Data Analyses and Modeling to Understand the Effects of Hydrodynamics on Delta Smelt Distributions and Abundance

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U.S. Geological Survey, retired
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Collaborators:

Salvage/ Flows	*Modeling*	*GIS*
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C. Ruhl, USGS	*H. Wong, USBR*	
IEP Biologists		

IEP Physical Modeling and Fish Management Workshop
Wednesday May 27, 2009

Acknowledgements

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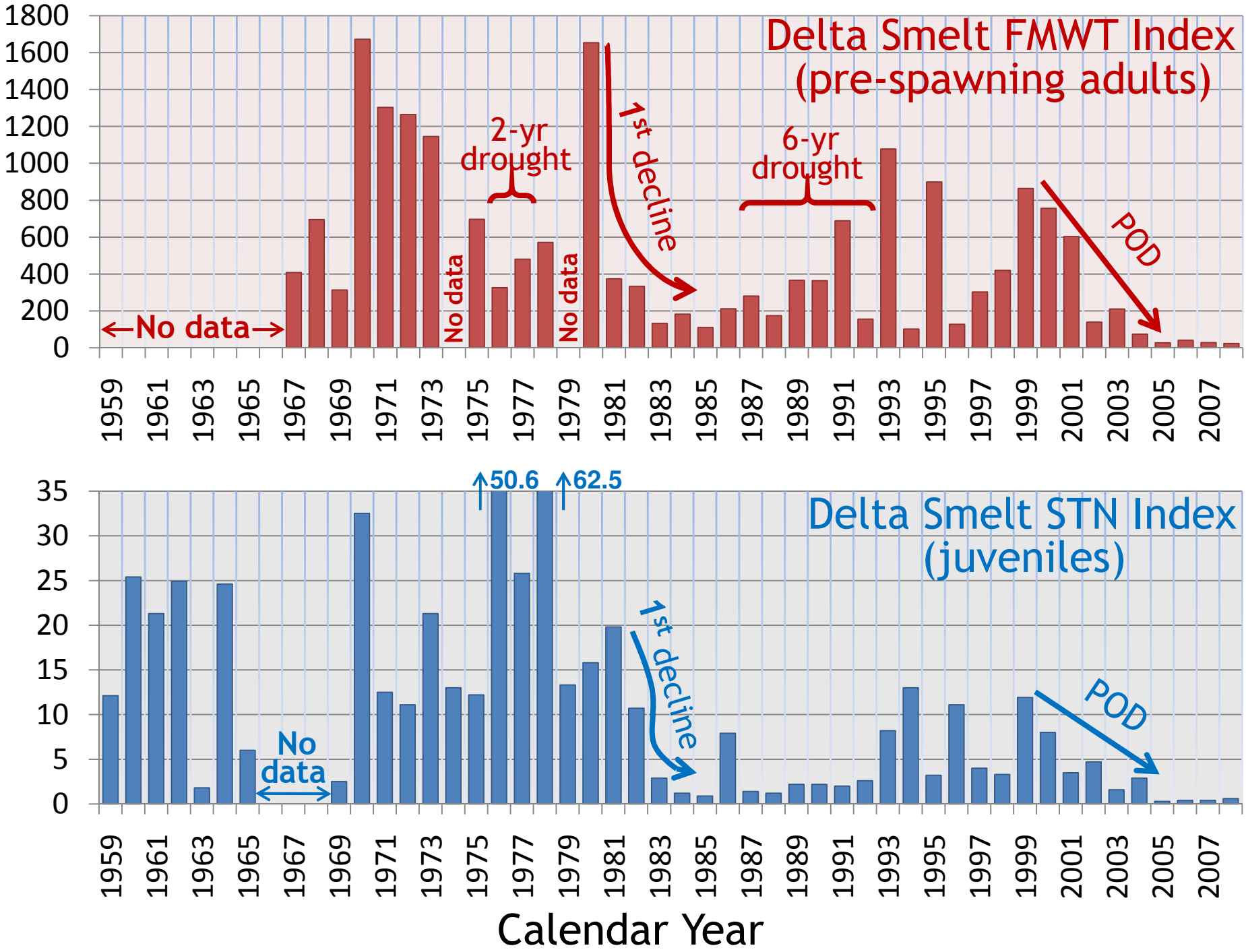
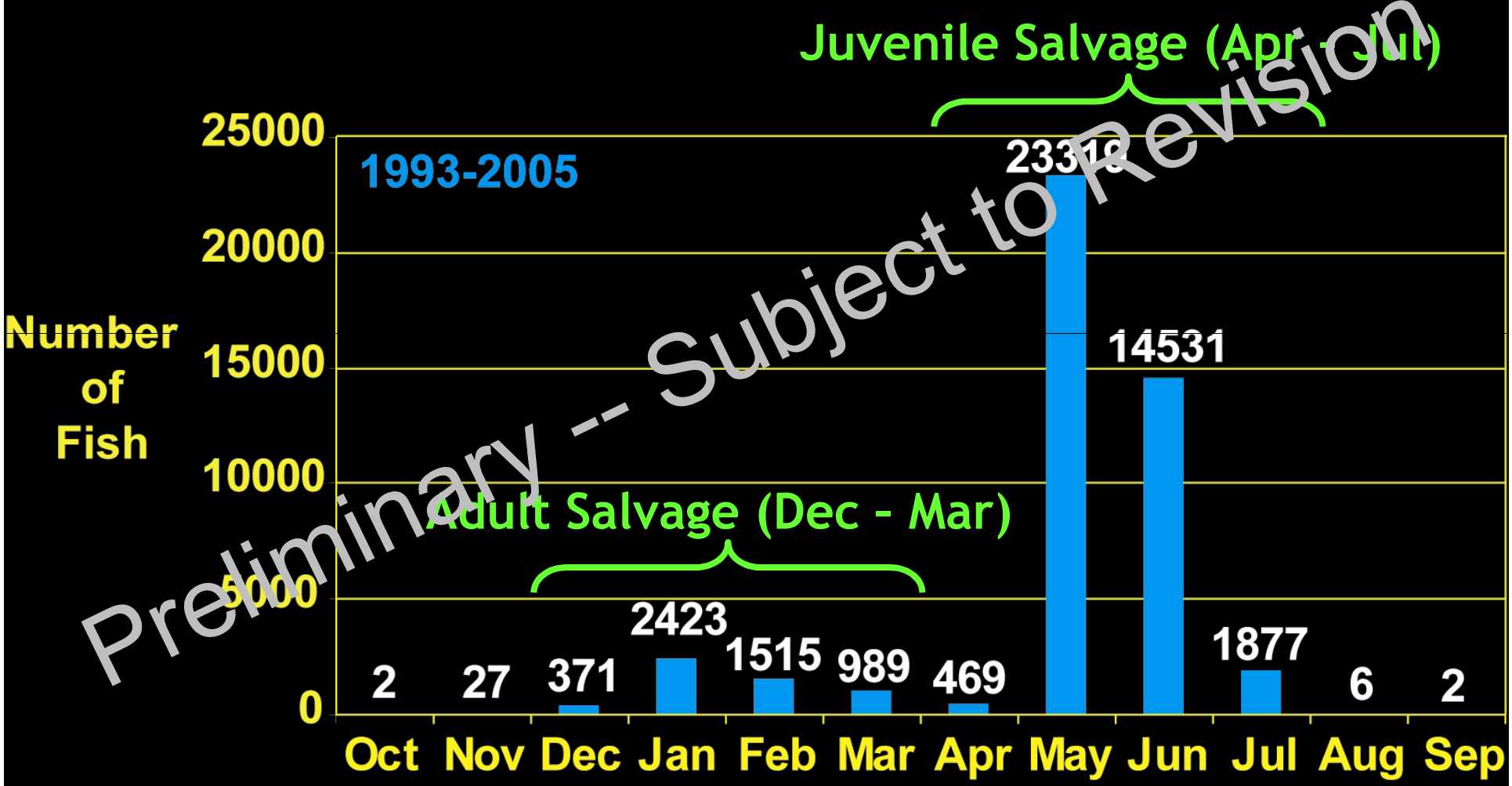
- Reclamation's Planning Division (MP-700), Erika Kegel, Sharon McHale, and Michael Tansey
- DWR's Bay Delta Office, Delta Conveyance Branch, Don Kurosaka
- Reclamation's Environmental Affairs Division (MP-150), Erwin Van Nieuwenhuyse, Ken Lentz

Outline

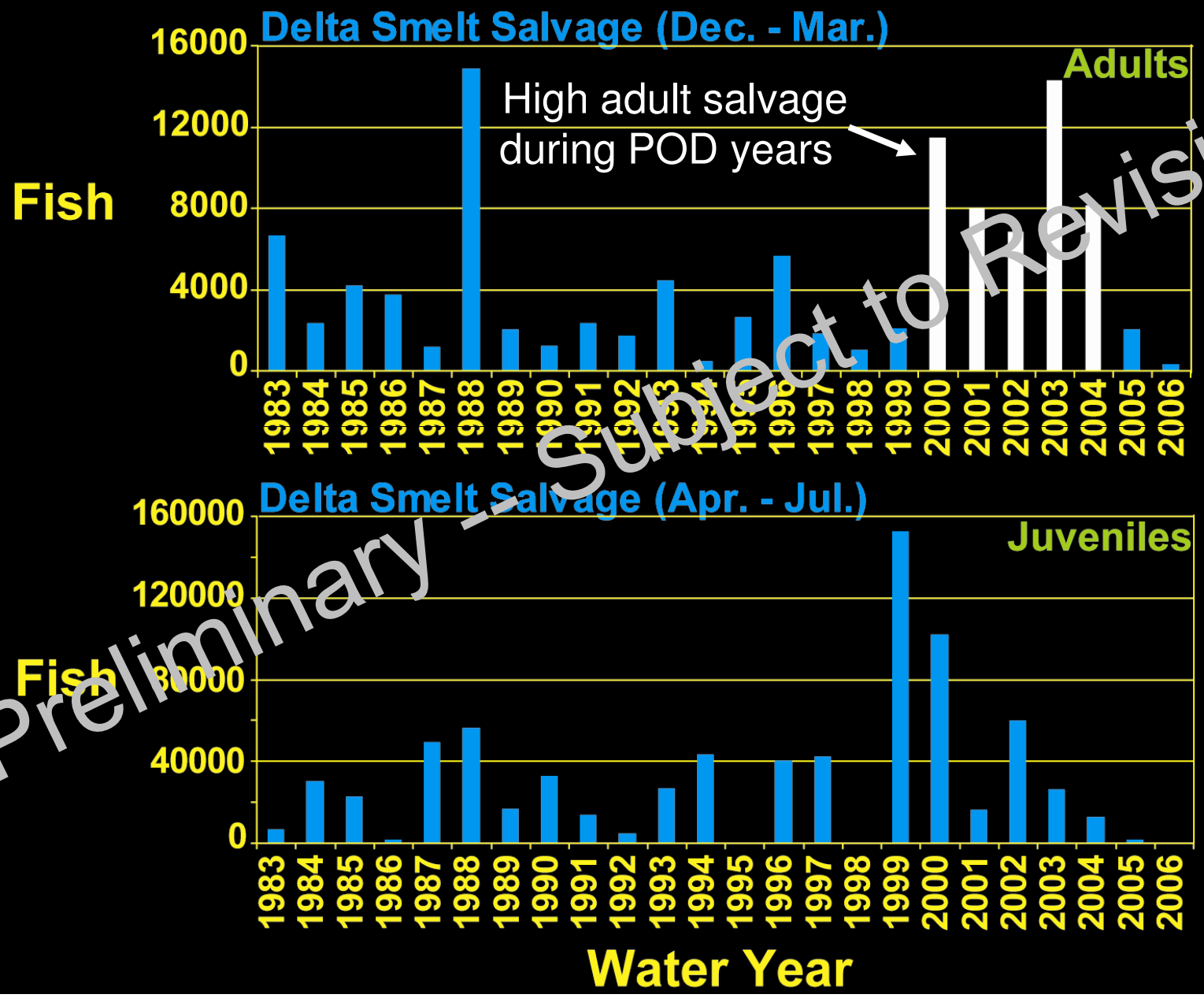
- Trends in delta smelt abundance indices
- Analyses of long-term Jersey Point EC data and fall hydrology
- Delta smelt and turbidity distributions during fall
- Retrospective analysis of wy1981 and the first decline in the delta smelt population
- Delta smelt and turbidity distributions in winter
- Retrospective analysis on wy2002 (a POD year) and modeling of winter entrainment


Delta Smelt FMWT Index
(pre-spawning adults)
1800
1600
1400
1200
1000
800
600
400
200
0
←No data→
No data
No data
2-yr drought
6-yr drought
1st decline
POD
Delta Smelt STN Index
(juveniles)
35
30
25
20
15
10
5
0
50.6
62.5
No data
1st decline
POD
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
Calendar Year

