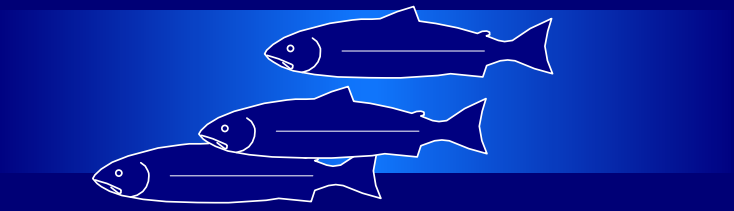
Exxon Valdez Oil Spill: Long Term Environmental Consequences of Oil Persistence and Toxicity After 23 Years

Dr. Stanley "Jeep" Rice
Auke Bay Laboratories
Alaska Fisheries Science Center
Jeep.rice@noaa.gov

PICES MONITOR/POC Topic Session: Effects of natural and artificial calamities on marine ecosystems and the scheme for their mitigation

Hiroshima, Japan
October 16, 2012




1989: A Northern
Oil Spill ~ 61N
42,000 cubic meters
Canadian Shield
Rocky Mountains
© 2009 GeoBasis-DE/BKG
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US Dept of State Geographer
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
60°39'41.12" N 147°04'31.80" W elev -470 ft
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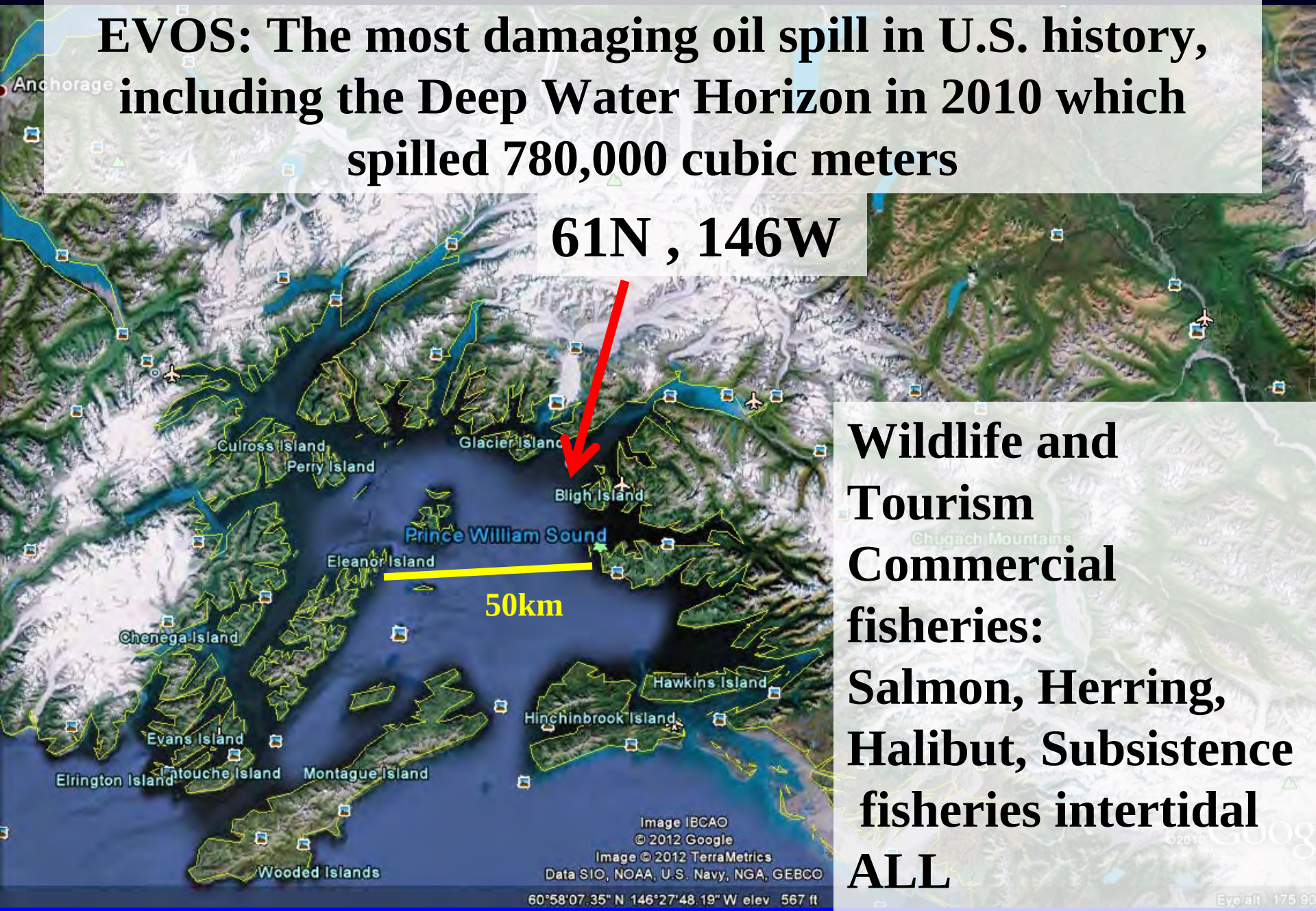
Eye alt 4006.05 mi

