

Salmon Life Cycles

Adult salmonids spend, on average, between 1 and 4 years in the open ocean, migrating in counterclockwise ellipses through the northeastern Pacific. They may travel as far north as the Aleutian Islands or as far south as northern California. Upon their maturation they return to coastal areas and begin following the coastline until coming upon the estuary of the river they migrated from as smolts. They migrate upriver, navigating by olfactory mechanisms, searching for their natal stream.

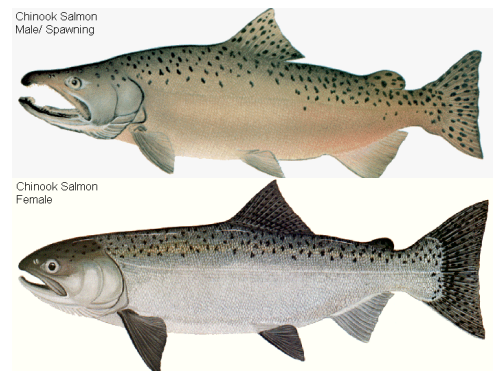
During the final stages of their homeward migration they cease feeding and begin to develop spawning coloration and the males develop a hooked nose known as a kype. Upon finding their natal stream, the female will dig a group of nests, termed a redd, in the gravel and courting males will spawn with the female upon satisfactory completion of the nest. After spawning the female will cover her redd, and stand guard until her reserves are depleted and she dies. Males will continue spawning as long as there are available females, fighting off other males for the privilege of fathering more offspring, until they too, deplete their physical reserves and die.

Salmonid eggs face a number of hazards during incubation. The gravel must have good flow and high oxygen content for the eggs to survive. Siltation from flooding and human disturbances can suffocate eggs during incubation. Eggs are also subject to high rates of predation if they are inadequately covered in the gravel. High flows and intense scouring of the streambed also dislodge eggs, which quickly become food for other species. Upon hatching, alevins will remain below the gravel in the streambed, orienting themselves upstream, a behavior known as positive rheotaxis. They will thrive on their yolk sac as they grow into the fry stage, at which point the fry will emerge from the gravel and take up residence in the stream or lake (Sockeye), feeding on insects, larvae, zooplankton and eggs of other species. Fry will continue to grow into parr and then smolts, as environmental and hormonal cues prepare the young fishes for migration.

CHINOOK – *Oncorhynchus tshawytscha*

DISTINGUISHING CHARACTERISTICS:

- Large, oval body
- Silver in color until close to spawning when the males turn orange or red and sometimes even green and brown in color. The females become darker silver to almost black.
- Spots on the upper portion of body and throughout tail.
- Crescent shape end of tail
- Black gumline
- 13 or more anal fin rays



Chinook Salmon, also known as King, Blackmouth and Tye, are the least abundant North American Pacific Salmon, but the most abundant species in the Columbia River (excluding Steelhead). This species is the most prized of all Pacific salmon because of its large size and flavorful flesh. Chinook are most closely related to Coho (*O. kisutch*) and are relatively primitive in the evolutionary chain of Pacific salmon.

Chinook have evolved into two races, Streamtype and Ocean type, a characteristic unshared by any other salmon. Streamtype fish typically spend a full year of their lives in freshwater, migrate to sea in Spring and return to spawn

in Spring. Streamtype are also called Spring and yearling Chinook. Ocean type fish spend less than a year in freshwater and migrate to sea as subyearlings in Summer, then return to spawn in Fall. Ocean type fishes are also known as Fall, Zero's and subyearling Chinook. The Columbia River has both races of Chinook, 22% classified as Streamtype (Chin 1) and 78% as Ocean type (Chin 0). Other rivers throughout the Chinooks range vary in make up, with some being all Streamtype and others being all Ocean type. The Sacramento River system has a unique race known as Winter run, which do not fall into either classification.

