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Water Temperature of Streams in the Cook Inlet Basin and Implications of Climate Change

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U.S. Department of the Interior
U.S. Geological Survey

PURPOSE

- Fish – Important Natural Resource
- Water temperature as an indicator of fish health

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SCOPE

- Compile existing water temperature data
- Analyze the data (trends, location, basin characteristics)
- Test air temperature/water temperature model
- Implications of climate change

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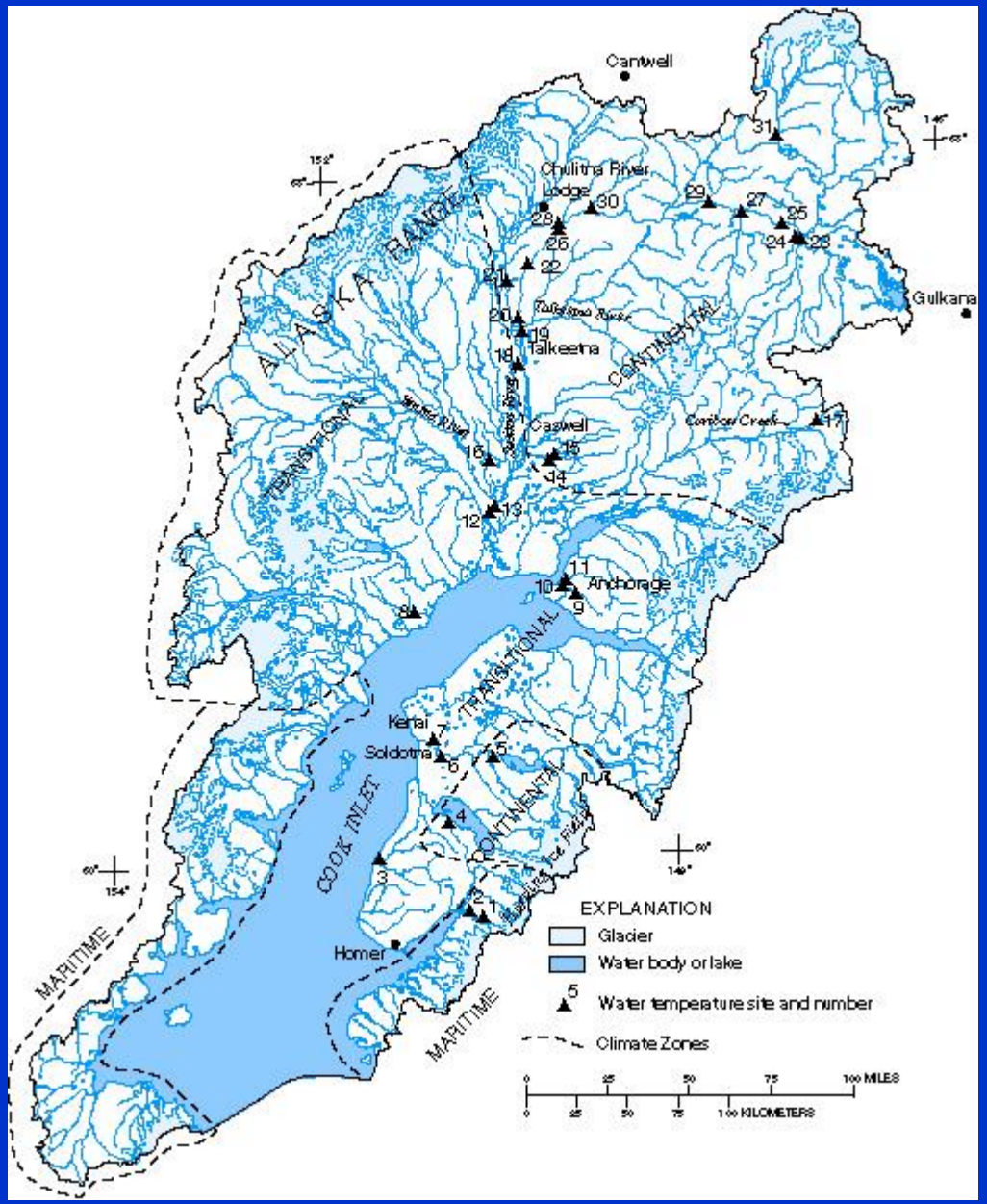
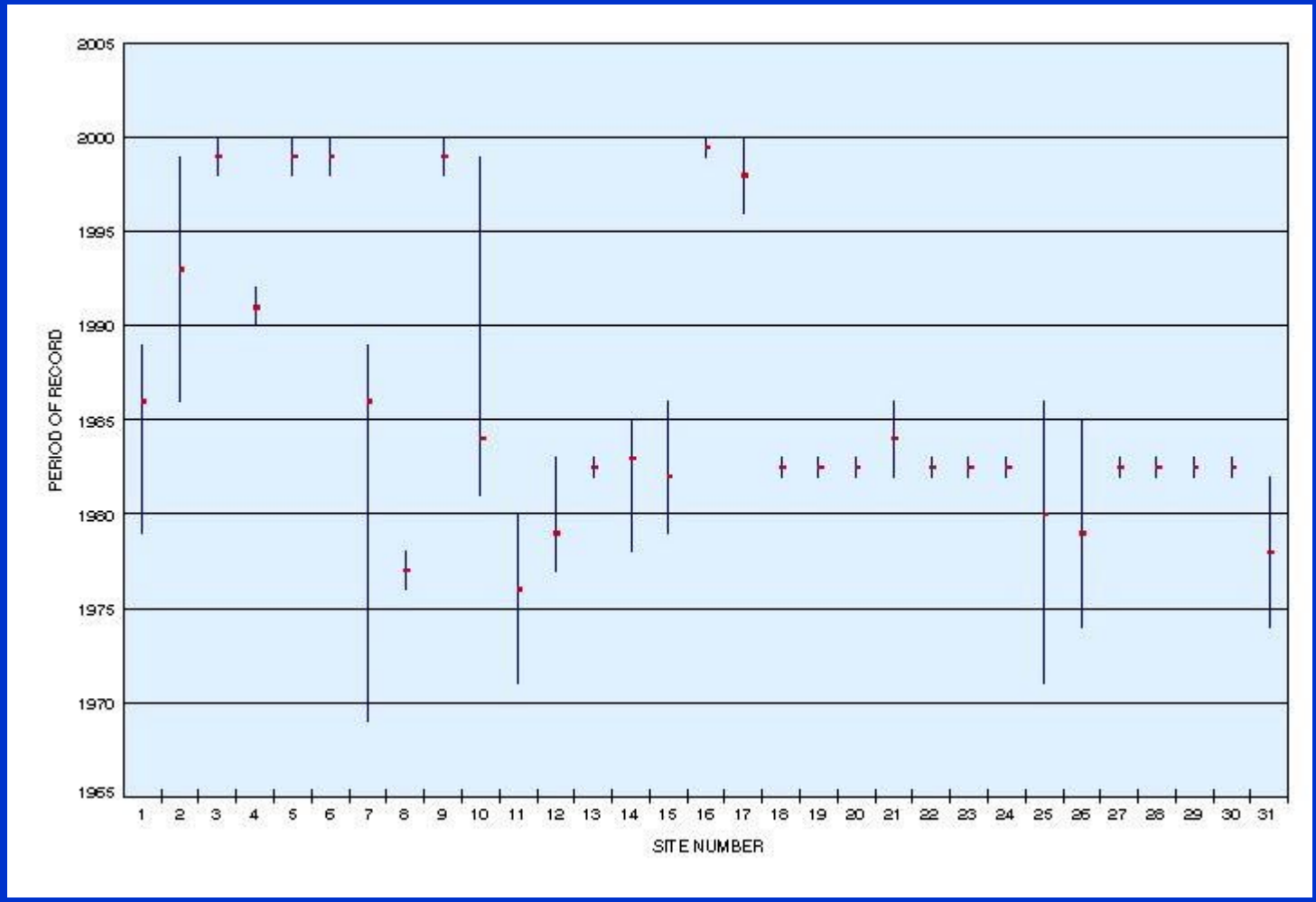

