INSTREAM TEMPERATURE MODELING AND FISHERY IMPACT ASSESSMENT FOR THE PROPOSED SUSITNA HYDROELECTRIC PROJECT

William J. Wilson
Michael D. Kelly

Arctic Environmental Information and Data Center
University of Alaska
707 A Street
Anchorage, AK 99501
(907) 279-4523

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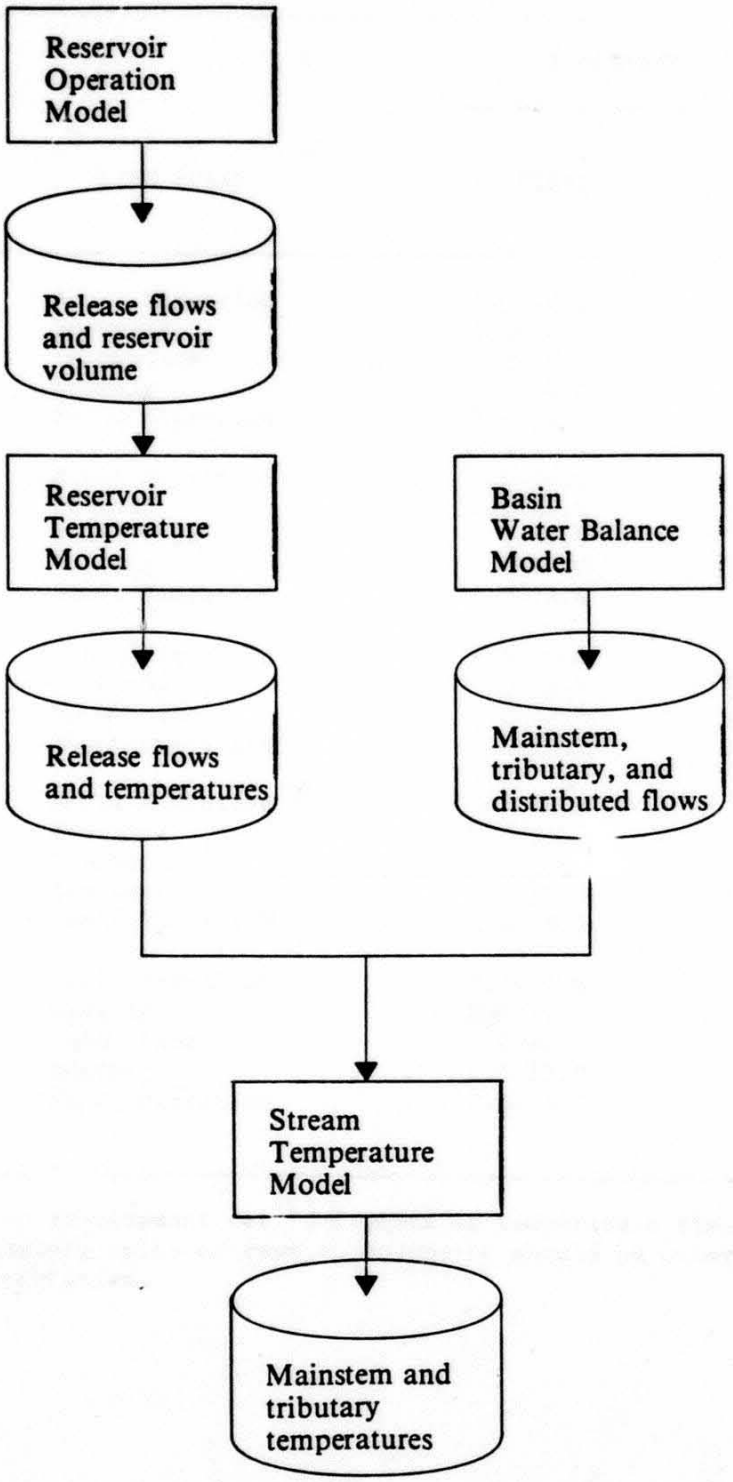
To predict natural and with-project temperature regimes downstream from the Watana and Devil Canyon reservoirs of the proposed Susitna Hydroelectric Project, a Stream Network Temperature Simulation Model (SNTEMP) was employed. This model, developed by the U.S. Fish and Wildlife Service's Instream Flow and Aquatic Systems Group, requires hydrology, meteorology, basin topography and stream geometry data as input and computes heat flux relationships and transports heat through the river system. This first application of SNTEMP in Alaska is allowing fishery biologists opportunity to examine the thermal effects of many potential Susitna reservoir operating schedules on fishery resources. Various combinations of meterological/hydrological conditions were used to simulate downstream river temperatures for natural, reservoir filling, and both one and two-dam operational scenarios. Thermal preference and tolerance criteria were developed for the five Pacific Salmon species inhabiting the Susitna River, and these SNTEMP predictions are compared to the various life phase temperature criteria.

These simulated temperatures show cooler conditions will exist in the river from May through August and warmer water September through April. These altered temperatures are still within the temperature criteria established for Susitna River salmon and in most cases should not significantly impact the resource. However, two significant events could occur from the altered temperature regime: 1) Improved mainstem incubation habitat due to warmer winter water temperatures and 2) Decreased juvenile growth from colder summer water temperatures.

