SAFE, TIMELY, AND EFFICIENT FISH PASSAGE

History, Purpose and Objectives of NMFS Screen and Bypass Criteria

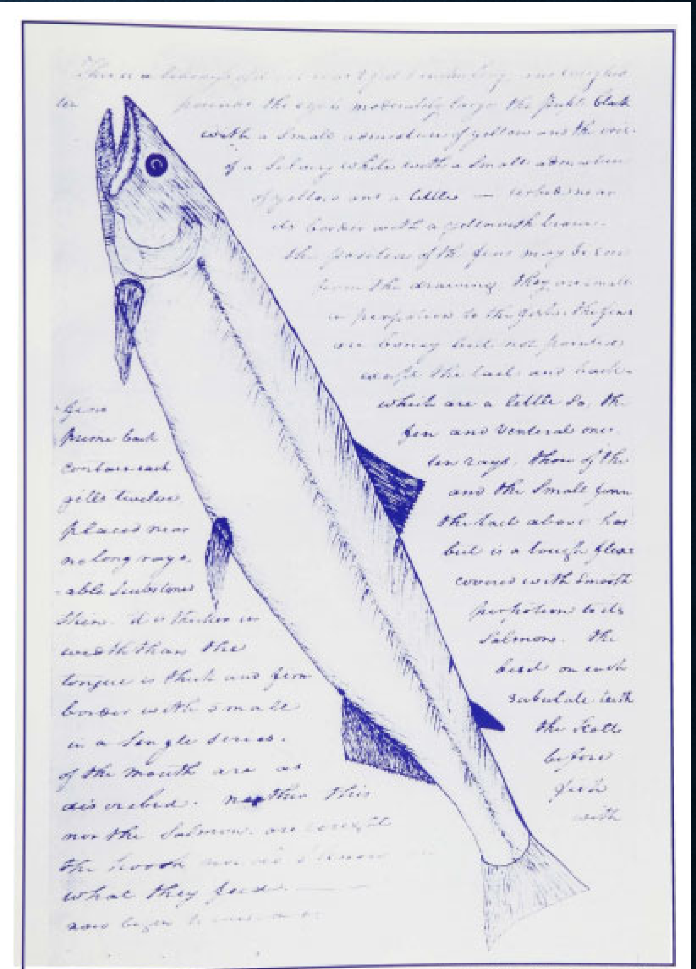
(Plus where NMFS is at now with the fish passage guidelines)

Jean M. Castillo, MSCE, P.E.

NOAA Fisheries

CHRONOLOGICAL HISTORY

Late 1800's – Reduction in the number of Salmon returning
1930's - Trial and Error Approach
1940's - Start of research programs USBOR & USFWS
1950's - Establishment of Fisheries Engineering Research program
1960's - Milo Bell increased research for juvenile d/s passage
1970's - Understanding of gas bubble disease development of Fisheries Handbook of Engineering Requirements and Biological Criteria (USACE)
1980's - USACE funding research for work that lead to an understanding on fish losses
1980's - Juvenile salmonid screen criteria developed by NMFS & WDFW
1990's - Bypass criteria were developed and added by NMFS & the Fish Oversight Committee utilizing criteria in ID, WA, OR and MT.
1995 - PNW Juvenile Screen Criteria
1997 - SW Region's Fish Screening Criteria, January 1997 Adapted from NMFS Northwest Region
2000 - NMFS RA requested that NMFS Engineers develop a comprehensive set of acceptable fishway design standards to facilitate faster implementation of mitigative measures.
2008 - ANADROMOUS SALMONID PASSAGE FACILITY DESIGN NATIONAL MARINE FISHERIES SERVICE NORTHWEST REGION (NMFS 2008)
2011 - Updated NMFS 2008 (NMFS 2011)
2022 - Release of combined SW 1997 and NW 2011

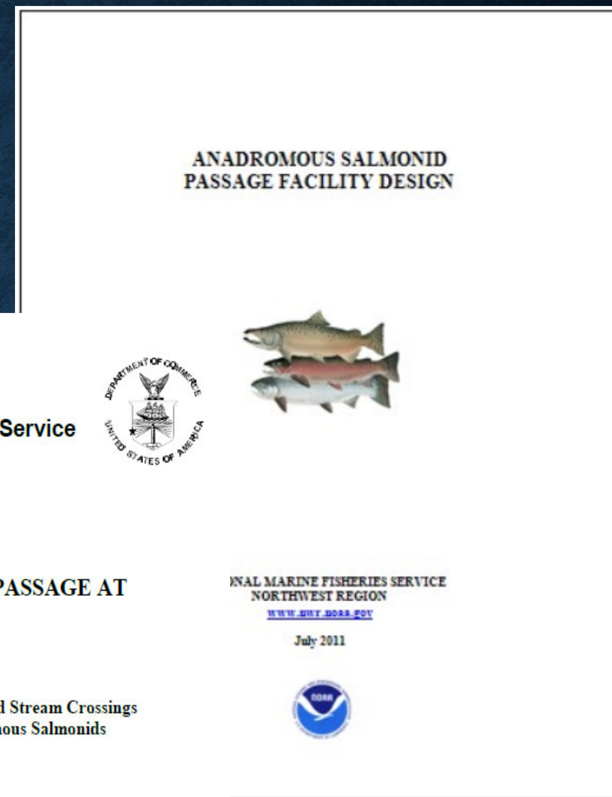


Explorer William Clark's Drawing of a Salmon.

HISTORY

PURPOSE
NMFS Design Manual

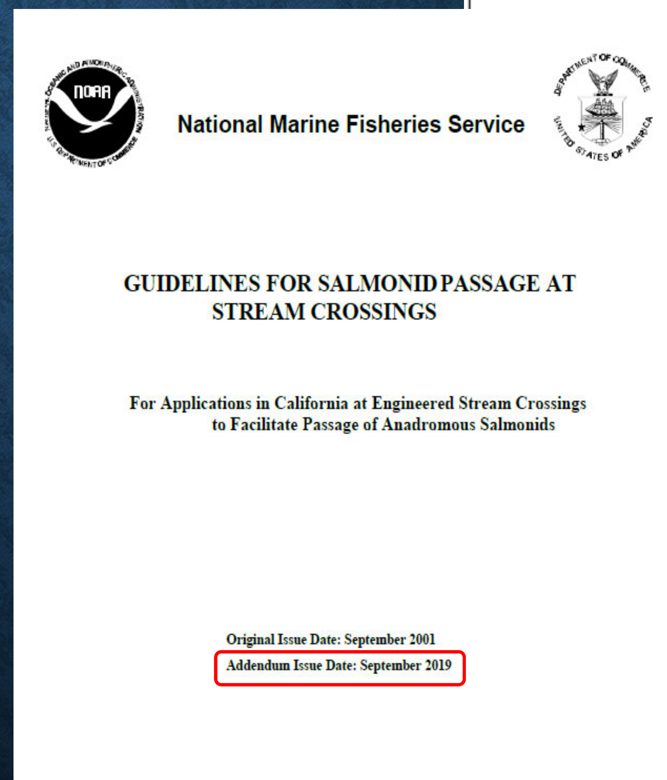
- Original intent - Batch Processing
- Starting point for design
- Case by Case



ANADROMOUS SALMONID
PASSAGE FACILITY DESIGN

NAL MARINE FISHERIES SERVICE
NORTHWEST REGION

July 2011



National Marine Fisheries Service

GUIDELINES FOR SALMONID PASSAGE AT STREAM CROSSINGS

For Applications in California at Engineered Stream Crossings to Facilitate Passage of Anadromous Salmonids

Original Issue Date: September 2001

Addendum Issue Date: September 2019

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 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 during the consultation process by NMFS.

OBJECTIVE
SAFE, TIMELY AND EFFECTIVE/EFFICIENT 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.

- Effective passage means that passage opportunity is continually maintained by vigilant operation and maintenance.

Safe passage

- Safe passage means that active migrants are passed upstream of an impediment 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.

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.

Effective vs Efficient Passage

- Effective passage is derived from the unofficial but reliable definition of a fishway presented by Congress in a report related to the Energy Policy Act of 1992.
- Efficient passage means that most or all of the active adult migrants 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, including the five public utility district operated dams on the upper Columbia River.

