PACIFIC REGION TECHNICAL NOTES

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The 1982 Nechako River Forecast Program

Earl Zilke, Officer-in-Charge
Prince George Weather Office

INTRODUCTION

During the summer of 1982 (July 6-Aug. 20) the Prince George Weather Office, at the request of the Department of Fisheries and Oceans, participated in a program of issuing 1 to 5 Day forecasts for the Nechako River drainage area. The purpose of these forecasts was to aid in the International Pacific Salmon Fisheries Commission (IPSFC) in it's advice to the Department of Fisheries and Oceans who were planning to order the Aluminum Company of Canada (ALCAN) to increase the flow from the Nechako Reservoir if it became necessary. The flow regulates or determines the water temperature of the river. Numerous detailed studies have show that water temperature is probably the most important factor in determining the spawning success rate of salmon in this river (Ref. Saxvik, Salmon Studies Associated with Potential Kemano 2 Hydro-electric Development, Vol. 2, Feb./79) (See maps Figures 1 and 2).

BACKGROUND

This same basic program was run for the 1981 season by the Pacific Weather Centre. It was fairly successful but apparently some forecast biases became evident from the verification. These biases resulted in some cases of increased flow rates that were excessive to maintain the critical temperature. It was felt that the forecasts could be improved if the Prince George Weather Office would make some local adjustments to the product. This was found to be the case. Of the 58 adjustments made to the PWC forecasts, the provided values of 48 were closer to their respective recorded parameters. Eight adjustments made the forecast less accurate. Throughout the program the team approach was stressed with frank discussions rather than any competition between PWC and Prince George Weather Office (YXS). For this reason, other than the above, no comparison was considered meaningless since experience and expertise gained from last season's program would distort the relationship.

ECONOMIC SIGNIFICANCE

Approximately 30% of the Fraser River salmon production results from salmon that have migrated up the Nechako River. The sockey alone had an estimated net value of over $5 million in 1976, the lastest year for which data is available. On the other side of the economic coin the amount of water impounded in the Neckako Reservoir system, and hence the hydro-electric generating potential, determines the production rate possible by ALCAN at their Kitimat plant. It is therefore imperative that the water temperature

be controlled below the critical mark with the minimum flow possible. The forecast and hence the flow control program could have a significant impact on both industries. Because of the financial aspects, ALCAN was reluctant and in fact on at least one occasion refused, to spill the water required to maintain the necessary flow. After a lengthy and very involved hearing Justice Berger ruled that ALCAN, "must comply with the Department of Fisheries and Oceans demand for any increase in flow".

CONSEQUENCE OF ERROR

A water temperature of 20°C has been found to be the critical value in the prespawning mortality rate. A very small temperature increase has been found to have very dramatic effects. For example, few sockeye have been observed to reach the spawning grounds when the mean temperature reaches 21°C. A temperature increase from 15°C to 25°C has been found to increase the metabolic rate of adult salmon by 53%. The body energy reserves are utilized at a higher rate and also the fatality rate from inherent diseases increase markedly with correspondingly higher temperatures. One study concluded that energy expenditure of some runs was nearly 80% of the maximum rate they could maintain, leaving little margin for any emergency demand on their energy stores.

THE PROGRAM

Meteorological factors affecting stream temperature include, in descending order of significance; water-air temperature differential, cloud cover (radiation) wind speed, precipitation, relative humidity, and atmospheric pressure (vapour pressure). IPSFC (Saxvik) developed a computer model and program to forecast the stream temperature by inputting the Day-1 to 5 forecast values for the various parameters.