SNTEMP Features

- built in regression model for filling incomplete data sets
- monthly variable topographic shading
- inflowing groundwater temperature prediction model
- time variable temperature and humidity lapse rates for transfering observed data throughout a basin
- adjustable period temperature predictions

Linked Simulation Models

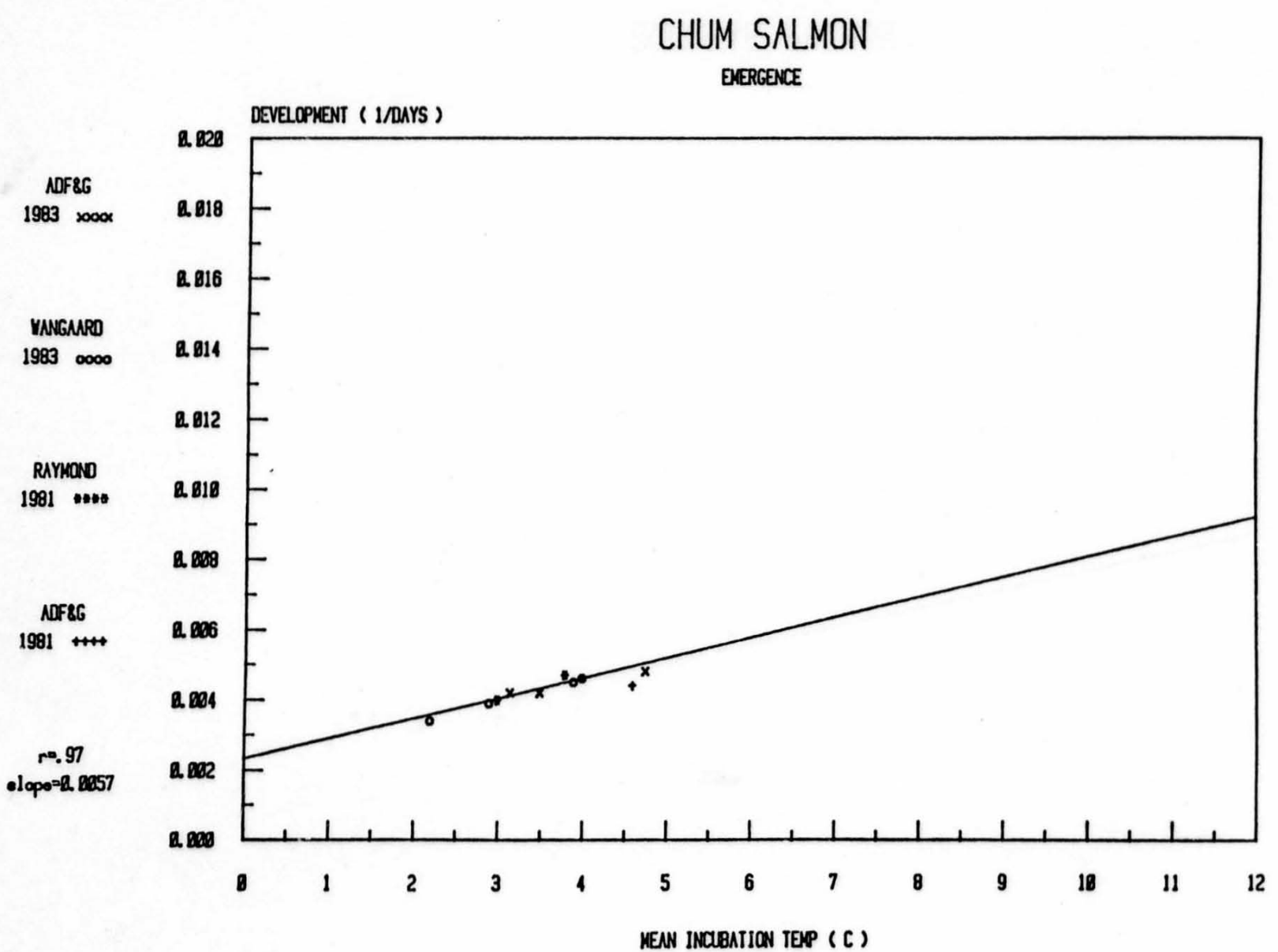


Preliminary salmon tolerance criteria for Susitna River drainage.

