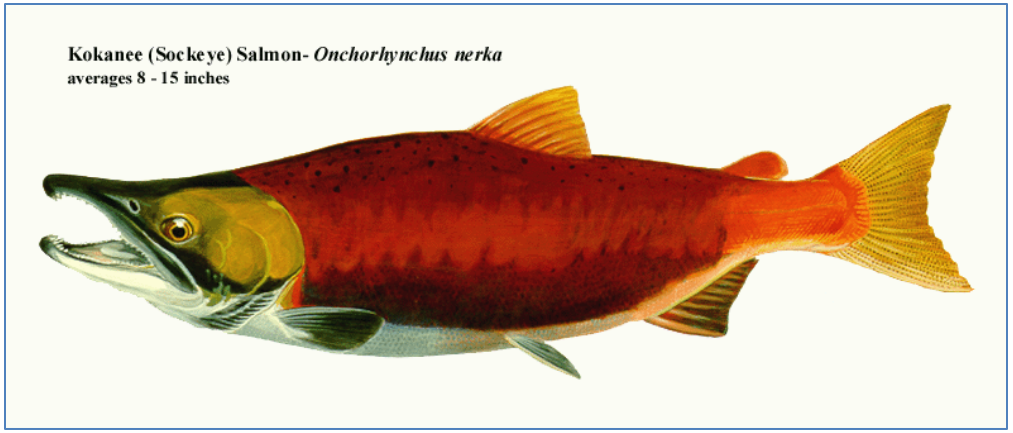
Thermal conditions for Lake Sammamish kokanee

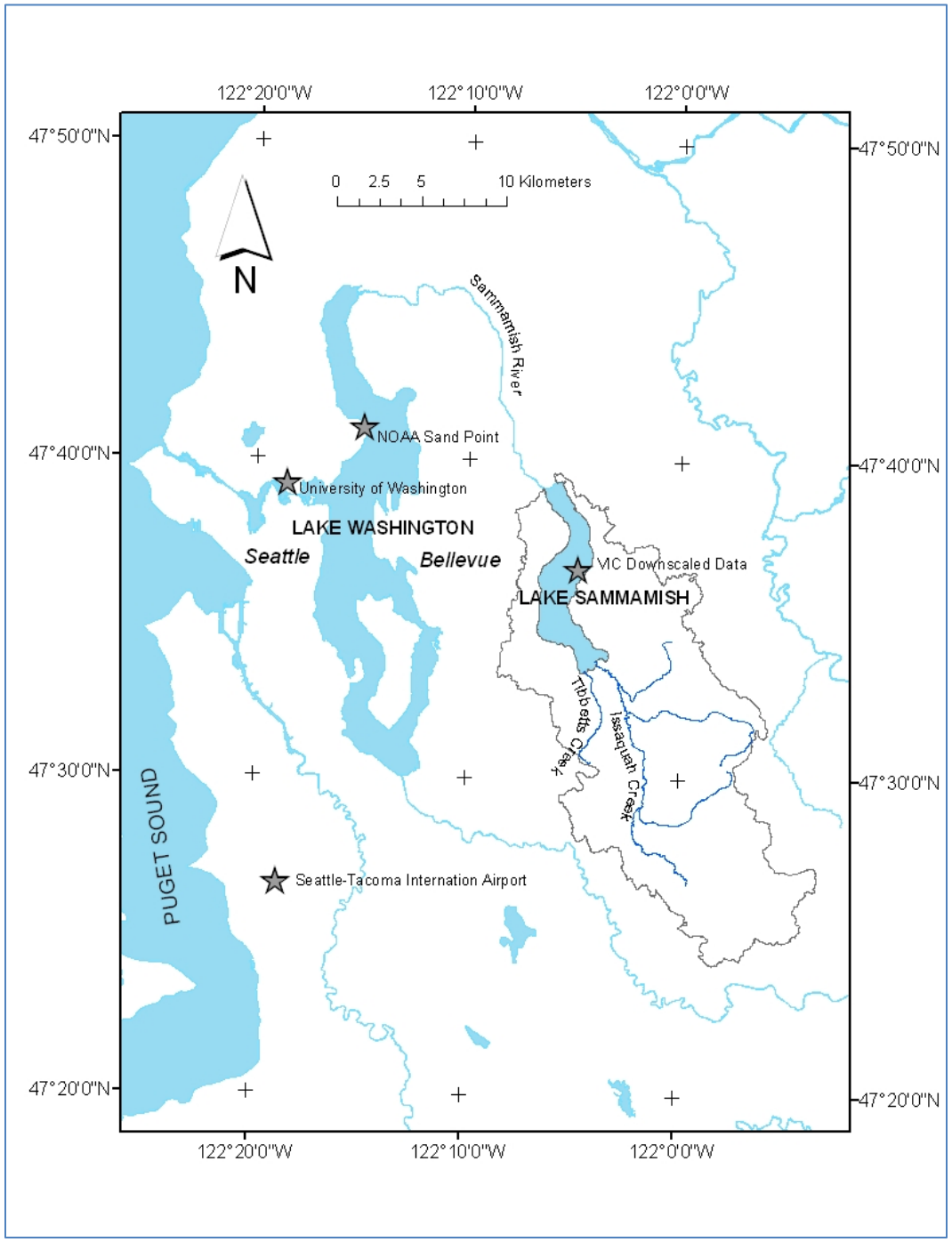
Historical and future projections

King County Water and Land Resources
Science Seminar
Thursday, October 24, 2013
Curtis DeGasperi, King County WLRD Science Section



Lake Sammamish Background

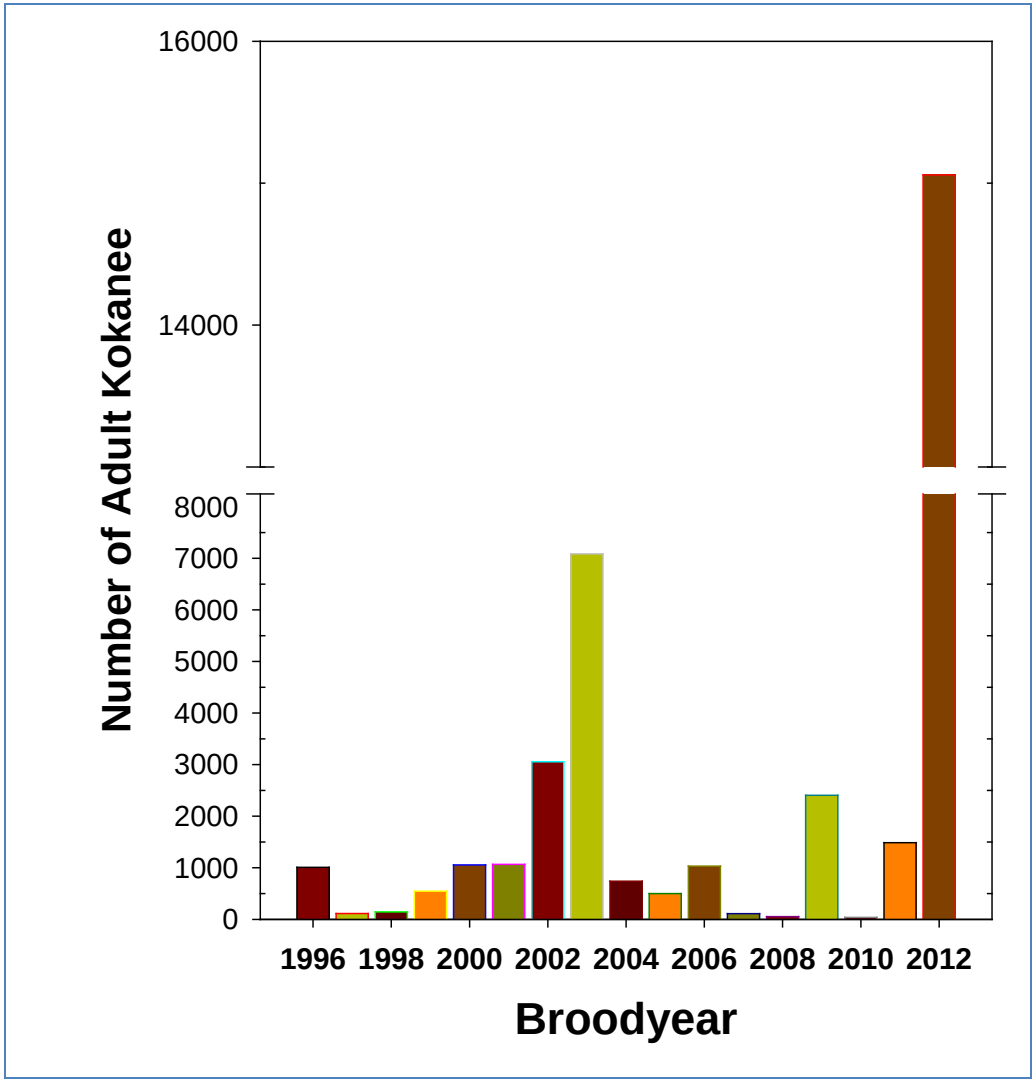
	Metric	English
Drainage Basin Area	230 km^2	57,000 ac
Issaquah Basin	145 km^2	35,600 ac
Lake Surface Area	19.8 km^2	4,900 ac
Lake Volume	$3.5x10^8$ m^3	283,860 ac-ft
Mean Depth	17.7 m	58 ft
Maximum Depth	32 m	105 ft
Mean Residence Time	1.8 years	



