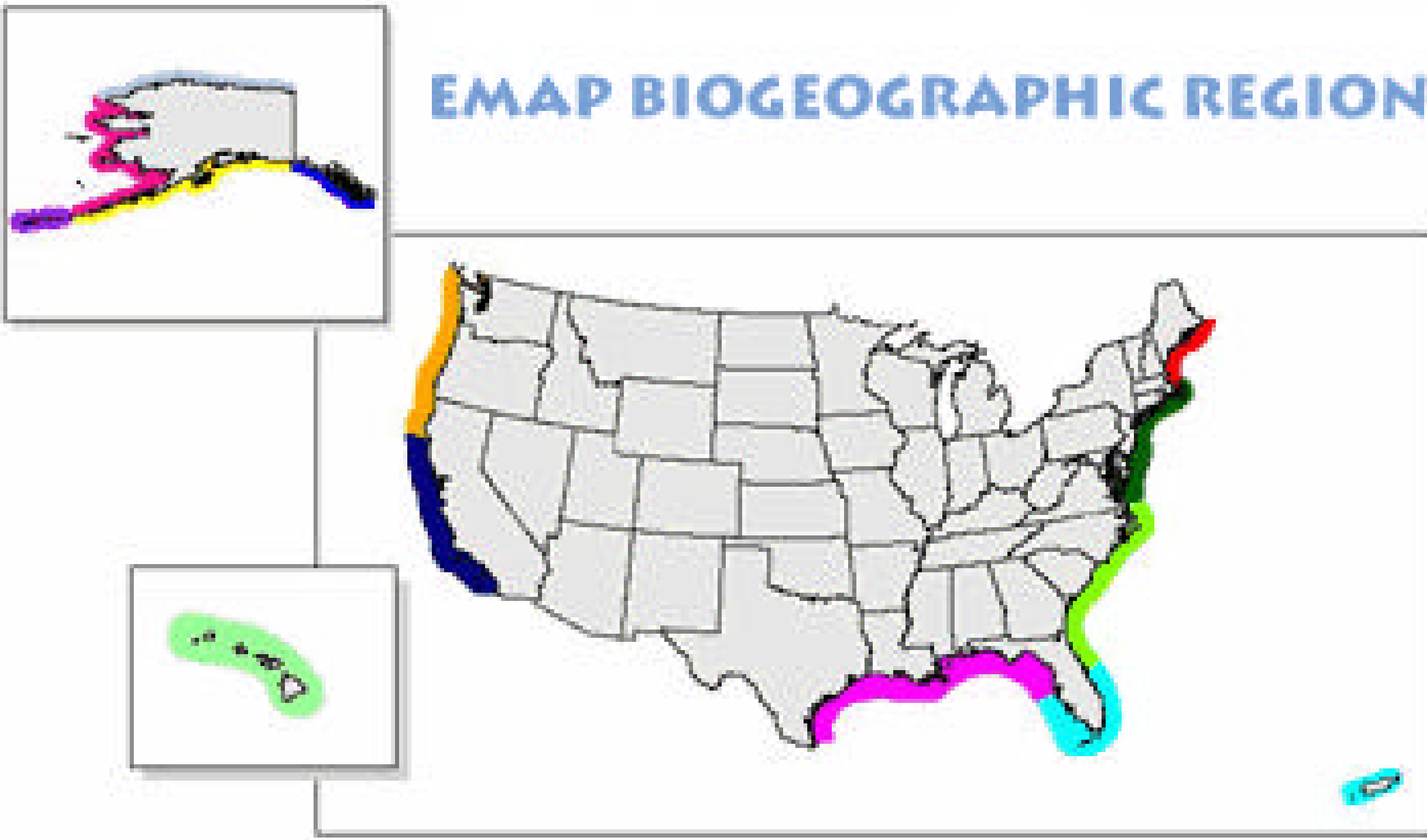
Coastal EMAP 2002:
Southcentral Alaska

Alaska Department of Environmental Conservation
Cook Inlet Regional Citizens Advisory Council

Alaska Coastal EMAP

- Background and Setting
  - Physical Environment
  - Existing studies/research
  - Human Use, Industry, Regulations
- Southcentral Alaska 2002
  - Survey/site locations and setting
  - Survey methods/team
  - Deviations/Additions to EMAP QAPP
  - Challenges for applying EMAP Protocols to survey area
  - DRAFT summary data
- Southeast Alaska 2004
- Future of EMAP in Alaska

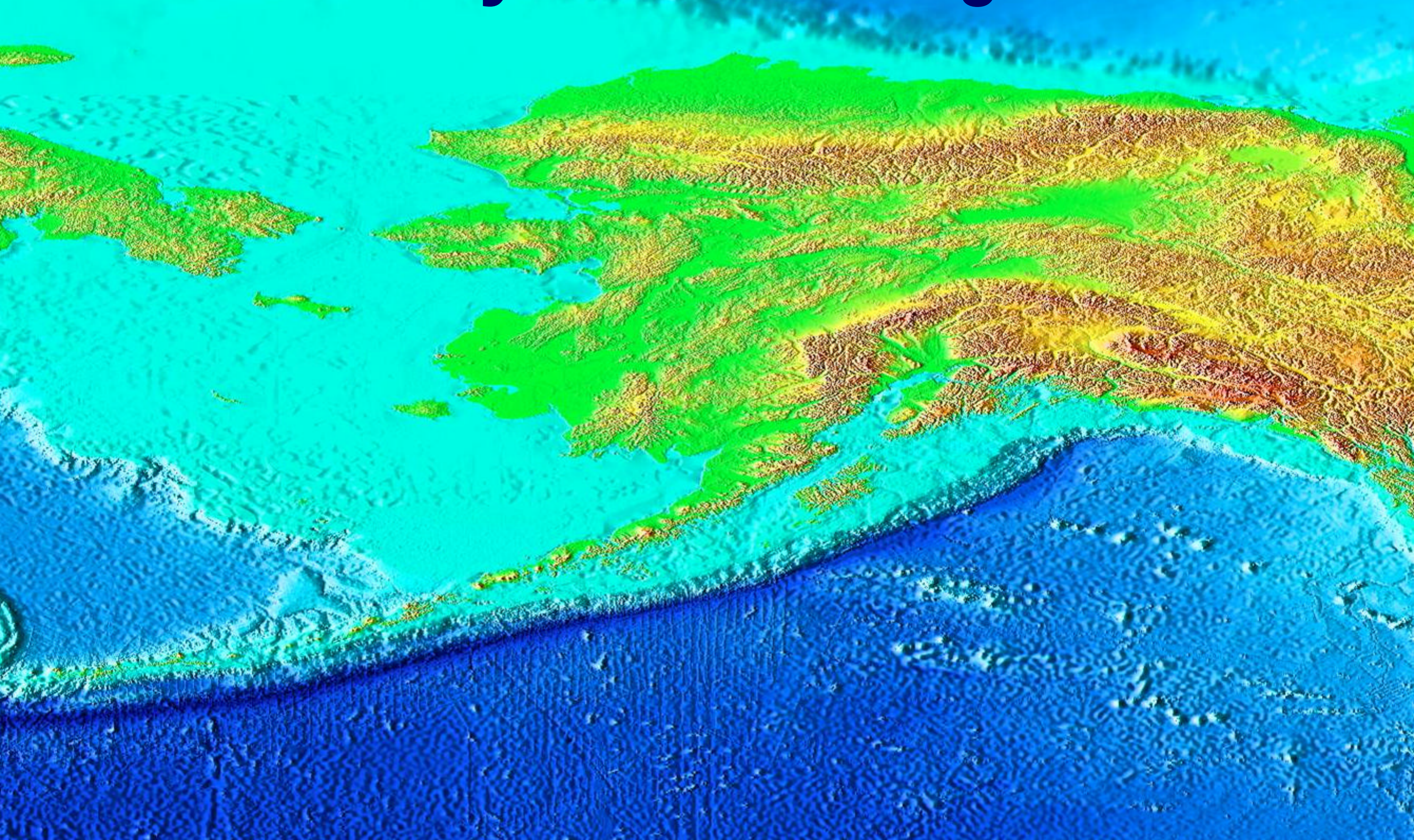
EMAP BIOGEOGRAPHIC REGIONS

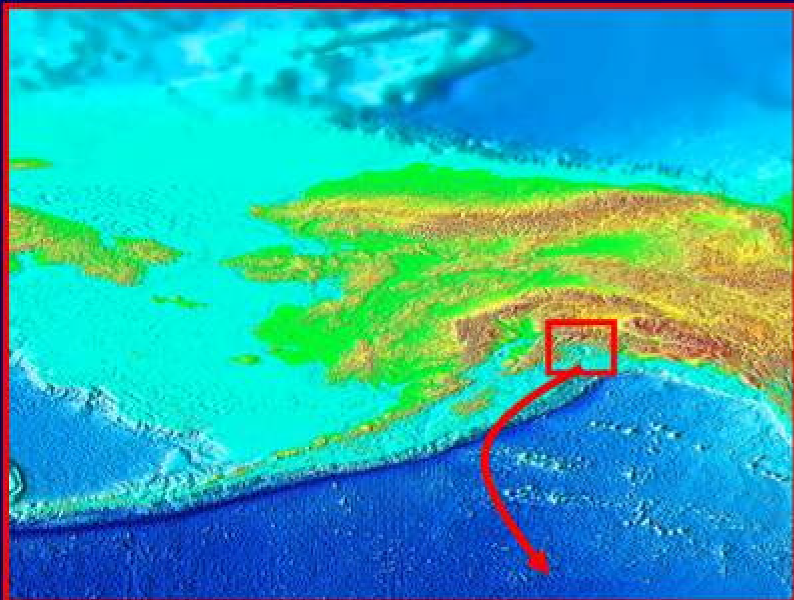


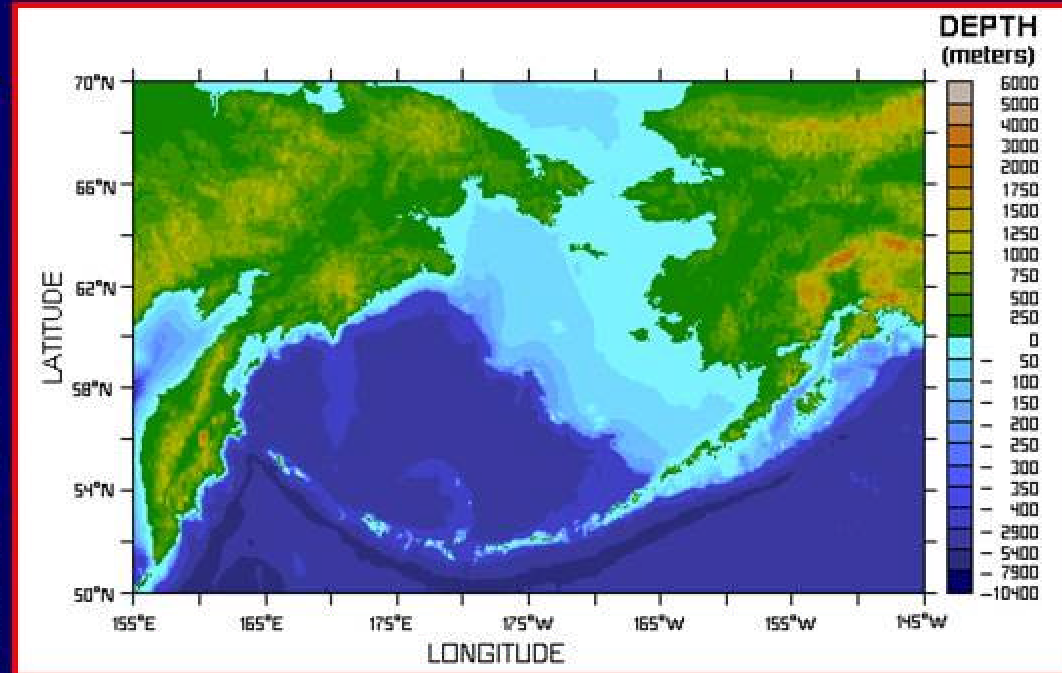
Alaskan Provinces

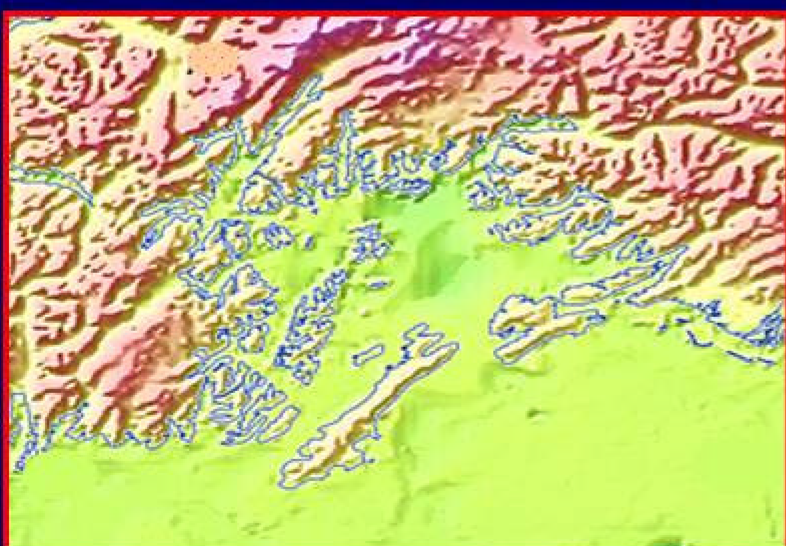
- Columbian (Southeast Alaska)
- Alaskan (Southcentral Alaska)
- Aleutian (Aleutian Chain)
- Bering (Western Alaska)
- Arctic (North Slope)

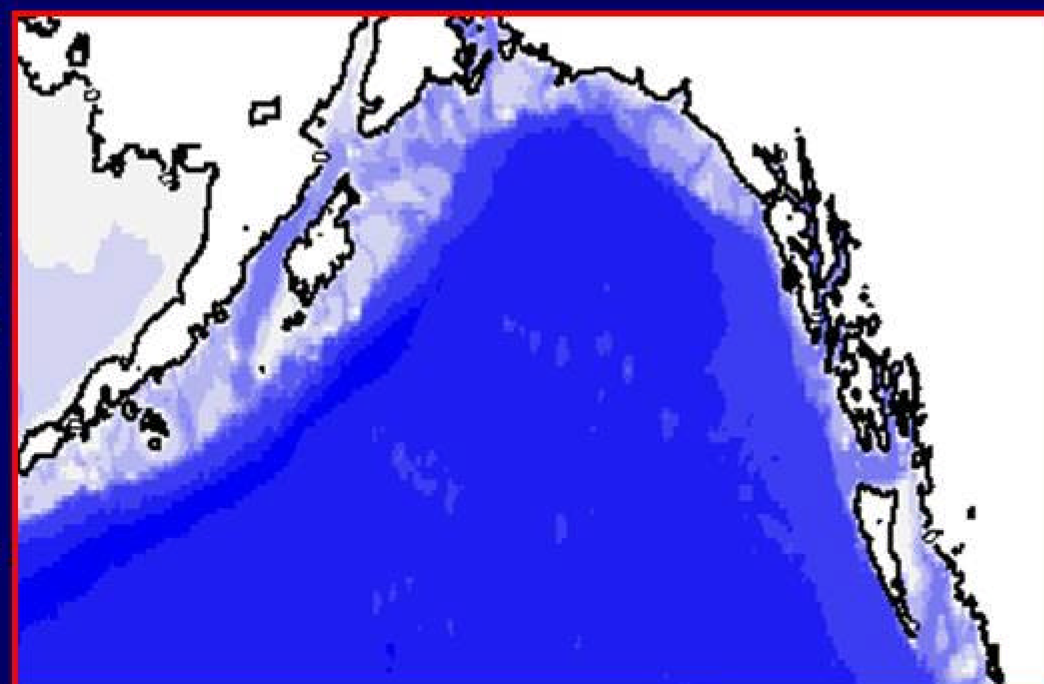
Alaska Coastal EMAP: Physical Setting





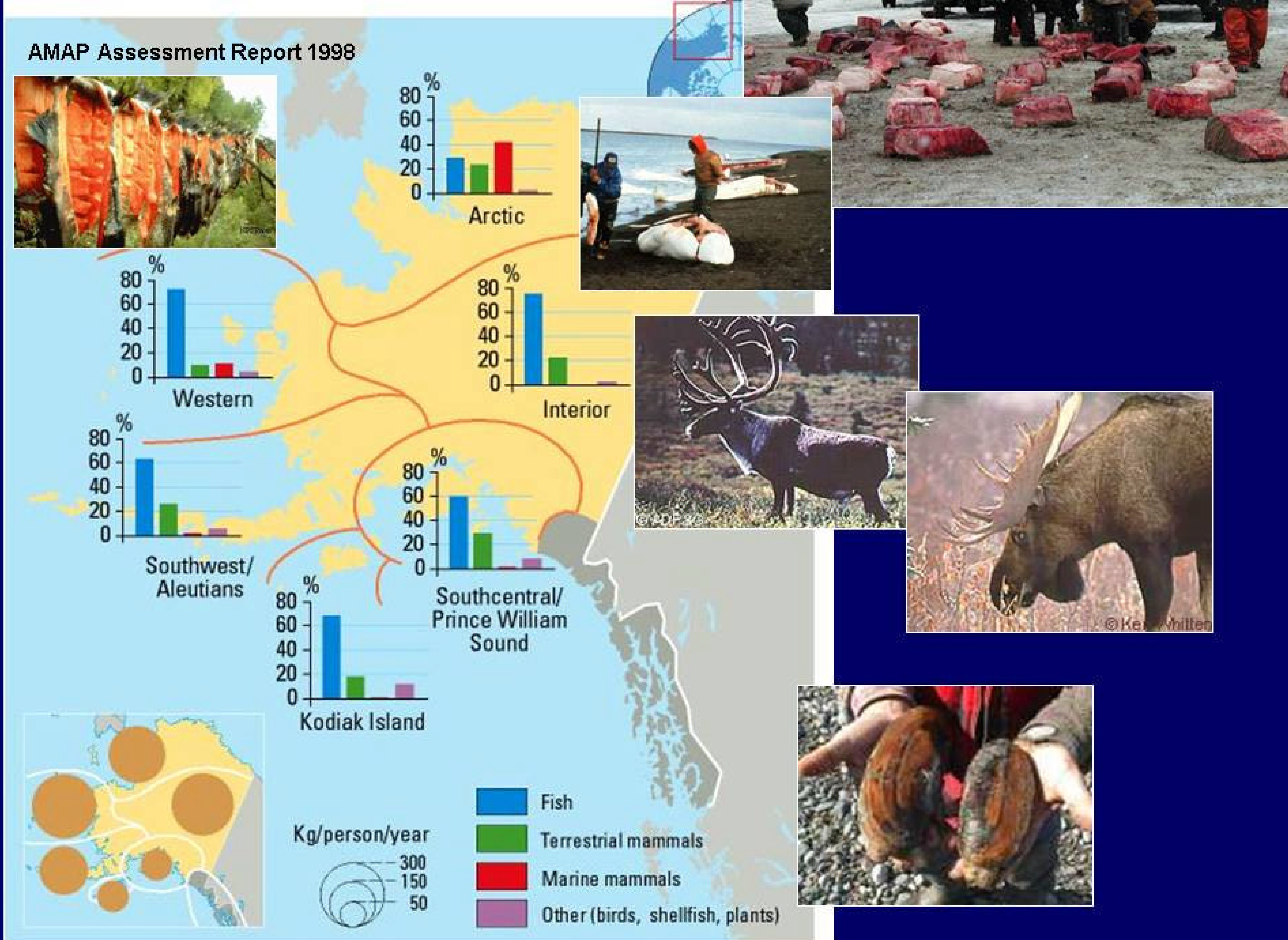

DEPTH
(meters)
6000
5000
4000
3000
2000
1750
1500
1250
1000
750
500
250
0
−50
−100
−150
−200
−250
−300
−350
−400
−2900
−5400
−7900
−10400
70°N
66°N
62°N
58°N
54°N
50°N
LATITUDE
155°E
165°E
175°E
175°W
165°W
155°W
145°W
LONGITUDE