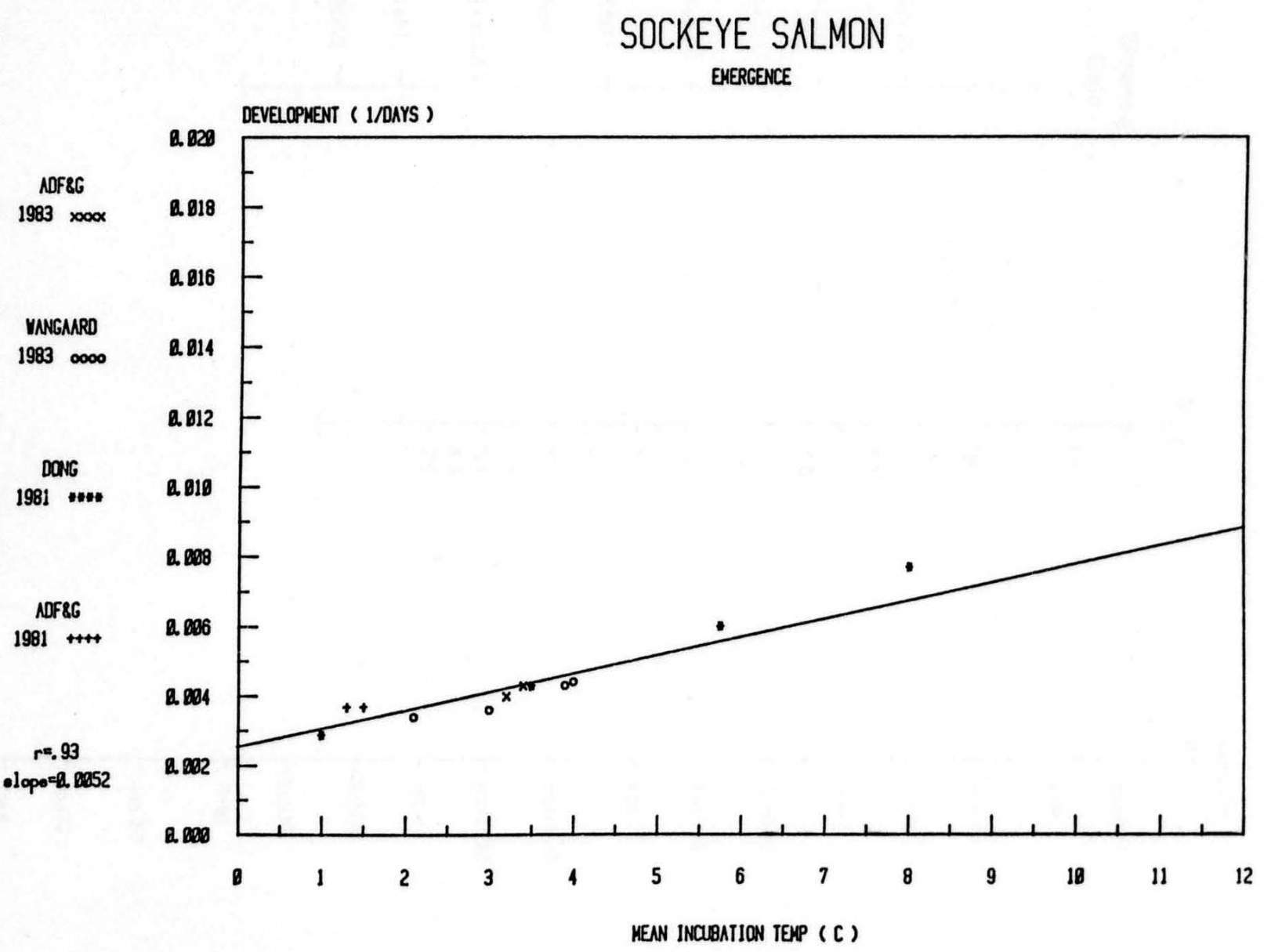
SPECIES	LIFE PHASE	TEMPERATURE RANGE (C) TOLERANCE	PREFERRED
Chum	Adult Migration	1.5-18.0	6.0-13.0
	Spawning	1.0-14.0	6.0-13.0
	Incubation[1]	0-12.0	2.0- 8.0
	Rearing	1.5-16.0	5.0-15.0
	Smolt Migration	3.0-13.0	5.0-12.0
Sockeye	Adult Migration	2.5-16.0	6.0-12.0
	Spawning	4.0-14.0	6.0-12.0
	Incubation[1]	0-14.0	4.5- 8.0
	Rearing	7.0-16.0	7.0-14.0
	Smolt Migration	4.0-18.0	5.0-12.0
Pink	Adult Migration	5.0-18.0	7.0-13.0
	Spawning	7.0-18.0	8.0-13.0
	Incubation[1]	0-13.0	4.0-10.0
	Smolt Migration	4.0-13.0	5.0-12.0
Chinook	Adult Migration	2.0-16.0	7.0-13.0
	Spawning	5.0-14.0	7.0-12.0
	Incubation[1]	0-16.0	4.0-12.0
	Rearing	2.0-16.0	7.0-14.0
	Smolt Migration	4.0-16.0	7.0-14.0
Coho	Adult Migration	2.0-18.0	6.0-11.0
	Spawnig	2.0-17.0	6.0-13.0
	Incubation[1]	0-14.0	4.0-10.0
	Rearing	2.0-18.0	7.0-15.0
	Smolt Migration	2.0-16.0	6.0-12.0

[1] Embryo incubation or development rate increases as temperature rises. Accumulated temperature units or days to emergence should be determined for each species for incubation.

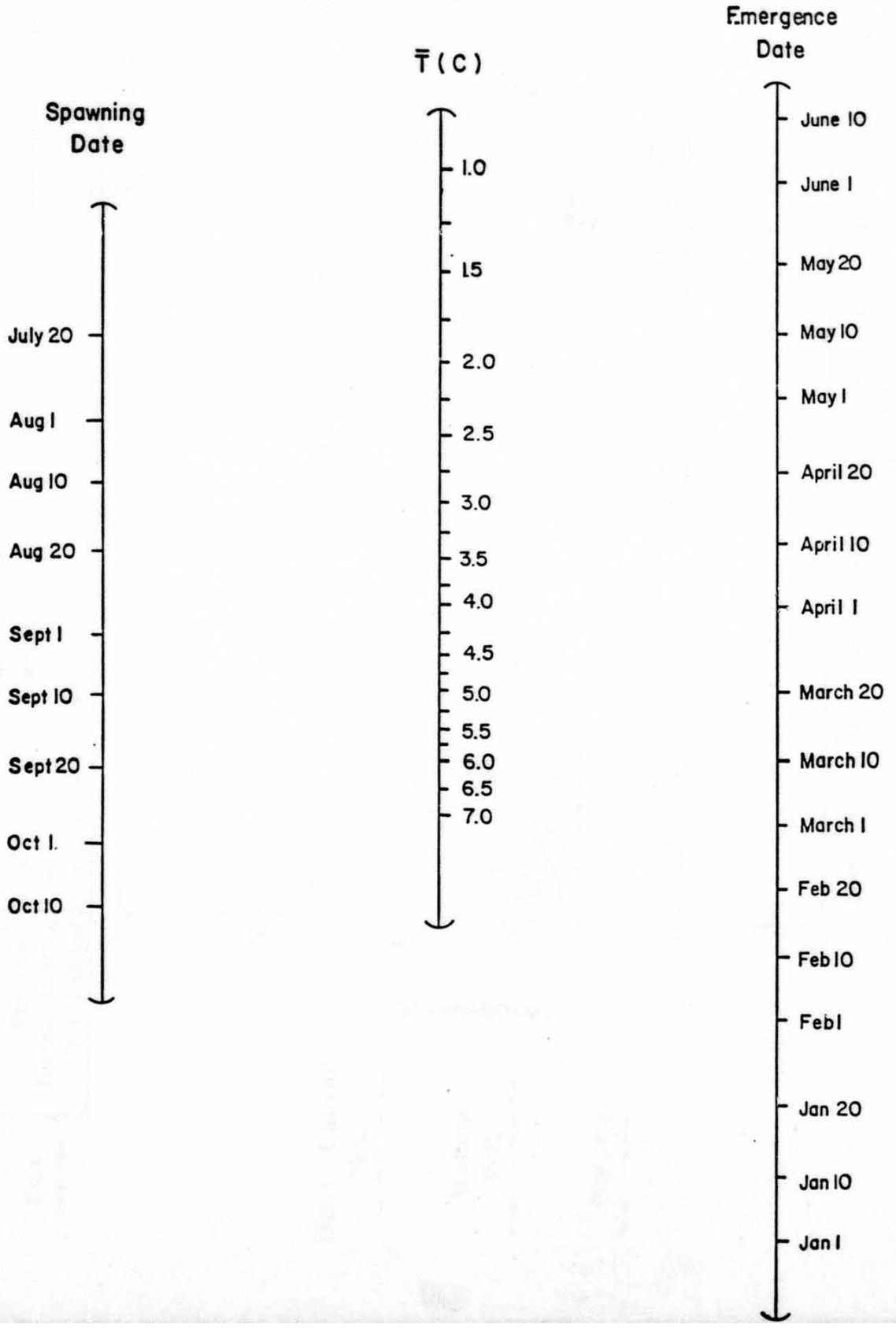
Development time to emergence versus mean incubation temperature for chum salmon.



