The Snake River Levee System Report

Teton County, Wyoming

Paul V. Anthony

Published by
Jackson Hole Conservation Alliance
September, 1998

TABLE OF CONTENTS

Executive Summary

SECTION I: Introduction and Levee History p.1
- Introduction
- History of Levee Project
- Types of Levees
- Levee Design
- Location of Levees

SECTION II: Major Studies on Levee Management.....p.4
- Snake River in Wyoming Interim Study
- The Jackson Hole Section 1135 Study
- The Jackson Hole Restoration Study

SECTION III: Regulatory Authority and Management of Levee Project.....p.6
- Corps Regulatory Authority
- Teton County Regulatory Authority
- State of Wyoming Regulatory Authority
- Federal Permits: Individual, Nationwide and Regional General
- Permit Evaluation Criteria and Enforcement
- Teton County Land Development Regulations and Permit Process
- FEMA National Flood Insurance Program
- The Corps and County Permit Relationship
- Division of Responsibilities Between County and Corps for Levee Management
- 1988 Lawsuit to Determine the Riparian Property Boundaries on Snake River

SECTION IV: Impacts to Morphology and Hydrology of Snake River.....p.15
- General Impacts
- Changes in the Snake River Flood Plain
- Changes in Aggradation and Degradation of River Bed
- Groundwater
- Wetlands

SECTION V: Ecological Effects of Levees.....p.17
- Introduction
- Habitat Loss
- Vegetation Comparison: 1956 to Present Conditions
- Channel and Flood Plain Complexity
- Snake River Cutthroat Trout and Spring Creeks
- Restoration Efforts of Spring Creeks
- Bald Eagles
- Other Animal Species

SECTION VI: Human Impacts in Project Area.....p.24
- Human Disturbances Measured by Model
- Human Disturbances - Cumulative Impacts

SECTION VII: Recommended Future Projects.....p.26
- Inventory of Private Lands Development in Snake and Gros Ventre River Corridors
- Analysis of Fema's Flood Plain Designation for Jackson Hole
- Analysis of Corps Monitoring and Enforcement of Permit Violations

LIST OF APPENDICES

Appendix A: Snake River Levee Project Location
Appendix B: Levee Names and Location
Appendix C: Annual Peak Discharges Comparison at Wilson Bridge
Appendix D: Location of Restoration Sites Location of Spring Creeks
Appendix E: Snake River Cross Section, 1956 and 1986
Appendix F: Average Erosion and Deposition by River Segment, 1954-1988
Appendix G: Cover Type Changes between 1956 and 1986
Appendix H: Summary of Total Estimated Spawning Above the Gros Ventre River Confluence [with Snake River]
Appendix I: Location of Crucial Habitat for Trumpeter Swans

SNAKE RIVER LEVEE SYSTEM STUDY

Executive Summary

Purpose
The purpose of this study is to collect and summarize existing information on the management and ecological effects of the Snake River levee system in Teton County, Wyoming (See: Appendix A). This study was initiated to address confusion regarding the division of governmental authorities over levee management, the permit process for water control projects and flood plain development, and, most importantly, the environmental effects the levees have had on the Snake River and its riparian corridor. It is also the intent of this study to serve as a general reference document from which more detailed future studies can originate. To facilitate these future investigations, topics needing further analysis are recommended, and a fully indexed bibliography and list of contacts are included.

Background
The first phase of the *Snake River Federal Levee Project* (Project) in Teton County, Wyoming, was completed by the US Army Corps of Engineers (Corps) from 1957 to 1964 (See: Appendix B). This part of the Project extended approximately 13 miles - from 4 miles south of the Grand Teton National Park boundary to 4 miles north of the Wilson Bridge. The purpose was to provide flood damage control to property owners, primarily ranchers, along the Snake River. Then, after the completion of this Project and until the late 1970's, a variety of intermittent levees were constructed to provide further protection. These levees, called non-Federal levees, were built by different authorities (private, local, state and federal) and extend from the southern terminus of the Federal levees to the South Park Bridge (See: Appendix B). In addition, a few non-Federal levees were built north of the Federal Levees. Today, these levees have been maintained and partially extended by the Corps. Additionally, private landowners have constructed numerous bank stabilization projects, channel plugs and other water diversion features.

Operation and Maintenance
In 1986, the Water Resources Development Act (WRDA) permitted the option of transferring responsibility for operation and maintenance (O&M) of the entire existing Project (both Federal and non-Federal levees) from Teton County to the Corps. After the completion of an Environmental Impact Statement and consultation with the County, the Corps officially assumed O&M of the Project in 1990. While the Corps has final decision-making authority over O&M matters, Teton County provides substantial financial support ($48,906 for FY 1999) and supplies most of the labor and equipment used to maintain the levees.

Army Corps Section 404 Permits
The Army Corps issues three basic Section 404 permits that regulate development activities within the waterways of the United States under the authority of the Clean Water Act: Individual Permits, Nationwide Permits, and Regional General Permits. Individual Permits are required for larger scale projects (e.g. major levee construction) and require public notice, whereas Nationwide Permits cover less damaging projects (e.g. minor bank stabilization) and do not require public notice. Regional General Permits are similar in scope to Nationwide Permits but are usually for slightly more comprehensive or complex projects (e.g. pond excavation for fish habitat). For projects in Wyoming, all three permits are issued by the Omaha District (Cheyenne, Wyoming office) of the Corps.

Teton County Permits
Teton County also requires certain development permits for development and land modifications in the 100-year flood plain in order to comply with conditions of the Federal Emergency Management Agency's (FEMA) Flood Insurance Program. Notwithstanding certain exceptions, the County does not allow development in the 10-year flood plain. County permits are of a variety of types and

do not require public hearings.

Regulatory Coordination
In terms of coordination between the Corps and County permit processes, the Corps has no legal responsibility to withhold approval of its permits until the applicant has first received all necessary County permits. Similarly, Teton County can approve or deny County permits regardless of whether the applicant has already obtained all necessary Corps permits. However, approval of Corps permits in no way exempts landowners from needing County permits or vice versa. Therefore, this means that applicants must receive approval of all Corps and County permits, regardless of sequence, before they can legally proceed with their project.

Ecological Impacts of Levees
The constriction of the River by the levees has had extensive ecological impacts - both between and beyond the levees. For example, the levees have reduced the flood plain from 25,000 acres to 2,500 acres for the 100-year flood. The gap between the levees is approximately 1,000 to 1,600 feet, compared to the natural channel which was approximately 1,000 to 4,000 feet and extended to 8,000 feet before the levees were constructed.

