Great Lakes Phosphorus - Multiple Models and the Decision

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Multiple Models for Management in the Chesapeake Bay

Scientific and Technical Advisory Committee

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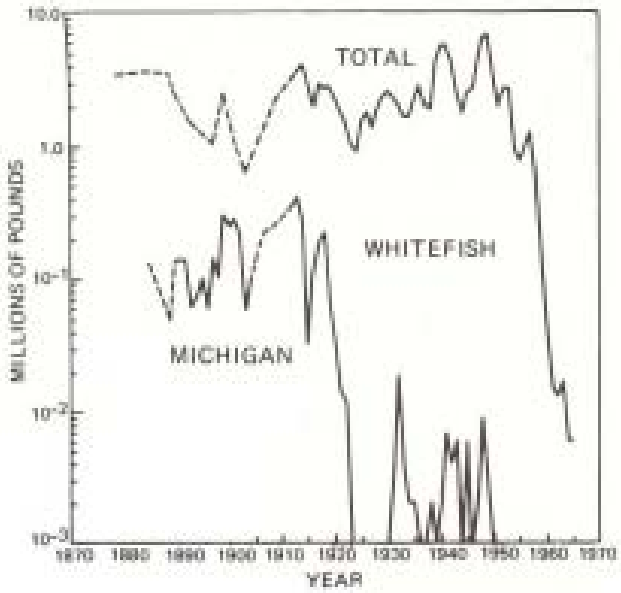
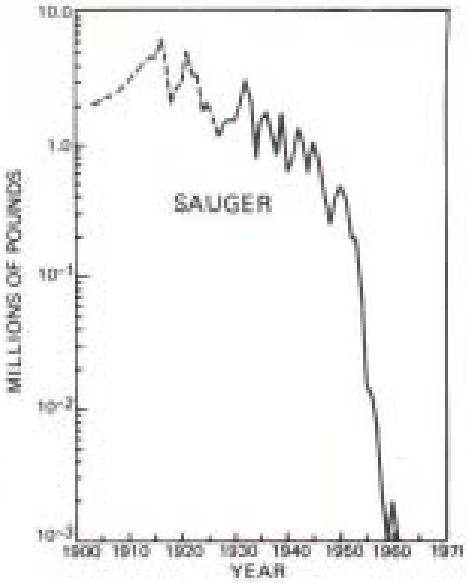
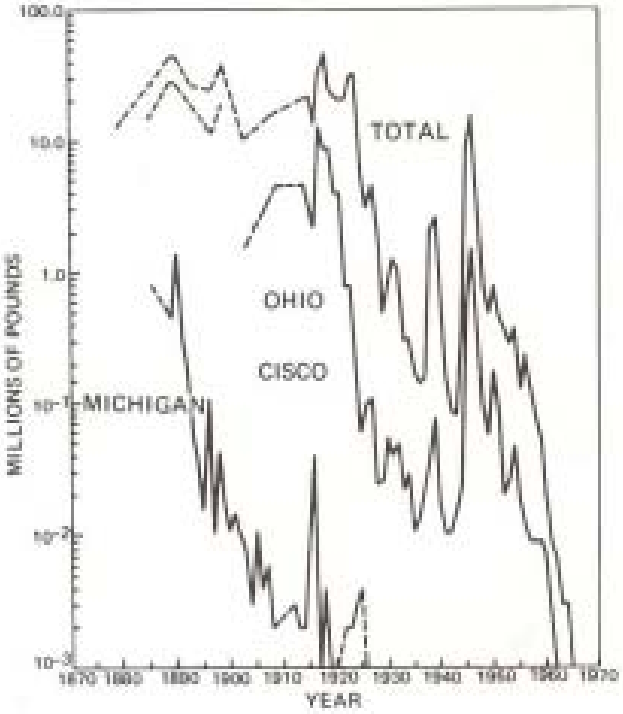
Commercial Production of Lake Erie Fish