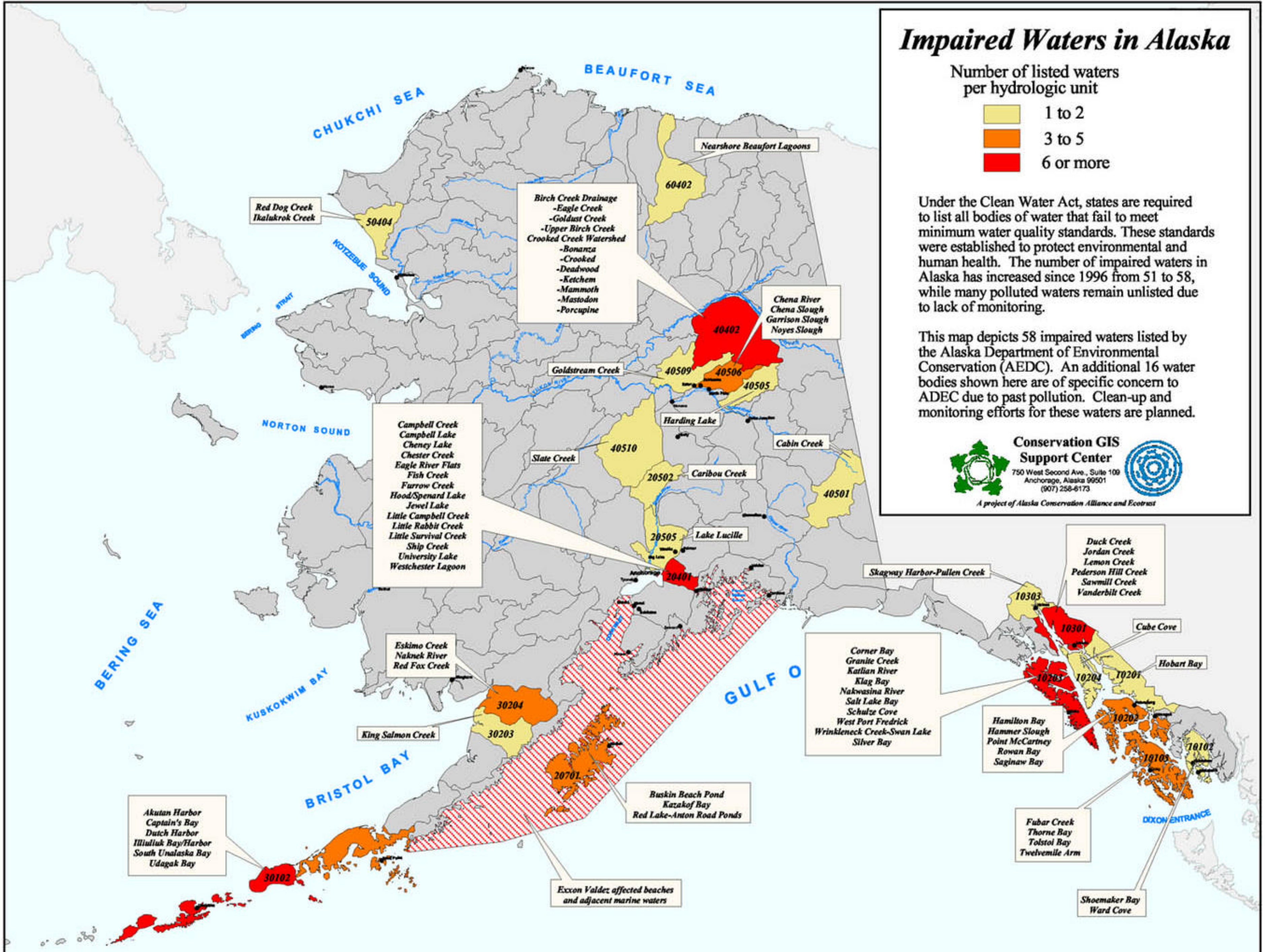

Barrow
Wainwright
Prudhoe Bay
Brooks Range
Nome
Delta Junction
St. Michael
Hooper Bay
St. Paul
St. George
BERING SEA
Port Heiden
Cold Bay
Sand Point
Akutan
Unalaska/Dutch Harbor
To Adak & Attu


Chukchi Sea
Beaufort Sea
Barrow
Hope Basin
Norton Basin
Nome
ALASKA
Navarin Basin
St Matthew Hall
Aleutian Basin
Cook Inlet
Anchorage
Bowers Basin
St George Basin
North Aleutian Basin
Gulf of Alaska
Kodiak
Shumagin
Aleutian Arc

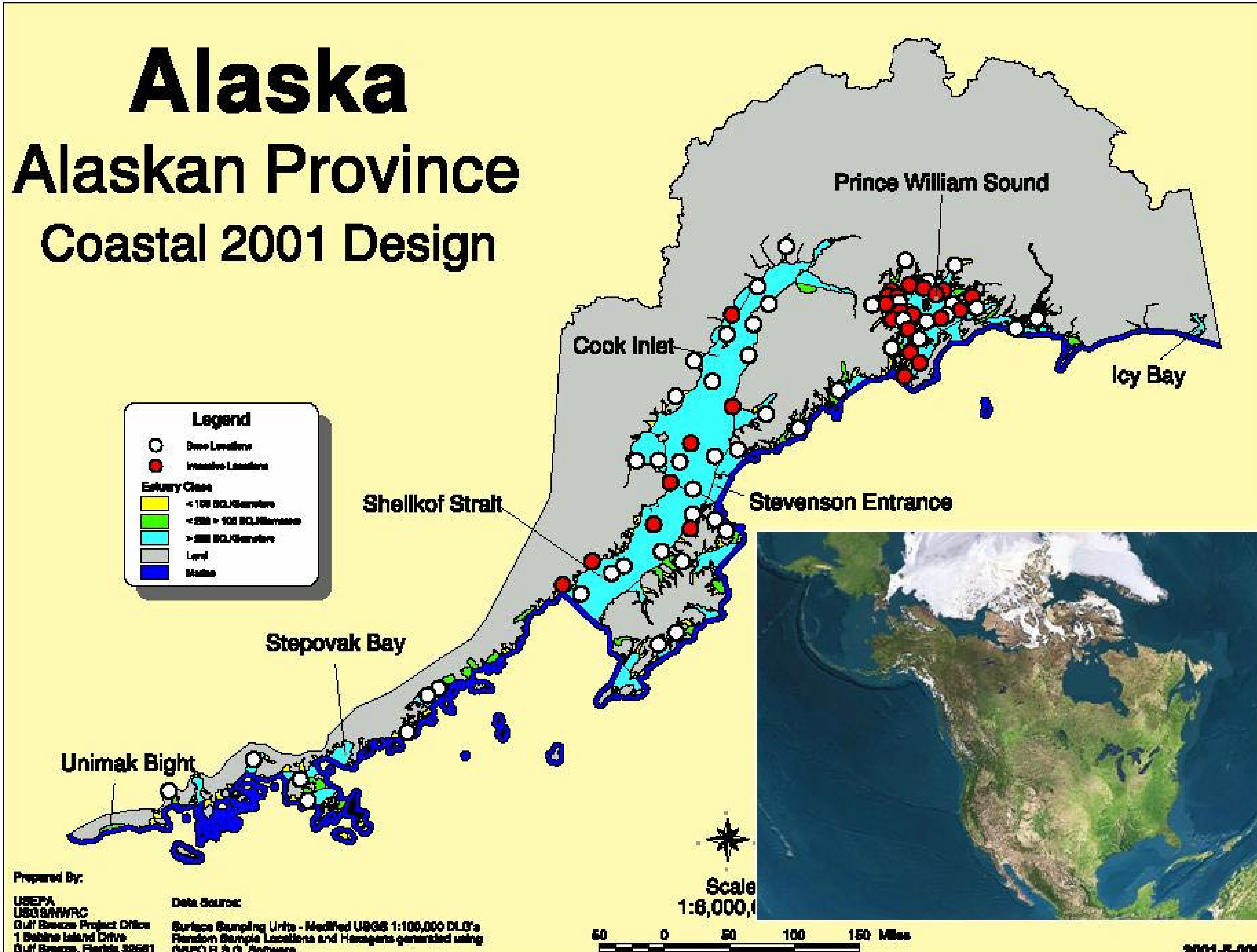

AMAP Assessment Report 1998
Arctic
Western
Interior
Southwest/
Aleutians
Southcentral/
Prince William
Sound
Kodiak Island
%
80
60
40
20
0
Kg/person/year
300
150
50
Fish
Terrestrial mammals
Marine mammals
Other (birds, shellfish, plants)

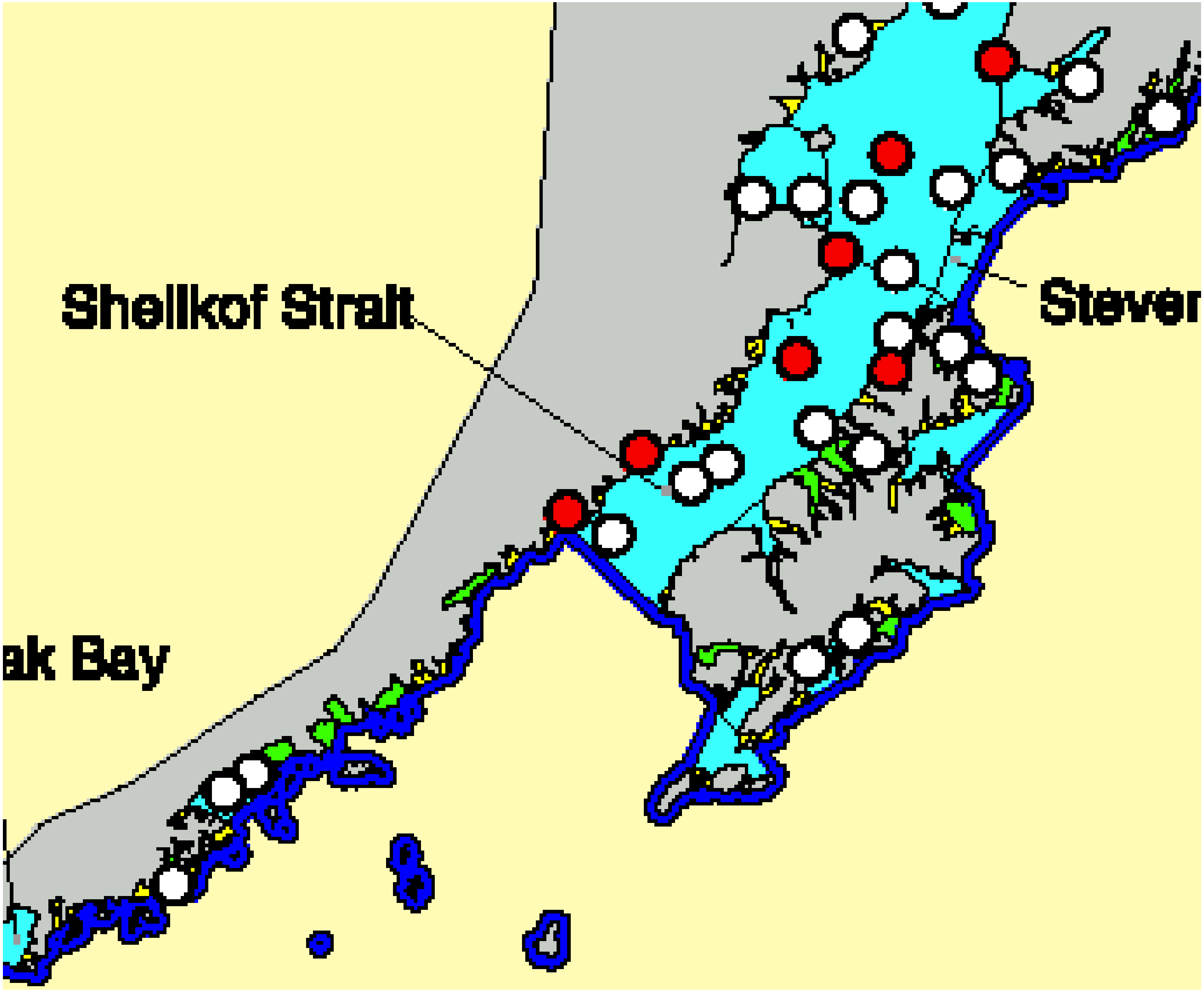
Need for Alaska EMAP NCA

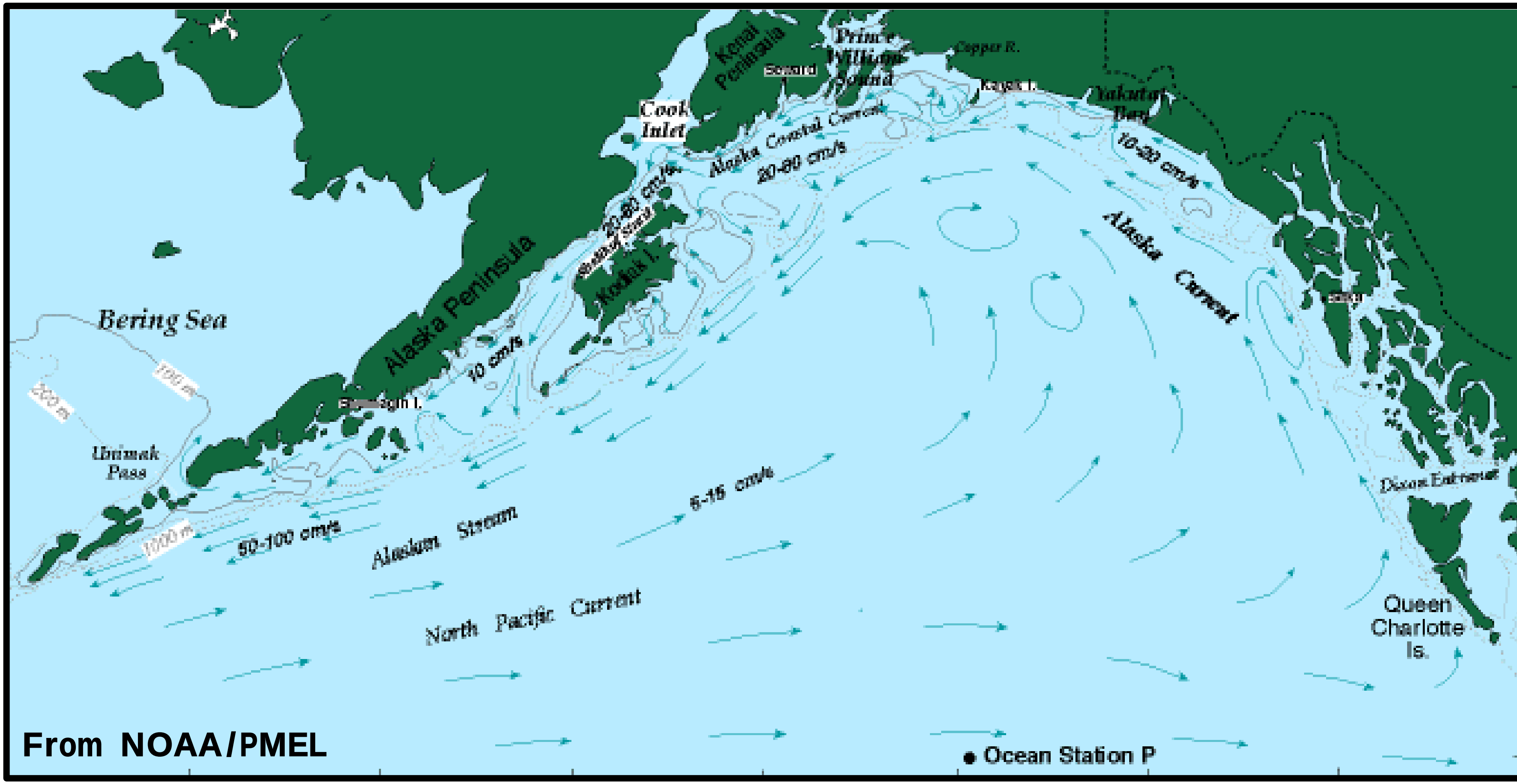
- Most studies targeted to specific issues, resource questions (OCSEAP, other MMS studies, EPA, RCACs, NPRB, EVOSTC)
- No probability-based survey designs across coastal environment
- Sediment Quality Triad approach needed to better interpret Alaskan sediment data (e.g. metal inputs)
- Need “context” for interpreting other, focused studies (*e.g.* EVOS oil spill, natural source rock, coal, seep, background PAH fingerprints)
- State of Alaska assessments targeted to known or suspected impaired waterbodies.



