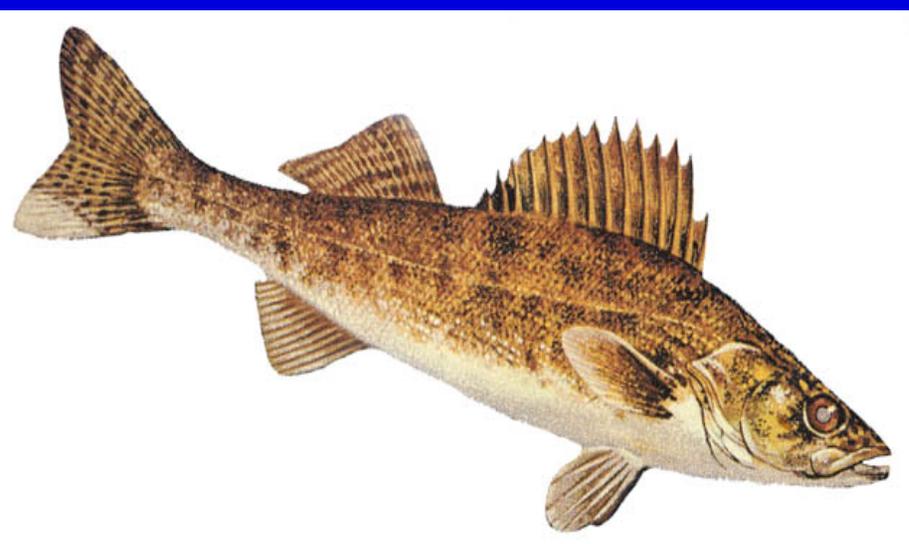
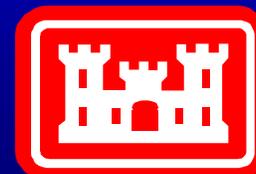


Assessment of Potential Impacts of Bucket Dredging Plumes on Walleye Spawning Habitat in Maumee Bay, Ohio



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The Dredging Operation in Maumee Bay

- **Problem: Shoals form during winter and early spring, creating a hazard to navigation. Environmental window imposed by ODNR constrains dredging to 1 March to 1 July.**
- **Concern: Shoal removal in spring/early summer could impact walleye spawning and nursery habitat.**
- **Requirements: Dredge 850,000 cu yds annually in the riverine and bay portions of the navigation channel.**
- **Typical dredge plant: MCM Marine Dredge #55 with a 15 cu yd open clamshell bucket (Occasionally a small hydraulic cutterhead dredge is used).**
- **Placement site: Sediment placed in upland Confined Disposal Facility or “barge loaded” for open-water placement.**

Hypothetical Impacts of Dredging-Induced Suspended Sediment

- **Smothering of eggs by impeding oxygen exchange.**
- **Increased water temperature due to increased turbidity can shorten incubation times, impacting growth and development.**
- **Gill abrasion due to suspended sediments.**
- **Modification of spawning substrates (i.e. loss of rock and gravel) by increased sedimentation.**
- **Hydrologic modification by channelizing tributaries can increase current velocities and TSS, which may reduce larval survival.**
- **Entrainment of egg, larval, or later life history stages by hydraulic dredge pumps.**

Potential Benefits of Dredging to Walleye Fishery

- **Some increases in turbidity may optimize visual contrast of prey such that feeding success and the onset of first feeding are enhanced (Reiger and Summerfelt 1997).**
- **Slightly turbid waters are more productive walleye nursery areas than clear offshore areas (Roseman et al. 2005).**
- **Low relief sand mounds parallel to the navigation channel resulting from historical placement of dredged material are apparently viable walleye spawning habitat (Roseman et al. 2002).**

Objective

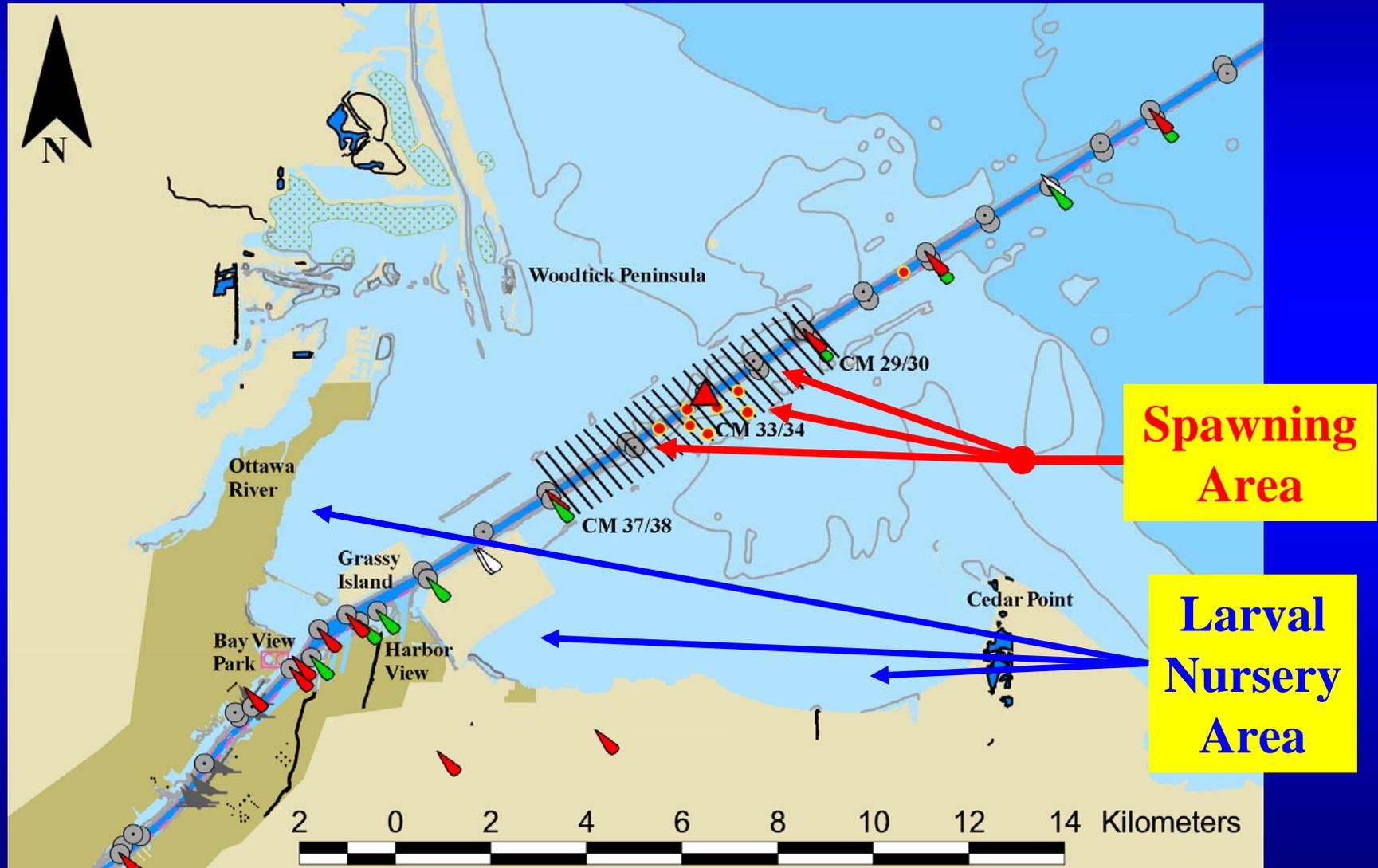


Characterize the spatial extent, concentration gradient structure, and temporal dynamics of suspended sediment plumes during bucket dredging operations.

15 cubic yard open bucket



Maumee Bay Study Area



Approach

- 1. Acoustic Doppler current profiler (ADCP) surveys to map plumes.**
- 2. Deployment of optical backscatter sensors (OBS) for time series records of turbidity.**
- 3. Water samples collected for gravimetric analysis and used to calibrate the acoustic backscatter data.**

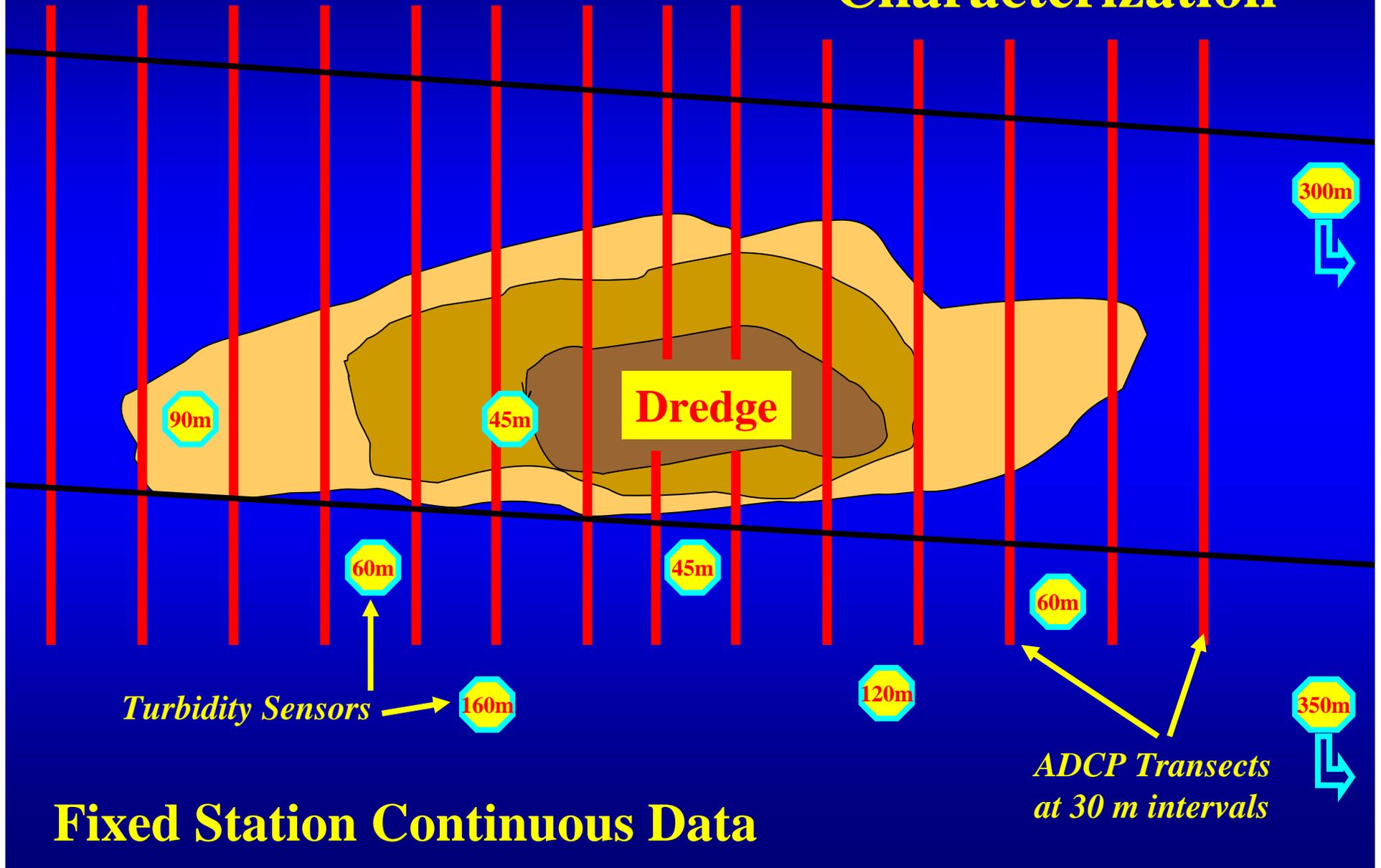
ADCP and Fisheries Hydroacoustics Transducers

