# *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

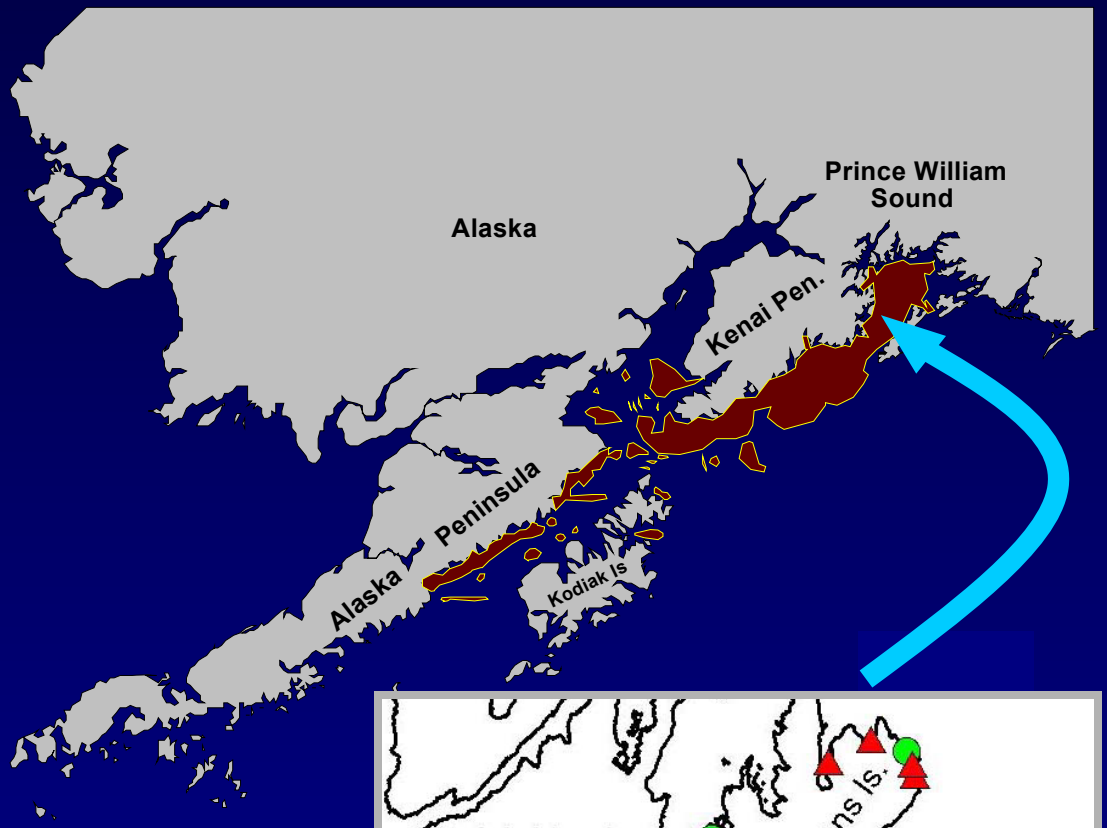
AND

2.) IF Oil is biologically available

AND

3.) IF there is toxicity paradigm shift

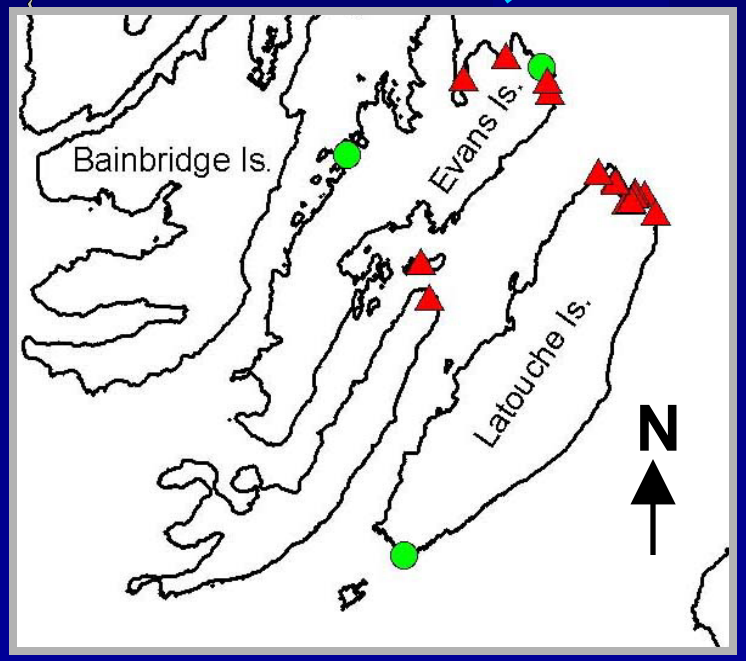
# Is the Oil Still There?