Kokanee Background

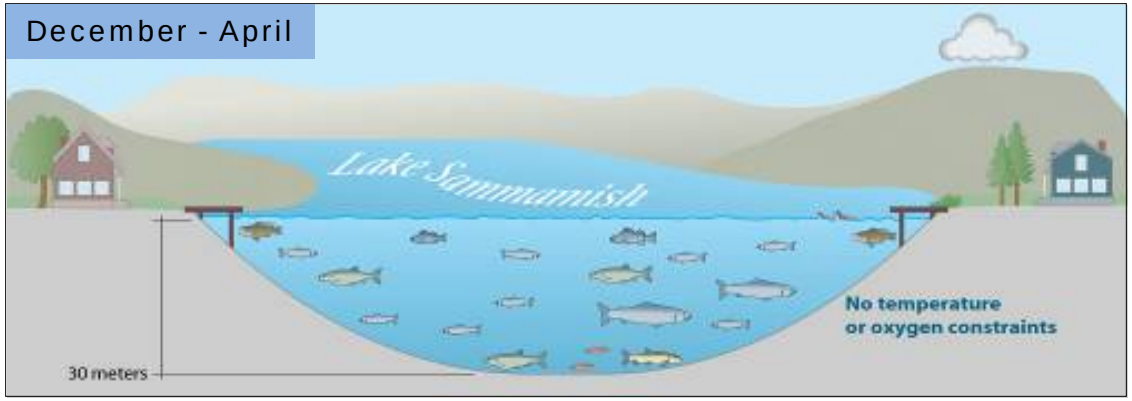
- Late run kokanee numbers have fluctuated in recent years
- Average age at maturity is 4 years
- They spawn in lake tributaries October through March
- Fish represented on spawning grounds resided in lake on average for three years prior to spawning

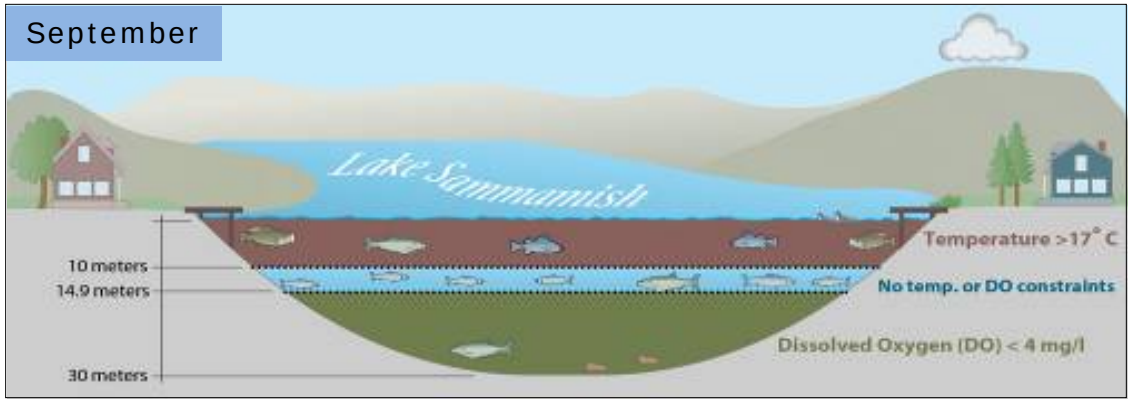
Late run kokanee escapement

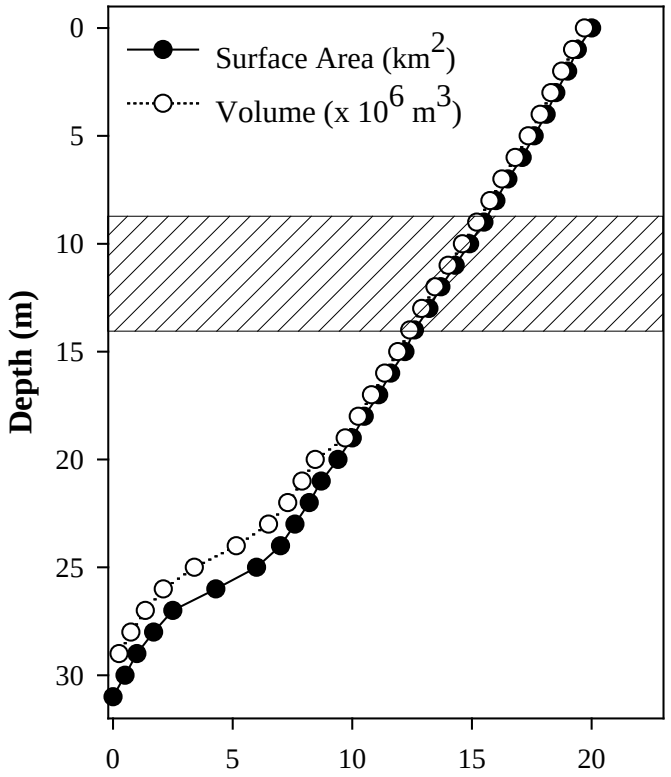


Source: Hans Berge

Temperature-DO squeeze







Berge, H. B. 2009. Effects of a temperature-oxygen squeeze on distribution, feeding, growth, and survival of kokanee (Oncorhynchus nerka) in Lake Sammamish, Washington. Master's Thesis, School of Aquatic and Fisheries Sciences, University of Washington. 84 p.

Temperature-DO squeeze (cont')

- July-September appears to be the most limiting period for lake kokanee growth

Source: Berge (2009)

