Exxon Valdez:

Long Term Effects From Residual Oil

(10 yrs, 4 research groups)

What is Different about the *Exxon Valdez* Oil Spill?

- $100 million into post spill research

- Fewer people effects

- Isolated environment

Three Species – Long Term Impacts:

1.) Pink Salmon 4 years

2.) Sea Otters ~10 years

3.) Harlequin Ducks ~10 years

What do these species have in common?

Spawn or Forage → Intertidal Zone

Residual Oil Effects:

1.) IF Oil is still there

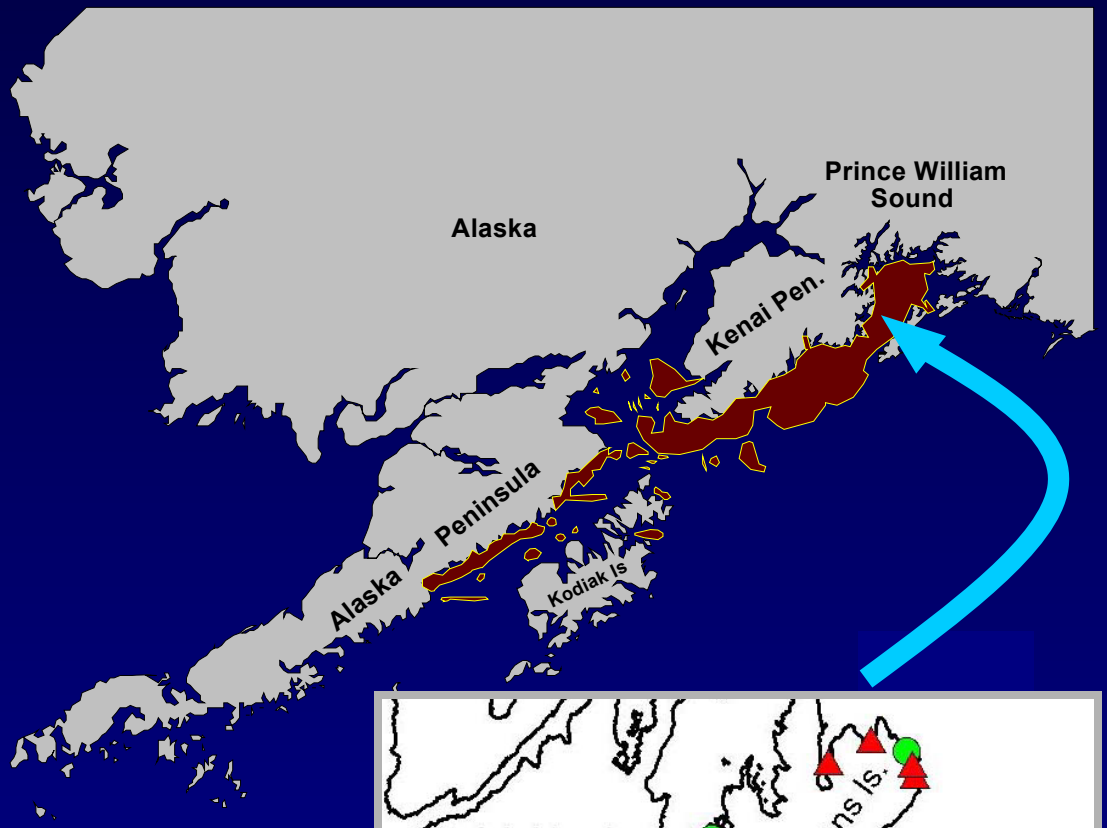
AND

2.) IF Oil is biologically available

AND

3.) IF there is toxicity paradigm shift

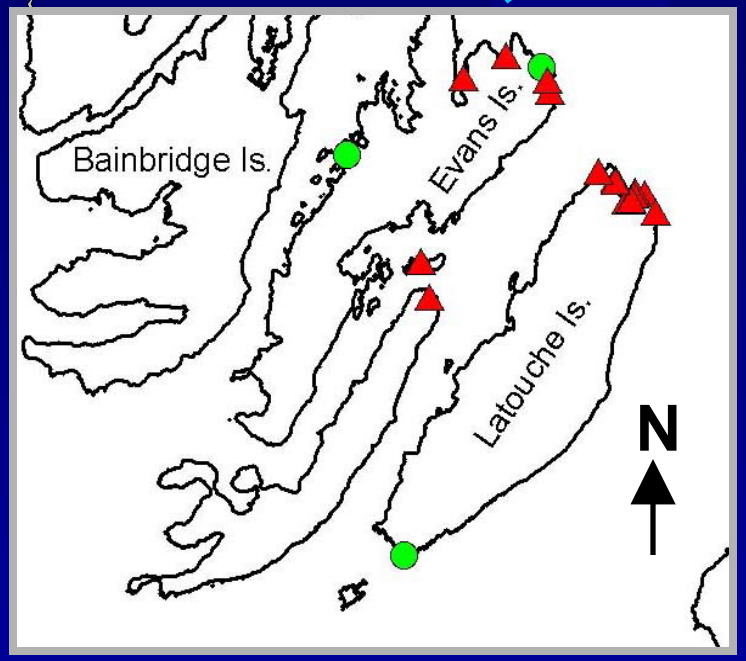
Is the Oil Still There?



