ambitions. The presentation, the proponents' background research, their restoration goals, and the information gathered from the 1999 project were a very important contributing factor to the determination of final park boundaries.[1]

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1 Personal communications with Tim Gerberding, Tombstone Steering Committee

There is the ability to establish Habitat Protection Areas for fish and wildlife under the Yukon Wildlife Act. Information from the Chandindu weir project will be useful in the development of a rationale for Habit Protection Areas to address sections of the Chandindu watershed that the park does not encompass. This valuable information will also aid in the development of a watershed plan. Development of this rationale and a watershed plan are now underway.

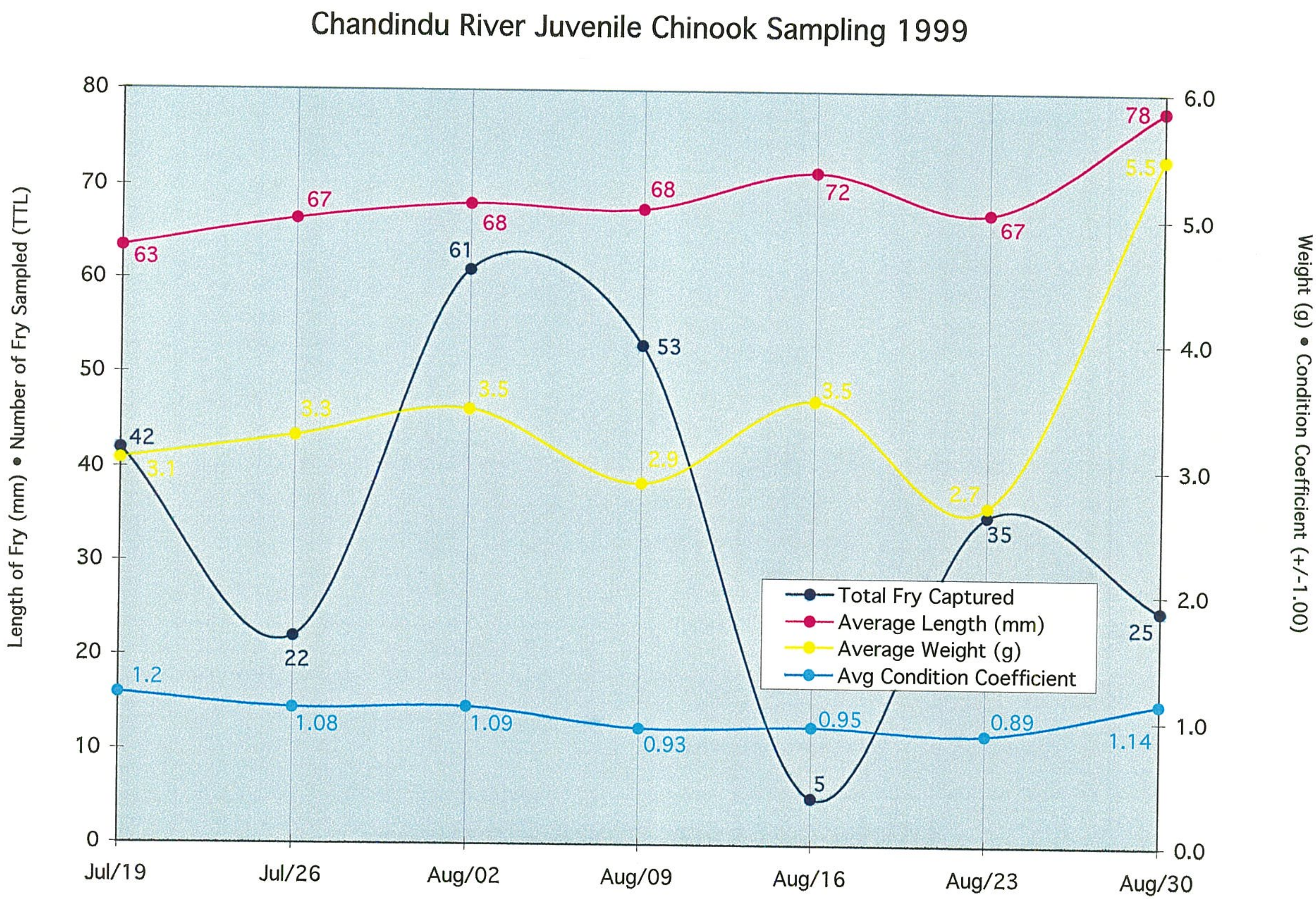
Chinook Salmon Results:

From July 16th to August 31st, a total of 239 chinook salmon (78 females, 161 males) passed through the weir on the Chandindu River. The first chinook was sampled on July 17th and the last chinook salmon was sampled on August 21st (Table 2). Eighteen spaghetti tags from F&OC's mark-recapture program were recovered from chinook salmon, representing under 8% of the fish counted. The weir was installed later than planned due to problems associated with forest fires and a small number of fish may have migrated through the weir before it was fish-proof. However, taking into account the lateness of the run and average salmon migration rates, estimated numbers of fish that could have passed through the weir prior to its operation would be extremely low.

It took an average of 4.1 days for chinook salmon tagged at the two F&OC fish wheels to migrate through the Chandindu River weir, distances of 99.5km and 104km, or 31.3km per day. This is similar to chinook migration rates found in other studies (Milligan et al., 1985) suggesting that migrating fish were not impeded by the weir.

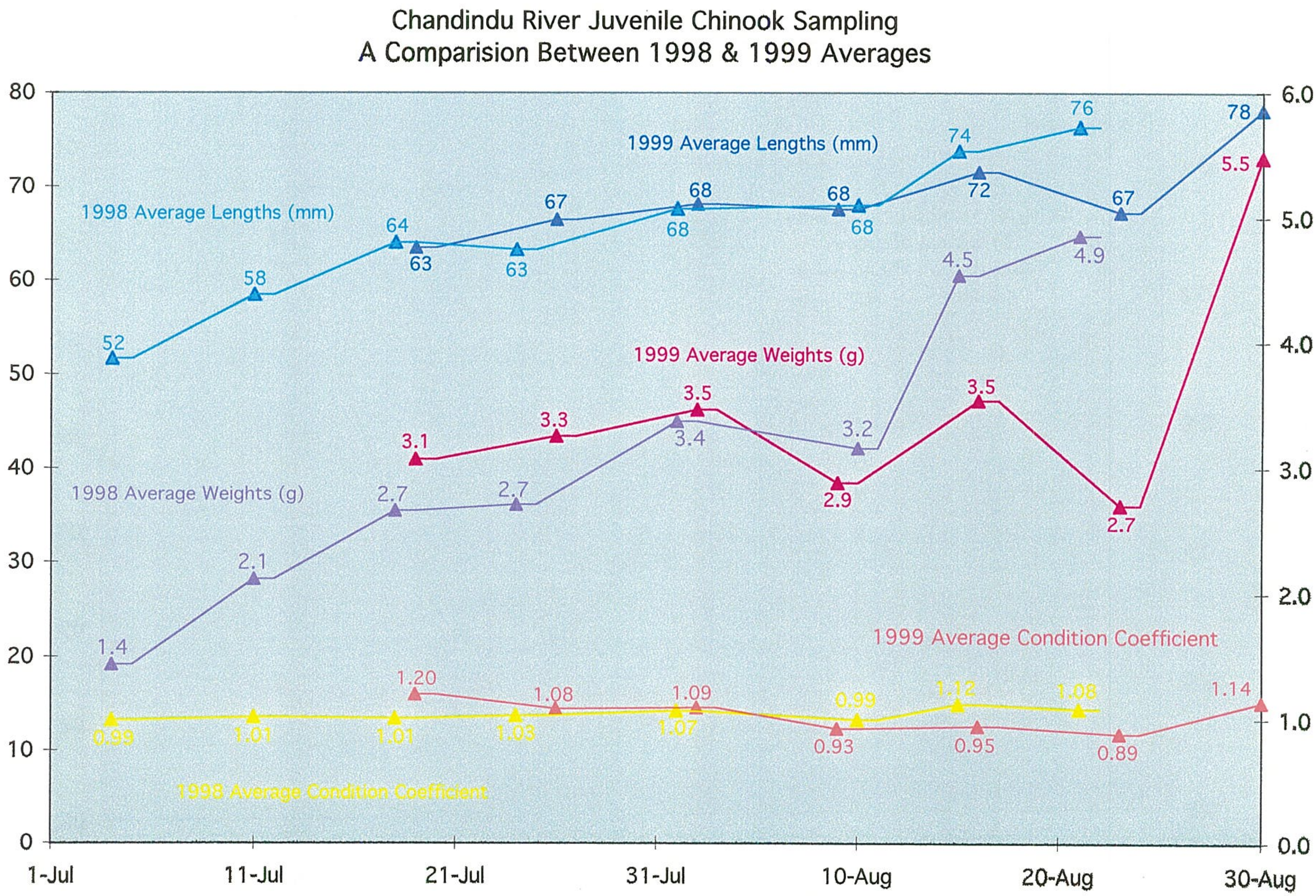
One notable observation was made by weir attendant Jay Farr. He found that if salmon were released into the live pen after sampling, and allowed to remain and leave on their own recourse, problems with fish hitting the upstream side of the weir were dramatically reduced. This observation, in comparison to older methods where fish were released above the live pen, benefitted the salmon by reducing unnecessary stress-related handling and almost eliminated the need for fish recovery tubes.

