

# **Coping with uncertainty and change: Research, Monitoring and Adaptive management in Ecosystem-scale Restoration**

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*Applied Marine Sciences*

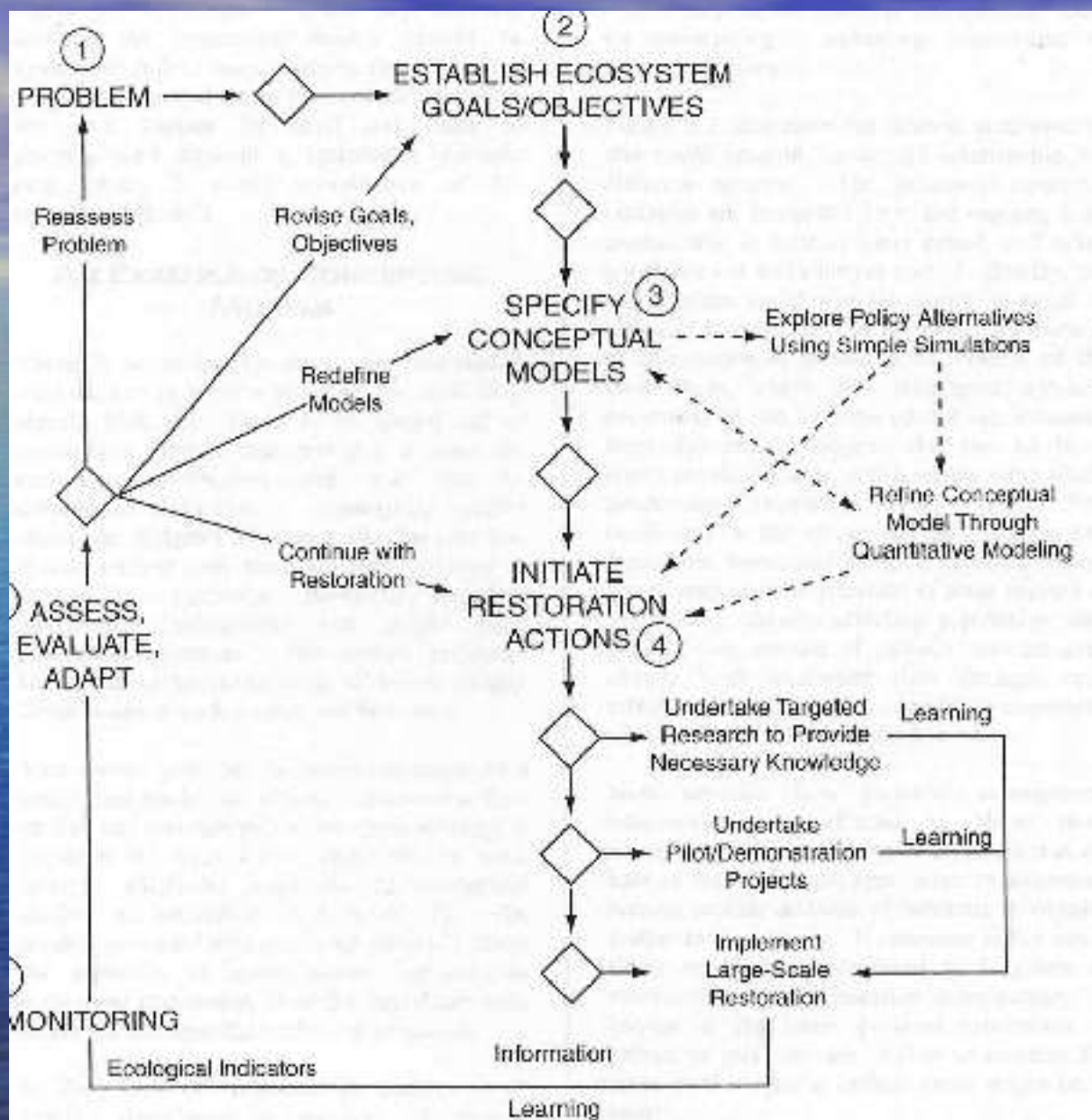
Our Estuaries

New Orleans

December 15, 2016

