Screens

ANS Control: Screens – Non-Mechanical and Mechanical, and Filters

Targeted Species: Screens are an effective control method for many types of organisms. Except for louvered screens and filters, the identified screens may be effective at controlling the fish and plant species identified as ANS of Concern – CAWS.[1] Louvered screens may be effective at controlling the fish species identified as ANS of Concern – CAWS. Filters may control all ANS of Concern – CAWS.

Selectivity: Depending on the type, screens will manage and/or control all organisms, and this Control is non-selective.

Fences such as this one along the Chicago Sanitary and Ship Canal are being used to prevent ANS from bypassing barriers during flood events.

Developer/Manufacturer/Researcher: There are many manufacturers of screens. The U.S. Army Corps of Engineers (USACE) uses a variety of screen types at dams, diversions, and intake structures.

Brief Description: A screen prevents the movement of ANS through an aquatic pathway while allowing water to continue to flow through the screen. The size and type of a screen depends upon the size of the target organism, the typical amount of debris in the waterway, and the water velocity. Screens fall into three general categories: non-mechanical screens, mechanical screens, and filters.

Non-Mechanical Screens – Non-mechanical screens consist of a variety of screen materials (e.g. woven cloth, perforated plate, or profile wire) mounted over an opening. The filtering capacity of the screen material is sized to prevent the target organism from passing through, but large enough to let water pass. Non-mechanical screens must be periodically cleaned of debris. There are several types of non-mechanical screens: fences, bar screens, trash racks, and curtains.

Mechanical Screens – Mechanical screens operate the same way as non-mechanical screens, but have an automatic cleaning mechanism to remove debris. Screens placed in a waterway are difficult to maintain in flowing environments because they intercept ice and debris, and clogged screens can cause debris jams and localized flooding. This is particularly problematic during floods when large amounts of debris naturally wash through waterways. Mechanical, self cleaning, screens reduce the need for continuous monitoring by operations and maintenance personnel. Several types of mechanical screens are available: chain bar screens, reciprocating rake bar screens, catenary bar screens, continuous belt bar screens, rotating drum screens (paddle wheel or power), wedge-wire cylinders, louvered screens, and mechanical climber screens (USACE 1994).

[1]For a complete list of the 39 specific ANS of Concern – CAWS, please see Table 1 of the main report.

Filters – A filter is a porous material through which a liquid is passed in order to separate particulate matter from the fluid. A variety of materials are used as filters including cloth, paper, porous porcelain, or a layer of charcoal, diatomaceous earth or sand. Most filters strain particulate matter, however, some remove material through adsorption.

Prior Applications: Screens are a common type of control technology used to prevent the movement of ANS (Hillyard et al 2010). Exclusion screens are used worldwide to prevent and restrict the movement of unwanted organisms or material between separated water bodies.

Non-Mechanical Screens – The most common measures employed to reduce turbine entrainment of fish consist of an angled bar trash rack with closely-spaced bars (approximately 2 cm) set at an angle to the intake flow path. Other types of fixed fish screens range from variations of conventional trash racks oriented perpendicular to flow, to more novel designs employing cylindrical, wedge-wire intake screens (Čada & Sale 1993).

Most recently, fences, a type of non-mechanical screen, have been installed to prevent the movement of adult Asian carp between the Des Plaines River and the Chicago Sanitary and Ship Canal (USACE January 2010, USACE 2012), and to divide Eagle Marsh in Indiana during flood events (USACE November 2010).

Mechanical Screens – Traveling screens are used in the gatewells of large hydroelectric projects to remove objects from the water (Čada & Sale 1993). Improved screen types are continuously being developed as new materials become available. Engineered polymer water screen technology is replacing steel in traveling screens at many hydropower facilities because it has strong impact resistance, lighter weight, and is easier to maintain than metal screens. The smooth surface of a polymer water screen is less likely to harm fish that come in contact with the screen.

Filters – Four types of filters are generally used in water treatment: slow sand filters, rapid sand filters, pressure filters, and diatomaceous earth filters. Slow sand filters are used for small groundwater systems; rapid sand filters are used for surface water treatment; pressure filters are used for iron and manganese removal in small groundwater systems; and diatomaceous earth filters are used in the food and beverage industry and for treatment of swimming pools.

General Effectiveness: Screen effectiveness is dependent on the size of the organism, and the mesh size, bar spacing, and type of filter membrane or medium. Screens are not as effective as other methods at preventing downstream movement of small organisms (e.g. fish eggs, larvae, diatoms, spores, seeds, or plant fragments). Filters are effective at removing small organisms, but are prone to clogging and require a high level of maintenance to remove solids accumulation, which reduce flow through the filter.

Operating Constraints: The optimal screen configuration depends on site conditions, desired flows, and the size of the target organism and typical debris material. Floods and ice jams should be considered in the design of a screening mechanism.