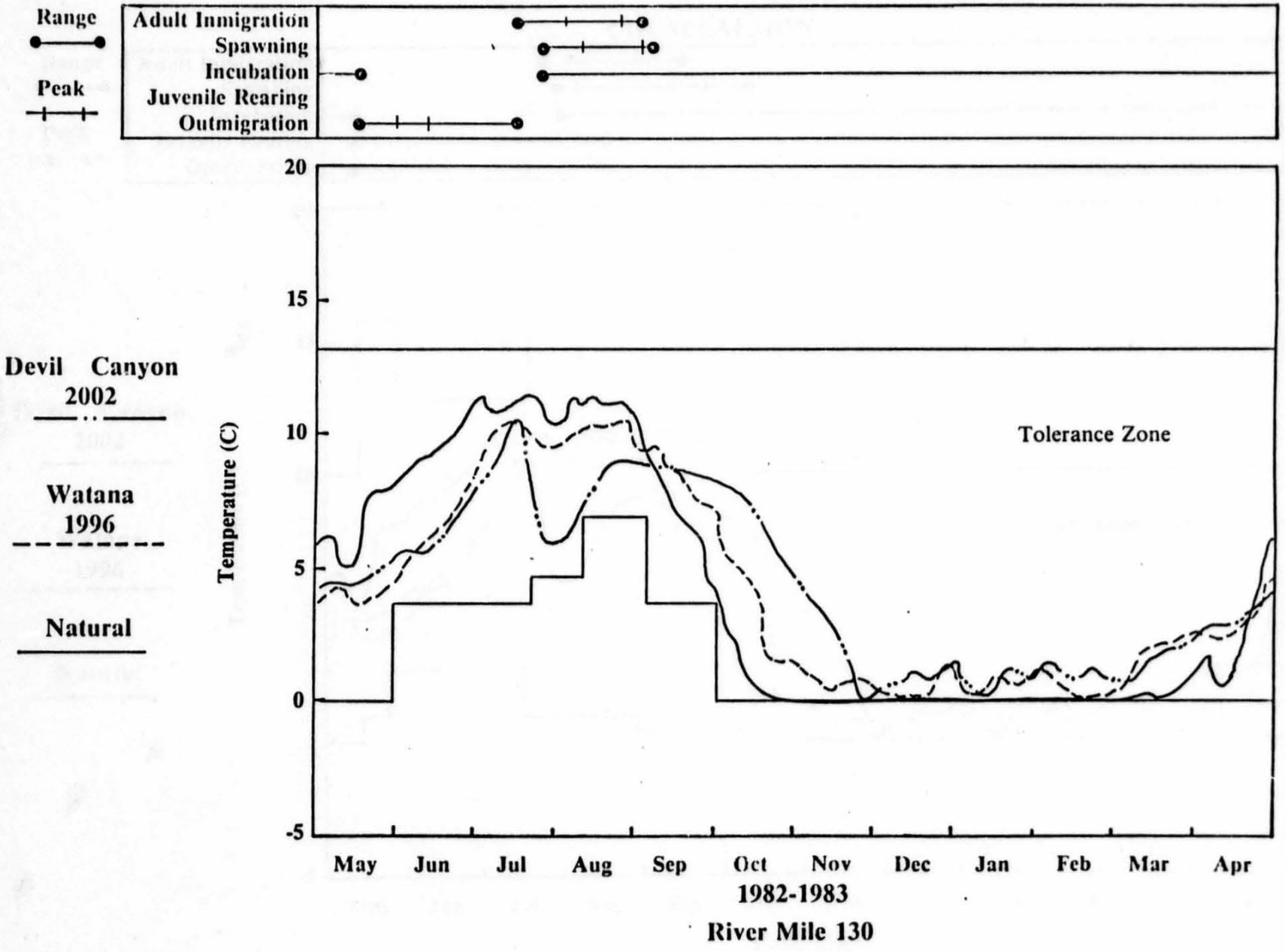
Development time to emergence versus mean incubation temperature for sockeye salmon.

