DESIGN OF UPSTREAM FISH PASSAGE SYSTEMS

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I owe these folks for key contributions to this course instruction

- Mentors - Bob Pearce and Steve Rainey, NMFS retirees
- NMFS engineering cohorts – Melissa Jundt, Jeff Brown
- Utility contacts – Tom Kahler and Rick Klinge (Douglas PUD), Eric Lauver and Mike Nichols (Grant PUD), Thad Mosey, Lowell Rainey and Chris Nystrom (Chelan PUD), Todd Olsen (Pacificorp)
- Consultants – Peter Christensen and Dana Postlewait (R2 Resource Consultants, Redmond, WA)

Section 1.1 - Introduction to Upstream Fish Passage Systems

Sockeye and Chinook Salmon in Viewing Window at Wells Dam, Columbia River (Photo courtesy of Tom Kahler, Douglas PUD)

Objectives of Upstream Passage Instruction

- Identifies the **concepts used for developing general criteria and guidelines** for use in completion of upstream fish passage facility design.
- Description of the of the **components, configuration and application** particular styles of fish ladders.
- Identify potential **pitfalls and advantages** for particular types of passage systems given specific site conditions.

Fish Passage Design Philosophy

- The task involved with successful upstream fish passage is a dynamic integration of **fish behavior, physiology, and bio-mechanics with hydraulic analysis, hydrologic study, and engineering**.
- All six of these integrated tasks play a **specific and important individual role** in the design of an upstream fish passage facility.
- None of these tasks can be ignored, and a fishway design can fail if each task isn't properly assessed and understood.
- Installing a fish passage structure does not constitute providing satisfactory fish passage unless all of the above components are adequately factored into the design.

Safe Upstream Fish Passage

- **Safe passage** means that active migrants are passed upstream of a barrier with **minimal facility induced injury and mortality rates**.
- Depending on the challenges of upstream passage at a site, combined injury and mortality rates at upstream passage sites in the Pacific Northwest are usually less than 2% from fish entry into the project tailrace to fish exit from the project forebay.
- Many or most upstream passage facilities for Pacific salmon have **survival rates of greater than 99.5%.**