Average Delta Smelt Salvage by Month

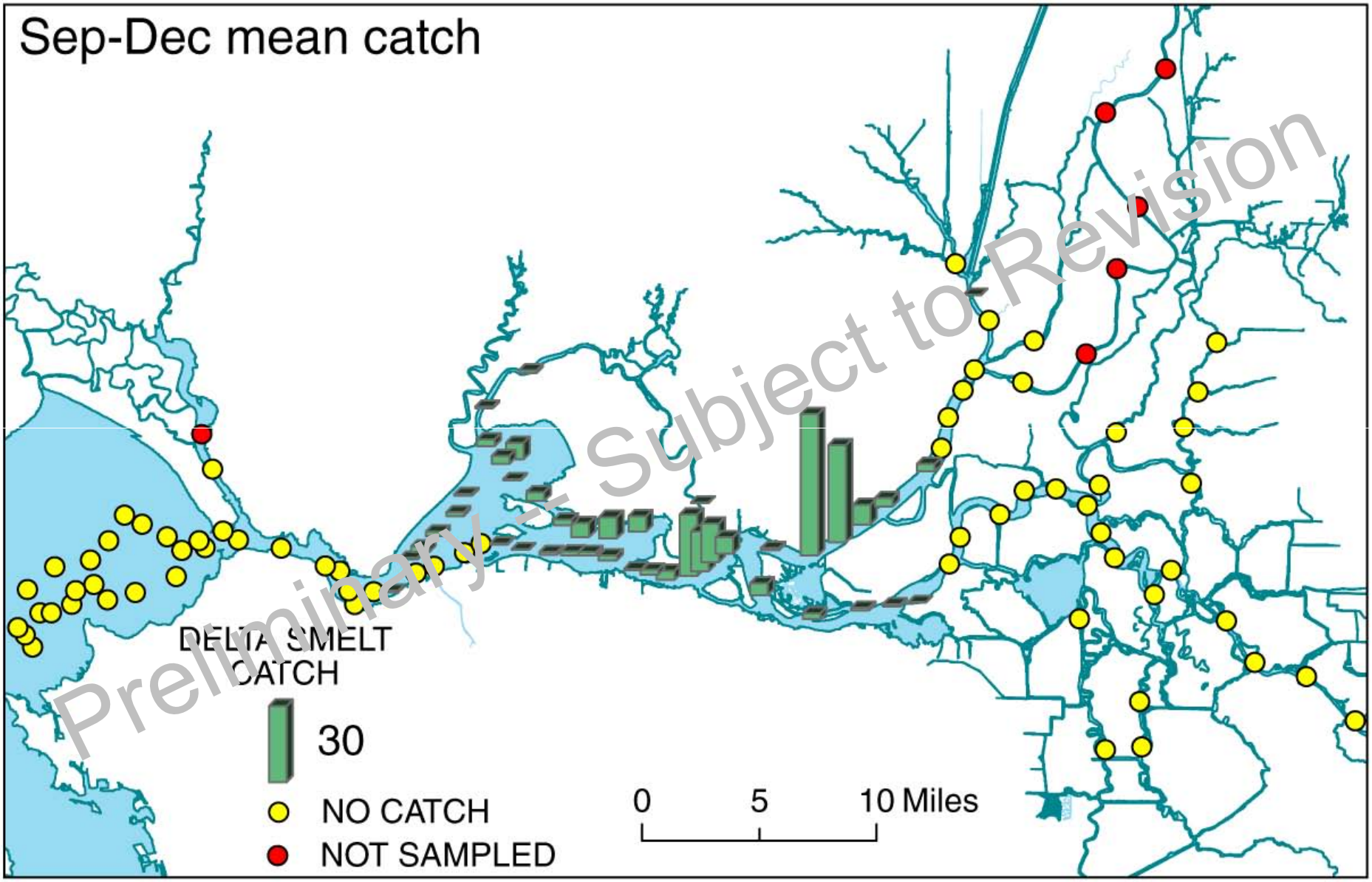


24-Year Trends in Delta Smelt Salvage

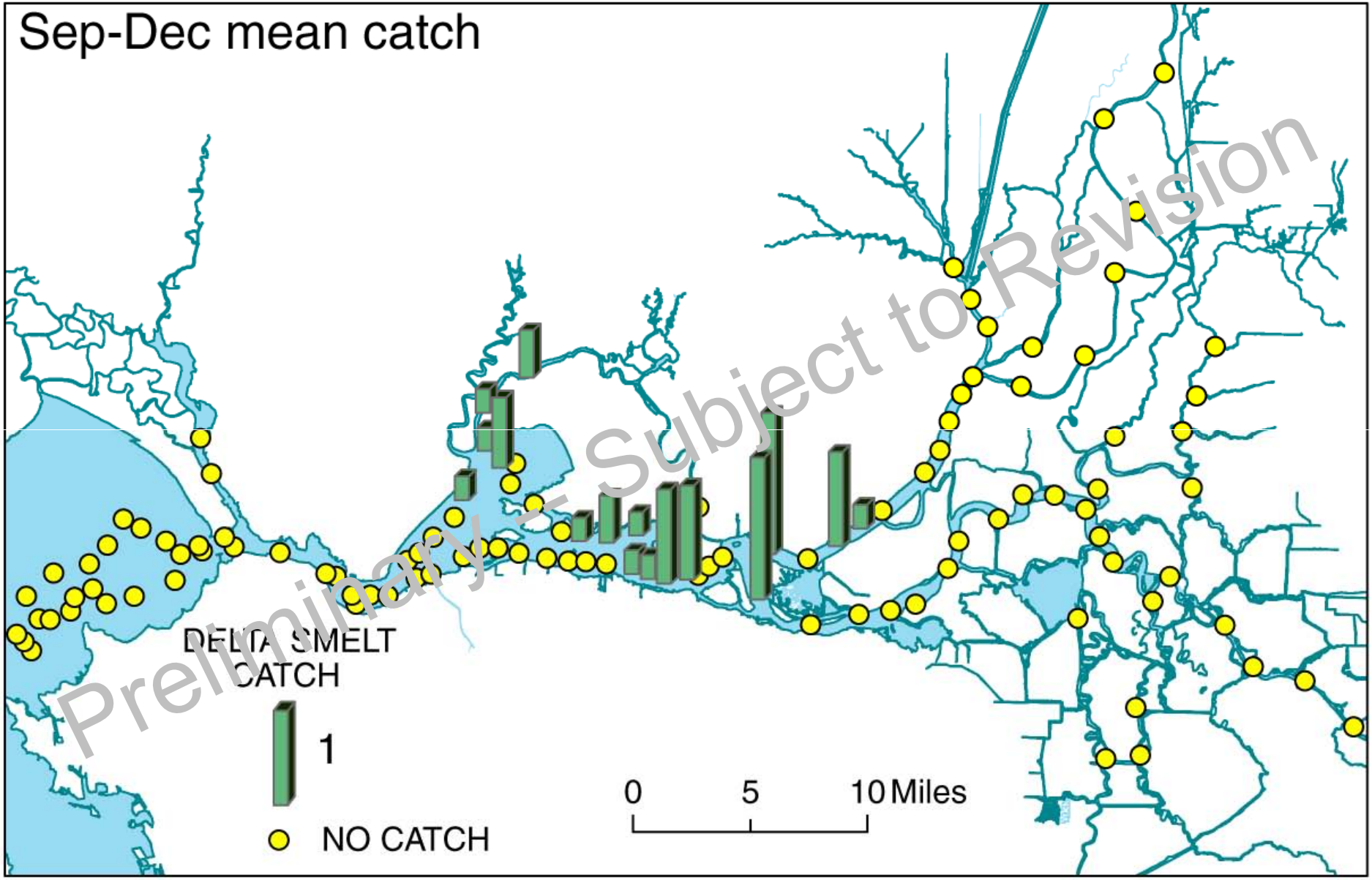


Preliminary - Subject to Revision

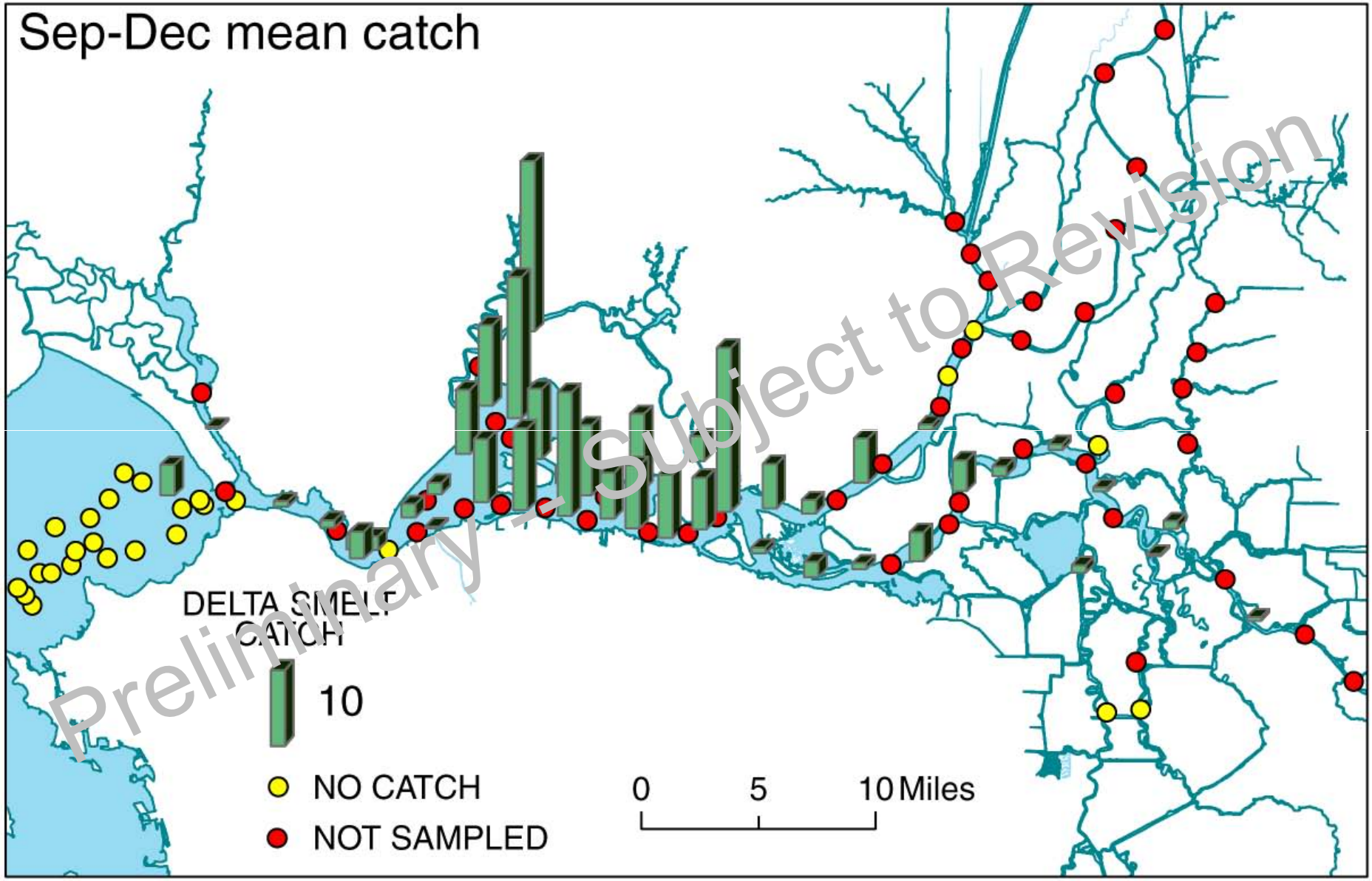
1993 Fall Mid-Water Trawl



2006 Fall Mid-Water Trawl

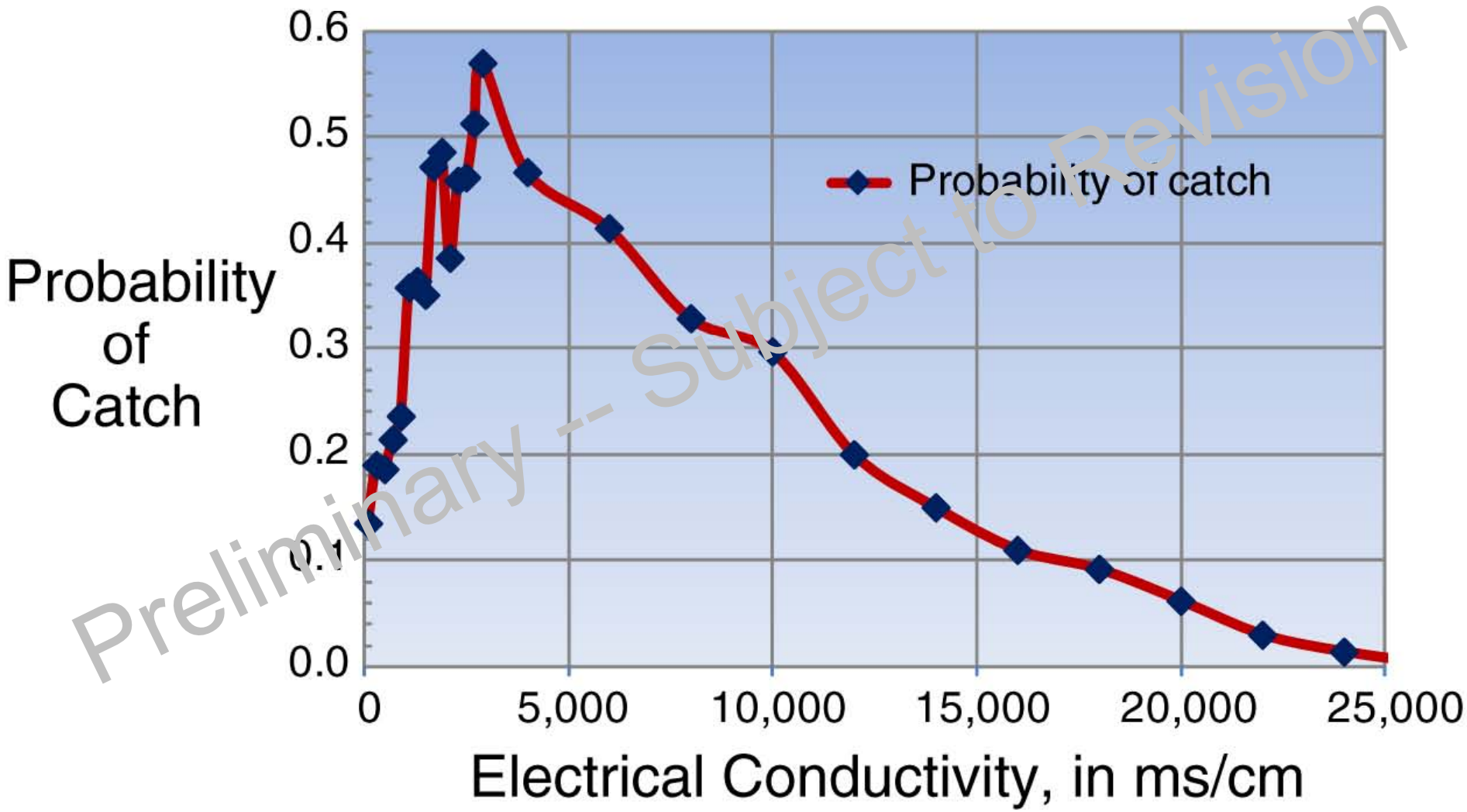


1970 Fall Mid-Water Trawl



Preliminary - Subject to Revision

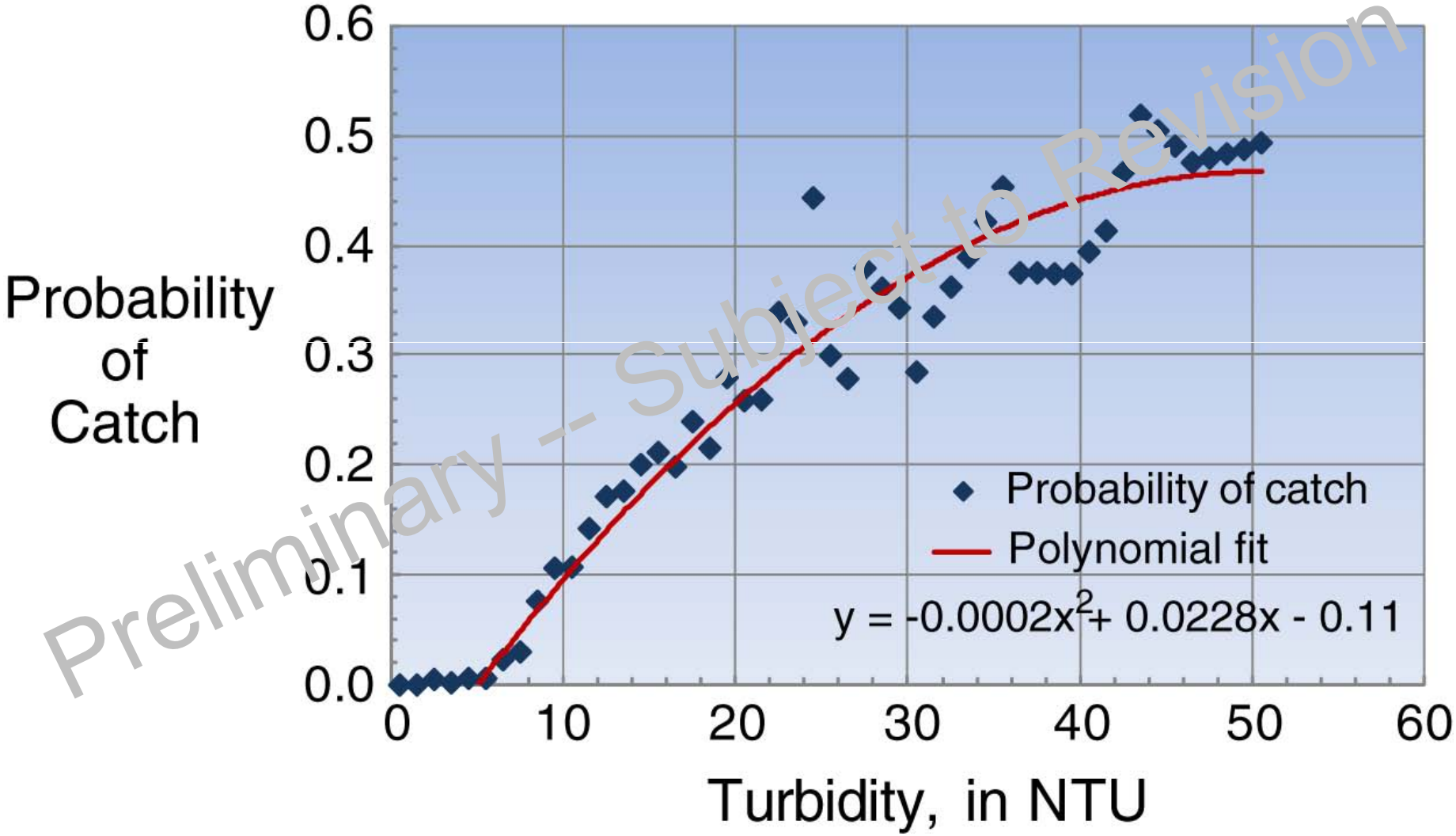
Probability of Catching Delta Smelt in a FMWT Sample versus EC



Preliminary -- Subject to Revision

Note: The "jog" in the curve at EC=2,000 may be a simple artifact from a change in the averaging interval for the data applied at that point.