EVOS: The most damaging oil spill in U.S. history, including the Deep Water Horizon in 2010 which spilled 780,000 cubic meters



Wildlife and Tourism

Commercial fisheries:

Salmon, Herring, Halibut, Subsistence fisheries intertidal

ALL DEVASTATED

Exxon Valdez Oil Spill (EVOS): 1989

Largest Spill Event ever at that time; few predictable effects, but many

<u>Unpredictable</u> effects:

1. **Acute effects to MM**
2. **Long term oil persistence**
3. **Long term effects to pink salmon**

Highest priority- liter remaining cargo off while good weather lasts …

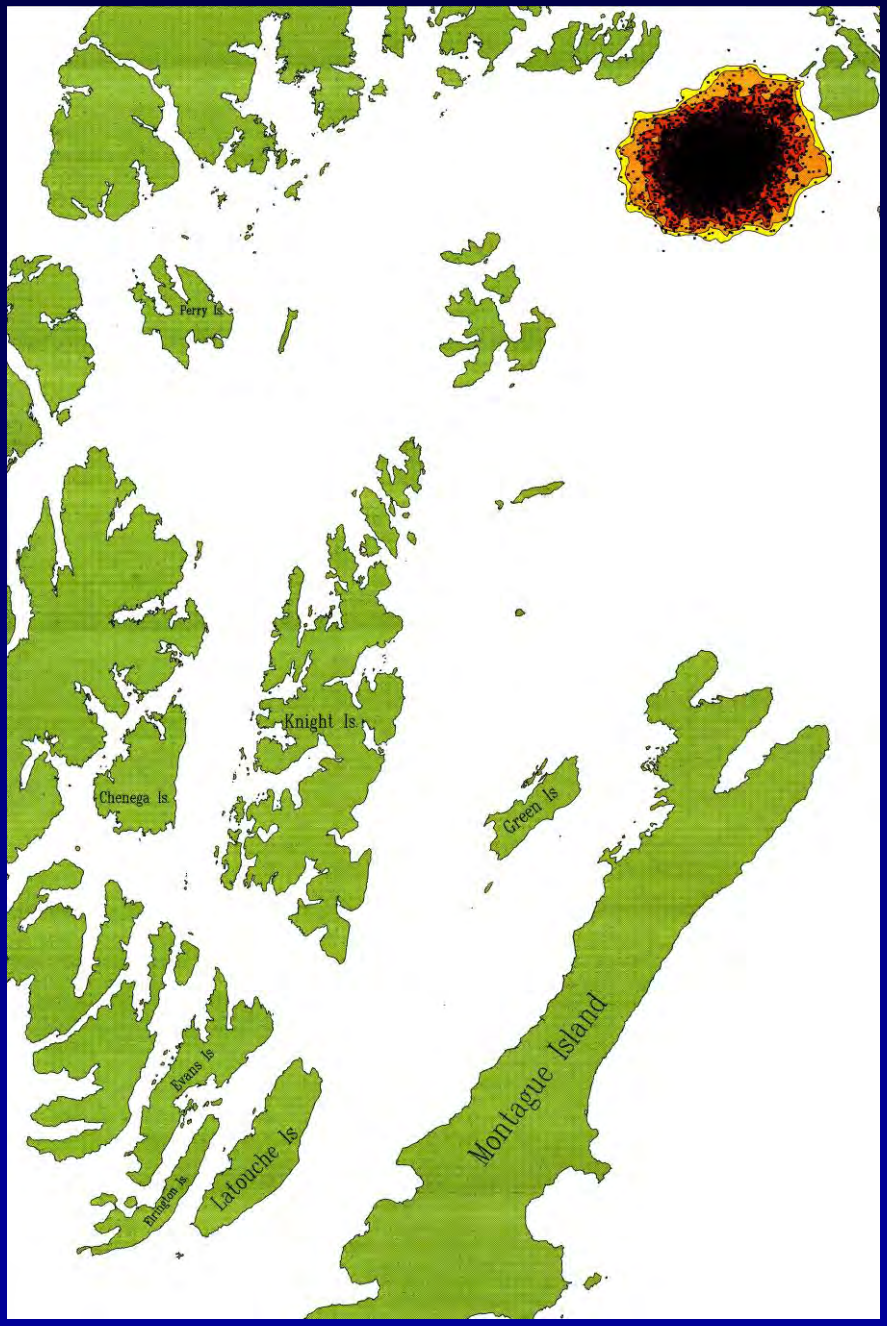
~ 80% of 210,000 cubic meters were litered off = 42,000 cm released

