Fish Passage: What is it and Why is it Necessary?




Ecological Connectivity

- A watershed is a network of channels that drain a common boundary.
- Channel characteristics formed by interaction of precipitation, geology, topography, and riparian vegetation.
- Inter-connected channels transport watershed products downstream and function as migration corridors for aquatic and riparian species.

Ecological Connectivity

- Stream channels and road networks are linear systems.
- Perpendicular orientation of stream channels and roads = many intersections.
- Both systems are at risk of disruption from each other.

Importance of Ecological Connectivity

- Disruption watershed processes.
- Disruption of migration patterns of numerous species.
- Loss of tributary habitat for spawning and rearing.
- Multiple impediments within single watershed = fragmentation.

Anadromous Salmonids in CA.

- Coho Salmon
- Chinook Salmon
- Coastal Rainbow Trout - resident and anadromous (steelhead)
- Coastal Cutthroat trout - resident and anadromous

General Salmonid Life History

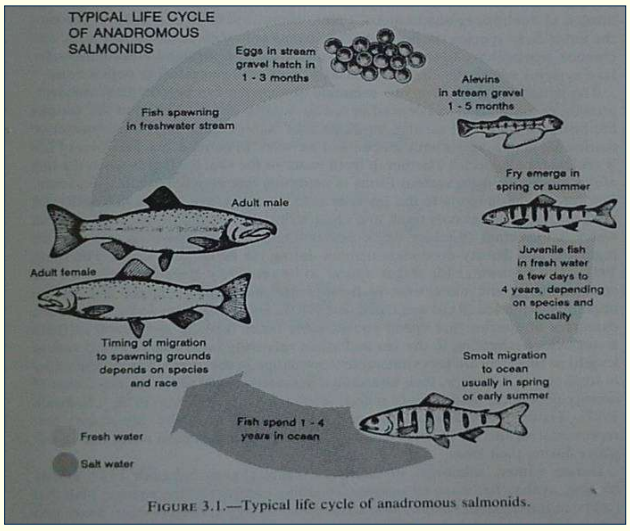


FIGURE 3.1.—Typical life cycle of anadromous salmonids.

Coho Salmon in CA.

- Oregon border to Santa Cruz County.
- Mostly three-year life cycle.
- Juveniles spend approximately 18 months in freshwater.
- Cool water temperatures and LWD.
- All Pacific salmon die post-spawn.

Coho Salmon

Chinook Salmon in CA.

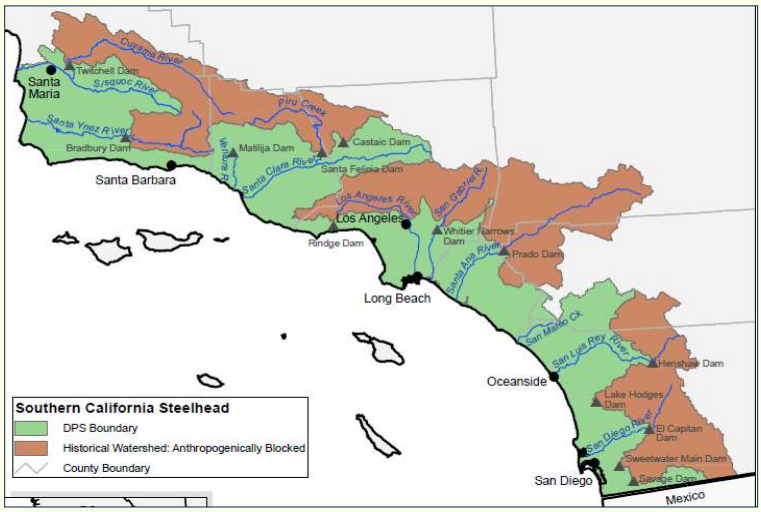
- Oregon border to Sacramento River.
- Largest of the Pacific salmon.
- Two to seven-year life cycle. Three to five years most common in CA.
- Fall-run and spring-run have distinctly different life history strategies.

Chinook Salmon

Steelhead in CA.