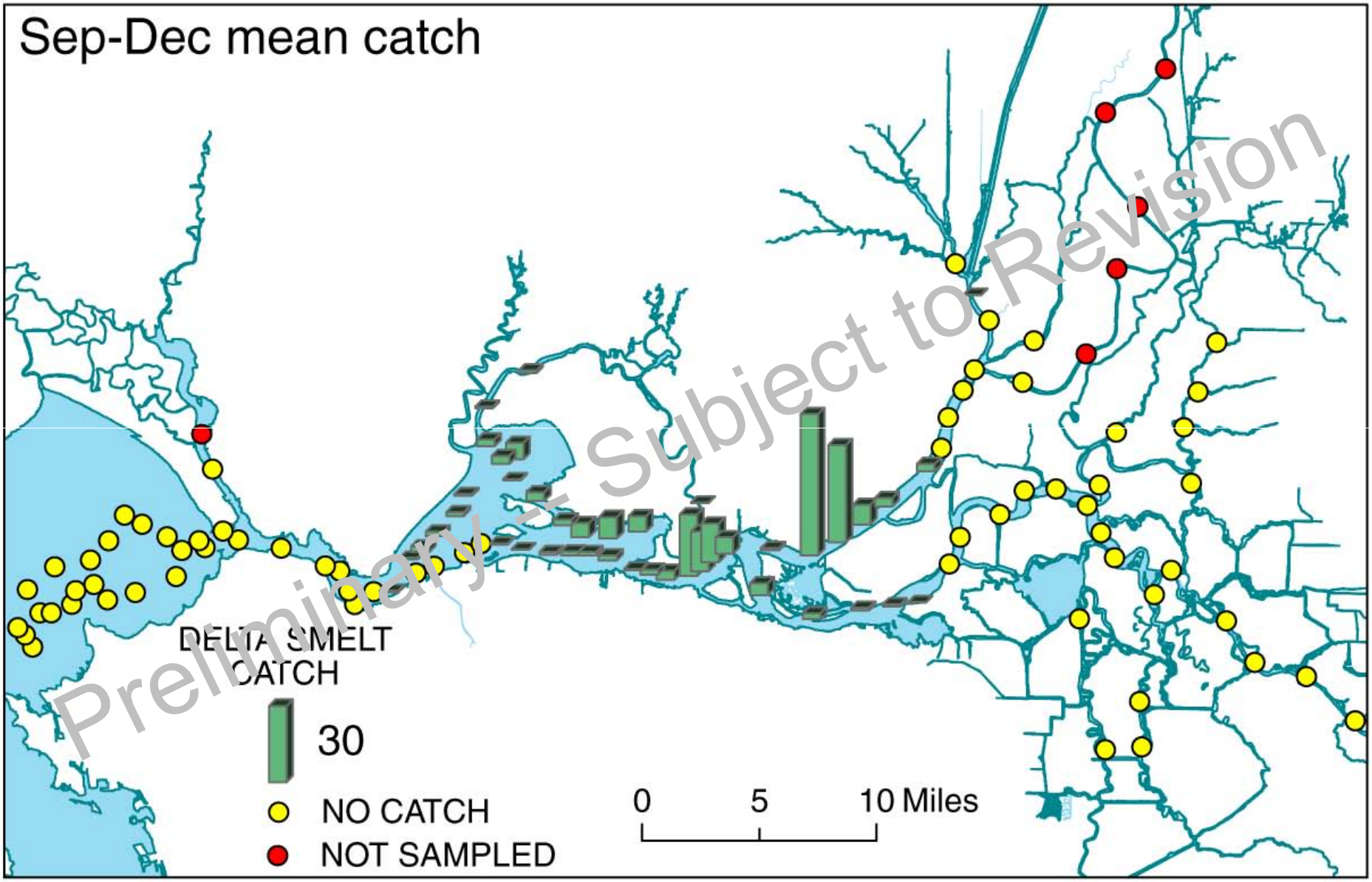
Probability of Catching Delta Smelt in a FMWT Sample versus Turbidity



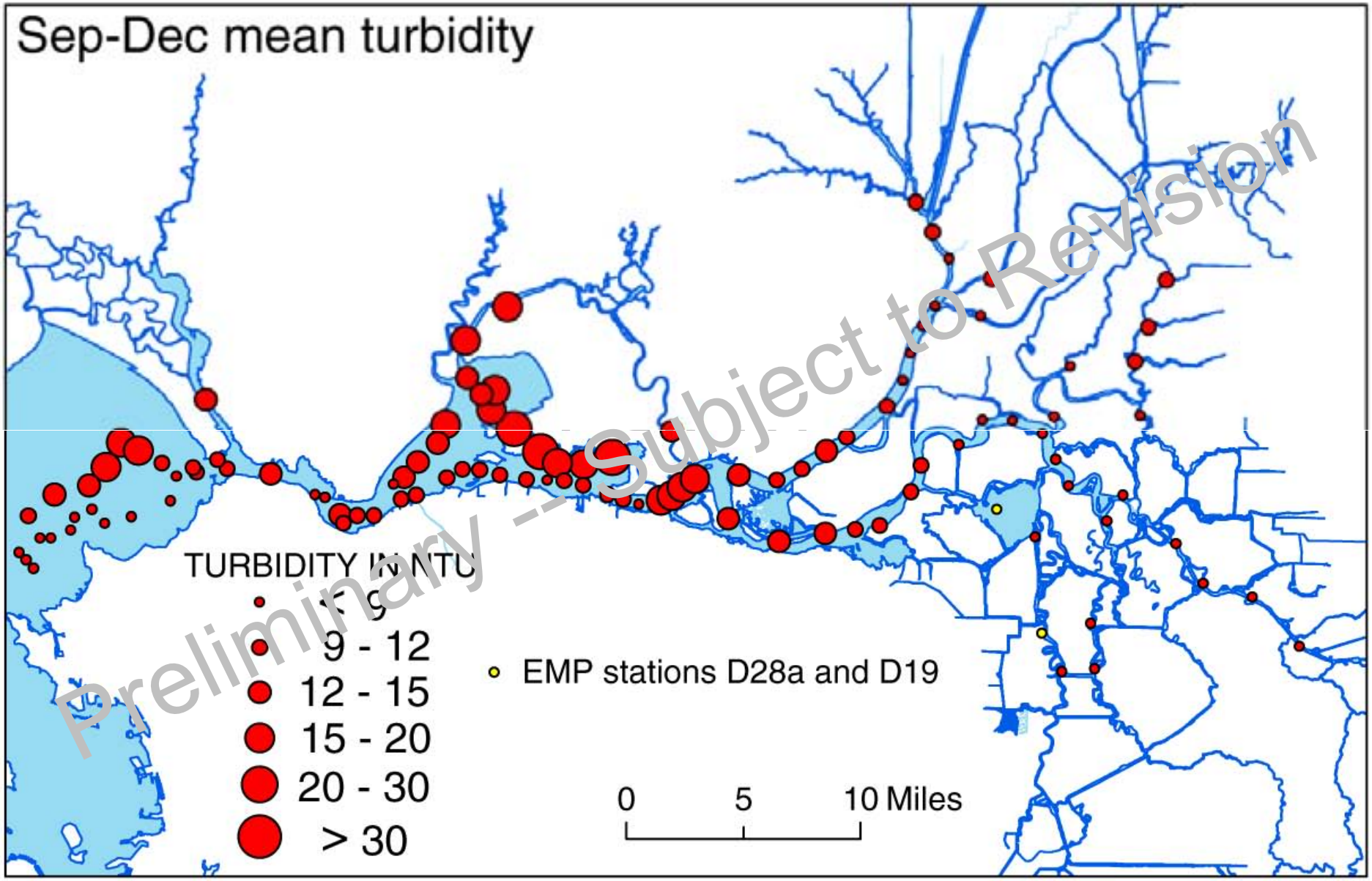
Preliminary -- Subject to Revision

Note: The turbidity values were obtained from secchi depth readings converted to turbidity by a nonlinear regression equation derived from DWR EMP data collected at Chipps island from 1986-1999. This conversion should be considered as approximate.

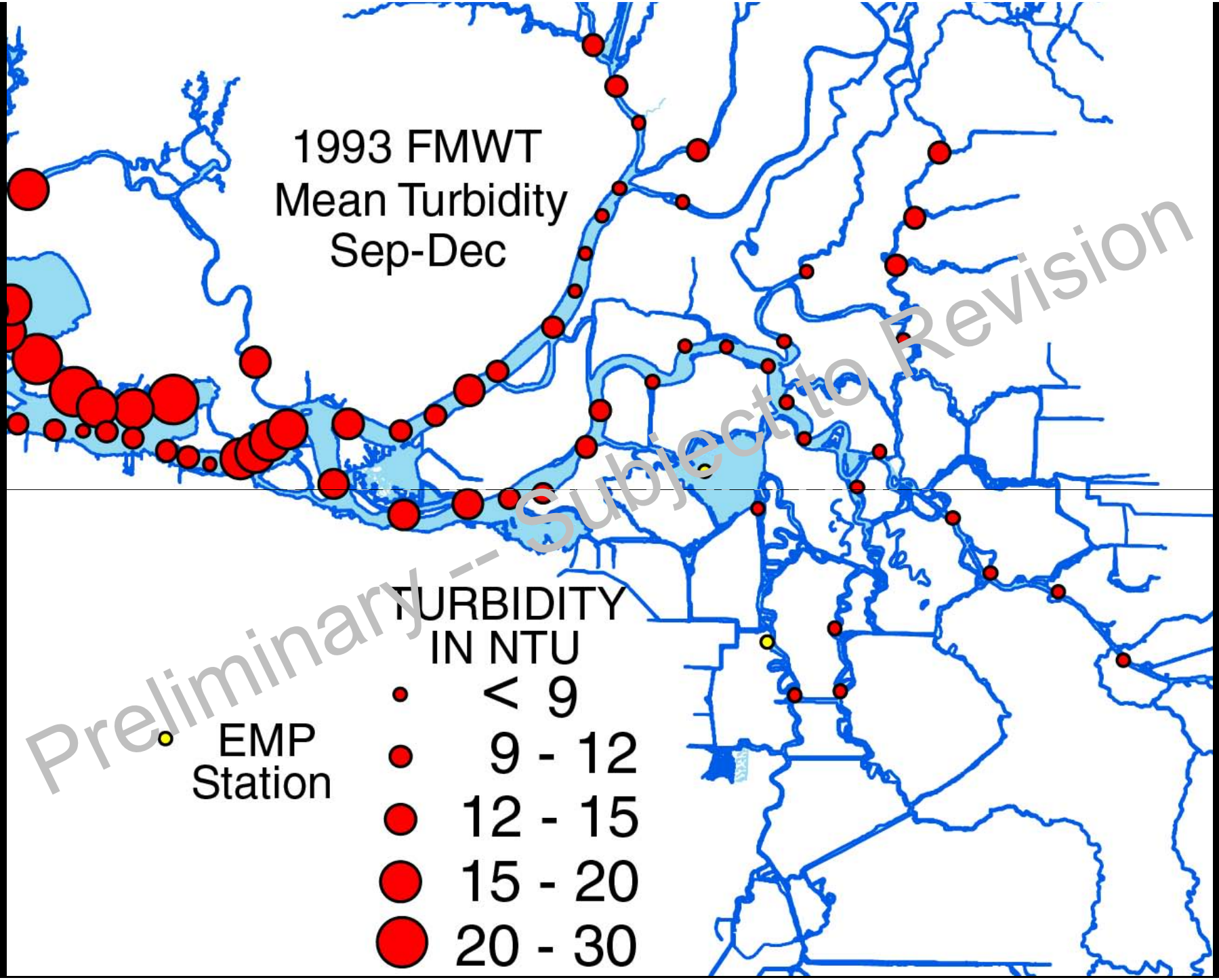
1993 Fall Mid-Water Trawl



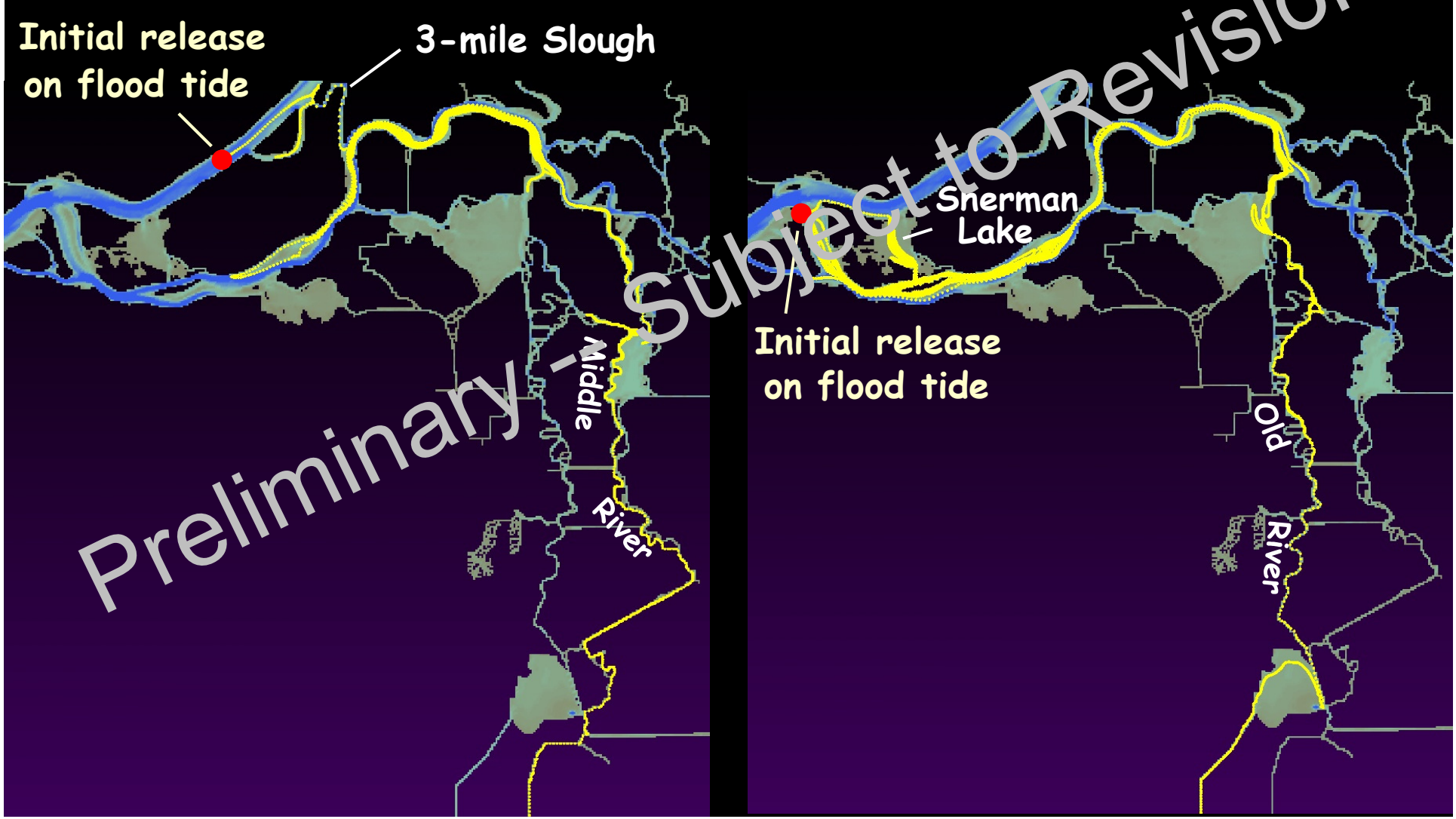
1993 Fall Mid-Water Trawl



Notes: Did not include 11/16/93 data
Did not include 9/14/93 data at station 912


1993 FMWT
Mean Turbidity
Sep-Dec
TURBIDITY
IN NTU
< 9
9 - 12
12 - 15
15 - 20
20 - 30
EMP
Station
Preliminary -- Subject to Revision

