Effects of Recreational Boating on the Upper Mississippi River System

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Technical Work Group
Effects of Recreational Boating

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Primary Physical Effects

- **Wake waves**
- **Propeller jets**
- **Noise**
- **Exhaust**

Secondary Physical Effects

- Sediment resuspension
- Bank erosion

Biological Effects

- Effects on aquatic plants
- Disturbance of fish
- Disturbance of wildlife
- Fish entrainment, impingement

Recreational Boating is Popular...
Big Business on the UMRS

- 6.9 million boater-days/year
- 2.6 million boat trips/year
- >600 developed boat access sites
- >18,000 marina slips
- 217,364 recreational boat lockages in 1999

Recreational Boating Forecast and Allocation Model

(Carlson et al. 2000)

Unconstrained traffic

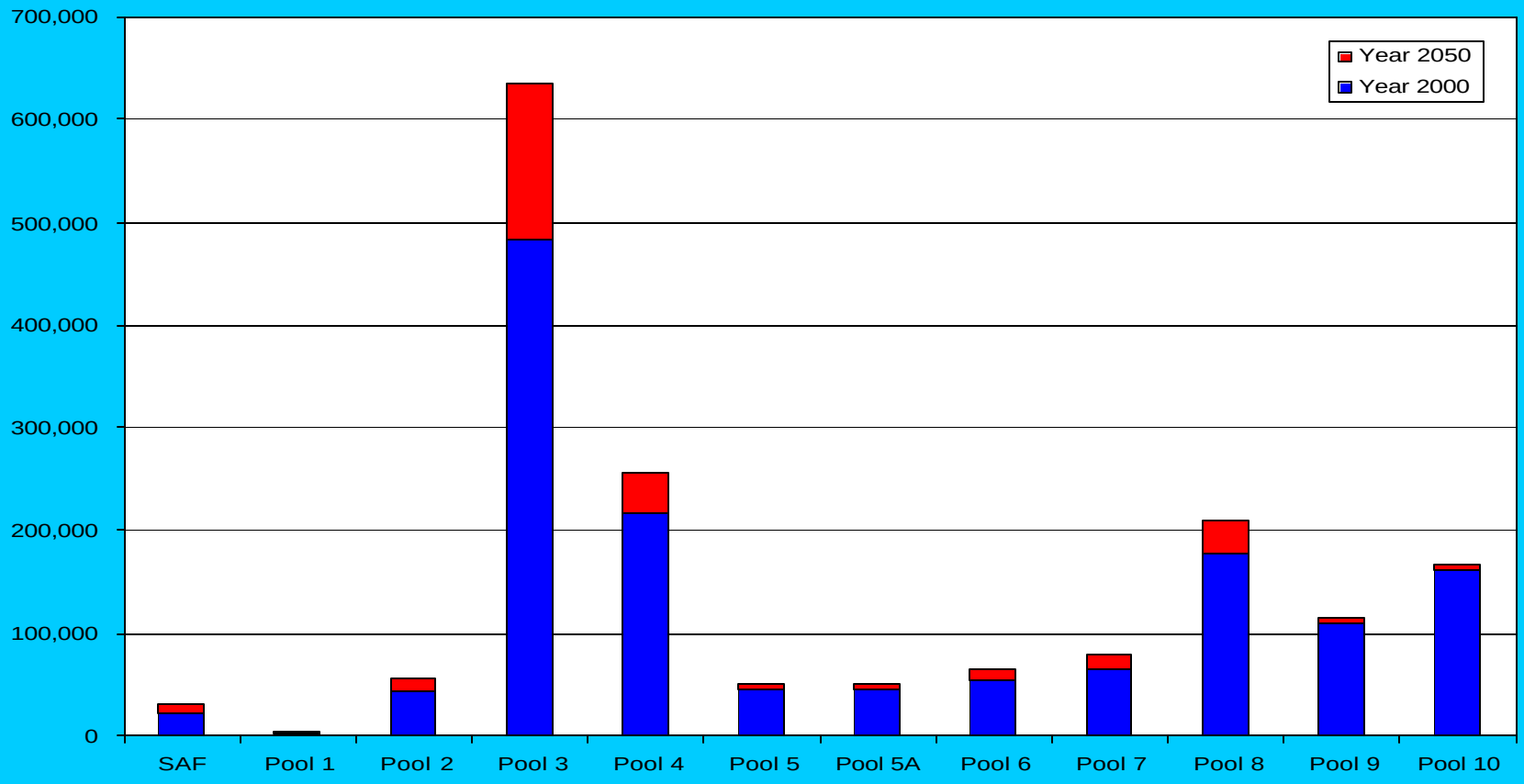
Years 2000 - 2050

Total growth on UMR ~ 19.6%

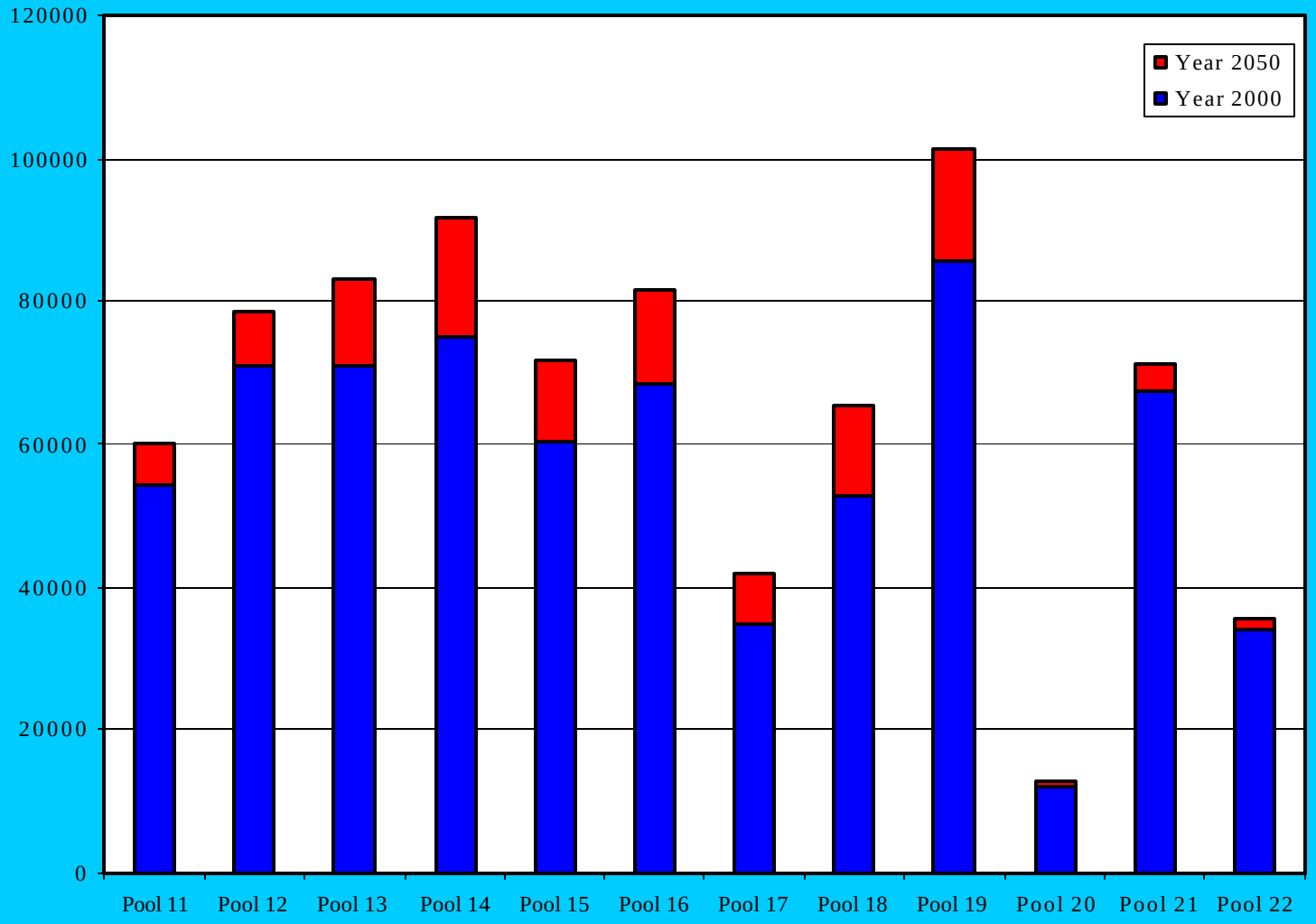
Total growth on IL River ~ 22%

Highest near metropolitan areas

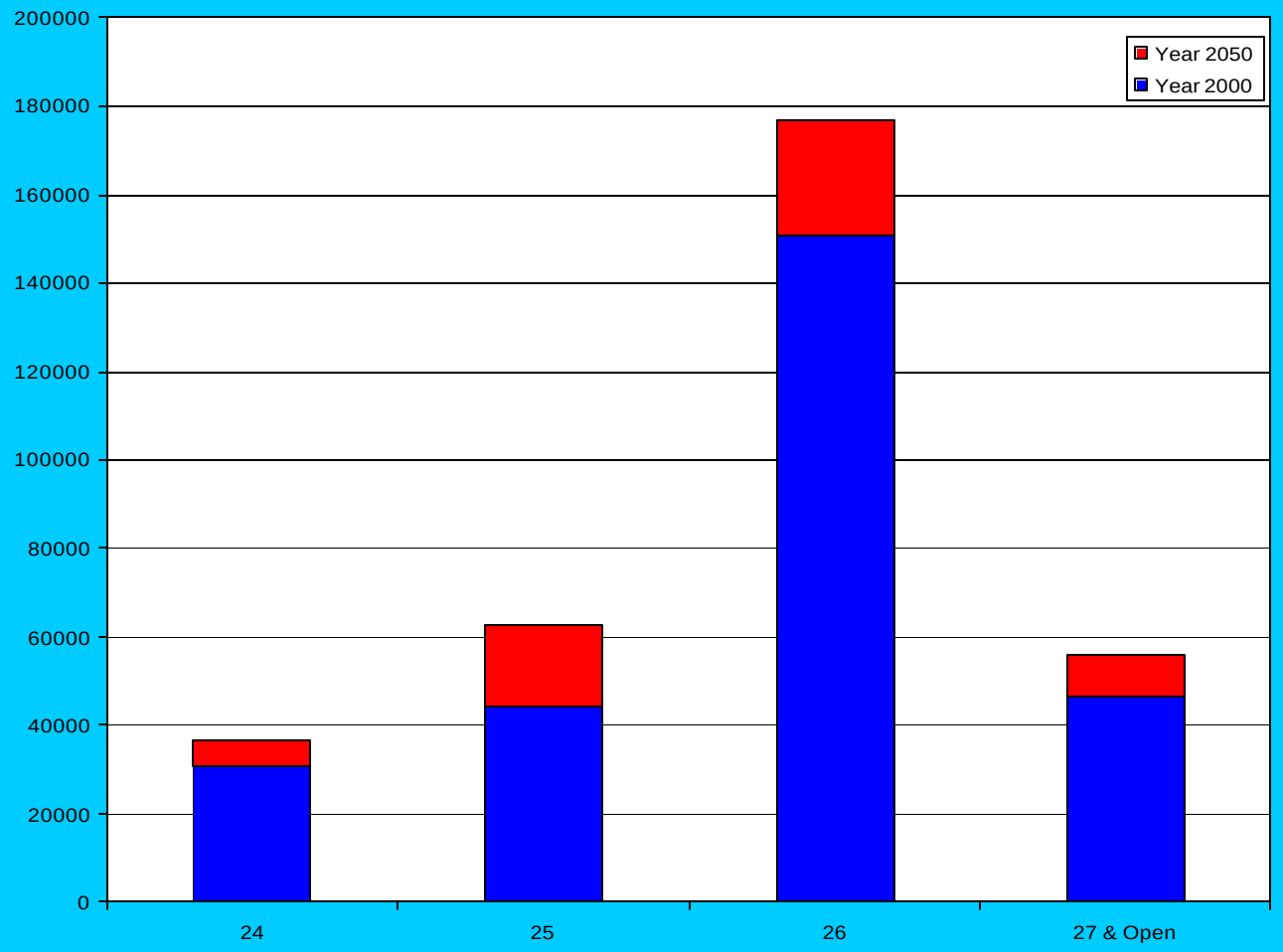
Recreational Boating Traffic Forecast - UMR St. Paul District