Filters would require continuous cleaning and maintenance. Filtration rates vary depending upon filter type. Filter operation is constrained by resistance through the filter membrane or medium, and filter fouling.

Cost Considerations: The costs of non-mechanical screens vary based on site-specific factors. Spacing, thickness, and screen type all have significant impacts on cost and design. As a general rule, clogging and fouling increases as the size of a screen opening decreases, increasing operation and maintenance costs.

Non-Mechanical Screens –

Implementation: Implementation costs of non-mechanical screens vary depending on the type of screen, the mesh size and material, site topography, and the amount of screen required for the project area. Planning and design activities in this phase may include research and development of this Control, modeling, site selection, site-specific regulatory approval, plans and specifications, and real estate acquisition. Design will also include analysis of this Control's impact to existing waterway uses including, but not limited to, flood risk management, natural resources, navigation, recreation, water users and dischargers, and required mitigation measures.

Operations and Maintenance: Maintenance costs include repairs, trash removal, and adjustments for changing conditions. Maintenance costs of non-mechanical screens are significantly less in upland areas, where the primary maintenance cost is cleaning the screens after flood events.

Mitigation: Design and cost for mitigation measures required to address impacts as a result of implementation of this Control cannot be determined at this time. Mitigation factors will be based on site-specific and project-specific requirements that will be addressed in subsequent, more detailed evaluations.

Mechanical Screens –

Implementation: Implementation costs of mechanical screens vary depending on the size of each screen, site topography, and total project area, as well as the complexity of the screening mechanism. Planning and design activities in this phase may include research and development of this Control, modeling, site selection, site-specific regulatory approval, plans and specifications, and real estate acquisition. Design will also include analysis of this Control's impact to existing waterway uses including, but not limited to, flood risk management, natural resources, navigation, recreation, water users and dischargers, and required mitigation measures.

Operations and Maintenance: Maintenance costs include repairs, trash removal, power and adjustments for changing conditions.

Mitigation: Design and cost for mitigation measures required to address impacts as a result of implementation of this Control cannot be determined at this time. Mitigation factors will be based on site-specific and project-specific requirements that will be addressed in subsequent, more detailed, evaluations.

Filters –

Implementation: Implementation costs would include the construction of a pipe system and filtration treatment facility. Construction of a facility and piping system would involve the facility, access, power, equipment, and associated construction costs.

Planning and design activities in the implementation phase may include research and development of this Control, modeling, site selection, site-specific regulatory approval, plans and specifications, and real estate acquisition. Design will also include analysis of this Control's impact to existing waterway uses including, but not limited to, flood risk management, natural resources, navigation, recreation, water users and dischargers, and required mitigation measures.

Operations and Maintenance: Maintenance costs include such costs as repairs, power, filter replacement, trash removal, and adjustments for changing conditions.

Mitigation: Design and cost for mitigation measures required to address impacts as a result of implementation of this Control cannot be determined at this time. Mitigation factors will be based on site-specific and project-specific requirements that will be addressed in subsequent, more detailed, evaluations.

Citations:

Čada, G.F. & M.J. Sale. 1993. Status of fish passage facilities at nonfederal hydropower projects, *Fisheries,* vol. 18(7), pp. 4-12. Accessed December 19, 2011. http://www.tandfonline.com/doi/pdf/-10.1577/15488446%281993%29018%3C0004%3ASOFPFA%3E2.0.CO%3B2

Hillyard, K.A., B.B. Smith, A.J. Conallin, & B.M. Gillanders. 2010. Optimising exclusion screens to control exotic carp in an Australian lowland river. *Marine & Freshwater Research*, vol. 61(4), pp. 418-429

McMichael, G.A., J.A. Vucelick, C.S. Abernethy, & D.A. Neitzel. 2004. Comparing fish screen performance to physical design criteria, *Fisheries,* vol. 29(7), pp. 10-16. Accessed December 19, 2011. http://dx.doi.org/10.1577/1548-8446(2004)29[10:CFSPTP]2.0.CO;2

U.S. Army Corps of Engineers. 1994. Mechanical and electrical design of pumping stations. Engineering Manual 1110-2-3105. Washington, D.C.

U.S. Army Corps of Engineers. November 2010. Great Lakes and Mississippi River Interbasin Study, Other Pathways Preliminary Risk Characterization. p. 76. U.S. Army Corps of Engineers, Great Lakes and Ohio River Division.

U.S. Army Corps of Engineers. January 2010. Dispersal Barrier Efficacy Study, Interim I – Dispersal Barrier Bypass Risk Reduction Study & Integrated Environmental Assessment. p. 54. U.S. Army Corps of Engineers, Chicago District.

U.S. Army Corps of Engineers. Des Plaines Bypass Barrier. Accessed April 3, 2012. http://www.lrc.usace.army.mil/AsianCarp/DesPlainesBypassFacts.pdf