## 2001 Survey Results:

91 sites and
9,000 pits

- 53 sites with oil
- 38 sites without oil





**Subsurface Oil -**

Light Oil Residue

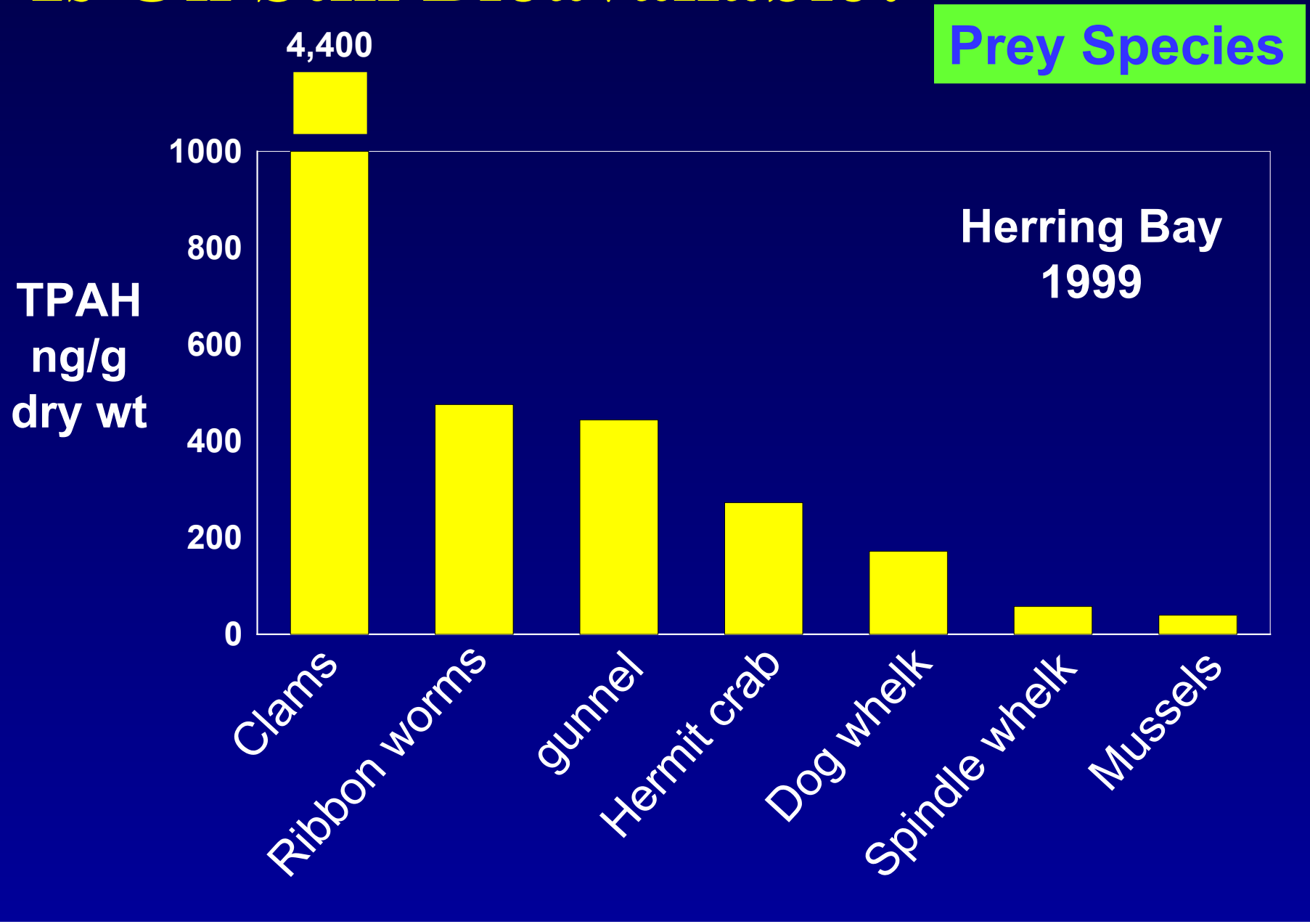
Moderate Oil Residue

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 |
| Biological Zone (lower Intertidal) | + 2.3 | 40 | **123** |
| | + 1.8 | 29 | **117** |
| | < 1m | Oil Below Sampling Grid = Yes<br>How far down = ? | |

# Is Oil Still Bioavailable?



# Is Oil Still Bioavailable?

Predators

1. Elevated P450 in oiled areas

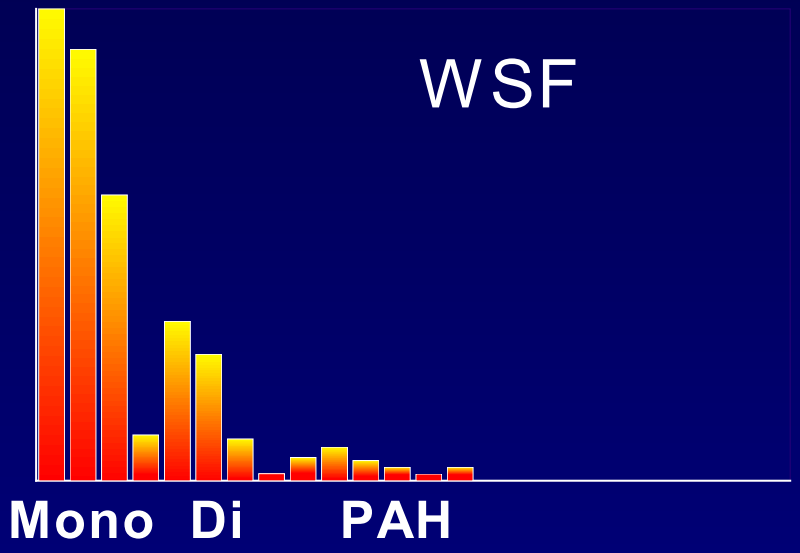
   **1996 – 98 Sea Otters**

   **1996 – 98 Sea Ducks**

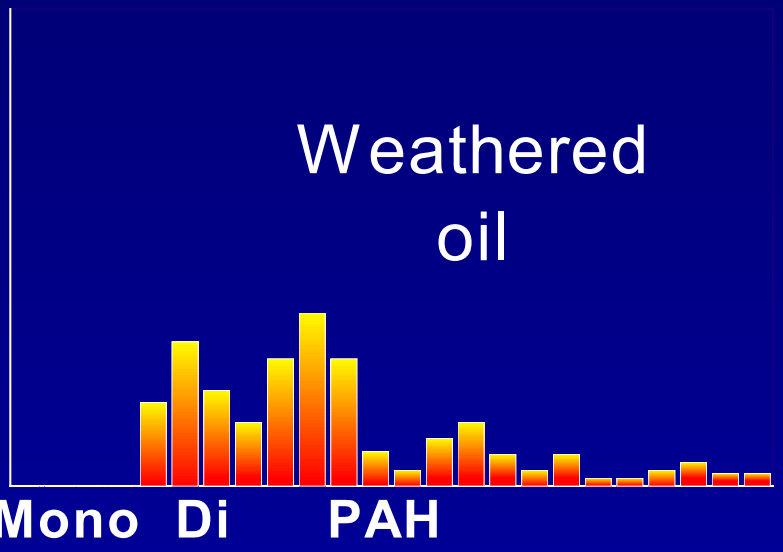
2. Poor population recovery in oiled areas (1989-99)

# Paradigm Shift in Ecotoxicity

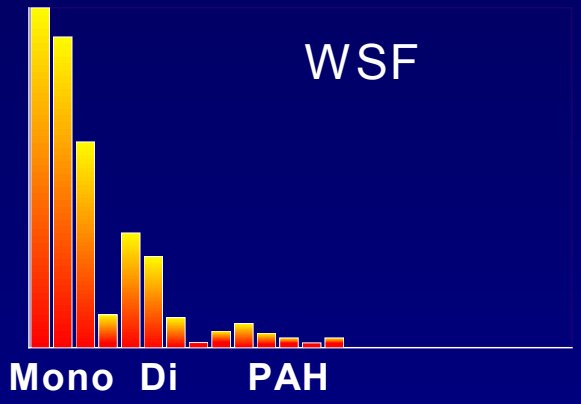
**1970s:**
**1-2 PAH rings**
**LC50 = 1 ppM**