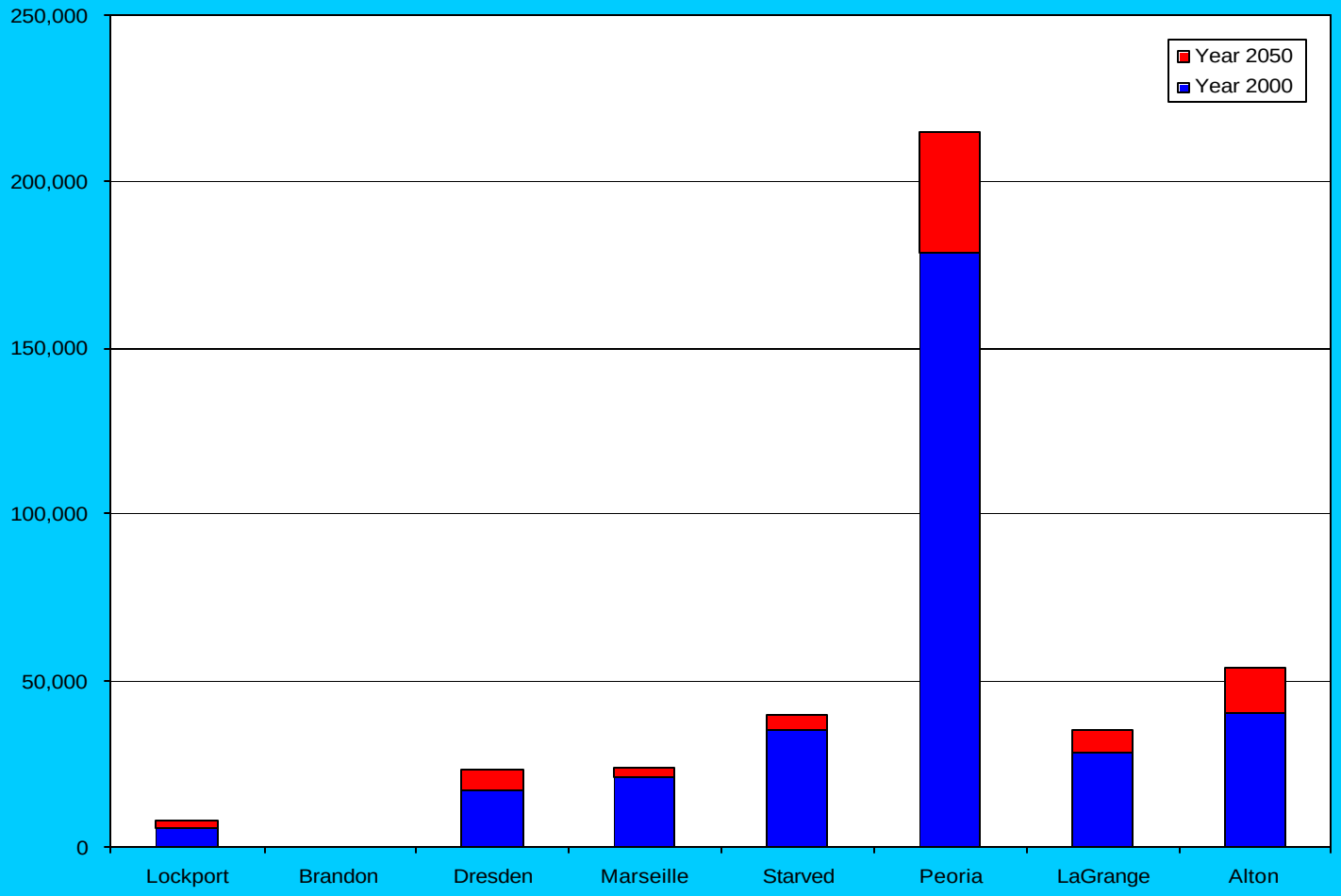
Recreational Boating Traffic Forecast - UMR Rock Island District