# Today's roadmap

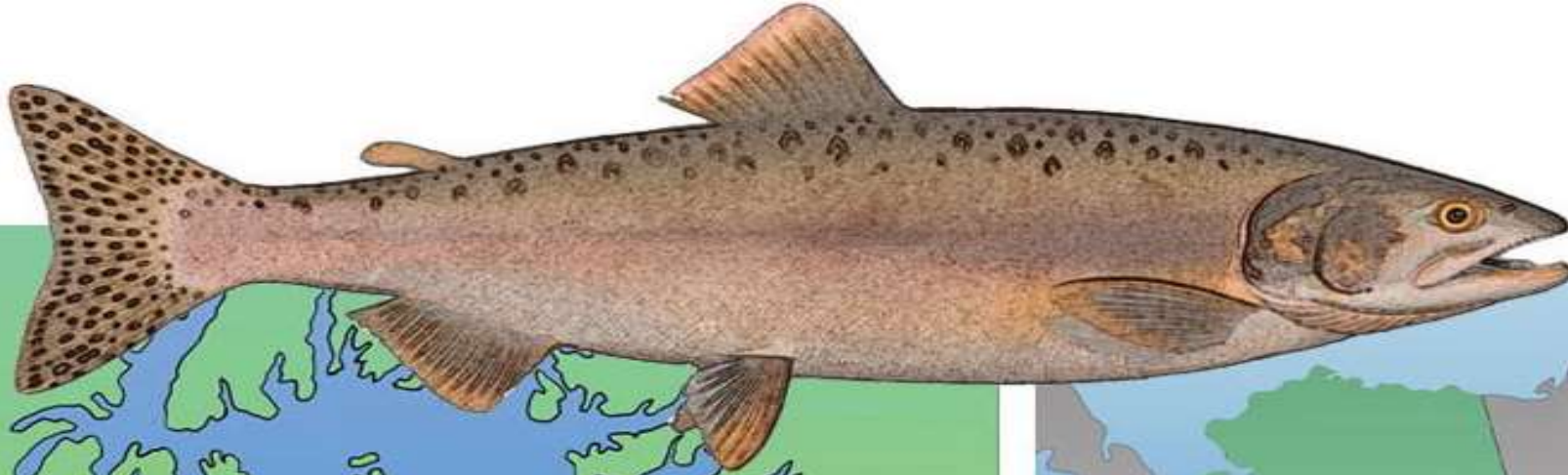
- The Ideal: The adaptive management framework
- The real: the Exxon Valdez Oil Spill Restoration Program for pink salmon



# Large oil spill







**1** JUL AUG



**IRST WINTER**  
6 - 7 months

**2** MAR APR



30 mm.

**3** MAY JUN



40 - 50 mm.