Example 3D particle tracks in the west Delta during Fall 1999 illustrating transport to the pumps is possible



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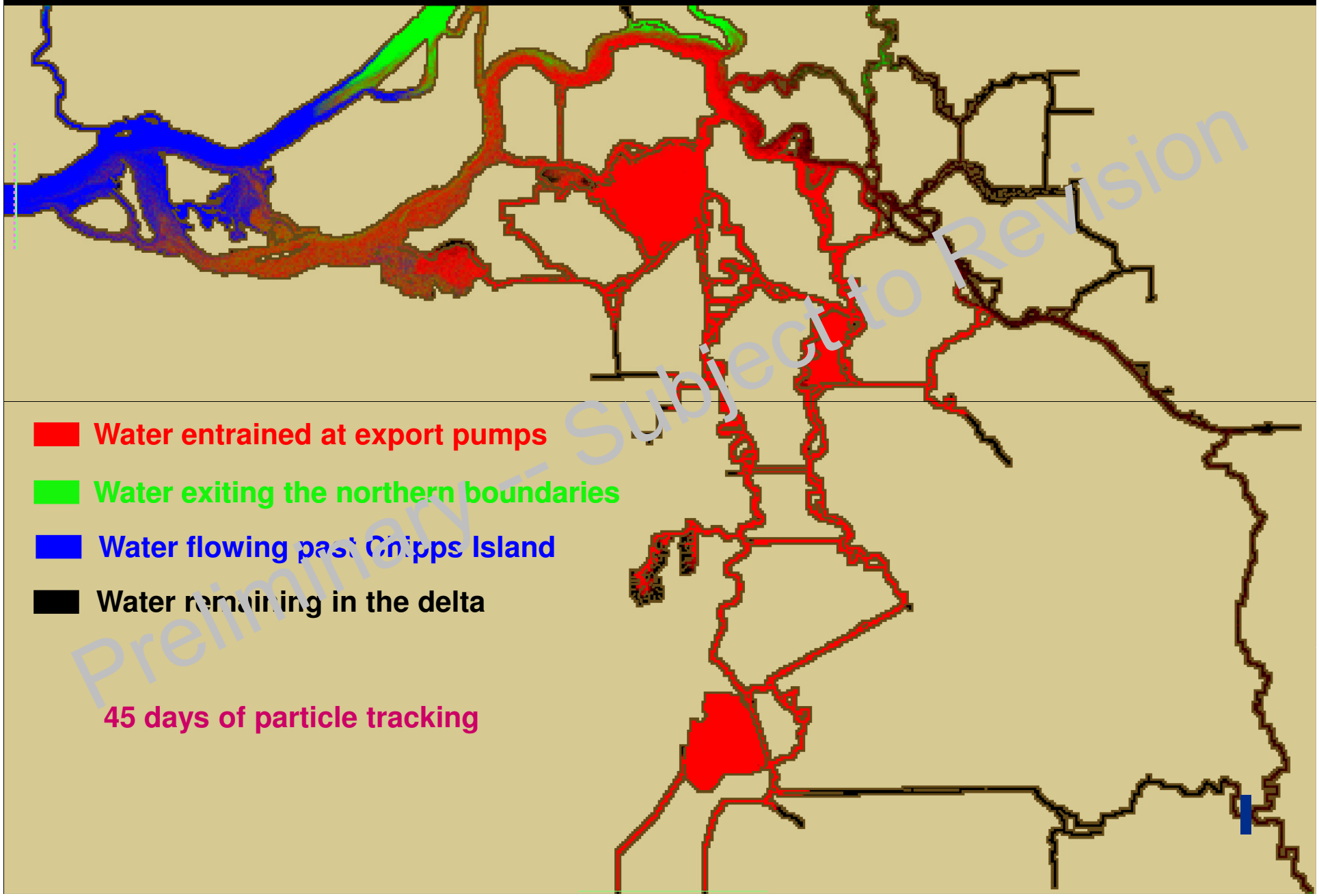
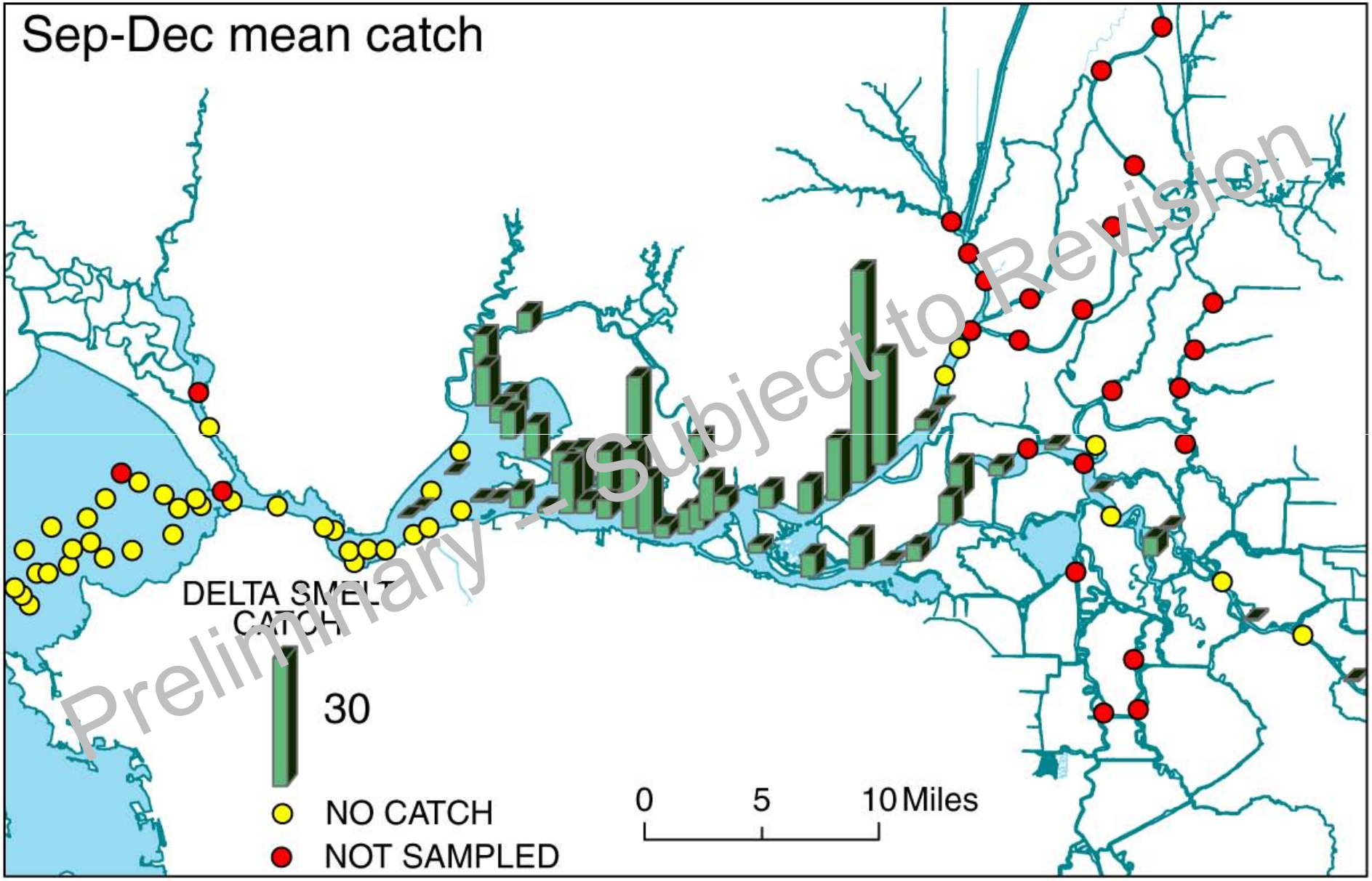
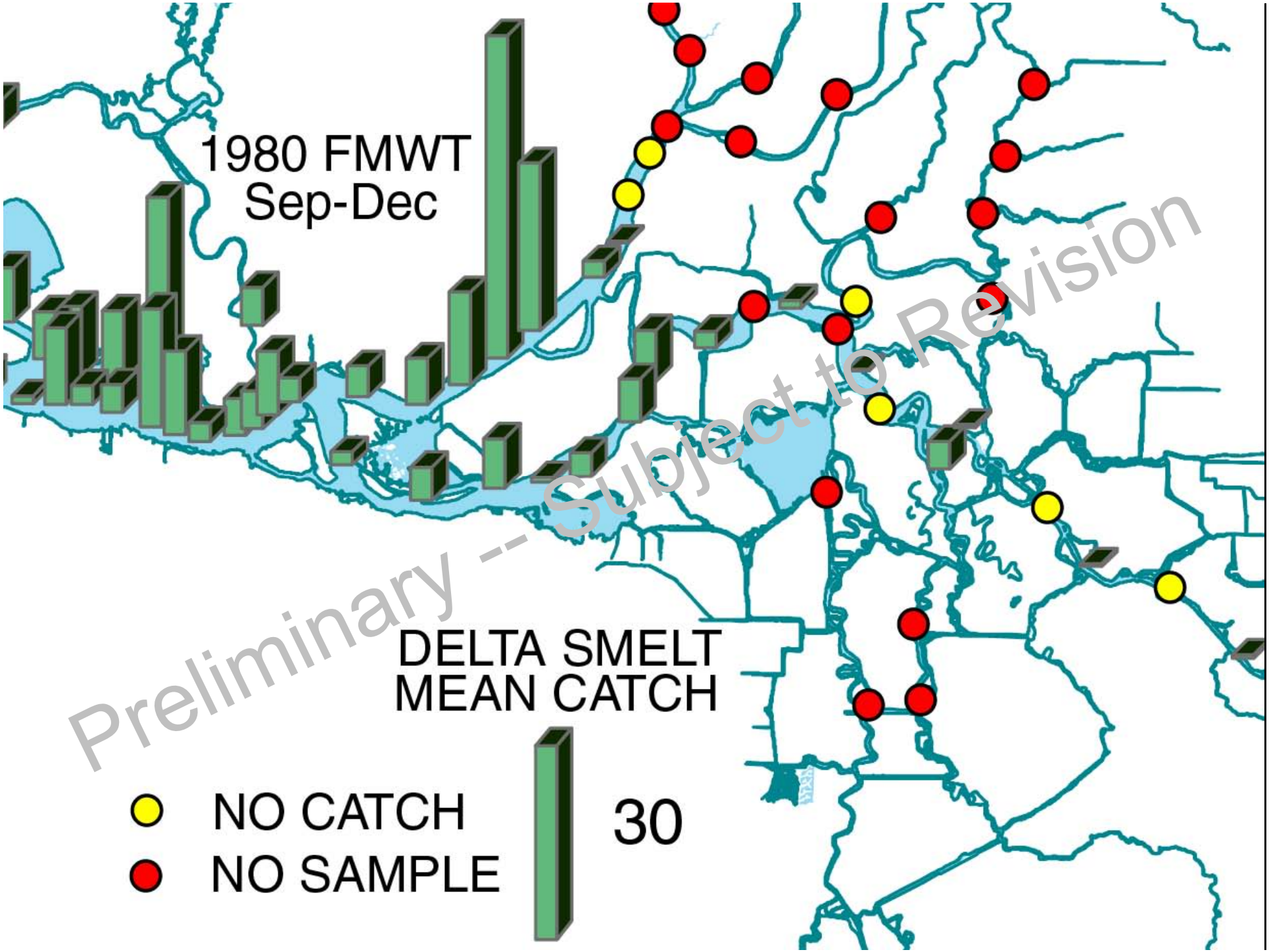
Zone of Entrainment - Aug 15, 1999

