

# COLUMBIA RIVER SALMON CUMULATIVE IMPACTS EXAMPLE

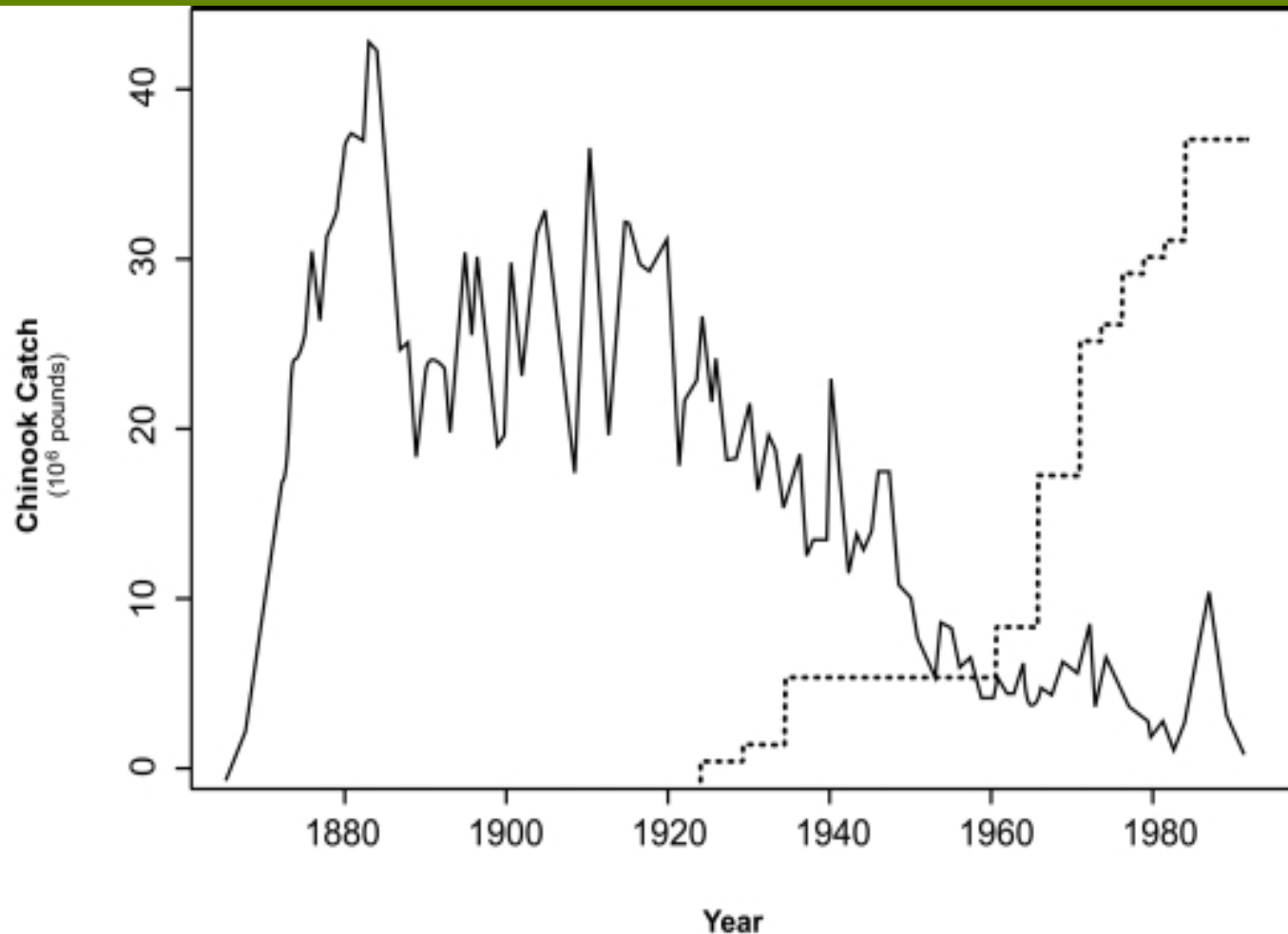