- Oregon border to San Diego County.
- Resident and anadromous inter-changeable.
- One to four years freshwater. One to two years most common in CA.
- Fall/winter-run and summer-run have different life history strategies.

Southern CA. Steelhead - Distribution



Southern CA. Steelhead - Adaptations

- Adapted to extreme conditions and marginal habitats.
- Juveniles - higher thermal tolerances.
- Lower smolt age and older ocean age.
- Use of non-natal streams for spawning.
- Complete life-cycle in freshwater.
- Resident progeny sustaining anadromy.
- Delay adult return from ocean during severe drought conditions.

Southern CA. Steelhead - Declines

- Severe (>90%) population declines since 1950's.
- 55,000 to less than 500 returning adults.
- Extirpated from approximately 14 larger drainages.

Southern CA. Steelhead - Impacts

- Dams and road crossings block more than 85% of historic spawning and rearing habitat.
- Loss/degradation of estuaries.
- Channelization and dewatering of mainstem migration corridors.
- Water pollution.

Coastal Rainbow-Steelhead

Coastal Rainbow-Steelhead Interactions

Coastal Cutthroat Trout in CA.

- Oregon border to lower Eel River.
- Resident and anadromous inter-changeable.
- One to six-year as juveniles in freshwater.
- Brief saltwater forays – rarely over-winters in ocean.