Table 3 - Fry Trapping Results



Chandindu River 1999

Table 4 - Fry Trapping Comparisons



Using Fisheries and Oceans Canada, Habitat and Enhancement Branch protocols, only 30% of a stock can be used for brood stock. When applying these protocols to the female component of the stock measured this year, 23 females could have been available for brood stock. If these females had an estimated fecundity rate of between 6,000-8,000 eggs per fish then between 140,400 and 187,200 eggs could have been collected. If this years salmon run was 57% lower than the recent 6 year cycle average and assuming that the sex ratio was closer to an average of 49.5% female, then in a more average year 208 females could have be present and 62 available for brood stock.[2] If those returning fish had an estimated fecundity rate of between 6,000-8,000 eggs per fish, then between 373,595 and 498,126 eggs could have been collected. If those fish were raised in controlled circumstances, they would enjoy higher survival rates upwards of 80%, in contrast to the natural 30% egg to fry survival rate. If these fry were released, and after natural fry to adult survival rates and exploitation rates were taken into account, a total (from the original **62** female chinook) of between **1,793** and **2,391** fish could feasibly return to the Chandindu River (Table 5). Natural production of the remaining females, not taken for brood stock, would be in addition to this.[3]

Therefore, notwithstanding the desirability of further study, it has been concluded that chinook salmon brood stock is available on the Chandindu River. In theory, sufficient numbers of chinook salmon are available to allow an incubation/outplanting program that would result in a marked increase to depleted Chandindu River chinook stocks. If the program were to continue through a six year cycle, then cease, the Chandindu River should be able to produce numbers of fish that would more closely reflect those found historically.

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[2] Rates and ratios based on personal communication with Pat Milligan, F&OC

[3] Please note: Pre-spawning brood stock mortalities have not been taken into consideration in these calculations.

Consideration of the costs and benefits related to the collection of brood stock on the Chandindu River and the accompanying restoration program, particularly, the costs per fish raised, the costs per returning adult, potential benefits from the exploitation of returning adults, potential benefits from the exploitation of adult returns in future years from an increased stock, are not yet available. To relate the brood stock availability to the costs and benefits in order to build an argument for the program's feasibility, in this study, is premature. The proponents are presently studying these costs and working on a restoration plan/program. They are also looking at specific sites for the facility.

<u>Chum Salmon Results:</u>

From July 16th to August 31st, a total of 92 chum (64 females, 28 males) salmon passed through the weir on the Chandindu River. The first chum was sampled on August 2nd and the last chum was sampled on August 31st (Table 2). Very high female:male ratios and early timing were noted. Sampling over the entire chum run was not done as the weir ceased operations prior to complete migration. This information is secondary to the data collected on chum stocks and has not yet been thoroughly examined. Samples from chum were taken and forwarded to F&OC. Further study into chum on the Chandindu River would be desirable.

Data collected from the weir in spreadsheet format is available on request.

Table 5 - Brood Stock Availability

Potential chinook salmon weir returns, broodstock availability, fry production and adult returns for the Chandindu River

Table using 1999 sex ratio

	1999 Weir Counts	POTENTIAL BROODSTOCK AT 30% HEB LIMIT	Potential Eggs 6000/female A	Potential Eggs 8000/female B	POTENTIAL FRY after 80% egg/fry A	POTENTIAL FRY after 80% egg/fry B	POTENTIAL ADULTS after 2% fry to adult survival A	POTENTIAL ADULTS after 2% fry to adult survival B	WEIR RETURNS after 70% exploitation rate A	WEIR RETURNS after 70% exploitation rate B
Males	161									
Females	78	23	140,400	187,200	112,320	149,760	2,246	2,995	674	899
Total	239									