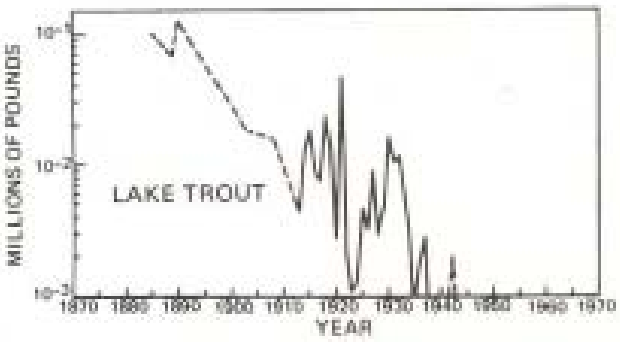


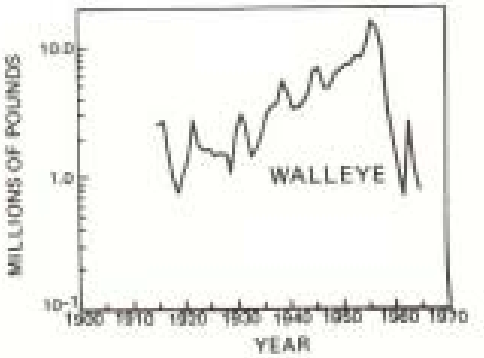
1900 1970





1900 1970