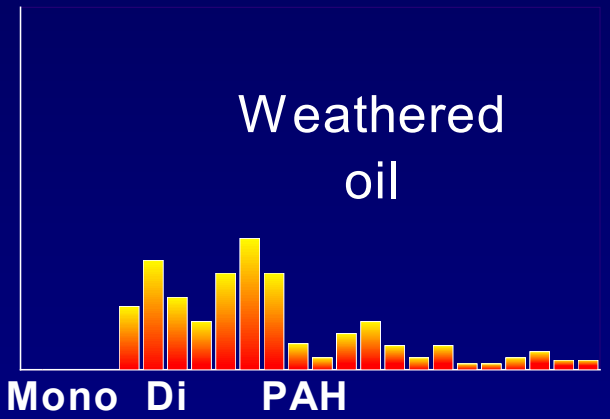



**1990s:**
**3-5 PAH rings**
**effects = 1-20 ppB**



# Different Toxic Mechanisms – from Different Toxic Compounds




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

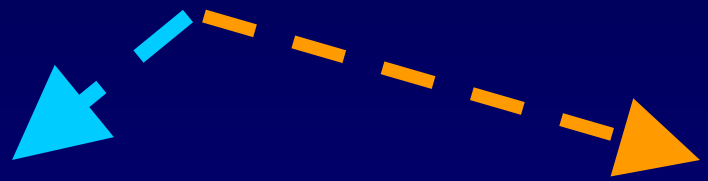
# Different Toxic Mechanisms -

| Monoaromatics | PAH |
| --- | --- |
| ↓ | ↓ |
| Acute Exposure | Chronic Low Level Exposure |
| ↓ | ↓ |
| "Narcosis" death | Leukemia |

≠

# Different Toxic Mechanisms -

E.g. **Benzene**



**Acute Exposure**

**Chronic Low Level Exposure**

**"Narcosis" death** ≠ **Leukemia**

# Reduced Fitness Results In:

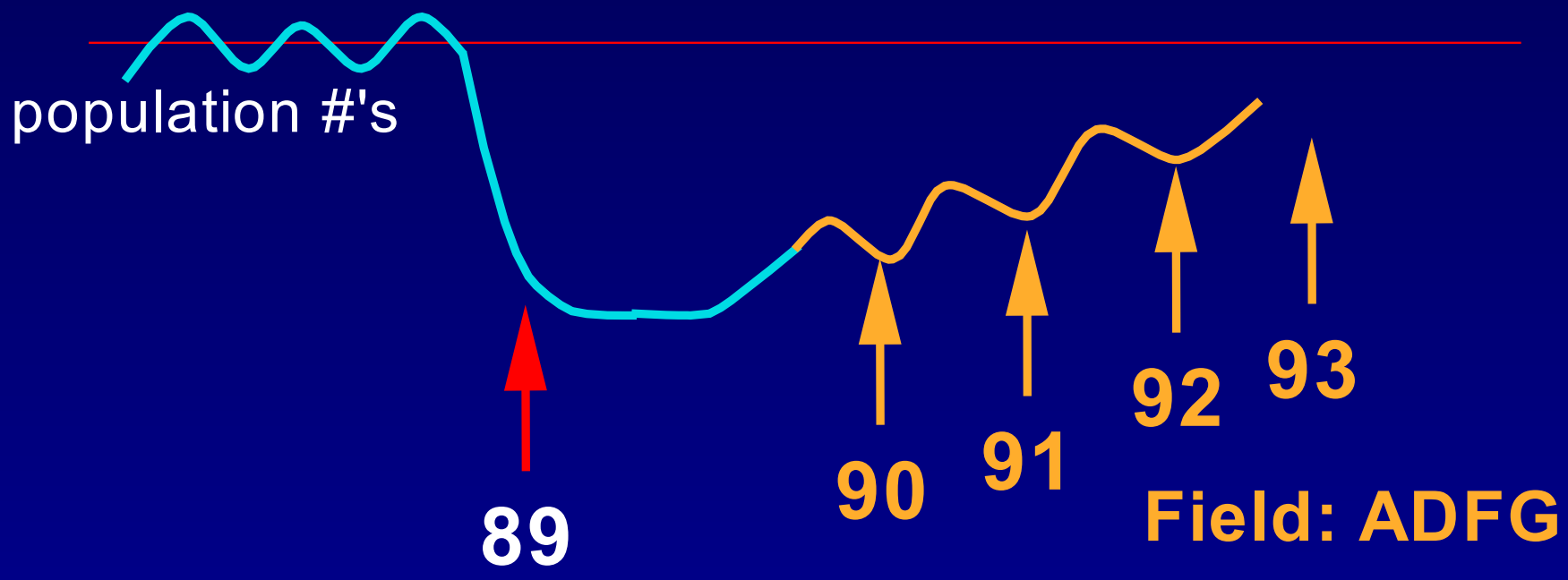
- ↓ in Survival -
  - ↑ in Deformities
  - ↓ in Growth
  - ↓ in Predator avoidance
  - ↓ in Reproductive Success

