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DISSOLVED OXYGEN REQUIREMENTS OF A "FISHABLE" DELAWARE RIVER ESTUARY

Report to the
Delaware River Basin Commission

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Ad-Hoc Task Force to Evaluate Dissolved Oxygen Requirements of Indigenous Estuary Fish

March 1979

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Introduction

This report and its recommendations are the result of deliberations and study by an ad-hoc task force appointed by the Delaware River Basin Commissioners. The Task Force to Evaluate Dissolved Oxygen Requirements of Indigenous Estuary Fish consisted of ten persons (Appendix 1) representing each of the four signatory states and the federal government. The Committee met on five occasions in the September, 1978 to January, 1979 period. Support services were provided by Delaware River Basin Commission staff.

The Task Force was established to provide fisheries expertise and guidance to two Commission programs: The Delaware River Basin Level B Water Resources planning effort (nearing completion) and the Commission's program to reevaluate its current waste load allocations and water quality standards, (underway). Both programs require a determination of a level of fisheries resource in the Estuary which would satisfy the "fishable" goal of 1972 and 1977 federal water pollution control legislation and a determination of associated dissolved oxygen levels. It was the purpose of the Task Force to make these determinations for input to the two Commission programs.

Definition of Fishable

Water Use: The "fishable" goal of the 1972 Water Pollution Control Act Amendments calls for water quality which "provides for the protection and propagation of fish, shellfish and wildlife ... wherever attainable." Current DRBC adopted water uses provides for fish passage and for the maintenance and propagation of resident fish in Zones 2 and 5; and maintenance only of resident fish in Zones 3 and 4. Existing standards violations severely impair adopted water uses, particularly in Zones 3 and 4.

The absence of propagation as a water use in Zones 3 and 4 results in a water use goal that is not consistent with the National goal. The Task Force believes that adopted water uses should provide for "fishable" water quality in every zone.

The Task Force perceives a contradiction in terminology, however. From a fisheries viewpoint a resident fish is one that spends its entire life cycle in a zone, including propagation stages. The attainment of a resident fish population of desirable fish species would, under the Task Force definition result in meeting the National "fishable" goal.

Based upon the knowledge of individual Task Force members and data concerning past and present Delaware Estuary Fisheries, the Task Force developed a list of thirteen migratory fish, thirteen resident fish and one endangered fish species (Table 1). This tabulation represents a target Estuary fish population in terms of sensitive game, forage, commercial and other desired fish species rather than a total anticipated population. Total Estuary fish populations are assumed to increase proportionately to the target species.

TABLE I

Selected Fish of Interest by Zone and Activity

<u>Aquatic Species</u>	<u>DELAWARE RIVER ZONE *</u>											
	<u>2</u>			<u>3</u>			<u>4</u>			<u>5</u>		
	<u>S</u>	<u>N</u>	<u>P</u>	<u>S</u>	<u>N</u>	<u>P</u>	<u>S</u>	<u>N</u>	<u>P</u>	<u>S</u>	<u>N</u>	<u>P</u>
<u>Migratory or Marine/Estuarine:</u>												
Striped bass	o	o	x	o	o	x	o	o	x	x	x	x
Alewife	x	x	x		x	x		o	x		x	x
Blueback herring	x	x	x		x	x		o	x		x	x
American shad	o	x	x	o	o	x	o	o	x			x
Mummichog			x**			x	x	x	x	x	x	x
Bay anchovy											x	x
Menhaden								x	x		x	x
Bluefish											x	x
Weakfish											x	x
Spot											x	x
Atlantic croaker											x	x
Atlantic silversides											x	x
Blue crab			x**			x**			x**		x	x
<u>Resident (freshwater/brackish water):</u>												
Pumpkinseed/bluegill	x	x	x	x	x	x	o	o	x	x	x	x
Largemouth bass	x	x	x	o	o	x	o	o	o	o	o	o
Walleye	x ⁺	x	x									
Channel catfish	x	x	x	x	x	x	o	o	x	x	x	x
Black crappie	x	x	x	o	o	o	o	o	o			x
Golden shiner	x	x	x	x	x	x	o	o	o			x
White perch	x	x	x	x	x	x	o	o	x	x	x	x
Silvery minnow	x	x	x	x	x	x	o	o	x	x	x	x
Carp	x	x	x	x	x	x	x	x	x	x	x	x
Goldfish	x	x	x	x	x	x	x	x	x	x	x	x
Brown bullhead	x	x	x	x	x	x	x	x	x	x	x	x
Yellow perch												x
<u>Endangered Species</u>												
Short nose sturgeon	x	x	x		o	x		o	x		x	x