The following approximate schedule and procedures were established for the program. The PWC Forecasting Supervisor would call YXS at 0845 with forecast values for temperature, cloud cover, wind, relative humidity, and sea level pressure. These values were discussed with the OIC when available or the Duty Technician in conjunction with the various forecasting aids. Some adjustments were made at this time. At 0930 the IPSFC observer phoned in climat data from the four control stations located along the Nechako drainage (Figure 2). A further evaluation was made of the forecasts in light of the climat data, considering geographical efffects, weather system timing, and direction of motion, etc. If considered necessary, further adjustments were made at this time. We then added the forecast radiation and station pressure values. The pressure values were forecast by starting with the PWC forecast sea level pressure and applying barometric correction tables and the forecast temperatures. No corrections were applied for pressure differences over the area. The radiation values were forecast by using the forecast cloud cover and applying a table of daily possible radiation (Saxvik, 1979) and the normal temperature correction. A cloud cover versus incoming radiation table had been derived by using past records of cloud cover and radiation records. A 10% reduction was applied to all

forecast radiation values because of the valley aspect. Verification was possible since YXS has a pyranometer and Envirocon had a similar unit at their Ft. Fraser Weather Station.

Mr. Saxvik usually phoned daily around 10 a.m. for the forecast and a general discussion. Verification graphs and tables were done daily as the information became available from the various weather reporting points. Copies of the tables and a Day-1 versus Day-5 table are attached (Figures 3 to 8).

VERIFICATION

Contingency tables as usually applied to forecast verifications have been taken a step further since we were more interested in the degree of accuracy. Tables are for Day-1, 3, and 5 only and are observed data versus forecast error. Because of the large range in the radiation values the tables are observed values versus the error expresssed as a %. Wherever possible the observed data from the IPSFC weather stations was used in the tables. When their data was not available or doubtful, YXS figures were inserted.

RESULTS

The program ended earlier than planned. A period of cool, wet weather in mid-August increased the flow and cooled the water temperature making the forecasts superfluous for the September salmon run. One run in early August had an extremely high mortality rate. Due to high water in the Fraser River the salmon simply ran out of time and energy and in addition, because of the high water, they diverted into side creeks and pools to rest where the warmer water also increased disease mortality. Some estimates of the successful spawners were placed at well under 5,000 out of the 50,000 that started the trip in that particular run. The limited number of spawners in turn made the accuracy of the forecasts even more critical.

CONCLUSION

Overall the program would have to be considered fairly successful. Day-1 and 2 forecasts were within the realm of our abilities. Unfortunately Day-3 to 5 conditions are more significant in the program but dramatic weather changes in this time frame tended to be underforecast. We have no way of knowing if this was a problem with the machine guidance or a reluctance on the part of PWC to accept the indicated values. Since a IPSFC report has not been received to date we cannot assess the ultimate significance of this fault or rate the true effectiveness of the overall program.

This program will not be operated in 1983 since ALCAN has plans to maintain a flow schedule that will provide the necessary water rather than have the uncertainties of past years.