1900 1970

Dissolved Oxygen in the Bottom Waters of Lake Erie - 1960

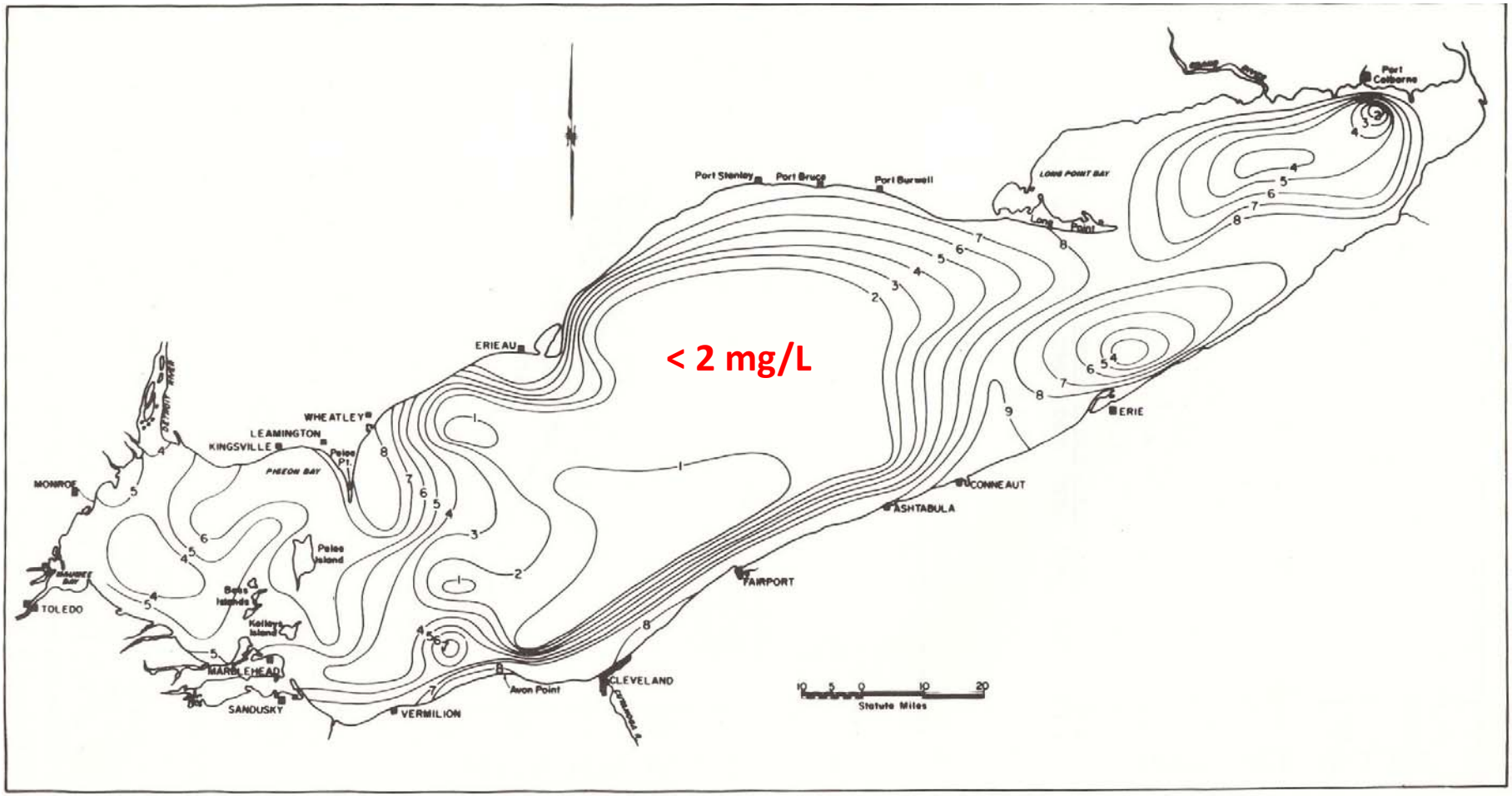