Recreational Boating Traffic Forecast - UMR St. Louis District



Recreational Boating Traffic Forecast - Illinois River

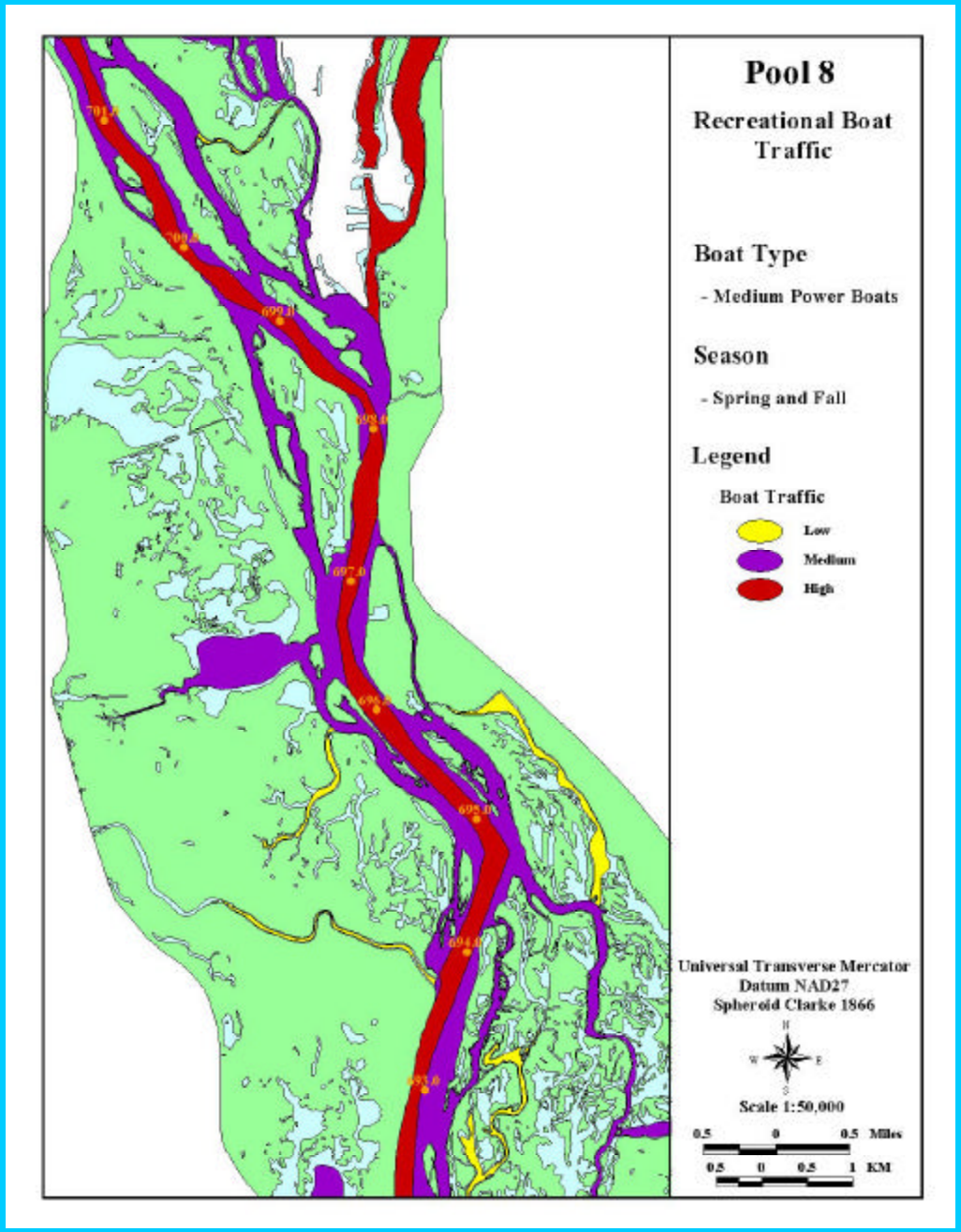


Sequence of recreational boating traffic allocation model development

- Trips /Year / Pool
- Trips / Year / Boat Class
- Trips / Month / Boat Class
- Trips / Day / Boat Class
- Trips/ Day / Boat Class / Navigated Area
- Passes / Day / Boat Class / Navigated Area

Percent by Vessel Class of Boats on the Water Summer of 1996 on the Upper Mississippi and Illinois Rivers Averaged Over All Locations

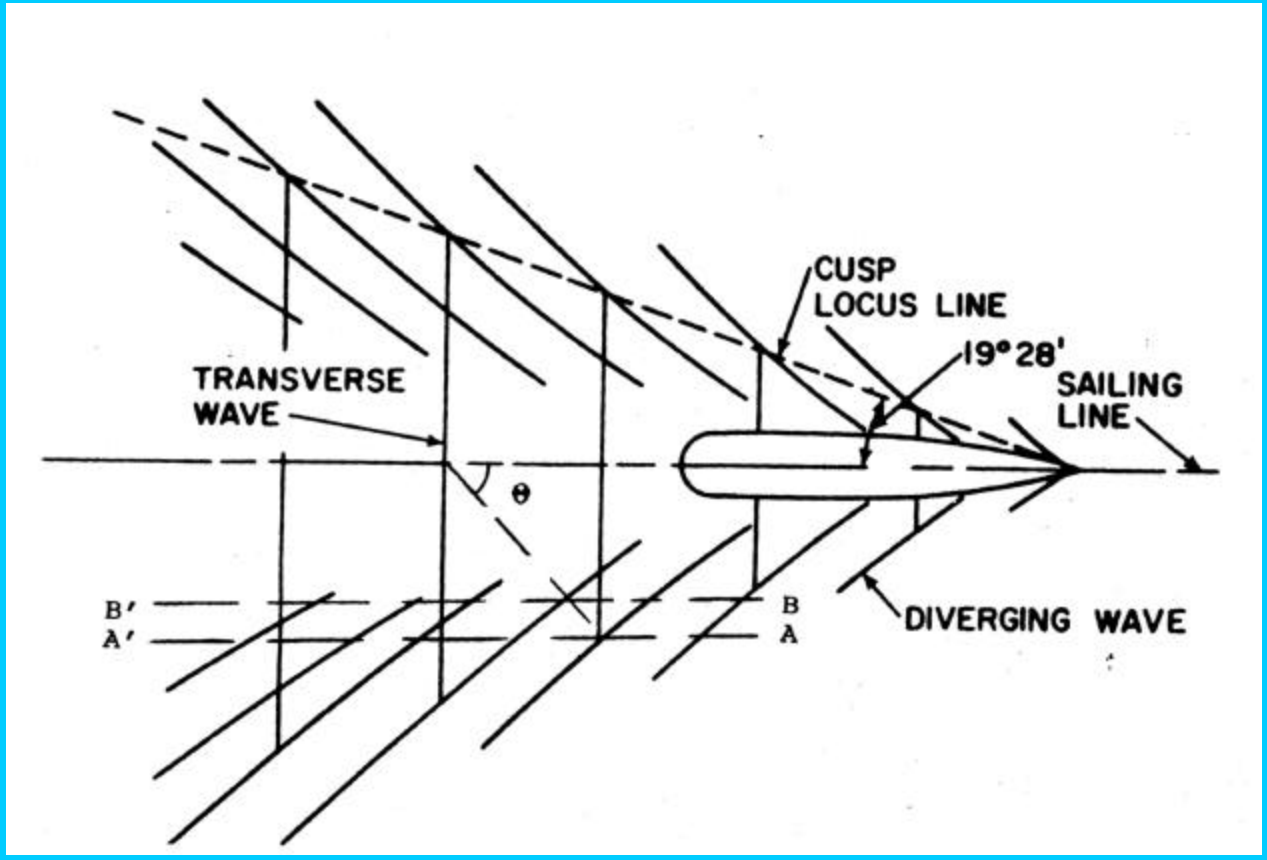
• **Sailboats**	**0.20%**
• **Fishing Boats**	**23.41%**
• **Pontoon Boats**	**2.78%**
• **Jet Skis**	**6.35%**
• **Medium Power Boats**	**40.48%**
• **Large Cruisers**	**24.01%**
• **Houseboats**	**2.78%**



