SCREEN AND BYPASS DESIGN

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Note: this presentation represents the views of the presenter, and in most cases, is based on fishway design experience in working for NMFS.

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HISTORY, PURPOSE AND OBJECTIVES OF SCREEN AND BYPASS DESIGN

Evolution of NMFS Design Manual

- Fishway designs for Pacific Salmon are based on design and operational experience of NMFS engineers and biologists dating back into the 1950's.

Swenson, Meyer and Nordlund?

Evolution of NMFS Design Manual

- Early fishway designs were often developed while simultaneously conducting research – for biological criteria development and assessment of fishway effectiveness.
- Successful fishway designs were retained with improvements made when needed.

Fish Screen and Bypass Criteria

- Juvenile salmonid screen criteria were originally developed by NMFS and WDFW in mid-1980's.
- Subsequent fry stamina testing reduced the maximum allowable approach velocity from 0.5 ft/s to 0.4 ft/s in late 1980's.
- Bypass criteria were developed and added by NMFS in early 1990's.

Fish Screen and Bypass Criteria

- End-of-pipe (pump screen) criteria was developed by FSOC and added by NMFS in the mid 1990's. Updated mesh standards were also added.
- In late 1990's, FSOC began utilizing NMFS screen and bypass criteria for waters containing salmonid fry in ID,WA,OR and MT.

Fish Screen and Bypass Criteria

- In 2000, NMFS Regional Administrator Lohn requested that NMFS Engineers develop a comprehensive set of acceptable fishway design standards to facilitate faster implementation of mitigative measures.
- The original NMFS fishway design manual was based on workshop discussions in 2001-2002 with state and Federal fisheries agencies, Native Tribes and others experienced with fishway design.