ADCP →

**Fisheries
Transducer** →



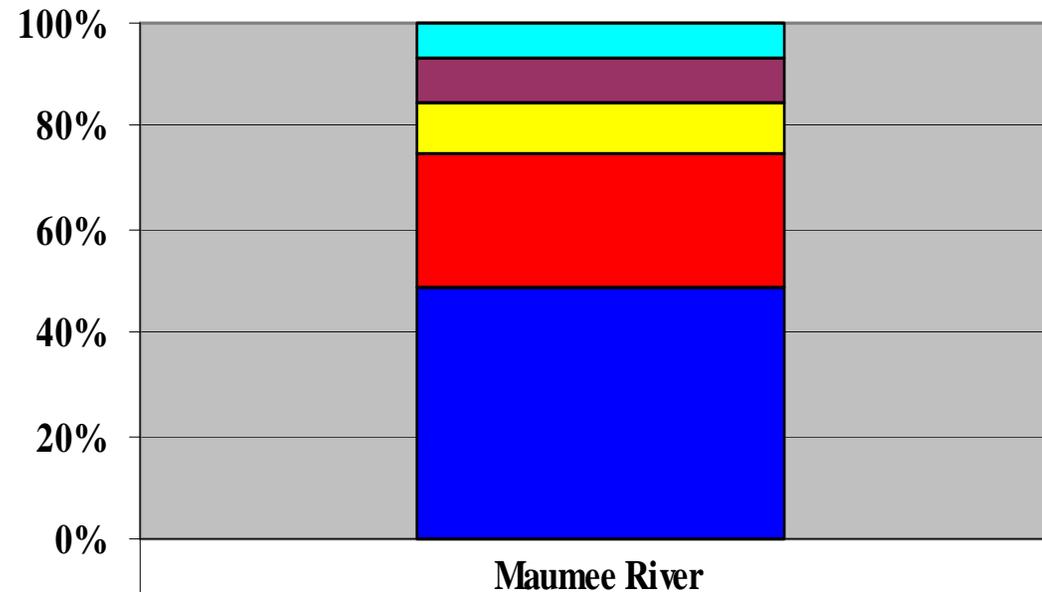
Wide Area Plume Characterization



OBS Buoy Deployed in Advance of Dredge Cut



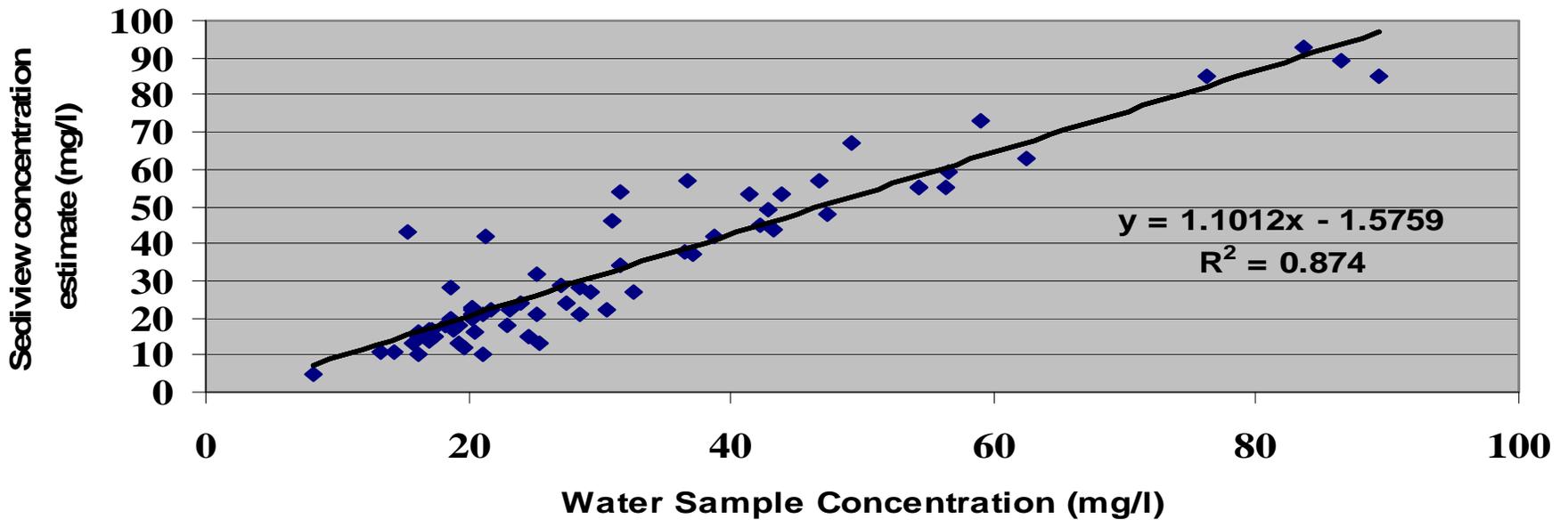
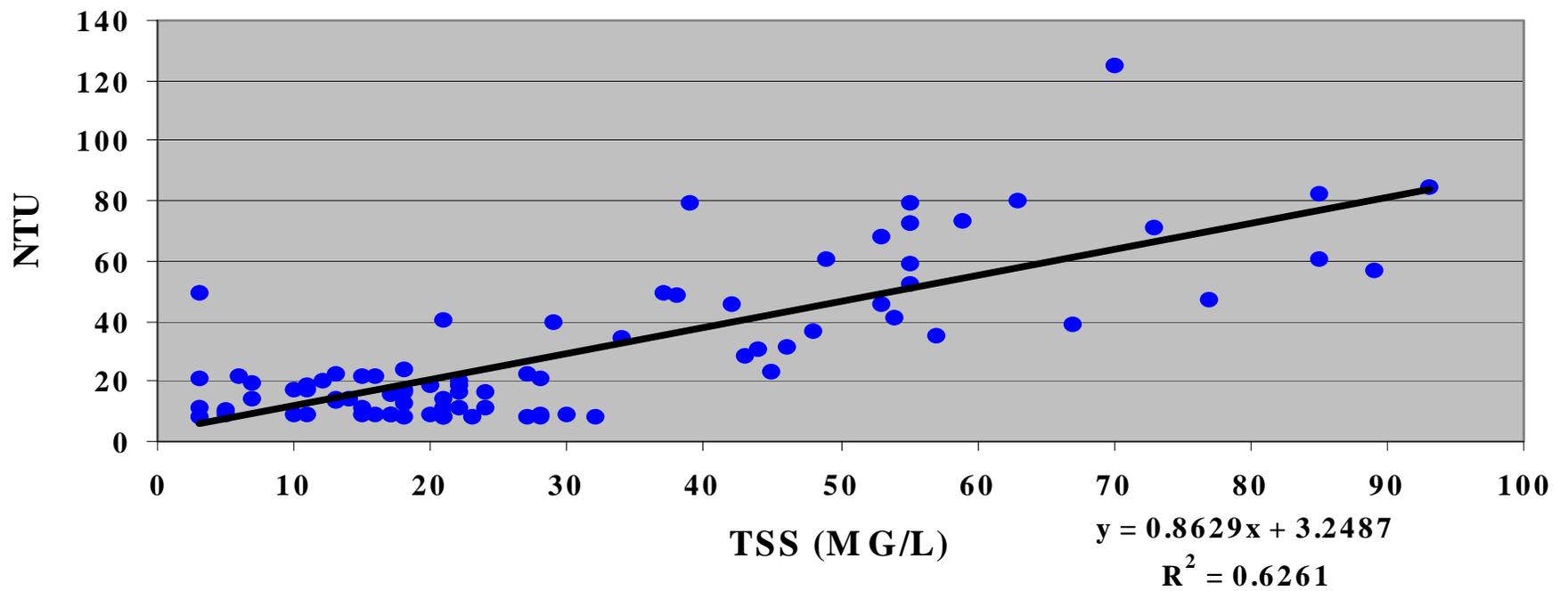
Sediment Grain Size Distribution



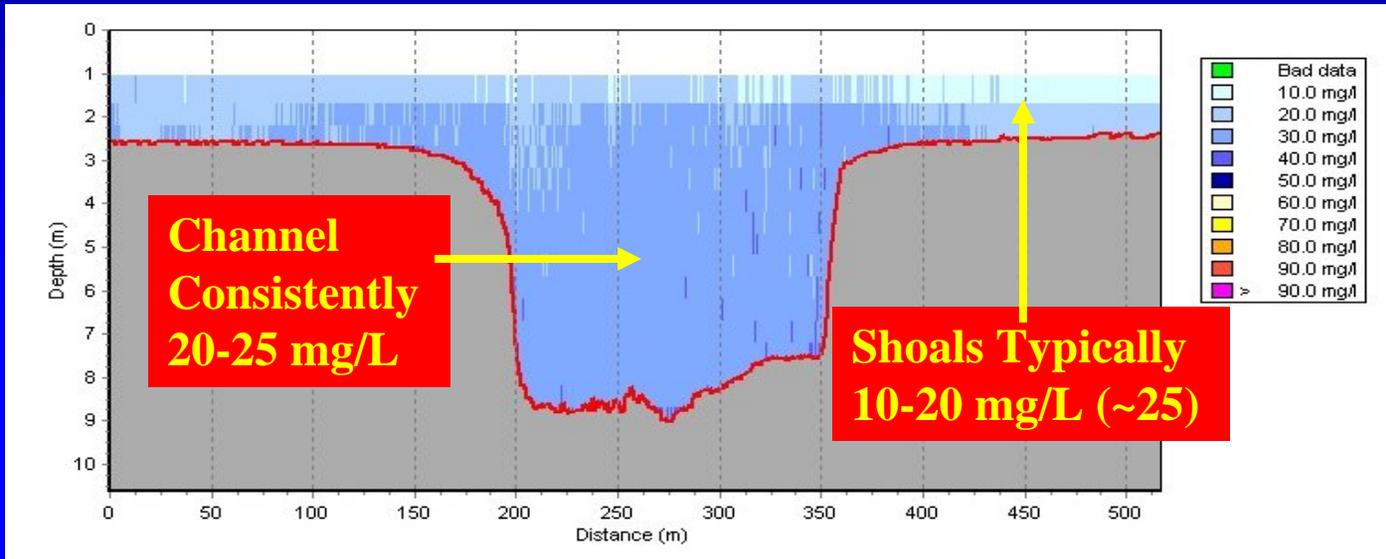
Maumee River	
Clay	0.30%
Very Fine Silt	6.50%
Fine Silt	8.70%
Medium Silt	10.00%
Coarse Silt	25.80%
Very Course Silt	48.80%



**ADCP transect
running in close
proximity to the
operating bucket**



Ambient Conditions (Maumee River and Adjacent Shoals)



Distance:
300 m

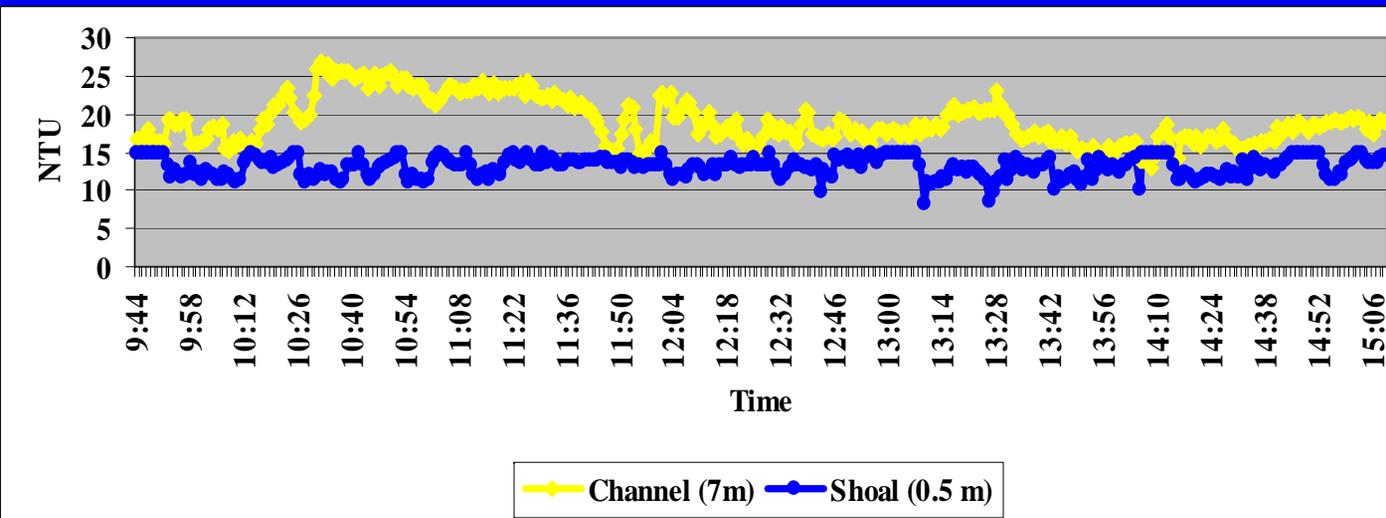
Dredge:
Idle

Channel

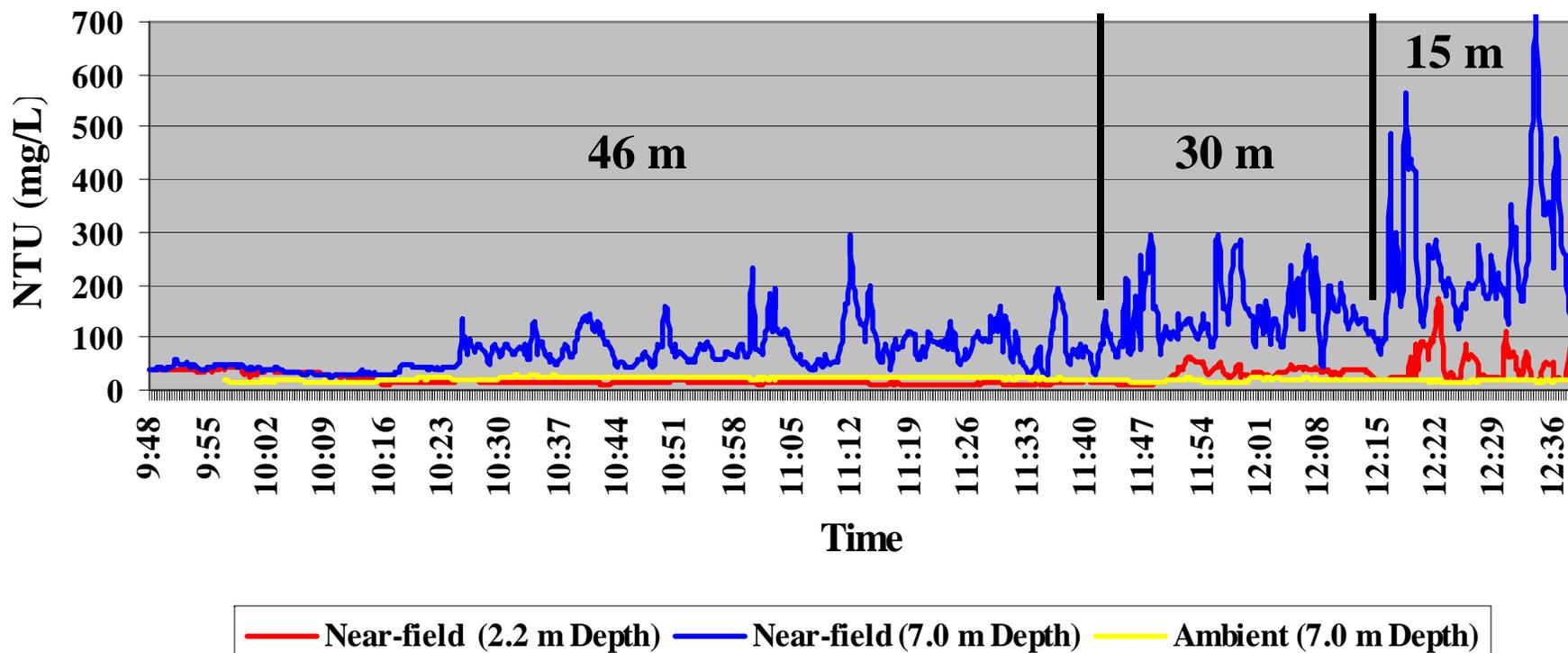
Avg. = 19
Max. = 27

Shoal

Avg. = 13
Max. = 15

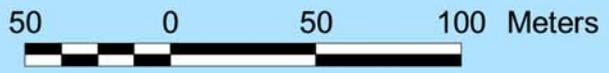


Near-Field Plume Conditions



Peak Lower Water Column Turbidity:
700 NTU (15 m) < 300 NTU (30m)

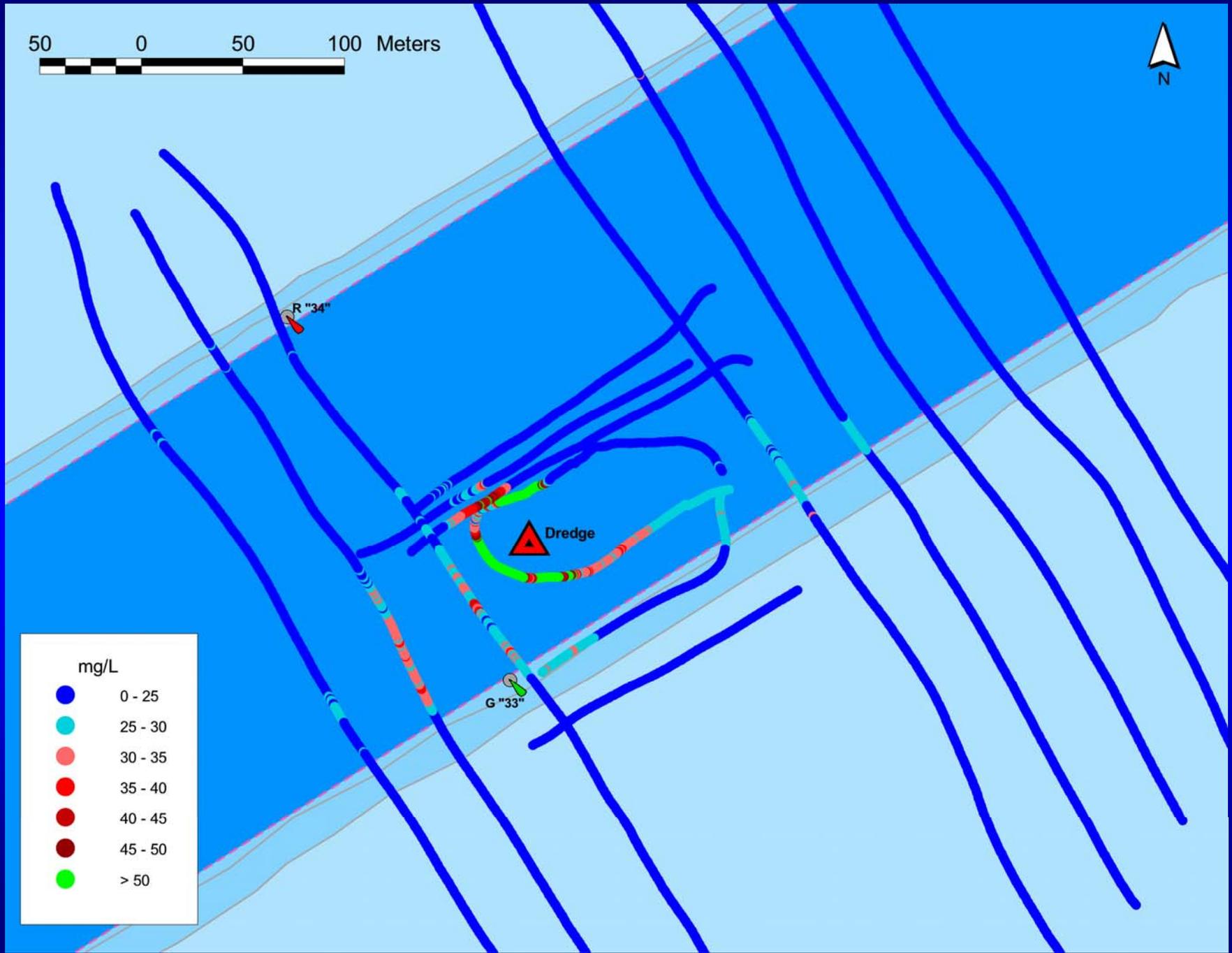
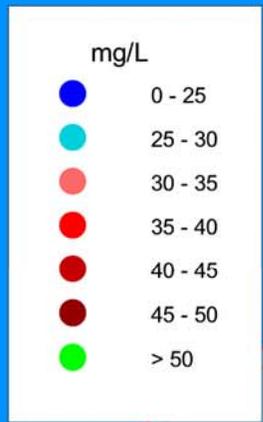
Peak Upper Water Column Turbidity:
175 NTU (15 m) 50 NTU (30m)
Ambient in < 50 m