**Supported by field and laboratory studies**

# Decreased Survival: -Pink Salmon

Field Research

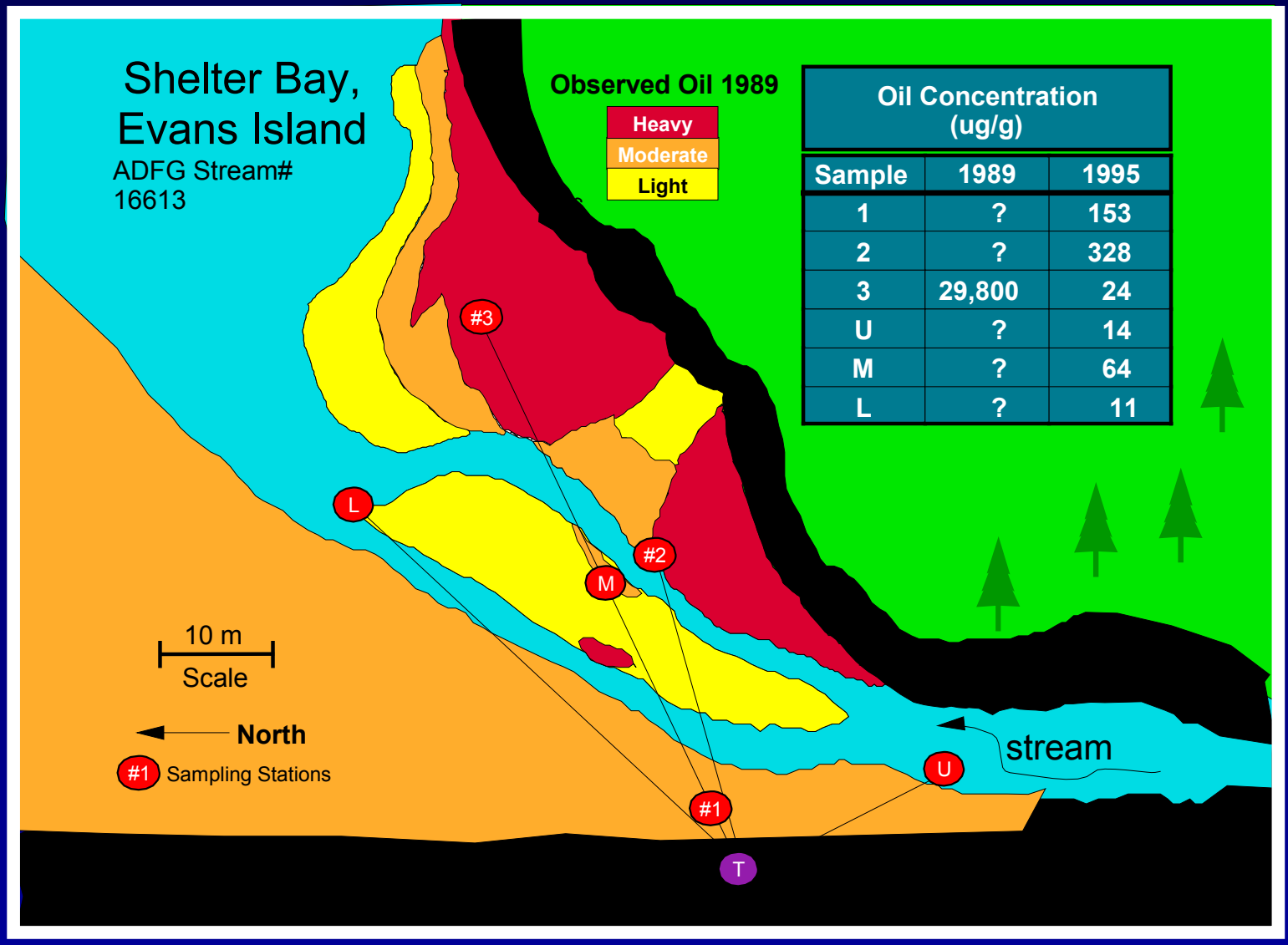
Elevated egg mortality in “oiled” stream