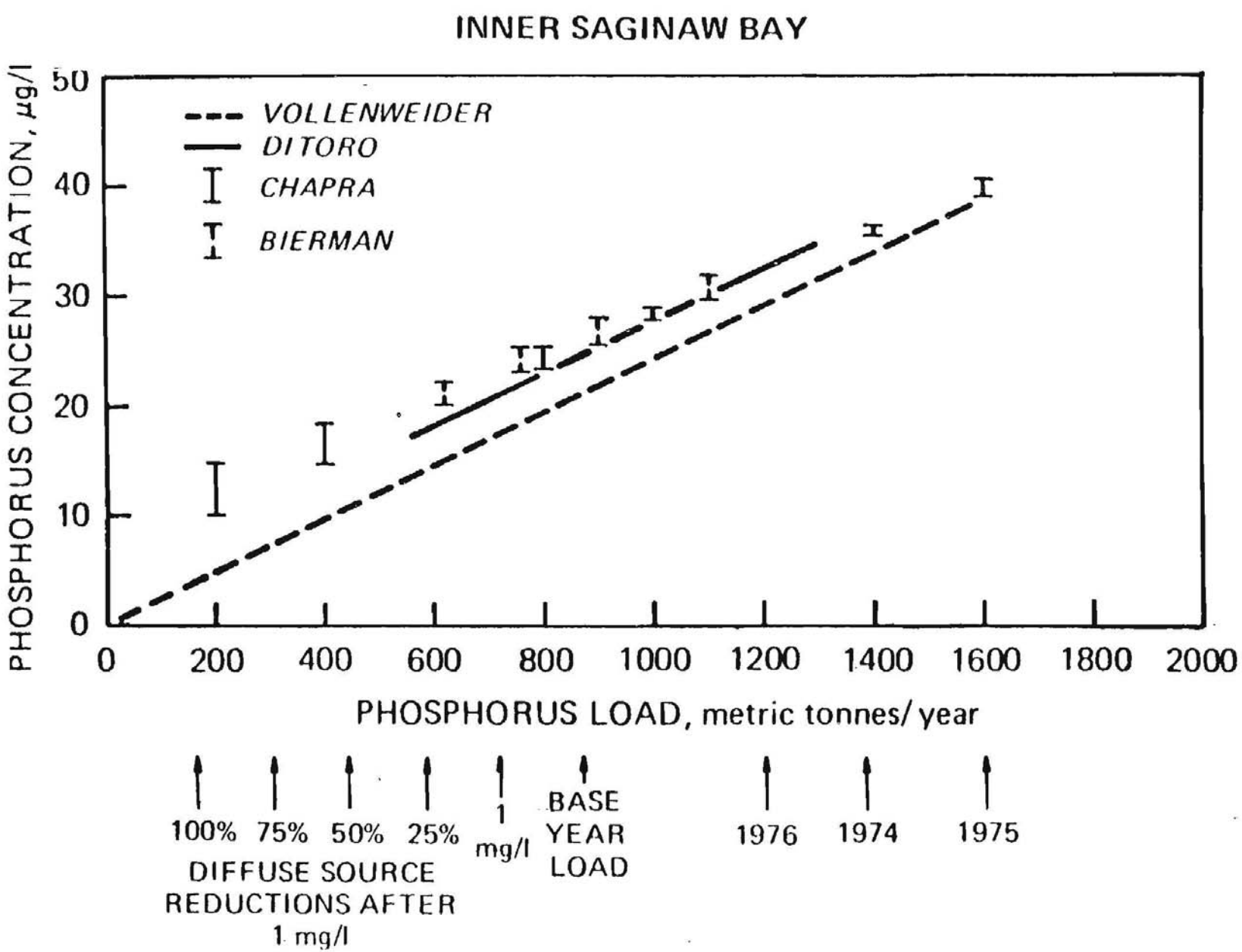
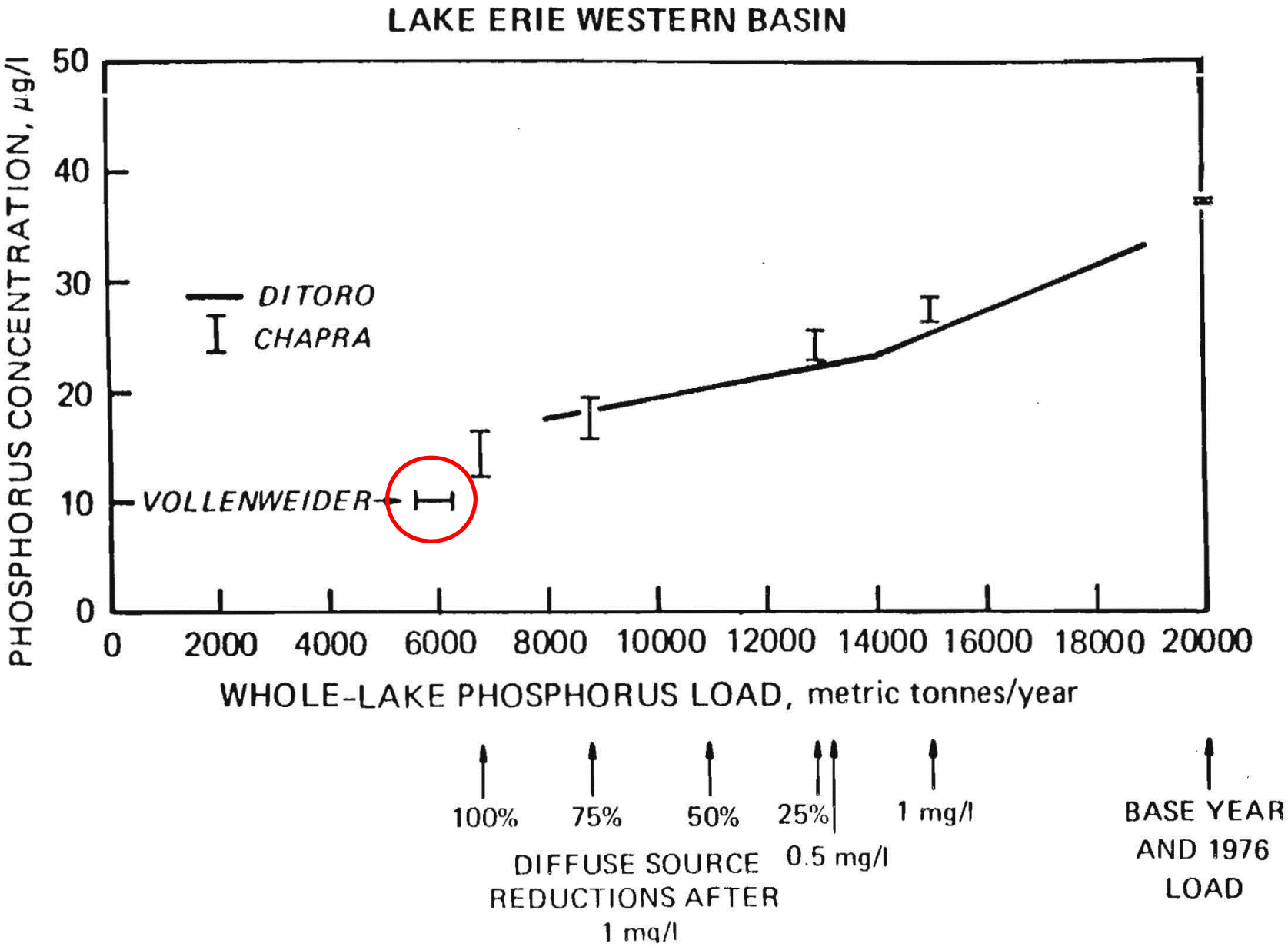
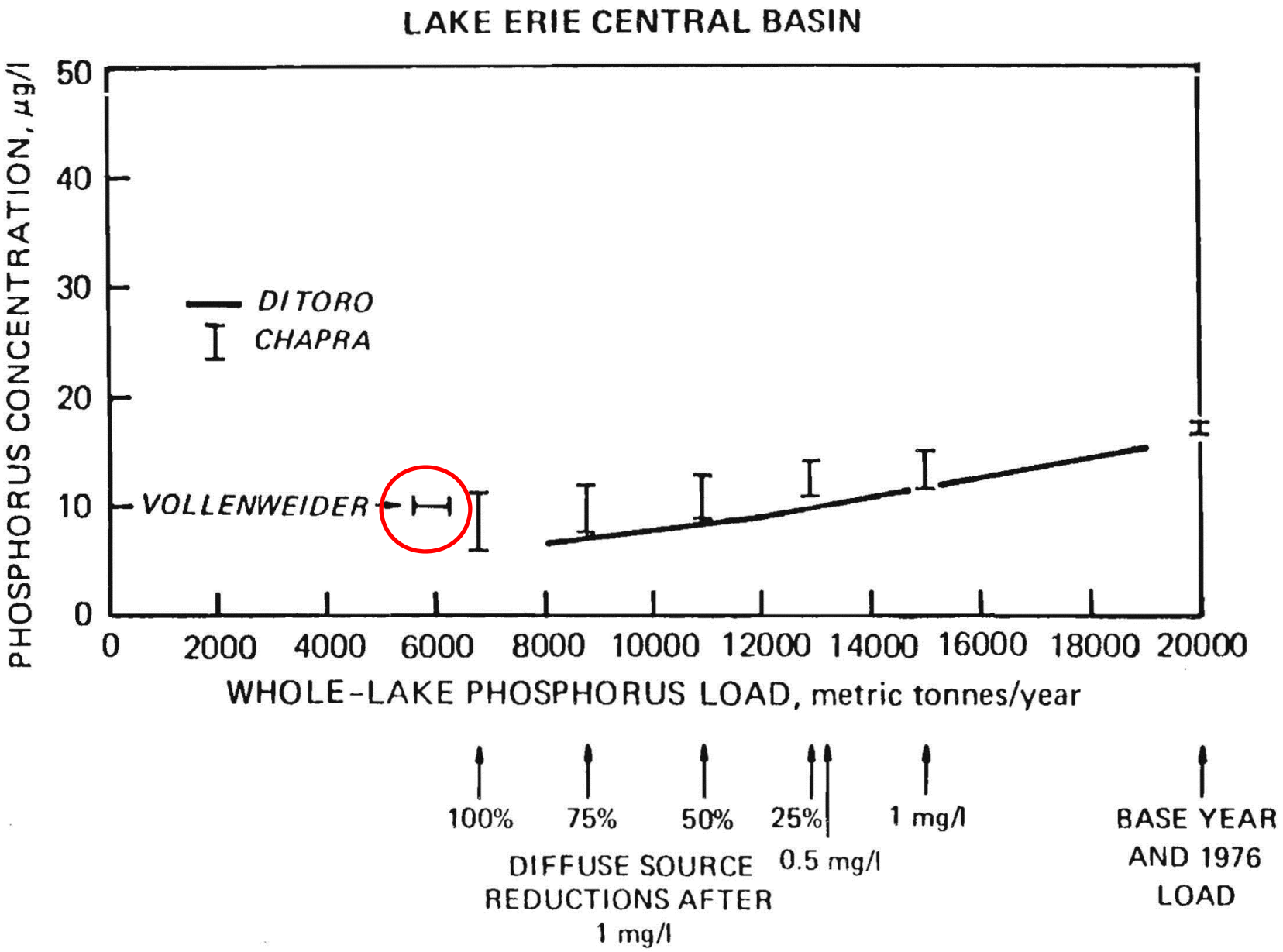