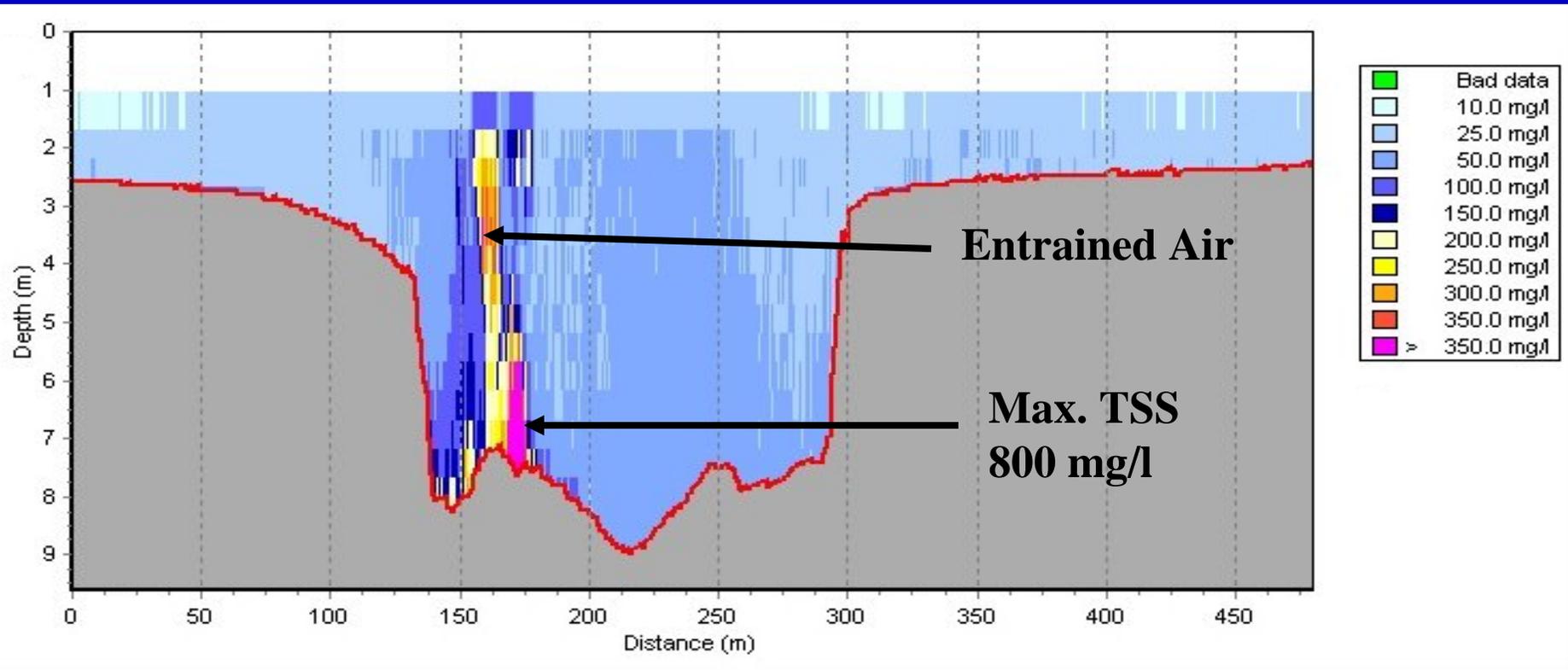
R "34"

Dredge

G "33"



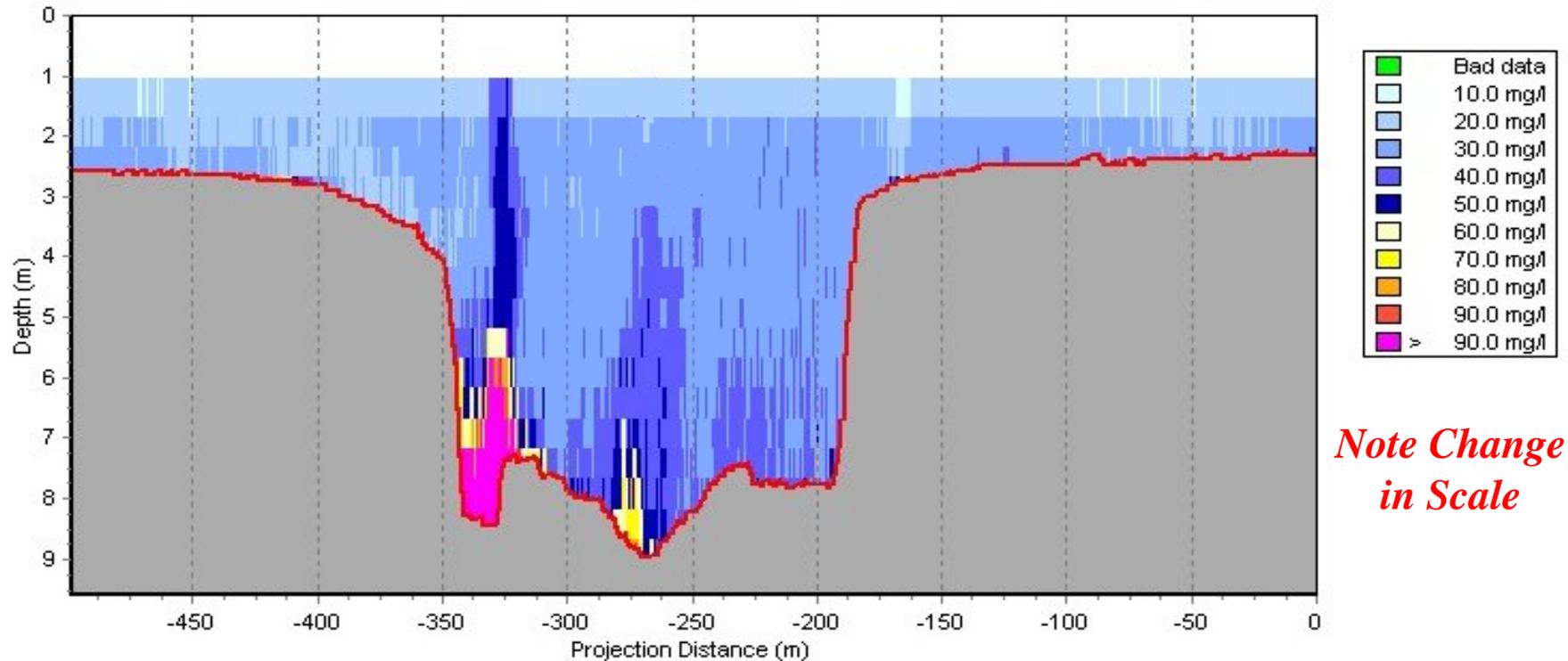
Near-Field Plume Conditions



Plume Width: 50 m

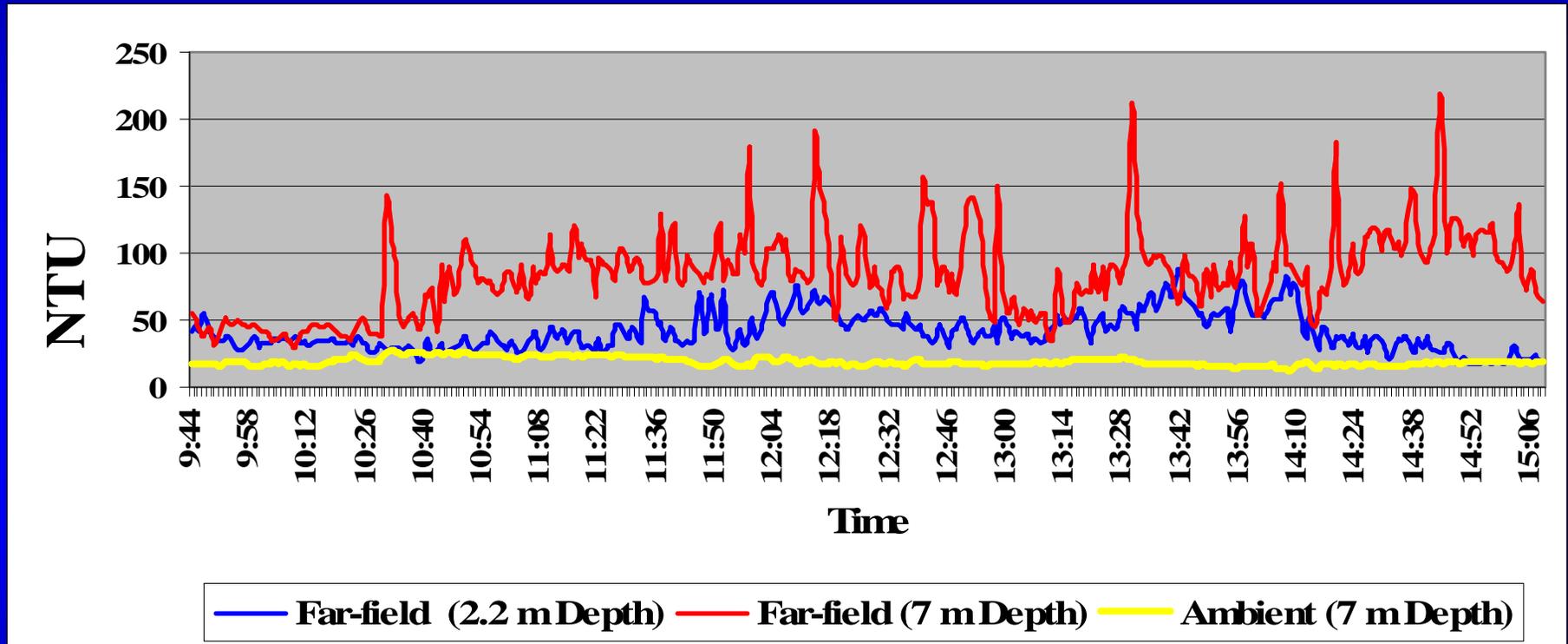
Distance from Dredge: 3m

Near-Field ADCP Plume Transect (27 Meters from Bucket Dredge)



- TSS decreased to < 300 mg/l at a distance of 24 m
- Highest TSS concs. found in lower 3-m of water column
- No detection of plume migration over shoals
- Very narrow surface plume 25 mg/l above background

Far-Field Plume Conditions

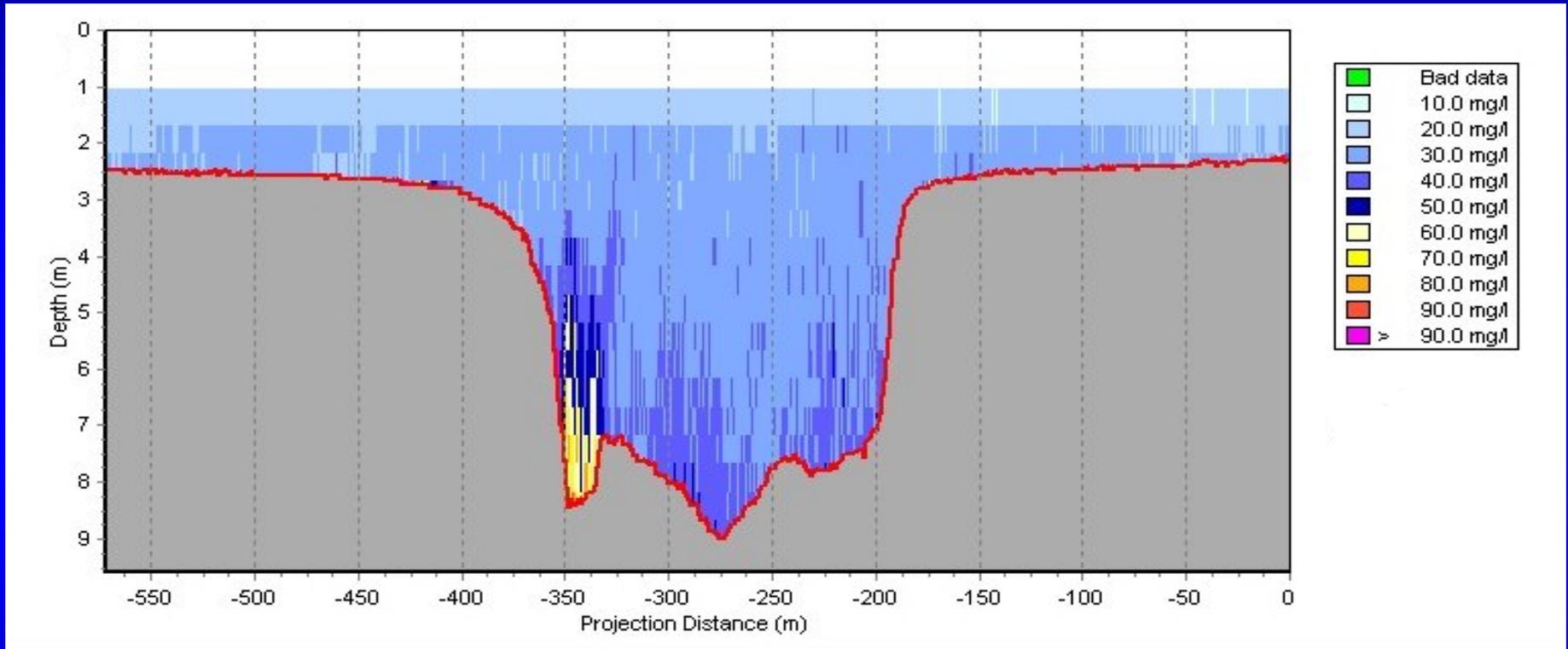


**Upper Water Column: Avg.
41 NTU, Max. 72 NTU**

**Lower Water Column: Avg.
84 NTU, Max. 218 NTU**

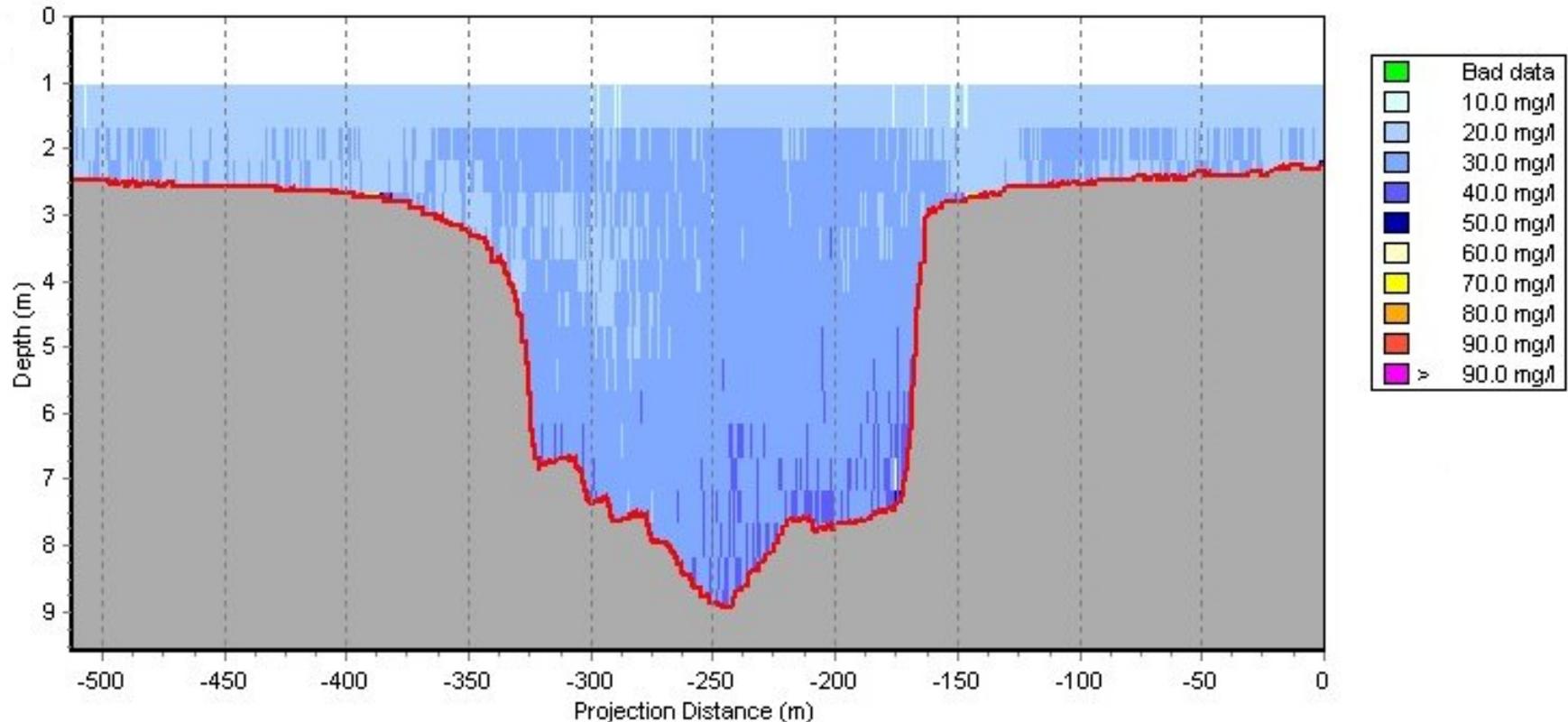
Far-Field Plume Conditions

(90 Meters from Bucket Dredge)