pre - spill → EVOS → spill

# 1989 & 1995 Oiled Salmon Streams

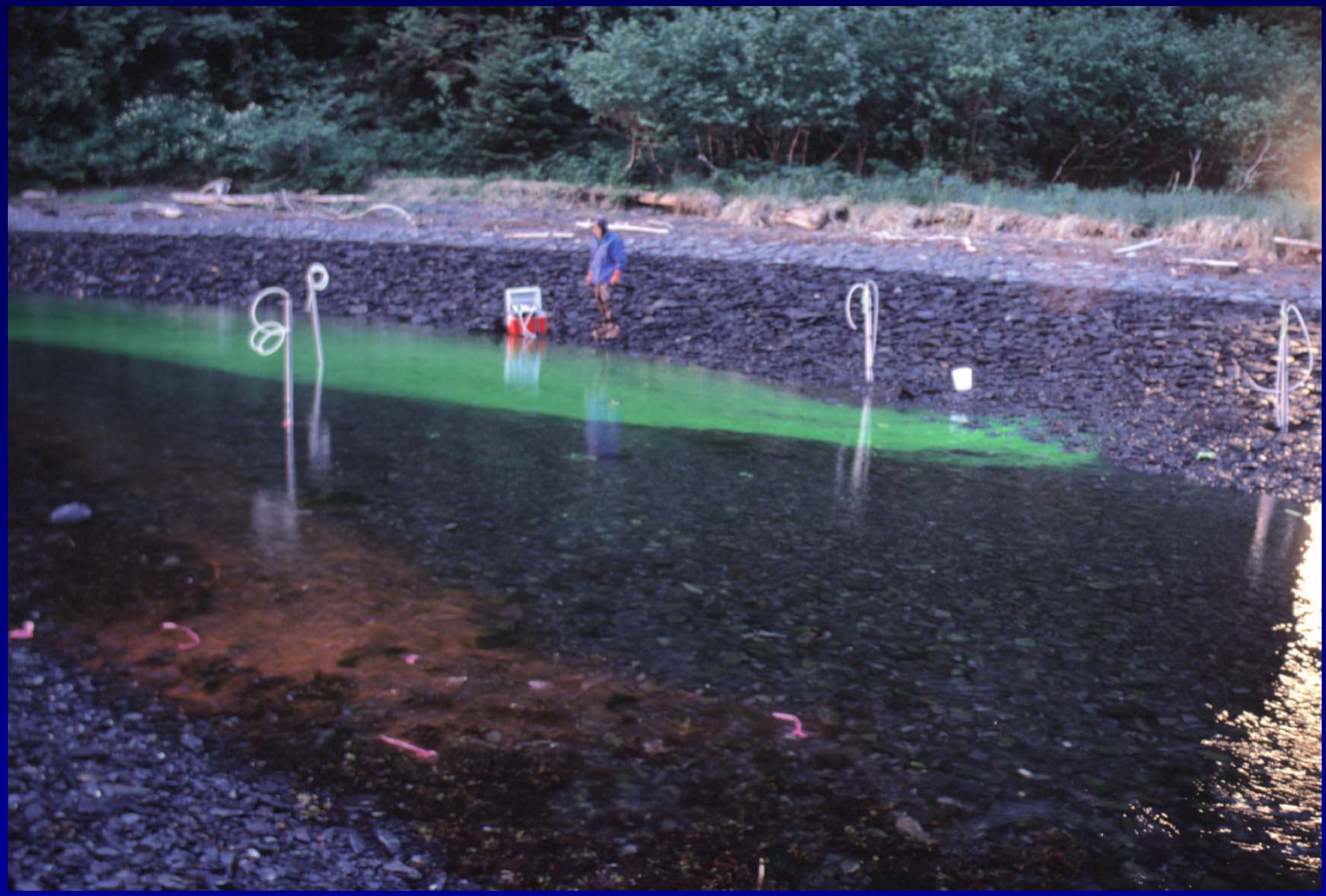
**Field Research**




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

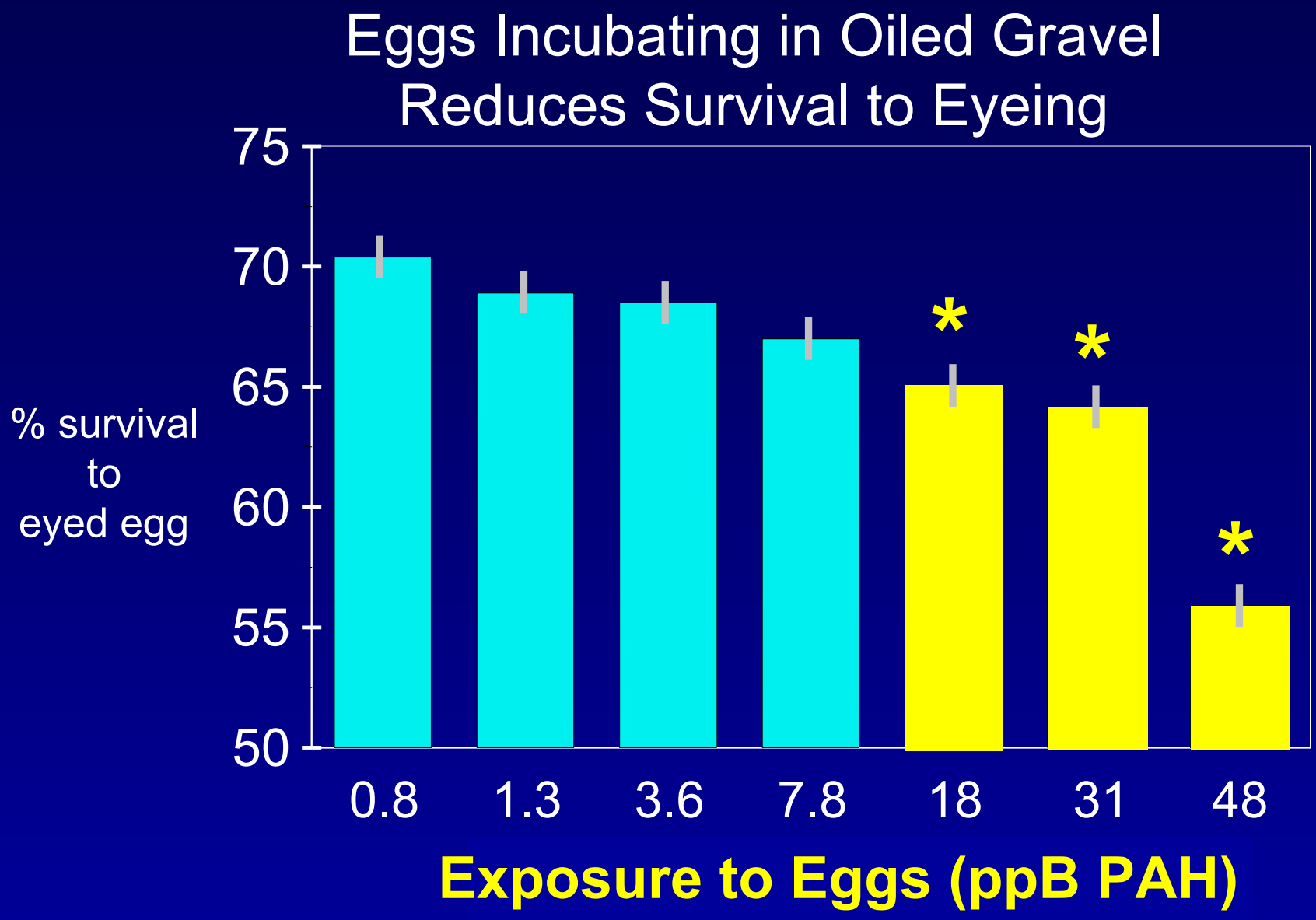
# Dye Released in Salmon Stream

Field Research



# Decreased Survival: Pink Salmon

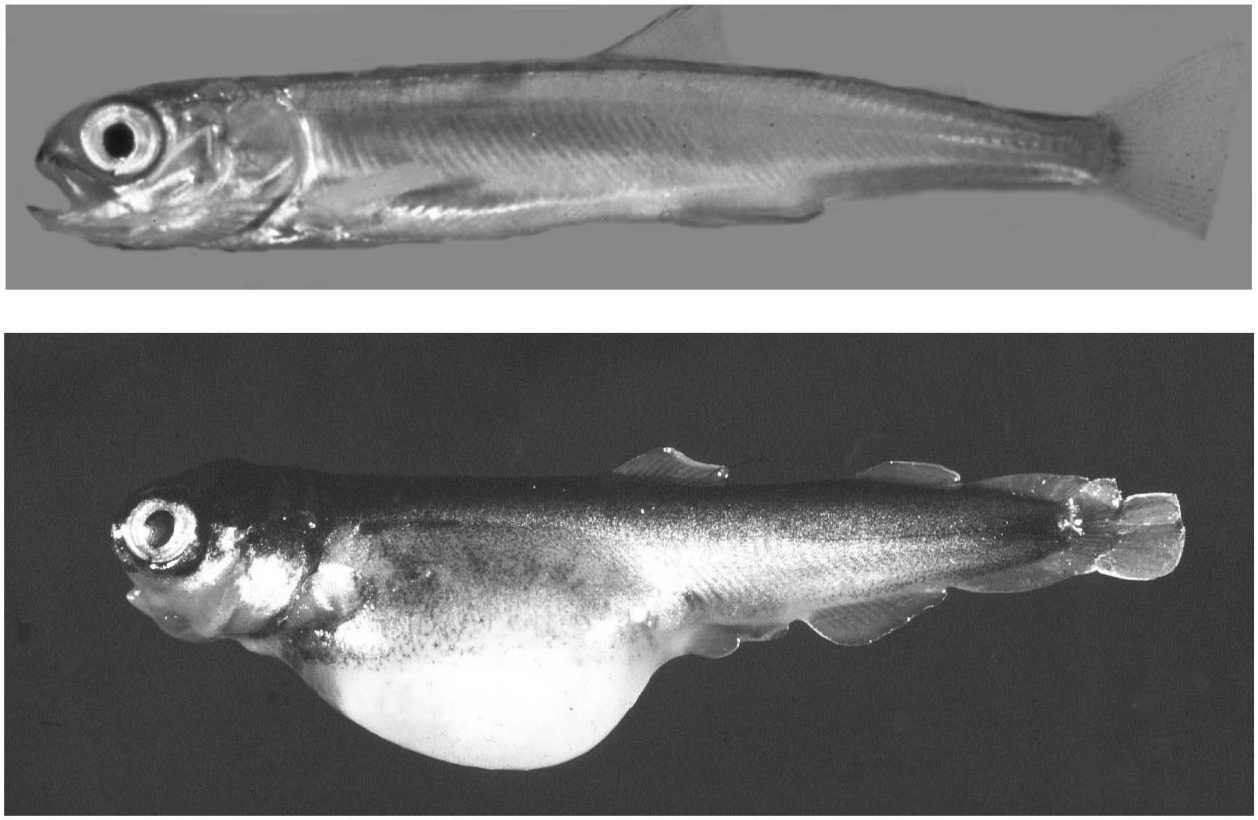
Lab Research



# Increased Deformities:

Lab Research

## Pink Salmon Alevin at Emergence



Exposure to Eggs (ppB PAH)

