

Exxon Valdez Oil Spill: Long Term persistence and and Long term effects

Looking back after 20 years



Dr. Stanley “Jeep” Rice

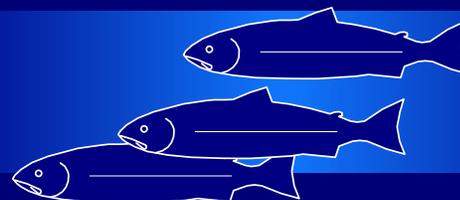
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Comparisons & Lessons Learned



Exxon Valdez - 1989



Deepwater Horizon 2010



Bottom Line:

What did we learn with EV that informs DWH spill?

Short Answer: Lots



First: quick comparison of both spill events

**PWS Exxon Valdez
Oil spill**

**GOM Deepwater Horizon
Oil spill**

Second: 5 big wows from the Exxon Valdez spill



First: Quick comparison of both spill events

**PWS Exxon Valdez
Oil spill**

**GOM Deepwater Horizon
Oil spill**

No two spill events are the same



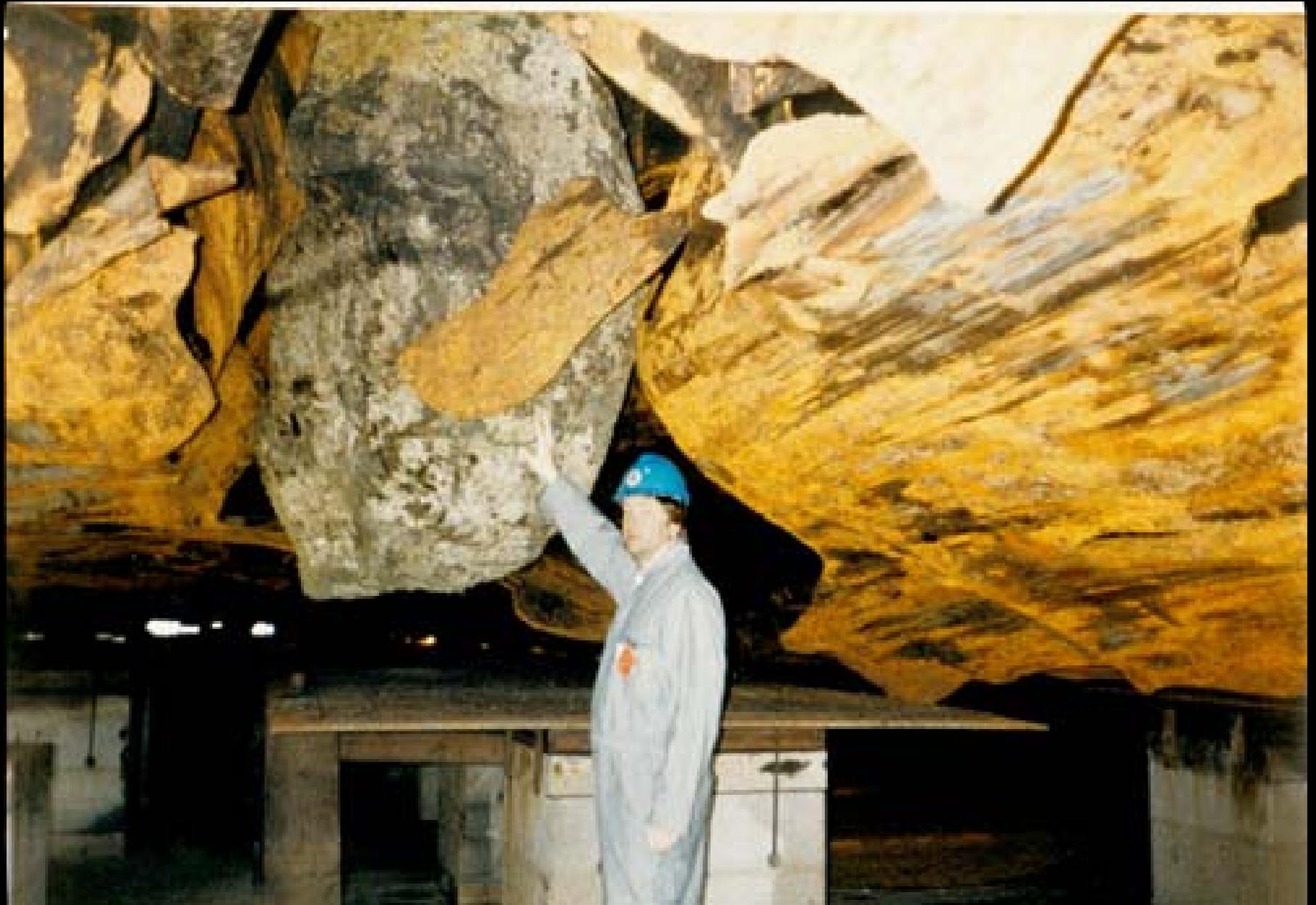
First: Quick comparison of both spill events

**PWS Exxon Valdez
Oil spill**

**GOM Deepwater Horizon
Oil spill**

No two spill events are the same

	Event scale	
11 M Gal	Volume of oil	100 M Gal
3 day	Time line of spill	40 day
Viscous	Oil chemistry	Light thin
NO	Dispersants	1 M Gal
NO	Burning	Yes
NO	Skimming	Yes
3	Politics	85



Highest priority- liter remaining cargo off



Exxon Valdez Oil Spill

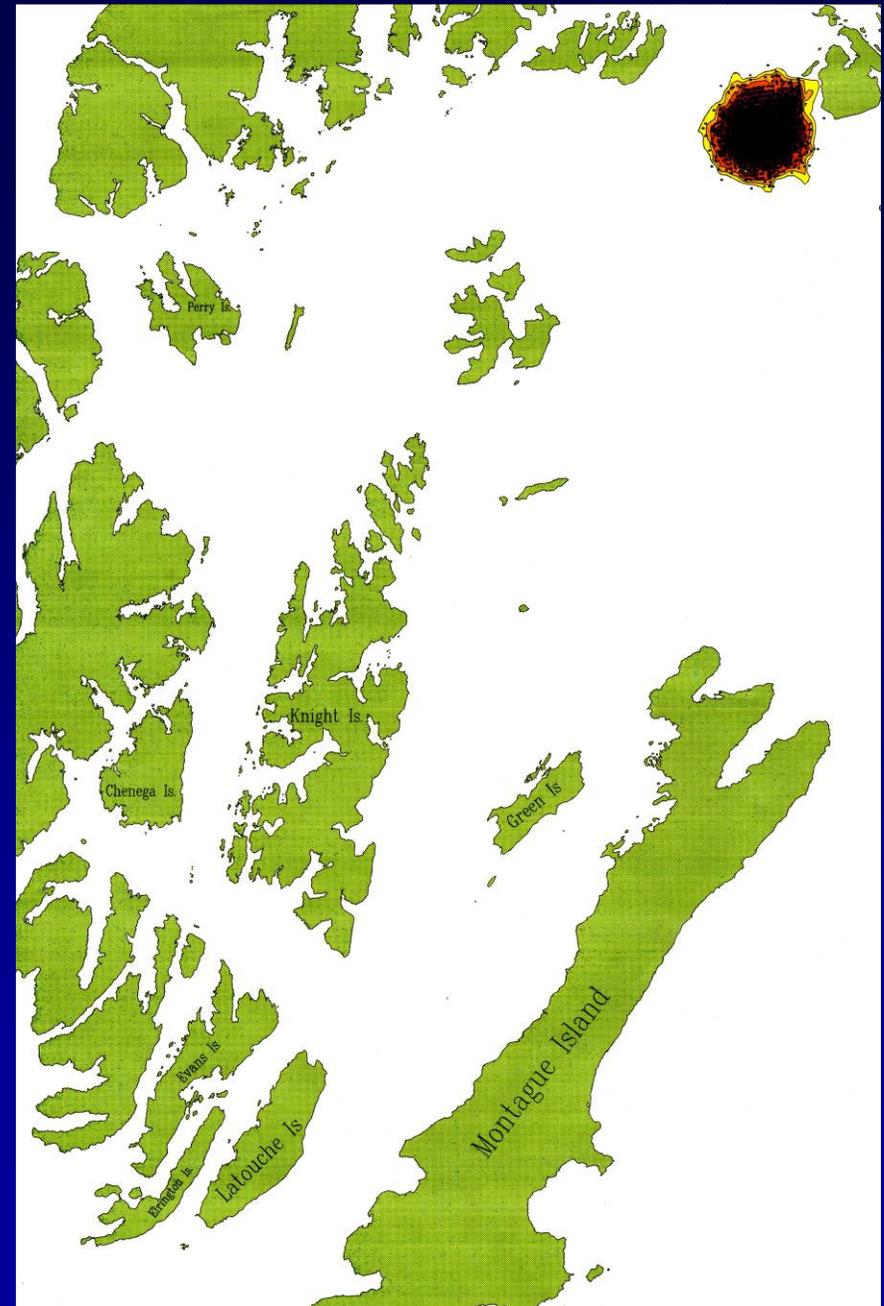
NOAA HAZMAT Trajectory Model

March 24, 1989

Day One

Legend

- 53 particles/sq mile
- 53 to 13 particles/sq mile
- 13 to 3 particles/sq mile
- 3 to 1 particles/sq mile
- Each particle represents
~1,100 gallons of oil
(twenty 55 gallon drums)



