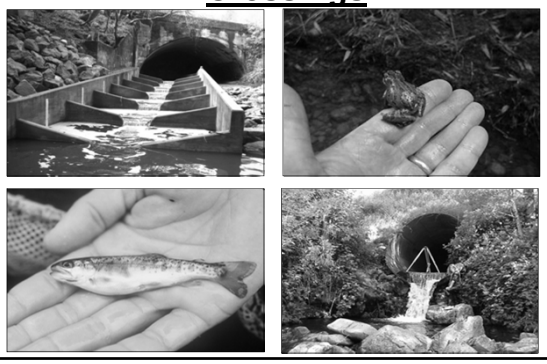
Aquatic Organisms and Stream Crossings



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.

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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.

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Importance of Ecological Connectivity

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

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Anadromous Salmonids in CA.

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

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General Salmonid Life History

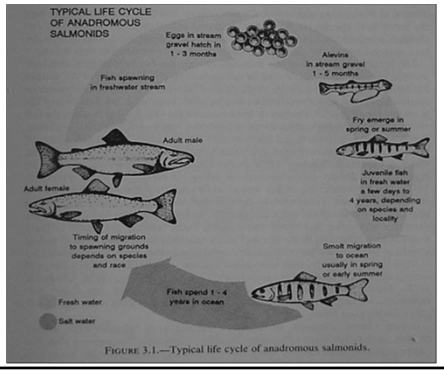

FIGURE 3.1.—Typical life cycle of anadromous salmonids.

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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.

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Coho Salmon

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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 winter-runs have distinctly different life history strategies.

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Chinook Salmon

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Steelhead in CA.

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

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Coastal Rainbow-Steelhead

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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 – never over-winters in ocean.

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Coastal Cutthroat Trout

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Native Fish Species

Tidewater Goby

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Native Fish Species

Prickly Sculpin

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Native Fish Species

Klamath Small Scale Sucker

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Native Fish Species

Santa Ana Sucker

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Native Fish Species

Pacific Lamprey

Photo: Aaron Martin, Yurok Tribal Fisheries

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Other Aquatic Species

Pacific Giant Salamander

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Other Aquatic Species

Red Legged Frog

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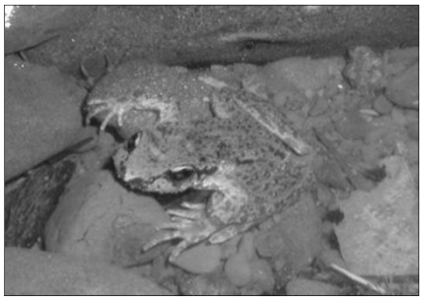
Other Aquatic Species

Tailed Frog



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Passage of Terrestrial Species

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Why Fish Need to Move - Migratory Patterns of Salmonids

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Reasons for Migration

Adults

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

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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.

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Migration Timing

Adults and Juveniles

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

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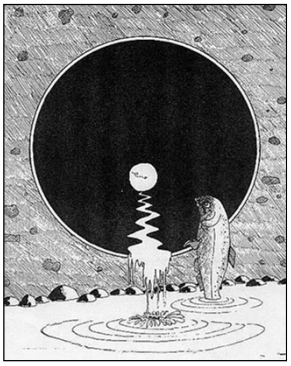
Stream Crossing Characteristics that Create Migration Barriers



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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.

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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.

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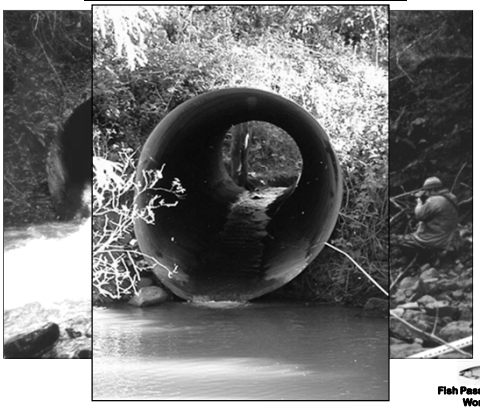
Velocity Barrier - Steep Slope



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Velocity Barrier - Concrete Floor

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Velocity Barrier - Concrete Apron

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Velocity Barrier - Inlet Drop

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Types of Passage Problems

Perched Outlets

- 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.

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Perched Outlet - Freefall to Pool

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Perched Outlet - Cascade over Boulder

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Perched Outlet – Over Remnant Dam

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Perched Outlet – Over Hardened Ford

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Perched Outlet – Water Line Encasement

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Just when you think you've seen it all!