OBJECTIVE

DESIGN BASIS
NMFS Design Manual

- Based on matching fishway design to biomechanical and behavioral traits.

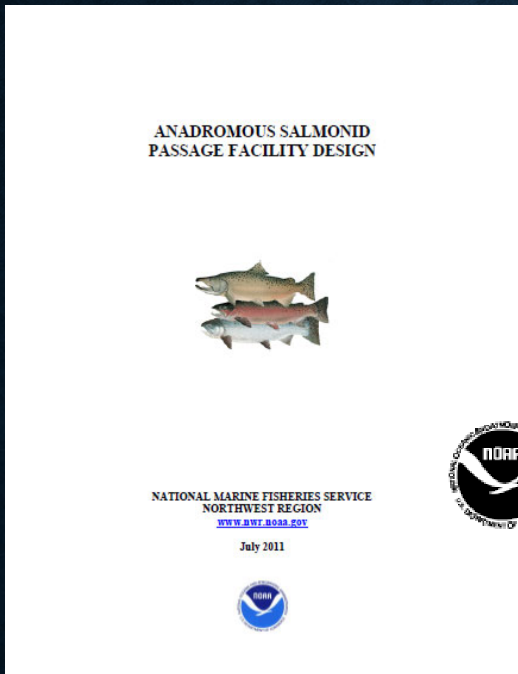
- Fishways are expected to pass the weakest swimmers in marginal water conditions.

Current Status

of NMFS'

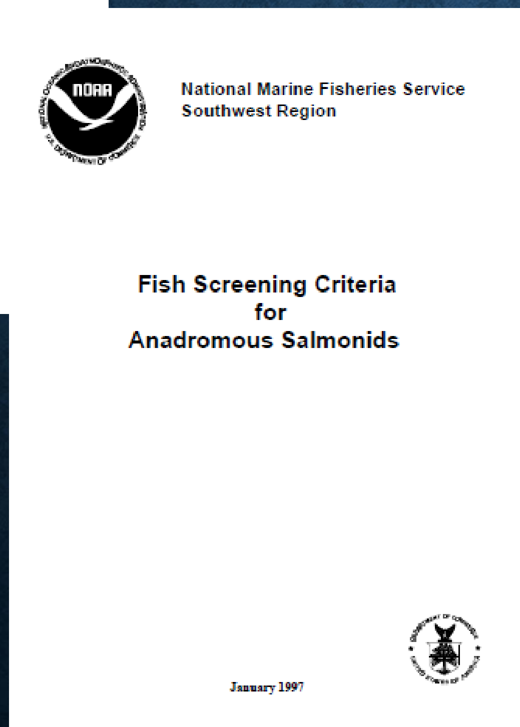
Updated & New Design Manuals

They're Released


ANADROMOUS SALMONID
PASSAGE FACILITY DESIGN

NATIONAL MARINE FISHERIES SERVICE
NORTHWEST REGION
www.nwr.noaa.gov

July 2011


National Marine Fisheries Service
Southwest Region

Fish Screening Criteria
for
Anadromous Salmonids

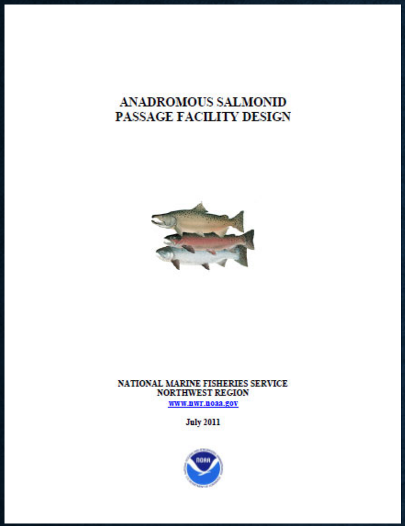
January 1997

1. Consistent Message
2. Literature Citations
3. Emerging Technologies

NORTHWEST REGION

SOUTHWEST REGION

CONSISTENT MESSAGE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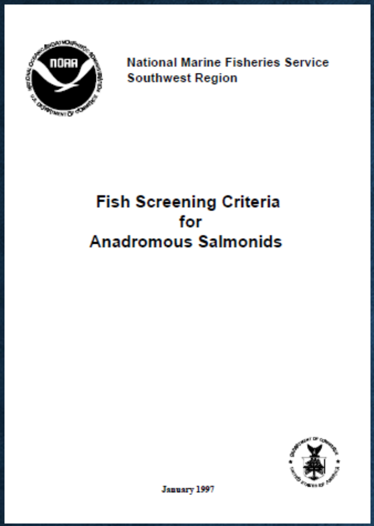
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Fish Screening Criteria
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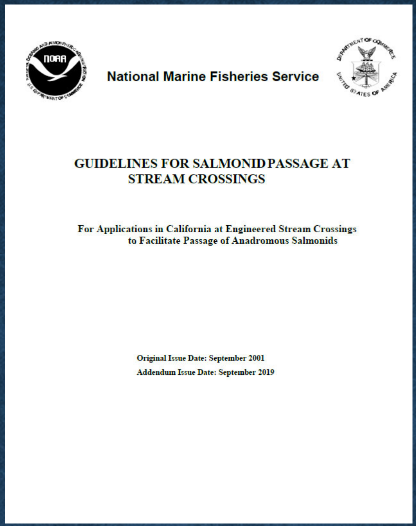
National Marine Fisheries Service

GUIDELINES FOR SALMONID PASSAGE AT
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Original Issue Date: September 2001
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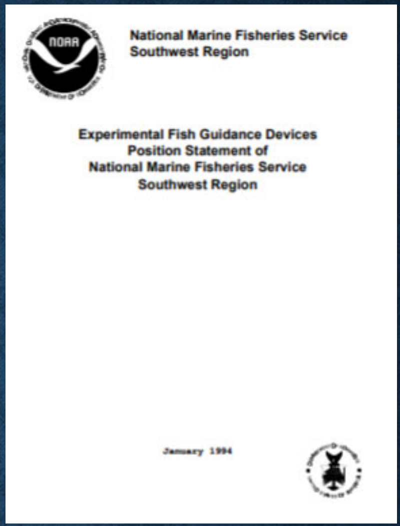
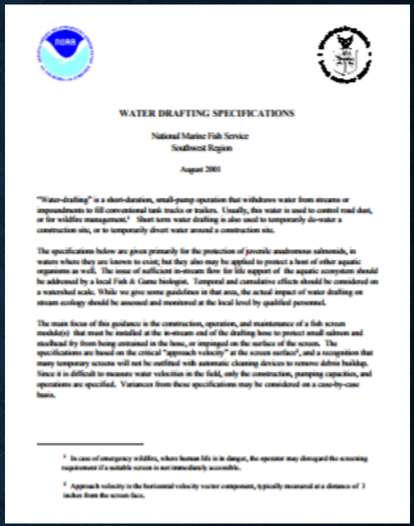

National Marine Fisheries Service
Southwest Region

Experimental Fish Guidance Devices
Position Statement of
National Marine Fisheries Service
Southwest Region

January 1994


WATER DRAFTING SPECIFICATIONS

National Marine Fish Service
Southwest Region

August 2001

- Northwest Region's Anadromous Salmonid Passage Facility Design document, July 2011
- Southwest Region's Fish Screening Criteria for Anadromous Salmonids document, January 1997
- Southwest Region's Guidelines for Salmonid Passage at Stream Crossings document, Sept 2019
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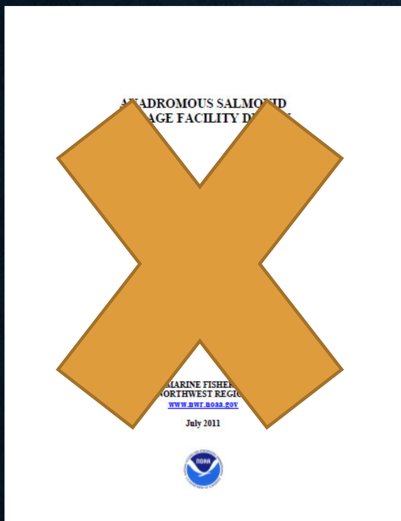

