Stansbery
1976

A DAM CONTROVERSY:

THE PROS AND CONS OF STREAM IMPOUNDMENT

David H. Stansbery
The Ohio State University Museum of Zoology
Columbus, Ohio 43210 USA

People are different. Each of us is genetically different and, as if that weren't enough, each of us has his own background of experiences. Since each of us is the product of a different hereditary-environmental mix, it is no surprise that we are different.

But different people have different tastes, different likes and dislikes, and different value systems. This is not only to be expected, it is obvious fact and we are glad of it! So long as the means of satisfying all of these many and varied needs exist in abundance we have no problems. But many of these wants cannot be met without the use of natural resources - and we are all aware that natural resources are finite, limited in both quantity and quality.

So long as the people on earth were relatively few in number, our resources - at least most of them - must have seemed infinite. Indeed, the physical limits of the earth itself have not been known until relatively recent times! As the human population has grown, people's wants have similarly grown, and more and more resources have come into short supply. A brief study of the extensive use and costs of water treatment plants and air-conditioning units reveals that two of our most abundant resources are indeed in short supply if we have any concern about the quality of the products we use and the convenience of their supply. And so essentially all goods and services have their price. As the population grows, the demands grow, competition for available natural resources increases, and prices rise. The only relief has been the efficiencies achieved by science and technology. Until recently the greater part of this effort has been to devise more efficient means of exploiting our remaining untapped resources. As the "bottom of the barrel" has become increasingly visible, we have shifted our problem-solving energies more toward techniques of reclaiming, reusing, and recycling. At the present time we seem to be approaching, however slowly, that point in history where man's principal technological concern will be increased efficiency in recycling techniques. Most material resources will be viewed as existing somewhere within one or several cycles involving human use-benefit at one or more points. The source and manipulation of the energy forms required in these processes is a somewhat different but equally important and interesting problem.

Water is one of our most important and most used resources. Life as we know it cannot exist in the absence of water. We ourselves are, in fact, mostly water - whether viewed in terms of weight or volume. We like to think of ourselves as terrestrial creatures, but all of us that is alive is continually bathed in an aqueous solution. We each exist in a

* Presented before The Columbus Audubon Society, Columbus, Ohio, 19 February 1976. The Ohio State University Museum of Zoology Report 24.

leathern sack of dead cells which keeps the precious water inside. And we must never forget that drying is dying.

Unfortunately, perhaps, nearly all the water we need (or believe we need) must be fresh water. The seas are not only distant from most of us; they are loaded with soluble salts which render them difficult or impossible to use for most of our water concerns. This wouldn't be so bad except for the fact that only 2% of the earth's surface is fresh water, and most of that is lakes.

Most of the water most people use comes from flowing systems.... rivers and subterranean aquifers. Most rivers in their natural state have a water volume which will support only cities if modest size during much of the year.

Our first dams in North America appear to have been built for the operation of mills for grinding grain or sawing lumber. Some of these were used and larger impoundments were later built to serve as reservoirs for domestic water, industrial water, agricultural irrigation, the generation of electrical power, or for flood control. In more recent years one of the major reasons given for the construction of impoundments has been flat-water recreation: boating, swimming, fishing and water skiing.

Not all of the results of dam-building have been beneficial, however. Some of the greatest costs of this method of water resource management have been slow to be recognized.

What happens when a river is impounded? First, a great deal of money is spent. This provides temporary income for workers and profits for industries supplying the needed materials. But what happens to the river at, below, and above the impoundment that is created? The water collects behind the dam, transforming what was once a flowing river into what approaches a lake physiographically, hydrologically and biologically. Most of the sediment being carried downstream precipitates to the bottom when the moving stream becomes quiet. The impoundment begins the process of eliminating itself by filling up with silt as soon as the dam is closed. This may take many centuries or only a few years. The problems created by siltation are several and sobering. If the dam was built for flood protection, its construction probably encouraged the construction of more homes and factories on the floodplain below the dam. This is usually a convenient location for an industry needing large amounts of water and is a picturesque site for homes. But most impoundments are built with just enough capacity to hold the water of any flood up to and including those that come, on the average, only once every hundred years. The problem is that it does not protect the flood plain development downstream from <u>all</u> floods. Any flood larger than the 100 year flood is still a threat. In addition, siltation may very soon reduce the 100 year flood capacity of the impoundment. This reduction of flood protection continues gradually "under water," hence out of sight and mind, until the storage capacity of the impoundment approaches zero. The probability of the occurrence of a disastrous flood increases with each passing year. Literally, a catastrophe becomes just a matter of time.

Part of the precipitated sediment is organic in nature. This material oxidizes at the bottom, thus depleting the oxygen supply necessary for most benthic life. The carbon dioxide produced combines with the water forming carbonic acid. Carbonic acid and other organic acids reduce the pH to an unnaturally low level, creating an acidic environment beyond the range of tolerance of many river forms, resulting in their death. This same organic sediment removed from suspension in the water means less nutrient material for filter feeders both here and downstream. Not only is the impoundment a sediment trap, it is also a nutrient trap. What is to be dome with the accumulated sediment when the reservoir is filled? Where will we go when the potential dam sites on our streams are all used? These are problems we are passing along to our children, grandchildren, and beyond.....

