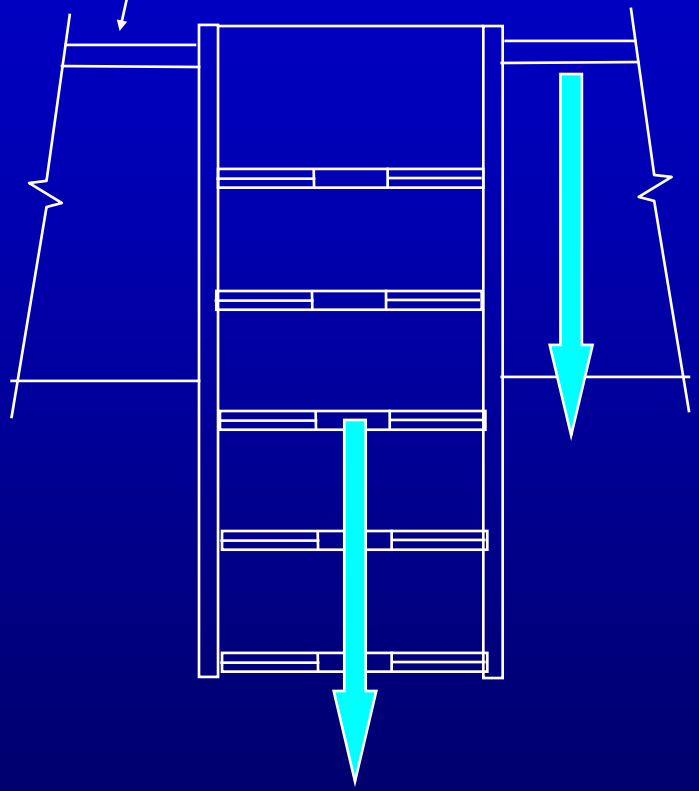
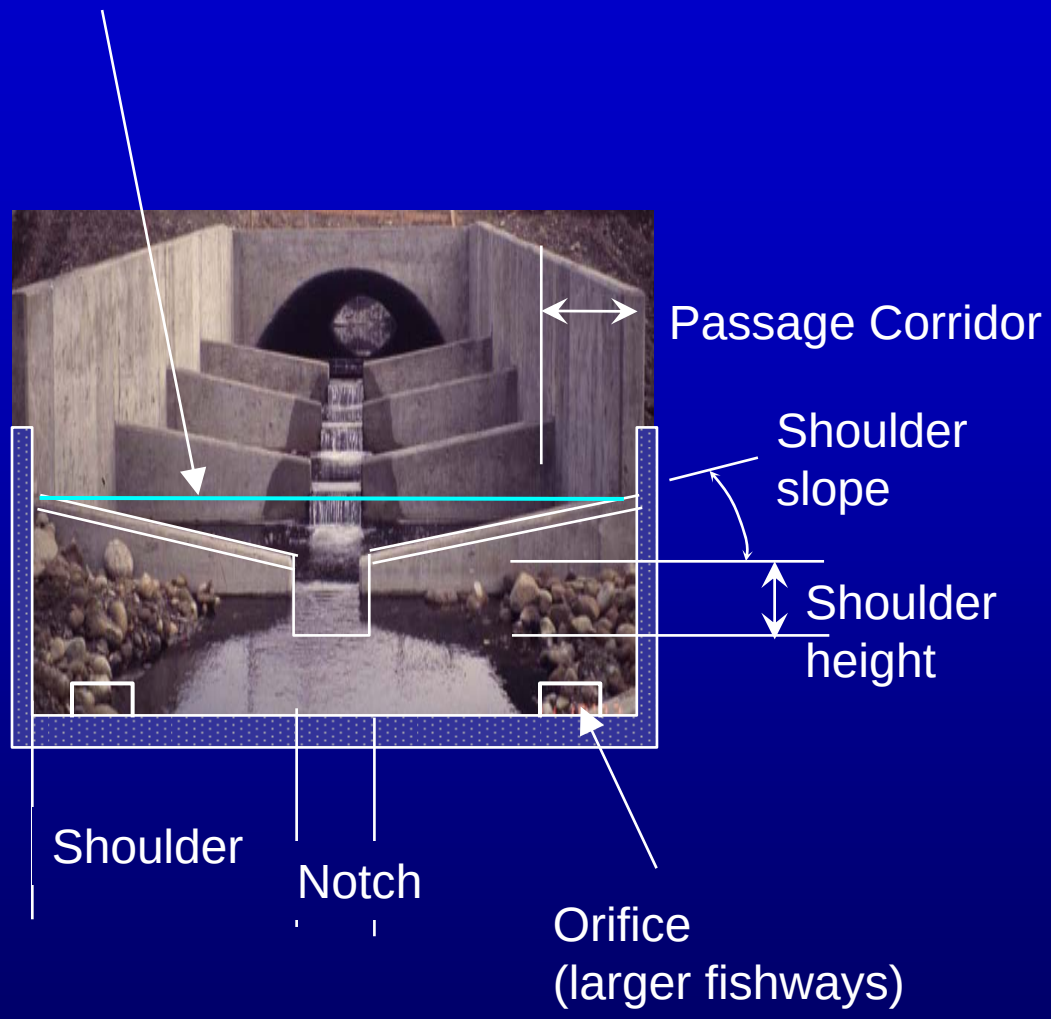
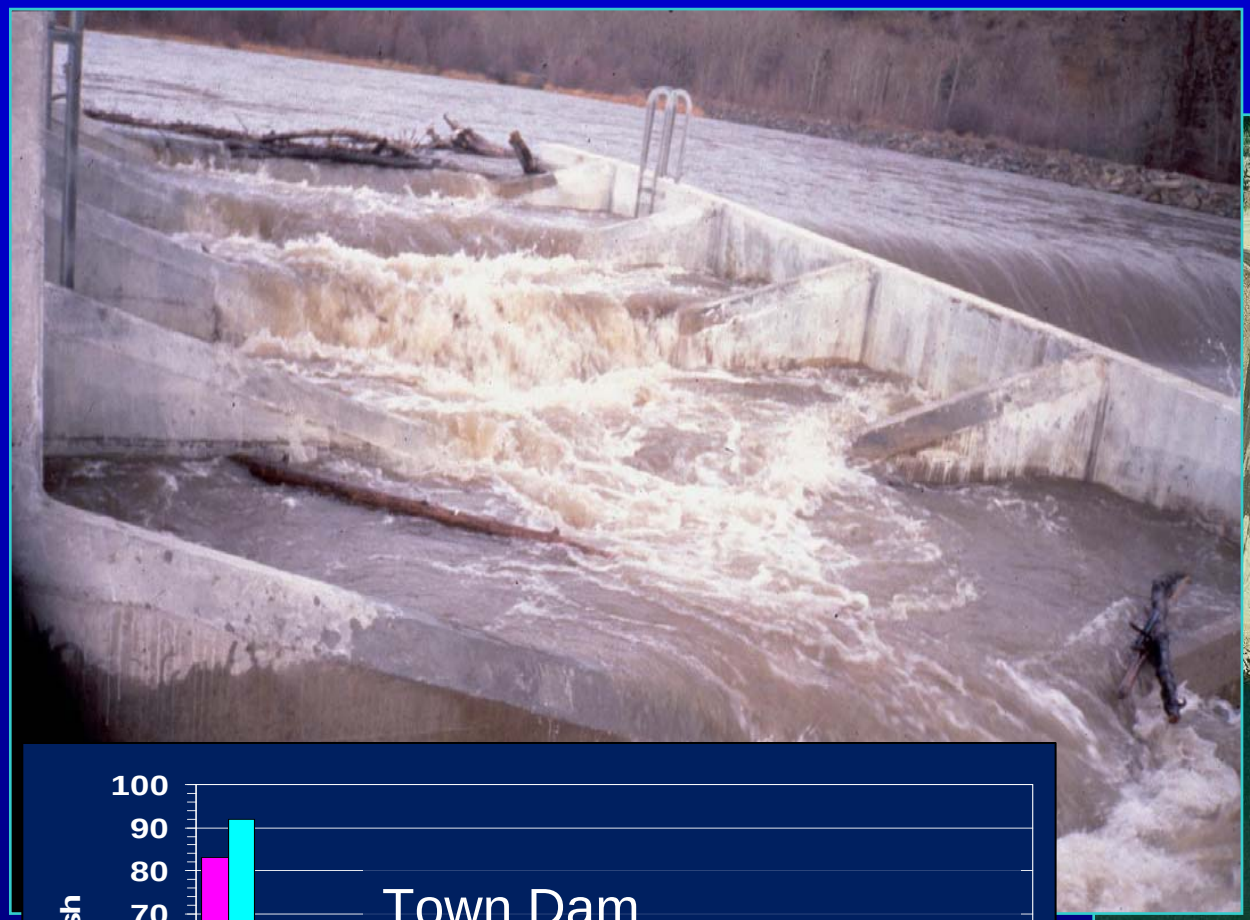
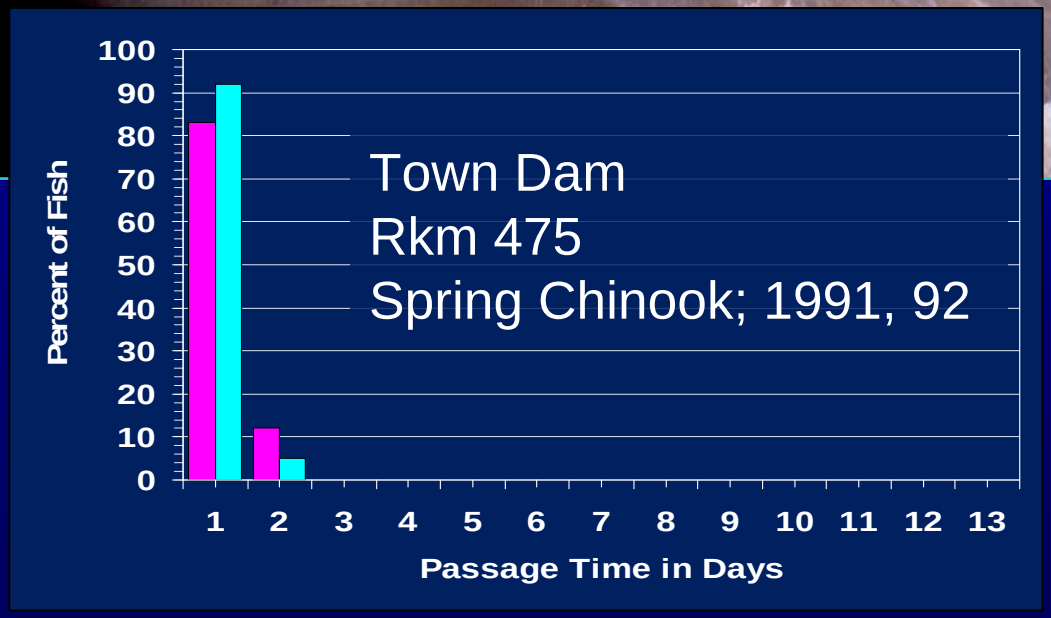
Pool and chute layout