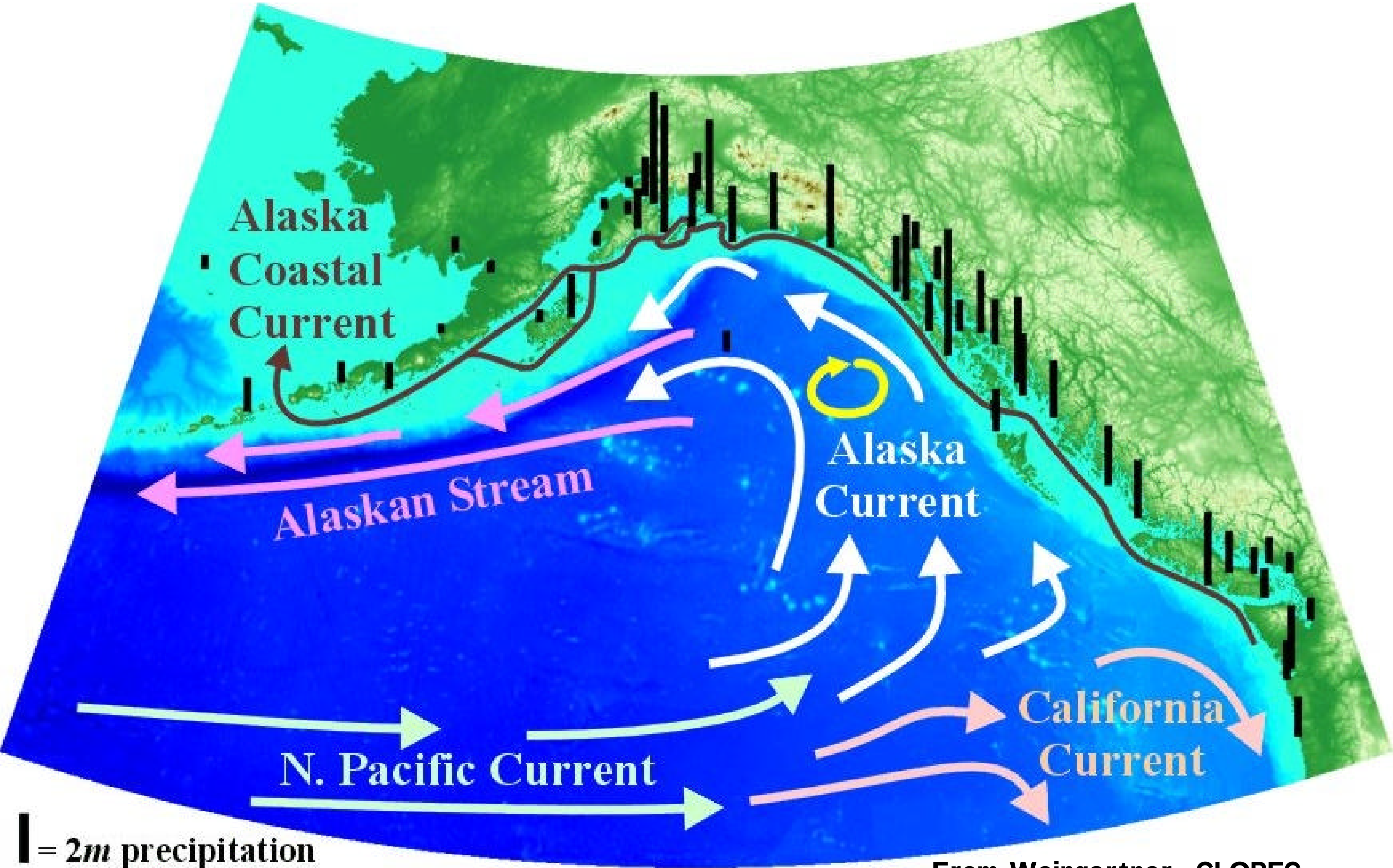
Impaired Waters in Alaska
Number of listed waters per hydrologic unit
1 to 2
3 to 5
6 or more
Under the Clean Water Act, states are required to list all bodies of water that fail to meet minimum water quality standards. These standards were established to protect environmental and human health. The number of impaired waters in Alaska has increased since 1996 from 51 to 58, while many polluted waters remain unlisted due to lack of monitoring.
This map depicts 58 impaired waters listed by the Alaska Department of Environmental Conservation (AEDC). An additional 16 water bodies shown here are of specific concern to ADEC due to past pollution. Clean-up and monitoring efforts for these waters are planned.
Conservation GIS Support Center
750 West Second Ave., Suite 109
Anchorage, Alaska 99501
(907) 258-6173
A project of Alaska Conservation Alliance and Ecotrust
BEAUFORT SEA
CHUKCHI SEA
KOTZEBUE SOUND
BERING STRAIT
NORTON SOUND
BERING SEA
KUSKOKWIM BAY
BRISTOL BAY
GULF O
DIXON ENTRANCE
Nearshore Beaufort Lagoons
60402
Red Dog Creek
Ikalukrok Creek
50404
Birch Creek Drainage
-Eagle Creek
-Goldust Creek
-Upper Birch Creek
Crooked Creek Watershed
-Bonanza
-Crooked
-Deadwood
-Ketchem
-Mammoth
-Mastodon
-Porcupine
40402
Chena River
Chena Slough
Garrison Slough
Noyes Slough
Goldstream Creek
40509
40506
40505
Harding Lake
Cabin Creek
Slate Creek
40510
20502
Caribou Creek
40501
Campbell Creek
Campbell Lake
Cheney Lake
Chester Creek
Eagle River Flats
Fish Creek
Furrow Creek
Hood/Spenard Lake
Jewel Lake
Little Campbell Creek
Little Rabbit Creek
Little Survival Creek
Ship Creek
University Lake
Westchester Lagoon
20505
Lake Lucille
20401
Skagway Harbor-Pullen Creek
10303
Duck Creek
Jordan Creek
Lemon Creek
Pederson Hill Creek
Sawmill Creek
Vanderbilt Creek
10301
Cube Cove
Hobart Bay
10204
10201
10203
Corner Bay
Granite Creek
Katlian River
Klag Bay
Nakwasina River
Salt Lake Bay
Schulze Cove
West Port Fredrick
Wrinkleneck Creek-Swan Lake
Silver Bay
Hamilton Bay
Hammer Slough
Point McCartney
Rowan Bay
Saginaw Bay
10202
10102
10103
Fubar Creek
Thorne Bay
Tolstoi Bay
Twelvemile Arm
Shoemaker Bay
Ward Cove
Eskimo Creek
Naknek River
Red Fox Creek
30204
King Salmon Creek
30203
20701
Buskin Beach Pond
Kazakof Bay
Red Lake-Anton Road Ponds
Akutan Harbor
Captain's Bay
Dutch Harbor
Illiuliuk Bay/Harbor
South Unalaska Bay
Udagak Bay
30102
Exxon Valdez affected beaches and adjacent marine waters


Alaska
Alaskan Province
Coastal 2001 Design
Prince William Sound
Cook Inlet
Icy Bay
Legend
Shelikof Strait
Stevenson Entrance
Stepovak Bay
Unimak Bight
Prepared By:
USEPA
Data Source:
Scale
50 0 50 100 150 Miles
2001-5-008


Shelikof Strait
Stever
ak Bay

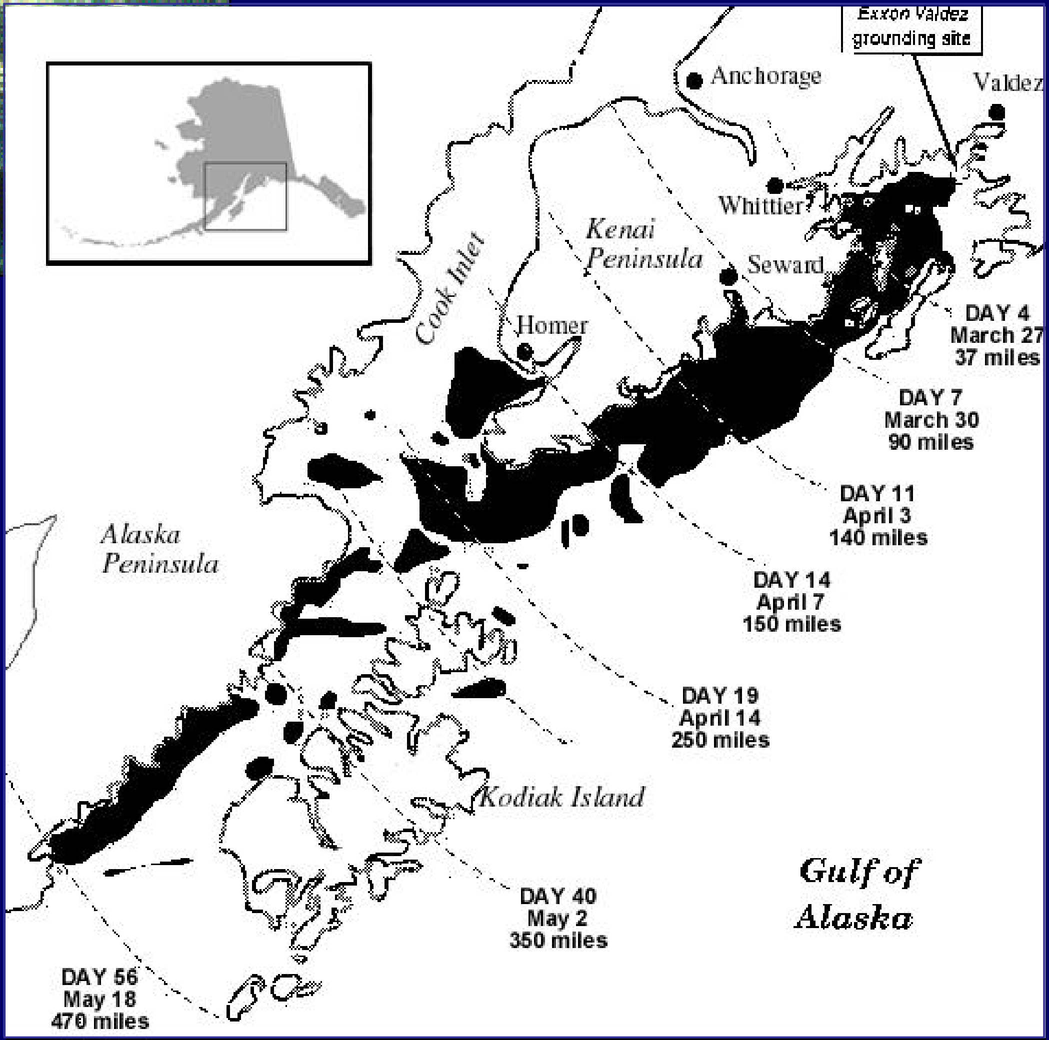

Bering Sea
Alaska Peninsula
Cook Inlet
Kenai Peninsula
Seward
Prince William Sound
Copper R.
Kayak I.
Yakutat Bay
Alaska Coastal Current
20-80 cm/s
10-20 cm/s
Alaska Current
Kodiak I.
10 cm/s
Unimak Pass
100 m
200 m
1000 m
50-100 cm/s
Alaskan Stream
5-15 cm/s
North Pacific Current
Dixon Entrance
Queen Charlotte Is.
Ocean Station P
From NOAA/PMEL

GOA Circulation



From Weingartner, GLOBEC

EXXON *VALDEZ*
Oil Spill–
MARCH 1989

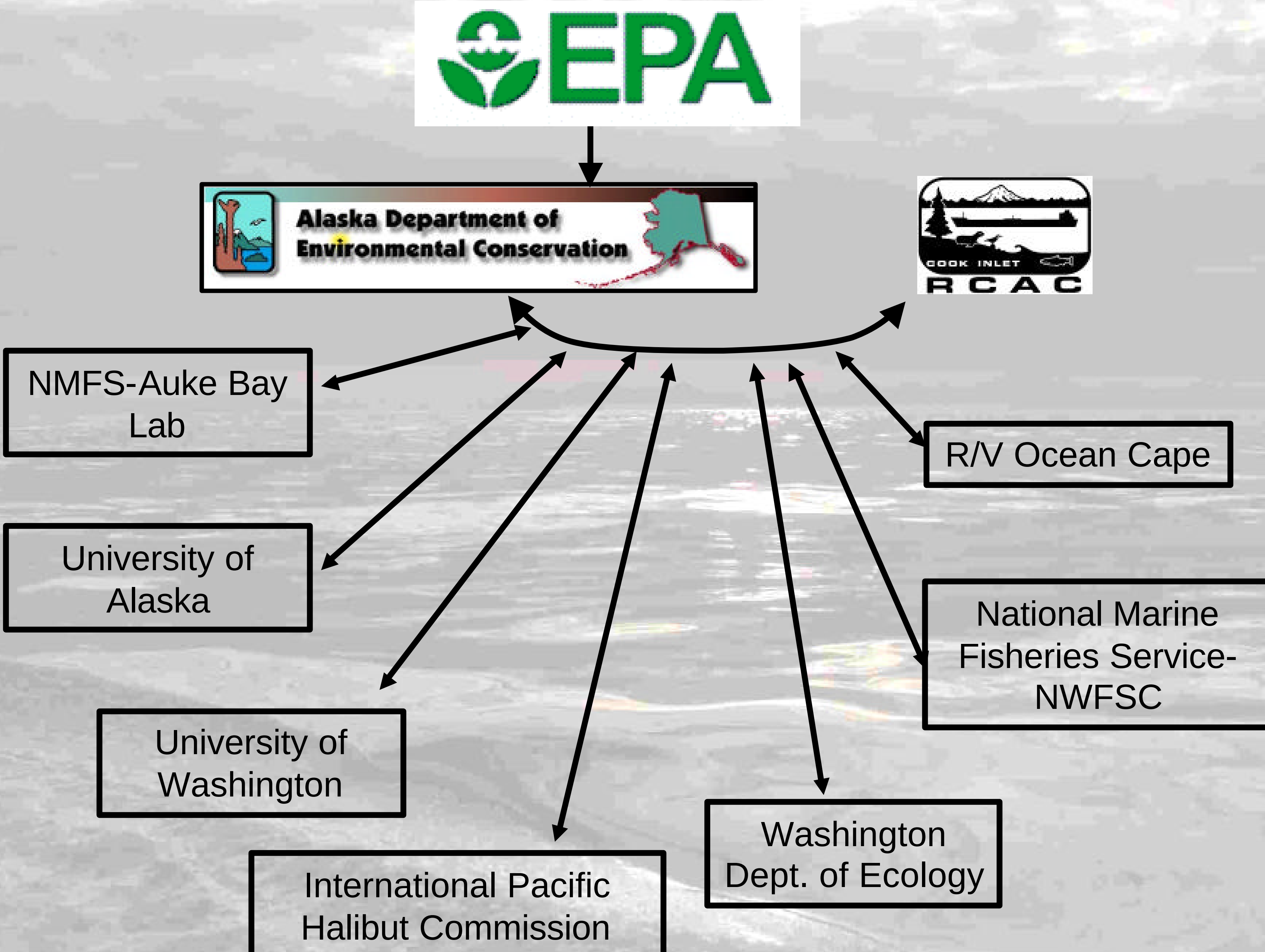



Sediment
Loads

"...create better tools for better air and water quality decisions."