J.A. Galt et al. 1991

Exxon Valdez Oil Spill

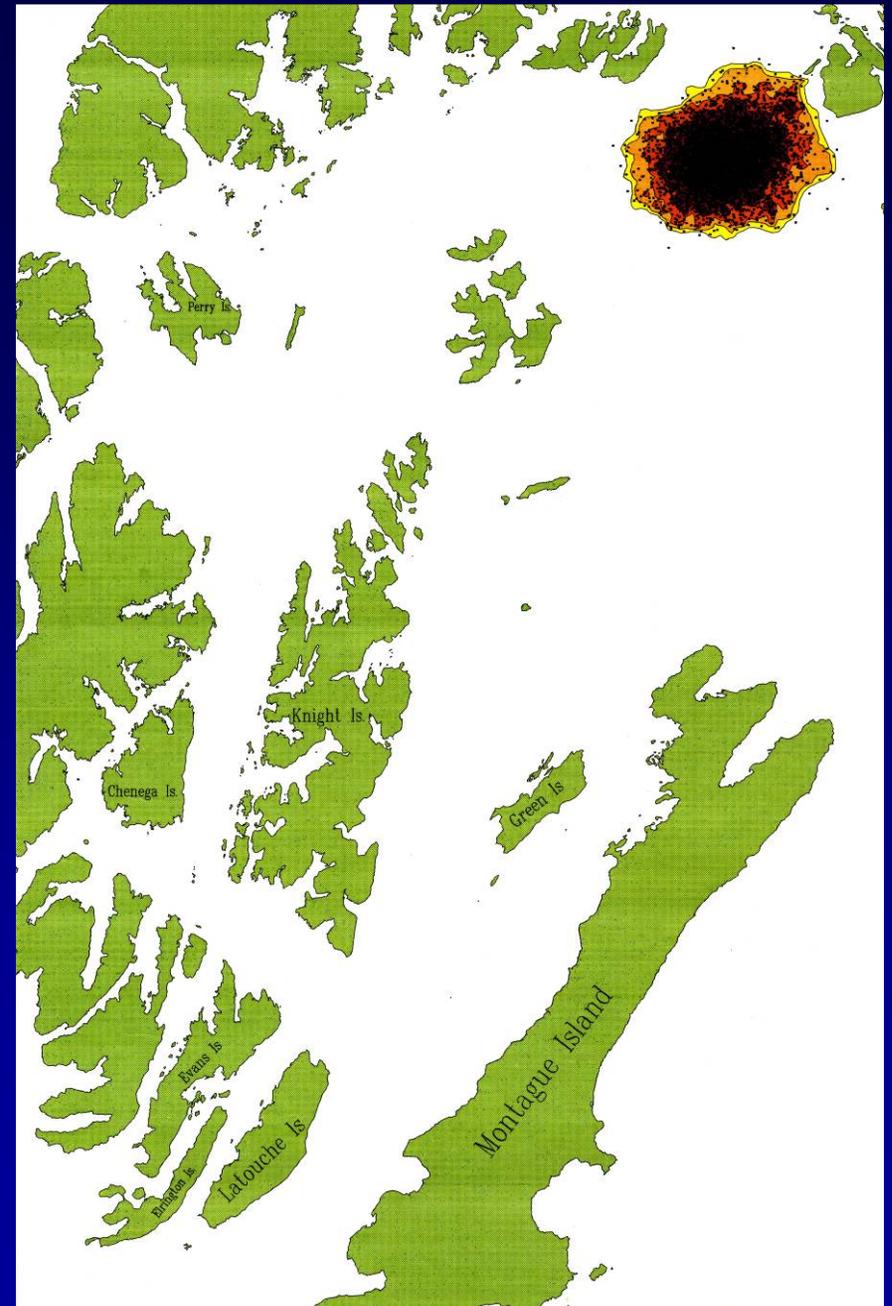
NOAA HAZMAT Trajectory Model

March 25, 1989

Day Two

Legend

- 53 particles/sq mile
- 53 to 13 particles/sq mile
- 13 to 3 particles/sq mile
- 3 to 1 particles/sq mile
- Each particle represents
~1,100 gallons of oil
(twenty 55 gallon drums)



J.A. Galt et al. 1991

Exxon Valdez Oil Spill

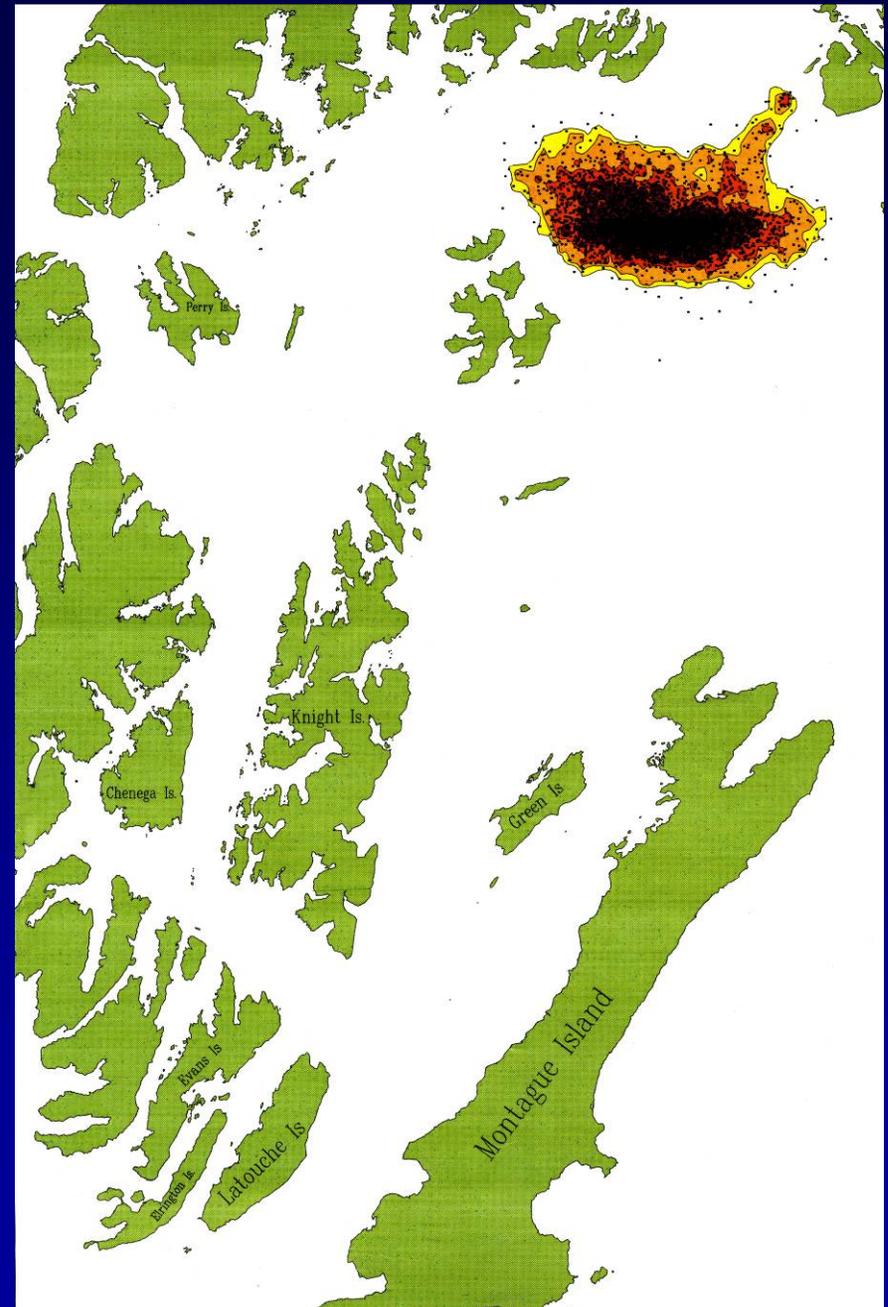
NOAA HAZMAT Trajectory Model

March 26, 1989

Day Three

Legend

- 53 particles/sq mile
- 53 to 13 particles/sq mile
- 13 to 3 particles/sq mile
- 3 to 1 particles/sq mile
- Each particle represents
~1,100 gallons of oil
(twenty 55 gallon drums)



J.A. Galt et al. 1991

Exxon Valdez Oil Spill

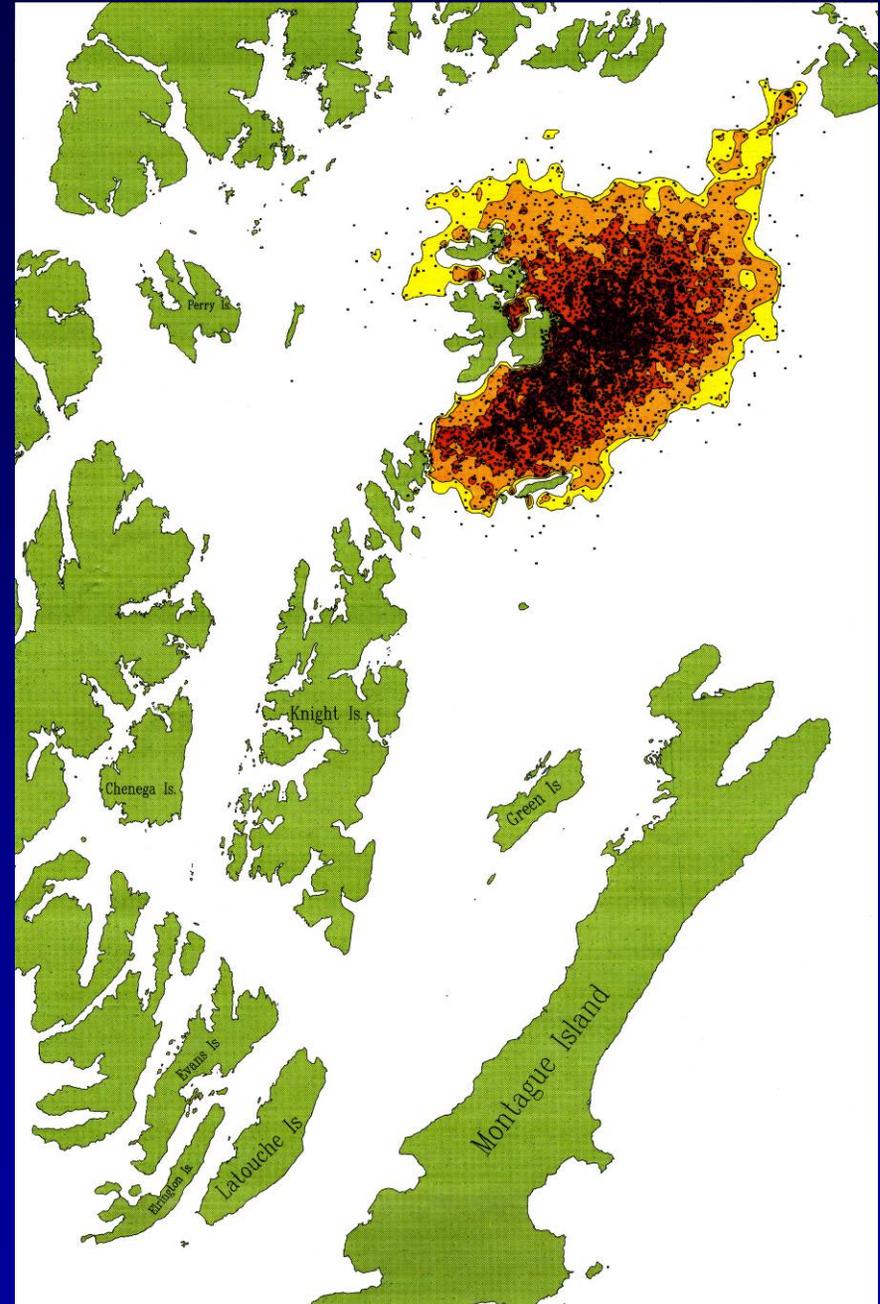
NOAA HAZMAT Trajectory Model

March 27, 1989

Day Four

Legend

- 53 particles/sq mile
- 53 to 13 particles/sq mile
- 13 to 3 particles/sq mile
- 3 to 1 particles/sq mile
- Each particle represents
~1,100 gallons of oil
(twenty 55 gallon drums)