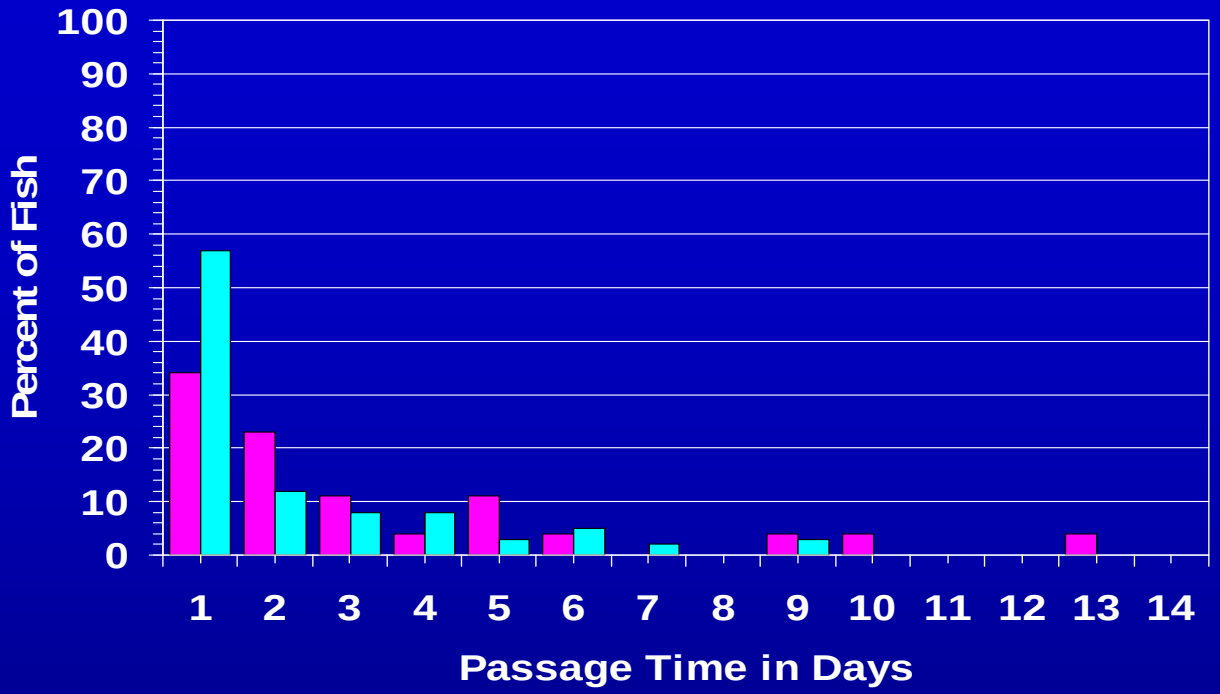




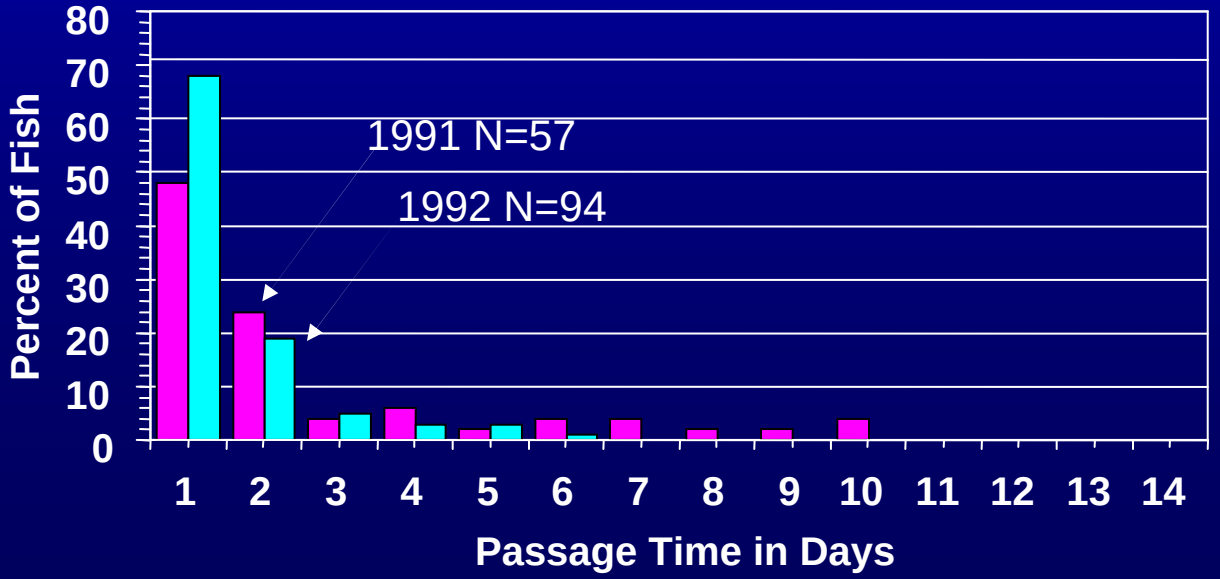



Percent of Fish
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11
12
13
Passage Time in Days
Town Dam
Rkm 475
Spring Chinook; 1991, 92

Spring Chinook radio tracking; 1991, 92



Roza Dam
Rkm 425
Rate 20-25 km/day



Prosser Dam
Rkm 370
Rate 10 km/day

Pool and Chute Fishway Characteristics

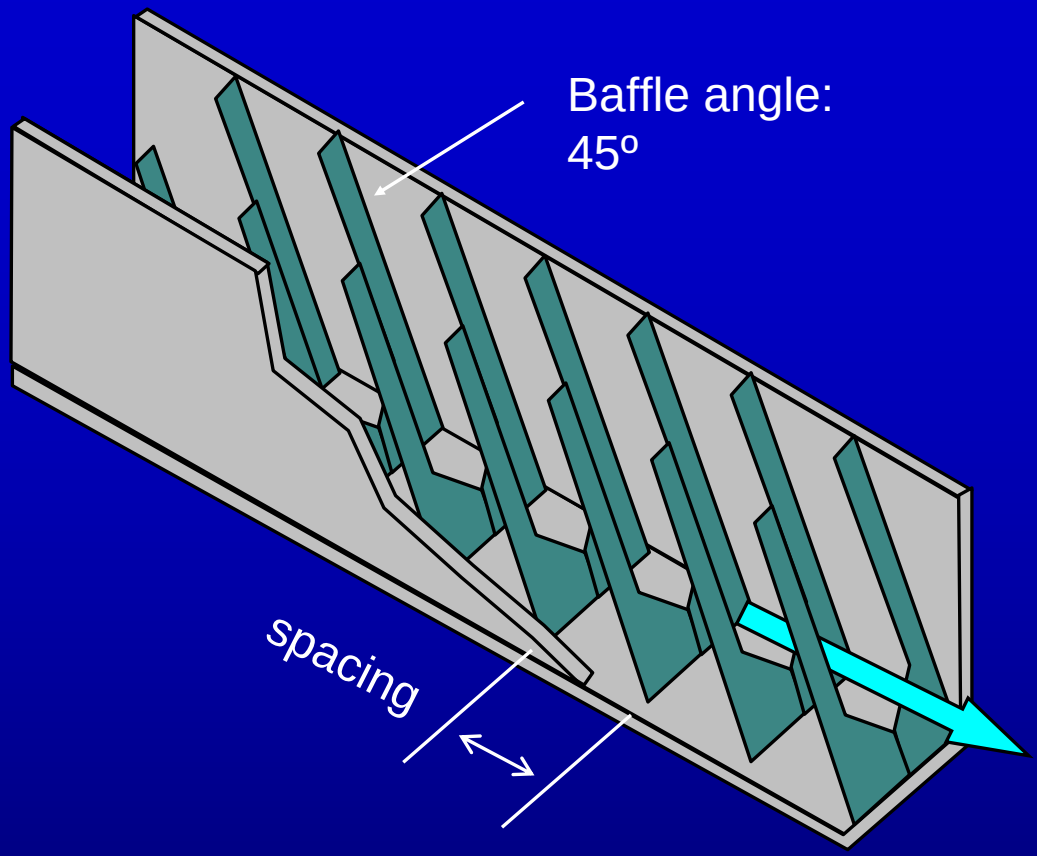
- + Wide flow range
- + Shorter pools than pool and weir
- + Variety of passage paths and conditions
- + Less vulnerable to debris problems
- + No additional entrance or auxiliary water
- - High energy hydraulics are precarious. Use at low head only or study more.
- - No fishway bends