Cantwell
Chulitna River Lodge
Talkeetna
Caswell
Gulkana
Anchorage
Kenai
Soldotna
Homer
ALASKA RANGE
TRANSITIONAL
CONTINENTAL
COOK INLET
MARITIME
EXPLANATION
Glacier
Water body or lake
Water temperature site and number
Climate Zones
100 MILES
100 KILOMETERS


2005
2000
1995
1990
1985
1980
1975
1970
1965
PERIOD OF RECORD
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
SITE NUMBER

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31 SITES

- 7 sites – Kenai Peninsula
- 3 sites – Anchorage
- 19 sites – Susitna River Basin
- 1 site – West side – Cook Inlet
- 1 site – Tributary to Matanuska R.

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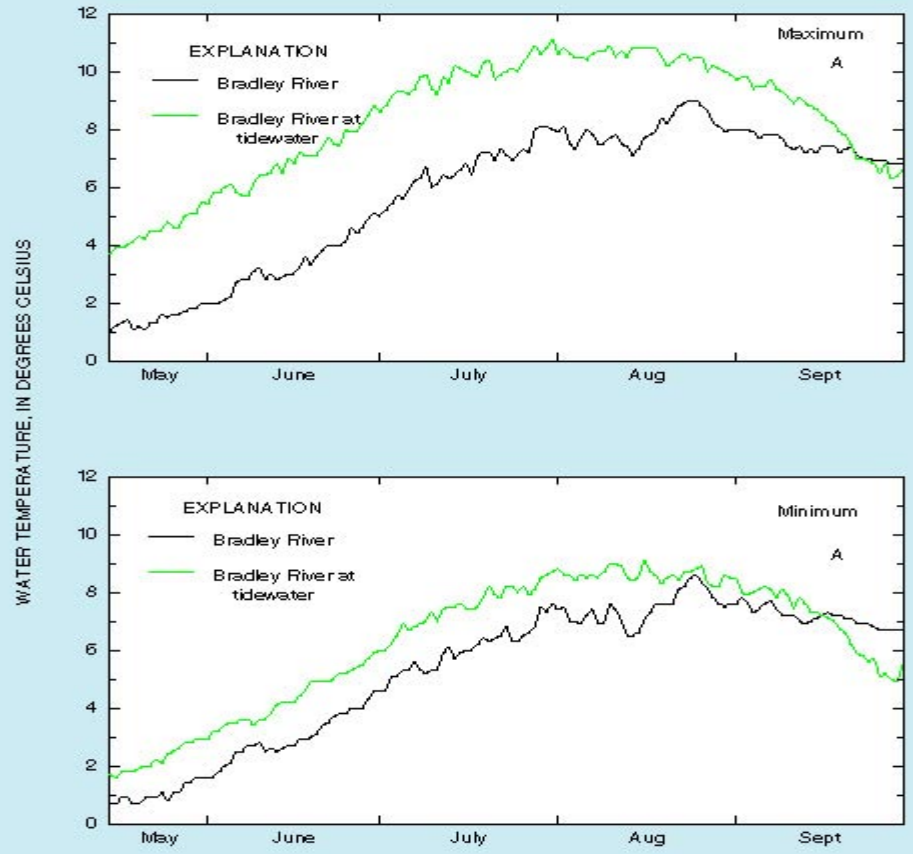
WATER TEMPERATURE, IN DEGREES CELSIUS
EXPLANATION
Bradley River
Bradley River at tidewater
Maximum
A
Minimum
A
0
2
4
6
8
10
12
May
June
July
Aug
Sept

