Lingering Oil in Prince William Sound:
what we know, past and present

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1989 Exxon Valdez Oil Spill: 11M gal crude oil; 2,100 km oiled shoreline

Herring Bay, PWS

EVOSTC: A Legacy of Significant Science and Ecosystem Approach

Evolution of EVOSTC Funded Science:

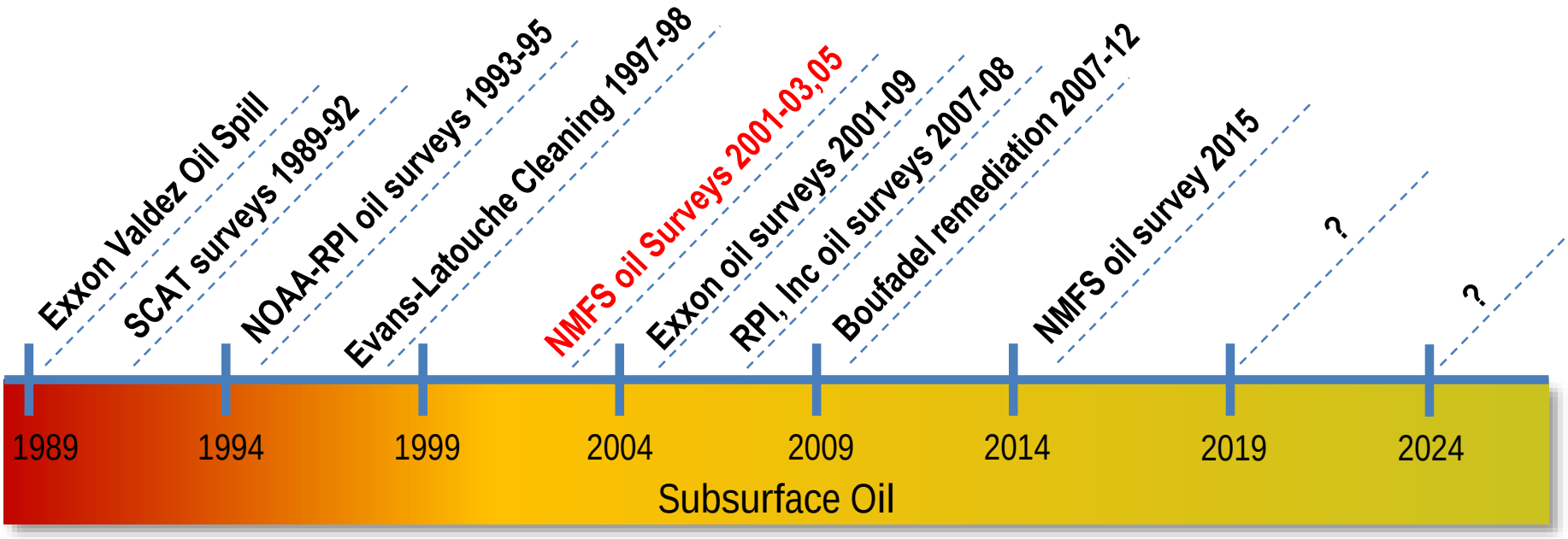
- **Injury assessment studies**
- **Recovery studies**
- **Ecosystem programs**
  - **SEA**
  - **APEX**
  - **Nearshore**
- **Long Term Monitoring**
  - **Gulf Watch Alaska**
  - **Herring Research and Monitoring**

March 1989: Killer whales next to grounded tanker

Low level toxicity to fish

Timeline: Oiled Shoreline Surveys

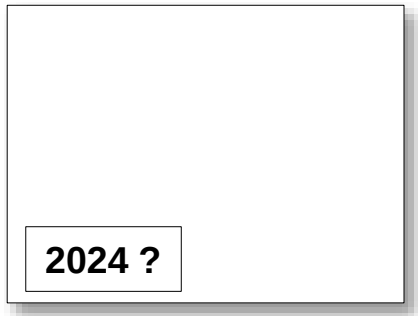
Decades of Persistent *Exxon Valdez* Oil



Heavy
Surface oil

Heavy
Subsurface oil

Heavy
Subsurface oil



?
Subsurface oil

Lingering Oil Project – 26 years after the spill

Goals:

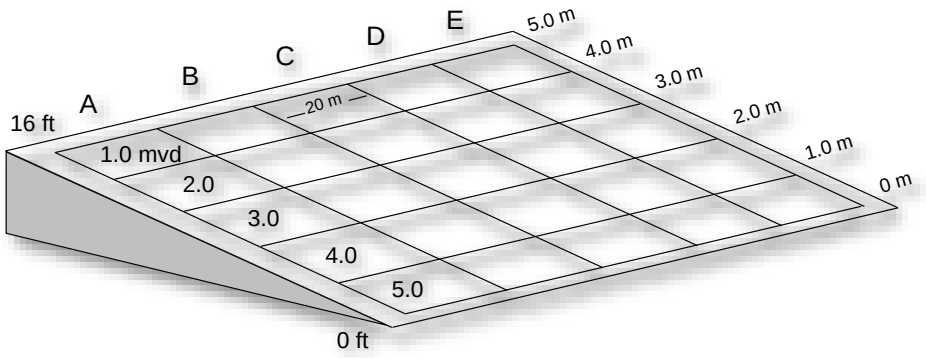
- Revisit sites with known history of persistent subsurface oil
- Low cost, small survey, may be no change
- Archive oil samples & analysis of chemical composition
- Check on bioavailability of the oil
- Recommendations for future monitoring

2015 Lingering Oil Survey – revisit sites surveyed by NMFS 2001-05

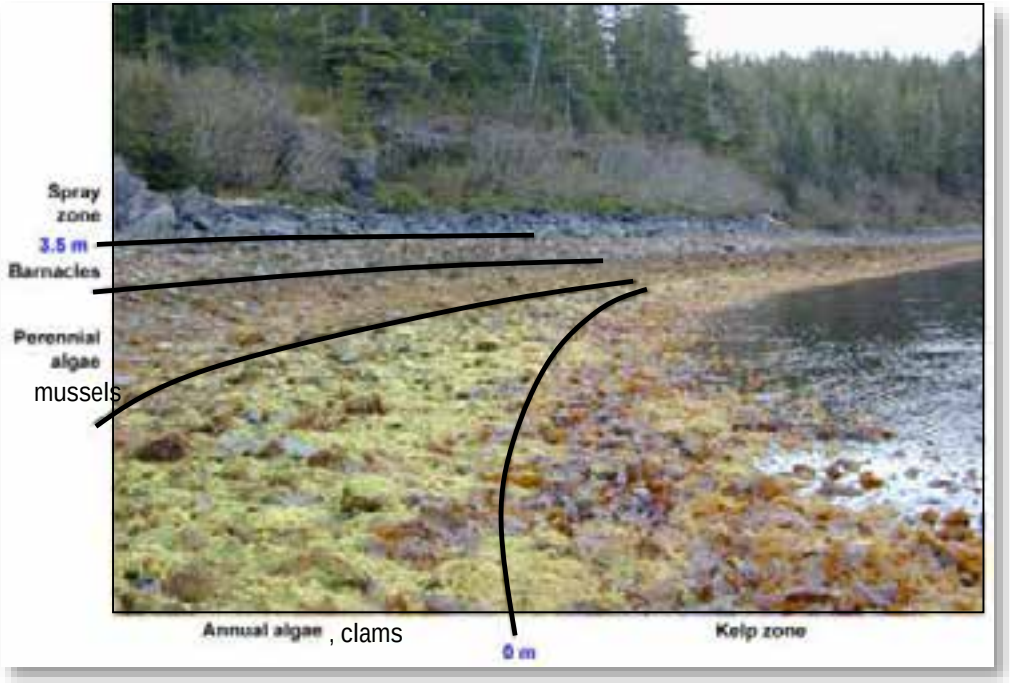
Beach Segment Protocol:

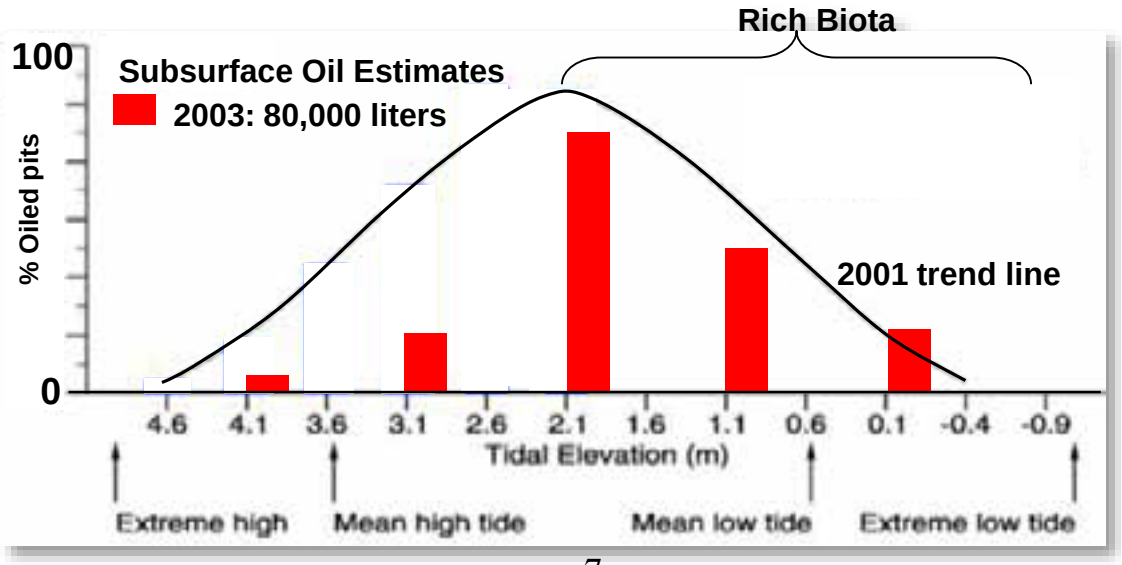
- **Survey Equipment & Grid**
  - **stratified by tide height**
    (meter vertical drops; MVD 1-5)
  - **5 (20) m wide columns**
  - **2 random pits within block**

- **Excavate random pits**
  - **.25 m^2 x .50 m depth**



2003 Lingering Oil Survey – subsurface oil distribution on beach segments





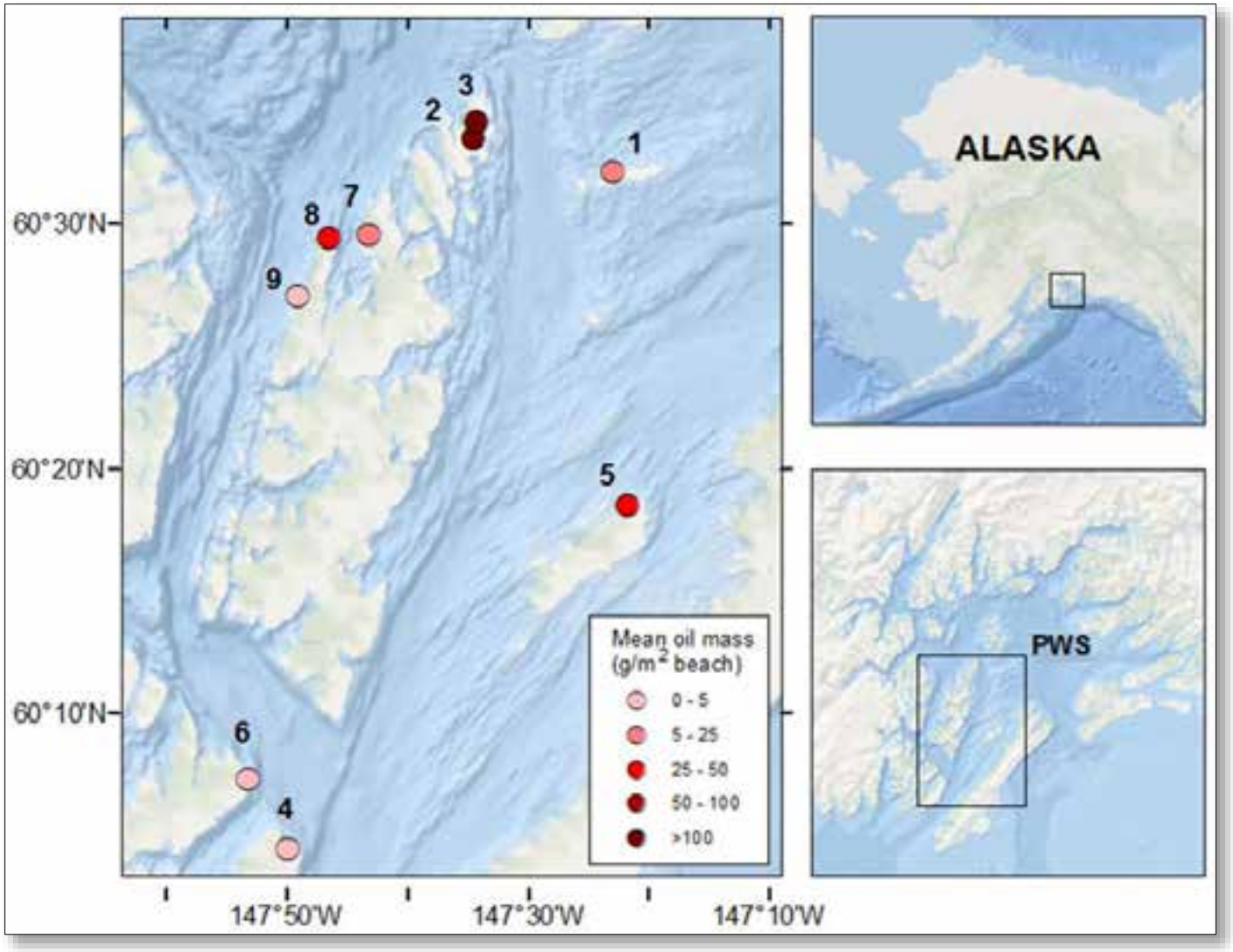
2015 Lingering Oil Survey – visual oil classifications observed in the field

