

AFS Policy Statement #8:
COPING WITH POINT SOURCE DISCHARGES
(Full Statement)

A. Issue Definition

Industry withdraws surface (and sometimes subsurface) water to use as either process or cooling water. Although industrial water is usually not greatly altered quantitatively it is usually altered chemically and/or physically. The basic question is whether this alteration is deleterious to human health and the environment. Industries typically withdraw water through a pipe, keep it relatively well contained during use, and discharge it through a pipe-hence, the term point source discharge. Although discharge may occur from more than one pipe, the point(s) of intrusion into aquatic ecosystems is (are readily identifiable., Land runoff (nonpoint) may occur throughout an aquatic ecosystem in varying quantities and qualities, and all types of discharges together should be considered in developing overall policy.

There are five important considerations in preparing a quality control program to ensure that point source discharges do not degrade the biological integrity (such degradation will be called pollution in this document) of the aquatic ecosystems into which they are discharged: (1) the relative percentage of pollution estimated to be due to nonpoint sources and the total percentage entering the receiving system due to point source discharges; (2) the vulnerability of the aquatic ecosystem to perturbation and the estimated time of recovery if the ecosystem is altered; (3) the uniqueness of the resource; (4) the reliability and soundness of the estimates of hazard, i.e., the probability of harm to aquatic life and the environment resulting from the proposed use; and (5) the amount of stream, lake, etc. needed for a mixing zone (a mixing zone is herein defined as an area in violation of existing standards or where there are biological effects that would be unacceptable for the whole system).

Important point source dischargers include municipal sewage works, steam electric power plants, chemical industries, pulp and paper processing factories, petroleum products industry, and food processing plants.

The primary value of developing a policy on point source discharges is to ensure that biological parameters receive more attention from regulatory agencies than they now do. No instrumentation devised by man will measure toxicity-only living material can be used for this purpose. This is not an attempt to deny the importance of chemical /physical parameters, but rather to assert that biological parameters have been badly neglected. Professional societies are an excellent way of affirming this simple fact.

B. Impacts on Aquatic Ecosystems

At certain concentrations, point source discharges can alter the following properties of communities and ecosystems: diversity, nutrient and energy transfer, productivity, biomass, density, stability, connectivity, species richness, and evenness.

Although it is not possible with present methodology to make precise predictions about the ability of an aquatic ecosystem to resist displacement in structure and/or function due to perturbation (ecological inertia) and the ability to snap back once displaced in these characteristics (ecological elasticity), some reasonably reliable estimates of these potentials may be made using available information. Some ecosystems may recover very rapidly following displacement and may even become dependent upon a certain frequency of perturbation in order to maintain the community that inhabits i.e., periodic flooding of certain types of wetlands. Other ecosystems may be highly resistant to perturbations but, once displaced in either structure or function, may require very large amounts of time, often many human generations, to recover. Even this lengthy recovery or rehabilitation may never result in an ecological condition nearly identical to the original. For this reason, the word rehabilitation, which indicates the replacement or restoration of certain desirable qualities, may be more appropriate than the word recovery, which, to some people at least, implies returning to the original condition.

Ecological vulnerability is thus a combination of the two factors (1) the ability to resist displacement and (2) the ability to snap back to some approximation of the original condition following displacement. In any estimate of elasticity, time is an extremely important factor, and one should provide an estimate of whether it will take a few years, more than a human life time, or is so unlikely that it should not be given serious consideration; at least in so far as societal needs are concerned. However crude these estimates may be, they are better than making no ecological evaluation before a new factory is constructed that will discharge wastes into a water ecosystem.

Probably the most dramatic evidence for aquatic ecosystem rehabilitation is the present condition of the Thames Estuary. Although the deliberate restoration of the tidal Thames was solely for the benefit of man, the associated benefits to aquatic organisms have been impressive. Most of the corrective measures were directed toward improving point source discharges- e.g., sewage plants, power plants. From no fish life in the region of Gravesend upstream for some 68 km in the years 1957-58, the river improved to such a degree that it had over 80 species in 1973. Recent evidence suggests that over 90 species may now be found in the area. Although not all are permanent residents, the use of the area by fish has substantively improved. The recovery of Lake Washington in the United States also provides convincing evidence of the benefits of enlightened management of point source discharges.

C. Effects on Fish, Shellfish, and Related Organisms

At certain concentrations, point source discharges may alter the following characteristics of fish, shellfish, and related organisms: life, fecundity, growth, visual acuity, swimming speed, equilibrium, flavor, behavior, feeding rate, response time to stimuli, predation rate, photosynthetic rate, spawning season, migration route, and resistance to parasites.

