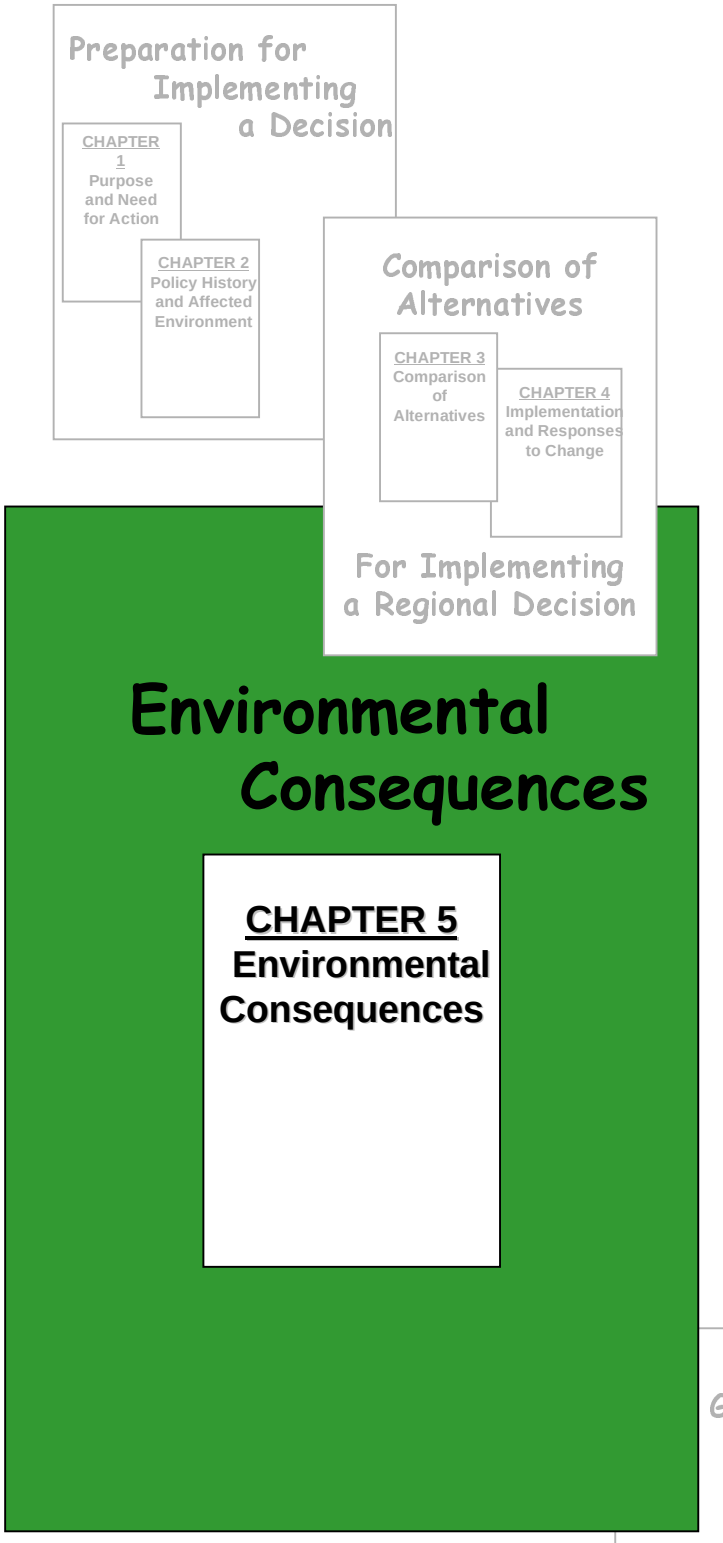

Chapter 5

Categories of Actions and Effects

Generic Environmental Consequences

Environmental Consequences of Policy Directions

Environmental Consequences of Reserve Options

CHAPTER 5 — ENVIRONMENTAL CONSEQUENCES

- **Briefly reviews the methodology that underlies the analysis of environmental consequences for this DEIS.**
- **Provides examples of generic effects and mitigation measures by common regional human activities.**
- **Illustrates the environmental consequences of proposed and reasonably foreseeable regional actions through providing an understanding of the relationship of human actions and their effects on natural and socioeconomic resources.**

Information in this chapter provides the technical and detailed basis for the analysis in this DEIS. For a summary of that analysis, please see Chapter 3 (Comparison of Alternatives).

This chapter is organized to allow logical review of the environmental consequences of implementing actions consistent with each of the Policy Directions. To allow for changing conditions, this document focuses on the broad perspective at the policy level, allowing for greater flexibility at the specific action level. The description of environmental consequences is based not upon numbers, but on the broader and more general qualitative analysis built upon observable relationships among policies, people, and their environment. These basic relationships will lead to a more reliable understanding of the environmental consequences of our actions, appropriate for this level of decision-making, and without giving a false sense of precision.

This DEIS includes a full range of foreseeable Policy Directions. Some Policy Directions will implement actions that are more favorable to fish and wildlife, but less favorable to some groups of people. Other actions may be more favorable to some groups of people but less favorable to fish and wildlife. This full range of potential Policy Directions requires a full range of descriptions of the potential effects. This description must include adverse effects on fish and wildlife, as well as adverse effects on natural resource users and other commerce. This chapter includes a description of potential mitigation for adverse effects. The full range of mitigation for potential adverse effects must also cover adverse effects from the fish and wildlife perspectives as well as from human perspectives.

Refresher: *The items below are summarized from Chapters 3 and 4 to provide an instant reference for the reader.*

1. *To arrive at the Policy Directions discussed in this DEIS, we studied the regional processes and proposals currently underway, the key issues identified, and the possible implementing actions. These bodies of information were grouped by theme to form the Policy Directions covering a broad range of possibilities.*

2. *The Status Quo is the No Action alternative, an option for continuing into the future with no Policy Direction change using all the same implementation actions currently in use. The region would experience more of the effects that characterize the existing environmental conditions.*
3. *All Policy Directions assume that human population and development will continue, though each Direction can influence the rate of growth. Specifically, with increased population and development, the Status Quo increases pressure on fish and wildlife and natural ecosystems as habitat is converted and as conflicts with fish and wildlife continue.*
4. *This DEIS has been prepared to meet NEPA requirements and to explore the environmental consequences (impacts) for each Policy Direction. With this information in hand, the BPA Administrator can be prepared to assess the potential effects of a given Policy Direction and to determine how BPA will meet its obligation to fund and implement actions arising out of that Direction.*
5. *Environmental consequences fall naturally into two areas:*
   (1) major environmental consequences for natural resources (land, water, and fish and wildlife resources) from common human activities, and
   (2) major environmental consequences for humans from actions taken to mitigate for past activities and recover fish and wildlife.
6. *The discussions below provide more detailed and technical information to support the comparisons found in Chapter 3 (Comparison of Alternatives). Consequences are expressed not in terms of exact numbers but, rather, in qualitative terms of whether they will be moving in a better or worse direction from the existing conditions under current policy.*
7. *The Policy Directions, as defined in this DEIS and discussed in terms of consequences below, are not rigidly set. This DEIS anticipates that the public or decisionmakers may modify them. Accordingly, the tools to facilitate analysis of modified Policy Directions have been provided. These tools include "mixing and matching" components (see Chapter 3), build your own alternative (Chapter 3 and Appendix E), response strategies (Chapter 4), reserve options (Chapter 4), and political or judicial intervention (Chapter 4).*

Section 5.1 provides background on the scope of the analysis in terms of the types of actions and effects analyzed. Section 5.2 describes adverse environmental consequences of more or fewer actions for fish, wildlife, and humans, as well as the range of factors that may influence the ultimate environmental effects. Section 5.3 discusses environmental consequences as they would occur under each of the five different Policy Directions compared to Status Quo.

5.1 CATEGORIES OF ACTIONS AND EFFECTS

The objective in the following section is to ensure that the BPA Administrator, as well as other decisionmakers and people in the region, understand the full scope of this DEIS. This scope involves actions taken for fish and wildlife recovery efforts as well as actions taken to reduce the costs and other adverse effects of existing fish and wildlife programs.

5.1.1 Categories of Actions

Implementation actions are commonly organized by four categories:

- *habitat* (the environment in which fish and wildlife live),
- *harvest* (commercial, sport, or other take of fish and wildlife),
- *hatcheries* (artificial, human-built ways to add to the populations of fish), and
- *hydrosystem* (actions involving operations or changes to dams or other water control facilities).

This set of "Hs" has become the commonly accepted elements of fish and wildlife recovery efforts under any Policy Direction.

- **Habitat.** Habitat actions include a large number of land and water management activities to improve survival of targeted species. Actions include *passive* restoration by reducing human activities and allowing natural regeneration and *active* restoration by physical modifications to land or vegetation. These two types of restoration can have very different patterns of natural and socioeconomic effects. Often, both types of actions will be used in a watershed to achieve habitat goals.

  Habitat actions are also classified according to the type of habitat affected:

  - *Uplands* are not hydrologically affected by downslope aquatic bodies. Habitat actions for fisheries on uplands generally seek to reduce polluted runoff to downslope aquatic systems.
  - *Riparian* areas are hydrologically connected to rivers and streams by groundwater or flooding. Riparian areas are often targeted for habitat improvements because of their close physical and ecological connections to river systems and their fish and wildlife. Habitat actions in riparian areas include avoidance and removal of human disturbances, reforestation and vegetation improvements, and active physical improvements such as land shaping.
  - *Wetlands* are seasonally or permanently wet. Habitat actions include wetlands creation and restoration by active and passive means.

- Habitat actions include active modifications to *river channels and streambeds* by physical means. Removal of riprap, adding woody debris or spawning gravels, and dredging management are examples.
- *Aquatic* habitat is the water environment itself. Many actions that affect aquatic habitat are classified as hydrosystem activities. [1]

- **Harvest.** Harvesting (taking fish or wildlife by various commercial, sport, or other means) modifies abundance, which can affect survival rates of species or their predators. Categories of harvest actions include ocean harvest reduction, shift to terminal harvest and selective harvest practices, change in harvest practices to allow more effective releases, and changes in recreational harvest including fishing and hunting regulations. [2] For unwanted predators of target species, actions include harassment, changes in sport harvest regulations, and incentives such as bounties.

- **Hatcheries.** Hatcheries include production facilities, supplementation hatcheries[3], genetic conservation facilities, and fish farms. Categories of hatchery actions include closing hatcheries, building new ones, and changing hatchery production practices. Hatcheries modify populations of targeted species by direct changes to population recruitment at specific life stages and points in time. Hatcheries may also modify desirable populations by interactions with hatchery-produced species through competition for space, food and reproduction. [4]

- **Hydrosystem.** Hydrosystem actions include changes in reservoir and diversion operations, or changes in hydrosystem facilities. The main purpose of hydrosystem actions for fish and wildlife is to increase survival for targeted species by improved aquatic habitat and migration conditions. These conditions include habitat volume and area; amount and timing of flow for water velocity, temperature, and other purposes; predator control; exotic species control; operations to control water quality, fish passage, and in-reservoir storage for

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[1] For a detailed assessment of the quality and quantity of freshwater habitat in the Columbia River Basin, current management and alternative management strategies, please see the Federal Caucus' Conceptual Plan (draft "All-H" paper) and its Basin-wide Strategy" (final "all-H paper) and the accompanying Appendix on Habitat.

[2] For a brief history of salmon harvest in the region, current harvest management and alternative harvest management strategies, please see the Federal Caucus' Conceptual Plan and Basin-wide Strategy papers and the accompanying Appendices on Harvest (Federal Caucus 199b, 2000b).

[3] Supplementation is an artificial propagation intended to reestablish a natural population or increase its abundance (Federal Caucus, 1999b, p. 144). A conservation hatchery program, by contrast, uses artificial propagation to recover Pacific salmon by maintaining the listed species' genetic and ecological integrity (Ibid., page 131).

[4] For a historical perspective on regional hatcheries, an assessment of current management and alternative management strategies, please see the Federal Caucus' Conceptual Plan and Basin-wide Strategy papers and the accompanying Appendices on Hatcheries (Federal Caucus, 1999b, 2000b), as well as Brown's Mountain in the Clouds: A Search for the Wild Salmon (1995) and Lichatowich's Salmon Without Rivers (1999).

resident fish and downstream use. Hydrosystem actions can also include modifications to the physical hydrosystem such as dam breaching, modifications for passage improvements, and streambed or bank modifications for flow purposes.[5]

It is important to recognize there are outer limits to certain actions under each of the Hs that are likely to be impractical or infeasible for a multitude of reasons. Below are some examples of possible limits for each "H."

- **Habitat**: restriction of all human access to essential habitat for fish and wildlife.
- **Harvest**: ban on all harvest (commercial, recreational, tribal).
- **Hatcheries**: closure of all hatchery operations.
- **Hydro**: removal of all dams and other human-made blockages.

(See Chapter 4, discussion of Reserve Options, for the more extreme applications of the Hs above.)

5.1.2 Categories of Environmental Effects

Implementation actions are generally undertaken to directly address a particular need and to achieve a desired or intended outcome. That action may also have associated "side" effects: outcomes that were not the primary objective of the action, but which occur nevertheless. It is important to understand the distinction between these two types of outcomes before proceeding to the discussion of environmental consequences.

Intended effects are those changes to the natural environment that are targeted by the implementing action, including the sequence of effects that is supposed to occur to achieve the desired effect.

- **Example**: Water may be released from one of the reservoirs to increase flow in the river to increase velocity to allow juvenile anadromous fish to move quickly toward the ocean, increasing the number that survive to adulthood. Increased flow, velocity, and survival are all intended effects.
- **Example**: Riparian reforestation (replanting along the banks of rivers and streams) is conducted to improve streambank characteristics, increase shading, and contribute to woody debris. These changes reduce erosion, moderate water temperature, and provide cover for fish in the stream. All of these are intended effects.

[5] For a more detailed assessment of the effects of hydropower on listed and other species, the current management of the system and alternative management strategies, refer to the Federal Caucus' Conceptual Plan and Basin-wide Strategy papers and their accompanying Appendices on Hydropower. The System Operation Review EIS (USDOE/BPA, Corps, and BOR, 1995) also provides background.

Associated environmental effects are not part of the intended effects to reach a direct action goal. When fish and wildlife recovery effort policy actions are taken to improve conditions for one or more species, indirect effects—associated negative effects—may occur for other fish and wildlife species or for humans. These effects are often unwanted and undesirable.

- **Example**: Water is released from the dams to increase flows to help the anadromous fish migrate to the ocean. At the same time, this action may lower the reservoir level. Lower water levels may affect cultural resources, wetlands, riparian habitat and communities, waterfowl, and spawning habitats. The lowering may also have negative effects on navigation and recreational activities, and further undesirable economic effects. The increased flow may increase undesirable gas (nitrogen) supersaturation and sedimentation, including turbidity in the water downstream.

This example illustrates a fundamental principle of environmental analysis. There are many complex relationships between actions and effects. If actions taken to achieve unambiguous resource improvements had no other effects, there would be little need for environmental analysis. Actions often have many effects, however, and environmental analysis is needed because some of these many effects are undesirable for some people and some fish and/or wildlife.

Actions often have trade-offs. A given implementation action may have the effect of limiting the potential for other actions.

- **Example:** A dam is breached. The *intended* outcome might be to support improved habitat for fish. The *associated* outcome, however, is that the dam can no longer be used to control operations on the river: a hydrosystem option has been eliminated. If different river flow patterns or reservoir levels are needed to facilitate fish and wildlife recovery efforts, those outcomes cannot be achieved by changing operations at the dam: the option of operating the dam is gone.

The following list illustrates trade-offs among hydrosystem actions by comparing the hydrosystem actions that would be best for different types of river uses. The optimum operation of reservoirs for one resource has effects that are not optimal for another.

OPTIMUM CONDITIONS FOR EACH RIVER USE[6]

Anadromous Fish - Streamflows as close to "natural" river conditions as possible, with mainstem reservoirs well below spillway levels.

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[6] Source: USDOE/BPA, Corps, and BOR, 1995, p. 4-2. How all of these effects are taken into account in making fish and wildlife policy can be reviewed in Section 2. Future site-specific projects will use this analysis of effects to determine the project's viability and provide specific details to where and how the effects will take place.

Cultural Resources - Stable reservoir elevations year-round.

Flood Control - Reservoirs drafted in early spring to capture snowmelt inflows.

Irrigation - Full reservoirs April through October (growing season).

Navigation - No reservoir drawdowns below minimum operating pool (MOP).

Power - Eliminate or reduce nonpower operating constraints on the system. Ramp flows up and down quickly to produce peaking power.

Recreation - Full reservoirs for long summer season (May-October) and stable downstream flows.

Resident Fish - Stable reservoirs year-round, with natural river flows.

Water Quality - Natural river flows with minimal spill.

Wildlife - Drawdown reservoirs year-round to expose maximum acreage for long-term habitat recovery. Allow flows as close to natural conditions as possible.

5.2 GENERIC ENVIRONMENTAL CONSEQUENCES

This section addresses the general nature of environmental effects in five fundamental areas: land, water, fish and wildlife, air, and socioeconomics. Each subsection provides the following:

- a summary of the types of human activities (whether carried out to further fish and wildlife or human needs) that **cause** this effect;
- a brief description of the **consequences** that are linked with the particular effect;
- a discussion of the **degree** (context and intensity) of those effects;
- a list of potential **mitigation measures** (actions that will lessen, eliminate, or compensate for the consequences); and
- a **discussion** that provides more background information on the intended and associated effects of each activity.

"Effects" and "mitigation" are used as they appear in the CEQ Regulations definitions, 1508.8 and 1508.20 respectively.