The channelization of the River has increased its velocity, thereby eliminating many cottonwood islands, diminishing fish habitat, causing extensive downstream bank erosion and leading to unnatural bedload movement. Outside the levees, in areas formerly flooded by the River or receiving higher water flows, riparian habitat for mammals, birds, amphibians, and fish has been drastically diminished or altered. Human settlement has now firmly established itself in these sensitive areas, leaving little doubt that restoration will be minimal. However, potential rehabilitation of certain areas is possible.

Specifically, the levees have significantly diminished cutthroat trout spawning habitat and increased the amount of mature cottonwood stands, while simultaneously decreasing the acres of younger replenishing cottonwood stands. Furthermore, the levees have promoted residential and commercial development in critical bald eagle nesting territories, increased the spread of noxious weeds, and potentially affected groundwater levels. However, some species, such as trumpeter swans, have potentially benefited from the confinement of the River.

The irony of the river channelization is that the levees themselves have created the need for even more levee construction and water control features downstream. Consequently, now that the levees are assumed to be permanent, the inescapable fact is that the Snake River will have to be perpetually manipulated in after-the-fact efforts to compensate for the levees' unnatural effects. Wyoming Game & Fish's efforts to rehabilitate spring creek spawning habitats degraded by levee construction have been largely successful at increasing cutthroat trout populations in those targeted streams. However, the sustainability of such efforts is questionable. In addition, the Corps is in the process of conducting a Snake River Restoration Study in which four sites between the levees are being considered for various restoration measures beginning in the fall of 1998.

Human Impacts
The increase in residential and commercial uses in the riparian areas protected by the levees has significant short and long-term consequences. For example, residential housing and its accompanying access roads not only directly eliminate habitat but indirectly eliminate or diminish habitat by the broader occupation (i.e. pets, children, landscaping/lawns) of that land. Unfortunately, the cumulative impacts of human encroachment into these sensitive riparian areas have been inadequately analyzed. Addressing cumulative development impacts is primarily a local responsibility, and it is apparent that Teton County landowners, planners and elected officials must provide better protection for our flood plain if those habitats are to retain their ecological importance in Jackson Hole.

Recommended Projects

Through the course of researching this report, future projects for the Jackson Hole Conservation Alliance have been identified for more detailed investigation. Recommended projects include: completing an inventory of private lands development in the Snake River and/or the Gros Ventre River corridors; collection of data on actual flood frequency in designated flood plains as part of a review of the accuracy of FEMA's flood plain designations in Jackson Hole; and a summary of Corps inspection and enforcement of permits.

SECTION I: INTRODUCTION AND LEVEE HISTORY

INTRODUCTION

The purpose of this study is to collect and summarize existing information on the management and ecological effects of the Snake River levee system in Teton County, Wyoming (See: Appendix A). Teton County is located in the northwestern part of Wyoming, just south of Yellowstone National Park where the Snake River originates. This study was initiated to address confusion regarding the division of governmental authorities over levee management, the permit process for water control projects and flood plain development, and, most importantly, the environmental effects the levees have had on the River itself and the entire riparian corridor. It is also the intent of this study to serve as a general reference document from which more detailed future studies can originate. To facilitate these future investigations, topics needing further analysis are recommended and an indexed bibliography and list of contacts are included.

HISTORY OF LEVEE PROJECT

In 1950, a severe natural flood prompted landowners in Teton County, Wyoming to ask the Army Corps of Engineers (Corps) for more comprehensive flood protection. Prior to this time, levee and bank protection consisted mostly of small, discontinuous projects designed to provide local flood protection. However, these efforts offered inadequate protection from the Snake River. Consequently, in March of 1954, Congress authorized the *Snake River Levee Project in Wyoming Interim Study, Upper Snake River and Tributaries General Investigations Study* under the authority of the Rivers and Harbor Act (1902). Through this study, the Corps identified the need for a levee system to better control floods. From 1957 to 1964, a nearly continuous system of levees ("Federal levees") was completed by the Corps along a 13-mile reach of the Snake River (See: Appendix B). Other levees, referred to as "non-Federal levees," were added to the original Federal Levee System by various Federal and local authorities up to the late 1970's (See: Appendix B). In 1986, the Water Resources Development Act (WRDA) permitted the transfer of responsibility for operating and maintaining (O&M) both the Federal and non-Federal levees (the Project) from Teton County to the Corps under the authority of the Secretary of the Army. However, the Corps did not officially assume responsibility until 1990. Most recently, in the mid 1990's, private levees, built and maintained by individual landowners, have also been added to the River system. (ACOE, Reconnaissance Report, 1993)

TYPES OF LEVEES

Federal Levees
"Federal" levees are only those levees which were part of the Corps' original *Snake River Flood Control Project* which was completed in 1964. These levees comprise about 75% of the existing levees (ACOE, Reconnaissance Report, 1993).

Non-Federal Levees
"Non-Federal" levees are all those levees built between 1964 and 1986, up to the time when the WRDA was passed. These levees were developed outside the limits of the original Federal levee project and constitute the vast majority of the remaining 25% of the levee system. Essentially, they were built to address localized problems which the Federal levees either created or did not address. Various Federal and local agencies constructed these levees. While most of them were built on the Snake River, three levees were built on the Gros Ventre River near the confluence of the Snake River. Non-Federal levees are sometimes referred to as the PL 84-99 levees because they were built under that law's authority. Technically, under the WRDA, non-Federal levees became Federal levees when the Corps took over responsibility of O&M for each levee type. However, many people retain the terminology, as we do in this report, because it conveniently distinguishes between the two periods of levee development. (ACOE, Reconnaissance Report, 1993)

Following are the names of the non-Federal levees:

Snake River
- 95 Ranch
- Federal Levee Extension
- Upper, Middle, and Lower Imeson
- Upper, Middle, and Lower Taylor Creek
- Sewell
- Spring Creek
- Upstream State Game and Fish
- State Game and Fish Intermittent
- South Park (State Highway Department)
- Evans

Gros Ventre River
- Nelson
- Lucas
- Hansen

Private Levees
Private levees are built, operated and maintained by individual landowners. Typically the landowner will contract the work to an engineering firm which usually consults the Army Corps for technical advice concerning recommended structural standards for the proposed levee, channel plug or other intended water diversion feature. Permits from the Omaha District (Cheyenne, Wyoming Office) for these structures are required by the Corps and usually the County. (Peter, Chandler; ACOE; personal communication)

