

RECLAMATION

Managing Water in the West

Water Resources Technical Publication

Fish Protection at Water Diversions

A Guide for Planning and Designing Fish Exclusion Facilities



**U.S. Department of the Interior
Bureau of Reclamation
Denver, Colorado**

April 2006

Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Water Resources Technical Publication

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**U.S. Department of the Interior
Bureau of Reclamation
Denver, Colorado**

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This manual is dedicated to the memory of Perry Johnson, who passed away December 23, 2005, after a short illness.

Acronyms/Abbreviations

BA	Biological Assessment
BLM	Bureau of Land Management
Corps	U.S. Army Corps of Engineers
DO	dissolved oxygen
EA	Environmental Assessment
EDF	Energy Dissipation Factor
ESA	Endangered Species Act
EIS	Environmental Impact Statement
EPRI	Electric Power Research Institute
FERC	Federal Energy Regulatory Commission
FONSI	Finding of No Significant Impact
FS	U.S. Forest Service
FWCA	Fish and Wildlife Coordination Act
GCID	Glenn-Colusa Irrigation District
HDPE	High Density Polyethylene
Interior	U.S. Department of the Interior
ITA	Indian Trust Assets
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA Fisheries	National Ocean and Atmospheric Administration Department of Fisheries
NPPC	Northwest Power Planning Council
NPCC	Northwest Power and Conservation Council
O&M	operation and maintenance

P.L.	Public Law
PVC	Polyvinyl Chloride
Secretary	Secretary of the Interior
Service	U.S. Fish and Wildlife Service
Reclamation	Bureau of Reclamation
USCS	U.S. Code of Standards
UHMW	ultra high molecular weight

Table of Contents

Page

Chapter I.	Preface	I-1
Chapter II.	Fish Protection	II-1
A.	The Need for Fish Protection	II-1
1.	Responsible Resource Management	II-2
2.	Fish Protection Legislation	II-6
B.	Development Process	II-13
1.	Regulatory Responsibilities	II-14
2.	Planning Checklist	II-16
Chapter III.	Overview of Fish Exclusion	III-1
A.	Design Guidelines	III-1
1.	Identifying Characteristics of the Target Fish Species	III-1
2.	Establishing Fish Protection Objectives	III-2
3.	Siting Options	III-6
a.	In-canal	III-7
b.	In-river	III-8
c.	In-diversion pool	III-10
d.	Closed conduit	III-12
4.	Design Discharge	III-14
5.	Debris and Sediment Loading	III-15
6.	Fish Predation	III-15
7.	Operation and Maintenance Requirements	III-16
8.	Capital Cost	III-18
B.	Fish Exclusion Alternatives	III-18
1.	Positive Barrier Screens	III-19
a.	Flat plate screens	III-20
b.	Drum screens	III-22
c.	Traveling screens	III-25
d.	Submerged screens	III-28
Cylindrical screens	III-29	
Inclined screens	III-34	
Horizontal flat plate screens	III-38	
e.	Coanda screens	III-40
f.	Closed conduit (Eicher and MIS) screens	III-43

Table of Contents—continued

	<i>Page</i>
2. Behavioral Barriers	III-47
a. Louvers	III-47
b. Light and sound behavioral devices	III-49
c. Other behavioral barriers (air bubble curtains, hanging chains, water jet curtains, electric fields)	III-53
C. Design Process	III-54
1. Design Process	III-55
2. Decision Chart	III-57
3. Design Data	III-61
4. Design Criteria and Elements	III-70
Chapter IV. Positive Barrier Screens	IV-1
A. Facility Design	IV-2
1. Site Selection	IV-2
a. In-canal siting	IV-3
b. In-river siting	IV-6
c. In-diversion pool siting	IV-12
d. In-closed conduit siting	IV-17
2. Site Isolation and Dewatering for Construction	IV-20
a. In-canal	IV-20
b. In-river and in-diversion pool	IV-21
3. Foundation Design	IV-22
4. Location of Screen Structures	IV-23
a. In-canal	IV-25
b. In-river	IV-25
c. In-diversion pool	IV-26
d. In-closed conduit	IV-26
5. Screen Hydraulics	IV-26
a. Sizing screen area	IV-26
b. Screen approach velocity	IV-28
c. Sweeping velocities	IV-29
d. Sweeping/approach velocity ratio	IV-29
6. Uniform Flow Distribution on Screen Surface	IV-30
a. Criteria	IV-31
b. Methods of generating uniform distributions	IV-32
Flow field geometry	IV-32
Baffling	IV-35
Variable porosity	IV-36
Uniform high resistance	IV-39
c. Other downstream controls	IV-39
d. Maintenance/operations considerations	IV-40

Table of Contents—continued

	<i>Page</i>
7. Design flow	IV-41
8. Head Loss Estimates	IV-41
a. Head loss through trashracks	IV-41
b. Head loss through screen	IV-43
Woven wire screen	IV-44
Perforated plate	IV-45
Profile bar	IV-47
c. Head loss through baffles	IV-50
d. Head loss through bypass	IV-52
9. Hydraulic Laboratory Model Studies	IV-53
10. Screen Design	IV-53
a. Screen material and fabric	IV-53
b. Screen connectors, seals, support backing	IV-57
11. Fish Bypass System	IV-58
a. Bypass entrance	IV-60
Bypass entrance placement	IV-60
Intermediate bypass entrances/ duration of screen exposure	IV-62
Changes in ambient light	IV-63
Sizing bypass entrances	IV-63
Bypass entrance velocities	IV-63
b. Bypass conduit	IV-66
Bypass down wells	IV-68
Non-gravity driven bypass	IV-69
Bypass bends	IV-70
Valves and gates in bypass	IV-70
c. Bypass outfall	IV-70
d. Bypass supplemental features	IV-73
e. Secondary screening	IV-74
12. Cleaning and Maintenance	IV-76
a. Fish screens	IV-76
b. Trashracks	IV-77
c. Backup power	IV-79
d. Maintenance	IV-79
13. Gantry/Lifting Equipment	IV-80
14. Sediment Management	IV-81
15. Predation Control	IV-84
a. Locations of predation	IV-84
b. Alternatives to reduce and control predation	IV-85
16. Fish Behavioral Influences	IV-87
a. Habitat	IV-87
b. Turbulence	IV-89

Table of Contents—continued

	<i>Page</i>
c. Lighting	IV-89
d. Diurnal effects	IV-90
e. Sound	IV-90
17. Summary Table	IV-91
B. Screen Specific Design Details	IV-93
1. Flat Plate Screens	IV-93
2. Drum Screens	IV-104
3. Traveling Screens	IV-111
4. Submerged Screens	IV-119
a. Cylindrical screens	IV-119
b. Inclined screens	IV-128
c. Horizontal flat plate screens	IV-135
5. Coanda Screens	IV-142
6. Closed Conduit Eicher and MIS Screens	IV-155
Chapter V. Behavioral Barriers	V-1
A. Louver Design	V-1
B. Electrical Fields	V-16
C. Strobes and Lighting	V-17
D. Sound	V-21
Chapter VI. Fish Manual Case Studies	VI-1
A. Design Examples	VI-1
1. Example 1 – Flat Plate Screen in Canal – “V” configuration (Based on concept study for intake Canal)	VI-2
2. Example 2 – Flat Plate Screen in River (Based on Glenn Colusa Irrigation District)	VI-18
3. Example 3 – Drum Screen in Canal – Small Screen Facility (Based on Lemhi River Site L-6 by Reclamation’s Pacific Northwest Region)	VI-33
4. Example 4 – Louver in Canal (Based on T&Y Canal and Diversion)	VI-46
5. Example 5 – Cylindrical Screening Facility (Based on Columbia River Pumping Plant, Oregon)	VI-60
Chapter VII. Post Construction Evaluation and Operation and Maintenance Plans	VII-1
A. Post Construction Evaluation	VII-1
B. Operations and Maintenance Plan	VII-4
C. Periodic Inspections	VII-4

Table of Contents—continued

	<i>Page</i>
Chapter VIII. Exclusion Barriers for Upstream Migrating Fish .	VIII-1
A. Velocity Barriers	VIII-1
1. Fish Swimming and Leaping Performance	VIII-2
2. Velocity Barrier Design	VIII-3
3. Hydraulic Design	VIII-5
4. Examples of Velocity Barriers	VIII-8
a. Coleman National Fish Hatchery Barrier	VIII-8
b. Walthamville Tailrace Barrier	VIII-9
B. Physical Barriers	VIII-11
1. Physical Barrier Design	VIII-11
2. Examples of Bar Racks	VIII-13
a. Nimbus Dam	VIII-13
b. Leaburg Tailrace	VIII-13
 Bibliography	 Bibliography-1
 Glossary	 Glossary-1
 Index	 Index-1
 Attachment A – Fish Screen Criteria	 A-1
1. Screen Criteria For Juvenile Salmonids (NMFS – Northwest Region 1995)	A-3
2. Juvenile Fish Screen Criteria For Pump Intakes (NMFS – Northwest Region – 1996)	A-11
3. National Marine Fisheries Service Southwest Region Fish Screening Criteria (1997) for Anadromous Salmonids	A-15
4. National Marine Fisheries Service Southwest Region – Experimental Fish Guidance Devices	A-27
5. State of Washington Screening Requirements for Water Diversions	A-35
6. State of California Department of Fish and Game – Fish Screening Criteria – June 19, 2000	A-39
7. Exclusion Barriers	A-45