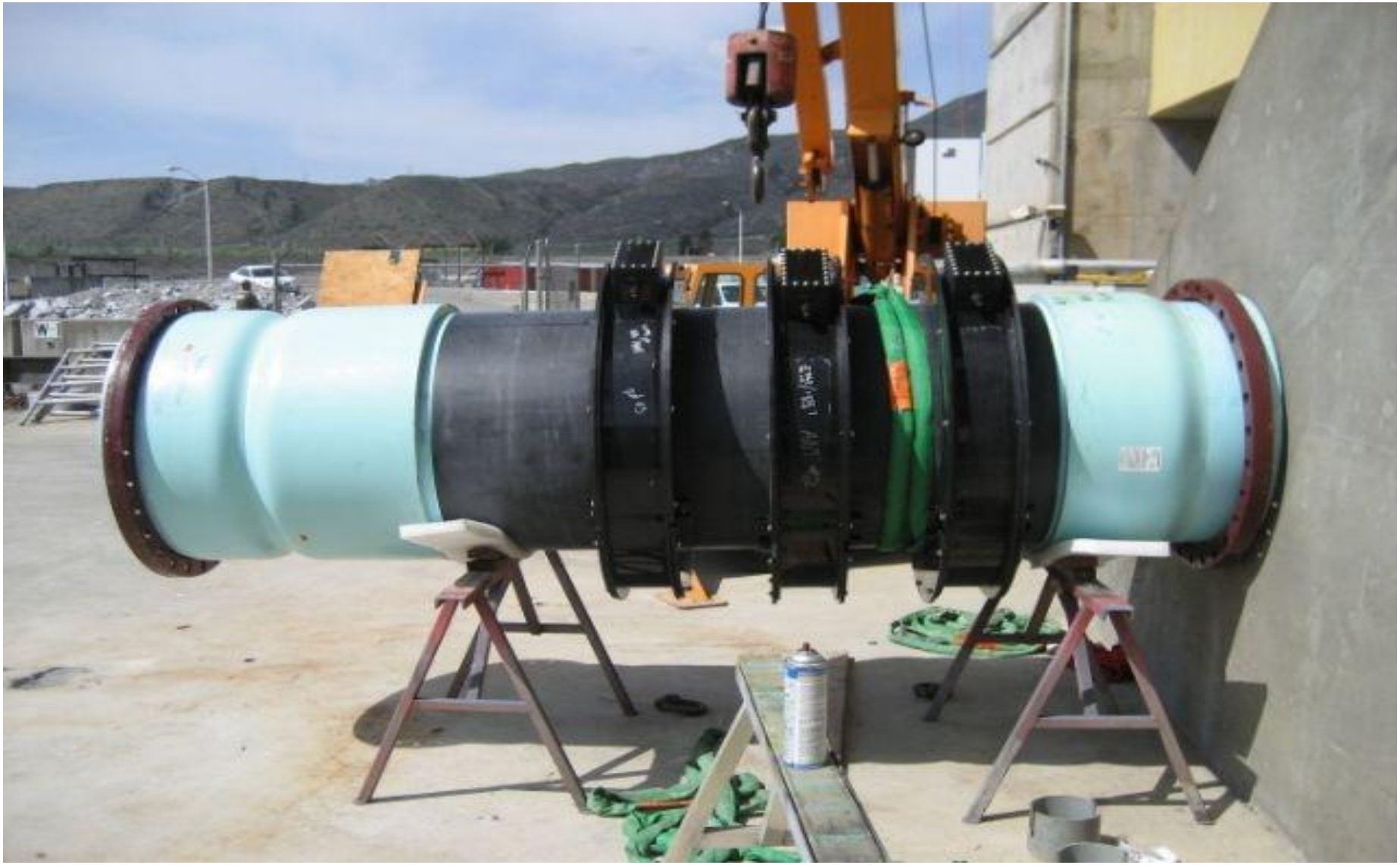
Timely Upstream Fish Passage

- **Timely passage** occurs when **delay time** for active upstream migrants is minimized.
- At some hydro projects in the Pacific Northwest, timely passage has been **defined as** passage times measured at **less than or equal to 24 hours**, with no more than **5%** of the active migrants taking **longer than 1 week** to pass.
- **Median delay times of less than 24 hours** have been achieved for multiple adult salmonid species at many hydro projects, as documented through radio telemetry studies in the Upper Columbia River and other locations.
- This parameter is **species dependent** and possibly **site dependent**

