

E.T. Zepel, P.E.

Santa Ynez River Fish Passage Restoration

Red Rock - above Bradbury Dam

E.T. Zepel, P.E.

Adult Fish Passage Technologies

Fish Ladders:

Expensive capital cost, low labor cost
Practical for heads 5 to 100 feet
intended for heavy use >200,000 fish
Require substantial water flow >25 cfs or more

Red Rock - above Bradbury Dam

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Adult Fish Passage Technologies

Trap and Haul:

Inexpensive capital cost, high labor cost
Practical for heads >100 feet
Intended for moderate to heavy use < 200,000 fish
Require minimal or no additional water flow

Red Rock - above Bradbury Dam

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Juvenile Fish Passage Technologies

Reservoir Outlets:

Low to moderate capital cost for retrofits
Limited efficiency if not surface withdrawal
Survival limited if not originally designed for fish
Intended for heavy use >100,000 fish
Require substantial water flow >15 cfs or more

Red Rock - above Bradbury Dam

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Juvenile Fish Passage Technologies

Floating Collectors:

Moderate capital cost, moderate labor costs
Attraction and collection efficiency must be carefully considered
Unaffected by variable pool reservoirs
Barrier or guide nets often required
Survival very good
Intended for moderate to heavy use >25,000 fish
Requires no additional water flow

Red Rock - above Bradbury Dam

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Juvenile Fish Passage Technologies

Large Fixed Screens:

High capital cost, moderate labor costs
Attraction and collection efficiency must be carefully considered
Complex elevation adjustment for variable pool reservoirs
Survival very good
Intended for heavy use >100,000 fish
Requires significant additional water flow if not pumpback

Red Rock - above Bradbury Dam

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Juvenile Fish Passage Technologies

Louvered Intake:

High capital cost, moderate labor costs
Collection efficiency poor to moderate
Complex elevation adjustment for variable pool reservoirs
Survival moderate to good
Intended for heavy use >100,000 fish
Requires significant additional water flow if not pumpback

Red Rock - above Bradbury Dam

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Existing Fish Passage Systems: Baker Lake

General:

Upper Baker Dam 312 ft high
Lower Baker Dam 285 ft high
10,000 to 30,000 adult fish trapped and hauled annually
75,000 to 325,000 smolts collected and hauled annually
2.5 FTE annual labor requirement

Lower Baker Dam

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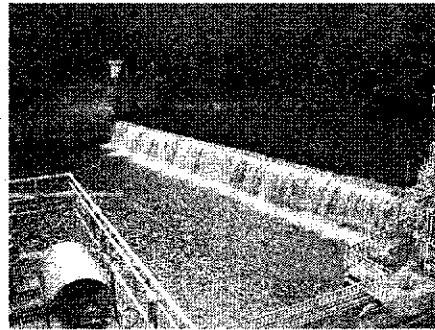
Existing Fish Passage Systems: Baker Lake

Adult Fish Trap and Haul:

Barrier Dam below Lower Baker Dam
Adult fish holding, crowding, loading system
Tank truck water-to-water transfer from hopper
60 mile round trip truck haul
10,000 to 30,000 adult fish trapped and hauled annually
Species primarily sockeye, coho

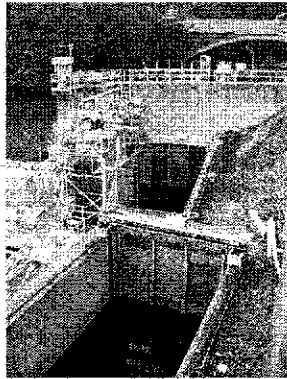
Lake Shannon

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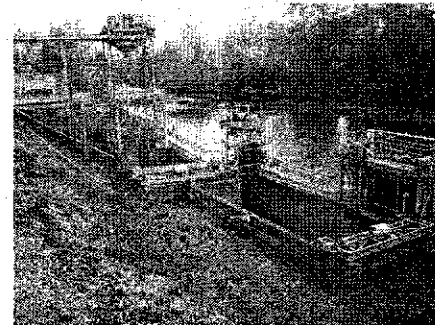
Adult Barrier Dam