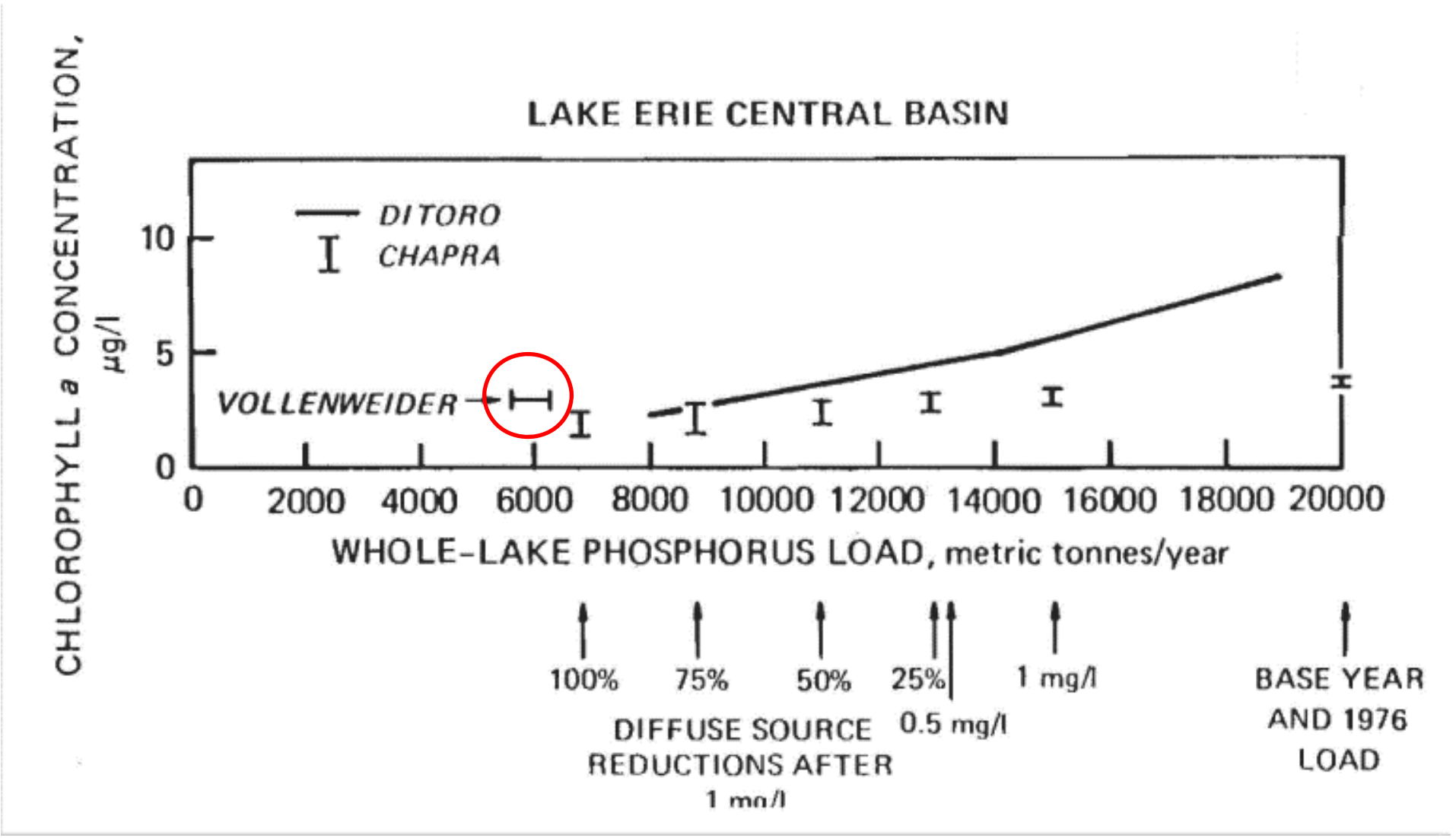
FIGURE 11 Distribution of dissolved oxygen (ppm) in the bottom waters of Lake Erie, 1960 (from Beeton, 1963).