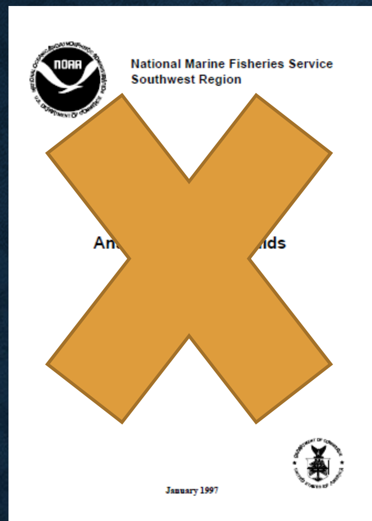

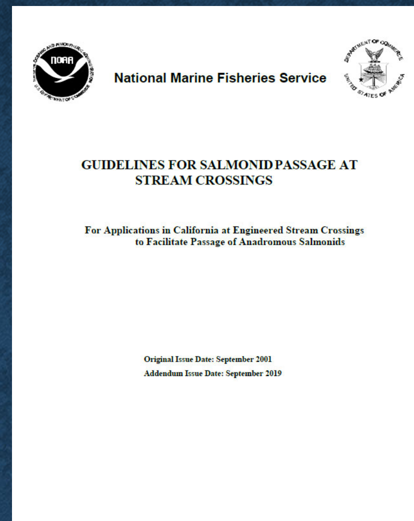

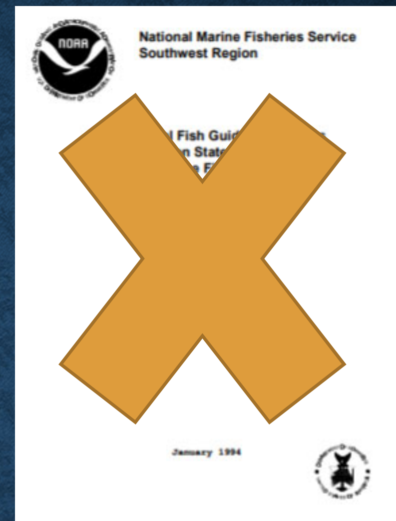

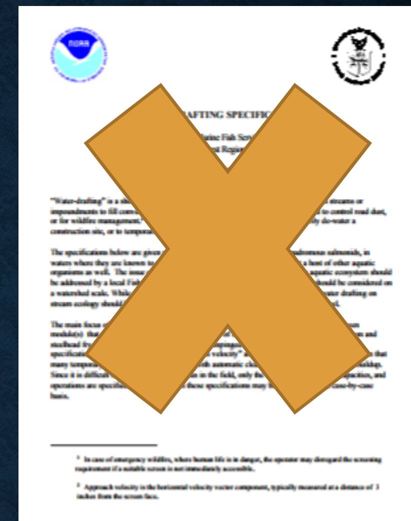

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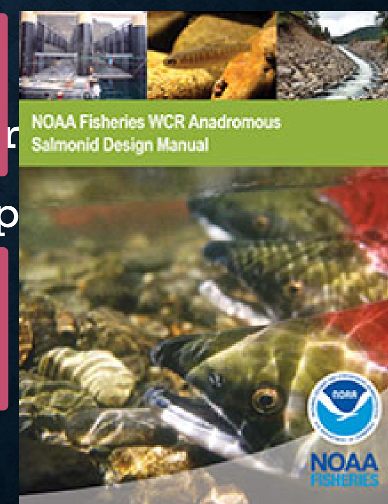
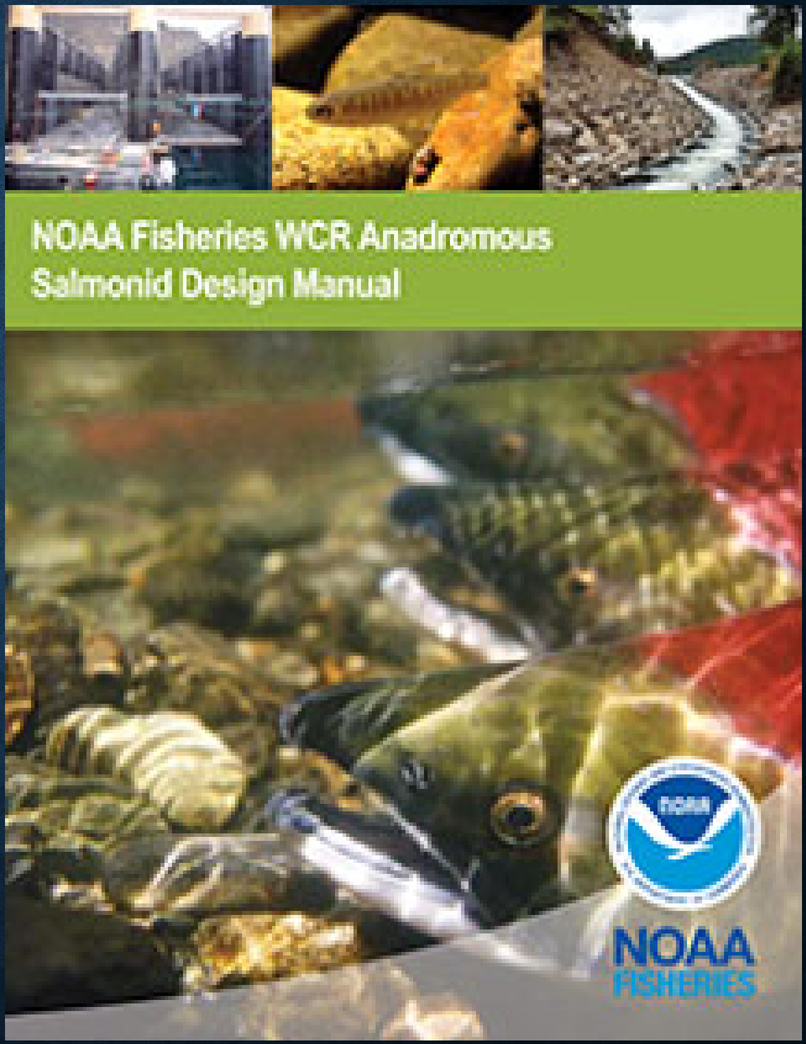


LITERATURE CITATIONS



Literature Citations

OLD PNW GUIDELINES

The *approach velocity* must not exceed 0.40 ft/s for *active screens*, or 0.20 ft/s for *passive screens*. Using these approach velocities will minimize screen contact and/or impingement of juvenile fish. For screen design, *approach velocity* is calculated by dividing the maximum screened flow amount by the vertical projection of the *effective screen area*.

UPDATED GUIDELINES

The design approach velocity for active screens should not exceed 0.4 ft/s for fish screens where exposure time is limited to less than 60 seconds, or 0.33 ft/s where exposure time is greater than 60 seconds (Smith and Carpenter 1987; Clay 1995). The design approach velocity for passive screens, as described in Section 8.5.6, should not exceed 0.2 ft/s (Cech et al. 2001).

A Bit of Screening History

The design approach velocity for active screens should not exceed 0.4 ft/s for fish screens where exposure time is limited to less than 60 seconds, or 0.33 ft/s where exposure time is greater than 60 seconds (Smith and Carpenter 1987; Clay 1995). The design approach velocity for passive screens, as described in Section 8.5.6, should not exceed 0.2 ft/s (Cech et al. 2001).

Smith and Carpenter reference talks about Chinook swimming at 0.4 ft/sec for 6-hours.

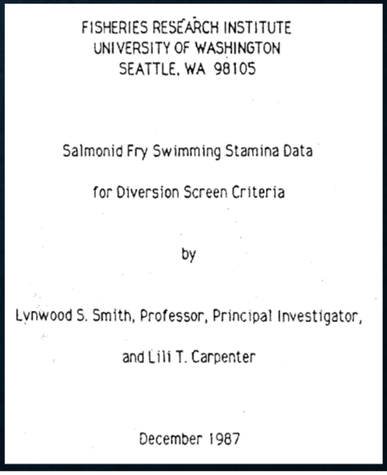
Clay 1995 references **Brett, Bainbridge and Kerr** (see graph in this document or page 181 in Clay.)

Brett - cruising speed for 1-inch sockeye and Coho salmon at 0.5 ft/sec for 1-hour.