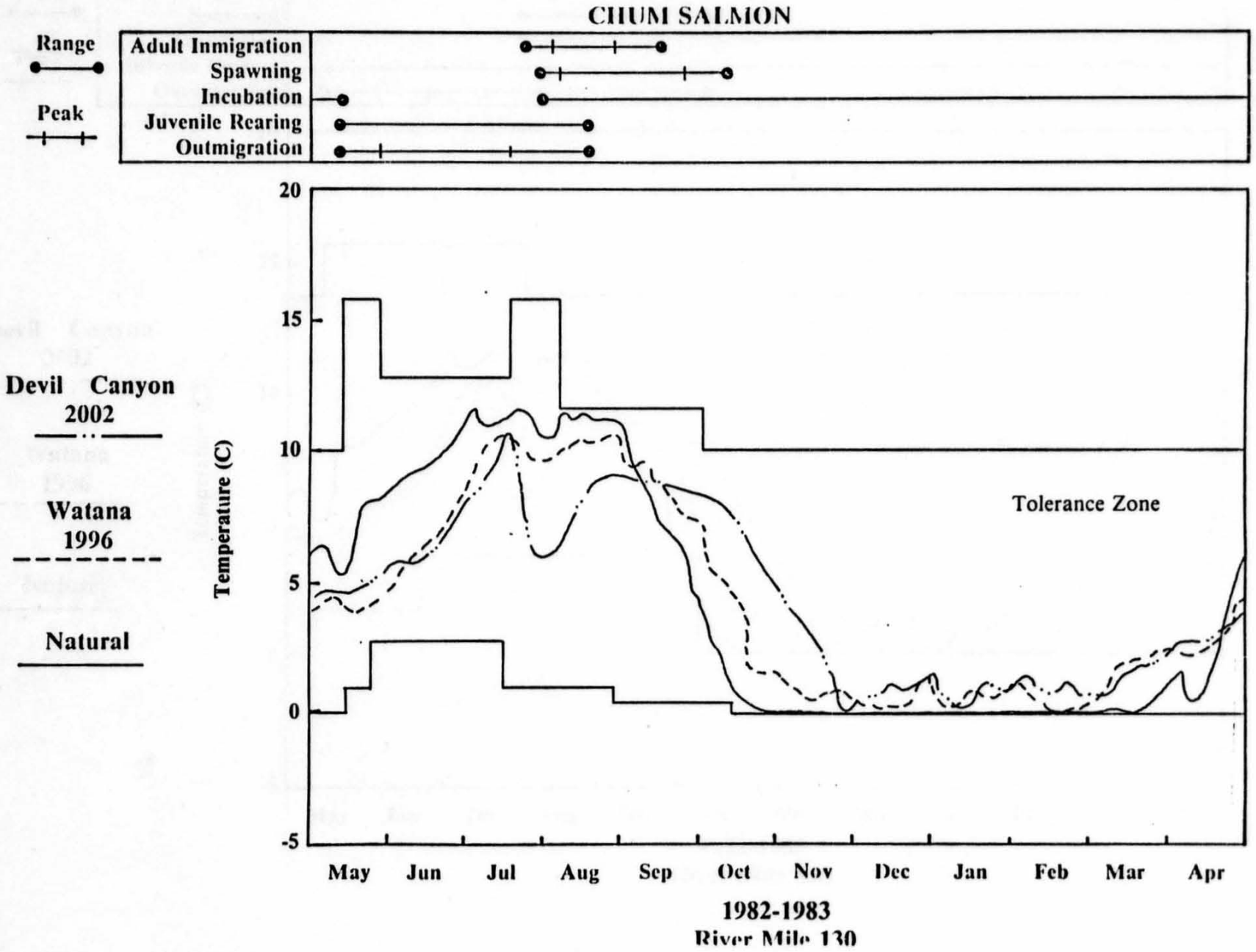


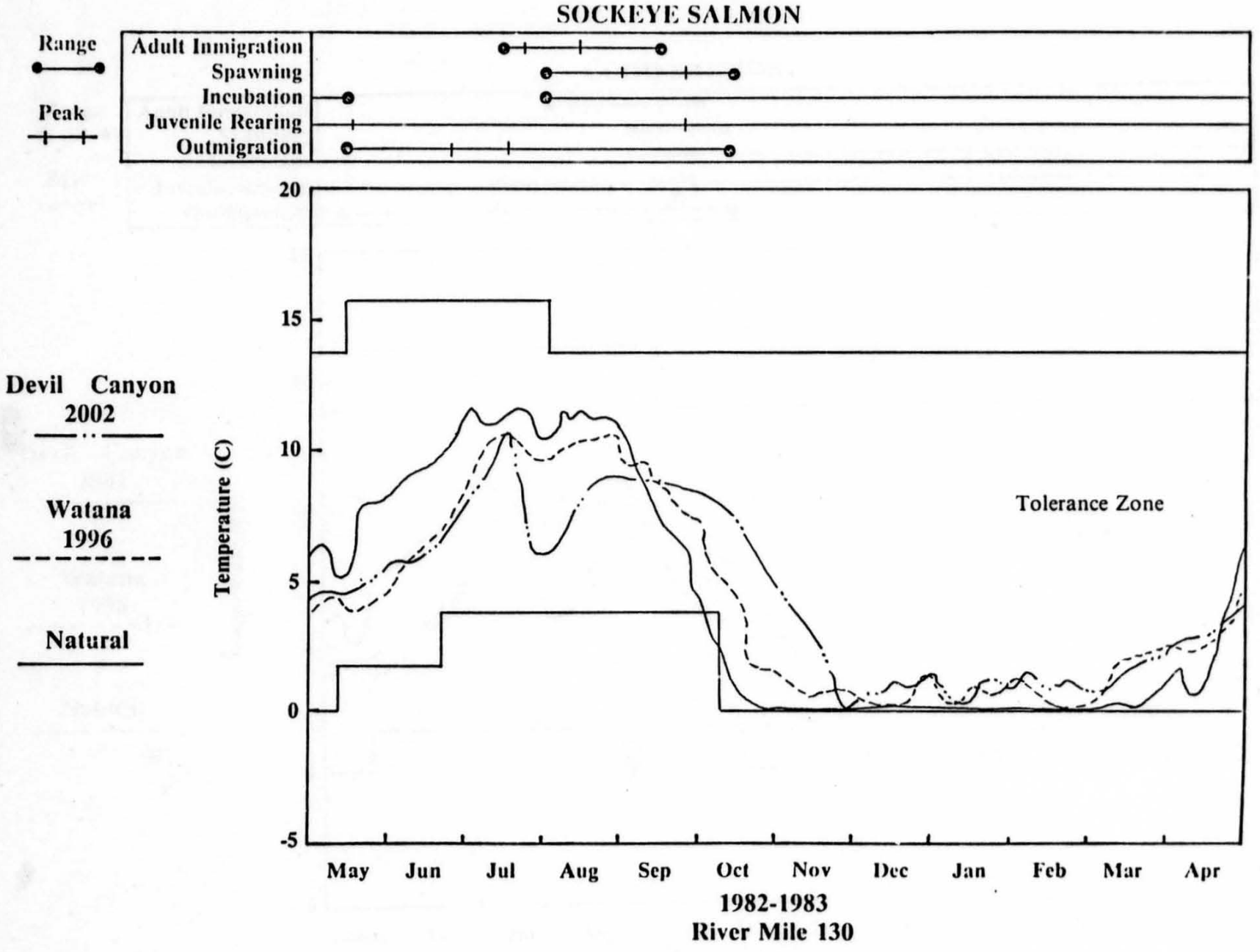
Chum salmon spawning time versus mean incubation temperature nomograph.