J.A. Galt et al. 1991

Exxon Valdez Oil Spill

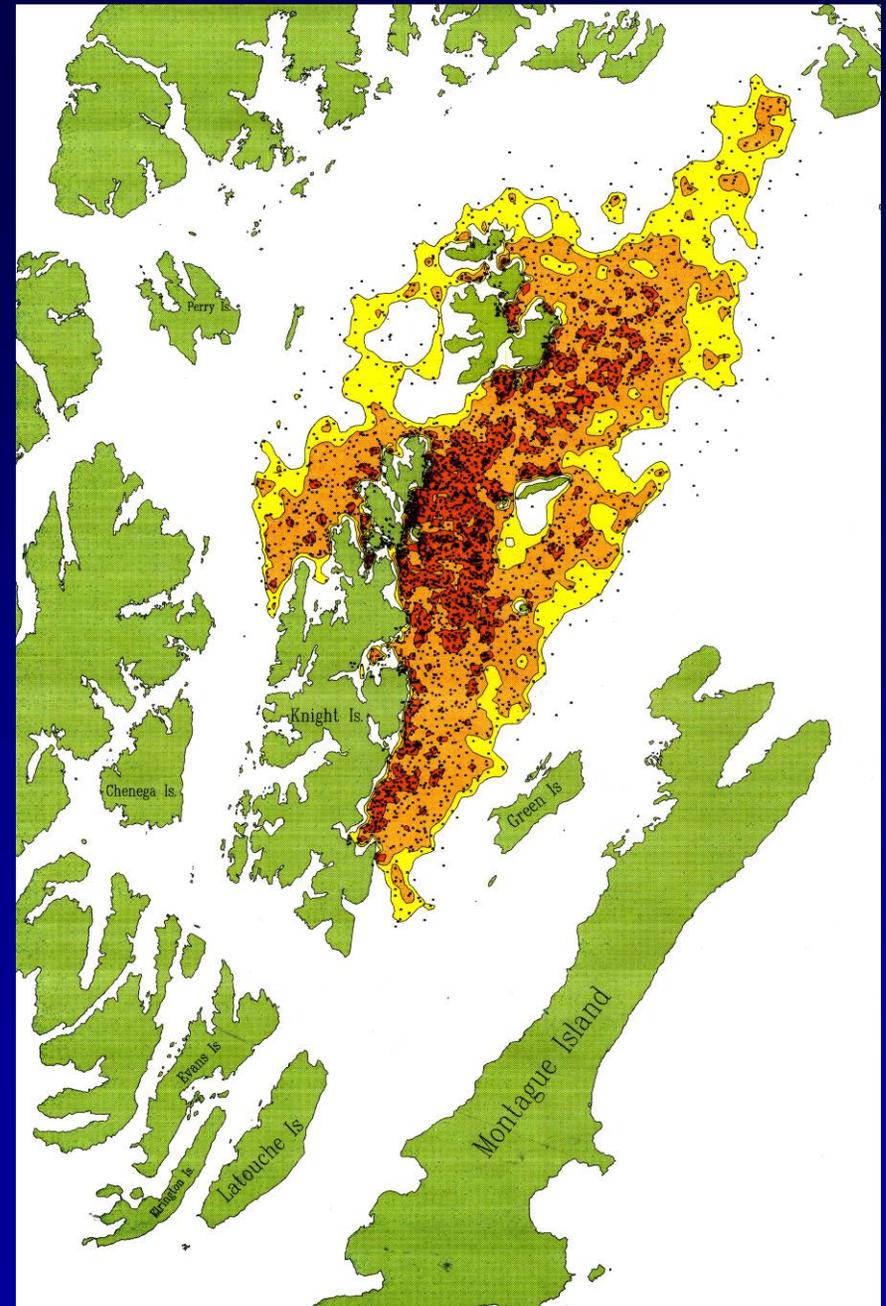
NOAA HAZMAT Trajectory Model

March 28, 1989

Day Five

Legend

- 53 particles/sq mile
- 53 to 13 particles/sq mile
- 13 to 3 particles/sq mile
- 3 to 1 particles/sq mile
- Each particle represents
~1,100 gallons of oil
(twenty 55 gallon drums)



J.A. Galt et al. 1991

Exxon Valdez Oil Spill

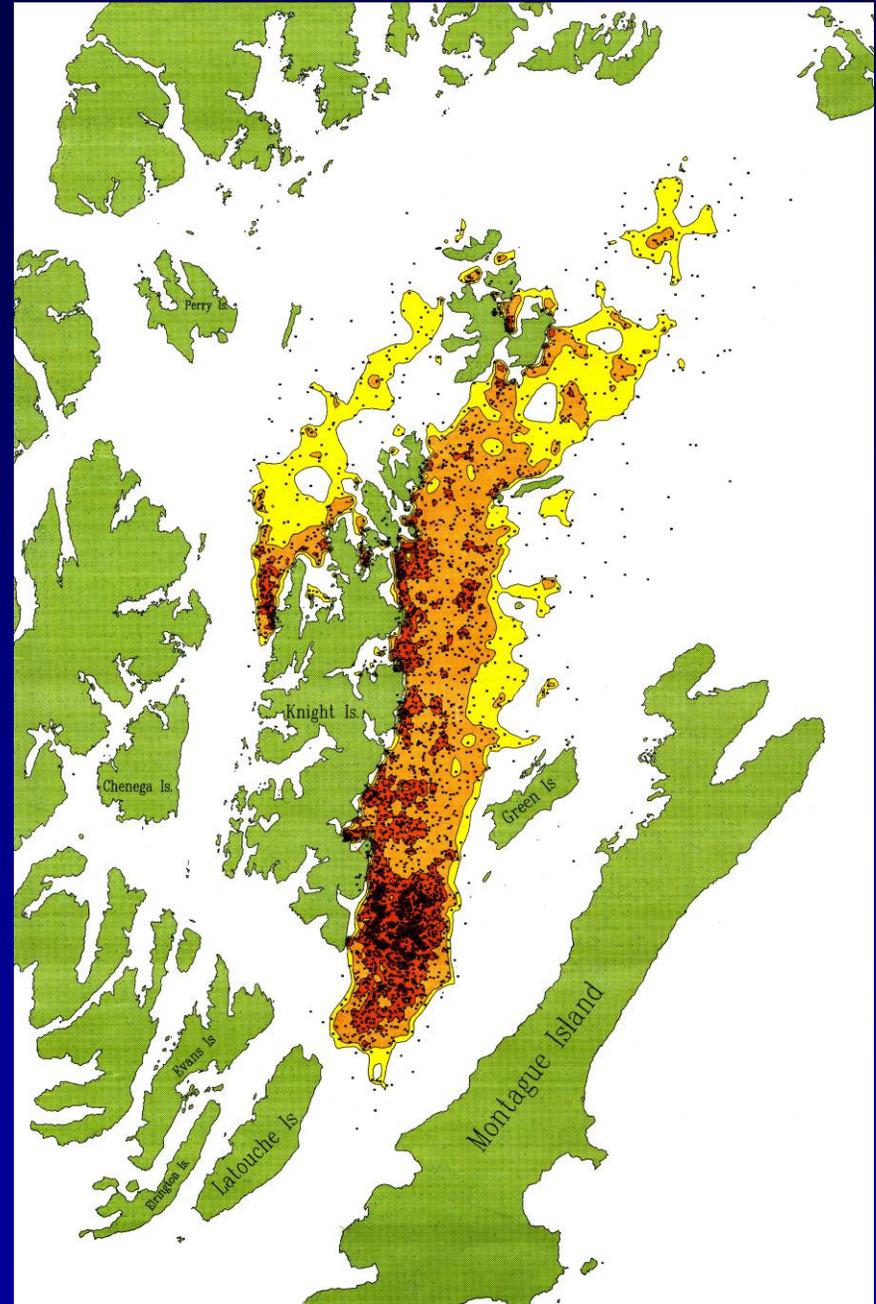
NOAA HAZMAT Trajectory Model

March 29, 1989

Day Six

Legend

- 53 particles/sq mile
- 53 to 13 particles/sq mile
- 13 to 3 particles/sq mile
- 3 to 1 particles/sq mile
- Each particle represents
~1,100 gallons of oil
(twenty 55 gallon drums)