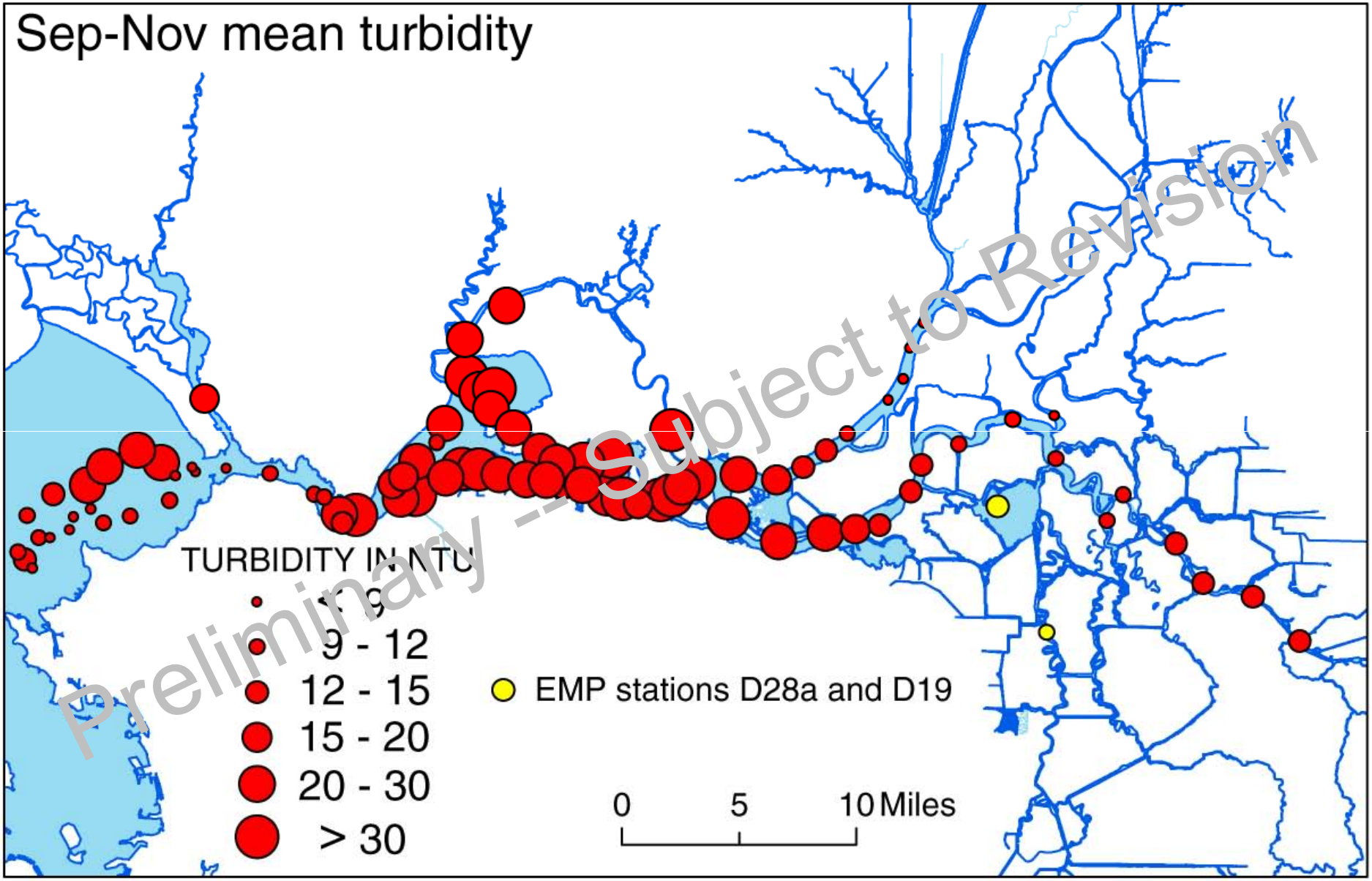


1980 Fall Mid-Water Trawl




1980 FMWT
Sep-Dec
DELTA SMELT
MEAN CATCH
NO CATCH
NO SAMPLE
30
Preliminary -- Subject to Revision

1980 Fall Mid-Water Trawl



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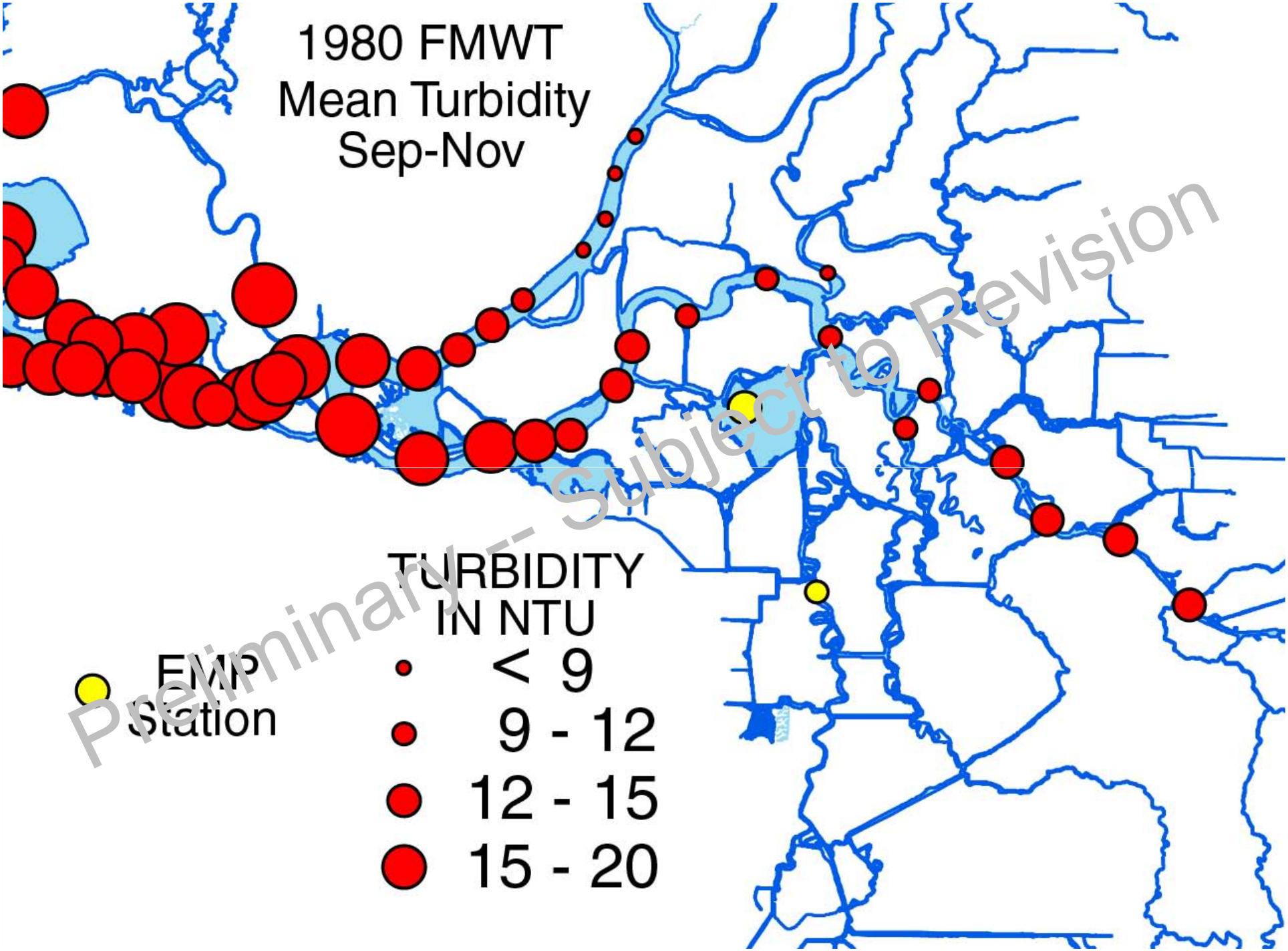
1980 FMWT
Mean Turbidity
Sep-Nov
TURBIDITY
IN NTU
< 9
9 - 12
12 - 15
15 - 20
EMP
Station
Preliminary -- Subject to Revision

Winters in the Delta have larger variability in precipitation, flows, salinity, and turbidity than during fall.

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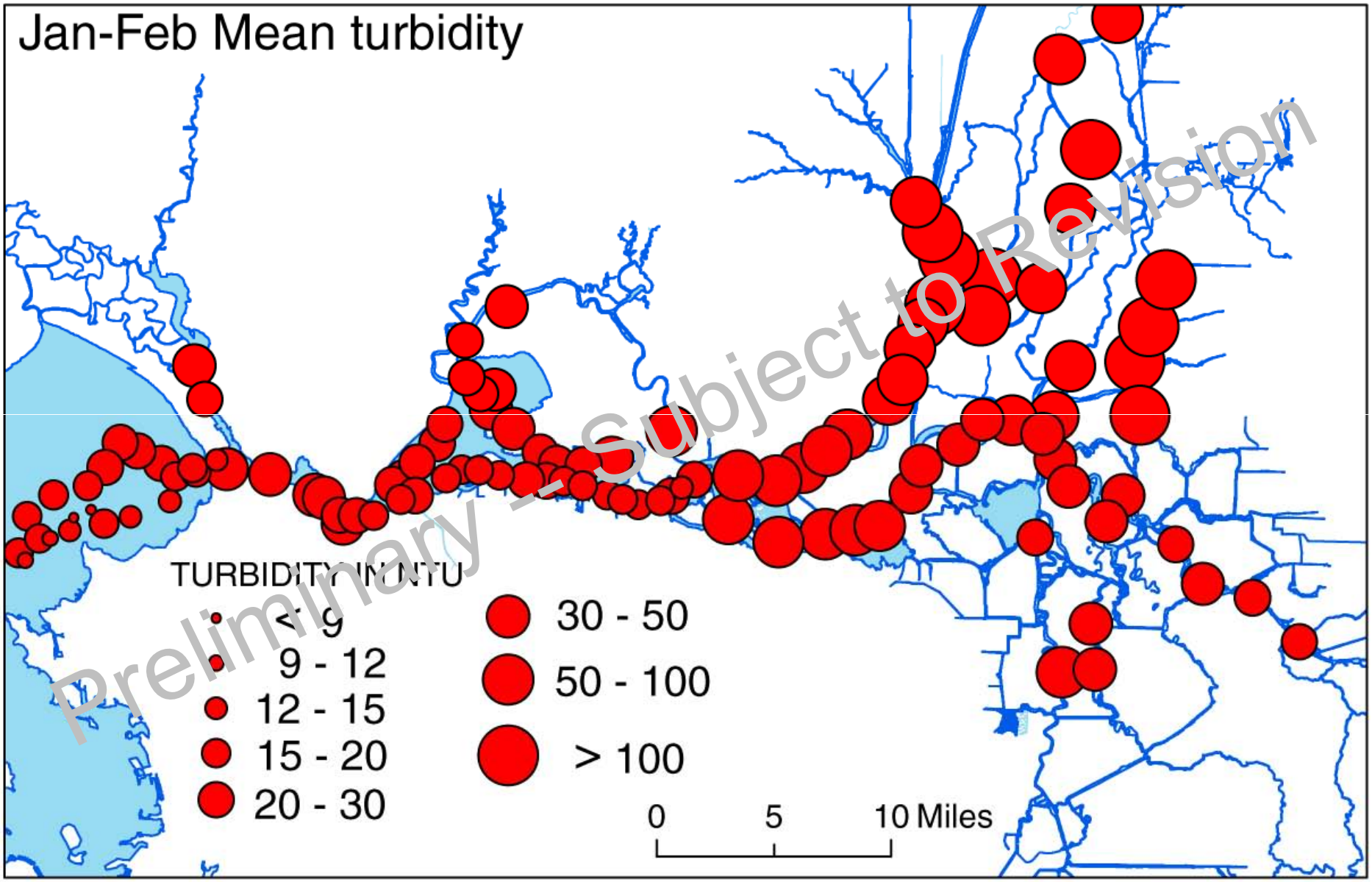
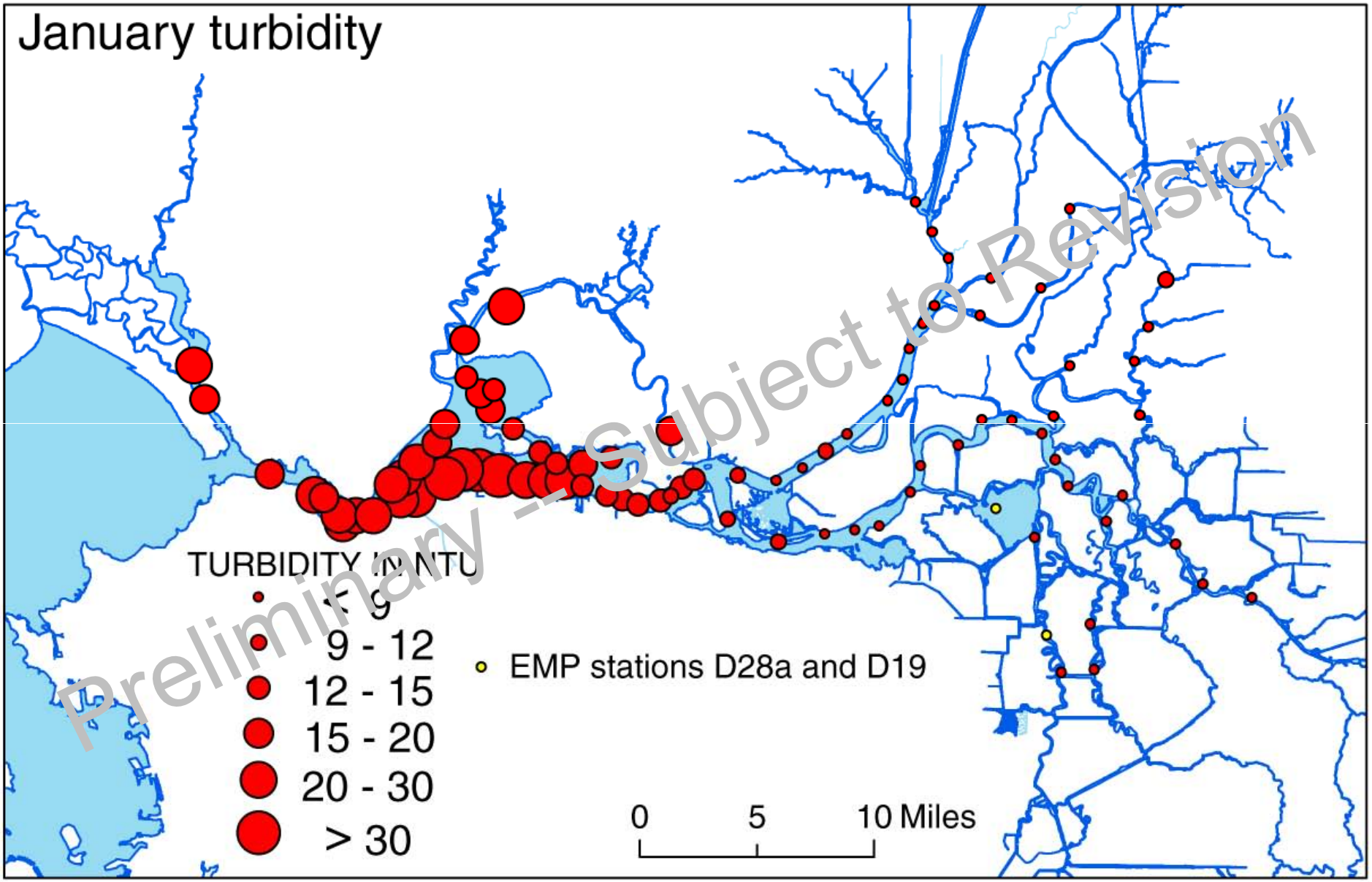
1993 Spring Mid-Water Trawl (WetYear)