*Key

S = Spawning

N = Nursery

P = Passage

o = potential

x = existing

**Limited or occasional presence (limited for reasons other than water quality)

+ Limited spawning in area (limited for reasons other than water quality)

For each target fish, Table 1 presents existing and potential activities (spawning, nursery and passage) by Estuary zone. The Task Force feels that current limitations on existing activities and population sizes, particularly in Zone 4, do not meet the intent of the National "fishable" goal. Restoration of fish populations to include the listed potential activities, however, will result in the minimal level of fisheries required to satisfy the national goal.

Recommended Dissolved Oxygen levels

Figure 1 depicts the current DRBC dissolved oxygen standards for the Estuary. These standards have not yet been attained year round for portions of the Estuary, particularly Zones 3 and 4. Key features of the Standards are the minimum 24-hour average concentration of 3.5 mg/l promulgated for Zone 3, Zone 4 and Zone 5 (portion); and an Estuary-wide seasonal average of 6.5 mg/l applicable for seasons defined as April 1 to June 15 and September 16 to December 31.

An immediate reaction by the Task Force is the unacceptability of standards expressed as a 24-hour or daily average. From a fisheries management viewpoint events occurring in time periods much less than twenty-four hours can be detrimental to fish survival. A conclusion of the Task Force, therefore, is that any Estuary dissolved oxygen standard should be promulgated as a 'minimum' (at any time) value.

Because of past estimates of a 3 mg/l difference between 24-hour average and minimum dissolved oxygen values, and the implications thereof, the Task Force requested that DRBC staff examine the dissolved oxygen variability observed at various Estuary monitoring stations over the last fifteen years. The initial results indicate a smaller variability than past estimates. The Task Force recommends that the DRBC staff prepare a report on their data analyses.

Individually and collectively the Task Force members examined the pertinent fisheries literature concerning the minimum dissolved oxygen requirements of the fishes and activities recommended in Table 1. Sublethal threshold response values measuring growth, movement, reproduction, reactions, etc., rather than lethal levels, were used to the extent possible since the latter were not considered pertinent to the goal of fish protection and propagation.

This information and the expertise of the Task Force results in Figures 2 and 3 which present the Task Force's recommended dissolved oxygen criteria; the latter for the critical summer season. The key features of the recommendation are the minimum dissolved oxygen criteria of 4.0 mg/l in Zone 4 and upper Zone 5 and the higher criteria, as shown, elsewhere.

It is envisioned that the bottom of the dissolved oxygen sag curve will be the only area with the 4.0 mg/l minimum value. Areas above and below the sag curve bottom, while having a minimum standard of 4.0 mg/l, will actually have higher dissolved oxygen concentrations since they are transition areas. These transition areas will require future refinement based upon Estuary model runs, and where possible the minimum dissolved oxygen criterion will be adjusted upward to reflect anticipated water quality.