Bainbridge – Graph is for trout, goldfish and Dace and it says 0.33 ft/sec for 1-inch long fry.

Kerr – 10 minute velocity endurance for chinook salmon 1.5-inch long swimming at 1 ft/sec 92% effective

Kerr – at 0.5 ft/sec 100% effective for 1-inch and to put a factor of safety for the smaller fish use 0.4 ft/sec as an approach velocity.


FISHERIES RESEARCH INSTITUTE
UNIVERSITY OF WASHINGTON
SEATTLE, WA 98105

Salmonid Fry Swimming Stamina Data
for Diversion Screen Criteria

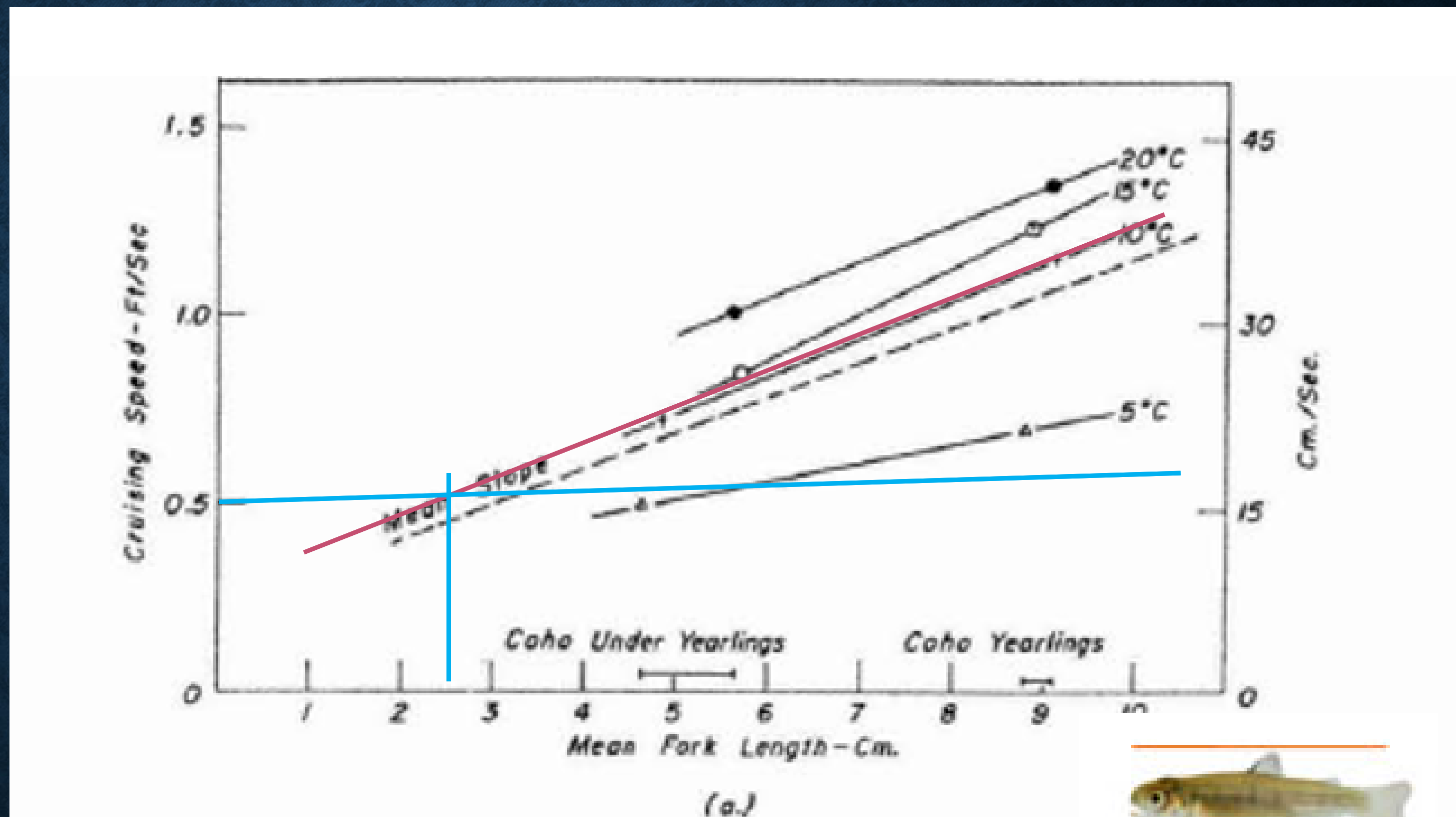
by

Lynwood S. Smith, Professor, Principal Investigator,
and Lili T. Carpenter

December 1987

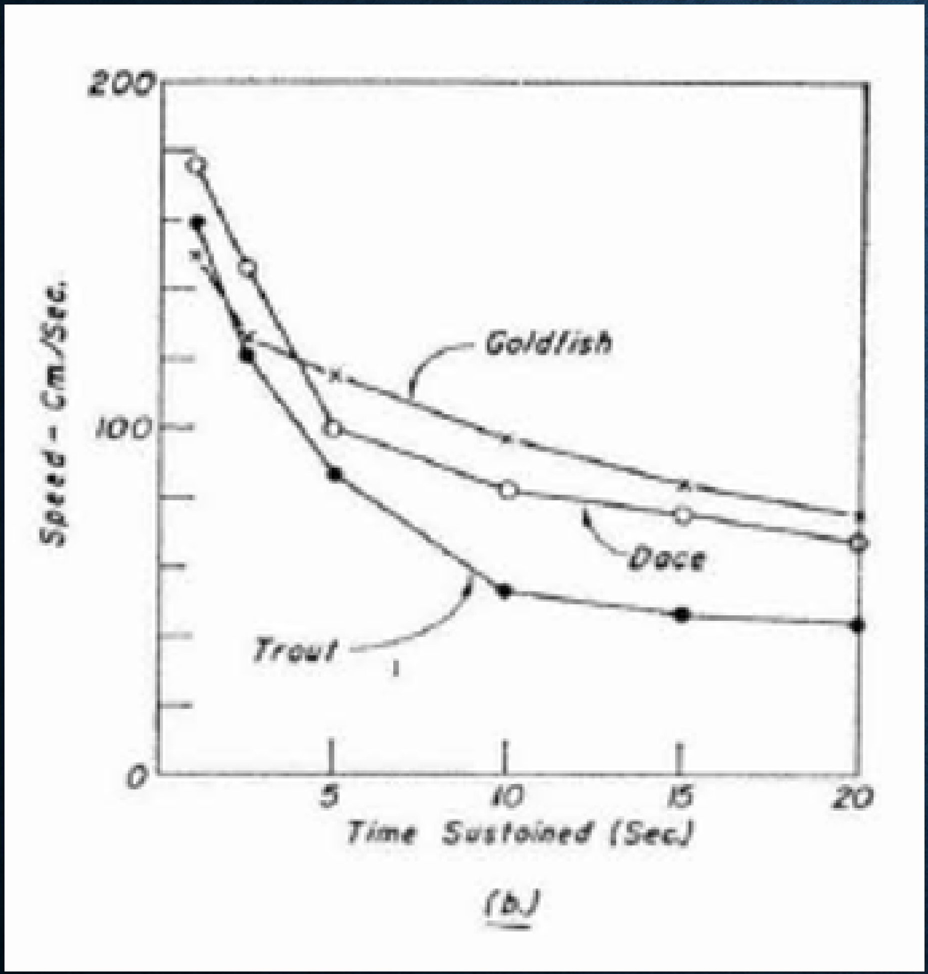
A Bit of Screening History

Brett et. al (1958) define the cruising speed for sockeye and Coho salmon as determined in their experiments as *“ the swimming speed which fish can maintain consistently for a minimum period of one hour under strong stimulus without gross variation in performance.”*



66 Days
Swim-up Fry

A Bit of Screening History



Bainbridge suggests a general relationship of

four times (4x) the fish's length per second for the speed that can be maintained.

