A GUIDANCE MANUAL FOR FISH PROTECTION AT WATER DIVERSIONS

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As westward migration occurred in the United States, aquatic habitats were altered, particularly as a result of water diversions. The decline in fish and wildlife species in general can be traced to the pressures that an expanding population put on the environment including fish and wildlife habitat. When species decline beyond natural expected changes in population sizes, something is wrong with the system. These specie declines are an indication of environmental degradation that can potentially affect human health and well-being. Solutions lie in applying the best scientific knowledge to maintain species in a viable ecosystem. There are many issues that place societal development in direct conflict with conservation of natural habitat. This has certainly been true in the case of water resource development and our natural environment. However, water resource development and management does not have to be an "either-or situation." The two interests of development and conservation can work effectively together.

Fish protection and recovery programs set up to actually allow water development to proceed while protecting or recovering the endangered fish are not without controversy or problems. However, many water resource managers see the recovery programs as the best way to avoid conflict between laws enacted by Congress to protect and preserve listed species and the use of the water resource to meet society's needs and to enhance the quality of people's lives. They feel the alternative of endless litigation is not in the public interest.

Solutions to fish protection problems come from alternatives developed by working with stakeholders and state and federal fisheries regulatory agencies that have diverging issues and concerns. The development of alternatives is an iterative process involving the best available science and public input where the most acceptable plan is identified after comparing and selecting from alternatives. The effort involves an interdisciplinary team representing a wide range of expertise and interests including some or all of the following: the owner/user of the existing facility where protection is needed as well as the disciplines of; fishery resource and regulatory agencies, economics, design, research, biology, recreation, hydrology, hydraulics, engineering and sociology.

The fishery resource agencies have established fishery resource management policies that strongly influence the selection of fish protection objectives. The resource agencies can also be expected to take a regulatory role in which they identify fishery protection needs and review and approve proposed designs. Often agencies have established design criteria and design guidelines that will directly affect and guide the fish exclusion design effort.

Various sitting alternatives are presented. They include: In-canal, In-river, In-diversion pool, and Closed conduit. Designs for fish exclusion facilities are typically developed and sized based on the maximum possible diversion discharge (the diversion water right). In some cases the water right is in terms of volume instead of flow. Diversions are typically

made based on demand, therefore diversion discharges are commonly smaller than the maximum or design discharge.

Additional guidelines are presented such as debris and sedimentation control, fish predation, and operation and maintenance. Positive barrier screens comprise a wide range of fish screen concepts. Although the screens vary widely in concept and configuration, they have numerous common characteristics. In all cases, the screen systems provide a "positive barrier" to passage of fish. The screens are typically designed to effectively screen both debris and fish from the diverted flow and to quickly and safely guide fish back to the natural water body from which they were drawn. In all cases, cleaning and maintenance requirements are important considerations since debris fouling of the screens reduces both the screens ability to safely exclude fish and reduce the flow capacities of the screens.

Fishery resource agencies have developed published screen criteria for juvenile salmon that are included in the appendix of the new manual. These criteria contain many items that need to be addressed in the design. They can be summarized in five major areas as: 1.Hydraulic considerations associated with the approach and sweeping velocities at the screen face, 2. Screen materials such as profile bar, perforated plate, and woven wire and limiting their effective opening, 3.Structural features to assure uninhibited guidance to the fish bypass, 4.Fish bypass structure with proper layout, entrance, conduit and outfall design, and 5.Operation and maintenance to assure long-term screen performance with proper debris and sedimentation control.

Fish can be guided by various stimuli in an effort to protect them from diversion intakes and guide them through fish facilities. Some of these are natural such as: ambient light and shadows, flow velocity, depth, channel shapes and temperature. Others, such as, bubbles, electrical, turbulence and sound are caused by artificial means. Where possible, bioengineering using these behavioral techniques can provide fish protection by excluding fish from intakes.

Behavioral barriers, in general, do not meet fishery resource agency criteria and therefore are not considered positive fish barriers.

Several examples are presented in the manual that present the planning and design steps needed to assure an effective fish protection facility design.

There is need for an application-based manual to assist water resource and fishery related professionals in the planning and design of fish protection facilities, more specifically, fish exclusion screens at water diversions

Keywords: fish protection, fish screens, fish screen design, water diversion, regulatory responsibilities, fishery criteria