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Adult Trap

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Holding Pools, Crowding, and Loading System

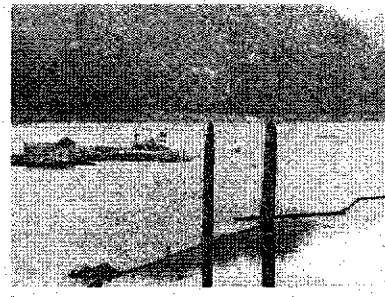
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Existing Fish Passage Systems: Baker Lake

Juvenile Fish Collection and Haul:
 Floating collectors in Lower and Upper Baker reservoirs
 Full Exclusion Guide / Barrier nets
 Upper Baker floating collection pump capacity 150 cfs
 Lower Baker floating collection pump capacity 90 cfs
 Tank truck water-to-water transfer from holding barge
 40 mile round trip truck haul
 75,000 to 325,000 smolts collected and hauled annually
 Species primarily sockeye and coho

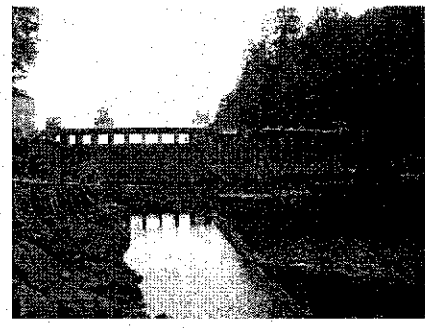
Baker Lake

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Lower Baker Juvenile Collector

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Lower Baker Dam and Hopper Transfer Crane

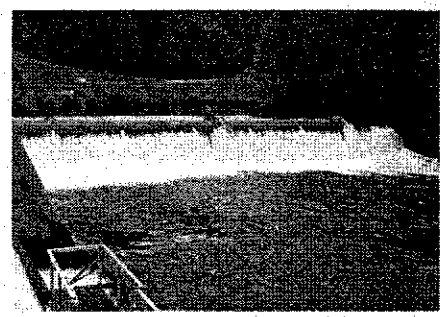
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Existing Fish Passage Systems: Howard Hanson Dam – Green River

General:
 Howard Hanson Dam 235 ft high
 10 to 150 wild adult steelhead trapped and hauled annually
 30 mile round trip truck haul
 10,000 to 50,000 smolts passed annually
 Species primarily steelhead and chinook
 0.3 FTE annual labor requirement

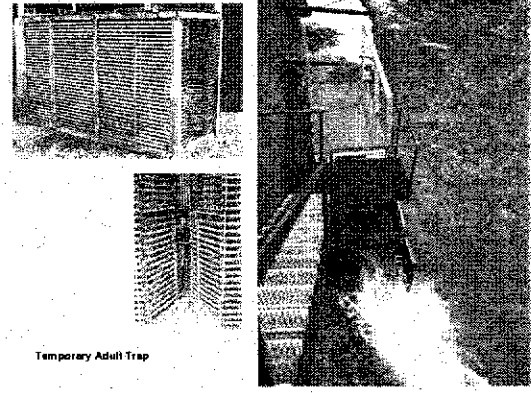
Howard Hanson Dam

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Diversion Dam

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Temporary Adult Trap

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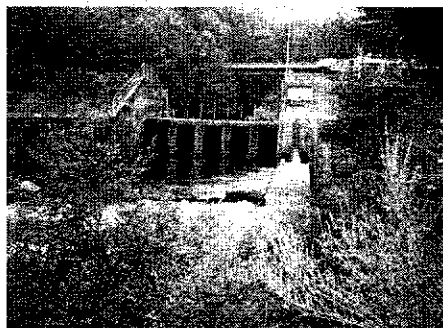
Existing Fish Passage Systems: Wynoochee Dam

General:

Wynoochee Dam 175 ft high
1,200 to 5,500 adult fish trapped and hauled annually
20 mile round trip truck haul
10,000 to 70,000 smolts passed annually
Juvenile fixed port collectors 200 cfs capacity each
Species primarily steelhead, chinook, and coho
0.5 FTE annual labor requirement