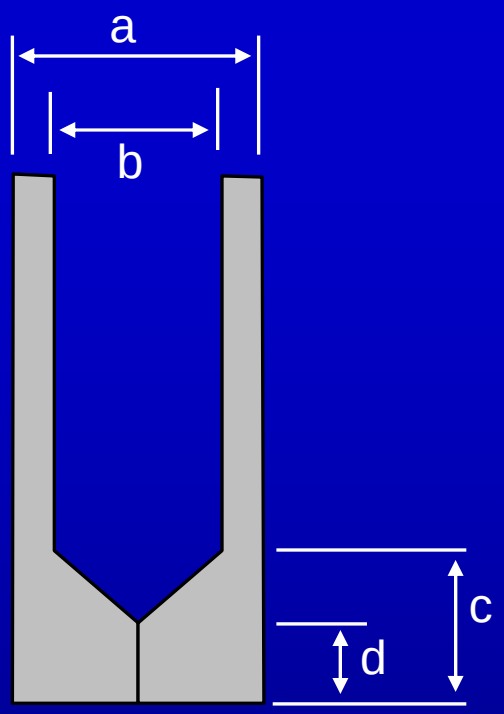
Roughened Channel Fishways

Denil

Alaska Steeppass

Alden Lab pic



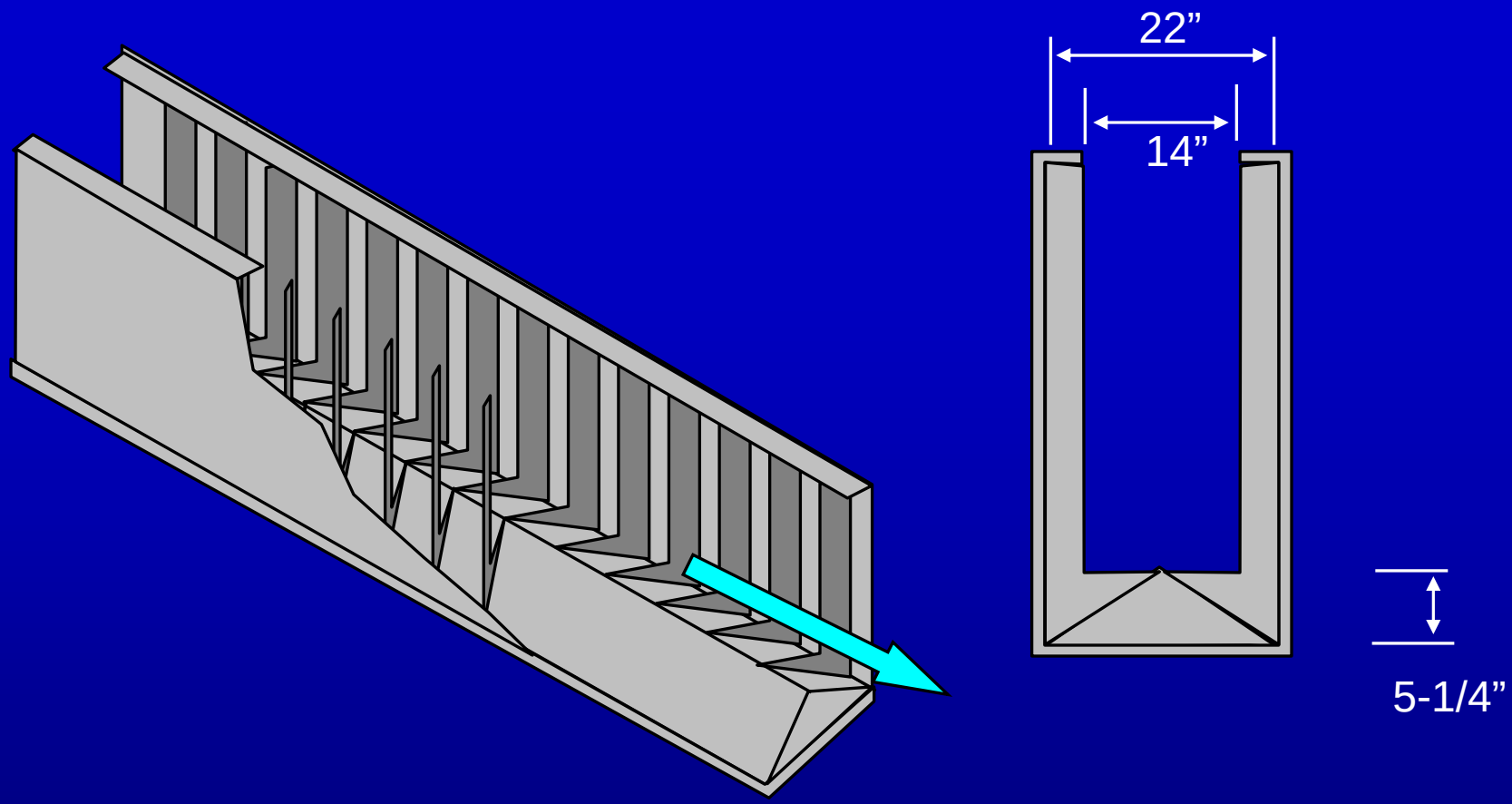


Denil Fishway

a	b	c	d	spacing
4’	2’-4”	2’-0”	12”	2’-9”
3’	1’-9”	2’-6”	9”	2’-0”
2’	1’-2”	1’-0”	6”	1’-4”

Denil fishway
In NW Primarily for temporary passage

Rivermill, Clackamas, R.
D. Cramer pic



Alaska Steeppass Fishway

Alaska Steeppass fishway
In NW Primarily for trapping and sorting

Denil, Steeppass Fishway Summary

- + Low flow; depends on style, dimensions, slope
- + Good attraction at low tailwater
- - Backwater drowns attraction
- - Narrow operating flow range
- + Inexpensive, portable, modular
- + Steep slopes
- - Vulnerable to debris blockage
- - Turbulence may block small fish
- - Not generally accepted in NW for permanent passage installations

"Natural" Roughened Channels

Bypass channel
Denmark

The objective…

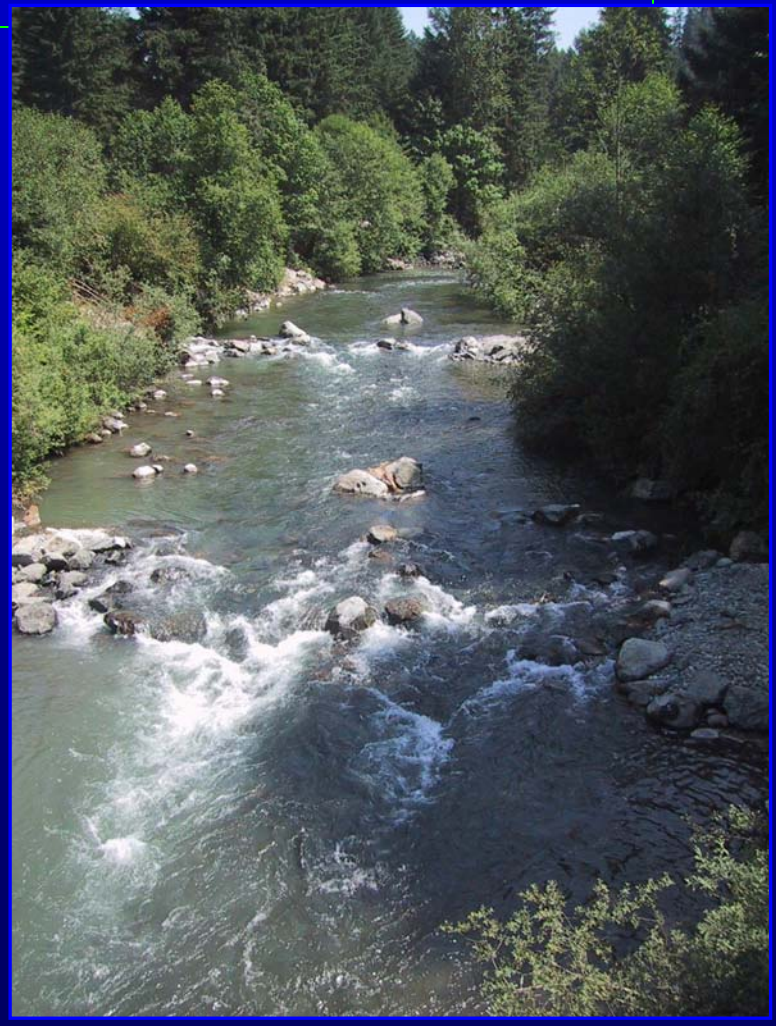
Bypass channel
Austria

Chutes and Pools Roughened Channel

S. Platte R.
Denver

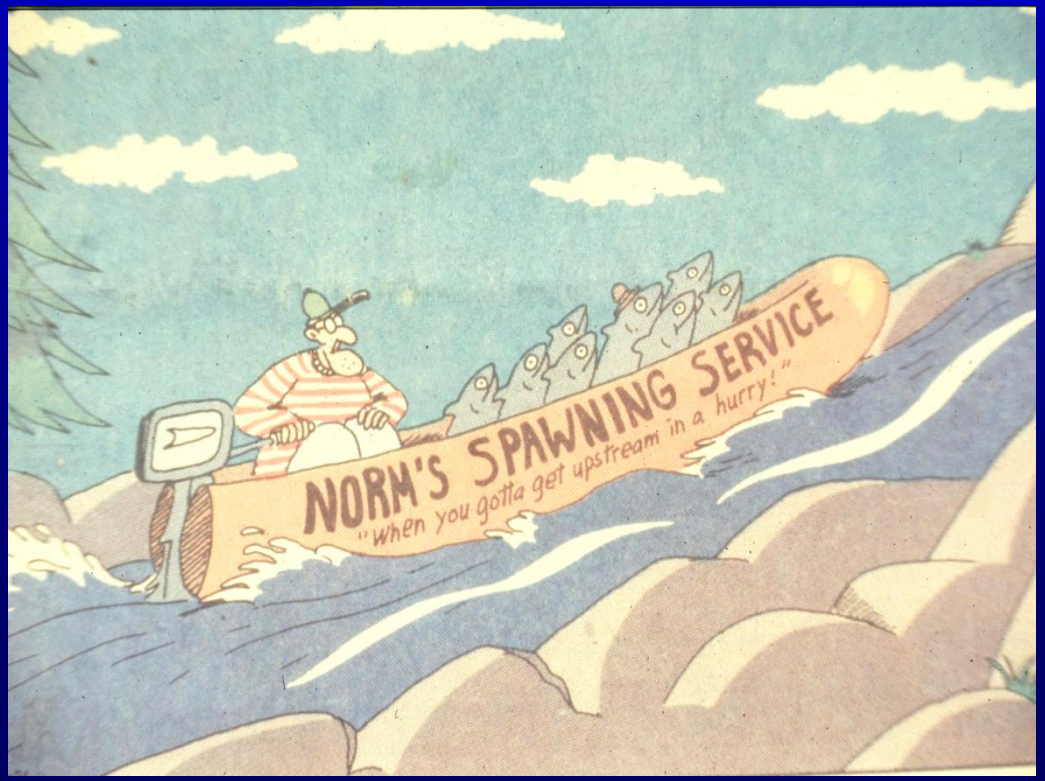
Roughened Channel Fishway Design Parameters

- ++ Diversity of hydraulics and migration paths
- Chutes and pools or continuous
- Calculate hydraulics; velocity, depth, length
- Roughness pattern, scale, and source
- Stability; semi-rigid structure
- Bed seal and construction practices
- Recreation safety