-Extra fins

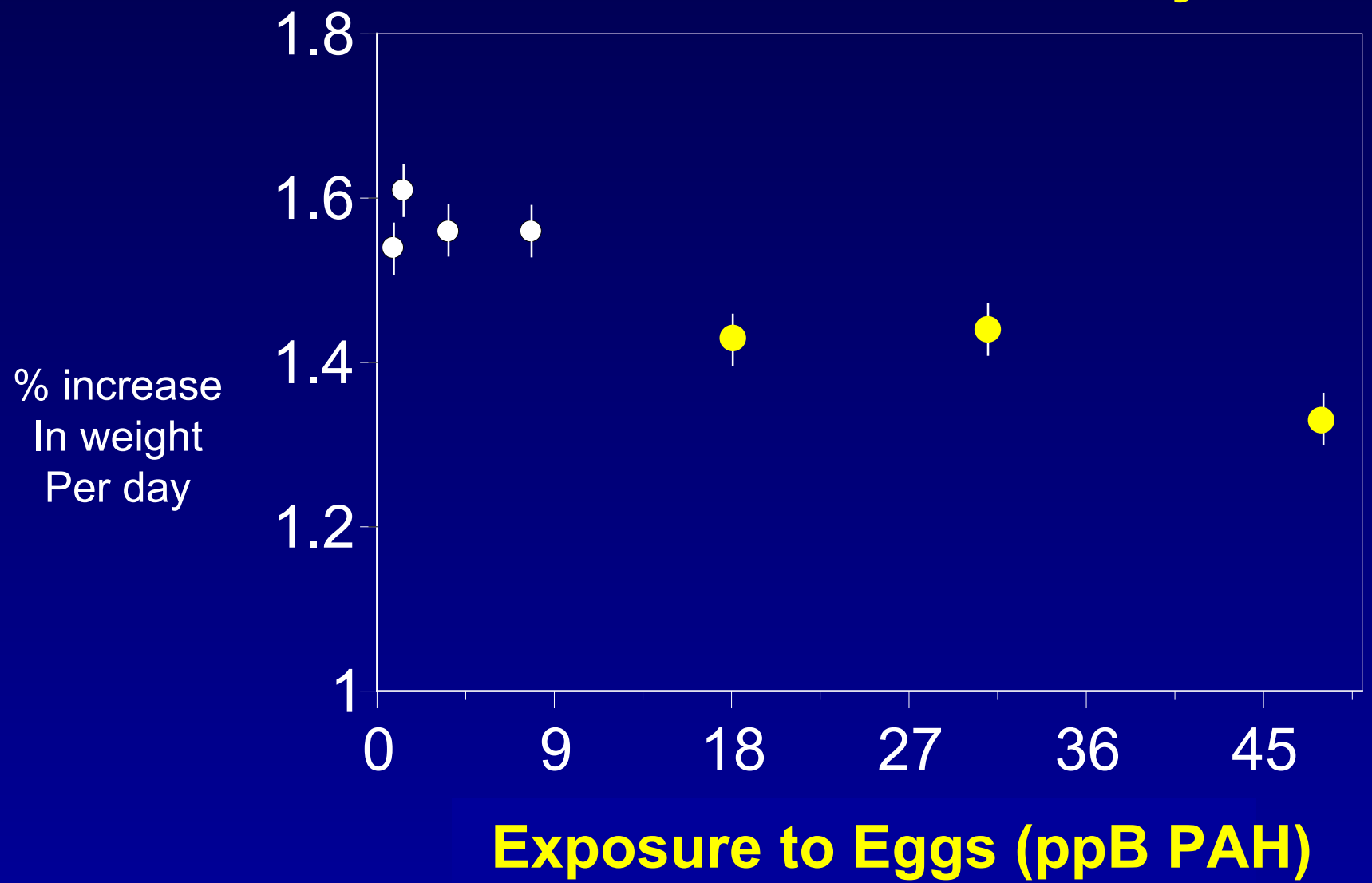
- Deformed mouth

- Metabolism problems

# Delayed Growth:

Lab Research

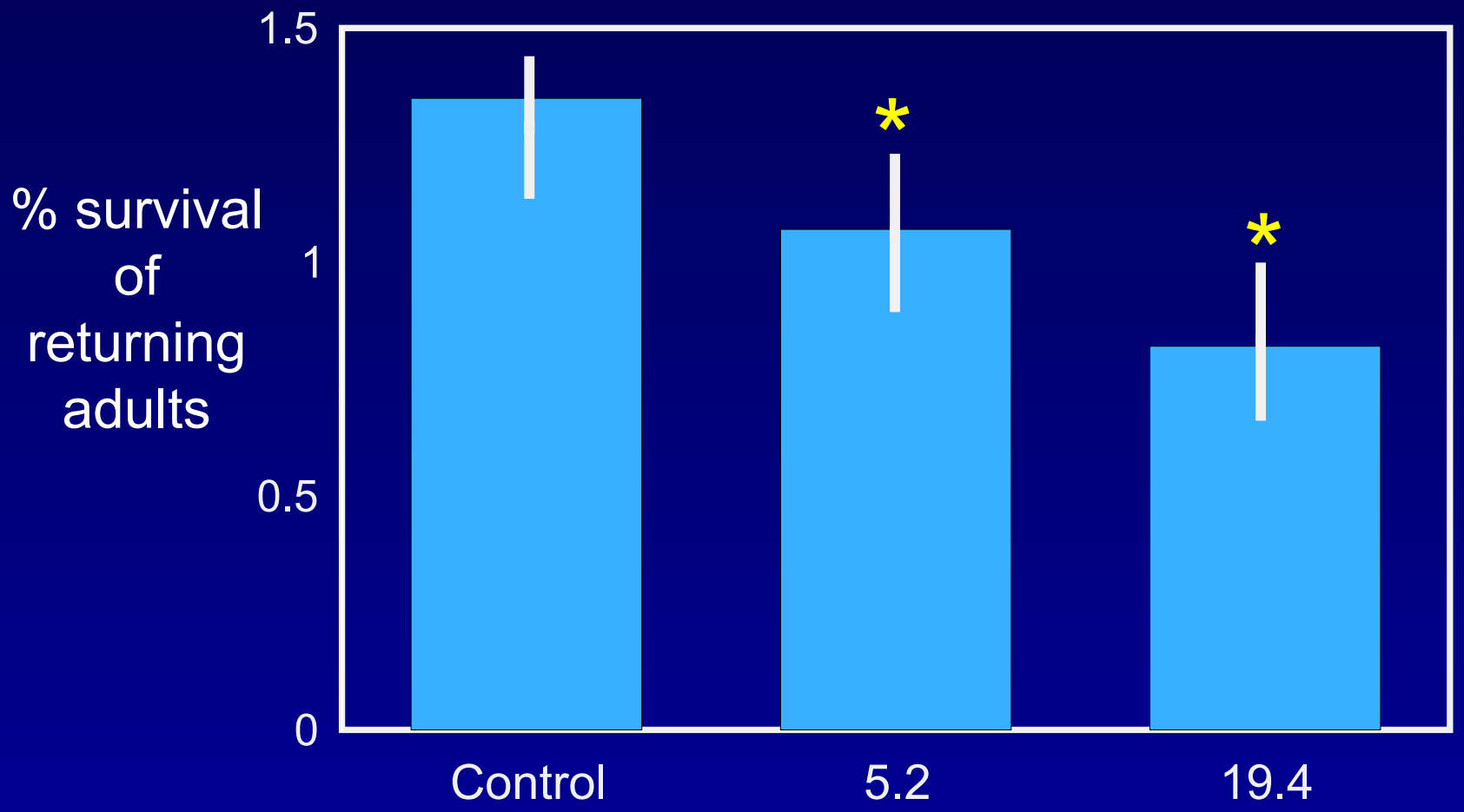
## Effects to Salmon Fry



# Delayed