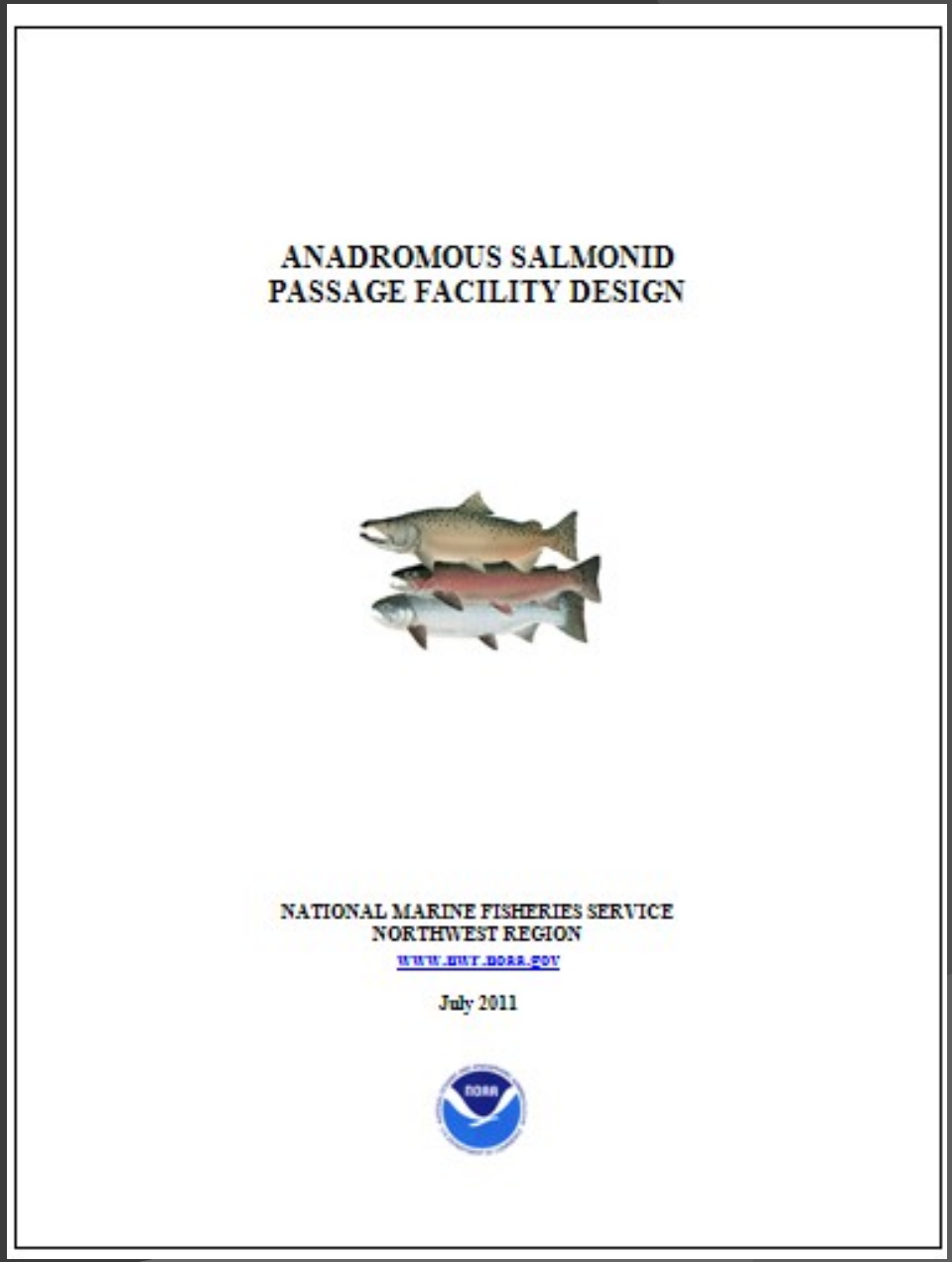
Fish Screen and Bypass Criteria

- NMFS Design Manual includes screen and bypass design criteria (Chapter 11) and guidelines.
- Manual is considered to be a working document, subject to revision when improvements can be made, errors or oversights corrected, or biological criteria are refined.

NMFS Design Manual

- Last update was completed and approved by NMFS Deputy Regional Administrator in 2011.
- Current version can be found at: http://www.nwr.noaa.gov/Salmon-Hydropower/FERC/upload/Fish-Passage-Design.pdf

NMFS Fishway Design Manual



ANADROMOUS SALMONID
PASSAGE FACILITY DESIGN

NATIONAL MARINE FISHERIES SERVICE
NORTHWEST REGION
WWW.NWR.NOAA.GOV

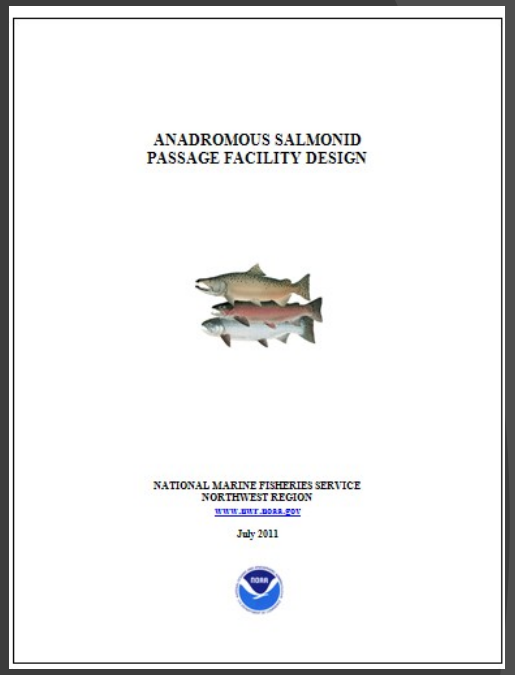
July 2011

Using NMFS design manual

- Original intent - document was developed for “batch processing” of similar passage facilities under a single programmatic NMFS Biological Opinion.

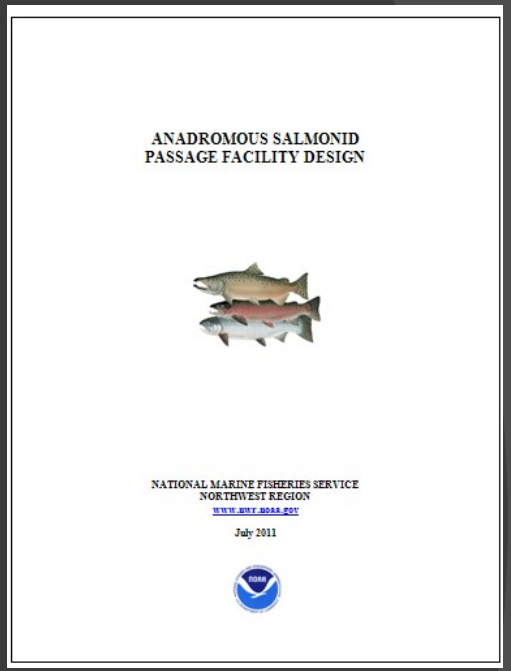
- Frequently used as a starting point for design criteria for a wide variety of fish passage projects.

- Design criteria and guidelines may require some degree of modification for specific sites.



Using NMFS design manual

- ODFW, WDFW, IDFG, U.S. Fish and Wildlife Service and some Tribal fishery agencies have adopted NMFS screen and bypass criteria for use in waters containing anadromous salmonids, through collaborative process and consensus vote of the Fish Screen Oversight Committee.