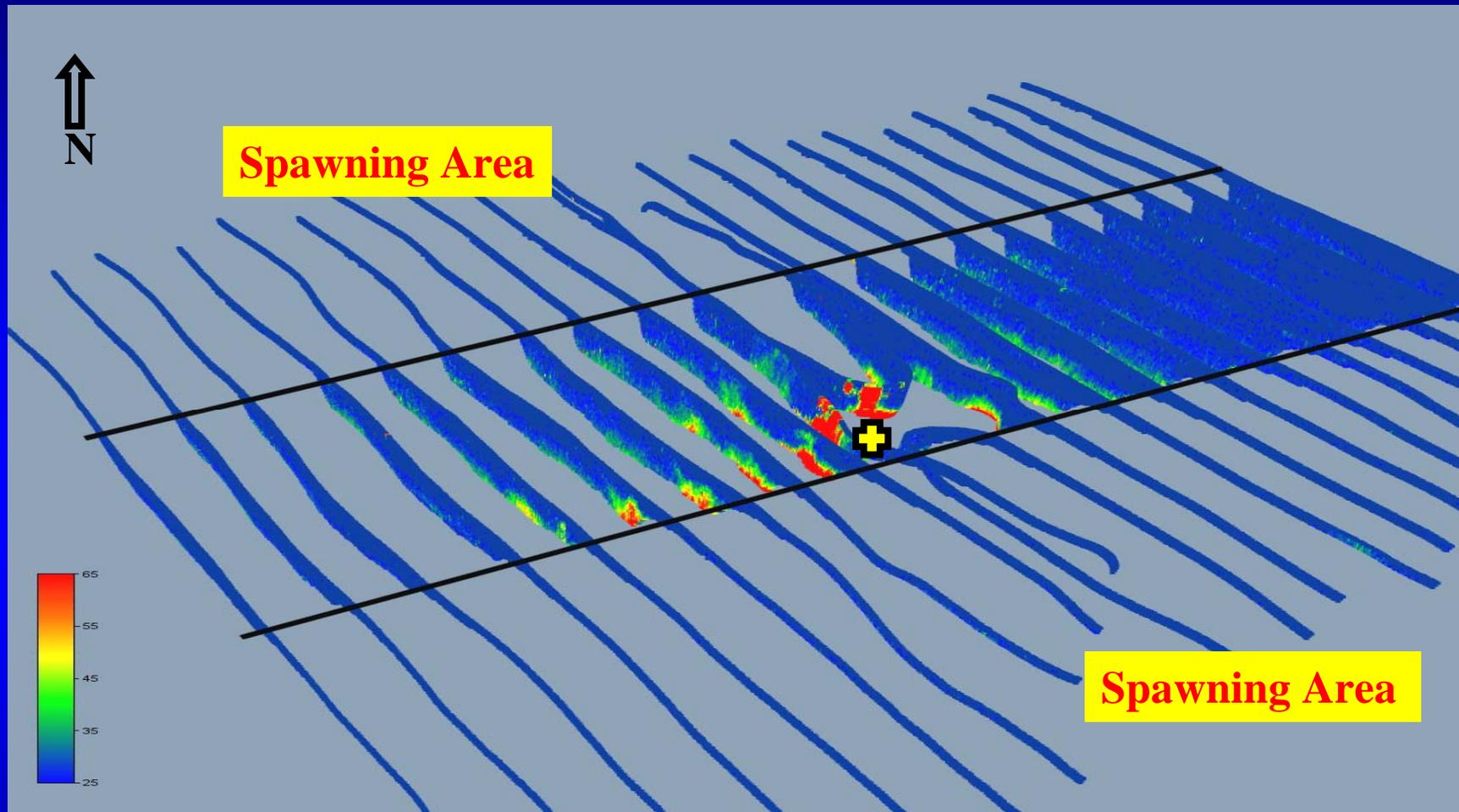
- **TSS < 80 mg/l**
- **Surface plume decayed**
- **No detection of plume movement over shoals**

Far-field ADCP Plume Transect (200 Meters from Bucket Dredge)



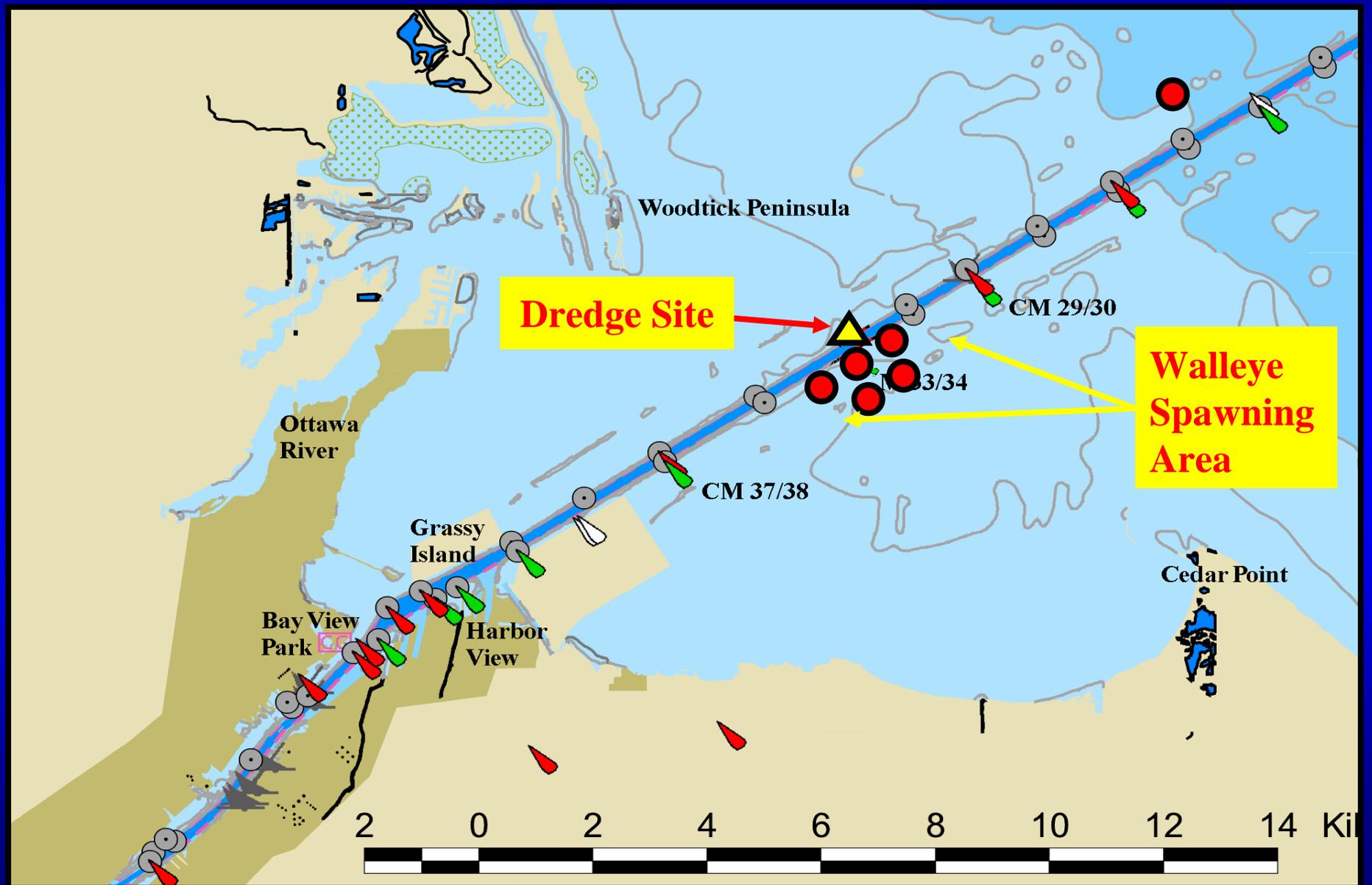
- **Plume no longer detectable above background**
- **Ambient conditions (< 25 mg/l) found over both shoals.**
- **Some sediment degassing on the northern side of the channel**

Spatial Distribution of Suspended Sediments

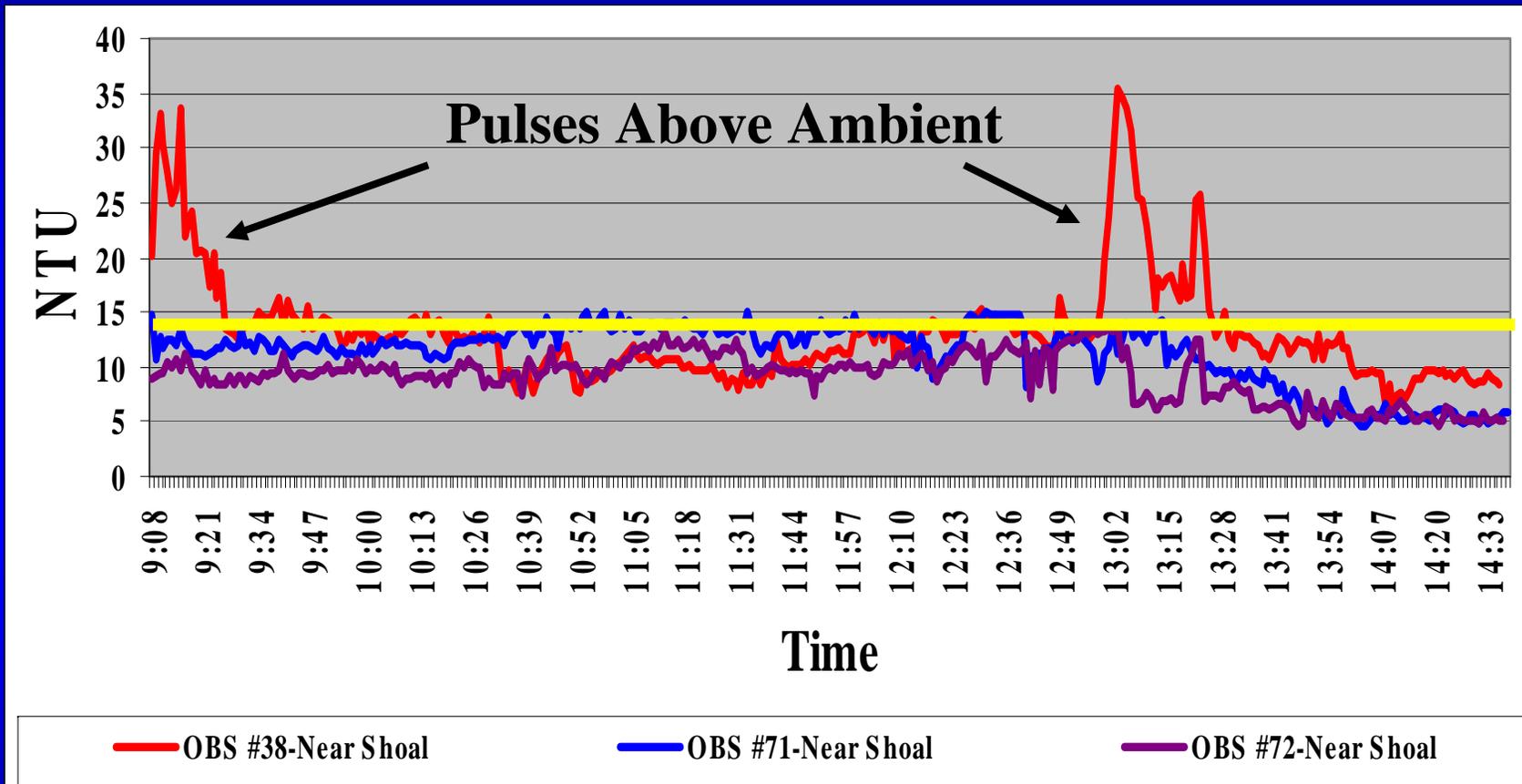


- Highest TSS found in the immediate vicinity of the dredging operation
- Plume movement limited to channel basin and lower side slopes
- Plume footprint <75 m wide; did not extend > 200 m up or down-channel
- Ambient conditions (blue shading) found over spawning grounds

Turbidity Monitoring Stations (Spawning Grounds)

