

Thermal conditions for Lake Sammamish kokanee

Historical and future projections

King County Water and Land Resources
Science Seminar

Thursday, October 24, 2013

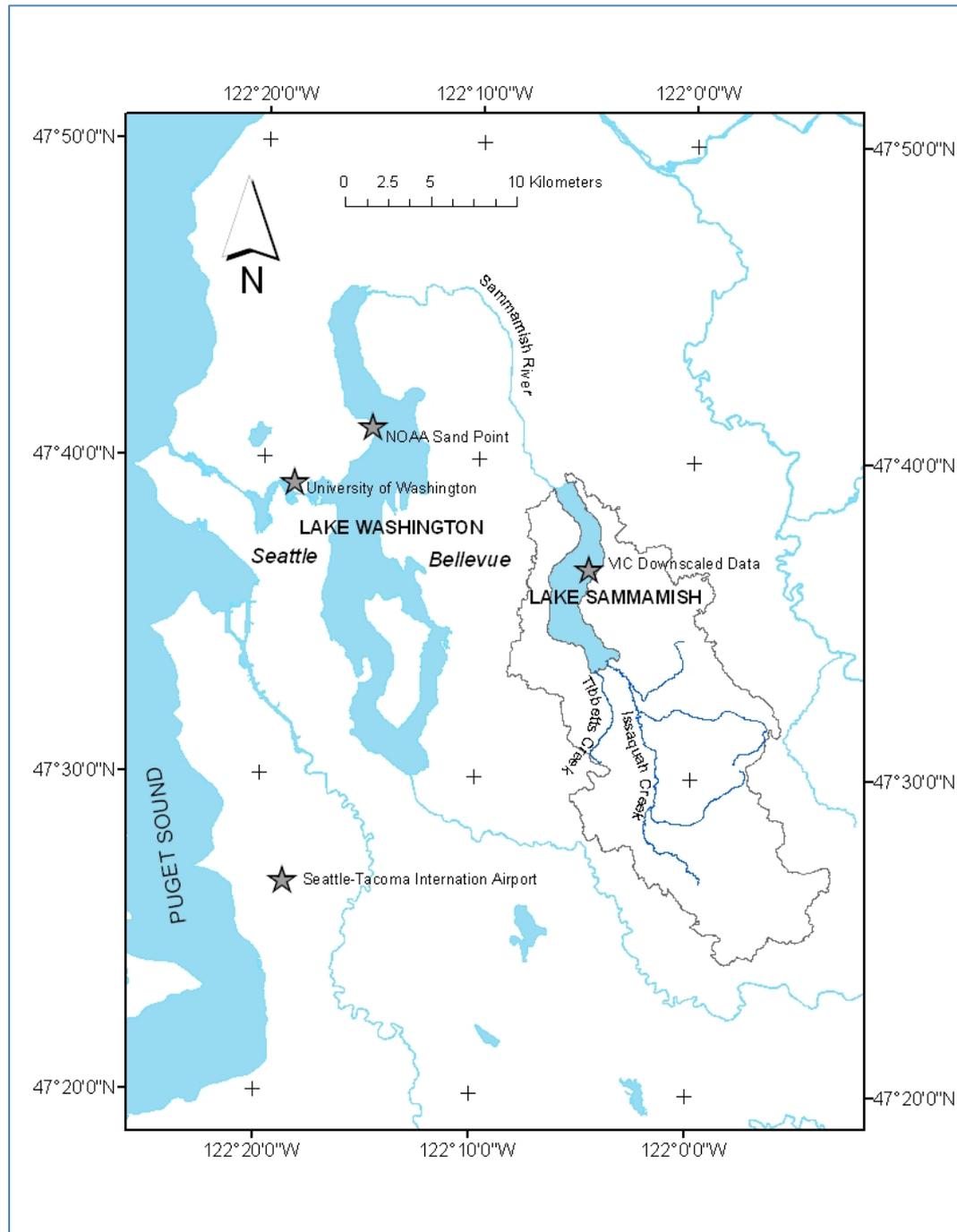
Curtis DeGasperi, King County WLRD Science Section