**4** JUL AUG



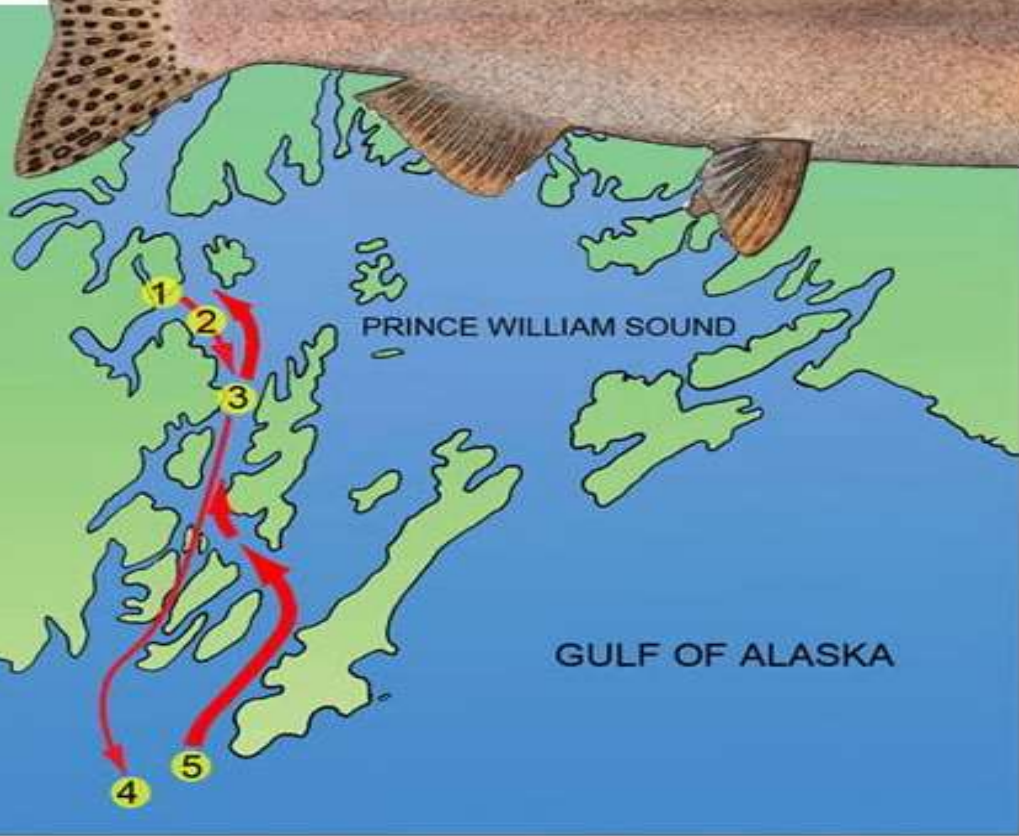
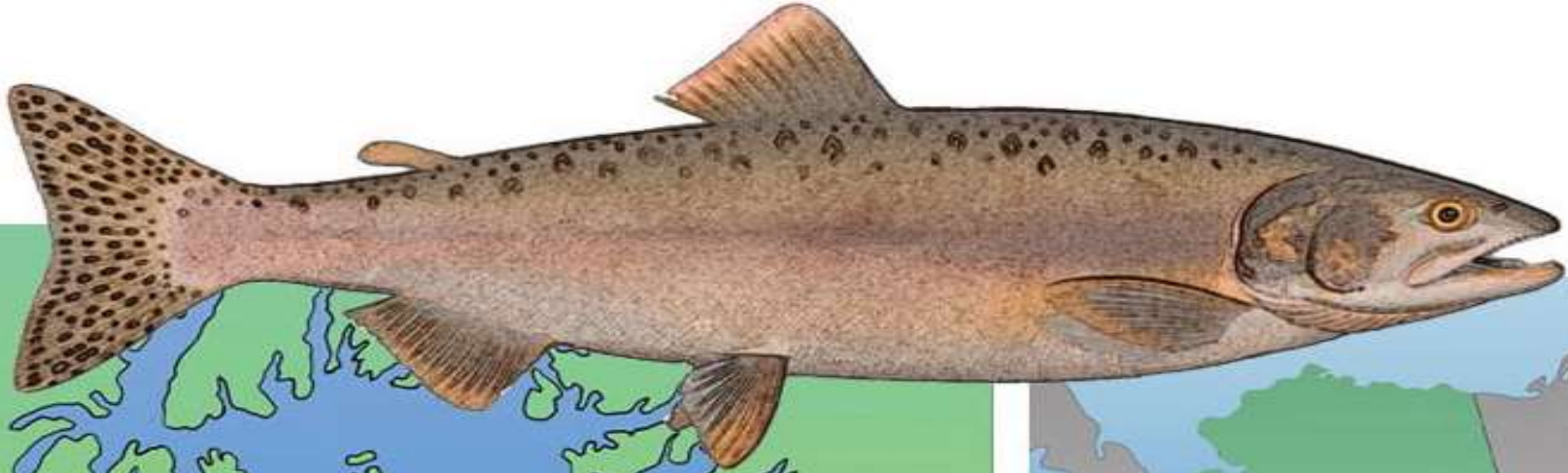
60 mm.

**COND WINTER**  
11 months

**5** JUL AUG



40 - 60 cm.



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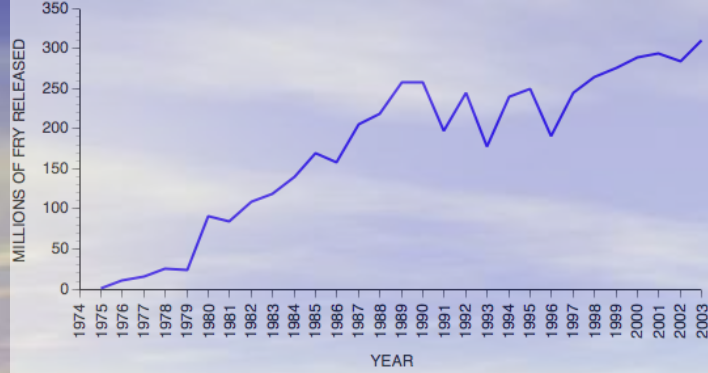
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**OIL**