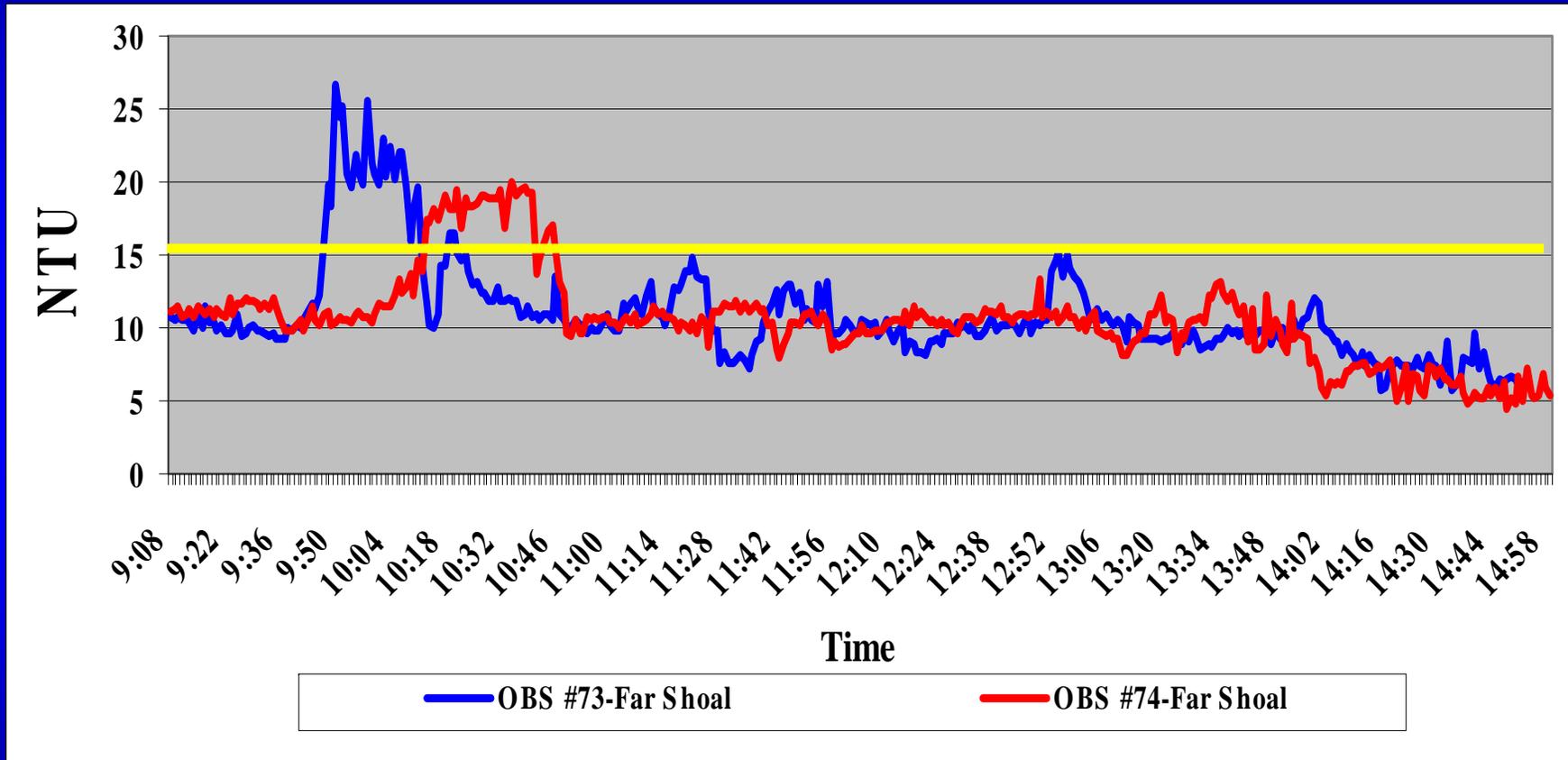


Turbidity Monitoring on Spawning Habitat



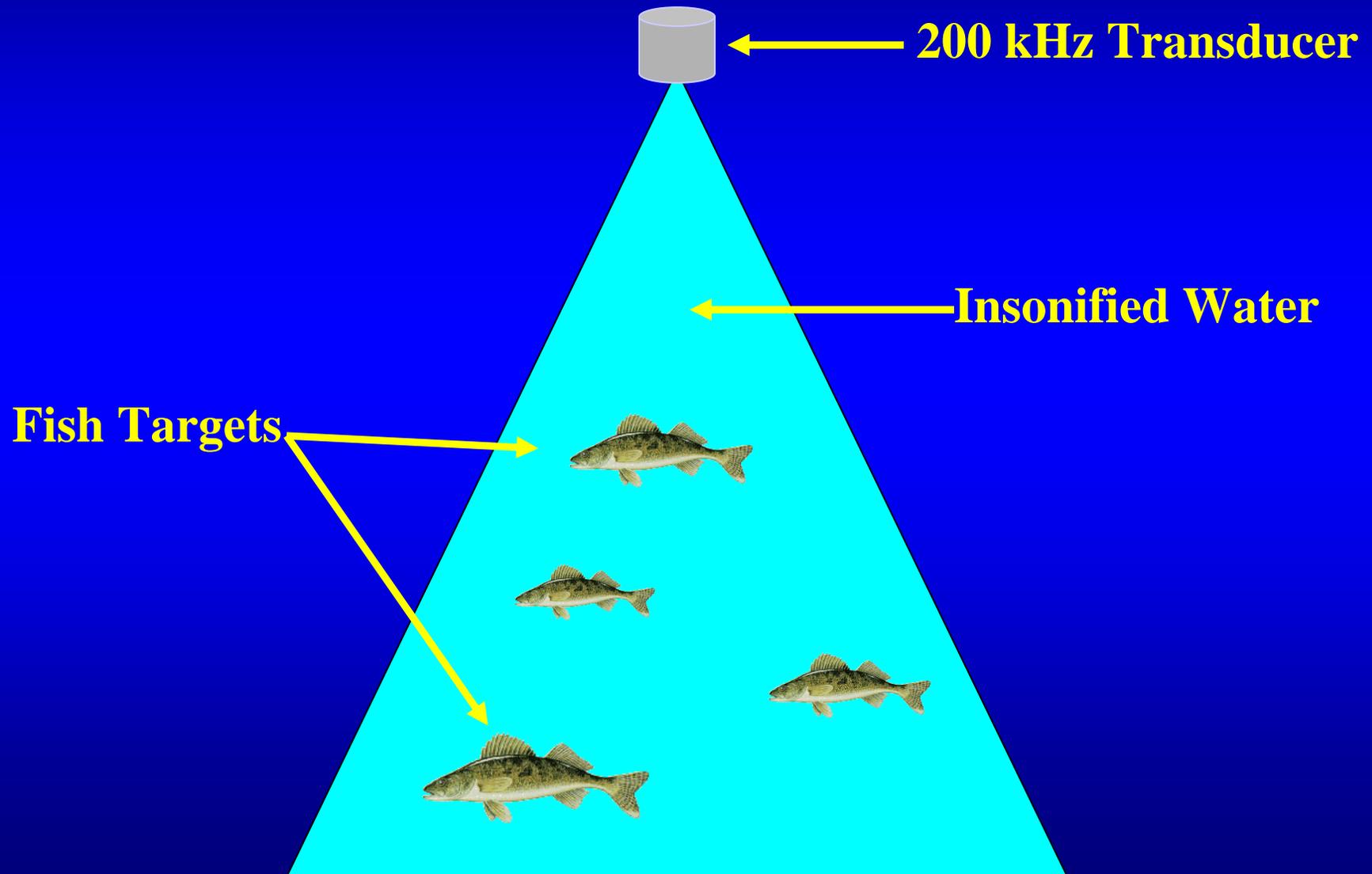
Sensors deployed along shallows near rim of channel

Turbidity Monitoring on Spawning Habitat

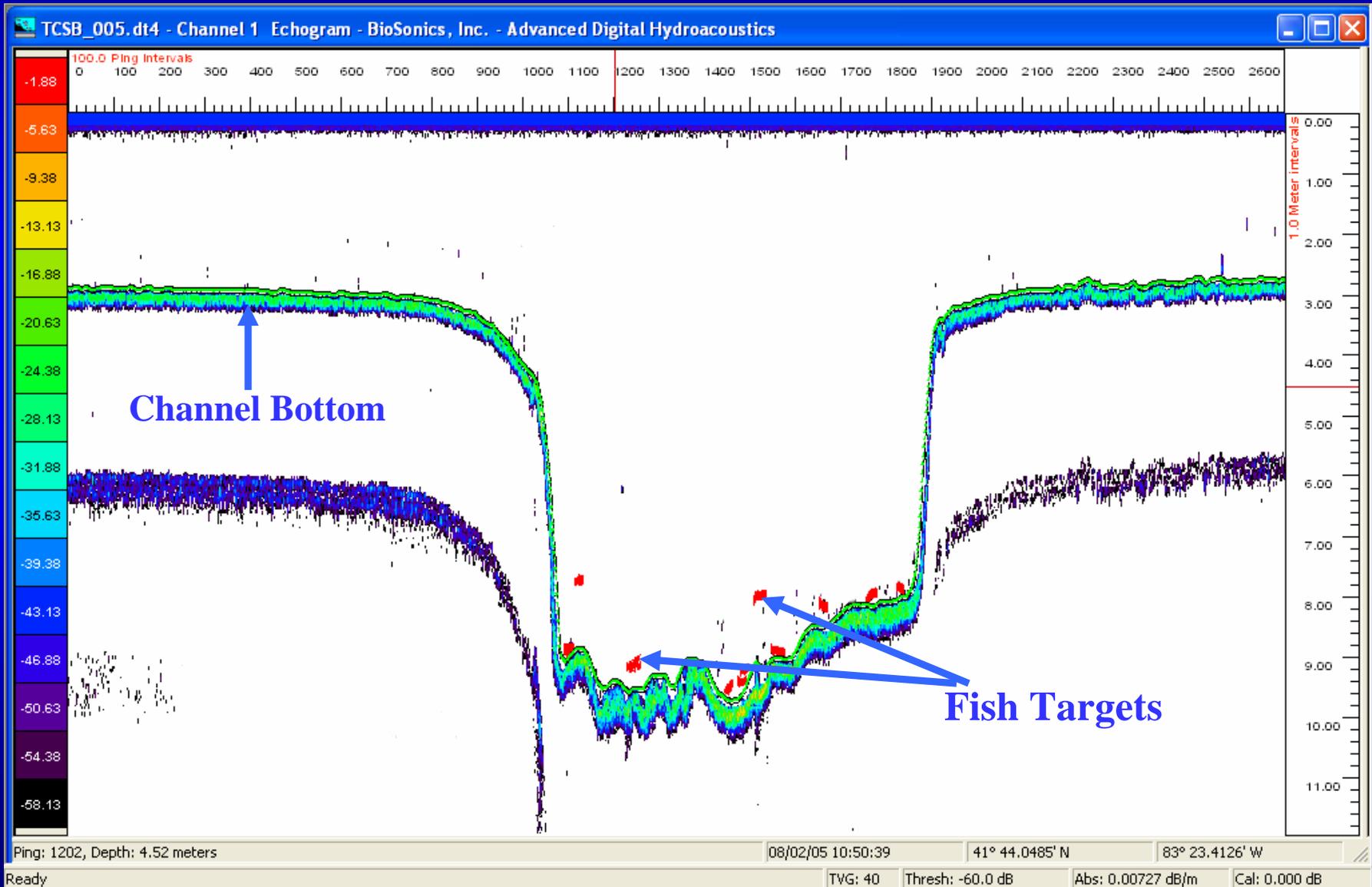


- Sensors deployed further from the channel and dredge during a 6 hour monitoring segment (OBS units at # 74 at 120 m and #73 at 160 m).

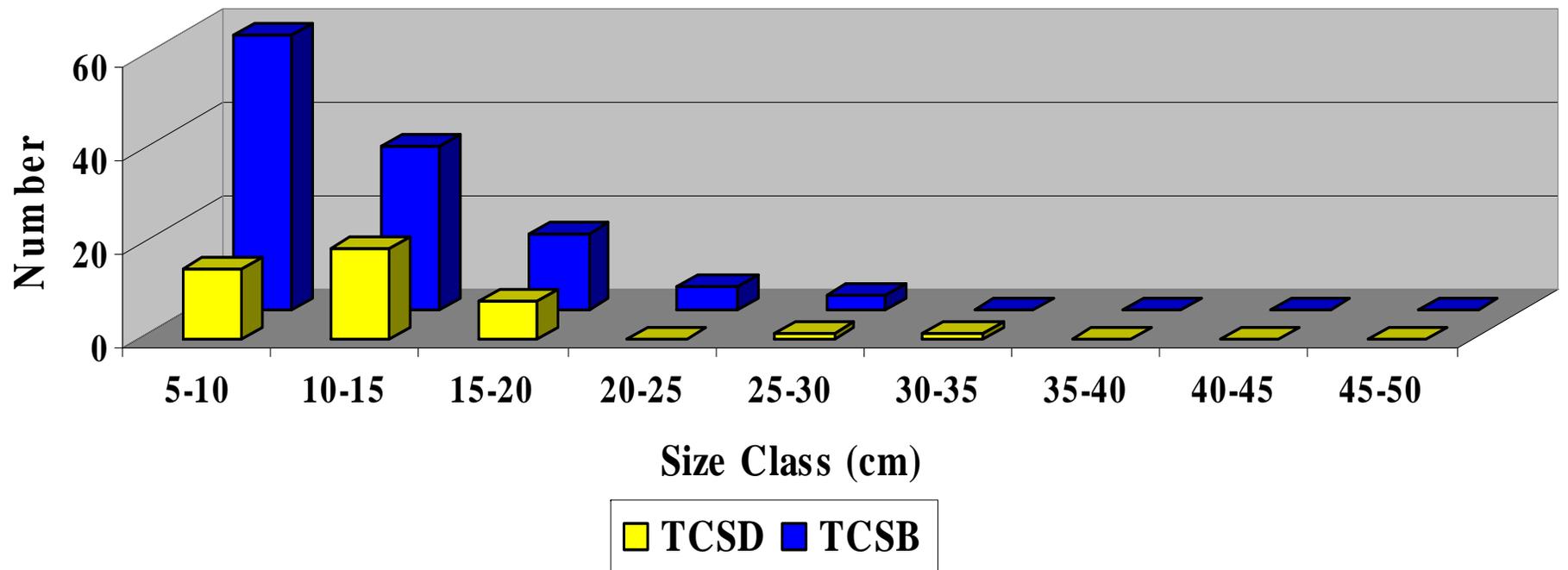
Fisheries Hydroacoustics



Example Fisheries Echogram (Maumee Bay Navigation Channel)

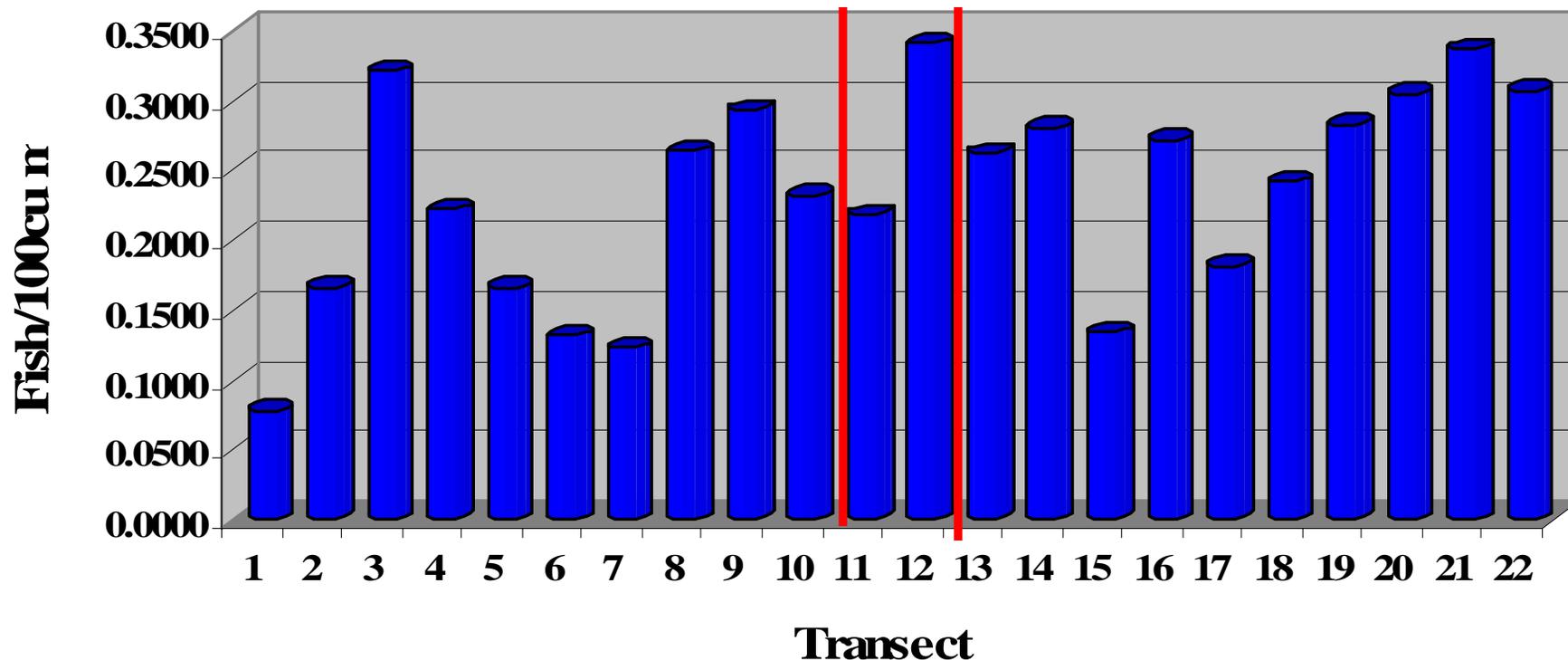


Fish Target Length Frequency Distribution (Maumee Bay)



Fish length distribution for two surveys (TCSB in the early morning and TCSD late afternoon) conducted on 2 August 2005.