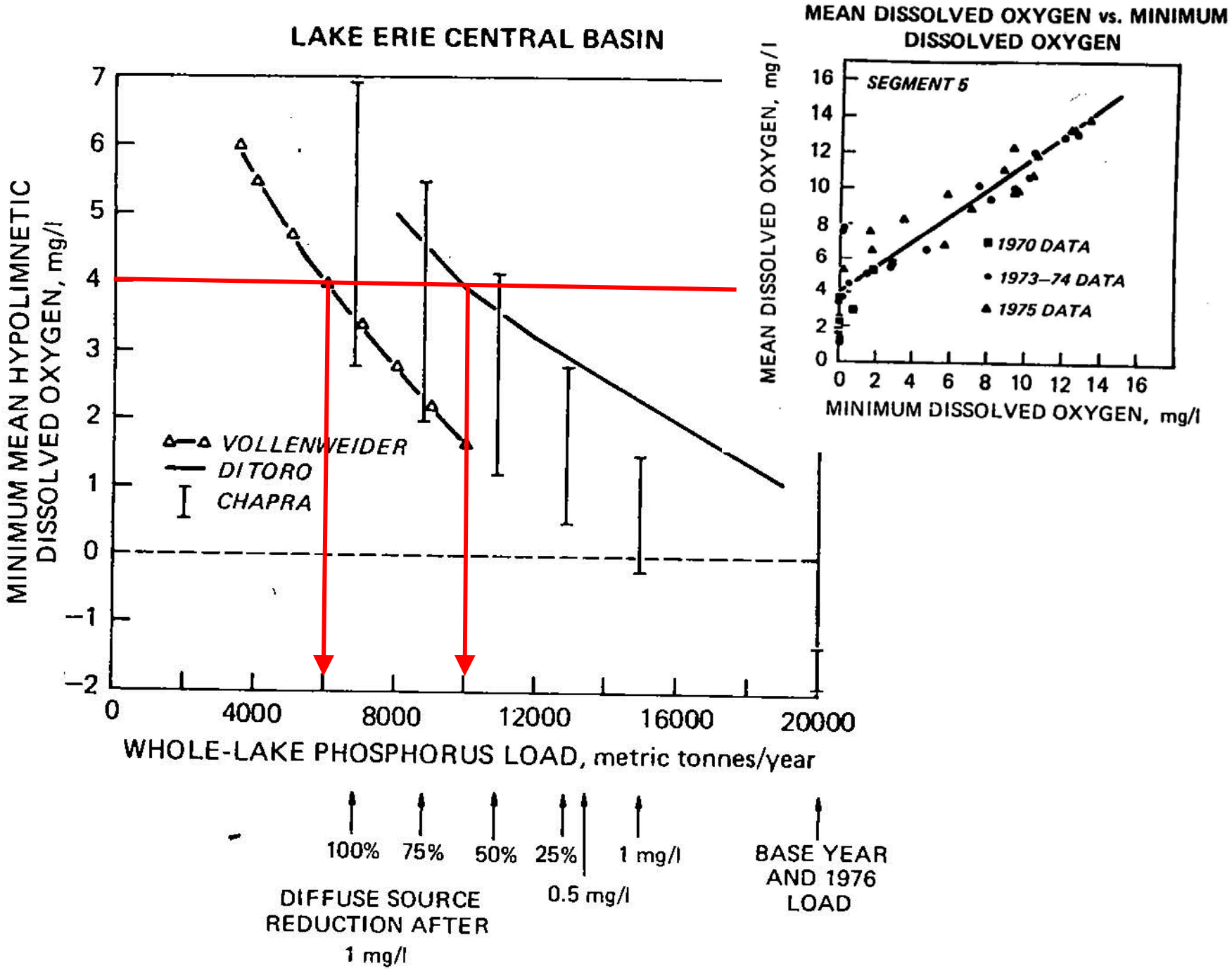
Characteristic	Type	Vollenweider All Basins	Chapra All Basins	Thomann /DiToro Ontario Huron	DiToro Erie	Bierman Saginaw Bay
Time Dependence	Dynamic		X	X	X	X
	Steady-State	X				
Spatial Sementation	None	X				
	Horizontal			X	X	
	Vertical			X	X	
Primary Variables	Phosphorus		X	X	X	X
	Nitrogen			X	X	X
	Silicon				X	X
	Total forms only	X	X			
	Available /Unavailable			X	X	X
Secondary Variables	Chlorophyll	X	X	X		
	Diatom/Non-diatom				X	
	Multi-class biomass					X
	Zooplankton			X	X	X
	Dissolved Oxygen	X	X		X	
Model	Direct Calculation			X	X	X
	Empirical Correlation	X	X			
Input Requirements						
	External loads for primary variables	X	X	X	X	X
	Depth	X	X	X	X	X
	Volume	X	X	X	X	X
	Hydraulic detention time	X	X			
	Temperature			X	X	X
	Light			X	X	X
	Water circulationrates			X	X	X
	Sediment nutrient release rates				X	

