United States Department of Agriculture

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

AQUATIC ORGANISM PASSAGE

CODE 396

(mi)

DEFINITION

Modification or removal of barriers that restrict or impede movement of aquatic organisms.

PURPOSE

This practice is used to accomplish the following purpose:

- Provide access to habitat by improving or providing passage for aquatic organisms

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all aquatic habitats where barriers impede passage of aquatic organisms. Barriers could include physical barriers, temperature or water quality/quantity, velocity, or turbulence.

CRITERIA

General Criteria Applicable to All Purposes

Planning and evaluation

Evaluate the existing channel stability and geometry when determining the type of structure to be installed.

Evaluate sites for variations in stage and discharge, tidal influence, hydraulics, geomorphic impacts, sediment transport and continuity, and organic debris movement. Design passage structures to account for the known range of variation resulting from this evaluation.

Mitigate undesirable channel profile shifts resulting from the modification or removal of a passage barrier. Examples of channel plan or profile shifts could include head cuts resulting from barrier removal or silt accumulation above existing barriers depositing downstream. Analyze the removal of obstructions using appropriate stream and geomorphic procedures.

Plan and locate passage for compatibility with local site conditions and stream geomorphology, to the extent possible.

Evaluate existing roads that have created barriers to determine whether it is appropriate to replace or to remove existing stream crossings. Road realignment to avoid stream crossings must be included in this evaluation.

Evaluate the effects of planned works on public safety and flooding.

Barrier removal, upgrades, or retrofitting can significantly affect wetlands, flooding potential, existing infrastructure, and social and cultural practices and resources. Evaluate and address the full range of impacts when planning or designing projects.

If passage was not historically present, an evaluation must be conducted to document that native species above the barrier will not be negatively impacted.

Design requirements
Design passage to accommodate present and reasonably anticipated changes in watershed conditions.

Evaluate the type and size of woody material, sediment, and debris upstream of the structure and how the passage structure will allow it to pass downstream.

When available, design passage structures according to known size, shape, swimming, and leaping capabilities of target species or a similar species with comparable swimming abilities to accommodate the movement and migration requirements throughout their life cycle.

Document how designs satisfy the physiological requirements of target organisms.

When aquatic species movement criteria are unknown, use stream simulation design solutions to mimic channel geometry and morphology.

At a minimum, design and evaluate passage structures for hydraulic performance and structural integrity at the bankfull and 25-year peak.

If using the hydraulic design method, determine the high and low fish passage design flows, water velocity, and water depth.

For structural design elements such as side slope requirements, stream approaches, load capacity, etc., reference requirements outlined in the NRCS National Engineering Manual (NEM) (Title 210), Part 536, “Structural Engineering,” the NRCS National Engineering Handbook (NEH) (Title 210), Part 654, “Stream Restoration Design,” and appropriate engineering practice standards.

Use trashracks only if required or necessary. Ensure that trashracks are either self-cleaning or easily maintained.

Select construction materials that are nontoxic and resistant to degradation.

Prior to construction, develop a written plan to address bypass flows during construction that contains guidance on pumping or rerouting of flows, aquatic species removal, pollution control, and project scheduling. The plan can be developed by NRCS and the contractor or by an outside party, but it must meet all NRCS and permit requirements.

Plan construction logistics, methods, and sequencing to minimize adverse effects to aquatic organisms, riparian areas, and instream habitat.

Take measures to prevent invasive species introductions during construction activities, including inspecting all vehicles prior to entering the site.

Use weed-free certified mulch when revegetating disturbed areas.

Additional Criteria Applicable to Stream Crossings
In streams with anadromous salmonid species, designs for bridges, bottomless arches, and culverts must have a streambed width and channel slope that is determined according to the National Marine Fisheries Service (NMFS) publication “Anadromous Salmonid Passage Facility Design.” Non-anadromous streams and streams with resident species should, at a minimum, meet guidelines identified by State agencies responsible for fish resources.

If ice jams or woody debris passage are a concern, increase the span and/or allow for extra clearance between the channel bottom and bridge low chord or top of culvert.

Additional Criteria Applicable to Fish Ladders

Conduct an assessment of structural integrity and stability when passage structures are to be integrated with an existing structure.

Avoid locating fishway entrances and exits in areas that will obstruct function, increase harassment or predation, or result in excessive operation and maintenance requirements.

Allow sufficient space between fishways exits and spillways, intakes, or other hydraulic structures to not harm target species.

Provide adequate attraction flow into a passage facility across the full range of discharge during which target species will move. See guidance in NRCS 210-NEH-654, Technical Supplement 14N, “Fish Passage and Screen Design.”

Additional Criteria Applicable to Instream Channel Bed Modifications and Nature-like Fishways

New streambed materials should be comprised of materials of similar composition (size, shape, and distribution) to natural streambed materials that form the natural stream channels. There should be a minimum of 5 percent to a maximum of 10 percent fines in the new streambed materials to prevent a porous bed.