2001 Survey Results:

91 sites and 9,000 pits

- **53 sites with oil**
- **38 sites without oil**



Subsurface Oil -

Light Oil Residue

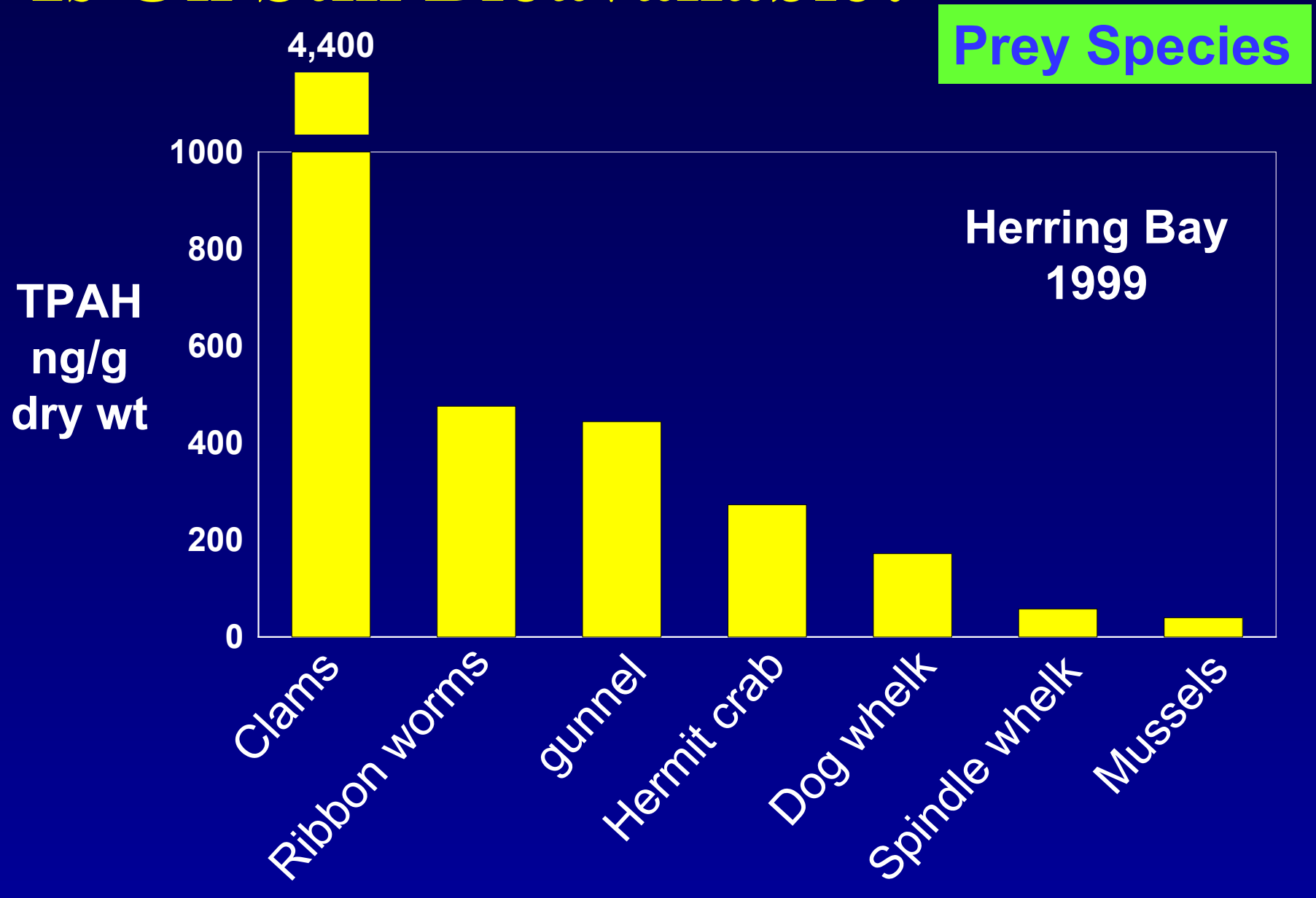
Moderate Oil Residue

Heavy Oil Residue

Distribution of Oil 12 Years Later:

	Tidal zone (m)	Surface Oil (# of pits)	Subsurface Oil (# of pits)
Upper Intertidal	+ 4.8	37	5
	+ 4.3	**56**	28
	+ 3.3	**58**	69
	+ 2.8	**60**	91
	+ 2.3	40	**123**
Biological Zone (lower Intertidal)	+ 1.8	29	**117**
	< 1m	Oil Below Sampling Grid = Yes How far down = ?	

Is Oil Still Bioavailable?



Is Oil Still Bioavailable?

Predators

1. Elevated P450 in oiled areas

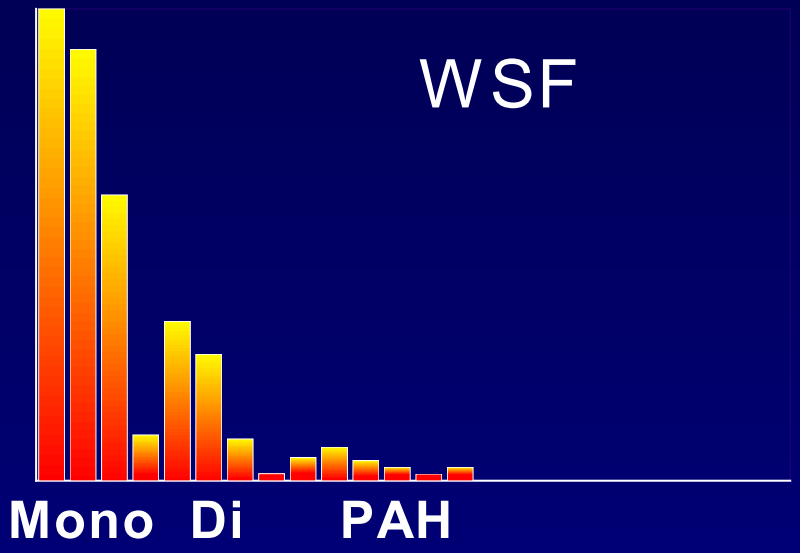
   1996 – 98 Sea Otters

   1996 – 98 Sea Ducks

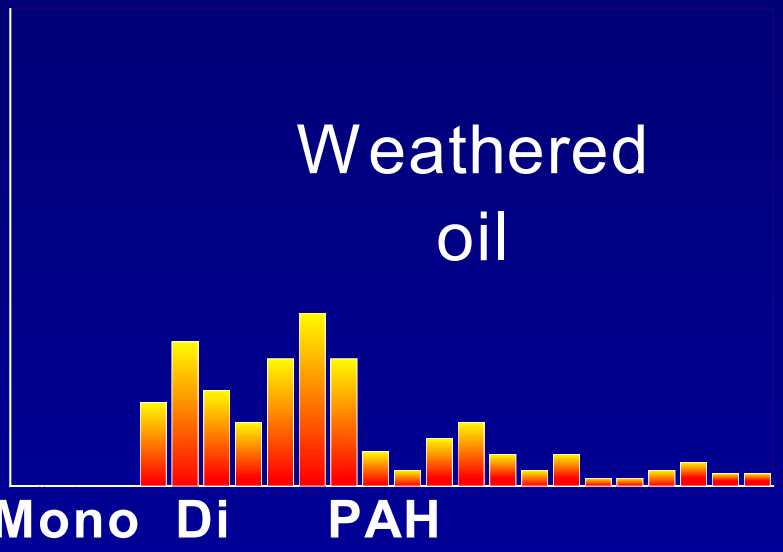
2. Poor population recovery in oiled areas (1989-99)