Coastal Cutthroat Trout

Native Fish Species

Tidewater Goby

Native Fish Species

Prickly Sculpin

Native Fish Species

Klamath Largescale Sucker

Native Fish Species

Klamath Smallscale Sucker

Native Fish Species

Sacramento Sucker

Native Fish Species

Santa Ana Sucker

Native Fish Species

Pacific Lamprey

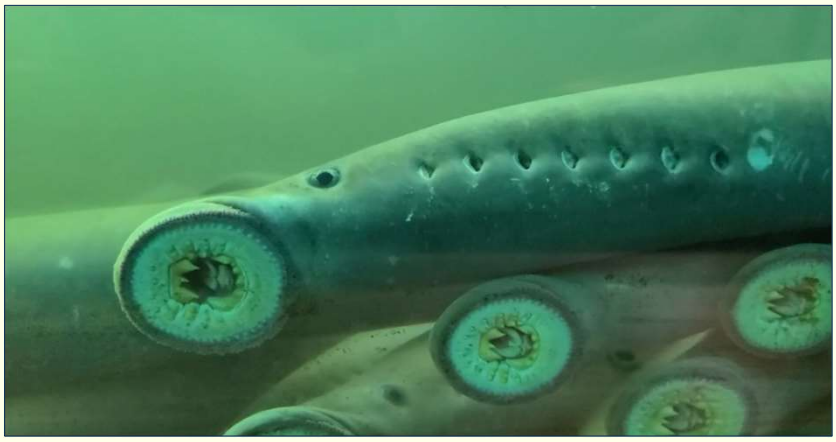


Photo: Aaron Martin, Yurok Tribal Fisheries

Other Aquatic Species

Rough-skinned Newt

Other Aquatic Species

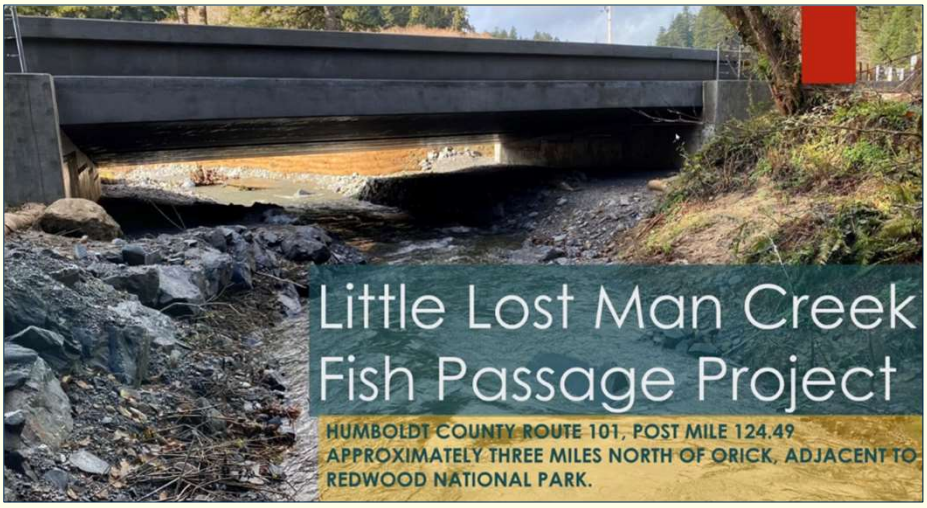
Foothill Yellow Legged Frog

Other Aquatic Species

Western Pearlshell Mussel

Passage of Terrestrial Species

Passage of Terrestrial Species



Passage of Terrestrial Species

Passage of Terrestrial Species

Why Fish Need to Move - Migratory Patterns of Salmonids

Reasons for Migration

Adults

- Migration to spawning habitat.
- Spatially separate from competing species.
- Spatially separate throughout a basin.
- Reduce mortality from redd superimposition.

Reasons for Migration

Juveniles

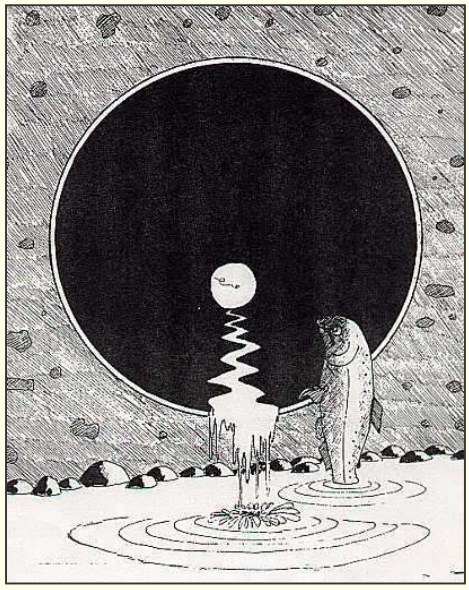
- Migration to favorable over-wintering habitat.
- In CA. coho, steelhead, and coastal cutthroat trout.
- Following potential food source upstream.
- Summer migration to thermal refugia.

Migration Timing

Adults and Juveniles

- Triggered by winter storms and stream discharge.
- Behavior dependent on storm magnitude and frequency.
- Falling limb of storm hydrograph.

Stream Crossing Characteristics that Create Migration Barriers



Types of Passage Problems

- Excessive velocity through crossing.
- Lack of depth w/in crossing.
- Perched crossing outlet.
- Lack of depth in outlet pool.
- Obstructions within crossing.
- Turbulence.

Types of Passage Problems

Velocity Barriers

- Crossing set at too steep of slope.
- Roughness reduced through crossing - varies with construction materials.
- Reduction of channel cross-sectional area - inlet drops.
- Length of crossing x velocity > fish swimming abilities.