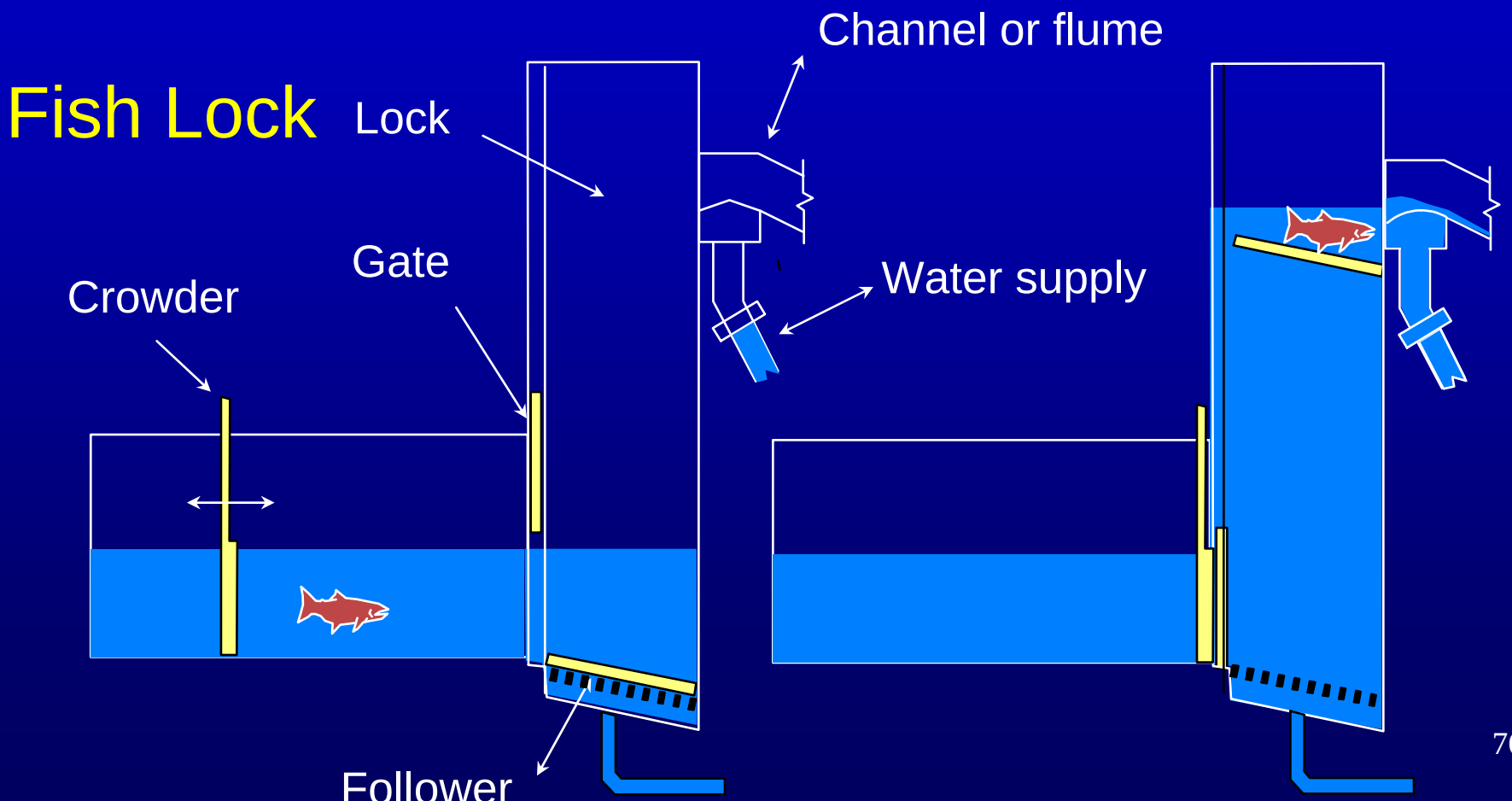
Mechanical Lifts

- Locks
- Lifts
- Trams
- Trap and Haul

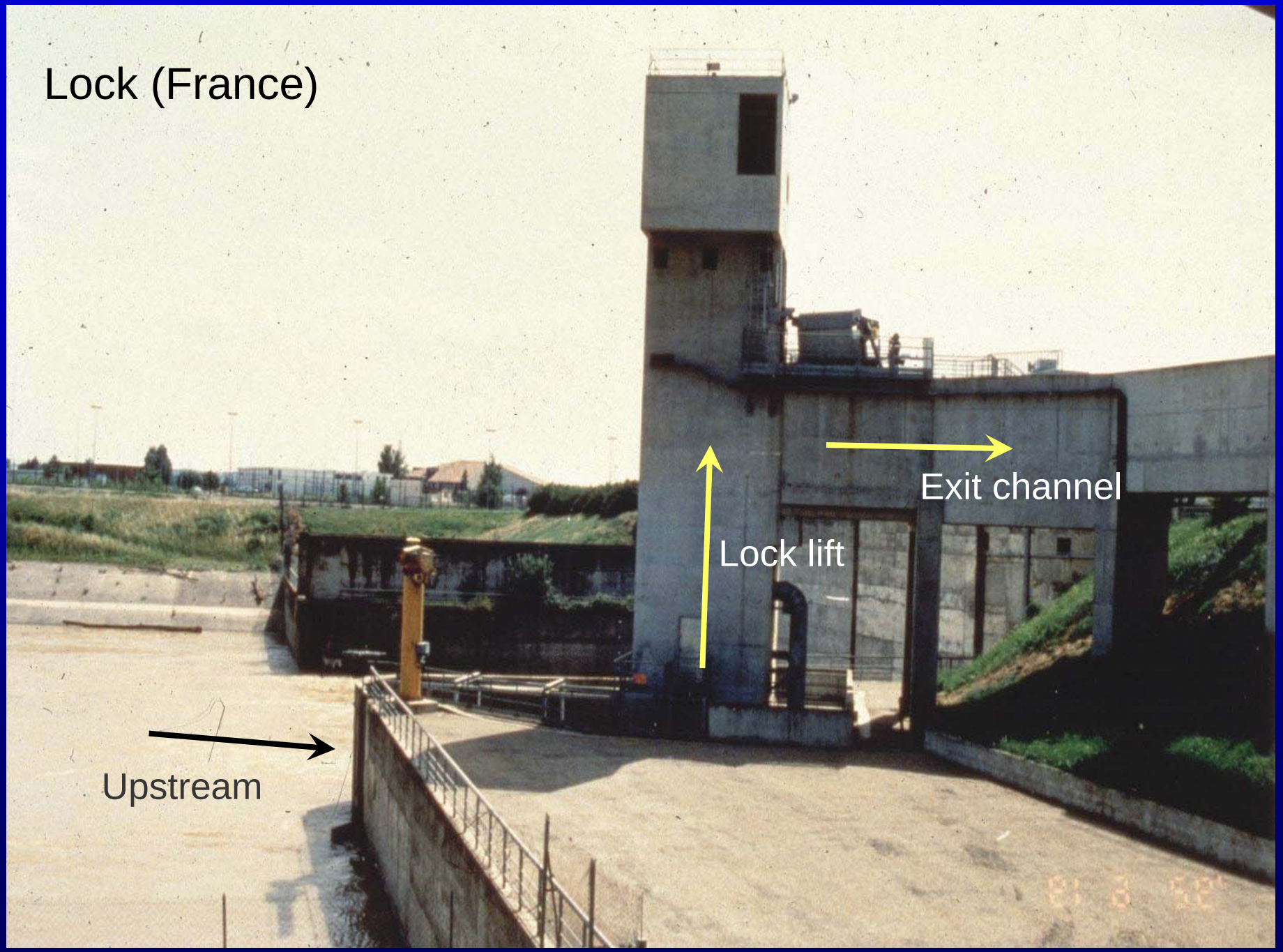


Locks and Lifts

Fish Lock

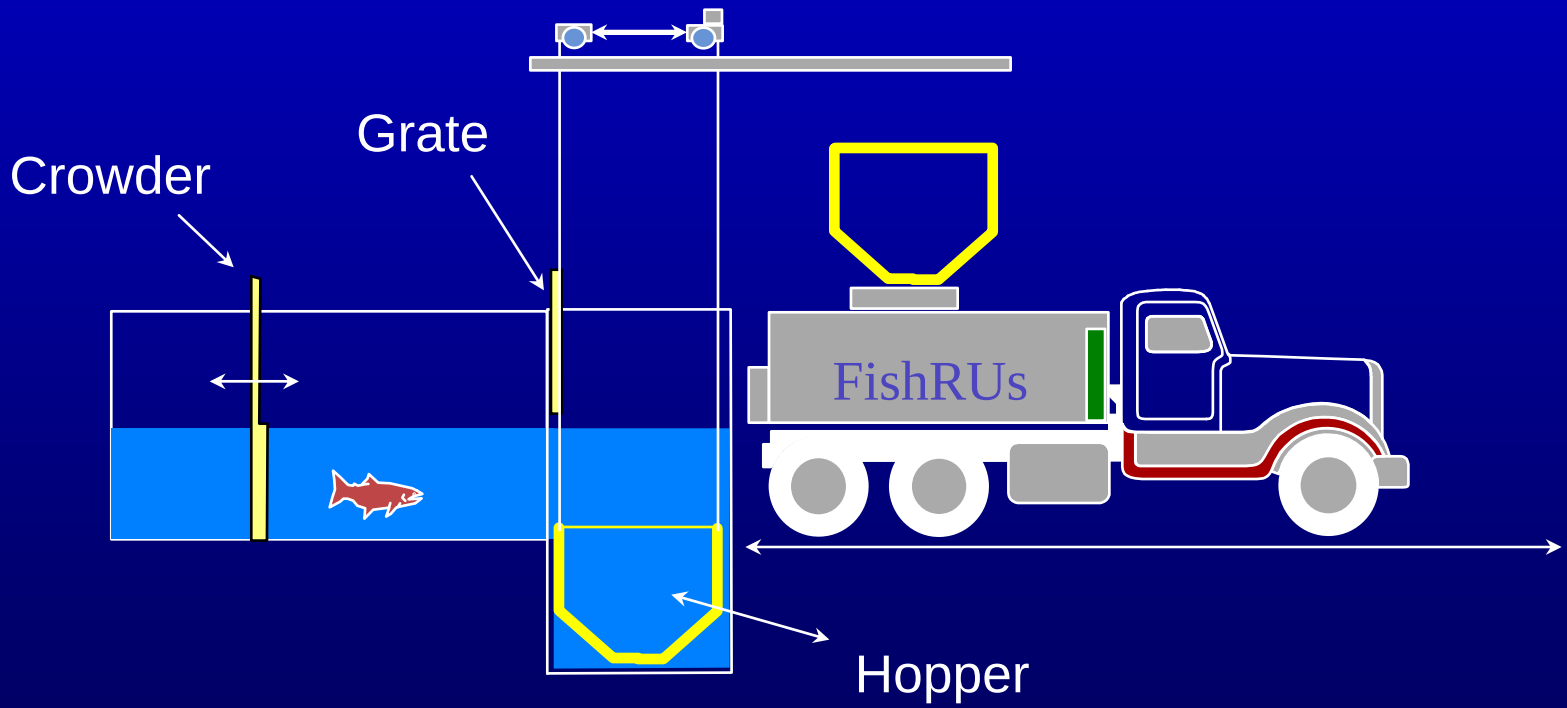


Lock (France)