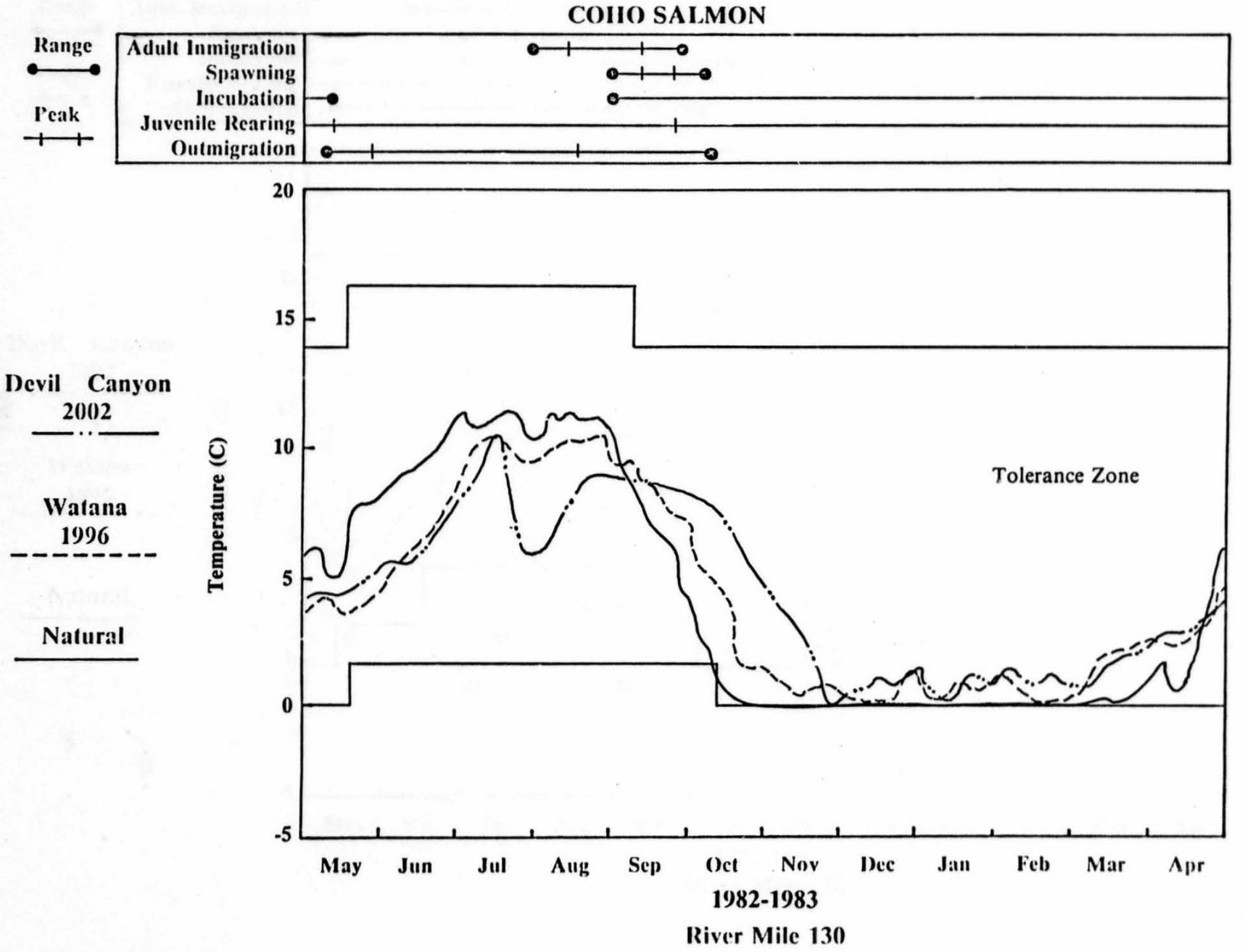


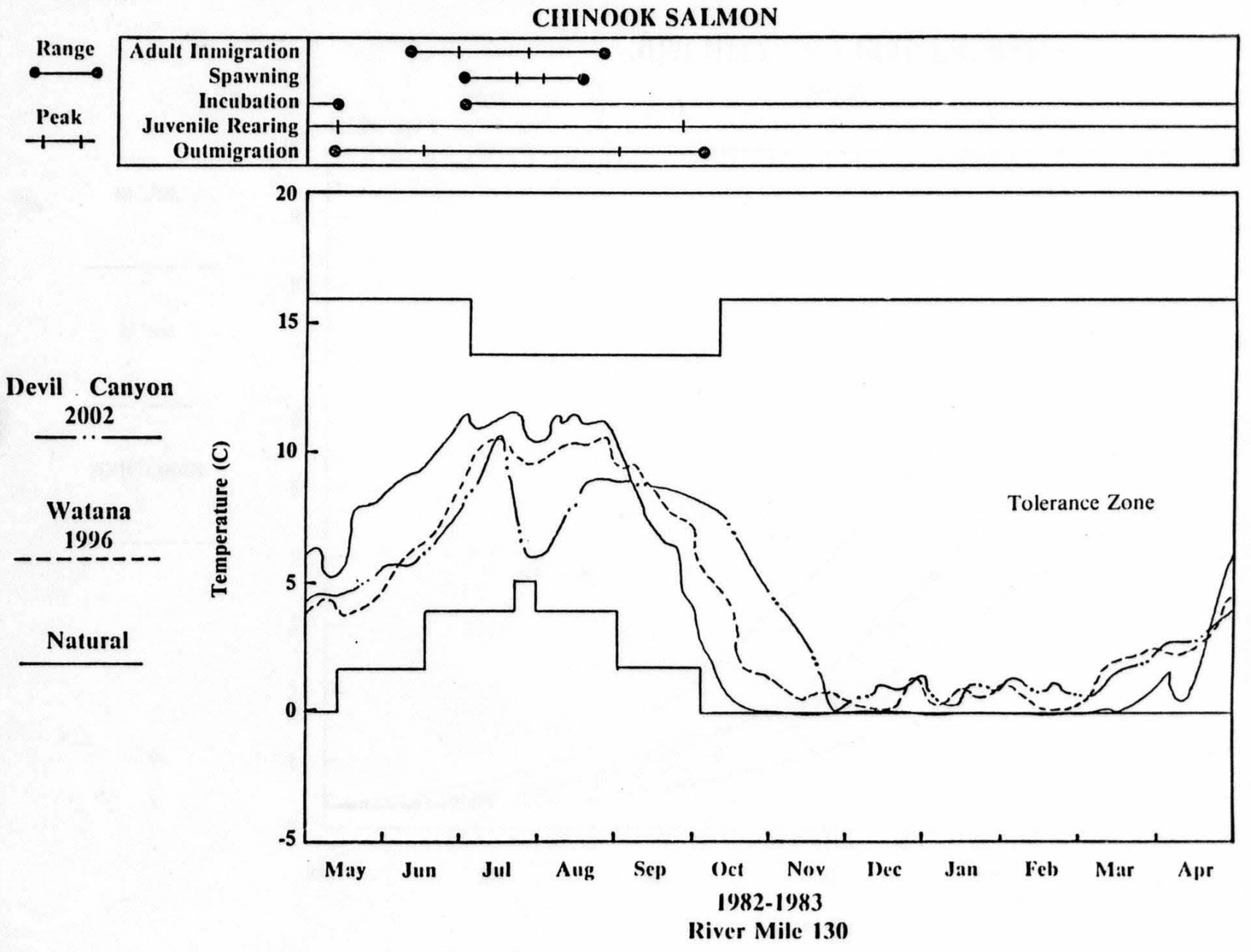
PINK SALMON


Range
Peak
Adult Immigration
Spawning
Incubation
Juvenile Rearing
Outmigration
Devil Canyon
2002
Watana
1996
Natural
Temperature (C)
20
15
10
5
0
-5
Tolerance Zone
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