Exxon Valdez Oil Spill

NOAA HAZMAT Trajectory Model

March 25, 1989 **Day Two**

Oil pooled around vessel;
No capacity to pick it up,
Weather getting worse



J.A. Galt et al. 1991

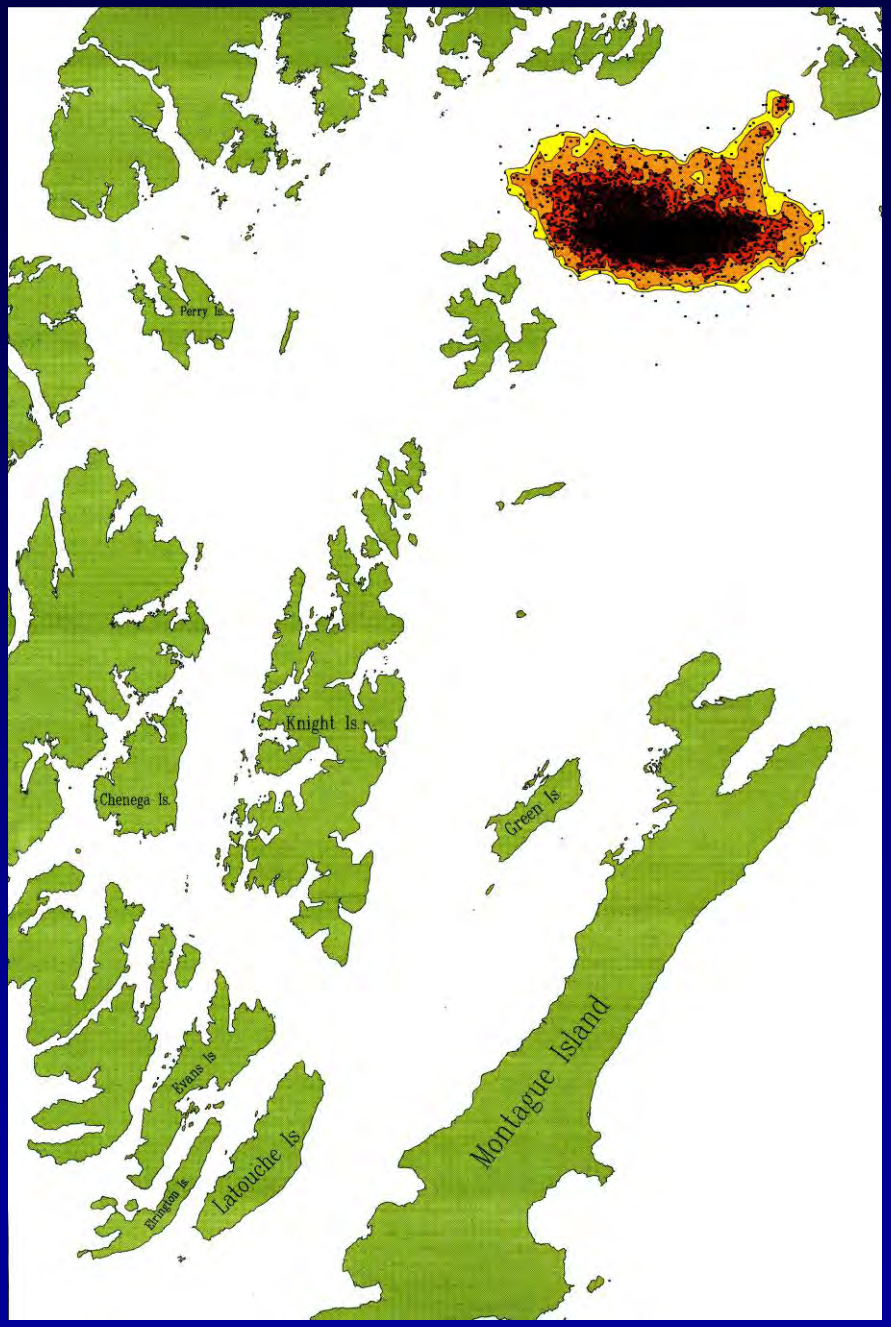
Exxon Valdez Oil Spill

NOAA HAZMAT Trajectory Model

March 26, 1989 **Day Three**

Storm Strikes

70 Knot winds out of the NE



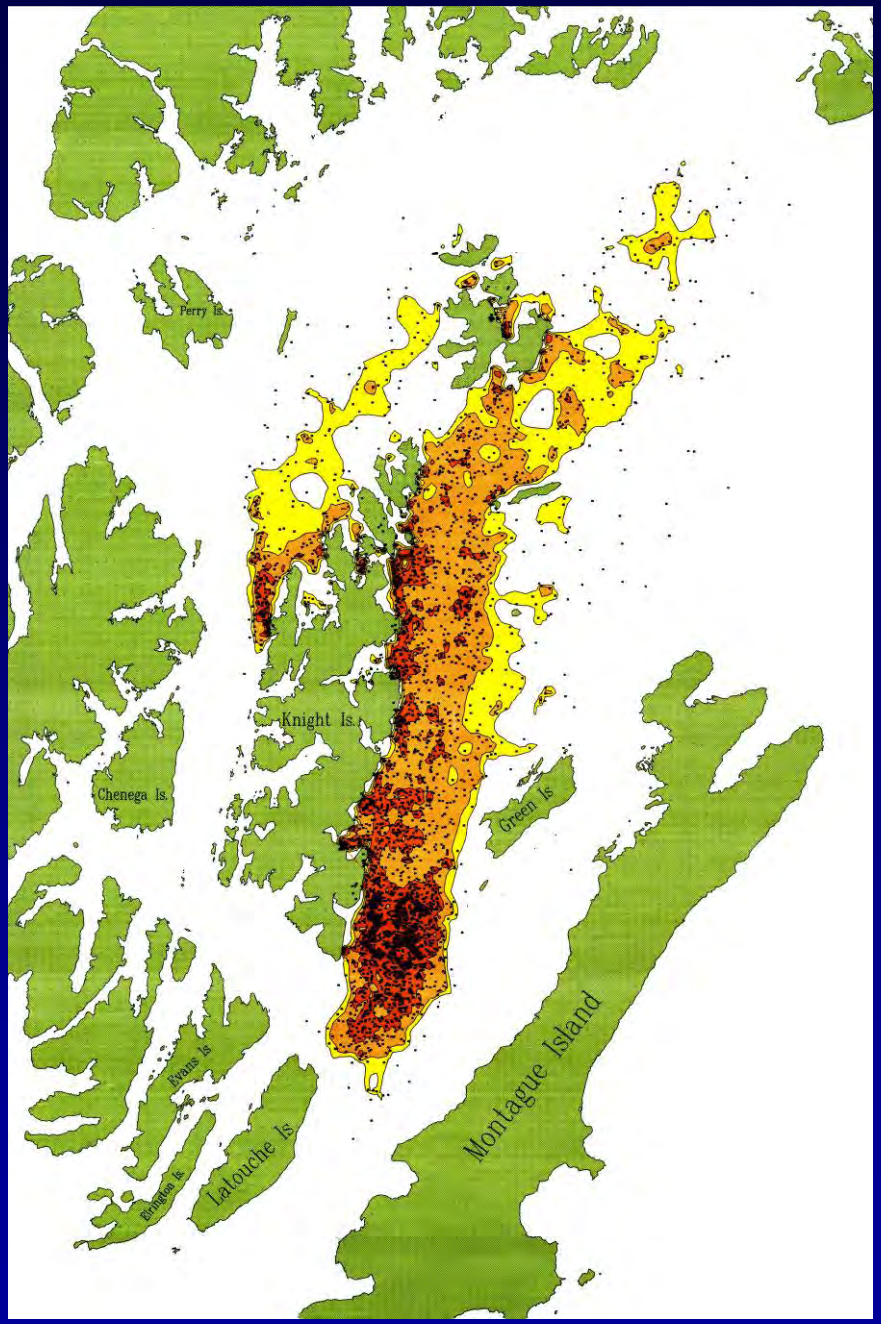
J.A. Galt et al. 1991

Exxon Valdez Oil Spill

NOAA HAZMAT Trajectory Model

March 29, 1989 **Day Six**

100’s Km of beach Impacted inside PWS, But high winds continued



J.A. Galt et al. 1991

EVOS Day 40, May 1, 2012

Bald Eagle

Predictable effects

Sea Otter

Sea Birds

Acute wildlife loss estimates included:

4,000 Sea Otters 500,000 Birds

How best to respond to the calamity?