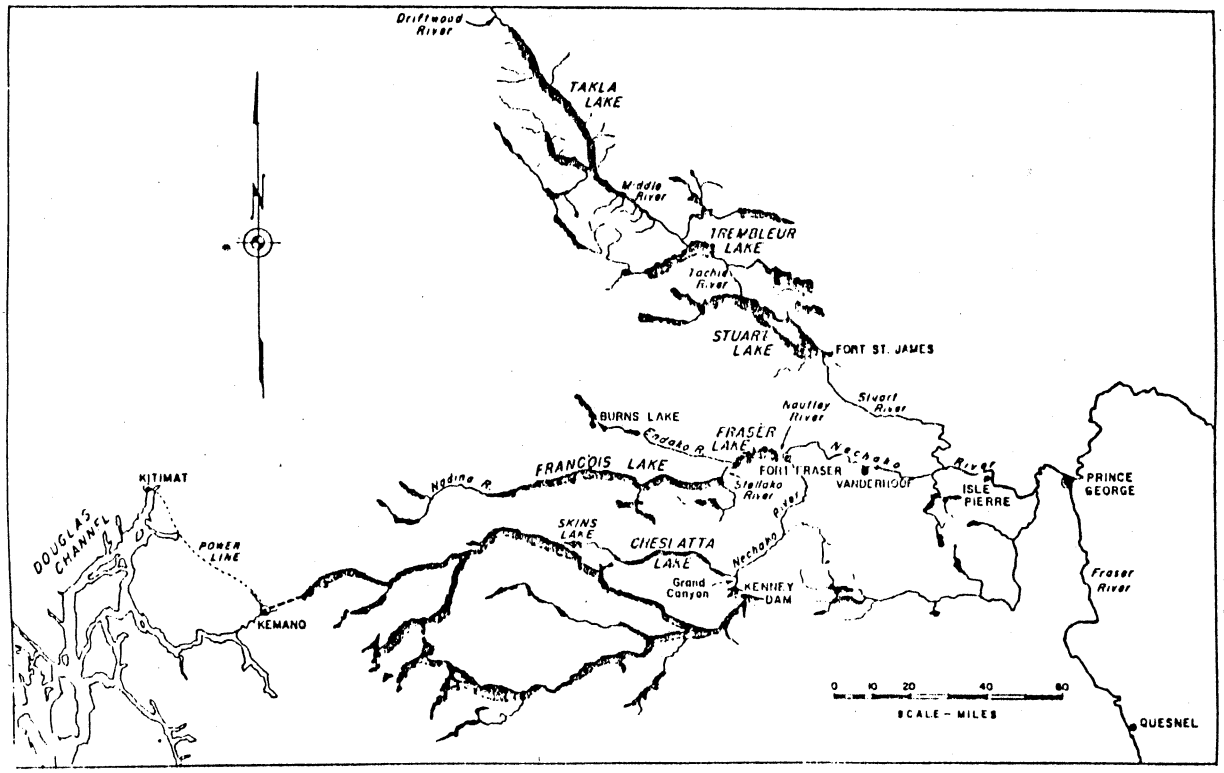
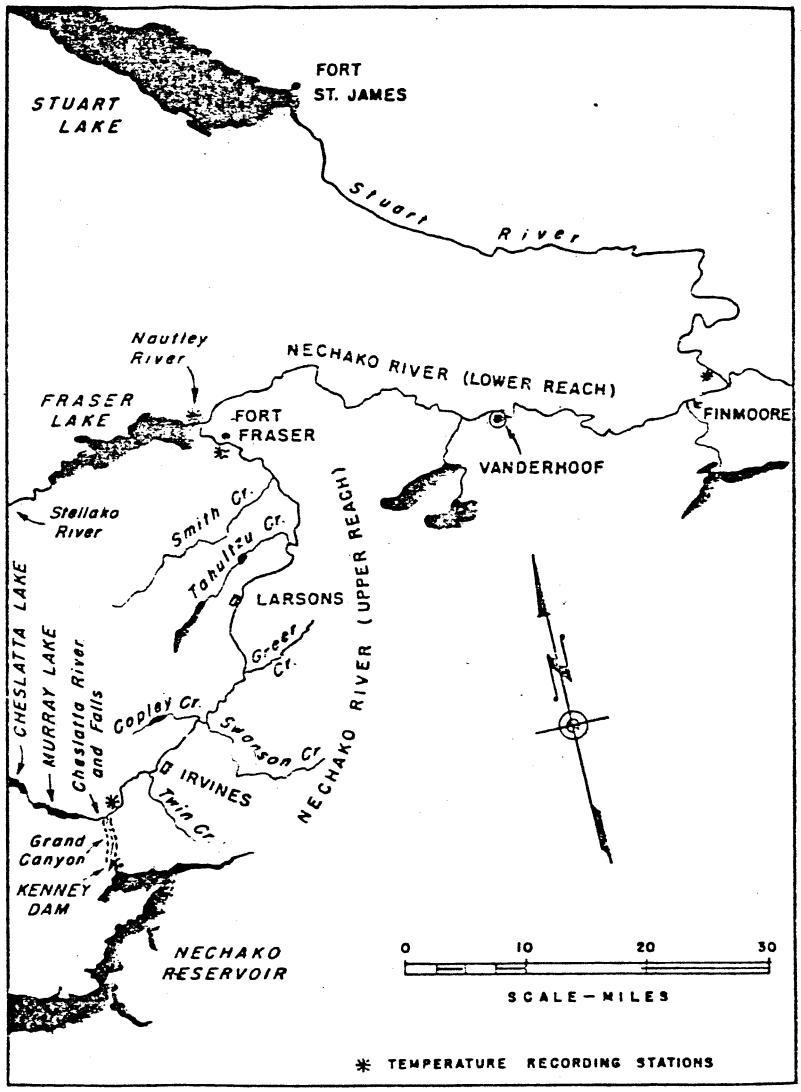


Figure 1. Nechako River watershed, showing the existing hydroelectric diversion to Kemano.