Probably any characteristic of living material can be altered by certain concentrations of various chemicals. It has been noted that not all alterations of environmental quality are

deleterious. Some cause no displacement others may be favorably regarded as a subsidy. The key to understanding the response is concentration and bioavailability. Some of the wastes entering the environment are stored in environmental "sinks," such as sediments in lakes or rivers, which may reduce their availability to many aquatic organisms. It is important to determine when this occurs and if it is likely to be a temporary or permanent reduction in bioavailability. For some aquatic organisms, particular heavy metals are essential to their well-being in "trace" amounts but become deleterious at high concentrations. Additionally, what is a lethal concentration of a chemical for species A may produce no stress symptoms in species B. Finally, there is abundant evidence that water quality e.g., hardness, pH, temperature, dissolved oxygen concentration -may influence the toxic response.

A well-documented study describing the behavior of an organic contaminant in a natural fish population in the Wabash River near Lafayette, Indiana, illustrates the benefits from managing a point source discharge. The fish downstream from an industrial discharge accumulated trifluralin (a, a, a-trifluoro-2, 6-dinitro-N, N-di-n-propyl-p-toluidine) in their body fat by direct uptake from the river water. The steady state concentration in the fish was accurately predicted both by theoretical models and by laboratory tests. The estimated bioconcentration factors ranged from 1800 for golden redhorse to 5800 for sauger. After installation of an improved waste treatment system in which trifluralin in the waste stream was removed by activated carbon, residues in the river fish rapidly declined. Significant reductions in fish body burdens of trifluralin were found eight weeks after carbon treatment began.

D. Needed Actions

Considerable recognition should be given to any industry with a management plan that includes ecological vulnerability in its site evaluations and that has made these an important, though of course not the only, consideration in site selection. Such a plan would be meaningless unless two or more sites were each considered seriously with regard to ecological vulnerability and the tradeoffs and cost-benefit analyses relative to the other considerations reasonably well documented. In the long run, fisheries biologists will benefit by providing the information and methods needed to expedite this process. In reply to the inevitable objections that our knowledge is inadequate to make these estimates with precision, there are only two possible answers: (1) they will not get better until we try, and (2) a crude estimate by an informed fisheries biologist will be better than one made by a totally uninformed person.

A new industry, having made the estimate of ecological vulnerability for several alternative sites, will have this information as a basis for designing a follow-up program once a particular site has been selected for construction. The follow-up program should be comprised of three main elements: (1) the establishment of present ecological conditions and a determination of their normal variability, (2) a hazard evaluation of the waste discharges anticipated from the plant, and (3) the establishment of a biological monitoring system to ensure that desirable water conditions are maintained in a biologically acceptable way.

Establishments of Ecological Baseline Conditions

To most biologists, the establishment of baseline conditions means an inventory of species present. An inventory is useful, but the evidence should go far beyond this. The study should include information on recruitment rates of important species and some estimates of important functions such as detritus processing, and the like. The scope of this document limits listing all of the criteria and methods that might be used. One should realize, however, that neither resources, finances, nor personnel are sufficiently abundant to permit inclusion of every method that is in the literature. A wide selection of methods must be made, and sound judgment must be used in doing so. Cost is a definite factor, and the study team director must exercise extraordinary judgment in seeing that the most useful information for making a sound decision is obtained in the most efficient manner. At least one reference or control station must be established, and more than one possibly should be used. Both community structural and functional characteristics, as well as chemical and physical parameters, should be components of the information base.

The discussion of the National Pollutant Discharge Elimination System (NPDES) permits, the Toxic Substances Control Act, and the like are beyond the scope of a policy statement, but the considerations mentioned in this document will be important in their implementation.

Hazard Evaluation

A hazard evaluation consists of determining the risk or the probability of harm from an actual predicted concentration of a chemical in aquatic environment. The hazard assessment designed to estimate the risk to an aquatic ecosystem requires evidence to make a scientific judgment on (1) toxicity-the inherent property of a chemical that will produce harmful effects to an organism or a community after exposure of a particular duration at a specific concentration, and (2) environmental concentration- those actual or predicted concentrations resulting from all point and nonpoint sources as modified by the biological, chemical, and physical processes acting on the chemical or its byproducts in the environment. "Safe" concentrations are those for which the risk is acceptable or, in other words, in which the benefits (not all biological, of course) clearly outweigh the risks. Again, the length of this document necessitates the exclusion of the things that might be done.