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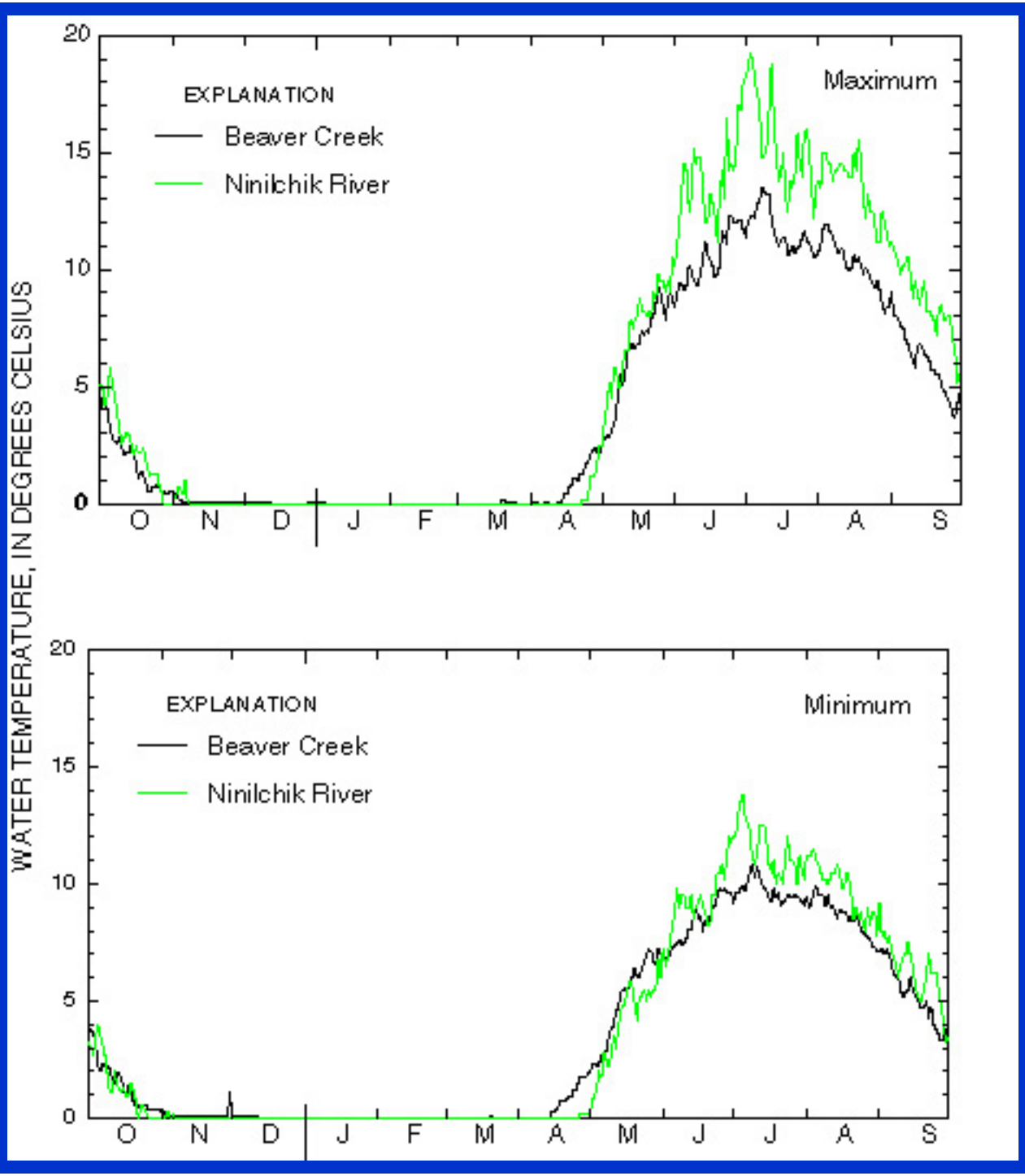
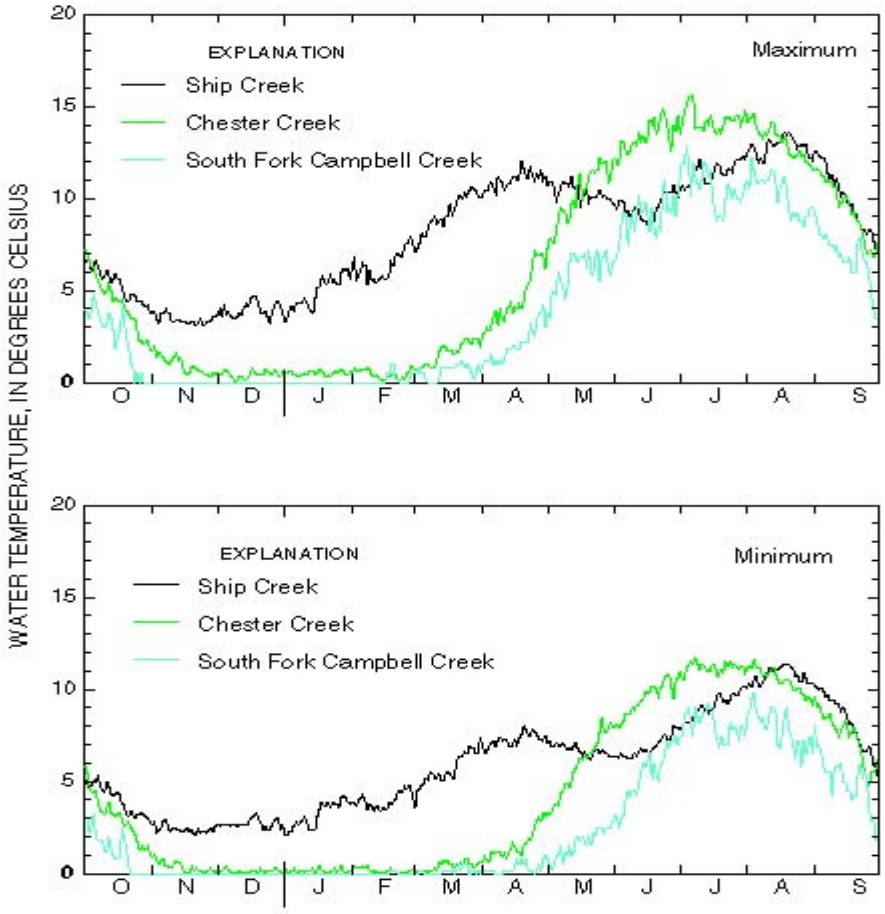