Velocity Barrier - Steep Slope

Velocity Barrier - Concrete Floor

Velocity Barrier - Concrete Apron

Velocity Barrier - Inlet Drop

Types of Passage Problems

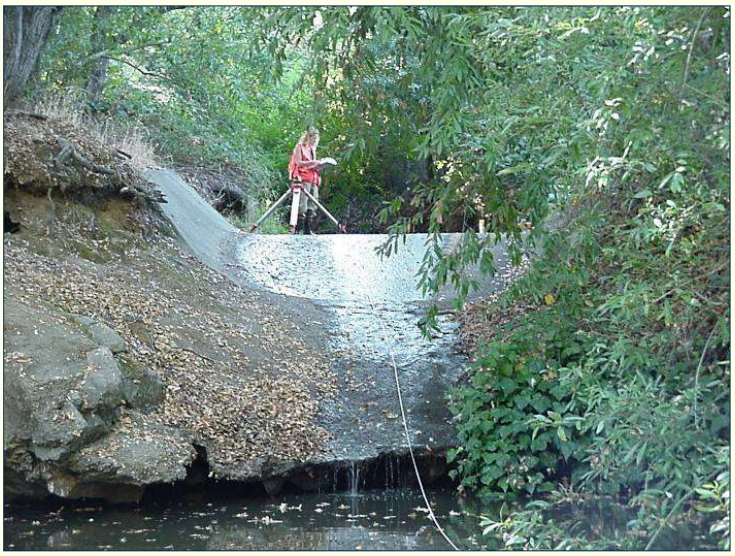
Perched Outlets and Drops

- Local scour of outlet pool by high-velocity flows exiting culvert/crossing.
- Crossings set in a static location within a dynamic system.
- Disrupts migration at heights less than observed maximum leaping abilities.
- Physical injury of migrating fish.

Perched Outlet - Freefall to Pool

Perched Outlet - Cascade over Boulder

Perched Outlet – Over Remnant Dam



Perched Outlet – Over Hardened Ford

Perched Outlet – Water Line Encasement

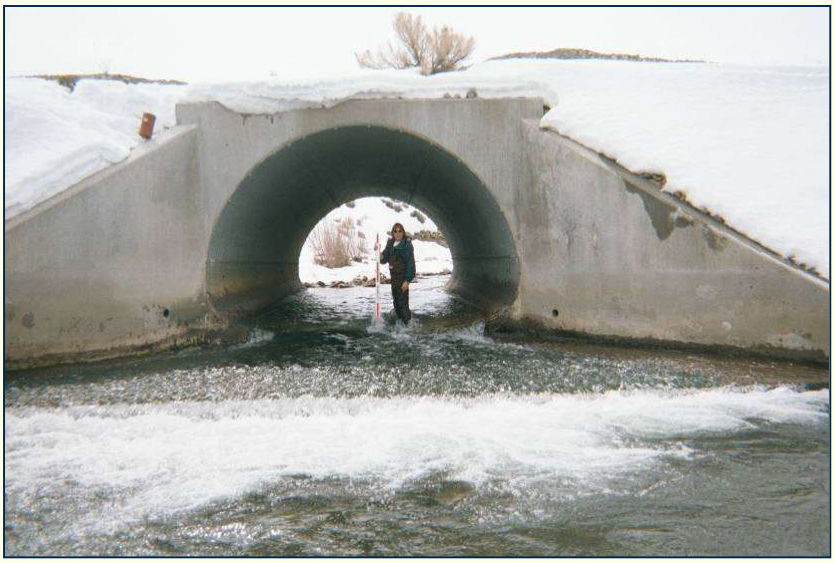
Types of Passage Problems

Lack of Depth within Crossing

- Wide, flat-bottomed structures.
- Concrete aprons.
- Reduces swimming abilities of partially submerged fish.
- Increases likelihood of injury or predation.

Lack of Depth - Concrete Bottom

Lack of Depth - Concrete Apron



Lack of Depth – Hardened Ford

Lack of Depth – Flood Control Channel

Types of Passage Problems

Lack of Depth in Outlet Pool

- Jump height to pool-depth ratio = 1:1.25-1.5
- Rip rap placed at outlet to dissipate stream flow.

Lack of Depth in Outlet Pool

Types of Passage Problems

Obstructions within Crossing

- Storm debris.
- Create turbulence.
- Damage to crossing.
- Additional consequences.

Obstructions within Crossing

Turbulence within Crossing

Biological Effects of Migration Barriers

Effects on Salmonids

Barrier Types:

Temporal - impassable to one or more species or age-classes at certain flows.

- **Potential Impact:** delays movement beyond barrier.

Partial - impassable to some species and/or age-classes at all flows.

- **Potential Impact:** exclusion of certain species or life-stages from sections of a watershed.

Total - impassable to all fish at all times.

- **Potential Impact:** exclusion of all species and age-classes from sections of a watershed.

Effects on Salmonids

Cumulative Effects:

- Multiple barriers/impediments within a fish's migration corridor.
- Delays at lower barriers/impediments may prevent passage at other crossings or structures.
- Effects of delays more apparent in years or areas of CA with sporadic rainfall.