Adults can return to spawn at anytime during the year, depending on the river. Streamtype fish usually enter the river from February to July, while Ocean type fish return from July to December. Streamtype fish can return as "Brights," meaning they retain their silvery ocean appearance, while Ocean type fish usually begin to exhibit spawning characteristics soon after entering fresh water. Streamtype fish are not fully mature upon return and can spend months in the river before spawning, thus explaining their appearance, while Ocean type fish are ready to spawn within days or weeks of arrival. Regardless of the return time, most Chinook spawn during the Fall season. Streamtype fish are typically found higher in river reaches. It is thought these fish arrive and migrate sooner than Ocean type to take advantage of peak summer flows, but also to give themselves time to reach their spawning grounds before full maturity. It seems that Streamtype fish suffer a double disadvantage because they lose ocean feeding time and must maintain their ion balance in freshwater without feeding for up to several months prior to spawning.

Spawning, like homeward migration, can occur at any time of the year. It seems spawning time is not only influenced by race, but by latitude. Northern stocks typically spawn earlier than Southern stocks. The Columbia river is in the central area of the range and spawning occurs primarily from August to late September, with Streamtype adults spawning earlier and Ocean type later in this period. Redds contain 4-5 nests and occur in areas of high subgravel flows. Streamtype fish tend to prefer courser substrate, such as in small tributaries, than Ocean type who will sometimes spawn in the mainstem of the Columbia. Streamtype fish have smaller redds, while Ocean types have been observed spawning in groups in a large redd, although usually they choose to spawn with a single partner. Fecundity ranges from 2000 to 17000 eggs per female, and is positively correlated with the size of the mother. Chinook always prefer areas of high subgravel flow for spawning. It is thought this preference is due to the size of their eggs. Chinook have the largest eggs of all the Pacific salmon, and their eggs have the smallest surface to volume ratio. The eggs are therefore more sensitive to reduced oxygen levels and require a more certain rate of irrigation. It is possible the need for strong subsurface flow may mean suitable Chinook spawning habitat is more limited than superficial observations suggest. Therefore, high population density may force spawners into less suitable spawning areas resulting in increased mortality. If this is the case, continued high production of Chinook in spite of reduced spawning populations is understandable, since the apparent reduction in spawning populations would not have been accompanied by a corresponding reduction in fry production.

Fry emerge from the gravel at night and move downstream with the current from February to May. Some fry will take up residence in the stream while others continue further downstream. It is thought this is a result of a density dependent dispersal mechanism which distributes fry to less crowded stream reaches for rearing. There is a strong correlation of downstream migration with high flows, and during flood periods fry migrate extensively. Juveniles will rear in the natal stream for weeks (Ocean type) or a full year (Streamtype) before migration to the estuary, although Ocean type juveniles will sometimes bypass the stream and rear exclusively in the estuary. Both races

spend time in the estuary after smoltification, with Streamtype fishes in residence from June to August. Ocean type fishes who previously utilized the habitat tend to migrate to sea in late May and June, coinciding with the arrival of Streamtype smolts in the estuary. Streamtype fishes then migrate to sea in late summer.

Chinook spend their first ocean year in sheltered coastal areas, however as their time at sea increases Streamtype fish tend to disperse into offshore areas throughout the North Pacific Ocean and Bering Sea. Ocean type fish, however, are generally found near shore and are thought not to disperse more than 1,000 km from their natal river. While at sea Chinook feed primarily on small fishes, amphipods, euphasids and crab megalopa. During some years insects make up a significant portion of the diet, as they do during stream residence, but its thought this has to do with regional and environmental variaton.

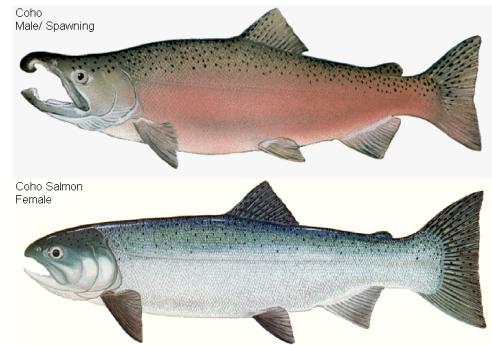
Spawning adults return to their natal streams anywhere from 1-8 years, depending on sex and race. In the Columbia the mean age of Ocean type male and female spawners is 3.55 and 4.29 years, respectively. For Streamtype, male and female ages are 3.98 and 4.39 years respectively. Regardless of race, females are usually older than males.

Columbia River Chinook salmon are not currently on the Endangered Species List, although Mid Columbia Summer Chinook were under review as of 1994 and Snake River stocks have been listed as Threatened since 1993. Chinook stocks of the Columbia are in decline.