1982-1983
River Mile 130

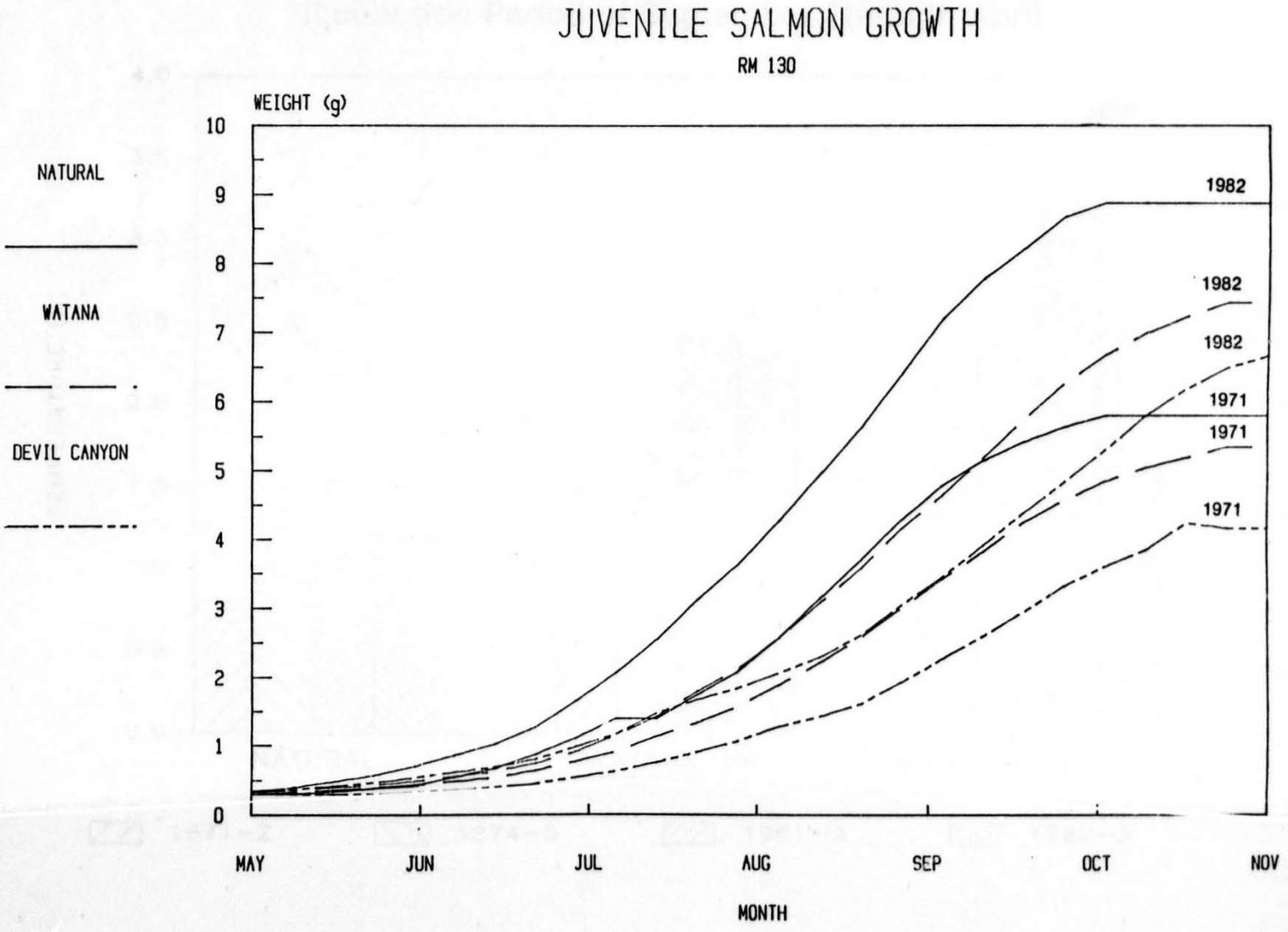

CHUM SALMON
Range
Peak
Adult Inmigration
Spawning
Incubation
Juvenile Rearing
Outmigration
Devil Canyon
2002
Watana
1996
Natural
Temperature (C)
20
15
10
5
0
-5
Tolerance Zone
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
1982-1983
River Mile 130


