THE EFFECT OF GRAVEL DREDGING ON MUSSEL PRODUCTION

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INTRODUCTION

The Tennessee Wildlife Resources Agency has been and now is concerned about the adverse effects of gravel dredging on the biota in the Tennessee River. This study was initiated and supported through the cooperative participation of the Tennessee Wildlife Resources Agency and NOAA, National Oceanic and Atmospheric Administration under PL88-309, Project No. 2-245-R.

The objectives of this study have been to find those methods and organisms that reveal best the effects of gravel dredging on the biotic communities. Many macrobenthic organisms and plankton were collected above and below the gravel dredging to compare their densities. Mussels were tagged, for the purpose of comparing growth rates and placed in areas above and below dredging. The best methods for measuring effects of gravel dredging were (1) use of tagged mussels as biological monitors and (2) use of a variety of artificial substrates which could be colonized with aquatic invertebrates. Growth differences of the mussels and different densities of the aquatic invertebrates above and below the dredging sites were recorded. A longer study period would validate the effects even better particularly since the gravel dredging is occurring along much of the length of the Tennessee River and each dredged area is different especially in water volume, rate of flow, and depth. Individual gravel dredging sites may reveal minimal effects in a short study but the total combined effect should be much more noticeable.

LOCATION OF STUDY

The primary study area was located at Tennessee River Mile 174 to 175 above Saltillo, Tennessee at Petticoat Riffle. This stretch of the Tennessee River averages 400 meters in width and 5 to 11 meters in depth except at Petticoat Riffle where the depth is 4 to 5 meters. Petticoat Riffle is approximately 200 meters in length and 150 meters in width.

The suction gravel dredge picks up all the bottom material, carries it upward and then it is sorted to sizes and washed. The undesirable material is returned immediately to the river often leaving the bottom irregular and from one to several meters deeper than before the dredging. The wash water is also returned directly to the river leaving suspended solids in the water for some distance (depends upon particle size, rate of flow, and depth) below the dredge.

METHODS

Mussels were identified, aged, weighed, measured and marked before placement in study locations. Tagging of mussels was accomplished by using a metal template with 25 drill holes in it in rows of 5. The template was placed against the right or left valve and small drill holes, representing numbers, made on the shell surface. Using both right and left valves for marking surfaces almost 1500 mussels can be marked in one area. Each mussel was weighed in grams, and the length, height and width were measured in millimeters. The age was determined by counting the concentric growth rests. These mussels were returned directly to the river bottom. The location of these tagged mussels was determined by extending a line from a fixed point on the shore to the point out in the river where the mussels were actually placed.

One of the weaknesses of this placement method is the difficulty of relocating the organisms. Much time is required to measure, weight, mark and place these mussels in the selected sites and when they are lost much information is lost. Approximately 500 mussels were used to determine the effects of gravel dredging.

These mussels were collected from a large population at T.R.M. 170.3 located above Swallow Bluff Island in a clean gravel environment and where the water is relatively shallow and free flowing. The species selected was *Fusconaia*

ebena, which is the most dominant species now in the Tennessee River. It is commercially valuable in the cultured pearl industry. The species depends on the skipjack herring which is its host fish during its parasitic stages. A minimum of eight to twelve years is required for this mussel to grow large enough to be harvested and sold. These mussels may live and continue to grow for twenty or thirty more years in a good environment.

When water quality is good the species *F. ebena* may grow several times larger at a given age than others in a poor environment. Quality of habitat has a significant effect on growth rates of mussels, therefore the mussels selected were all members of a population in a specific area above Swallow Bluff Island. The original sizes and weights in age categories were nearly alike above and below the gravel dredge.

The marked mussels were placed in several locations to determine the effect of altered conditions on them. (1) Some were placed in an area immediately behind the dredge where the bottom had been altered by removal of several sizes of gravel. These mussels were gone when a search for them occurred. (2) Some were placed on the bottom at a previously dredged site along Wolfe Island; these had disappeared after one month. A second group of fifty to sixty marked mussels were again placed in that same location. A month later they were gone. (3) Some were placed below the gravel dredge where the bottom had not been altered but where the influence of suspended materials could be measured on the growth of the mussels. These were recovered after one year in this location and their weight and growth changes recorded. (4) Some were placed above the dredge and their location marked by one of the red buoy cans in the river. These were lost, however, because the red buoy was moved. (5) Another group was placed upstream in a habitat not influenced by silt or suspended materials and after one year these were collected, remeasured and reweighed.

The differences in weight increase and growth above and below the gravel dredge are rather large (Figs. 1 & 2). These differences are further magnified when one considers the total area of the Tennessee River affected, the total number of mussels involved and the life span potential for mussels.

