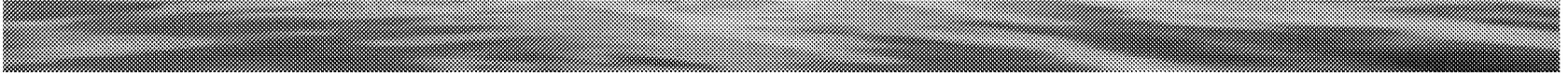




# Climate Change and Pacific Fisheries

*Prepared for DFO Fall Consultations 2008*





## Outline

- The Global Picture – result from the IPCC
- What has been happening in BC?
- Climate change impacts – fresh water, coastal and open ocean
- What can we expect?
- What are we doing about it?

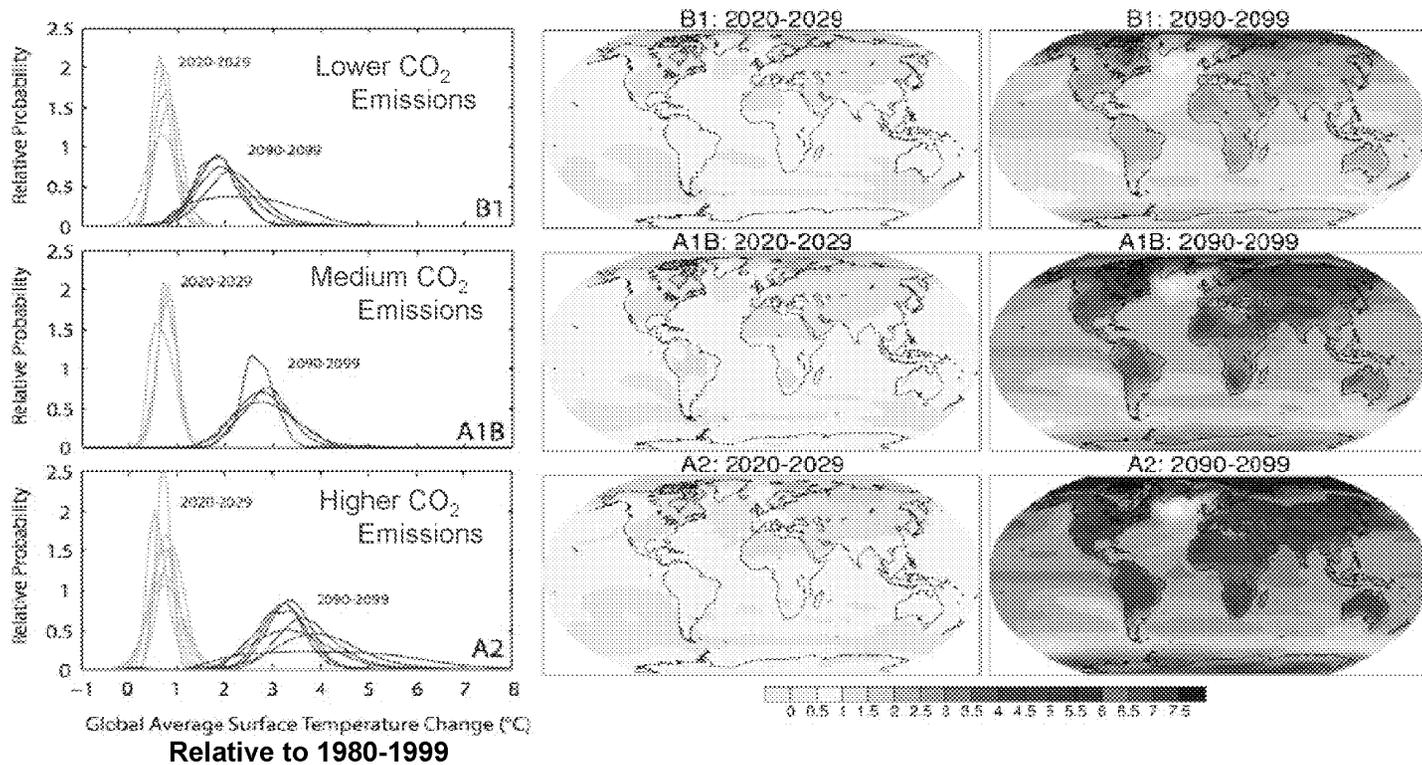
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# Temperature – greatest warming over land and at high latitudes