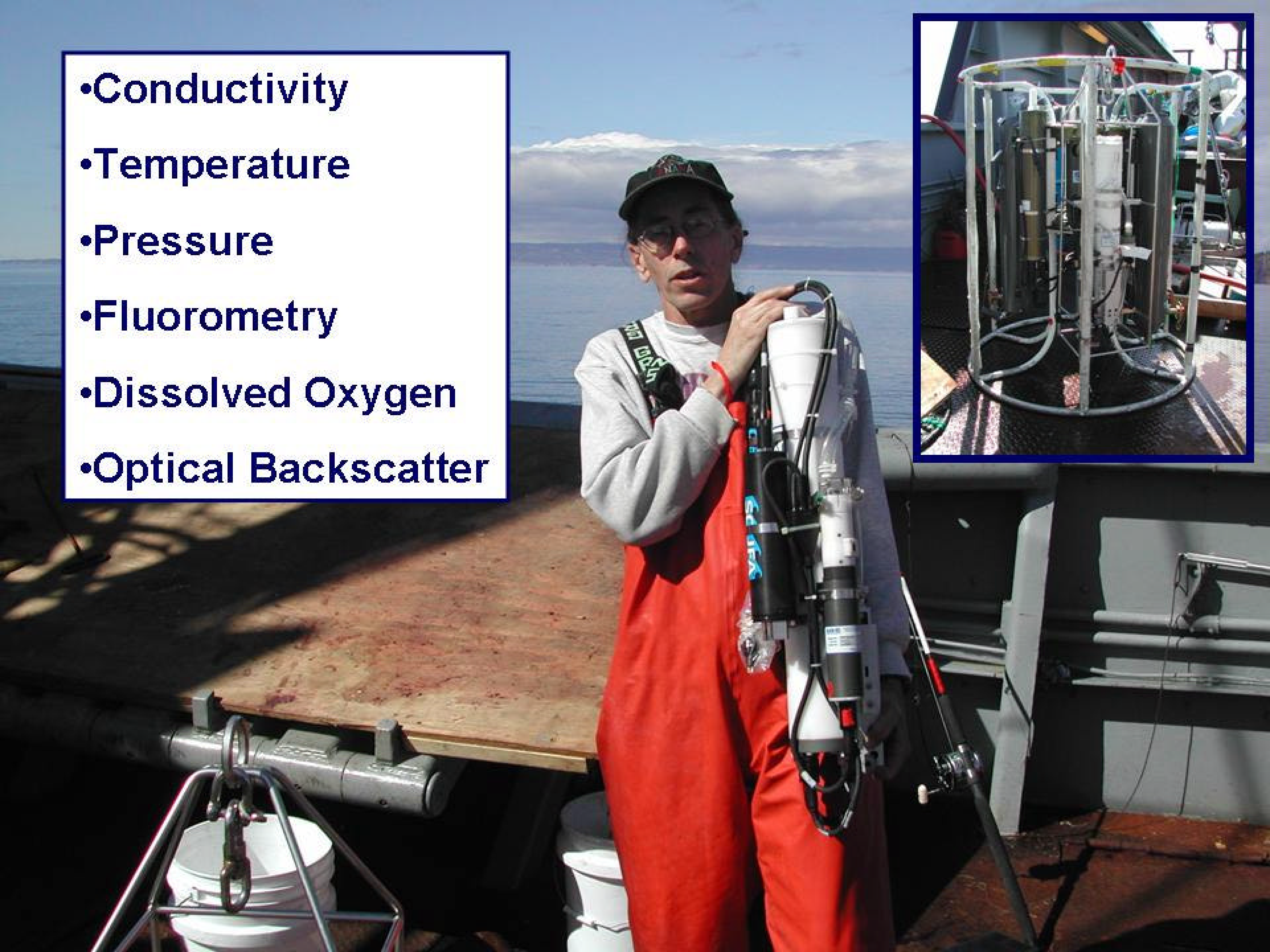
"...devise and manage a comprehensive program of monitoring environmental impacts of [oil industry] operations... in the Cook Inlet region."

Maximize expertise and resources


EPA
Alaska Department of Environmental Conservation
COOK INLET RCAC
NMFS-Auke Bay Lab
University of Alaska
University of Washington
International Pacific Halibut Commission
Washington Dept. of Ecology
National Marine Fisheries Service-NWFSC
R/V Ocean Cape

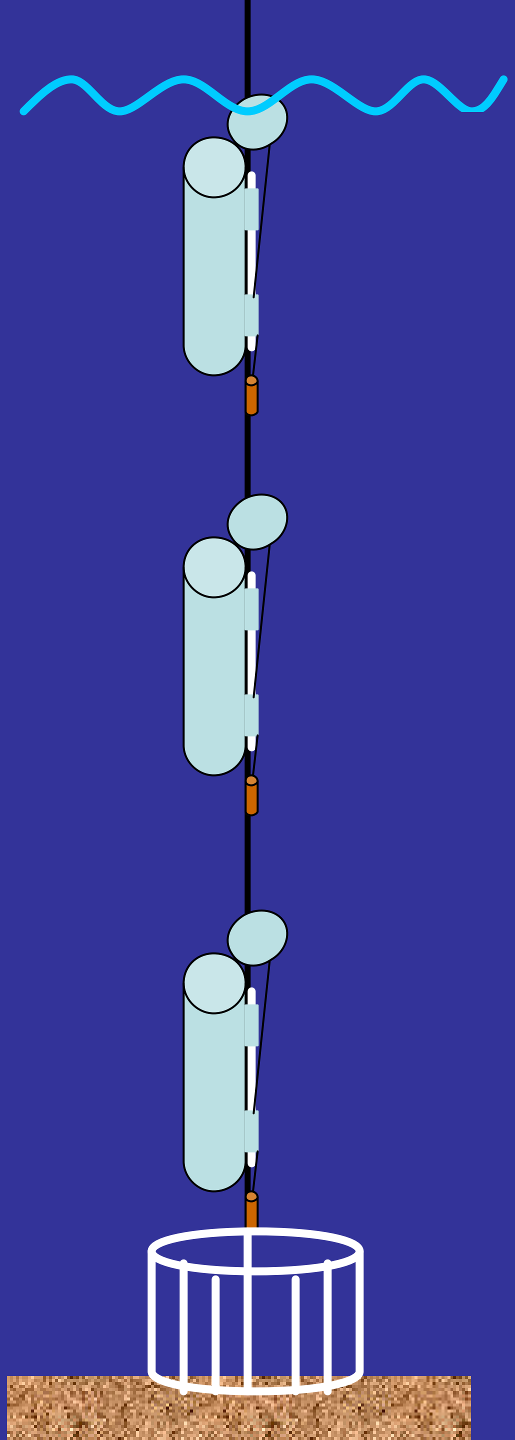

R/V Ocean Cape
TDX/BSE
OCEAN CAPE

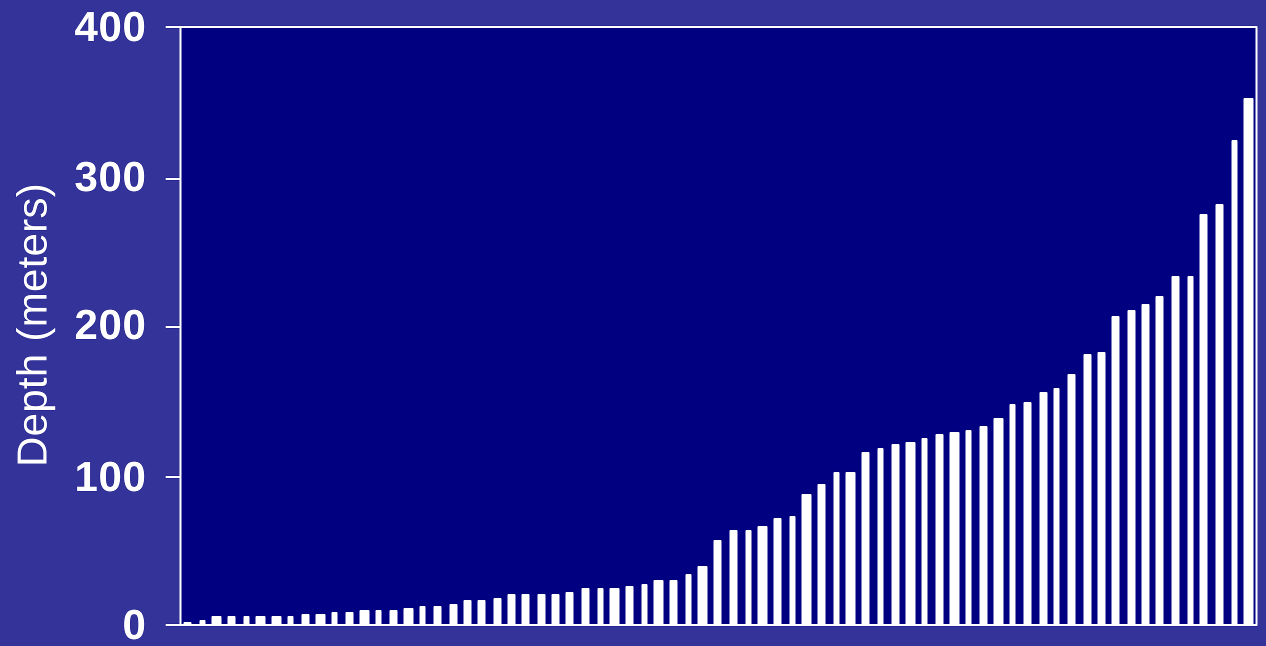
Small Boat Operations for Nearshore Stations

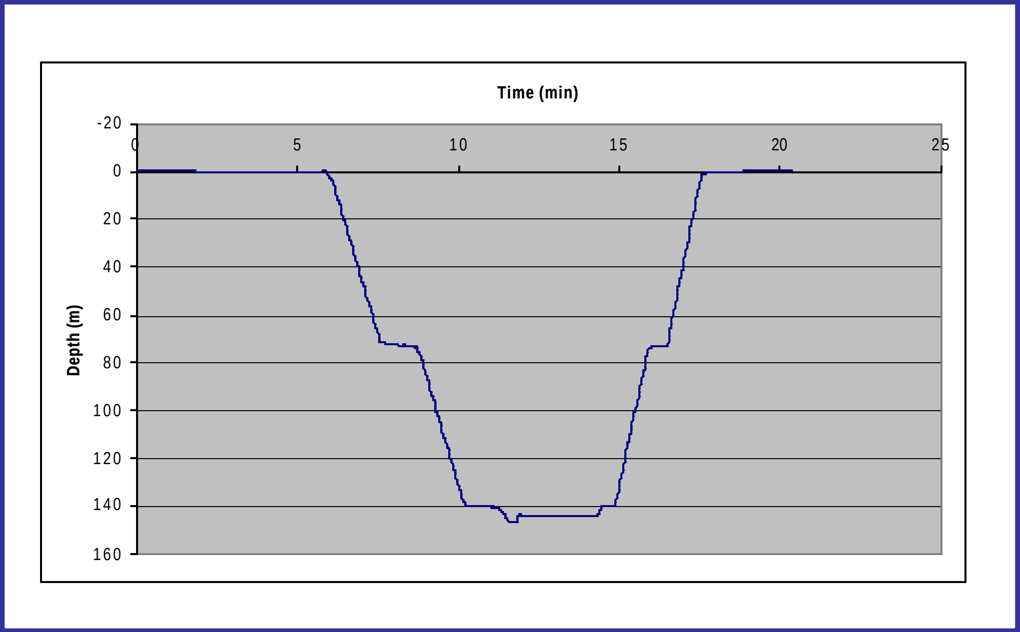

•Conductivity
•Temperature
•Pressure
•Fluorometry
•Dissolved Oxygen
•Optical Backscatter

Discrete Water Quality Sample Parameters

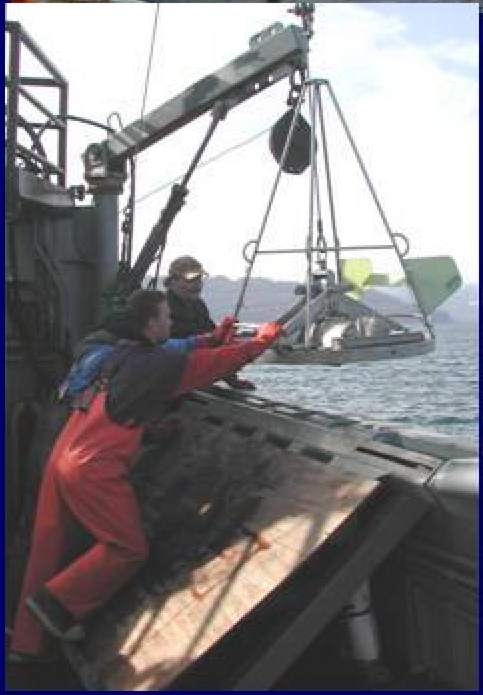
- Total Suspended Solids
- Extinction Coefficient (Secchi Depth)
- Nutrients
- Chlorophyll-a
- pH




Depth (meters)
400
300
200
100
0


Time (min)
Depth (m)
0
5
10
15
20
25
-20
0
20
40
60
80
100
120
140
160

Benthic Sediments: Chemistry Samples



Polynuclear Aromatic Hyrdrocarbons

Napthalene
C1-C4 Napthalene
Biphenyl
Acenaphthylene
Acenaphthene
Fluorene
C1-C3Fluorene
Phenanthrene
Anthracene
C1-C4 Phenanthrene/Anthracene
Dibenzothiophene
C1-C3 Dibenzothiophene
Fluoranthene
Pyrene
C1 Fluoranthene/Pyrene
Benzo(a)anthracene
Chrysene
C1-C4 Chrysenes
Benz(a)anthracene
Benzo(a)pyrene
Biphenyl
Chrysene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzo(e)pyrene
Benzo(a)pyrene
Perylene
Indeno(1,2,3-c,d)pyrene
Dibzneo(a,h)anthracene
Benzo(g,h,I)perylene
Total PAH

Aliphatic Hydrocarbons

n-C_{10} - n-C_{34}
pristane
phytane

21 PCB Congeners

8	2,4’-dichlorobiphenyl
18	2,2’,5-trichlorobiphenyl
28	2,4,4’-trichlorobiphenyl
44	2,2’,3,5’-tetrachlorobiphenyl
52	2,2’,5,5’-tetrachlorobipheyl
66	2,3’4,4’-tetrachlorobiphenyl
101	2,2’,4,5,5’-pentachlorobiphenyl
105	2,3,3’,4,4’-pentachlorobiphenyl
110/77	2,3,3’,4’,6-pentachlorobiphenyl/ 3,3’,4,4’-tetrachlorobiphenyl
118	2,3,4,4’,5-pentachlorobiphenyl
126	3,3,4,4’,5-pentachlorobiphenyl
128	2,2’,3,3’,4,4’-hexachlorobiphenyl
138	2,2’,3,4,4,5’-hexachlorobiphenyl
153	2,2’,4,4’,5,5’-hexachlorobiphenyl
170	2,2’,3,3’,4,4’,5-heptachlorobiphenyl
180	2,2’,3,4,4’,5,5’--heptachlorobiphenyl
187	2,2’,3,4’,5,5’,6-heptachlorobiphenyl
195	2,2’,3,3’,4,4’,5,6-octachlorobiphenyl,
206	2,2’,3,3’,4,4’,5,5’,6-nonachlorobiphenyl
209	2,2’,3,3’,4,4’,5,5’6,6’-decachlorobiphenyl

Other Parameters

Sediment Grain Size (additional size classes)
Total Organic Carbon
Butyl tins

DDT and metabolites

2,4’-DDD
4,4’-DDD
2,4’-DDE
4,4’-DDE
2,4’-DDT
4,4’-DDT

Other Chlorinated pesticides

Aldrin
Alpha-Chlordane
Dieldrin
Endosulfan I
Endosulfan II
Endosulfan sulfate
Endrin
Heptachlor
Heptachlor epoxide
Hexachlorobenzene
Lindane (gamma-BHC)
Mirex
Toxaphene
Trans-Nonachlor

Trace Elements

Aluminum
Antimony
Arsenic
Cadmium
Chromium
Copper
Iron
Lead
Manganese
Mercury
Nickel
Selenium
Silver
Tin
Zinc

Benthic Sediments: Infaunal Samples

>1.0 mm; 1.0 > archived > 0.5 mm

Bottom Trawls - Fish species, counts, lengths, pathology; Invertebrate species and counts

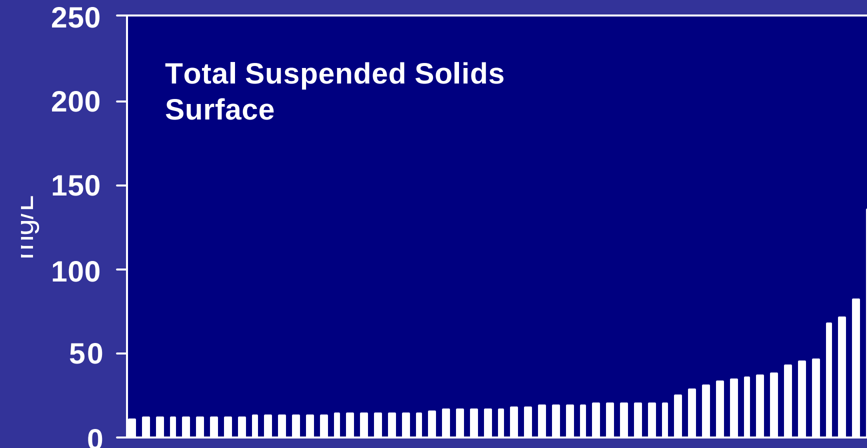
Eastern 400 Deep Stations (29 m footrope); Tri-net otter trawl Nearshore Stations (6 m footrope)