1994 Spring Mid-Water Trawl (Dry Year)



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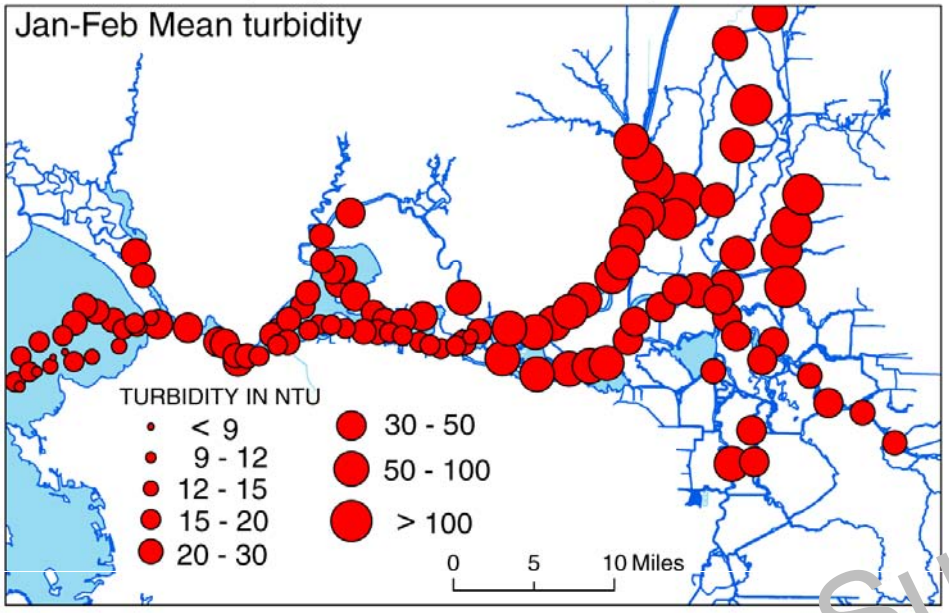
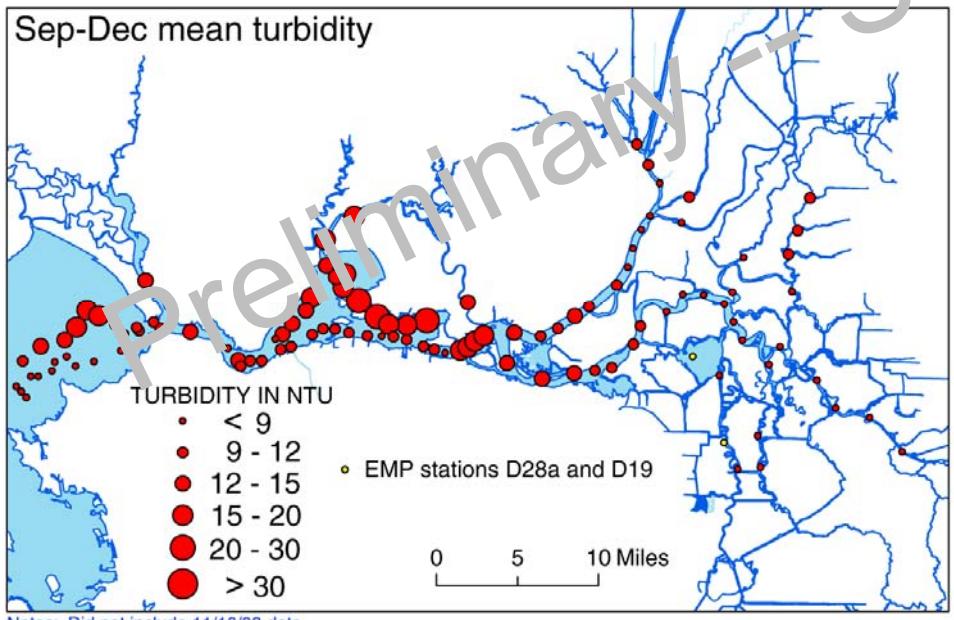
Calendar Year 1993 (Wet)





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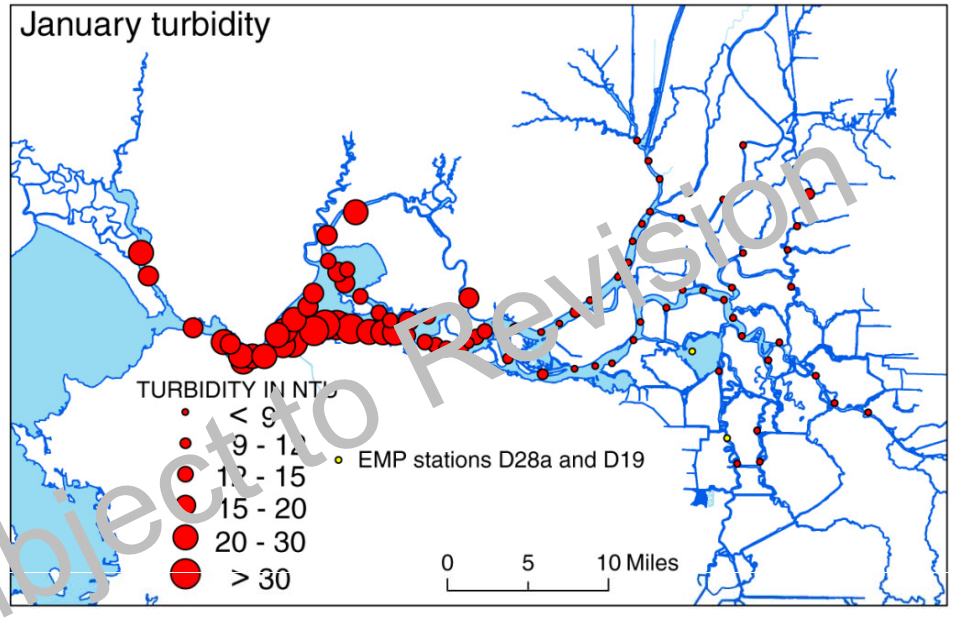
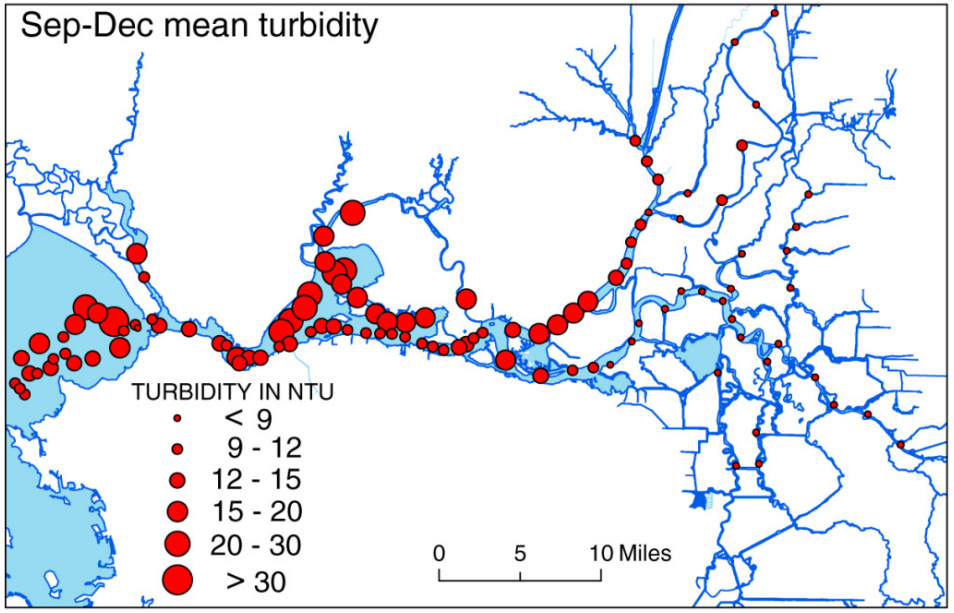
Did not include 9/14/93 data at station 912

Calendar Year 1994 (Dry)





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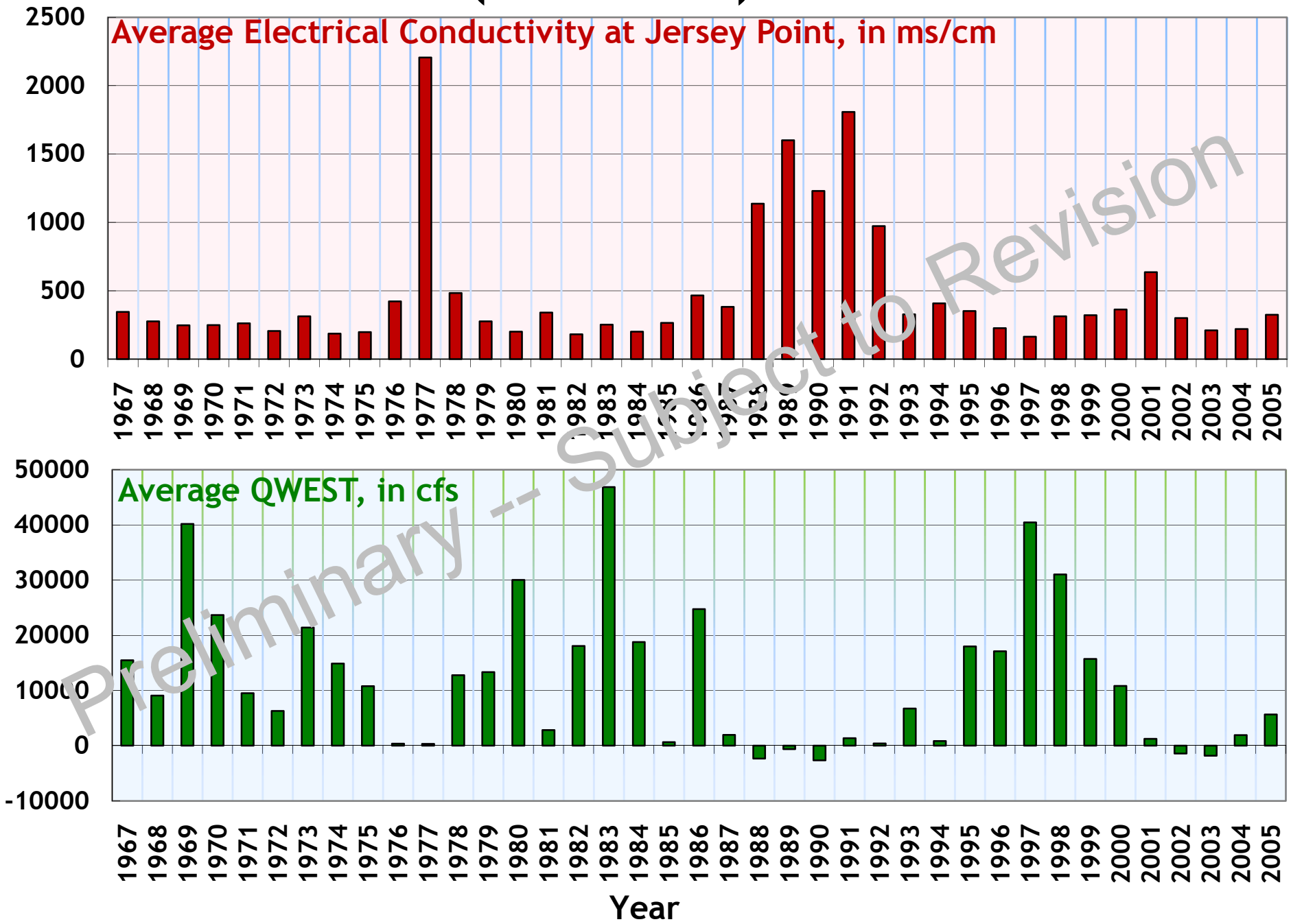
Winter (Jan-Mar) Conditions

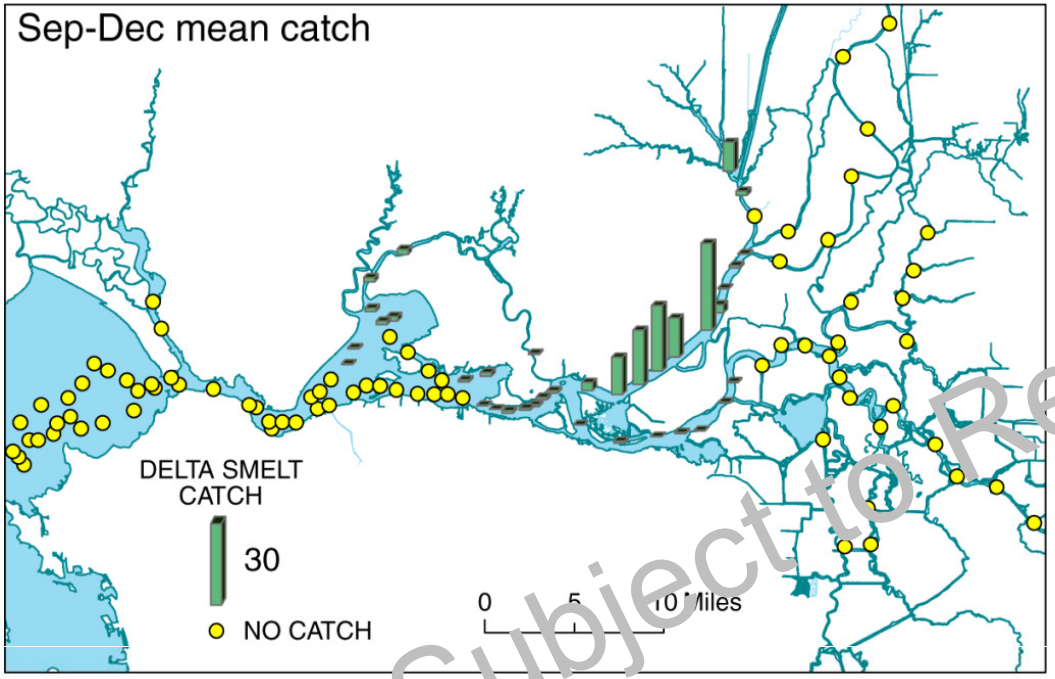


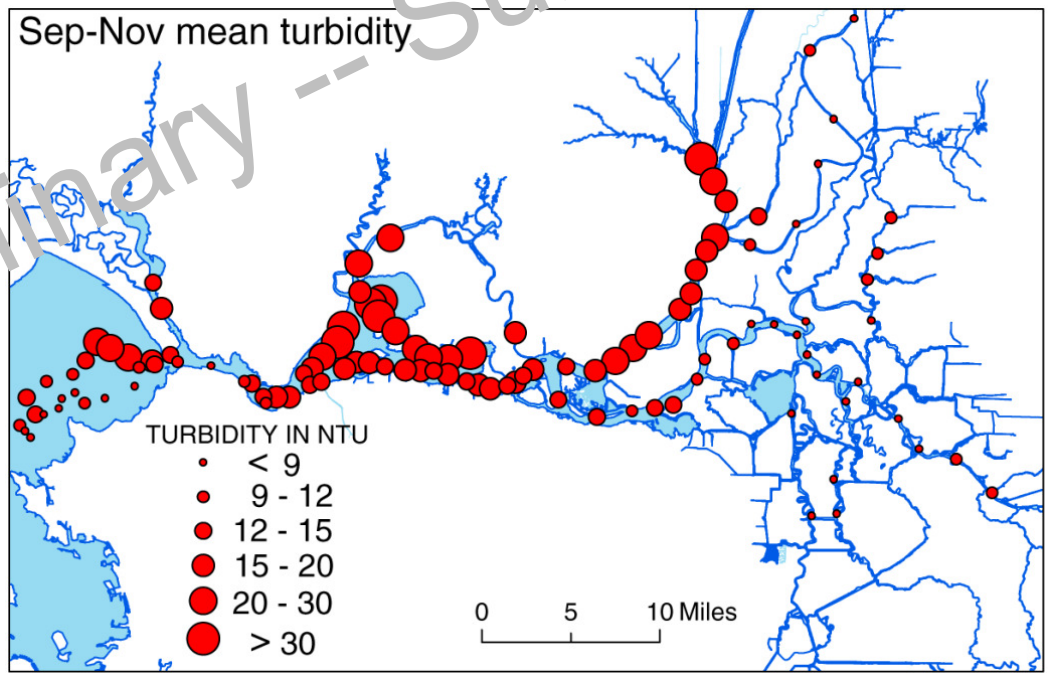
Preliminary -- Subject to Revision

Let’s take a look at water year 2002, a POD year and the first year that winter sampling for delta smelt was done with the Spring Kodiak Trawl

