LOGGING AND FISH

by

I.L Wither

Fisheries Management Report No. 49

FISH & WILDLIFE BRANCH
DEPARTMENT of RECREATION & CONSERVATION

2204 Main Mall, University of British Columbia
Vancouver, B.C. V6T 1Z4

Lutkler. M.R. #49

Pls. do not remove. 1965

LOGGING AND FISH

This outline describes some of the effects of logging on aquatic environments. Your better understanding of the possible adverse effects to aquatic life (including fish) of some logging practices may help to preserve our valuable sport and commercial fisheries.

The Industry

The forest industry is expanding to include harvesting areas in even relatively remote parts of the province. This trend has been accentuated by a recent extension of pulp mill locations from the coast to various points in the interior. Generally, large sustained yield units managed by large logging companies are replacing small timber sales let to smaller logging operators.

Management of large forest areas by one large company on a sustained yield basis may be comparatively advantageous to fisheries managers. First, large responsible companies usually wish to maintain good public relations by running a "clean" operation. Second, sustained yield management of forests should mean rapid replanting of logged-over areas. Third, proper soil and water management techniques can be incorporated with forest management practices.

Where does the Fish and Game Branch fit in?

Fisheries workers want to see that clean streams and healthy fish populations co-exist with logging. Trout, salmon and char flourish best in clear streams and lakes which have water temperatures below 65°F. and an oxygen concentration above 7 p.p.m. They must have an adequate supply of aquatic and terrestrial food. Our job is to see that these conditions prevail in as many streams as possible.

What are the effects of logging on fish?

Logging practices rarely kill fish directly. The adverse effects of logging are transmitted directly to the fishes' environment and indirectly to fish. Adverse effects may be expressed as excessive siltation, oxygen depletion, extremely high or low stream flows, disturbed spawn or food chains, or unnatural barriers to fish passage.

Siltation

Stream siltation may result from a variety of logging and associated practices. For example, poorly designed and constructed logging roads can contribute silt to streams unnecessarily by use of inadequate culverting (causing "wash-outs"), by use of long, steep grades (promoting erosion), and by dumping of "fill" and waste road construction materials in water courses. Clear-cut logging promotes siltation by allowing more rapid drainage of precipitation from watersheds. Often, logging debris left in streams is subject to shifting with changing waterflows: abrasion of a stream bottom will result. Or, if debris accumulates in shallow water areas, the adjacent stream bank may erode from a diverted stream flow. Finally, silting may result from skidding logs or moving heavy equipment in stream beds.

Silt seldom kills adult fish directly. Experiments show that silt concentrations must reach 175,000 to 225,000 parts of silt per million parts of water before gill filaments become sufficiently clogged to kill fish. Sub-lethal quantities of silt may, however, impair circulation of the fish's blood, slow respiration and upset excretion and salt balance.

On the other hand, fish eggs deposited in spawning gravel, and alevins (newly hatched fish) before emerging from spawning gravel, are particularly sensitive to stream bed silting. It is probably the principal cause of pre-emergence losses.

Trout and salmon select spawning sites in stream beds which are permeable to water: consolidated gravels are avoided. A direct relationship exists between the rate of water percolation in gravel and survival of fish eggs. In experiments with salmon eggs, at velocities of more than 3.5 feet per second between 2.9 and 5.8 percent of the eggs died. At velocities between 1.5 and 3.5, mortality ranged from 10.1 to 13.0 percent. At velocities of 0.5 to 1.5, mortality rates ranged from 24 to 40 percent. Silt may fill interstitial spaces of a gravel surface and thereby block water flow to subsurface gravels.

Silt can kill developing eggs and alevins by direct contact. The chorion (outer layer of a fish egg) loses its smooth and glossy exterior by attracting fine silt particles and soon becomes completely covered by a dark coat of sediment. All early fertilized eggs in this condition die without hatching. Newly hatched alevins repel suspended particles through pectoral fin action and intermittent tail flexions. But, about 24 hours after hatching, the mouth and gills of the alevin begin functioning to create a new hazard. A continuous addition of fresh sediment results in inflammation of the gill membranes which eventually causes death. As alevins move out of the gravel, they are better able to cope with siltation.

Silt is not very dangerous in the normal stream if excesses occur only at intervals; continuous applications over the redds may be much more detrimental.

Silt can reduce the quantity and variety of the living organisms which inhabit the bottoms of streams and rivers. The bacteria, algae, protozoa and other lower forms are the basic components of the ecological community. They play important roles in food chains converting inorganic nutrients to fish populations utilized by man. Apparently, silt destroys the effectiveness of the breathing apparatus of lower aquatic life, or it simply covers and smothers it. Also, inorganic silt is the poorest of substrates for growing bottom fauna. Insect production is highest in rubble and decreases as the substrate becomes composed of finer materials. The processes of erosion greatly increase the relative proportion of finer materials on stream bottoms.