Navigated Areas

GIS

Wake Wave Pattern

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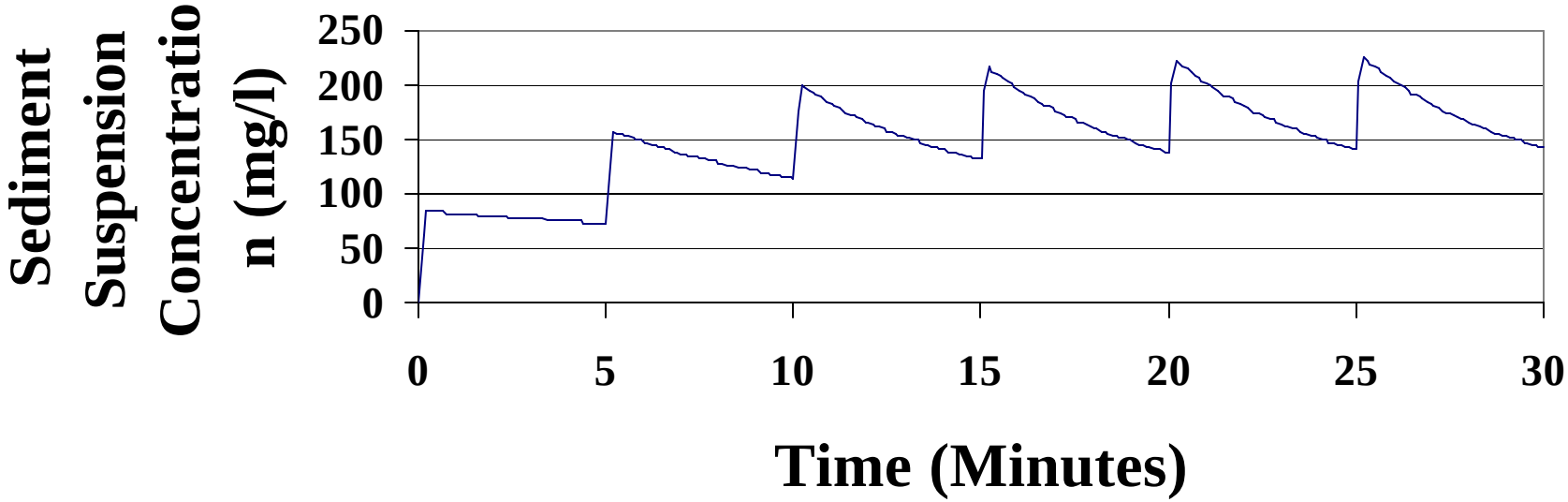
Maximum Wake Wave Heights