"Effects" include the following:
(a) Direct effects, which are caused by the action and occur at the same time and place.
(b) Indirect effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.

Effects and impacts as used in these regulations are synonymous. Effects include the ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative. Effects may also include those resulting from actions that may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial.

"Mitigation" includes:

(a) Avoiding the impact altogether by not taking a certain action or parts of an action.

(b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation.

(c) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.

(d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.

(e) Compensating for the impact by replacing or providing substitute resources or environments.

5.2.1 Analytical Coverage

Coverage refers to the scope of an analysis in terms of where, what, when and who. This DEIS is focused on effects within the Pacific Northwest region. For purposes here, this region is defined as any part of the United States within the Columbia River Basin or within BPA's service area; although there may also be effects in the Pacific ocean off the coasts of Oregon, Washington, British Columbia, and Alaska. Most fish and wildlife effects are expected to occur within the region. Most important social and economic concerns are within the region, although some effects might spread outside the region through imports and exports.

This DEIS is intended to have a very broad coverage: the range of foreseeable Policy Directions and actions for fish and wildlife in the region. Context and intensity, discussed below, also pertain to what is covered. The time horizon for the analysis includes short-term and long-term considerations. The short term includes effects up to 10 years from now. Long-term effects extend beyond 10 years and include the time horizon needed for ecosystems to recover to near-pristine conditions.

Analytical perspective, discussed in 5.2.1.2 below, defines who is covered by the analysis.

5.2.1.1 Context and Intensity

The alternative Policy Directions in this DEIS are meant to describe general changes in policies relative to the Status Quo. Most actions taken under a given Policy Direction could be implemented within a wide range of *intensity* or *amount*.

- **Examples:** Any number of hatcheries could be built, any number of commercial fishing vessels could be retired, and habitat practices could be applied to any number of acres or stream miles.

This document does not try to define such specific quantities for each Policy Direction. Rather, the DEIS tries to provide an understanding of how larger or smaller amounts of selected activities will have a strong influence on the degree of environmental effect. However, these qualitative assessments are based upon the technical data on each subject found in the SOR FEIS (USDOE/BPA, Corps, and BOR 1995), the Lower Snake River Juvenile Salmon Migration Feasibility Report DEIS (Corps, 1999a), the Business Plan FEIS (USDOE/BPA, 1995), ICBEMP SDEIS (USDA/USFS and USDOI/BLM, 2000), the Framework Report (Council, 2000a), and the Federal Caucus' Conceptual Plan paper (1999b) and Basin-wide Strategy (2000b) papers. For a more quantitative presentation, please refer to these documents, including the respective appendices. The specific references are noted throughout the qualitative analysis. The exact magnitude of effects will be determined as the specific implementing actions for the chosen Policy Direction are applied. These specific effects will be consistent with the qualitative analysis identified in this document and will be further detailed in the future tiering of decisions (Tiered RODs) carrying out the Policy Direction in play.

This chapter discusses effects in terms of *context* and *intensity*:

- **Context:** Actions will be implemented in a frame of reference that includes society as a whole, the affected region, the affected interests, and the locality. This means that the *significance* of a given action may vary with the *setting* of the action. Both short-term and long-term effects are relevant.
- **Intensity:** The intensity of an effect refers to its *degree of severity.* We consider whether it affects public health or safety, whether it helps or harms a unique resource, whether the effects are likely to be highly controversial, the degree of risk, and the extent to which it supports or adversely affects protected species or resources. [7]

Context and intensity in section 5.2.2 (consequences for fish and wildlife) are discussed in relation to natural resources affecting the most important parts of fish and wildlife life cycles. Context and intensity in section 5.2.3 (consequences for humans) are discussed in relation to groups of people and regional communities (e.g., tribes, people who fund fish and wildlife restoration, various industries) that may be affected by actions. The distribution of effects of fish and wildlife actions among industry subgroups—owners,

[7] For more information on these terms, see Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act, 40 CFR § 1508.27.

workers, and consumers—depends on the structure of the industry, market conditions, and institutional considerations, among other factors.

"Socioeconomic" consequences can cover many areas: social, economic, aesthetic, cultural, and health-related effects. Those effects are strongly shaped by how actions are implemented, how human behavior is affected, and by how people respond to the actions. Scientists, elected officials or other individuals or groups may react by seeking to adjust the policy or the actions in order to improve the intended effects or to mitigate the associated effects, thus beginning a new round of action-effect-reaction. Figure 5.1 illustrates this iterative process.

5.2.1.2 Analytical Perspective

Chapter 2 described existing environmental conditions: the natural environment as it relates today to fish and wildlife, the socioeconomic environment as it relates to humans, and the existing policy environment, including new policy initiatives. These environmental conditions were determined over time through a series of interactions between humans and the natural environment. The interactions and their results may be viewed from the perspective of humans and from that of the fish and wildlife resource.

This section reviews the environmental consequences data from both perspectives:

- **Generic effects for land and water are reviewed from the fish and wildlife perspective.** The fish and wildlife perspective is concerned with improvement of fish and wildlife resources. Land and water categories include the overwhelming share of direct effects on fish and wildlife. Most of the adverse effects described below result from human activities or actions that reduce fish and wildlife protections.

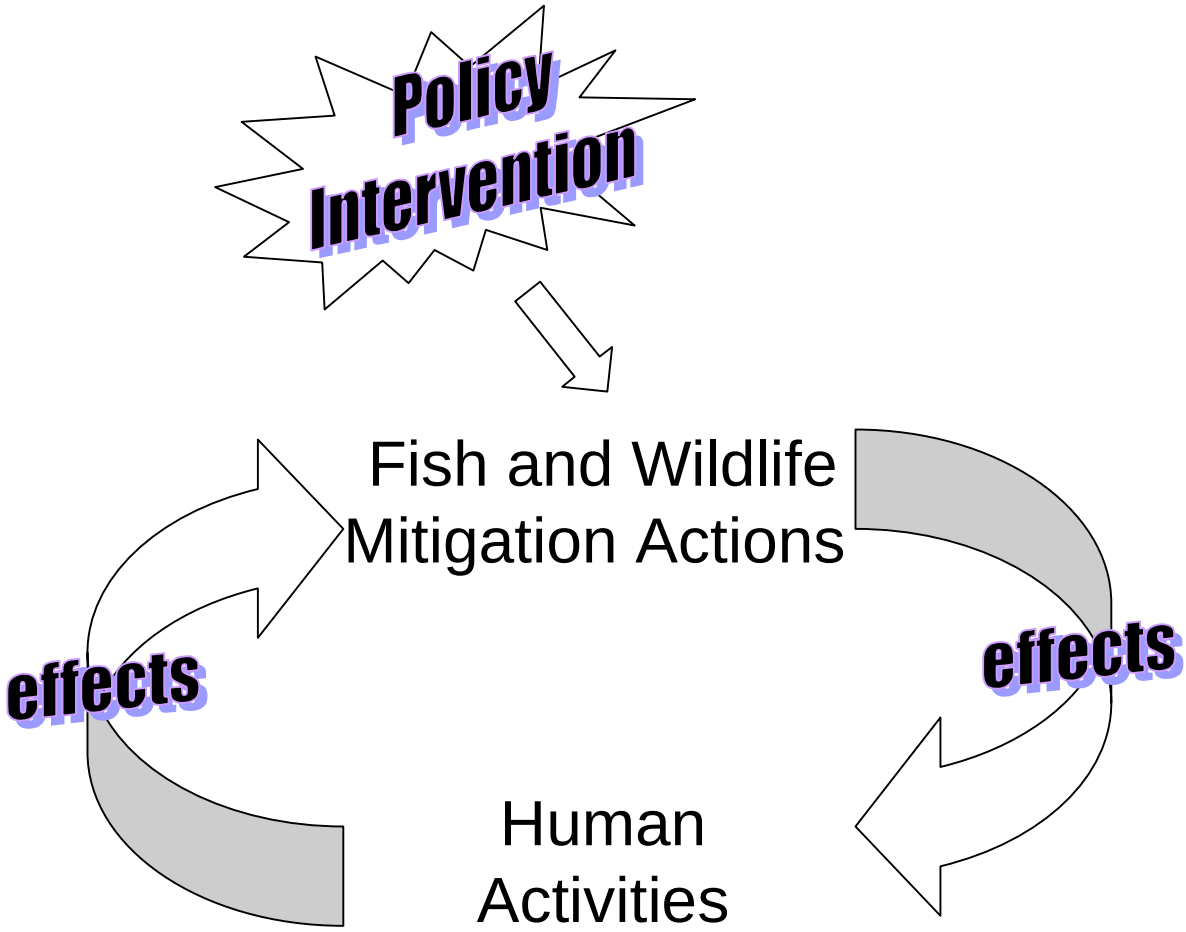
- **Generic effects for air and socioeconomic resources are reviewed from the human perspective.** The human perspective is concerned with human improvements, including economic and social values associated with fish and wildlife. Most of the adverse effects from the human perspective result from either (1) losses of valuable fish and wildlife, or (2) costs of actions taken to rebuild, recover or protect fish and wildlife populations.

5.2.2 The Major Environmental Consequences for Fish and Wildlife From Common Contributing Human Activities

Refresher: *Effects on land and water resources encompass the overwhelming share of habitat effects, either intended or associated, on fish and wildlife. Generic effects for land and water are reviewed from the fish and wildlife perspective.*

Below, effects are expressed in terms of the associated adverse effects of human use and development on fish and wildlife. These adverse effects would generally be associated with actions that reduce fish and wildlife protections or allow more

Figure 5-1: Actions-Effects-Reactions Illustration



human use and development. Potential mitigation strategies for these adverse effects are provided.

For actions that would intentionally reduce human use and development, a beneficial effect would generally occur from the fish and wildlife perspective. These beneficial effects have human values associated with increased numbers and size of fish and wildlife, and perceptions of an improved environment. Generally, the discussions below could be expressed oppositely to derive these beneficial environmental effects. Economic values may involve commercial fishing, recreational fishing and hunting, and aesthetic, option and existence values. These economic values are discussed in more detail in Section 5.2.3.2.

5.2.2.1 Land[8]

Human Activities

The types of activities that affect land use and habitat quality and quantity are as follows:

- forestry;
- agriculture, including irrigation, cropping and grazing;
- recreation;
- mining;
- urban and rural development for residential, commercial, and industrial uses; and
- utilities and transportation.

Possible Adverse Effects

There are three primary land habitat concerns:

- direct loss of, or disturbances to, fish and wildlife habitat
- land use effects on quality of aquatic and terrestrial habitat; and
- direct adverse contact with fish and wildlife.

Context and Intensity

Many factors influence the degree of effect of human activities on land habitat values. The degree of effect on land resources is a function of the types, intensity and amount of land use, and these factors are themselves a function of economic factors, technology, tastes and preferences, and other cultural factors.

[8] Consequences discussions are drawn directly from existing regional studies. For more information and background, please see: Federal Caucus 1999b and 2000b, Council 2000a, Corps 1999a, USDA/USFS and USDOI/BLM 2000, and USDOE/BPA, Corps, and BOR, 1995 at 4.3.

Table 5.2-1
Factors that Shape Effects of Land Use and Terrestrial Habitat Values on Fish and Wildlife

Factors Leading to Effect	Effect
Market factors such as population growth, demand for land use products, supplies of products from other regions, technology, tastes and preferences, other cultural factors, and environmental regulations	Types and amounts of land uses, intensity of these uses
Public land use policies, pricing of forest products and grazing	Amounts and intensity of grazing and forestry
Sport fishing and hunting regulations	Recreational fishing and hunting land use
State water doctrines and laws	Amount and characteristics of irrigated land use
Economic conditions, local zoning and development regulations	Characteristics of development and land use practices

Possible Mitigation Measures

Forestry actions used to reduce potential adverse effects on fish and wildlife habitat can include the following:

- preservation (non-harvest) of forest lands and stream corridors to allow natural habitat development;
- modified harvest practices, tailoring of harvest methods to slope and soils, and closing or controlling access and obliteration of forest roads to control use and erosion, and that foster forest regeneration and productivity;
- harvest techniques that retain some of the original forest features such as seral stages, snags, downed wood, large trees, and preferred species;
- creating forest patterns, ages, structures, and compositions to support local wildlife with the preferred habitat qualities;
- developing of more sustainable wildlife forest habitat by silvicultural techniques, including controlled burns; and
- forest stewardship to improve forest health and habitat representation.

Agriculture actions to reduce potential land use conflicts with fish and wildlife habitat include the following:

- management of cropland or shifting crop type to improve wildlife values; and
- land retirement and restoration of land back to native habitat.

Livestock grazing actions commonly used to reduce livestock effects on fish and wildlife habitat are as follows:

- fencing livestock out of sensitive areas;
- strategic placement of watering sources on uplands;

- seasonal or rotational grazing, changed grazing intensities, or deferred grazing, and
- land acquisition and retirement.

Recreation actions can include the following:

- changes to sport fishing and hunting regulations,
- public education,
- controlled intensity or rotational use,
- location of recreational activities away from fish and wildlife habitat, and
- improved regulations and enforcement.

Urban and rural development actions to reduce effects on fish and wildlife habitat include the following:

- location of urbanization away from sensitive habitats;
- acquisition and conservation easements of sensitive habitats;
- limited public access or use of habitats;
- public education;
- improved laws governing refuse;
- road reclamation;
- retention of roadless areas;
- road maintenance/improvements including fish passage, culverts; and
- "fireproofing" the rural/wildland interface.

Discussion

Many actions taken under the Policy Directions would decrease or reverse current terrestrial habitat disturbances; however, some Policy Directions might allow for increased use of existing habitat for human purposes. Human land-use activities can degrade the habitat for different species differently. In some cases, changing land use creates new or improved habitat for some species**.**

Common human activities that affect land include forestry, grazing, other agriculture, recreation, urban development, and urban land-use practices contributing to stormwater run-off. These activities can cause the loss of normally functioning habitat for fish and wildlife through loss of food, space, other critical needs, or pollution. Direct mortality can occur as the activity is taking place. Land-use practices have off-site effects through processes that transport materials off-site. For example, runoff transports agricultural and urban pollutants and large woody debris is moved downhill toward streams by mass wasting events. Problems associated with degraded runoff are discussed in the water use, Section 5.2.2.2, below.

Forestry practices can contribute to adverse effects on fish and wildlife through direct temporary loss of habitat for certain species. Wildlife can be affected through modification of cover, food sources, or roosting and breeding areas. For fish, forestry practices in riparian areas can be detrimental through modification of aquatic shading and other riparian values, and removals of large trees that reduce potential contributions of large woody debris to increase stream habitat complexity. Roads, culverts, and chemicals can also disrupt ecosystem integrity.

Livestock grazing can affect fish and wildlife by competition for food and space, by habitat degradation, and by directly trampling plants, or nests. Where livestock are allowed in riparian corridors, damage to riparian areas and streambanks is considered an important contributor to salmonid spawning and rearing habitat degradation. Trampling contributes to reduction of plant life, alteration of shading, loss of meanders, and loss of important streambank characteristics such as overhangs. Grazing can contribute to a reduction of important riparian plants such as willows and plants that support insects fed on by fish. Livestock sometimes walk or stand directly in streambeds, where they can disrupt salmonid nesting and degrade water quality.

Agriculture affects wildlife primarily by loss of native habitat. Conversion from native habitat to cropland is a near-complete loss of the original native species that occupied that land. Cropland or pastureland can sometimes provide habitat benefits (food source and open spaces), and these benefits can be increased by improved management.

Recreational land use can have adverse effects on fish and wildlife through loss of habitat, disruption of fish and wildlife feeding, spawning and mating, and direct mortality by coming in contact with recreational activities. Important recreational activities include sport fishing and hunting, use of vehicles, and development of recreation facilities. Direct effects can be caused where anglers wade into streams, destroying anadromous fish nests; by poaching; or where automobiles directly strike and destroy wildlife. Development may result, for example, in a loss of habitat for parking or other facilities, disruption of normal fish and wildlife activities, and deposition of trash (e.g., fishing line or food debris that is a hazard to fish and wildlife.

Commercial and residential development activities can contribute to fish and wildlife losses through direct losses of habitat and through activities on urban lands which directly or indirectly destroy fish and wildlife or their habitat. Urbanization may result in loss of food sources, modified habitats unsuitable for existing wildlife, or introduced toxic chemicals that can injure or kill fish and wildlife. Fish and wildlife may also be killed by automobiles, boats and the other artifacts of modern civilization.

5.2.2.2 Water[9]

Human Activities

The types of activities that affect water use and value for habitat are as follows:

- reservoir operations,
- point and non-point sources of water pollution, and
- diversion and consumptive use of water.

Possible Adverse Effects

There are six primary water concerns:

1) water quality and flow effects from land-use activities;
2) loss of riverine habitat caused by reservoir inundation;
3) impediments to fish passage caused by dams and other structures and the slack water behind them;
4) changes or disturbances to downstream flow and water quality through river and reservoir operations for multiple uses;
5) direct pollution of the water; and
6) water withdrawals reduce flow and remove organisms from aquatic systems.

In addition, the introduction of the zebra mussel, a filter feeder, alters the freshwater ecosystem by causing changes in water quality.

Context and Intensity

Many factors influence the degree of effect of human activities on water use, aquatic habitat and habitat values, as Table 5.2-2 illustrates.