## AOGCM Projections of Surface Temperatures



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## Decline in Arctic Sea Ice

- The summer extent of sea ice is important for transportation and Arctic marine ecosystems.
- The global models are doing a fairly poor job of predicting this.
- These changes are important for Arctic communities



~ Minimum extent  
of ice cover 2005

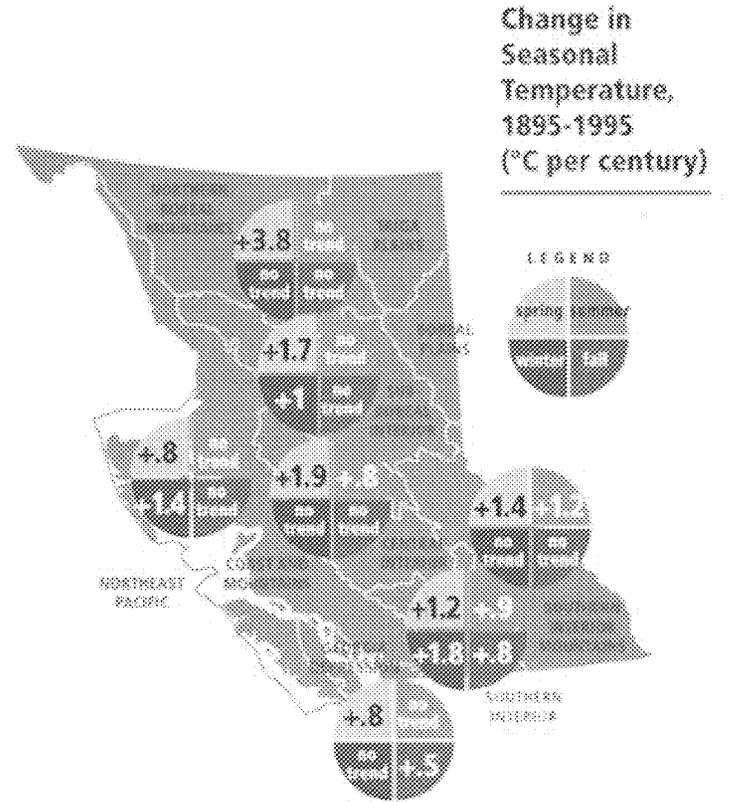
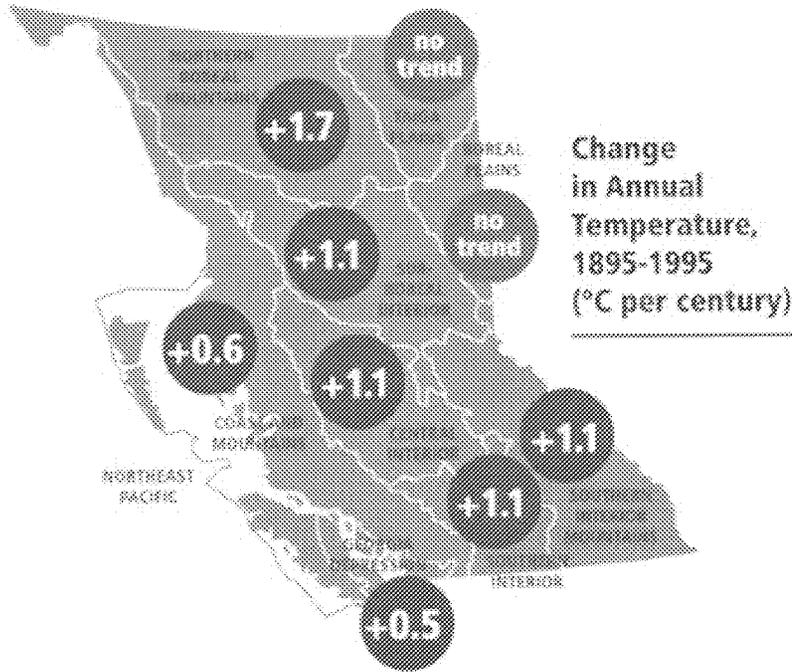
~ Median minimum extent  
of ice cover (1979-2000)