Paradigm Shift in Ecotoxicity

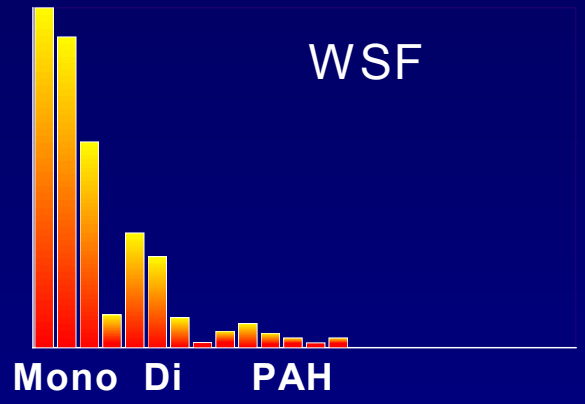
1970s:
1-2 PAH rings
LC50 = 1 ppM

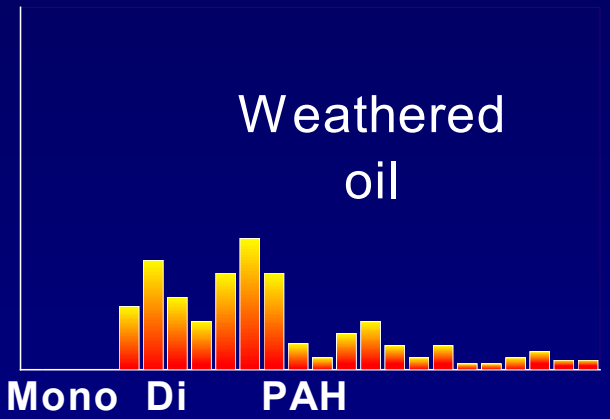


1990s:
3-5 PAH rings
effects = 1-20 ppB



Different Toxic Mechanisms – from Different Toxic Compounds





Acute LC50 Narcosis → **Long Term "Reduced Fitness"**

Different Toxic Mechanisms -

Monoaromatics

↓

Acute Exposure

↓

"Narcosis" death

≠

PAH

↓

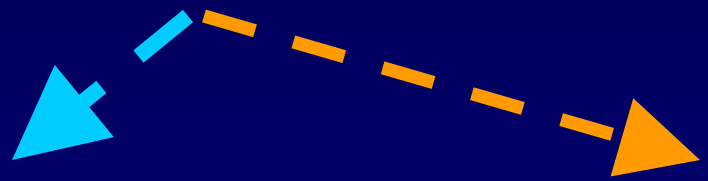
Chronic Low Level Exposure

↓

Leukemia

Different Toxic Mechanisms -

E.g. **Benzene**



Acute Exposure

Chronic Low Level Exposure

"Narcosis" death ≠ **Leukemia**

Reduced Fitness Results In:

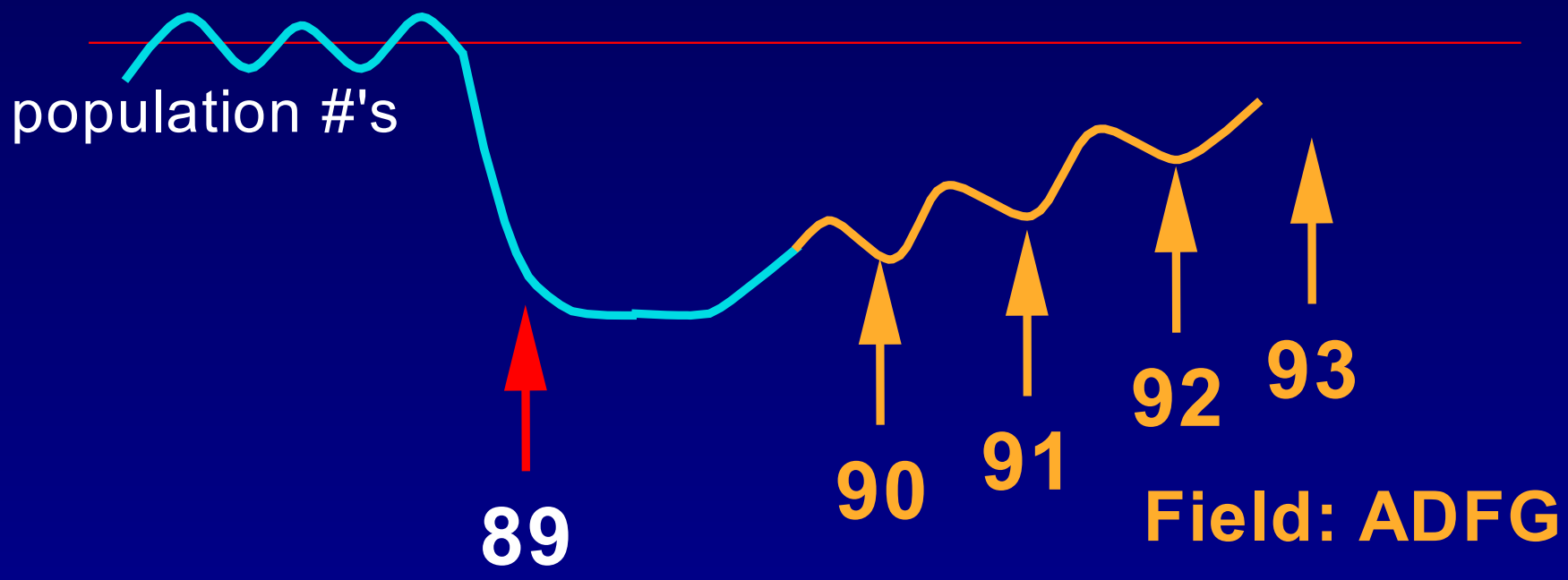
- ↓ in Survival -
  - ↑ in Deformities
  - ↓ in Growth
  - ↓ in Predator avoidance
  - ↓ in Reproductive Success