How to learn what is damaged?

How to mitigate for the damages?

No answers in 1989 because;

1. No monitoring = no baseline
2. No baseline = no measure of damages
3. *Transient shock* paradigm advised no long term concerns, so no need for mitigation

Clean up Efforts 1989 - 1990

10 K people, 2 summers, $2.5 B

Steam cleaning the intertidal destroyed shellfish and other organisms in the subtidal …

Not Understood 1989: Chronic long term toxicity: Debunking the transient shock paradigm

Oil Persistence

Long Term Toxic Effects on Salmon and other biota

Pink Salmon – Post 1989

Elevated embryo mortalities

1989, plus 4 more years

Surprising, Perplexing: Contradiction of Transient Shock Paradigm


This where 75% PWS salmon spawn: intertidal

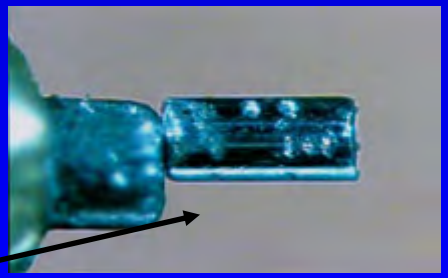

Approximate 1989 conditions: storm buried large amounts oil in river mouth sediments

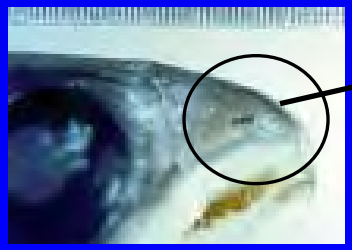
Resolving Delayed Effects

Incubate fish with and without oil <u>on gravel</u>

Tag survivors and release to wild

Recover adults when they return to spawn





Recover tags, count number from each group

1992-2000:

Lab Tests prove that exposed embryos to low doses will affect Adult returns

Design:

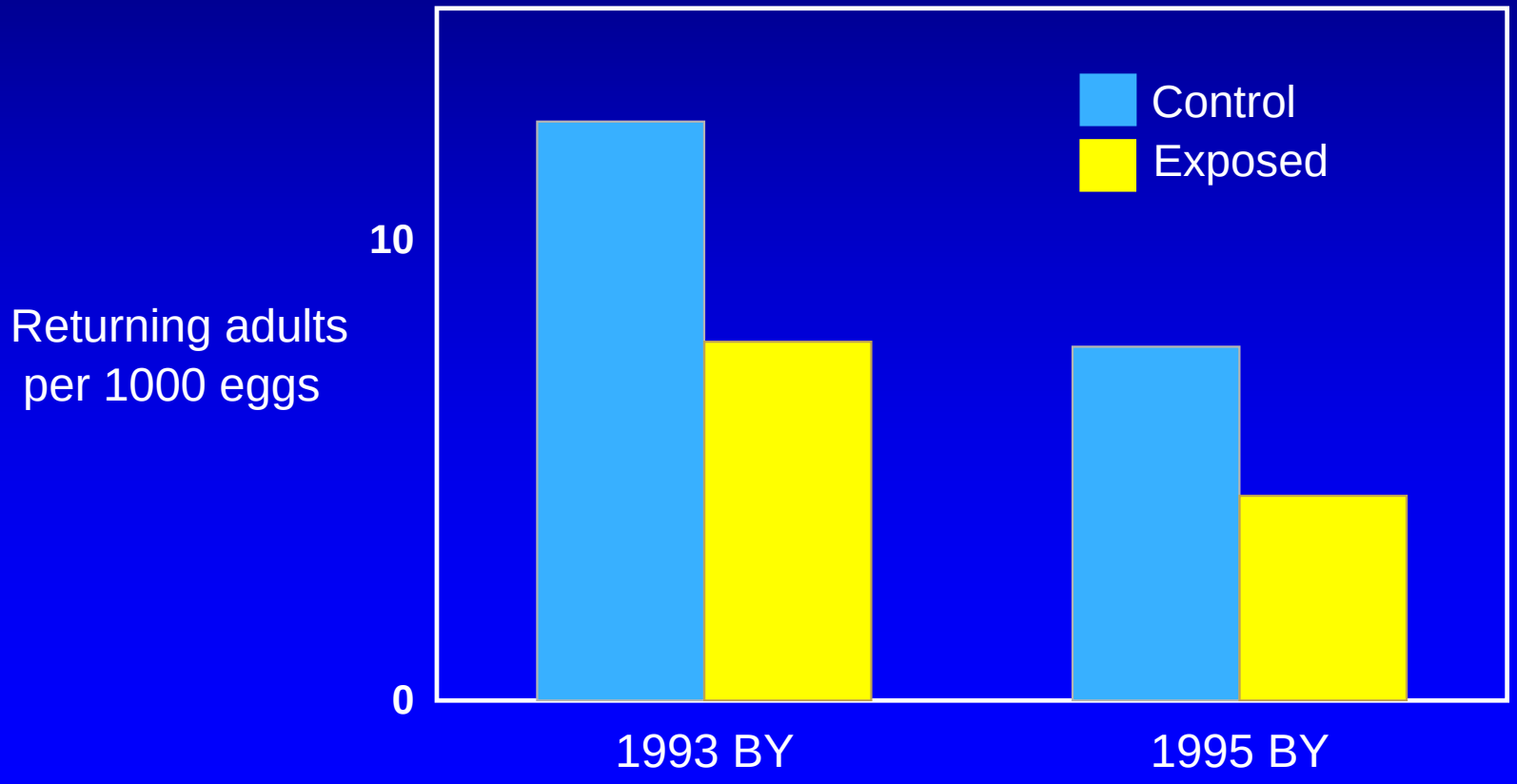
- Long term exposures **(Months)**
- Low **ppb** exposures
- Released **tagged** Fry
- Assess when **Adults return**