COHO – *Oncorhynchus kisutch*

DISTINGUISHING CHARACTERISTICS:

- Long oval body
- Silver in color until they are near spawning, when the male turns a brick-red color and the female becomes a dull bronze
- Spots on upper portion of body and only on upper tip of tail
- Crescent shaped end of tail.
- White gum-line.
- 13 or more anal



Coho salmon, also known as Silver, and is the fourth least abundant North American Pacific species, with only Chinook being less abundant. In the Columbia River Coho are less abundant than Chinook and more abundant than Sockeye.

Coho are not thought to have different races or seasonal runs like Chinook, although a few rivers do exhibit some evidence of winter or spring runs. Throughout their range (Monterey Bay, CA to Pt. Hope, AK), stocks tend to return earlier in the year to spawning grounds in the northern part of the range, and later in the year in the southern part. In the Columbia River, mid-range, coho return in fall, from September through October.

Although coho do not seem to have races in spawning times, there are thought to be two adult migrant types.

Coastal type occupy outer coastal and offshore waters and migrate further from their natal streams than Inshore type. Interior type fish remain in inside waters, closer to shore. There is a difference in body shape, with Coastal fish having a large median (dorsal) fin and a deep robust body while Interior forms have small median fins and a streamlined body.

Most coho return to their natal stream during their third year of life, having spent one winter in the ocean (the other in the stream). Coho do not migrate to the extreme upper reaches of rivers, and most stocks seldom migrate more than 240km upriver. Some exclusions to the rule apply, as in the Columbia River where coho migrate as many as

800 km to spawn in the Grande Ronde River. Spawning occurs primarily from November through February in Oregon rivers, and females deposit, on average, 800 to 900 eggs per nest. Coho are thought to be the least particular of the Pacific salmon in choosing nest sites and will spawn in substrate from fine gravel to boulders, although preferring small gravel. Females dig 3-4 nests per redd and after spawning will guard it for 10-15 days.

Eggs incubate from 110 to 115 days and hatch earlier in low oxygen environments and later in colder temperatures. Fry emerge with yolk sacs virtually complete between 10 and 47 days after hatching. Early emerging fry are usually larger and have more opportunity to grow than later emerging counterparts and are thought to have a higher survival rate than later emerging fry. Coho fry are highly territorial while rearing in stream environments, although lake rearing coho do not generally exhibit territorial behavior. Fry which prematurely migrate to seawater are not thought to live to adulthood. Salinity tolerance appears not to be a function of age but a function of size, the threshold size for saltwater survival being 7-8cm. Fry generally rear in the freshwater environment for a year before migration.

Smoltification and migration begins in spring, roughly a year and a half since they were deposited in the gravel as eggs, although some coho will rear for up to 4 years in northerly streams. Smolts migrate earlier in the year from rivers in the southern part of their range, and later in the year in northern rivers. The peak migration time for coho in Oregon and Washington is usually May, and ranges between late March and June. At the onset of smoltification stream resident fish become less territorial and begin forming aggregations. Migrating fish tend to move downstream in schools of 10-50 smolts, grouping themselves by similar size.

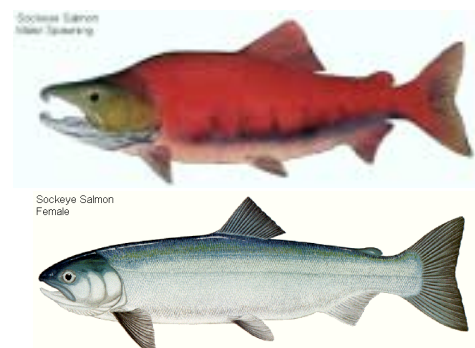
Smolts will remain close to shore their first few months at sea and then will begin moving northward along the coast. After about 12 months at sea coho migrate southward along the coast, while others follow a counter-clockwise migration in the Gulf of Alaska. Not all coho migrate to Alaska, and some of Washington and B.C. stocks migrate only short distances to good feeding grounds and remain there until reaching sexual maturity. Coho were not thought to undertake extensive migrations and are generally found close to shore, although further research indicates that some stocks travel great distances. However, in comparison to chinook salmon, coho do not migrate as far. Adults usually spend 1 winter at sea and return to spawn in their natal streams as 2 or 3 year olds. Upon return, adults of the Columbia river weigh on average 4.5 kg, with southerly stocks being larger, and northerly stocks smaller.