Supported by field and laboratory studies

Decreased Survival: -Pink Salmon

Field Research

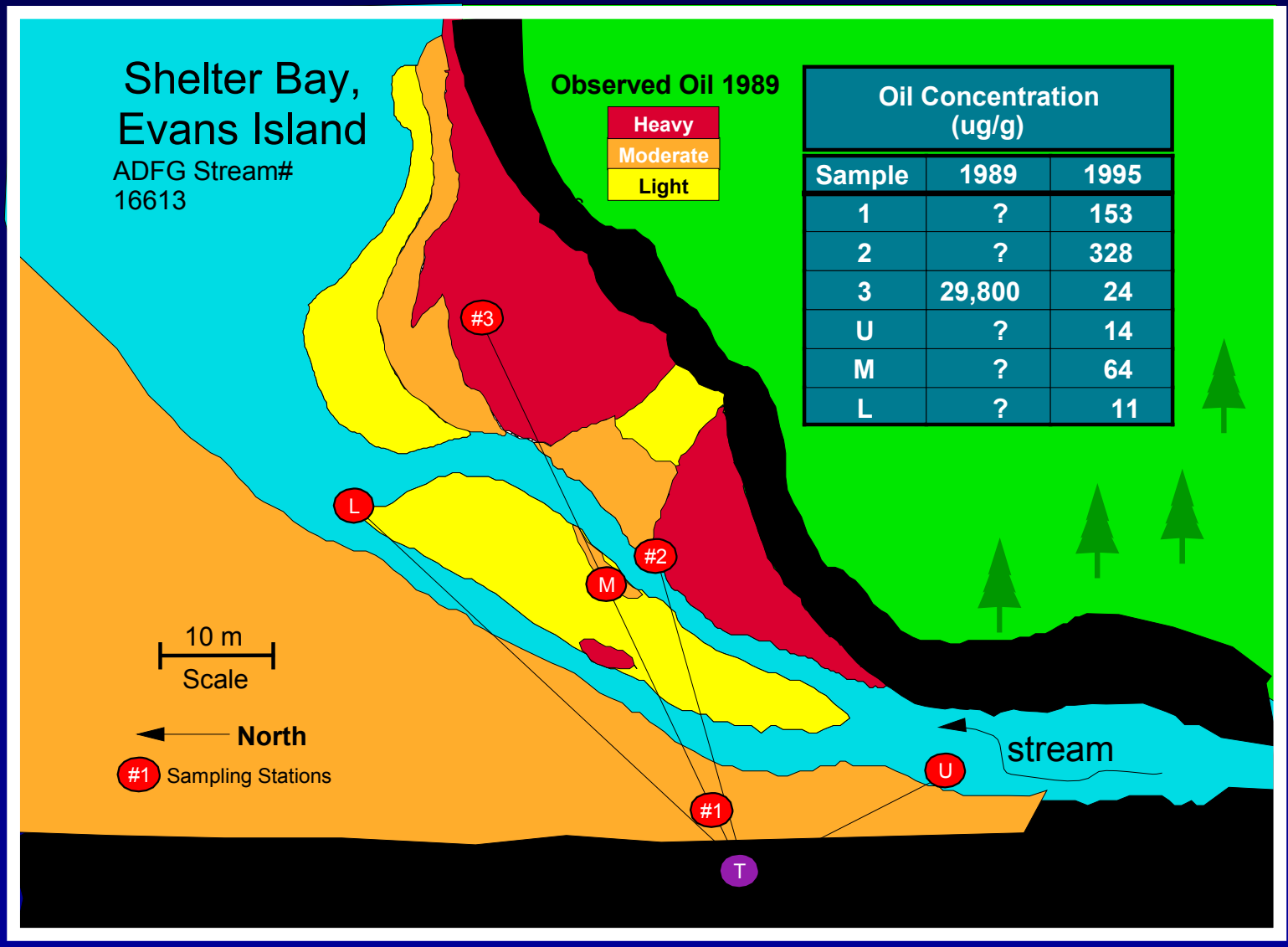
Elevated egg mortality in “oiled” stream