Preliminary – Subject to Revision

2001 Fall Midwater Trawl





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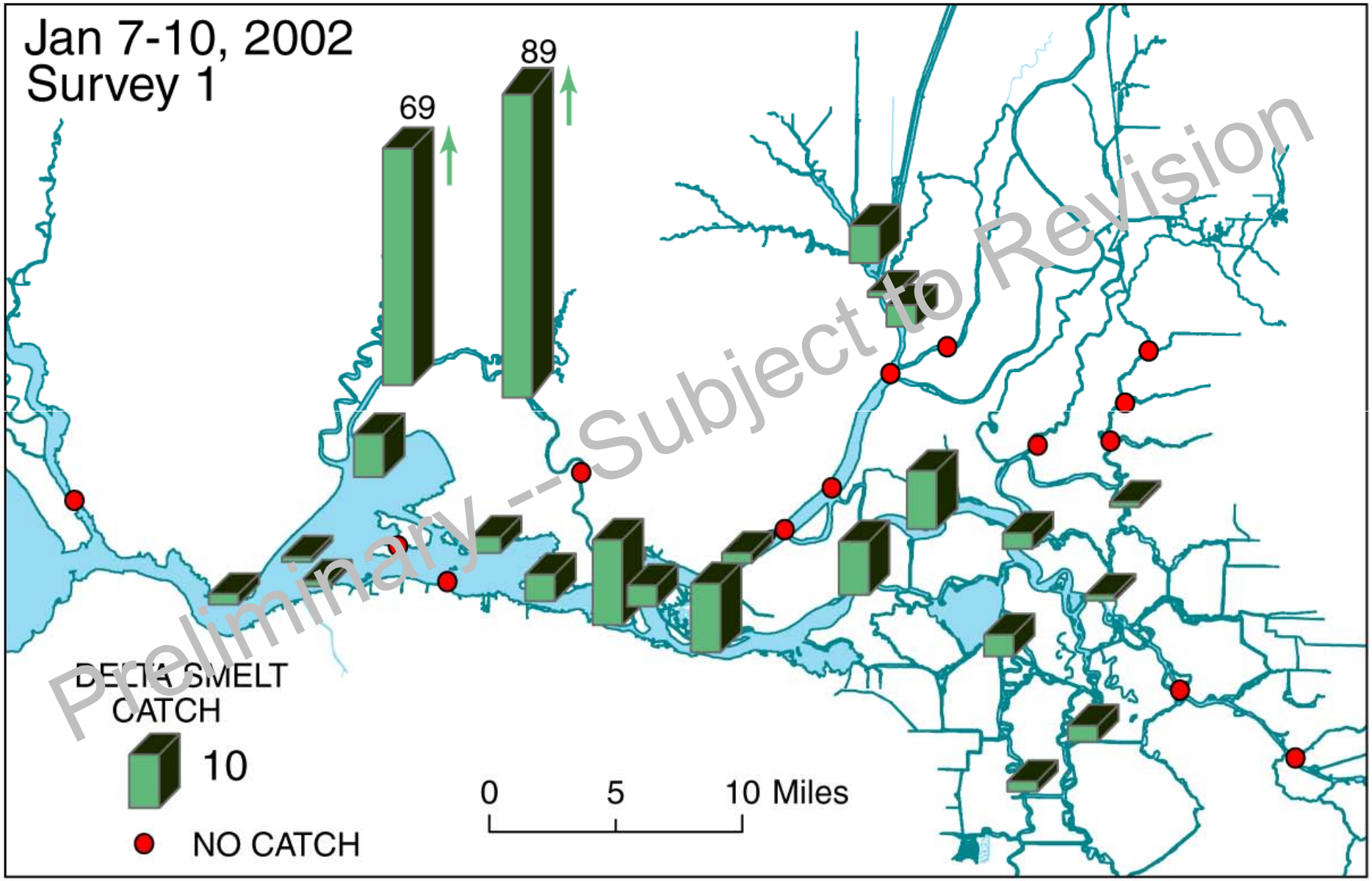
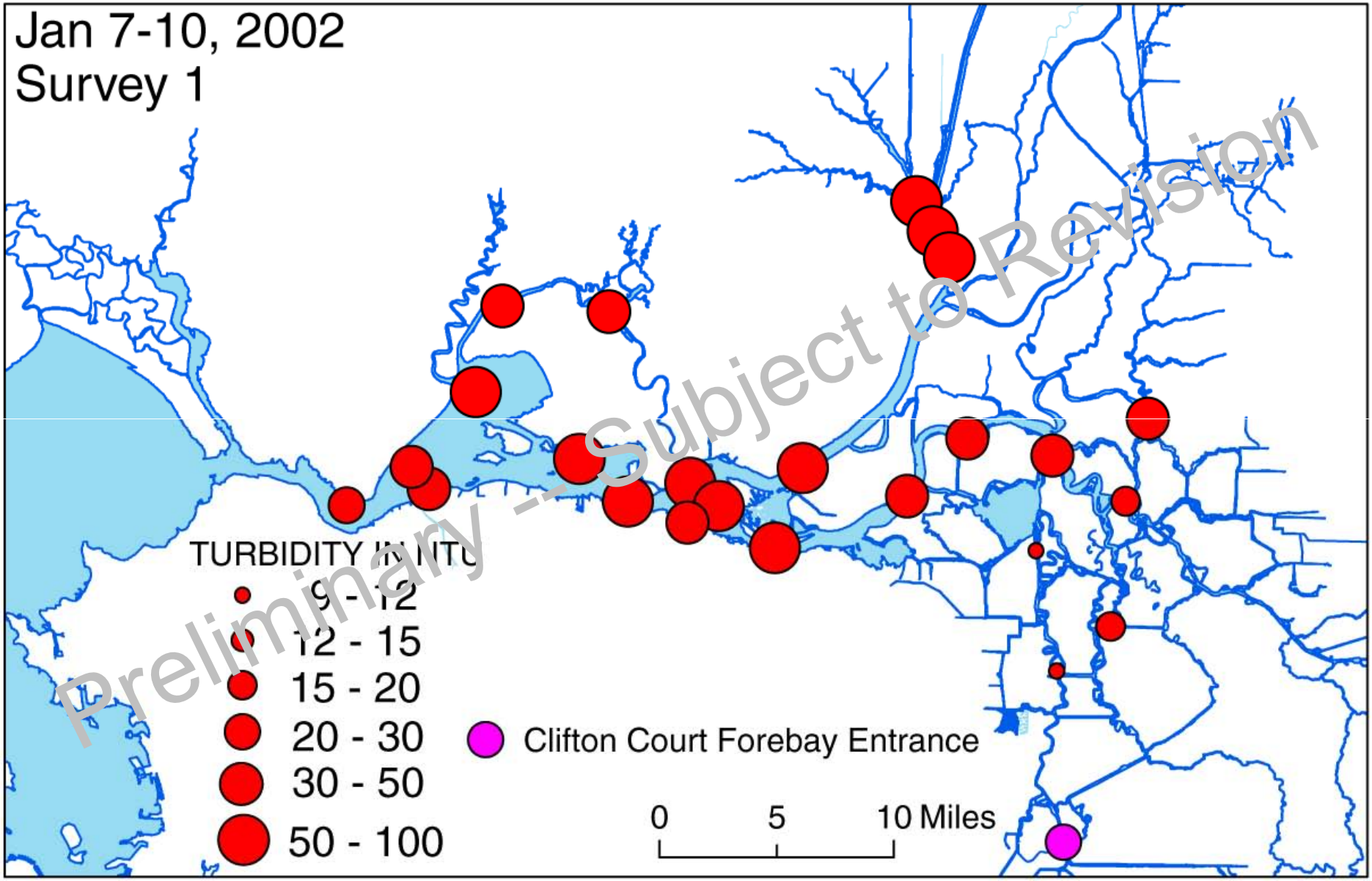
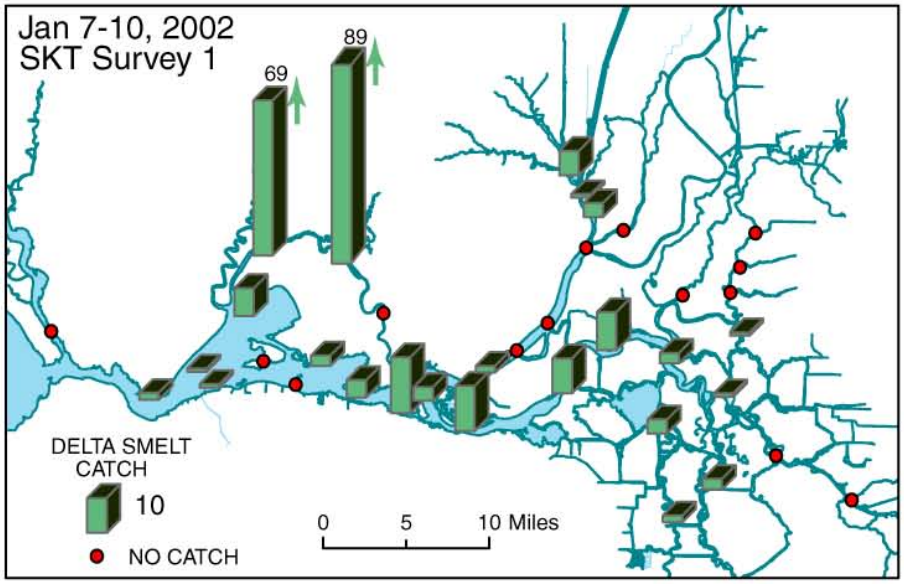
2002 Spring Kodiak Trawl