Maumee Bay Fish Target Density



Mean = 0.23 fish/100 cu m

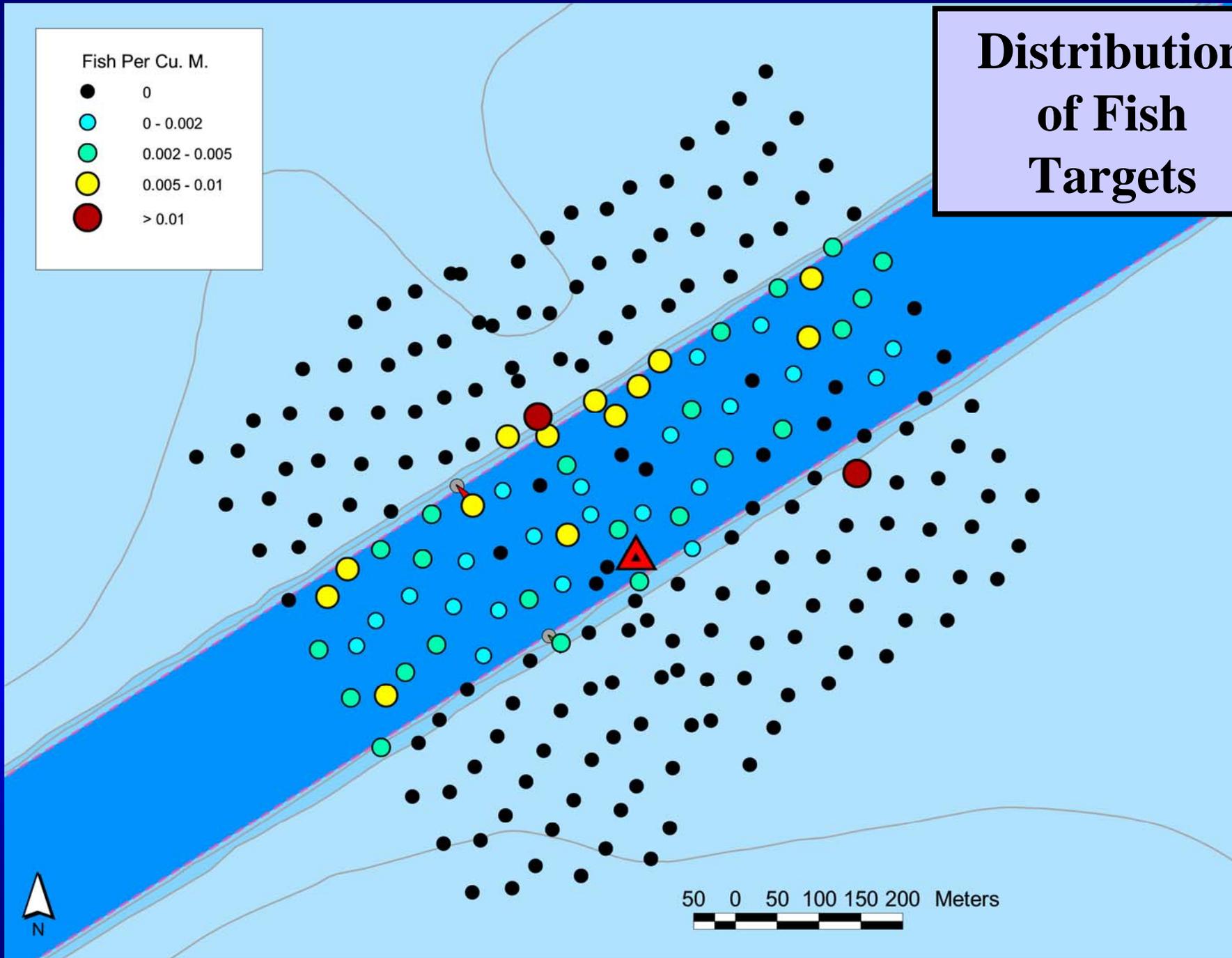
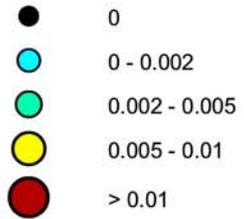
Transects 1-10 occupied 2 to 261 m downriver from dredge

Transects 11 and 12 occupied port and starboard

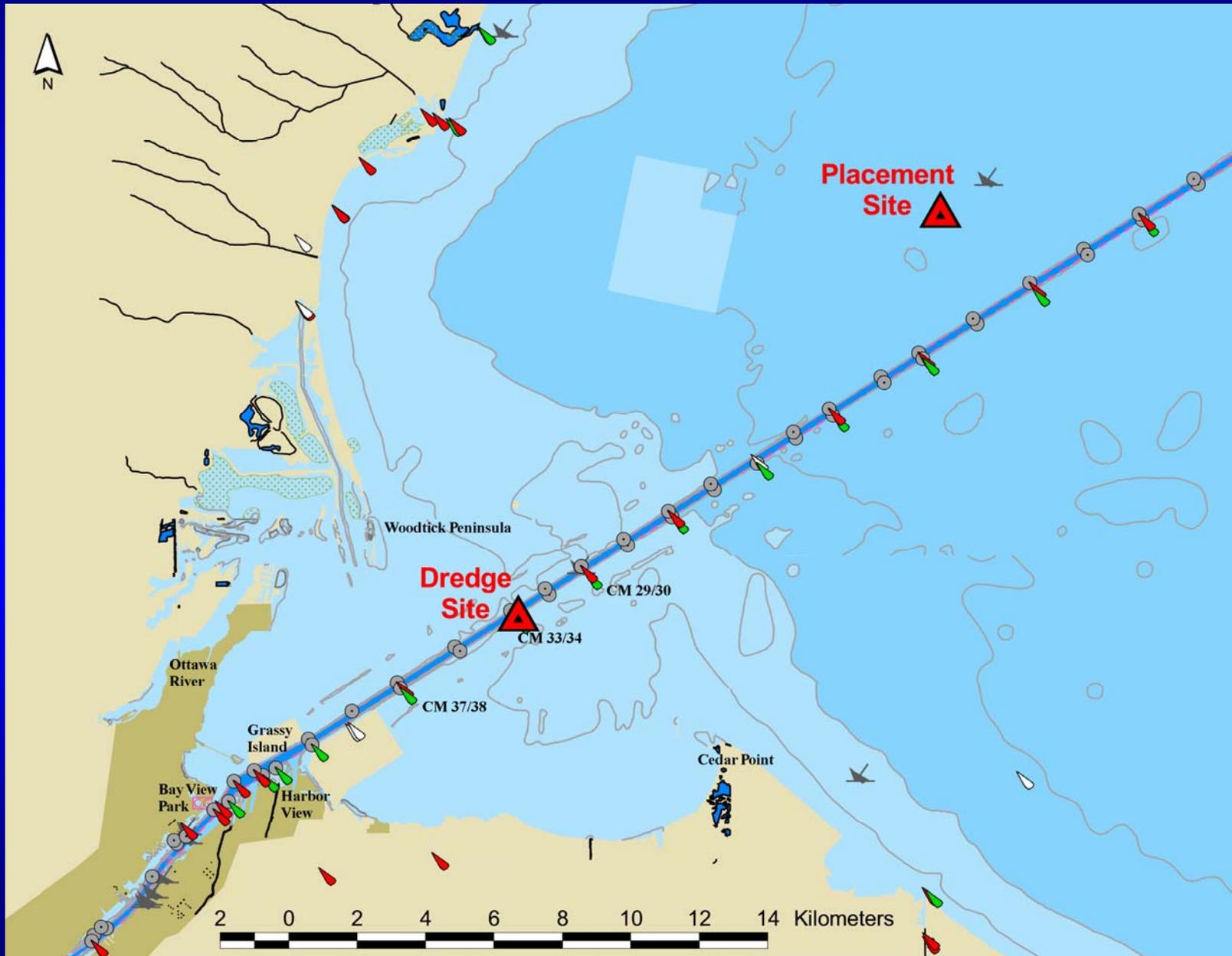
Transects 13-22 occupied 2 to 254 m upriver from dredge

Distribution of Fish Targets

Fish Per Cu. M.