pre - spill → EVOS → spill

1989 & 1995 Oiled Salmon Streams

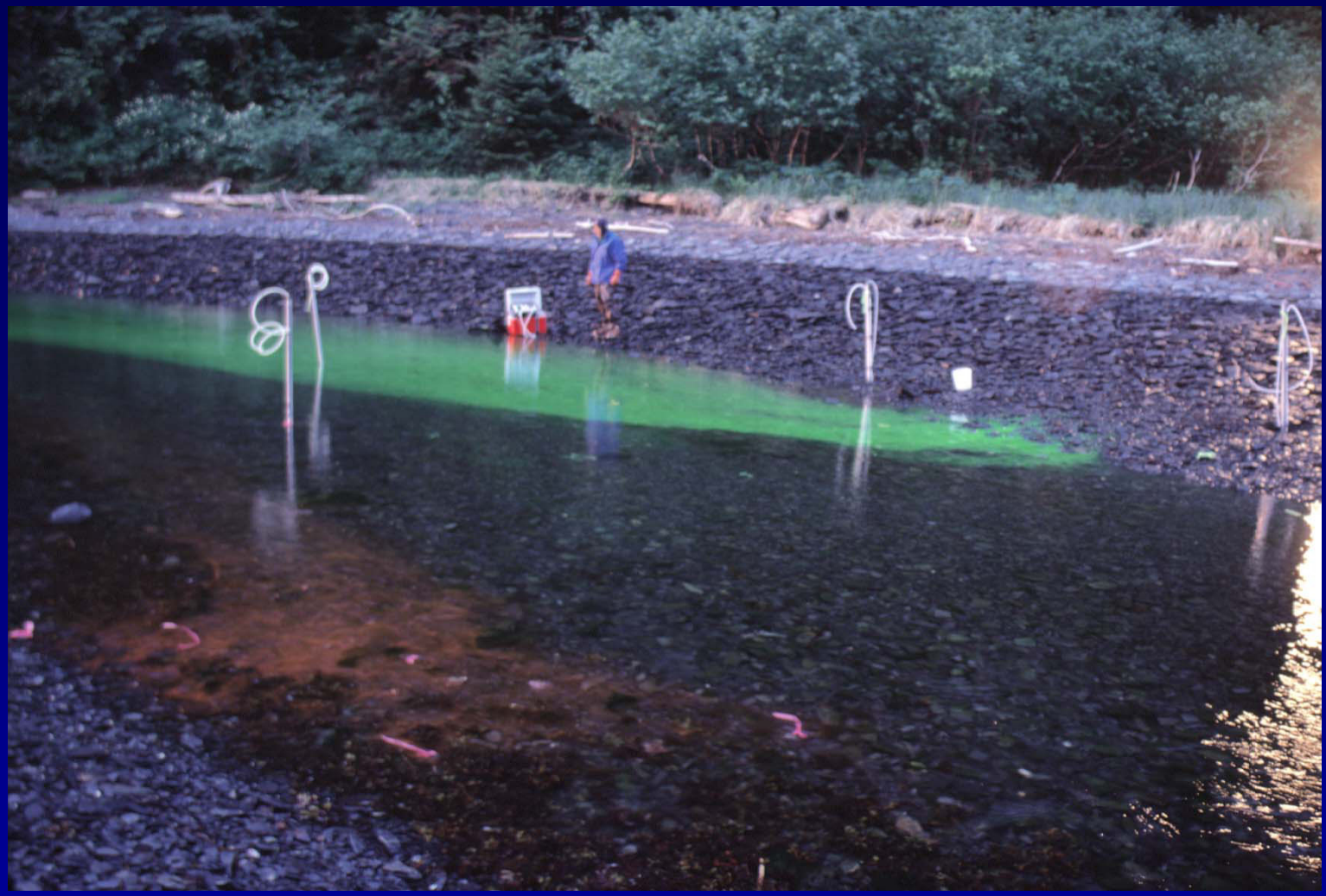
Field Research



Oil Concentration (ug/g)		
Sample	1989	1995
1	?	153
2	?	328
3	29,800	24
U	?	14
M	?	64
L	?	11

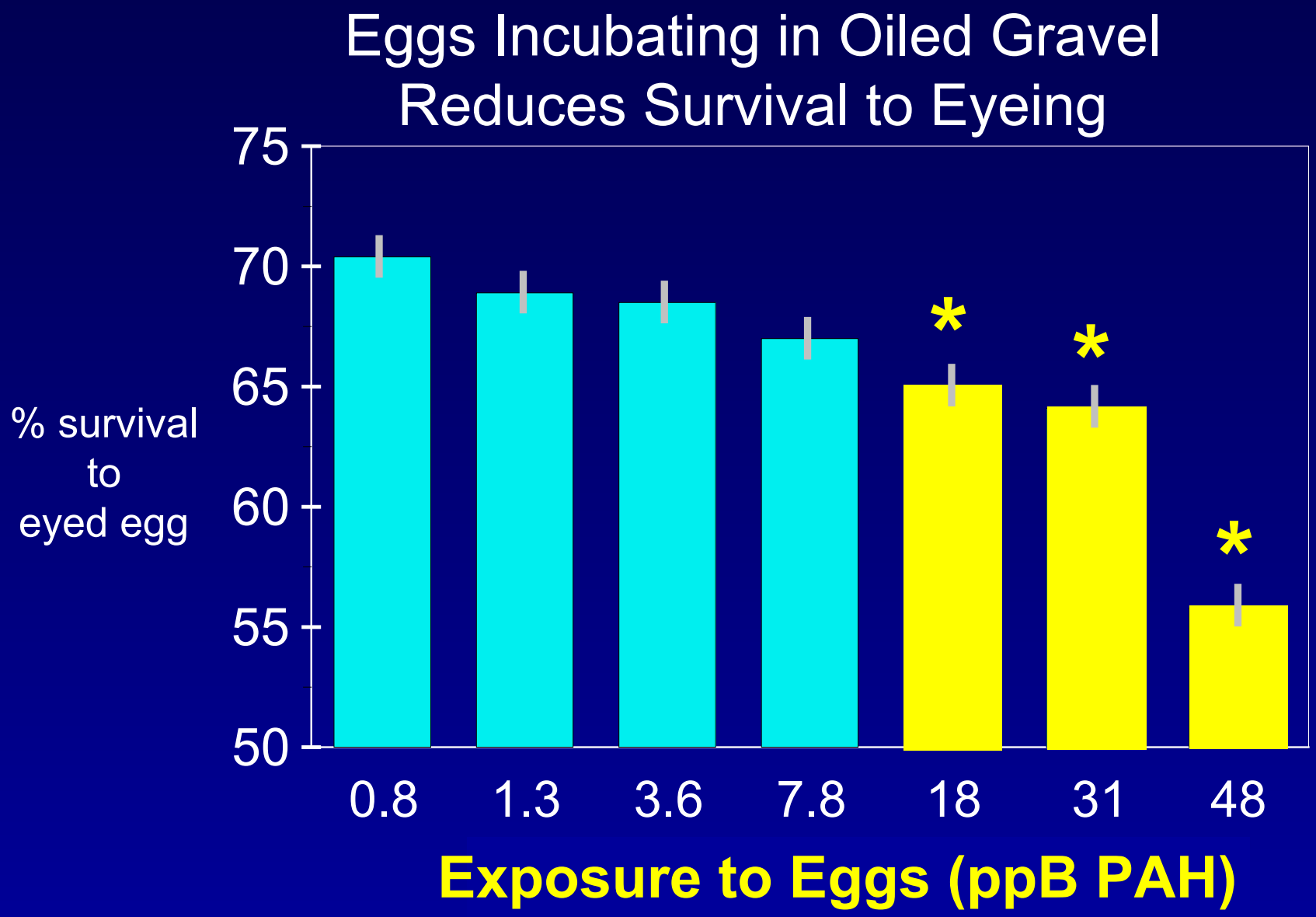
Dye Released in Salmon Stream

Field Research



Decreased Survival: Pink Salmon

Lab Research



Increased Deformities:

Lab Research

Pink Salmon Alevin at Emergence

-Extra fins

- Deformed mouth

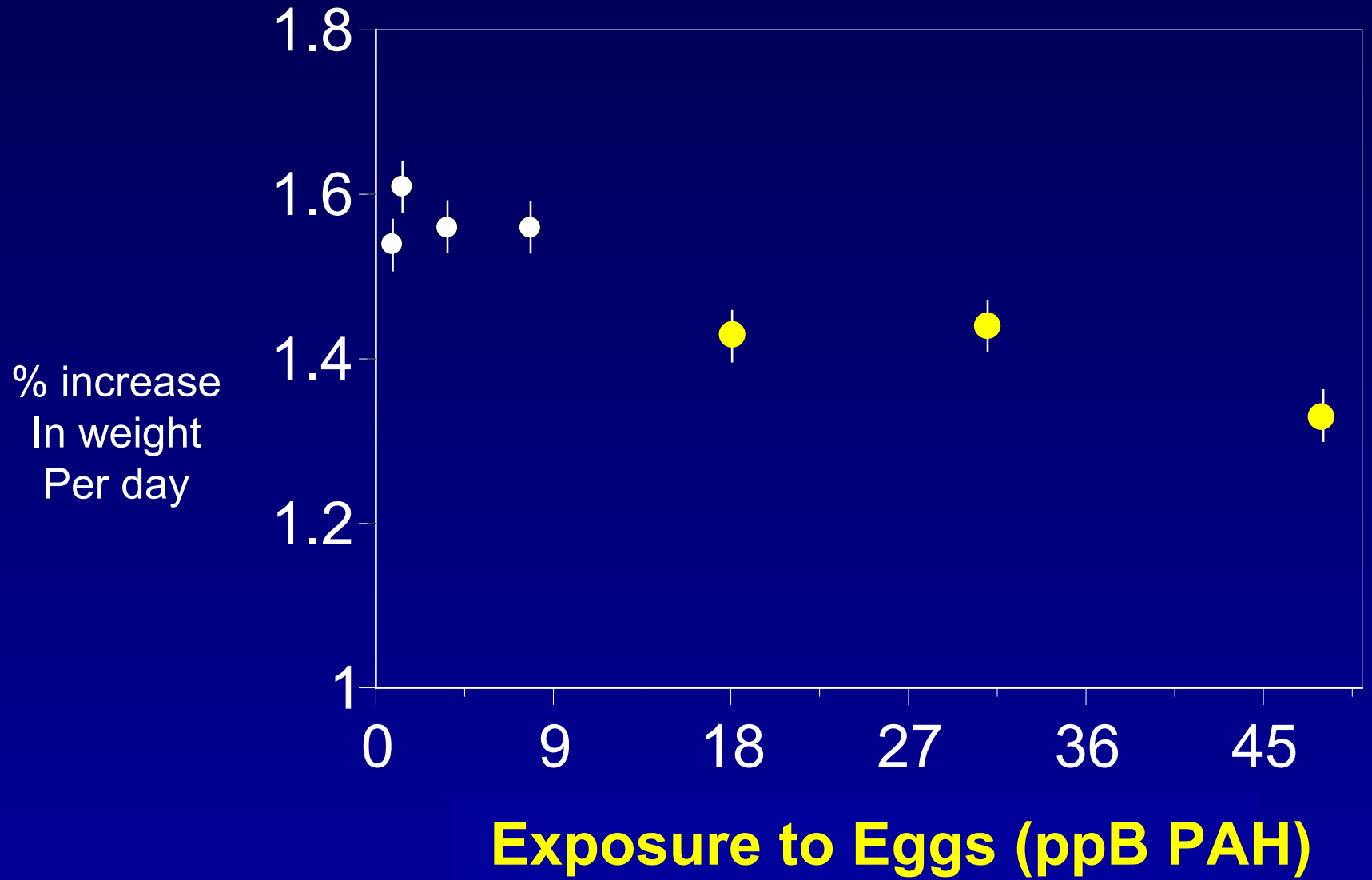
- Metabolism problems

Exposure to Eggs (ppB PAH)

Delayed Growth:

Lab Research

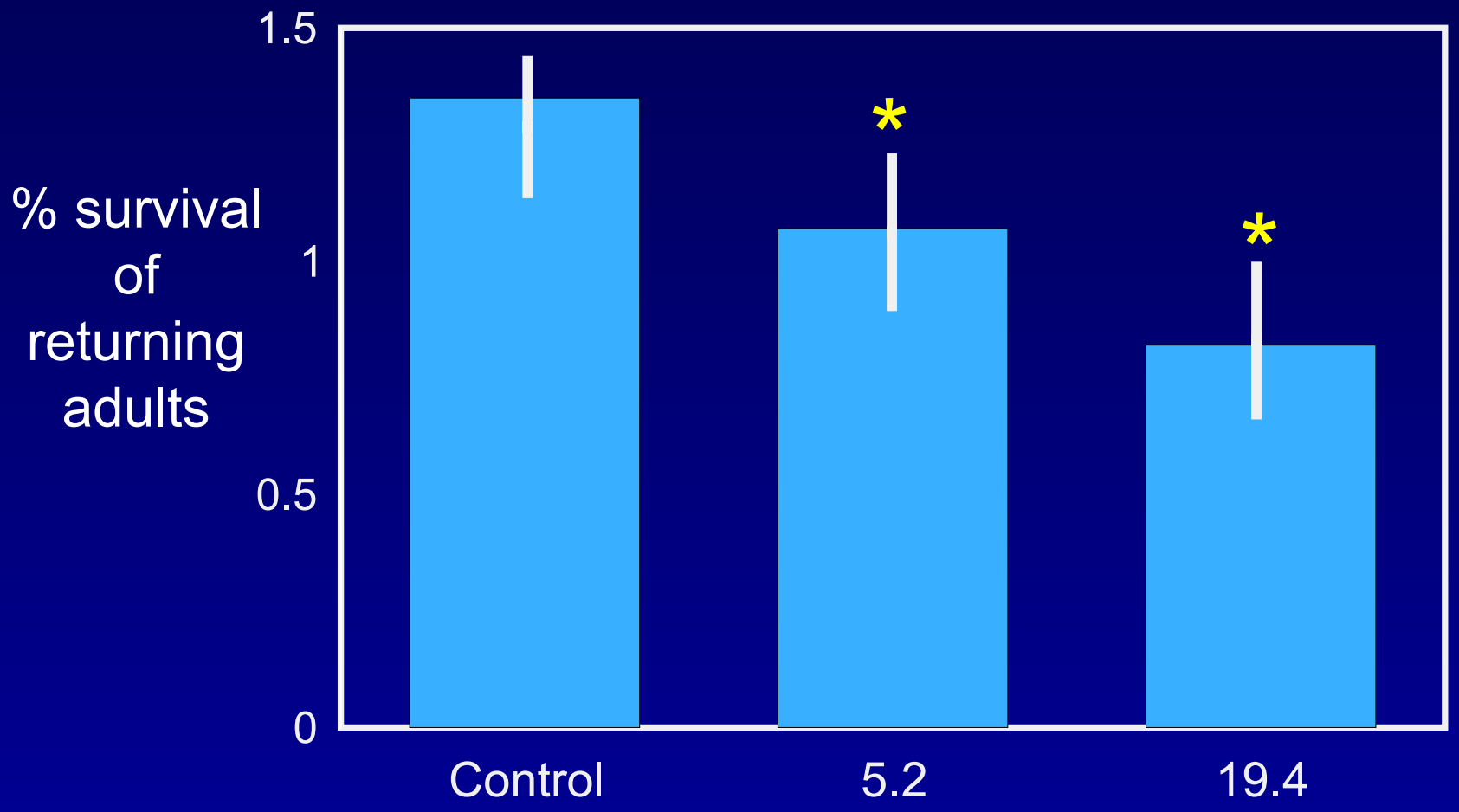
Effects to Salmon Fry



Delayed Growth:

Lab Research

Effects on Adult Salmon Returns

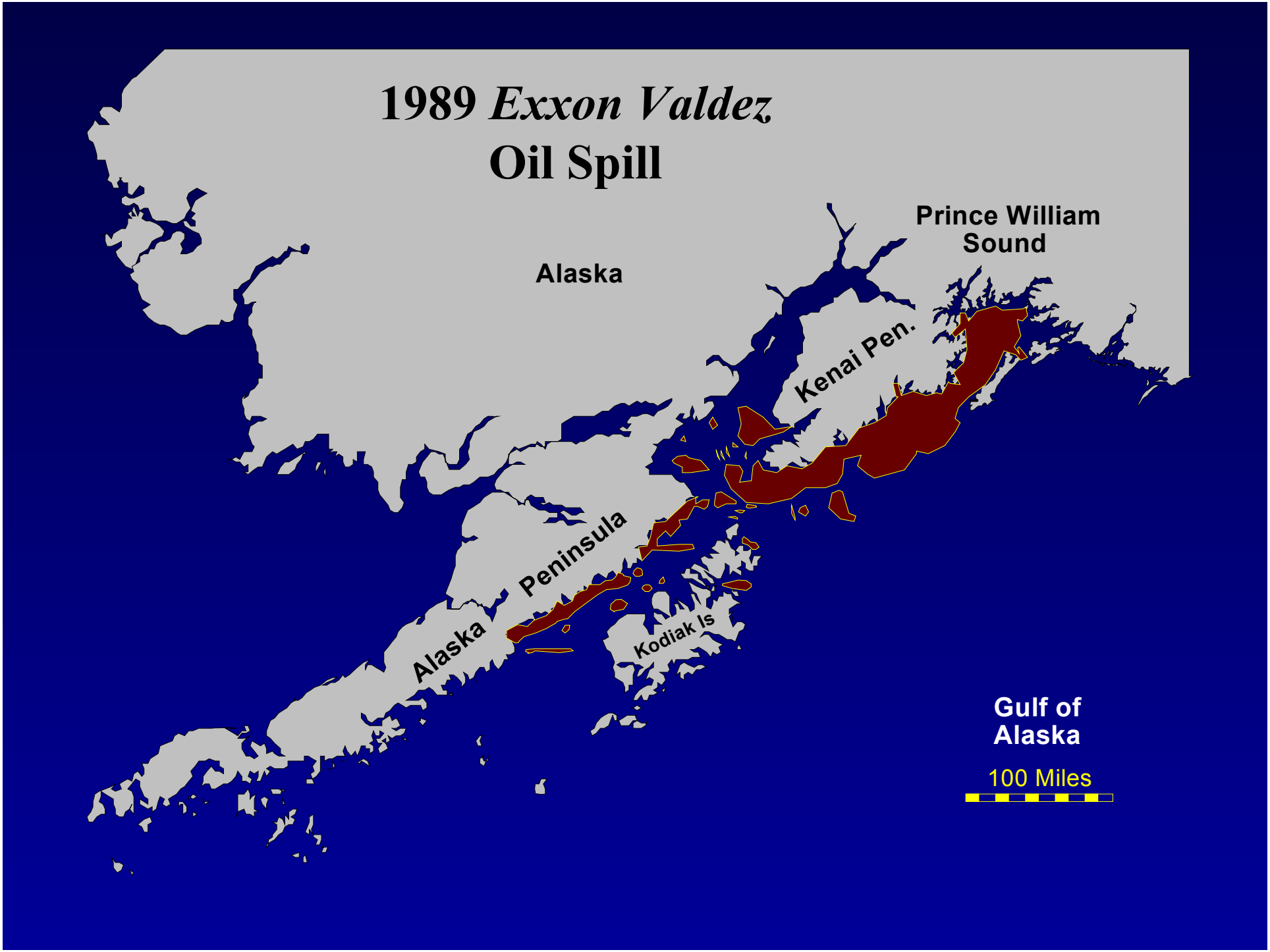


Conclusions:

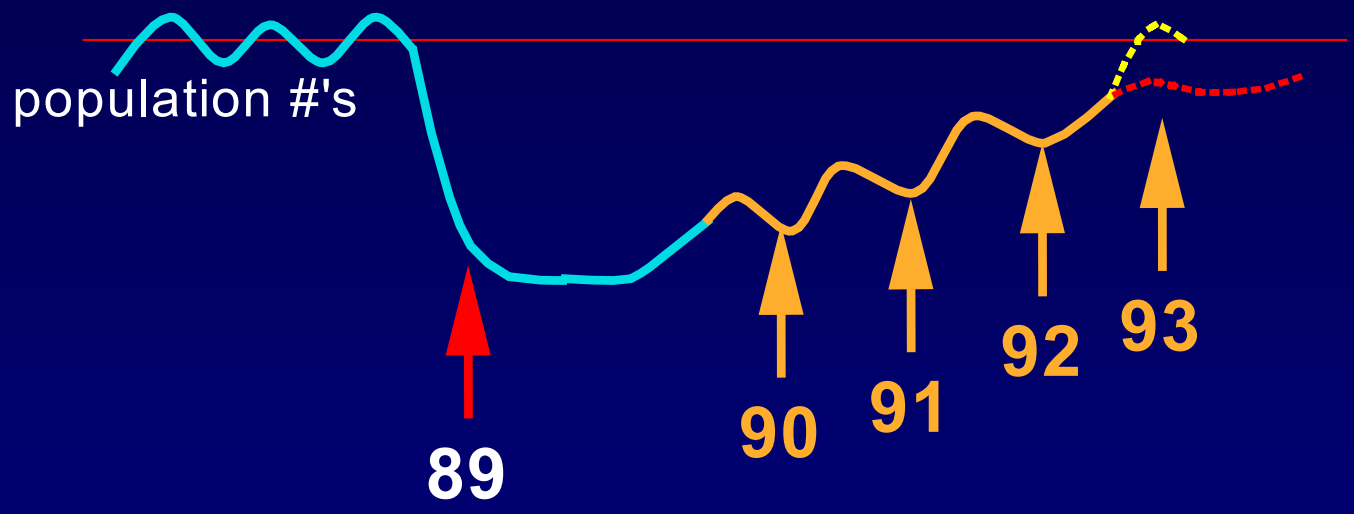
Residual oil with 3-5 ring PAH

- can persist
- is toxic
- affects fitness

= ↓ Populations


1989 *Exxon Valdez*
Oil Spill
Prince William
Sound
Alaska
Kenai Pen.
Peninsula
Alaska
Kodiak Is
Gulf of
Alaska
100 Miles

Exxon Scientists Disagree

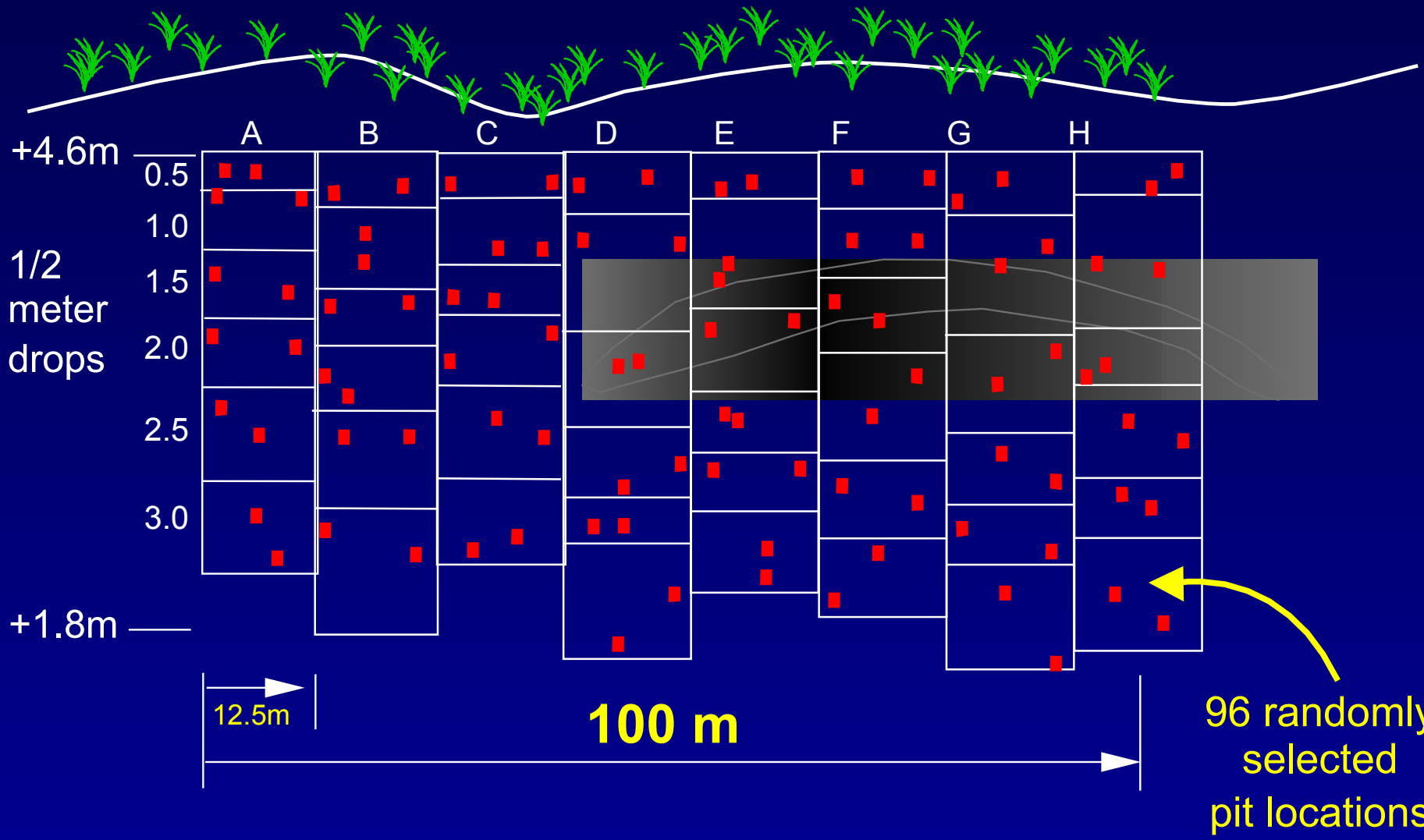


Statistical Power

	ADFG	Exxon
# Oiled Stream	10	5
# Eggs per Stream	12,000	1,200
# Years	9	1

Oiled Mussel Bed 1999

Stratified Random Sampling Grid



Total # random pits = 6,775