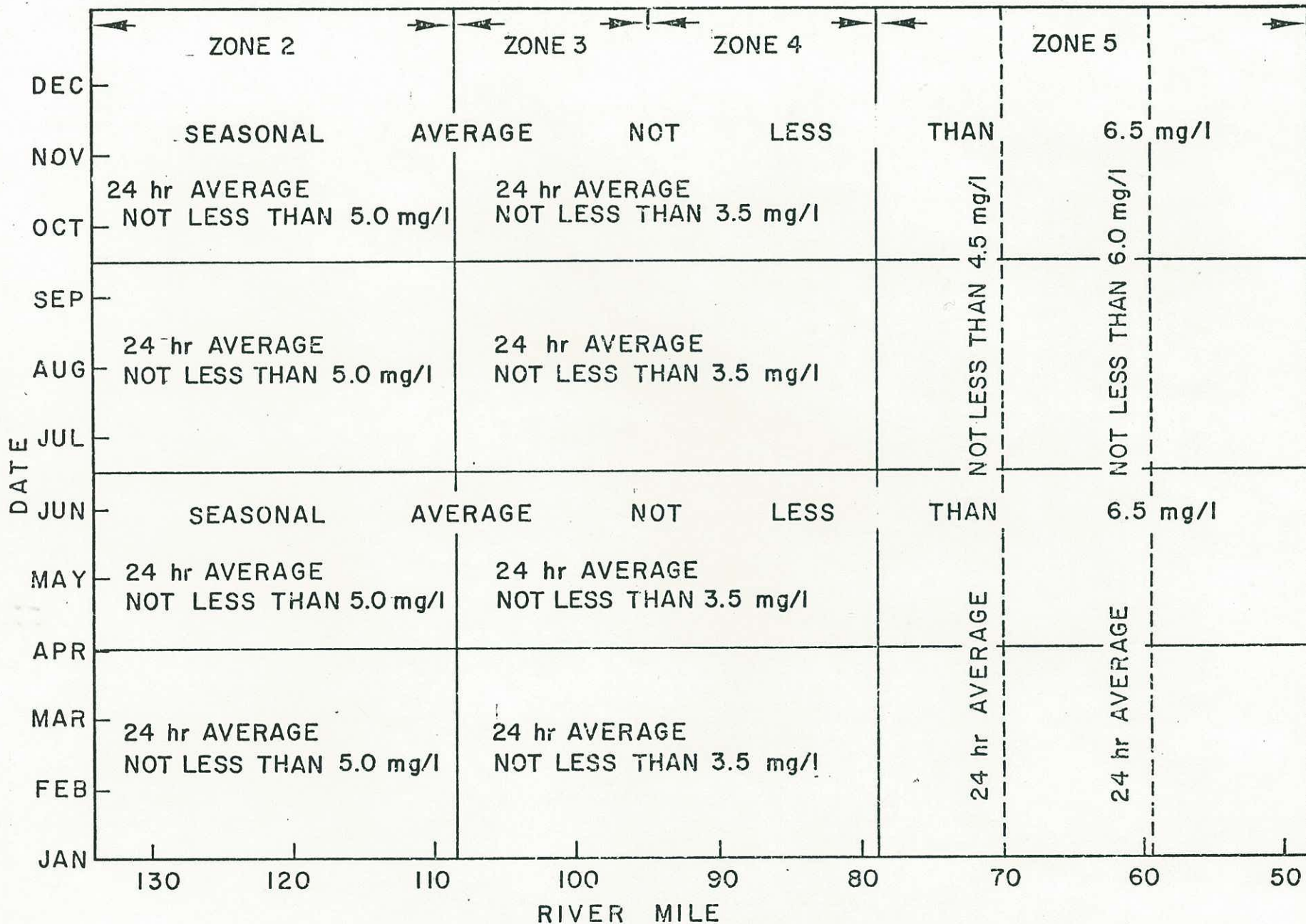


FIGURE I. EXISTING ESTUARY DISSOLVED OXYGEN STANDARDS

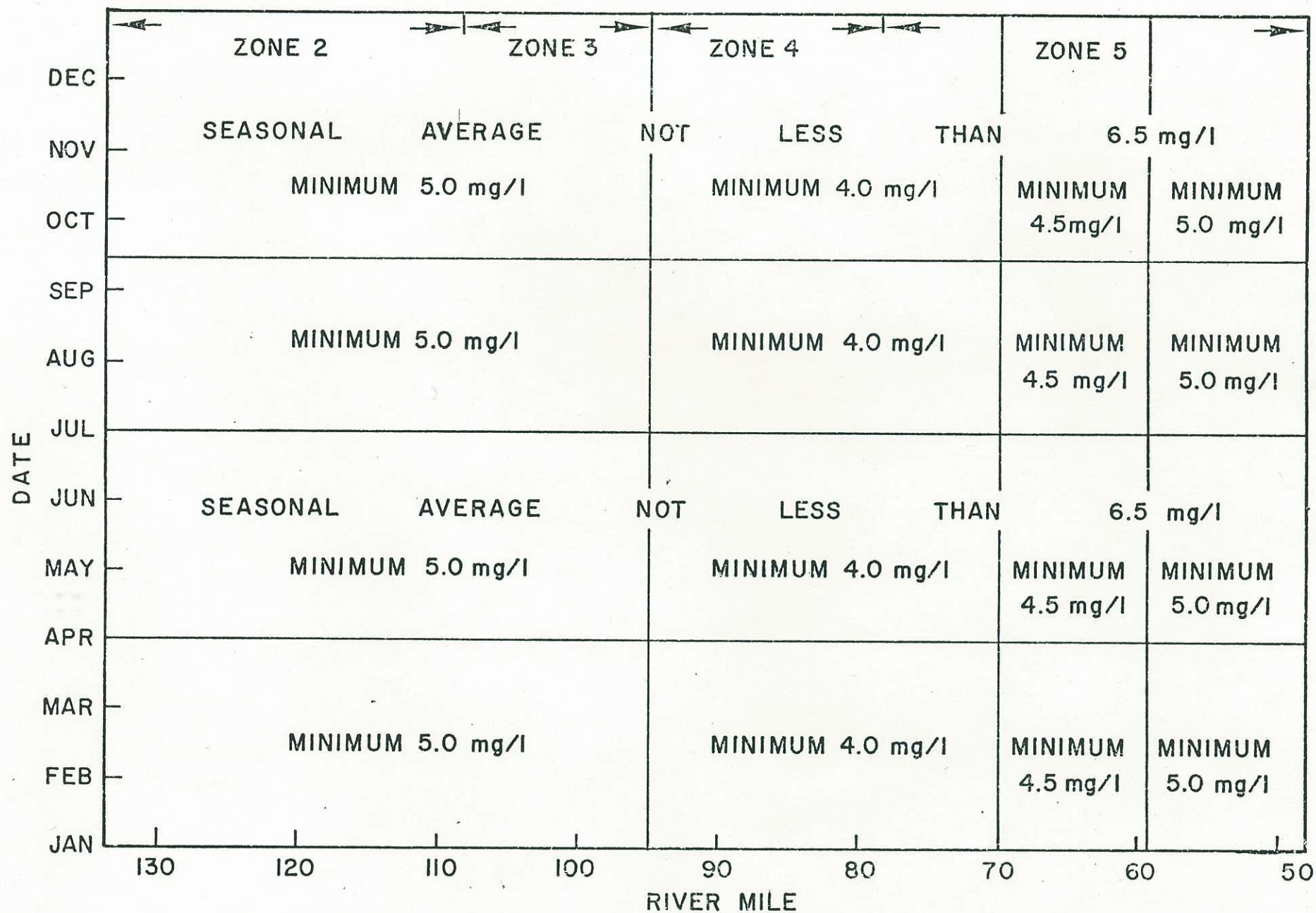


FIGURE 2. RECOMMENDED ESTUARY DISSOLVED OXYGEN STANDARDS

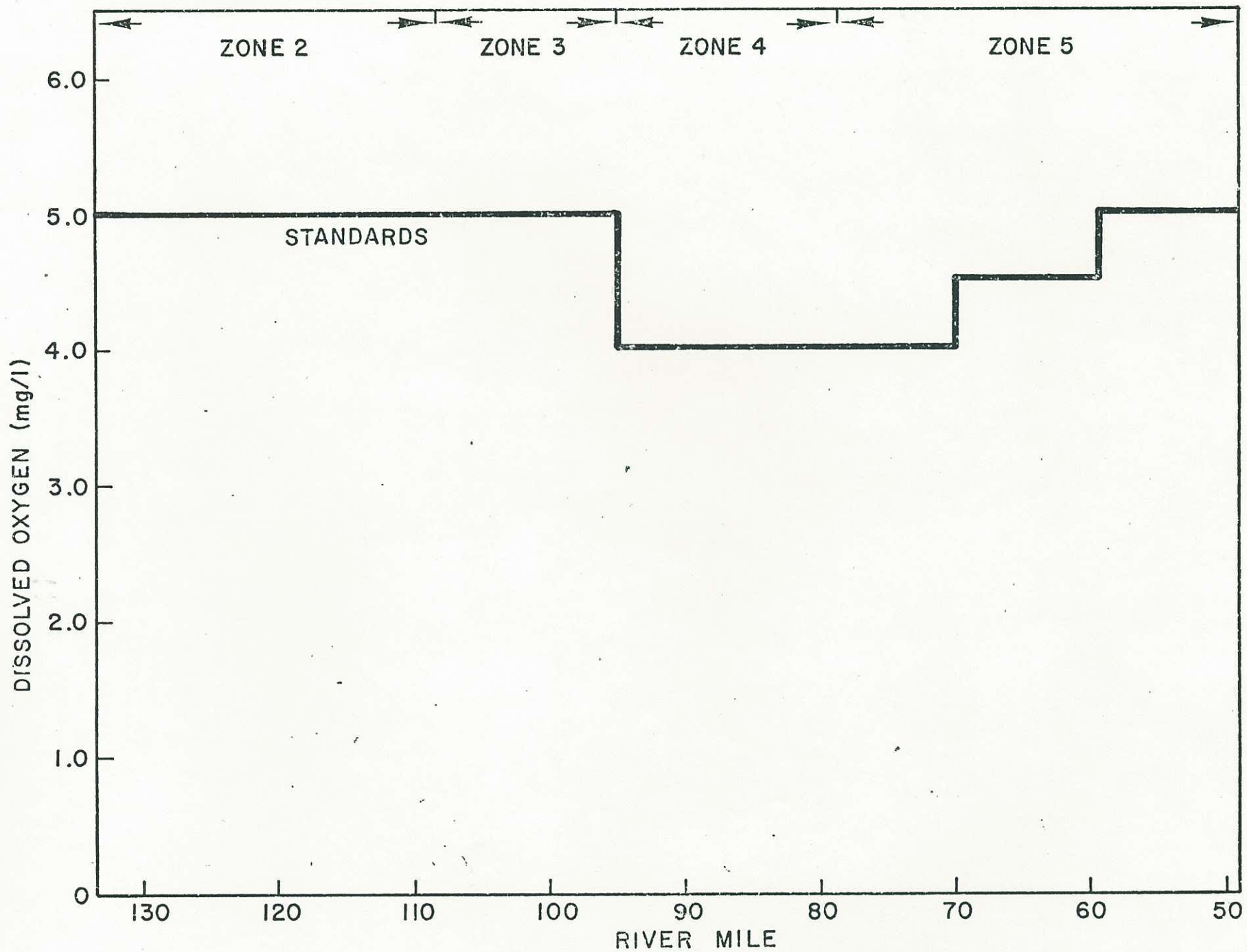


FIGURE 3. RECOMMENDED DISSOLVED OXYGEN STANDARDS - SUMMER PROFILE. ALL VALUES AS MINIMUMS. JULY 1 TO SEPTEMBER 15.

Recommended Changes to the Fish Passage Seasons

The number of American shad returning to and from non-tidal spawning areas is affected by dissolved oxygen levels, flows and other factors during the passage season. The current DRBC fish passage seasonal average dissolved oxygen standard is acceptable to the Task Force. In order to increase the probability of successful adult shad emigration from the upper river the Task Force recommends that the spring passage season be extended from June 15 to June 30.

Policy Considerations and Alternatives

The technical, political and financial feasibility of pollution abatement efforts beyond current strategies was not examined by the Task Force. The dissolved oxygen concentration necessary for fish survival and propagation are independent from these factors. A fish community cannot adjust its requirements for life.