LEVEE DESIGN

The Federal levees were designed to contain floods of 45,000 cubic feet per second (cfs) below the mouth of the Gros Ventre River and 37,000 cfs above its confluence with the Snake River. Records show that average annual peak flows, measured since the construction of Jackson Lake Dam in 1909, at the Wilson Bridge fall in the range of 18,000 to 25,000 cfs (See: Appendix C). This design was intended to offer 500 year flood protection (0.2 percent chance of flooding each year). However, the levees were engineered (e.g. levee cross-section specifications) to offer 500 year flood protection for rivers such as the Mississippi or Missouri which are slower moving and less dynamic than the Snake which has powerful flood events and constantly changes its course. Consequently, after observing considerable damage to the Federal levees during large flood events, the Corps decided to downgrade the Federal levees to a 100 year flood (1 percent chance of flooding each year) protection level. This downgrade was due more to the risk of structural weakening from strong currents than to the likelihood of the levees being over-topped. Presently, the reality is that the levees have structural attributes (e.g. height) that theoretically offer greater than 100 year protection, yet experience has caused the Corps to remain conservative and treat these levees as 100 year levees. (ACOE, Final EIS, 1990; Barney, Don, TCR&LD; personal communication)

The non-Federal levees, with one exception, do not provide 100 year flood protection. Only the Upper Taylor Creek levee is a 100 year levee. The Middle Taylor Creek offers 50 year flood protection while the remaining non-Federal levees generally provide 10 year or annual flood protection. (ACOE, Final EIS, 1990)

Private levees and other private water control features provide a wide range of flood protection depending on the landowner's need and financial constraints. For example, many of the levees built in the Bear Island area probably offer near 100 year flood protection, but are quite large and expensive.

LOCATION OF LEVEES

The original Federal levees begin about 4 miles south of the bridge at Moose and end about 4 miles north of the Wilson Bridge. More specifically, the right bank (i.e. looking downriver) levees begin at River Mile (RM) 961.0 and end at RM 947.6 (approximately 13 miles). The left bank levees begin at RM 961.8 and also end at RM 947.6, but have a break between RM 957.2 and RM 952.8. The break is in the vicinity of the Gros Ventre confluence in a reach with a narrow flood plain left of the main channel. (ACOE, Reconnaissance Report, 1993)

The non-Federal levees basically extend, intermittently, on both sides downriver (southward) from the Federal levees to the South Park Bridge. There are also three non-Federal levees on the Gros Ventre River near its confluence with the Snake River as well as the 95 Ranch Levee which lies north of the Federal levees on the left bank of the Snake River. (ACOE, Reconnaissance Report, 1993)

Private levees/channel blocks (those not part of the official levee system) are primarily located in the Bear Island area just south of Grand Teton National Park, and in the Sewell Ranch area. In addition, Fall Creek Associates are proposing to construct a channel block on the Nelson high-water channel (Peter, Chandler; ACOE; personal communication; Barney, Don, TCR&LD, personal communication).

SECTION II: MAJOR STUDIES ON LEVEE MANAGEMENT

SNAKE RIVER IN WYOMING INTERIM STUDY

A variety of studies aimed at improving the management of the levee system, including some that consider mitigation measures, have been conducted in the past. In 1961, The Army Corps initiated the *Snake River in Wyoming Interim Study* (Interim Study). As a segment of this study, a report was published in 1965 which identified levee additions to be made on the 8-mile river section south of the existing Federal Levee Project. Many of these proposed additions were eventually built as part of the non-Federal levees. Subsequent studies were initiated but not completed for lack of economic justification. In 1986, Teton County requested that the *Interim Study* be resumed to evaluate the possibilities for reducing flood damage within the entire levee system. This study was delayed due to the passage of the WRDA which required the Corps to conduct an Environmental Impact Statement (EIS) to determine the economic feasibility of assuming operation and maintenance of the levee system. This EIS was completed in 1990. Then, in 1992, the *Interim Study* was resumed once again. Major levee improvements considered in this phase of the study included extension of the left bank Federal levee south to the confluence of the Gros Ventre River and making the Gros Ventre levees 100-year flood protection level. The Corps has since reconsidered the feasibility of these proposals and, as of this writing, has no plans to take these actions. (ACOE, Reconnaissance Report, 1993)

THE JACKSON HOLE SECTION 1135 STUDY AND DEMONSTRATION PROJECT

The transfer of operation and maintenance of the levees in Teton County to the Army Corps, initiated in 1986 and finalized in 1990, both disrupted some ongoing studies and fostered new ones. Under section 1135(b) of the WRDA, a fish and wildlife restoration demonstration project was approved for implementation in the Jackson Hole area. It is a regulatory requirement of Section 1135 that restoration activities can only be done in areas *outside* of the levees. Project work *between* the levees must be done under the authority of separate legislation. A draft Detailed Project Report and Environmental Assessment (DPR/EA) was completed in 1992. The draft DPR/EA proposed restoring flows to some of the alluvial channels cut off by one segment of the levee system in the Jackson Hole area (ACOE, Reconnaissance Report, 1993). A 50/50 cost-sharing agreement between the Corps and the County was tentatively arranged but the Corp's cost estimate of $600,000 for the total project (i.e. $300,000 for the County) was more than the County was willing to bear. In addition, this project was complicated by the fact that one of the thirty-five affected landowners (those people whose property would receive increased flows or water impacts) would not consent to the project. Thus, the Teton County Board of Commissioners was forced to either approve the condemnation of that particular property or withdraw their support for the project. The Board would not condemn the property, so the project looked doomed. In hopes of saving the project, the Corps offered an alternative that would be cheaper and would flood nearly all the same areas as originally planned, but would avoid the property of the uncooperative landowner. Unfortunately, the cost of this "cheaper" alternative was the same as the original plan. Consequently, the Board voted to drop the 1135 project. It is possible that another 1135 project in the riparian zones of the Snake River could be initiated in the future. (Gay, Rik, TCNRDC; personal communication & Barney, Don, TCR&LD; personal communication)

THE JACKSON HOLE RESTORATION STUDY

The WRDA of 1990 authorized the *Jackson Hole Flood Damage Reduction Fish & Wildlife Habitat Restoration Study* (Restoration Study). This study emanated from public reactions to the Corps' 1990 O&M Environmental Impact Statement [1]. The public wanted to see the Corps determine how the levees affected fish and wildlife habitat and recommend short-term and long-term restoration measures. (ACOE, Reconnaissance Report, 1993)

[1] In 1990, the Corps completed this EIS in order to access the feasibility of assuming operation and maintenance for the entire levee system from Teton County as stipulated by the Water Resources Development Act of 1986.