J.A. Galt et al. 1991

Exxon Valdez Oil Spill

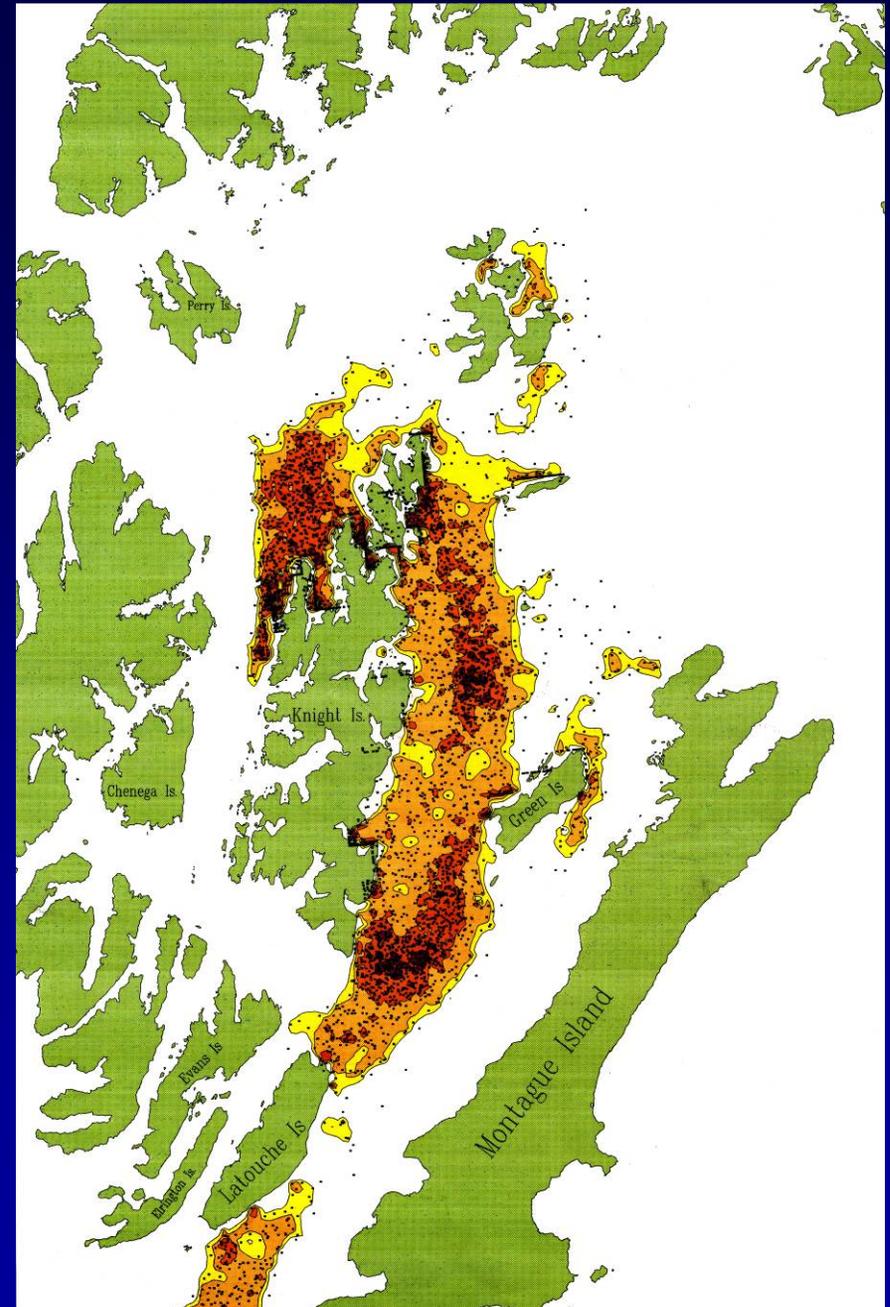
NOAA HAZMAT Trajectory Model

March 30, 1989

Day Six

Legend

- 53 particles/sq mile
- 53 to 13 particles/sq mile
- 13 to 3 particles/sq mile
- 3 to 1 particles/sq mile
- Each particle represents
~1,100 gallons of oil
(twenty 55 gallon drums)

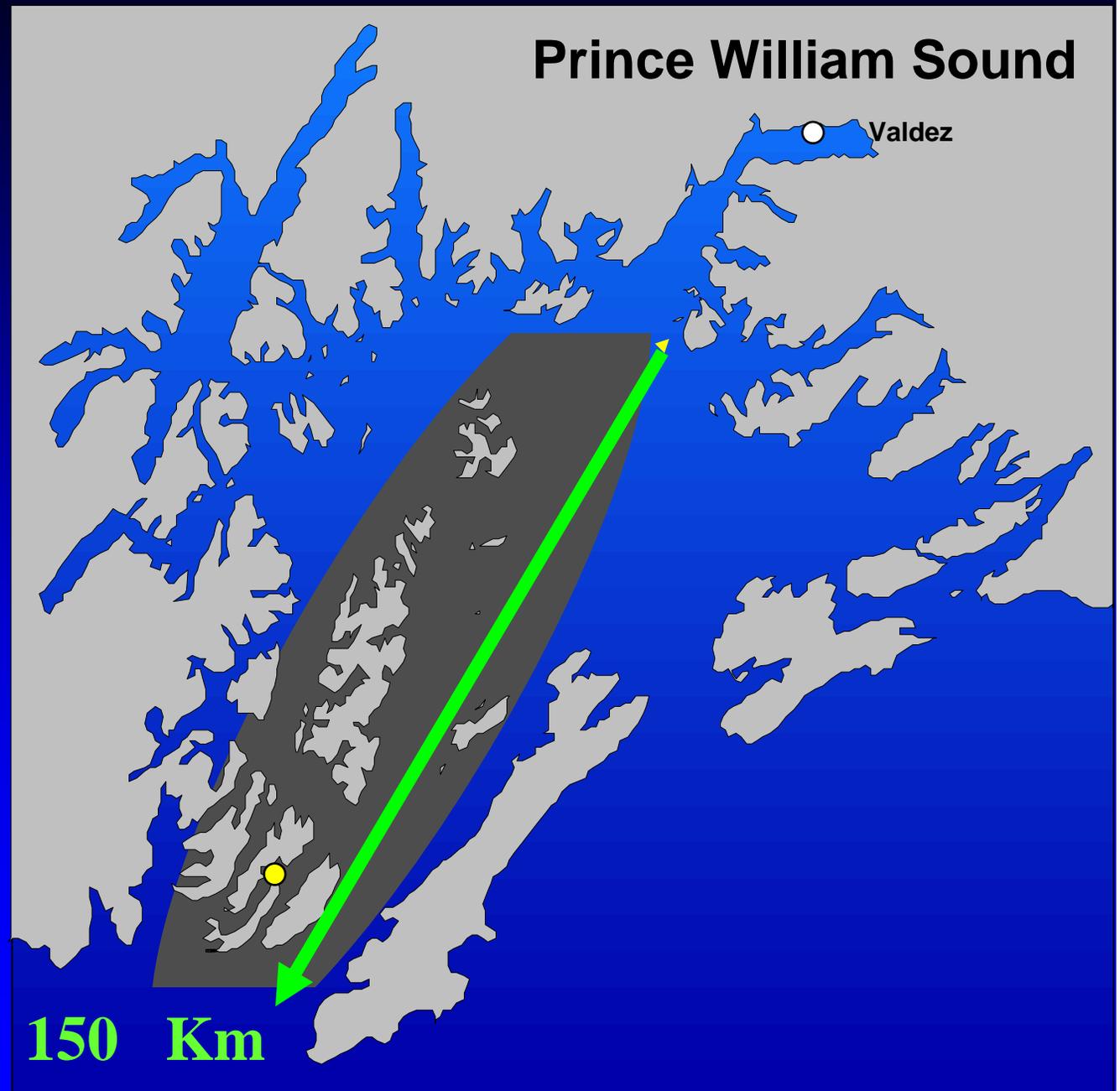


J.A. Galt et al. 1991

**Spill Zone
After the
first week**

**11 Million
gallons**

**70 Knot winds
day 3**









Predictable effects



Acute wildlife loss estimates included:

4000 Sea Otters **500,000 Birds**

Short Answer: Lots



Second:

5 big wows from the Exxon Valdez spill

Long Term Effects, persistence

1. Long term effects (Short term exposure) Killer Whale Story



Killer Whale biology

Long Lived

Low reproductive rates



Organized along Matri-lines

> discrete pods

Two types:

Residents- fish eating

Transients- Marine Mammal eating

Killer Whale biology



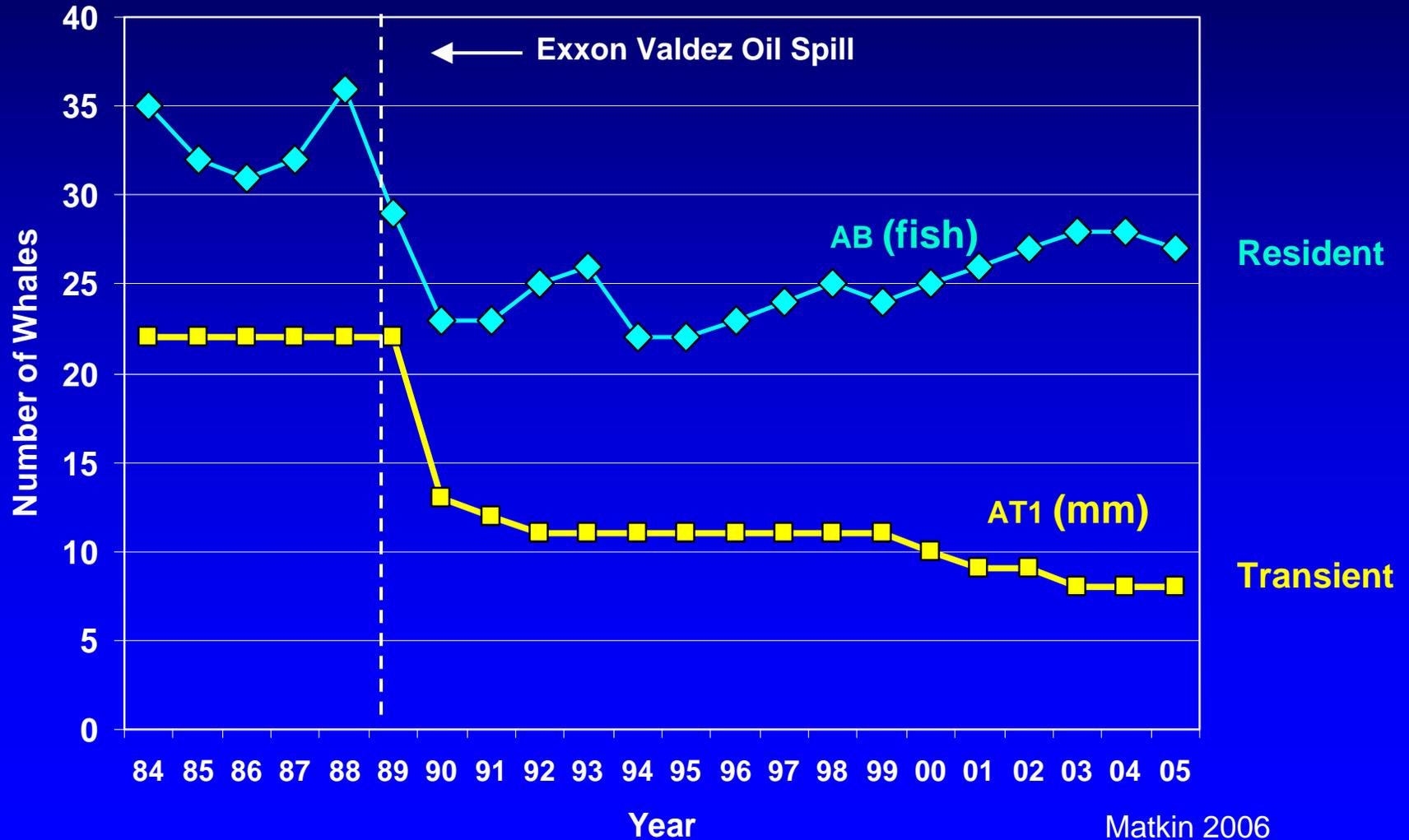
Individuals photo-Identified
since 1984

Two pods photographed in oil slicks AB and AT1 pods



PWS Orca Survival After the Exxon Valdez Oil Spill

Residents / Transients



2. Embryos are sensitive- PPB!

Pink Salmon embryos -
1989, plus 4 more years



Surprising,
Perplexing



75% PWS salmon spawn IT



Approximate 1989 conditions

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**



Pink Salmon Eggs

Incubation in Oiled Rocks



Extreme
5.22 g/kg



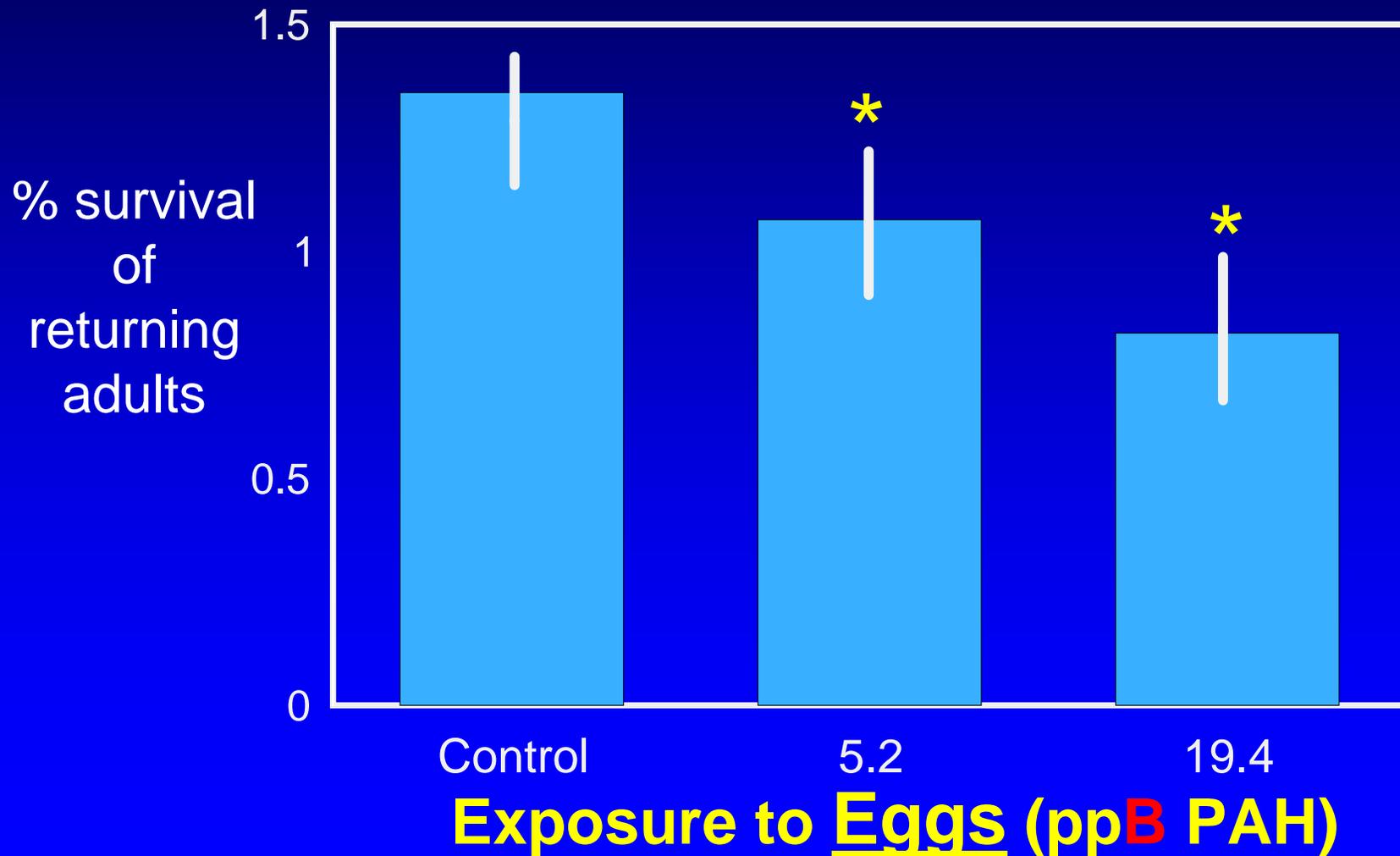
Control
0 g/kg



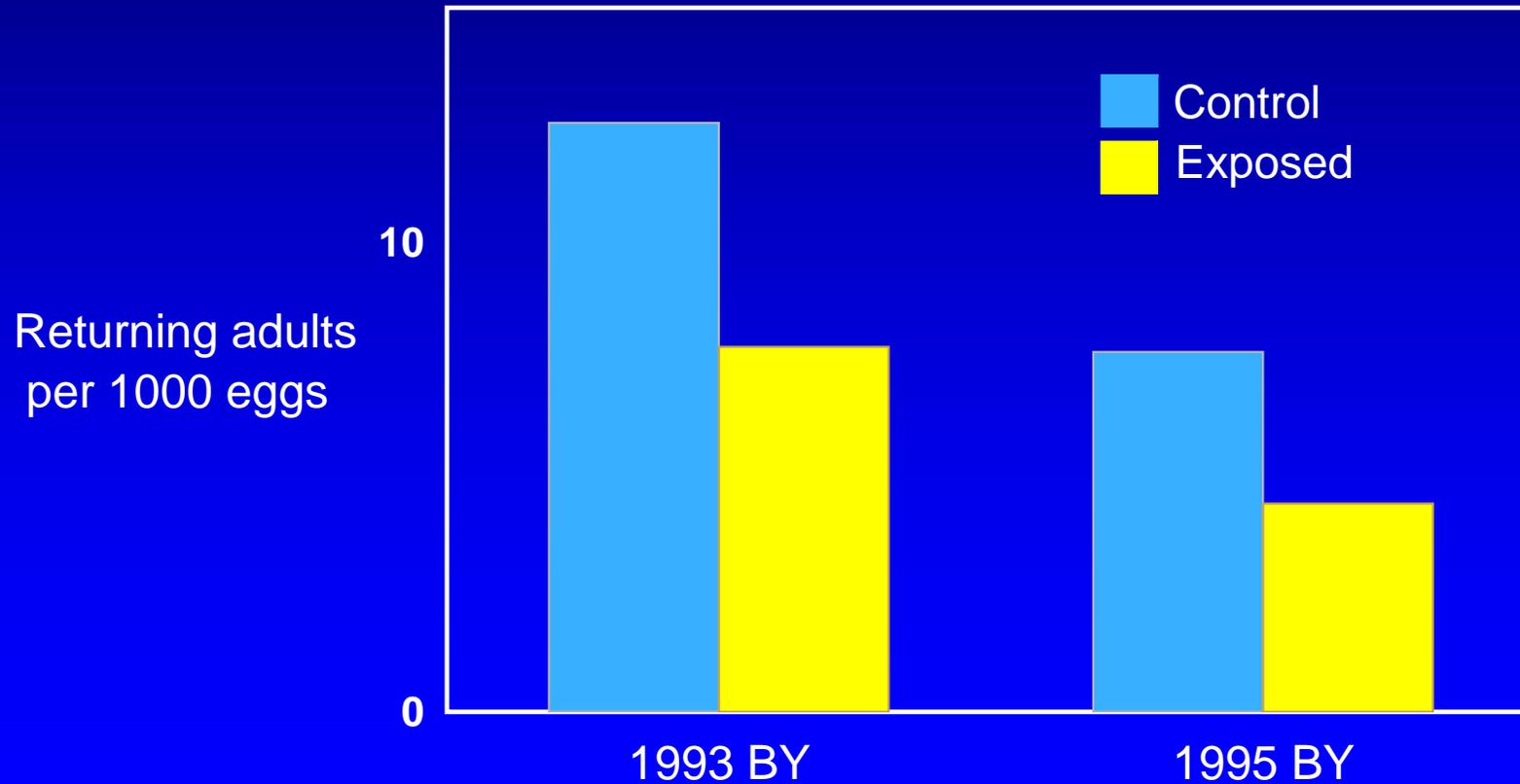
oiled-rock
columns



Adult Returns Reduced **20%** at 5 PPB



Adult returns Reduced (Eggs exposed in 18 ppB)



Pink Salmon Summary

ADFG- 4 year effect in Streams

ABL- Changed toxicity paradigm

Toxicity from ppM to ppB exposures

Fewer Adults return

3. Oil persists -

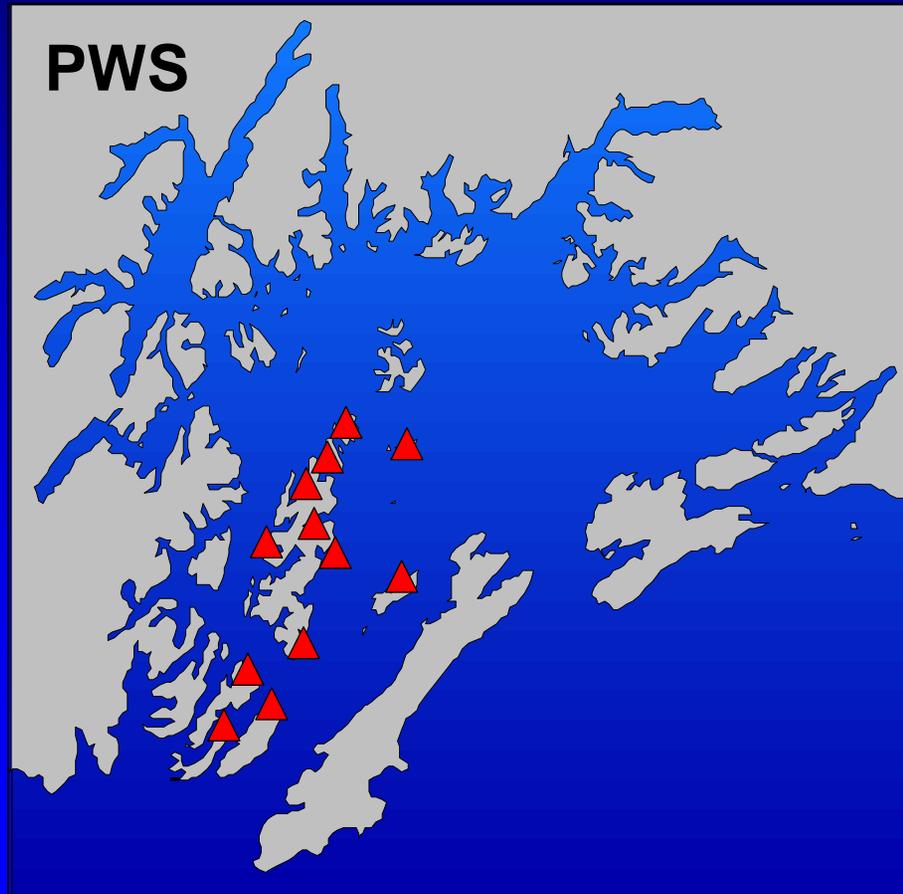
How much?
Where?