- Surface Oil Residue (SOR)
- Subsurface Oil
  - Heavy Oil Residue (HOR)
  - Moderate Oil Residue (MOR)
  - Light Oil Residue (LOR)

2015 Lingering Oil Survey – samples collected in the field

- **Oil Composition**
  - weathering, biomarkers
- **Oil Weight**
  - gravimetric
- **Oil Bioavailability**
  - semi- permeable membrane devices

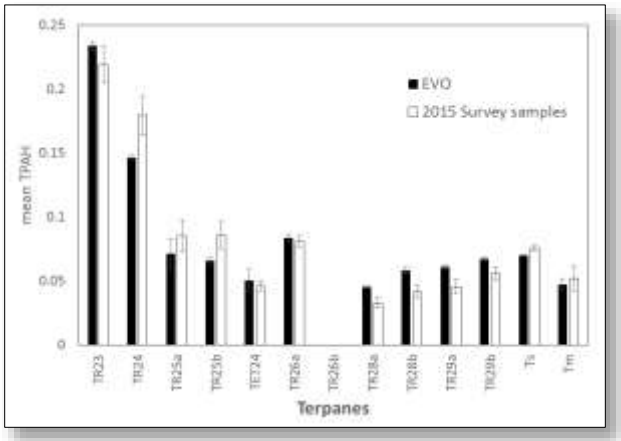
2015 Lingering Oil Survey – map of sites with persistent subsurface oil

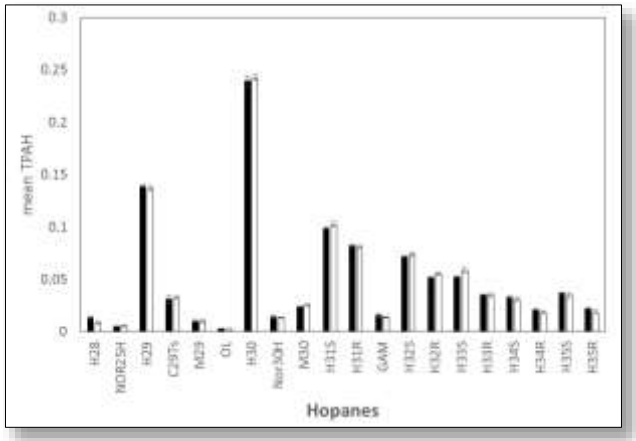


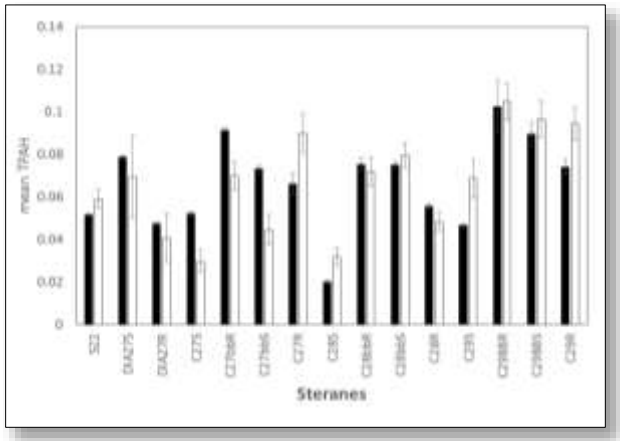
2015 Lingering Oil Survey – oil composition, it is Exxon Valdez oil