Table using 49.50%
AVG female ratio over recent cycle average
1993-98

	1999	Return if 1999 run is 57% below Recent Cycle AVG (93-98)	POTENTIAL BROODSTOCK AT 30% HEB LIMIT	Potential Eggs 6000/female A	Potential Eggs 8000/female B	POTENTIAL FRY after 80% egg/fry A	POTENTIAL FRY after 80% egg/fry B	POTENTIAL ADULTS after 2% fry to adult survival A	POTENTIAL ADULTS after 2% fry to adult survival B	WEIR RETURNS after 70% exploitation rate A	WEIR RETURNS after 70% exploitation rate B
Males	121	212									
Females	118	208	62	373,595	498,126	298,876	398,501	5,978	7,970	1,793	2,391
Total	239	419									

Daily Cumulative Weir Counts from 1998 and 1999				
Date	1998 Cumulative		1999 Cumulative	
	Chinook	Chum	Chinook	Chum
July/1	0	0	0	0
July/2	0	0	0	0
July/3	0	0	0	0
July/4	2	0	0	0
July/5	5	0	0	0
July/6	6	0	0	0
July/7	6	0	0	0
July/8	11	0	0	0
July/9	11	0	0	0
July/10	11	0	0	0
July/11	14	0	0	0
July/12	19	0	0	0
July/13	23	0	0	0
July/14	29	0	0	0
July/15	35	0	0	0
July/16	39	0	0	0
July/17	44	0	1	0
July/18	50	0	2	0
July/19	56	0	4	0
July/20	63	0	11	0
July/21	65	0	12	0
July/22	71	0	24	0
July/23	75	0	35	0
July/24	82	0	49	0
July/25	86	0	63	0
July/26	90	0	81	0
July/27	94	0	103	0
July/28	100	0	125	0
July/29	101	1	139	0
July/30	104	1	153	0
July/31	107	3	165	0
August/1	108	3	184	0
August/2	112	3	201	2
August/3	113	6	212	6
August/4	117	6	216	13
August/5	121	11	219	13
August/6	122	11	222	14
August/7	123	11	225	16
August/8	125	12	228	18
August/9	125	13	230	18
August/10	127	13	231	21
August/11	128	13	231	21
August/12	128	13	231	22
August/13	128	15	232	25
August/14	128	19	234	26
August/15	128	21	234	30
August/16	128	22	234	35
August/17	128	24	235	35
August/18	128	26	236	38
August/19	129	27	237	49
August/20	131	30	237	57
August/21	131	31	239	60
August/22	131	32	239	62
August/23	131	34	239	67
August/24	132	34	239	70
August/25	132	35	239	77
August/26	132	35	239	85
August/27	132	35	239	87
August/28	132	35	239	88
August/29	132	35	239	88
August/30	132	35	239	90
August/31	132	35	239	92

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D. Petkovich, W.R. Ricks, October 19, 1998 *Klondike Area Central* Incubation/Outplant Facility Feasibility Study Progress Report

Tr'on dëk Hwech'in, March 10 1998 *Tr'on dëk Hwech'in Final Agreement, among the Government of Canada and the Tr'on dëk Hwech'in (Formerly Know as the Dawson First Nation) and the Government of the Yukon*

Photo List

1. Chandindu River Salmon Enumeration Weir 199, photo by Jody Cox
2. Filling 400 Sandbags for the weir
3. The crew takes a break after getting the sandbags on site
4. Temporary camp set up at the landing during forest fires
5. Temporary camp
6. Boats at landing readied for camp evacuation
7. Poor visibility on Yukon River during forest fires
8. Forest fires flaring up at the mouth of the Chandindu River
9. Forest fire hot-spots across the river from the weir camp site
10. Forest fires picking up in high winds (weir in foreground)
11. Fires at the mouth of the Chandindu River
12. Crowning forest fire at the mouth of the Chandindu River
13. Fire flaring up on hill by the weir site
14. Cutting trail to the weir site after fire damage
15. Rebuilding ATV trail to weir site
16. Rebuilding ATV bridges after fires
17. Rebuild ATV bridge
18. Damage to weir from forest fires
19. Hot-spots on river bank below weir
20. Aerial photo of weir with forest fires looking downstream
21. Aerial photo of weir with forest fires before DIAND conducted a "back-burn"
22. Aerial photo of weir after DIAND conducted a "back-burn"
23. Chandindu River valley when Dawson District Fire #11 headed for the Fifteenmile River
24 Mike Taylor sampling a chinook on the weir
25 Chinook salmon recovering after sampling in live pen
26. Chandindu River valley from weir site after forest fires, photo by Al von Finster