WATER TEMPERATURE, IN DEGREES CELSIUS
20
15
10
5
0
EXPLANATION
Beaver Creek
Ninilchik River
Maximum
O
N
D
J
F
M
A
M
J
J
A
S
20
15
10
5
0
EXPLANATION
Beaver Creek
Ninilchik River
Minimum
O
N
D
J
F
M
A
M
J
J
A
S


WATER TEMPERATURE, IN DEGREES CELSIUS
20
15
10
5
0
EXPLANATION
Ship Creek
Chester Creek
South Fork Campbell Creek
Maximum
O N D J F M A M J J A S
EXPLANATION
Ship Creek
Chester Creek
South Fork Campbell Creek
Minimum
O N D J F M A M J J A S

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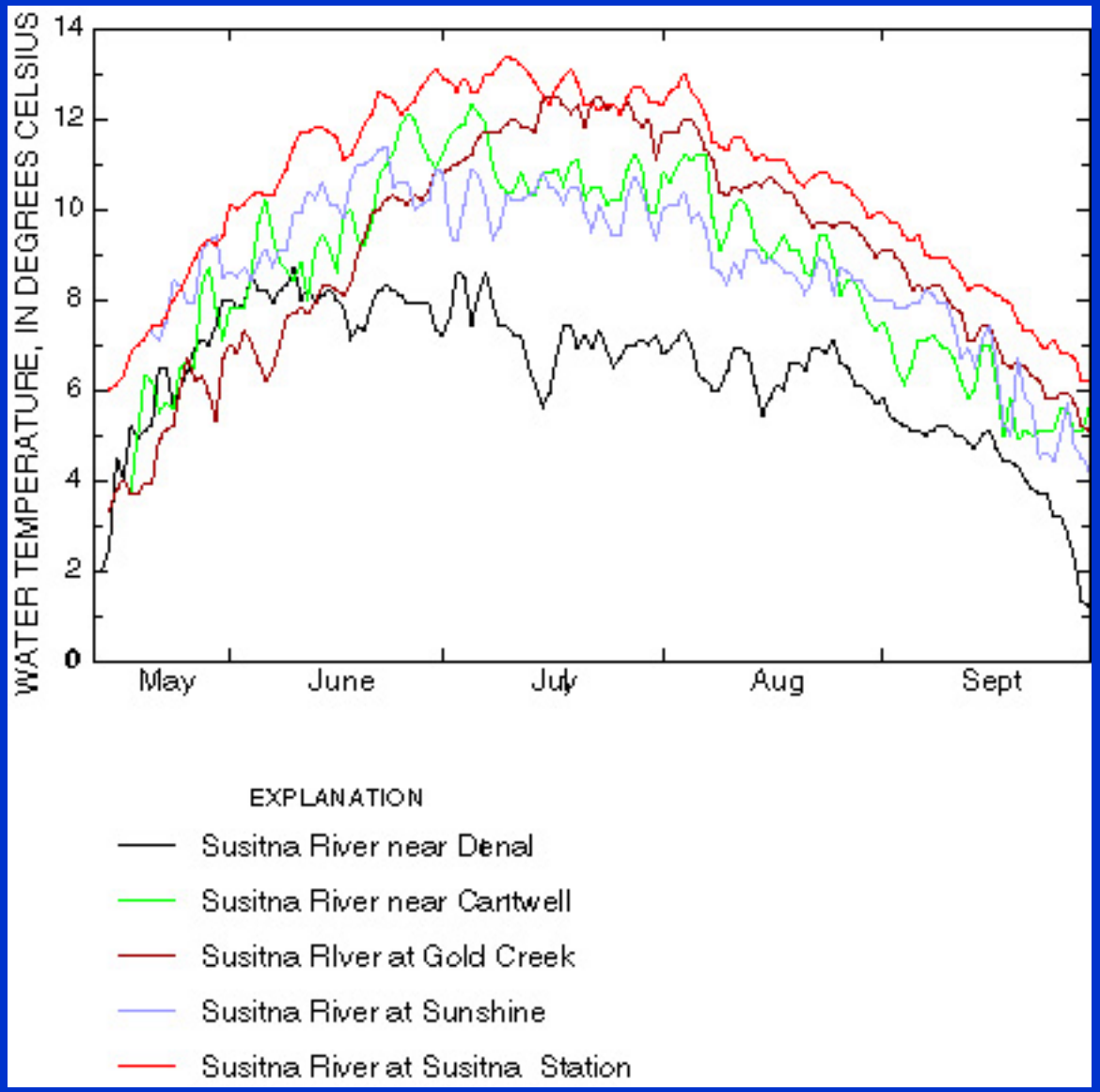
WATER TEMPERATURE, IN DEGREES CELSIUS
0
2
4
6
8
10
12
14
May
June
July
Aug
Sept
EXPLANATION
Susitna River near Denal
Susitna River near Cantwell
Susitna River at Gold Creek
Susitna River at Sunshine
Susitna River at Susitna Station

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AIR-WATER TEMPERATURE MODEL

- Mohseni (1998) – University of Minnesota
- Regression model using logistic function
- Determines average weekly water temperature based on average weekly air temperature