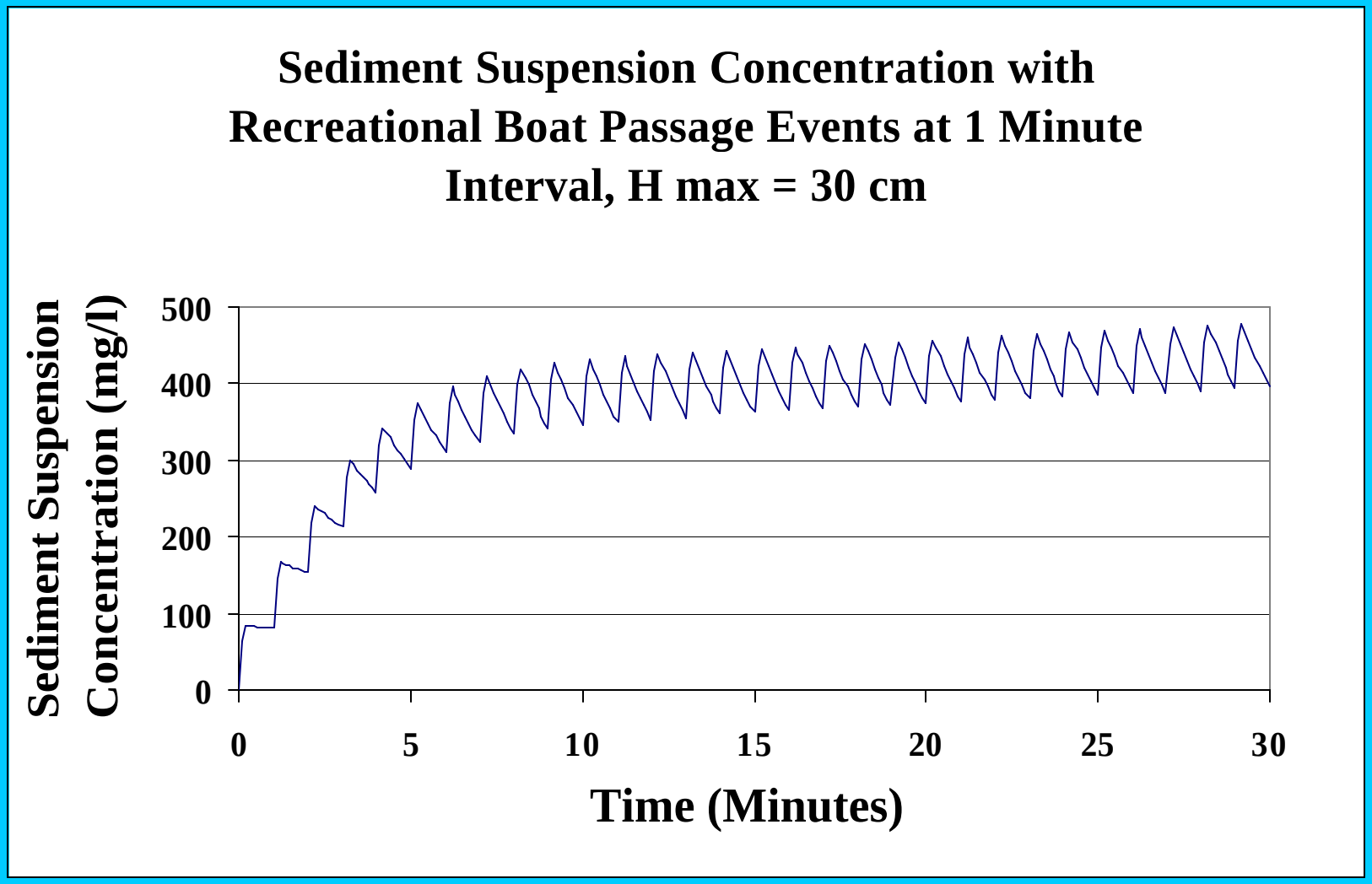
Vessel Type	Distance from Sailing Line		
	0 to 100 ft	100-300 ft	300-500 ft
Sailboats	N/A	N/A	N/A
Jet Skis	8 cm	4 cm	0
Fishing Boats	16 cm	8 cm	4 cm
Pontoon	8 cm	4 cm	4 cm
Medium Power	24 cm	20 cm	10 cm
Large Cruisers	50 cm	40 cm	20 cm
House boats	8 cm	4 cm	4 cm

Comparison of characteristics of typical wake waves generated by tow boats and recreational boats

Parameter	Commercial tow boat and barges	Recreational Boat
Duration of a single event	400 seconds or about 7 minutes	24 seconds
Number of waves in one event	200	12
Initial wave height	2 cm	2 cm
Occurrence of maximum wave height	Wave #25	Wave #3
Intermediate wave height	Wave #75	Wave #6
Ending wave height	2 cm	4 cm
Period of each wave	2 sec	2 sec

Sediment Suspension Concentration With Recreatinal Boat Passage Events at 5 Minutes Interval, H max = 30 cm




Sediment Suspension Concentration with Recreational Boat Passage Events at 1 Minute Interval, H max = 30 cm
Sediment Suspension Concentration (mg/l)
500
400
300
200
100
0
0
5
10
15
20
25
30
Time (Minutes)

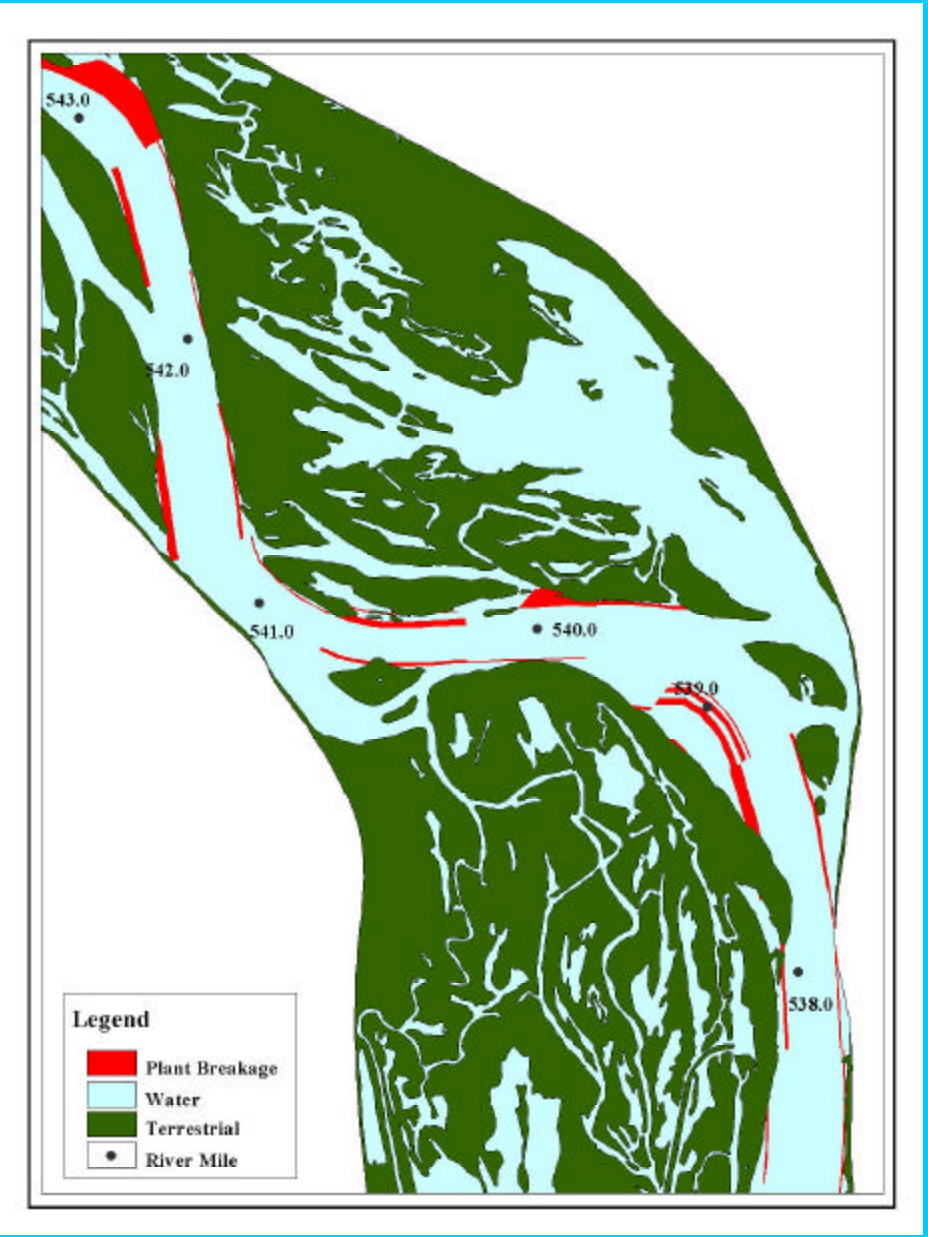
Equilibrium sediment concentrations (mg/L) resuspended by recreational boat wake waves