Coho stocks are in decline throughout their range and southern Oregon and northern California stocks have been listed as threatened. Oregon's coastal coho were listed as threatened in fall of 1998.

SOCKEYE – *Oncorhynchus nerka*

DISTINGUISHING Characteristics:

- Metallic blue on the back with silvery sides.
- Spawning males turn bright red with a green head and tail and a hump on its back. Females turn a similar color but the body is a darker blotched red and has no hump.
- Fine black speckles across the back.
- Almost clear tail and fins.
- 13 or more anal fin rays.



Sockeye salmon are the third most abundant Pacific Salmon, but the least abundant in the Columbia River system. Also called red or blueback salmon, these fish are best known for the intense red and green coloration achieved during spawning and their dark pink flesh. Landlocked, or non-migrating Sockeye are commonly known as Kokanee or silver trout. Both migrating Sockeye and Kokanee are found in the Columbia.

Sockeye are unique among other Pacific salmon in that many runs prefer to spawn and rear in lake environments. Adults return in late spring and summer and spawn from July to January, with the majority of fishes spawning from mid-summer to late autumn. Spawning usually occurs in streams associated with lakes or lake shores with strong upwelling, although some fish choose spring areas and side channels. Egg deposition can occur in substrate as fine as sand or as coarse as cobble and boulders. Females dig, on average, 4-5 nests per redd and deposit 500 to 1100 eggs per nest. Incubation is a function of temperature and oxygen availability. Research shows Sockeye have one of the longest incubation periods for Pacific salmon during constant conditions. However, low temperatures or low oxygen levels can slow or speed the incubation period respectively.

Fry emerge under cover of nightfall mainly from mid April to early June, peaking in mid May, and immediately migrate downstream (negative rheotaxis). Shortly after emergence, they exhibit positive rheotaxis and, moving in schools, make their way to the rearing lake. Juveniles spawned in a river system without a lake environment migrate soon after emergence to the estuary where they feed for a short time and then enter the ocean as sub-yearlings.

Sockeye feed in the lake environment on zooplankton, insects and insect larvae, and larval fishes for 1-3 years, with Columbia stocks generally taking 1 year to rear. Smoltification begins in the lake environment and is usually completed by the time migrants reach the estuary.

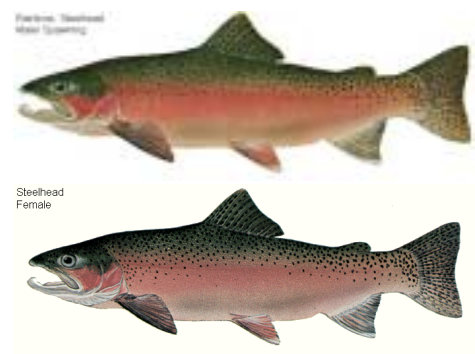
Sockeye spend from 1-4 years at sea, with Columbia stocks spending 1-2. Migration occurs in counterclockwise ellipses throughout the North Pacific Ocean, Bering Sea, and Gulf of Alaska. Southern stocks, including the Columbia system, generally do not migrate as far north or west and are found mainly in the Gulf of Alaska. They feed on euphasids, amphipods, small fish and squid, with lesser preferred prey comprising of copepods, pteropods and crustacean larvae. Food composition depends clearly on the availability and abundance which vary by season and location. Upon return to their natal streams adult Columbia system Sockeye average 1.58 kg, the smallest of all the Pacific stocks.

Sockeye in the Columbia and Snake Rivers are in decline. Columbia and Snake River Sockeye have been listed as endangered since 1992.

STEELHEAD TROUT - *Oncorhynchus mykiss*

DISTINGUISHING CHARACTERISTICS:

- Long slender body ("torpedo" shaped).
- Steel blue, spotted back with silvery sides. When close to spawning, both the male and female will develop a pink to rose-red stripe down their side (the "rainbow") and get a slight olive green tint to the back.
- Straight end of tail with spots throughout.
- Fewer than 13 anal fin rays.