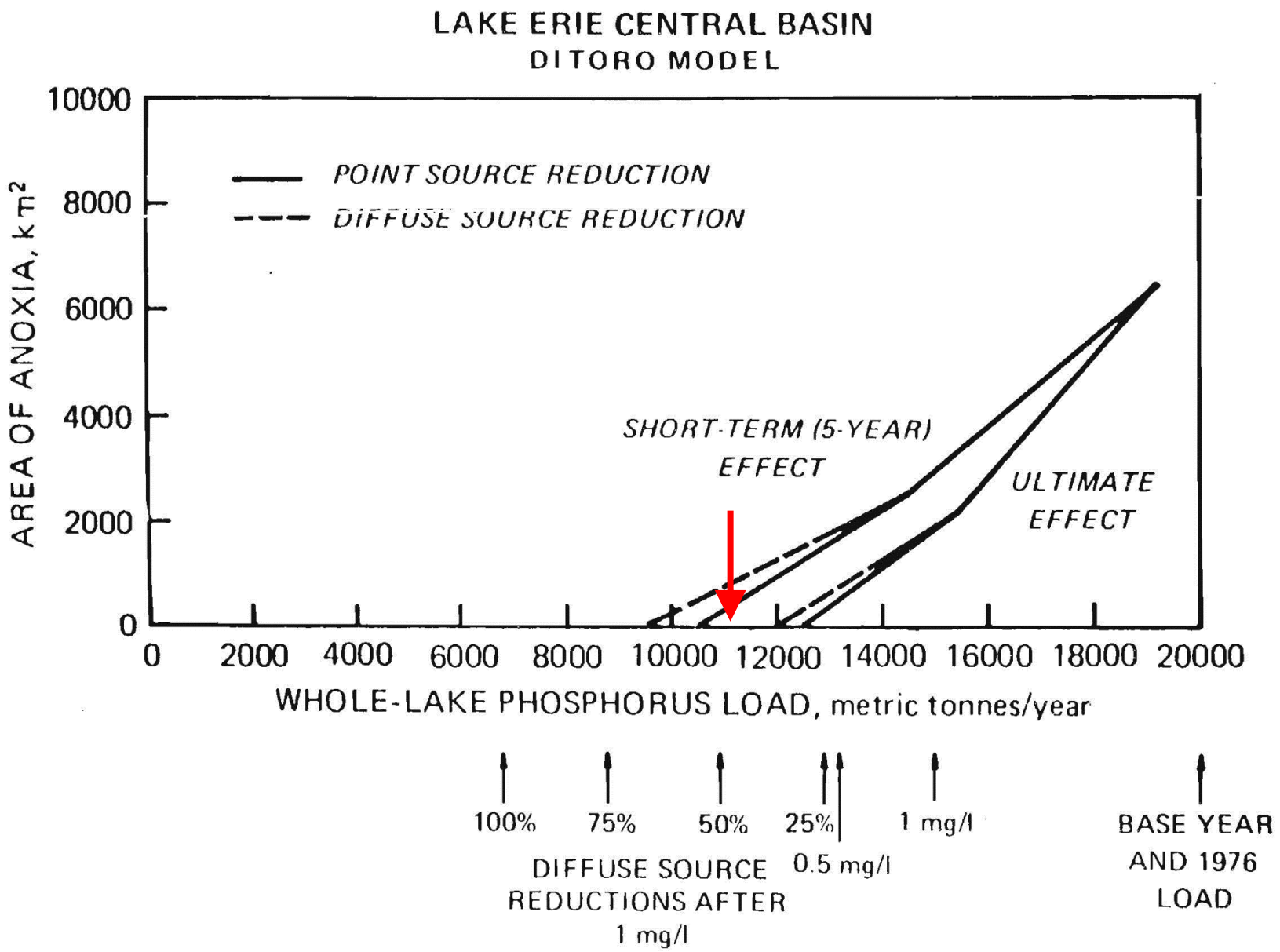

INNER SAGINAW BAY
VOLLENWEIDER
DITORO
CHAPRA
BIERMAN
PHOSPHORUS CONCENTRATION, µg/l
0
10
20
30
40
50
0
200
400
600
800
1000
1200
1400
1600
1800
2000
PHOSPHORUS LOAD, metric tonnes/year
100%
75%
50%
25%
1 mg/l
BASE YEAR LOAD
1976
1974
1975
DIFFUSE SOURCE REDUCTIONS AFTER 1 mg/l


LAKE ERIE WESTERN BASIN
PHOSPHORUS CONCENTRATION, µg/l
50
40
30
20
10
0
DITORO
CHAPRA
VOLLENWEIDER
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
WHOLE-LAKE PHOSPHORUS LOAD, metric tonnes/year
100%
75%
50%
25%
1 mg/l
0.5 mg/l
DIFFUSE SOURCE REDUCTIONS AFTER 1 mg/l
BASE YEAR AND 1976 LOAD


LAKE ERIE CENTRAL BASIN
PHOSPHORUS CONCENTRATION, µg/l
50
40
30
20
10
0
DI TORO
CHAPRA
VOLLENWEIDER
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
WHOLE-LAKE PHOSPHORUS LOAD, metric tonnes/year
100%
75%
50%
25%
0.5 mg/l
1 mg/l
BASE YEAR
AND 1976
LOAD
DIFFUSE SOURCE
REDUCTIONS AFTER
1 mg/l


LAKE ERIE CENTRAL BASIN
CHLOROPHYLL a CONCENTRATION, µg/l
DITORO
CHAPRA
VOLLENWEIDER
10
5
0
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
WHOLE-LAKE PHOSPHORUS LOAD, metric tonnes/year
100%
75%
50%
25%
1 mg/l
BASE YEAR AND 1976 LOAD
DIFFUSE SOURCE REDUCTIONS AFTER
0.5 mg/l
1 mg/l


LAKE ERIE CENTRAL BASIN
MINIMUM MEAN HYPOLIMNETIC DISSOLVED OXYGEN, mg/l
7
6
5
4
3
2
1
0
−1
−2
VOLLENWEIDER
DI TORO
CHAPRA
0
4000
8000
12000
16000
20000