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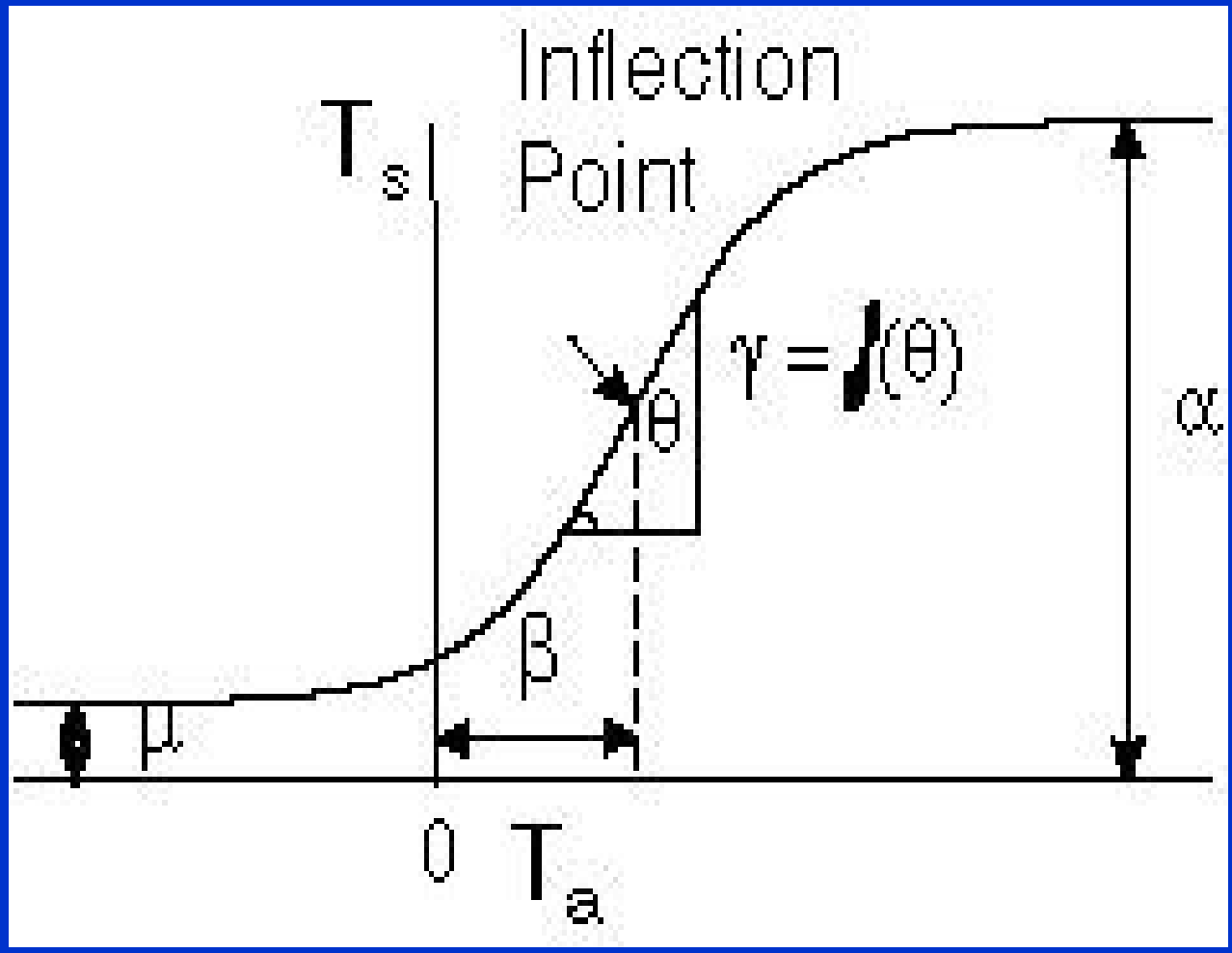

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INPUT VARIABLES, FORMAT, OUTPUT

- Air Temperature – Chose 7 climate stations

- Compute the average weekly air temperature
- Compute the average weekly water temperature

- Computes average weekly water temperature
- Compares predicted and observed temperatures
- Compute the Nash-Sutcliffe Coefficient - NSC

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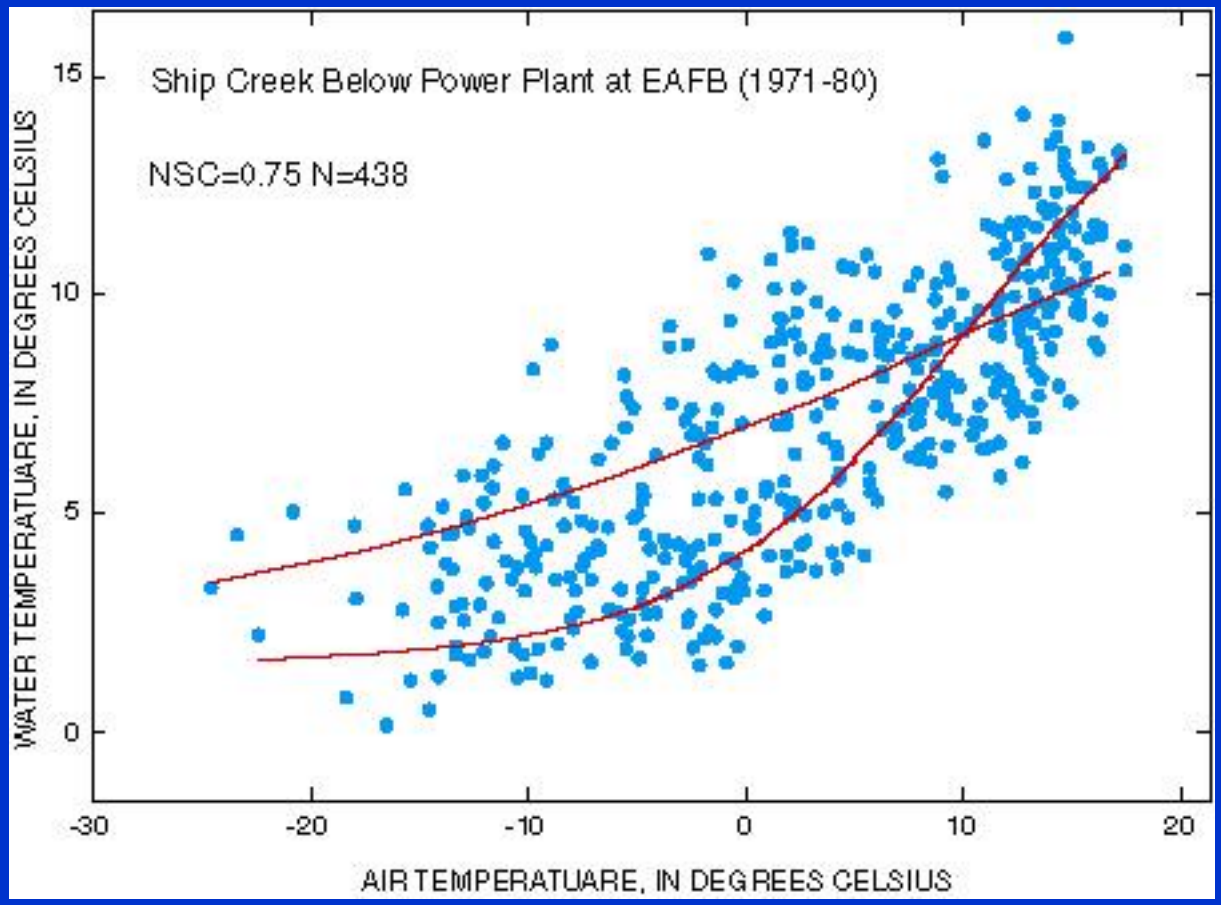
Ship Creek Below Power Plant at EAFB (1971-80)
NSC=0.75 N=438
WATER TEMPERATUARE, IN DEGREES CELSIUS
AIR TEMPERATUARE, IN DEGREES CELSIUS
15
10
5
0
-30
-20
-10
0
10
20