Fisheries and Oceans | Pêches et Océans

MEMORANDUM NOTE DE SERVICE

To / A	**File – Chandindu River**	Security Classification - Classification de sécurité
		Our file - Notre référence
From / De	**Al von Finster** **HEB DFO**	Your File - Votre référence
		Date **August 13, 1999**

Subject / Object **OBSERVATIONS: OVERFLIGHT OF CHANDINDU RIVER, JULY 30, 1999**

The Chandindu River is a right bank tributary of the Yukon River, entering 28 (river) km downstream of Dawson City. The Chandindu has a basin area of 1680 sq. km. The headwaters are located in the Ogilvie Mountains. The upper reaches have a north-south alignment. The river then makes a slow bend into the Tintina Trench, which it crosses diagonally to the west. At the confluence with Thane Creek, it turns 90 degrees to the south and pierces the south wall of the trench to enter the Yukon River valley. The Chandindu has clear, bright water under most conditions. The gradient is moderate throughout.

The Chandindu is a major tributary of the Yukon River North Mainstem sub-basin and is under active investigation by a partnership of the Yukon River Commercial Fishing Association (YRCFA) and the Tr'on dek Hwech'in (TDH). The partnership has been formed to restore fish stocks in the TDH traditional territory, which corresponds closely to the sub-basin planning area. Many watercourses in the sub-basin have been negatively affected by a century of placer mining and associated activities. The Chandindu is one of the least affected of these rivers.

The winter of 1998-9 was dry in the Dawson area. Fires started along the north shore of the Yukon River downstream of the City. The fires continued until near the end of July, when cool and moist weather extinguished most. Reports indicated that the forest cover over much of the lower drainage basin of the Chandindu had burned. Concerns were expressed within DFO that the effects of the fire would compromise the operation of the counting fence or of the overall restoration project.

In accordance with HEB's commitment to provide service to our partners both within the Department and outside of it, an overflight of the affected area was conducted on July 30, 1999. Present were Angela Sinclair, DFO HEB Community Liaison Biologist, Jay Farr of the TDH and myself.

We started at the mouth and proceeded upstream to the confluence with the Little Twelve Mile River, which we left the river to ascend. Only the mainstem of the Chandindu was flown.

The following account provides a description of observed physical features of the river and surrounding features; an account of the extent of the fires; and an interpretation of the effects of the fires on the land, the river and on the counting fence and the overall project. Photographs taken during the overflight may be found in AvF 99.7.7

General characteristics of the Chandindu River valley

The Tintina Trench dominates the section of the Chandindu flown. This structural feature is an extension of the Rocky Mountain Trench. To the south are the rolling uplands of the unglaciated Klondike plateau. Valleys dissecting the plateau tend to be narrow, "V" shaped in cross-section, and concave in profile. To the north are the Ogilvie Mountains. The Ogilvies are cordilleran in nature and were subject to alpine glaciation. Valleys tend to be "U" shaped in cross-section and to have complex profiles. Between the two lies the trench. Map 1 shows the overall drainage.

Reach boundaries were chosen for the purpose of this investigation only, and were based on broad geomorphologic processes . Future investigators will wish to use boundaries which are appropriate to the type and intensity of study or other management undertaking which they may be conducting.

Reach 1

The Chandindu has a weakly developed fan extending into the Yukon River. For much of this reach, the river flows in two stable channels. This reach is downstream of the counting weir and is limited in to the lowest ~1.5 km of river. It was therefore not examined.

Reach 2

Physical Description - The river enters a relatively narrow (i.e. >10 X channel width) valley incised into the southern wall of the Trench. The river generally flows through a single channel. The riparian zone is narrow, and the flood plain is limited in width. Some ground water fed channels are present. Permafrost extends to the stream bank in some locations, particularly on the left (east) side. Bedrock exposures are apparent on both valley walls. No tributaries enter the river. This reach ends immediately downstream of the mouth of Thane Creek.