Offshore Study Site

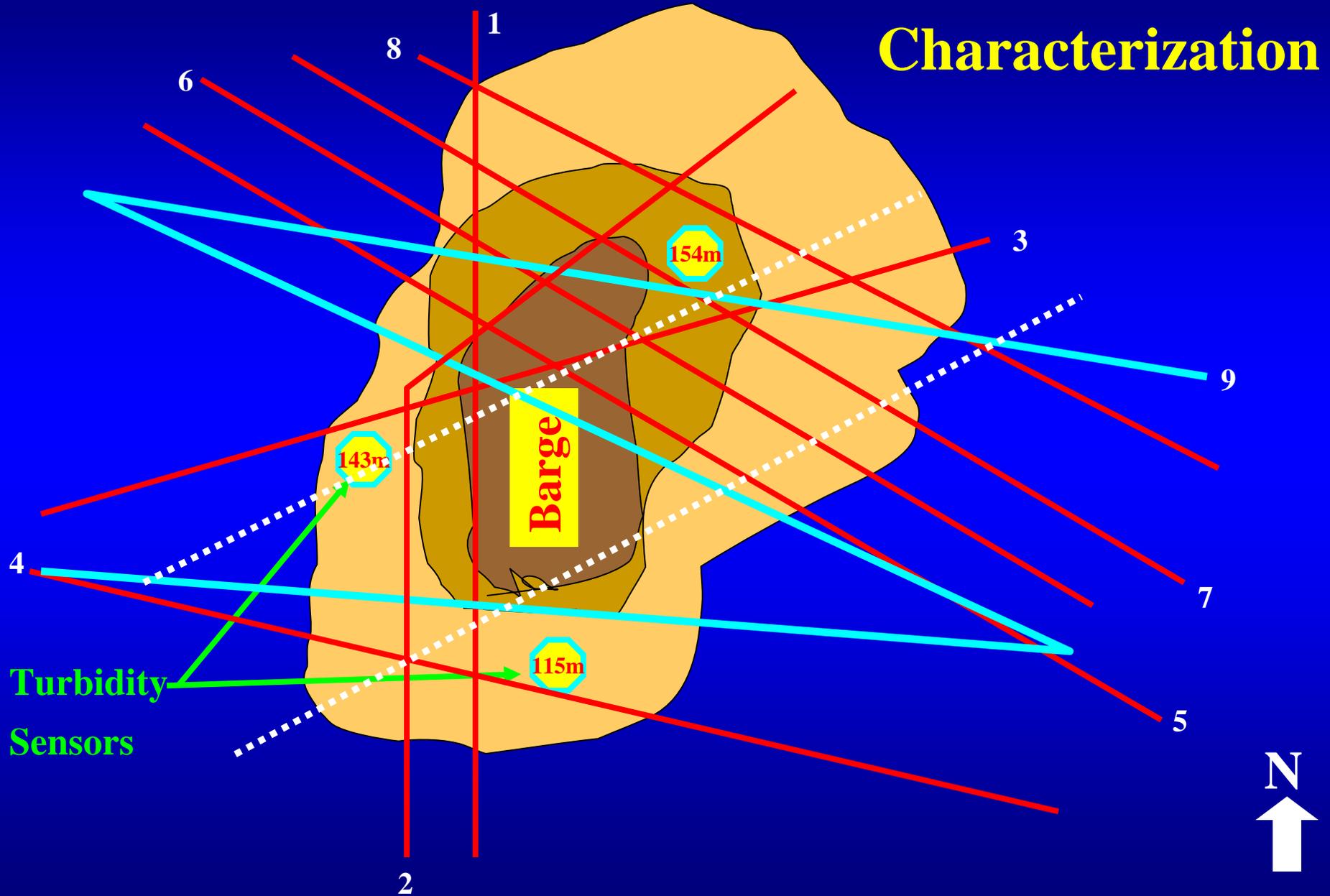


Barge Approaching Placement Site

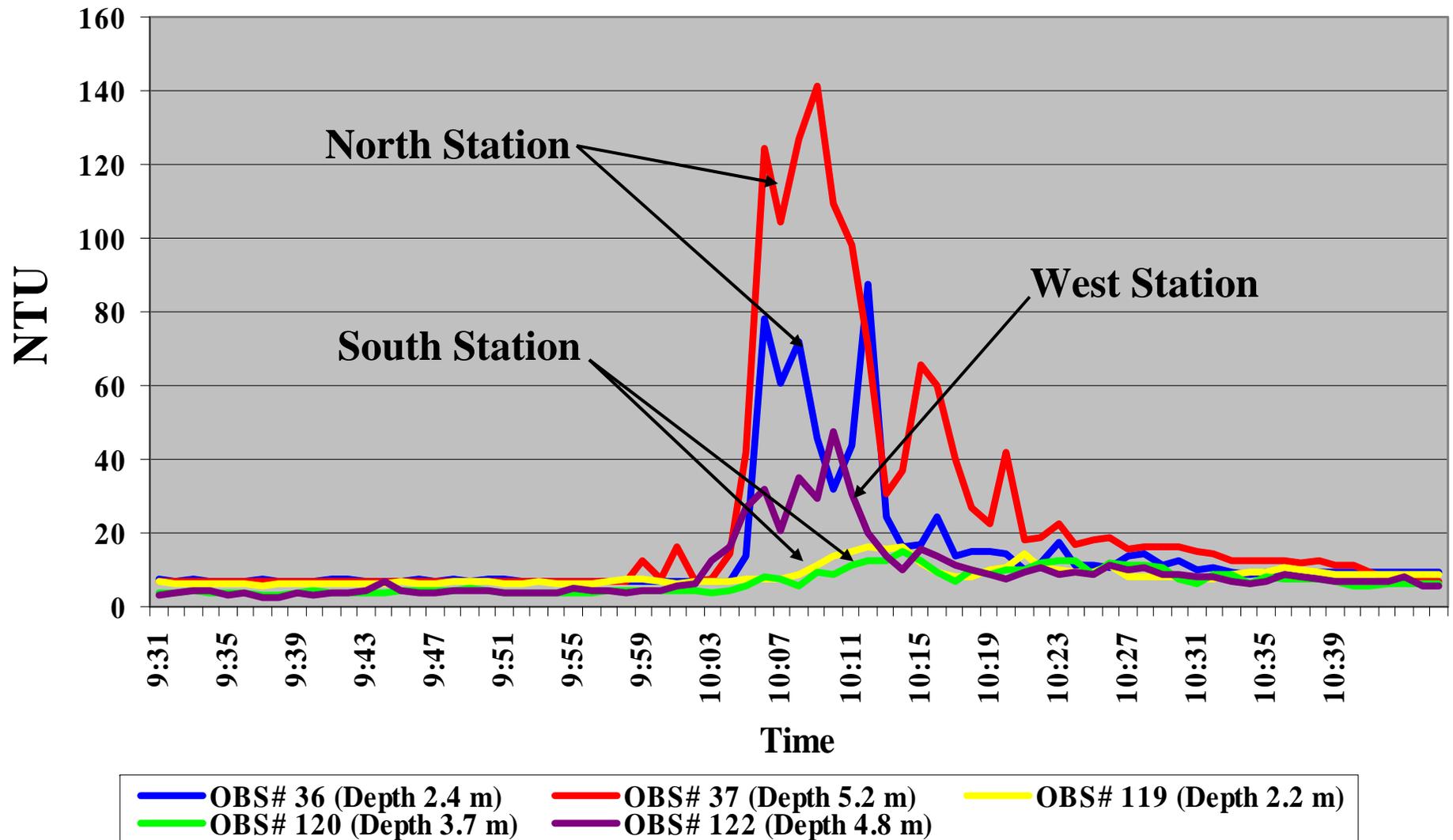


OBS Buoys

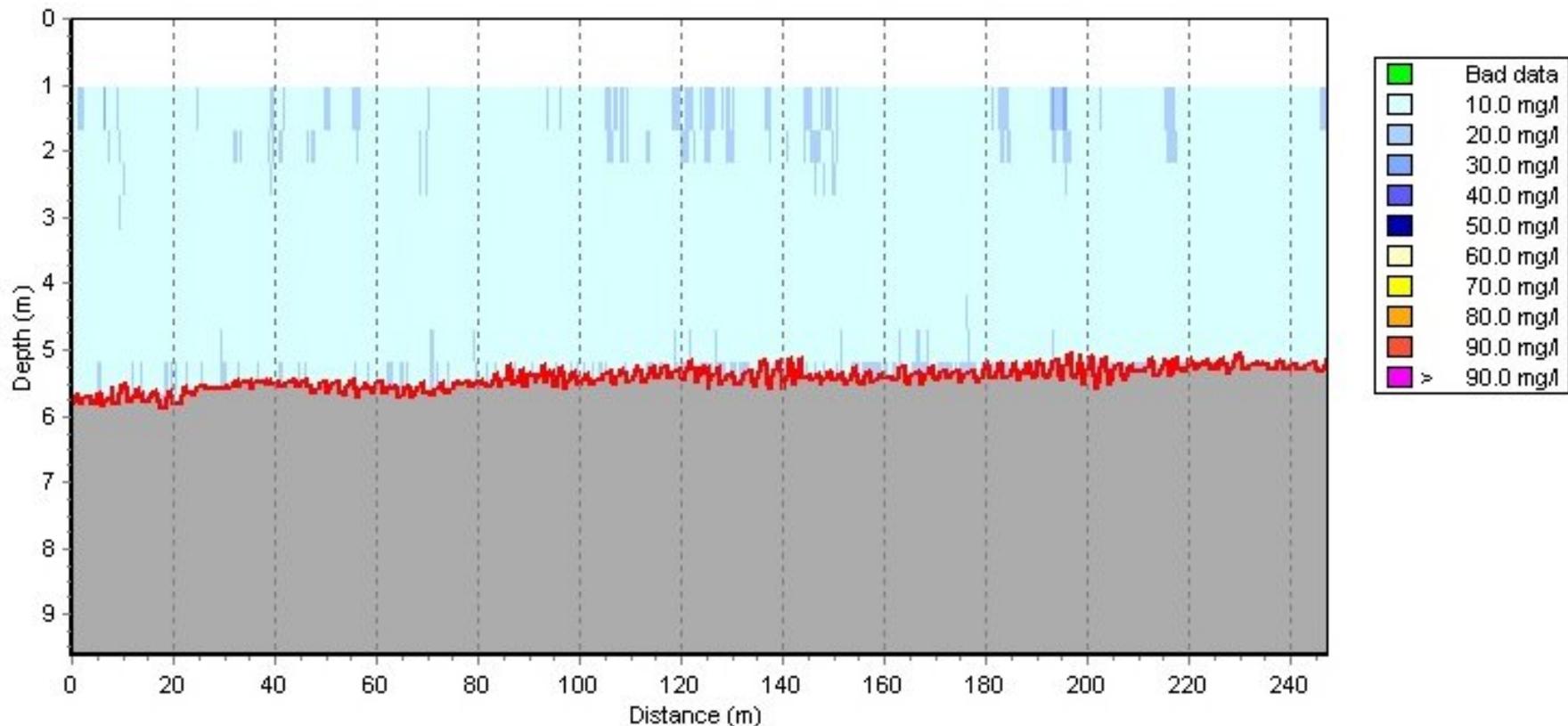
Offshore Plume Characterization



Turbidity at Offshore Placement Site



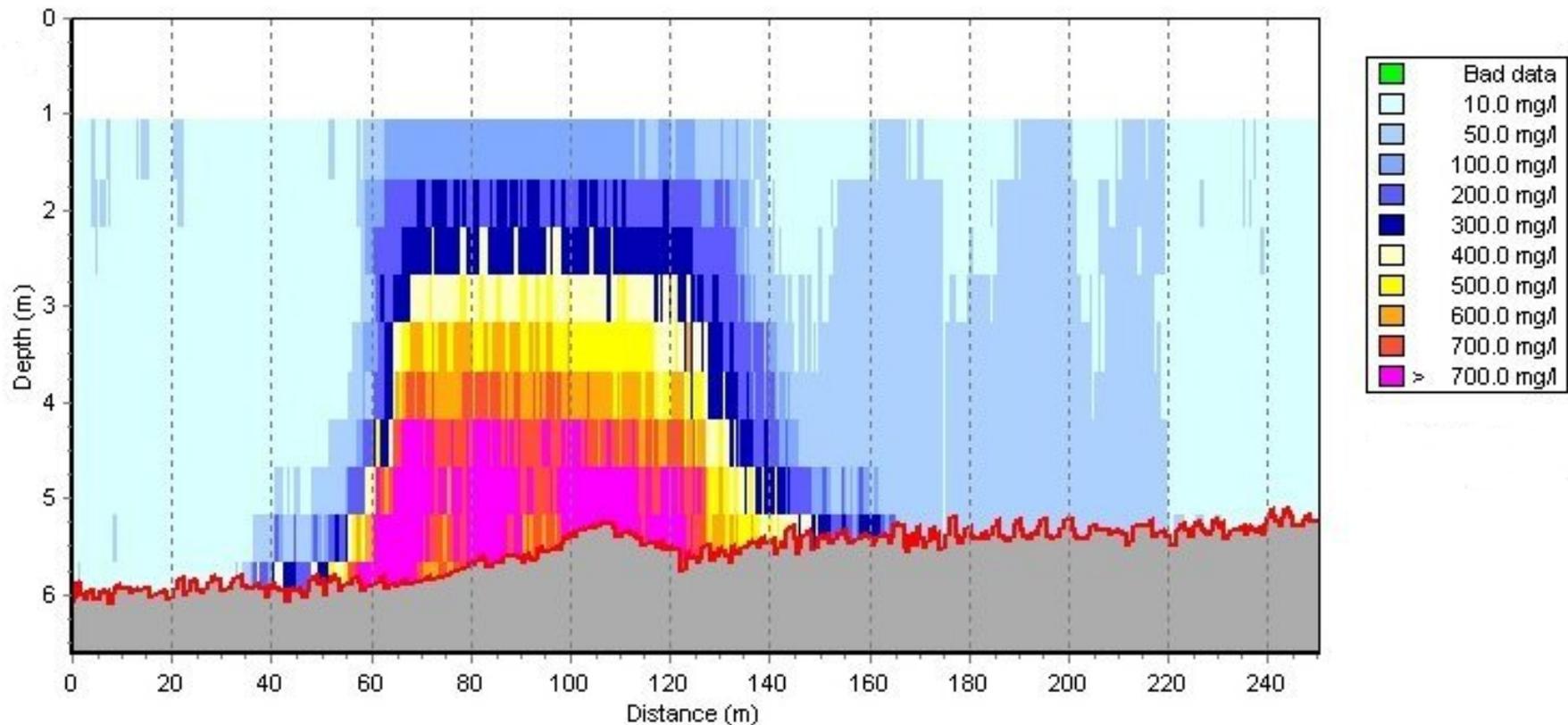
Ambient Conditions at Placement Site Prior to Disposal



Ambient conditions averaged < 10 mg/l at the offshore placement site on 4 August 2005

Plume Profile

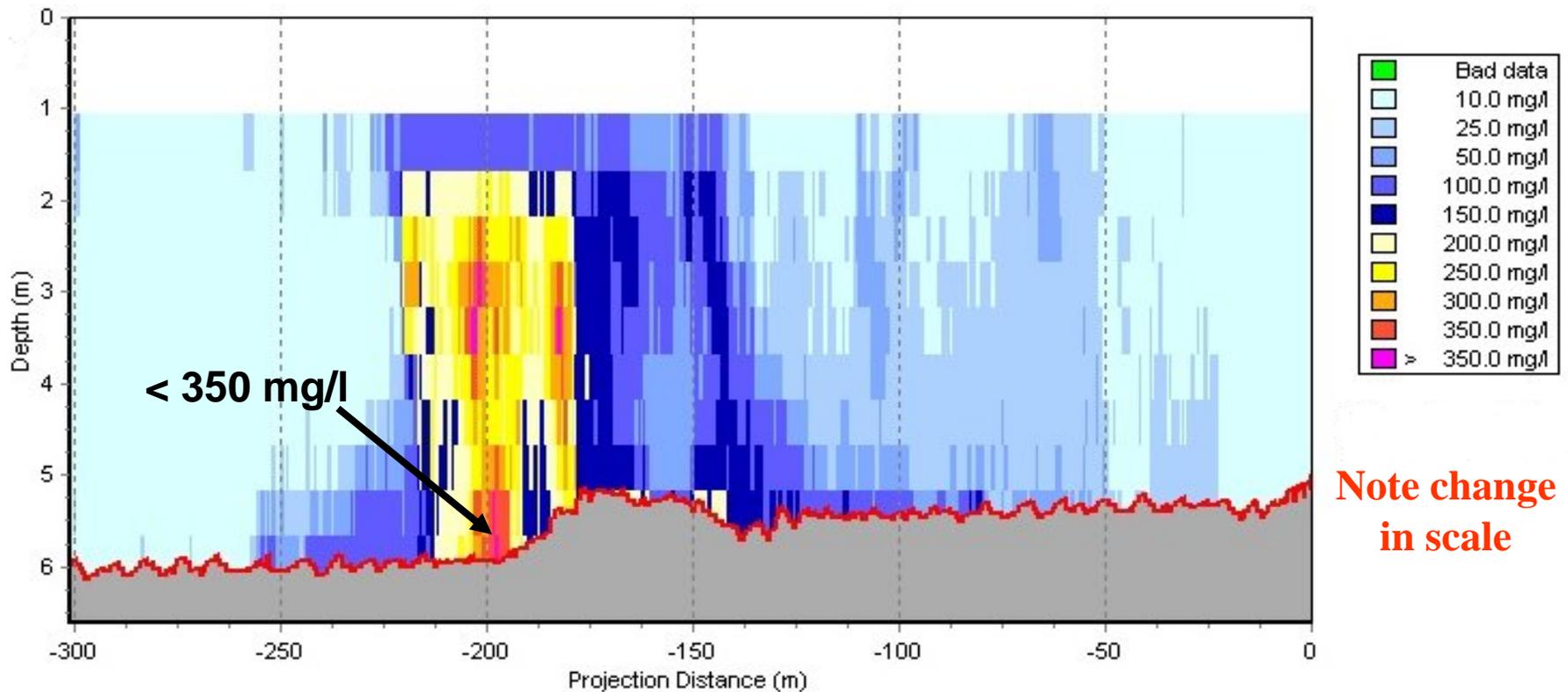
(N-S 10 m west of dump, 4 minutes post)



Near-field plume conditions immediately after sediment release. Peak TSS concentrations 1,100 mg/l

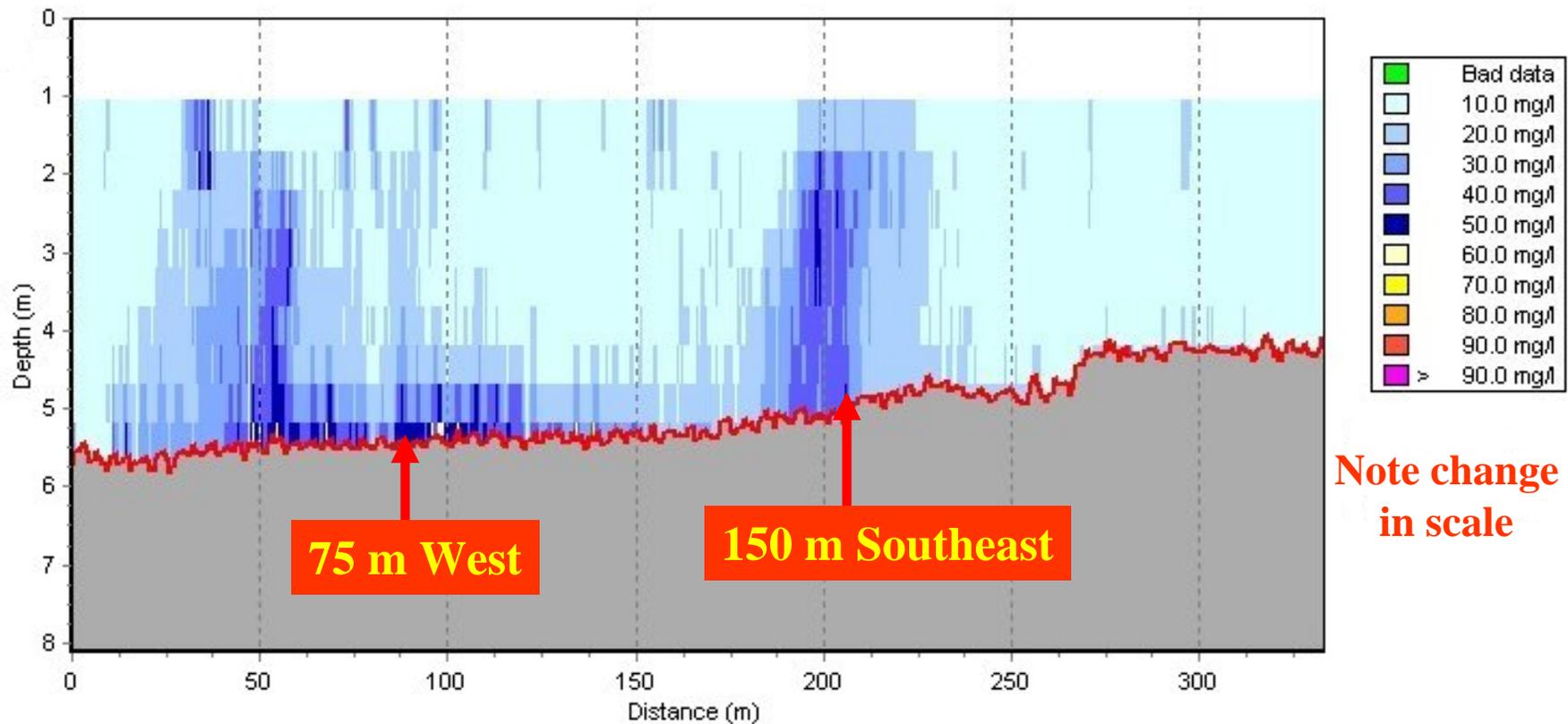
Plume Profile

(S-N 20 m west of dump, 8 minutes post)



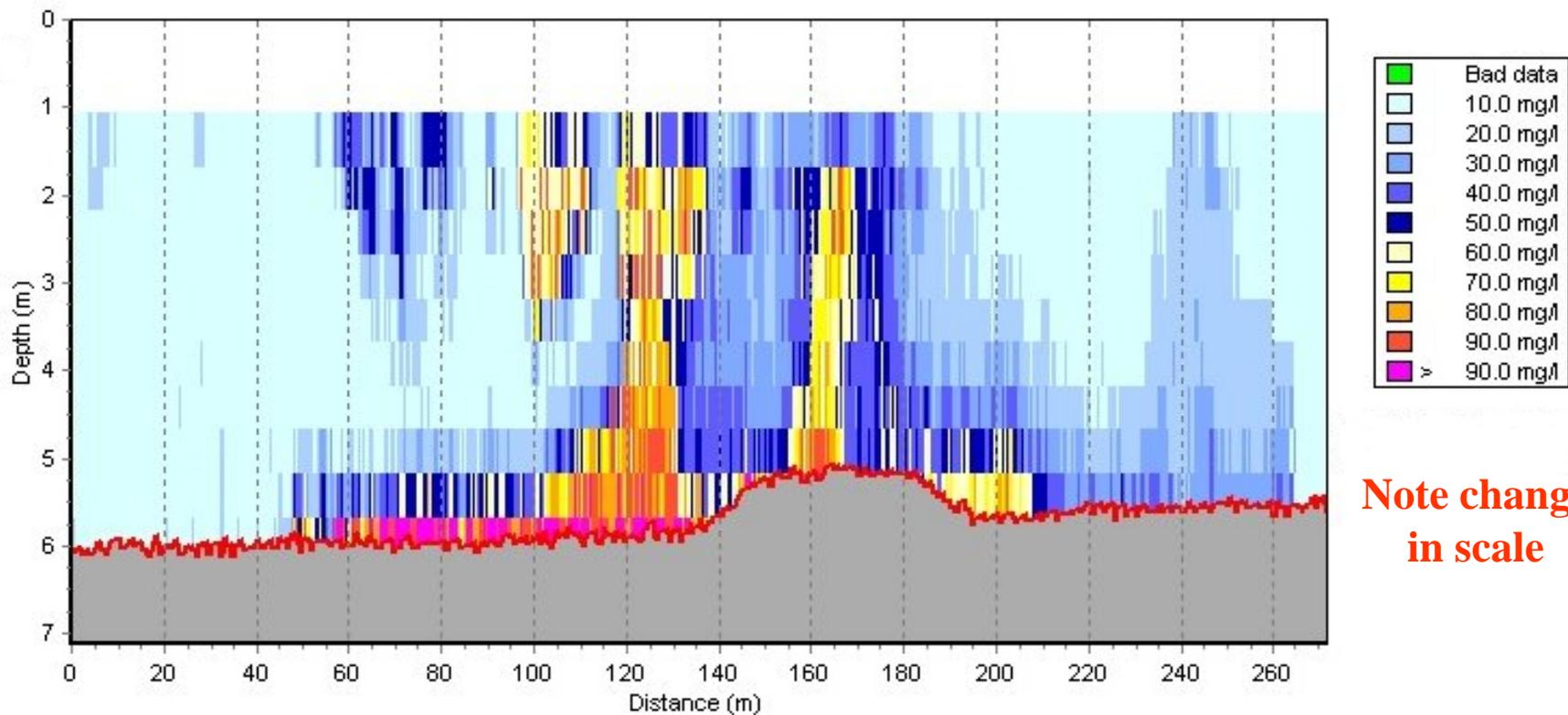
The bulk of the material released plunged directly to the bottom as a dense mass. TSS concentrations decreased by a factor of 2 in comparison with previous transect.