# Example Learning Goals

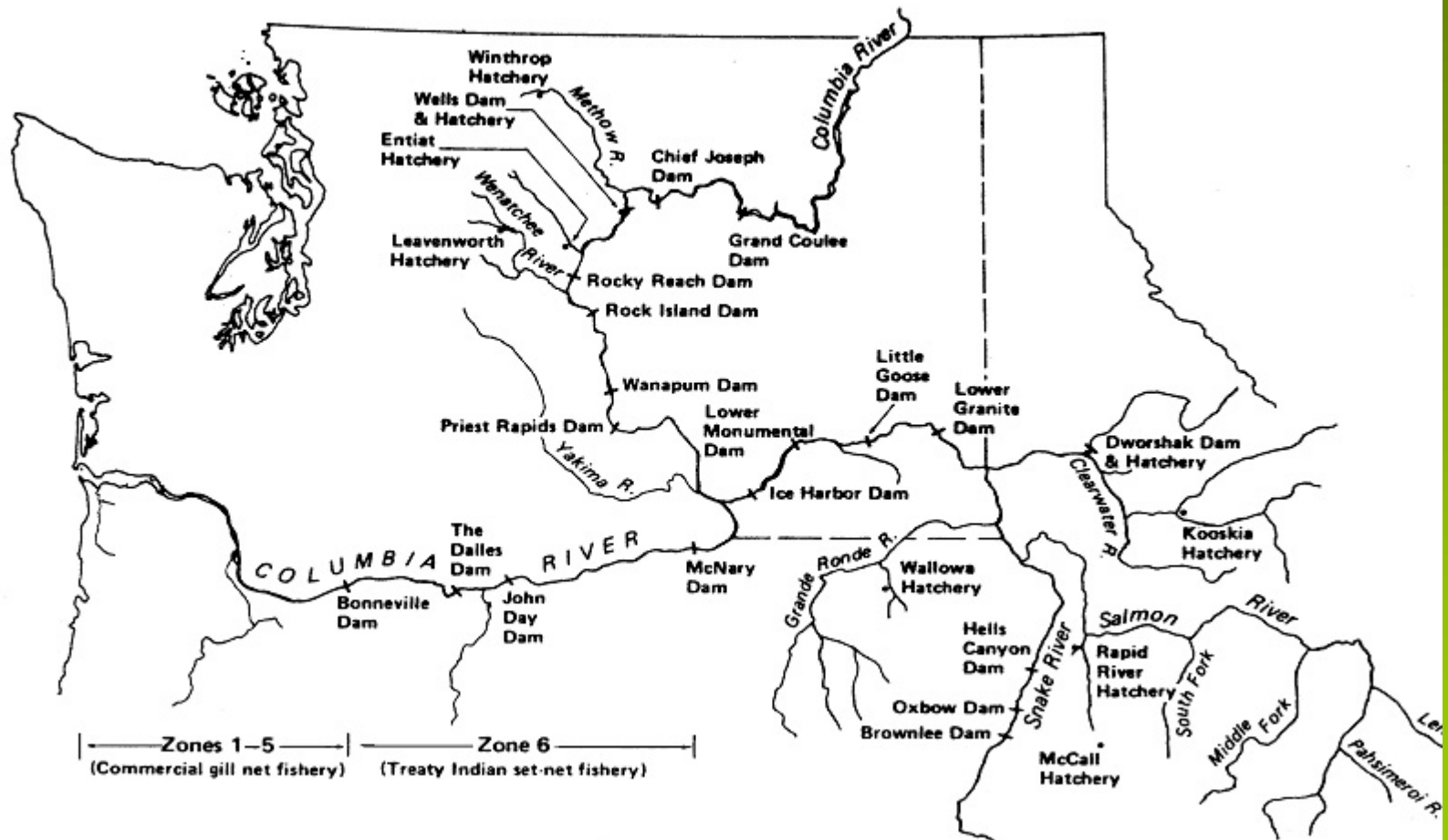
This example will provide insights into:

- The **complexity** of ecological systems
- Biological **uncertainty**; understanding is always incomplete
- Interactions between ecology, economics and policy
- Effects of **institutional complexity**; institutional roles must continually evolve

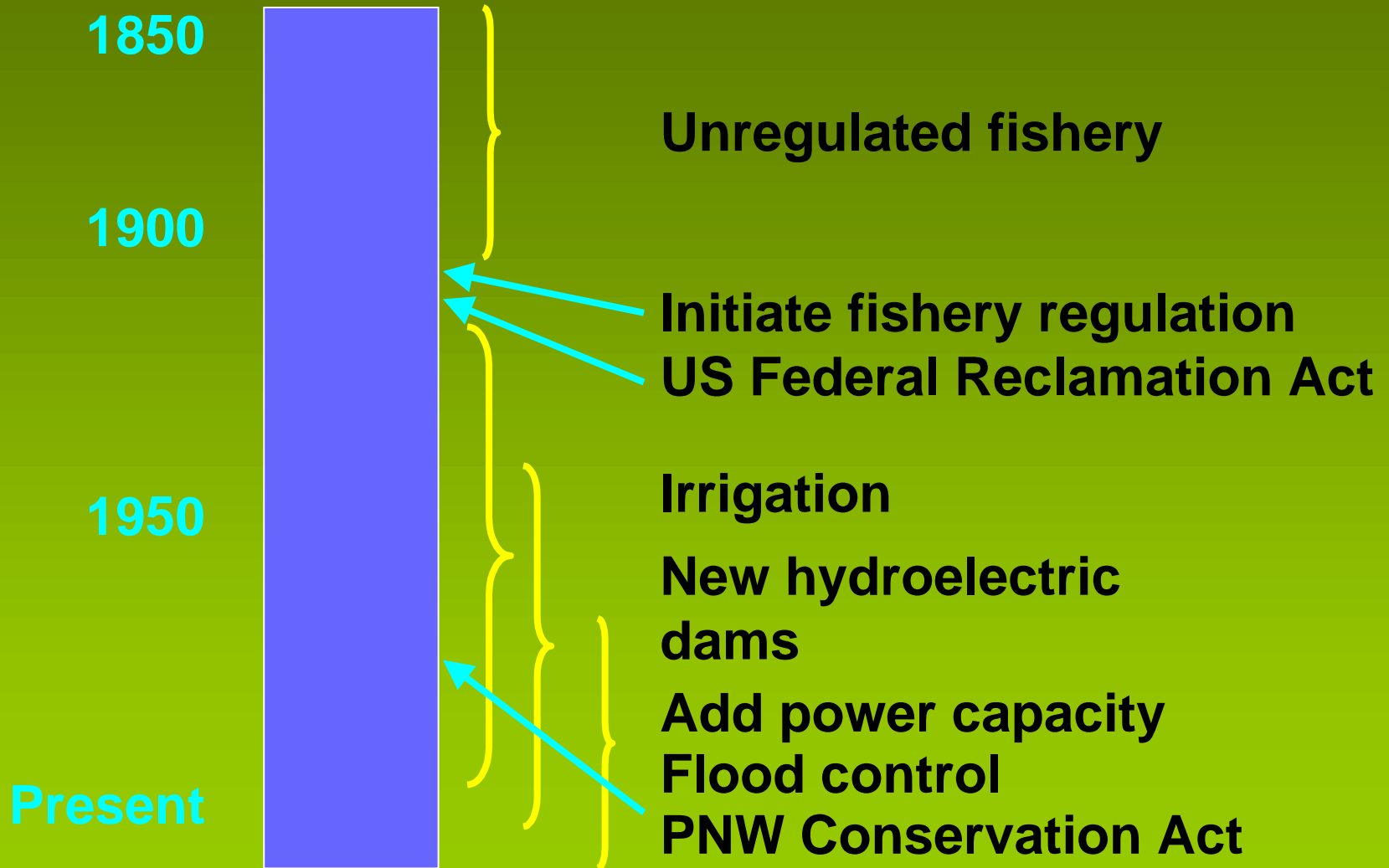
# Changes in Salmon Catch Associated with Hydropower Development