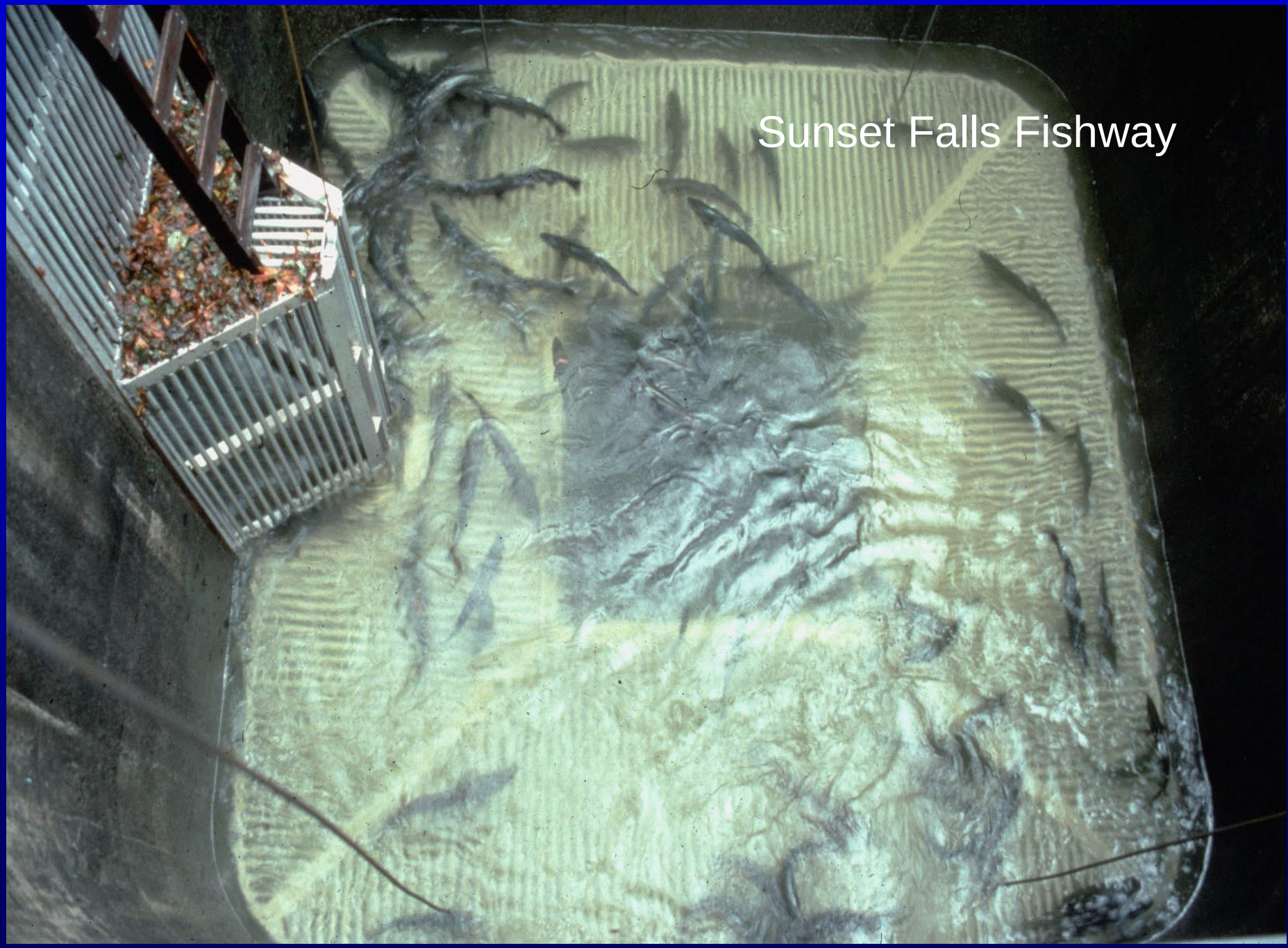


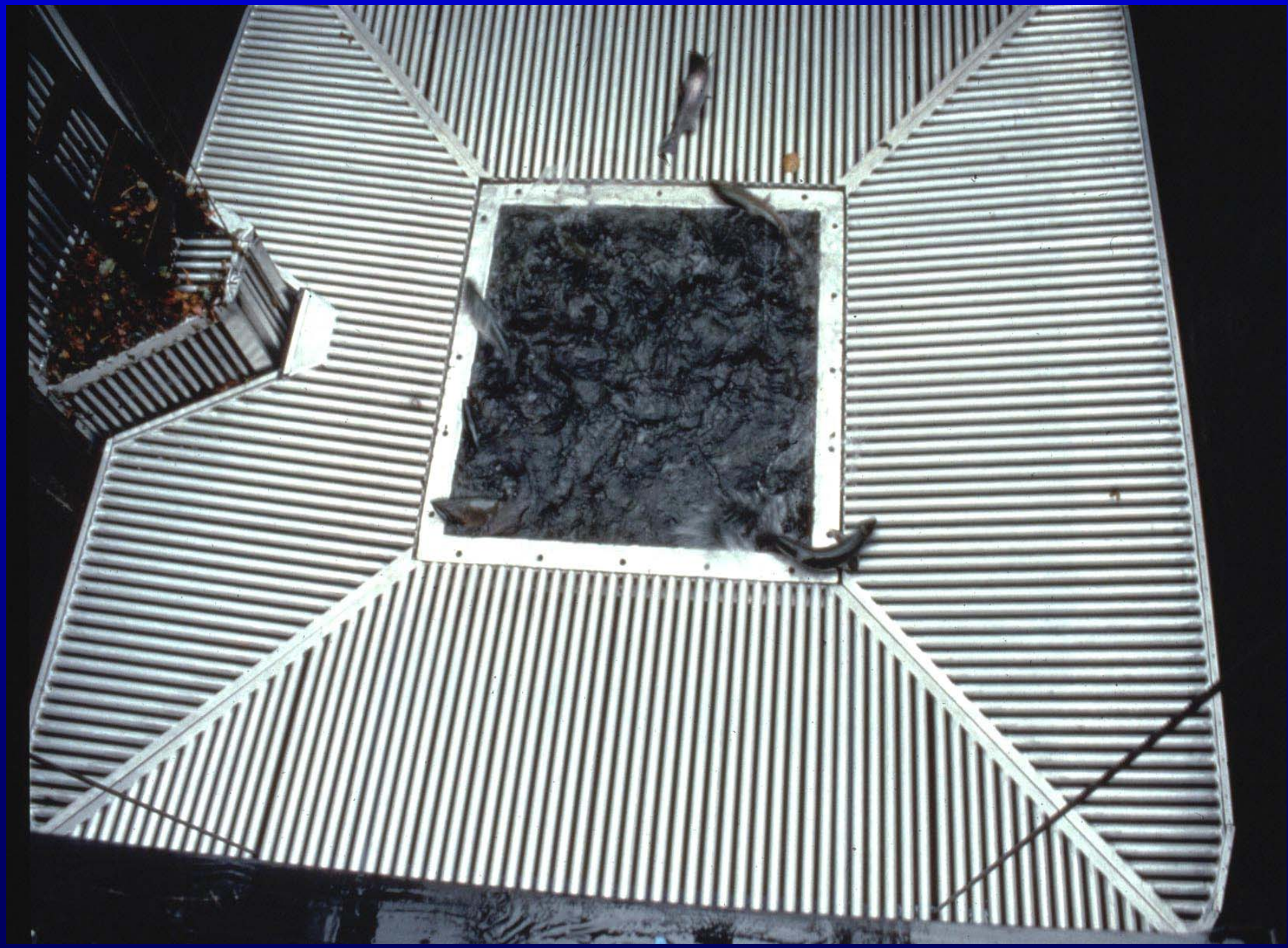
Trap and Haul

Fish loading hopper



Former Baker Hopper


Sunset Falls Fishway



Mechanical Fish Lift Characteristics

- - Nothing volitional here
- ++ Unlimited slope, height, distance
- + Applicable to wide variety of fish species
  - Problematic for lamprey
- - Mechanical flow control required
- - High capital, maintenance, and operating costs
- - Potential for mechanical failure
- Entrance, trapping holding, auxiliary water required

Fishway Flow Control

Fishway flow control limits fishway flow to operating range.