Kokanee (Sockeye) Salmon- *Onchorhynchus nerka*
averages 8 - 15 inches



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	



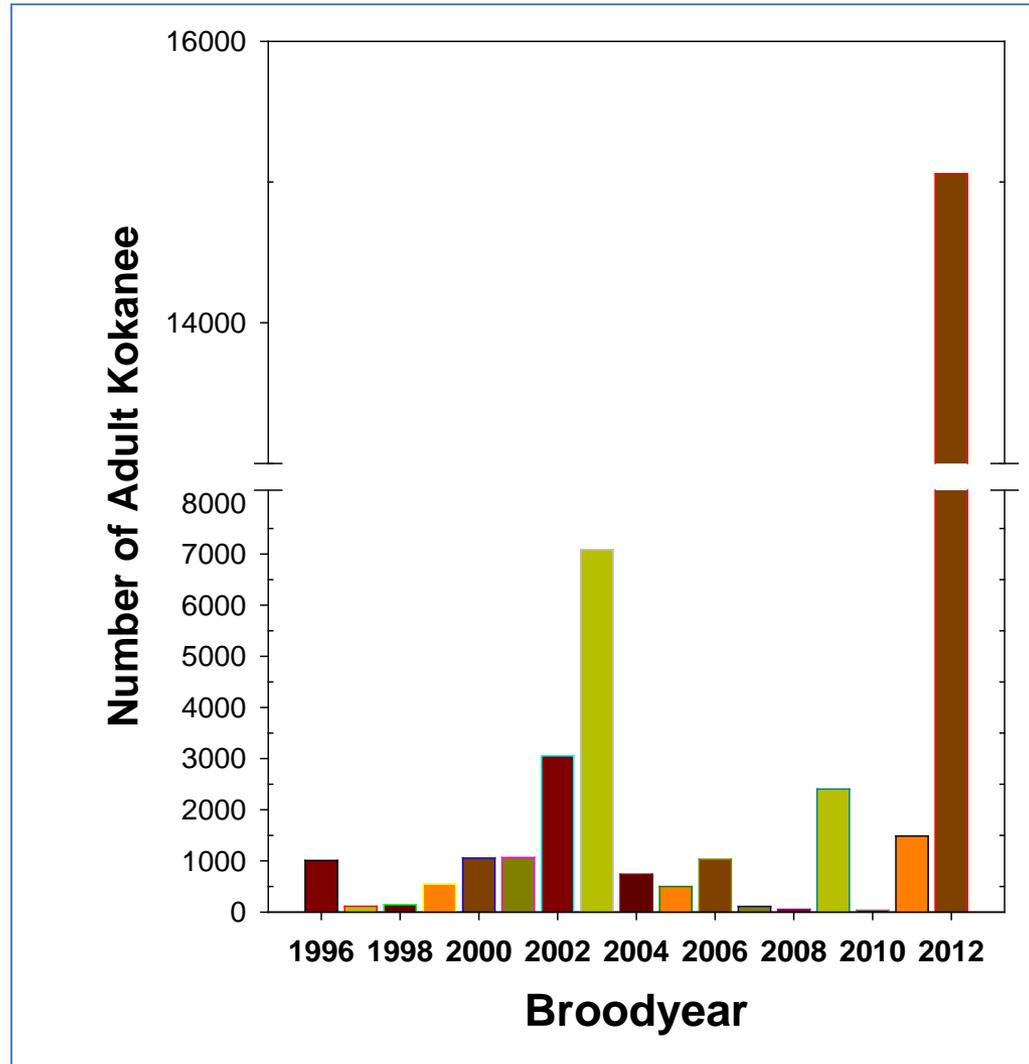
Kokanee

Background



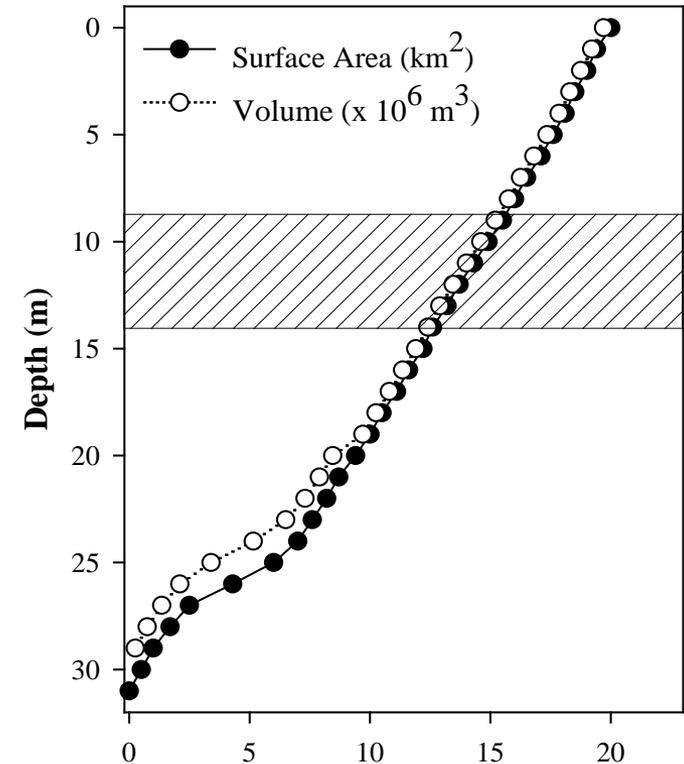
- Late run kokanee numbers have fluctuated in recent years
- Average age at maturity is 4 years
- They spawn in lake tributaries October through March
- Fish represented on spawning grounds resided in lake on average for three years prior to spawning

Late run kokanee escapement



Source: Hans Berge

Temperature-DO squeeze

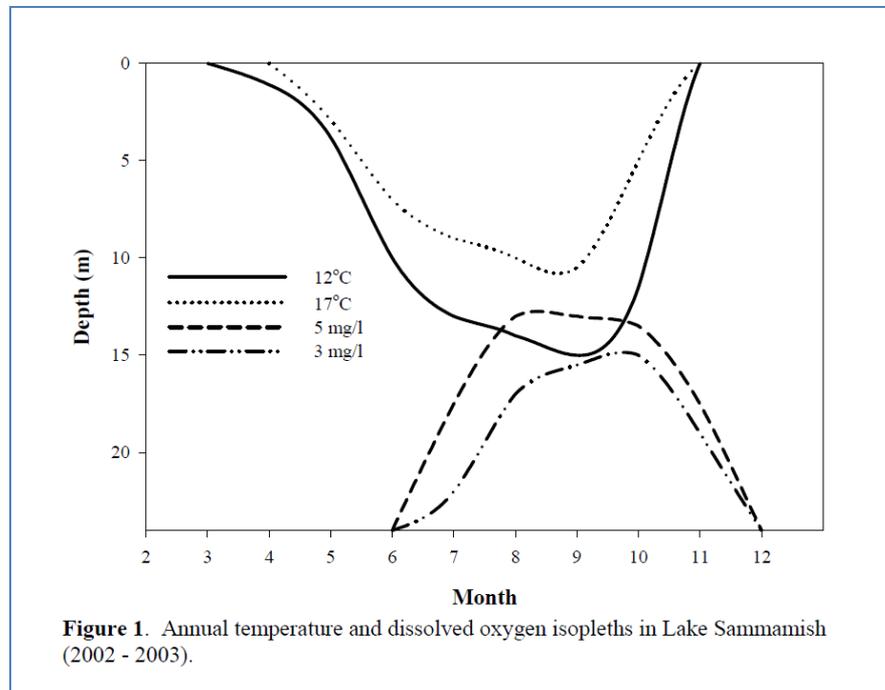


Berge, H. B. 2009. Effects of a temperature-oxygen squeeze on distribution, feeding, growth, and survival of kokanee (*Oncorhynchus nerka*) in Lake Sammamish, Washington. Master's Thesis, School of Aquatic and Fisheries Sciences, University of Washington. 84 p.

Temperature-DO squeeze (cont')

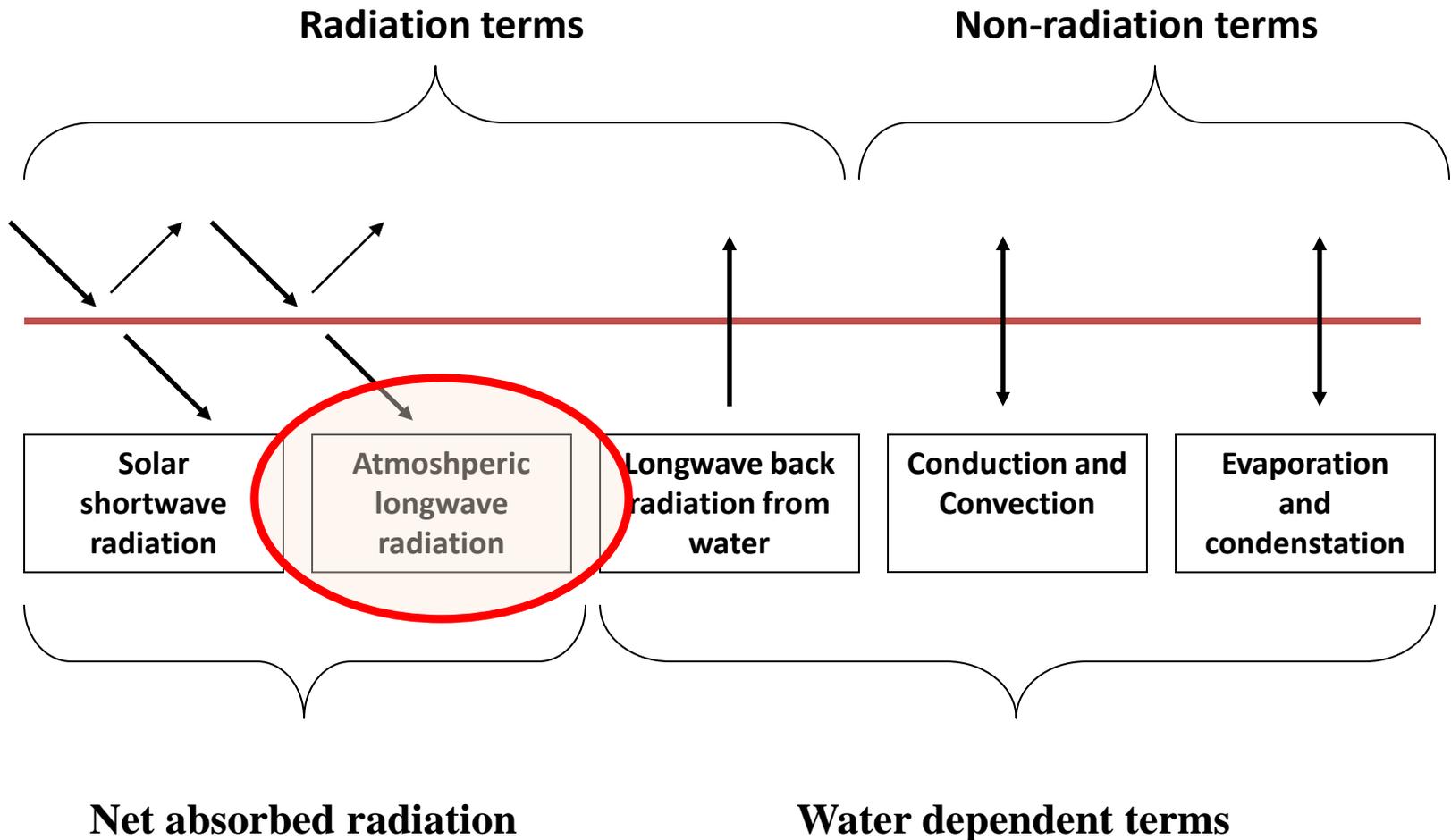
- July-September appears to be the most limiting period for lake kokanee growth