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# Air temperature is increasing



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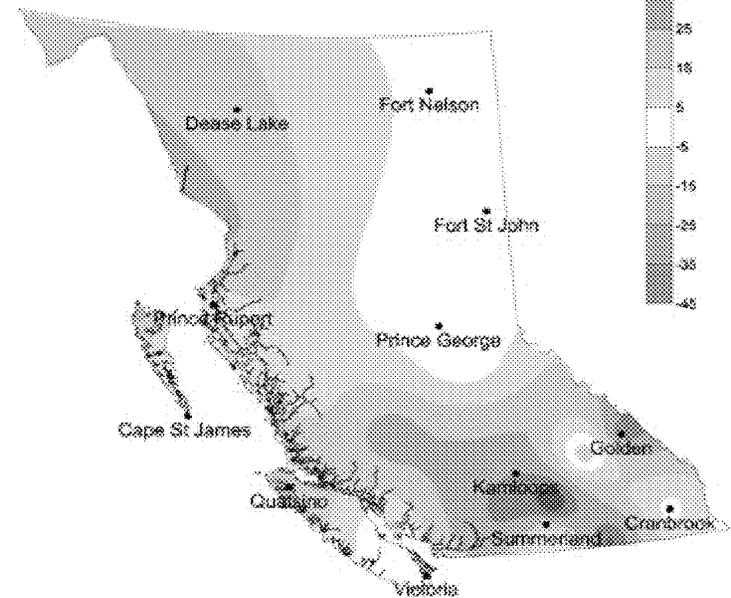
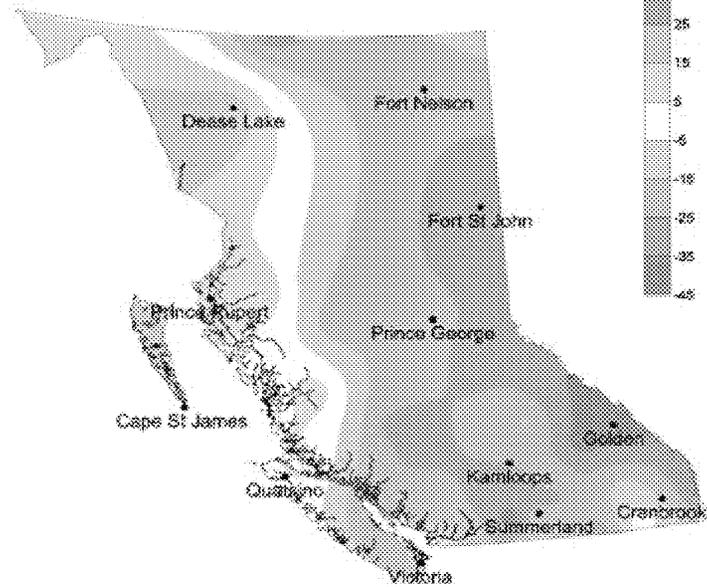
## Trend in Winter Precipitation from 1950

