Aggregate Operator's Best Management Practices Handbook

Appendix 2
SALMONID LIFE HISTORIES AND HABITAT REQUIREMENTS

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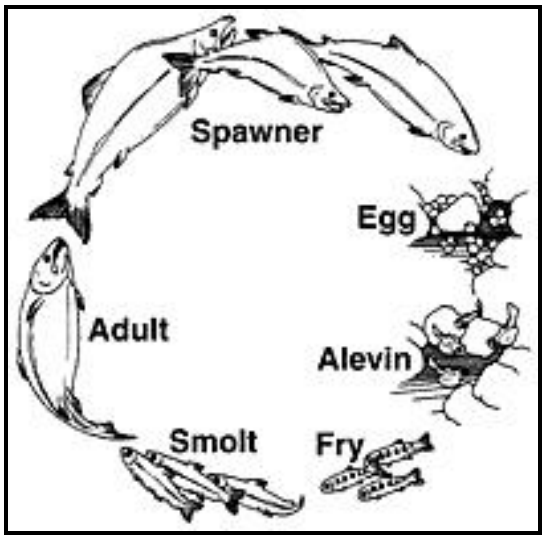
Salmonid Life Histories and Habitat Requirements

Salmonid Life Histories

Anadromous salmonids use the ocean for a major portion of their growth, but depend on freshwater for reproduction. A significant characteristic of anadromous salmonids is their habit of returning from the ocean to spawn in their natal streams, where they were spawned and reared. This homing characteristic has resulted in the development of distinct and separate stocks, each adapted to the particular conditions of its natal stream. There are, therefore, differences between populations in the seasonal timing of adult migration and spawning in freshwater. Each salmonid species is unique in its life cycle and habitat requirements in the freshwater phase. All species of anadromous salmonids require a freshwater environment for spawning and embryonic development, but the species differ in the extent to which they rear in freshwater after emerging from the spawning gravel as fry. Pink and chum salmon migrate to sea immediately following emergence, while the other species rear in streams, lakes or estuaries for periods of months to several years before entering saltwater. The generalized life cycle of the anadromous salmonid is shown in the following figure.

Image A2 - 1: Generalized life cycle of anadromous salmonids



There are significant differences in the life histories of the Pacific salmon, trout and char. While Pacific salmon die after spawning, trout and char may survive to spawn more than once. Salmon and char characteristically spawn in the fall, in declining temperatures, whereas trout spawn in winter or spring, when water temperature generally rises. All species use the gravel bottom of streams or upwelling groundwater sources for spawning sites. The spawning nest or redd, which is constructed by the female, consists of a series of pockets in the gravel in which fertilized eggs are deposited and buried to a depth of 20 to 50 cm. Development of the embryo proceeds from the egg stage to hatching, then through alevin development to full absorption of the yolk sac, and eventually to emergence of fry from the gravel. The period from spawning to fry emergence may range from as little as 2 months in the case of spring-spawning trout, to as much as 9 months for those Pacific salmon populations spawning in colder periods, where temperatures close to 0°C

prevail through most of the winter. In the latter case, spawning would likely occur in early to mid-September, eggs would reach the eyed stage (when the eyes, head and body form of the embryo first become apparent) during October, hatching would occur in the following March and April, and the fry would emerge during May. With the exception of the coastal cutthroat trout and anadromous Dolly Varden char, which use near-shore inter-tidal and estuarine areas, many races of anadromous salmonid species migrate extensively for feeding in the Pacific Ocean. They range between northern California and the Gulf of Alaska, and can be found up to 1600 km offshore. Other races of salmonid species remain and feed in coastal waters, such as Georgia Strait, throughout the marine portion of their life. Several species of trout and char have exclusively freshwater life histories where adult migration, spawning, incubation and rearing all occur in, and between, lakes, rivers and streams.

Salmonid Habitat Requirements

Salmonids are a group of fishes adapted to the variable habitat of north temperate, "recently" deglaciated regions. Individually, they often have to cope with severe and variable conditions and as a result might be thought of as an especially "tough" or "insensitive" group of species. They appear to be remarkably resilient in habitat use, in feeding, growth and reproduction, as well as in many other ecological and behavioural characteristics. Despite this, they are environmentally sensitive fishes, particularly with respect to the habitat and water quality requirements of the incubating and rearing portions of their life cycle. The typical food items for those species that use streams for nursery purposes are terrestrial and aquatic invertebrate animals whose own life cycles depend on similar habitat and water quality characteristics as salmonids.