Fig. 1



Nechako River temperature study area.

Fig. 2

FIGURE 3

Day-1 versus Day-5 Forecast Accuracy

TEMPERATURE

	Day-1	Day-5
Within 1°C	59%	26%
2°C	82%	51%
3°C	100%	79%
4°C	-	85%
5°C	-	92%

RADIATION

	Day-1		Day-5	
	YXS	ENVIROCON	YXS	ENVIROCON
Within 10% of recorded	48%	40%	50%	44%
20%	78%	62%	76%	61%
30%	85%	80%	85%	78%

WIND

	Day-1	Day-5
Within 1 km/h	42%	31%
2 km/h	55%	44%
3 km/h	66%	53%
4 km/h	79%	69%
5 km/h	82%	75%
More than 5 km/h off	18%	25%

RELATIVE HUMIDITY (YXS)

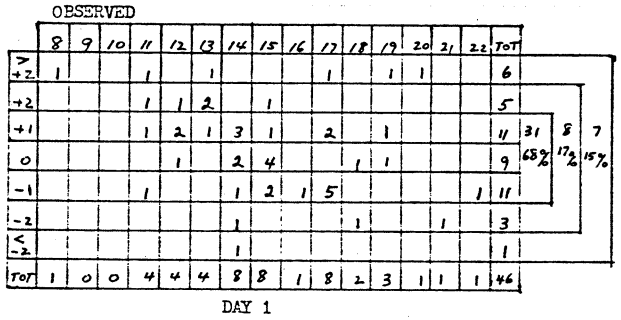
	Day-1	Day-5
Within 5% of observed	38%	37%
10%	85%	56%
More than 10% off	15%	44%

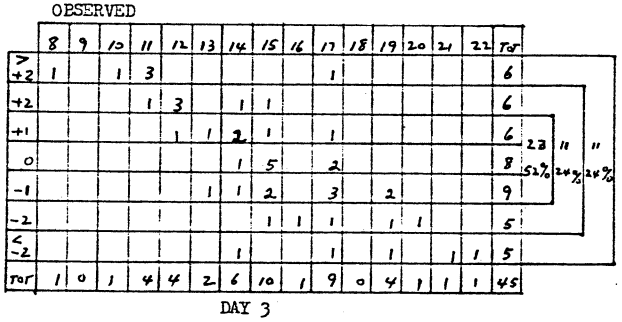
PRESSURE (YXS)

	Day-1	Day-5
Within .1 kpa	63%	16%
.2 kpa	85%	29%
.3 kpa	92%	42%
.4 kpa	96%	58%
.5 kpa	100%	61%
More than .5 kpa off	-	36%