The first major product of the *Restoration Study* was the *Reconnaissance Report*, released in June, 1993. The purpose of this report was to consider flood damage reduction measures, collect existing scientific and land use information pertaining to the impact of the levees on the riparian areas, identify future information needs, identify potential restoration activities and to determine whether it was desirable to move the study to the next phase, which was a more detailed feasibility phase. The decision was made to proceed to the feasibility stage, and in July of 1996 the *Feasibility Study, Cost Sharing Agreement and Project Study Plan* was completed. This 1996 document contains specific information concerning project management, project costs, allocation of these costs to sponsoring parties, assignment of tasks and responsibilities, and a more detailed description of the proposed restoration measures. In February of 1998, the Corps released an *Interim Status report of the Feasibility Study* . On July 29, 1998 another steering Committee meeting was held at which the Corps described in the greatest detail yet the engineering specifications and logistics of the different restoration tools (e.g. brush fences) proposed for the four experimental restoration sites.

The *Restoration Study* project area lies between Moose, Wyoming and the US Highway 26 bridge (South Park bridge). Originally, it considered twelve sites between the levees for restoration. However, the costs were too high for the County, so the number of restoration sites was reduced to four areas, also within the confines of the levees. The three general study objectives were defined as: wetland restoration - riverine and palustrine; riparian restoration - island protection and restoration; and endangered species habitat protection and creation. More specifically, the following four objectives constitute the "multi objective" approach to best meet the above general objectives (ACOE, Feasibility Study, 1996):

a) Channel creation. Channel creation to restore fisheries - wetland values dependent on surplus gravel and disposal options (i.e. gravel users)

b) Island Protection.

c) Island Restoration.

d) Fish Habitat Creation. Fish habitat creation (low energy areas in high energy environments) through stream structure alteration (i.e. spur dikes)

The four selected restoration sites are #s 1, 4, 9, 10 (See Appendix D). Progressing north to south, site 10 is at the confluence of the Snake and Gros Ventre Rivers, site 9 is immediately north of the Wilson Bridge, site 4 is immediately north of the Upper Imeson levee, and site 1 is between the Sewell and Spring Creek levees. (ACOE, Feasibility Study, 1996)

The project will utilize four restoration tools that were adopted from other river restoration projects. Due to the extreme nature of the Snake River conditions, each restoration tool was designed to withstand high-river forces. The restoration tools consist of gravel removal, brush fences, anchored root wad logs, and spur dikes (see ACOE, Feasibility Study, 1998 for more details).

SECTION III: REGULATORY AUTHORITY AND MANAGEMENT OF LEVEE PROJECT

CORPS REGULATORY AUTHORITY

Section 404 of the Clean Water Act regulates the discharge of dredged and fill material into the waters of the United States. All Wyoming waterbodies and wetlands are regulated under Section 404. Typical Section 404 activities include: riprap, roadway fills, jetties, channel blocks, dikes/dams, boat ramp dredging, and channel changes. In addition, Section 10 of the Rivers and Harbors Act of 1899 regulates activities affecting navigable waters of the United States. Flaming Gorge Reservoir is the only Section 10 waterway in Wyoming. Typical Section 10 activities include: boat docks, dredging, water intakes, and aerial power crossings. (ACOE, Protecting Wyoming Waters)

The Corps is only responsible for activities that impact waterbodies and wetlands. Therefore, locally in Teton County, the Corps is responsible for the Snake River, its tributaries, and all Federally designated wetlands.

NOTE: There is often confusion regarding the division of responsibilities between the two Corps districts - the Walla Walla District and the Omaha District - which govern management of the Snake River and the levee system. For the purposes of this report, the fundamental difference is that the Omaha District handles the regulatory duties, such as Section 404 permits in Wyoming (e.g. Nationwide Permit), while the Walla Walla District handles all other responsibilities concerning the Snake River, such as operation and maintenance of the levee system as well as any special Snake River projects (e.g. *Restoration Study*). (Barney, Don; personal communication).

TETON COUNTY REGULATORY AUTHORITY

Teton County has the authority to regulate land development in flood plains. For example, within flood plains, the County controls the amount and type of residential, agricultural, and commercial development, specifies the location and size of roads, regulates gravel operations, and oversees other activities that may negatively impact riparian areas and associated wildlife.

STATE OF WYOMING REGULATORY AUTHORITY

The regulatory authorities and responsibilities of the Wyoming Department of Environmental Quality (DEQ), Water Quality Division, are based on:

(1) State water quality laws, specifically Article 3, Sections 35-11-301 and 35-11-302 of the Wyoming Environmental Quality Act.

(2) Section 401 of the Clean Water Act requires the state pollution control agency to provide certification that projects requiring a Section 404 permit from the Corps will not impair water quality and violate state water quality standards. Section 401 applies to both the construction and subsequent operation of all facilities involving discharges into the waters of the state.

NOTE: There are many other regulatory responsibilities required of the state by the Clean Water Act, but they are generally not applicable to the management of the levee system in Jackson Hole.

FEDERAL PERMITS: Individual, Nationwide, and Regional General

Introduction
The Corps determines whether a proposed project requires an Individual, Nationwide, or Regional General Permit based on the scope and nature of the project. Oftentimes, the applicant will contact

the Corps to discuss their proposal and receive advice on what type of permit they may need, how to modify the project's scope to better meet their goals, and how to make the project's construction structurally sound. This permit process came into existence in 1977. Prior to 1977, levees were built without the need for any Corps permits. Therefore, because a majority of the "non-Federal" levees were built before 1977, they have not gone through a Federal permitting process. (Peter, Chandler, ACOE; personal communication)

Individual Permit
An Individual Permit is required when a project is of a greater scope of magnitude than either the Nationwide or Regional General Permits. Individual Permit applications are reviewed according to the degree to which the following impacts are involved: (1) located in aquatic resources of limited natural function; (2) small in size with little direct impact; (3) have little potential for secondary or cumulative impacts; and/or (4) cause only temporary impacts (OCOE, Protecting Wyoming Waters).