Table 5.2-2
Factors that Shape Effects of Water Use on Fish and Wildlife

Factors Leading to Effect	Effect
Factors affecting land use. See Table 5.2-1	Land use, water induced erosion, characteristics of degraded runoff and sedimentation
Reservoir levels, inflow, spill operations, bypass facilities in place, fish transportation, flows through turbines, turbine efficiency	Fish passage survival; resident fish spawning, rearing, and foraging survival
Reservoirs built and normal operating range	Amount of riverine habitat lost

[9] Consequences discussions are drawn directly from existing regional studies. Also see, Federal Caucus 1999b and 2000b, Council 2000a, Corps 1999a, USDA/USFS and USDOI/BLM 2000, and USDOE/BPA, Corps, and BOR, 1995 at 4.3.

Table 5.2-2
Factors that Shape Effects of Water Use on Fish and Wildlife

Factors Leading to Effect	Effect
Operations for hydropower, flood control, irrigation, fish and wildlife, other purposes	Downstream flow, water quality and saturated gas conditions; sedimentation, riparian flood plains
Growth and types of industry, water pollution laws, pollution control technology	Amount and characteristics of point-source water pollution
Agricultural markets, agricultural costs, irrigation technology and costs, water conveyance technology and costs, water conservation and screening incentives	Amount of irrigation, irrigation efficiency, amount of diversion and mortality of aquatic life.

Possible Mitigation Measures:

Gas supersaturation can be reduced by:

- reduced spill;
- facility modification, such as deflectors, that reduce potential for supersaturated water;
- using juvenile bypass or transportation systems to keep fish away from areas with supersaturated water;
- dam removal;
- lowering dam/reservoir crest levels;
- constructing more reservoir storage capacity; and
- deeper flood control evacuation leading to reduced spill later.

Sedimentation can be reduced by:

- modern forestry best management practices;
- preservation (non-harvest) of forest lands;
- tailoring of harvest methods to slope and soils;
- closing, controlling access, or reclamation of forest roads;
- regenerating vegetation quickly following harvest;
- land retirement and restoration of land back to native habitat, or changes in farming practices to reduce or capture runoff;
- using modified cultivation practices, conservation tillage, no-till agriculture, cropping changes, and development of small ponds to retain water; and
- grazing practices that reduce grazing intensities and exclusion fencing.

Temperature of the water can be controlled:

- on a limited basis at dams by pool elevation adjustments (but the relationships are complex and differ among projects: storage pools are deep and stratify thermally during the summer, while run-of-the-river pools typically have more uniform temperature distribution);
- using techniques to provide adequate shade to help control temperature. Stable flows and periodic flooding without drawdowns help maintain riparian vegetation; and
- reducing irrigation return flows, which are often warmer than receiving water, via irrigation water management or land retirement.

Non-thermal pollution can be reduced:

- for livestock effects on aquatic systems, by fencing out livestock and providing alternative watering sources on uplands;
- by seasonal or rotational livestock grazing, reduced grazing intensities, deferred grazing, and land acquisition and retirement**;**
- by strategies to avoid polluted surface water runoff from agriculture, including changes in farming practices such as modified cultivation practices, conservation tillage, no-till agriculture, development of tailwater ponds to retain water, increased use of organic farming techniques, and cropping changes to reduce or capture impaired runoff;
- for feedlots, by using best management practices to prevent off-site water quality degradation;
- via strategies to reduce degraded irrigation return flows, including irrigation land retirement, lease or purchase of irrigation water, and irrigation water conservation;
- by using wastewater and sedimentation ponds to retain and treat degraded runoff from uplands;
- by capping contaminated sediments with clean material. Contaminated sediments are rarely dredged because dredging disperses the pollutants and creates a disposal problem; and
- by filtering and/or distilling out metals and organic contaminants in water. The processes are expensive and typically sterilize the water of all living organisms.

Water withdrawal effects may be reduced by:

- retirement of irrigated land;
- fallow of irrigated land in dry years to maintain downstream flows;
- using irrigation water conservation techniques to reduce diversions and return flows, often with water quality and quantity benefits for the aquatic system; and
- screening of irrigation diversions to avoid direct mortality of juvenile salmonids.

Discussion

Human activities on land can contribute to sedimentation and degraded quality of surface water runoff. Erosion is caused by agricultural, forestry, and urban land-use practices, and natural run-off, including flooding. Surface water irrigation contributes to sedimentation in some tributaries because return flows are often high in sediments. Dryland farming and grazing can also contribute to sedimentation through disruption of soil surfaces. Forestry can contribute to stream sedimentation through construction and maintenance of roads and stream crossings, use of machinery to harvest and transport timber, and loss of vegetative cover.

Sedimentation can also be caused by pool level fluctuations. If the water level in a reservoir drops quickly, the increased weight of the saturated materials, along with removal of lateral support from the water, can cause slumping or may cause mass wasting.

Sedimentation reduces survival of eggs and alevins, reduces primary and secondary productivity, interferes with feeding, causes behavioral avoidance and breakdown of social organization, and pool filling or addition of new large structures to channels**.** However, some level of sediment and resulting turbid conditions may be quite important to some species and particular parts of life history. For example, turbid conditions during spring freshets may be helpful to migrating juvenile salmon and sturgeon.

Surface water withdrawals can directly dewater streams and rivers (especially in dry years), impeding access to spawning areas, uncovering eggs (causing them to dry out), increasing water temperatures, and causing direct mortality or injury by sucking fish into the water intakes. Surface and ground water withdrawals can lower groundwater tables, possibly affecting deep-rooting plants and streamflows.

Non-thermal pollution can enter surface water from industrial discharges, stormwater, sewers, and agricultural run-off. Septic systems also contribute to this type of pollution in some areas. The pulp and paper industry discharges include dioxins and furans. Metals originate from many places, including natural sources, construction, urban runoff, wastewater, coal combustion, mining, and smelting. Polycyclic aromatic hydrocarbons (PAHs) come from combustion sources (forest fires, auto exhaust, and the aluminum industry). Chlorinated hydrocarbons come from sewer and industrial discharges. Insecticides come from domestic and agricultural uses. PCBs, although no longer manufactured, are very persistent and are found worldwide, even in the most remote areas. Simple grazing of cattle or other livestock near streams and rivers can introduce animal wastes that release potentially harmful chemicals and *E. coli* bacteria.

Non-thermal pollution's primary concern for fish is through ingestion of pollutants. Pollutant toxicity is difficult to describe because there are complex interactions between pollutants; many have similar toxic mechanisms or target organs compounding their effects. Insecticides generally attack the central nervous system, affecting fight-or-flight responses and systems such as the olfactory senses. Metals can affect multiple organs and metabolic processes such as food utilization, respiration, and growth and

reproduction rates as well as behavior. In addition, some metals (lead and mercury) preferentially target the central nervous system. Copper is particularly toxic to fish and aquatic food chain organisms. Some are also carcinogenic (nickel, arsenic, cadmium, chromium, and in some cases, lead.) PCBs are associated with immunological suppression, reproductive impairment and cancer. PAHs cause a whole host of problems including reduced growth, reduced reproductive success, immunological dysfunction and cancer.[10] It is also well known that immuno-suppressed fish are more susceptible to disease and pathogenic challenges and ultimately experience an increase in mortality.[11]

Storage of water in reservoirs can alter the normal thermal regime of a river. Too much storage can increase temperature due to reduced flow volumes downstream of reservoirs. It can also increase thermal regime in shallow reservoirs. Deep reservoirs can release too much cold water in hypolimnetic deep-water releases and too much warm water during the winter.

Temperature extremes can harm fish and aquatic organisms. Too much cold water can delay egg development and migration of salmon. Too much warm water can stress salmon physiologically and become lethal depending on exposure time, or trigger premature egg hatching. Water temperatures affect adult migration patterns. Above-optimal temperatures accelerate development of eggs and alevins, cause earlier fry emergence, increase metabolism, increase primary and secondary production, increase susceptibility of both juveniles and adults to certain parasites and diseases, and increase predation on juvenile fish. Mortality of salmonids occurs at sustained temperatures of greater than 73 degrees Fahrenheit. Sub-optimal water temperature can also cause cessation of spawning, increased egg mortalities, and susceptibility to disease.[12]

During their downstream migration, juvenile anadromous fish can be harmed by the hydrosystem in several ways. Migration may be slowed due to lower water velocities and difficulty in passing dams. No correlation exists between migration speed and mortality, but hypotheses include increased predation and delayed ocean entry as potential mortality factors. Also, populations of the endemic northern pikeminnow, which preys on salmon, have increased in response to the reservoir environment. At the dam, they may pass through the hydroelectric turbines and/or pass through spillways; and they may be diverted to bypass systems directing them away from the spillway and turbines. Some are transported downstream by barge and truck. Depending on the passage route, the juveniles may be subject to increased mortality related to aging, shock, temperature, sudden pressure changes, disorientation, or increased predation downstream.

Large volumes of voluntary spill have been used as an interim passage strategy by NMFS, pending development of more effective alternatives.[13] In general, moderate

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[10] NOAA(a), NOAA (b), McCain et al. 1990, Arkoosh et al. 1991, Arkoosh et al. 1994, Stein et al. 1995.

[11] NOAA (a), NOAA (b).

[12] See: Corps (1991) and Conceptual Plan (Federal Caucus, 1999b) and Basin-wide Strategy (2000b), Habitat Appendix, pg. 134 and Hydro Appendix, pg. 39, 1/11/00)

[13] NMFS BiOps of 1995, 1998, 1999

levels of spill provide for increased Fish Passage Efficiency (FPE) at relatively low risk. However, as spill increases above about 30% of flow, the incremental benefits of increasing spill diminishes. At spill levels higher than 30%, the risk of undesired effects also increases, including risks to both juvenile and adult migrants (as well as resident species) from gas supersaturation and adverse hydraulic conditions. Voluntary spill for fish passage is provided at each of the eight federal mainstem dams in the spring, limited by interim dissolved-gas limits established by the states of Oregon and Washington. Fish spill is provided at Bonneville, The Dalles, and Ice Harbor Dams for 24 hours a day, and for 12 hours a day at John Day, McNary, Lower Monumental, Little Goose, and Lower Granite Dams.

Spill can have the undesired effect of increasing levels of gas-supersaturation in the water, which in turn increases the risk of gas bubble disease (a condition similar to the bends in humans) to migrating salmon. Gas supersaturated water reduces survival of eggs and alevins, results in smaller size at emergence, increases physiological stress, and diminishes growth. Total dissolved gas (TDG) can be abated structurally (e.g. flow deflectors) and operationally by controlling spill by using storage, surface bypass, and baffled spillways.

Other passage methods, including mechanical bypass systems and transporting juvenile fish in trucks and barges to release sites below Bonneville Dam, are currently in use. Juvenile fish transportation was developed as a means to convey fish past multiple dams and reservoirs to reduce the cumulative effects of dam-related and reservoir-related mortality. Juvenile migrants that are guided by turbine intake screens can be collected and loaded onto trucks or barges and transported for release below Bonneville Dam. There they continue their migration to the ocean.

Currently, flow augmentation programs help restore more natural/seasonal flow patterns during the time juvenile salmon and steelhead are migrating downstream. A flow augmentation program, first called for by the NPPC and later increased under NMFS' 1995 and 1998 Biological Opinions, aims to restore more natural flow patterns during the time juvenile salmon and steelhead are migrating. The 1995 and 1998 Biological Opinions include two flow management strategies: limit the winter and spring drafts of storage reservoirs to increase spring flows and the probability of full reservoirs at the beginning of summer; and draft from storage reservoirs during the summer to increase summer flows. There is evidence that controlled releases for spring migrants provide very little survival benefit to spring chinook juveniles. Controlled releases may increase survival of fall migrants.[14]

The human-introduced zebra mussel is likely to have enormous impacts on the food chain upon which salmon depend. In the decade since it was first sighted in the U.S., the zebra mussel has been described as "the biggest natural threat to existing freshwater ecosystems

[14] Olsen et al 1998.

of our time."[15] Their presence causes a decrease in phytoplankton and zooplankton, resulting in increased water clarity. Water quality impacts include increased soluble phosphorous and inorganic nitrogen, and decreased dissolved oxygen—to the point of violating water quality standards.[16]

5.2.2.3 Fish and Wildlife[17]

Human Activities

The previous two sections explained how human use of land and water affect fish and wildlife. Fish and wildlife life cycle diagrams were created to illustrate where the different effects occur and have the most impact. The interaction of land and water effects with the life cycles is central to the analysis conducted in section 5.3 below. As can be seen in the life cycle diagrams (Figures 5-2, 5-3, 5-4, 5-5, 5-6, and 5-7), changes to land and water resources affect anadromous and resident fish and wildlife differently.

Land and water use activities are not the only human activities that affect fish and wildlife. Other human activities that affect fish and wildlife are

- commercial harvest, including tribal and non-tribal;
- fish hatcheries and other artificial production facilities; and
- introduction and spread of exotic plants and animals.

Possible Adverse Effects

The major adverse effects are shown using the life cycle diagrams below. Many of these effects were discussed in Sections 5.2.2.1 and 5.2.2.2. Other adverse effects include the following:

- direct mortality by harvest;
- unintentional mortality to fish hooked, netted, or delayed, but not harvested;
- reduced life history and genetic diversity by harvest;
- competition with hatchery fish for food and space;
- artificial selection and breeding with hatchery-produced fish leading to long-term changes in genetic characteristics of stocks;
- competition with exotics for space or food, predation by exotics, or replacement of valuable food sources by exotics;

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[15] O'Neill, C.R., Jr. 1996. "The Zebra Mussel: Impacts and Control," Cornell Cooperative Extension Information Bulletin 238, page 62.

[16] Effler, S.W., and Siegfries, C. 1994. *Zebra mussel (Dreissena polymorpha) in the Seneca River, New York: Impact on oxygen resources.* Environmental Science Technology, Volume 28, pages 2216-2221.

[17] Consequences discussions are drawn directly from existing regional studies. Also see, Federal Caucus 1999b and 2000b, Council 2000a, Corps 1999a, USDA/USFS and USDOI/BLM 2000, and USDOE/BPA, Corps, and BOR, 1995 at 4.3.

- maintenance of unnaturally high predator populations by large influxes of juvenile hatchery and exotic fish; and
- interference with migration at fish ladders caused by introduced species.

Context and Intensity

Many factors influence the effects of human activities on fish and wildlife. Many of these factors work through land and water habitat quality and hydrosystem effects. These factors were explained in Tables 5.2-1 and 5.2-2, respectively. Additional factors involve harvest and hatcheries. Many natural, social, cultural and economic factors interact with harvest and hatcheries to determine their consequences for fish and wildlife.

Table 5.2-3
Factors that Shape Effects on Fish and Wildlife

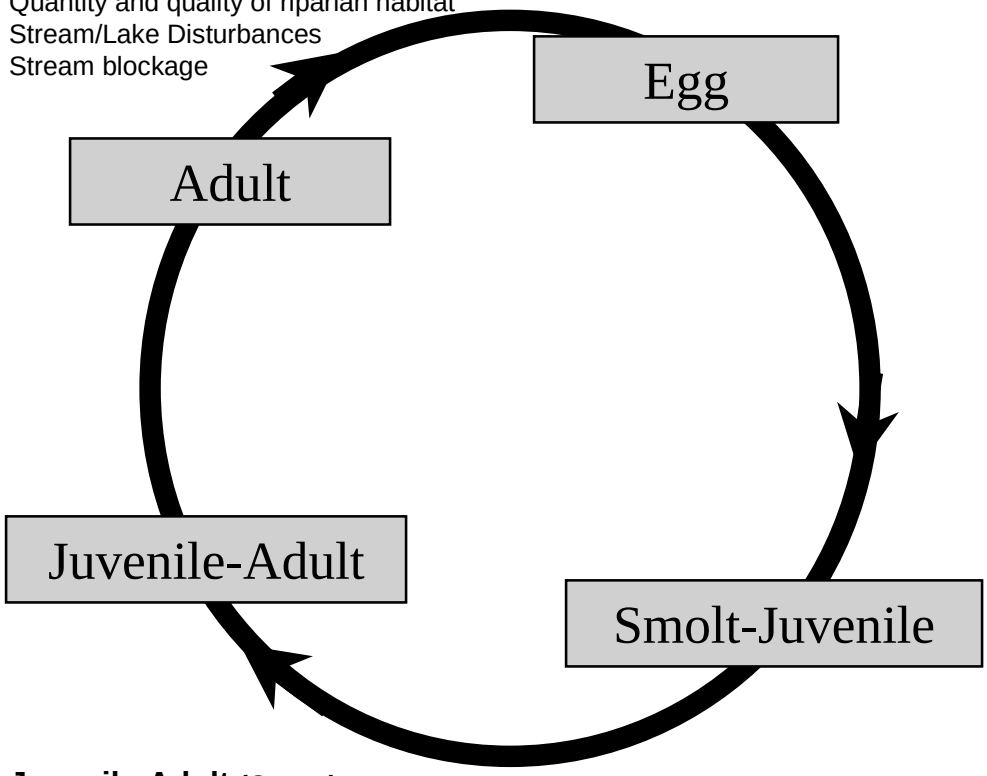
Factors Leading to Effect	Effect
Land use and terrestrial habitat	Amount and quality of terrestrial habitat, see table 5.2-1
Water use and aquatic habitat	Amount and quality of aquatic habitat, see table 5.2-2
Fishing seasons, regulations, economics, size of the fishing fleet	Amount of fish harvested
Size of caught fish, interactions with marine mammals, regulations	Mortality of hooked or netted fish
Number of fish produced by hatcheries, timing and location of releases. Characteristics and operations of hatcheries	Characteristics of fish competing with native stocks, extent of cross-breeding
Types, locations and densities of exotic plant and animal species	Consequences of exotics

Possible Mitigation Measures

Potential mitigation strategies for adverse effects of harvest, hatcheries and exotic species on anadromous fish include the following:

- reduce fishing season,
- reduce limits,
- change fishing gear regulations,
- develop selective fishery techniques,
- buy out fishing permits,
- change international fishing treaties,
- develop terminal fisheries,
- phase out hatcheries,
- change hatchery operations to minimize effects on wild populations, and

Figure 5-2: Examples of Major Environmental Effects
Anadromous Fish Life Cycle



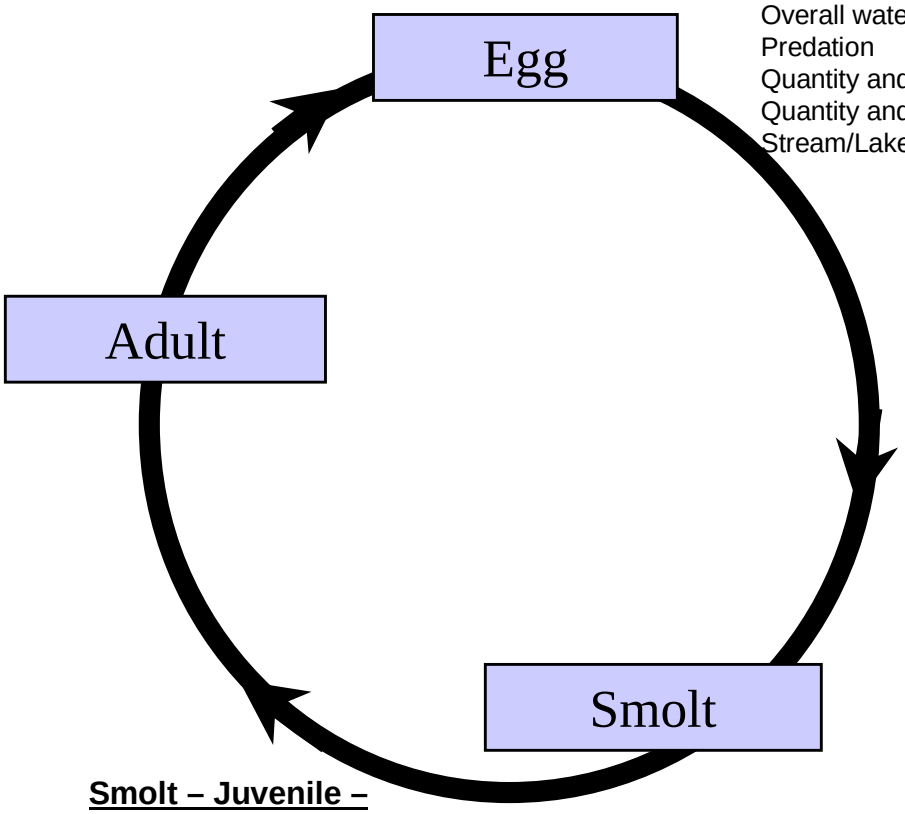
Adult
(Pre-spawning/Migrating upstream)
Competition with other species
Dam passage
Disease
Fishing
Overall watershed hydrologic balance
Predation
Quantity and quality of instream habitat
Quantity and quality of riparian habitat
Stream/Lake Disturbances
Stream blockage

Egg – Alevin – Fry - Fingerling
Competition with other species
Disease
Lack of food
Overall watershed hydrologic balance
Predation
Quantity and quality of instream habitat
Quantity and quality of riparian habitat
Stream/Lake Disturbances

Juvenile-Adult (Ocean)
Chemical pollutants
Competition with other aquatic species
Disease
Fishing
Lack of food, nutrients
Lack of oxygenation
Predation
Water temperature too warm, too cold

Smolt – Juvenile
(Migrating downstream)
Competition with other species
Dam passage
Disease
Incidental take by fishers
Lack of food
Overall watershed hydrologic balance
Predation
Quantity and quality of instream habitat
Quantity and quality of riparian habitat
Stream/Lake Disturbances
Stream blockage

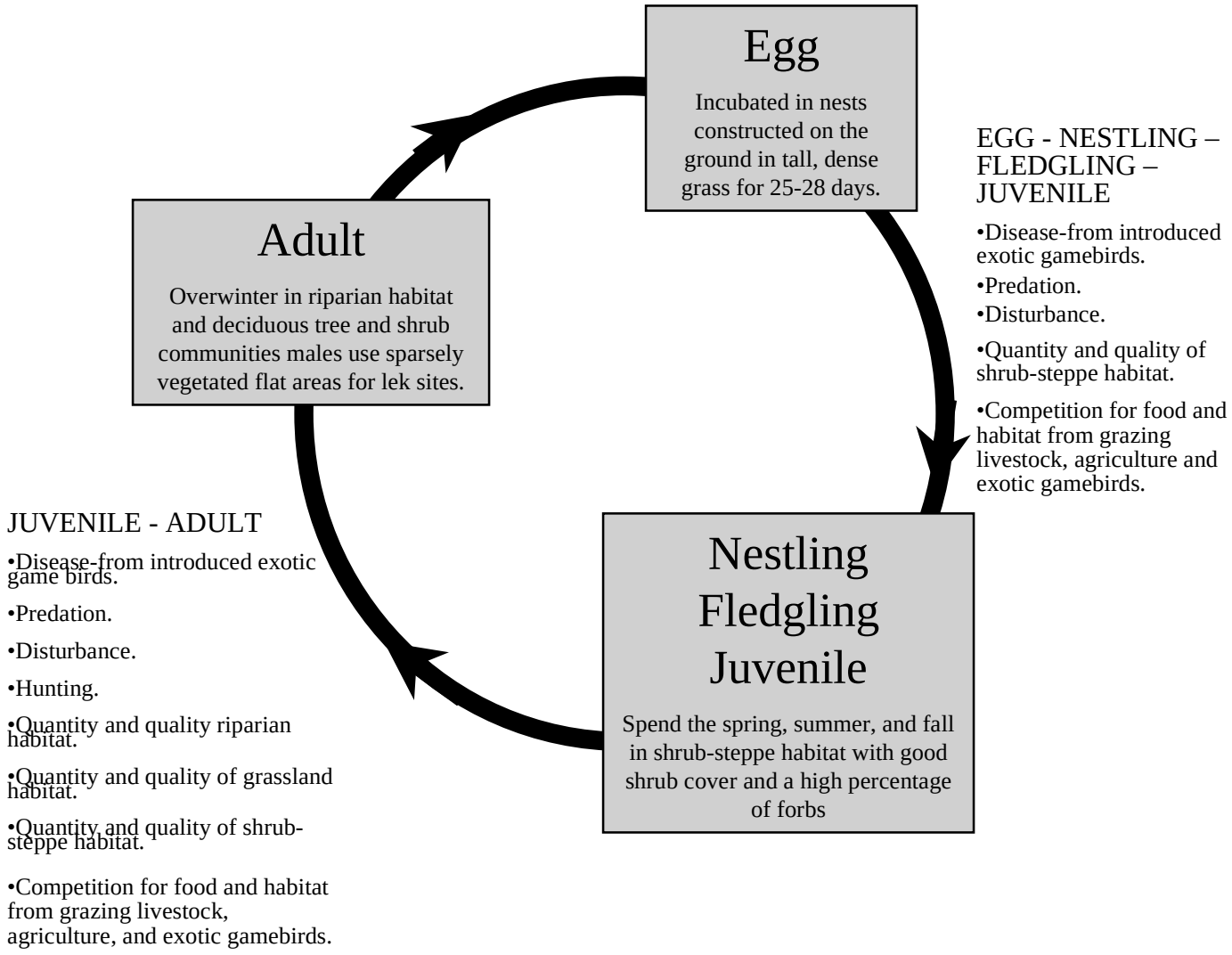
Figure 5-3: Examples of Major Environmental Effects
Resident Fish Life Cycle



Egg – Alevin – Fry – Fingerling
Competition with other species for food, space
Disease
Lack of food
Overall watershed hydrologic balance
Predation
Quantity and quality of instream habitat
Quantity and quality of riparian habitat
Stream/Lake Disturbances

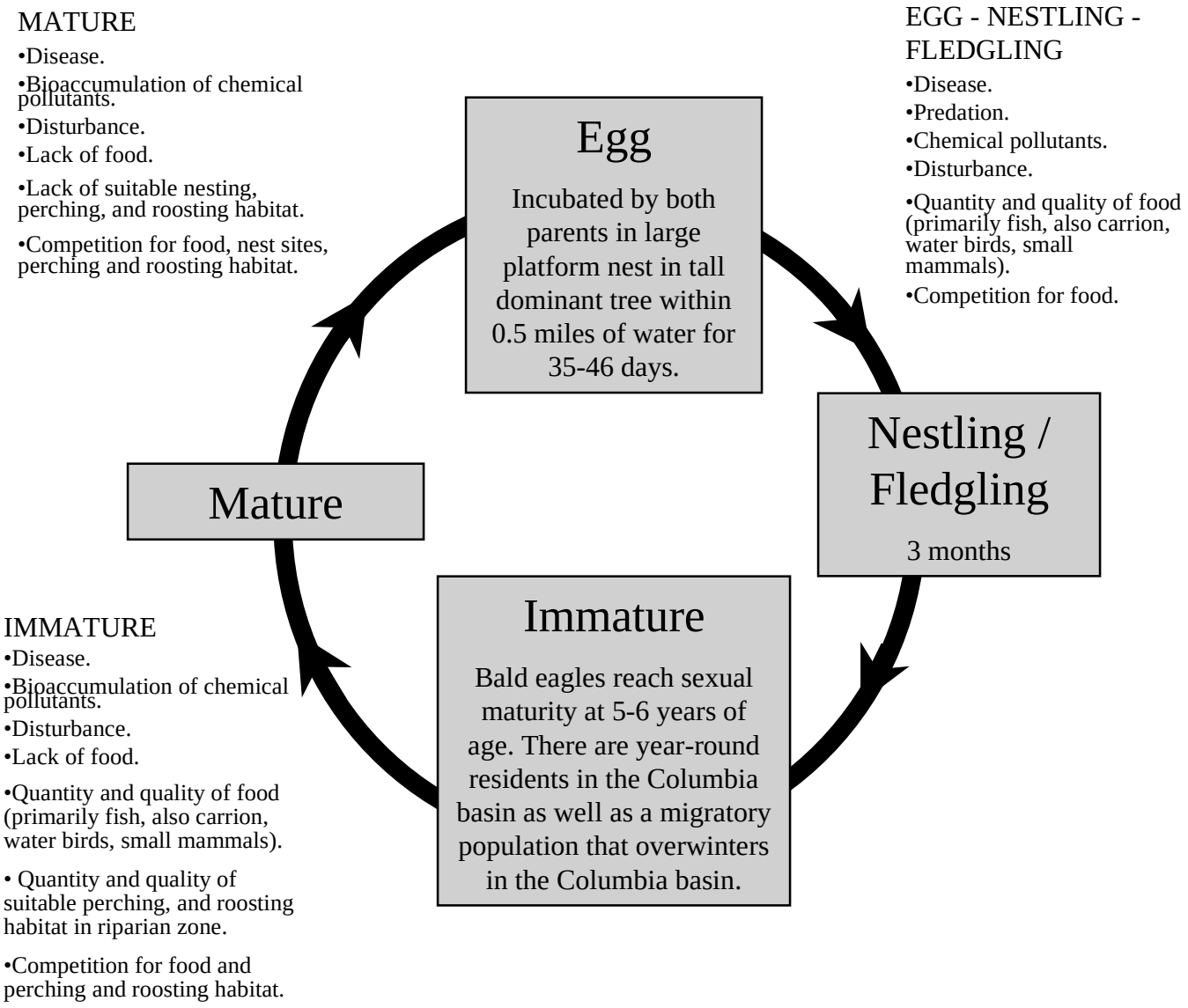
Smolt – Juvenile – Adult – Spawning Adult
Competition with other species for food, space, spawning habitat
Dam passage
Disease
Fishing, including incidental take
Lack of food
Overall watershed hydrologic balance
Predation
Quantity and quality of instream habitat
Quantity and quality of riparian habitat
Stream/Lake Disturbances
Stream blockage

Figure 5-4: Examples of Major Environmental Effects
Riparian Forest and Upland Shrub-Steppe
(Life Cycle of Sharp-tailed Grouse)



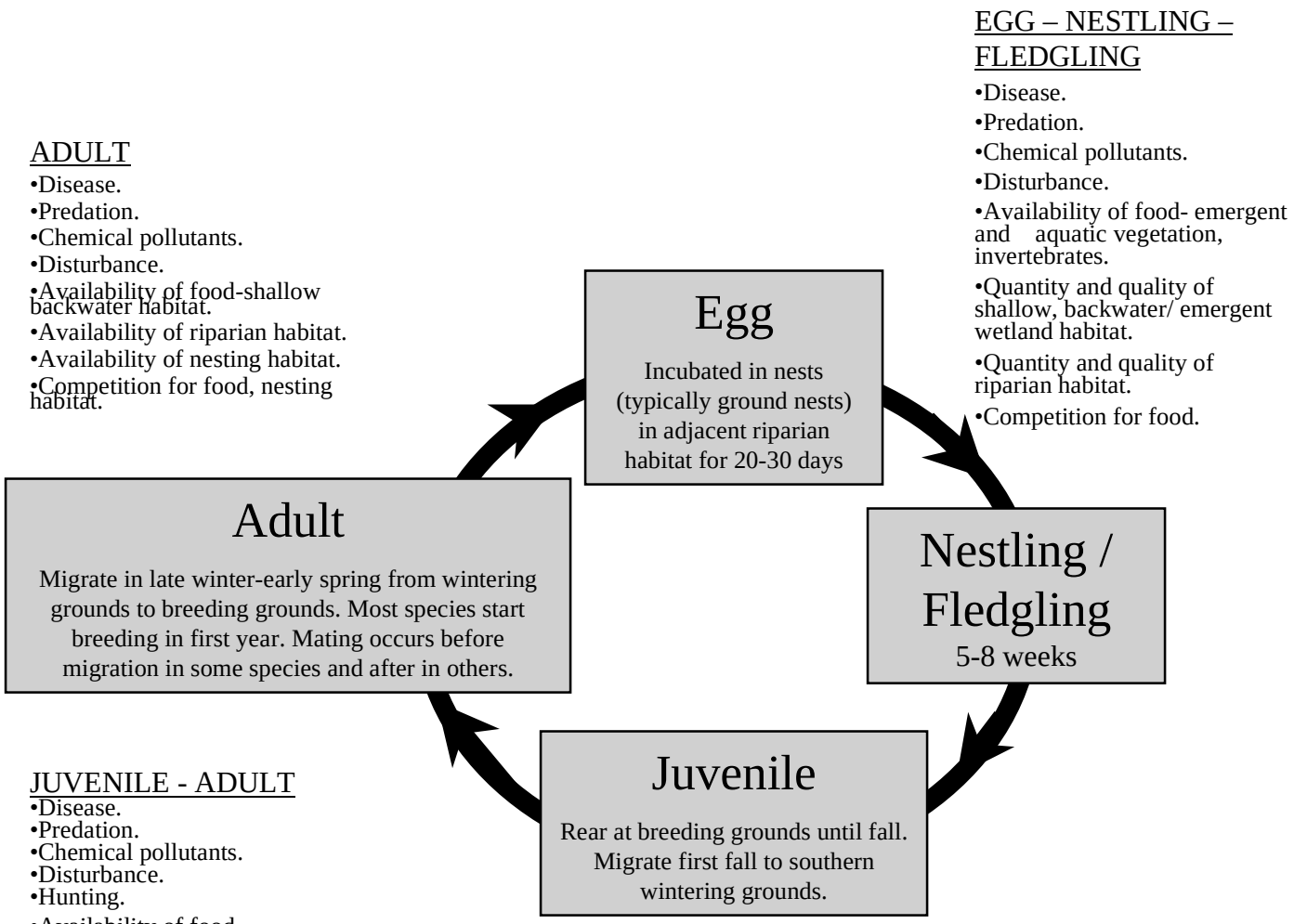
Species that depend upon upland grassland and shrub-steepe or riparian habitats within these upland habitat types: Swainson's hawk, golden eagle, prairie falcon, gray partridge, chukar, sage grouse, long-billed curlew, burrowing owl, common poorwill, Great Basin spadefoot, short-horned lizard, desert horned lizard, sagebrush lizard, western fence lizard, western skink, racer, striped whipsnake.