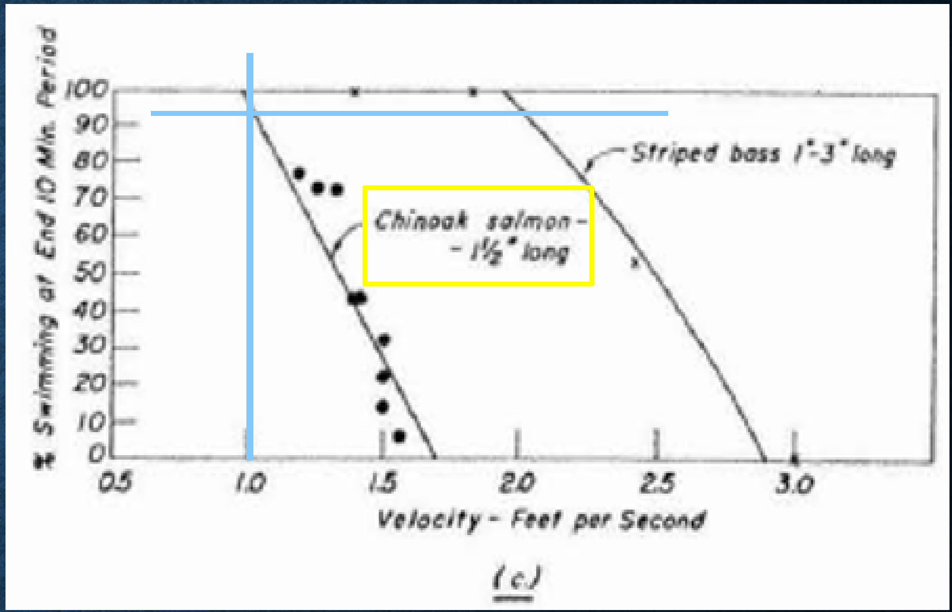
This works out to be only 0.33 ft/sec for the 1-inch long fry.

BUT notice this is with Goldfish, Dace and Trout

A Bit of Screening History

Graphs from his studies indicate that at 0.5 ft/sec 100% of the fry this size could swim for 10 min.

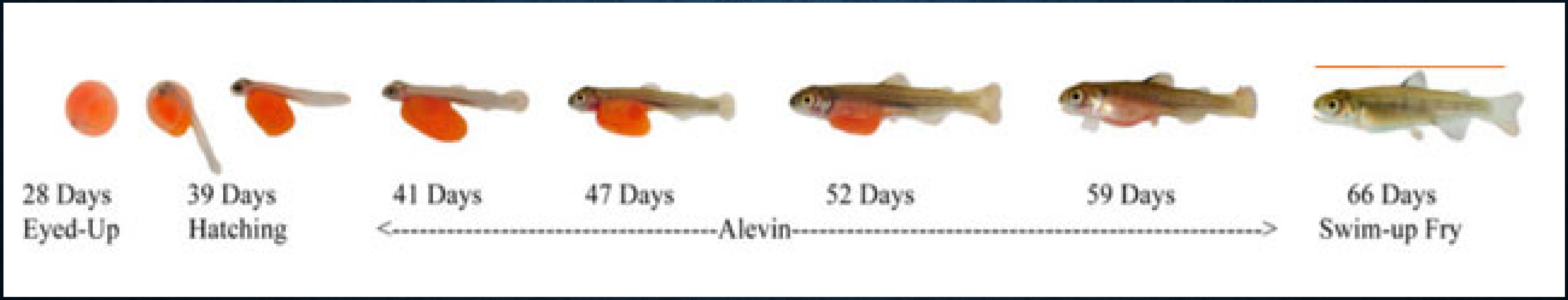
It was concluded that the optimum velocity for salmon of the sizes tested was approximately 1 ft./sec., and that even though the salmon might be impinged on screens for short periods of time, they will still survive upon release.



Because there is usually a lack of complete uniformity in the velocity of the water approaching a screen, and variations in temperature are also possible, it is considered desirable to allow a further safety factor in the overall design and an approach velocity of **0.4 ft/sec (12 cm/s) is** recommended for screens that are properly maintained in a clean condition.

A BIT OF SCREENING CRITERIA HISTORY

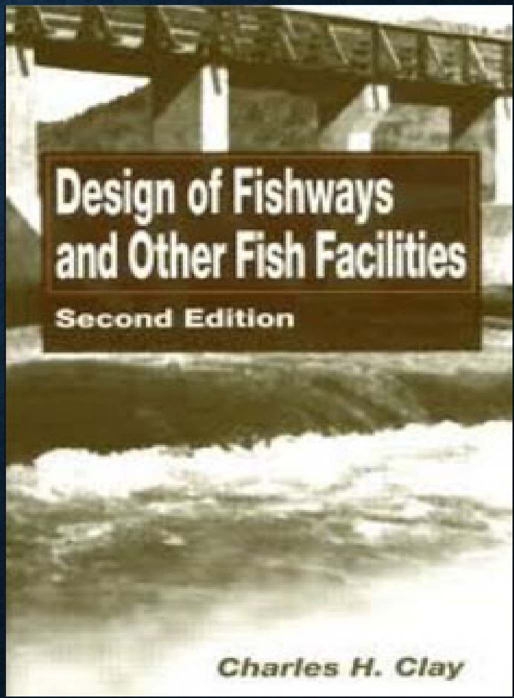
It has been found that as velocities of approach to the screens increase above 0.4 ft/sec, the smallest salmon fry rapidly become exhausted and are swept against the screen and killed. (Clay 1995, pg 182)



CLAY 1995 – Providing a Bypass

"In other words, the screen is far enough from the river that it is unlikely fish migrating downstream and entering the approach channel would return back up the channel to the river after reaching the screen.

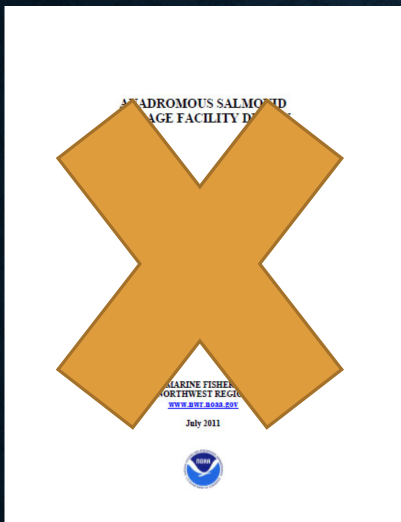
It is therefore necessary to provide a bypass so that they might continue their journey downstream." (Clay 1995, pg 180)

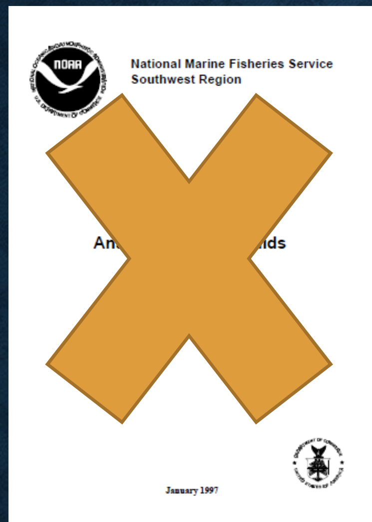


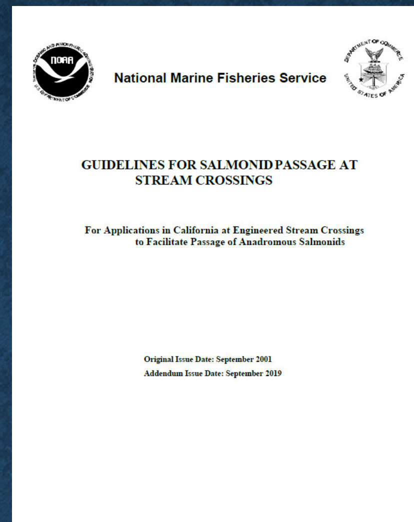
Emerging Technologies

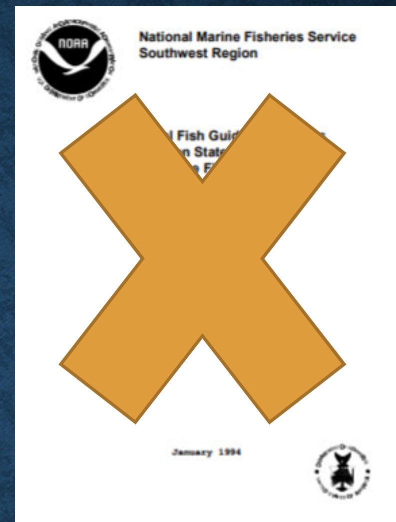
Table of Appendices in UPDATED GUIDELINES