Source: Berge (2009)



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

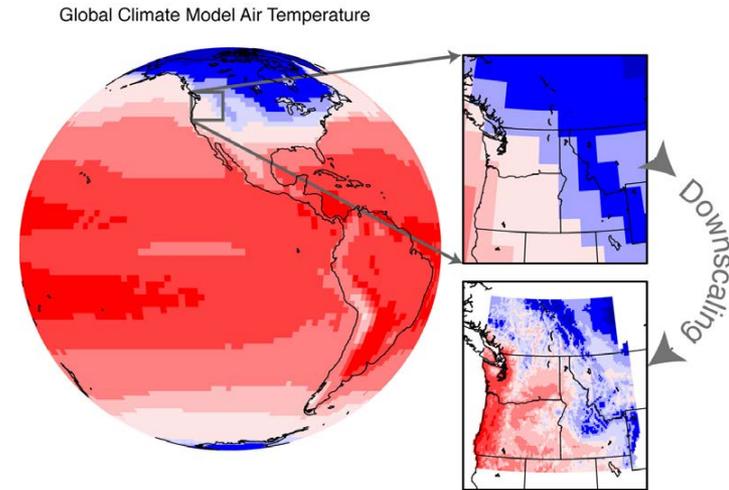


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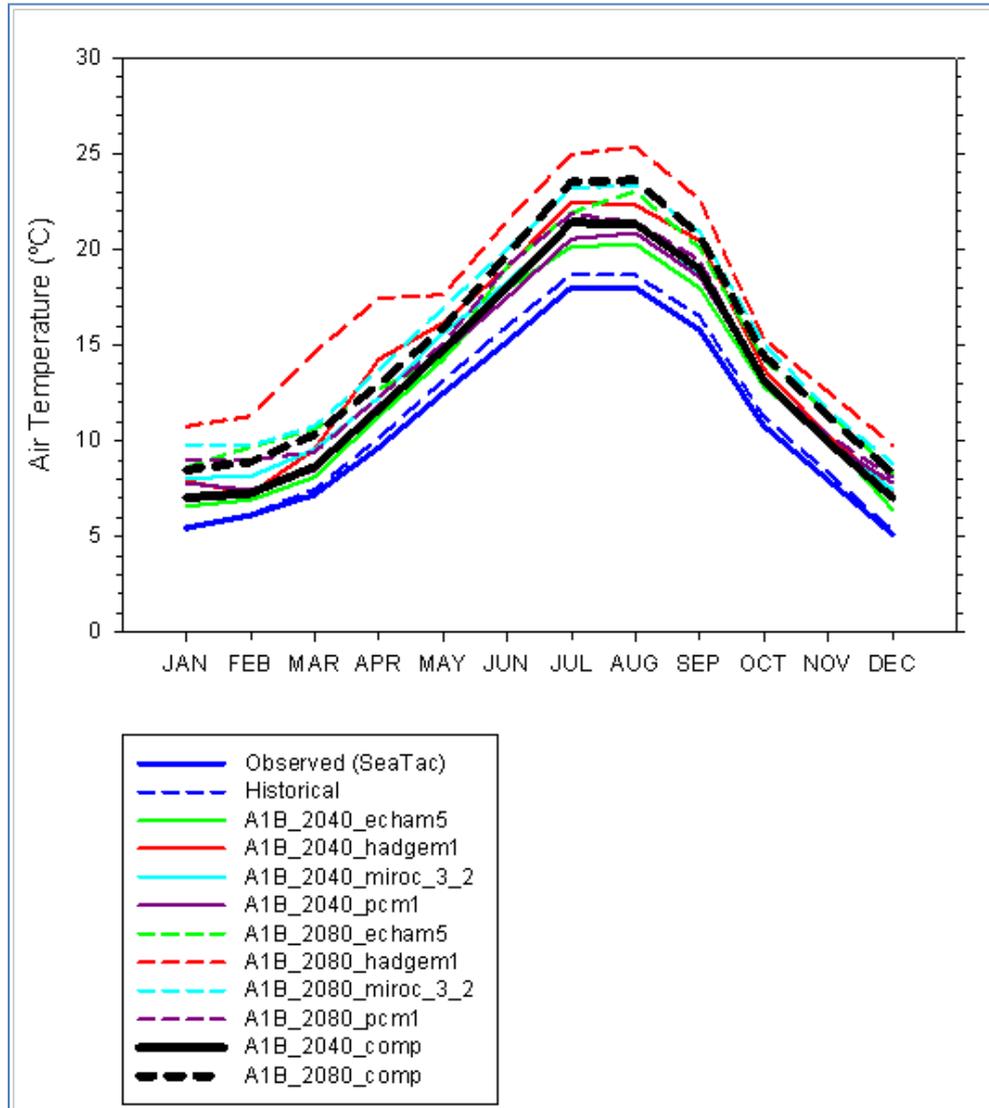
Downscaled Climate Data