Figure 5-5: Examples of Major Environmental Effects
Mature Riparian Forest
(Life Cycle of the Bald Eagle)



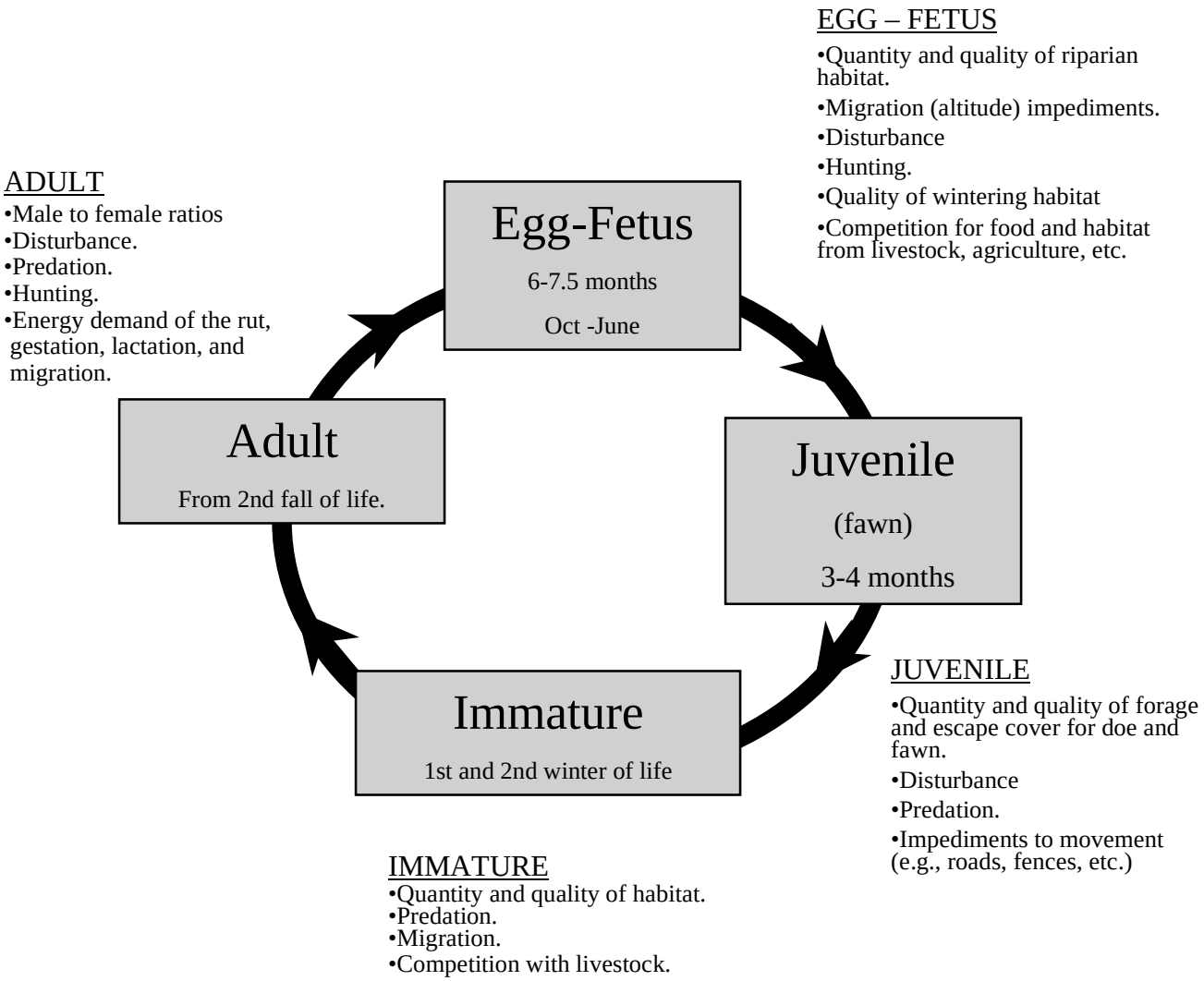
Species that depend on mature riparian forests during some part of their life cycle include: wood duck, Harlequin duck, hooded merganser, common merganser, osprey, ferruginous hawk, western screech owl, great-horned owl, Vaux's swift, pileated woodpecker, Lewis' woodpecker, beaver, western pond turtle, northern alligator lizard.

Figure 5-6: Examples of Major Environmental Effects
Shallow Water – Emergent Wetland Habitat
(Life Cycle of Migratory Nesting Waterfowl)



Species that depend upon shallow backwater and emergent wetland riparian habitat during some part of their life cycle include: mallard, American coot, green-winged teal, blue-winged teal, cinnamon teal, northern pintail, northern shoveler, wood duck, canvasback, redhead, American widgeon, ruddy duck, Canada geese, great blue heron, green heron, Virginia rail, sora, sandhill crane, American avocet, American kestrel, beaver, muskrat, mink, long-toed salamander, rough-skinned newt, Woodhouse's toad, Pacific chorus frog, red-legged frog, northern leopard frog, painted turtle, western pond turtle, western terrestrial garter snake.

Figure 5-7: Examples of Major Environmental Effects
Upland and Riparian Shrub forest
(Life Cycle of Deer and Elk)



- reduce spread of exotics and control where necessary.

Discussion

Harvest has an obvious and direct link to fish mortality. Harvest strategies to date have been focused on reducing overall effort. Strategies to implement terminal fisheries or other targeted harvest approaches are still under development. One method for terminal fisheries might be to use existing adult fish passage facilities to monitor and harvest hatchery fish or strong stocks while allowing wild fish or weak stocks to pass.

The adverse consequences of hatcheries are receiving increased attention. Hatchery fish can compete with wild fish for food and space. Conventional hatchery practices tend to promote specific runs and genetic features within runs, reducing biodiversity.

Introductions of non-native plant species have had a profound effect on the ecology of the region. Important species include freshwater bass and shad. Introductions of noxious plants contribute to reduced quality of rangelands and other habitat types; notable examples include thistles, starthistles, knapweeds, and saltcedar.

Some exotics, introduced for purposes of sport fishing, now prey on and compete with juvenile anadromous fish. Important species include the walleye, channel catfish, freshwater bass, brook trout, and shad. The adult American shad population in the Columbia River Basin now exceeds four million fish annually. Their young provide a large food base for predators throughout the late summer and fall when salmonids are not as abundant.[18] These exotic species, along with large influxes of juvenile hatchery fish, maintain predator populations at unnaturally high levels, increasing predation on salmon.

Impacts of Hatchery Salmonids on Native Populations. The focus of ESA efforts is to preserve and rebuild the natural populations and their ecosystems. Thus, hatcheries are no longer seen as the technical solution or the legal solution to preventing extinction. In fact, hatcheries may actually contribute further to extinction: for examples, harvesting hatchery fish may require equivalent take of wild fish, and straying hatchery fish may compete with wild fish. Also, by eliminating natural selection in the hatchery, humans induce genetic changes to the population that may further degrade wild fish when hatchery and wild fish interbreed. Therefore, when spawning occurs, a fish that may have been eliminated in the wild by natural selection is now contributing to the gene pool.[19] Finally, disease becomes an important issue in hatchery environments where antibiotics may create highly resistant bacteria.

Hatcheries' possible effects (positive and negative) on native populations is influenced by the management approaches. For example, a hatchery-produced fish that can be isolated from wild fish and harvested for commercial use should have little impact on native

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[18] Kaczynski, V.W. and J.F. Palmisano. 1993. Oregon's Wild Salmon and Steelhead Trout: A Review of the Impact of Management and Environmental Factors. April 1993, Oregon Forest Industries Council, Salem, Oregon.

[19] USDOE/BPA (1996c).

populations. But the introduction of an entirely new genetic population into a watershed could create instant competition with the native salmon population.

Even hatcheries producing fish that are originally from a native population, intended only to supplement the fishery, can harm the native population. Broodstock fish are typically selected for their large size and early returns. However, these larger, more aggressive fish can compete with and consequently decrease numbers of wild fish in stocked streams.[20] The early return runs produce early spawning, which is not always helpful in establishing a wild population. If spawning occurs before snowmelt is completed, late high flows could wash away hatchery fry. In contrast, the natural population, by spawning later in the spring, would avoid the high flows.

Another impact of hatchery-produced fish is the potential unknown effects of genetic introgression into wild fish from the hatchery strays. Some proportion of hatchery fish does reproduce in the wild. Fish not subject to natural selection may carry linked genes or resistant strains of disease that could lead to inbreeding depression or non-adaptive traits.

However, not all aspects of hatchery programs are negative. Where there is a clear lack of juvenile rearing or adult spawning habitat, hatcheries offer the only option to provide fish to an area. Hatchery-reared fish can have positive effects on native populations. In supplementation programs, native fish from the local area are used to supplement production of the wild population. This strategy reduces the rate of straying during returning runs and helps to rebuild a strong wild population.[21] With proper marking (adipose clips), it may be possible to target hatchery fish in harvest, depending on gear used or spatial separation from wild stocks. This could maintain harvest, yet take fishing pressure off native populations during recovery. The practice of marking the hatchery fish also allows creel and harvest surveys. These surveys calculate straying and return rates that can be used for future management of harvest and hatchery programs.

Finally, hatcheries can serve as reservoirs of endangered stocks until habitats or passage to blocked habitats can be restored. Hatchery programs can be structured to support the long-term goals of the ESA wild population recovery plan and provide sustainable fisheries.[22]

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[20] Ford, M. and J. Hard. ND. Does traditional hatchery production help conserve wild salmon—a comment on the Fall Creek coho hatchery controversy.

[21] Federal Caucus, 2000b. Vol. I.

[22] ORAFS, 2000.

5.2.3 Major Environmental Consequences for Humans from Common Fish and Wildlife Actions

***SUMMARY OF MAJOR POINTS**: This section focuses on the potential effects of fish and wildlife recovery efforts on a variety of human concerns, including the following:*

- *Human Health*
- *Industry Impacts*
- *Economic Costs*
- *Regional Economics*
- *Tribal Benefits*
- *Funding of Fish and Wildlife Programs.*

5.2.3.1 Air Quality and Associated Health Effects[23]

Human Activities

There are three primary air quality concerns:

- reservoir breaching and dust blowing from exposed reservoir sediments, some of which may contain heavy metals and other potentially toxic materials;
- deconstruction and increased emissions from increased truck traffic; and
- air emissions from replacement of lost hydro generation.

Possible Adverse Effects [24]

- Particulate matter can have adverse health effects, and particulate matter can discolor paint, corrode metal, and reduce visibility.
- Heavy metals can have adverse health effects. Some heavy metals bioaccumulate and render fish and wildlife inedible.
- Carbon monoxide can affect people and animals at low concentrations.
- Sulfur dioxide (SO_2)is corrosive, a respiratory irritant, and negatively affects visibility.
- Oxides of nitrogen have effects similar to SO_2, and can slow plant growth and reduce crop yield.
- Carbon dioxide absorbs heat radiated from the earth, preventing heat loss to space (global warming concept).

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[23] Consequences discussions are drawn directly from existing regional studies. Also see, Federal Caucus 1999b and 2000b, Council 2000a, Corps 1999a, USDA/USFS and USDOI/BLM 2000, and USDOE/BPA, Corps, and BOR, 1995 at 4.3.

[24] USDOE/BPA, Corps, and BOR, 1995, at 4.2.3

- Some polycyclic aromatic hydrocarbons (PAHs) have been determined to be probable human carcinogens and may cause other detrimental human health effects.

Context and Intensity

Most factors affect the amount, location and severity of air quality effects. The types, amount and location of new generation capacity are important. These factors are shown in Section 5.2.3.2, Table 5.2-5.

Table 5.2-4
Factors that Shape Effects on Air Quality

Factors Leading to Effect	Effect
Replacement power for lost hydro power capacity	Emission characteristics of new generation
Which reservoirs are breached	Location of most upstream navigation port and amount of new transportation and air emissions required, amount and location of exposure of reservoir bottoms and particulate air effects, amount and location of air quality problems caused by deconstruction
Relative economic viability of rail and trucking, programs to replace lost navigation	Selection and location of new transportation mode and, therefore, mix and location of air effects
Type and timing of restoration of former reservoir bottoms, weather conditions during exposure, success of restoration	Duration of particulate air effects from exposure of reservoir bottoms

Possible Mitigation Measures [25]

Appropriate mitigation for adverse air quality effects vary according to the source of the air emission. The mitigation can include the following:

- for particulate matter from exposed sediments, mitigation may include reseeding as soon as practical, land contouring and management to reduce wind erosion, or watering to reduce wind erosion;
- for products of combustion turbines, adverse effects may be minimized by power facility location, by use of modern air pollution control facilities; and
- for increased air pollution from transportation, mitigation may include use of efficient transportation practices, use of rail instead of trucks where possible, and highway improvements to accommodate increased traffic.

Discussion

Changes in river operations could decrease the amount of hydroelectric power generated at least on a seasonal basis, and require replacement generation from thermal plants. Additional thermal generation would increase air pollution around the affected thermal

[25] USDOE/BPA, Corps, and BOR, 1995, at 4.3.3

plant.[26] See **Appendix F** ("per-unit table") for the specific levels of air emissions associated with the different types of power generation.

Ambient concentrations of carbon monoxide (CO) do not measurably affect plants or materials. CO has 210 times more affinity for red blood cells than does oxygen, so continued exposure to CO interferes with the oxygen-carrying capacity of the blood. Prolonged exposure to low levels can impair physical coordination and cause dizziness. Continued exposure to CO above 750 parts per million (ppm) can cause death.

When combined with moisture, sulfur dioxide (SO_2) forms sulfuric acid, which corrodes most building materials and causes lake acidification and loss of plant life. Sulfuric acid and SO_2 are both respiratory irritants. About 40% of the natural gas processed in the province of Alberta (Canada) contains sulfur and is termed "sour gas." Processing removes much of the sulfur in gas, recovering it as a salable by-product. Another by-product is sulfur dioxide, which can acidify and impoverish soils and have long-term effects on crops and forests, and possibly on nearby livestock.

Nitrogen oxide (NO_2) can also slow plant growth and reduce crop yield at relatively low concentrations. NO_2 is a respiratory irritant which, in the presence of sunlight, combines with hydrocarbons to form photochemical smog (ozone, peroxyacetyl nitrate (PAN), and peroxybenzoyl nitrate (PBN)). Photochemical smog drastically reduces visibility and causes respiratory and eye irritation.

Carbon dioxide (CO_2) is a natural product of respiration and is produced by burning fossil fuels. It is taken up by plants during photosynthesis for use it as a building block for leaves and growth. Elevated concentrations are known to accelerate plant growth. Atmospheric CO_2 absorbs heat radiated from the earth, preventing heat loss to space. For this reason CO_2 is considered a greenhouse gas and has been linked to global warming. It has no health effects at atmospheric concentrations. CO_2 is also produced during the production of natural gas.

Polycyclic aromatic hydrocarbons (PAHs) consist of over 100 chemicals that are formed during the incomplete combustion of fossil fuels, municipal waste, and other organic substances. Humans are exposed by breathing PAHs bound to airborne particles. Although no harmful effects have been proven in humans, PAHs may reasonably be expected to be carcinogens. Animal studies have shown adverse effects on the reproductive cycle, body fluids, and the ability to fight disease.

Reservoir drafting exposes shoreline areas that are normally underwater to the drying action of the sun and wind. Clear, windy summer days typically provide the weather conditions most conducive to high levels of blowing dust. Effects would occur primarily around reservoirs located in the drier portions of the Columbia River Basin, and would

[26] USDOE/BPA, 1995, Section 4.3.1.1 Health/Environmental Effects of Air Pollutants.

affect both local residents and recreational users of the projects. An estimated 40,000 people live within 1 mile of the shorelines of the major reservoirs. Approximately 4.5 million people visit these shorelines each year for recreation. Effects would decrease as land is reclaimed.

Additionally, two types of air quality effects could potentially be important locally, though less substantial on a regional basis. Consequences of deconstruction include increased dust and emissions from construction equipment. Also, breaching would result in a permanent increase in truck transportation. Increases in emissions may be particularly critical in eastern Washington. [27]

Air quality issues associated with particulate matter include exceedance of air quality standards, nuisance effects from blowing dust, and health effects from fine particulate matter and airborne chemicals attached to the dust. Animal and plant health effects depend upon the size of the particulates and the pollutants contained in the particle. Particulate matter less than 10 microns in diameter travels deep into the lungs, where pollutants can rapidly diffuse into capillary beds. Elevated particulate concentrations are associated with an increase in the severity and frequency of respiratory diseases. The EPA is currently considering lowering the primary PM-10 (particulate matter of 10 microns or less) standard because the existing standard (75 $\mu g/m^3$) does not adequately protect human health.

5.2.3.2 Social and Economic Environmental Consequences

Actions for fish and wildlife affect both social and economic activities. Beginning with industries, those most affected by fish and wildlife actions are as follows:

- Power Generation and Transmission,
- Transportation,
- Agriculture (both farming and grazing) and Forestry,
- Commercial Fishing,
- Recreation,
- Residential and Commercial Development and Construction, and
- Other Industries (Mining, Services, Aluminum).

Some actions are clearly focused on one type of industry. Actions to reduce fish harvest, for example, have readily identifiable effects in the commercial fishing sector. Other actions directly affect many industries. Dam breaching, for example, causes direct adverse effects on several of the industries listed above.

Habitat actions can affect almost any of these industries because the term “habitat” basically encompasses the entire land and water environment on which fish, wildlife, and

[27] GAO, 2000.

humans depend. Habitat actions to restore riparian lands may affect agriculture, forestry, or urban development, depending on which industry happens to be located in the riparian zone. Other habitat actions are specifically targeted to an industry activity such as irrigation or grazing. Actions to modify in-stream areas and in-stream passage might not create any loss of economic activity in any industry; economic costs are generally just the costs of implementing the actions.

This section also covers economic costs, regional economics, tribal effects, and funding. All of these economic categories are related to industry effects and to each other. Generally, there is overlap in terms of the persons affected under each category.

- Economic costs are paid by all affected persons, including ratepayers, taxpayers, workers, and business owners.
- Regional economics includes economic costs, but the concept also includes income, output, employment, and other economic measures defined for a specific geographic region.
- Tribal effects counts economic costs and other effects on tribal members.
- Funding is concerned primarily with ratepayers, especially program costs, and the ability of ratepayers to cover costs.

Economic costs and funding are related when a fish and wildlife action requires a costly change that is paid for, or compensated for, using ratepayer funds.

The discussion for each industry first identifies the types of fish and wildlife actions that affect that industry. Then, factors that condition the intensity, location and groups of persons affected are described. Finally, potential mitigation actions are provided. Each industry includes a discussion to clarify the reasoning and information behind the pattern of environmental effects described.

Power Generation and Transmission

Human Actions

The types of proposed actions that would affect this industry are as follows:

- dam breaching or drawdown,
- changes in reservoir operations,
- facility modifications for fish and wildlife,
- changes in transmissions needs,
- increases/changes in habitat protection that conflict with transmission system maintenance, and
- non-hydro load-carrying alternatives.