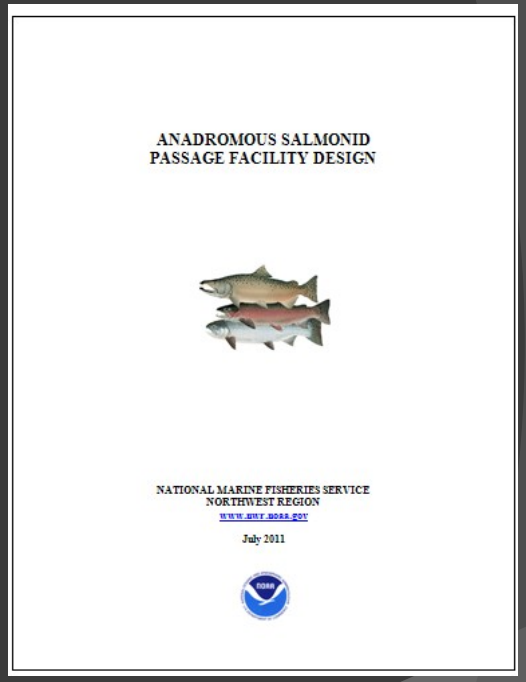


- Other sections of the document do not have this same consensus endorsement, although design inconsistencies regarding agency criteria for anadromous salmonids are resolvable.

Applying NMFS criteria to specific projects

- Criteria are specific biologically based standards that cannot be changed without a written waiver from NMFS. Criteria are preceded by the word “must.”

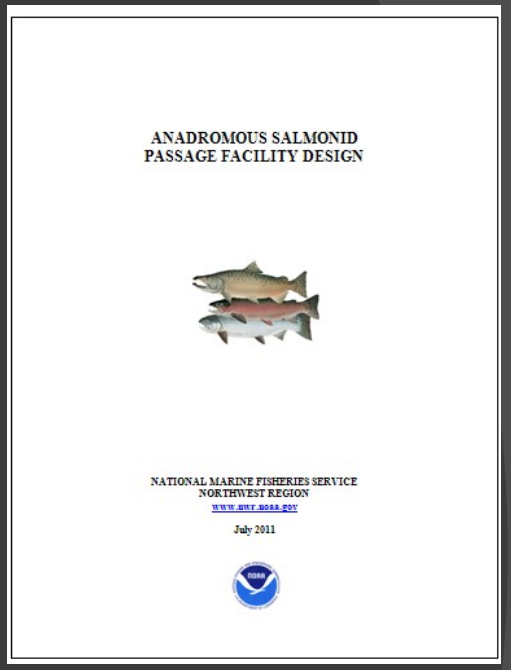
- A criterion can not be changed unless there is site-specific biological rationale for doing so.



Applying NMFS guidelines to specific projects

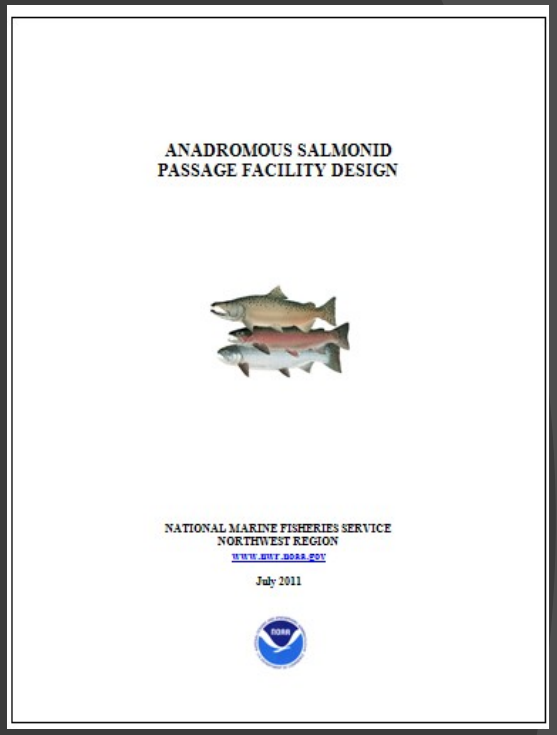
- A guideline is a range of values or a specific value that may change when site conditions are factored into the conceptual design. Guidelines are preceded by the word "should."

- Guidelines should be followed unless site-specific information indicates that a different value would provide better fish passage conditions or solve site-specific issues, and is agreed to by NMFS.