Designs for road abandonment and culvert removal must include a new channel segment through the existing road fill prism that meets or exceeds the requirements for streambed width and channel slope to provide passage for aquatic organisms based on the stream simulation design method. See NRCS Conservation Practice Standard (CPS) Open Channel (Code 582) and Channel Bed Stabilization (Code 584).

Additional Criteria Applicable to Fish Screens

Screens implemented under this practice are for the purpose of protecting species movement within the natural stream channel and will prevent species from accessing irrigation canals, farm fields, or other nonaquatic environments.

Locate screens based on minimizing the delay of fish encountering the diversion.

Ice and debris loads must be considered when designing screen structures.

Target species size and swim capabilities will determine screen mesh size requirements. Many species can be protected utilizing NMFS juvenile salmonids requirements (Nordlund, 2008); however, locations with non-salmonid species should also use local State guidelines. See guidance in NRCS 210-NEH-654, Technical Supplement 14N, “Fish Passage and Screen Design.”

CONSIDERATIONS

Develop or adopt a quantitative method to identify and evaluate passage barriers (see “References”).

Remove passage barriers rather than installing or retrofitting a new facility or structure. Complete or partial barrier removal often provides better passage conditions and is more economical than designing, constructing, operating, and maintaining many new passage structures.

Bridges, culverts, or bottomless arches designed using the stream simulation approach (USDA Forest Service, 2008) that incorporate natural streambed substrates throughout their length are preferred over other culvert configurations for passage purposes.

Bridges are the preferred structure type when the bankfull width is greater than 20 feet. Bankfull widths less than 20 feet may use a bridge, bottomless arch, or embedded culvert.

Design and locate features to improve or provide passage for as many different aquatic and semi-aquatic species and age classes as possible.

Retain as much riparian and streambank vegetation as possible during project access and construction activities to maintain shade, riparian continuity, and sources of nutrient and structural inputs for aquatic ecosystems.

Restore temporary construction areas using native vegetation appropriate to the site and consider opportunities to enhance wildlife and pollinator habitat.

Where appropriate, remove access roads or trails and restore native vegetation representative of the site.

Replacing or removing an existing instream structure may trigger channel adjustments (e.g., aggradation and/or degradation) upstream and/or downstream of the work site. Restore natural stream grade at the site if possible and when appropriate, constructed riffle/roughened channel design solutions are preferred over channel spanning grade control structures. To mitigate adverse physical or ecological consequences of existing structure removal see NRCS CPSs Channel Bed Stabilization (Code 584) and Grade Stabilization Structure (Code 410).

Analyze any potentially negative interactions (including hybridization, disease, competition, or predation) between target and aquatic nuisance species when passage is provided above a barrier. If serious consequences are likely, take steps to minimize adverse effects.

Incorporate the habitat requirements of other aquatic, semi-aquatic, or terrestrial species that may be affected by a passage project. Some passage facilities may improve survival for terrestrial vertebrates by providing safe migration routes under roadways by providing a bankfull or floodplain bench through the structure or through the use of additional floodplain relief culverts.

Assess the amount of habitat upstream and downstream of a barrier to evaluate for project feasibility, cost effectiveness, and/or potential for connecting fragmented habitats. Using a watershed approach whenever possible provides a framework for project planning.

Fish passage facilities are often associated with water diversions or intakes that may injure or kill aquatic species. Prevent fish entrainment or impingement, particularly of juveniles, into diversions, penstocks, or pumps by installing screens.

Passage projects can affect water management practices such as diversion, power generation, or storage. Strive to balance aquatic organism passage with other water management objectives.

Consider upstream and larger watershed issues that may affect passage. Common solutions may include maintaining or restoring adequate instream flow and/or other water quality parameters (e.g., temperature, dissolved oxygen).

Floodplain and water development often alter historic river channel pattern and location. Consider bypassing a barrier by restoring streamflow to former, stable natural channels.

Passage facilities can assist population recovery and management. Consider local, State, or Federal brood stock collection and management of nonnative species when planning passage features.

Consider using self-regulating tidegates in marine environments. These structures can be adjusted to automatically regulate saltwater intrusion into estuaries and often improve estuarine functions and passage conditions.

Water quality impacts from vehicular pollutants and erosion caused by tire action can be severe. Where possible, reroute roadways or install hardened instream crossings (see NRCS CPS Stream Crossing (Code 578)). Also consider placing crushed aggregate at crossing approaches, running planks on the full width of timber bridges, design road ditch turnouts away from the stream, and construct waterbars to reduce direct input of sediment into the stream.