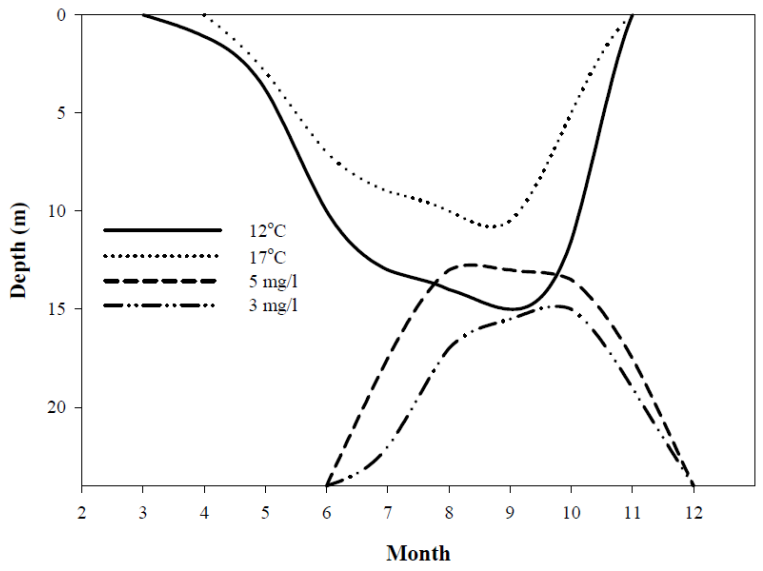
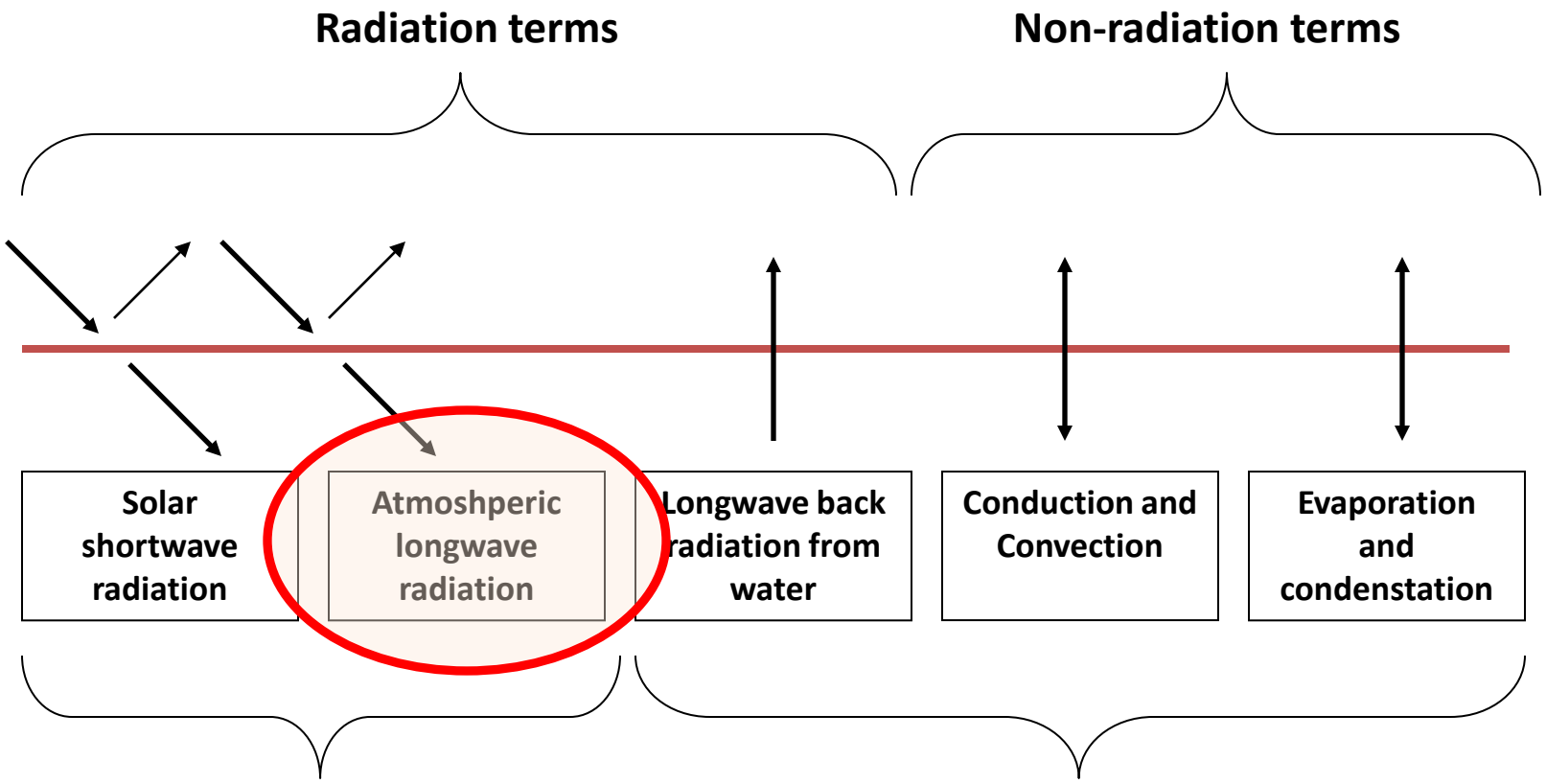


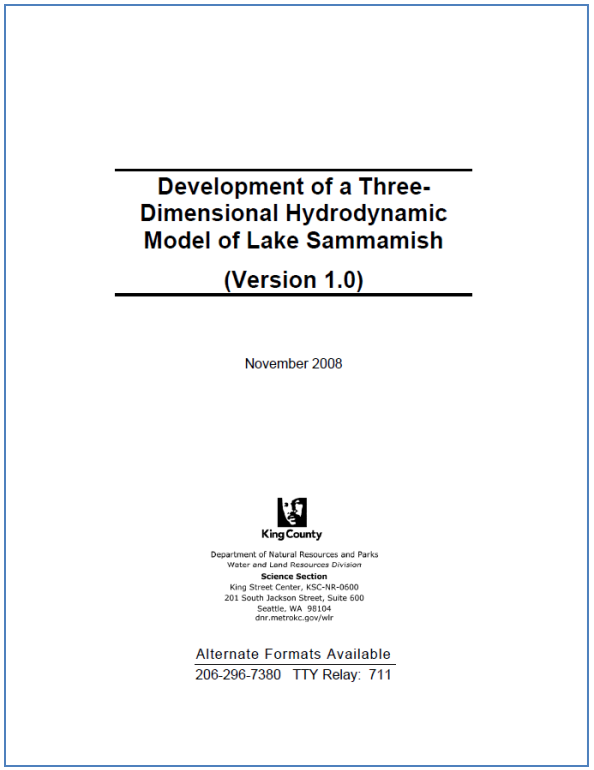
Figure 1. Annual temperature and dissolved oxygen isopleths in Lake Sammamish (2002 - 2003).

Lake Temperature Modeling
Surface Heat Exchange



Opportunity

- USFWS interest in climate change
- Cooperation with WDFW and Climate Impacts Group (CIG)
- Existing calibrated 2-D and 3-D lake temperature models



Development of a Three-Dimensional Hydrodynamic Model of Lake Sammamish

(Version 1.0)

November 2008

King County

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Water and Land Resources Division
Science Section
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201 South Jackson Street, Suite 600
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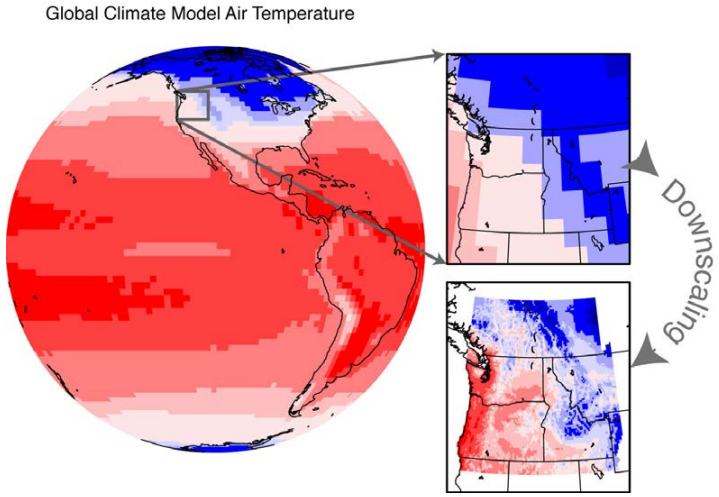
dnr.metrokc.gov/wlr

Alternate Formats Available
206-296-7380 TTY Relay: 711

http://www.kingcounty.gov/environment/waterandland/lakes/lakes-of-king-county/sammamish/3D-hydrodynamic-model-lake-sammamish.aspx