The loose irregular bottom material in a dredged area will not support mussels for several

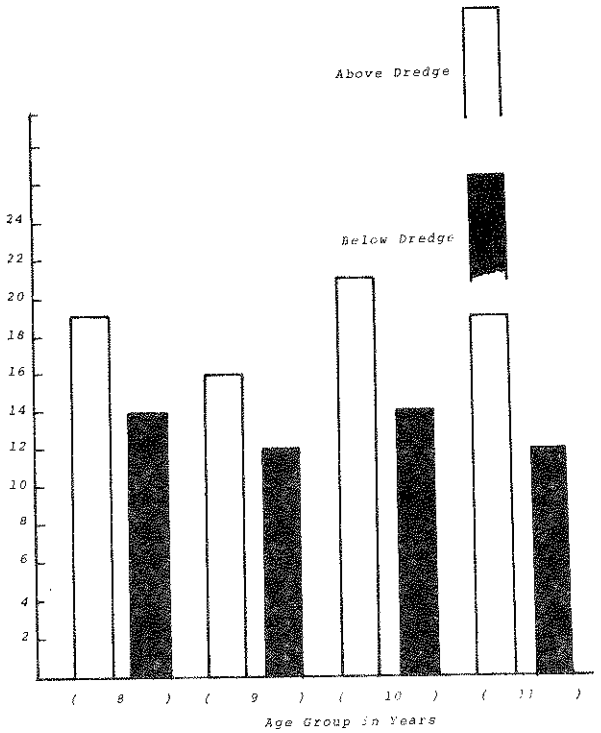

Figure 1. Mean percentage weight increase in *Fusconaia ebena* after one year.

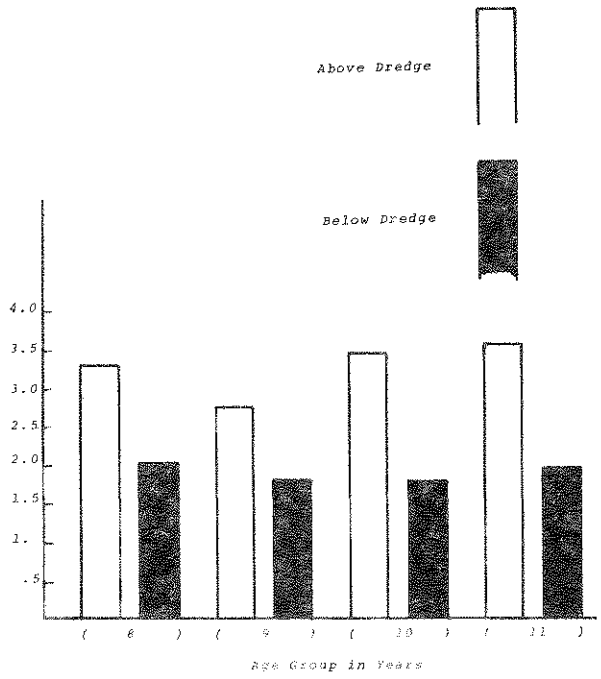

Figure 2. Mean shell growth of *Fusconaia ebena* millimeters per year.

months to years because it tends to shift. Also, the assortment of particle sizes is not immediately favorable for mussels, especially the first year stages. Since the bottom must first attract fish hosts carrying the larval mussels, it may be many years before a lost population of mussels returns to a dredged area. Mussel beds result from the host fish concentrating in an area. As the fish are feeding or spawning the metamorphosed mussels drop from their gills or fins and begin a free-living existence if the bottom is favorable. Then, for five or more years they go unnoticed while growing to about one inch in diameter. Another five years must elapse before they reach harvestable size for the cultured pearl industry. Whatever areas are dredged thus lose their mussel production for at least a decade. This is further amplified by the fact that these spawning areas are continuously being reduced and lost. Therefore, recovery time increases because the removed populations won't have neighboring populations from which the loss can be regained.

The ability to recover decreases after each environmental change and extends the potential time for recovery.

CONCLUSION

The resilience of the Tennessee River is not the same along its length nor are the organisms equally capable of reverting to their original densities.

Freshwater mussels are sedentary and have low resilience requiring much longer time to recover after a habitat alteration. Anything which causes the host fish of a mussel species to avoid or leave an area also eliminates the mussels. Many of the fish species that serve as hosts to freshwater mussels are not tolerant to silt.

Mussels have had a prominent historical and economic significance in the Tennessee River. The ecological role of mussels has not been completely evaluated but it is known that the quality of water they inhabit is usually good. Mussels do filter suspended organic matter from the water and improve its quality for fish and other swimming forms. Mussels are natural food for muskrats, some aquatic birds and some fish.

The number of mussel species living in the Tennessee River today is less than half the number recorded fifty years ago. The remaining species are decreasing now even faster based on surveys made in the past few years. When a mussel species disappears the host fish species and many other interrelated organisms have probably disappeared.

RECOMMENDATIONS

1. Surveys and impact studies should precede any new gravel dredging sites in the Tennessee River and its tributaries. These impact statements should be presented to appropriate state game and fish agencies who, in turn, should take necessary action to preserve the fauna.

2. Biological monitors ought to be placed above and below gravel dredges in all areas of the Tennessee River to assess the intensity of the effect on the biota. Monitoring should occur on a continuing basis in order to compile data on the differences between the results at each dredging site.