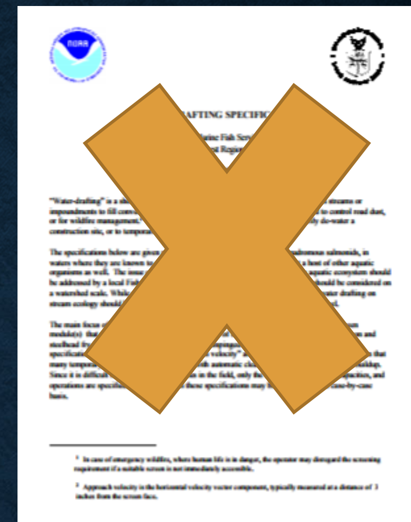
Appendix A	Near-Field Hydraulics that Affect Salmonid Passage in Tide Gates
Appendix B	Infiltration Galleries
Appendix C	Experimental Technologies
Appendix D	Surface Collection
Appendix E	Performing Hydraulic Evaluations
Appendix F	Juvenile Fish Collection and Evaluation Facilities
Appendix G	Columbia and Snake River Fish Passage Facilities
Appendix H	Sizing Fish Ladder Pools Based on Energy Dissipation and Fish Run Size
Appendix I	Upstream Juvenile Fish Passage











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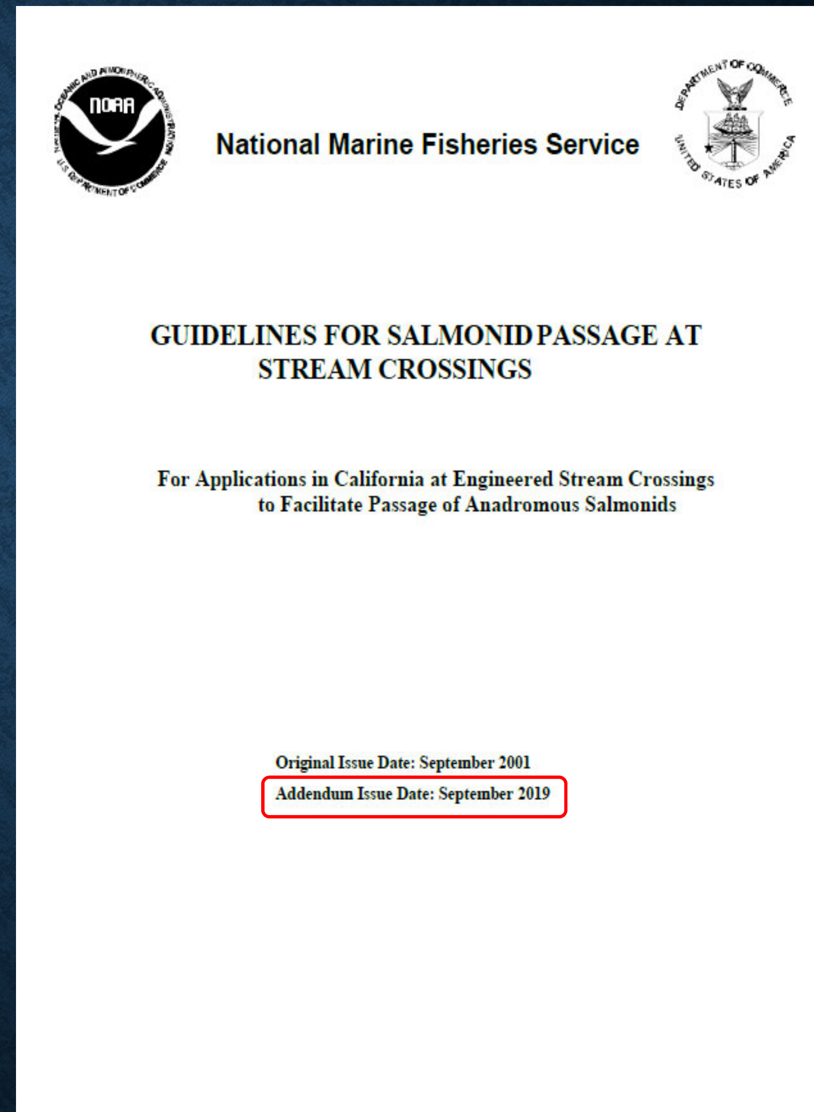
Updated in 2019

a) Maximum hydraulic drop for juvenile salmonids is increased from 6” to 12” as a general guideline

b) The high fish passage design flow for all hydraulic designs should be 50% of the 2-year event (where less than 20-years of gauge data exist) or the 1% exceedance flow during the migration season (where 20+ years of gauge data exist).



National Marine Fisheries Service

GUIDELINES FOR SALMONID PASSAGE AT STREAM CROSSINGS

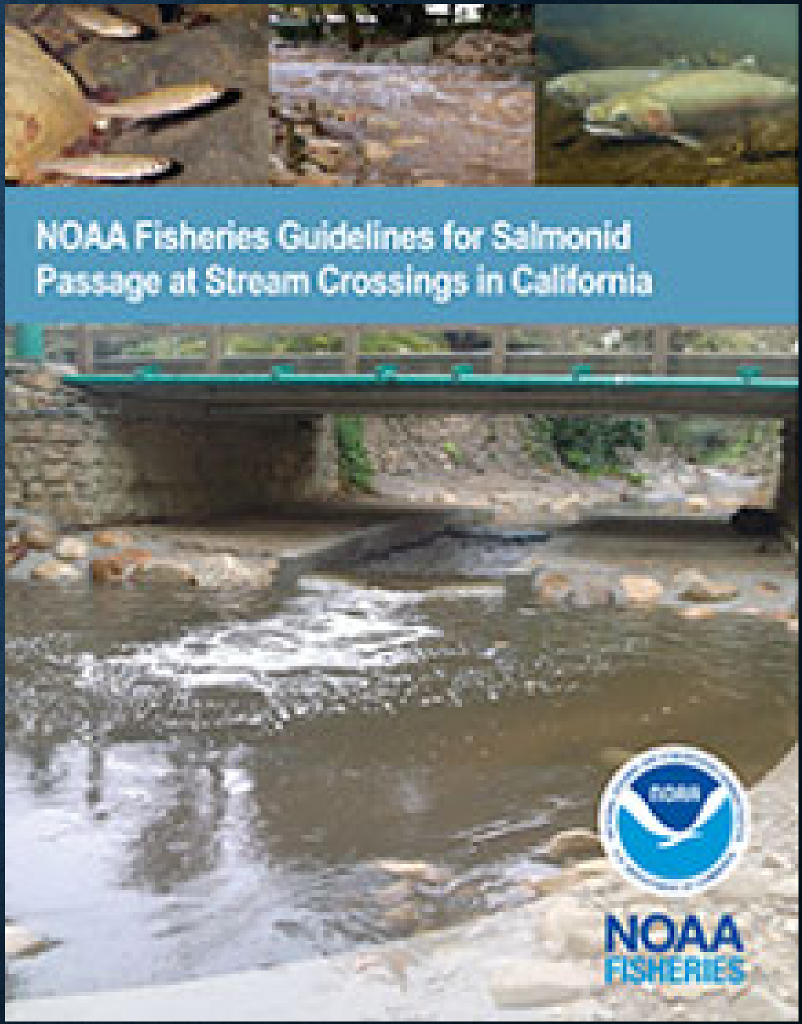
For Applications in California at Engineered Stream Crossings to Facilitate Passage of Anadromous Salmonids