Processing an application for an Individual Permit requires the circulation of a public notice to Federal agencies, including the EPA and US Fish and Wildlife Service, state agencies including Wyoming Game & Fish Department and Wyoming DEQ, local agencies, and interested individuals and organized groups. During the public notice comment period (normally 30 days) a public hearing may be requested. If the Corps determines that a public hearing would provide necessary additional information for the public's benefit, then a hearing will be held. In addition, the Corps may extend the comment period upon the request of any interested groups. Finally, a determination is made whether the project is in the public interest, and the permit is either denied or issued. (ACOE, Caring for out Nation's Waters)

Nationwide Permit
A Nationwide Permit is required for projects that routinely have "minimal" environmental impact. Unfortunately, the Corps has no official definition which specifies exactly what constitutes a "minimal" environmental impact. The application of this vague standard is ultimately driven by the persuasions of senior Corps officials in Washington DC. It normally takes a very short period of time to process applications for a Nationwide Permit. There are 40 different types of Nationwide Permits, each distinguished by the nature of the project's activity. Applicants may either apply for a single permit or combine (called "stacking") different permit types for more complex projects. Only a portion of the total permit types are relevant to the levee system in Jackson Hole. For example, the following permits are the most often used: #13 Bank Stabilization Permit; #14 Road Crossing Permit; #18 Minor Discharges Permit; and #27 Headwaters and Isolated Water Discharges Permit (Chandler Peter, ACOE; personal communication). Some Nationwide Permits must have prior approval from WDEQ or the Environmental Protection Agency (EPA) before they can be approved for use in Wyoming. (ACOE, Public Notice - Nationwide Permits, 1997)

Certain Nationwide Permits require notification of the Corps prior to approval while other permits do not. For those permits that require prior notification, a written Pre-Construction Notification (PCN) must be sent to the Corps. PCNs are required in instances where the Corps has determined that an individual review is necessary to ensure that activities authorized by the Nationwide Permit will result in minimal individual and cumulative adverse impacts to the aquatic environment. A PCN is also required for any project that combines/stacks permits, such as permits 12 through 40. The PCN must conform to a standard format and must contain a minimum amount of essential information in order to allow a responsible review. For example, permit #14 Road Crossing Permit requires that a wetland delineation be provided. (ACOE, Public Notice - Nationwide Permits, 1997) The applicant can only commence construction once verbal or written approval from the Corps is granted. However, often in emergency-driven instances such as spring floods, applicants sometimes notify the Corps after they have already begun or completed construction. In such cases, the Corps usually gives after-the-fact permits with little or no penalty to the applicant. Enforcement of Nationwide Permits is less stringent than it is for Individual Permits because the projects are of a smaller scope. Examples of Nationwide Permit activities include minor bank

stabilization; minor road crossing; discharges of fill material that are less than 25 cubic yards; repair, rehabilitation, or replacement of existing structures; utility crossings; and discharges of fill or dredged material into non-tidal waters above their headwaters. (ACOE, Caring for Our Nation's Waters)

NOTE: On July 1, 1998 the Corps published, in Part II of the Federal Register its proposal to issue six new Nationwide Permits (NWP), modify six NWPs, and modify six NWP conditions. A final ruling will be made no sooner than March of 1999. The proposed new NWPs are: (a) Residential, Commercial, and Institutional Activities; (b) Master Planned Development Activities; (c) Stormwater Management Facilities; (d) Passive Recreational Facilities; (e) Mining Activities; and (f) Reshaping Existing Drainage Ditches (ACOE, Special Public Notice: Nationwide Permit Issuance, 1998). To date, these proposed changes, especially the new NPWs, have sparked considerable debate on all sides of the political spectrum. The proposed permits allow developers to fill in several acres of wetlands (one permit allows filling up to 10 acres) at one time without going through a prolonged regulatory review. Many environmentalists feel these new permits will result in the loss of even more wetlands than what current permits allow, while many developers feel that the new permits will add burdensome restrictions to an already over regulated area of development (Casper Star Tribune, 6/26/98). At this writing, it is too early to predict whether the Corps's proposals will be approved. The Corps is accepting public comments and is having a public hearing in Cheyenne on August 18, 1998. There will likely be additional public hearings held in Cheyenne in 1999 (ACOE, personal communication).

Regional General Permit
Regional General Permits are similar in scope to a Nationwide Permit but are for projects that are slightly more comprehensive. Examples of activities which would fall under a Regional General Permit include both temporary and permanent fills in conjunction with roadway crossings. It also includes fill placed in conjunction with fishery habitat improvement structures (i.e. ponds excavated for fish habitat are structurally more complex than ponds excavated for aesthetic purposes). (ACOE, Caring for out Nation's Waters)

PERMIT EVALUATION CRITERIA AND ENFORCEMENT

In reviewing individual permit applications, the Corps analyzes the impacts of the proposed activity on the public interest. In determining the public interest, the Corps is supposed to consider all factors of the proposed activity, including conservation, economics, aesthetics, general environmental concerns, historic values, fish and wildlife values, flood damage prevention, land use, navigation, recreation, water supply and quality, and the general needs and welfare of the people. Similar criteria are used for Nationwide and Regional General Permits, but they are less stringently applied. A permit is supposed to be denied when the project is determined to be contrary to the public interest. (ACOE, Caring for out Nation's Waters)

As an important part of their permit review, the Corps must determine if all "practicable" alternatives that would avoid impacts to the aquatic ecosystem have been considered. Practicable alternatives are defined as those available to the applicant taking into consideration cost, logistics, and existing technology. However, the Corps is not obligated to dismiss an alternative simply because it is more costly to an applicant. On the other hand, prohibitively expensive alternatives can be eliminated. A Memorandum of Agreement (MOA) between the Corps and EPA in 1990 formalized "sequencing" as a permit review process. Essentially, sequencing means that the review process prioritizes project efforts to first avoid impacts, secondarily to minimize impacts, and lastly to mitigate impacts as a final resort. The MOA specifically states that mitigation may not be used to reduce the environmental impacts of an alternative to make it the least damaging, practicable alternative. In other words, an applicant cannot just bypass avoidance measures by simply offering mitigation measures up front as adequate compensation. Generally, the level of scrutiny rises with the scope of the proposed project. (ACOE, Protecting Wyoming Waters)

Emergency Authorizations
Emergency permit authorizations can be granted if the situation poses an imminent threat to life, a significant loss to property, or an immediate unforeseen and significant economic hardship if corrective action requiring a permit is not taken. An abbreviated processing procedure is used in such instances. (ACOE, Caring for out Nation's Waters)

Violations
Doing work in waterbodies or wetlands without a permit or failure to comply with the terms of a permit can have serious consequences. However, monitoring and enforcement of violations is difficult. Because site inspections by the Corps are infrequent, they rely heavily on citizen activism to report suspected violations. Violators may be subject to civil and/or criminal court action, fines of $500 to $50,000 per day, imprisonment for up to 2 years, and removal of structures and materials. However, in terms of the kinds of violations typical on the Snake River in Jackson Hole, removal and smaller fines are likely the most severe forms of punishment. (ACOE, Caring for out Nation's Waters)

TETON COUNTY LAND DEVELOPMENT REGULATIONS AND PERMIT PROCESS

Teton County's Land Development Regulations governing flood plain development include both locally-driven standards and regulations needed to participate in the Federal Emergency Management Agency's (FEMA) Flood Insurance Program. Below is a summary of Teton County's regulatory standards for sensitive flood plain areas (See Teton County Land Development Regulations for full standards).