The best evidence that a biologically deleterious alteration of water quality will occur as a consequence of a point source discharge is to observe it directly. However, this is unsatisfactory because prevention of impacts is more desirable than documentation of their occurrence. Therefore, a keystone of a damage prevention program will be laboratory toxicity tests designed to predict effects over a wide range of concentrations, including, of course, ones estimated from discharge volume and river flow at different seasons. The frequency of these toxicity tests should be determined by (1) the degree of variability in quality and /or quantity of the point source discharge; (2) the degree of variability in flow and water quality in the receiving system. More general use of this

type of predictive capability should be encouraged; and (3) the proximity of the waste concentration, after mixture with the receiving water, to the concentration producing a significant adverse biological response.

Toxicity tests should be carried out on the prospective plant waste in time to influence the waste treatment system design. These tests should be made with pilot or simulated wastes and not postponed until the final treatment system has been established and is operating. The biological information must influence the waste treatment system design.

Biological Monitoring Systems

Definitions:

Survey: An exercise in which a set of standardized observations (or replicate samples) is taken from a station (or stations) within a short periods of time to furnish qualitative or quantitative descriptive data.

Surveillance: A continued programme of surveys systematically undertaken to provide a series of observations in time.

Monitoring: Surveillance undertaken to ensure the previously formulated standards are being met.

It is not sufficient to make estimates of what will happen to the biota as a consequence of a point source discharge without a systematic attempt to determine whether these estimates were correct. This is the essence of biological monitoring. No quality control system can function properly without feedback of information directly from the system in which quality is being maintained. Since the primary objective of a quality control system is to protect the biota, including the fishery, use of some biological parameters related to this need is mandatory. Therefore, a prudent waste control engineer will not rely entirely on chemical-physical parameters to protect the biota in the receiving system because (1) some chemicals have deleterious biological effects at concentrations below present analytical capabilities, (2) some compounds act synergistically with others so that their combined effects far exceed their individual additive toxicities, and (3) the toxic response is strongly mediated by water quality so that the toxicity of zinc to bluegill sunfish in the hard waters of Texas is substantially different from what it is in the soft waters of the eastern coastal drainage basin. Water quality varies not only regionally but seasonally and even diurnally as well. As a consequence, even though concentration of the waste may remain constant, the toxicity may vary because the water quality has changed. On the other hand, chemical -physical evidence must not be neglected, because one will not be able to determine precisely what caused the adverse biological response if such evidence is absent.

Nonbiologists must recognize the futility of trying to determine a biological response from chemical-physical information alone. Biologists must work closely with those who study the effects and distribution of chemicals in the environment because, in the absence

of this information of chemical transformation, degradation, recombination, partitioning, etc., the biological evidence will be of considerably less use than it would be if coupled with the latter.

E. Responsibilities of Biologists

The foregoing has been a general description of the responsibility of point source dischargers to provide evidence that will increase the probability that the point source discharges will not harm the aquatic community in the receiving system. By

espousing these responsibilities for point source dischargers, biologists acquire some of their own. Biologists must meet three principal responsibilities if point source dischargers are to fulfill adequately their responsibilities to protect aquatic organisms: (1) identification of the biological parameters that are most suitable for use in protecting aquatic communities, (2) identification of methods and procedures best suited to make these determinations, and (3) determination of the qualifications of the persons making these measurements, i.e. certification. The selection of appropriate criteria to protect water quality and the aquatic community that inhabits water ecosystems can best be carried out by professionals engaged in such activities. If they fail to meet this responsibility, it is unreasonable to expect industry or the courts to do so for them.

Once these criteria or parameters just mentioned have been selected, biologists are again in the best position to endorse as a profession those methods most suitable to make these measurements, i.e. development of standard methods. If biologists shirk this responsibility and less qualified people develop such standard methods, biologists will then be required to spend time and energy to fight unsuitable methods instead of helping to protect the environment directly. Since the American Society for Testing and Materials and American Public Health Association already have well recognized systems for producing standard methods, AFS membership participation in the development of standard methods through these organizations would be most efficient.

Future Action

In addition to a policy statement by AFS, other measures would be appropriate:

1. Encourage the establishment of a national pool of baseline information on aquatic ecosystems. This should not be interpreted as a call for more publications but rather increased availability of information gathered by industries, state, and federal agencies, etc., but kept primarily as "internal" documents.
2. Help broaden the array of species suitable for laboratory bioassays by helping make possible maintenance and culture of additional species under laboratory conditions.
3. Establish a stock of "standard" genetically uniform reference strain of fish similar to the "white rats" used for mammalian tests. This need not be among the species listed

above or even be a native species. It serves as a reliable "yardstick," against which other results can be compared.