ADCP Plume Transect (12 minutes post-dump)



TSS < 50 mg/l both west and southeast of the release point
Maximum TSS 40 mg/l above background

ADCP Plume Transect (90 m northeast, 15 minutes post-dump)

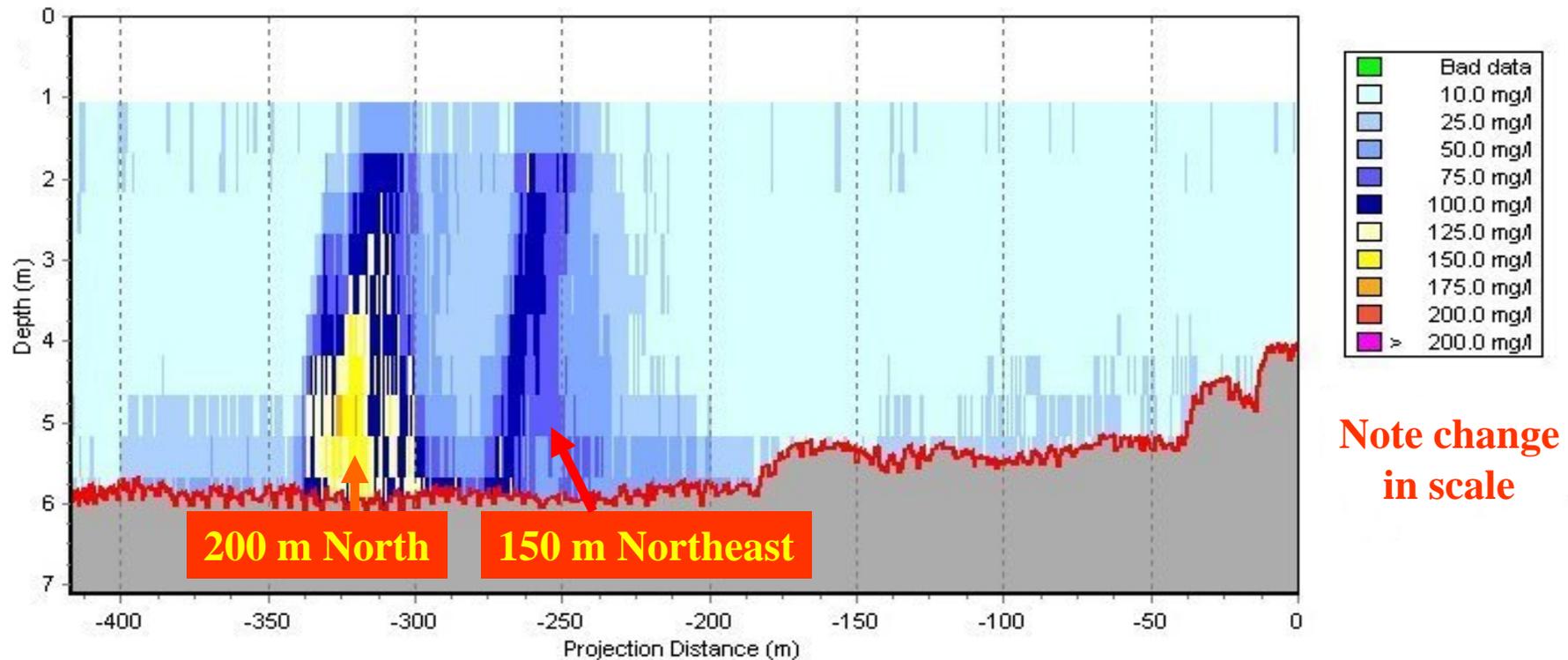


Note change
in scale

TSS values < 125 mg/l

Plume Profile

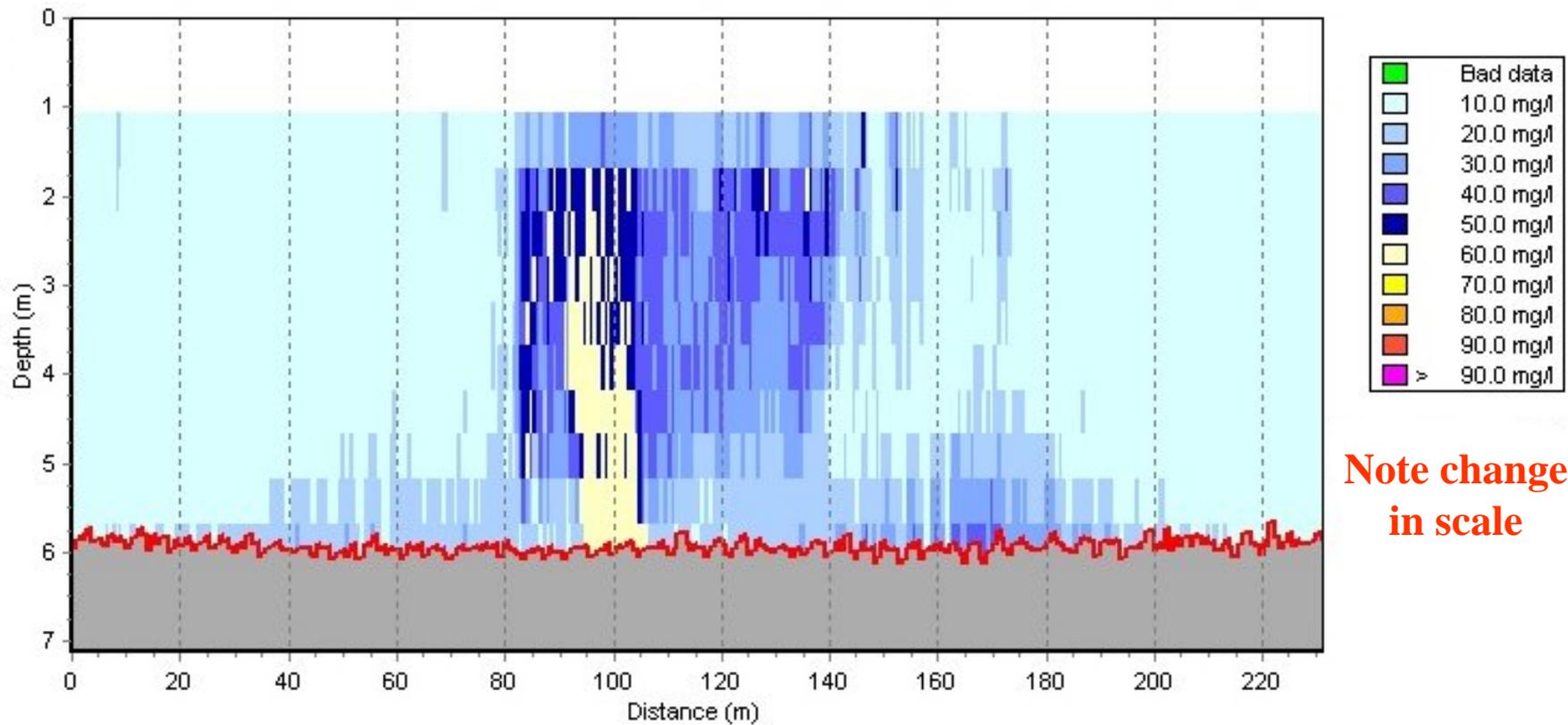
(150 m northeast, 20 minutes post-dump)



Maximum TSS concentration 175 mg/l at 200 m north of the release point

Plume Profile

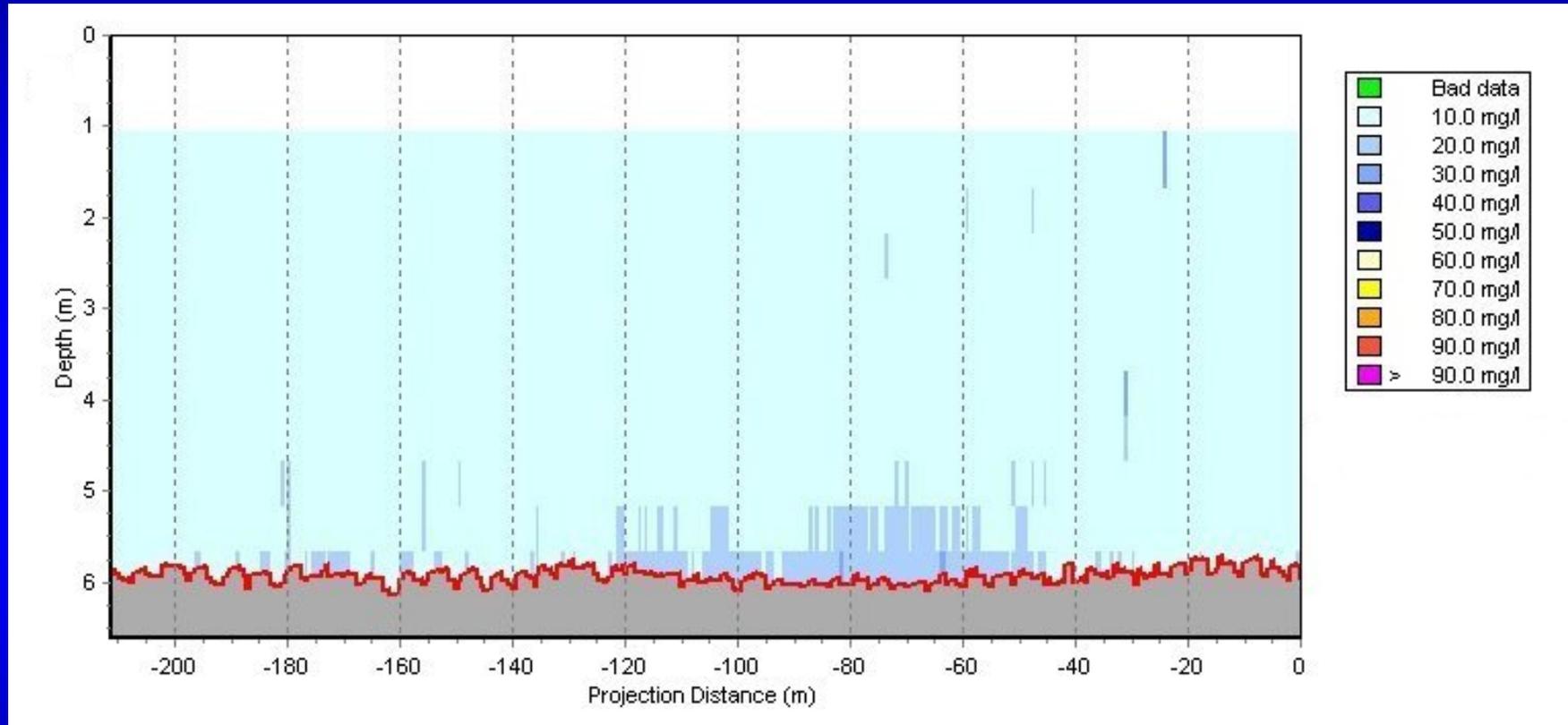
(215 m northeast, 23 minutes post-dump)



Maximum TSS concentration 70 mg/l at 215 m northeast of the release point

Plume Profile

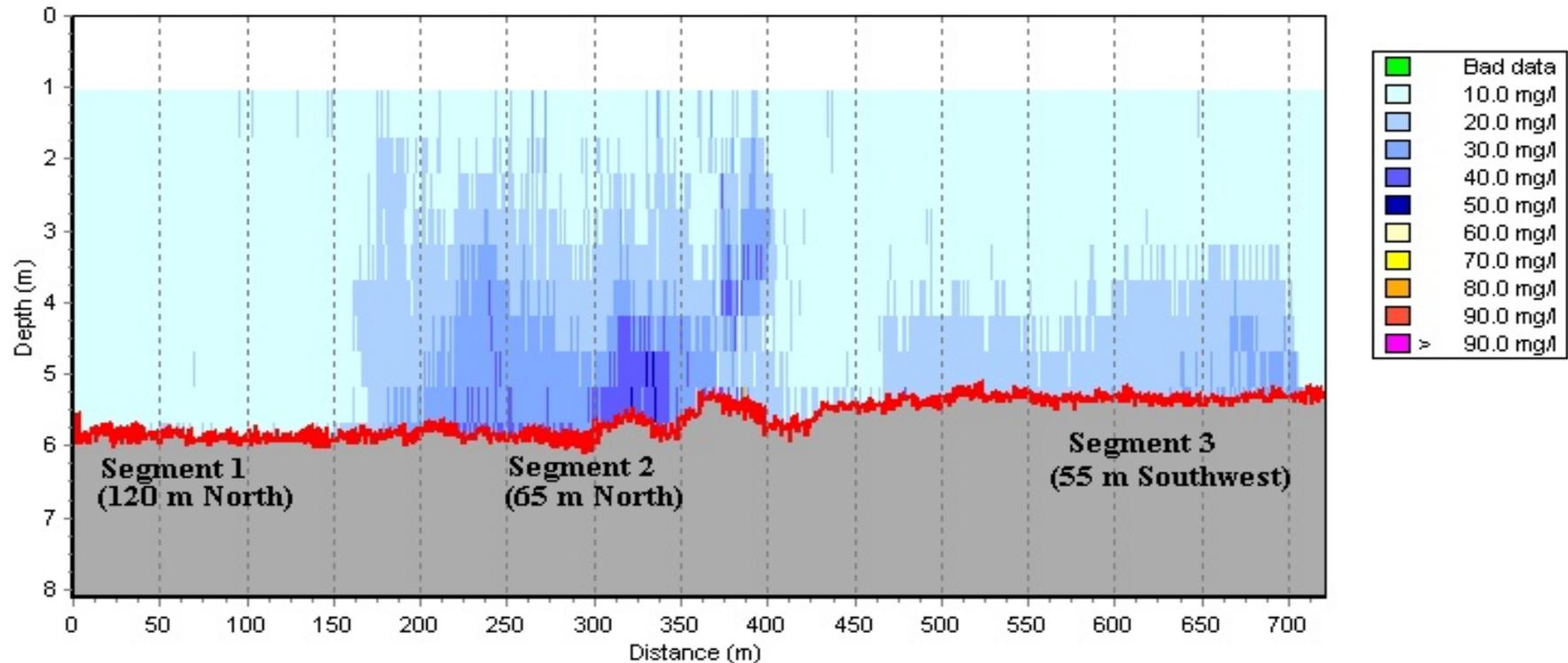
(265 m northeast, 25 minutes post-dump)



- **Traces of plume signature remain on bottom at 265 m northeast of the release point**
- **Return to background conditions within 340 m**

Plume Profiles

(Zig-zag transects, 38 minutes post-dump)



Maumee Bay Summary

- **Plumes produced by bucket dredging as conducted in this study can be described as relatively narrow bands of elevated TSS concentration that decayed rapidly within short distances from the source.**
- **The plan-view “footprint” of the plume was typically less than 75 m wide and extended no more than 200 m down-drift.**
- **Surface plumes were not detected beyond 60 m from the source.**

Maumee Bay Summary (Cont.)

- **At distances beyond 60 m, the plume remained well below the rim of the navigation channel.**
- **Plume movement was effectively confined by the channel side-slopes.**
- **Detectable plumes decayed to ambient conditions within 200 m of the source.**
- **No ADCP-based evidence was seen of plume excursion over the shoals (spawning grounds).**
- **Fish density averaged 0.23 fish/100 cu m.**
- **Fish targets were primarily in the relatively small 5-10 and 10-15 cm TL size classes.**

Offshore Summary

- **Background TSS concentration was < 10 mg/l.**
- **Maximum estimated TSS concentration 1,100 mg/l at 10 m from the release point, falling by $>$ than 50% over the next 10 m, indicating that most of the discharged sediment dropped as a dense mass directly to the lake bottom.**
- **A “pancake” effect was observed as suspended sediment dispersed in all directions from the release point.**

Offshore Summary (Cont.)

- **Net plume movement was in a northeasterly direction**
- **Background conditions present within 340 m after 30 minutes**

Conclusions

- **Given the relatively small spatial dimensions of the plume generated by the 15 cubic yard open bucket, the rapid plume decay rate, and the general confinement of the plume within the basin of the navigation channel, it is highly unlikely that similar bucket dredging operations in Maumee Bay pose a meaningful risk to walleye spawning habitat.**

Conclusions

- **Under conditions prevailing at the placement site, little evidence of short-term, far-field transport of sediment as suspended sediment plume was observed.**
- **Observed disposal plume behavior consistent with monitored events elsewhere**

Questions ?



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