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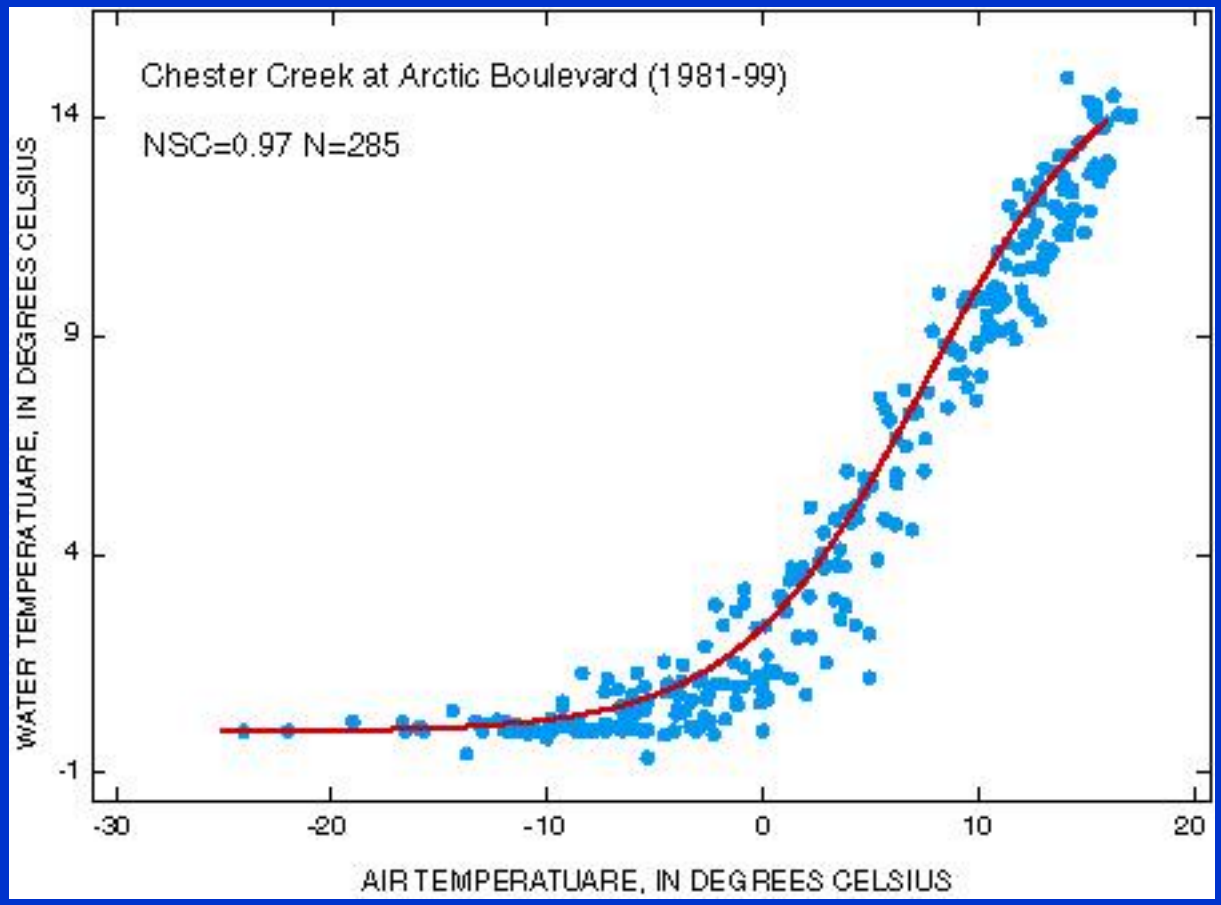
Chester Creek at Arctic Boulevard (1981-99)
NSC=0.97 N=285
WATER TEMPERATUARE, IN DEGREES CELSIUS
14
9
4
-1
-30
-20
-10
0
10
20
AIR TEMPERATUARE, IN DEGREES CELSIUS