Table of Contents—continued

Tables

<i>Table</i>	<i>Page</i>
1 Positive barrier screen alternatives	III-19
2 Screen fabrics and materials	IV-57
3 Fish screen bypass ratios	IV-64
4 Summary table – fish screen criteria	IV-92
5 Field documented fish survival rates for closed conduit screens (EPRI, 1994)	IV-161
6 Summary of existing louver evaluations	V-4
7 Summary of field application experience with lighting and strobe systems	V-19
8 Summary of field application experience with sound systems	V-23
9 Flows and water surface elevations at fish screen structure	VI-20
10 Head loss in intermediate bypass	VI-32
11 Canal flow versus water surface elevation	VI-36

Figures

<i>Figure</i>	<i>Page</i>
1 NEPA documents and process (Laitos, 1992)	II-15
2 Informal consultation process (Service, 2000)	II-21
3 Typical environmental compliance actions and timetable (Service, 2000)	II-24
4 In-canal fish exclusion structure	III-7
5 In-river fish exclusion structure – Glenn Colusa Irrigation District (GCID) on the Sacramento River, California	III-9
6 Aerial view of GCID fish screen structure	III-10
7 In-diversion pool fish exclusion structure – Roza Diversion Dam, Washington	III-11
8 Plan view of Puntledge Screens, British Columbia (Rainey, 1985)	III-13
9 Fish exclusion structure in a closed conduit (Electric Power Research Institute – EPRI, 1994)	III-14
10 Flat plate screen “V” configuration with terminal Fish bypass – Red Bluff Fish Evaluation Facility, California	III-20
11 Sectional view of drum screens (Pearce and Lee, 1991)	III-22

Table of Contents—continued

<i>Figure</i>	<i>Page</i>	
12	Drum screens at Roza Diversion Dam, Washington. Note concrete piers are shaped to match drum screens	III-23
	a. Construction 1986	III-23
	b. Operation	III-23
13	Traveling screen	III-27
14	Fixed cylindrical screens (Johnson Screens)	III-30
15	Installation of cylindrical tee-screens at East Unit Pumping Plant, Washington	III-31
16	Installation Showing three raised retrievable cylinder screens – Davis Ranches Site #1, California (intake screens incorporated)	III-31
17	Track mounted, retrievable rotating cylindrical screen with fixed brush cleaner (intake screens incorporated)	III-32
18	Fixed inclined screens	III-35
19	Inclined screen along river bank	III-36
20	Horizontal flat plate screen, East Fork Ditch Company: East Fork, Weiser River, Idaho	III-38
21	Field site Coanda screen, Rocky Mountain Arsenal, Denver, Colorado	III-41
22	Eicher screen (EPRI)	III-44
23	Louver concept (Rhone, 1960)	III-47
24	Georgiana Slough Facility, California	III-50
25	Decision chart	III-58
26	Elevation view of Chandler Canal Fish Screen, Washington	IV-4
27	Plan view of Chandler Canal Fish Screen Structure	IV-5
28	Debris boom in front of the Wilkins Slough Fish Screen Structure, California (RD-108)	IV-7
29	Aerial photo of Wilkins Slough Fish Screens (RD-108)	IV-8
30	Plan view of Wilkins Slough positive barrier fish screen (RD-108)	IV-9
31	Cylindrical tee screens on delivery barge for installation at Columbia River Pumping Plant, Oregon	IV-12
32	Aerial view of Roza Diversion Dam and Fish Screen Facility	IV-14
33	Plan view of Roza Fish Screen Facility	IV-15
34	Sectional view of Roza Fish Facility Drum Screen Structure	IV-16

Table of Contents—continued

<i>Figure</i>		<i>Page</i>
35	Site isolation and dewatering for construction, Highline Canal Fish Screen Facilities at Grand Junction, Colorado	IV-21
36	Effect of approach channel on screen flow distribution (Pearce and Lee, 1991)	IV-24
37	Screen hydraulics	IV-27
	a. Screen approach velocity and sweeping velocity (Pearce and Lee, 1991)	IV-27
	b. Velocity ratio as a function of screen angle placement	IV-27
38	Approach channel geometry influences on screen approach velocity distributions	IV-33
39	Exit channel geometry influences on screen approach velocity distributions	IV-33
40	Curved entrance walls at Three Mile Falls Left Bank Fish Screen Facility, Umatilla, Oregon	IV-34
	a. Photo	IV-34
	b. Schematic of site	IV-34
41	Fixed perforated plate baffle behind Red Bluff flat plate fish screen	IV-37
42	Vertical vane -type adjustable baffles Behind Red Bluff flat plate screen	IV-38
43	High flow resistance perforated plate element as used in turbine intake screens, Columbia River (Weber, 2001)	IV-40
44	Head loss coefficient as a function of fractional open area for woven wire screen (Padmanabhan, 1976)	IV-45
45	Head loss coefficient as a function of fractional open area for thin perforated plate (Weber, 2001)	IV-46
46	Normalized head loss coefficient as a function of fractional open area (Miller, 1990)	IV-46
47	Head loss coefficient as a function of fractional open area for profile bar (Wedgewire) screen (based on a coefficient ratio adjustment applied to 45) (Weber, 2001)	IV-49
48	Multiplier for adjustment of loss coefficients resulting from the angled placement of profile bar (Wedgewire) screen with slots oriented with the flow (Yeh and Shrestna, 1989)	IV-49

Table of Contents—continued

<i>Figure</i>	<i>Page</i>
49	Woven wire screen IV-55
50	Perforated plate screen IV-55
51	Profile bar screen IV-56
52	Bypass entrance design for drum screen concept IV-61
53	Bypass placement with a complex geometry and approach flow – Bonneville Dam forebay (Corps, 1999) IV-61
54	Bypass entrance and conveyance system with downwell (Rainey, 1985) IV-66
55	Bypass outfalls to natural water IV-71
	a. Looking upstream at Red Bluff fish bypass Outfall, Sacramento River IV-71
	b. Roza Diversion Dam fish bypass right bank outfall IV-71
	c. Kittitas Canal bypass outfall, Yakima River, Washington IV-71
56	Secondary screening layout with skewed wall IV-75
57	Secondary screening without pumping IV-75
58	Mechanical driven rake on trashrack structure (Atlas Polar – Hercules Hydro Rake) IV-79
59	Drum screen gantry crane and monorail hoist IV-80
	a. Red Bluff Gantry Crane IV-80
	b. Cascade Canal fish screen monorail hoist IV-80
60	Air Burst Device Placed in the Bay Immediately downstream from the Wilkins Slough Fish Screen (RD-108) IV-84
61	Average percent of juvenile American shad found upstream from trashracks with various bar spacing – channel velocity of 1.0 ft/s. (Reading, 1982) IV-86
62	Downstream view of flat plate screening panel, support frame, and screen IV-97
63	Joint with caulking – Red Bluff flat plate screen (screens bolted to supports) IV-98
64	Flat plate screen with horizontal brush cleaner (GCID) IV-100
65	Mechanical brush cleaner and drive mechanism at Red Bluff Fish Evaluation Facility IV-100
66	Flat plate screen with horizontal brush cleaner and air nozzle at bottom of cleaner arm IV-101

Table of Contents—continued

<i>Figure</i>	<i>Page</i>
67	Intake with concrete headwall – ice protection at Wapatox (Rainey, 1985) IV-103
68	Small paddle-wheel drum screen (2.5 ft ³ /s) located on Deep Creek near Adel, Oregon IV-105
	a. Operation – in the dry IV-105
	b. Dismantled from drive shaft and raised IV-105
69	Drum screen drive system IV-107
70	Sacrificial anodes inside drum screen at Tracy Fish Facility, California IV-107
71	Looking down on drum screen pillow block bearing with grease tubing IV-108
72	Drum Screen bottom brush seals and side neoprene seals IV-108
73	Vertical traveling screen (EPRI, 1986) IV-112
74	Inclined traveling screen with continuous belt – Lilly Pumping Plant, Oregon IV-112
75	Vertical traveling screen with increased effective Screen height IV-113
76	Traveling screen field site with angled wall – Chandler Canal secondary screen/ pumpback structure IV-114
77	Location of vertical traveling screen basket frame Relative to screen material IV-115
78	Vertical traveling screen seals (basket or tray type) IV-117
79	Intake retrofit using fixed cylinder screen with air burst cleaning at Brewster Flat River Pumping Plant, Washington IV-123
80	Plan and elevation of Columbia River Pumping Plant IV-123
81	Brush cleaners for retrievable cylinder screens IV-124
	a. Internal brush projecting through the screen IV-124
	b. External brush IV-124
82	Surface disturbance resulting from the air burst cleaning of Fixed cylindrical screens IV-127
83	Potter Valley inclined screen, California (Pacific Gas & Electric) IV-130
84	Red Bluff inclined screen in fish bypass/evaluation channel IV-132
	a. Schematic of screen structure IV-132
	b. Photo of inclined screen IV-132
85	Chandler inclined screen in juvenile fish bypass facility with downstream adjustment capability IV-132

