Fact Sheet Date: Draft

NEW YORK STATE
- AQUATIC FACT SHEET -

Ambient Water Quality Value
for Protection of Aquatic Life

SUBSTANCE: Dissolved Oxygen **CAS REGISTRY NUMBER:** Not Applicable

TYPE:	BASIS:	SALTWATER AMBIENT WATER QUALITY VALUE (mg/L):
Chronic	Propagation	Not less than a daily average of 4.8[1]
Acute	Survival	Not less than 3.0 at any time

REMARKS:

[1] The DO concentration may fall below 4.8 mg/L for a limited number of days, as defined by: where DO_i = DO concentration in mg/L between 3.0 - 4.8 mg/L and t_i = time in days. This equation is applied by dividing the DO range of 3.0 - 4.8 mg/L into a number of equal intervals. DO_i is the lower bound of each interval (i) and t_i is the allowable number of days that the DO concentration can be within that interval. The actual number of days that the measured DO concentration falls within each interval (i) is divided by the allowable number of days that the DO can fall within interval (t_i). The sum of the quotients of all intervals (i...n) cannot exceed 1.0: i.e.,

The DO concentration shall not fall below the acute standard of 3.0 mg/L at any time.

INTRODUCTION

These values are derived to protect saltwater aquatic life (also referred to as marine life or marine organisms) from the effects of low concentrations of dissolved oxygen. Values for the protection of propagation of aquatic life are referred to as Aquatic (Chronic) or A(C) values, which are analogous to the CCC, or criterion continuous concentration in EPA

water quality criteria documents. Values for the protection of survival of aquatic life are referred to as Aquatic (Acute) or A(A) values, which are analogous to the CMC, or criterion maximum concentration in EPA water quality criteria documents.

SUMMARY OF INFORMATION AND DERIVATION OF VALUE

The EPA published final national chronic and acute aquatic life criteria for dissolved oxygen (DO) in saltwater (U.S. EPA, 2000) which were reviewed by the Department. EPA=s chronic criterion was determined to be based on appropriate data and derived according to the scientific procedures consistent with 6NYCRR Parts 702 and 706, although there were some variations to those procedures as allowed by 6NYCRR Part 702.9(g) (see U.S. EPA. 2000). The Department believes that the EPA chronic criterion is the appropriate A(C) value for the protection of saltwater aquatic life in New York State. However, the Department does not believe that the EPA=s acute criterion is adequately protective. The DO standards for Class SA, SB, SC, I and SD waters apply to all water column depths. DO measurements at different depths are not averaged. The lowest measured DO in the water column represents the low DO concentration for the entire water column.

Acute Value

The U.S. EPA used survival of juvenile and adult organisms as the basis for acute criterion. Following procedures described in U.S. EPA 1994 (which are equivalent to the methodologies described in 6NYCRR Part 706.1), they evaluated 23 laboratory-DO mortality tests to establish the acute criterion of 2.3 mg/L. The Department acknowledges that the scientific methodology used to derive this criterion is consistent with U.S. EPA Guidance and methodologies typically employed for deriving criteria for toxic chemicals. However, the Department is not satisfied that DO mortality studies conducted under carefully controlled laboratory conditions accurately estimates the threshold for acute low DO effects to organisms in the field. Field studies have shown that the population biomass of whiting, striped searobin, little skate, and rock crab is reduced when exposed to low DO concentrations between 3.0 and 4.8 mg/l (Simpson et al., 1996). In terms of aggregate finfish abundance, data indicate that dissolved oxygen becomes a limiting factor at levels of 3.7 mg/l, 3.5 mg/l, 3.1 mg/l and 2.6 mg/l for demersal finfish abundance (biomass), demersal species richness, species richness, and demersal finfish abundance (numbers), respectively (Simpson et al. 1995). These dissolved oxygen values are well above the proposed U.S. EPA acute criterion of 2.3 mg/l and suggest that a higher standard would be necessary to be adequately protective of most marine life in Long Island Sound. U.S. EPA (2000) states that acute risks are limited to adult and juvenile life stages only, and do not address risks of larval mortality. The explanation for this limitation is inadequately discussed and completely undocumented. However, studies show that lethality begins to occur in larval fishes and crustaceans at dissolved oxygen values of less than 3.0 mg/L (Poucher and Coiro 1997), again suggesting that 3.0 mg/L is a better threshold criterion for low DO impacts than the proposed criterion of 2.3 mg/L.