## Trend in Summer Precipitation from 1950

Decreasing over most  
of the province

Increasing over most of  
the province

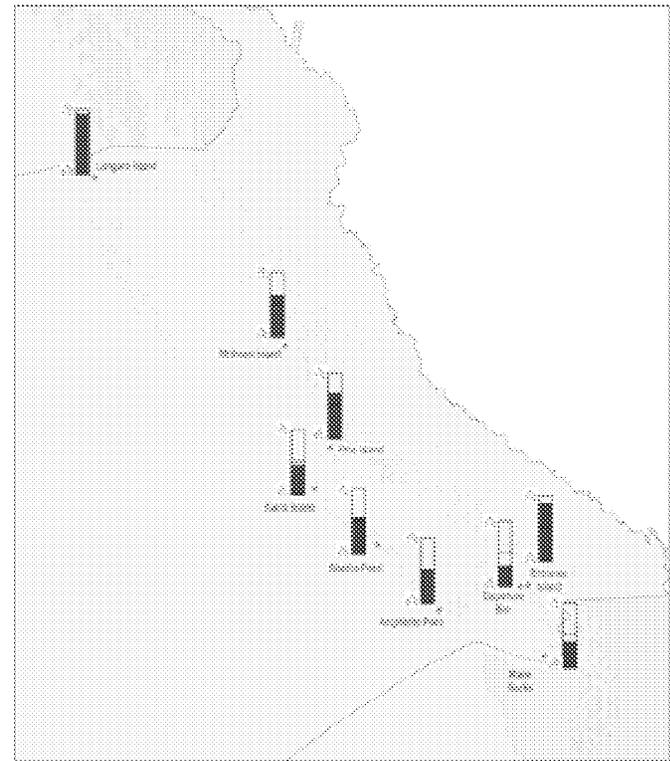
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## Sea Surface Temperatures are increasing

SST has risen  
between 0.3 and  
0.9 degrees over  
the last 50 years



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## Impacts on the aquatic ecosystems – Fresh Water

- Changing pattern of run-off in BC rivers
  - more flow in winter; reduced spring run-off
- More frequent occurrence of high mortality events for returning salmon on the Fraser.
- Lake habitat for juvenile salmon is “squeezed”
  - surface waters become too warm and warmer surface waters reduce lake mixing. The reduced lake mixing leads to bottom waters where the oxygen is too low.

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## Impacts on the aquatic ecosystems – the coastal ocean

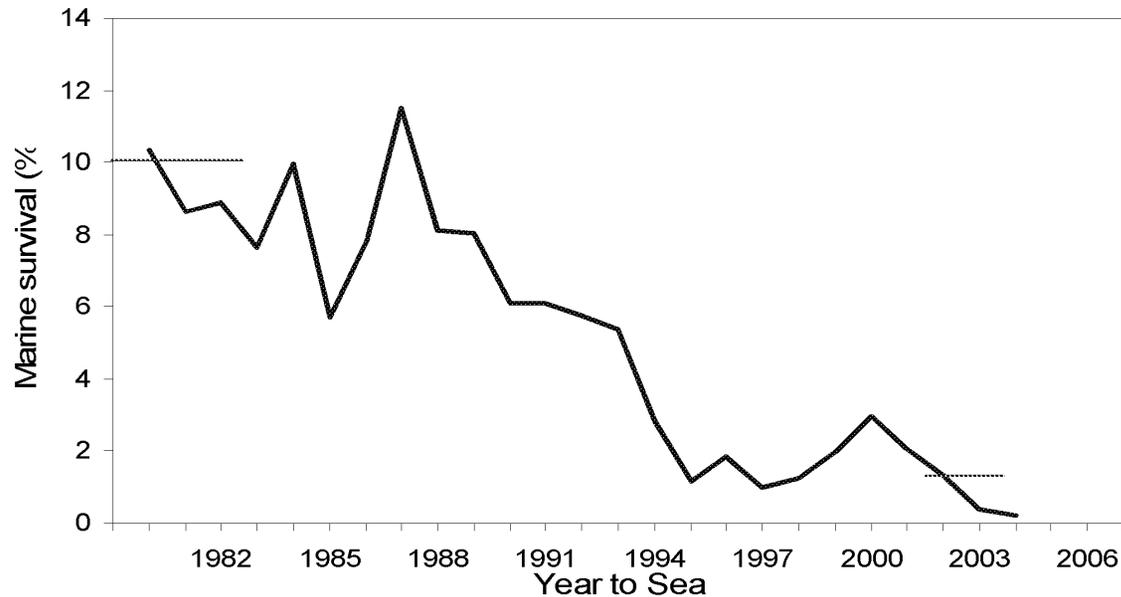
- Changes in ocean productivity
  - warming in the Strait of Georgia is reducing the prey available to coho and chinook salmon. They grow less and have higher mortality over the winter when ocean conditions are harsher.
- Changes in the abundance and distribution of marine fish
  - e.g. Pacific Hake and Sardines
- Changes in the “timing” of events in the annual cycle
  - will there be appropriate food available when young fish enter the coastal ocean?