Fish passage design flow range

Fishway hydraulic limitations

↘ ↙

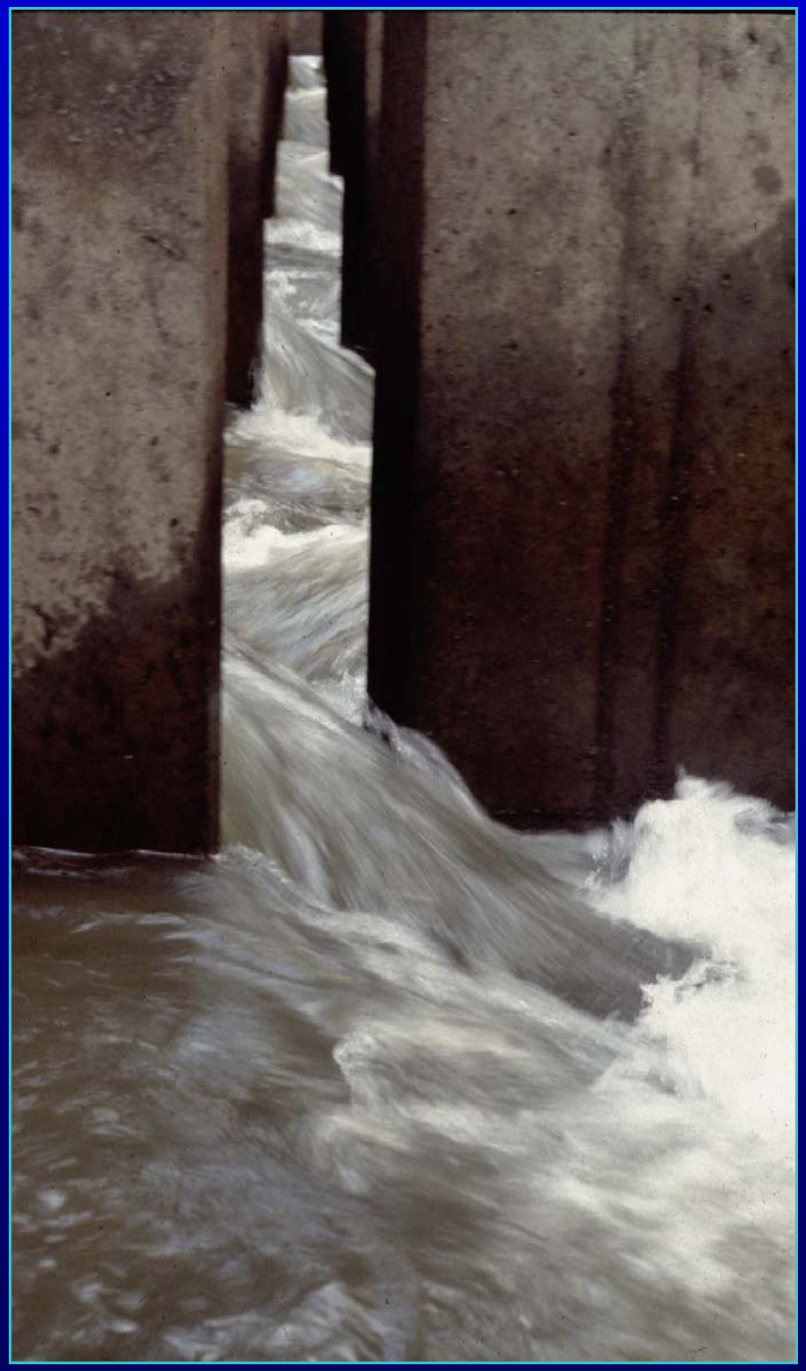
Flow control

Styles of flow control

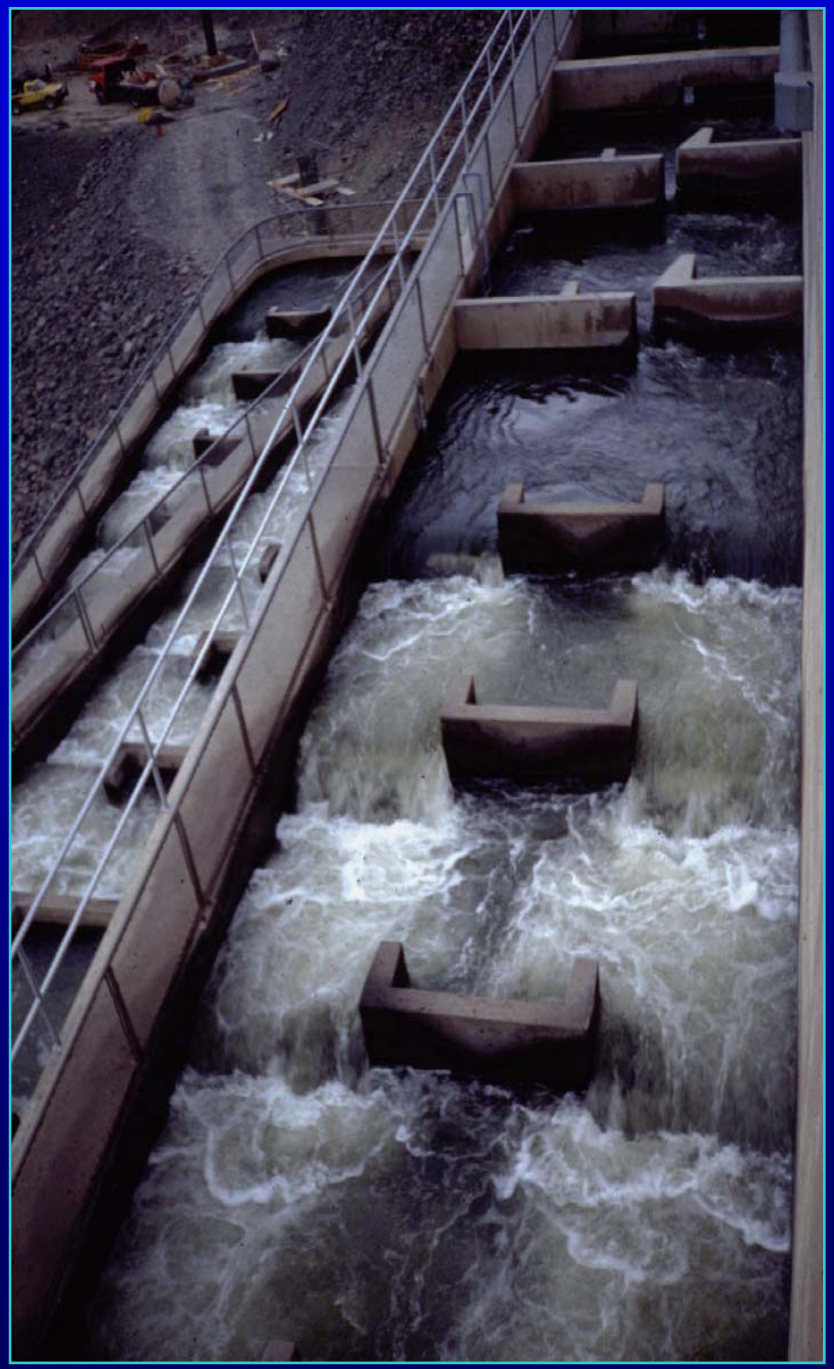
- Spillway control
- Self adjusting
- Orifice or vertical slot control
- Adjustable weirs
- Multi-level outlet