1999



Persistence?

2001 Survey: Yes!



91 sites

- 53 sites with oil
- 38 sites without oil

(9000 pits, 1 summer)

Diggers Working in Boulder Field





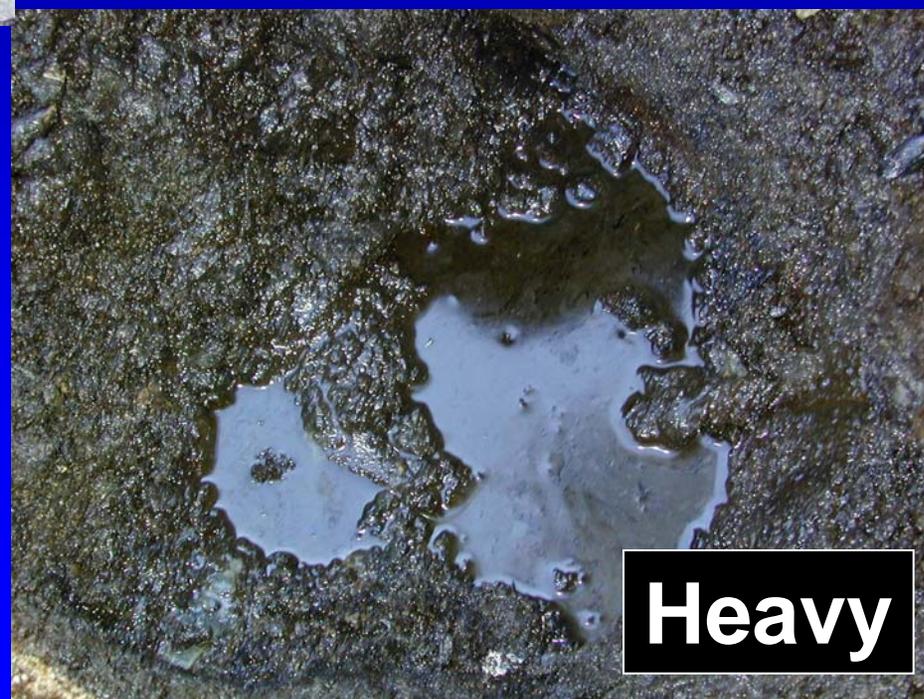
Light sheen



Oil drops

2001
Subsurface Oil > Surface

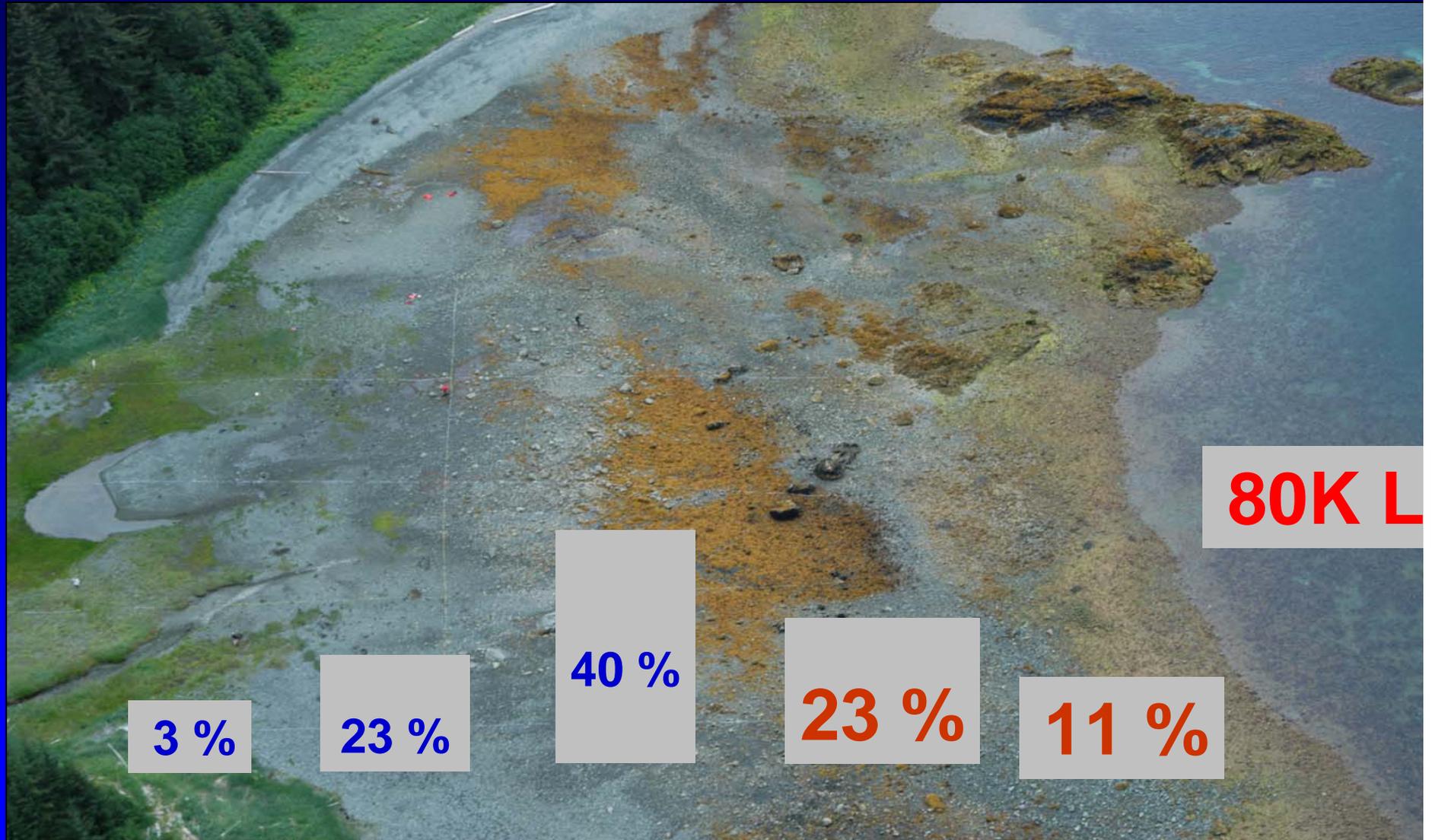
80,000 L
estimated



Heavy



Vertical Distribution of Intertidal Subsurface Oil 2001



Summary of Oil Persistence

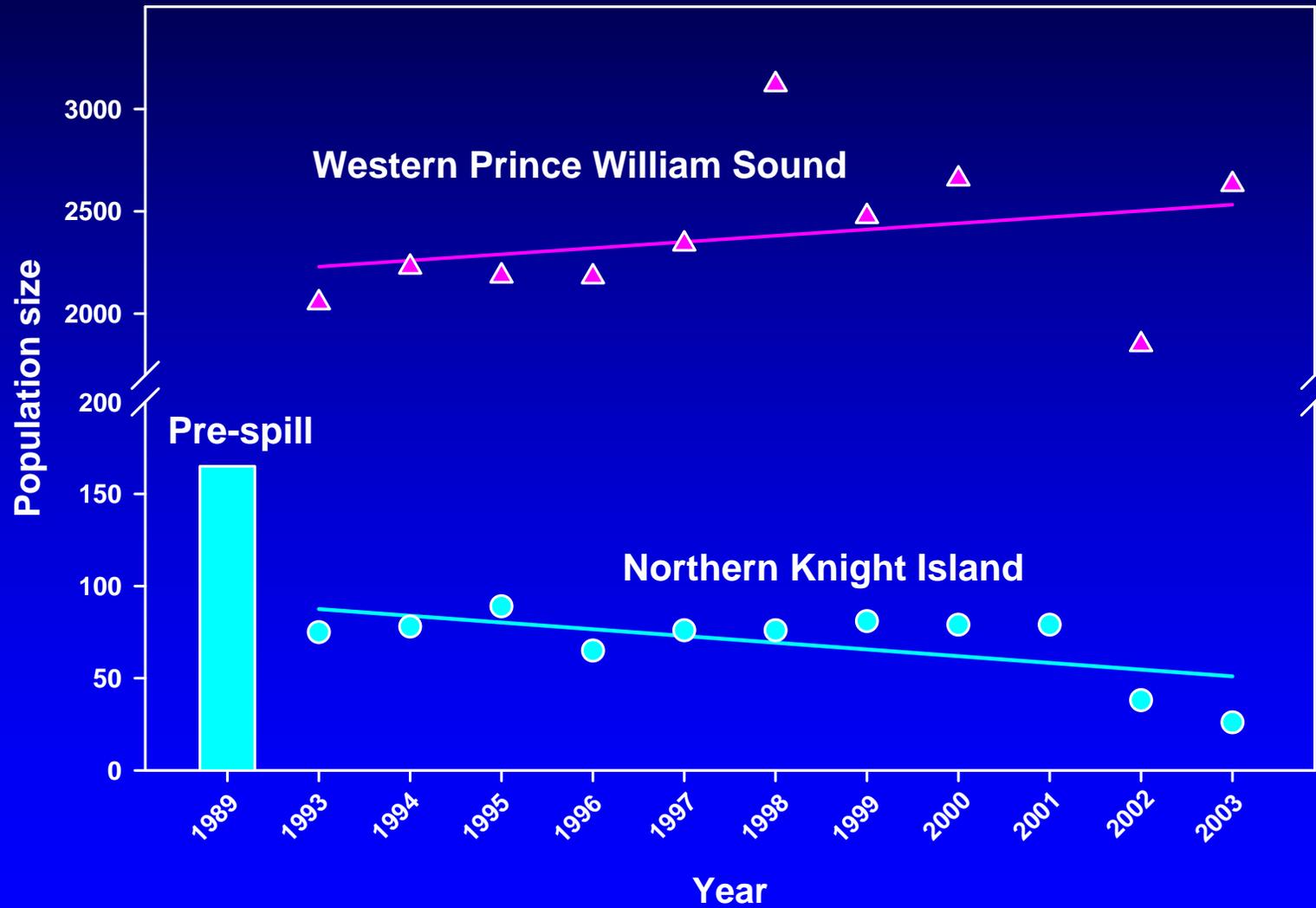
More oil than expected

Lots in the lower intertidal zone

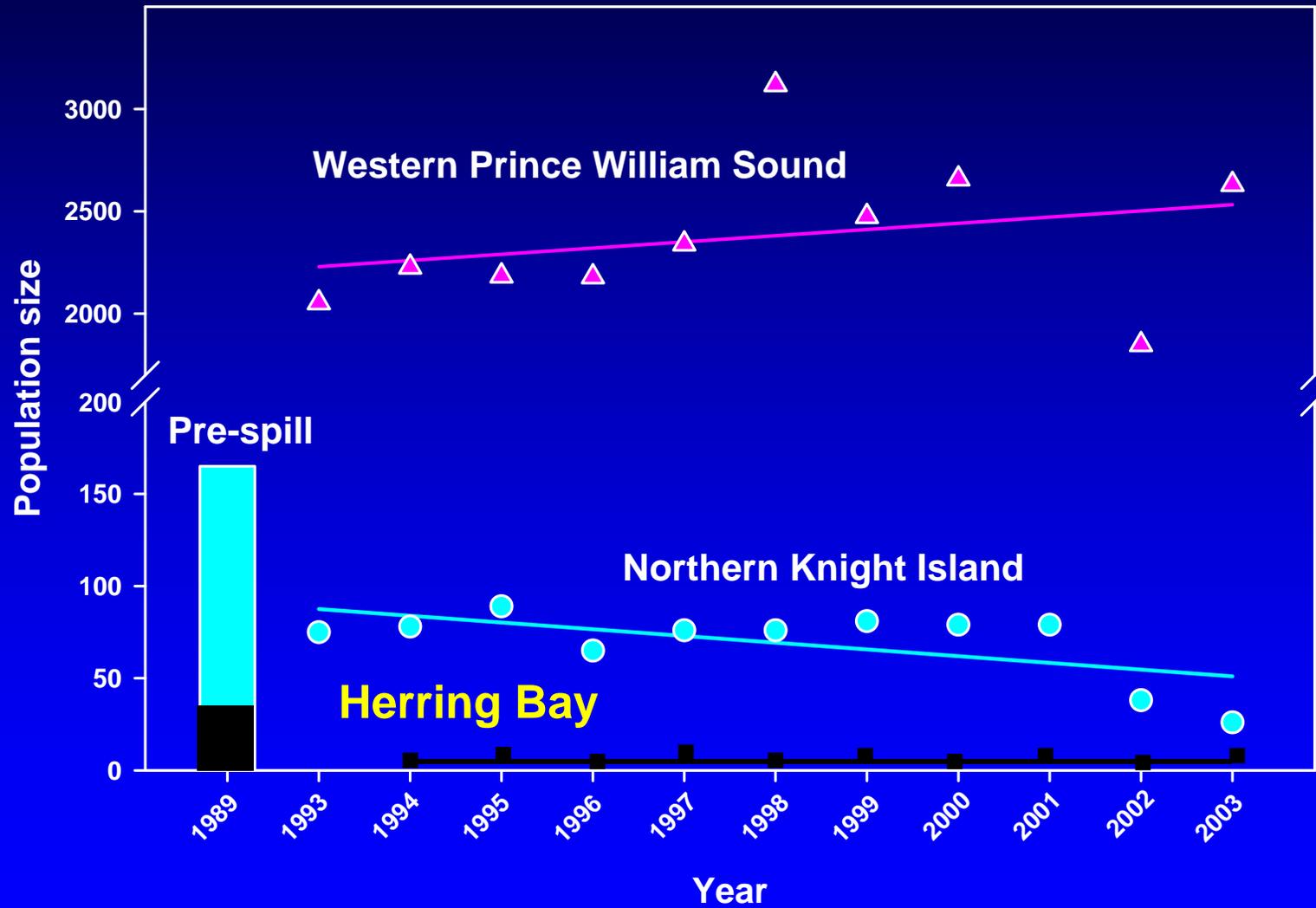