Table of Contents—continued

<i>Figure</i>	<i>Page</i>
86	Horizontal flat plate screen schematic-laboratory model IV-136
87	Side view of horizontal screen in laboratory model showing good flow depth over screen IV-137
88	Coanda screen IV-142
89	Features of Coanda screen – typical arrangement and design elements IV-143
90	Coanda screen with low screen slope (planar) Wildcat Ranch, Carbondale, Colorado IV-146
91	Concave Coanda screen (commercially available) (Wahl, 2001) IV-151
92	Planar reference screen on 15 degree slope, 3-ft long with 1-mm slots (Wahl, 2001) IV-152
93	Features and typical arrangement for a rectangular conduit MIS screen (EPRI, 1996) IV-156
94	Louver and bypass entrance design – Tracy Fish Collection Facility V-2
95	Fouling of Tracy Fish Collection louvers by Egria V-11
96	Spray bars used to clean louvers at Tracy Fish Collection louvers (downstream spray bar not operating) V-11
97	Detailed louver layout V-13
98	Tracy louver panel V-13
	a. In louver guides V-13
	b. Looking at downstream side of louver V-13
99	Site plan – Example 1 VI-3
100	V-configured fish screen – Example 1 VI-8
101	Steel support structure – Example 1 VI-8
102	Bypass entrance – Example 1 VI-14
103	Profile of bypass pipe – Example 1 VI-14
104	Bypass outlet structure – Example 1 VI-15
105	Site plan – Example 2 VI-24
106	New screen structure – Example 2 VI-25
107	Cross section of screen bay – Example 2 VI-28
108	Bypass entrance – Example 2 VI-31
109	Bypass Bellmouth entrance – Example 2 VI-31
110	Site plan – Example 3 VI-35
111	Structure plan – Example 3 VI-40
112	Section through drum screen structure – Example 3 VI-40
113	Section through bypass entrance – Example 3 VI-41
114	Fish bypass pipe profile – Example 3 VI-44

Table of Contents—continued

<i>Figure</i>		<i>Page</i>
115	Bypass outlet structure section – Example 3	VI-45
116	Overview of T&Y Diversion with fish louver structure – Example 4 (T&Y Irrigation District)	VI-52
117	Layout of T&Y Diversion Project – fish louver Structure – Example 4 (T&Y Irrigation District)	VI-53
118	T&Y Diversion Dam trashrack structure – Example 4 (T&Y Irrigation District)	VI-54
119	View looking upstream at the T&Y louver placed at an angle to the channel flow – Example 4 (T&Y Irrigation District)	VI-56
120	Louver structure setting on 1-ft. Curb – Example 4 (T&Y Irrigation District)	VI-56
	a. Flow is from Left to right through the louvers	VI-56
	b. View through support structure on backside of louvers . . .	VI-56
121	Schematic layout of T&Y Diversion Project – Example 4 (T&Y Irrigation District)	VI-57
122	Louver structure detail – partial plan – Example 4 (T&Y Irrigation District)	VI-57
123	Louver and Walkway. Note river on the left and Canal downstream of louver structure – Example 4 (T&Y Irrigation District)	VI-58
124	Section through bypass outlet – Example 4 (T&Y Irrigation District)	VI-59
125	Schematic of velocity barrier weir	VIII-4
126	Inclined jet impinging on a horizontal surface (White, 1942)	VIII-6
127	Fish barrier weir at Coleman National Fish Hatchery, Battle Creek, California	VIII-9
128	Weir Crest Extension applied to the Coleman National Fish Hatchery, barrier weir	VIII-10
129	Walterville tailrace velocity barrier weir, McKenzie River, Oregon. (Eugene Water and Electric Board).	VIII-10
130	Nimbus Dam bar rack barrier, American River, Sacramento, California (Nimbus Fish Hatchery)	VIII-13
131	Leaburg bar rack tailrace barrier McKenzie River, Oregon. (Eugene Water and Electric Board)	VIII-14

Chapter I. Preface

The purpose of this manual is to provide design guidance for fish protection at small dams and water diversion structures by providing fish exclusion alternatives. This manual is addressed to the water user community involved in assessing, recommending, and designing appropriate fish exclusion facilities at water diversion structures. This manual focuses on Bureau of Reclamation's (Reclamation) fish exclusion experience for water resources projects, presenting design methods and operation standards developed and used in recent years. Fish protection, exclusion and bypass at water diversions and other facilities will be the major theme covered in this first volume. A second volume is envisioned covering fish passages using fish ladders, including upstream and downstream passage for adult and juvenile fish passage structures; improvements in reservoir and river operation for control of temperature and dissolved gases; and habitat enhancement.

Although water resource planners, fishery biologists, and engineers have been aware of the need for fish protection, there has been inconsistent application of criteria and technology, or more importantly, a lack of consensus among fishery resource agencies and the water resource development community as to the scientific basis of past and present criteria. Recently, there have been advancements in the understanding of fish behavior and exclusion methods across a greater number of species and locations in the Western United States. These recent advancements are the result of cooperative efforts among engineers and fishery biologists in various Government agencies, consulting firms and universities to bring consensus to the planning and design of fish exclusion facilities. Reclamation has documented its laboratory and field experience over time, with internal reports and professional papers and various site-specific fish exclusion concepts. However, the need for an application-based manual incorporating these latest advancements in the planning and design of fish exclusion facilities at water diversions has become increasingly evident.

This manual includes recent advancements in fish exclusion concepts, knowledge, and applications to both warm and cold water fish species. The manual will present information on the following topics or subjects:

- Responsible Fish Resource Management

- Regulatory Responsibilities

- Various Fish Exclusion Alternatives

- Design Criteria and Guidelines (biological, behavioral, and hydraulic considerations)

- Design Details for Positive Barrier Screens and Behavioral Barriers

Case Studies

Post Construction and Performance Evaluation

Exclusion Barriers for Upstream Migrating Fish

The body of this manual integrates a comprehensive documentation of past and present Reclamation fisheries engineering projects with a summary of reference material. The manual emphasizes the synergy of biological and engineering disciplines. Specific topics covered under fish exclusion are screens, upstream and downstream barriers, and secondary methods of exclusion enhancement such as behavioral avoidance methods.

Although this manual is focused almost exclusively on the planning and design of fish exclusion facilities, it is important that those involved in the design of such facilities be familiar with the requirements of the Endangered Species Act, Federal and State fish screen criteria, and the full range of existing technologies. There should also be an appreciation for the complexities of competing demands on the limited water resource.

This manual was prepared by engineers and fishery biologists of the U.S. Department of the Interior, Bureau of Reclamation. The Denver Technical Service Center and regional, area, and project office staff have provided invaluable assistance in the writing of this manual. The Science and Technology Program of Reclamation has played a significant role in funding research associated with the development of fish exclusion at water diversions. In addition, many others participated in the preparation of the text. Special recognition is given to the five member team who coordinated, wrote, and edited this first edition:

Philip Burgi, P.E. Consultant, Retired Manager, Hydraulics Laboratory

Rick Christensen, Mechanical Engineer

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Tony Rozales, Pete Mazza, and Victor Aguirre drew or modified many of the illustrations. Numerous engineers, technicians, and support personnel participated with this team in the preparation of this first edition, and their efforts are greatly appreciated. The following individuals provided invaluable assistance in the review and editing of the draft manual: Eugene Humbles, Denny Hudson, Stephen Grabowski, Charles Liston, John Dyson, and Bob Norman.

The Bureau of Reclamation expresses grateful appreciation to those organizations that have permitted the use of material from their publications, especially National Ocean and Atmospheric Administration, Department of Fisheries (formerly the National Marine Fisheries Service), U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, California Department of Fish and Game, Washington Department of Fish and Wildlife, Electric Power Research Institute, and BC Hydro.

There are occasional references to proprietary materials or products in this publication. These references must not be construed in any way as an endorsement because Reclamation cannot endorse proprietary products, processes of manufacturers, or the services of commercial firms for advertising, publicity, sales, or other purposes.

The users of this manual should verify the criteria published herein with the latest fish resource agencies draft criteria before advancing into the predesign and final design phases of a fish exclusion project.

Chapter II. Fish Protection

“In all things of nature there is something of the marvelous.”

Aristotle (384 BC – 322 BC)

A. The Need for Fish Protection

“We do not inherit the land from our ancestors, we borrow it from our children.”