Biomarkers are environmentally persistent compounds derived from plant material that was the source of the oil. The fingerprint pattern to the concentrations of these compounds is unique to every oil.

Relative concentrations of biomarker compounds in survey samples match those in EVO



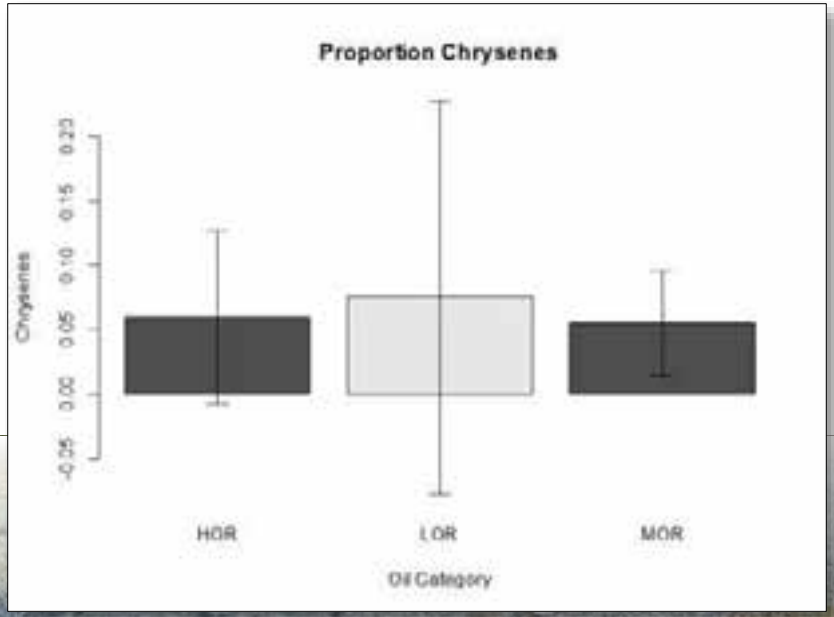


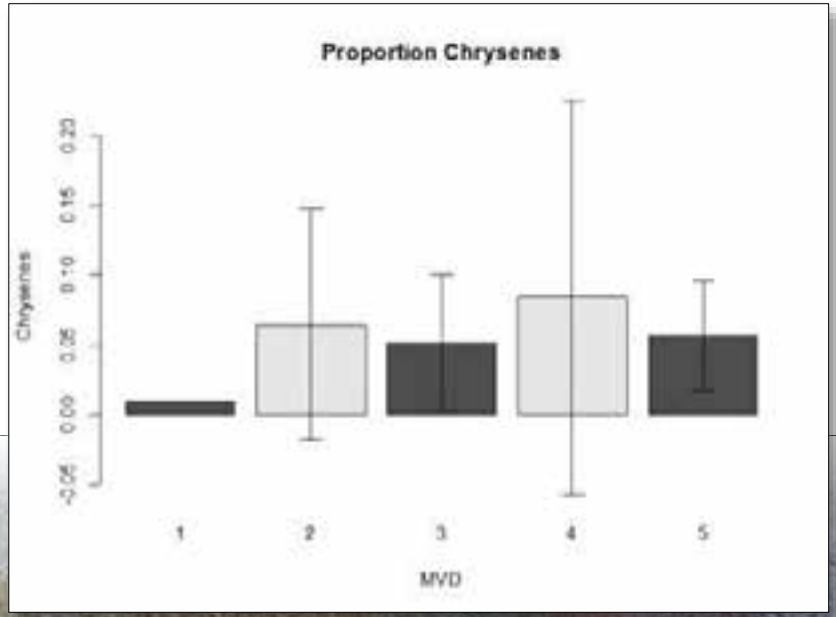


2015 Lingering Oil Survey - oil composition, no differential weathering

The contribution of chrysenes, another class of environmentally persistent compounds, to the total mass of PAHs increases over time as the lighter compounds are weathered out.