Keys to Study

70 thousand emergent fry tagged each dose

250,000 fry tagged / released to ocean per experiment

Adult returns Reduced (Eggs exposed in 18 ppB)



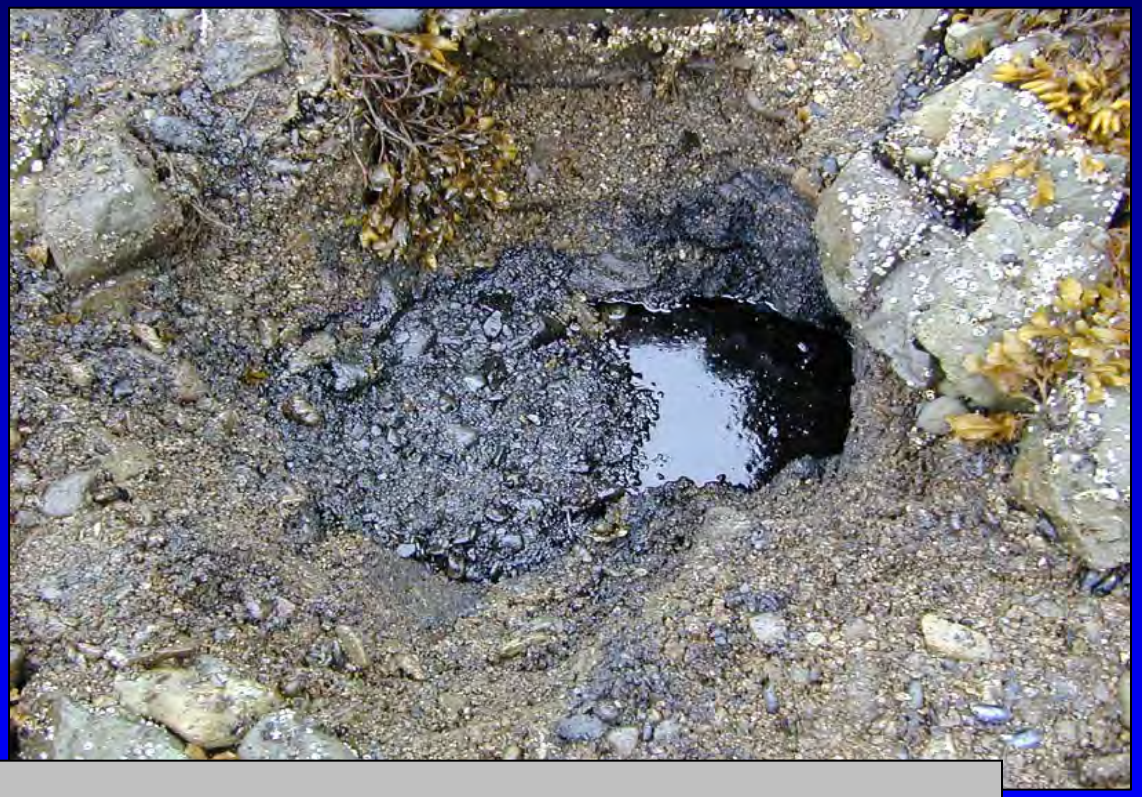
Lingering oil in river deltas reduced salmon survivals for at least five years, 1989 – 1993: Fewer salmon return to spawn