Extent of fire - The valley walls are extensively burned. Intensity varies considerably: in some cases, soils have burned, while in others it was merely charred on the surface. The fire has extended in some locations to the riverbanks. The fire generally stopped where it reached ground water fed back-, side- or valley wall channels.Effects of fire - the right (west) side of the valley will probably not be subject to mass soil movements. The soils are either dry and limited in depth or are located on flat ground. The left (east) side appears to be moister and to have permafrost under sloping soils. Some mass movement from gully formation or from debris torrents is likely, and effects will extend to the river. This will contribute sediment, potentially contribute stems and other debris to the river. The finer fractions of sediment will soon move through the system. Larger particle sizes will move more slowly. Sands, which are generally the particle size of most concern in regard to spawning salmonids, are expected to be a minor component of the sediment released from torrents in this reach. The effects on the counting weir are expected to be minimal unless a major torrent enters immediately upstream from the left (east) valley wall. The stability of the valley wall may be relatively easily monitored over time by walking the slopes looking for signs of distress such as slow deformation of the land surface, gaping, etc;

Reach 3

Physical Description - The river leaves the confined valley and turns abruptly to the west. It first flows along the south side of the trench and then moves toward the centre of the valley. The bottom of the primary valley, which is also the bottom of the trench, is wide and flat in cross-section. The valley slopes gradually upward toward the east. The gradient of the Chandindu is somewhat less, resulting in a secondary valley of increasing depth with distance upstream. The walls of the secondary valley are initially set well back from the channel. The bottom of the secondary valley appears to be a flood plain and to be almost entirely comprised of thawed ground. Riparian forests are vigorous. There are stands of very large old growth spruce. Perhaps emergent or early successional communities such as young cottonwood, willow, etc cover 50% of the flood plain. This implies significant lateral movement of the channel. In some areas the channel anastomises: that is, it splits into distributory channels which then rejoin to form the mainstem. Immediately down stream of the mouth of Alder Creek the secondary valley narrows and the river flows through a single channel. Above and below this feature the flood plain is wide with a high density of seasonally active side channels and ground water fed back channels.

These complex channel forms, result in a wide range of stream energy regimes. This is reflected in the river substrate: depending on available energy, it varies between boulder/cobble to fines. The larger particles are noticeably rounded, in contrast to the angular to sub-angular cobbles and boulders in the rivers entering the Yukon River from the unglaciated areas to the south.

The general characteristics of this reach are those of a high bedload mountain river. There are two obvious sources of the bedload. The first is the series of massive slides from the mountain to the south of the mouth of the Little Twelve Mile River. The latest of this series occurred in autumn of 1995 and initially raised fears of massive degradation of the fish habitat of the Chandindu. Monitoring of the site has shown the formation of a relatively stable channel where the Little Twelve Mile flows over the toe of the slide.

The deep deposits of glacial or glacio-fluvial materials forming the bottom of the primary valley comprise the second source of material. Where visible, these materials were massive in form, poorly stratified and composed of poorly sorted materials. Larger particles in the faces of the exposures were well rounded. It appears that, in the erosion of the secondary valley, finer materials were carried out of the system while the large particles remained to form the base of the present channel complexes.

A number of tributaries enter this reach. Principal among them are Thane, Ballerat, Alder and Kentucky Creeks. These generally drain from valleys, which have been incised into bedrock.

Extent of fire – Much of the vegetative cover of the primary valley bottom has burned. The intensity of the burn varies significantly. In some locations, it appeared that the fire had travelled laterally through the shrub layer, leaving the ground surface essentially untouched. In others, the soil itself had burned. Of interest is that the low gradient areas clearly underlain by permafrost were far more likely to be burned than those on thawed ground. Essentially none of the vegetation in the secondary valley had burned between Thane Creek and Ballerat Creek. The fire rarely extended to the riverbank, and did so only where the river was actively eroding into the surface of the primary valley.

The exception to this was observed at the upstream limit of the area observed. Fire had extended to the riverbank in some areas.

The tributaries were not looked at in detail. Looking upstream from the mouths as we flew by, though, suggested that but the effects of the fire were in the narrow valleys were more severe both on the valley floor- and walls.

Effects of fire - Direct effects of the fire on the channel of the Chandindu are expected to be minor, particularly in the lower section of this reach (i.e. downstream of the mouth of Kentucky Creek). Indirect effects may be more significant. There will be three types of indirect effects:

The thermokarst of flat to very low gradient highly ice rich soils, with run-outs to the river.