PLANS AND SPECIFICATIONS

Provide site-specific plans for this practice. Plans and design documents will specify passage structure design, layout, and overall goals and objectives, and include (at a minimum)—

- Location map and plan view of site, and description of design flows.
- Identification of the species of interest and specific passage requirements.
- A project map or description that includes known and/or potential upstream or downstream barriers affecting the project goals. This will include documentation of miles of access to the next passage barrier for reporting purposes as outlined in the NRCS National Biology Handbook (Title 190), Subpart D, Part 640.00, "Guidance for Assessing and Reporting Stream Miles Affected by Activities Completed Under Conservation Practice Standard 396, Fish Passage."
- Detailed construction drawings showing existing and planned site conditions including elevations, typical profiles, and cross sections of planned structures.
- Construction specifications describing materials, logistics (including erosion control), and timing.

OPERATION AND MAINTENANCE

Develop an operation and maintenance plan for all applications of this standard. Within the plan, provide for periodic inspection and corrective action should passage conditions become impaired because a structure is damaged or inoperable. At a minimum, operation and maintenance items should include—

- Guidance for post-construction evaluation and monitoring to assess structural integrity and compliance with design criteria.
- Specifying what entity is responsible for the daily operation and maintenance of a passage structure.
- Annual, seasonal, and/or daily operating activities necessary to ensure proper function of the structure.
- Checking passage structure at regular intervals to ensure it is operating within design criteria.
- Cleaning trashracks, fish screens, and debris collectors or removing debris accumulations regularly.
- Adjusting gates, orifices, valves, or other control devices as needed to regulate flow and maintain a passage structure within operating criteria.
- Periodically checking flow metering devices for accuracy.
- Annually inspecting passage structures for structural integrity and disrepair.
- Inspecting gate and valve seals for damage.
- Replacing worn or broken stoplogs, baffles, fins, or other structural components.

REFERENCES

Aquatic Nuisance Species Task Force. 2011. "Aquatic Nuisance Species." Accessed March 22, 2021. https://www.anstaskforce.gov/ans.php

Mefford, B. 2014. Pocket Guide to Screening Small Water Diversions. U.S. Bureau of Reclamation, Denver Technical Service Center. https://www.usbr.gov/tsc/techreferences/hydraulics_lab/pubs/manuals/Small%20Screen%20Design%20Manual%20USBR.pdf

National Marine Fisheries Service. 2011. Anadromous Salmonid Passage Facility Design. NMFS, Northwest Region, Portland, OR. https://www.fisheries.noaa.gov/resource/document/anadromous-salmonid-passage-facility-design

Nordlund, B. 2008. Designing Fish Screens for Fish Protection at Water Diversions. National Marine Fisheries Service. https://www.fishscreensoc.com/wp-content/uploads/2016/10/DESIGNING-FISH-SCREENS-2008.pdf

Turek, J., A. Haro, and B. Towler. 2016. Federal Interagency Nature-like Fishway Passage Design Guidelines for Atlantic Coast Diadromous Fishes. Interagency Technical Memorandum. https://www.fws.gov/northeast/fisheries/pdf/NMFS_2016_Federal_Interagency_NLF_Passage_Design_Guidelines.pdf

USDA Forest Service. 2006. Low-Water Crossings: Geomorphic, Biological, and Engineering Design Considerations. 0625 1808—SDTDC. San Dimas, CA. https://www.fs.fed.us/eng/pubs/pdf/LowWaterCrossings/LoWholeDoc.pdf

USDA Forest Service. 2008. Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings. 0877 1801—SDTDC. San Dimas, CA. https://www.fs.fed.us/eng/pubs/pdf/StreamSimulation/hi_res/%20FullDoc.pdf

USDA NRCS. 2008. National Engineering Handbook (Title 210), Part 654, Stream Restoration Design. Washington, D.C. https://directives.sc.egov.usda.gov/.

USDA NRCS. 2009. National Biology Handbook, Subpart B, Conservation Planning. Washington, D.C. https://directives.sc.egov.usda.gov/

USDA NRCS. 2010. National Engineering Manual (Title 210), Part 536, Structural Engineering. Washington, D.C. https://directives.sc.egov.usda.gov/.

USDA NRCS. 2012. National Engineering Handbook (Title 210), Part 630, Hydrology. Washington, D.C. https://directives.sc.egov.usda.gov/.

USDA NRCS. 2013. National Engineering Manual (Title 210), Part 531, Geology. Washington, D.C. https://directives.sc.egov.usda.gov/.

USDA NRCS. 2021. National Engineering Handbook (Title 210), Part 650, Chapter 16, Soil Bioengineering for Streambank and Shoreline Protection. Washington, D.C. https://directives.sc.egov.usda.gov/.

USDI Bureau of Reclamation. 2008. Fish Passage for Non-Salmonids. Western Water and Power Solution Bulletin. https://www.usbr.gov/research/projects/download_product.cfm?id=2180

U.S. Fish and Wildlife Service. 2017. Fish Passage Engineering Design Criteria. USFWS, Northeast Region R5, Hadley, Massachusetts. https://www.fws.gov/northeast/fisheries/pdf/USFWS_R5_2017_Fish_Passage_Engineering_Design_Criteria.pdf