Transient Shock Paradigm is not correct; effects of 1989 oil spill are still being measured in 2012

<u>Where is the oil?</u>

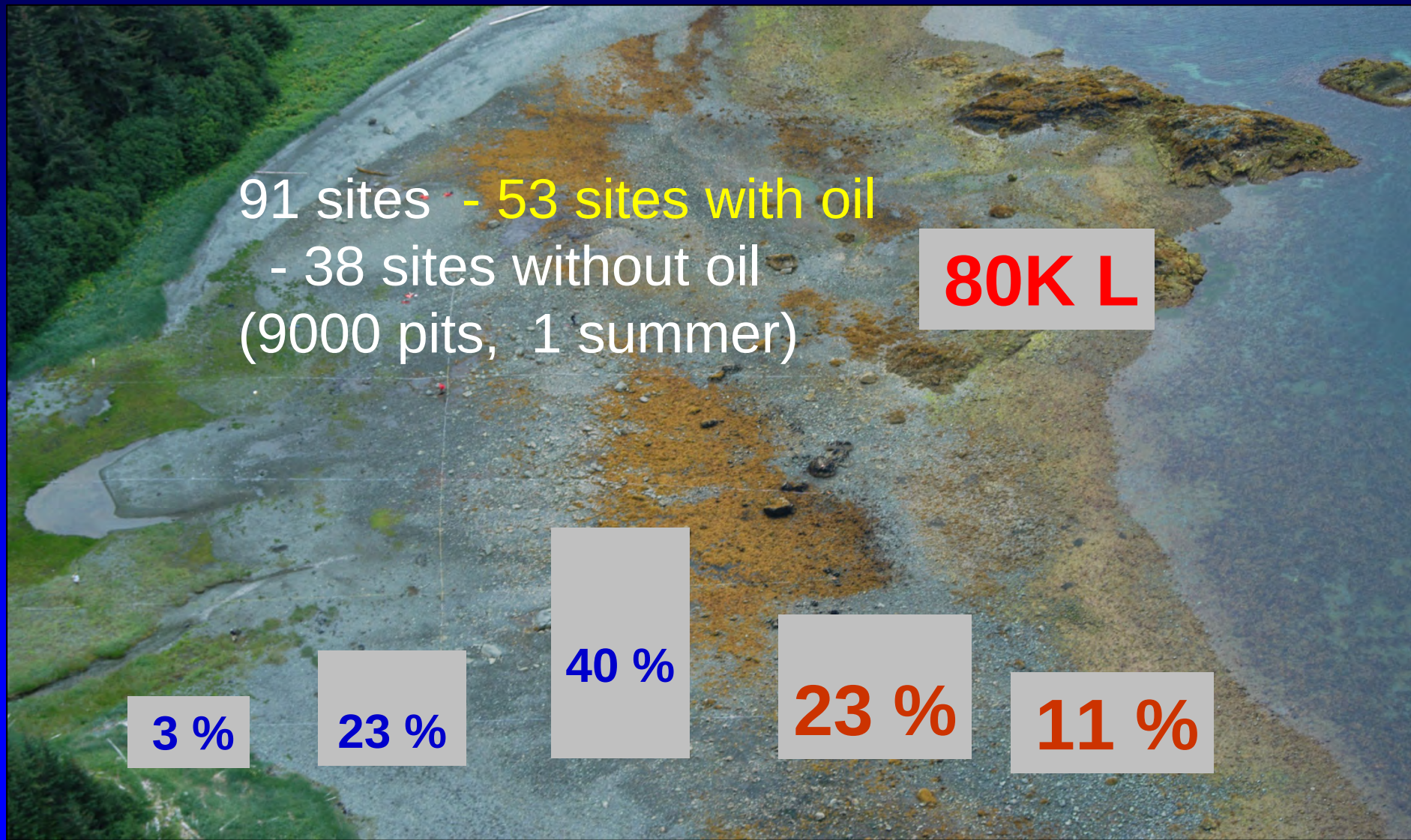
Persistent Toxicity:Lingering Oil -

How much?
Where?