Downscaled Climate Data

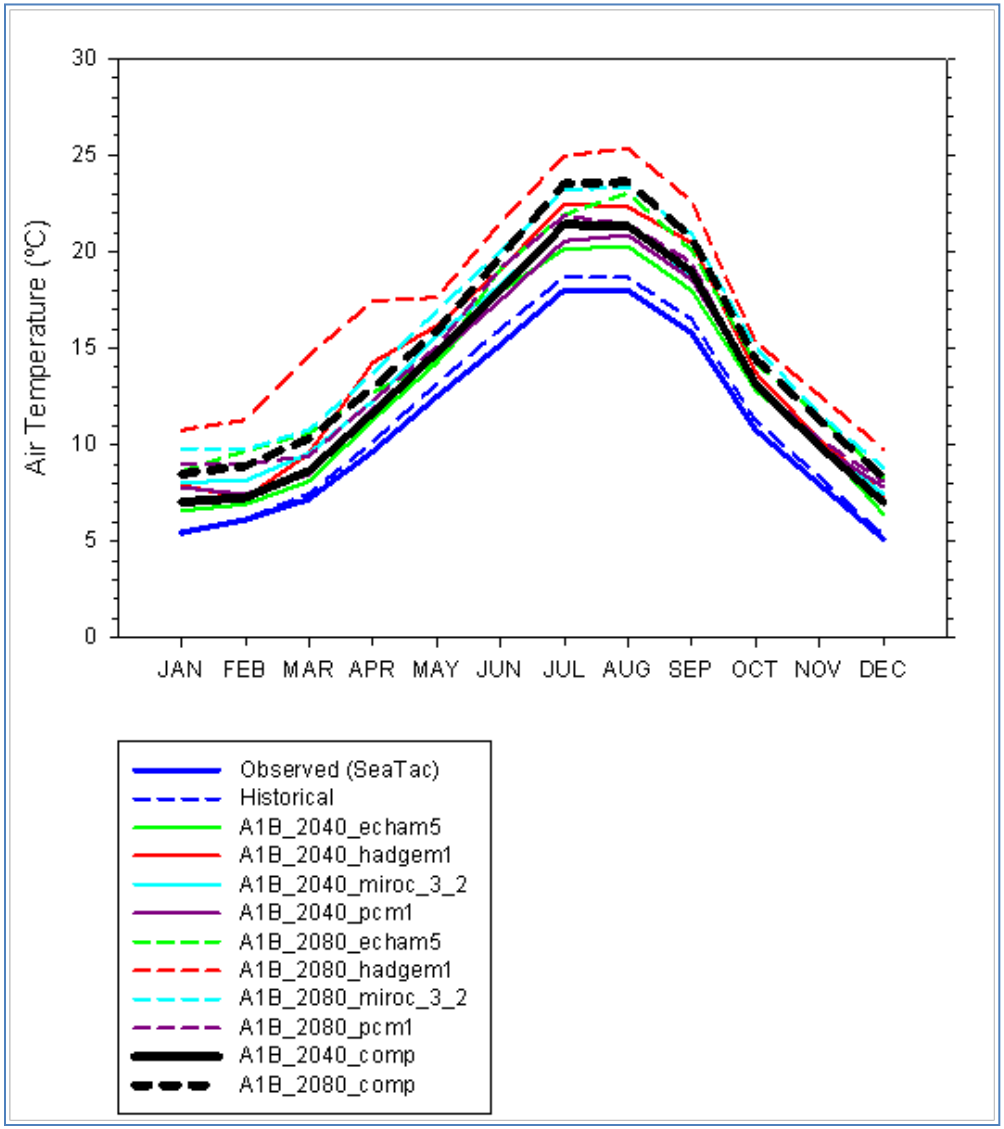
A1B Emissions Scenario



- **Composite** – average of 10 best models
- **ECHAM5** - ECHAM5 Global Climate Model
- **HadGEM1** - HadGEM1 Global Climate Model
- **MIROC_3.2** - MIROC 3.2 'medres' Global Climate Model
- **PCM1** - PCM1 Global Climate Model