Native American Proverb

As the Western United States was settled, aquatic habitats were altered, particularly as a result of water diversions. Recent declines of native western fish species have resulted in numerous listings of species as threatened or endangered under Federal and/or State laws (Minckley and Deacon, 1992). The general decline in fish and wildlife species can be traced to the pressures that an expanding population put on the environment, including fish and wildlife habitat. These recent species declines are an indication of environmental degradation that can potentially affect human health and well being. Solutions to stopping the declines 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 sustainable natural habitat. This has certainly been true in the case of water resource development and our natural environment. However, the relationship between water resource development and conservation of the natural environment does not have to be an “either-or situation.” The two interests, development and management on the one hand and conservation on the other, can work effectively together. If these interests are to work together to maintain a viable ecosystem and maximize fish protection efforts, the public must receive reliable scientific information to ensure an adequate understanding of the issues. Public values have shifted from an emphasis on water resource development to management of Western waters, the Bureau of Reclamation’s (Reclamation) contemporary hydraulic research program has also changed. The program now centers on infrastructure protection (safety of dams), water conservation, and fish protection (Burgi, 1998). The intent of this manual is to facilitate responsible resource development and management by providing guidelines and viable fish exclusion alternatives at water diversion structures.

1. Responsible Resource Management

“All the waters of all the arid lands will eventually be taken from their natural channels. And there is not sufficient water to supply the land.”

Major John Wesley Powell

Water resource projects developed by the Reclamation over the past century have significantly contributed to sustained economic growth and enhanced quality of life in the Western United States. Effective resource management balances competing interests and needs and requires managing lands, water, and other resources in the most responsible way possible. The challenge lies in striking a balance.

Many dams in the Western United States are more than 75 years old and were constructed for irrigation, power generation, recreation, and flood control as part of the development of the Western United States. “Human habitation in the West as we know it would not be possible without this kind of active control and use of its surface water resource. Though vilified by many for the environmental damage they have caused, dams provide important, essential functions now relied upon to some degree by virtually every person who lives in the West” (MacDonnell, 1999). During early development, there was little information available about the life history requirements of resident and migratory fish species, and little consideration was given to their needs, especially in-stream migratory behavior. In many cases, dam construction has impeded fish movement and contributed to declining fish populations by limiting access to suitable spawning, rearing, and foraging habitat. Although significant attention has been given to understanding anadromous fish behavior and passage needs, very little attention has been given to other native fish. During the past 100 years, some 21 species and subspecies among 6 fish families have become extinct from the 17 Western States; some 64 species and subspecies are now Federally listed as threatened or endangered (Minckley and Deacon, 1992). Most of these species declines are related to alteration of habitat and the detrimental effects of non-native fishes. Recovery of threatened and endangered fish species requires reestablishing access to natural spawning, rearing, and forage areas.

Quartarone’s (1993) interesting historical perspective gives insight to people’s attitudes toward endangered species in the Upper Basin of the Colorado River in the early years of the 20th century. “The increase in opportunities for fishing for catfish and trout in the upper basin figured greatly into people’s opinions of the native species. When faced with the option of catching the endangered fish or trout and catfish, people chose the latter two. The endangered fish fell into

disfavor and seemed to become a scapegoat for criticism. My idea is they're just a trash fish; you can't eat them, and they're not much fun to catch. If you put trout or something in there that you could eat, and people could use them... why I think it'd be a benefit to have. Some people got different ideas." George Anderson (Quartarone, 1993).

It has been only in recent years that the scientific community has started to study the behavioral and physiological characteristics of native fish species. Efforts are underway through "recovery programs" to restore native fish species in western rivers such as the Colorado River. Studies include:

- ▶ The impacts of stocked fish versus a naturally reproducing population
- ▶ The amount and timing of in-stream flows needed to provide a sustainable fishery
- ▶ The need for shallow wetlands in the stream corridor to provide fish spawning during high flows
- ▶ Providing rearing areas for young fish
- ▶ Conservation plans by western irrigators to provide additional in-stream flows
- ▶ The control of non-native fish that either compete for habitat or consume native fish

Fish protection is an important aspect of fishery management at water diversions. Fish protection is often defined as fish exclusion from water diversions. Protection includes not only limiting entrainment of fish at diversions, but also protecting fish from injury or mortality resulting from operation of the diversion. The death and injury of fish at water diversions have long been identified as major sources of fish mortality (Spencer, 1928; Hallock, 1977). Fish entrained into agricultural or municipal and industrial diversions can experience nearly 100 percent mortality. Fish entrained into power intakes incur high mortality, and also experience injuries and disorientation that can lead to increased predation losses. A recent study on a seasonal irrigation canal associated with the Shoshone River in northwestern Wyoming provided insight into the potential for fish entrainment into these irrigation diversion systems. A total of 5,732 fish of 11 species were collected from a combined 5 miles of three canals by electro fishing, block netting, and draining techniques (Karp et al., 1993).

The numbers of fish entrained by a diversion are in part a function of diverted flow rates (higher flow rates will likely entrain more fish) and the concentrations of fish in the water body that the flow is diverted from. If the flow is diverted

from a biologically productive water body that both supplies habitat for adult fish and also supplies habitat for spawning and juvenile fish rearing, the potential exists to entrain large numbers of fish. For example, studies conducted by the California Department of Fish and Game (1987) indicate that Reclamation's Tracy Pumping Plant entrains millions of fish each year (Helfrich, Liston, and Weigman, 1996).

Most of these fish are less than 6 inches long, and of the fish that are less than 6 inches long, most are less than 1 inch long. The Tracy Pumping Plant pumps from the Sacramento – San Joaquin Delta, which is a highly productive water body composed of numerous intertwined channels. Pumping rates at the Tracy Pumping Plant are also high, averaging over 4,000 cubic ft per second.

Fish exclusion approaches include numerous technologies. Positive barrier screens have long been considered the best technique to prevent entrainment of fish into a diversion. These structures, although highly effective, can be expensive to install and the need to clean the screens, remove trash, deal with sediments, and provide regular maintenance adds to the costs.

Since the early 1960s, behavioral methods have been studied as an alternative to positive barrier screens. Behavioral methods offer fish exclusion options that reduce capital costs and operation and maintenance (O&M) requirements. For example, louvers were first used in 1957 by Reclamation at the Tracy Pumping Plant Central Valley Project, California. The hydraulic turbulence associated with louvers affects the behavior of fish and directs them away from water diversions and to a fish bypass. Other behavioral methods include startle-response techniques such as lights (strobes), sound, and electrical fields. There is skepticism over the use of such behavioral devices. Where behavioral devices have been installed and used at diversions, evaluations have shown fish exclusion efficiencies that are considerably less than 100 percent. (Vogel, 1990; Electric Power Research Institute, 1986; Karp, Hess, and Liston, 1993).

Fish protection and recovery programs that are defined or set up to actually allow water development to proceed to meet the needs of society 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 the Congress to protect and preserve listed species and the use of the water resource to meet societal needs and to enhance the quality of people's lives. The alternative of endless litigation is not in the public interest.

Following is a list of typical questions often asked by owners of diversions who have serious concerns about their ability to continue diverting water and pay for the improvements but wish to cooperate in restoring fishery resources that have been listed:

- ▶ Is the Biological Opinion a law, rule, or just an opinion?
- ▶ How much power does a Biological Opinion have over the delivery of diverted water?
- ▶ Does installation of a fish screen structure specified in a Biological Opinion put the owners of the diversion in jeopardy or risk of being fined or imprisoned for incidental take?
- ▶ If a fish screen fails to perform as designed, will the regulatory agencies remove the structure or require additions or modifications?
- ▶ Will State, local, or Federal Government lay claim to the water right and/or portion of land that the proposed fish screen structure occupies?
- ▶ If the fish screen is installed and later abandoned, who owns the structure?
- ▶ What are the benefits of installing a fish screen on or near our diversion structure?
- ▶ What are the liabilities or risks of installing a fish screen on or near a diversion structure?
- ▶ Who will maintain, update, and operate the fish screen as proposed?
- ▶ If funding for the endangered species program ends, how will the proposed fish screens be operated? Or if removal is required, will funding be available for removal?
- ▶ Who will own the fish screen and related structures?
- ▶ What type of operational guarantees will come with the proposed screen and its related structures?
- ▶ Will there be some kind of a damage clause in the contract to cover the diversion shareholders in the event of crop damage?

These are typical issues that owners of water diversions and regulatory agency staff will need to address before proceeding to design and construction.

2. Fish Protection Legislation

“Rarely has a law with such humble beginnings had such a far-reaching effect on the American people as the Endangered Species Act”

*William D. Ruckelshaus
First Administrator, EPA*

Fishery resources associated with water development are protected by State and Federal laws. Wildlife protection law can be traced to various decisions and proclamations from the Roman Empire through feudal European history to the beginning of the United States as a sovereign nation. In England before the signing of the Magna Carta in 1215, wildlife was the property of the king, who granted hunting and fishing rights to the nobility. Later, Parliament assumed the right to control the harvest of wildlife. In the United States, Federal statutes and regulations, executive orders, treaties, and other international agreements govern the action of Federal agencies, while State laws, administrative orders, and court decisions provide the authorization for action at the State level (Shogren, 1998).