Weathering distribution by oil class and MVD (CI 95%)
Expressed as percent chrysenes (environmentally persistent compounds)





2015 Lingering Oil Survey – Results for each beach segment

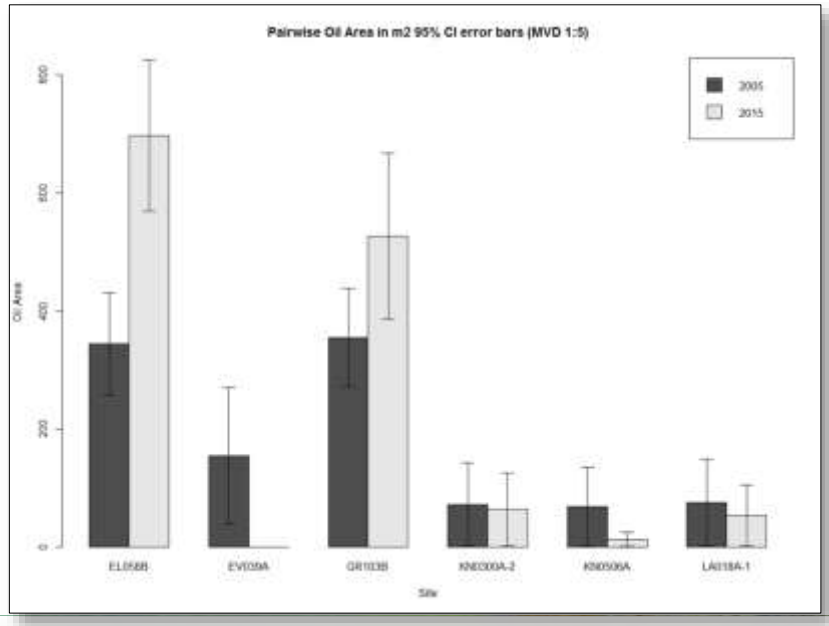
Shore Segment	Length (m)	Estimated area (m^2)	Total # of pits sampled	# of pits LOR	# of pits MOR	# of pits HOR	2015 probability of encountering SSO	2007 model heavy SSO
SM006B	100	5,488	50	1	5	3	20%	>30%
EL056C	90	2,594	50	4	3	10	40%	>30%
EL058B	51	1,892	30	1	4	2	33%	>30%
LA018A-1	100	3,132	50	-	1	-	2%	5-15%
GR103B	100	4,398	50	1	1	2	12%	1-5%
EV039A	109	4,809	50	-	-	-	0%	1-5%
KN0114A	68	2,676	40	1	6	-	23%	>30%
KN0300A-2	52	2,076	40	-	-	1	3%	1-5%
KN0506A	50	1,960	40	-	-	1	3%	0-1%
Totals	720	29,025	400	8	20	19		

A summary of measured physical parameters, estimate of oiled area and probability of encountering subsurface oil in 2015 and 2007 model for heavy subsurface oil (SSO) (Nixon and Michel, 2015).

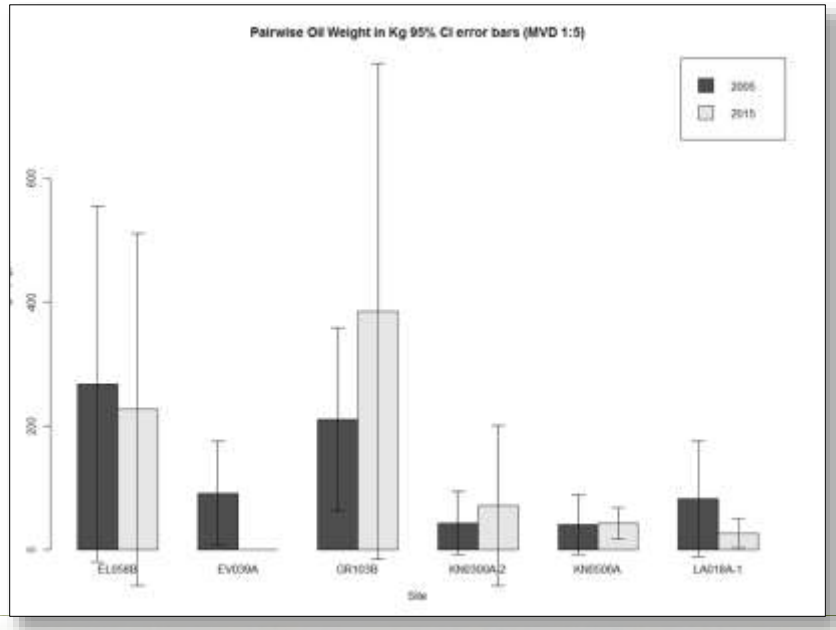
2015 Lingering Oil Survey – Estimate of how much oil we found