Data provided by Guillaume Mauger, UW Climate Impacts Group

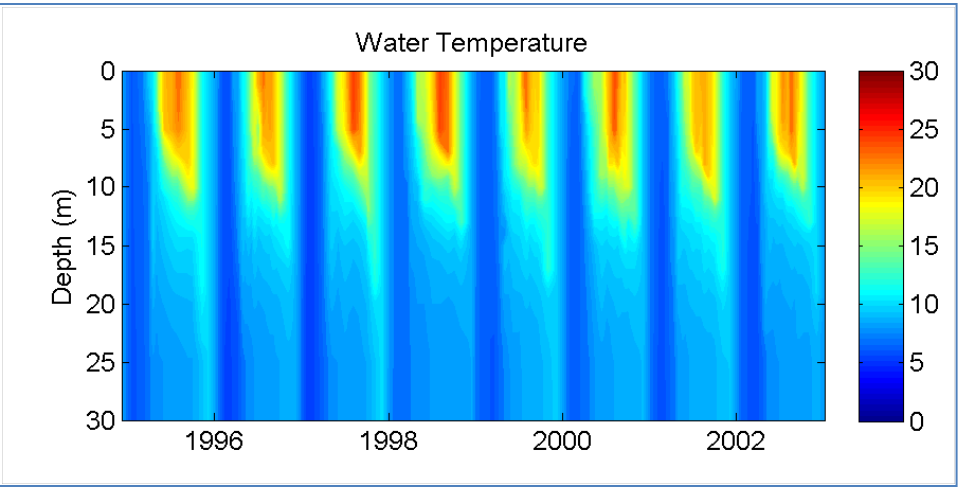
Air Temperature Summary

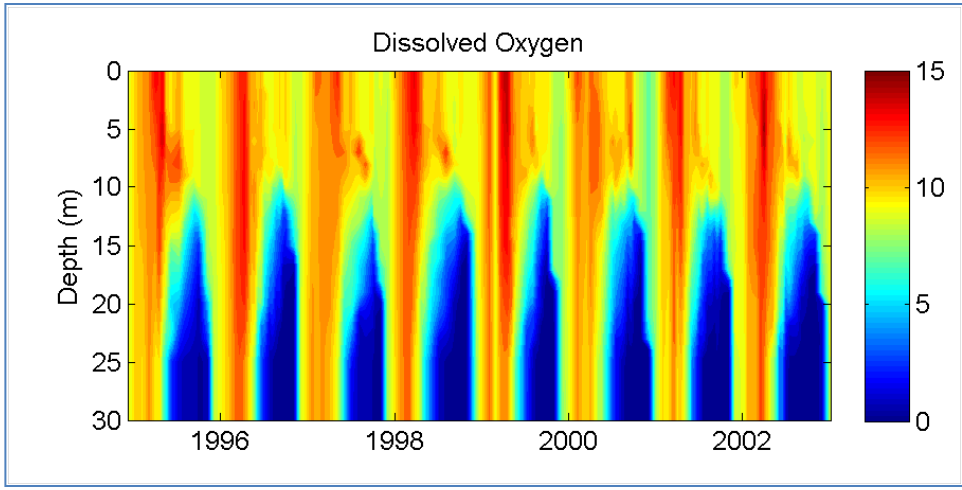


Temperature and DO thresholds

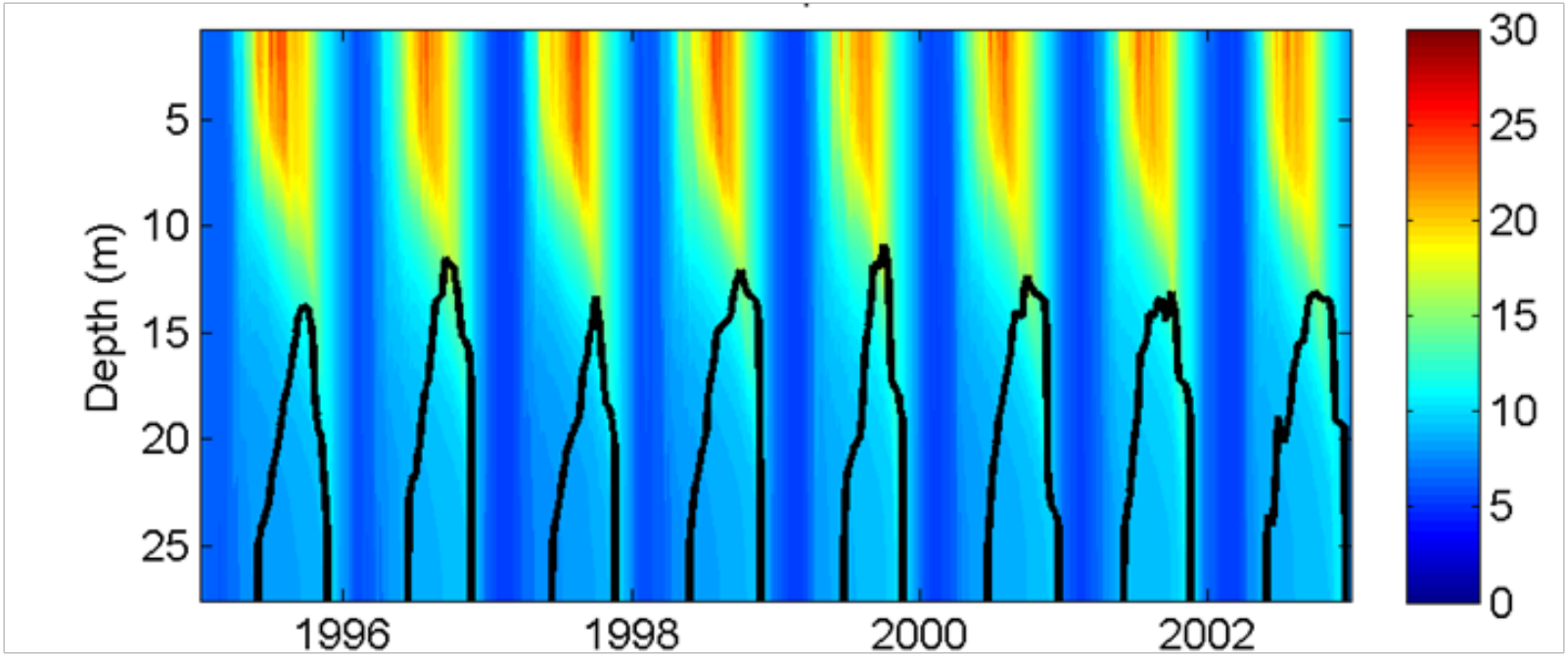
Source: Kirk Krueger, WDFW

- >17 °C, salmonid avoidance
- 21.5 °C, salmonid thermal maximum
- 25.1 °C, salmonid lethal threshold
- <4 mg DO/L, salmonid avoidance



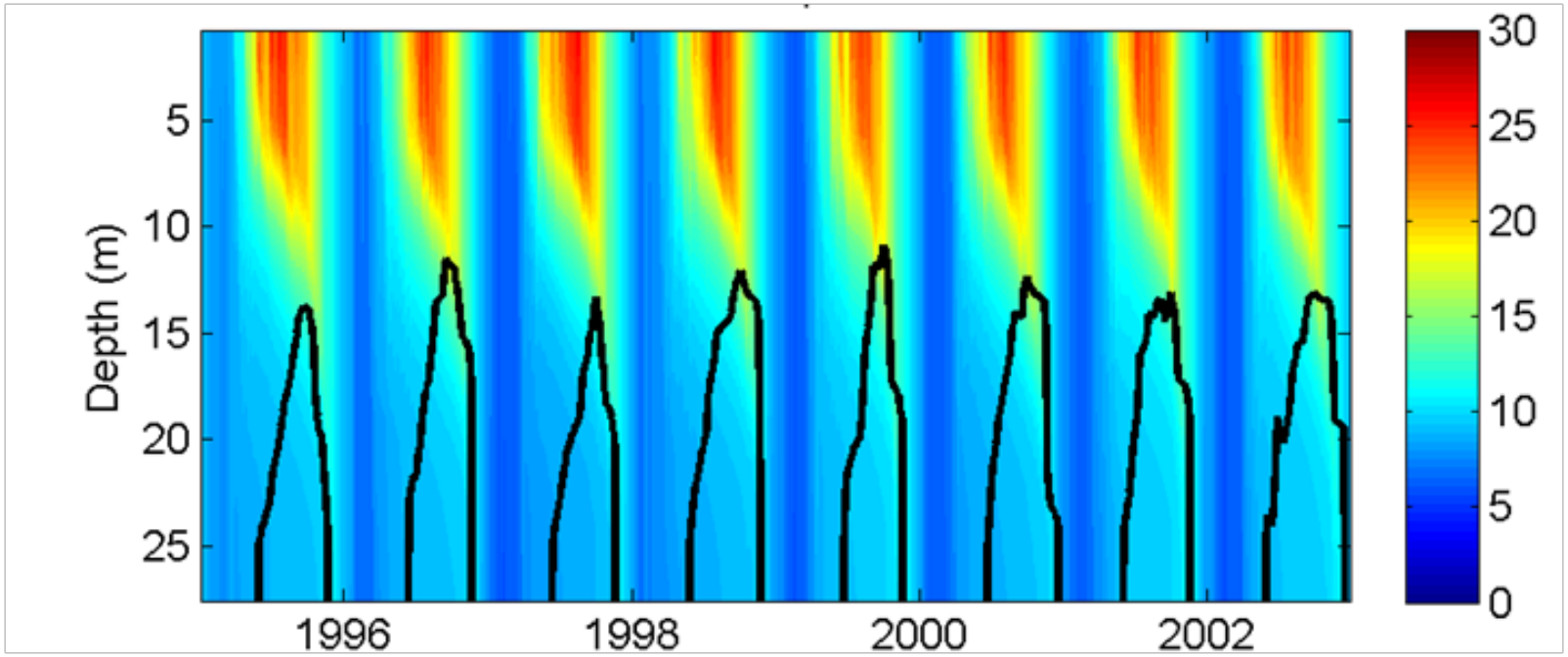


3-D Model – Historical Climate



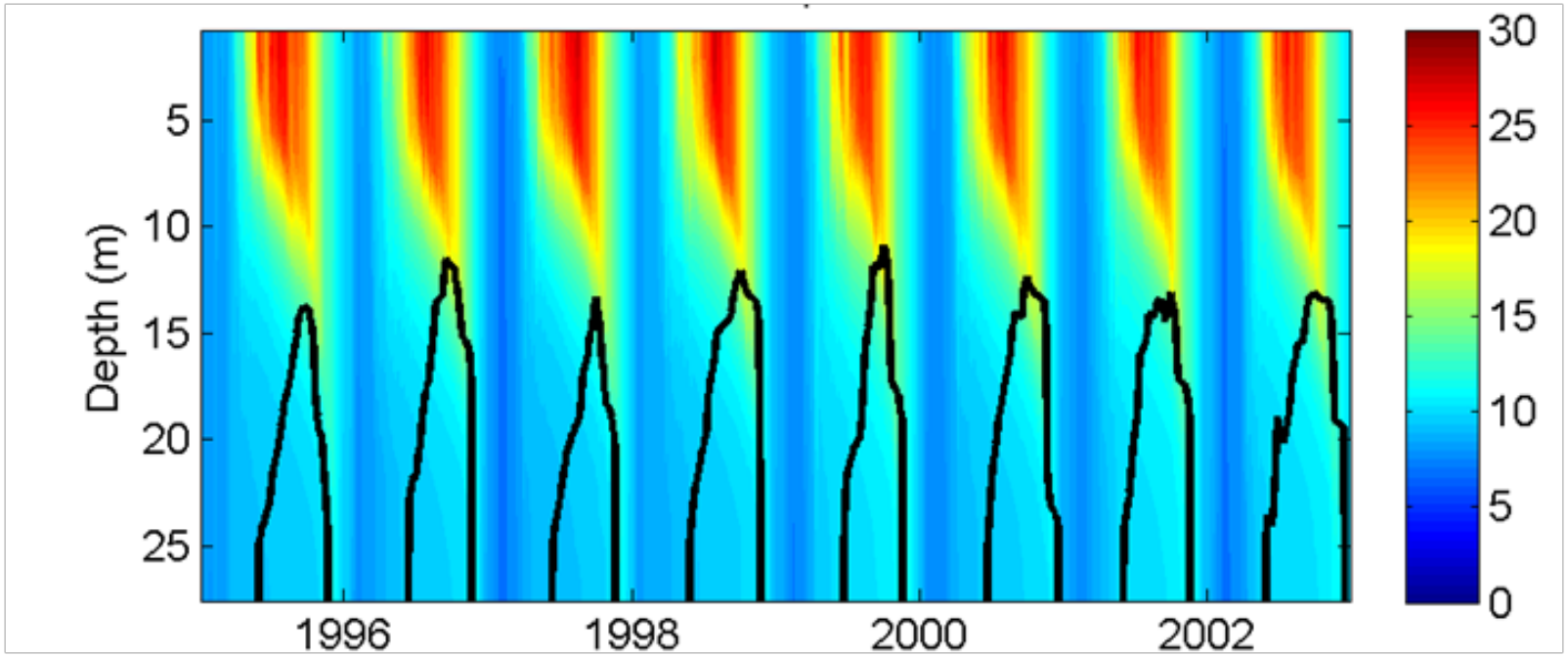
Note: Black line represents the 4 mg/L DO isopleth.