Moss (1967) points out:

Since early times, Americans have shown concern for the protection of fish and the water they inhabit. Before 1750, local laws had been enacted: Middlesex County, Virginia, prohibited the use of ‘jack lights’ for night fishing; New York City permitted the taking of fish from fresh-water ponds with “angle rod, hook and line only.” In 1871 Congress appointed the Commissioner of Fish and Fisheries; 1903 the Bureau of Fisheries was designated and in 1956 the Fish and Wildlife Act created the U.S. Fish and Wildlife Service (Service) in the U.S. Department of the Interior (Interior) made up of two Bureaus: Commercial Fisheries (became National Marine Fisheries Service [NMFS]) and Sport Fisheries and Wildlife.

More than a century and a quarter has passed since this nation began formal attempts to conserve and sustain its valuable fishery resources. In that time impressive studies in fishery science, habitat management, and the enactment of protective laws have combined to provide managers the tools to conserve recreational fisheries.

Shogren (1998) summarizes the history of Endangered Species Regulations in the United States:

- 1926**– Passage of the Black Bass Act – Passed and later amended to regulate importation and transportation of black bass and other fish.
- 1934**– Passage of the Fish and Wildlife Coordination Act (FWCA) – Specifically emphasized the impact of water development projects on wildlife.
- 1956**– Passage of the Fish and Wildlife Act – Created the Service.
- 1966**– Passage of the Endangered Species Preservation Act – Directed the Service to prepare and maintain an official list of endangered native animals. It also authorized funds for management and research for listed species.
- 1969**– Passage of the National Environmental Policy Act (NEPA) – Established the policy that Federal decision making should include evaluating the effects of Federal actions on the quality of the human environment.
- 1973**– Passage of the Endangered Species Act (ESA) – Conserved ecosystems upon which endangered and threatened species depend, provided a program for the conservation of such endangered and threatened species, and took appropriate steps to achieve the purposes of the treaties and conventions set forth in the ESA. Recognized “threatened” species and provided protection for species before they were placed in imminent danger of extinction. Encouraged public participation in the listing process. Allowed people to request a public hearing in addition to the normal public comment period. Also allowed any person to bring action in the U.S. District Court for alleged violation of the ESA.

The goal of the ESA process is to restore listed species to a point where they are secure, self-sustaining components of their ecosystem so as to allow “delisting.” As a result, ecosystems upon which endangered and threatened species depend may be conserved. The ESA provides a program for conservation and management of such species and their habitat (Shogren, 1998).

Since fishery protection is so closely associated with the quantity and quality of water, water law becomes an important issue in protection of the fishery resource. Water law does not operate by providing for the ownership of water in the way that real property law allows for ownership of land. Rather, water law generally grants rights to the use of the water. More recently, laws have been instituted pertaining to minimum flow requirements of rivers to maintain viable fish populations. These requirements have, at times, come into direct conflict with water rights as defined by riparian or prior appropriation rights. Riparian rights

come from the English common law and are law in the 31 Eastern States where the use of water is a property right. The essence of the system is that only the owner of a parcel of land touching a watercourse has riparian rights (Laitos,1992). Prior appropriation started in the 1880s as a result of the miners and settlers in the Western States seeking water rights not necessarily associated with the property. In prior appropriation States, the water right resides with the first person to divert water (appropriate) from a stream or creek, and that person is granted a vested right to that amount of water: “First in time, first in right.” Appropriated waters may be used anywhere, regardless of the distance from the watercourse. The quantity of the water right is the amount that historically was put to a beneficial use. The Western States are essentially divided into two “doctrines.” The California Doctrine includes nine States (North and South Dakota, Nebraska, Kansas, Oklahoma, Texas, Oregon, Washington, and California) and allows for both riparian and prior appropriation rights. The Colorado Doctrine uses prior appropriation only and includes Colorado, Utah, Wyoming, Idaho, Montana, New Mexico, Nevada, and Arizona. These early laws were based on “beneficial use” of the water which was often defined as resulting in economic benefit (Dzurik 1990). In Western States where water has often been over used or over appropriated, it is often difficult to find the needed water to provide fish protection because there is no excess natural flow. In some cases, storage reservoirs in the Western States have provided the answer to supplying fishery water needs.

There are numerous State and Federal agencies that have authority over fishery resources. The following list includes some of the agencies involved with fish management or that, because of their actions, are involved in fishery resource issues:

- ▶ Environmental Protection Agency
- ▶ NMFS (National Ocean and Atmospheric Administration, Department of Fisheries [NOAA-Fisheries])
- ▶ Fish and Wildlife Service (Service)
- ▶ U.S. Army Corps of Engineers (Corps)
- ▶ U.S. Forest Service (FS)
- ▶ Bonneville Power Administration
- ▶ Northwest Power and Conservation Council
- ▶ Federal Energy Regulatory Commission
- ▶ Bureau of Indian Affairs
- ▶ Solicitor’s Office of the Department of the Interior
- ▶ Bureau of Reclamation (Reclamation)
- ▶ Bureau of Land Management (BLM)
- ▶ Indian Nations

- ▶ State water resource agencies
- ▶ State fish and game agencies

Following is a listing of Federal legislation affecting fishery resources (Service, 1992):

Federal Power Act of 1920 – Where there is the possibility for power development at a diversion site, Section 18 of the Act 16, United States Code of Standards [USCS] §811, states in part:

“The commission shall require the construction, maintenance and operation by a licensee of....such fishways as may be prescribed by the Secretary of Commerce or the Secretary of the Interior.”

Currently, the Service will issue a Decision Document called a Prescription for a Fishway pursuant to Section 18 of the Federal Power Act. The document is typically developed with input from fisheries biologists and fishway engineers from the Service and other appropriate agencies. The document will present the record on the decline of the specific fish species, discuss the management goals for the fish species for which improved fish passage is targeted, and provide details about where the fishway is to be located, its size, the quantity of water needed to effectively operate the fishway, and other pertinent items related to the design and operation of the fishway.

“Federal Energy Regulatory Commission (FERC) Section 18 of the Federal Power Act gives the Federal resource agencies authority to prescribe mandatory fish passage conditions to be included in FERC license orders.”

Although FERC has sole authority under the Federal Power Act of 1920 to approve power projects, the Act did not provide FERC sole authority to determine all the conditions associated with that approval. The original Federal Power Act provides for cooperation between FERC and other Federal agencies, including fishery resource agencies, in licensing and relicensing power projects. In deciding whether to issue a license, FERC is required to give “equal consideration” to the following purposes: power and development; energy conservation; protection of, mitigation of damage to, and enhancement of, fish and wildlife (including spawning grounds and habitat); protection of recreational opportunities; and preservation of other aspects of environmental quality. The time frame for a license can not exceed 50 years.

FERC is required to mandate the construction, maintenance, and operation of fish passage facilities as prescribed by the Secretary of Commerce or the Secretary of the Interior (Secretary). The 1986 amendments to the Federal Power Act, entitled the Electric Consumers Protection Act, mandated several fish and wildlife

provisions. Each license is to include conditions to protect, mitigate, and enhance fish and wildlife affected by the project. The conditions are to be based on recommendations received pursuant to the FWCA from the Service, the NMFS (NOAA Fisheries), and State fish and wildlife agencies (Service, 1992).

Fish and Wildlife Coordination Act (FWCA) of 1934 and amendments of 1946 – Require consultation with the U.S. Service and the fish and wildlife agencies of States where the “waters of any stream or other body of water are proposed or authorized, permitted or licensed to be impounded, diverted. . . or otherwise controlled or modified” by any agency under a Federal permit or license. A formal FWCA compliance memorandum or report to the Federal agency should be included as an appendix in the final NEPA document.

National Historic Preservation Act (NHPA) – Section 106 of the NHPA requires Federal agencies and other entities spending Federal funds to take into account the effect of their undertaking on historical properties. Federal agencies are required to take the lead in complying with Section 106 even if funding is provided to other entities. There are several steps that make up the Section 106 compliance effort. These steps must be followed in the event an archeological or historical property is found within an area of potential effect. These steps include:

1. **Inventory** – Site-specific inventories are required for each project or action.
2. **Evaluation** – The lead Federal agency evaluates each property for possible inclusion in the *National Register of Historic Places* in consultation with the State Historic Preservation Officer.
3. **Determination of Effort** – Avoidance of impacts is the best alternative to preserve the qualities that make the property eligible for inclusion in the National Register. If direct or indirect impacts are expected, then mitigation measures must be developed in cooperation with the State.
4. **Mitigation** – Mitigation measures will be developed if a project will adversely effect eligible historic properties.

If an initial inventory fails to reveal the presence of a cultural resource, a properly documented project may proceed.