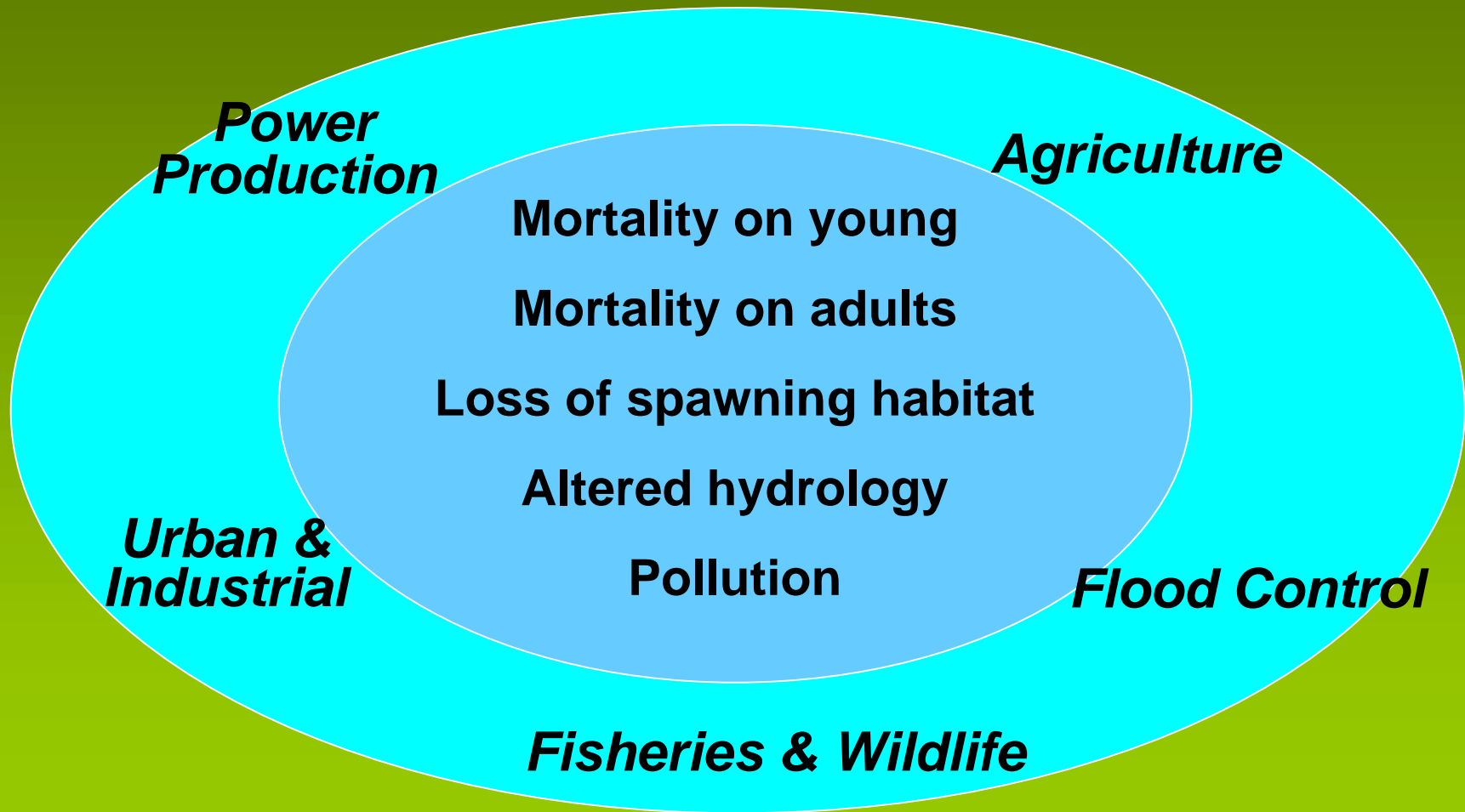
# Columbia River and Human Development



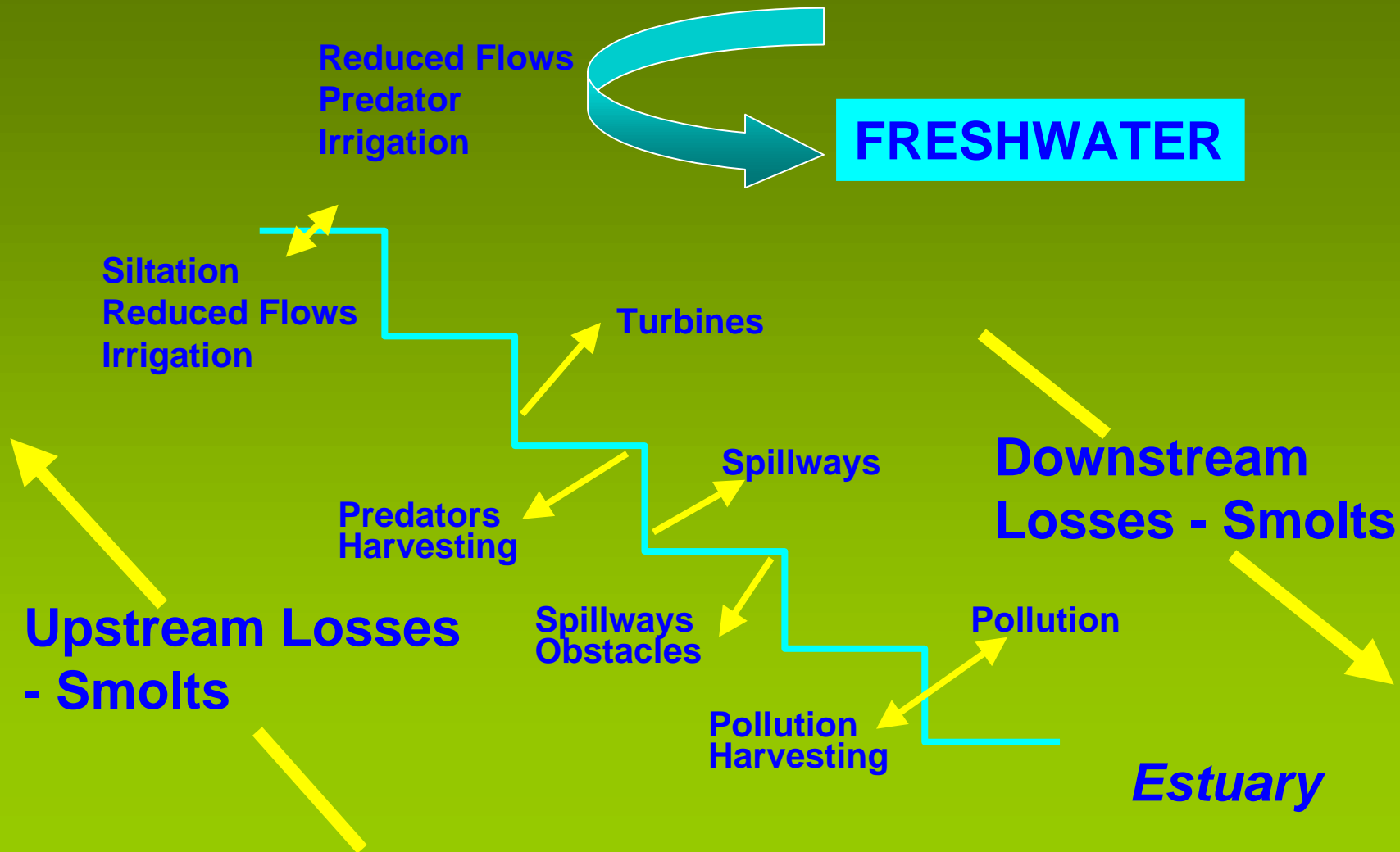
# Development Timeline



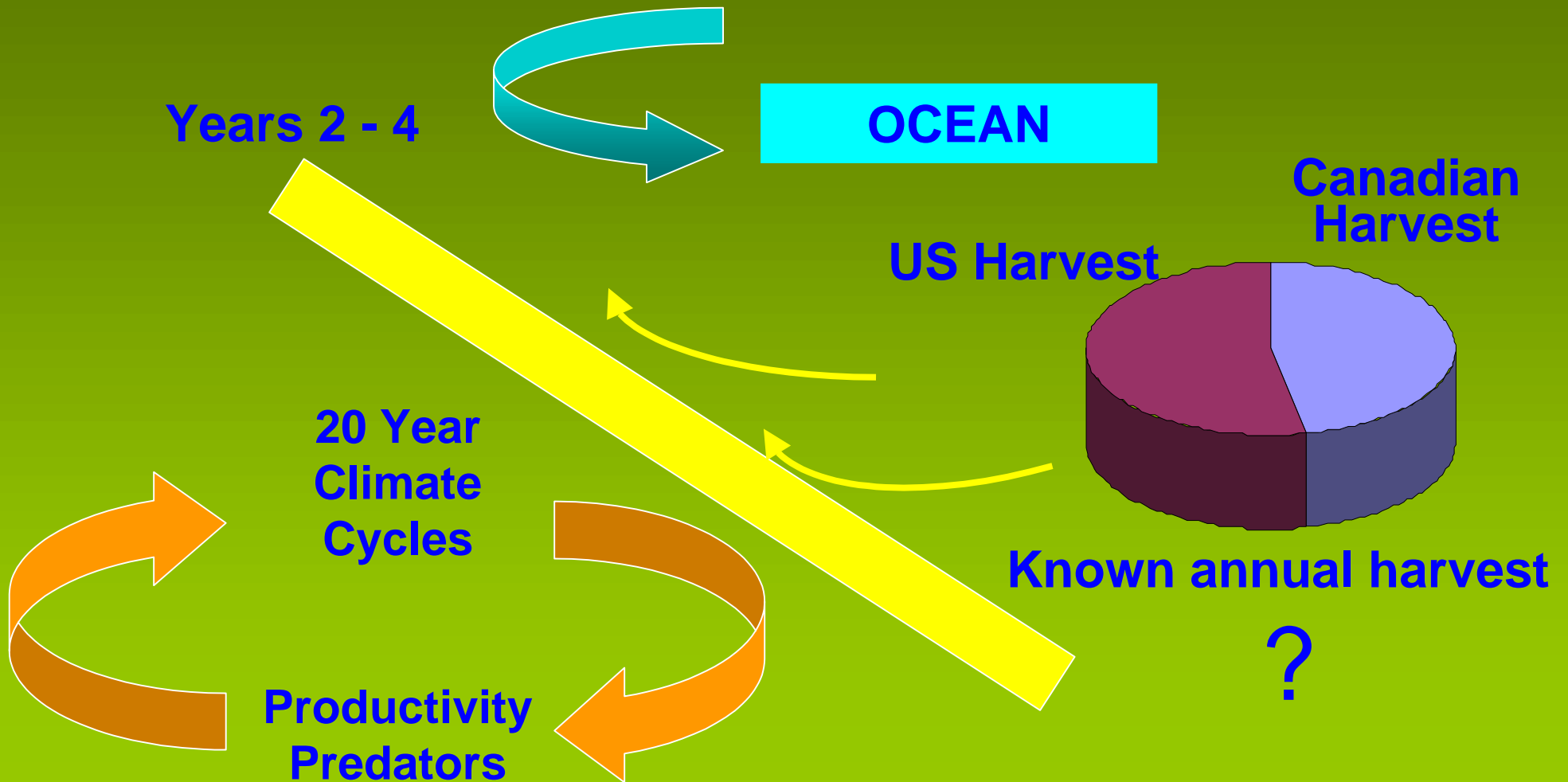
# Development and Impacts on Salmon



# Cumulative Impacts and Habitat



# Cumulative Impacts and Harvest





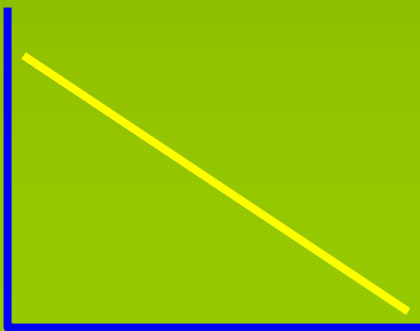
# Summary of Impacts

- ➔ Direct Impacts
  - » Losses at dams, habitat degradation, harvest, predation
- ➔ Indirect Impacts
  - » Hydrology alteration