Growth:

## Effects on Adult Salmon Returns

Lab Research

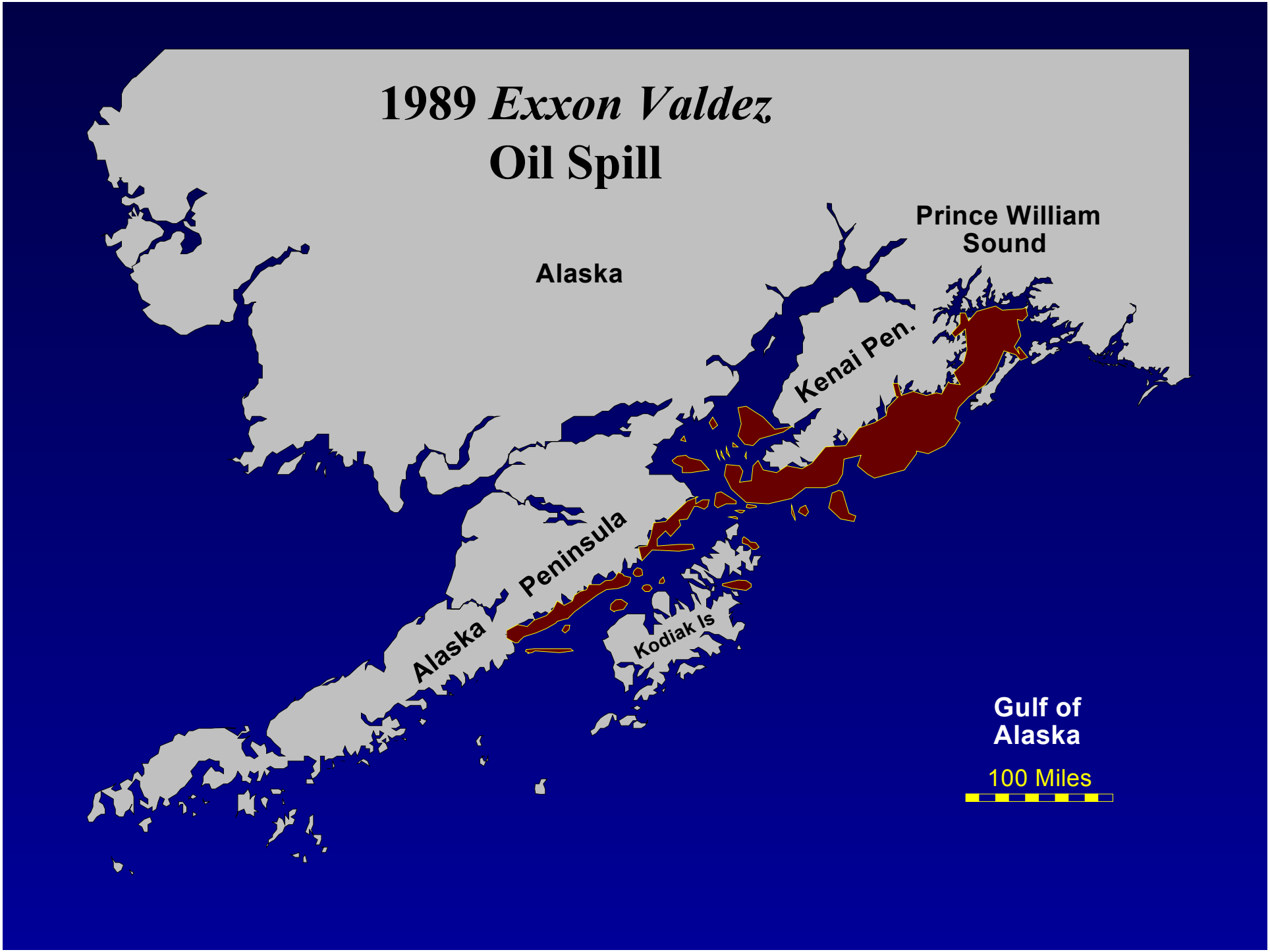


# Conclusions:

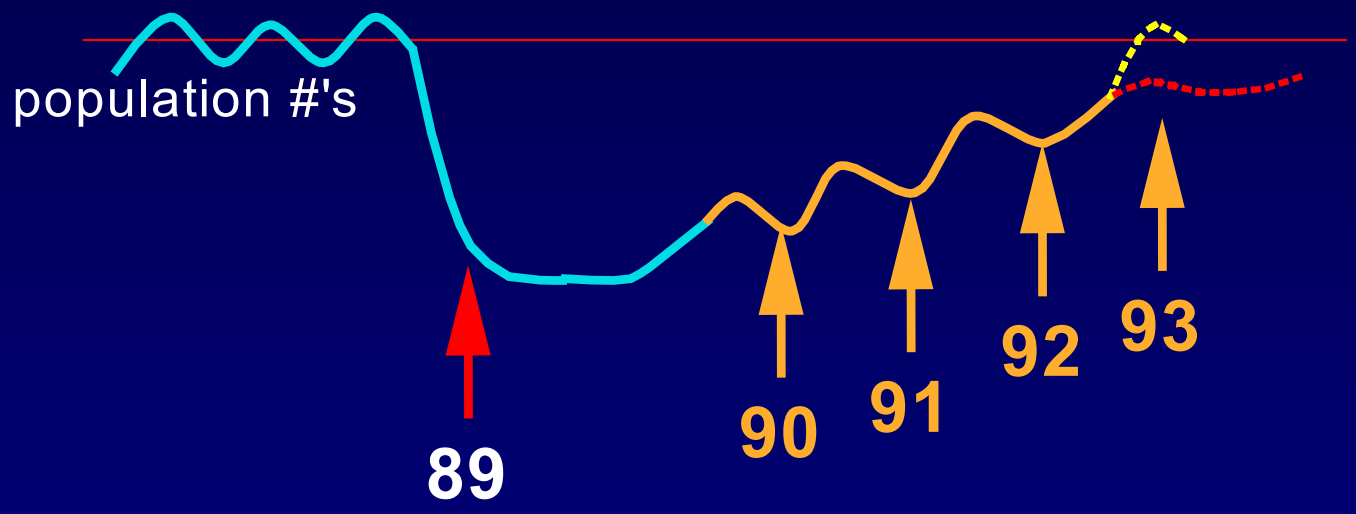
Residual oil with 3-5 ring PAH

- can persist