RE: Development in waterbodies, the 10 year flood plain, and wetlands is prohibited except for essential facilities listed below:

- Flood control, irrigation, or essential crossings
- Not for human habitation
- Compliance with Floodplain Management Resolution [FEMA]
- Minimize negative impacts on wildlife
- Fills in floodplains
    - (a) only allowed for essential crossings, water dependent uses, or flood control.
    - (b) No fill shall be in floodway or within twenty feet of the floodway.
    - (c) Fill or other materials shall be protected against erosion by riprap, vegetative cover, sheet piling, or bulkhead sufficient to prevent erosion.
    - (d) Fill shall be clean and compacted to minimize erosion potential.

RE: Teton County Setback/Buffer Requirements

Rivers:	150 feet
Streams (general):	Located outside of riparian plant community. No less than 50 feet and no more than 150 feet.
Natural Lake/Pond:	Located outside of riparian plant community. No less than 50 feet and no more than 150 feet.
Wetlands:	30 feet

The area protected by the setback is the "buffer" and is required to remain free from development, parking, open storage of vehicles, refuse or any other material. Terrain disturbance for legitimate agricultural purposes, flood protection, wildlife habitat enhancement, or pathways are permitted in the buffer upon receipt of applicable permits.

RE: Wetlands
Obtaining a local permit for developing wetlands does not absolve the developer from obtaining all other State and Federal permits necessary to develop wetlands. Wetlands may be developed under the following circumstances:

(a) Wetland degraded by high-intensity use or agriculture
(b) Necessary to reshape wetland to provide building site
(c) Essential crossings when alternative is not available
(d) Wetland impacts require mitigation

Natural Resources Overlay
The Natural Resources Overlay (NRO) is intended to protect sensitive habitat areas for elk, moose, deer, trumpeter swans, cutthroat trout and bald eagles. Given that all of these species are partially or wholly dependent on preservation of riparian areas for survival, the NRO logically covers the flood plain areas of the Snake River, which includes many private properties that are protected by the levees. Unfortunately, the NRO has proven largely ineffective because its boundaries are not fixed, and it is used for advisory purposes only with no coercive power.

FEMA NATIONAL FLOOD INSURANCE PROGRAM

FEMA has delineated the 10, 100 and 500 year flood plains, as well as the 100 year floodway (the active flood channel area), for the Snake River and its tributaries through Jackson Hole. FEMA uses the 100 year flood (1 percent annual chance of flooding) as the base flood for flood plain management purposes. This 100 year flood area is called the “area of special flood hazard”. (FEMA, Flood Insurance Study, 1989)

FEMA uses both a detailed and an approximate method to determine flood plains (see FEMA’s Flood Insurance Rate Maps in Alliance files for flood plain delineations). According to FEMA, the "detailed method" includes site visits by engineers to survey river characteristics, hydrology, levee conditions, and then cross-checking their findings with topographic data as well. The "approximate method" relies more exclusively on remote methods such as studies of aerial photographs, topographic maps, climatic conditions and older flood data. Both methods were used for the Snake River.

Basically, the "approximate method" was used for the river sections in Grand Teton National Park from the Jackson Lake Dam to the beginning of the Federal levees south of the Moose Bridge. The "detailed method" was used for the river sections from the beginning of the levees to the South Park bridge. However, due to the fact that FEMA’s maps are not developed with thorough site inspections and are based on large-scale topographical maps and rivers that flood by overflowing their banks (e.g. Mississippi) rather than by dynamic channelization (e.g. Snake), many people agree that the maps are outdated and need to be refined.

In order to comply with the conditions of the FEMA Flood Insurance Program, the County is required by FEMA to issue permits for development/improvements (e.g. residential, gravel extraction, channel plugs) within the 100 year flood plain as delineated on FEMA’s maps. The purpose of these permits, the conditions of which are determined by FEMA, is to ensure FEMA that the County is only approving development in the 100 year flood plain which is designed to both minimize human exacerbation of flood levels and reduce damage to life and property (FEMA, Flood Insurance Study, 1989). To receive the permit, the property owner must have an engineer certify that the proposed improvements will not increase the flood hazard in that area. Applicants are required to provide other pertinent information concerning their proposed project and make sure that structures comply with construction standards determined by FEMA (see Floodplain Management Resolution in Comprehensive Plan). Many of these development permits are considered minor development permits and, therefore, only notification of adjacent property owners is required - no public hearing is needed. However, in cases where only a building permit is

needed, there are no notification requirements of any kind.

NOTE: The County Planning Department has expressed its frustration that FEMA's maps delineating the 10, 100 and 500 year flood plains are not at a proper scale; the scale is too large and inexact to provide sufficient accuracy in order to reasonably implement applicable flood plain regulations to specific properties. It is this unreliability of FEMA's maps (the only flood plain maps the County has to use) which weakens, legally and politically, local efforts to manage land use in flood plains. This also makes consistent application of the regulations difficult and engenders little confidence that protection of the resource can result from such an inadequate foundation. (Collins, Bill, TCPD; personal communication)

In order to improve the utility of FEMA's maps, the County Planning Department is considering using Geographical Information Systems (GIS) computer software to create maps that will more clearly and accurately delineate the 10, 100, and 500 year flood plains. However, until the County receives updated and reliable flood plain data from FEMA to put into the GIS program, these new maps would be doing nothing more than transforming the same inaccurate information into an equally inaccurate, but easier to read, map. Therefore, the County is waiting until FEMA completes its next detailed update of the Flood Insurance Study for Teton County before they attempt to proceed with their GIS mapping plans. Presently, the County is in communication with FEMA in the hopes of accelerating FEMA's commitment to initiate this study. (Collins, Bill, TCPD; personal communication)

FEMA Development Requirements
To develop in areas of special flood hazards, certain construction techniques are required of the landowner to meet FEMA's development standards. For example, all new structures are to be anchored to prevent flotation or collapse, utilities are to be located to avoid water damage, and flood resistant construction materials should be used. In addition, residential, commercial and other substantial structures are to be elevated one foot above the flood level. (See Floodplain Management Resolution in Comprehensive Plan)

In terms of the levees' impact on the flood plain designations, if the levees are certified by FEMA as offering 100 year flood protection, then the levee itself becomes the boundary of the 100 year flood plain (Liou, John, FEMA, personal communication). Consequently, land immediately landward of these certified levees is not in the 100 year flood plain and has few development restrictions other than wetlands permits from the Corps, if necessary and certain County requirements (e.g. setbacks). The Federal Levees built by the Corps from 1957 to 1964 automatically meet FEMA's qualifications for providing 100 year flood protection. However, the non-Federal levees are not automatically certified but must be certified independently on the request of the landowner. At this time, the only non-Federal levee that can qualify for 100 year certification is the Upper Taylor Creek Levee.