Comparison of 2005 and 2015
No real change

oiled area (m2) (CI 95%)

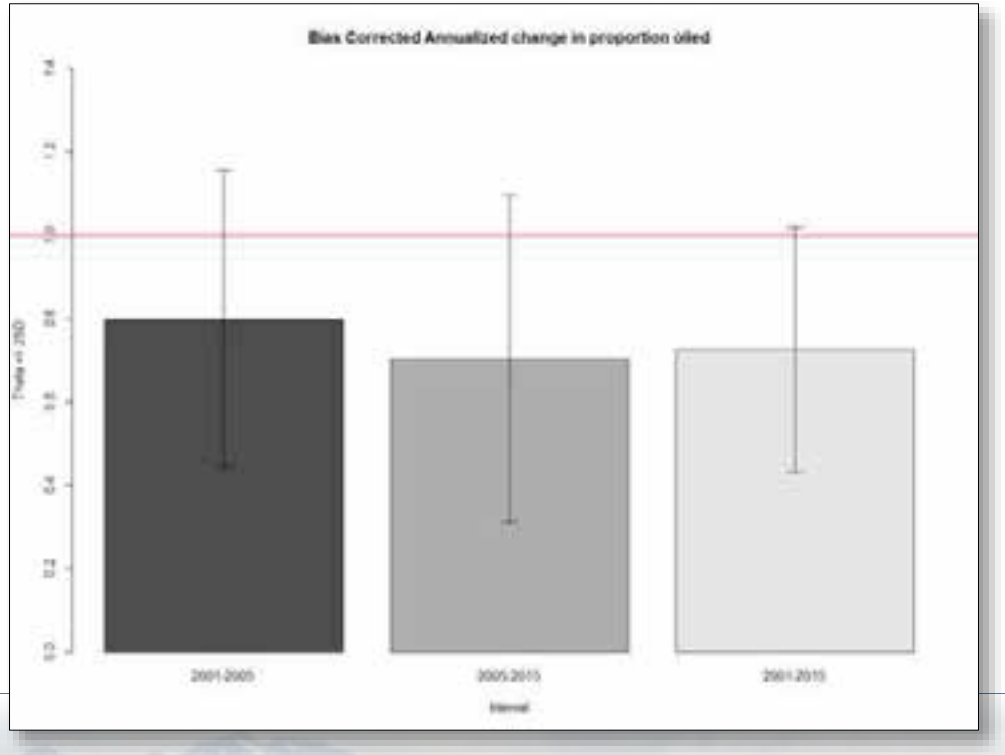


oil mass (kg) (CI 95%)



2015 Lingering Oil Survey – little oil loss over different time intervals

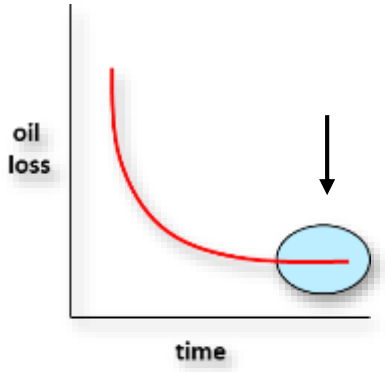
Bias corrected annualized oil retention rates (CI 95%)
All sites, MVD 1-3 only

