

agency relating to any activity that may result in the discharge of heated effluents into interstate or navigable waters or into tributaries of such waters. . . ." This subsection would permit the Secretary of Interior to permit such discharges providing they will not reduce the quality of such waters below applicable State or Federal water quality standards.

Mr. Chairman, "Thermal Pollution of Water" was the subject of our entire SFI BULLETIN 191 (enclosed for the record) which deals with the very grave situation developing throughout the country where fossil and nuclear-fueled electric power generating stations are using both fresh and marine waters to cool their condensers. This results in water temperatures being elevated to as high as 143° F.!

Heat can be detrimental to our aquatic resources and if we consider the following definition of water pollution, then it too, is a pollutant: "Water pollution is the specific impairment of water quality by agricultural, domestic, or industrial wastes (including thermal and atomic wastes), to a degree that has an adverse effect upon any beneficial use of water, yet that does not necessarily create an actual hazard to the public health." Under this definition, if there is no impairment of desired use by the presence or addition of any factor, there is no pollution. This is an important concept to adopt because (1) it is easily understood, (2) it is reasonable, and (3) it is potentially enforceable.

We would like to list some ten effects of heated water on marine aquatic life, as enumerated by Dr. Donald P. deSylva of the Institute of Marine Sciences, University of Miami, Miami, Florida:

(1) Considering temperature alone, for every 18-degree (F.) increase in temperature, the rate of a chemical reaction in an organism or in an environment is *doubled*, and the rate of *each* of the many reactions within a biochemical system of an organism is affected.

(2) Oxygen, considered essential to life, is present in smaller concentrations at higher temperatures, and high temperatures increase salinity, which also somewhat decreases the dissolved oxygen concentration.

(3) High temperature speeds the flocculation of finely suspended particles in seawater, which then remove oxygen from water. More important, these particles cause turbidity which decreases the clarity of the water, thus preventing sunlight from penetrating adequately. Plant growth and the resulting dissolved oxygen from plant respiration is reduced. In this connection there is also good evidence that the amount of light penetration affects the behavior of fishes.

(4) High temperatures also increase, to a point, the metabolic rate of fishes and invertebrates at various times of their life cycle, depending on the species and area, after which point their rate of survival drops rapidly. Increasing temperatures affect the rate of development of the eggs and larval stages but extremes induce mortality in eggs, larvae, and adults. Also, a temperature increase causes a salinity increase, thus reducing the survival rate of eggs and larvae. This temperature increase also reduces the concentration of dissolved oxygen, thus increasing mortality in eggs and larvae.

(5) Increasing temperatures change the mode of behavior in larvae and adults. Larger individuals tend to move out of an affected area, but larvae and juveniles cannot often move sufficiently fast to avoid a sudden temperature increase. The metabolic rate is increased with a temperature increase, and more oxygen is used; where this needed oxygen is scarce, organisms perish. Ordinarily, organisms are able to escape predatory forms, but increased temperatures and reduced oxygen or both may slow the organisms' metabolism and ability to detect and escape predators. Such changes in behavior are usually caused by varying amounts of stress placed on the organisms due to changes in metabolism brought on by external factors such as temperature increase. The ability of fishes to maintain their salt balance, for example, is determined by water temperature, and the increased stress placed on fishes by increased temperature and concomitant low oxygen makes them more susceptible to changes in their physical, chemical and biological environment.

(6) Increased water temperature may alter the structure, behavior, and migration of fish schools. Even slightly increased temperatures, as well as the addition of pollutants, can cause fish schools to avoid a contaminated area. This would also affect their availability to sport and commercial fishermen.