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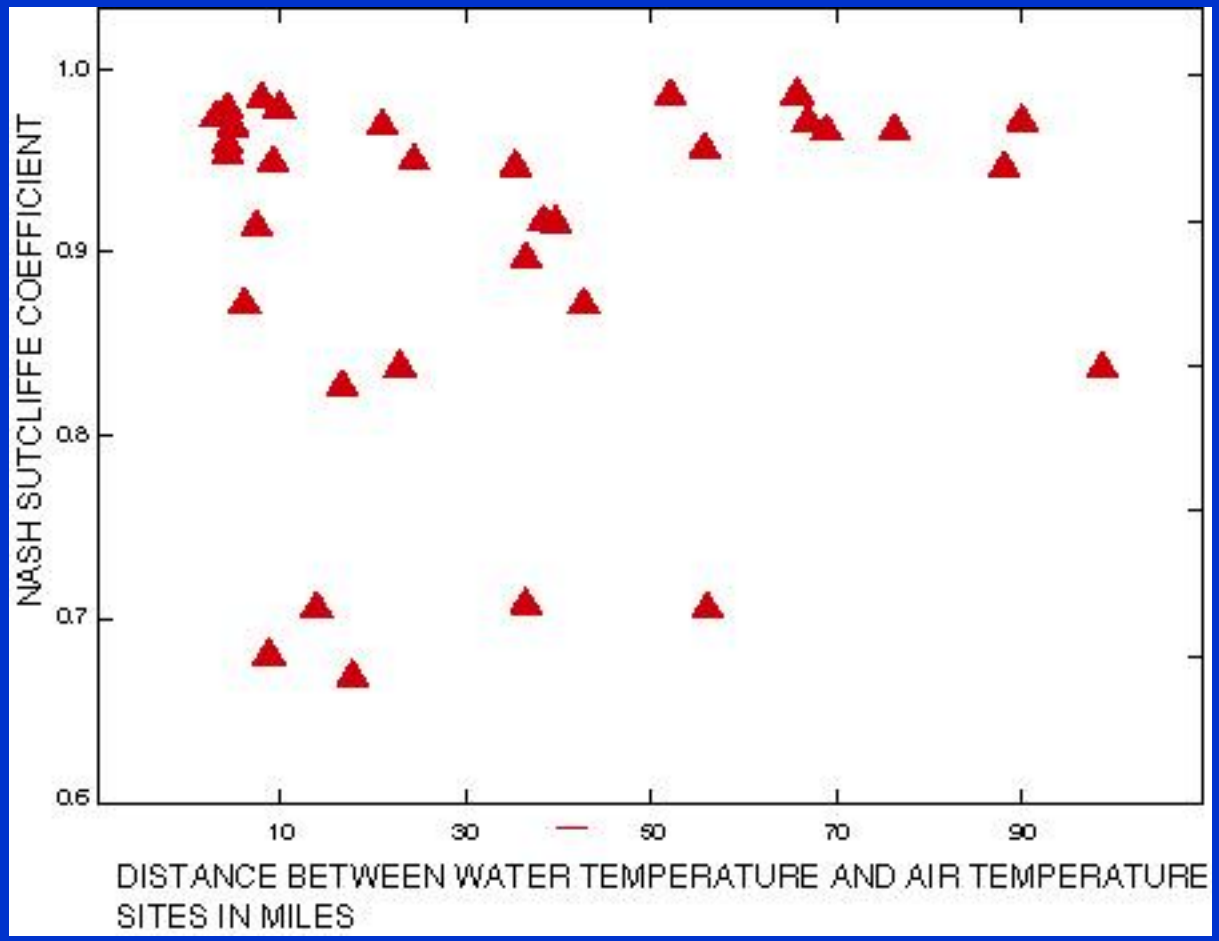
NASH SUTCLIFFE COEFFICIENT
1.0
0.9
0.8
0.7
0.6
10
30
50
70
90
DISTANCE BETWEEN WATER TEMPERATURE AND AIR TEMPERATURE
SITES IN MILES

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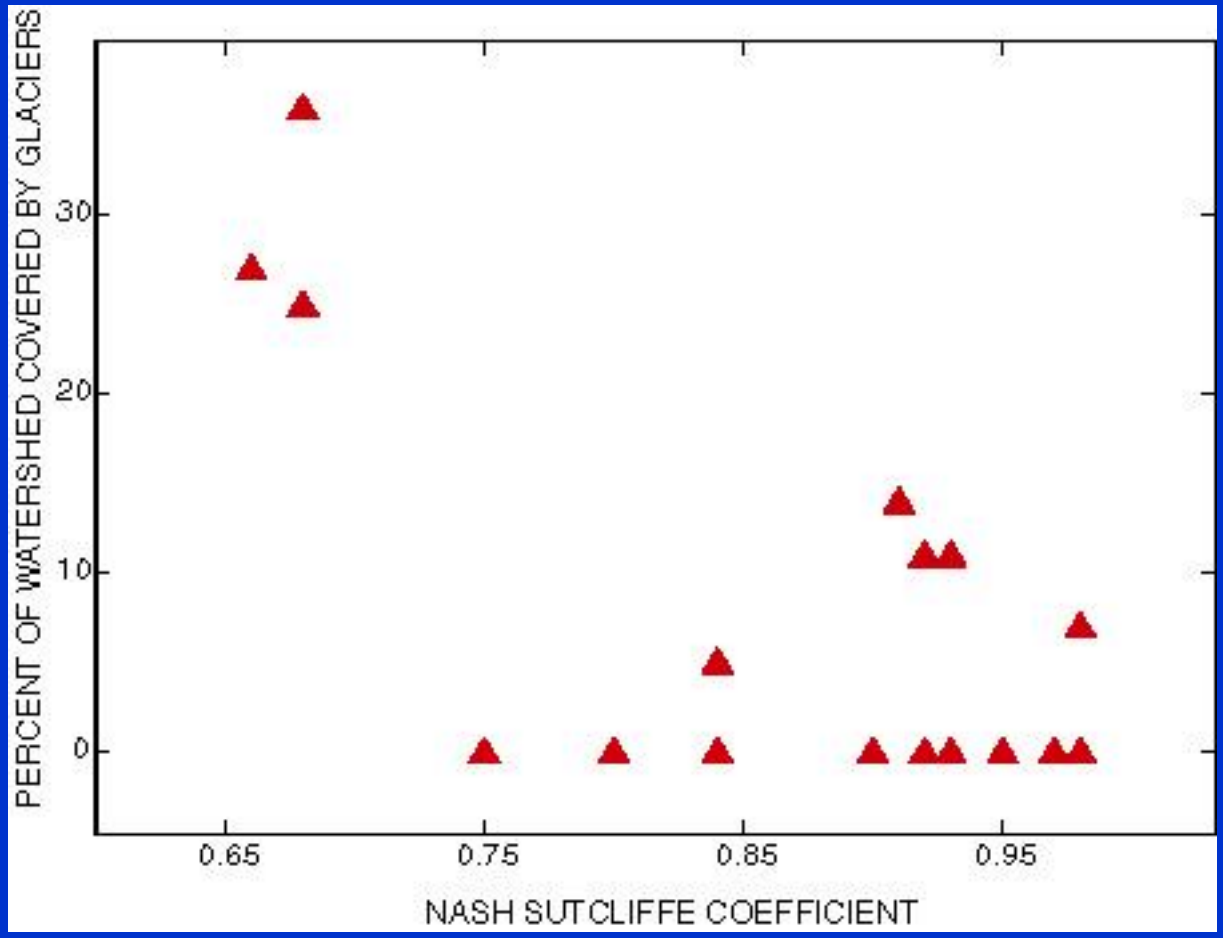
PERCENT OF WATERSHED COVERED BY GLACIERS
30
20
10
0
0.65
0.75
0.85
0.95
NASH SUTCLIFFE COEFFICIENT