Laboratory tests alone do not take into account natural stressors that are likely to be present when low DO events occur in the natural marine habitat. The EPA acknowledges that their acute criterion does not take into consideration other accompanying stressors such as water temperature, extremes of salinity, and the presence of toxicants (U.S. EPA, 2000). Although EPA reviewed a limited number of field studies to validate their acute criterion, their laboratory-derived value does not satisfactorily address behavioral responses to low DO that might make organisms more susceptible to predation, less competitive, impair hunting and feeding, or inhibit other survival-related activities. The Department believes that to protect juvenile and adult organisms from mortality due to hypoxia, given the range of natural stressors likely to be in effect in the marine environment during a low DO event, the appropriate acute aquatic life value for the minimum DO level should be 3.0 mg/L rather than the 2.3 mg/L derived by the EPA (Figure 1).

U.S. EPA's proposed acute DO criterion of 2.3 mg/L is applicable to the entire Virginian Province, a geographically expansive area from Cape Cod to Cape Hatteras. The Simpson et al. (1995, 1996) studies were focused exclusively on organisms living in Long Island Sound and are thus more representative of the species, and their concomitant DO requirements, that inhabit marine waters of New York State.

Chronic Value

For deriving a chronic criterion, the EPA examined 37 tests of the impact of low DO on growth. They found that DO levels below 4.8 mg/L resulted in impaired growth of larval stages of marine organisms. Adult and juvenile stages were less sensitive. Following appropriate procedures (U.S. EPA, 1994) the value of 4.8 mg/L DO was calculated to be the chronic criterion (Figure 1).

The EPA also demonstrated that populations of marine organisms could tolerate short excursions below 4.8 mg/L DO, and that these short excursions were unlikely to have any detectable impact on the population as measured by larval recruitment. To estimate the duration and magnitude of DO excursions below 4.8 mg/L that could be tolerated with minimal predicted impact to larval recruitment (i.e., # 5%), the EPA employed a larval recruitment model to evaluate hypoxia dose-response effects on the recruitment of larvae from 9 genera of marine water column organisms representing a range of sensitivities to hypoxia. The model was used to calculate the maximum number of days larval cohorts could be exposed to a range of different low DO concentrations and still maintain a larval recruitment rate 95% or better of the larval recruitment rate expected when DO concentrations were maintained above 4.8 mg/L. From the four most sensitive genera of the nine genera tested, an equation for a curve was derived that illustrated the number of days at which different DO concentrations below 4.8 mg/L could persist without impairing larval recruitment (Figure 1). The equation is:

where DO_i = Allowable DO concentration in mg/L;
t_i = Time interval in days at that DO concentration.

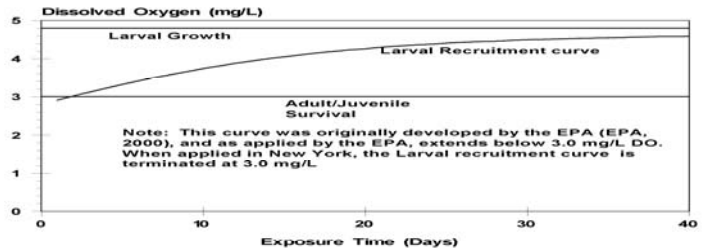

Figure 1. Graphic water quality values for dissolved oxygen in saltwater. Shown are the Larval recruitment curve produced by equation 1, the saltwater chronic (Larval growth) water quality value, and the saltwater acute (Adult/Juvenile survival) water quality values for DO.

LITERATURE CITED

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