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## Impacts on the coastal and continental shelf – survival of coho salmon in the Strait of Georgia



Warming in the Strait of Georgia is reducing the prey available to coho and chinook salmon. They grow less and have higher mortality over the winter when ocean conditions are harsher.



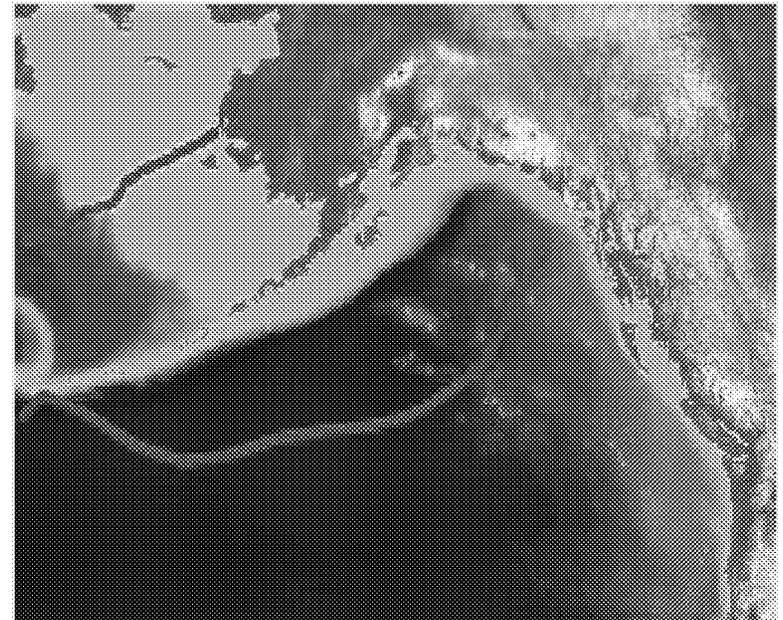


## Impacts in the open ocean – reduction in habitat for sockeye in the North Pacific?

*Projected southern limit of  
sockeye salmon under a  
doubling of CO2 climate  
change scenario*



*1995 southern limit of  
sockeye salmon distribution*



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## What can we expect?