Wave height (cm)	Equilibrium sediment concentration (mg L^{-1}) at various inter-arrival times					
	1 min.	5 min.	10 min.	20 min.	30 min.	60 min.
10	$1.0X10^{-3}$	$4.1X10^{-4}$	$2.8X10^{-4}$	$2.0X10^{-4}$	$1.7X10^{-4}$	$1.3X10^{-4}$
20	325	110	78	58	50	38
30	865	230	160	110	95	75
40	800	330	240	175	140	110
50	1070	470	350	250	225	180

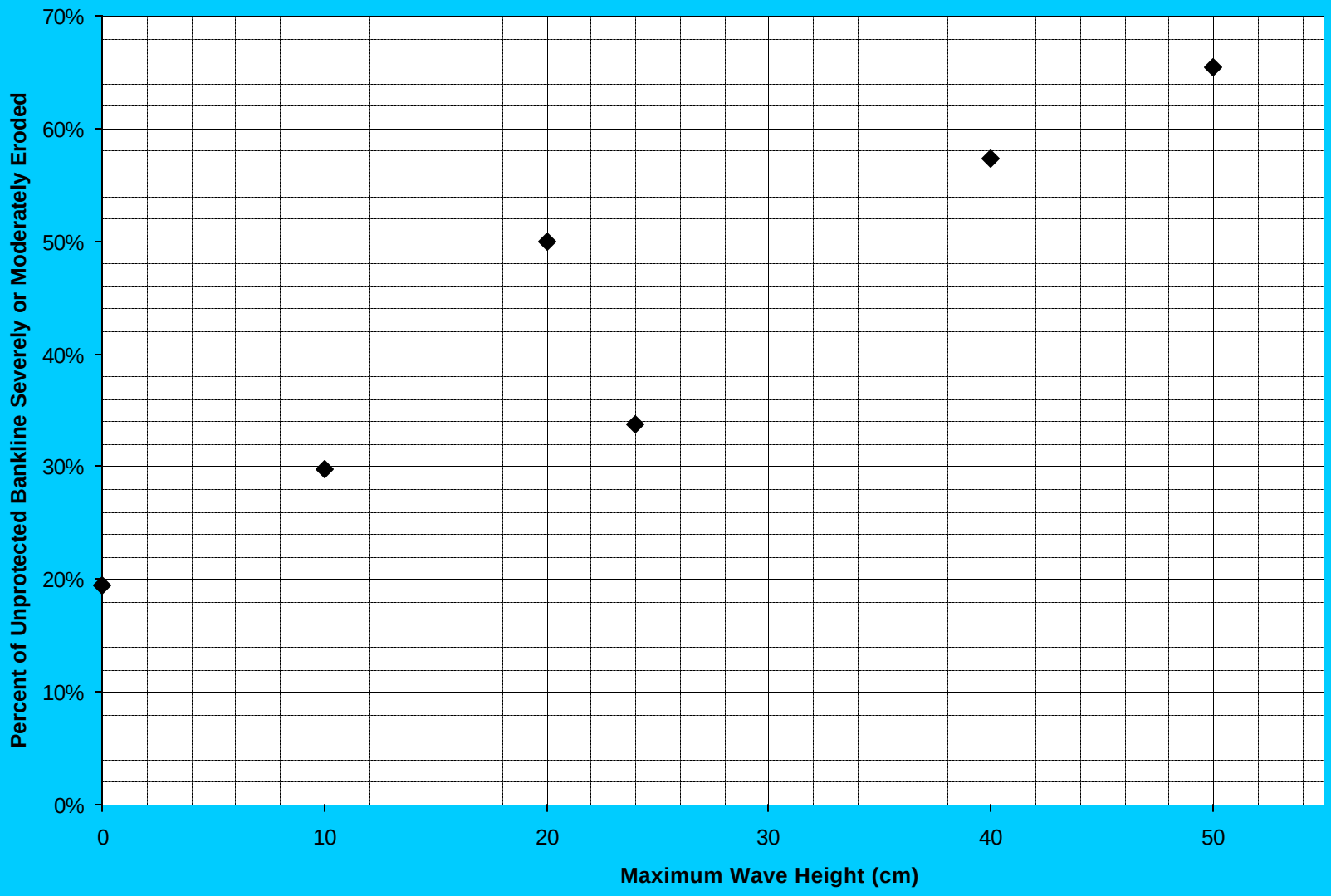
Estimated Reduction of Aquatic Plant Growth Due to Sediment Resuspended by Recreational Boats