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RESULTS OF MODEL – PART 1

- Available data for most sites – open water
- NSC ranged from 0.64 to 0.98
- 26 sites had NSC of 0.75 or higher
- 3 sites – 25 percent or more consists of glaciers
- 2 sites – No explanation

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IMPLICATIONS OF CLIMATE CHANGE

- Global Circulation Models (GCMs) predict a warming of the mean annual temperature for Cook Inlet ranging from 7.2°C to 8.5°C based on doubling of CO_2
- Could increase temperatures affect fish?
- Input increased air temperatures into model

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RESULTS OF MODEL – PART 2

- Only 26 sites used
- All sites showed increase in water temperature
- Temperature increase ranged from 0.3 to 7.6^{o}C
- 13 sites showed increases of 3^{o}C or higher*

- *3^{o}C or higher can lead to higher incidence of disease in fish

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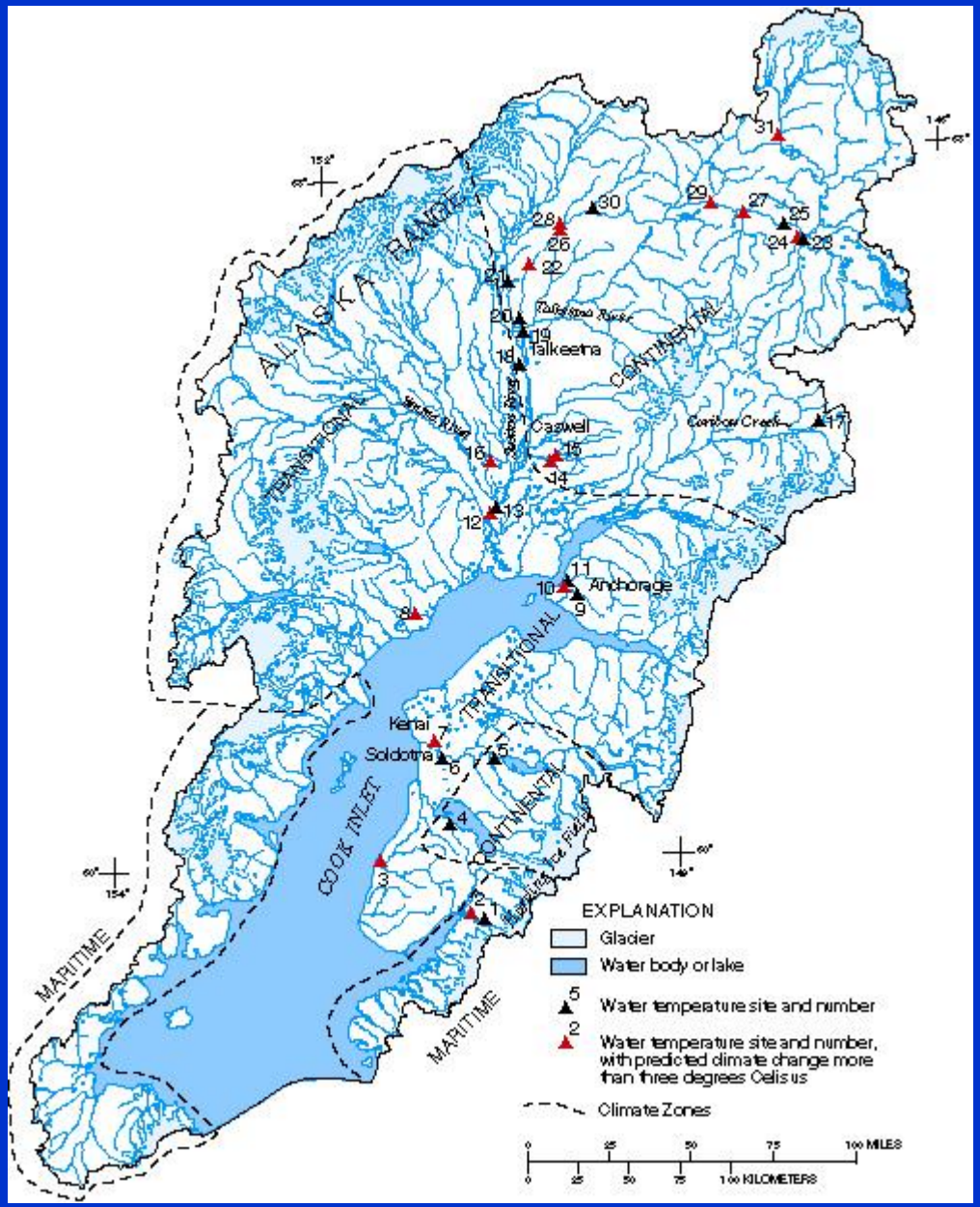
ALASKA RANGE
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Soldotna
COOK INLET
MARITIME
MARITIME
CONTINENTAL
TRANSITIONAL
EXPLANATION
Glacier
Water body or lake
Water temperature site and number
Water temperature site and number, with predicted climate change more than three degrees Celsius
Climate Zones
0 25 50 75 100 MILES
0 25 50 75 100 KILOMETERS

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CONCLUSIONS

- Water temperature dependent on basin characteristics (elevation, glaciers) and anthropogenic sources
- Water temperature increases and decreases along the course of the Susitna River
- Air temperature model predicted water temperature for 26 sites
- Applying GCM results indicates half the sites would have increased temperatures of 3°C or more

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