  - » Oceanic cycles
- ➔ Impacts not additive and linear

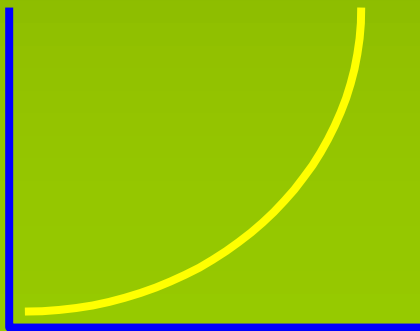
# Measuring Impacts on Columbia River Salmon

- Catch and effort data
- Counts at dams
- Spawning escapement estimates
- Tag returns

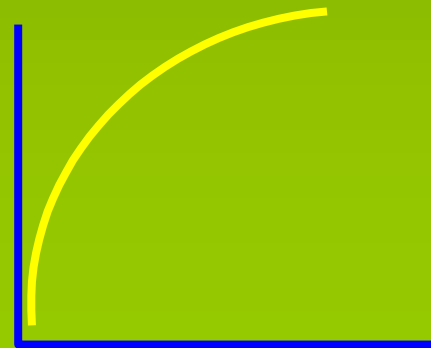
**Abundance**



**Data**



**Understanding**



# Mitigating Cumulative Impacts in the Columbia River

- ➔ Fish Protection
  - » Transport around dams
  - » Dam renovation or removal
  - » Water flow
  - » Harvest restrictions
- ➔ Enhanced Fish Production
  - » Hatcheries, artificial spawning channels
- ➔ Habitat Restoration
  - » Protected areas: natural spawning beds
  - » Forest management

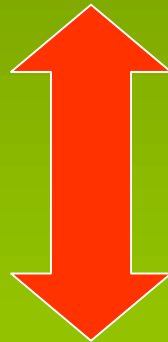
# Institutional Complexity

- Many agencies 'steer the course'
- Requires explicit consensus building
- Requires long-term commitment of funding

# Unpredictable Events

## Effects on Columbia River Migrations:

- ~1978 - 1982: Failure of Nuclear Power
- Mitigation actions (small scale)



- Ocean temperature cycle (large scale)

# Concluding Thoughts

Important points to remember are:

- Cumulative impact problems are conceptually complex
- Mitigation is expensive and its effectiveness uncertain
- Common interests are more important than special interests

# Concluding Thoughts (Cont'd)

Additional points to remember are:

- Biological uncertainty is large
- Institutional complexity exceeds traditional approaches or experience
- Surprise is expected