TEMPERATURE FORECASTS

DAY 1 vs DAY 3 vs DAY 5





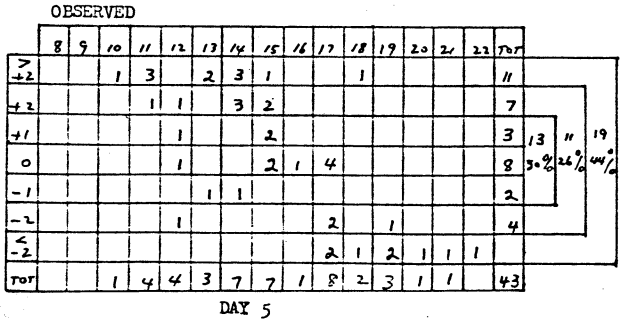
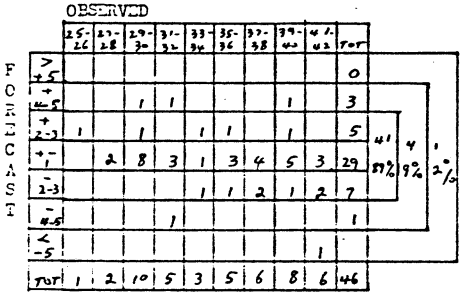
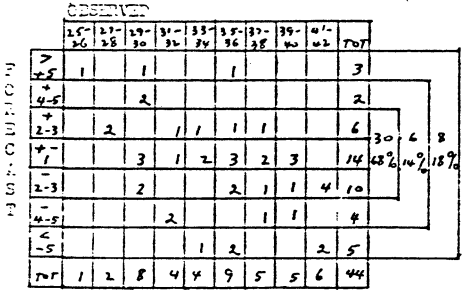


Fig. 4

ATMOSPHERIC PRESSURE kPa (digits & tenths)

DAY 1 vs DAY 3 vs DAY 5





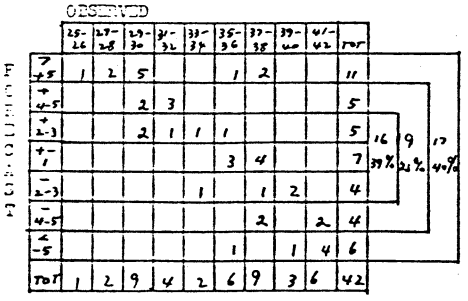
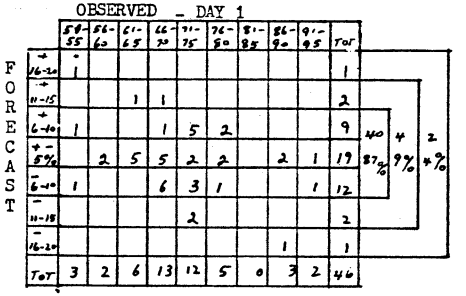
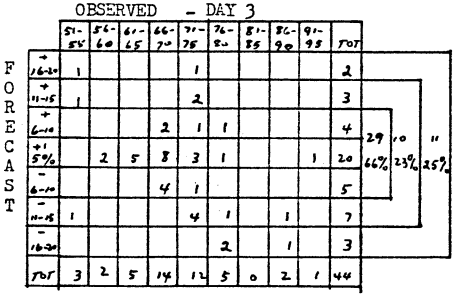


Fig. 5

RELATIVE HUMIDITY (%)

DAY 1 vs DAY 3 vs DAY 5





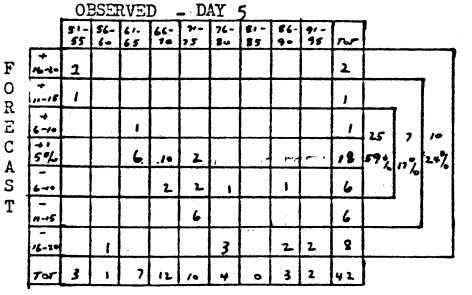


Fig. 6

RADIATION (Langleys)