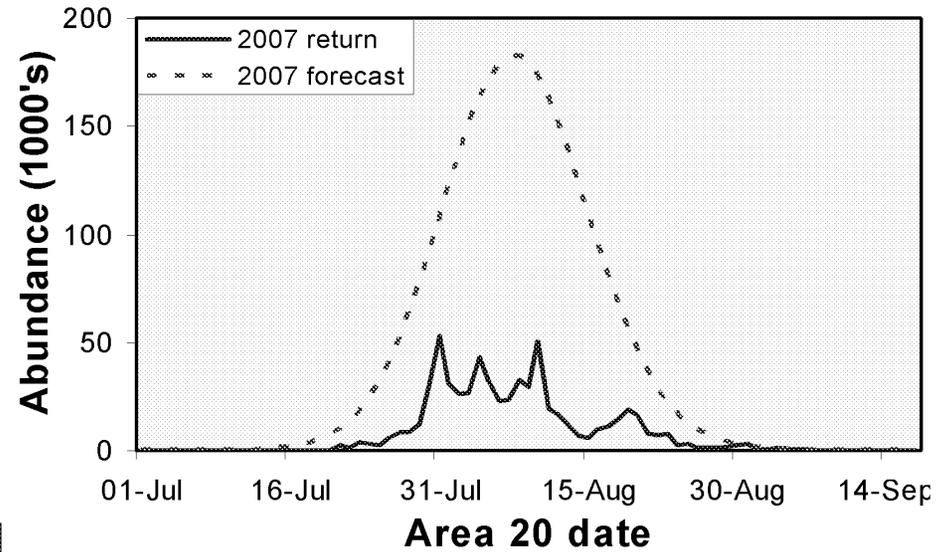
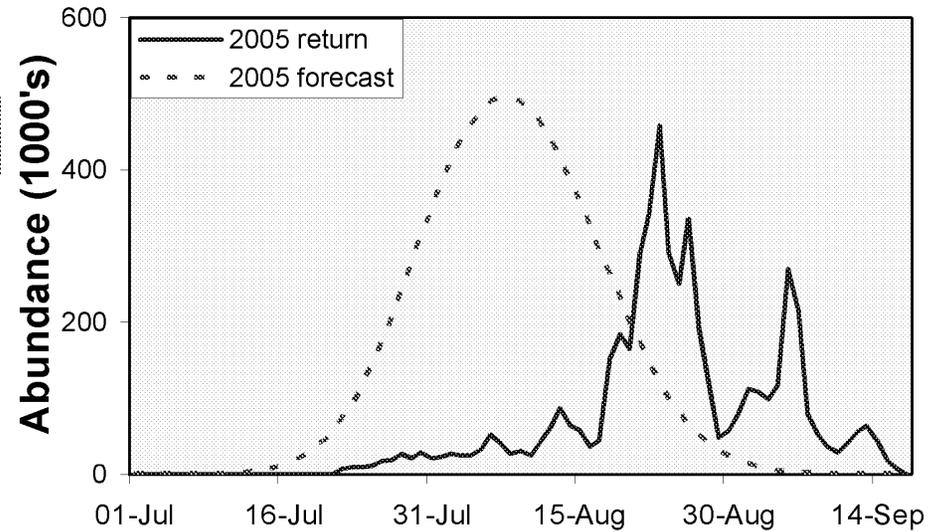
- Changes will not be “smooth”
- Our ability to predict future status of fish stocks will likely decrease
  - we are moving out of the historical range of our observations
- We will face some new issues and challenges
  - Hypoxia (low oxygen) in coastal waters
  - Ocean acidification
  - Invasive or “unusual” species





### Forecasting challenges: Fraser River summer run sockeye

- In 2005, ABUNDANCE was reasonably well forecast but TIMING was off.
- In 2007, ABUNDANCE was significantly over-estimated, but TIMING was fine.



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## What is DFO doing about this?

- **Monitoring**
  - open ocean, coastal and freshwater to detect /quantify changes (e.g. Wild Salmon Policy Strategy 1- standardization of monitoring of wild salmon status Strategy 1; WSP Strategy 3-Inclusion of ecosystem values and monitoring))
- **Research**
  - The role of the ocean in climate change
  - Regional climate modeling and projections (with Environment Canada)
  - Impacts of climate change (e.g. WSP Strategy 3-Inclusion of ecosystem values and monitoring)
  - Preserve biodiversity (e.g. WSP Objective 1- Safeguard the genetic diversity of salmon)
  - Adaptation Research (some exciting new tools for this)
- **Operations**
  - Develop and implement systems/approaches to manage the impacts (e.g. Fraser River Environmental Watch)