WHOLE-LAKE PHOSPHORUS LOAD, metric tonnes/year
100%
75%
50%
25%
1 mg/l
0.5 mg/l
DIFFUSE SOURCE REDUCTION AFTER 1 mg/l
BASE YEAR AND 1976 LOAD
MEAN DISSOLVED OXYGEN vs. MINIMUM DISSOLVED OXYGEN
SEGMENT 6
MEAN DISSOLVED OXYGEN, mg/l
MINIMUM DISSOLVED OXYGEN, mg/l
1970 DATA
1973–74 DATA
1975 DATA
0
2
4
6
8
10
12
14
16


LAKE ERIE CENTRAL BASIN
DITORO MODEL
AREA OF ANOXIA, km²
10000
8000
6000
4000
2000
0
POINT SOURCE REDUCTION
DIFFUSE SOURCE REDUCTION
SHORT-TERM (5-YEAR) EFFECT
ULTIMATE EFFECT
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
WHOLE-LAKE PHOSPHORUS LOAD, metric tonnes/year
100%
75%
50%
25%
1 mg/l
0.5 mg/l
DIFFUSE SOURCE REDUCTIONS AFTER 1 mg/l
BASE YEAR AND 1976 LOAD

Workshop Questions

- Why was the modeling work done (especially, what management issues did it address)?
- How many models were used?
- How widely did the models differ in concept and application?
- Who developed and ran the different models?
- How were the results of the different models used together to draw conclusions or make decisions?
- What decisions were made based on the models?
- What extra costs were incurred by having multiple models?
- What benefits resulted from having multiple models?
- How did multiple models affect the results and decisions (outputs and outcomes) compared to having a single model?
- What recommendations would this example suggest for the Chesapeake Bay Program modeling?