Vessel Type	Navigation Pool	% Total Biomass Reduction	
		Wild Celery	Sago
Jet ski	none	0	0
Fishing boat	4, 7, 8, 9, 10	0 % to 9 %	0% to 6%
Medium powerboat	4 through 12	34 % to 79%	5% to 71%
Large cruiser	All 4 - 13	8% to 100%	1% to 100%
House boat	none	0	0
Pontoon	none	0	0

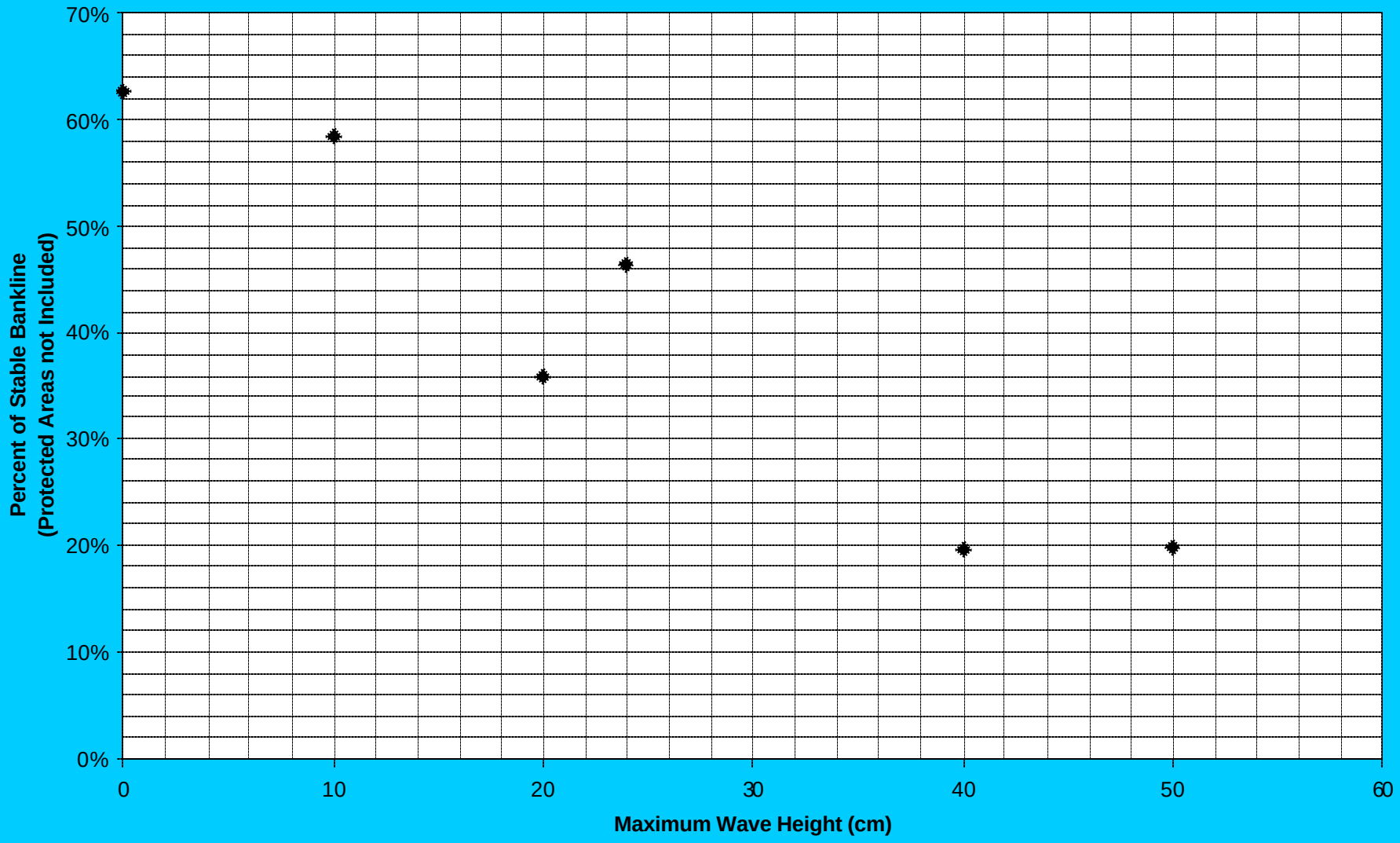
Locations in part of Pool 13 where boat wake waves may break aquatic plants



Percent of unprotected UMR banklines severely or moderately eroded vs. maximum recreational boat wake wave height



Percent of stable unprotected UMR banklines vs. maximum recreational boat wake wave height



Classification of UMRS bank erosion potential by maximum height of waves (at the bank) generated by recreational boats

Erosion Potential	Maximum Wave Height
High	> 35 cm
Medium	20 – 35 cm
Low	< 20 cm

Volume of Water Entrained Through Recreational Boat Propellers

$E_V = D_P \times P_P \times S_P \times V_B \times T \times n$ where:

E_V = Volume of water entrained
D_P = Propeller diameter
P_P = Propeller pitch
S_P = Propeller slip
V_B = Boat speed
T = Time
n = Number of boats

Estimated volumes of water entrained through recreational boat and towboat propellers on the UMRS during April through August in year 2000

River System	Water Entrained Through Recreational Boats (m^3)	Water Entrained Through Towboats (m^3)
Upper Mississippi River (impounded reach)	7.45×10^9	4.13×10^{10}
Illinois Waterway	1.15×10^9	1.50×10^{10}
Open River	--	7.74×10^9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