3-D Model – 2040s Composite Climate



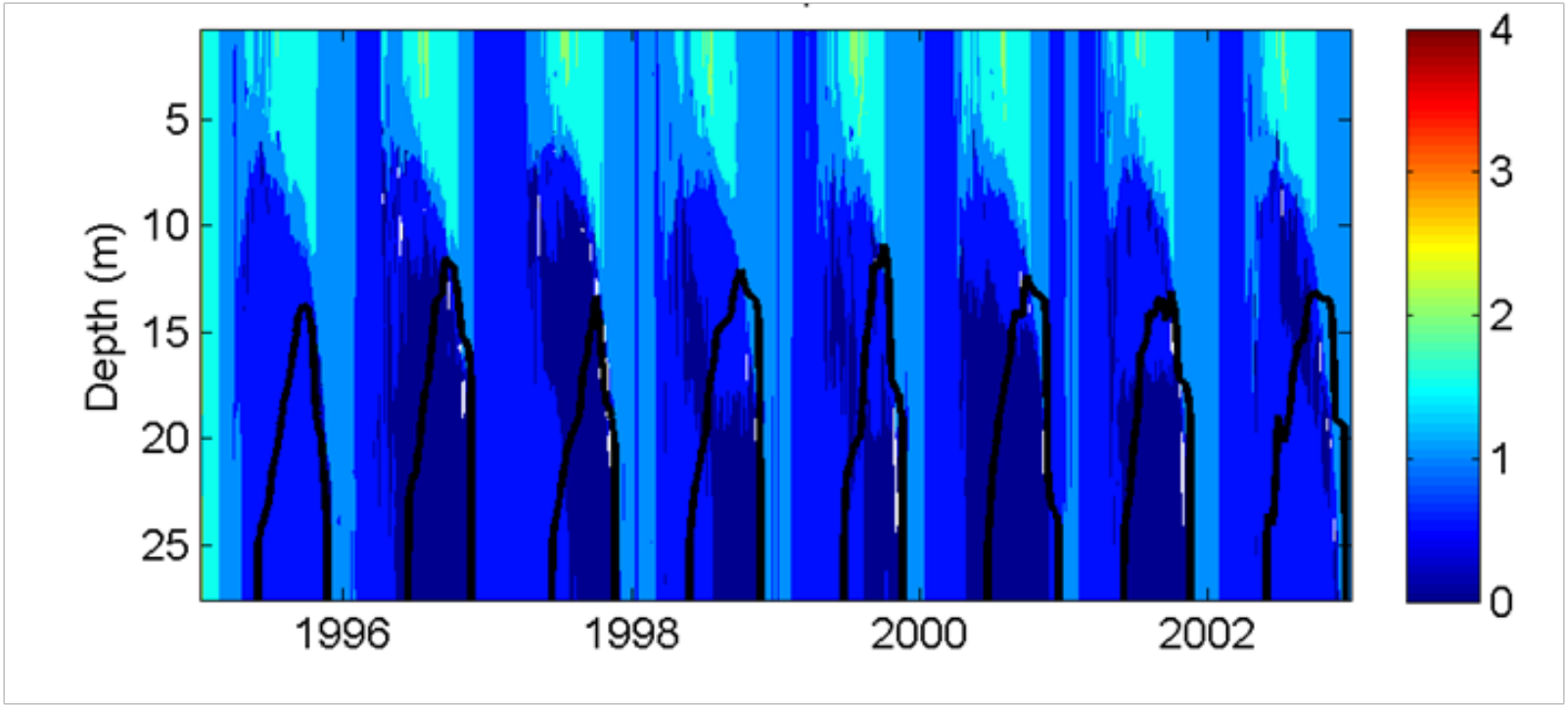
Note: Black line represents the 4 mg/L DO isopleth.

3-D Model – 2080s Composite Climate



Note: Black line represents the 4 mg/L DO isopleth.

3-D Model – 2040s minus Historical



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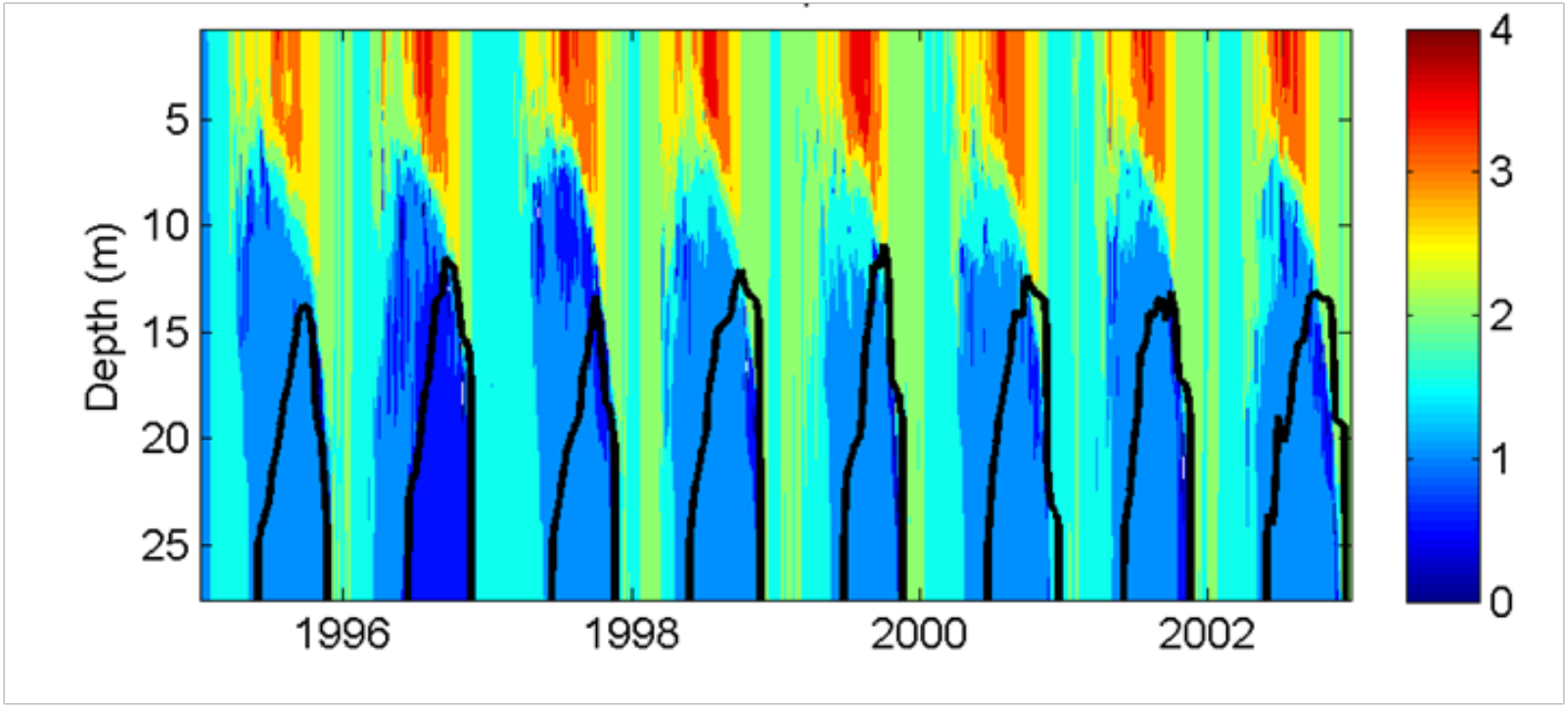
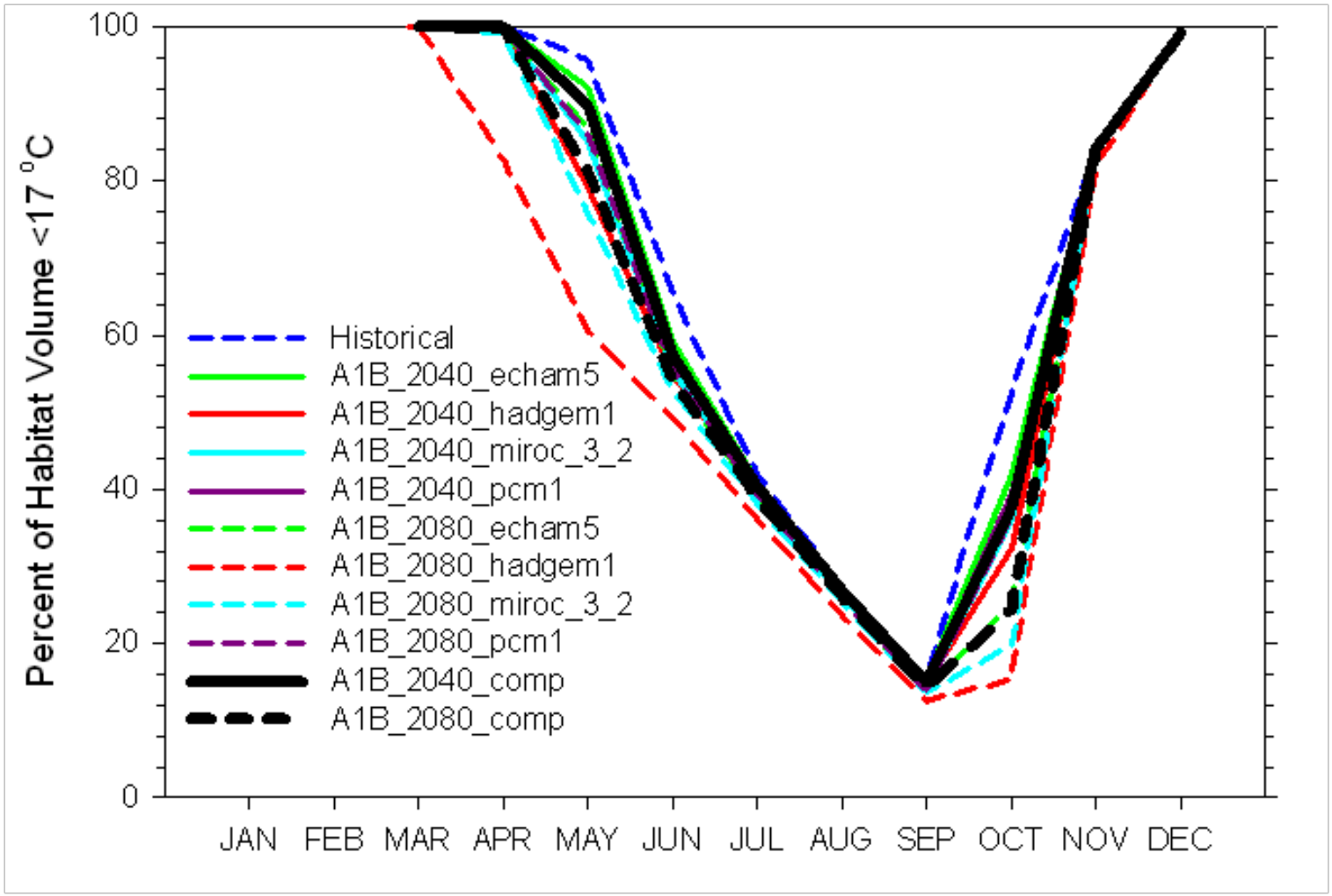
3-D Model – 2080s minus Historical