Spillway Flow Control

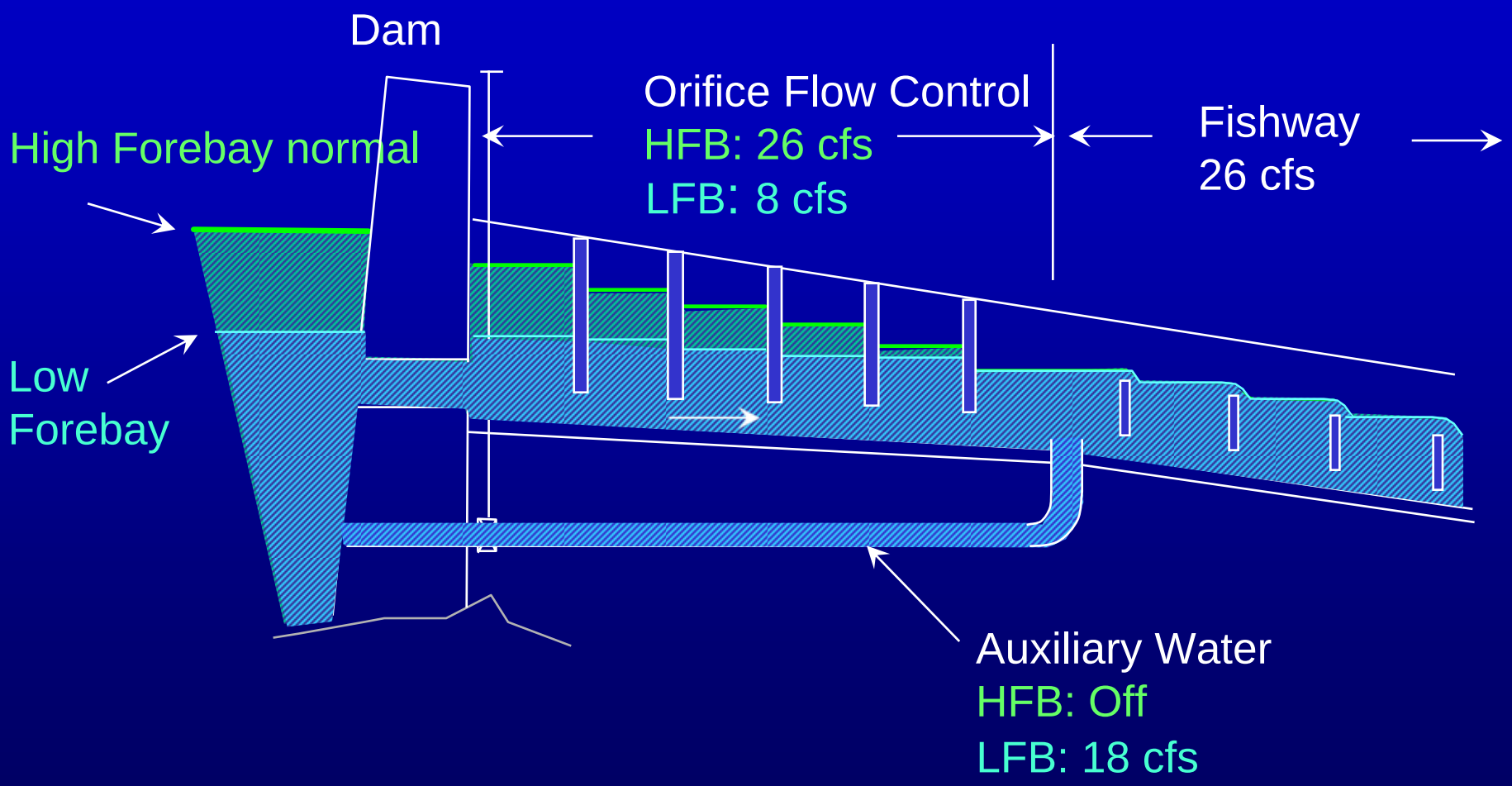
Self Adjusting Flow Control

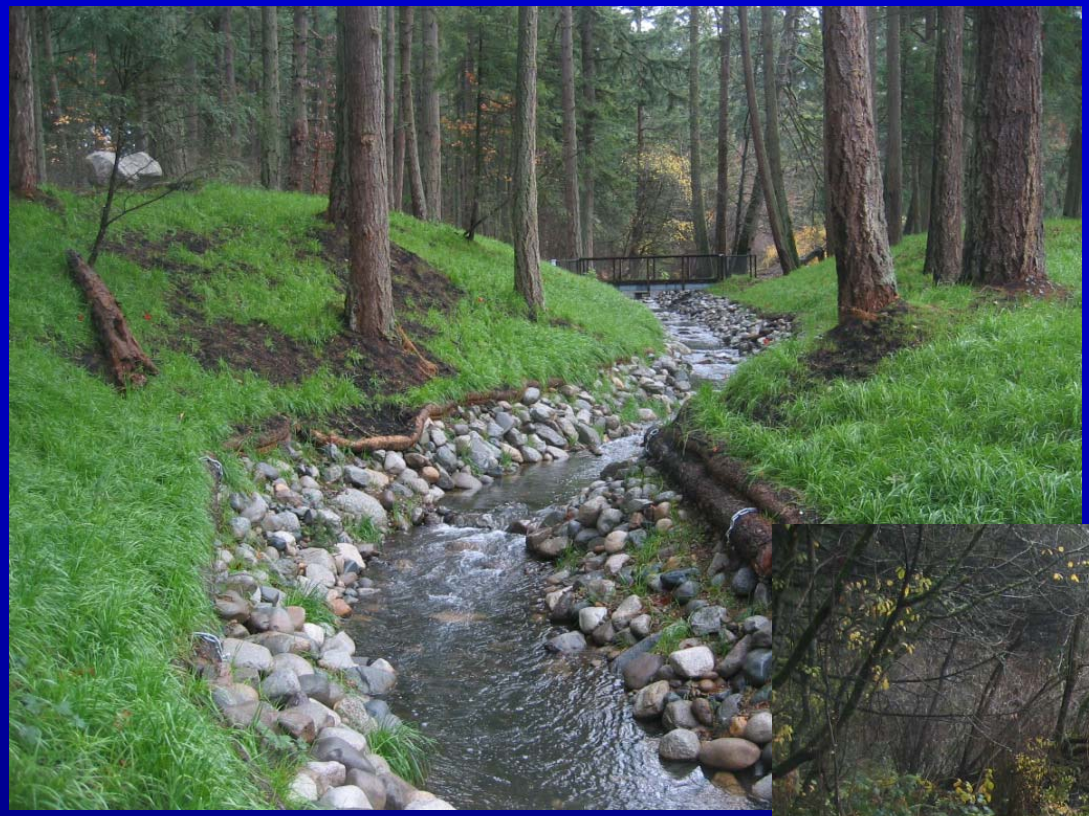


Vertical Slot Flow Control Section



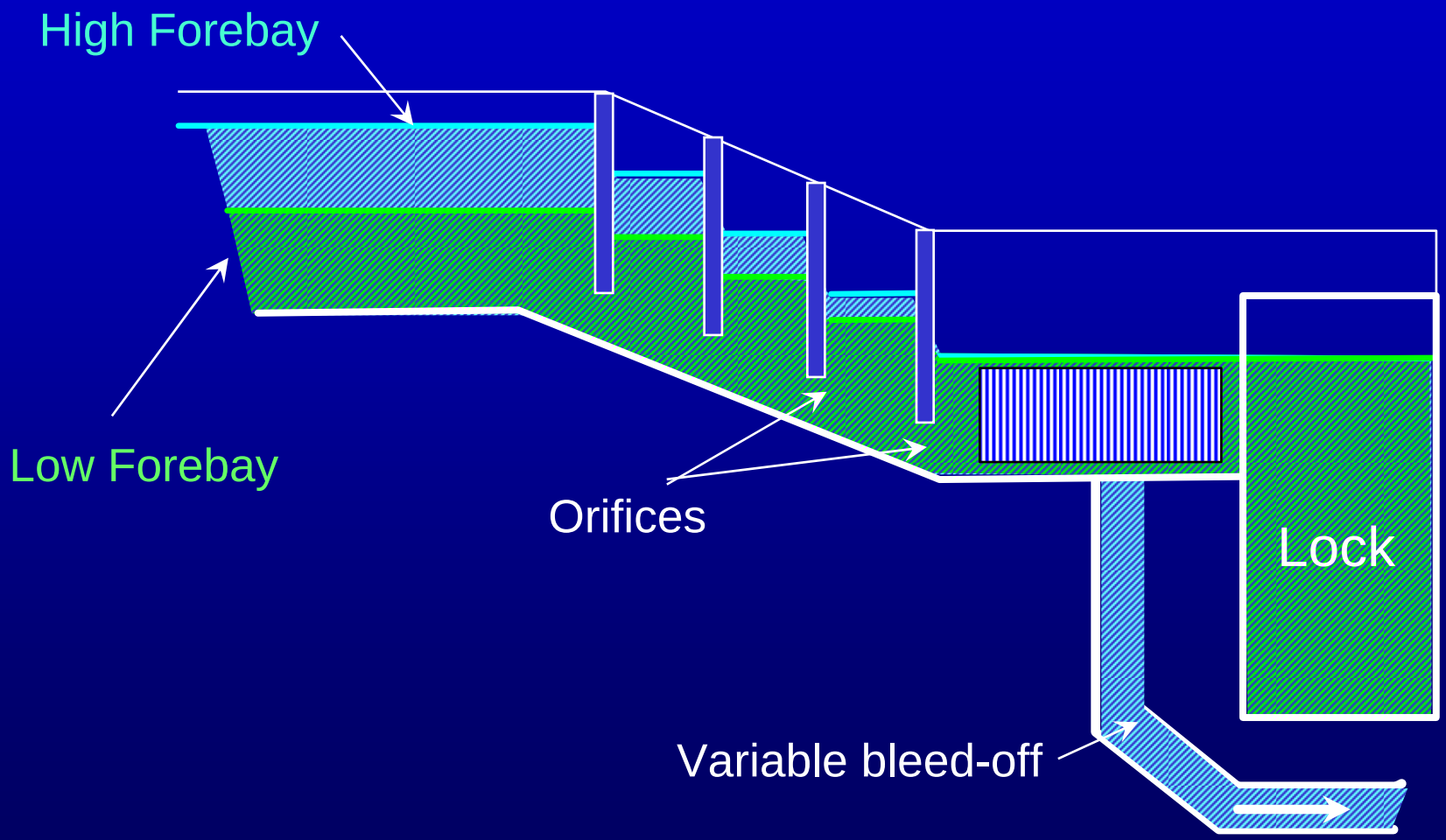
Fishway with Orifice Flow Control (or vertical slot)