Possible Adverse Effects

The types of effects that follow from these actions are as follows:

- Dam breaching or drawdown results in a complete loss of electrical generation. Breaching or drawdown may also affect downstream hydrology in a way unfavorable to downstream power generation.
- Changes in reservoir operations affect power generation at the reservoir and at downstream generation facilities.
- Facility modifications for fish and wildlife can have adverse or beneficial consequences for power generation. Sometimes, a facility modification can result in improved generation efficiency. For example, modifications may allow fish to be protected with less spill, and turbine improvements increase generation while passing fish with less mortality.
- Transmission facilities are affected by large shifts in the location of generation capacity. Reduced voltage support from these generators and transmission capacity reductions caused by the loss of generation can require additional transmission facilities. New generation can also require additional transmission facilities. If the new generation facility is strategically located, however, it can defer some load service transmission that might otherwise be needed.
- Habitat restoration/protection activities can change the capability of the transmission system due to decreased maintenance activities (vegetation removal, pesticide use) at or near habitat areas causing costs to increase. Decreased road densities that affect transmission facility access could increase the time required for maintenance activities causing costs to increase.
- Power and transmission facilities affect socially acceptable environmental qualities.

Context and Intensity

The power generation and transmission industry consists of ratepayers, owners of generation and transmission equipment, and workers. Changes in costs tend to affect ratepayers more than the other groups because the structure of the industry allows most costs to be passed to consumers. Effects on some owners and workers may be positive even as ratepayer effects are negative. For example, loss of hydropower capacity can lead to construction of thermal capacity and transmission facilities at a benefit to workers and owners of the new capacity, but to the detriment of ratepayers and hydropower owners.

Many factors influence socioeconomic effects involving power generation and transmission, as Table 5.2-5 illustrates.

Table 5.2-5
Factors that Shape Effects on Power Generation and Transmission

Factors Leading to Effect	Effect
Specific changes in hydro operations and facilities	Amount of power loss or gain
Market conditions, power industry deregulation, timing of power loss or gain	Dollar value of power loss or gain
Extent to which policies may influence new generation, power markets, laws affecting economics and feasibility of new power capacity	Amount of new generation
Extent to which states, affected public, markets and other institutions influence the characteristics of new generation	Characteristics of new and socially acceptable generation
The amount of renewable energy resources used to meet demand and energy conservation measures that can be taken	Characteristics of air emissions and subsequent costs
The changes that alter the present availability of transmission facilities, the capacity of the lines, and the ability to reroute power efficiently in emergency conditions	Availability of subscribed transmission, cost of new transmission to replace the transmission capability that was lost
New generation	New transmission is required to connect the new generation to the transmission system. Depending upon where the new generation is located, it might either cause new transmission to be built or defer existing transmission project
The changes that result in different maintenance practices to improve habitat across the system	Costs increase, and transmission capability may decrease in certain areas

Possible Mitigation Measures

The types of mitigation that might be undertaken to eliminate, reduce or compensate for these adverse effects are:

- Increase cost-effective energy conservation to reduce electricity use in the most environmentally and socially acceptable manner. Electricity consumers could be encouraged to consume less by education, subsidies, higher prices, or by development and application of new technology.
- Increase thermal generation for replacement of lost hydropower. This would be generation capacity above and beyond capacity needed to meet population and economic growth. Natural gas combustion turbines are currently the most economical and reasonable replacement for peaking and base load capability, but additional natural gas pipeline capacity will likely be needed.
- Renewable energy resources could be used to replace some of the lost hydropower at a more socially acceptable environmental cost than thermal

combustion. The economic cost of power may be more than combustion turbines. In some cases the power is dependent upon an unreliable supply of natural resources (i.e., wind and solar).

- Increase power imports or reduce exports to reduce power replacement costs. Additional power imports will be limited at times by the capacity of transmission systems.

Discussion

Hydrosystem strategies include all plans directed at the configuration or operation of reservoir facilities on the mainstem Columbia and Snake rivers. Hydropower facilities on tributaries also are included. Actions being considered include the removal or construction of dams, modification of dam configuration to improve passage or downstream habitat conditions, and change in dam operations to affect reservoir storage, downstream flows, or water quality.

Hydropower losses for any alternative that includes mainstem dam breaching range into hundreds of millions of dollars annually.[28] Considerable new, higher-cost generation capacity would be required to compensate for the loss of any major dam and low-cost power. Breaching of the Lower Snake dams would require changes to the regional transmission system. Breaching of John Day or McNary also would require more transmission additions. Additional economic effects of dam breaching include sales, income, and job losses that might be caused by increased electricity ratepayer costs.

Hydrosystem operations actions include changes to the operations of existing dams to provide more flow downstream or to otherwise improve habitat conditions. Flow management strategies would operate reservoirs differently to achieve normative seasonal flow patterns, temperature, estuarine conditions or flooding; for channel maintenance; or to minimize dissolved gas or flow fluctuations. Tributary reservoirs could be managed to achieve normative flow conditions in tributary streams. Reservoir operation rules could be modified to achieve resident fish habitat goals using Integrated Rule Curves, or operation rules could be set to meet flow or water quality criteria. Other actions would operate passage facilities for a longer period or all year.

Hydrosystem configuration actions would change the facilities at existing dams to facilitate passage and water quality goals. Examples include new fish ladders, surface bypass structures, other bypass improvements, modified turbines, turbine intake screening systems, and facilities for gas abatement. Juvenile fish transportation is included because the potential for successful transportation is closely linked to dam configurations. Juvenile fish transportation currently uses trucks and barges to carry

[28] See, for example, the Lower Snake River Juvenile Salmon Migration Feasibility Study (Corps, 1999a) or the Human Effects Analysis of the Multi-Species Framework Alternatives (Council, 2000a).

young anadromous fish downstream past reservoirs, turbines, and other sources of mortality.

The removal of economically marginal dams on tributaries would also result in some losses in jobs, and income, and increased ratepayer costs. However, hydropower effects would be less severe than those estimated for removal of mainstem dams. Deconstruction costs also would be much less than those estimated for the mainstem dams.

Changes in habitat protection and enhancement priorities by BPA and other entities could increase restrictions on how the transmission system is maintained and operated. These restrictions have the potential to greatly increase costs of transmission in the region, and to affect the capability of operating the system safely.

Transportation

Human Actions

The types of proposed actions that would affect this industry are as follows:

- dam breaching or drawdown,
- substantial changes to juvenile fish transportation, and
- habitat improvements targeted at transportation infrastructure.

Possible Adverse Effects

The types of effects that follow from these actions are:

- Dam breaching on the lower Snake or mainstem Columbia would eliminate barging transportation downstream to the last dam breached. It is expected that rail and trucking would be used to replace the lost barging, but costs would increase and new rail and road capacity might be required. Local upstream economic activity associated with barging ports would be lost, or perhaps relocated to new downstream ports.
- Substantial changes to juvenile fish transportation would have a small effect on fish transportation expenditures and related industries. Current transportation expenditures are about $1 million annually.
- Habitat improvements targeted at the transportation industry could affect the location and costs of new roads, railroads, pipelines, and other transportation infrastructure.

Context and Intensity

The transportation industry consists of owners, workers and consumers of barge, rail and road transportation. Dam breaching or drawdown below minimum operating pools can render the mainstem Columbia or Snake rivers unusable for barge navigation. The transportation industry can also be affected by many other types of actions including juvenile fish transportation, habitat measures on roadways and other

transportation corridors, and effects of financing fish and wildlife on economic growth.

Many factors influence socioeconomic and other human effects involving the transportation industry, as Table 5.2-6 illustrates.

Table 5.2-6
Factors that Shape Effects on Transportation

Factors Leading to Effect	Effect
Location of the most downstream dam breached or drawn down below MOP	Amount of navigation lost from dam breaching
Availability and costs of alternative transportation routes, infrastructure costs, and transportation market structure	Dollar value of navigation, and net transportation employment lost
Location of dam breaching, fish transportation strategy used	Amount of fish transportation used
Types of habitat actions implemented; extent to which mitigation is used, costs of compliance	Effects of habitat actions on transportation infrastructure and taxes for infrastructure

Possible Mitigation Measures

The types of mitigation that might be undertaken to eliminate, reduce or compensate for these adverse effects are:

- compensation, retraining employees, and facilitating movement of resources and employment out of the adversely affected transportation industries; and
- habitat protections, planned with existing and future transportation in mind. Transportation projects should include mitigation for adverse consequences at the least possible cost.

Discussion

The existing reservoirs on the Columbia and Snake rivers support commercial barge navigation to Lewiston, Idaho. Grains, primarily wheat and barley, account for about three-quarters of the tonnage shipped on the Lower Snake River.

The annual cost of transportation needed to replace barge navigation lost from breaching Snake River and mainstem dams ranges from tens of millions to $100 million annually, depending on which reservoirs are lost and which study assumptions are used.[29] The Corps' Lower Snake River Juvenile Salmon Migration Feasibility Study and the John Day Drawdown Study did not measure economic losses in the navigation or port industries, or the job gains and increased profits in the

[29] Cost estimates are from Corps, 1999a and 1999b, the Corps Lower Snake River Juvenile Salmon Migration Feasibility Study and the John Day Drawdown Study.

rail and trucking industries. Losses in the navigation and port industries would be substantial. No data are available about the offsetting increases in rail or trucking.

Little information is available to suggest how habitat actions might affect the development or improvement of transportation infrastructure.

Agriculture and Forestry

Human Actions

The types of proposed actions that would affect these industries are as follows:

- dam breaching and changed hydrosystem operations,
- habitat improvements targeted at land use, and
- point and non-point pollution controls and subsidies.

Possible Adverse Effects

The types of consequences that follow from these actions are as follows:

- Dam breaching and changed hydrosystem operations. Agriculture and forestry would be affected in several ways. Agriculture would be affected by higher electricity costs as a power consumer. Irrigation surface water diversions that depend on water elevations behind breached dams would have to be relocated. Groundwater irrigation adjacent to the same reservoirs would be impaired by lower water tables following breaching. Barging of agricultural products and inputs would be eliminated from Lewiston downstream to the furthest downstream breached dam. As a consequence, agriculture and forestry would pay higher costs for transportation of products and supplies.
- Habitat improvements targeted at land use. Many types of habitat improvements would be targeted at agricultural and forestry land use practices, increasing costs; and some agricultural and forestry production would be lost.
- Non-point pollution controls and subsidies could affect dryland cropping, irrigation, livestock management, and forestry.

Context and Intensity

The agriculture and forestry industries include landowners, farmers, ranchers, workers, and persons who sell to or buy from farms and timber industries. Agriculture and forestry are affected primarily by habitat actions. The effects of habitat actions depend on the habitat values being diminished by these activities, and the habitat values are themselves dependent on a number of unique local and human conditions. The effect of dam breaching on irrigation water diversions and pumping lifts, transportation costs for agricultural commodities and inputs and wood products, and irrigation power costs are also important issues.

Many factors influence the socioeconomic and other human effects involving agriculture and forestry, as Table 5.2-7 illustrates.

Table 5.2-7
Factors that Shape Effects on Agriculture and Forestry

Factors Leading to Effect	Effect
Amount of expenditure on active versus passive restoration	Amount of expenditure for land shaping or construction verses expenditures that compensate for lost use; potential increased risk from fires and other natural disturbances verses risk reduction
Extent to which regulation and positive incentives are used	Distribution of adverse economic effects between farmers and landowners versus ratepayers and taxpayers
Amount and quality of land removed from production, either directly or because of increased cost. Changes in crop yields caused by changes in irrigation technology or deficit irrigation	Amount of agricultural/forestry production lost or gained
Types of crops affected, agricultural markets	Value of agricultural/forestry production lost or gained
Effects on transportation costs, see Table 5.2-6	Transportation costs for products and inputs (i.e. raw materials, energy, other components of production processes)
Locations of dams breached, who pays costs of diversions/wells improvements	Effects of lower water levels and groundwater tables
Power effects, see Table 5.2-5	Effects of power costs on irrigation costs
Extent of competition in agriculture, affected production as a share of market total, share of affected production exported	Effects of cost increases or reduced production on consumers.
Linkages between the local farms/forestry and local economies; location of suppliers and forward processing industries	Effects on rural communities

Possible Mitigation Measures

The types of mitigation that might be undertaken to eliminate, reduce or compensate for these adverse effects are as follows:

- Use agricultural and forestry practices that preserve or enhance production while meeting the fish and wildlife purpose.
- Use positive incentives and education rather than regulation.
- Avoid actions that would have unprecedented or permanent effects on local agricultural/natural resource-dependent communities.
- Land or water purchase or lease compensates the farmer for his loss of net income, but regional economies may suffer because the farmer's expenditures

in the regional economy are lost. Mandatory water supply reductions are damaging to individual farmers as well as the regional economy.

Discussion

Many habitat actions would affect land use, or they have the potential to impair land uses that rely on water or land adjacent to streams. Habitat costs consist of the costs of economic activities impaired or eliminated, plus implementation costs.

Habitat costs resulting from changes in agricultural/forestry land use could be large, depending on intensity of the overall effort. The intensity of most habitat actions corresponds to the amount of acreage proposed for improvement.

Socioeconomic consequences are very sensitive to the implementation method chosen; especially, to what extent, if any, resource users are compensated. For private lands and water, methods of compensation include subsidies, land lease or purchase, and/or water lease or purchase. For public resources, users may not be compensated for their lost use.

Many implementation options can be used to change irrigation practices; the selected option has a strong effect on irrigation water use and economics. Land or water purchase or lease compensates the farmer for his loss of net income, but regional economies may suffer because the farmer's expenditures in the regional economy are lost. Fallow of irrigated land only in dry years can be used to maintain flows in these more adverse conditions, and the regional benefits of agricultural production are retained in most years.

Irrigation water conservation techniques are often used to reduce diversions and return flows, often with water quality and quantity benefits for the aquatic system. Conservation subsidies can be beneficial to regional economies as well as individual farmers because spending on irrigation technology increases, and crop yields and productivity may increase. Most irrigation occurs on private lands, but some irrigation occurs with water from federal facilities. Some regulation for water conservation may be feasible within state and federal laws. Mandatory water supply reductions are damaging to individual farmers as well as the regional economy. Screening of irrigation diversions is used to avoid direct mortality caused by diversion of fish with water.

Over 300,000 acres of irrigated land are served out of the Lower Snake reservoirs. Breaching or lowering of the reservoirs would require modifications to surface irrigation diversions or fundamental changes to irrigation use. In addition, many wells benefit from the raised groundwater levels caused by reservoir storage nearby. The annual cost of fixing wells and diversions impaired by breaching could run into tens of millions of dollars annually.

Habitat actions may affect dryland agricultural land use for purposes of watershed protection or water quality improvement. Such actions generally increase the costs of agricultural production.

Many strategies are used to reduce livestock effects on aquatic systems. In riparian areas, livestock are often fenced out and alternative watering sources are provided on uplands. Other actions include seasonal or rotational grazing, reduced grazing intensities, deferred grazing, and land acquisition and retirement. Wastewater and sedimentation ponds are often used to retain and treat degraded runoff from feedlots or intensively grazed uplands.

Forestry actions would limit unnatural forest patterns; reduce density of poorly performing forest roads; and reduce forestry effects to riparian and aquatic ecosystems. Harvest techniques to retain some of the original habitat elements can be used instead of clearcuts. Size of harvest units can be reduced. More normal forest habitat can be developed by appropriate silvicultural techniques, including controlled burns. Forestry actions used to reduce sedimentation include sound silvicultural practices, tailoring of harvest methods to slope and soils, and closing and obliteration of forest roads. Costs would include the net economic value of lost timber production, including changes in the economic costs of these activities and implementation costs.

Commercial Fishing

Human Actions

The types of proposed actions that would affect this industry are as follows:

- changes in fishing regulations (reduced season length, alternate year fishery closures, change in allowable methods, size or location, or better enforcement of existing regulations might be used);
- buy-outs or other payment to stop commercial fishing (fishing effort would be reduced by purchase of the fleet or by payment to not fish at specific times and or places);
- changes in hatchery practices; and
- any other actions that decrease fish populations.

Possible Adverse Effects

The types of consequences that follow from these actions are as follows:

- For changes in fishing regulations, adverse effects are generally catch- and revenue-decreasing, or cost-increasing.
- In buy-outs or other payment to stop commercial fishing, the owner of the fishing “right” is fully compensated. However, deckhands, other labor, and coastal communities may still be adversely affected.

- Following changes in hatchery practices, increasing or decreasing hatchery production could have strong effects on commercial catch. Adverse effects are generally catch and revenue losses.
- Increased poaching may increase.
- Adverse effects from reduced fish populations are decreased revenues, net revenues, and decreased ability to cover costs

Context and Intensity

There are many factors that will influence the socioeconomic and other human effects on commercial fishing, as Table 5.2-8 illustrates.

Table 5.2-8
Factors that Shape Effects on Commercial Fishing

Factors Leading to Effect	Effect
Total amount of fish produced (Table 5.2-3), including hatchery and non-Columbia stocks, which stocks are recovered, changes in commercial harvest practices	Amount of fish available for harvest
Technologies, timing and locations allowed for selective harvest	Costs of fishing, quality and timing of catch.
Ocean conditions, location of harvest, amount of fish harvested	Quality of fish for harvest
Market conditions, fish harvest costs	Value of fish harvested
Linkages between the local fleet and local economies; location of suppliers and forward processing industries	Effects on coastal communities

Possible Mitigation Measures

The types of mitigation that might be undertaken to eliminate, reduce or compensate for these adverse effects are as follows:

- use of education and positive incentives instead of regulation;
- use of Community Based Policing[30]
- assistance in transferring fixed and human capital (boats and fishermen) to alternative fishing uses such as guide-based sport fishing, or other employment;
- compensation for costs of regulation; and
- compensation or retraining/retooling for local communities.