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

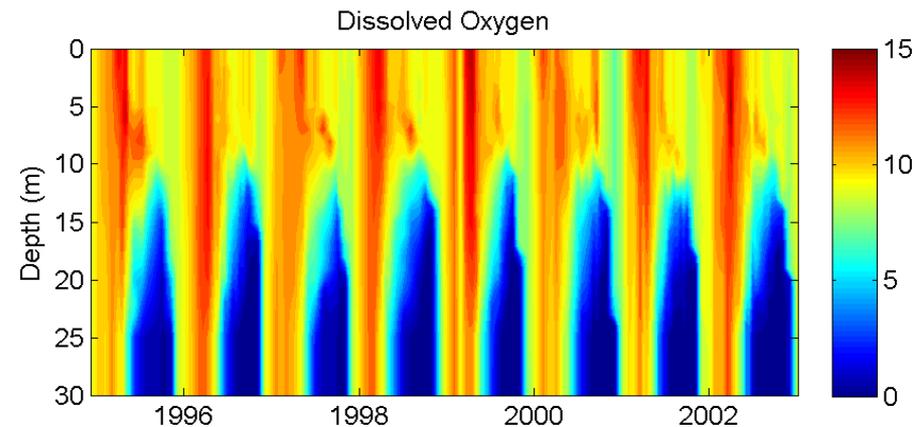
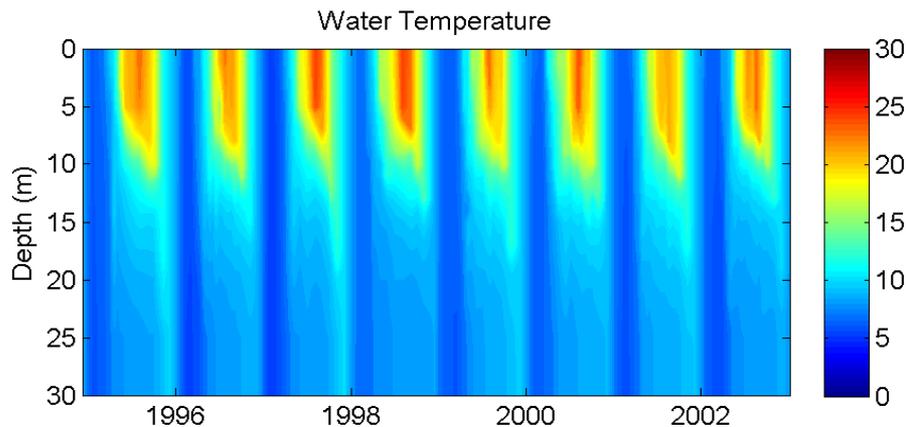
Air Temperature Summary