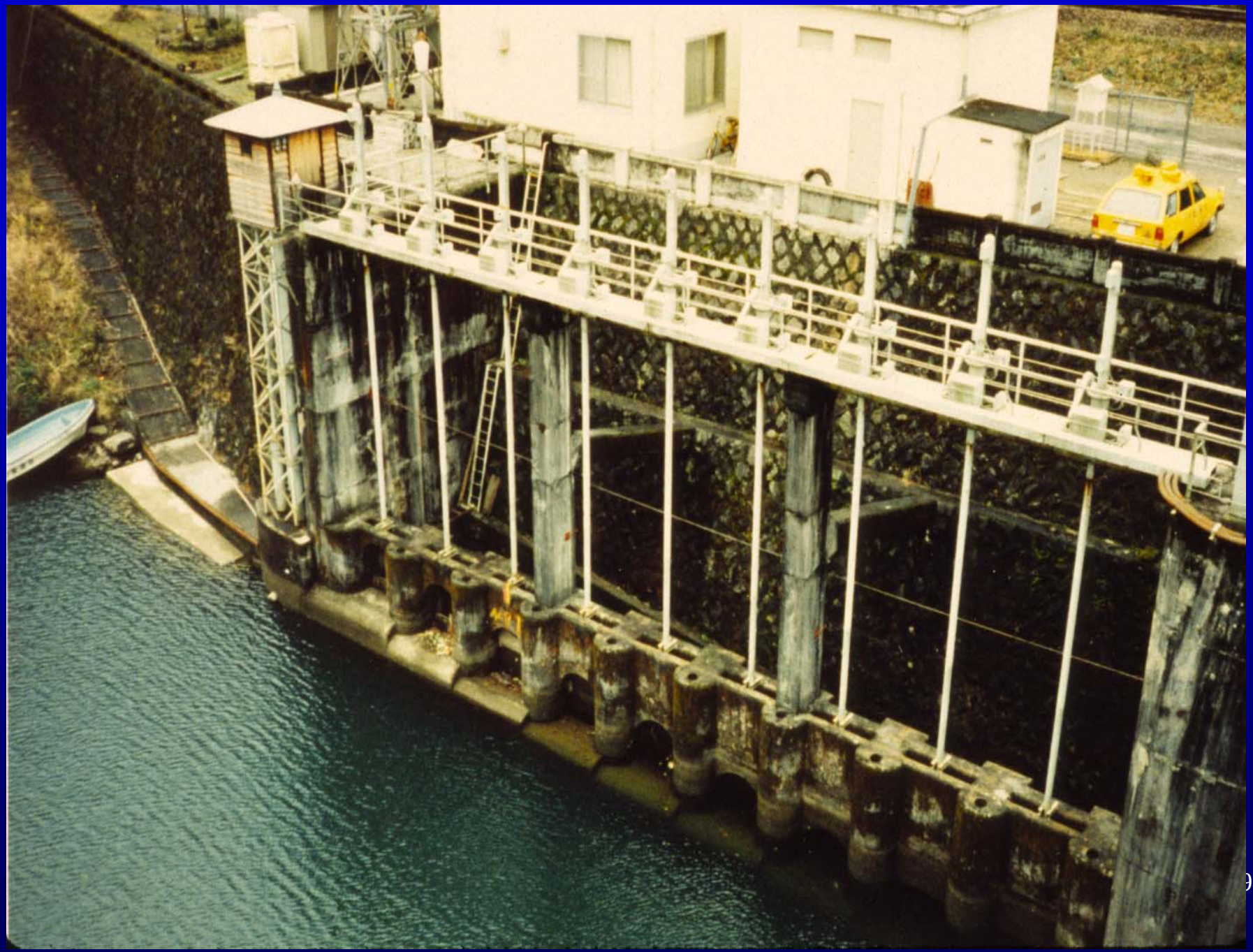


Orifice flow control

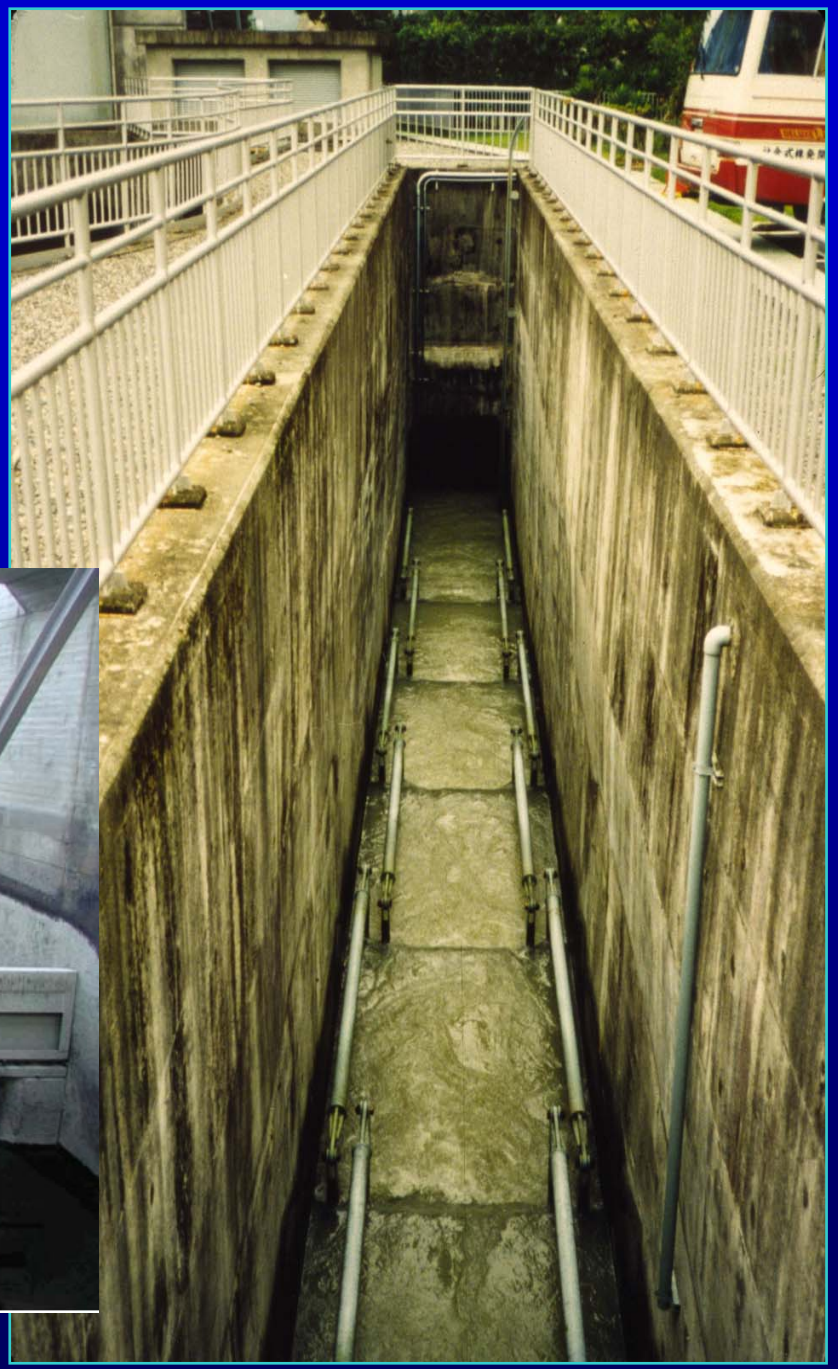
Lock with Orifice Flow Control



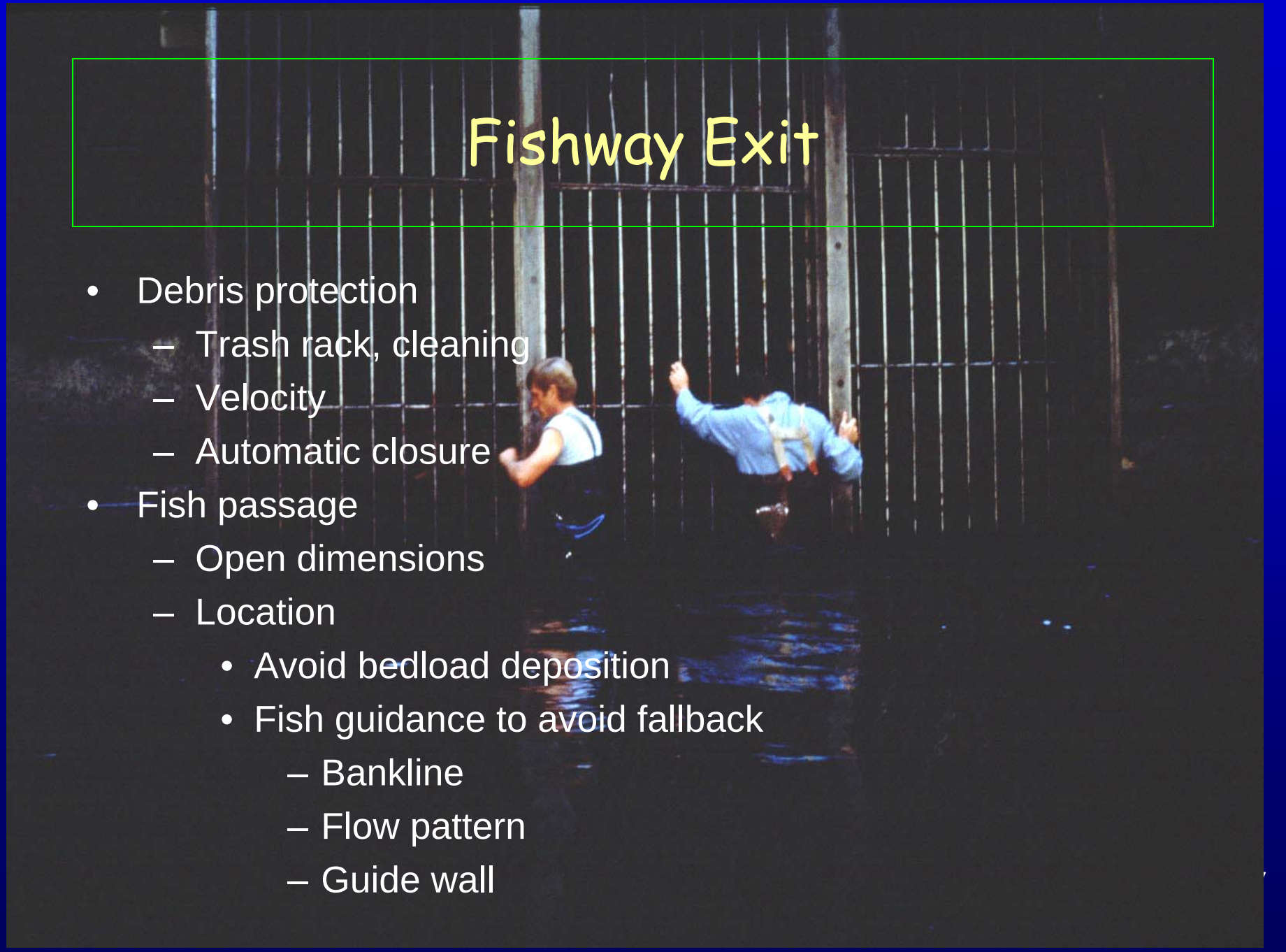
Multi-Level Outlet



Adjustable Weirs

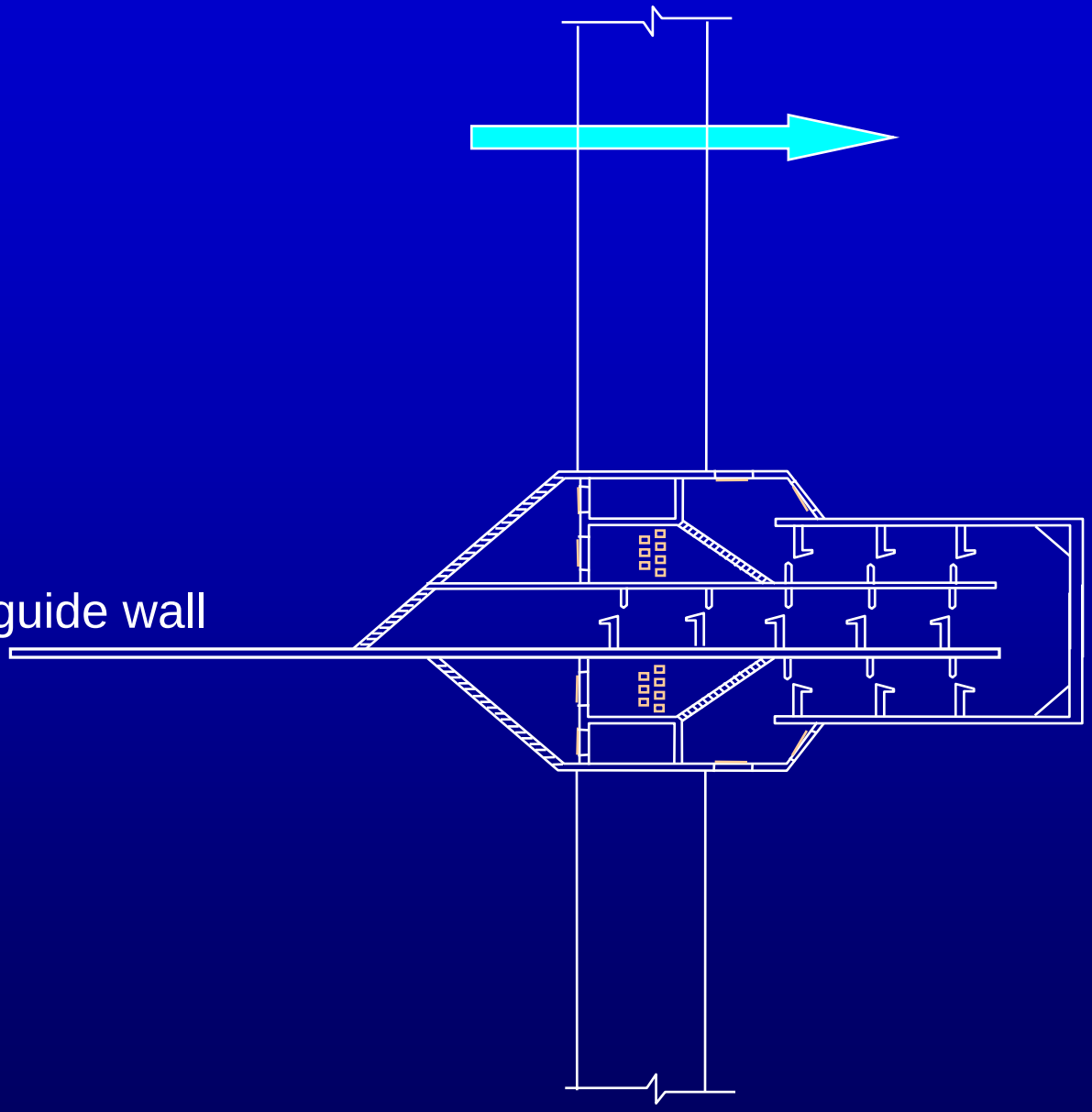


Fishway Exit



- Debris protection
  - Trash rack, cleaning
  - Velocity
  - Automatic closure
- Fish passage
  - Open dimensions
  - Location
    - Avoid bedload deposition
    - Fish guidance to avoid fallback
      - Bankline
      - Flow pattern
      - Guide wall

Exit guide wall



DOWNSTREAM FISH PASSAGE

Bryan Nordlund, P.E.
National Marine Fisheries Service
Lacey, Washington

Note: this presentation represents the views of the presenter based on fishway design experience in working for NMFS

POSITIVE EXCLUSION SCREENS AND BYPASS SYSTEM DESIGN

Positive Exclusion Fish Screen and Bypass Criteria

- Originally developed by NMFS and WDFW
- Current (July 2011) version has been adopted by FSOC for use in waters inhabited by anadromous salmonids in OR, WA, ID and MT.
- Available at: http://www.nwr.noaa.gov/Salmon-Hydropower/FERC/upload/Fish-Passage-Design.pdf

Fish Screen Criteria

- A second basic principle is that fish that avoid the screen will be swept downstream towards the bypass at a rate exceeding the screen approach velocity.
- This principle has not been specifically tested scientifically. Rather, this has been verified by successful screen and bypass testing and refinement of screen and bypass designs over the years.

Top 5 - Fish Screen and Bypass Criteria

- 0.4 ft/s max screen approach velocity
- 0.8 ft/s min sweep velocity, suggest 2-3 ft/s
- No deceleration or rapid acceleration along screen face or into bypass
- Proven screen cleaner (most screens)
- 3/32” circular or square openings, 1.75 mm slotted openings

The “Design” Fish – for NWR Criteria

- Pacific Salmon and Steelhead fry
- Downstream-migrating salmonids
- Passage barriers and screens

Objectives

Practical Knowledge of:

1. Hazards for fish
2. Biological basis of design
3. Educate participants in project
4. Data requirements
5. Apply design data
6. Screen types
7. Screen materials
8. Perform calculations
9. Draw conceptual layouts
10. Expedite permit review process

Topics

1. The Typical Water Diversion
2. Swimming Capabilities of Juvenile Salmonids
3. Behavior of Juvenile Salmonids
4. Basic Methods of Guiding Juvenile Salmonids
5. Design Objectives