NETS
NETS
OCEAN
ST. PAUL IS., AK
CAPE

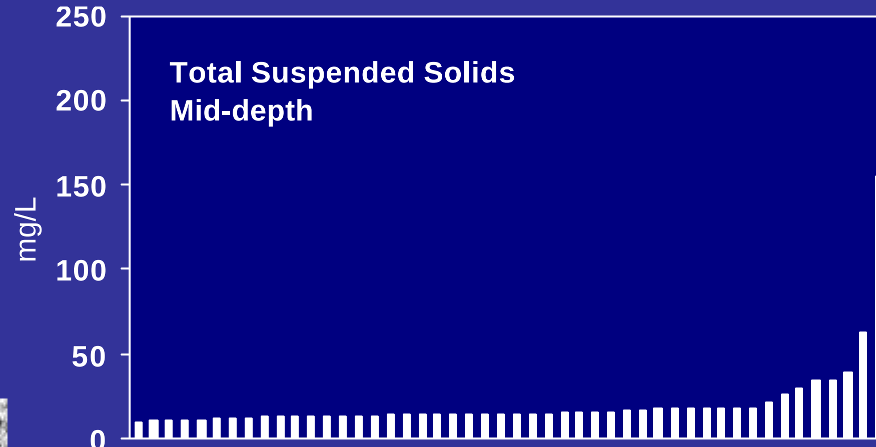

OCEAN

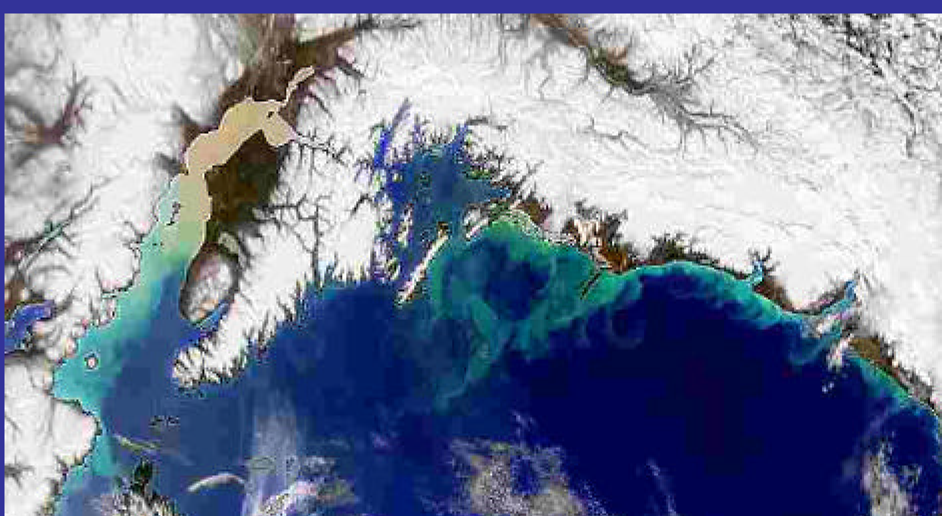

OCEAN
CAPE

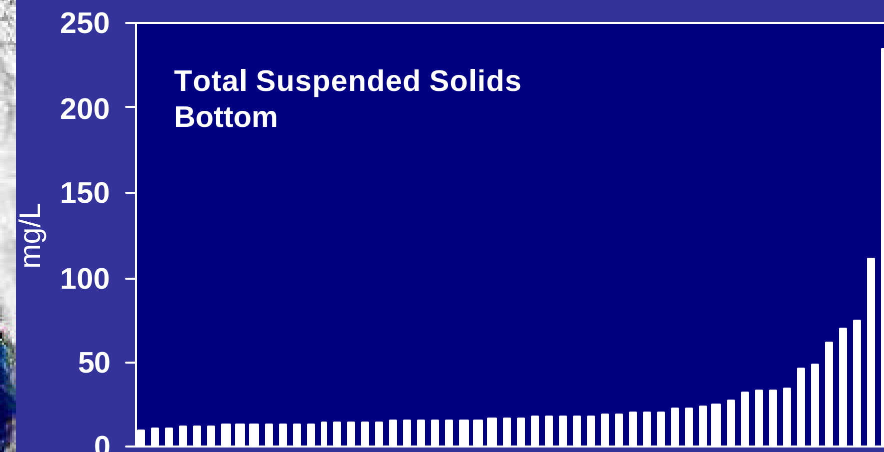
Alaska
WASILLA
ANCHORAGE
VALDEZ
KENAI
CORDOVA
Cook Inlet
HOMER
Prince William
Sound
Gulf of
Alaska
Shelikof Strait
KODIAK
Bering Sea
Bristol Bay
Alaska Peninsula
N
W
E
S
Legend
Locations
Base
Intensive
Roads
National Park Bo
Pacific Ocean
Unimak Bight
50 0 50 100 150 Miles
Portion of Alaskan Coast and South-East Co
Contiguous United States at Identical Sca



- Secchi depths as low as 0.1 meters
- Sites with the lowest Secchi depths:
  - Every instance of low water clarity corresponded to areas known for high influx of glacial silt
- TSS data showed same trend





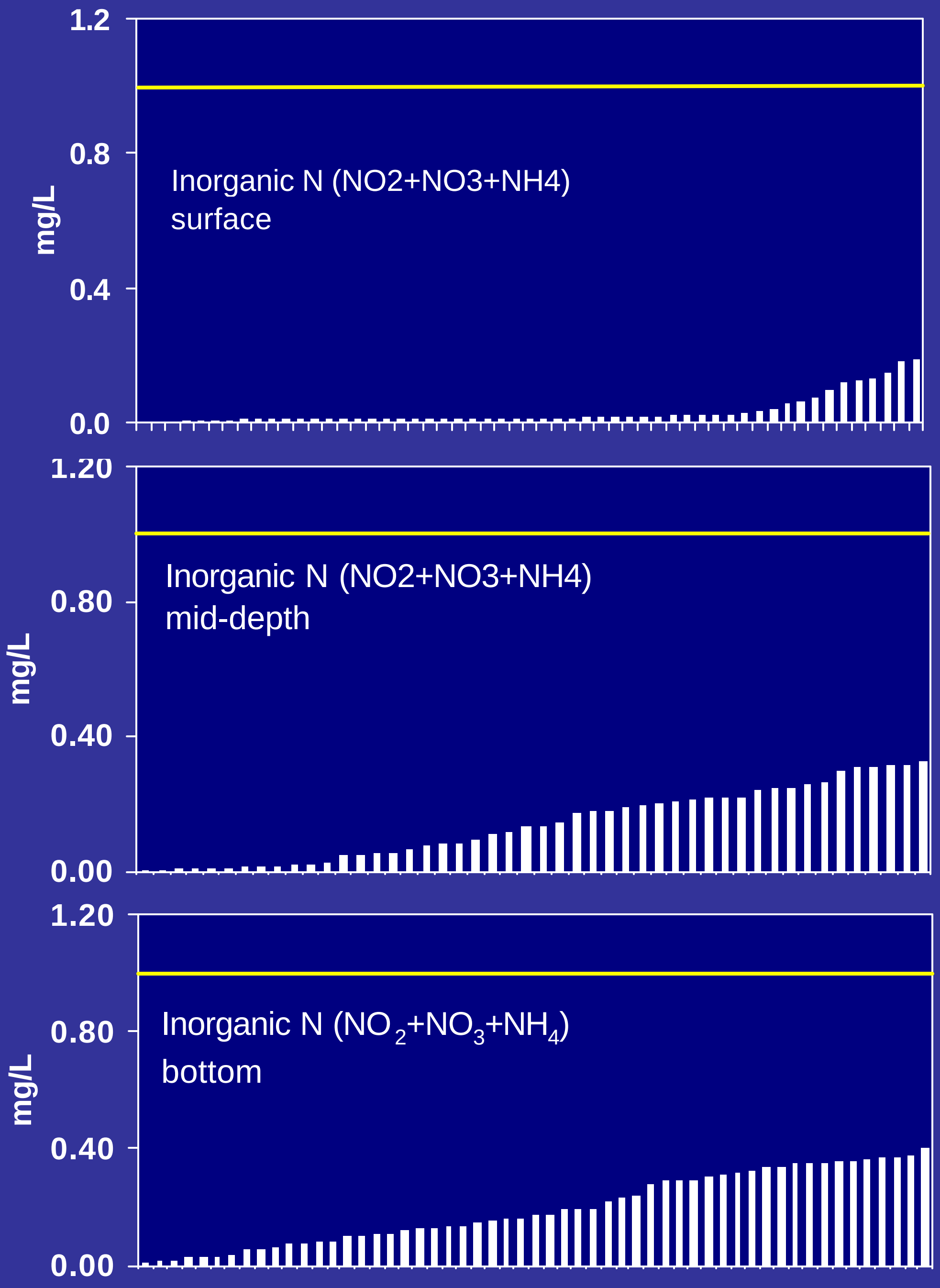


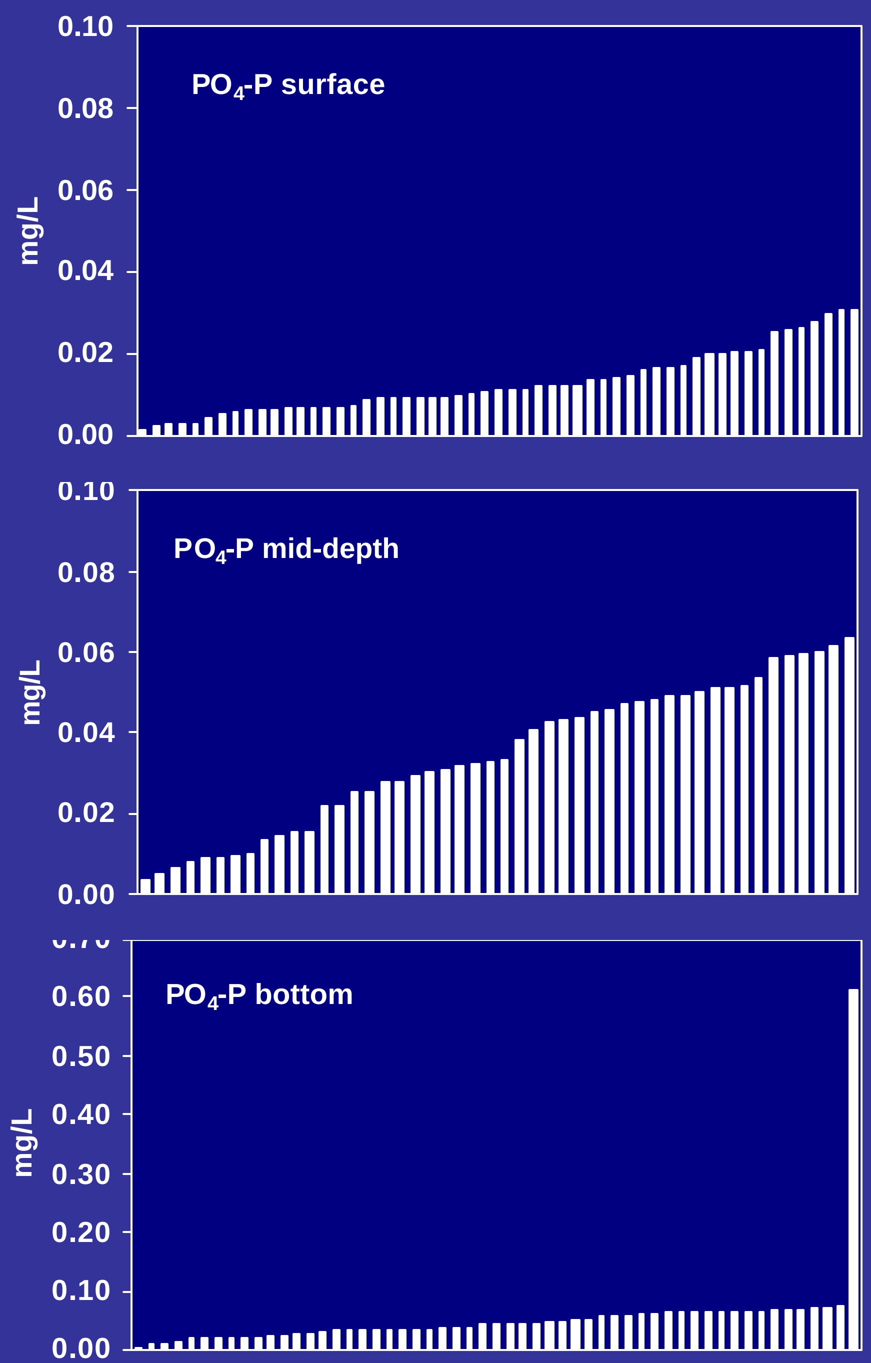
Water Column Results: Dissolved Oxygen
SBE 23y sensor on CTD

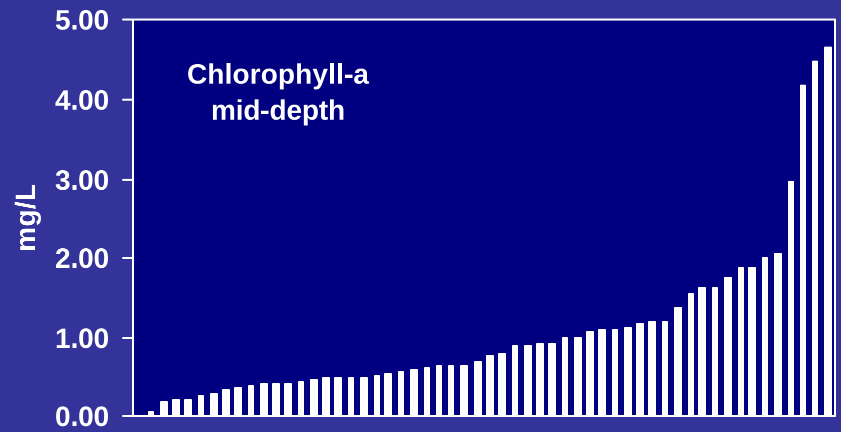
•All DO values at all depths met AWQS which state that for applicable marine water uses (*i.e.* Aquaculture, Growth and propogation of aquatic life, Harvesting aquatic life).
•All DO values for all stations and depths were > 6 mg/L and < 13 mg/L.

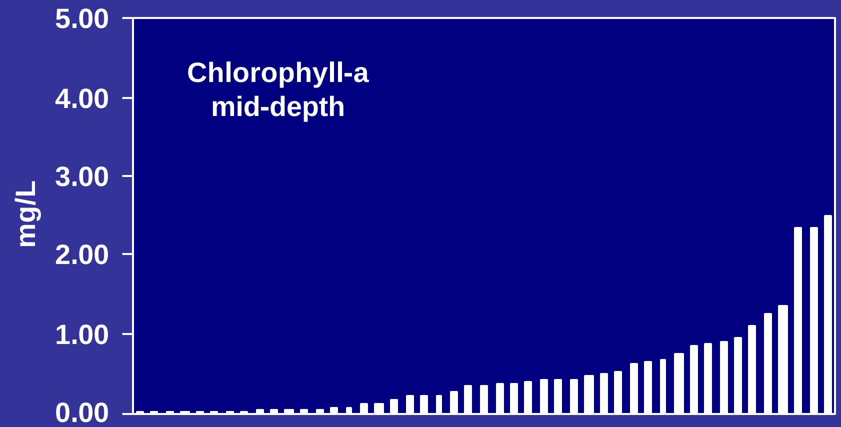
Water Column Results: pH
Orion Model 250A pH meter; Triode electode

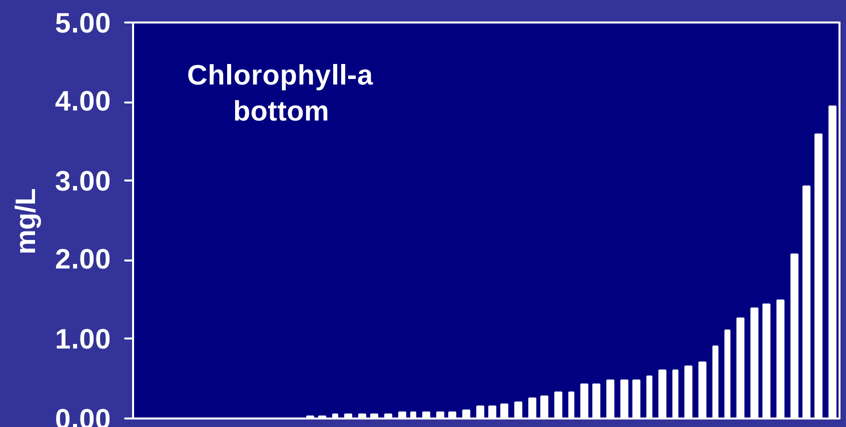
•Only two stations (at bottom) had pH < 6.5
•Only one station (at surface) had pH >8.5
•All other pH measurements met AWQS for Aquaculture and Growth and propogation...
•All pH measurements met AWQS for Harvesting...

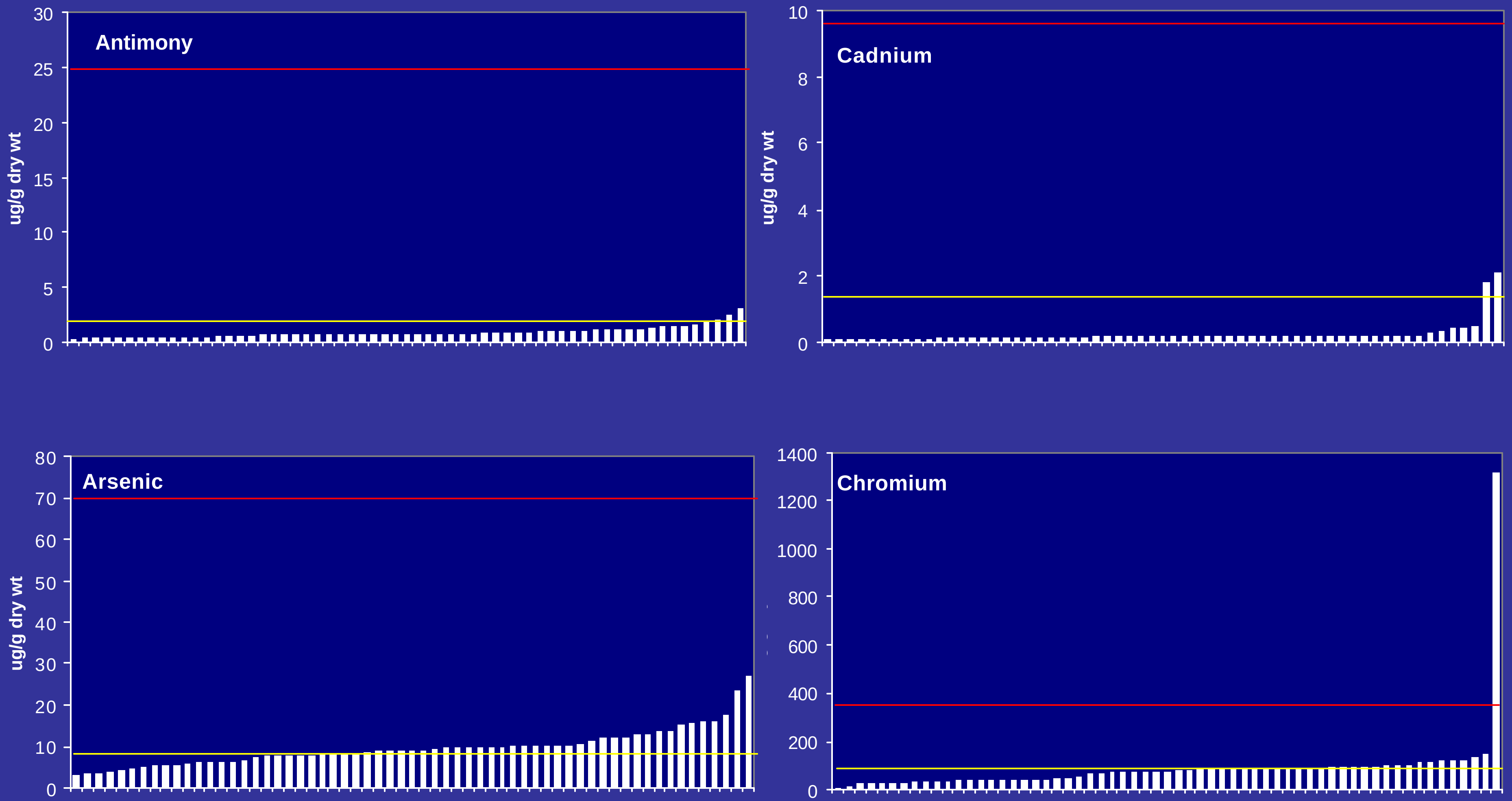

1.2
0.8
0.4
0.0
mg/L
Inorganic N (NO2+NO3+NH4)
surface
1.20
0.80
0.40
0.00
mg/L
Inorganic N (NO2+NO3+NH4)
mid-depth
1.20
0.80
0.40
0.00
mg/L
Inorganic N (NO_2+NO_3+NH_4)
bottom