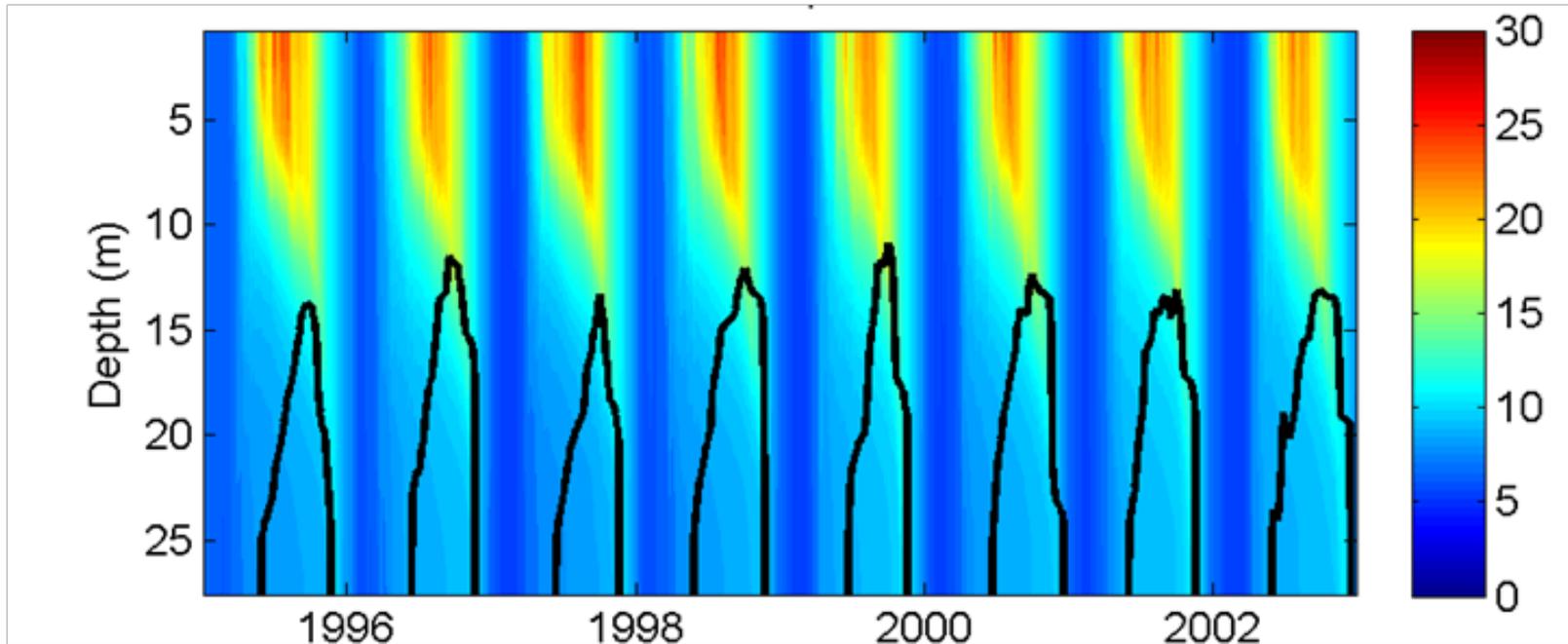
Temperature and DO thresholds

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

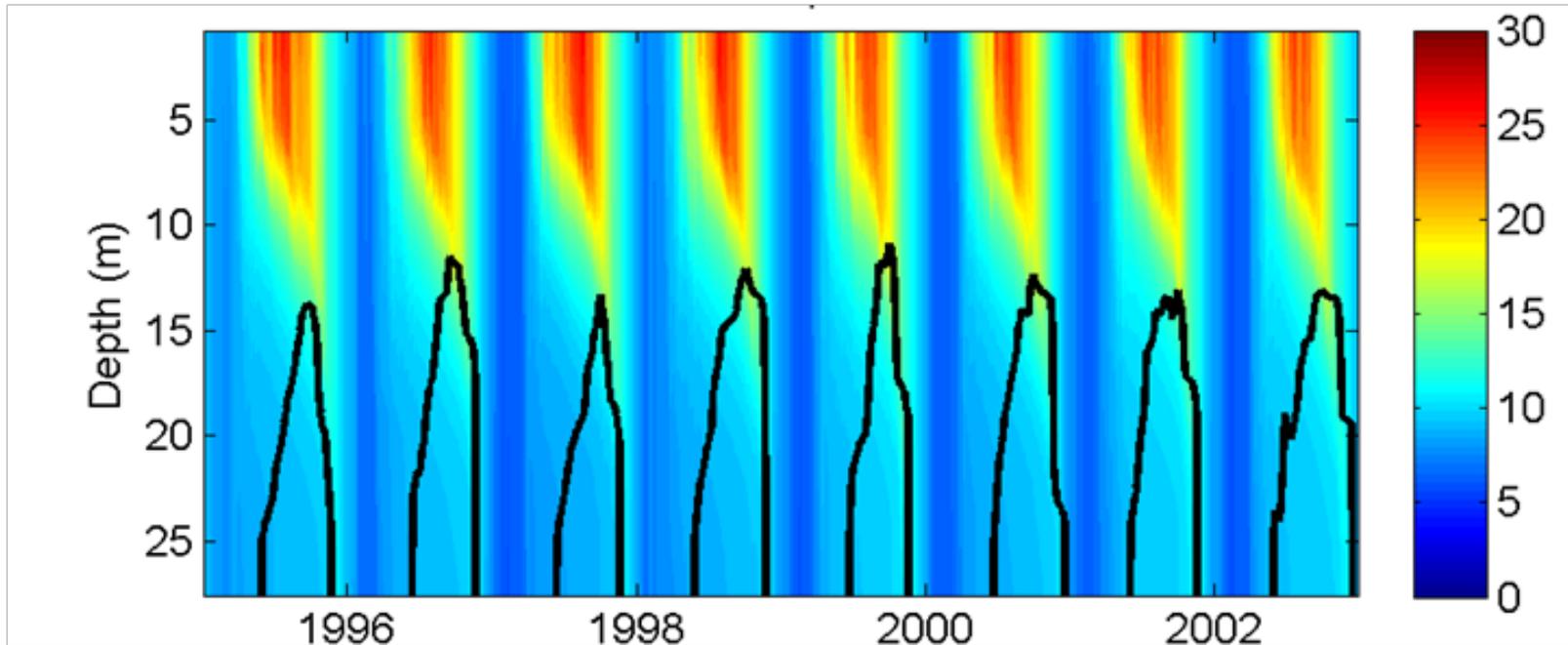


3-D Model – Historical Climate



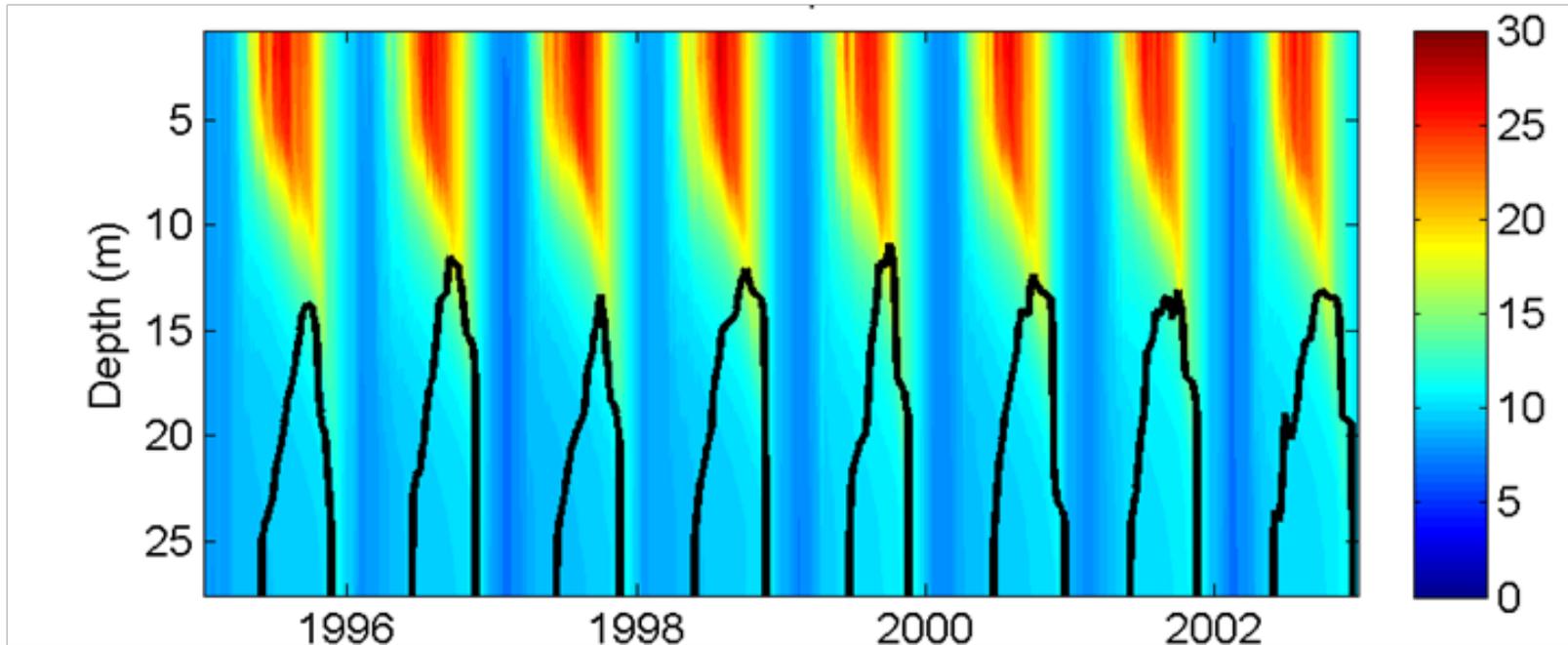
Note: Black line represents the 4 mg/L DO isopleth.