1999
10 years after the spill

Vertical Distribution of Intertidal Subsurface Oil 2001



Summary of Oil Persistence

More oil than expected

1/3 in the lower intertidal zone

Mitigation:

Restrict harvest in oiled areas

Restrict harvest in oiled areas

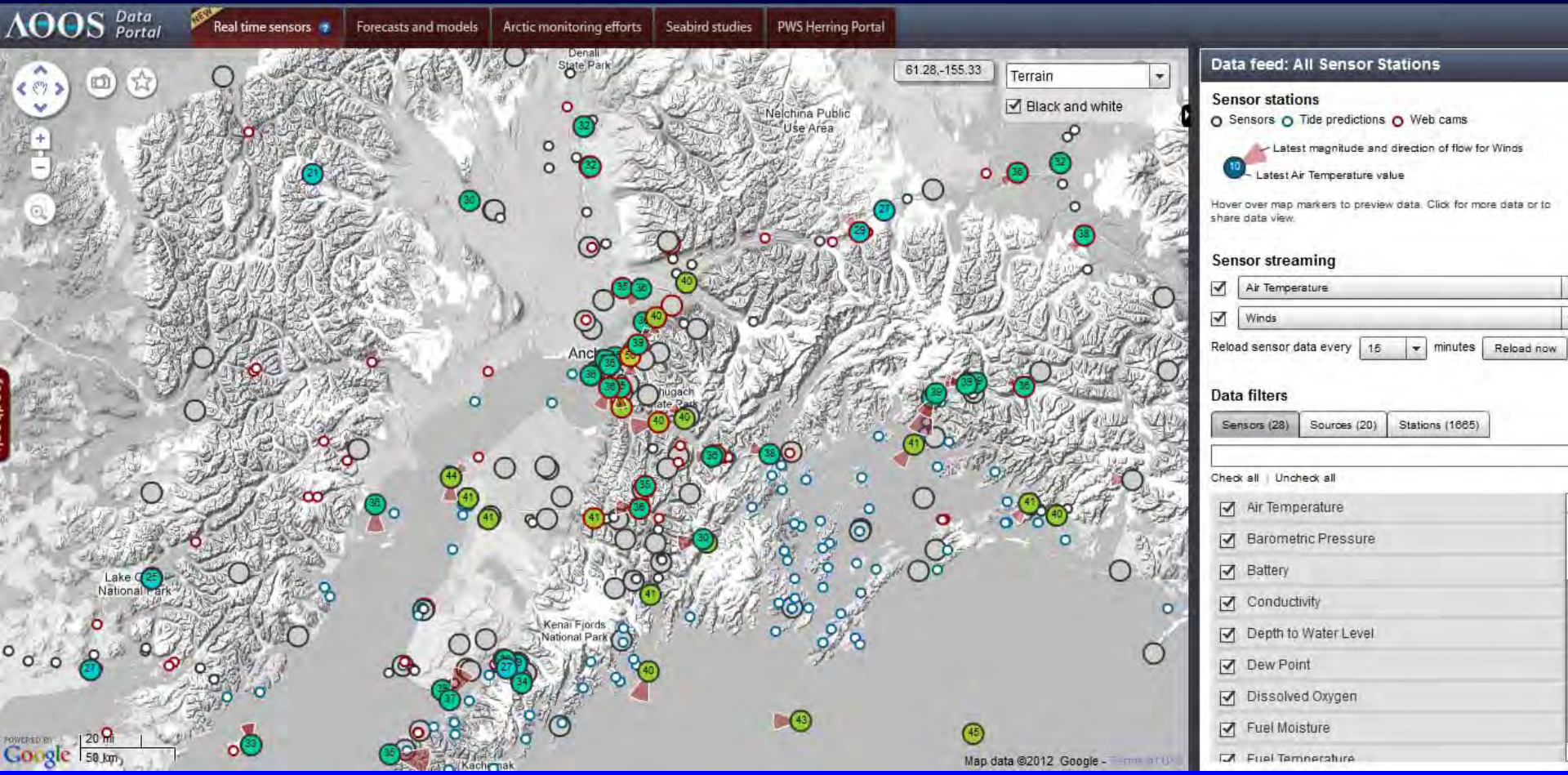
Bioremediation of oiled habitats

Conclusions:

Lack of monitoring baseline required 14 years of research to identify damages and to formulate mitigation, Nonetheless majority of damages will never be known due to lack of baseline

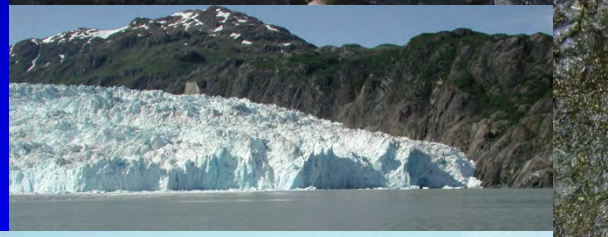
Areas vulnerable to natural and artificial calamity must be monitored

Prince William Sound- Today



Real time sensors informing hydrographic and atmospheric models

Prince William Sound- Today



Productive, mostly recovered

Oil persists

PWS is not the same as before, Never will be

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