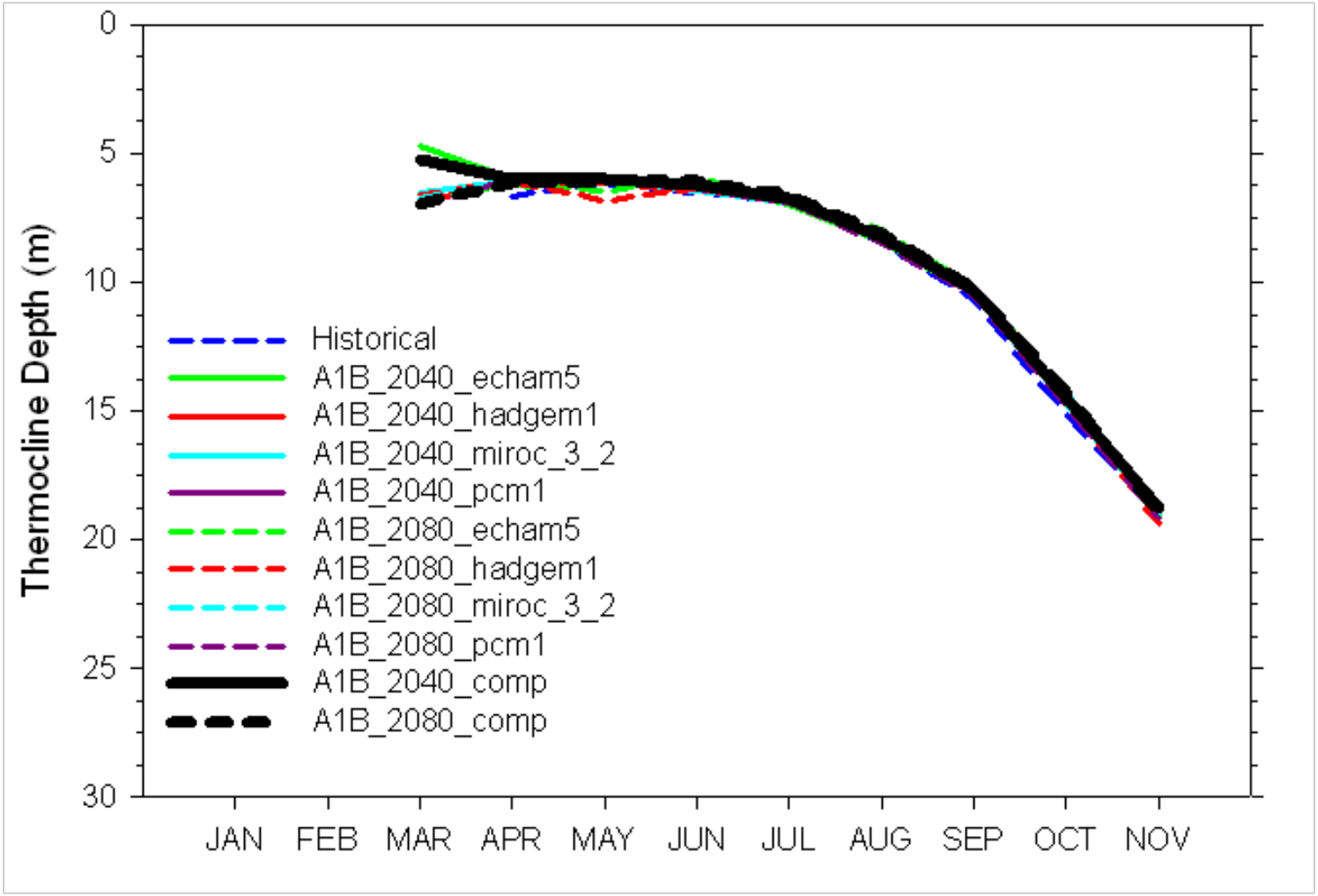
Note: Black line represents the 4 mg/L DO isopleth.