In these areas soils may liquefy and flow downslope. The majority of the material will not travel far unless it can drain onto a slope of relatively high gradient and considerable length. There is some risk that the land surface near the river will be subject to this and that flows will directly enter the river. If so, there will be a pulse of high turbidity as the finer fraction travels downstream as suspended solids. The sand fraction will be fairly high from releases of this type, and will locally degrade spawning habitats for chinook salmon. The duration of such degradation will depend on the hydrologic conditions at the site and in the river generally. As the ground cover of ice rich areas is usually sparse, only limited amounts of debris will enter the river. The debris will, however, travel well downstream and increase maintenance requirements for the counting weir.

The thermokarst/mass movement of surficial materials from higher gradient areas draining toward the river.

It is likely that there will be earth flows from the higher gradient slopes which comprise, or are located, upslope of the valley walls of the secondary valley. Significant quantities of surficial material are expected to be involved. Most of these materials will probably be coarse (i.e. sand size or larger) and not to move far from the source areas. Fine materials will erode from the surface of the earth flows during precipitation events and will reach the river. Pulses of turbidity in the Chandindu will result.

The mass movement of surficial material into tributary streams in association with direct effects of the fire.

These tributaries tend to have narrow valleys and steep slopes. North facing slopes are almost certainly underlain in places by perma-frost. Earth flows are likely, and may result in the damming of the stream with subsequent bursts of sediment. It is also likely that the earth flows will carry masses of stems, roots, etc downslope and into the creek. Stems and debris carried to the creek by earth flows will add to the vegetation, which has fallen into the creek due to the burning of soil and roots. These riparian stems, many of which will be large in diameter, tend to fall at or near right angles to the stream. This is due to a heavier mass of branches facing towards the creek than away from it. The larger stems will bridge the stream and lock against stems, roots, etc on the opposite side. Smaller debris will pile up against the stems. The flow of the stream will be obstructed to such an extent that a new channel will be eroded in the adjacent forest floor.

The effects on the Chandindu of the mass movements to and down the affected tributaries may be expected to be locally severe immediately downstream of the mouths. The transport of finer material will increase the turbidity of the Chandindu, but levels of suspended sediments will probably only be of concern during high to extreme flows. The complex channel form of the Chandindu River will mitigate this effect to a great extent by providing significant areas and volumes of refuge habitat for fish generally and rearing salmon specifically. The gradient of the Chandindu will transport the majority of the sand particle size downstream or to floodplain storage in a relatively short time (i.e. years rather than decades).

Fine debris will move downstream or will be deposited on the flood plain, where it will soon decompose. Larger debris will generally contribute to the existing logjams on the upstream ends of the many islands. These logjams will generally only move under extreme flows. The increased bed load and the confinement of the channels due to the growth of the existing logjams will increase the rate of lateral channel migration.

Conclusions

The Chandindu River will be affected by the 1999 forest fires. Sediment transport will increase, with the following effects. Increased wash load, the very fine clay fractions that do not settle out easily, will result in an increase in turbidity. This will have a minimal effect on fish habitat, although it may both negatively (through reducing the weir operator's ability to see the salmon) and positively (through reducing the salmon's chance of seeing the weir operators) affect the operation of the counting weir. Suspended sediment and bed load, which are composed of sediment particles which are more coarse than those of wash load, will have a greater effect on salmon habitat, as they may become deposited on or within the substrate. This will result in some local degradation of chinook salmon) spawning habitats. It may also affect summer chum, if such fish are present and if the Alaskan spawning model (open channel, no orientation to ground water) is accepted. Fall chum spawning should not be negatively affected due to their reliance on ground water. Effects to rearing chinook salmon at current stock sizes will be largely mitigated by the vertical and lateral complexity of the channels within the Chandindu flood plain.

There will be an increase in debris loading as stems, branches, shrubs, roots, tussocks etc are deposited to the creek. This will result in an increase in the maintenance requirement for the fence operators. Source areas for large debris are generally well upstream of the counting weir. Existing logjams at the upstream ends of existing islands and bars will capture most large debris. The large jams will probably only move under extreme flow conditions.

There is a slight chance of mass movements from the eastern slope immediately upstream of the weir. This slope should be monitored for surface deformation. If deformation is noted, DFO HEB staff should be consulted.

It is my opinion that the increased risks to the overall program component of the YRCFA/TDH restoration program – that is, the restoration of salmon stocks in the Chandindu River basin – are in no way so severe that it should be abandoned should be abandoned. The Chandindu remains a valid restoration opportunity.

The risks to the weir have increased, but this may be largely mitigated by planning for increased maintenance. Current staffing strategies should be continued. The Chandindu is a large river: at 1680 square kilometres (and no lake storage/buffering), it probably approaches the upper limit of watercourses for which seasonal conduit-based counting weir may be used. The maintenance of the weir will require able, skilled and motivated personnel.