[30] Peters et al., 1998.

Discussion

Specific actions would require selective (targeted) fisheries, a focus on sport or commercial and sport fisheries, harvest based on escapement needs for the smallest population unit or population aggregates, management of overall harvest to meet escapement needs, or the use of various new harvest techniques, such as fish wheels or use of fish ladders to select individual fish for harvest or release.

Some actions would eliminate almost all ocean salmon fishing, at least until stocks recover. Salmon range up and down the coast in mixed stock fisheries. Therefore, the entire west-coast salmon fishery, and even some non-salmon fisheries, from California to Southeast Alaska would need to be eliminated to ensure that no Columbia River fish were caught. As a practical matter, ocean catch of Columbia River fish would not be entirely eliminated. Rather, those fisheries that catch the largest shares of Columbia River fish would be eliminated or modified, and some Columbia River catch would continue as long as total harvest stays within harvest goals.

Costs of harvest management include implementation costs, enforcement costs, and lost profits from reduced fishing. Numbers, size and quality of fish are important, but fishing costs, affected by fishing methods and regulations, are also important. Any strategy that reduces harvest would have the direct consequence of reducing the annual value of salmon catch. Actual costs may be even higher, since economic incentives and value for fisherman may not be based solely on the value of the catch. Reduction in harvest levels would also require costs for implementation and enforcement, in addition to lost value.

Recreation

Human Actions

The types of proposed actions that would affect this industry are as follows:

- dam breaching and reservoir operations,
- changes in recreational fishing and hunting regulations,
- changes in hatchery practices,
- controlled recreational access and quality associated with habitat actions,
- build more boat and fishing access sites, and
- actions that decrease non-targeted fish and wildlife populations.

Possible Adverse Effects

The types of effects that follow from these actions are:

- Dam breaching and reservoir operations. Dam breaching would eliminate most flatwater recreation that occurred on the reservoir, including activities

such as fishing, boating and water-skiing. Changes in reservoir operations can adversely affect reservoir fishing and other recreation opportunities.

- Changes in recreational fishing and hunting regulations. Recreational fishing and hunting regulations might be changed to help fish and wildlife by reducing harvest, incidental catch, or damage to habitat, or by increasing recreational effort on undesirable species. Generally, losses are associated with a diminished value of the recreation experience.
- Changes in hatchery practices. Some hatcheries produce fish primarily for recreation; these hatcheries might be eliminated or modified. Generally, losses are associated with a diminished value of the recreation experience.
- Effects on recreational access and quality associated with habitat actions. Some habitat actions might make more areas available for certain types of recreational use, but other actions might reduce the availability of areas to some types of use.
- Decreased fish and wildlife populations would reduce economic value of recreational fishing and hunting, and other outdoor recreation activities that are enhanced by fish and wildlife.

Context and Intensity

The recreation industry includes individual recreationists as well as the commercial recreation industry that serves them. Virtually all types of outdoor recreation could be affected. Table 5.2-9 illustrates how factors influence socioeconomic effects involving recreation.

Table 5.2-9
Factors that Shape Effects on Recreation

Factors Leading to Effect	Effect
Total amount of fish and game provided (Table 5.2-3), which stocks are recovered, changes in sport fishing and hunting regulations.	Amount of fish and game available for recreation harvest
Amount of fish and game caught, changes in regulations.	Value of fishing and hunting recreation
Which dams are breached.	Amount of flatwater and riverine recreation available
Amount and conditions of access to lands, types of uses that may be restricted	Value of recreation on lands affected by habitat actions

Possible Mitigation Measures

The types of mitigation that might be undertaken to eliminate, reduce or compensate for these adverse effects are as follows:

- development or improvement of alternative recreational opportunities, and

- focus on education rather than regulation.

Discussion

Some of the more popular recreational activities, such as boating, fishing, and swimming, require developed facilities that allow access to water. Hydrosystem actions that would result in changes to lake elevation and river flow patterns would affect recreation areas, influence visitation, and affect the ability to use facilities.

Reservoir drafting can expose waterside facilities such as beaches, swimming areas, boat ramps, docks, and marinas, leaving them unusable and unsightly. Some floating facilities, such as docks, can be relocated as pool elevations drop. However, moving the facilities can be difficult and is often not practical when surface elevations change rapidly. Large drawdowns may leave camping, picnicking and other land-based facilities visually and physically separated from the water.

Hydrosystem operations can also reduce or improve fish and wildlife population numbers, which in turn influence opportunities for fishing, hunting and wildlife viewing. Low pool elevations can expose rocks, tree stumps, and other objects that can pose hazards for water recreationists. Increased water velocity can increase risks to swimmers and water craft operators.

Reservoir drafting exposes shorelines and lake bottoms to the effects of wind. Fine sediments dry out and are carried off by the wind, which can be a nuisance to nearby residents and recreationists. Odors can be created in areas where organic material is exposed as a result of drafting. When water levels in reservoirs are lowered, the remaining water flows at a higher velocity and picks up additional sediment, which in turn leads to increased turbidity. Increase in turbidity can decrease water clarity and change its color.

As a consequence of dam breaching, there may be beneficial effects from restored recreational opportunities on formerly inundated land or rivers. Activities on the formerly inundated river include fishing and boating. There would be little whitewater in the rivers that are restored by breaching dams on the Lower Snake and mainstem Columbia. Formerly inundated land might be used for recreation, but some land would also be used for other purposes.

Recreational fishing and hunting adverse effects from fish and game population declines are conditioned by regulations, alternative opportunities for use of time, quality of recreational amenities, and recreational costs such as license fees and gasoline prices. Recreational values are often measured from information on recreational expenditures such as travel costs. Some regional economies have important economic linkages with recreational fishing and hunting.

Recreational fishing can be an important source of mortality for special status species, both by intentional and incidental catch. Actions may include keep limits, tackle regulations such as flies-only or barbless hooks, and better posting and enforcement

of special regulations. Other recreational activities affect habitat or fish and wildlife directly. Public education, location of recreational activities away from fish and wildlife habitat, and improved regulations and enforcement can all be used to diminish effects of recreation on fish and wildlife habitat.

Residential and Commercial Development and Construction

Human Actions

The types of proposed actions that would affect these industries are as follows:

- dam breaching and other direct construction effects;
- effects on residential and commercial development associated with habitat actions; and
- effects on economic growth associated with fish and wildlife costs, and effects associated with quality of living.

Possible Adverse Effects

The types of consequences that follow from these actions are:

- Dam breaching and other direct construction effects. These effects are the expenditures for dam breaching and other construction programs paid to construction interests. Other construction programs may include hatcheries, dam and facility modifications, and construction of new diversion and outfall facilities at affected reservoirs.

  The expenditures on construction are generally recognized to be beneficial from the perspective of regional economics. Other construction effects are adverse. Adverse effects from construction may include habitat loss, community disruption, local public finance costs, air quality effects, runoff problems, and social dislocation.

- Effects on residential and commercial development associated with habitat actions. These actions may include preservation of lands that would otherwise be developed. Programs to reduce non-point source and source pollution may increase costs to existing and future urban areas.

- Effects on economic growth associated with fish and wildlife costs, and effects associated with quality of living. Increased fish and wildlife costs, paid through electricity costs or taxes, may increase living and business costs and reduce the attractiveness of the region to potential new residents and businesses.

Context and Intensity

The residential and commercial development and construction industries include people affected by the development of real property, including construction, realtors, lenders, other industries using real estate, and home buyers and renters. Residential

and commercial development are affected primarily by the habitat group of fish and wildlife actions.

Table 5.2-10 shows how residential and commercial development is influenced by factors. The location and types of habitat actions are important, but so are the methods of obtaining these actions. Especially, policies can choose to affect land use by regulation, by purchase, or by other negative or positive incentives. The mix of incentives, regulation, and purchases will have an important influence on the distribution of costs among real property owners, taxpayers, and ratepayers.

Table 5.2-10
Factors that Shape Effects on Residential and Commercial Development and Construction

Factors Leading to Effect	Effect
Location and types of habitat actions selected, effects of hydrosystem actions on floodplain	Development and land use patterns
Types of habitat action implementation chosen; land use restrictions, purchases or incentives, real estate markets	Economic costs of development effects
Amount of new development restrictions, construction markets, location of owners and workers. Amount of construction activity is positively related to amount of active habitat restoration	Employment and incomes in construction
Costs passed on to real property owners depend on housing and electricity markets, initial allocation of costs among ratepayers, taxpayers and others	Housing and building costs
Size and characteristics of local economies, communities and infrastructure	Economic and social effects of construction
Habitat actions that limit construction	Construction revenues

Possible Mitigation Measures

The types of mitigation that might be undertaken to eliminate, reduce or compensate for these adverse effects are as follows:

- Economic effects from construction are generally beneficial or zero. Therefore, no mitigation is required.
- Habitat acquisition, erosion control, and assistance to local communities can help to permit construction.
- Where habitat needs limit development, suitable alternative sites for development can be acquired.
- Adverse effects on economic growth can be minimized by maximizing the efficiency of fish and wildlife investments to reduce need for higher levels of mitigation.

Discussion

Potential fish and wildlife actions associated with urban areas include locating urbanization away from sensitive habitats, acquisition of sensitive habitats, improved municipal water diversion management, improved wastewater treatment, public education, and improved laws governing refuse and use of stormwater drains.

Non-point pollution and wastewater are increasing problems near urban areas. Actions would improve municipal wastewater management and urban storm runoff control. Urban road management (other than culvert replacement) is included. Stormwater detention ponds or wetlands for wastewater treatment can have incidental habitat benefits.

Other Industries

Human Actions

The types of proposed actions that would affect these industries are as follows:

- habitat actions targeted at mining practices and cost recovery for mine rehabilitation,
- any actions that affect electricity generation and its costs, and
- actions to reduce point-source pollutants.

Possible Adverse Effects

The types of effects that follow from these actions are as follows:

- The mining industry may be affected by habitat actions targeted at mining practices and cost recovery for mine rehabilitation.
- The aluminum industry and other direct service industries would be harmed by increased electricity prices in most Policy Directions.
- The pulp and paper industries could be affected by stringent point-source pollution control costs, costs of raw materials, and transportation costs.
- Industrial development could be affected by changes in hydropower and natural resource costs and availability.

Context and Intensity

There are several industries that may experience important consequences related to fish and wildlife actions. The following are examples of the major industries linked with fish and wildlife effects.

Table 5.2-11 Factors that Shape Effects on Mining, Aluminum, Pulp and Paper, and Other Industries	
Factors Leading to Effect	**Effect**
Markets for minerals, mining regulations, government programs	Share of costs passed to industry owners, consumers and government
Aluminum markets, share of aluminum consumed locally and nationally, share of increased fish and wildlife costs passed to aluminum electricity costs	Share of increased power cost paid by aluminum owners, workers and consumers; share of consumer cost paid locally and nationally
Nature of effluent regulations, forest product markets, share of products used locally and nationally	Share of increased products costs paid by industry owners, workers and consumers; share of consumer cost paid locally and nationally
Comparative cost of power and local and imported natural resources	Amount of cost increase and comparative advantage of local natural resource industries

Possible Mitigation Measures

The types of mitigation that might be undertaken to eliminate, reduce, or compensate for these adverse effects are as follows:

- minimize adverse effects of electricity price increases by maximizing the efficiency of fish and wildlife mitigation investments, and
- emphasize subsidies and education, as opposed to regulation.

Funding

Human Actions

Funding is concerned with the distribution of fish and wildlife program costs among ratepayers, taxpayers and others. The types of proposed actions that would affect funding are as follows:

- financing fish and wildlife programs using ratepayer revenues, tax revenues, or other public revenues;
- use of regulation instead of positive incentives to achieve habitat goals; and
- constraint of increased funding through ratepayers by maximum sustainable revenue (MSR)[31], and uncertainty in ratepayer fish and wildlife cost shares, resulting in increased planning costs for BPA and its customers.

Possible Adverse Effects

- Funding through ratepayers or taxpayers has a similar effect in that their discretionary income is reduced, and they have less to spend.

[31] See Chapter 2, Section 2.3.2.3, for more detail on MSR.

- Regional economies are affected by the reduced discretionary income of ratepayers and taxpayers. Ratepayers and taxpayers may be located in different areas, however, so the distribution of reduced spending is affected. While federal taxation is spread around the nation, ratepayer funding has important regional implications because most ratepayers live in the region. These adverse effects are offset to the extent that fish and wildlife expenditures are paid back to the regional economy.
- Increased wholesale power costs may cause wholesale buyers to shift to alternative sources. An increase in the retail cost of electricity may cause ratepayers to use less of it. BPA cannot increase prices to cover costs when customers reduce their electricity use or switch to other, low-cost power sources.

Context and Intensity

Funding of fish and wildlife programs will be influenced by the types of actions proposed, their context, and their intensity. Table 5.2-12 shows some of the factors that may influence funding.

Table 5.2-12
Factors that Shape Effects on Funding

Factors leading to Effect	Effect
Scale of fish and wildlife recovery effort	Total cost of fish and wildlife programs to resource users, taxpayers, and ratepayers
Use of regulation versus subsidy, acquisition or education	Share of cost paid by resource users versus ratepayers and taxpayers
Costs of thermal generation, electricity market conditions, willingness of electricity consumers to pay higher prices	Distribution of fish and wildlife costs among ratepayers versus taxpayers, and others
Use of regulation instead of compensation to achieve objectives	Impairment of value and use of private property
Effects on agriculture, forestry, transportation, and residential and commercial development	Local government costs and revenues

Possible Mitigation Measures

- Adverse effects of funding can be mitigated by maximizing the effectiveness of fish and wildlife expenditures.
- Spreading costs so that no one group is disproportionately affected.
- This situation then requires one of the response strategies as discussed in Chapter 4.

Discussion

Funding issues involve the source of money needed to pay for fish and wildlife programs in the region. For every dollar of money spent for construction of passage

improvements, habitat improvements, or hatcheries, for every dollar received for services, education or subsidies—someone must pay.

Although BPA is a federal agency, programs administered by BPA are funded by receipts from BPA's sales of electricity. In other words, BPA's fish and wildlife expenditures are funded by ratepayers rather than by federal taxpayers. Some fish and wildlife programs administered by federal agencies are funded by federal taxpayers through appropriations from the US Congress. Some federal actions, such as CWA programs, have multiple benefits that include fish and wildlife protection and enhancement. Regional fish and wildlife programs may also be funded through state or local taxes, fees, and fines, or through private, commercial, or tribal groups. Other funds come though costs of regulation, volunteer contributions and other private contributions. Socioeconomic effects include all of these related groups.

BPA has been concerned that a combination of fish and wildlife costs and reduced efficiency of hydropower generation can result in hydropower costs that are not competitive. Recent events in regional power markets have overshadowed these concerns. Current concerns involve the financial stability of power buyers, tradeoffs between fish protection and electricity needs, and BPA's role in regional power markets. Low power prices increase concerns involving fish and wildlife and other costs, but high prices increase concerns regarding lost hydropower generation and ability to shape loads as affected by fish protection goals and requirements.

Regional Economy

This category of effects considers all of the industry-level effects combined, plus the effect of trade linkages, on regional economic activity. There are no actions targeted to regional economies. Rather, adverse economic effects on natural resource industries, higher costs for electricity and other goods, and reduced personal income combine to diminish value of regional output, employment, and income. Actions that reduce non-targeted fish and wildlife populations reduce commercial fishing, recreational fishing and hunting, and other wildlife-related economic activity. Regional economic effects vary from locale to locale. Not all effects are adverse. Some persons in some places will benefit in almost any case.

Possible Adverse Effects

The types of effects that follow from fish and wildlife actions are as follows:

- Reduced regional production causes reduced buying and selling in the region. This reduces income, output and employment in linked industries
- Reduced regional production can have price effects for bulky products and products sold locally.
- Reduced regional economic activity may adversely affect local public finance including property and sales taxes, and costs of public services may be increased.

- Financing (funding) of fish and wildlife programs reduces discretionary income used for other spending
- Decreased non-targeted fish and wildlife populations would reduce commercial fishing, recreational fishing and hunting, and other outdoor recreation activity. Coastal and tribal communities have important economic links to commercial fishing, and substantial decreases in commercial catch would decrease regional economic activity through economic multiplier effects. Reduced sport-fishing activity would hurt economic activities such as guiding, lodging, and services that depend on these activities.

Context and Intensity

Table 5.2-13 shows regional economic effects and influencing factors.

Table 5.2-13
Factors that Shape Effects on Regional Economics

Factors Leading to Effect	Effect
Amount of funding and effects on ratepayers and taxpayers (Table 5.2-12)	Amount of reduced discretionary income for regional spending
Incremental spending patterns for discretionary income	Pattern of regional effects from reduced discretionary income
Value of lost production in transportation, agriculture, forestry and recreation; pattern of spending (imports) and sales (exports) by these industries (Tables 5.2-5 to 5.2-11)	Reduced spending by these industries in regional economies
Local markets, supply and demand patterns	Price effects
Effect of adverse regional effects on property values	Property tax revenues
Fish and wildlife populations (Table 5.2-3) and effects on related industries (Tables 5.2-8 and 5.2-9)	Spending by commercial and recreational fishers and hunters
Extent to which adversely affected resources (unemployed persons) seek assistance	Local government costs for services

Possible Mitigation Measures

The types of mitigation that might be undertaken to eliminate, reduce or compensate for these adverse effects are as follows:

- Adverse effects on the regional economy can be minimized by maximizing the efficiency of fish and wildlife mitigation investments.
- Land retirement actions and other actions that reduce production should not be concentrated in economic regions.
- Adverse effects on regional industries can be minimized as discussed previously for each industry.