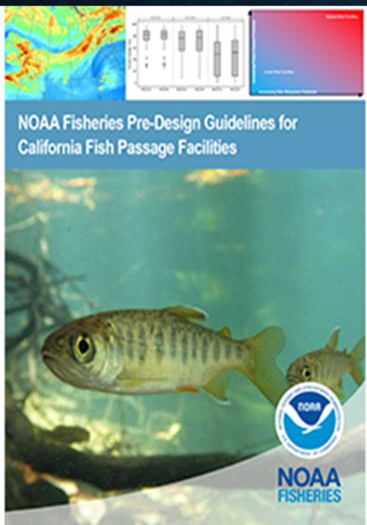
Original Issue Date: September 2001

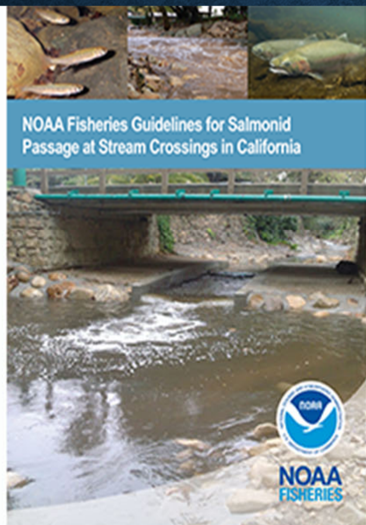
Addendum Issue Date: September 2019

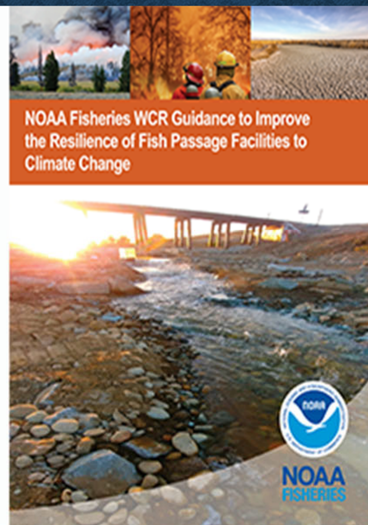
Updated in 2023

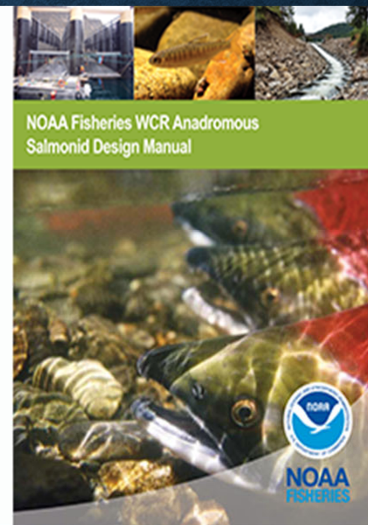
- Added Title Page and Flow Chart
- Section 3. Added citations for Stream Simulation Design (Forest Service Stream-Simulation Working Group, 2008;Barnard et al., 2013)
- Section 3. Revised two design suggestions;
  - 1) the minimum crossing span is changed from equal to or greater than the bankfull channel width to 1.5 times the bankfull channel width, and
  - 2) the slope of the reconstructed streambed within the crossing should maintain an average slope of 1.0 to 1.25 times the natural average slope of the adjacent upstream and downstream reaches.

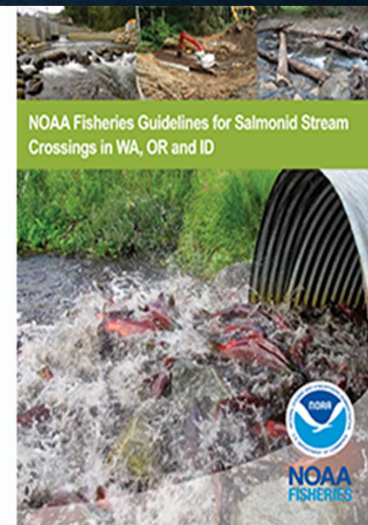












Pre-Design Guidelines for California Fish Passage Facilities (New)
Guidelines for Salmonid Passage at Stream Crossings in California (Updated)
Guidance to Improve the Resilience of Fish Passage Facilities to Climate Change (New)
Anadromous Salmonid Passage Design Manual (Updated from the NW 2011 and the SW 1997)
Guidelines for Salmonid Passage at Stream Crossings in OR, WA, and ID (New)

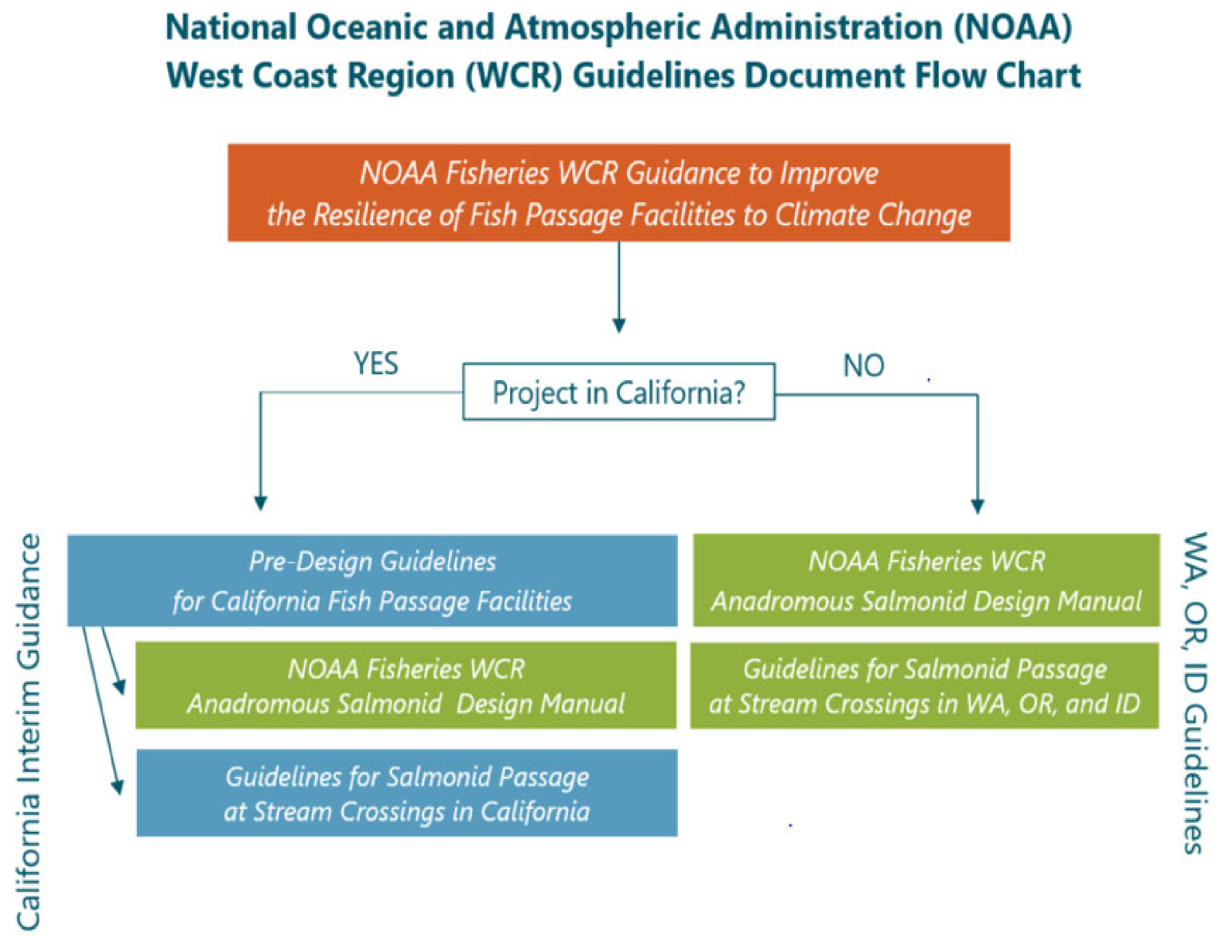


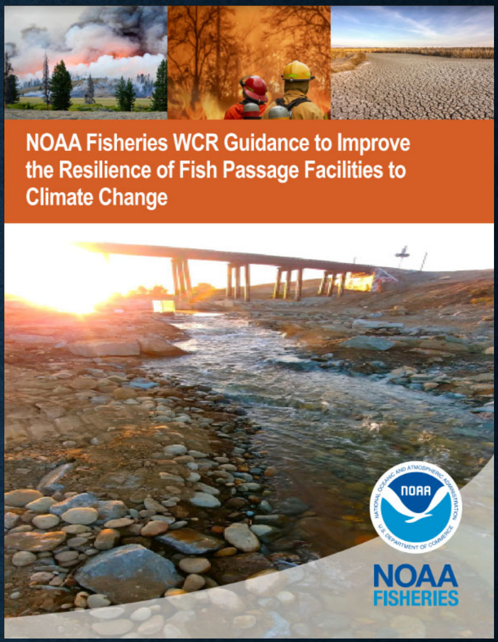
Figure 1. Flow chart of NMFS guidelines documents applicable for the West Coast Region.