There is some increased risk of extreme summer flows resulting in high volumes of stems and root wads proceeding downstream. If this occurs, the weir will almost certainly be breached and some of the weir material destroyed. Consideration may be given to having a large supply of spare weir material on site. A measure of protection may be afforded the collection chamber by cabling in a stiff leg upstream to deflect any floating debris etc to the centre of the stream. This would have to either be done in such a manner that it did not affect the movement of the fish, or only deployed during high water.

Equipment should also be on site in subsequent years to deal with large debris: this includes a chain saw winch, choker cables, chain, and peaveys. Use of this equipment is hazardous. Weir staff should be adequately trained, and contingency planning in place to deal with the type of injury which may occur.

LICENCE AUTHORIZING FISH COLLECTION FOR SCIENTIFIC PURPOSES

Pursuant to Part VII of the Fisheries(General) Regulations
Yukon & Transboundary Division
Fisheries and Oceans Canada
PHONE (867) 393-6722
FAX (867)393-6738

License No. CL99-42 Date Issued: June 30, 1999

License Holder: Jake Duncan

Company/Institution: Yukon River Commercial Fishing Association/TDH

Address: Box 844
Dawson City, Yukon
YOB IGO

Assistants: to be determined

The following conditions will apply to this permit:

1. Collection Period: June 30- September 30, 1999. This permit is subject to immediate termination upon written or verbal notice from a representative of Fisheries and Oceans Canada.

2. Species (Quantity): Adult chinook salmon, all other species to be released unsampled.

Collection Area: Chandindu River, tributary of the Yukon River

Collection Methods: Weir for livesamples and spears or gaffs etc. for post-spawning fish or carcasses. The sampling permitted under this license shall include: age-scales, sex determination, length, and condition. The project authority is to advise Patrick Milligan if there is a problem with respect to chinook salmon moving through the weir (ie fish held up), high water temperatures (16o C+), or if there are significant mortalities occurring during sampling activities or in areas below the weir. If the fish hold for a protracted period of time below the weir, the sampling will be reduced or curtailed; reducing sampling actives will be left to the discretion of the crew members.

Notice: One of the following employees of the Department of Fisheries and Oceans must have prior notice of your intended operation in their area.

Patrick Milligan Stock Assessment Biologist, DFO.
Phone (867) 393-6720 (Office)
Phone (867) 668-4694 (Home)
Fax: (867) 393-6738

Or

Adrian Sturch Fishery Officer, DFO
Phone: (867) 393-6727
Fax: (867) 393-6738

Need to carry and produce permit: A copy of this permit shall be stored in the camp, and must be produced upon the request of any representative of Renewable Resources (Government of Yukon) or of the Department of Fisheries and Oceans.

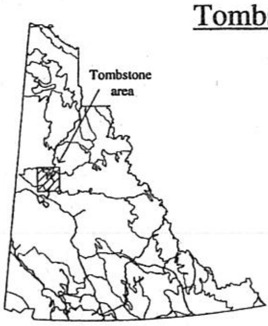
7. Summary: A summary describing the sampling activities, including the dates and times of sampling, the overall success of the sampling and any other relevant details must be submitted to:

Fisheries and Oceans Canada
Suite 100, 419 Range Road
Whitehorse, Yukon
Y1A 3V1

by September 30, 1999.

Patrick Milligan
Stock Assessment Biologist
Fisheries and Oceans Canada
Suite 100, 419 Range Road
Whitehorse, Yukon
Y1A 3V1

Tombstone Territorial Park Study Area



Map of Yukon showing Tombstone area, ecoregion borders (green) and highways (red)

Scale 1:400,000 1cm to 4.0Km.

Yukon
Renewable Resources
Protected Areas Secretariat

LEGEND

- Study Area 2
- Core Area
- Study Area 1
- Highway
- Ecoregion
- Historic Trail
- Campground

Digital Data Sources

Base Maps:

National Topographic Database files
compiled by Natural Resources Canada at 1:250,000 scale (NAD 83).

Ecoregion Boundaries
compiled by Agriculture and Agri-Food Canada at 1:1 million scale.

The Department of Renewable Resources is not responsible for the accuracy of data obtained from other agencies.

Digital map compiled with MapInfo GIS version 4.1 - April 24 1997

Map current as of February 24, 1999