Fact Sheet No. 28: Fishery Habitat: 3) Sediment and Pollutants

There are many sources and types of pollutants that can affect fish, including waste water, pesticides, toxic chemicals, organic chemicals, acidic rain, and sediments.

Sediment may be the most important pollutant in streams of the Western United States. It has been suggested that sedimentation, especially from the slow and continual input caused by erosion, may result in the gradual depletion of fishery habitat within any given stream (Cordone and Kelley, 1960).

Sediment, from a fishery standpoint, is defined as fine inorganic waterborne material below a certain specified diameter (Everest et al., 1987). The diameter for fine sediment is usually less than 0.25 in. (Chapman, 1988).

Sediment is commonly measured in concentrations or turbidity units. Concentration measurements are generally recorded in parts per million (ppm), or more recently, milligrams per liter (mg/l). Turbidity is an optical property of water where sediment causes light to be scattered or absorbed rather than transmitted in a straight line (APHA, 1980). Turbidity may only be used as an estimate of concentration because finely divided organic matter, plankton, and other microscopic particles will scatter and absorb light in a manner similar to clay or silt particles. Turbidity units are recorded in Jackson (JTU), formazin (FTU), or nephelometric (NTU) turbidity units.

Fine sediment, whether in suspension or settled, can have negative impacts on fish. Suspended sediment blocks light affecting feeding and movement of fish and causes direct gill damage (if concentrations are high enough) that may lead to death. Excessive sediment in the stream bottom may act as a physical barrier and stop the emergence of fry or prevent proper flow of water to redds. A redd is a nest built by fish in the gravel of the stream bottom. Proper water flow is necessary to carry dissolved oxygen to incubating eggs and to remove waste products from the developing embryo. Lloyd (1987) summarized 15 different effects of excessive sediment, including fatality, stress, altered behavior, and reductions in growth and abundance (Table 1).

Table 1. The different effects, at varying concentration, that sediment can have on fish.

			Range of Reported Values				
			ppm		**Turbidity Units[1]**		
Effect	**Species**	**Life**	**Low**	**High**	**Low**	**High**	**Unit**
Fatal	Coho salmon	Juveniles	509	1,217	---	---	---
Fatal	Chinook salmon	Juveniles	488	---	---	---	---
Reduced survival	Chum salmon	Eggs	97	---	---	---	---
Reduced survival	Rainbow trout	Eggs	110	---	---	---	---

Reduced survival	Rainbow trout	Juveniles	90	2,500	---	---	---
Reduced survival	Coho salmon	Juveniles			15	27	JTU
Reduced survival	Coho salmon	Adults	1,400	1,600	---	---	---
Reduced abundance	Brown trout	---	1,000	6,000	---	---	---
Reduced abundance	Lake trout	---	---	---	<10	---	FTU
Reduced growth	Rainbow trout	Juveniles	50	---	---	---	---
Reduced growth	Brook trout	Juveniles	---	---	32	86	JTU
Reduced growth	Coho salmon	Juveniles	---	---	25	---	NTU
Reduced food conversion	Rainbow trout	Juveniles	---	---	<70	---	JTU
Reduced feeding	Coho salmon	Juveniles	100	300	---	---	---
Reduced feeding	Coho salmon	Juveniles	---	---	10	60	NTU
Reduced feeding	Cutthroat trout	---	35	---	---	---	---
Reduced feeding	Brown trout	---	---	---	7.5	---	NTU
Reduced feeding	Rainbow trout	--	---	---	70	---	JTU
Reduced condition factor	Rainbow trout	Juveniles	110	---	---	---	---
Altered diet	Rainbow trout	Juveniles	110	---	---	---	---
Stress	Coho salmon	Juveniles	500	---	---	---	---
Stress	Brook trout	Juveniles	---	---	231	---	NTU
Stress	Coho salmon	Juveniles	---	---	15	27	JTU
Stress	Steelhead	Juveniles	2,000	---	---	---	---
Disease	Rainbow trout	Juveniles	100	270	---	---	---
Avoidance	Chinook salmon	Adults	350	650	---	---	---
Avoidance	Lake trout	---	---	---	6	---	FTU
Avoidance	Coho salmon	Juveniles	---	---	22	265	NTU
Avoidance	Steelhead trout	Juveniles	---	---	22	265	NTU
Displacement	Rainbow trout	Juveniles	110	---	---	---	---
Displacement	Coho salmon	Juveniles	---	---	40	50	NTU
Displacement	Steelhead	Juveniles	---	---	40	50	NTU
Altered behavior	Trout	---	---	---	25	---	JTU
Altered behavior	Brook trout	---	---	---	7	---	FTU
Altered behavior	Coho salmon	Juveniles	---	---	10	60	NTU
Altered behavior	Coho salmon	Juveniles	---	---	15	27	JTU
Change in body color	Coho salmon	Juveniles	---	---	15	27	JTU
Reduced Tolerance to salt water	Chinook salmon	Juveniles	3,100	---	---		---

In addition to affecting incubation and emergence, excessive sediment can have indirect effects on fish, such as decreased visibility affecting feeding and the filling of pools which decreases living space.

The physical, chemical, and biological components of aquatic ecosystems are very complex. Susceptibility to sediment depends on the species and life stage (Lloyd, 1987). Only the simplest aspects of interactions between sediment and salmonids have been explored in these very complex aquatic ecosystems (Everest et al., 1987).

As with temperature, fish can be acclimated to different sediment concentrations, thus providing some explanations for variable results in studies. Adult fish can withstand high concentrations for short periods of time without harm, but sediment on stream bottoms will reduce survival of eggs and newly hatched fry (Cordone and Kelly, 1960).

As with temperature, natural variation of sediment in streams is high. The process of erosion and sedimentation in streams is high. The process of erosion and sedimentation is a natural process. Problems exist when natural sedimentation rates are exceeded. Sedimentation will vary depending on soils, storms, and upland management. Spatial and temporal variation also exists within and between streams (Everest et al., 1987).

The most significant source of sediment may depend on the basin size. In the Pacific Northwest, perhaps the largest source of sediment in streams is from mass failures, roads, and gully erosion, especially in large or steep basins. In smaller basins, surface erosion, root throw, and animal burrowing are significant sources of sediment (Swanson et al., 1987).

Some mitigation of excessive sediment in streams can occur. Fine sediment can be cleaned from the stream bottom gravel by scouring during peak flows. Spawning salmonids can also significantly improve their chances of reproductive success through behavioral adaptations (Everest et al., 1987). During the redd construction (e.g., digging nests in the stream bottom) fine sediments are cleaned from the gravel (Everest et al., 1987). In addition, redds are located at the interface of the riffles and pools which lead to optimal physical conditions (adequate oxygen supply and waste removal) for incubation and emergence of salmonids (Chapman, 1988).

We would like to thank Dr. Peter B. Moyle, Professor of Wildlife, Fish Conservation Biology, Department of Wildlife and Fisheries Biology, University of California, Davis, for reviewing this fact sheet and providing information.

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Note: This fact sheet only contains general information about fishery requirements. Additional sources of information include *Pacific Salmon Life Histories*, edited by C. Croot and L. Margolis, UBC Press, Vancouver. For information on specific species see *Habitat Suitability Information: for species interested in...*, published by U.S. Department of Interior, Fish and Wildlife Service. See your local fishery biologist for information about fish in any specific stream.

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