PO4-P surface
mg/L
0.10
0.08
0.06
0.04
0.02
0.00
PO4-P mid-depth
mg/L
0.10
0.08
0.06
0.04
0.02
0.00
PO4-P bottom
mg/L
0.60
0.50
0.40
0.30
0.20
0.10
0.00

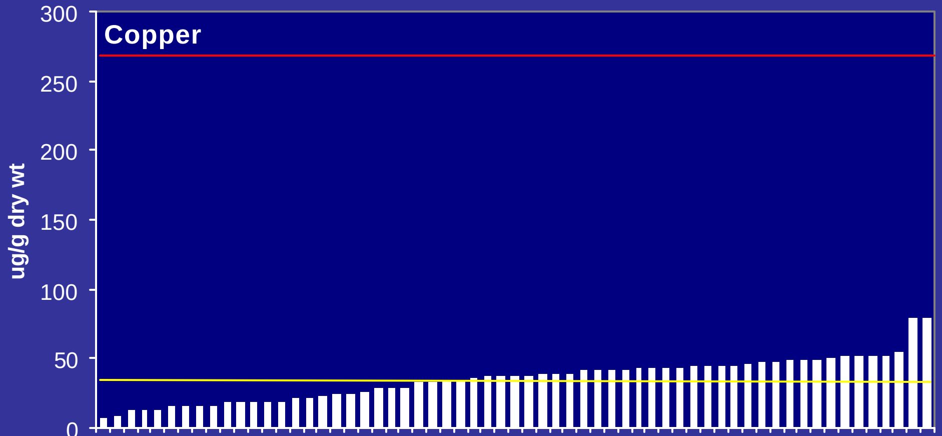

5.00
4.00
3.00
2.00
1.00
0.00
mg/L
Chlorophyll-a
mid-depth

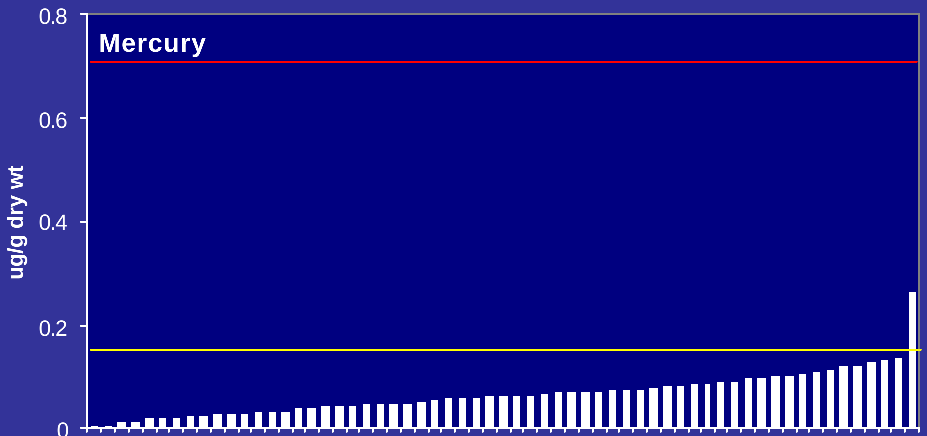

5.00
4.00
3.00
2.00
1.00
0.00
mg/L
Chlorophyll-a
mid-depth

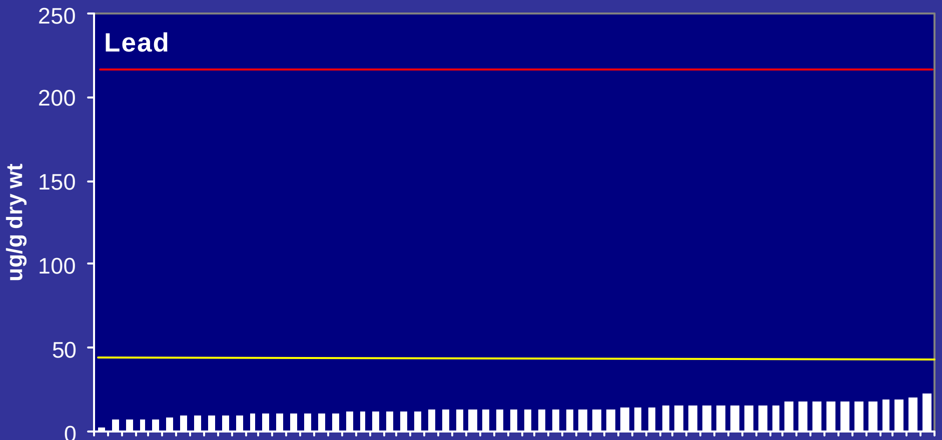

5.00
4.00
3.00
2.00
1.00
0.00
mg/L
Chlorophyll-a
bottom

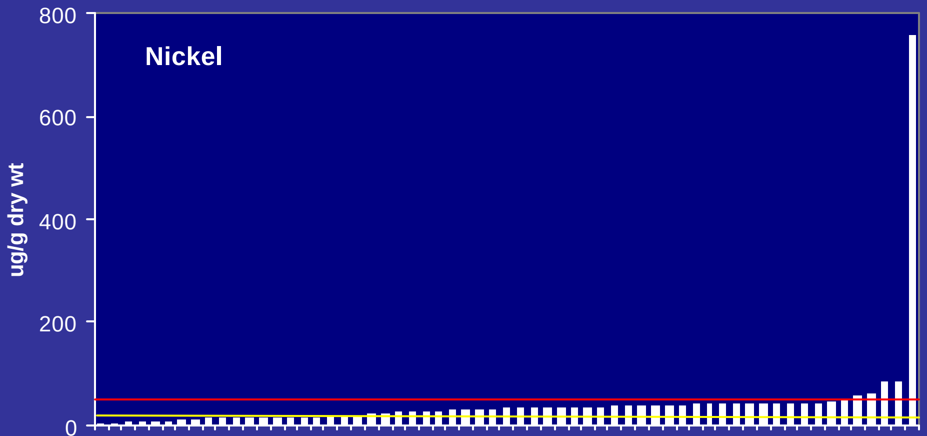


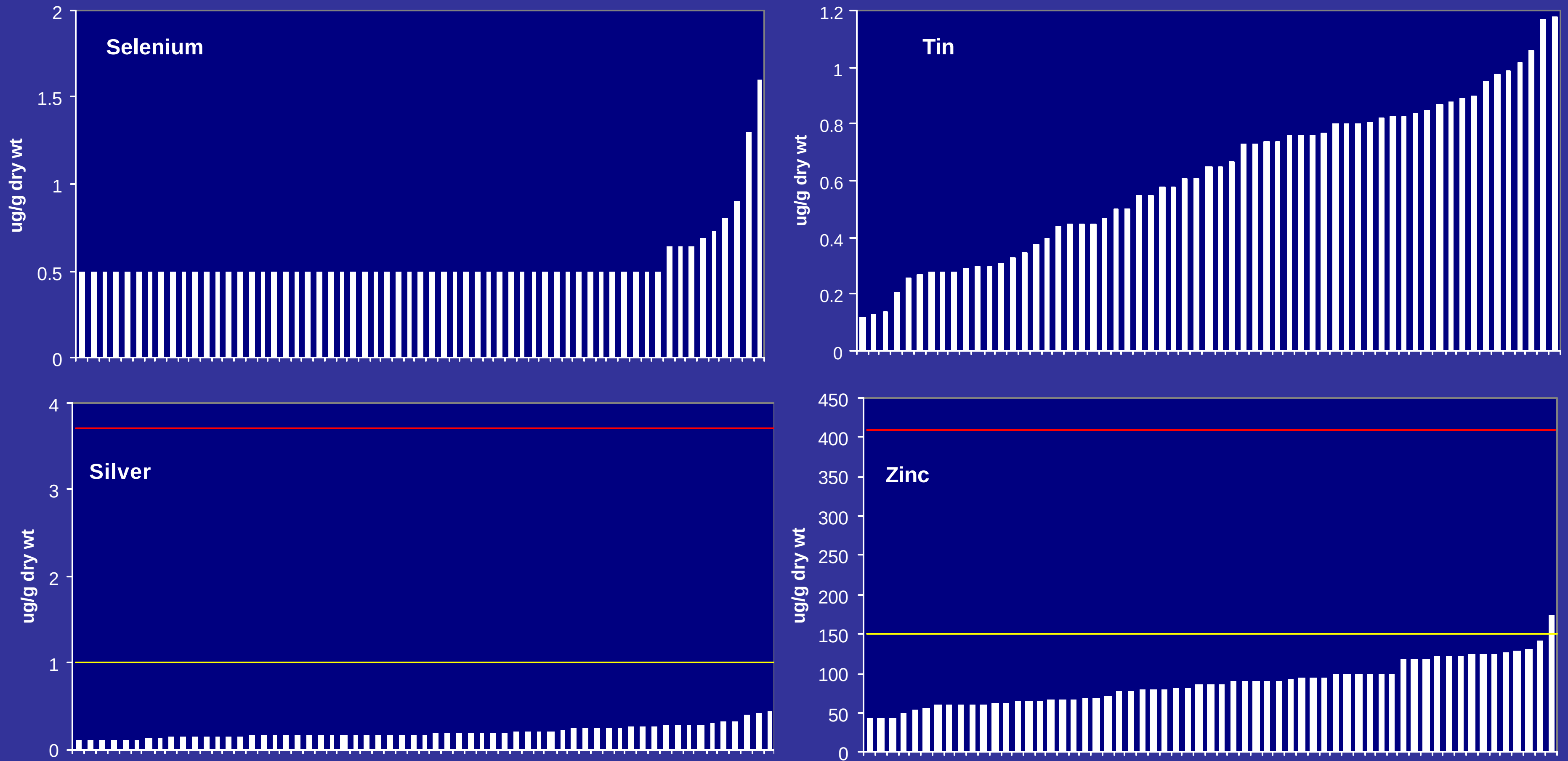
Antimony
ug/g dry wt
30
25
20
15
10
5
0
Cadnium
ug/g dry wt
10
8
6
4
2
0
Arsenic
ug/g dry wt
80
70
60
50
40
30
20
10
0
Chromium
1400
1200
1000
800
600
400
200
0