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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.

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Lack of Depth - Concrete Bottom

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Lack of Depth - Concrete Apron

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Lack of Depth – Hardened Ford

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Lack of Depth – Flood Control Channel

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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.

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Lack of Depth in Outlet Pool

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Types of Passage Problems

Obstructions within Crossing

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

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Obstructions within Crossing

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Turbulence within Crossing

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Effects of Migration Barriers at Stream Xings

Photo: M. Love

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Effects on Salmonids

Barrier Types:

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

Potential Impact: delays movement beyond barrier.

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

Potential Impact: exclusion of certain species or lifestages from sections of a watershed.

Total - impassable to all fish at all times.

Potential Impact: exclusion of certain species or lifestages from sections of a watershed.

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Effects on Salmonids

Cumulative Effects:

- Multiple crossings within a fishes migration corridor.
- Delays at lower crossings may prevent passage at other crossings.
- Effects of delays more apparent in years or areas of CA with sporadic rainfall.

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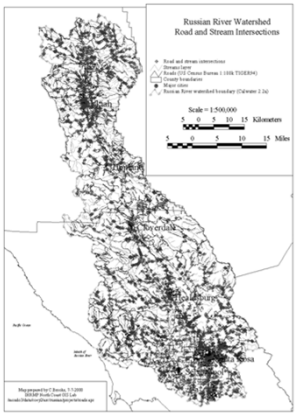

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Effects on Salmonids

Adults:

- Disrupts spawning migrations.
- Under-utilization of tributary habitat.
- Over-crowding of available spawning habitat.
- Increased likelihood of stress, injury, or predation/poaching.
- Limits spatial separation of competing species.

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Effects on Salmonids

Juveniles:

- Limits or prevents use of over-wintering habitat in tributaries.
- Increases predation in outlet pools.
- Limits or prevents summer migration from thermally-stressed main-stems to cool-water refugia.

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Culvert Hydraulics vs Fish Abilities

Leaping and Swimming Abilities:

- Size of fish.
- Condition of fish.
- Level of exertion required - cruising, sustained, or burst speed.
- Other: water temperature, water quality, leap conditions.

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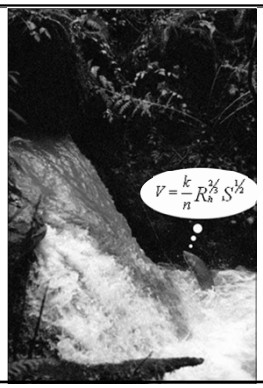
The "Design" Fish



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The "Design" Fish

Factors to Consider:

- Selection of an appropriate species or age-class.
- Is designing for a single species or age-class a valid approach?
- Timing, behavior, and variations of individual abilities lead to uncertainties.

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Swimming Abilities and Requirements

Types of Swimming Modes:

- Sustained – maintained indefinitely.
- Prolonged – maintained for 20 seconds to 200 minutes.
- Burst – highest velocity mode, maintained for < 20 seconds.

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Swimming Abilities and Requirements

Adult Anadromous Assessment Criteria:

Minimum Depth	0.8 ft
Prolonged swim speed	6 ft/s for 30 minutes
Burst (maximum) swim speed	10 ft/s for 5 sec
Maximum leap speed	15 ft/s (Leap heights less than 2 ft with good jump pool conditions)

Part IX California Salmonid Stream Habitat Restoration Manual (Taylor and Love, 2003)

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CDFG Stream Crossing Ranking

Ranking Objectives:

- A first-cut, sorting of evaluated sites using "scored" criteria.
- Division of sites into groups of: high, medium, and low priority.
- Consideration of other factors prior to selection of sites for remediation.
- Identification of restoration sites vs. maintenance sites.

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CDFG Stream Crossing Ranking

Ranking Criteria:

- Species diversity and listing status.
- Extent of barrier for three groups of salmonid age classes.
- Quantity and quality of potential upstream habitat.
- Sizing and condition of current crossing.

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CDFG Stream Crossing Ranking

Other Factors to Consider:

- Additional stream crossings or migration barriers.
- Current diversity of species versus historic diversity.
- Presence of fish at stream crossing during migration periods.
- Costs of treatment options.
- Opportunity.
- Scheduling of other road maintenance projects.
- Amount of road fill at undersized and/or poor condition stream crossings.

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Why is Fish Passage Important???

- Improve transportation network.
- Safety.
- Comply with ESA regulations.
- Restore fish populations.