Applying NMFS design manual to specific projects

Bottom Line - It is up to the design developer to provide compelling site specific evidence in support of any proposed waiver of criteria or modification of a guideline for NMFS approval early in the design process.



NMFS Design Manual chapters include:

- Juvenile fish screens and bypass systems
- Upstream adult passage
- Adult traps and handling facilities
- Exclusion barriers
- Culverts and road crossings
- Upstream juvenile passage
- Definitions, design flows, experimental tech development, O&M, temporary facilities, evaluations

NMFS Design Manual – chapters in development include:

- Tide Gates
- Infiltration Galleries
- Reservoir Passage Systems
- Roughened Stream Channels (update)
- Juvenile Traps and Handling Facilities
- Horizontal Screens (added in 2010)

Fishway Design Development

- NMFS works with anadromous salmonid passage.
- NMFS fishway design manual was developed specifically for anadromous salmonid species.
- Integrating passage of other species (eg. Lamprey, Bull Trout, others) is becoming more prevalent in fishway design work or design modification.
- What works for Pacific Salmon species may or may not work for other species.

NMFS Design Manual – Design Basis

- Based on matching fishway design to biomechanical and behavioral traits
- Conclusive scientific data is sparse for specific criteria/guidelines. Design Manual is based on extracting criteria from successful designs and scientific data where it exists.
- Fishways are expected to pass the weakest swimmers in marginal water conditions.

Objective - Safe, Timely and Effective Passage

Safe, Timely and Effective Passage

- Safe passage means that fish are passed with facility induced injury and mortality rates less than agreed to for a specific project (usually 2-5% for juvenile fish).
- Timely passage means that median delay is low, as defined for a specific project.
- Efficient passage means that passage opportunity is continually maintained by vigilant operation and maintenance.

Safe Passage

- Passage facilities are designed to minimize the potential for injury or mortality.
- As examples, this involves design scrutiny looking for strike potential, high turbulence and shear, safe landing zones, predation potential, rejection of passage facility, delay mechanisms etc.
- For a passage facility designed using NMFS criteria, injury and mortality are rare. However, designs fail and stuff happens….

Safe Passage

- Example: In the Rocky Reach Surface Collector screen and bypass system (6000 cfs screen, 250 cfs bypass), pre-season tests are conducted annually. Combined injury and mortality rates are normally less than 2%, and frequently 0%.

Timely Passage

- Rule of Thumb: For a screen and bypass system, the time a fish spends between the point of diversion and bypass return to the originating stream should be about the same time it takes for a fish to transit between these same points staying in the stream.

Timely Passage

- Example: In preseason tests, it takes less than ½ hour for nearly all of the test fish released in the forebay of the screens to travel over ½ mile to reach the sampler located near the bypass outfall. This is a similar rate of travel for fish transiting the Rocky Reach pool (about 1 mile per hour).

Effective Passage

- Example: Effective passage means that facilities are maintained and operational per design criteria at all times during the passage season.

Rocky Reach Surface Collector Entrance

Rocky Reach Screen (1 bay)

Rocky Reach Bypass Pipe

Rocky Reach Sampler and Bypass

Rocky Reach Sampling Lab

Basic Design Principles - Screen and Bypass Systems

The “Design” Fish – for NWR Criteria

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

Basic design principle #1

- Fish can avoid impingement (i.e. contact with the screen face) if their swimming ability exceeds the screen approach velocity.
- Swimming ability has been established tested scientifically for many species and life stages, and adapted to the design of fish screens.
- Maximum 0.4 ft/s screen approach velocity

Basic design principle #2

- Fish will be swept downstream towards the bypass at a rate exceeding the screen approach velocity, if hydraulic criteria are achieved.
- 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.

Basic design principle #2 (cont.)

- 0.8 ft/s min sweep velocity, suggest 2-3 ft/s
- No deceleration or rapid acceleration along screen face or into bypass

Basic design principle #3

- Debris and sediment are the number one Achilles Heel of screen and bypass design.
- No natural or developed waterway is continually debris and sediment free.
- Inadequate consideration of debris impingement or entrainment can and usually does lead to catastrophic failure, structurally and biologically. Proven screen cleaner is required.

Basic Design Principle #4

- Fish squeeze through openings that are often smaller than their cross-section.
- Unless you want them too…..
- Maximum 3/32” circular or square openings, 1.75 mm slotted openings.

Course Objectives

Practical Knowledge of:

1. Hazards for fish
2. Biological basis of design
3. Project data requirements
4. Applying design data
5. Different screen types
6. Screen materials
7. Perform calculations
8. Develop conceptual designs

Overall Objective

- Expedite permit review process for screen and bypass designs