Salmonids have different habitat requirements for each life stage, but generally they need fairly cool, well-oxygenated water, a clean gravel substrate, and abundant cover and shade. They need special conditions for successful spawning, for the subsequent development and hatching of eggs and for growth and survival of their young. Fry and juveniles move to different habitats as they grow older, and hence they require access up and down the stream and into smaller tributaries. This may include swampy areas, wetlands, small streams and side channels or intermittently wetted areas. These vital areas may sometimes not seem like appropriate habitat to the untrained eye. Adult salmonids require adequate flow and access to spawning areas for completion of their life cycle.

The range and diversity of aquatic environments the various salmonids inhabit throughout their life history combine to make them much more vulnerable to environmental changes. These changes are generally associated with water use and impacts of land use activities on the aquatic environment. Water diversions and pollution, hydroelectric projects, forest harvesting, road construction and land development can each adversely affect salmonids. Their habitat use varies widely with species and also with races of a species, between discrete populations and even between individuals of the same population. This makes it difficult to generalize about their areas of preference and habitat requirements. It also means that salmonid habitat protection and management must be based on specific and up-to-date information about local populations and conditions.

Specific environmental requirements of salmonids vary with species; the requirements of different species may even be in direct conflict (e.g., a small log jam may create a nursery area for coho salmon but remove a spawning area for chum or pink salmon). The following is a generalization of the optimum requirements of the habitat characteristics and water conditions of the salmonid freshwater environment:

Water Temperature

A temperature between 12 and 14°C is preferred by the young of all salmon species, with marked avoidance of temperatures above 15°C, and fatality at temperatures of about 24-25°C. Increased stream temperature means more dissolved oxygen (DO) is needed for the increased metabolic rate of fish. However, DO saturation levels decrease with increasing temperature, so lower concentrations of DO are available as temperatures rise.

Dissolved Oxygen (DO)

Stream-dwelling salmonids require high levels of DO in both the intragravel and surface waters. It is difficult to set down useful minimum oxygen requirements for stream salmonids given the great diversity of requirements for different life stages, activities and stresses any population experiences. It must be stressed that temperature and water quality markedly affect the levels of DO saturation (i.e., percentage of total saturation at a given temperature) and concentration (mg/l) in stream waters. Generally, optimum DO saturation is greater than 90% and minimum optimum DO concentration is greater than 8 mg/l.

Water Clarity and Suspended Sediment

Stream water must be clear enough to permit the sunlight to reach the stream bottom and the algal community where most of the primary production of a stream occurs. Elimination of such production may severely reduce the invertebrate fauna of a stream. Salmonids feed by sight and can have difficulty finding food items in highly turbid water. High concentrations of suspended solids may also directly damage invertebrates and fish, primarily their fragile gill structures. Additional impacts can occur if suspended sediments settle onto stream bottoms and suffocate Incubating salmonid eggs and alevins, and destroy benthic invertebrate populations.

Stream Substrate

For successful spawning, salmonids require clean stable gravel, typically located in riffles or runs, depending on fish size and species. High quality gravel will permit redd building and an intragravel flow of water adequate to provide each embryo and alevin with a high concentration of dissolved oxygen and to remove metabolic wastes such as carbon dioxide and ammonia. Clean spawning gravel, from 5 mm to 150 mm in diameter, and larger rocks and cobbles, found on the stream bottom and banks, is required for production of aquatic insects and habitat for young juvenile salmonids.

Riparian Cover and Stream Structure

Stream salmonids require cover in the form of undercut banks, logs, rubble substrate, turbulence, deep pools and overhanging streamside vegetation as found in a viable healthy riparian area. Such cover is used by juveniles for feeding areas, as a source of food items, and as refuge for escape and over-wintering. Adult salmonids use deep pools as cover for resting and escape during spawning migrations. Research has also shown that in order to have substantial mixed populations of salmonids, such as the commonly found associations of steelhead trout and coho salmon or cutthroat trout and coho, a stream with a stepped gradient and high proportion of both riffles and pools is required. Large organic debris (LOD) forms an integral part of the stream morphology by stabilizing the streambed, by providing habitat, and by altering the stream structure with scours and pools. Naturally occurring LOD, such as fallen logs, root wads and small jams, should not be altered or removed.

Access

The spawning and nursery areas of streams must be accessible to adult salmonids migrating upstream, and to fry and juveniles seeking rearing habitat. This includes small feeder streams, wetlands and side channels, which provide valuable habitat in the stream or river environment.

Stream Flow

A relatively stable flow, without extreme freshets and droughts, characterizes the best salmon and trout streams. Stable stream flow is characterized by a minimum of freshets and floods causing excessive bed load transport and bank instability, consequently destroying benthos or any developing embryos or alevins that might be in the substrate. While too much water might be detrimental, too little is also damaging. A sufficient flow of water is required for each life stage. Sufficient flows are required during the normal low flow period of late August and September to provide adequate nursery area for the young salmonids and access for returning spawners, and also during the winter, when embryos and alevins in the gravel could be exposed to freezing.