3-D Model – 2040s Composite Climate



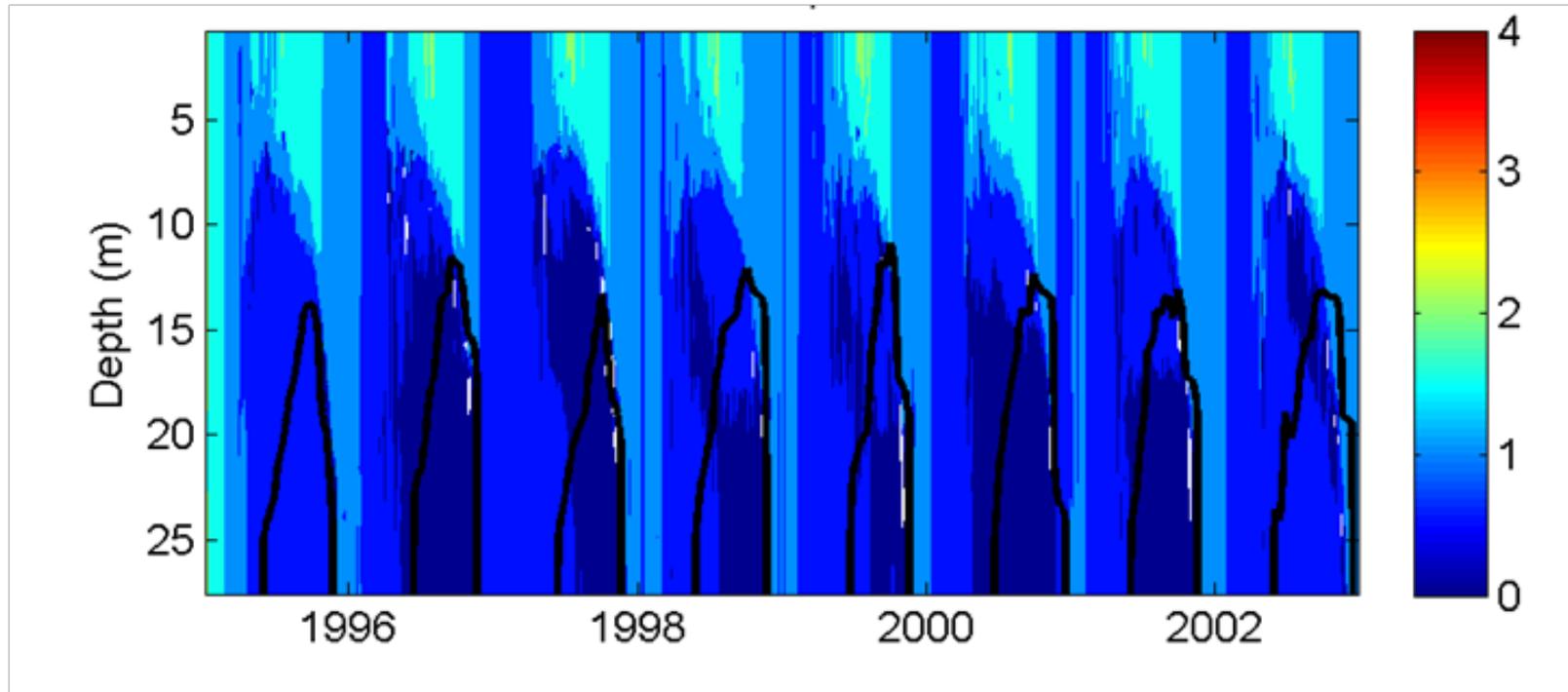
Note: Black line represents the 4 mg/L DO isopleth.

3-D Model – 2080s Composite Climate



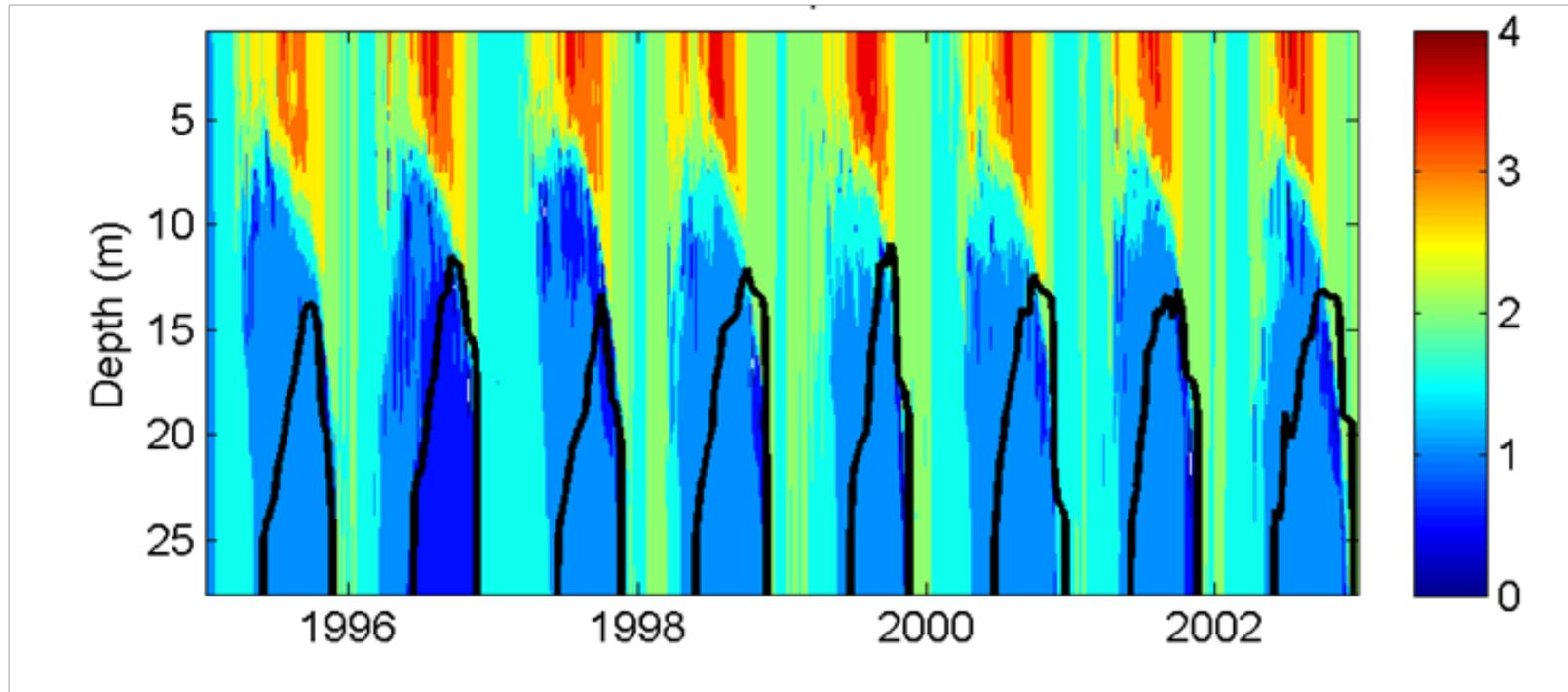
Note: Black line represents the 4 mg/L DO isopleth.