Tribal Effects[32]

This section is concerned with the potential adverse effects of fish and wildlife declines on tribal members and communities. The discussion is focused on the effects of human actions on Native Americans. The values of tribal members in the larger non-Indian society are covered in the other sections.

Human Activities

The types of human activities that will affect Native Americans are as follows:

- changes in timing and extent of reservoir operations, e.g., increased reservoir drawdowns;
- multiple decisionmaking processes and associated decisions reducing tribal opportunities to have and use resources (e.g., harvest opportunities decreased as use of hatcheries moved away from production purposes);
- actions reducing funds available for fish and wildlife mitigation and recovery; and
- non-Native forestry; agriculture, including irrigation, cropping and grazing; recreation; mining; urban and rural development for residential, commercial, and industrial uses.

Possible Adverse Effects

- increased exposure of cultural resources, decreased resident or anadromous fishing opportunities; decreased tourism; exposure to toxic sediments; reduced scenic values of reservoirs; land lost to new generation and transmission facilities;
- decline of practices essential to preservation of tribal culture and religion;
- reduced tribal employment; reduced tribal health; reduced protection and mitigation for fish and wildlife and their habitats; and
- greater competition for fewer resources; increased air, land and water pollution; habitat declining in quality and quantity.

Context and Intensity

Many factors influence the degree of effect of human activities on Native American values. The degree of effect on Native Americans is a function of the extent that decisionmakers choose to take the actions identified above, and the types, intensity, and amounts of such actions. Native American interests may be cultural, religious, economic, or recreational. Tribal members also express values related to water

[32] Considerable analysis has been conducted in the Lower Snake River Feasibility Study (Corps, 2000a, b) and its Drawdown Regional Economics Workgroup (DREW)] and a report on tribal conditions titled "Tribal Circumstances and Perspective Analysis of Impacts of the Lower Snake River Project on the Nez Perce, Yakama, Umatilla, Warm Springs, and Shoshone Bannock Tribes" (CRITFC, 1999). Additional analysis is available in the Framework Report (Council, 2000a).

quality, use of traditional resources and locations, preservation of cultural resources, health education, and socioeconomic concerns such as employment and income.

Many factors affect the socioeconomic and other human effects involving tribal groups, as Table 5.2-14 illustrates.

Table 5.2-14
Factors that Shape Effects on Native Americans

Factors Leading to Effect	Effect
Total amount of natural resources, especially anadromous fish, available for Native American use; definition of ESU under ESA	Amount and location of fish available for tribal harvest; cultural, economic, social and spiritual value of resources available to Native Americans
Choices between competing resources such as resident fish and anadromous fish, wild fish and hatchery fish, or land for wildlife habitat or economic development	Native Americans affected depending upon rights under treaties, statutes, or executive orders
Failure to allow tribal management of natural resources and use of traditional tribal techniques and knowledge	Reliance on Western scientific method leading to tendencies of underestimating risk of extinction of stocks listed under the ESA
Increasing number and complexity of decisionmaking processes	Disenfranchisement of tribes as resource co-managers and sovereign entities; depletion of tribal economic and staff resources as they try to maintain presence in the numerous processes
Funding available for mitigation and recovery	Employment and incomes; level of mitigation and recovery achieved
Changes by Congress, the President, states, tribes, and agencies in laws and policies, or their implementation	Further limit, clarify, or resolve tribal trust and treaty obligations of the United States; reduction of environmental protection under Federal law

Possible Mitigation Measures

The tribes themselves recommended many of the following mitigation measures in government-to-government consultations and policy level discussions during the comment processes on the Lower Snake River Feasibility Study EIS and the 2000 FCRPS Biological Opinions. BPA derived other possible mitigation measures based on its experiences in working with tribes and the advice of BPA's tribal liaisons.

- **Changing Reservoir Operations**
  - Update NEPA coverage; especially examine resident fish, toxic waste, and cultural resource impacts of upriver and blocked areas on tribes.
  - Implement storage reservoir rule curves in Montana for sturgeon and bull trout.
  - Cooperate with EPA in toxic sediment studies and mitigation.

- **Multiple decisionmaking processes**
  - Create enhanced process structure for Federal action agencies consulting with the tribes.
  - Provide appropriate level of funding for tribal participation in numerous federal processes and multi-agency decision making forums.
  - Increase number of Native Americans in agency decisionmaking positions.
- **Reducing funds available for fish and wildlife**
  - Design, locate and operate hatcheries in a manner that respects tribal cultural values and fishing practices.
  - Transfer operation of some hatcheries to tribes.
  - Raise power rates; sell BPA to entity more responsive to Native American rights and needs.
  - Re-evaluate priorities in regional funding decisions regarding resident fish and wildlife and the effectiveness of mitigation.
  - Increase number of mitigation contracts with tribes or businesses owned by tribes; pay tribal employment ordinance taxes on all projects on or near reservations.
- **Greater competition for fewer resources**
  - Decrease over-grazing, non-sustainable forestry, water spreading, and urbanization of rural areas; confine industrial, commercial, and residential development to urban areas.
  - Clarify tribal trust and treaty rights; fund and enforce them.
  - Apply conservation necessity principles to assure that treaty fishing takes priority over non-treaty fishing and other sources of salmonid mortality.
  - Enforce Clean Water Act total daily maximum load requirements on all tributaries in all states in Pacific Northwest.

Discussion[33]

Native Americans have unique concerns that transcend their roles in the non-tribal economy. Given the broad cultural and spiritual relationship between Columbia Basin natural resources and tribal peoples, it is likely inappropriate—and also not fully possible—to establish linkages between Policy Directions and the circumstances of tribal peoples based on some single measure. Direct information provided by Native Americans provided an important basis for identifying which Policy Direction would improve tribal living circumstances, and which would not.

[33] This text is paraphrased from the Human Effects Analysis of the Multi-Species Framework Alternatives (Council, 2000a).

Historically, Native Americans have been substantially affected by the cumulative destruction of the salmon-producing capabilities of the FCRPS and by declines of many game and plant species upon which tribes depended. Much of this destruction has often been accompanied by assurances of mitigation that, with time, did not occur as promised by the government or as anticipated by the tribes. As a result, the tribes are skeptical of promises regarding mitigation. Policy Directions that do not further tribal goals for fish and wildlife will likely engender litigation and even greater tribal skepticism of the Federal government.

Assessment of tribal effects depends heavily upon whether populations of key fish and wildlife species, and more broadly, Columbia Basin ecological diversity, increases or decreases. Tribes fear that the Federal commitment to upholding trust responsibilities and treaty rights will continue to diminish under the Status Quo or other Policy Directions that do not place a higher priority on mitigation and recovery of all fish and wildlife. Policy Directions that do not curb or concentrate growth and development will support encroachment on resources valued by tribes and diminish the area over which tribes may exercise their rights to manage and use resources. In the long run, tribal influence may be eroded and, both off and on their reservations. Tension and conflict will increase between Native Americans and other citizens as tribes increasingly compete with others for limited resources.

Tribes may overextend their political and economic resources attempting to participate in the many processes in which tribal interests may be adversely affected—hydropower relicensing proceedings, the Council's program, harvest regulation, forest and range planning, siting of new generation and transmission facilities, harvest and hatchery agreements, water rights adjudications, NEPA processes, ESA consultations, and CWA enforcement actions, to name a few. With the shrinking of tribally influenced areas and over-extension of tribal government, Native American culture may also be further fragmented and lost, especially traditional knowledge and practices pertaining to natural resource management.

Conflict could increase between treaty tribes and Executive Order tribes under alternatives that emphasize anadromous fish mitigation and recovery. Upriver or blocked-area Executive Order tribes often face or perceive increased environmental, social, and economic impacts from efforts to address ESA-listed anadromous fish because there is less funding available for resident fish and wildlife. In addition, there are greater upriver impacts from deeply drafted reservoirs. Upriver tribes feel excluded from mitigation and recovery processes that omit proposals to reintroduce anadromous fish to areas permanently blocked by dams or laws and policies that prohibit them from participating in fisheries. These tribes also may view an emphasis on anadromous fish as slighting their cultures, some of which have historically depended more on resident fish and wildlife than anadromous fish.

Hatchery, harvest, and implementation of the ESA all directly affect all the Region's tribes. Closing hatcheries for all but conservation purposes—that is, using hatcheries only for preserving genomes, not for supplementation or production for harvest—

could severely reduce the fish available for harvest and undermine mitigation promises. Or, increased use of hatcheries for production or supplementation could, in the long run, have deleterious effects on the genetic integrity of wild stocks and potentially lead to reduced survival and declining fish population growth rates. Continued focus on lower Columbia River hatcheries, to the exclusion of upper river hatcheries could favor downstream non-tribal harvest over upper basin tribal harvest. Finally, continuing to define ESUs restrictively (such that individual stocks are protected instead of whole species) will prolong mitigation and recovery efforts by forcing all activities in all four Hs to be closely regulated—including tribal harvest.

Adverse Economic Effects from Declining Fish and Wildlife Populations

This section provides a summary discussion of economic and social adverse effects from fish and wildlife population reductions. Commercial, recreational, regional and tribal effects were discussed previously. Additional adverse effects involve non-consumptive use values and non-use values that are lost when fish and wildlife populations decline or biological diversity is lost.

Given the level of detail of this EIS, as well as the state of the science, economic losses of alternative Policy Directions caused by fish and wildlife populations and harvest can not be calculated. Economic losses are not quantified because future fish and wildlife populations are not quantified, but also because the amount of economic loss as a function of population decline is also quite uncertain. **Appendix F** provides some typical commercial, recreational and non-use unit values for fish and wildlife.

Possible Adverse Effects

Economic and social adverse effects may include the following

- tribal effects;
- commercial fishing losses;
- recreational fishing and hunting losses;
- aesthetic economic values associated with lost viewing of fish, wildlife, or other natural features;
- non-use economic values such as existence, option and bequest values; and
- losses associated with feeling of moral or ethical obligation, religious beliefs, pity or equity.

Context and Intensity

Fish and wildlife losses will be influenced by human culture, activities and development and by the characteristics of fish and wildlife restoration, mitigation and recovery. Table 5.2-15 shows some of the factors that may influence economic losses from fish and wildlife declines.

Table 5.2-15
Factors that Shape Effects Involving Economic Losses of Fish and Wildlife Declines

Factors Leading to Effect	Effect
See Table 5.2-14. Tribal members are also affected through their roles within the larger society	Tribal effects
See Table 5.2-8. Fish populations and characteristics. See Table 5.2-3. Also, commercial fishing regulations, technology, markets, costs of inputs	Commercial fishing losses
See Table 5.2-9. Fish and wildlife populations and characteristics. See Table 5.2-3. Recreational fishing and hunting regulations, alternative recreation opportunities, recreation costs, especially travel	Recreational fishing and hunting losses
Fish and wildlife populations and characteristics. See Table 5.2-3. Locations and mobility of humans; cultural attributes	Aesthetic values (non-consumptive use)
Fish and wildlife populations and characteristics. See Table 5.2-3. Human and cultural characteristics and preferences	Non-use values: existence, option, and bequest values; feeling of moral or ethical obligation, religious beliefs, pity or equity

Possible Mitigation Measures

- Mitigation measures are largely those used to reduce fish and wildlife declines; see Section 5.2.
- Mitigation for economic effects may include monetary compensation, provision of alternative economic opportunities, or retraining.

Discussion

Commercial fishing losses are perhaps the most simple and easily calculated economic losses, and recreational losses associated with reduced availability of fish and game are commonly estimated. Other types of adverse economic effects are not so easily measured.

Many persons enjoy observing fish and wildlife. Observation is sometimes classified as "non-consumptive use" because fish and wildlife are not taken. Some observation, such as birdwatching, is a specific recreation activity, but much observation is incidental to other activities.

Non-use values occur even though their holder has no intent to actually use or observe the valued resource. Types of non-use values *include existence* values, a value associated with continued existence of a resource; *option* value, associated with retaining the option to use a resource in the future; and *bequest* value, associated with maintaining the resource for future generations. Some persons may maintain that they have a moral, ethical, or religious responsibility toward other living things, or they may express empathy or equity values for fish and wildlife.

Economists and other social scientists are largely unanimous in their belief that non-use values exist and that they are justifiable economic values. The economic measurement of these values, however, is a very contentious matter. Economists often base their measurement of economic value on prices. There are, however, no useful prices for non-use values. Therefore, measurement must rely on a variety of indirect methods. *Contingent valuation* uses a survey format to query people about their willingness to pay for their non-use values. Proponents of this method can provide evidence in support of their results, but opponents can provide evidence that results are not realistic economic values.

Even with the uncertainty of measurement, most studies agree that, with fish and wildlife population declines, economic value of lost uses is less than the non-use values. Commercial use losses are especially limited because most species, especially wildlife species, are no longer sold commercially. Commercial salmon values are limited by a very competitive international market and the growth of inexpensive salmon farming as an alternative to conventional production and harvest techniques.

The counting of losses requires a definition of *whose* losses are being counted. In this case, we are primarily concerned with regional economic losses: those losses incurred by citizens of the region. Regional residents suffer most fish and wildlife losses. Exceptions involve recreational fishing and hunting by non-residents and non-use values of nonresidents.

Regional citizens include tribal members. Economic and social losses for this group were described previously. Primary values are cultural, religious and subsistence. Fish and wildlife losses might reduce levels of self-sufficiency, perceptions of control, and tribal health. Tribal members also have economic interests in common with the larger non-Indian society, as described above.

Cultural Resources and Aesthetics

Cultural resources are specific places that may be or are important in the history of the nation and its peoples. The term encompasses archaeological resources such as prehistoric settlements and artifacts, historical resources such as settlers' homes and other buildings, and existing cultural resources such as buildings, structures, and locations that help define and maintain existing cultures.

Applicability or eligibility is largely derived from and limited by Federal law, regulation, and Executive Orders, and Departmental or agency standards or policies. A cultural resource becomes important as it bears witness to the values, uses, meanings, and relevance people hold for their natural, cultural, and spiritual world. An historic property or historic resource—any prehistoric or historic district, site, building, structure, or object

included in, or eligible for inclusion on the National Register, including artifacts, records, and material—remains related to such a property or resource.[34]

Aesthetic effects involve the qualities of sensory experiences. These qualities are inherently a matter of personal value judgments, and different people have different preferences. For many aesthetic values, there is no commonly accepted basis for what is beneficial or adverse. Some people prefer natural attributes, while others prefer developed ones.

Human Activities

- Reservoir drawdown would expose reservoir sediments and lead to impaired aesthetic values. Increased emissions from thermal generation could impair visibility.
- Certain river operations will involve the modification of structures such as spillways, dam embankments, and fish passage facilities, potentially causing direct effects on historic or cultural properties.
- Habitat restoration actions could convert farmland to native vegetation, and preservation could keep some land from being converted to urban uses.

Possible Adverse Effects

Possible adverse effects on cultural resources and aesthetics include the following:

- exposure and loss of cultural resources;
- exposure of unsightly reservoir sediments;
- reduced visibility; and
- changes in scenic qualities that some persons would dislike.

Possible Mitigation Measures

Adverse effects can be mitigated by planning and acting to protect historic and cultural resources.

Discussion

Changing water levels and flows can cause wave action, inundation, and exposure of reservoir drawdown zones, all of which can affect cultural resources. System operations can also cause indirect consequences for historic properties as a result of changes in the human use and aesthetics of shore and drawdown zones.

Effects within the reservoir pool occur most often to non-structural archeological deposits, since initial reservoir construction and filling usually removed or damaged above-ground or structural cultural resources such as historic architecture. Direct

[34] Definitions adapted from Governors, 2000.

effects on archeological deposits resulting from reservoir shoreline fluctuations occur differently in each of three reservoir zones: (1) exposed beach; (2) wave-impact; and (3) inundation zones. Indirect effects on historic and cultural properties due to system operation strategies involve changes in the human use of the shore. The devegetation and deflation of archeological sites in the exposed beach zone make them more visible to the public, increasing the likelihood of theft, vandalism or disturbance.

Decisions to develop or permit camping, summer homes, hiking trails, or off-road vehicle uses may all lead to increased effects on historic and archeological sites from human caused erosion, vandalism, and artifact theft.

System operation strategies that change land uses might also change the integrity of "feeling" or association of a historic property. Reservoir drawdown might destroy the visual integrity of a historic sight or traditional cultural property by introducing an element that is inconsistent with its historic or cultural character.

Reservoir operations, primarily drafting, can have pronounced aesthetic effects on adjacent lands. These consequences result from a number of factors, including increased shoreline visibility and contrast, erosion, changes in recreational facilities, reduction in the size of embayments and seep lakes, changes in water characteristics, and production of dust and odors. A decrease in aesthetic quality at a project can affect recreational use and have social and economic consequences for visitors and residents.

5.2.3.3 Summary of Generic Effects By Common Activity

The following diagrams are offered as a way for the reader to view the generic effects of common human activities. In the previous sections, the generic effects were given by type of effect and a discussion was provided on what activities were associated with them. That format works well for the analysis needed to determine environmental consequences addressed in this DEIS.

In response to requests made during the public meetings and in early scoping, we are providing below an easy way for those who want to understand the possible environmental effects of their activities. These diagrams are an attempt to illustrate some of the same material in Sections 5.2.2 and 5.2.3 in a condensed, easy-to-read format that shows the environmental concerns of several common human activity. There are several other activities that could be shown, but these represent those that were specifically requested by the public that participated in meetings with the DEIS team.