Technical, political and financial feasibility considerations, however, are inherent in the Task Force recommendations. The recommendations represent minimally acceptable standards rather than optimal or ultimately desired standards.

The optimal or ultimately desired standards are presented in Figure 4. Implementation of an abatement program to reach these future objectives will result in fish population which is optimal in size, species diversity and distribution including migratory species in non-estuary areas. (Due to irreversible loss of habitat and other factors the optimal fish population is not necessarily equivalent to "natural").

Adoption of the optimal dissolved oxygen standards (Figure 4) as a long range goal with the recommended standards (Figure 2) as an interim goal; should be considered by the Delaware River Basin Commission.

In its deliberations the Task Force recognized that parameters other than dissolved oxygen influence fish populations either independently or in combination with dissolved oxygen. Toxic and tainting substances were of particular concern. The abatement of these problems was assumed to occur concurrently with improved dissolved oxygen in order that a "fishable" Delaware Estuary is attained.

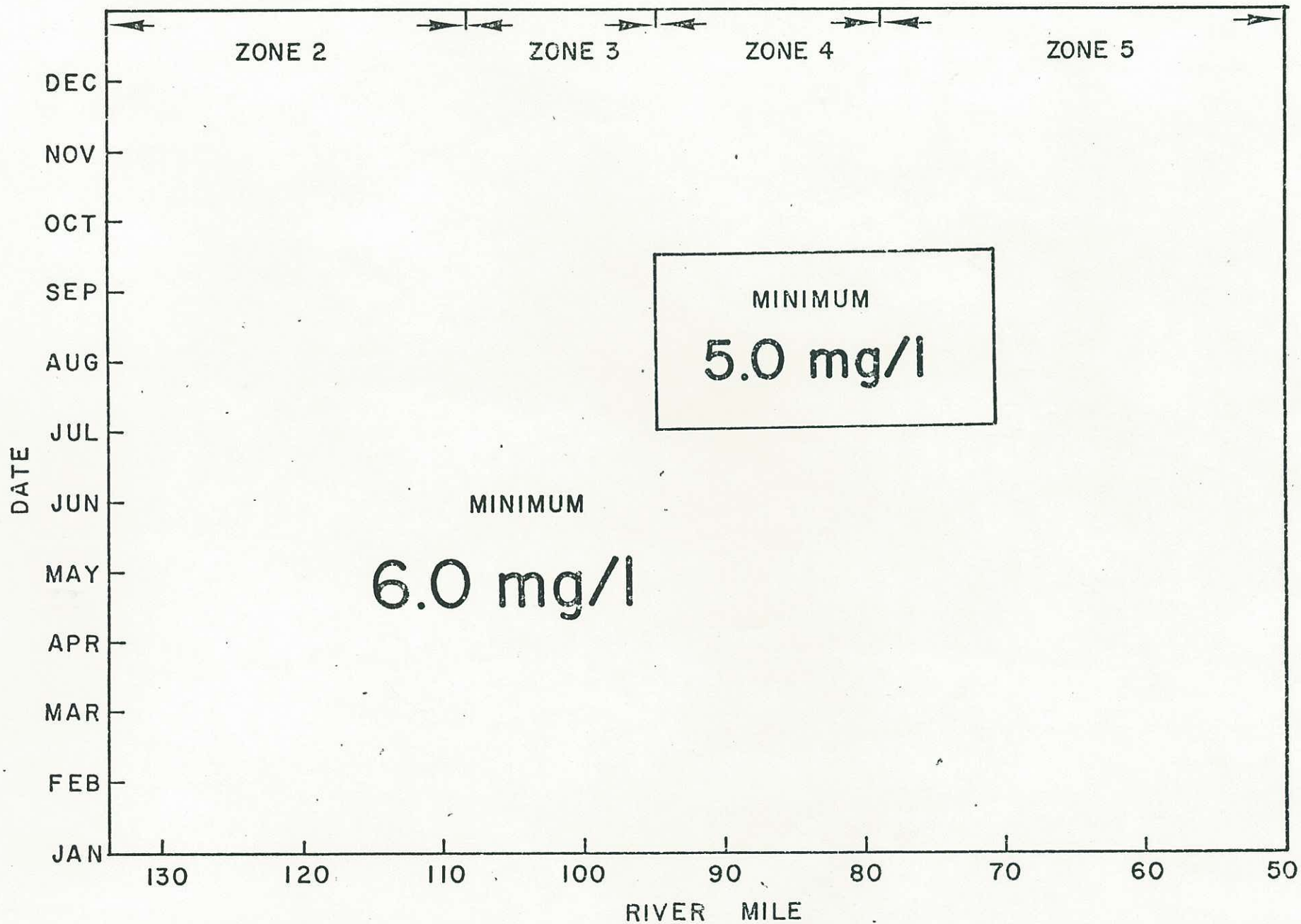


FIGURE 4. RECOMMENDED ULTIMATE DISSOLVED OXYGEN STANDARDS

Conclusions and Recommendations

(1) Federal water pollution control legislation establishes a National goal of water quality which provides for the protection and propagation of fish: the so-called "fishable" goal. The absence of propagation of resident fish as a water use in Zones 3 and 4 results in currently-adopted DRBC water uses providing for less than "fishable" water quality in those zones. The Task Force believes that fish "residency" must be defined in water use descriptions as including all life stages including propagation.

(2) The attainment of "fishable" water quality in every zone should be a goal of the Commission's water quality management program. Fishable water quality is necessary for conformance with national goals and for improvement of estuary fisheries.

(3) A definition of "fishable" specific for the Delaware River Estuary is presented. Restoration of Estuary fisheries to include sizeable populations of the listed fish and activities would result in a minimum level of fisheries that satisfies the intent of the national "fishable" water quality goal.