3-D Model – 2040s minus Historical



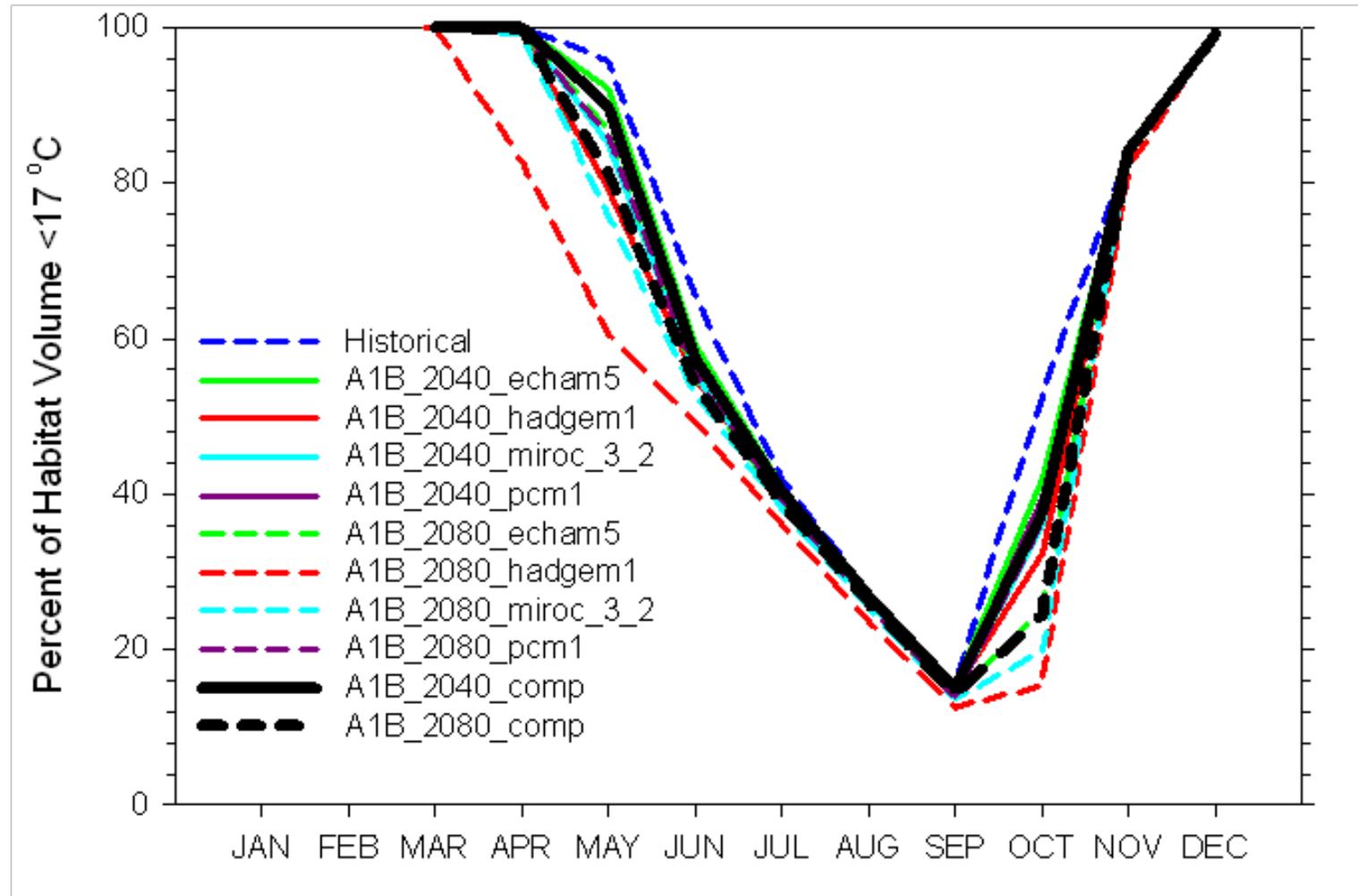
Note: Black line represents the 4 mg/L DO isopleth.

3-D Model – 2080s minus Historical



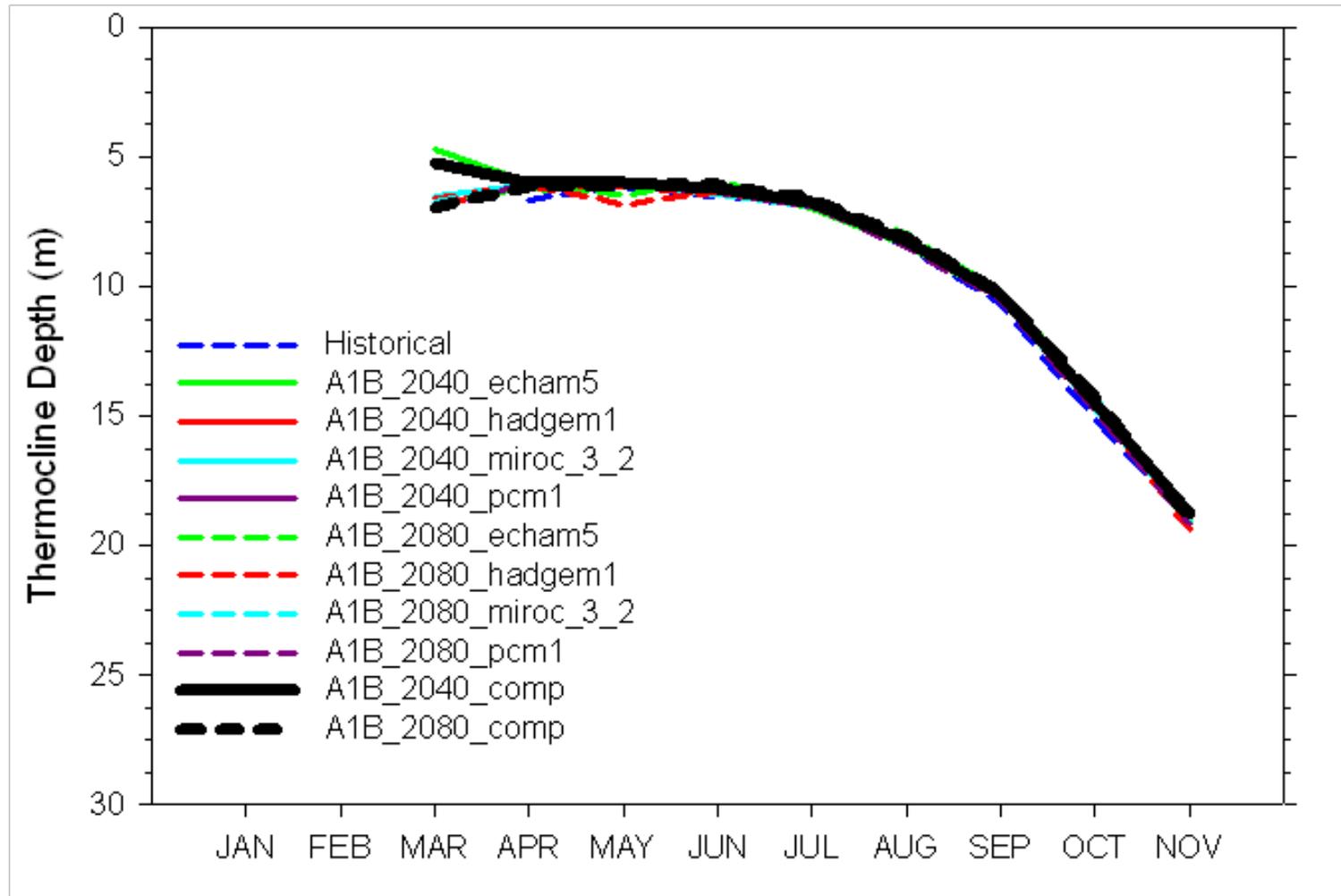
Note: Black line represents the 4 mg/L DO isopleth.