4. Lingering oil impacts- Sea Otter Recovery for 20 yrs



Sea Otter Population Trends 1993-2003



Sea Otter Population Trends 1993-2003



Was it food?

**Recovery was
Incomplete by
Late 1990s**

Was it oil?



**Both feed
in the
lower
intertidal**

Photo courtesy of R. Davis

Both
Need to eat
A lot
(winter)



➤ 25 %
Body Wt
Per day



Photo courtesy of R. Davis

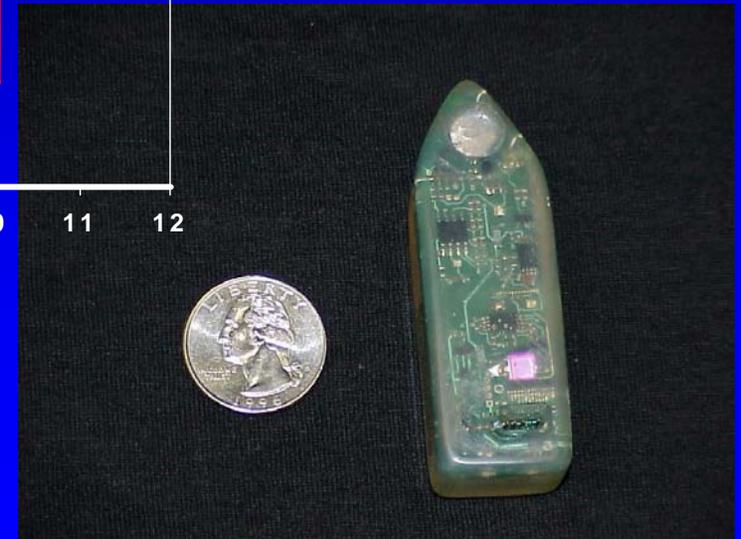
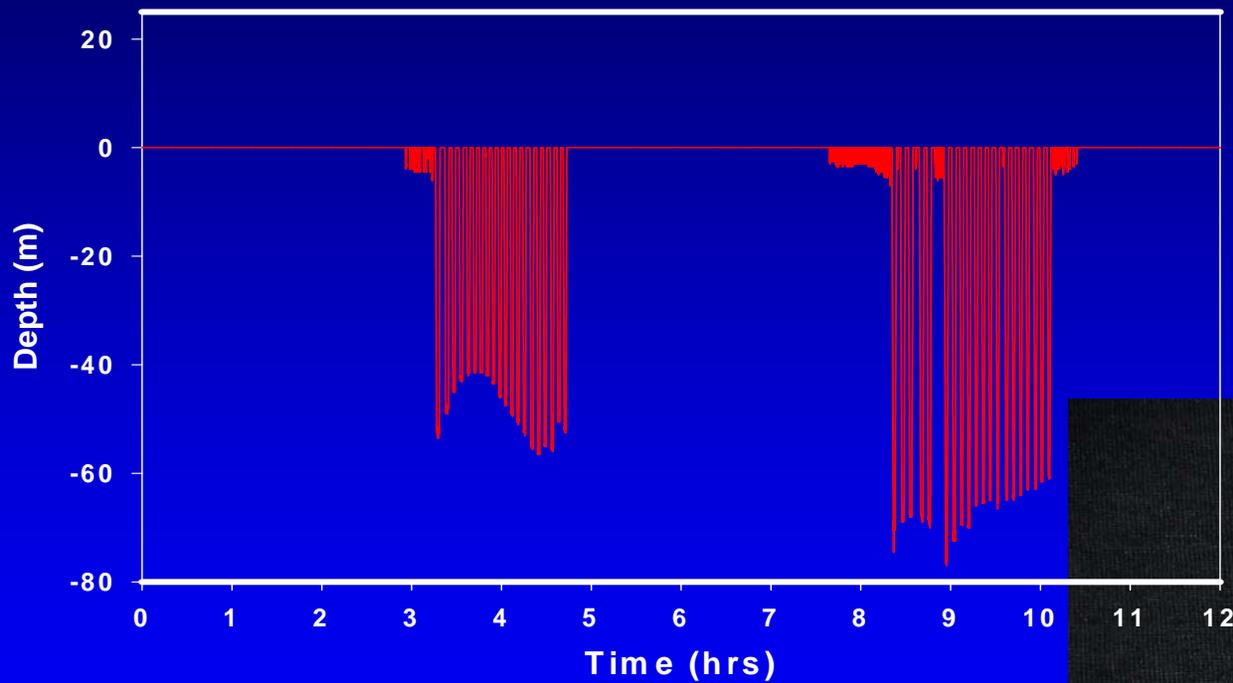




HOW Many IT pits?



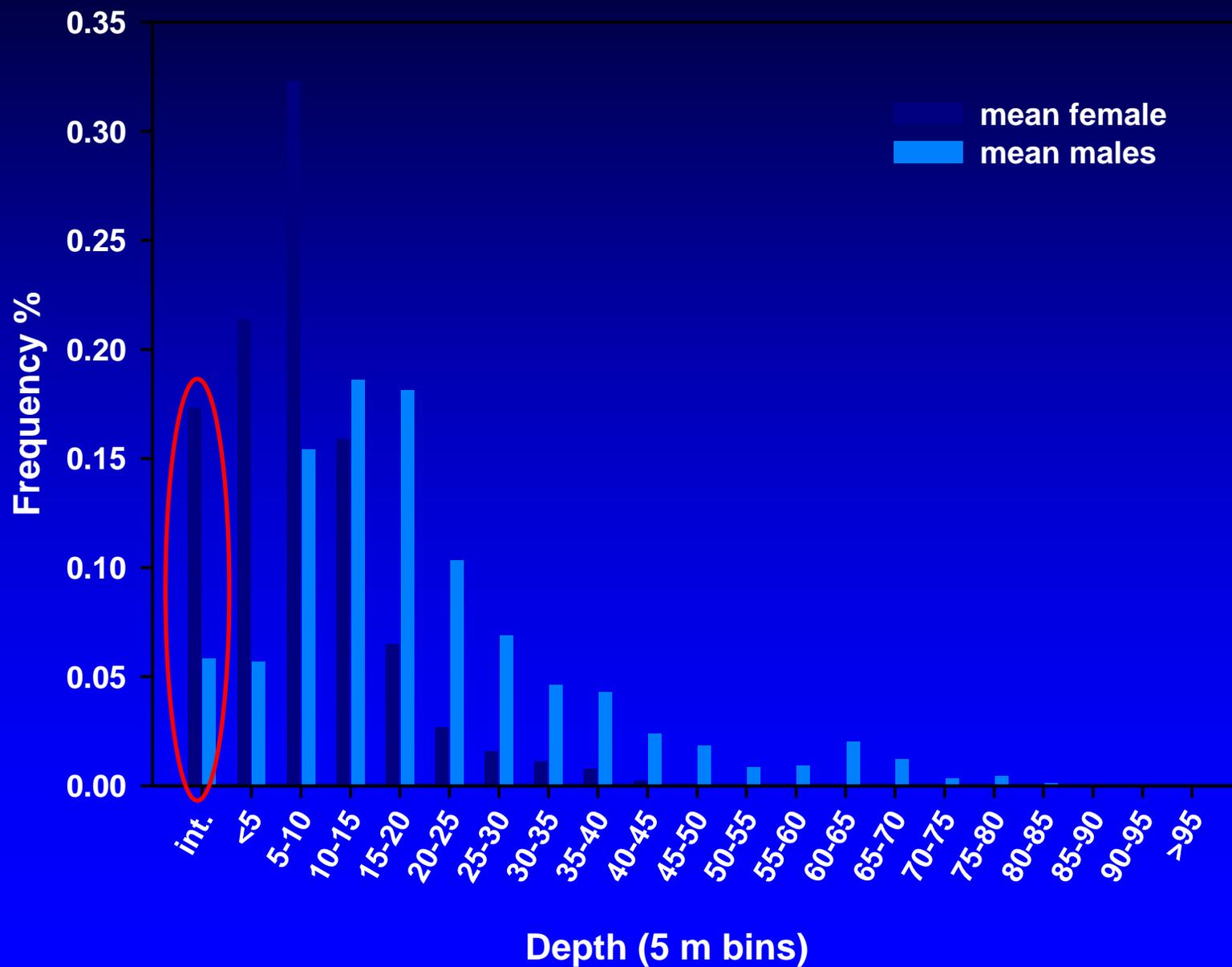
Time Depth Recorder Implants to Estimate Extent of Intertidal Foraging