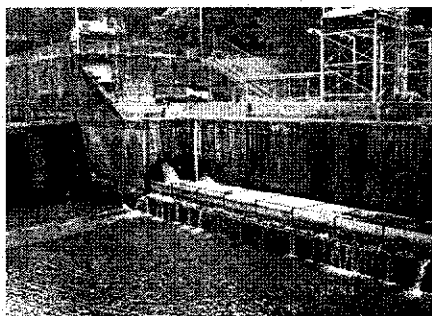
Wynoochee Dam

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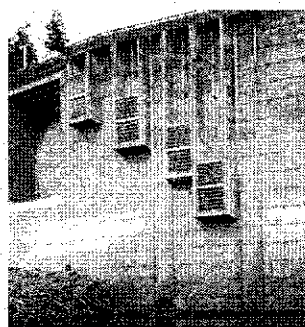
Barrier Dam

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Barrier Dam and Trap

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Juvenile Fixed Port Collectors

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Existing Fish Passage Systems: Mud Mountain Dam

General:

Mud Mountain Dam 432 ft high
5,000 to 40,000 adult fish trapped and hauled annually
30 mile round trip truck haul
50,000 to 1,200,000 smolts passed annually
Juvenile passage through reservoir outlet
Species primarily steelhead, chinook, and coho
0.5 FTE annual labor requirement

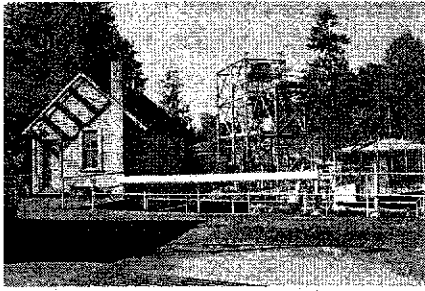
Mud Mountain Dam

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Diversion Dam

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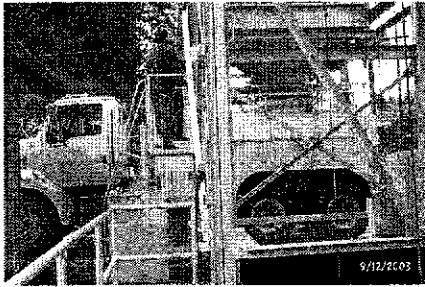
Adult Trap and Loading Hopper

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Raising Hopper

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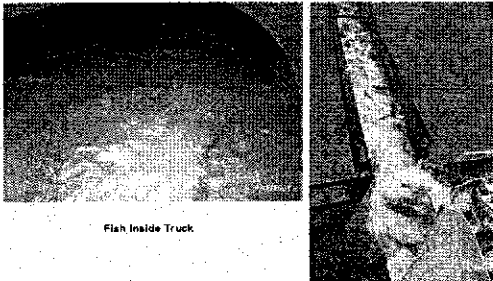
Loading Truck

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Adult Release Sluice

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Fish Inside Truck

Unloading Truck

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Existing Fish Passage Systems: Cowlitz River Project

General:

- Mossyrock Dam 606 ft high, largest of 3 dam complex
- 30,000 to 140,000 adult fish trapped and hauled annually
- 120 mile round trip truck haul
- 750,000 to 3,500,000 smolts collected and hauled annually
- Juvenile fixed collector 30 cfs capacity
- Species steelhead, chinook, coho, searun cutthroat
- 3.5 FTE annual labor requirement

Mossyrock Dam & R/Ws Lake

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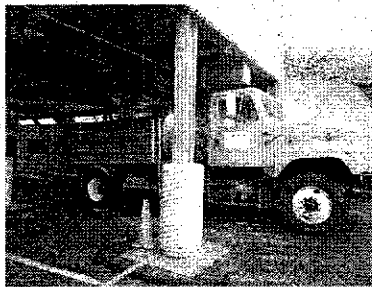
Barrier Dam