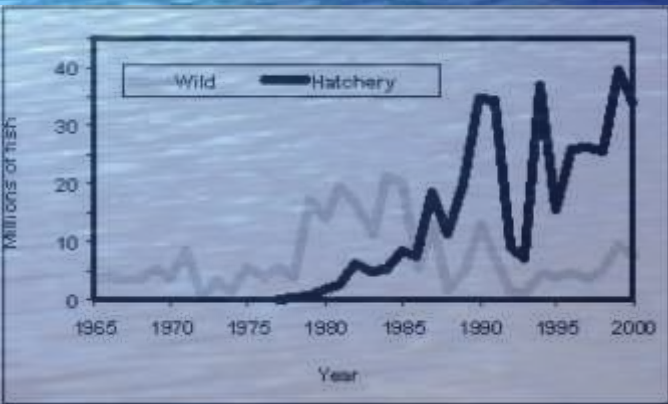
Returning Adults

Wild stock streams

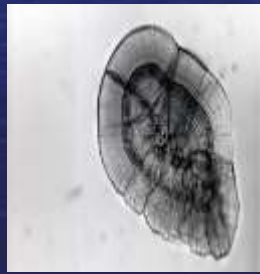
Hatcheries

Spawning

Overwintering



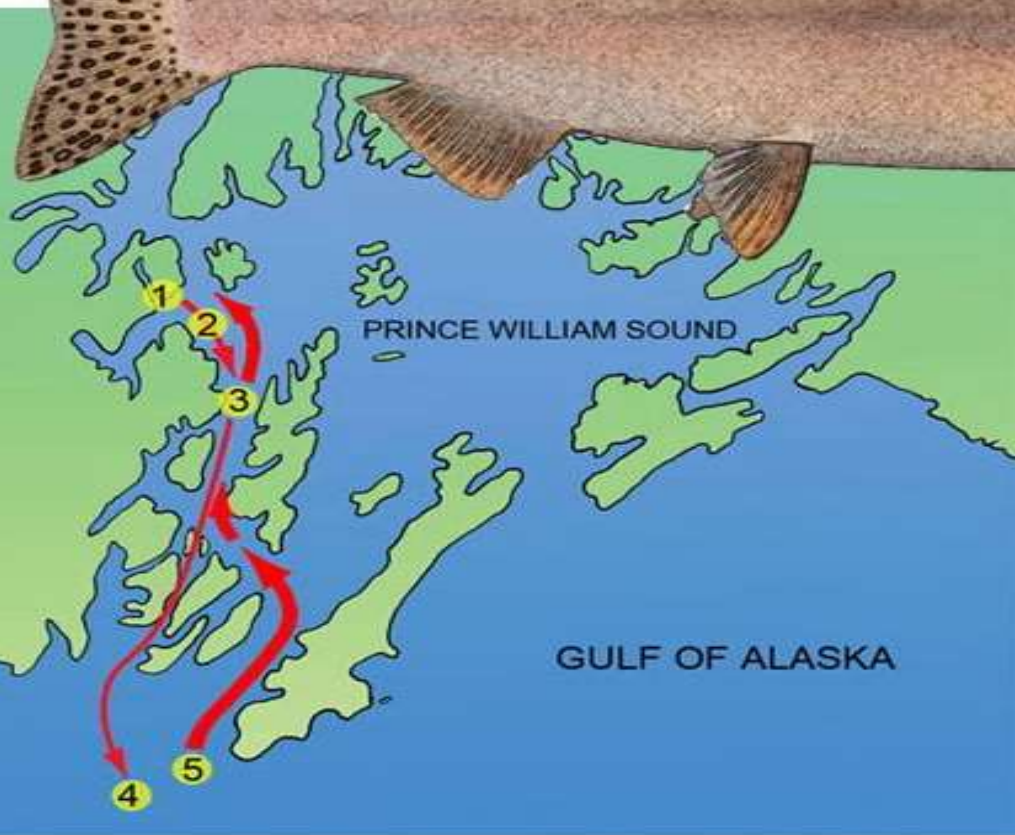
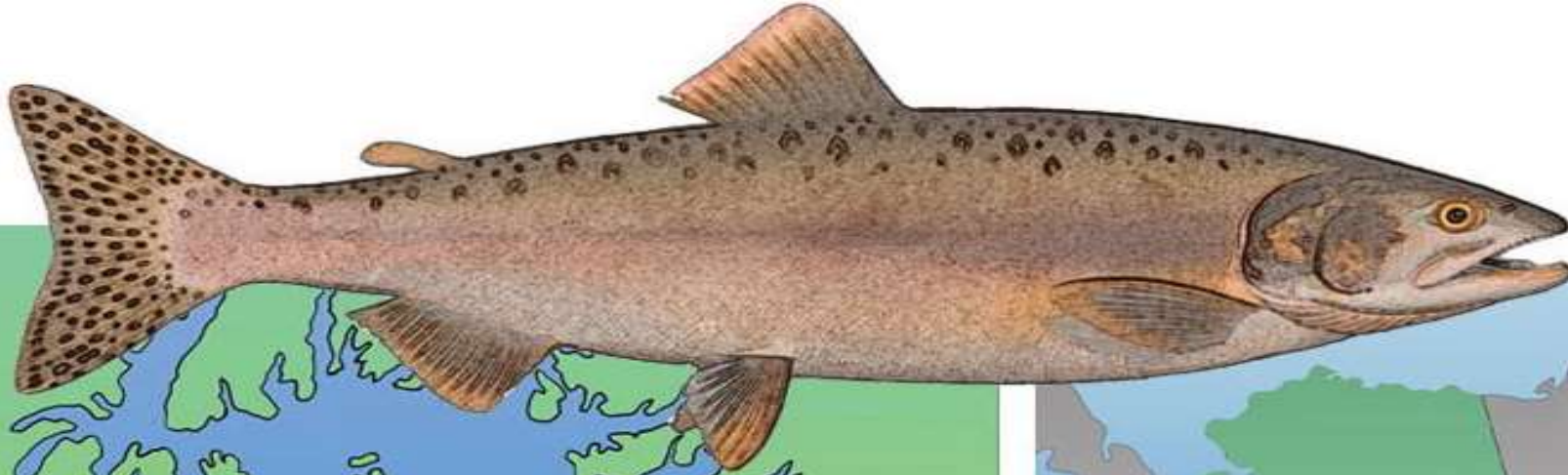
1 fry in 1500