Shallow dives for Mothers with pups



Forage dive depth distributions 12 females and 4 males PWS 2003-2005



How many intertidal pits do they dig?

2003-2005 data, n=16



at N Knight Island

- **65 Otters dig about 200,000 pits / yr**
- **4 million pits over 20 years**

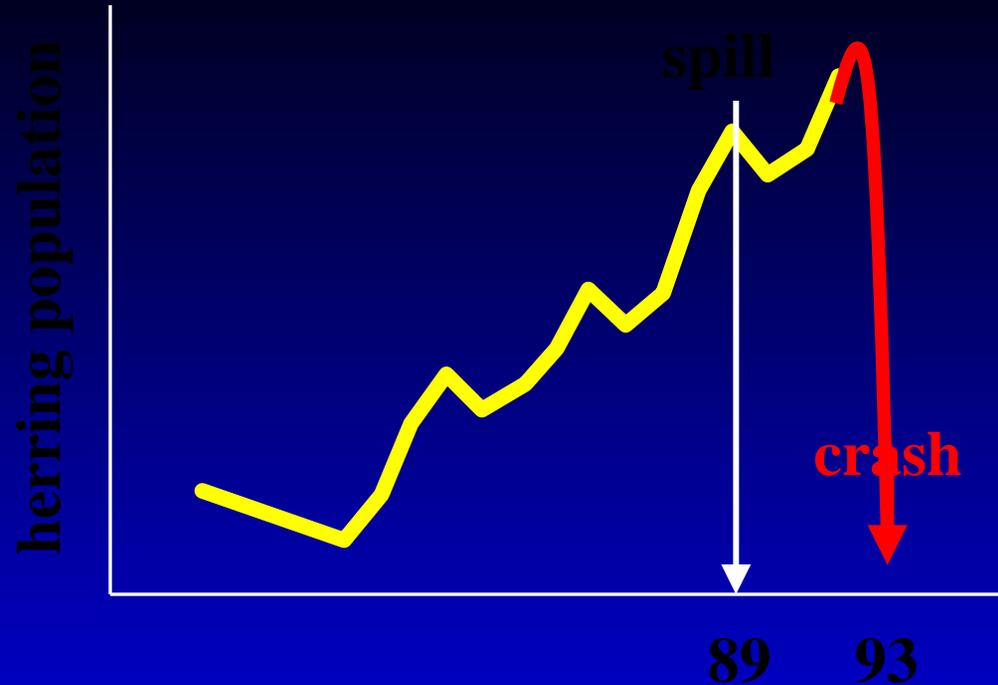


***5. Watch out for the
ecosystem surprises!***



***Pacific Herring of PWS
continue to struggle in 2007***

PWS Herring



Short Term Impacts

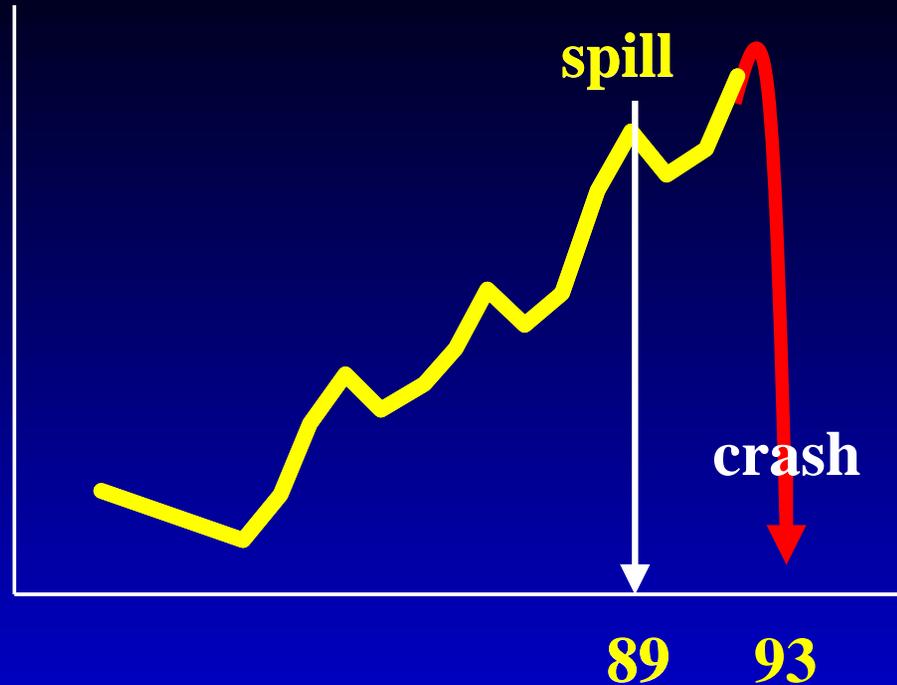
- did Not affect population

Long Term Impacts

- Huge crash; related to oil?

1993: Was it Oil?

herring population



Direct Oil? = No

Indirect Oil ? Possible?

(no where else in AK has there been a crash)

Big Problem

- Recovery continues to be poor





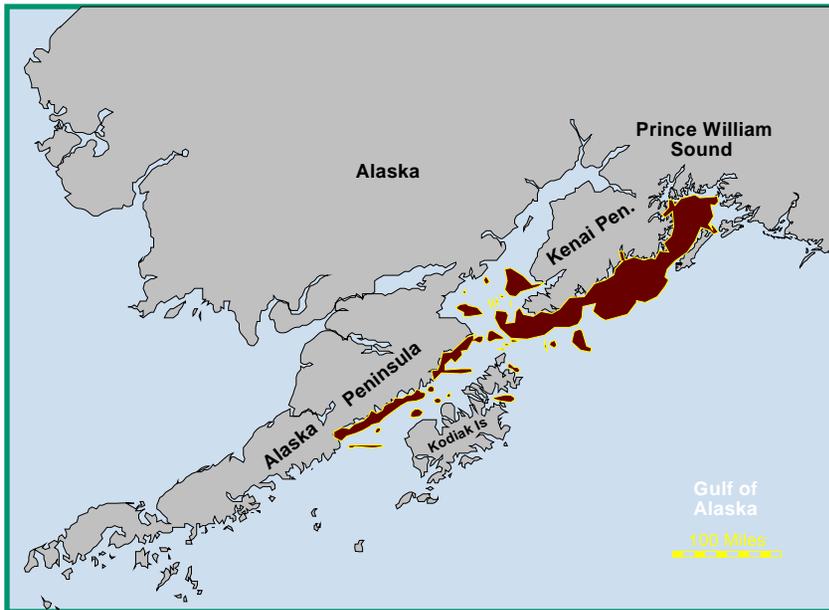
Summary: Developed a case
for Linking
Persistent Oil and
long term effects in
some species
Failed to
explain other
long term



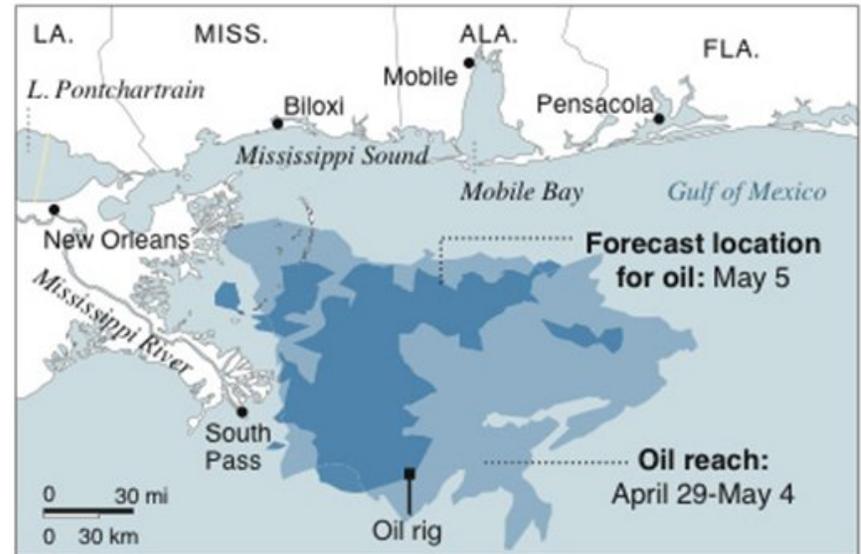
Text



PWS Exxon Valdez Oil spill



GOM Deepwater Horizon Oil spill



SOURCE: NOAA

AP

Text



PWS Exxon Valdez Oil spill



GOM Deepwater Horizon Oil spill



Text



PWS Exxon Valdez Oil spill



GOM Deepwater Horizon Oil spill



Text



PWS Exxon Valdez Oil spill



GOM Deepwater Horizon Oil spill



Text



PWS Exxon Valdez Oil spill



Village of Tatitek

GOM Deepwater Horizon Oil spill



City of New Orleans