THE CORPS AND COUNTY PERMIT RELATIONSHIP

In cases where property owners need permits from both the Corps and the County before they can legally begin construction, there is some confusion as to whether the Corps can issue permits for construction prior to the granting of the concurrently needed County permit(s).

The simple answer is that the Corps is in no way legally bound to base approval of their permits (e.g. Individual Permit) on whether or not the landowner has obtained all of their required County permits (Peter, Chandler, ACOE; personal communication). In such cases when a landowner begins construction under a Corps permit without first obtaining all necessary County permits, it is the legal responsibility of the County to halt or penalize such action because the violation concerns only a local regulation. The Corps' scope of legal responsibility for issuing permits is limited by the Clean Water Act - specifically Section 404. As mentioned previously, under the CWA, the Corps is not responsible for flood plain development, but only for development in waterways and

wetlands. Therefore, once a landowner can prove that their proposed project meets the Corps criteria for having acceptable impacts on these two areas of jurisdiction, the Corps is free to issue the permit regardless of any complications or inconsistencies with local regulations concerning, for example, setbacks, sensitive habitat areas or gravel extraction. Because the Corps is neither required, equipped nor inclined to closely monitor local land use development issues, Teton County cannot reasonably expect the Corps to serve as a backup enforcer of local flood plain development regulations which the County is having difficulty enforcing.

Nevertheless, when reviewing permits, the Corps does consider the concerns and comments of the County. This is more true for Individual Permits than for Nationwide Permits which regulate smaller projects and usually receive fast-track approval. For example, the Corps sometimes delays granting approval for an Individual Permit in order to give the County time to complete local regulatory requirements or conduct site evaluations. While such delays are not required, the Corps may delay final action because the County is often seeking information the Corps feels would aid their own permit review. In addition, the Corps sometimes takes extra time in order to incorporate local comments into their required consideration and development of project alternatives. However, it should be emphasized again that any modifications made by the Corps to the process or substance of the permit review are voluntary. (Peter, Chandler, ACOE; personal communication)

DIVISION OF RESPONSIBILITY BETWEEN TETON COUNTY AND CORPS FOR LEVEE MANAGEMENT

General

In 1986, the Water Resources Development Act gave the Corps the option to assume full operation and maintenance (O&M) responsibility (which includes operation, maintenance, repair, replacement and rehabilitation) for the levee system on the Snake River in Jackson Hole. Up to this time, Teton County was responsible for O&M of the levee system. However, before the Corps could accept this new responsibility, they had to complete an economic feasibility study to determine whether they could afford to do so (ACOE, Reconnaissance Report, 1993). The ensuing feasibility study and Environmental Impact Statement (EIS) in 1990 justified the Corps' assumption of O&M duties. It was determined that the Corps would maintain the levees at the protection level present in 1986 (ACOE, Final EIS; 1990). This task is complicated when changes in the river dynamics, such as bedload accumulation at the base of a levee, changes a particular levee's flood protection capability. In such cases, it is the Corps' responsibility to modify that levee in order to reestablish its previous level of flood protection (Barney, Don, TCR&LD; personal communication).

In 1990, the Corps and Teton County signed a Local Cooperation Agreement (Agreement) which officially transferred the operation and maintenance responsibilities of the entire levee system (both Federal and non-Federal levees) to the Corps. More specifically, this Agreement is the contract between the Corps and local sponsor (i.e. Teton County) which divides management tasks and financial contributions in order to best utilize the available resources of the two authorities.

In summary, Corps responsibilities include the construction of any minor and major additions (i.e. physical modifications or extensions) to the existing levees. While the Corps has ultimate legal and managerial control over the operation and maintenance of the Project, the County, being the local sponsor, is physically responsible for the vast majority of the daily, on-site O&M duties (Cooperation Agreement, 1990). Therefore, in addition to the current $48,906 for FY 1999 the County pays to the Corps (the contribution started out as $35,000 in 1986 but is increased each year to include cost-of living adjustments which bring the current contribution to $48,906), the County also spends money to pay for personnel salaries, equipment costs and other expenditures. It is estimated that the County spends an average of about $100,000 per year on the levees. In bad flood years the County has a reserved budget which allows them to spend more money than their mandatory $48,906, but they are reimbursed by the Corps for all of these costs after the flood protection work has been completed. (Gierau, Mike; personal communication; Barney, Don, TCR&LD; personal communication)

All private levees, such as those constructed in the Bear Island area and in the Sewell Ranch area, are neither the Corps' nor the County's responsibility to build, maintain or inspect. The landowner assumes full responsibility for their structures, as well as any financial losses for their failure. However, the reality is that the County will often come to a landowner's aid in emergency situations. (Gierau, Mike; personal communication)

Obligations of the Corps and the County
(the following information is taken directly from the 1990 Local Cooperation Agreement between the Department of the Army and Teton County and the FY 1998 Task Order)

CORPS

* The Corps operates and maintains the levee system. They have exclusive control over hiring contractors to perform any O&M work, although the County's comments concerning such contracts are considered.

TETON COUNTY

* The County shall make an annual cash payment towards operation and maintenance costs for the levees. This payment is a minimum of $35,000 per year. However, at the end of each fiscal year the Corps will compute the County's actual payment share, which depends on the costs of work needed in that year, and credit towards the following year's annual payment any money not used. Typically, all of the $35,000 is used by the Corps.

* The County shall continue to make the site known as the Walton Quarry available to the Corps for mining and processing rock until the time when the Corps determines that the site is not necessary for O&M of the Project. The County still controls the Walton Quarry and is otherwise responsible for the maintenance and reclamation of the site.

* The County agrees to participate in and comply with applicable Federal flood plain management and flood insurance programs.

* The County must publicize flood plain information in the area concerned and shall provide this information to zoning and other regulatory agencies for their guidance in preventing unwise future development in the flood plain.