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



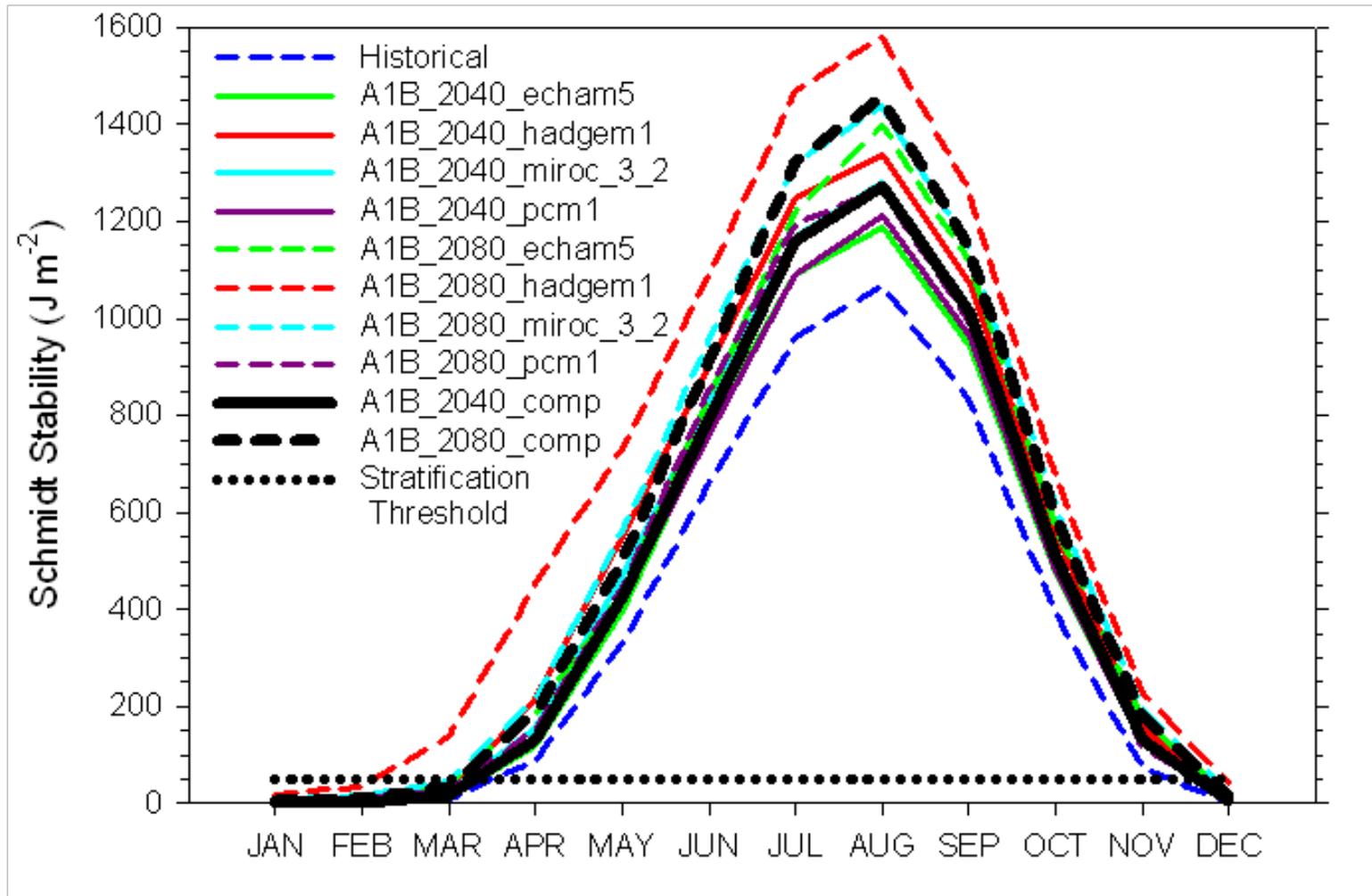
2-D Model

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

The screenshot shows the King County website interface. At the top left is the King County logo. A search bar is located at the top right. A navigation menu includes 'Home', 'How do I...', 'Services', 'About King County', and 'Departments'. The main content area features a banner for 'Salmon and trout' with the subtitle 'Science, volunteer opportunities, and Endangered Species Act response'. Below the banner is a breadcrumb trail: 'You're in: Salmon and trout » Kokanee » Reports » Climate change effects on kokanee'. A left sidebar contains a list of navigation links, with 'Climate change effects on kokanee' highlighted. The main content area displays the report title 'Predicting Climate Change Effects on Kokanee Habitat Suitability in Lake Sammamish' and a paragraph of text. To the right of the text is a thumbnail image of the report cover. Further right is a 'Related information' section with a list of links and a 'Related agencies' section with two links. At the bottom of the main content area, there is a 'Download here:' section with a link to the report PDF (6.1 Mb) and a note about contacting Curtis DeGasperi for more information.

King County Search Kingcounty.gov

Home How do I... Services About King County Departments

Salmon and trout

Science, volunteer opportunities, and Endangered Species Act response

You're in: Salmon and trout » Kokanee » Reports » Climate change effects on kokanee

- Salmon and trout
- Salmon and trout identification
- Salmon Watcher Program
- Bull Trout White Paper
- Salmon viewing locations
- Core Areas: A Framework for Identifying Critical Habitat for Salmon
- Kokanee
 - Pictures
 - Videos
 - Reports
 - Zaccuse Creek design guidance
 - Endangered Species Act documents
 - 2012 Conservation Supplementation Plan
 - The Current Status of Kokanee in the Greater Lake Washington Watershed
 - Historic and Current Status of Kokanee in the Lake Washington Basin
 - Climate change effects on kokanee**
 - Presentations
 - Kokanee workgroup products
 - Archived news
 - Riparian vegetation
 - Archived news
 - Site map
 - To offer a suggestion or

Predicting Climate Change Effects on Kokanee Habitat Suitability in Lake Sammamish

Lake Sammamish becomes thermally stratified in summer with surface waters that become too warm for coldwater fish like kokanee while oxygen levels in the cold bottom waters become too low for these fish. Kokanee require suitable dissolved oxygen and temperature conditions to survive. It has been postulated that climate change (i.e., warming) could exacerbate the spatial and temporal extent of unsuitable dissolved oxygen and temperature conditions for kokanee in Lake Sammamish – the so-called temperature-dissolved oxygen squeeze. The potential effect of climate change on restoration efforts has yet to be considered, although recent research suggests that the potential success of salmon restoration efforts will be poorly characterized if climate change is not explicitly evaluated.

This report documents the ability of 2- and 3-dimensional (2-D and 3-D) lake temperature models developed as part of an earlier King County study to simulate observed lake temperatures over an 8 year period (1995-2002). The report also documents the application of these models to estimating the potential effect of climate change on lake habitat suitability for kokanee.

This report is provided in Adobe [Acrobat PDF](#) format.

Download here:

[Predicting Climate Change Effects on Kokanee Habitat Suitability in Lake Sammamish](#) (6.1 Mb)

For more information on *Predicting Climate Change Effects on Kokanee Habitat Suitability in Lake Sammamish*, please contact [Curtis DeGasperi](#), Lead Hydrologist, [Science Section - Hydrologic Services Group](#).

Related information

- Lake Sammamish
- Sammamish Watershed
- Climate change response - King County
- WLR Science Section

Related agencies

- Dept. of Natural Resources and Parks
- Water and Land Resources Division

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

Kokanee (Sockeye) Salmon- *Onchorhynchus nerka*
averages 8 - 15 inches



Questions?

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Science Section

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Water Density vs Temperature