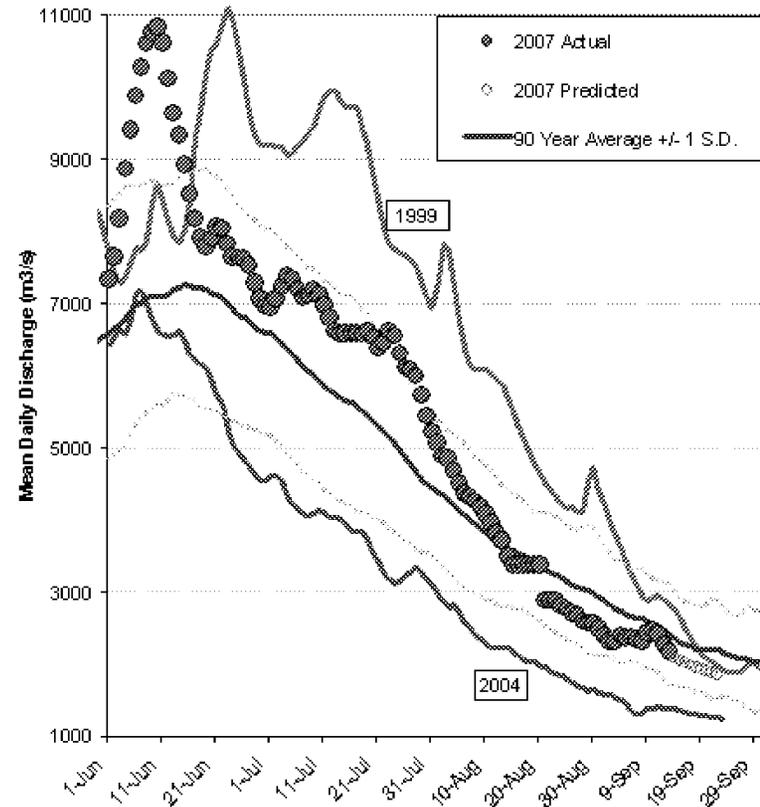
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## Operational Models to guide in-season decision-making

- A numerical model predicts Fraser River flow and temperature conditions
- These predictions drive a biological effects model to estimate in-river mortality
- If required, harvest levels are reduced to compensate for excessive predicted in-river mortality



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## Summary

- Global models predict more warming
- Changes will not be “smooth”
- Predictions of the future status of fish stocks will become more uncertain – salmon are a particularly difficult problem
- New issues will likely arise (e.g. hypoxia)
- Monitoring and adaptation research may provide some hope for improved understanding and predictions





## Some Recommended Reading

|  |  |
|--|--|
| PCC 4 <sup>th</sup> Assessment Report: Summary for Policy Makers | GOOGLE: IPCC Summary for Policy Makers or<br><a href="http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf">http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf</a> |
| DFO's State of the Ocean Report                                  | <a href="http://www.dfo-mpo.gc.ca/csas/Csas/Publications/ResDocs-DocRech/2008/2008_013_e.htm">http://www.dfo-mpo.gc.ca/csas/Csas/Publications/ResDocs-DocRech/2008/2008_013_e.htm</a>        |
| From Impacts to Adaptation: Canada in a Changing Climate 2007    | GOOGLE: Canada in a Changing Climate 2007 or<br><a href="http://adaptation.nrcan.gc.ca/assess/2007/index_e.php">http://adaptation.nrcan.gc.ca/assess/2007/index_e.php</a>                    |
| British Columbia's Coastal Coast Environment                     | <a href="http://www.env.gov.bc.ca/soe/bcce/">http://www.env.gov.bc.ca/soe/bcce/</a>  |
| Keeping our Cool' by Andrew Weaver (2008)                        | Penguin Books QC981.8.G56W42<br>ISBN 978-0-670-06800-5   |
| Climate Effects on Pacific Salmon in the Ocean                   | <a href="http://www.fish.bc.ca/files/ClimateEffectsPacificSalmonOcean_2008_0_Ccomplete_0.pdf">http://www.fish.bc.ca/files/ClimateEffectsPacificSalmonOcean_2008_0_Ccomplete_0.pdf</a>        |

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## DISCUSSION QUESTIONS

- What do you think about what you have heard?
- Based on your experience, are there other climate change impacts on fisheries in your region that you would like to highlight?
- What steps could be taken within the fisheries to monitor or address the impacts of climate change:
  - By you?
  - Your community/organization?
  - By government (DFO, Ministry of Environment, etc.)?