Copper
ug/g dry wt
300
250
200
150
100
50
0


Mercury
ug/g dry wt
0.8
0.6
0.4
0.2
0

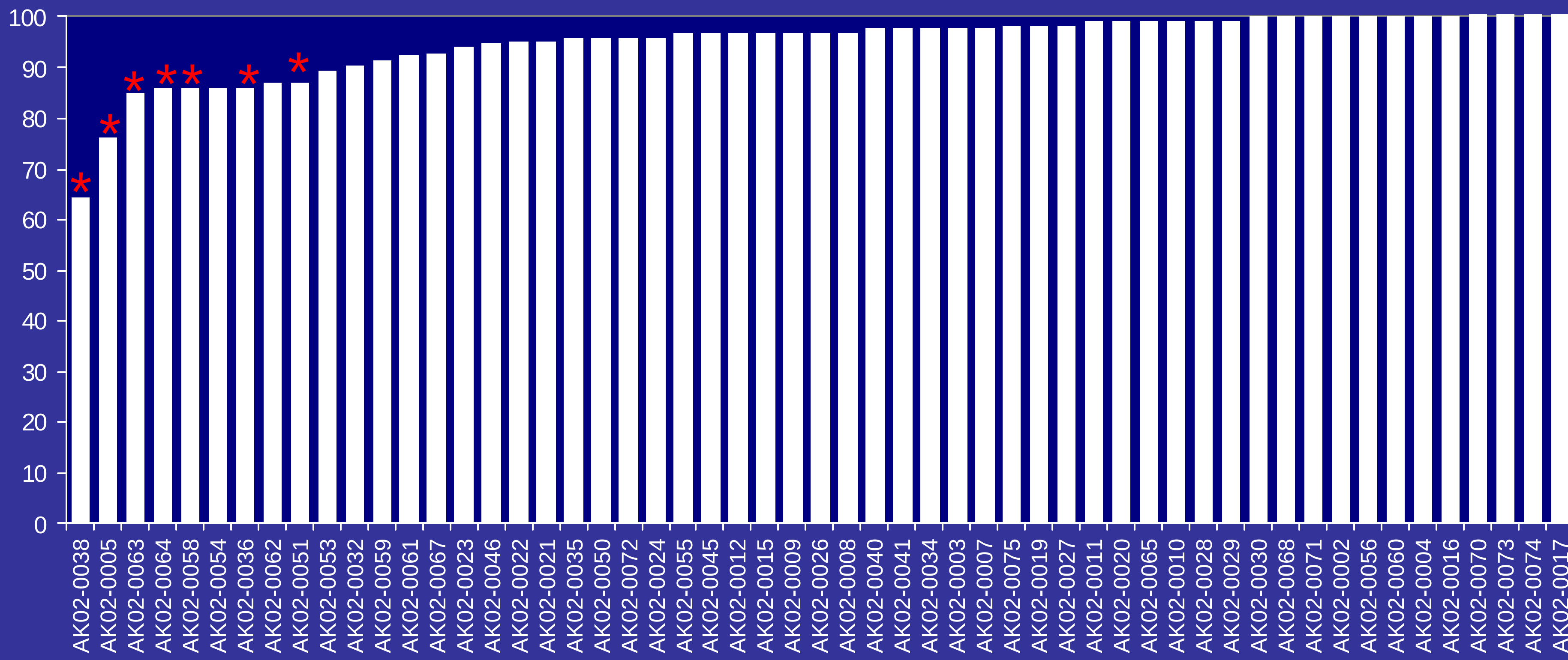

Lead
ug/g dry wt
250
200
150
100
50
0


Nickel
ug/g dry wt
800
600
400
200
0

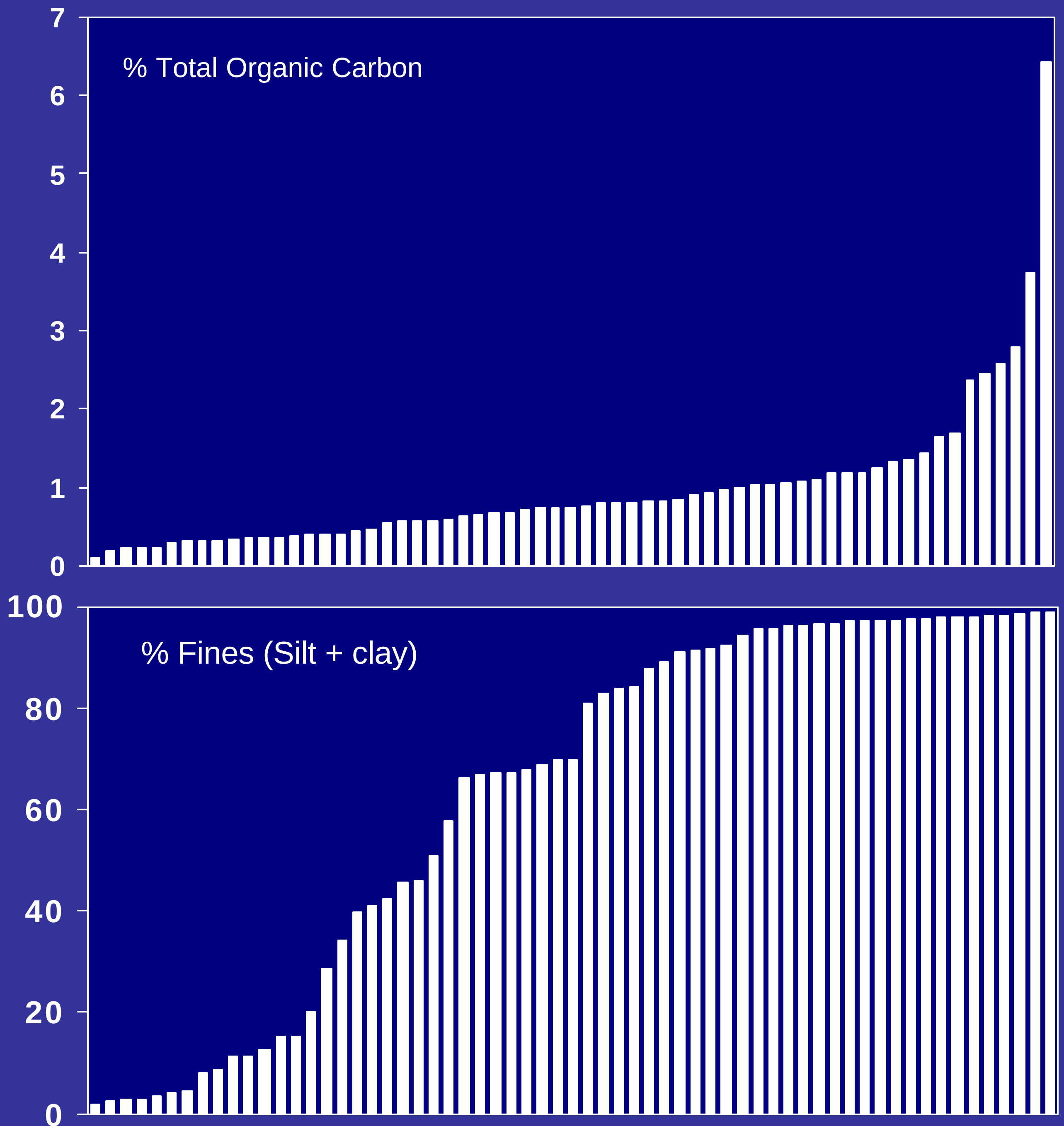


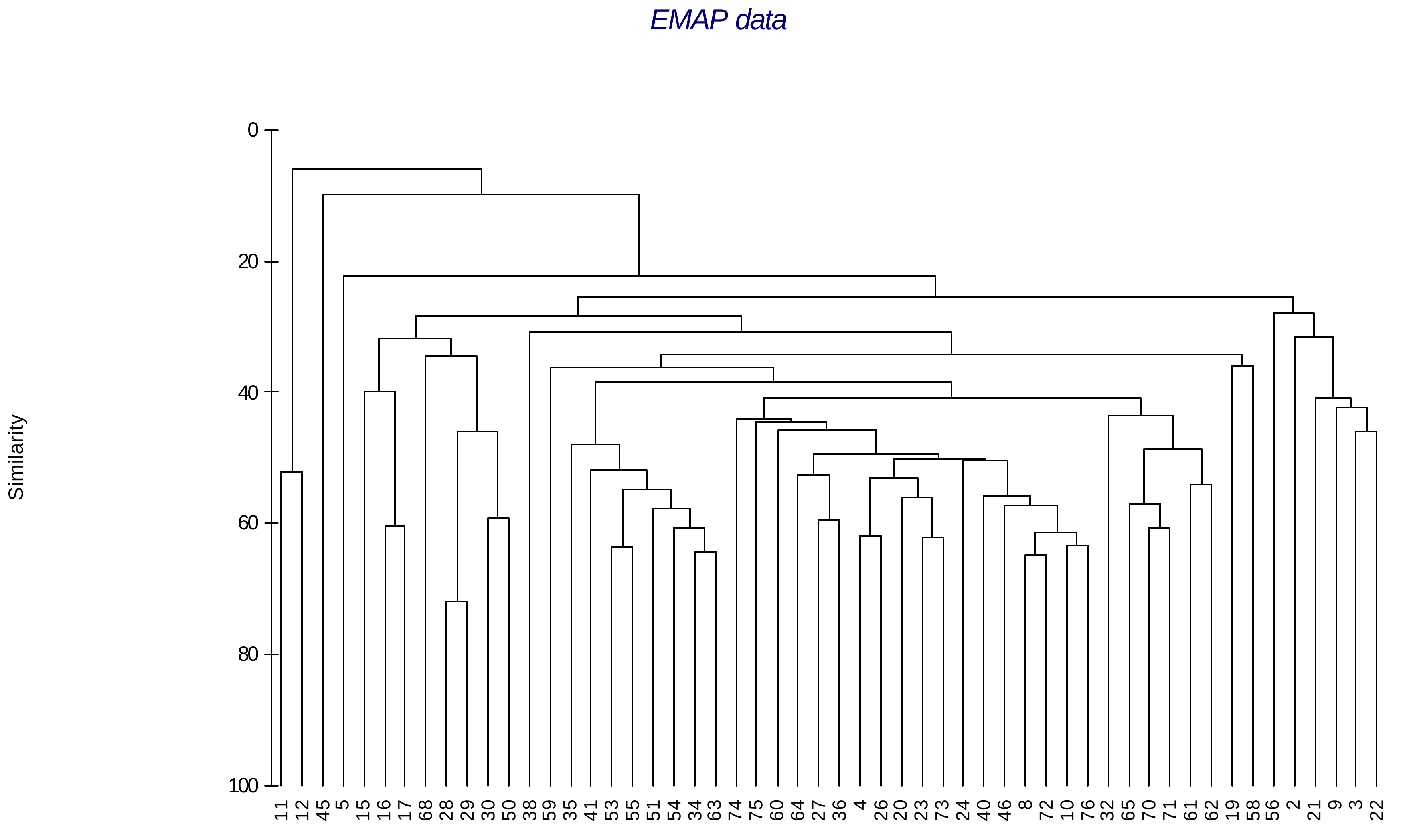
Selenium
ug/g dry wt
2
1.5
1
0.5
0
Tin
ug/g dry wt
1.2
1
0.8
0.6
0.4
0.2
0
Silver
ug/g dry wt
4
3
2
1
0
Zinc
ug/g dry wt
450
400
350
300
250
200
150
100
50
0

Ampelisca abdida 10-day static toxicity test



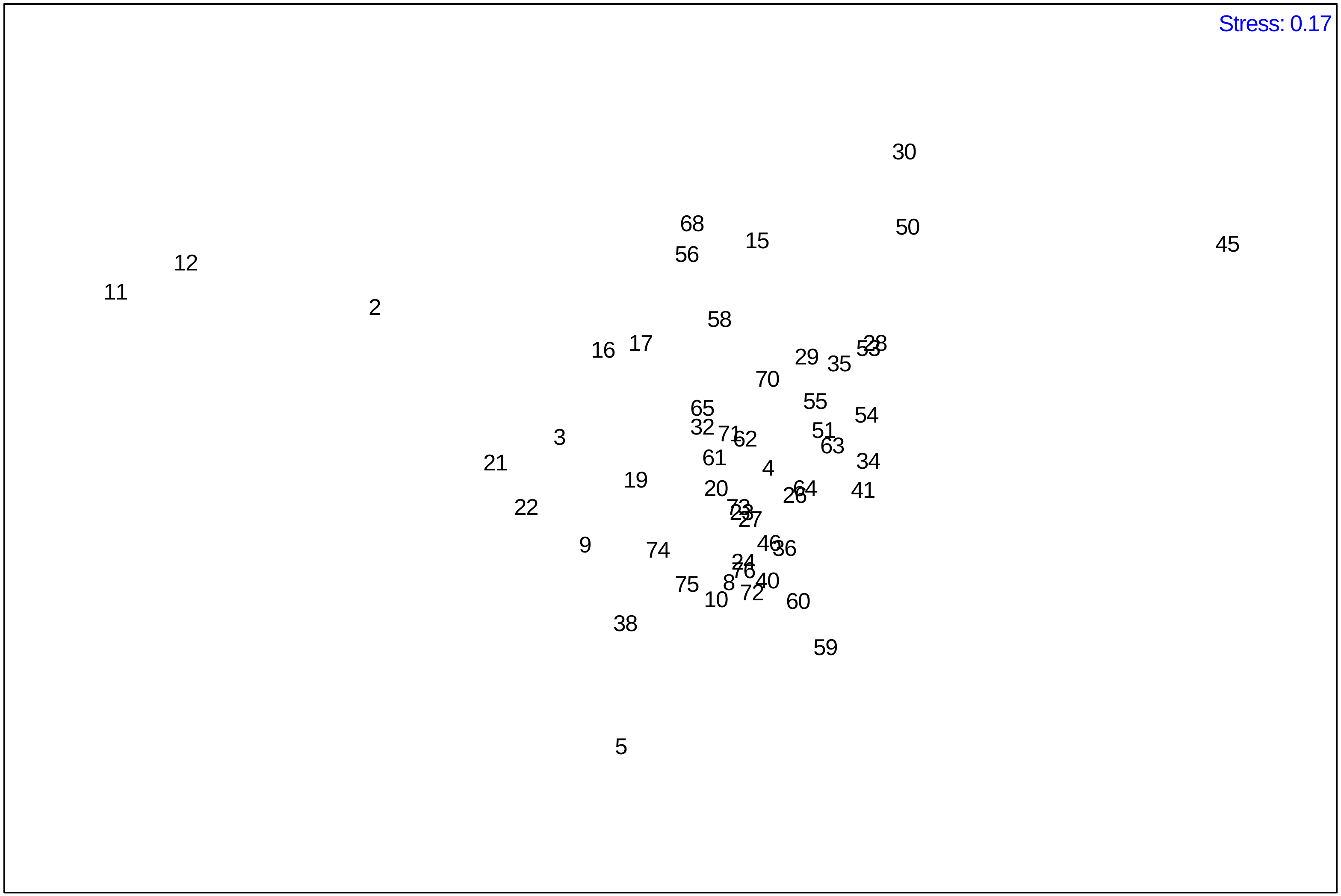
- Only two stations had amphipod survival that was statistically different than control sediments AND had control-corrected suvival less than 80%.
- Site AK02-0038 was a relatively shallow site (5m) and had significant amounts of decomposing eelgrass in the sample (6.34% TOC); Site AK02-0005 had highest concentrations of Cr and Ni in study area.


% Total Organic Carbon
0
1
2
3
4
5
6
7
% Fines (Silt + clay)
0
20
40
60
80
100



EMAP data
Similarity
0
20
40
60
80
100
11 12 45 5 15 16 17 68 28 29 30 50 38 59 35 41 53 55 51 54 34 63 74 75 60 64 27 36 4 26 20 23 73 24 40 46 8 72 10 76 32 65 70 71 61 62 19 58 56 2 21 9 3 22

EMAP data


Stress: 0.17
30
68
50
15
45
56
12
11
2
58
28
17
16
29
35
70
55
65
54
32
71
62
51
63
3
21
61
34
4
19
20
64
26
41
22
73
27
9
74
46
36
24
76
75
8
40
72
10
60
38
59
5

Number of Sites Where Fish Species Caught

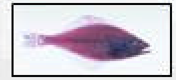
Arrowtooth flounder	34	Shortfin eelpout	8	Bering poacher	2
Flathead sole	32	Starry flounder	7	Masked greenling	2
Walleye pollock	26	Pacific tomcod	6	Red Irish lord	2
Rex sole	21	Sebastes spp., juvs.	5	Thorny sculpin	2
Pacific halibut	20	Snake prickleback	5	Giant wrymouth	2
Dover sole	19	Wattled eelpout	5	Daubed shanny	2
Eulachon	19	Bigmouth sculpin	5	Lingcod	2
Rock sole	19	Alaska plaice	4	Armourhead sculpin	2
Spinyhead sculpin	19	Pacific staghorn sculpin	4		
Pacific cod	19	Spiny dogfish	4		
Alaska skate	18	Blackfin sculpin	4		
Longnose skate	18	English sole	3		
Black cod (sablefish)	15	Longsnout prickleback	3		
Sturgeon poacher	12	Monster snailfish	3		
Yellowfin sole	12	Pacific sandfish	3		
Pacific ocean perch	12	Sand sole	3		
Yellow Irish lord	11	Showy snailfish	3		
Butter sole	9	Whitespotted greenling	3		
Great sculpin	9				

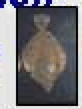
Occurred at only one site:
Blackfin eelpout, Blacktip poacher, Cottiidae, juvs., Dusky rockfish, Greenling, (unspecified), Kelp greenling Longnose eelpout, Plain sculpin, Rock greenling, Roughback sculpin, Searcher, Slender eelblenny, Smooth lumpsucker, Sockeye salmon (smolt), Spinycheedk starsnout, Threaded sculpin Variegated snailfish, Yelloweye rockfrish Wolf-eel

Red species were original priority target species based on historical NMFS data on geographic range and abundance

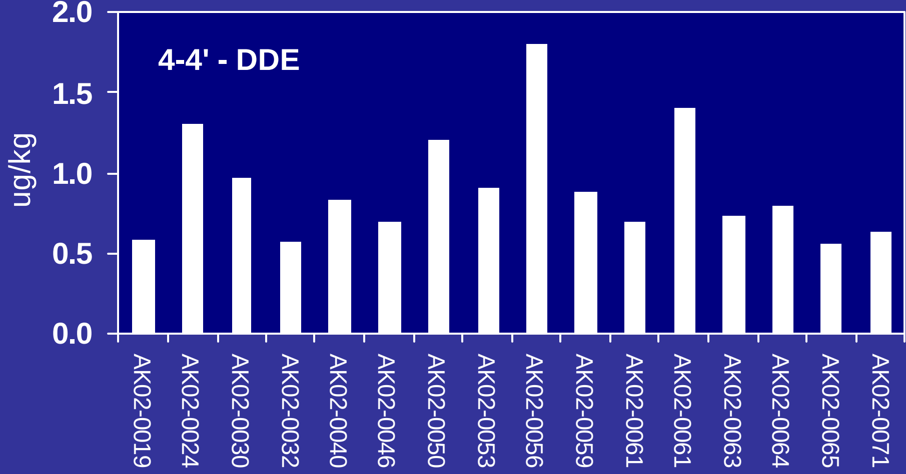
Fish Samples for Tissue Chemistry Analyses

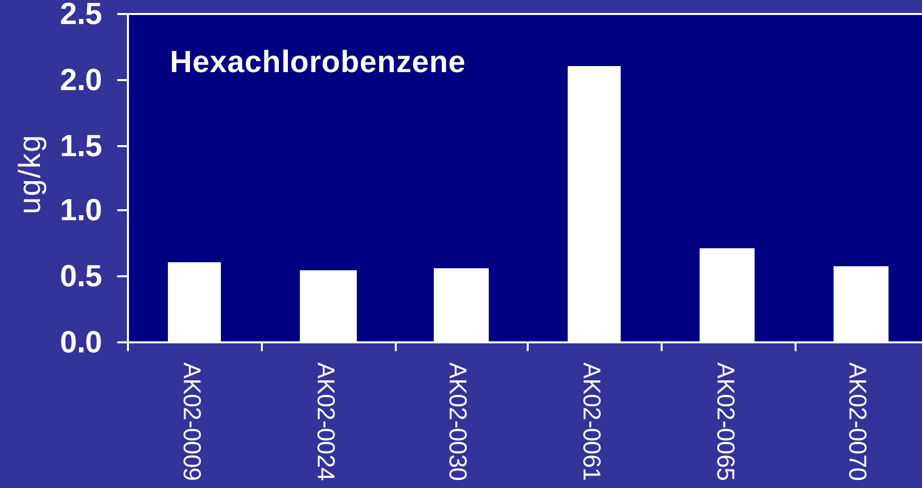
Arrowtooth flounder	*Atheresthes stomias*	28
Yellowfin Sole	*Limanda aspera*	8
Flathead sole	*Hippoglossoides elassodon*	24
Rock Sole	*Pleuronectes bilineatus*	11
Pacific Tom Cod	*Microgadus proximus*	3
Pacific Cod	*Gadus macrocephalus*	2
Starry Flounder	*Platichthys stellatus*	2
Walleye pollock	*Theragra chalcogramma*	3
Butter Sole	*Isopsetta isolepis*	2
Rex sole	*Glyptocephalus zachirus*	7
Pacific halibut	*Hippoglossus stenolepis*	1
Dover sole	*Microstomus pacificus*	2
Eulachon	*Thaleillchthys pacificus*	2
Pacific Sandfish	*Trichodon trichodon*	1

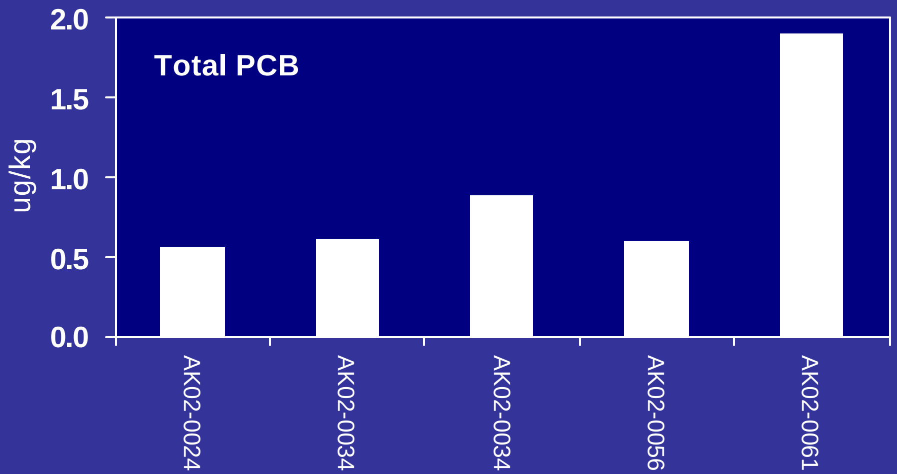


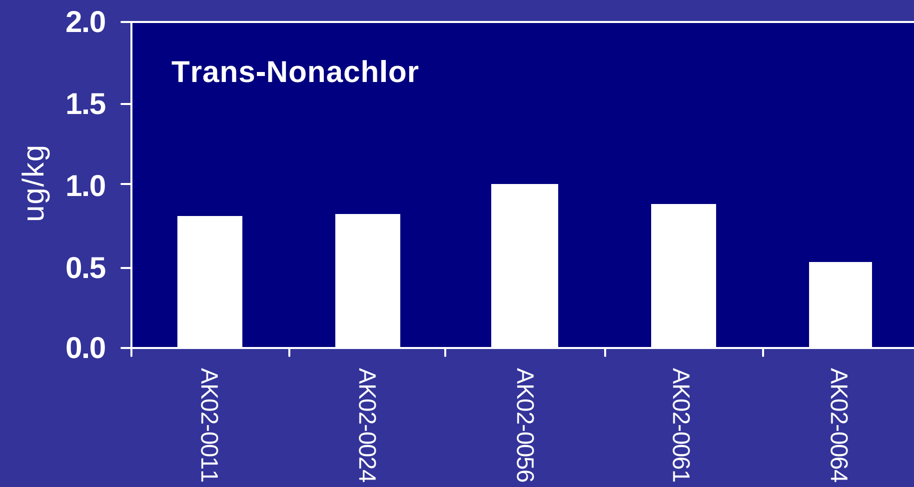




Initial analyses for one species per site; oversampled in the field and later raised funds to analyze archived fish tissue samples