Mitchell Act of 1938 – Specifically directs establishing salmon hatcheries in the Columbia River Basin, conducting engineering and biological surveys and experiments, and installing fish protection devices. Federal activities in the basin

are carried out by the Department of Commerce. (Federal Land Policy and Management Act of 1976 [BLM])

Fish and Wildlife Act of 1956 – Confirmed the position of Commissioner of the Service under Interior. It also established a comprehensive national fish, shellfish, and wildlife resources policy with emphasis on the commercial fishing industry. It also directed that the act be administered with regard to the inherent right of every citizen and resident to fish for pleasure, enjoyment, and betterment and to maintain and increase public opportunities for recreational use of fish and wildlife resources. Two bureaus were established: Commercial Fisheries (in 1971 renamed NMFS of the Commerce Department) and Sport Fisheries and Wildlife.

NEPA of 1969 – Requires that all Federal agencies prepare detailed environmental impact statements (EIS) for “every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment.” The act created the Council on Environmental Quality in the Executive Office of the President. All Federal agencies have a responsibility to protect Indian Trust Assets (ITAs). The NEPA compliance process addresses ITAs. The affected environmental consequences chapters of the NEPA document must have a separate section that shows that the ITAs have been considered.

Federal Water Pollution Control Act of 1972 – Clean Water Act/Rivers and Harbors Act – Fish protection and passage projects in the United States may involve the dredging or filling of waters or occur in navigable waters that require a section **404 permit** under the Clean Water Act or a section 10 permit under the Rivers and Harbors Act or both.

ESA of 1973 as amended – Provides for the conservation of ecosystems upon which threatened and endangered species of fish, wildlife, and plants depend, both through Federal action and by encouraging the establishment of State programs.

The ESA:

- ▶ Authorizes the determination and listing of species as endangered or threatened
- ▶ Prohibits unauthorized taking, possessing, selling, and transporting of listed species
- ▶ Authorizes establishing cooperative agreements and grants-in-aid to States that establish and maintain active and adequate programs for endangered and threatened wildlife and plants

- ▶ Authorizes assessing civil and criminal penalties for violating the ESA or regulations
- ▶ Authorizes paying rewards to anyone furnishing information leading to the arrest and conviction for any violator of the ESA or any regulation issued thereunder

Pacific Northwest Electric Power Planning and Conservation Act

(Public Law [P.L.] 96-501) of 1980 – Authorizes establishing and operating the Pacific Northwest Electric Power and Conservation Planning Council, also referred to as the Northwest Power and Conservation Council (NPCC). There are two individuals appointed to the Council from each of the States representing the Columbia River drainage: Idaho, Montana, Oregon, and Washington. Among other things, the Council is responsible for preparing a regional conservation and electric power plan as well as a fish and wildlife protection, mitigation, and enhancement program to deal with the operation of hydroelectric facilities on the Columbia River and its tributaries. A 1984 amendment authorizes the Secretary to design, construct, operate, and maintain fish passage facilities within the Yakima River Basin in accordance with this statute. In 1991, the NPCC amended program included measures that are to be undertaken to help improve the survival of salmon. Amendment 1.1 (f) asks Reclamation, along with the FS and BLM, to require, as a condition of authorization, diversion structures to have functional fish screens and other passage facilities that meet current NMFS (NOAA Fisheries) criteria for salmon and steelhead.

National Energy Policy Act of 1992 – Section 1701(b) P.L. 102-486, Title XVII, §1701(b), 106 Stat. 3008, states:

The items which may constitute a “fishway” under Section 18 [16 USCS §811] for the safe and timely upstream and downstream passage of fish shall be limited to physical structures, facilities, or devices necessary to maintain all life stages of such fish, and project operations and measures related to such structures, facilities or devices that are necessary to ensure the effectiveness of such structures, facilities, or devices for such fish.

National Invasive Species Act of 1996 – P.L. 104–332 – Reauthorizes and amends the Non-indigenous Aquatic Nuisance prevention Control Act of 1990 (P.L. 101–646). Authorizes the Secretary of Transportation to develop national guidelines to prevent the introduction and spread of non-indigenous species into the United States waters via ballast water of commercial vessels.

A variety of specific and omnibus authorizing statutes provide for fish and wildlife conservation at Reclamation and Corps water resource projects.

In some cases, work is needed to address fish protection and passage issues; however, there may not be legislation to help drive the needed improvements. Such is the case with much of the Restoration program on the Colorado River. In this case, funds are provided for the construction, long-term O&M, and water is reserved in upstream reservoirs for minimum flow needs.

B. Development Process

“The best laid schemes of mice and men
Gang aft a-gley;
And leaves us naught but grief and pain
For promised joy”

Robert Burns

The development process relative to fish protection issues consists of identifying the fishery resource in need of protection and the specific needs for protection, developing alternative plans that address those needs, and selecting from the alternatives one that best satisfies the identified protection needs. Solutions to fish protection problems come from alternatives developed by working with stakeholders and State and Federal fisheries and 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 should involve 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 or site where protection is needed as well as the disciplines of:

- ▶ fishery resource and regulatory agencies
- ▶ economics
- ▶ design
- ▶ research
- ▶ biology
- ▶ recreation
- ▶ hydrology
- ▶ hydraulics
- ▶ engineering
- ▶ sociology

The following sequence of steps can serve as a guide in developing fish protection facilities :

- ▶ Identify the need for fish protection
- ▶ Follow environmental and regulatory processes and develop documentation
- ▶ Develop various alternative designs that will provide the needed protection based on fish species behavior, physiology, consideration of the river and diversion flow requirements, constructability, and O&M issues
- ▶ Evaluate alternative designs for both cost effectiveness and benefits to the fish species of concern
- ▶ Select final design
- ▶ Construct the facility
- ▶ Monitor and evaluate the facility's effectiveness

1. Regulatory Responsibilities

"A policy is a temporary creed liable to be changed, but while it holds good it has got to be pursued with apostolic zeal."

Mahatma Gandhi 1869–1948

Legislation and public concern have fostered a multi-objective approach to all water projects and more serious consideration of the potential environmental consequences of development. This applies as well to projects conceived in an effort to fix previous negative impacts to the natural environment. Environmental aspects must be considered from the initial planning and design of a project through its construction and operation. The NEPA of 1969 adds a component of environmental awareness to all Federal agency decision making. NEPA is the key environmental statute that must be considered within natural resources law. Many, if not all, water resource projects require compliance with NEPA and other pertinent Federal regulations. NEPA is triggered if there is a proposal for "major Federal action" [42 U.S.C. 4332(2)(C)]. This results in three questions centered on the words: "major," "Federal," and "environmental." Certainly, any Federal construction activity that will have a significant environmental impact will likely be considered a "**major**" Federal action. Federal action within the

authority of NEPA includes not only action by the agency itself, but could also include action permitted or approved by a federal agency. In general NEPA does not apply to private projects. There must be a “**Federal**” link. Regarding “**environmental**,” there must be a significant environmental impact for NEPA to apply (Laitos, 1992).

The NEPA process requires various documents to help ensure a thorough, well thought out process. Figure 1 summarizes the NEPA documents and process:

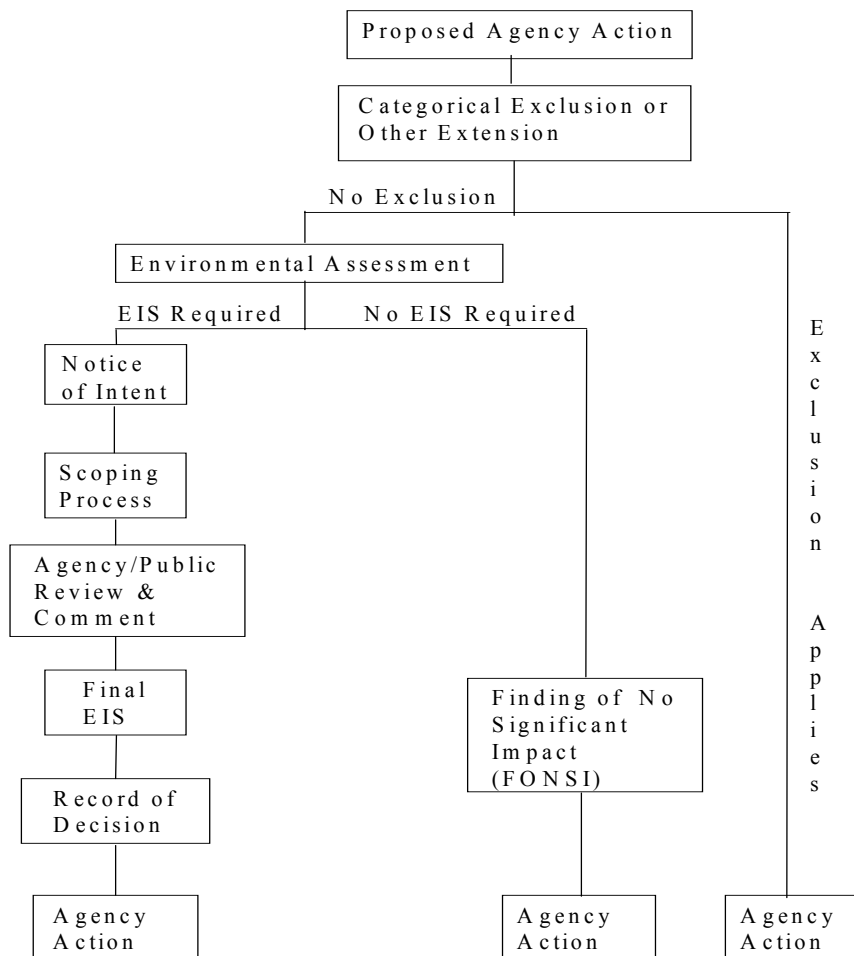


Figure 1.—NEPA documents and process (Laitos, 1992).