SOCKEYE SALMON
Range
Peak
Adult Immigration
Spawning
Incubation
Juvenile Rearing
Outmigration
Devil Canyon
2002
Watana
1996
Natural
Temperature (C)
20
15
10
5
0
-5
Tolerance Zone
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
1982-1983
River Mile 130

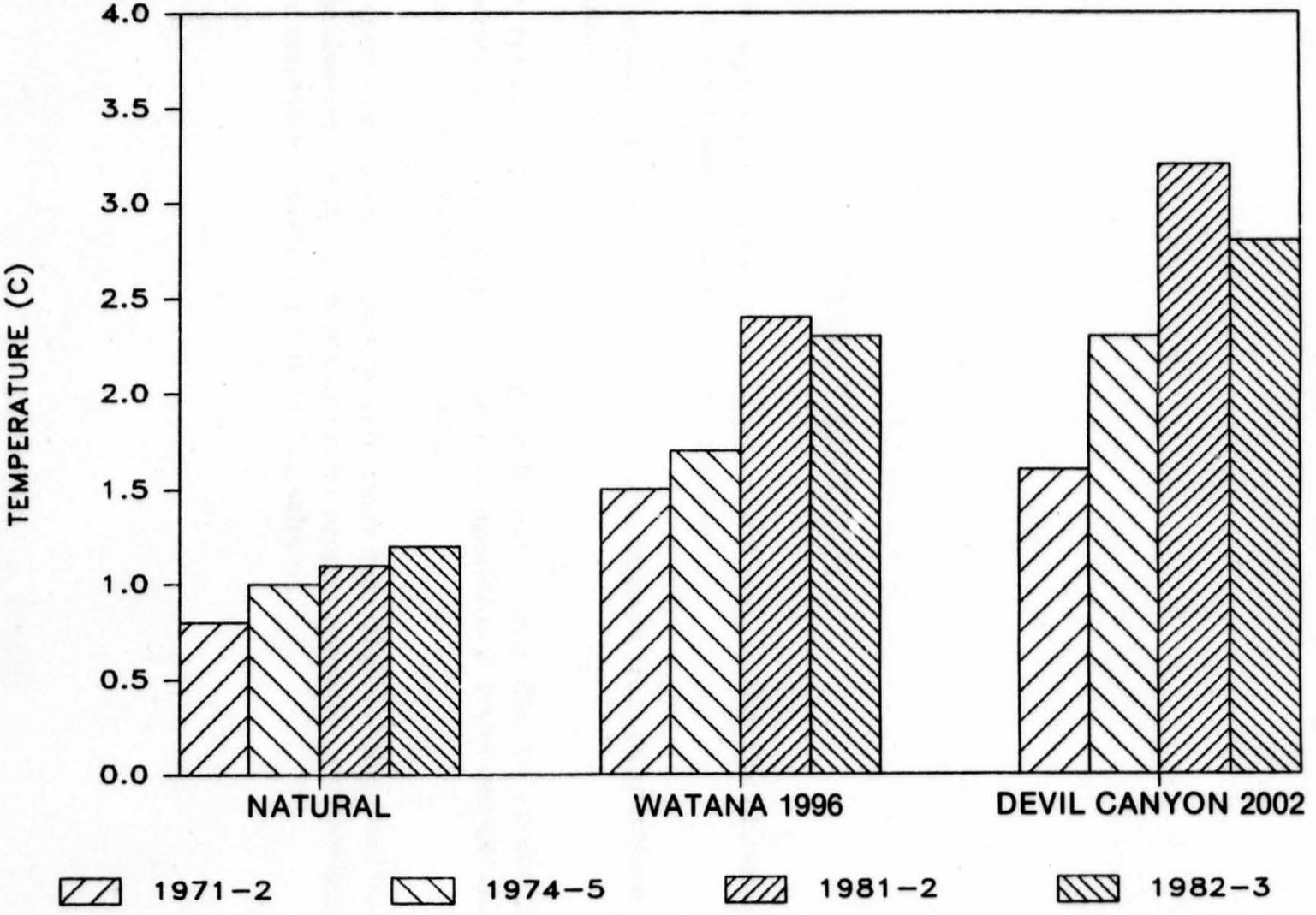

COHO SALMON
Range
Peak
Adult Inmigration
Spawning
Incubation
Juvenile Rearing
Outmigration
Devil Canyon
2002
Watana
1996
Natural
Temperature (C)
20
15
10
5
0
-5
Tolerance Zone
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
1982-1983
River Mile 130


CHINOOK SALMON
Range
Peak
Adult Inmigration
Spawning
Incubation
Juvenile Rearing
Outmigration
Devil Canyon
2002
Watana
1996
Natural
Temperature (C)
20
15
10
5
0
-5
Tolerance Zone
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
1982-1983
River Mile 130

Estimated juvenile salmon growth ranges under simulated natural and with-project conditions.



Mainstem Susitna River Average Water Temperatures During the Incubation Period of September Through April



CONCLUSIONS:

1. Go through a series of steps to relate model runs to fish life phases and their respective established temperature criteria.

2. Preliminary runs show no obvious adverse impacts from temperature changes on salmon species.

3. Some retardation of juvenile growth may occur due to cooler summer temperatures, even though the project operational water temperatures are within the established tolerance range.

4. Mainstem water temperatures, which under natural conditions may be limiting for incubation, would be increased under project operation and could provide a better mainstem incubating habitat for salmon.