DAY 1 vs DAY 3 vs DAY 5

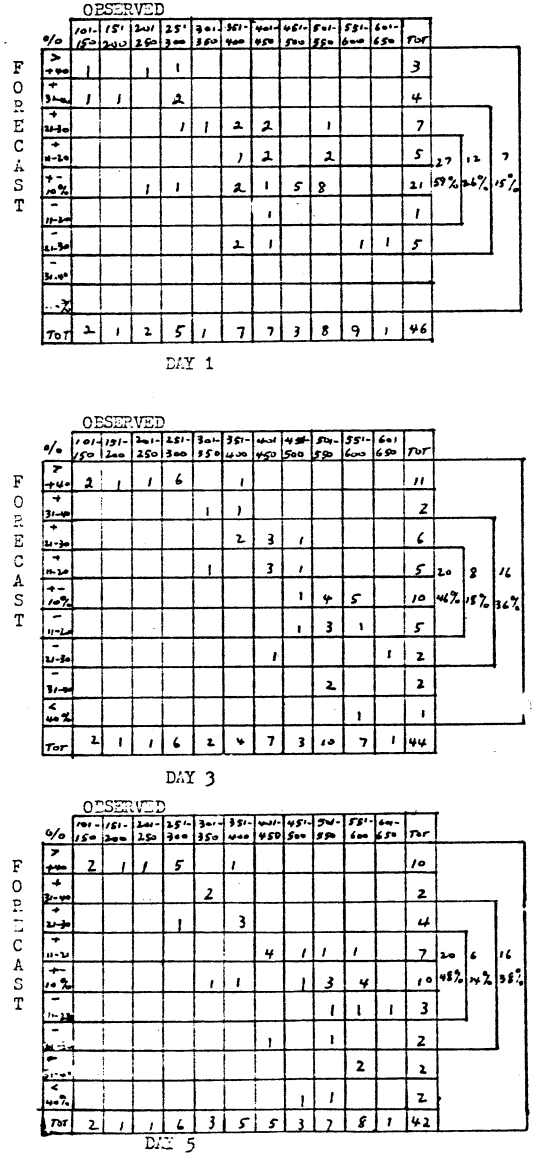


Fig. 7

WIND SPEED (Km/h)

DAY 1 vs DAY 3 vs DAY 5

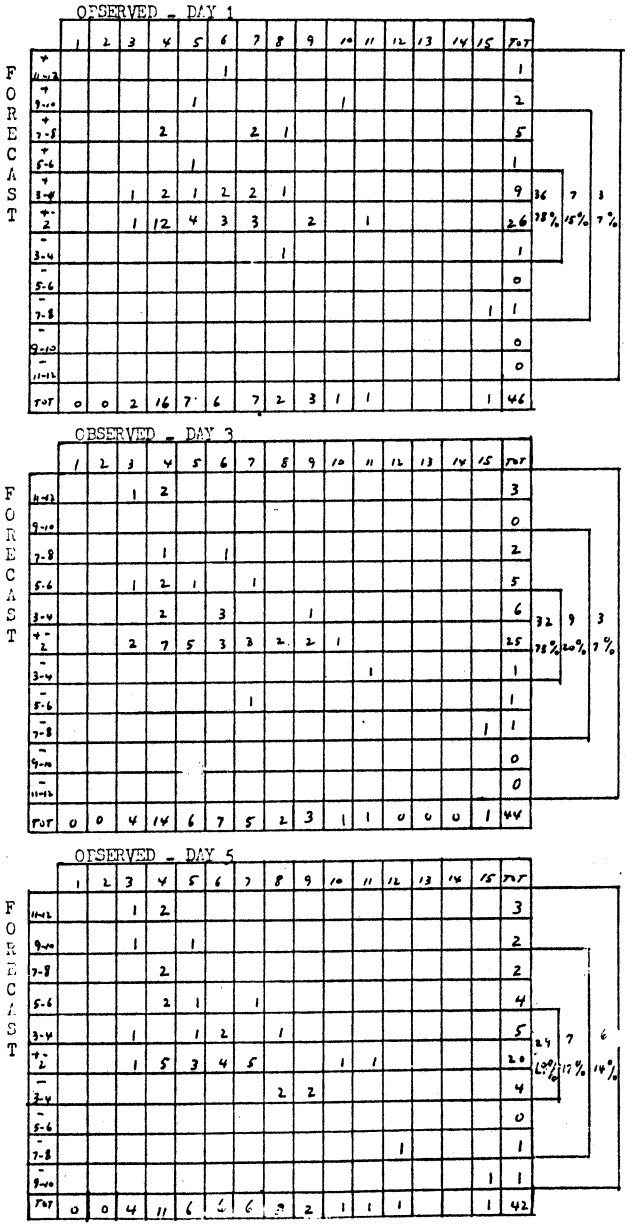


Fig. 8