Monthly Average Suitable Habitat Volume Temperature<17° C & DO>4 mg/L



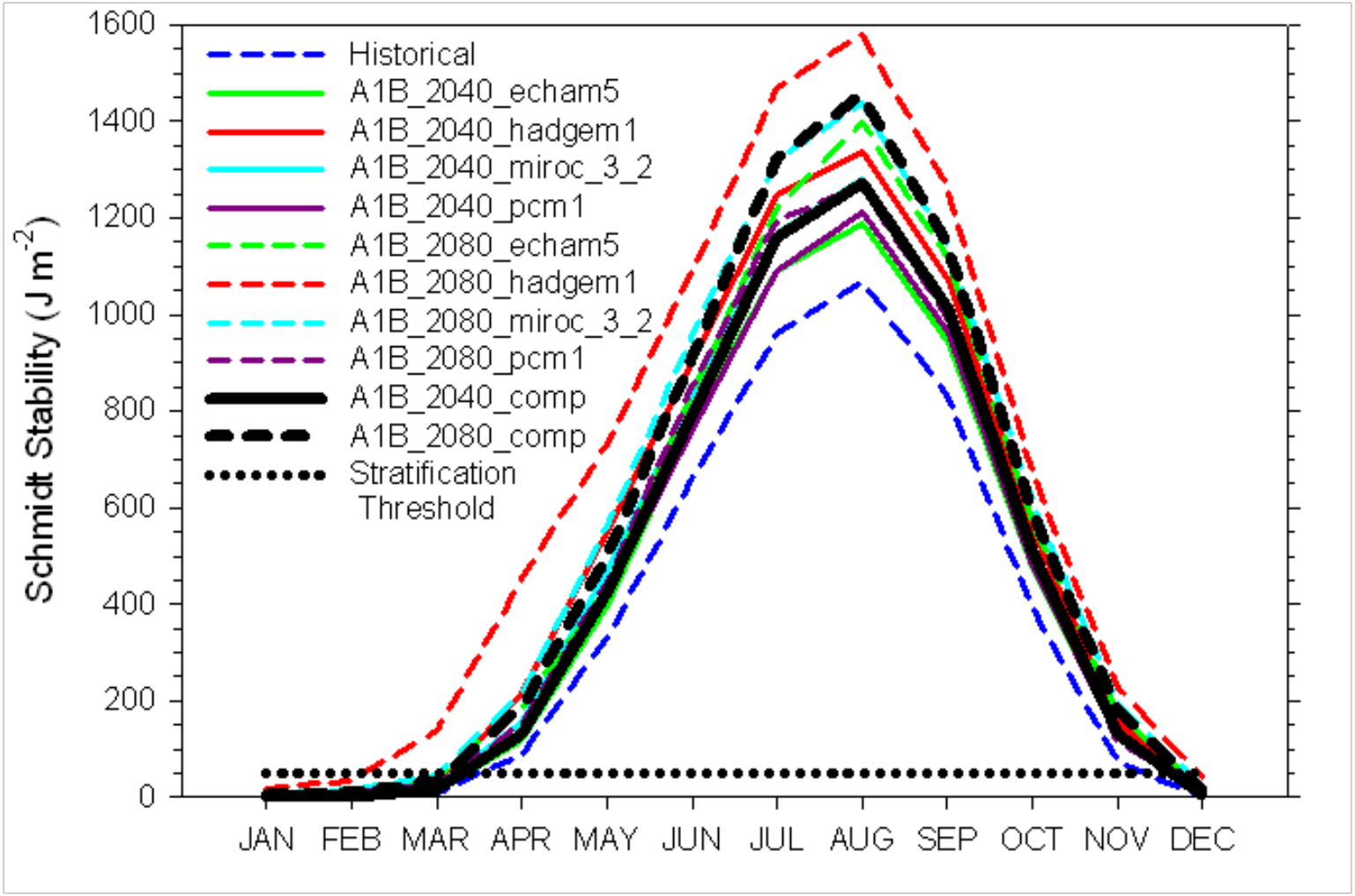
2-D Model

Monthly Average Thermocline Depth



3-D Model

Monthly Average Schmidt Stability

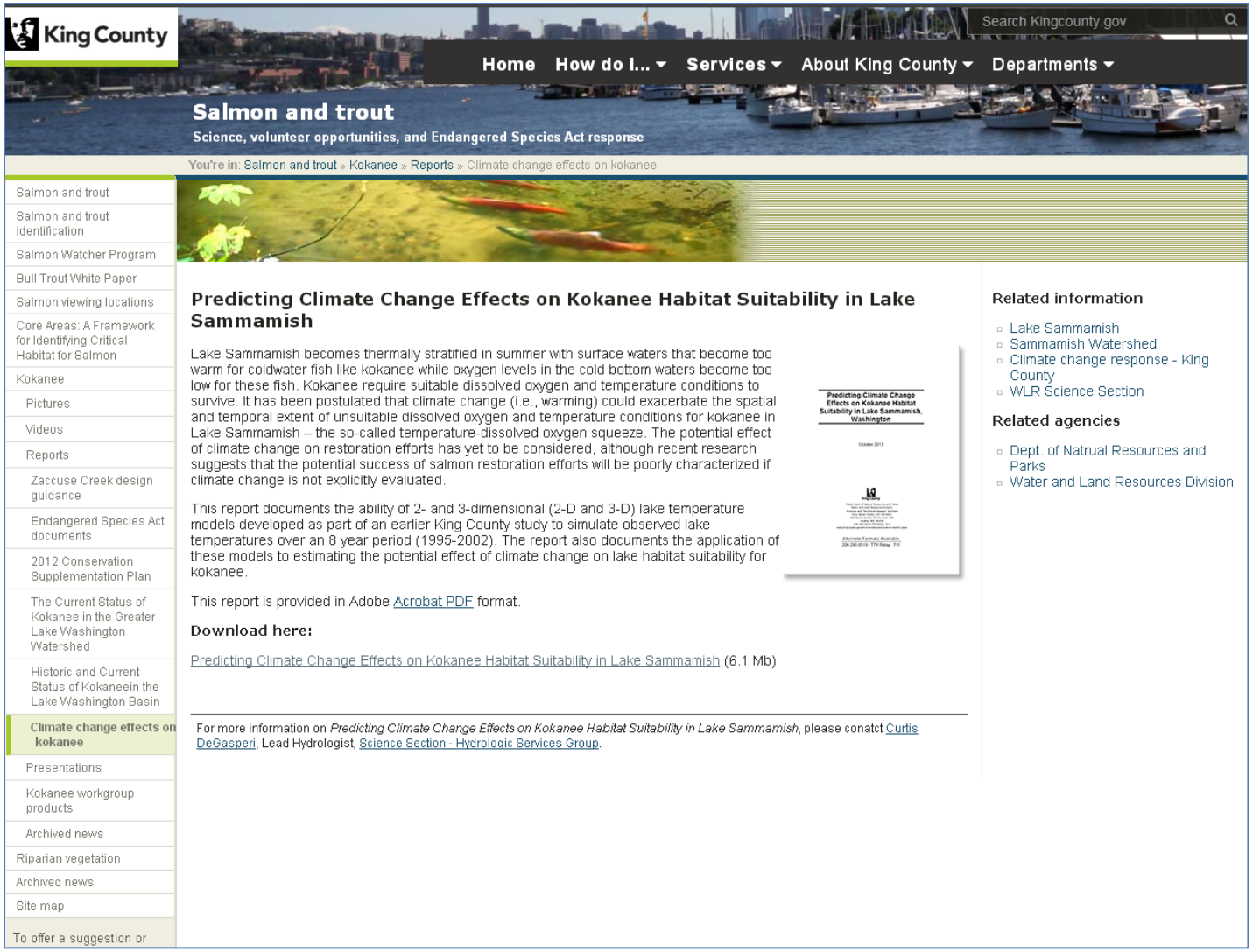


2-D Model

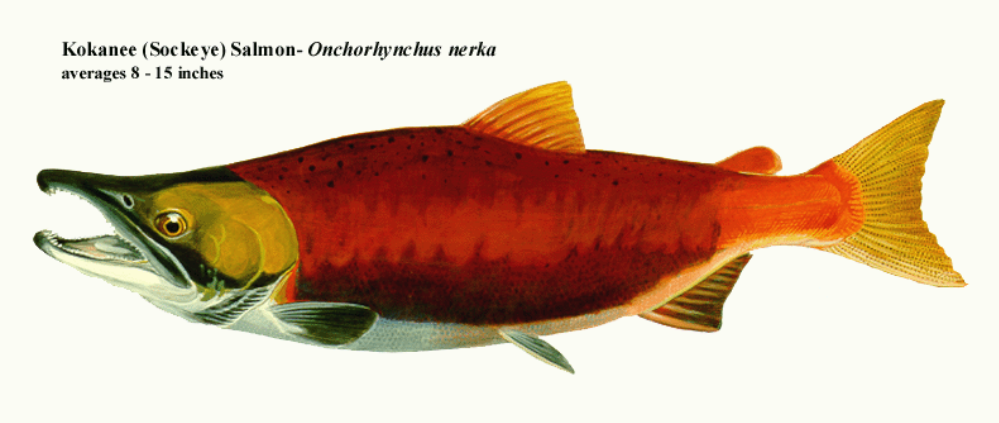
Recommendations

- Develop 1-D model for long-term simulations
- Include climate change effects on tributary temperatures and flows
- Develop water quality model (based on 1-D model above)
- Identify relationships between observed inter-annual variation in suitable habitat and kokanee survival and production

Report Available Online



http://www.kingcounty.gov/environment/animalsAndPlants/salmon-and-trout/kokanee/documents/climate-change-kokanee-habitat.aspx



Questions?

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Water Density vs Temperature