(4) Current DRBC Dissolved Oxygen standards are expressed as a "minimum 24-hour average concentration". Fisheries protection requires the expression of standards in terms of minimum at any time. A report analyzing daily dissolved oxygen variability, as observed in the Estuary, should be prepared by the DRBC staff.

(5) Although existing dissolved oxygen standards have not been met, higher dissolved oxygen levels are recommended in Figure 2. These levels are considered the minimally acceptable levels which will result in the minimum level of "fishable" water as defined in Table 1. Adequate margins of safety and increased dissolved oxygen levels as represented in Figure 4 will result in a greater increase and protection of "fishable" fisheries. These levels should be considered for adoption.

(6) The spring fish passage season should be extended from June 15 to June 30. This change plus the dissolved oxygen improvement recommended above (Figure 2) will have a positive affect on the Delaware River Basin shad fishery. Attainment of the dissolved oxygen levels presented in Figure 4 will result in an optimum shad fishery.

(7) Attainment of "fishable" water quality requires the concurrent abatement of toxic and tainting substances and other parameters which may act independently or in combination with oxygen to reduce fish populations.

APPENDIX I

Members and Participants

Ad-Hoc Task Force to Evaluate Dissolved Oxygen Requirements for Indigenous Estuary Fish

Federal:

Royal Nadeau EPA-Region II (member)
Roland Hemmett EPA-Region II
Joseph Miller, U.S. Fish and Wildlife Service

Delaware:

Roy W. Miller, Division of Fish and Wildlife, Department of Natural Resources
and Environmental Control (member)

New Jersey:

Douglas M. Clark, Division of Water Resources, Department of Environmental
Protection (member)
Don Jacangelo, Division of Fish, Game and Shellfisheries, Department of
Environmental Protection

New York:

Lawrence Skinner, Division of Fish and Wildlife, Department of Environmental
Conservation (member)

Pennsylvania:

Richard W. Marshall, Pennsylvania Fish Commission (member)
Thomas A. Strekal, Norristown Regional Office, Department of Environmental
Resources (member)
Charles Emery, Pennsylvania Fish Commission

Delaware River Basin Commission:

Seymour D. Selzer, Planning Branch
David P. Pollison, Planning Branch
Richard C. Albert, Planning Branch
Robert C. Kausch, Environmental Unit
Alison A. Anderson, Level B Study