1. Meet considerations in the NMFS Protected Resource Division's Guidance for Treatment of Climate Change in NMFS Endangered Species Act Decisions (NMFS 2016).

2. Address the effects of climate change on fish passage designs
   i. Peak Flows are getting larger and low flows are getting lower.

3. Provide biologists and project proponents tools to incorporate the change in climate

4. Reduce risk and uncertainty associated with the facility to help ensure the safe, timely and effective passage of fish over the life of the design



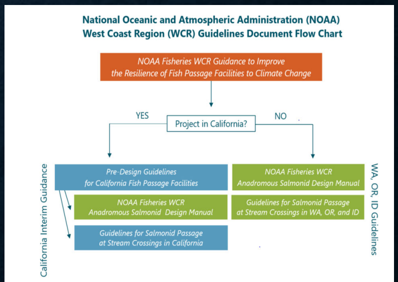
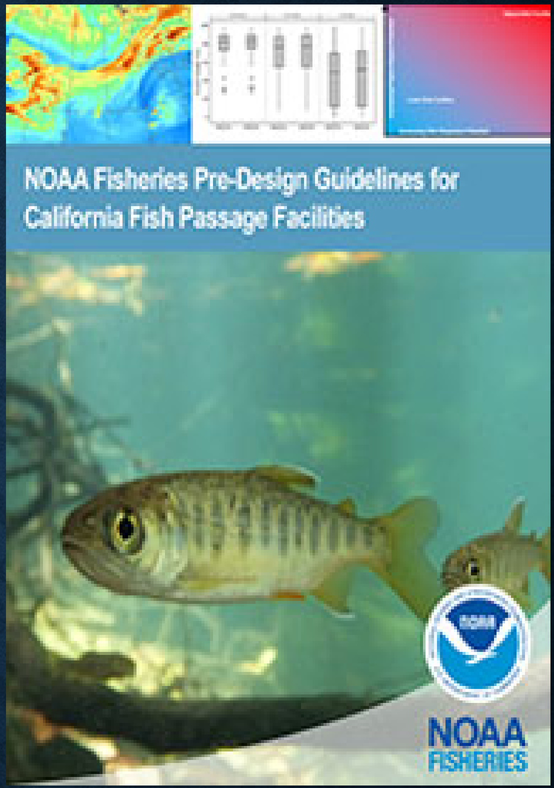


Figure 1. Flow chart of NMFS guidelines documents applicable for the West Coast Region.

The CA *Pre-Design Guidelines*

- ✔ Did you seek NMFS' technical assistance regarding the following key design development topics?
- ✔ Does the project account for basic migration and habitat needs?
- ✔ Does the project identify and account for the watershed's historical, existing, and future limiting conditions at all the spatial and temporal scales that they can exist?
- ✔ Does the project account for how the watershed's hydrologic regime, sediment regime, and water uses continuously interact over different spatial and temporal scales to create historical and anthropogenic limiting conditions and how the proposed project could change the watershed's physical processes and limiting conditions?
- ✔ What are the project goals and objectives?
- ✔ What design alternatives were considered?
- ✔ How were the design alternatives compared?
- ✔ How was the preferred alternative selected?
- ✔ Was a project basis of design report developed that includes:
- ✔ Based on the guidance provided in this document, does your project's basis of design report answer all of the questions NMFS is likely to have regarding your project?



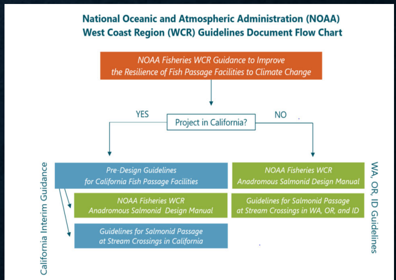
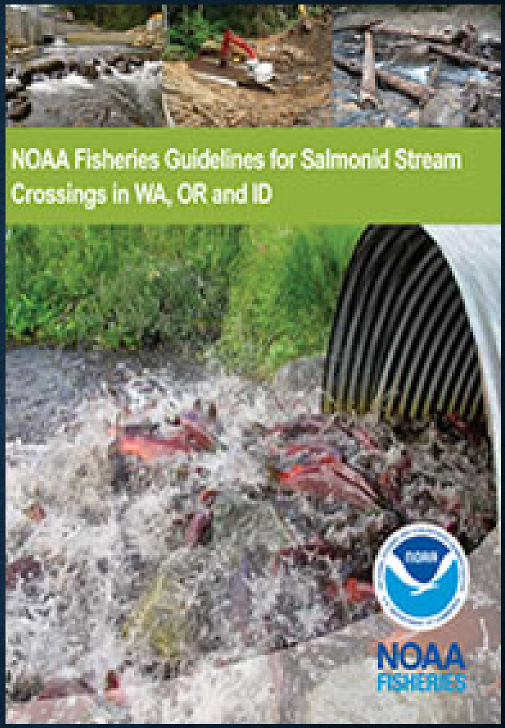


Figure 1. Flow chart of NMFS guidelines documents applicable for the West Coast Region.

OR/WA/ID Stream Crossings

The criteria and guidelines in this document is for the design of stream crossings that provide upstream and downstream movement for all life stages of anadromous salmonids present at a site. These criteria and guidelines apply to bridges, culverts, and fords. For the purpose of fish passage, the distinction between a bridge, culvert, and low water crossing (also referred to as a ford) is less important than the effect the structure has on the form and function of the stream.

In addition to providing fish passage, any stream crossing design should maintain the ecological function of the stream, pass woody debris, pass flood flows and sediment, analyze the scour potential, and account for other species present at the site. The design team should collaborate with biologists and engineers familiar with the site to assess potential effects on species and life stages present and site geomorphology.



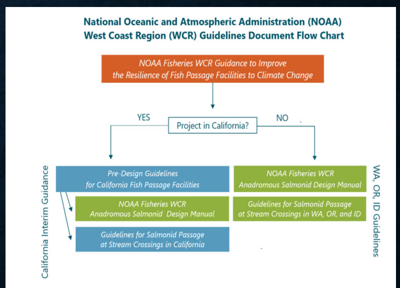


Figure 1. Flow chart of NMFS guidelines documents applicable for the West Coast Region.

NOAA Fisheries Internet Website

West Coast Fish Passage Guidelines

NOAA Fisheries developed this guidance to communicate the importance of considering climate, hydrologic, geomorphic and biologic processes before designing fish passage facilities.

West Coast

Table of Contents

Guidelines Documents

- Guidance to Improve the Resilience of Fish Passage Facilities to Climate Change

California Guidelines

- Pre-Design Guidelines for California Fish Passage Facilities

California Interim Guidance

- Anadromous Salmonid Design Manual
- Guidelines for Salmonid Passage Stream Crossings in California

Washington, Oregon and Idaho Guidelines

- Anadromous Salmonid Design Manual
- Guidelines for Salmonid Passage at Stream Crossings in WA, OR, and ID

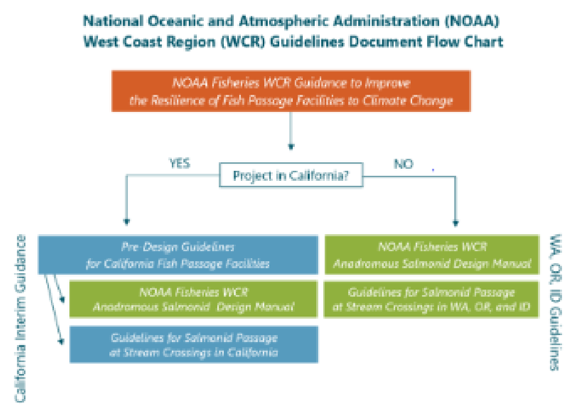


Figure 1. Flow chart of NMFS guidelines documents applicable for the West Coast Region.

QUESTIONS?

Thank you