A determination of a categorical exclusion is the first step in the process – it is necessary to determine whether or not the action is significant enough to warrant an Environmental Assessment (EA). An EA should include an Introduction, Proposed Action and Alternatives, Affected Environment and Environmental Consequences, Consultations and Coordination, and Cited References. If a categorical exclusion applies, the agency action can proceed to project construction without an EA. If there is no categorical exclusion, the agency must complete an EA. The EA is shorter and less detailed and involved than an EIS, usually no more than 20 pages. The EA process helps determine if an action will have a significant environmental impact. If, based on the EA, all major issues are addressed and it is determined that the proposed action does not significantly affect the environment, a finding of no significant impact (FONSI) can be prepared and agency construction action can proceed.

If an EA indicates that there will be an impact, an EIS is required, which helps decision makers weigh those impacts for a balanced decision. Notices of intent, the scoping processes, and periods for review and comment help to involve the public. Knowledge of environmental integrity and concern for a sustainable environment will enable the project to proceed with responsible decision making. This process will often influence others in the community regarding the principles of sustainable resource management and development.

Scoping is an important component of the process that allows an agency to identify the problem areas relative to a project. It provides the base map, and public involvement puts the roads on it. Public involvement and participation in the decision process is vital. It centers around effective communication among partners, agencies, organizations, the various stakeholders, and the interested public. Public involvement and participation should not be confused with public relations, public information, or public education (Reclamation, 1996)

2. Planning Checklist

“It is our task in our time and in our generation to hand down undiminished to those who come after us, as was handed down to us by those who went before, the natural wealth and beauty which is ours.”

John F. Kennedy 1917–1963

Public involvement initiatives should begin during the draft EA phase. A well written EA will often meet the compliance requirements of the NEPA of 1969 and the ESA of 1973. Often, this provides the opportunity to inform the public about

the project and address some of the local issues before they become serious road blocks in the process. It also provides the opportunity to inform the public about legal requirements of the action agencies under the ESA. Copies of the draft EA should be sent out soliciting comments, and public meetings with interested parties should be held. The following are typical concerns and comments raised in a public involvement meeting with a fish protection proposal:

- ▶ It's a waste of taxpayer's money
- ▶ Water rights and supplies should be protected
- ▶ O&M issues need to be addressed
- ▶ Non-native fish management needs to be addressed
- ▶ "Incidental take" of a listed species needs to be addressed more clearly

These issues can usually be successfully resolved during the public involvement phase of the draft EA process eliminating the need for an EIS. If FONSI is the determination, the agency may proceed toward construction. It is important to note that each fish exclusion project will generate its own list of public concerns.

In the planning phase for fish exclusion facilities, there are many issues that need to be identified and addressed in a professional and timely fashion. The ability to adequately address all these issues is paramount to a successful fish exclusion project. These issues include not only environmental considerations but cultural resource issues; water rights (adjudication); right-of-way, permitting by Federal, State and local governmental entities; funding; issues of ownership, operation, and maintenance; and construction considerations. The following checklist can be very helpful in the predesign phase for a fish exclusion facility. The list is given in a chronological order that is typical for a predesign, as currently used in the Pacific Northwest Region of Reclamation.

Checklist for Predesign of Fish Screens

1. Fish Protection required

What are the fish species of concern?

What are the biological requirements of the species; e.g., spawning, rearing, or foraging habitats that require protection?

2. Type of Screen

To exclude fish from the diversion or to allow the diversion and then screen and provide bypass back to the river?

3. **Socio-economic and Political Concerns**

Acceptability of the fish facility concept to the technical work group team?

4. **Biological Concerns**

If used, will the bypass pipe cause false attraction to fish?

What is the migration season of the fish species of concern?

Is telemetry needed to determine fish movement; is other monitoring of fish movement required; what equipment is required?

5. **Site Features**

Do headworks exist; if so, is modification necessary?

Location of river thalweg; e.g., is it suitable for a bypass pipe?

Site geometry for screen layout?

Space constraints for the selection of screen type?

Adaptability of site to a standard screen or other various style screens?

6. **Operational Aspects**

What is the duration of the irrigation season?

Is there floating debris in the canal or the river?

Will cleaning of the screens be a problem?

7. **Non-structural Changes**

What are possibilities of consolidating several diversions into one?

8. **Structural Changes**

What type of bypass is appropriate for the site; e.g., submerged, ramped, perched?

Are screens required to operate at optimum submergence for all flows?

Possibility of retrofit for existing screens?

Expandability of screen design or application should canal flow increase?

9. **Survey Needs**

Complexity, accuracy, and availability of survey information?

10. **Geology**

Existence of rock in foundations and general geology of area?

11. **Cultural Considerations**
 - Cultural resources constraints at site?

12. **Ambient Conditions**
 - Adverse climatic condition at site; e.g., icing, extreme weather changes?

13. **Hydrology of Canal and River**
 - Quantity and velocity of canal flow?
 - River velocities?
 - Availability of hydrological data on river and canal?

14. **Hydraulics of Concepts Considered**
 - Available bypass flow, closed pipe or open channel, and ability to incorporate a bypass pipe into the design?
 - Type of tailwater control for fish screen?

15. **Constructability**
 - Difficulty in diverting stream and maintaining stream integrity during construction?
 - Difficulty in dewatering construction site?
 - Difficulty in constructing screens?

16. **Right-of-Way Needs**
 - Existing rights of way or easements and ability to obtain additional rights of way?
 - Temporary construction easement?

17. **O&M Concerns**
 - General O&M?
 - How will screens be removed for maintenance; e.g., gantry, jib crane, boom truck, etc?
 - Power availability (paddle wheel or solar drive feasible)?
 - Ability and experience of O&M personnel to maintain proposed screen?
 - O&M access?
 - Will cleaning of screens be problematic?
 - Frequency of O&M?

18. **Cost of Screen Design**

Both capital and O&M costs?
Cost effectiveness?

19. **Scheduling and Permits**

Construction window to complete all work?
Difficulty in obtaining State, Federal, and local permits?

Consideration of Adverse Effects During Fish Exclusion Project Construction

Although fish screen projects built and operated to meet fishery resource agency design criteria have a long-term beneficial effect on fish species, adverse effects to listed fish species may occur during in-river construction activities from water quality degradation, habitat destruction, physical injury, or entrapment. If fish screens are not 100 percent effective in preventing entrainment and impingement of juvenile fish, adverse effects may occur during the long-term operation of the screen.

Figure 2 shows a typical *informal* consultation process recommended by the Service, Sacramento, California.

If a proposed Federal action has any adverse effects on listed species or habitat, formal consultation is required. Formal consultation will be needed to authorize *incidental take* of the listed species during the construction and operation phases of such a project.

Regarding *environmental considerations* at fish exclusion structures, construction activities normally have only minor, short-term, and localized negative environmental effects. Most construction for fish exclusion at small diversions is conducted during the non-irrigation season and in dewatered canals. The effects of the construction will normally be limited to primarily six environmental parameters: air quality, water quality, noise, vegetation, wetland resources, and fish and wildlife. Often, a FONSI is the result of the EA process. Regarding *permits and clearances*, construction will typically involve placement or excavation of materials within a stream or river. This will require permits, clearances, or approval from various Federal, State, and local agencies. These permits and clearances may include:

Section 404 permit from the Corps
Water quality certifications from involved States
County Shoreline Management Act exemption