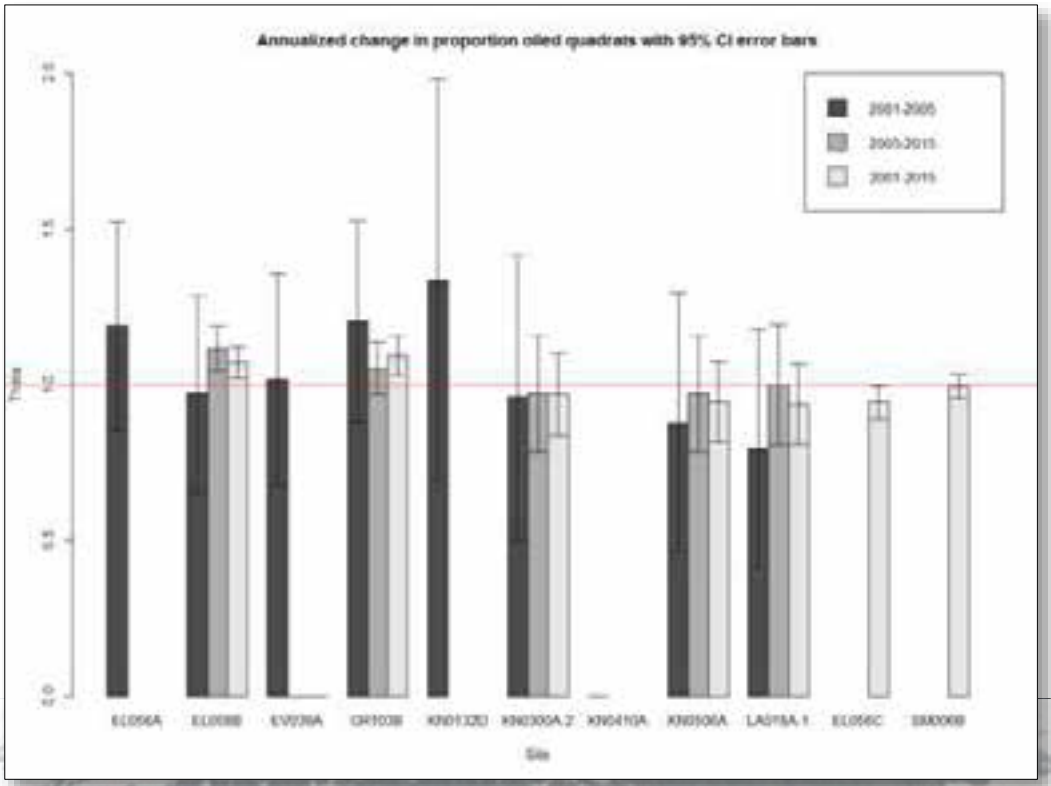


No loss

2015 Lingering Oil Survey – little oil loss over time by each site

Pairwise comparison of oil retention for sites sampled in 2001, 2005 and 2015 (CI 95%)
Based on meter vertical drops (MVD) 1-3



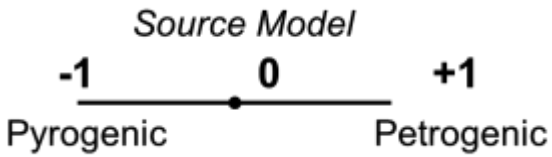


No loss

2015 Lingering Oil Survey - Bioavailability

No difference from field blanks at this site in 2015.

Bioavailable oil is doubtful on this beach.



Year	Bay	Source model	TPAH	Units
2015	Herring Bay	0.017	77	ng/g device
2015		-0.083	54	ng/g device
2015		-0.083	37	ng/g device
2015		-0.083	26	ng/g device
2015		-0.067	23	ng/g device
2015		-0.050	20	ng/g device
2015	Blank, field	-0.017	26	ng/g device
2015	Blank, field	-0.067	58	ng/g device
2015	Blank, lab	0.000	0	ng/g device
2015	Blank, lab	0.000	0	ng/g device
2015	Blank, trip	-0.033	51	ng/g device
2015	Blank, trip	-0.067	18	ng/g device
Previous				
2002	Herring Bay	0.767	17124	ng/g device
2002		0.700	3682	ng/g device
2002		0.700	3475	ng/g device
2002		0.700	2041	ng/g device
2002		0.700	1361	ng/g device
2002		0.767	1016	ng/g device

2015 Lingering Oil Survey – Conclusions and Recommendations

- Known beach segments with persistent subsurface oil have not changed in 26 years
- There is little indication of Exxon Valdez oil weathering, however some biomarkers for fingerprinting the oil are weathering
- This suggests the oil is well sequestered and not bioavailable unless disturbed
- Future surveys do not need to be as frequent (e.g. alternate every 5-years: oil composition-bioavailability sampling and small scale subsurface oil surveys)

Questions?