Aquatic plants are important as the basis of the food chain for aquatic animals and as the producers of oxygen by photosynthesis. Silt in streams can destroy plant life (algae and rooted plants) by two processes. First, sediment is believed to destroy algae by a grinding action or by simply covering the bottom of the stream with a blanket of silt. Second, it may shut off the light needed for photosynthesis.

Finally, streams with clean rubble bottoms have the largest trout and salmon populations and streams with bottoms containing much sand or silt contain fewer fish.

Oxygen Depletion

If large amounts of organic material (for example, leaves, bark or sawdust) are brought into a stream during a runoff period, some portion of this material will be deposited in the bottom of pools and other areas of low velocity. Silt will cover these deposits to form a so-called "benthal deposit". The covered organic material will decompose slowly by an anaerobic process - a process which does not require oxygen. The end products of this decomposition (hydrogen sulfide, ammonia, iron, methane gas, carbon dioxide and hydrogen) are soluble in water and gradually diffuse upward through the overlaying silt and sand. Bacteria in the water utilize these materials in an aerobic (oxygen-consuming) process which takes oxygen from the stream.

This oxygen demand usually comes at a time when temperatures are high and stream flows are low. Oxygen depletion from this source is greatest at the stream gravel surface; it can seriously reduce the stream areas in which some bottom-dwelling organisms may survive.

Stream Flows

The physical environment of the streams in which fish live is intimately dependent upon the conditions of terrestrial vegetative cover, soil mantle and past history of land treatment. After timber removal, more precipitation reaches the ground, and the soil mantle, where infiltration capacity has been reduced by logging, yields run-off sooner and faster. Transpiration is reduced. Abnormally high waterflows cause abnormal gravel shifting. This can cause scouring of incubating fish embryos from the gravel. Also gravel shifting remove algae and aquatic insects by grinding action and dislogement of the plants and animals. Rapid spring run-off can result in abnormally low summer and fall stream flow, a factor which limits the "living room" of all aquatic animals.

Water Temperature

Summer stream temperatures following logging depend largely upon what happens to streamside vegetation during logging. Streams shaded by vegetation tend to be cooler than more open ones. Conversely, winter temperatures can be expected to be lower in exposed streams than in well covered ones.

Stream temperatures may rise following logging to levels at which high mortality of salmonids will occur (above about 72°F). Lower winter temperatures would extend the incubation period for fall spawning fish. This condition would apply particularly to salmon species. The longer embryos remain in the gravel, the more probable is the occurrence of severe floods and unfavourable intra-gravel conditions. Extension of fry emergence beyond normal could increase losses to predators and decrease growth in the first year of life.

Barriers

Barriers are the most spectacular and obvious effect of logging. These can prevent or delay upstream migration of adult spawners. Improper culvert gradient or placement, soil and rock slides and logs and debris in streams are by-products of logging and road building that can partially or completely stop fish migration and utilization of otherwise suitable environments. Complete obstruction in spawning migration can eliminate egg deposition; delay can increase egg mortality.

Aesthetics

Debris is streams is offensive to the eye.

How can the logging manager help us?

It is hope that a closer association with managers of logging operations will allow us to act as advisors in planning operations where fisheries may be affected. Some simple protective measures incorporated with planning and logging may reduce possible damage to the fishes' environment to a minimum.

Road Construction

1. Locate roads at least 50 feet away from stream banks if possible.
2. Locate roads so that overcast and fill material does not get into streams.
3. Use gradients of less than 12 percent if possible.
4. Avoid long sustained slopes - undulating grades will not collect as much water.
5. Keep all ditches, culverts and dips open.
6. Where practical, roads should slope toward their outside edges.
7. Do not use streams for skid areas.

Timber Cutting

1. Do not destroy all streamside vegetation, even if this requires leaving an occasional merchantable tree uncut to hold the stream bank in place.
2. Trees near the river banks should be felled away from the river.
3. Keep stream beds and dry water courses free of logging debris.
4. Revegetate bare areas by planting or seeding as soon as possible.
5. In the long run, erosion control should be integrated with the entire logging plan.

Gravel Removal

Gravel for construction purposes should not be removed from stream beds. Gravel removal from streams can create pool areas with silt and debris covered bottoms which are of no use for spawning or incubation. It can create "pot holes" which may cause stranding of fish during low water flows. It alters the composition of the stream bed, disturbs aquatic insect communities and causes downstream silting.

Discussion

We wish to preserve our fisheries in the face of province-wide forest industry expansion. This may best be accomplished by engendering a spirit of cooperation through an attempt to understand the requirements of forest and fisheries resources.

The Fisheries Act is clear-cut in its provision for keeping streams clean of logging debris, and it will be used in instances where voluntary debris removal is not offered. But, mutual cooperation between forestry and fishery managers is the surest way to preserve some stream cover, stabilize water flows and practice integrated forest, land and water management.

Fisheries Management Division

Fish and Wildlife Branch

1965