Efficient Upstream Fish Passage

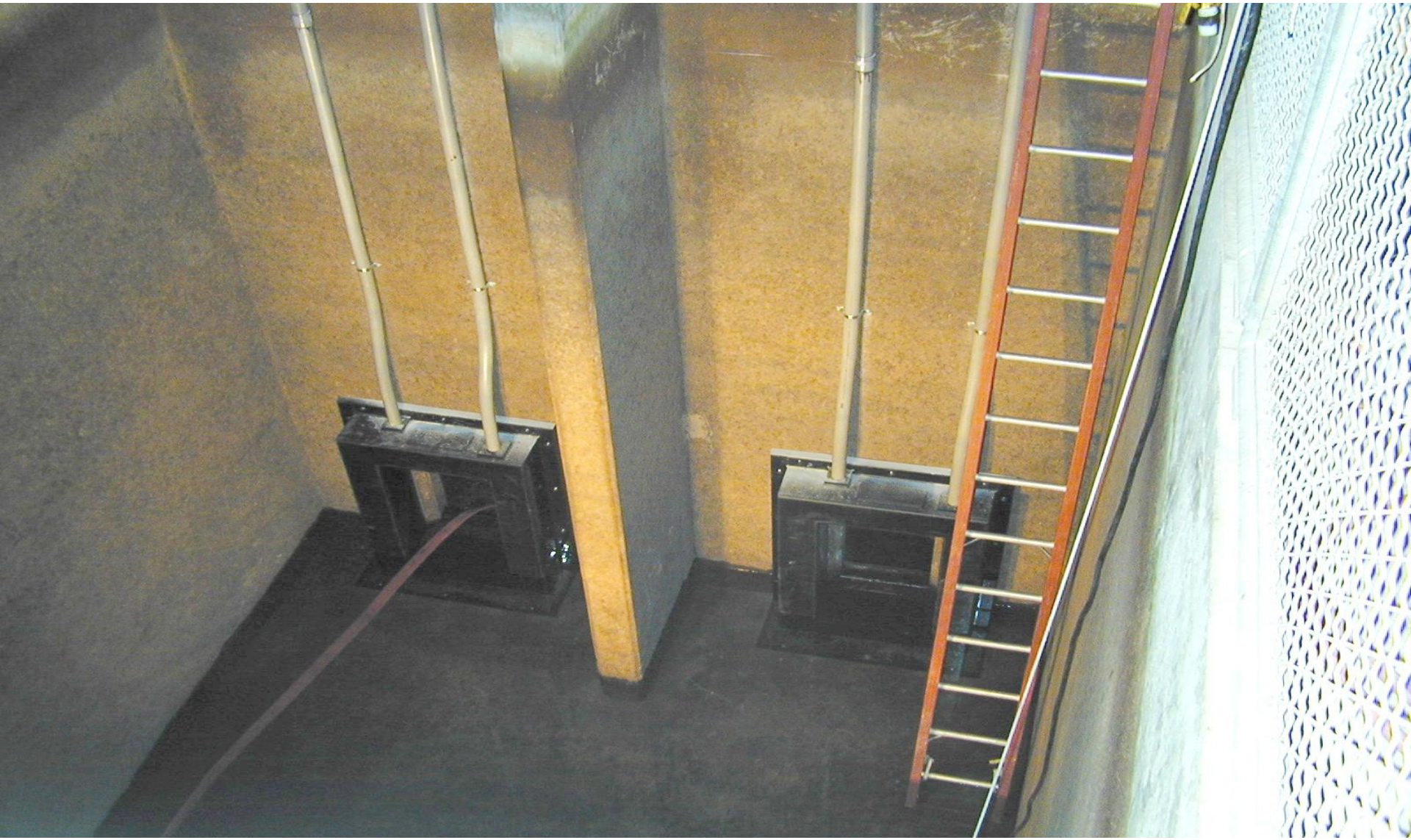
- **Efficient passage** means that **most or all of the active adult migrants pass are passed** upstream of the dam.
- Passage success has been measured at **greater than 98%** for multiple adult salmonid species at many hydro projects in the Pacific Northwest.
- PIT tag detections from 2003 to 2008 indicate that summer steelhead, spring Chinook and summer Chinook migrating through the Columbia River from Priest Rapids to Wells Dams (**5 dams total**) pass at minimum rates of **98.2%, 98.1% and 98.3%** per dam. These are considered to be **minimum** dam passage efficiency rates due to removal of tagged fish from fisheries, hatcheries, and other activities.

Wells PIT tag reader for adult trap (pre install)



(Photo courtesy of Mike Schiewe, Anchor Environmental)

Adult PIT tag detectors installed in Wells Dam forebay control orifices



(Photo courtesy of Tom Kahler, Biologist, Douglas PUD

Upstream Passage Impediments and Barriers

- An upstream passage impediment is defined as any structural feature or project operation that **causes** adult or juvenile fish to be **injured, killed, blocked, or delayed to a greater degree than in a natural river setting**.
- An upstream passage impediment that **entirely blocks** the upstream migration is a **barrier**.

Upstream Passage Impediments and Barriers

- Artificial impediments require a fish passage design using **conservative criteria**, because the **natural complexity** that usually provides fish passage has been **substantially altered**.
- Conservative criteria are **also required** to allow for a **range in the physical abilities** of multiple life stages and multiple species of fish, as well as variability within specific species and life stages.
- **No upstream passage facility** constructed at an upstream passage impediment **can fully compensate** for an unimpeded natural channel.

Examples of Impediments and Barriers at a Hydro Dam:

- Attraction to a **dead end passage route** (spillway, turbine flows)
- **Fallback** through spillways, locks or turbines
- **Reductions in streamflow**
- A **vertical structure** spanning a mostly horizontal river
- **Inadequate attraction** to fishways

Take home introductory message

- The criteria and guidelines included in this document are **specifically developed** for the different species of anadromous **Pacific salmon**.
- Use of these criteria and guidelines for **other species is not suggested** by their use in examples in this fish passage course, and is in fact **irresponsible, unless** it can be verified that they are suitable for other fish species.
- The **goals** of this fishway instruction are to identify a **process for fishway design**, along with presentation of the **role for and design of various components** of upstream passage systems, and the **integration of components** of a passage system to provide a design for an **upstream fish passage facility**.