Every fry







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11 months

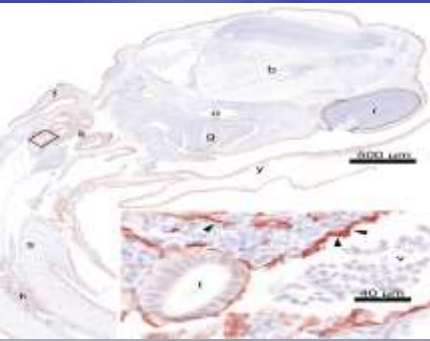
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Predation

OIL



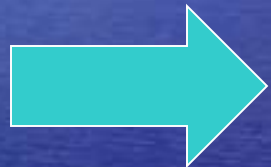
Wild stock streams



Hatcheries

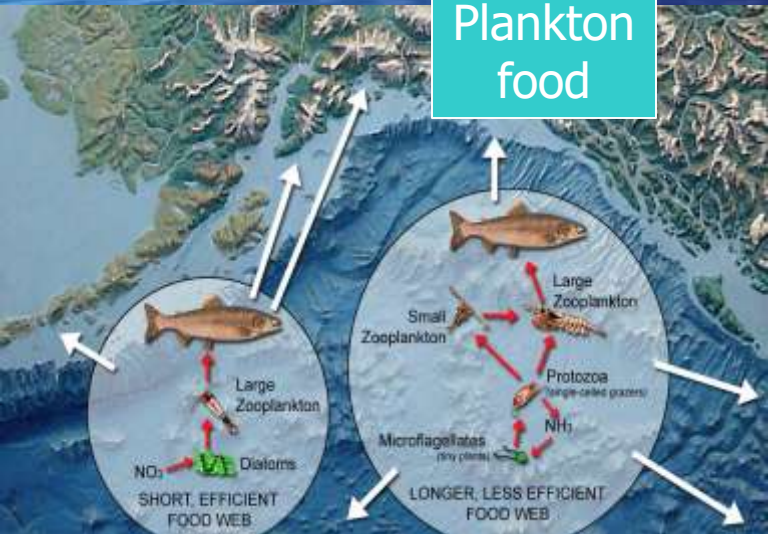


Early marine fry

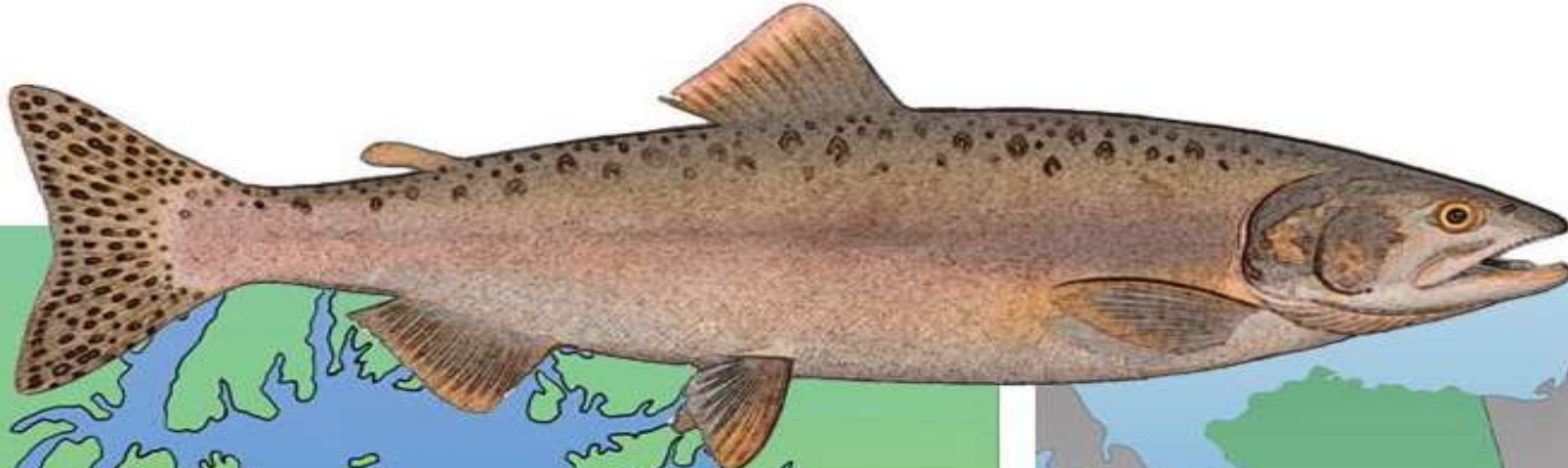


Maturation in Gulf of Alaska

Plankton food



ABUNDANT SPRING ZOOPLANKTON	WEAK SPRING ZOOPLANKTON
<ul style="list-style-type: none"> <li>• More food - faster growth, less time as prey</li> <li>• Other prey for predators, less predation on salmon</li> <li>• Better shelter inshore</li> <li>• Good Year Class</li> </ul>	<ul style="list-style-type: none"> <li>• Less food - slower growth, more as prey</li> <li>• Less alternative prey for predators</li> <li>• Poorer shelter offshore</li> <li>• Poor Year Class</li> </ul>



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# Pink salmon Monitoring, Research, Restoration and Management

**Monitoring**—large increases in effort after spill

1. Adult returns in fishery (test fishery, weirs, aerial surveys)
2. Oil injury to wild embryos in streams, all fry in saltwater
3. Oil in stream gravels
3. Oil in adults

**Research**—Little research funds before spill; large increases after spill

1. Toxicity in lab and field
2. Straying, genetic structure of wild populations
3. Ecosystem studies of survival; age class strength

**Restoration**-What was done

1. Close fishery during spill
2. Restore geomorphology
3. Otolith mass marking better discrimination of returning hatchery and wild stocks

**Management**

1. Local closures to harvest
2. Adjust timing of fry release from hatcheries
3. Adjust management districts

# Conclusions

Successful restoration depended on a variety of scientific efforts, including:

routine monitoring by resource management agencies

injury determination by Trustees

recovery monitoring by Trustees\*

basic ecosystem- based research

implementation of new management techniques (adaptive management)

\*participation by mother nature is gratefully acknowledged



Questions ?