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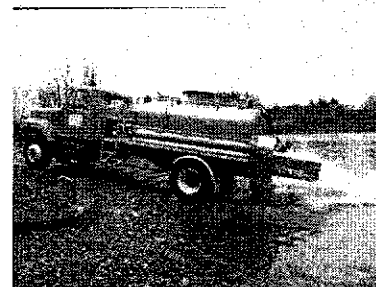
Sorting Fish

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Loading Truck

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Unloading Truck

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Conceptual Fish Passage Systems: Bradbury and Gibraltar Dams

Adult Passage Options:

- Temporary Trap and Haul
- Permanent Trap and Haul

Juvenile Passage Options:

- Fixed port collectors at Dam w/ pump back
- Fixed intake collectors at Dam w/ pump back
- Floating collector at Dam w/ pump back
- Floating collectors at tributary inlets w/ pump back
- Haul downstream to release site

Lake Cachuma

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Adult Passage: Temporary Trap

- Floating or fixed picket weir
- \$100 per lineal ft stream width
- Pickup truck tank 300 to 500 gallons
- Up to 1,000 adults annually
- Total capital cost \$50,000 to \$100,000
- 1.5 to 3 FTE partial year labor requirement

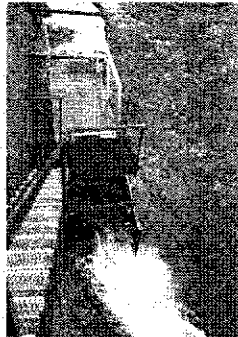


Temporary Trap

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**Adult Passage:
Semi-Permanent
Trap**

- Fixed to dam structure, OR
- Light duty barrier dam and pickets
- 1-ton truck tank 1,000 gallons
- Up to 2,000 adults annually
- Total capital cost \$300,000 to \$600,000
- 2 to 4 FTE partial year labor requirement

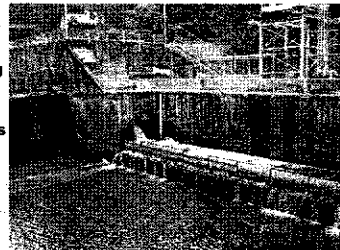


Semi Permanent Trap

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**Adult Passage:
Permanent Trap**

- Permanent barrier dam w/ trap
- Holding and sorting pools
- Larger truck tank 1,000 to 3,000 gallons
- 10,000 or more adults annually
- Total capital cost \$1.5 million to \$3 million
- 3 to 6 FTE partial year labor requirement

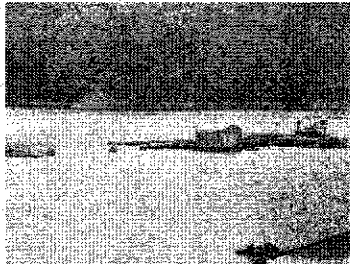


Permanent Barrier Dam & Trap

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**Juvenile Passage:
Floating Collector at Dam**

- Pump back for attraction flow
- Without exclusion barrier guide net
- Barge and hopper transfer system
- Total capital cost \$2.5 to 5 million
- Same staff used on adult and juvenile collector



Floating Collector

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**Juvenile Passage at
Bradbury Dam:
Floating Collector at
Tributary Inlets**

- Pump back for attraction flow
- With exclusion barrier guide net
- Barge and hopper transfer system
- Total capital cost \$5 million to \$10 million per collector
- 1 to 2 FTE partial year add'l + same staff used on adult trap

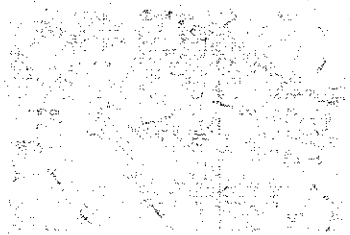


Floating Collectors at Major Tributaries

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**Juvenile Passage at
Gibraltar Dam:
Floating Collector at
Mainstem and
possibly Tributary
Inlets**

- Pump back for attraction flow
- With exclusion barrier guide net
- Barge and hopper transfer system
- Total capital cost \$5 million to \$10 million per collector
- 1 to 2 FTE partial year add'l + same staff used on adult trap



Floating Collector at Mainstem

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Santa Ynez River Fish Passage Restoration