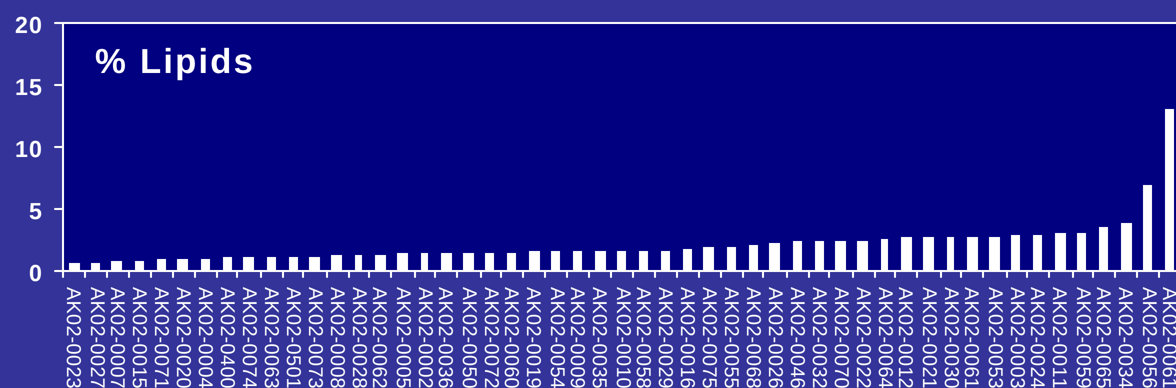






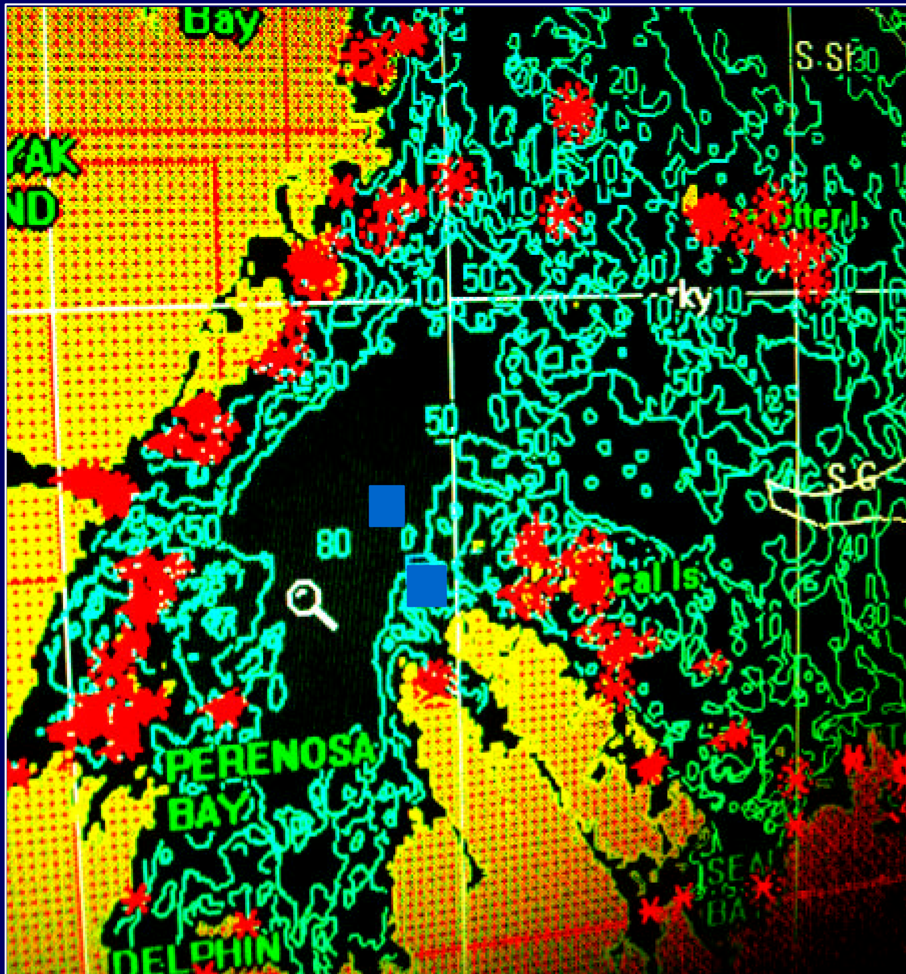
POP detects

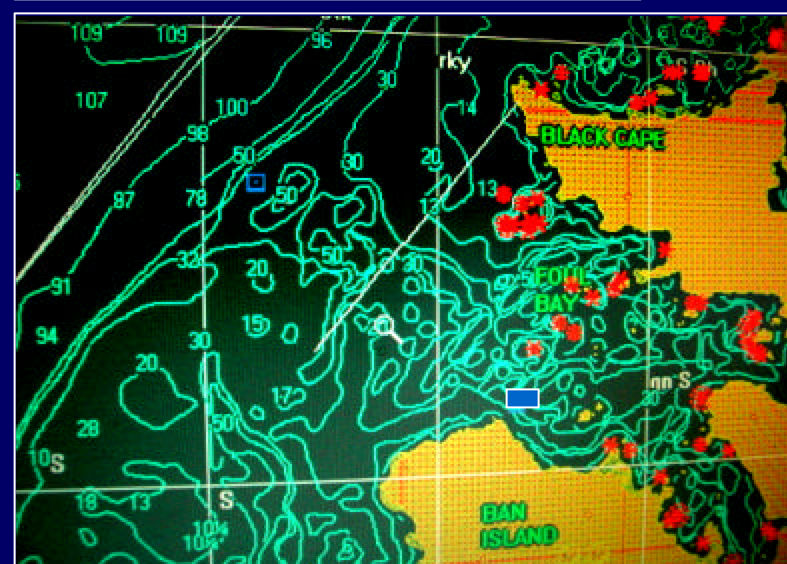
Fish Tissue



Deviations from EMAP protocols

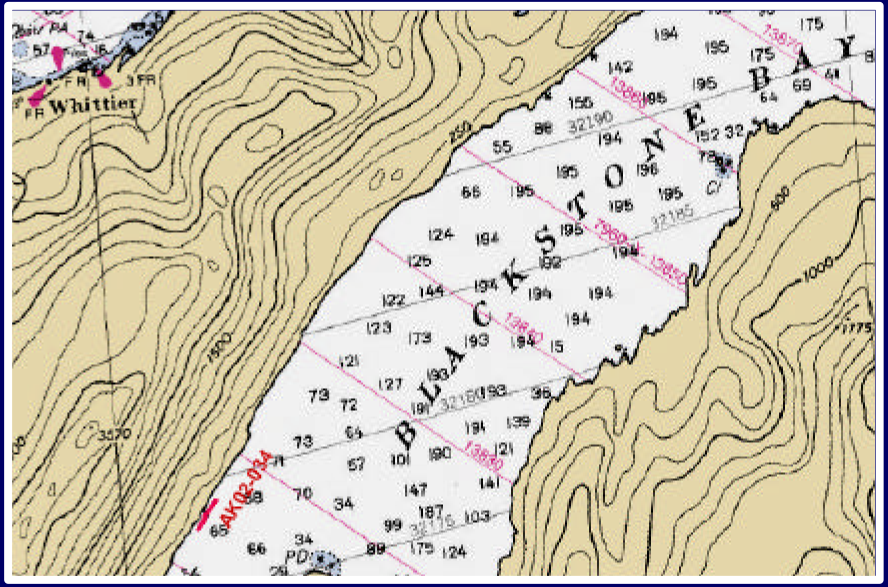
- No PAR sensor
- pH for discrete water samples; no profile
- Trawl times reduced
- Two different trawl sizes (deep and shallow stations)
- Shipping/storing times - logistical limitations
- Numerous sites sampled outside of EMAP protocols for distance away from “target” location

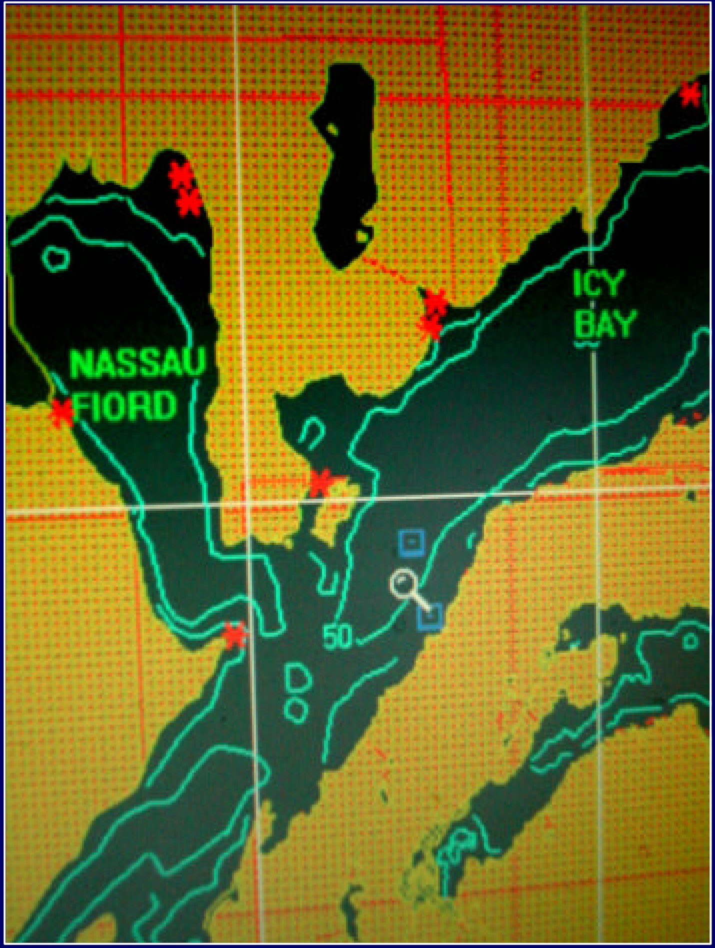


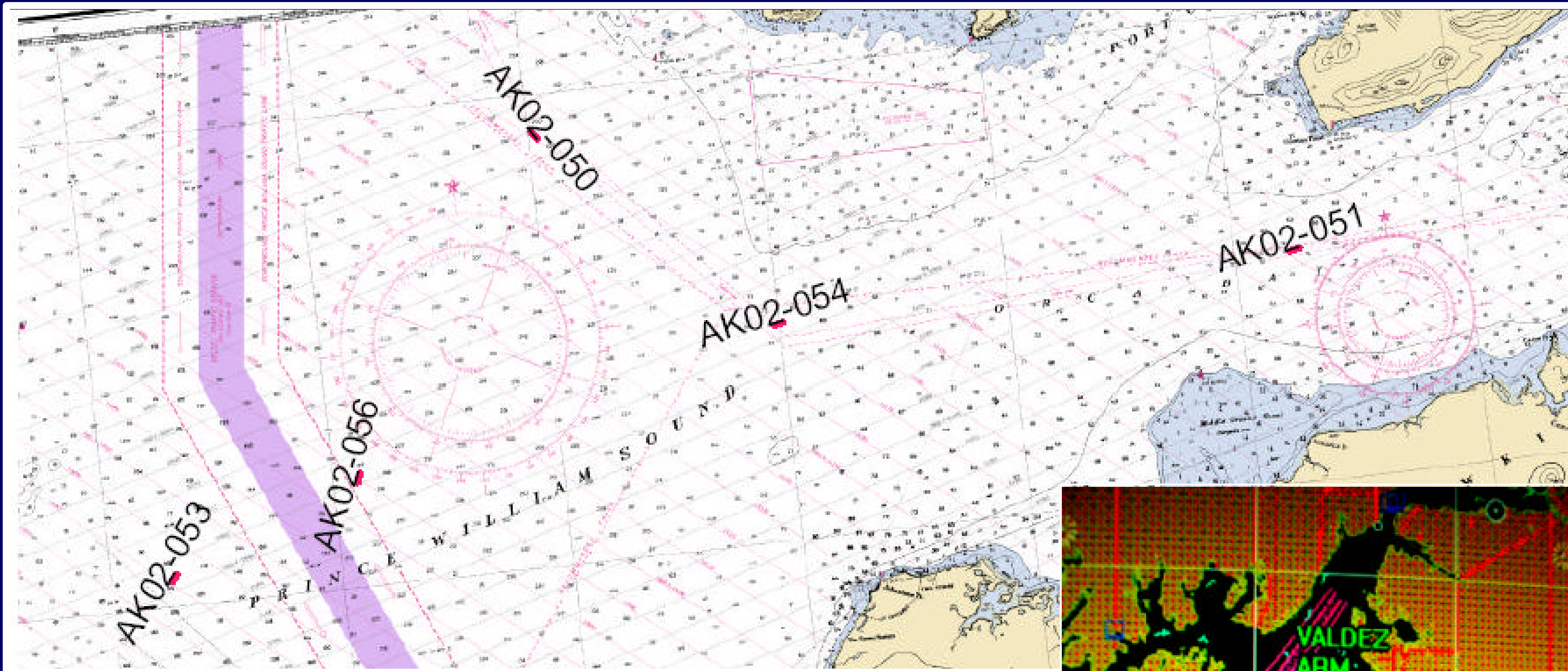


Substrate/ rocky or uneven

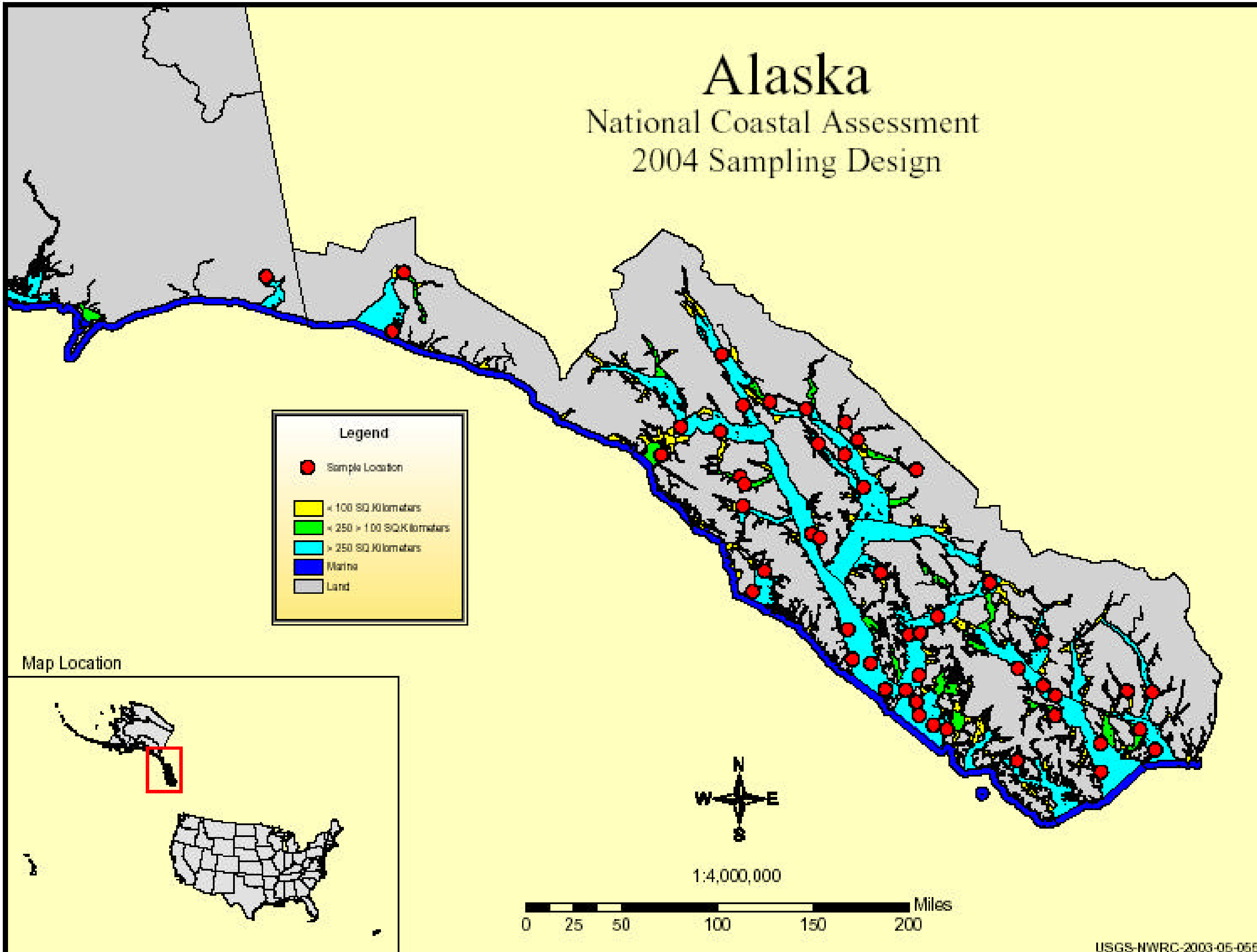
Bathymetry (Steep)







Interferences


Alaska
National Coastal Assessment
2004 Sampling Design
Legend
Sample Location
< 100 SQ.Kilometers
< 250 > 100 SQ.Kilometers
> 250 SQ.Kilometers
Marine
Land
Map Location
N
W
E
S
1:4,000,000
Miles
0
25
50
100
150
200
USGS-NWRC-2003-05-055

EPA

COOK INLET RCAC

Alaska Department of Environmental Conservation

ADEC - Cruise Ship Program

NMFS-Auke Bay Lab

R/V Ocean Cape

University of Alaska

National Marine Fisheries Service-NWFSC/RACE

Alaska Dept. Fish and Game (NIS)

EPA Contract Laboratories

International Pacific Halibut Commission

Alaskan Provinces

- Columbian (Southeast Alaska)
- Alaskan (Southcentral Alaska)
- Aleutian (Aleutian Chain)
- Bering (Western Alaska)
- Arctic (North Slope)


OCEAN CAPE
15
14
13