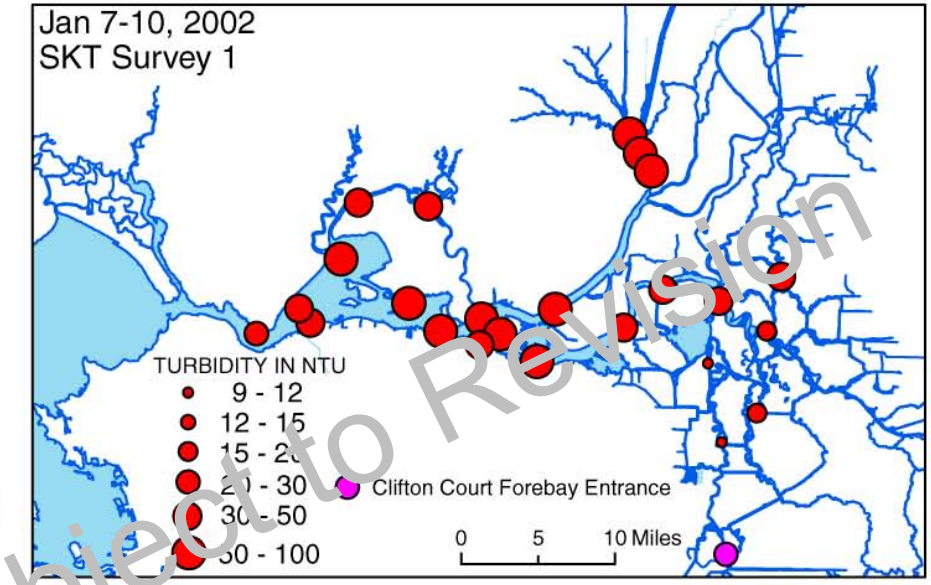


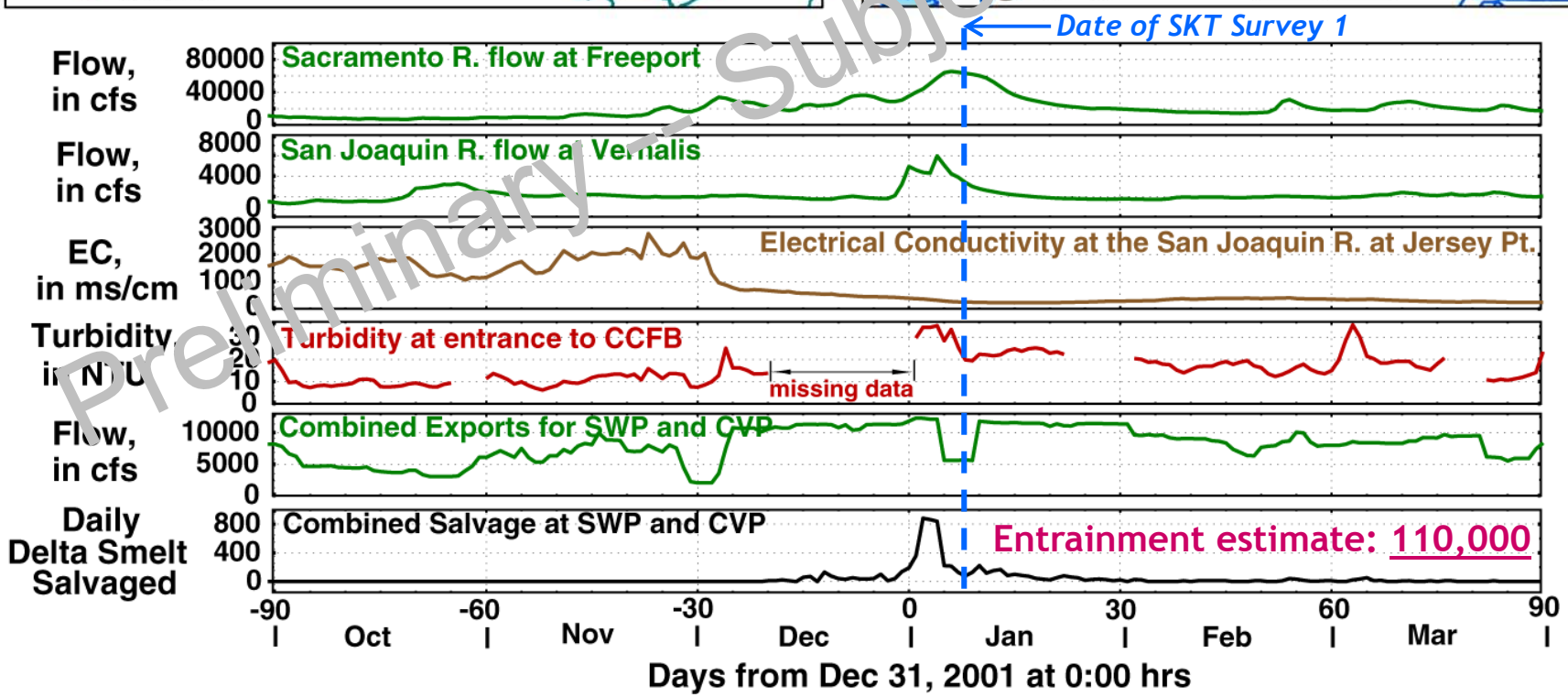
2002 Spring Kodiak Trawl



WY 2002







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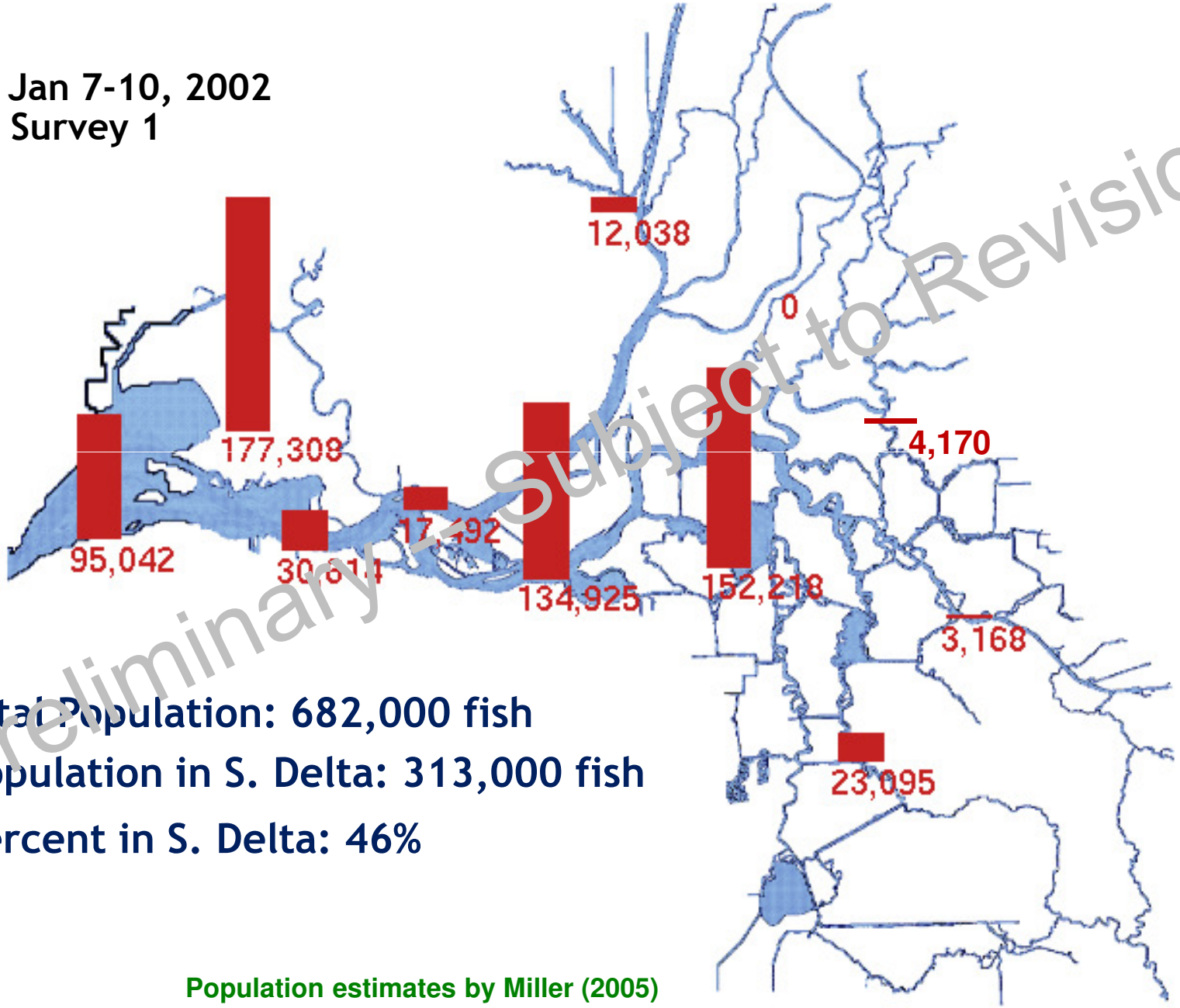
January 2002 SKT Population Estimates by Area

Jan 7-10, 2002
Survey 1



Total Population: 682,000 fish

Population in S. Delta: 313,000 fish

Percent in S. Delta: 46%

Population estimates by Miller (2005)

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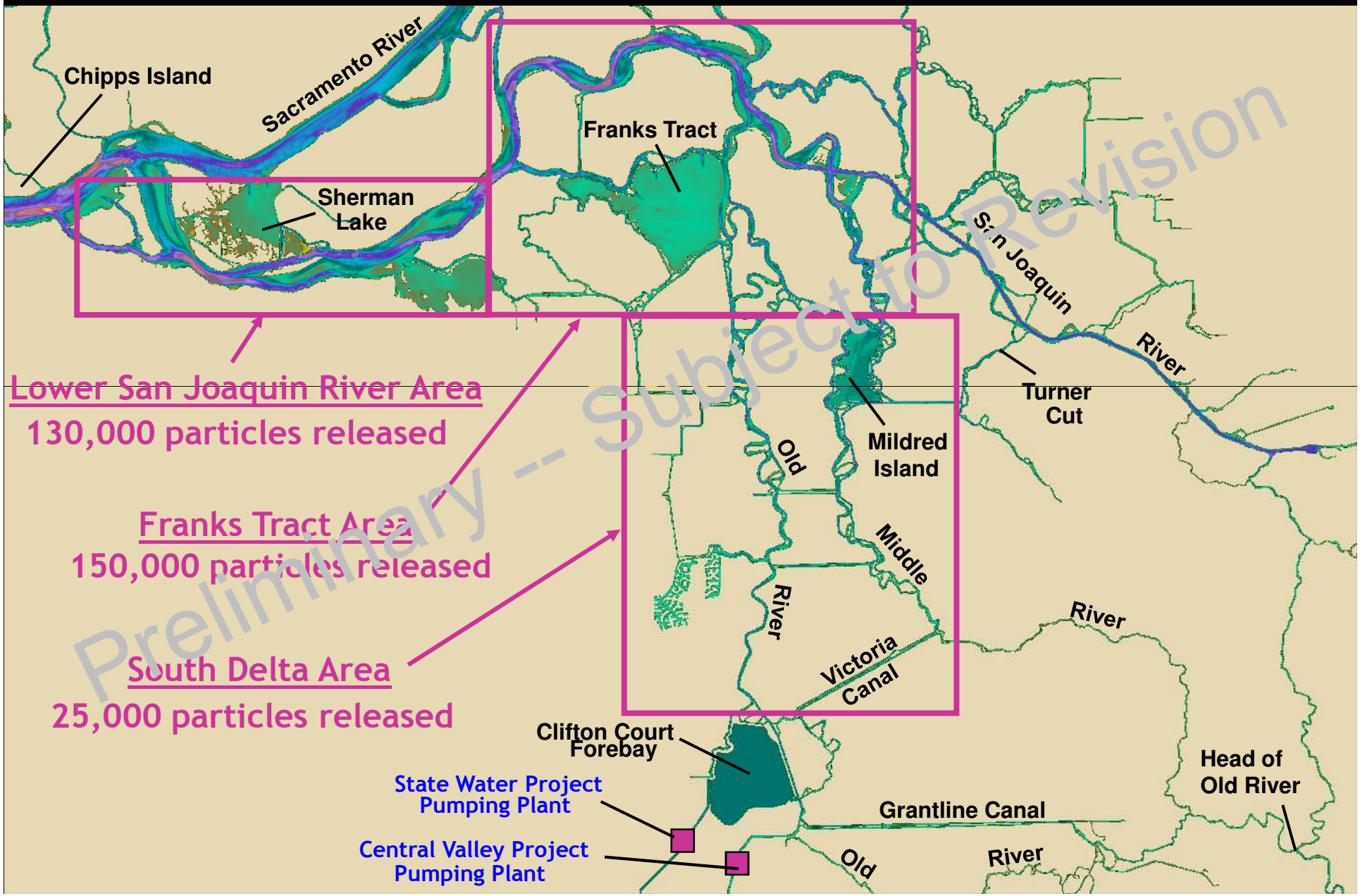
Three Areas Used for Particle-Tracking Experiment to Estimate Adult Delta Smelt Entrainment in WY 2002



Details of PTM Experiment

- Particles, each simulating an adult delta smelt, were released randomly in each of the three areas beginning on Dec 10, 2001 and continuing for two weeks.
- Particles were only released in the upper 12 feet of the water column
- Particles were tracked for 45 days and counted if they were entrained at the pumps.

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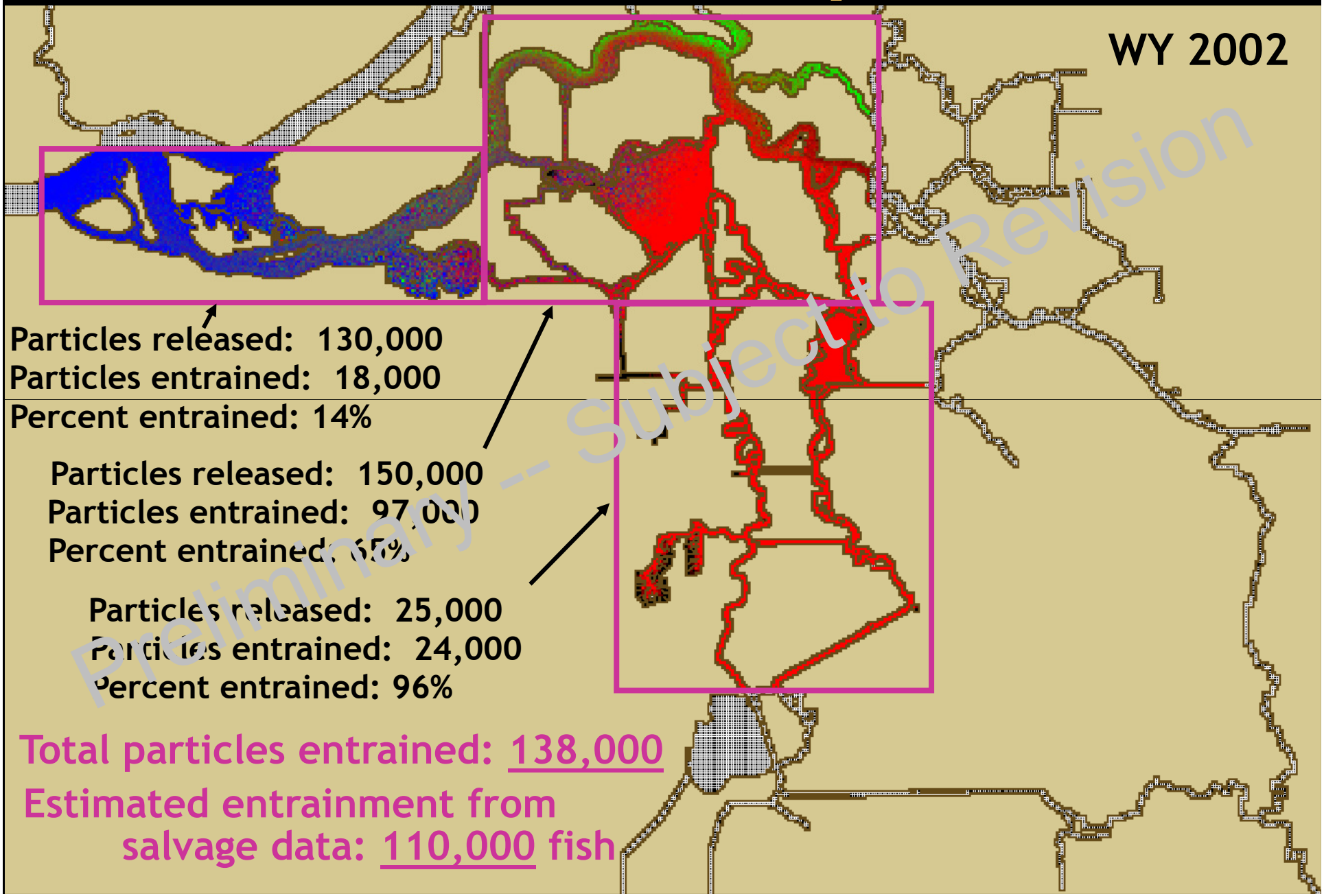
Results of PTM Experiment



Particles released: 130,000
Particles entrained: 18,000
Percent entrained: 14%

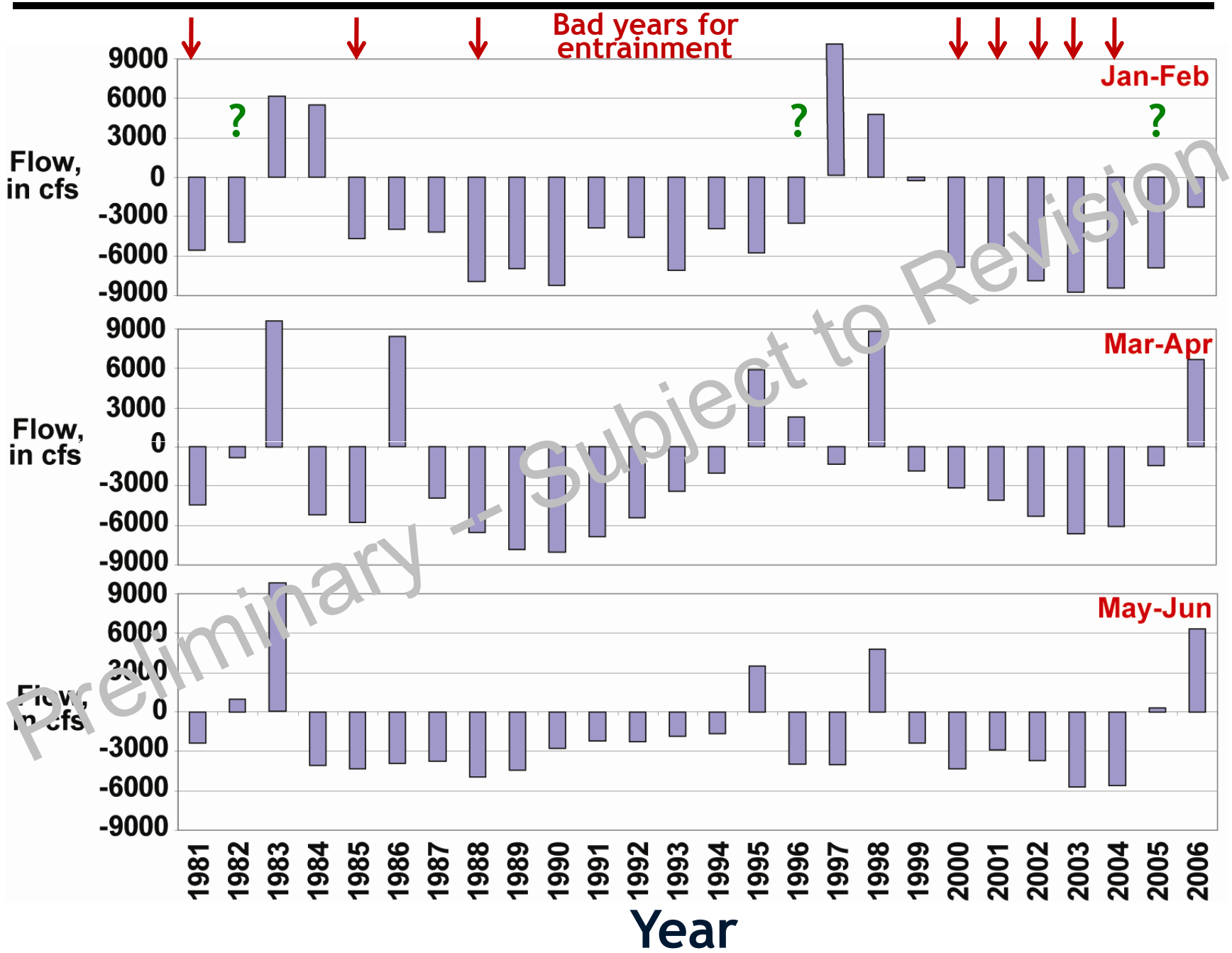
Particles released: 150,000
Particles entrained: 97,000
Percent entrained: 65%

Particles released: 25,000
Particles entrained: 24,000
Percent entrained: 96%

Total particles entrained: 138,000

Estimated entrainment from salvage data: 110,000 fish

Combined Old and Middle River Flows



Preliminary – Subject to Revision

END