Steelhead trout are rainbow trout that migrate to the sea. They average 10 pounds and can grow as large as 42 pounds.

Unlike salmon, steelhead trout do not necessarily die after spawning but may spawn several times. They spend from 1 to 4 years in the ocean before returning to their spawning stream. Spawning occurs any time from late winter to early spring. Juvenile steelhead can spend from 1 to 3 years in the freshwater before migrating to the ocean.

Steelhead can be seen throughout the year although most steelhead run past Bonneville Dam from July through September. There are two runs of steelhead:

- Summer: April through October
- Winter: November through April

Many winter run steelhead spawn in the lower Columbia tributaries. Summer run fish pass over Bonneville Dam and migrate to the upper reaches of the Columbia and Snake Rivers where they spend the winter, then move to their home streams in the spring to spawn.

AMERICAN SHAD - *Alosa sapidissima*

DISTINGUISHING CHARACTERISTICS:

- Tear-drop body shape ("football" shaped)
- Deeply notched tail that forms a "V" shape
- Bright silver color with no spots
- Often seen in groups.

Shad are members of the Herring family. Adults average a foot in length and 2 to 6 pounds and can grow as large as 13 pounds. These Atlantic Ocean fish were introduced into the Sacramento River in 1831 and are now found as far north as Alaska along the Pacific Coast. Adult shad spend 3 to 5 years in the ocean. Most return to spawn in open water in the Columbia River at age 5. Shad may return to spawn up to 5 times during their life. Juveniles spend the summer in fresh water and migrate to the ocean in the fall.

Shad can be seen at Bonneville from May to August. The run peaks in mid-June.

WHITE STURGEON - *Acipenser transmontanus*

DISTINGUISHING CHARACTERISTICS:

- Grey color, with sharp bony plates (scutes) along the back.
- The skeleton is mostly cartilage
- Toothless mouth protrudes from the underside of the head.
- Can live up to 100 years of age and grow to 20 feet long and 1,800 pounds!
- Contrary to popular belief, they do not change sex.

The White Sturgeon are commonly found above and below Bonneville Dam, as well as throughout the Columbia and Snake Rivers. These fish like deep, cavernous areas, and are bottom feeders. Sturgeon are anadromous, which means they go from the ocean to fresh water to spawn. If they are not able to get to the ocean, they may live their entire life in fresh water.

Although rarely seen in the fish ladders at Bonneville, many sturgeon are caught by anglers below the dam. Their roe (eggs) are a delicacy and their flesh is tender and boneless. State fishing regulation limit the size of a sturgeon you can keep. Fish below the minimum size have very little edible flesh. The upper limit is to protect the breeding fish. The larger the fish, the more eggs they produce. A nine-foot, 50 year old female might contain three million eggs!

Their population is being studied to prevent depletion from over-fishing.

Few sturgeon migrate through the fish ladders although they are sometimes seen in the ladders looking for lamprey to eat. Anglers fish year round for sturgeon below the dam.

There are a few live sturgeon (adult and juvenile) on display at the Bonneville Fish Hatchery.

GENERAL LIFE HISTORY CHARACTERISTICS OF COLUMBIA RIVER SALMON AND STEELHEAD

Species	Adult Migration times	Spawning Time	Downstream Migration	Location of Spawning
Spring chinook	Jan-May	Late July to late Sept	During 2nd spring/summer	Tributaries to mainstem
Summer chinook	June-mid-August	Sept-mid-Nov	During 2 nd spring	Tributaries
Fall chinook	Aug-Dec	Sept-Jan	April-Sept (before they are a year old)	Mainstem Hanford Reach
Coho	Early Oct -late Dec	Mid-Nov -early Jan	March-July (after their first year)	Tributaries- backwater areas
Sockeye	Early run-late July to early Aug; Late run Sept-Oct	Aug-Nov	April-June	Tributaries above lakes; fry then enter lakes & remain 1-3 yrs before migrating to ocean
Steelhead				
Summer run "A" group (earlier run)	June-early Aug	Feb-March	March-June	Tributaries
"B" group (later run)	Aug-Oct	April-May	March-June	Tributaries
Winter run	Nov-mid-June	Feb-June	March-June	Tributaries