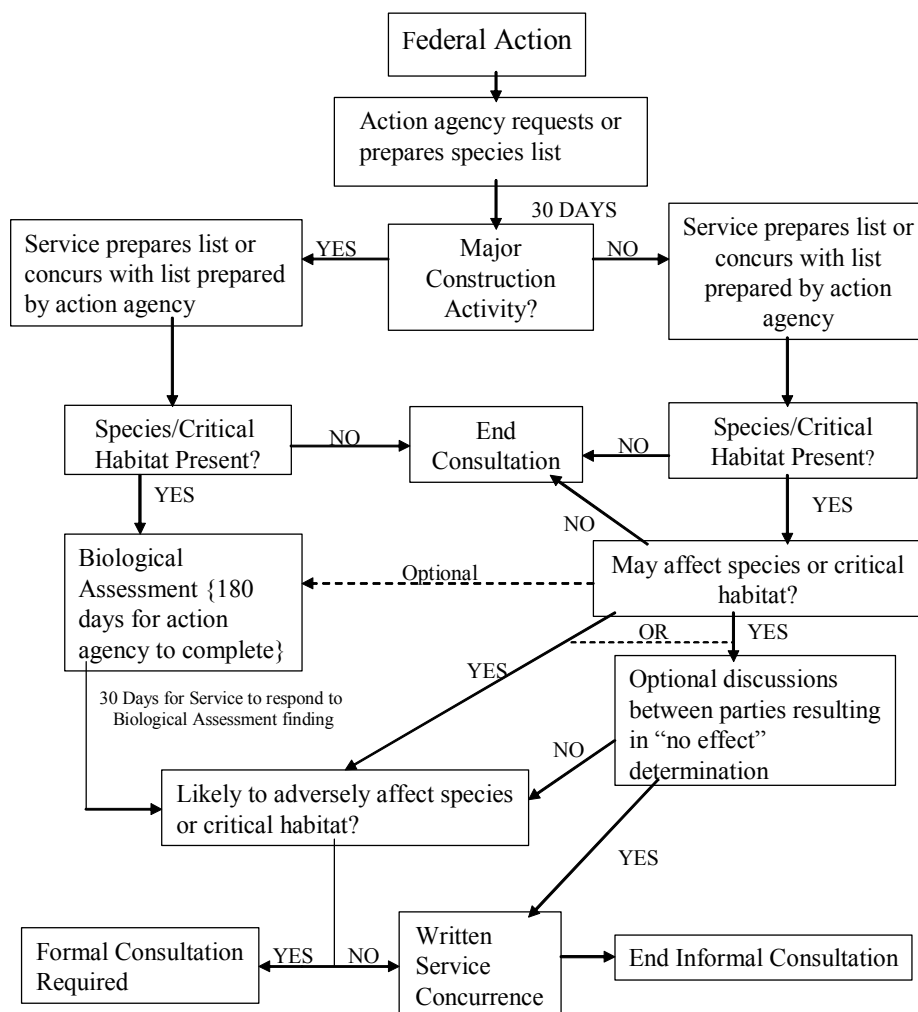


Figure 2.—Informal consultation process (Service, 2000).

Hydraulic project approvals from involved States
 Water standards and modifications from involved States
 Right-of-way and construction access approval from facility owners and private landowners
 Railroad crossing agreements where appropriate

Regarding *O&M*, responsibility for *O&M* costs will have to be determined before fishery exclusion facilities can be designed and constructed.

Operation costs include:

- ▶ adjustment of flow distribution on screens and bypass operation
- ▶ evaluation of facility during initial years of operation

Maintenance costs include:

- ▶ routine maintenance of trashracks, screens, and gates
- ▶ periodic cleaning, repair, and painting
- ▶ removal of debris and silt accumulation at screens
- ▶ removal of sediments from screen forebay areas

Replacement costs include:

- ▶ replacement of screen mesh, seals, gates, motor and drive mechanisms, cleaning equipment, and structural metalwork

Power costs include:

- ▶ power to operate trashrack and screen cleaning
- ▶ power to operate screen mechanisms
- ▶ backup power needs

A realistic estimate of annual operation, maintenance, replacement, and power costs needs to be determined, followed by an agreement, signed before construction proceeds, defining the responsibilities of the affected entities.

From a fish and wildlife perspective (Service, 2000), as soon as a proposed fish exclusion project is identified, a species list should be requested from the Service. An agency can also develop its own species list and confer with the Service or NMFS (NOAA Fisheries) as appropriate. This starts an informal consultation process. The Service and the NMFS (NOAA Fisheries) for anadromous species, will provide a list of threatened and endangered species that may occur in the project area or may be potentially affected by the proposed project. The list could take up to 30 days to prepare and, eventually, should be included in the appendix of any EA. Although an EA and a biological assessment (BA) have different content, an EA that adequately addresses impacts to listed and proposed species may serve as the BA pursuant to the ESA.

The BA should make one of the following determinations regarding effects:

No effect – the appropriate conclusion when the Federal lead agency determines its proposed action will not affect a listed species or critical habitat.

Is not likely to adversely affect – the appropriate conclusion when effects on the species or critical habitat are expected to be beneficial, discountable, or insignificant. Beneficial effects have current positive effects without any adverse effects to the species or habitat. Insignificant effects relate to the size of the impact and should never reach the scale where *take* of the fish species occurs. (“...to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct”). Discountable effects are those extremely unlikely to occur. Based on best judgement, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur.

Is likely to adversely affect – the appropriate conclusion if any adverse effect to listed species or critical habitat may occur as a direct or indirect result of the proposed action or its interrelated or interdependent action. In the event the overall effect of the proposed action is beneficial to the listed species or the critical habitat, but also is likely to cause some adverse effects, the proposed action “*is likely to adversely affect*” the listed species or critical habitat. An “*is likely to adversely affect*” determination requires formal consultation pursuant to Section 7 of the ESA.

When the BA indicates no effect or not likely to adversely affect, the Service provides a letter of concurrence, which completes informal consultation.” (Service, 2000)

The time period required to comply with the ESA, NEPA, FWCA, and Clean Water Act will depend on the complexity of the project, level of environmental impacts, document preparation, review and revision, and agency workloads. Figure 3 is an example of the typical time periods that may be required to meet compliance criterion.

If the biological opinion from the Service or NMFS (NOAA Fisheries) is a “jeopardy opinion” (project adversely affects a listed species), it contains a *reasonable* and *prudent* alternative that consists of few to many action items that the action agency is required to address. If the biological opinion shows a project is “likely to adversely affect” (short of jeopardy opinion), it contains *reasonable* and *prudent* measures that include terms and conditions that have a different suite of action items. They may both contain conservation recommendations. Biological opinions are issued to the Federal Government for Federal actions that may have potentially negative impact on a listed species.

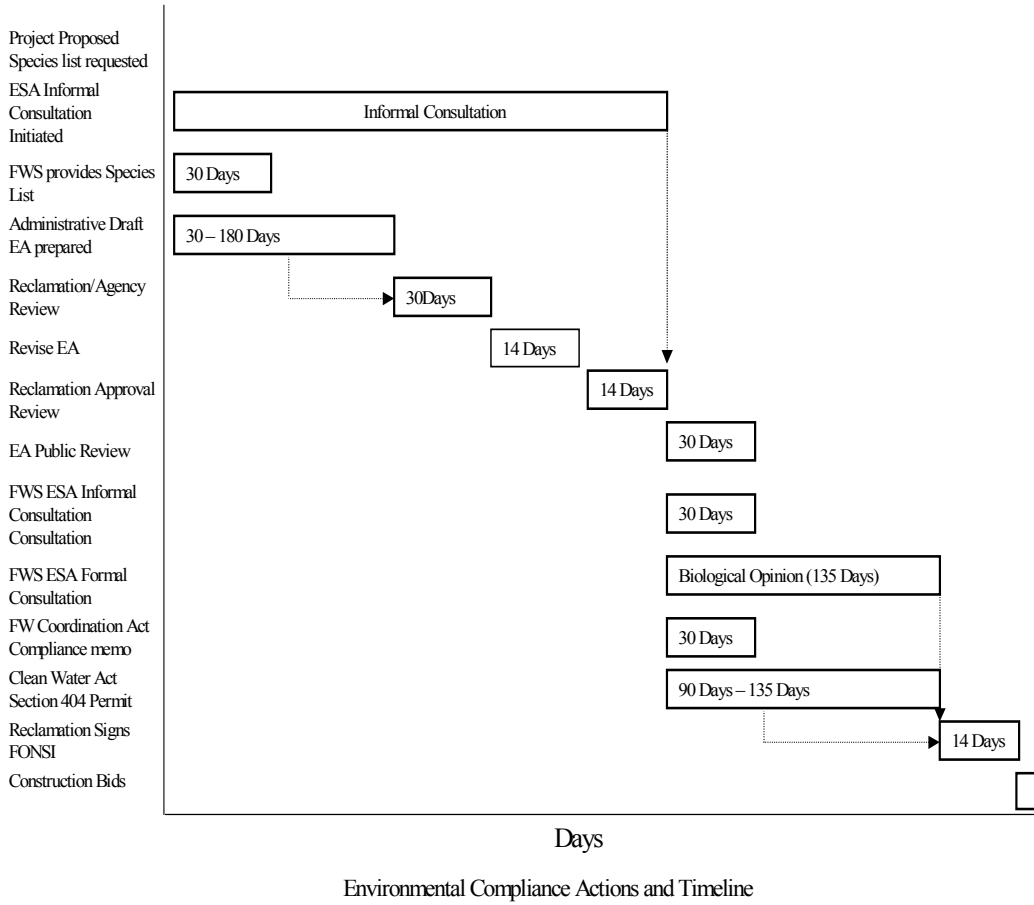


Figure 3.—Typical environmental compliance actions and timetable (Service, 2000).