- is toxic
- affects fitness

= ↓ Populations



# Exxon Scientists Disagree

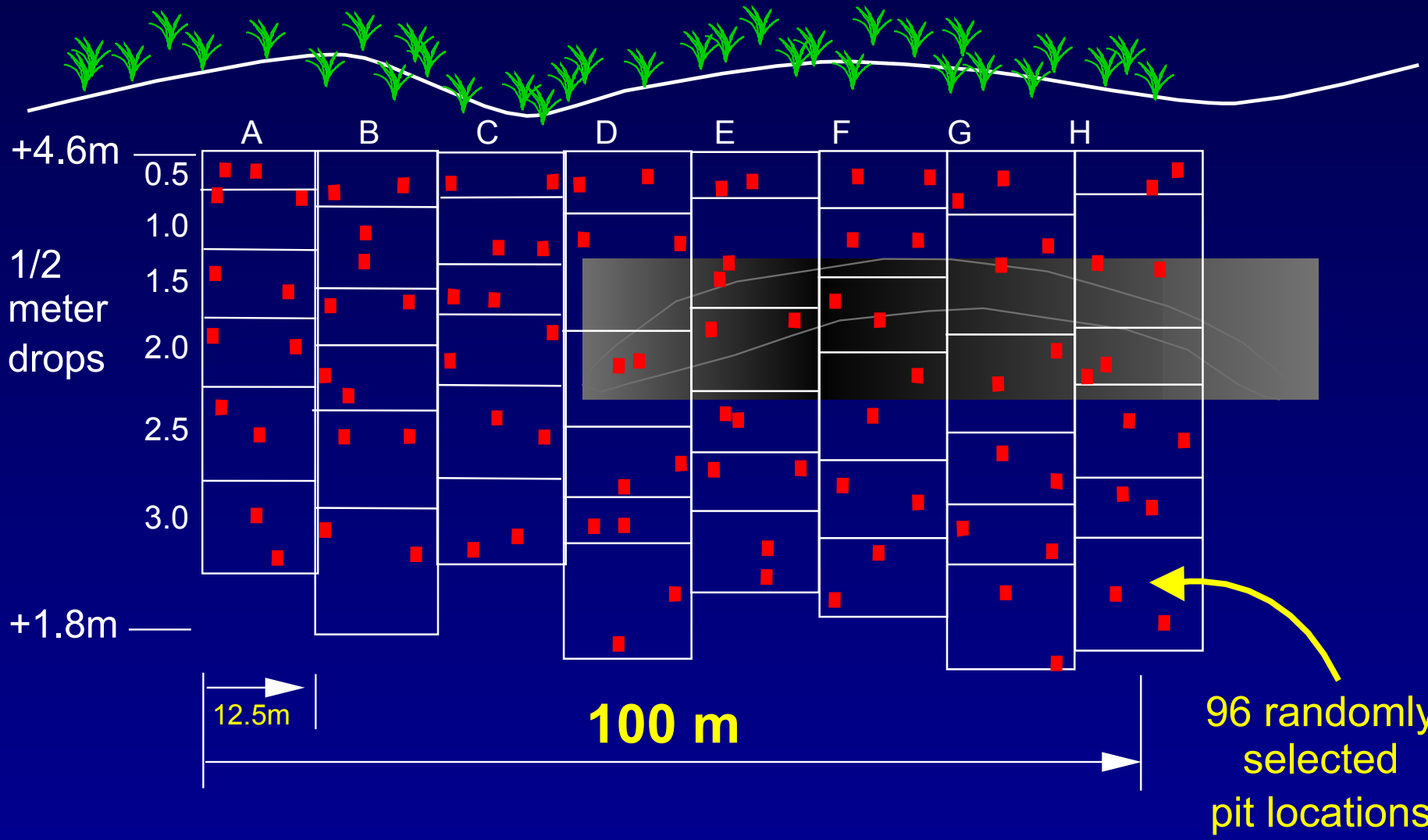



Statistical Power

| | 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