A great deal of water leaves an impoundment by evaporation from its broad, sun-heated surface. The loss of water from the Aswan High Dam impoundment is so great that engineers have considered covering it with a layer of oil. If the outflow of an impoundment is over the top of its dam, the uppermost layer of water, which has been superheated, is selected to move downstream. This abnormally warm water may be beyond the tolerance of many river species downstream. It is also typically without nutrient sediment and, lacking a sediment load, has greater erosive power downstream. Allowing the water to leave the impoundment from the base of the dam causes the downstream habitat to have an abnormally low temperature and pH. Either extreme is damaging to the native stream life below the dam and may allow introduced species to become excessively abundant. Multiple outlets may solve the temperature problem, but the restoration of precipitated nutrients has yet to be achieved.

Stabilization of stream flow effected by careful dam operation is effective in flushing sewage or sewage treatment effuent downstream in seasons of low water. This is termed low flow augmentation and has aesthetic merit since it removes sludge bars and bad odors or prevents their occurrence. Contrary to common opinion, however, it is not necessarily advantageous for the native stream biota. These plants and animals (including fishes, mollusks, insects, etc.) evolved into being and were surviving with seasonal fluctuations in flow when our pioneer ancestors arrived here. The biotic community was adjusted to cyclic fluctuations in temperature, nutrient, flow level, and behavioral movements. The transformation from the natural regimen of the stream acosystem to that produced by stabilization of flow may be highly damaging to some and catastrophic to other stream species.

A dam is a very obvious physical barrier and an equally effective, if less obvious, biological barrier. A number of fishes typically migrate from one part of a stream system to another in feeding forays or reproductive runs. A barrier preventing successful reproduction, survival of the young, or blocking access to feeding areas can eliminate more than just the fish species. Nearly all bivalve mollusks must spend a metamorphic part of their development encapsulated upon the gill filament or fin of a fish. Only one or a very few fish can act as satisfactory hosts for any one species of mollusk. Even under favorable, natural or near-natural conditions, it has been calculated that only 2 individuals out of every 30 million young bivalves ever grow to become adults. Because of this delicate obligate relationship, the barrier of an impoundment may drastically affect the life of a stream far above and below the impoundment itself. And all of this occurs quietly beneath the water, out of sight and largely, out of mind.

The above are only some of the benefits and costs of stream impoundment. If we wish to avoid these costs and others and still enjoy the benefits provided by dams, we must find other and satisfactory solutions to our water resource management problems.

The prevention of flood damage seems to involve wiser land use planning to involve not building damageable structures on that part of the river complex known as the flood plain. Flood plains do lend themselves to man's use in other ways: 1) green belts, 2) parks, 3) natural areas, 4) bike and/or hiking trails, and 5) agriculture. The process of moving man's flood susceptible structures off the flood plain appears from here to be a long and painful one. Since society permitted some of its members, even large parts of cities, to locate buildings in flood hazard areas, so society should share the cost of corrective measures.

The use of master streams for barge traffic with society paying the cost of construction and maintaining the right-of-way seems grossly unfair to the railroads and trucking industry who must add their right-of-way costs to the price of the service they perform. Perhaps making the barge industry pay its own way would give the railroads a just and badly needed assist in the competitive struggle.

The problems associated with dams seem to increase with the size of the structure. Perhaps we need a policy of correlating the size of a metropolitan area's population with the reasonable accessibility of those resources required for its continued maintenance and operation. It has been calculated that if all transportation suddenly stopped, most of the population of New York City would starve before the people could, by walking, reach adequate food. The proposal of a reasonable resource accessibility factor may sound purely academic, but so did "a man on the moon" a few years ago, and so did governmental recognition of endangered species only a decade ago. Admittedly the problem of adjusting the size and distribution of human populations to fit our natural resources or vice-versa is a far more complex problem. We are just now coming into the "alchemy days" of its solution. Its difficulty should not, however, discourage us from planning our first steps, uncertain and faltering though they may be.

Greater use should be made of ground water where it is available and especially of recycling wherever it is technologically and economically feasible. The City of Columbus is fortunate in having a generous supply of ground water in the Scioto Valley aquifer extending from Columbus south to Portsmouth. This water would initially require greater softening than current sources of surface water, but the recycling of this precious demineralized water could result in substantial savings in water treatment once the city was equipped to do the job economically.

The means of emptying our impoundments of their sediment loads should be studied. Although admittedly a stop-gap technique, it may provide us the time needed to find truly long-term solutions to our water problems. It has been suggested, for example, that this fertile silt could be used to help reclaim strip-mined areas.

Our water management problems are large, complex and closely related to nearly all of the other problems faced by our generation. Solutions may indeed have to come in faltering, uncertain, experimental steps. But I am convinced that we will accomplish far more and do it sooner if we make every reasonable effort to understand the entire problem at the start and make truly long-term solutions our ultimate and uncomprimising objective.