* The County shall furnish all lands, easements, rights of ways, relocations, and suitable borrow and dredged material disposal areas originally required for the Project. In the event that the Corps determines that they will need additional amounts of the above resources or services, the County may provide them, incrementally if necessary, and be financially credited by the Corps for the commitment of these resources. (See text of Cooperative Agreement for complete explanation)

Management of Operation and Maintenance
(See FY 1998 Task Order for complete list of tasks)

* Both the Corps and Teton County have appointed representatives to coordinate scheduling, plans, specifications, modifications, contract costs, and other matters relating to the O&M of the Project. Presently, Mike Gierau is the County Levee Commissioner, Don Barney is the Teton County representative and Jim Wood is the Corps representative.

* The County is responsible for furnishing all plant, labor, materials, equipment, supervision, administration, and performing all operations necessary to complete the tasks as specified in the annual Task Order agreements between the Corps and the County.

* The County may subcontract all work except operations. Operations include: administration, coordination (providing logistical assistance regarding quarry and stockpiling sites,

levee access, levee road inspections, easements), and inspections (safety, trespass, litter, riprap stockpile sites).

* Maintenance duties of County include: supervision, security and traffic control, snow removal, road/levee surface maintenance, drainage maintenance, vegetation maintenance, road/levee repair, and materials. (See Task Order FY '98 for specifications for each of these duties)

* Emergency activities: patrol levees as needed to identify and immediately report damage; provide emergency response to minimize damage to the Project; and to immediately notify the Corps of any Project damage.

As is evident from the above discussion, the Corps is essentially responsible for oversight management and long-term planning for the levee system, while Teton County is responsible for actually performing nearly all of the daily maintenance tasks. The "buck" stops with the Corps, but the Corps is heavily dependent on the provision of local knowledge and resources in order to carry out their responsibilities.

1988 LAWSUIT TO DETERMINE RIPARIAN PROPERTY BOUNDARIES ON SNAKE RIVER

In 1988, a lawsuit was settled between the Bureau of Land Management (BLM) and landowners adjacent to the Snake River. Essentially, the settlement determined that each landowner's property line extends to the thread of the river. Therefore, the property lines change with the River's course. The settlement also prohibited camping along the Snake River in all but one or two sites. These sites are of limited public knowledge and, therefore, are not used. The lawsuit also stipulated that any boaters who go ashore on a section of the Snake River not designated as a public access area would be subject to a trespassing violation (e.g. Von Gontard's landing at South Park bridge). (ACOE, Feasibility Study, 1996)

SECTION IV: IMPACTS TO MORPHOLOGY AND HYDROLOGY OF THE SNAKE RIVER

GENERAL IMPACTS

By channelizing the Snake River, the levees have increased and concentrated its energy into a much smaller area (See: Appendix E). Associated river changes in the main channel areas between the levees include the following (ACOE, Reconnaissance Report, 1993):

* The river has adjusted by increasing the size of the channels within the levees, generally moving from a complex braided structure to a single or double main channel;

* The channel bed (i.e. the single or double channel) that experiences bedload transport does so more frequently. In other words, bed materials in the active channel area are being more frequently reworked as a result of the concentration of flow;

* The distribution of physical aquatic habitat types has changed as a result of the change in size, distribution and possibly slope of channels. The general effect has been a reduction in low-energy pool areas and a general increase in higher-velocity areas;

* The concentration of water flow within the levees appears to have on average lowered (degraded) the river bed elevation. It appears as though the degradation is relatively evenly distributed across the channel width. However, three areas are experiencing significant aggradation;

* River-bed degradation has the potential of lowering the elevation of the flood plain groundwater table;

* It is plausible that material eroded from the Federal levee reach is being deposited in the slower moving, intermittently leveed sections downstream, causing sediment and bedload buildup (aggradation). However, evidence for such aggradation is not fully available.

The levees have also induced significant physical changes to the flood plain areas beyond the levees (ACOE, Reconnaissance Report, 1993):

* The flow of water into areas that previously experienced flow, at least seasonally or in floods, has been reduced or eliminated;

* This reduction in flood water area coverage has affected flows and channel conditions, including the supply and quality of gravels used for spawning in former side channels and spring creeks;

* The reduction in flood waters has affected the recharge of the valley-floor aquifer and of the soil water content. The exact magnitude of these two impacts is not known (see discussions on impacts to wetlands and riparian vegetation for related analyses);

* The reduction or elimination of floodwaters to portions of the valley floor has reduced or eliminated the contribution of fine sediments and accompanying nutrients that are deposited as a result of flooding. These sediments and nutrients are an essential component in maintaining certain wetland and riparian plant communities.

CHANGES IN THE SNAKE RIVER FLOOD PLAIN

The levees have reduced the flood plain from 25,000 acres to 2,500 acres for the 100-year flood. The gap between the levees is approximately 1,000 to 1,600 feet, compared to the natural channel

which was approximately 1,000 to 4,000 feet and extended to 8,000 feet. (ACOE, Reconnaissance Report, 1993)

CHANGES IN AGGRADATION AND DEGRADATION OF RIVER BED

Degradation
During the 34-year period (1954-1988) in which cross sections were surveyed in the Project reach, there has been degradation or loss of material from the river bed (See: Appendix F). During this period, 3.1 million cubic yards of material were lost from the Project reach. This is an average lowering of the channel by over 10 inches if spread evenly throughout the entire area between the levees. Measurements show that the rate of degradation was greatest in the years between 1954 and 1967 (during and immediately after completion of the Federal levees). Today, the rate is less than half what it was during this 13-year period. These findings strongly indicate both that the levees had an immediate impact on the morphology of the river and that this impact has slowed over time. In addition, the overall pattern of degradation is surprising considering that under natural conditions the reach would probably aggrade. (ACOE, Reconnaissance Report, 1993)

Aggradation
However, it should be understood that not all areas are being degraded. The average figures hide the true extent to which the stream bed is being reworked; some river sections have actually experienced substantial aggradation (elevation increases). For example, the river bed area directly upstream of the Wilson Bridge has risen 8 feet since 1954 (See: Appendix F). (ACOE, Reconnaissance Report, 1993)

GROUNDWATER

Until very recently, little information had been collected to determine the impacts the levees have had on the groundwater table, especially in the West Bank area. However, at the time of this writing, the Wyoming State Engineer's Office is monitoring many well sites on the West Bank and will release a full report on their findings in late 1998. Preliminary results indicate that the levees have not had a meaningful impact on groundwater levels. The monitoring is demonstrating that, presently, groundwater ebbs and flows with the level of the river similar to the way it presumably did under natural conditions. (TCR&LD, personal communication)

WETLANDS

No study has been conducted to determine the levees' impacts on wetlands within the Project area. However, Zaunbrecher (1991) has characterized a sample of Jackson Hole wetlands and the US Fish and Wildlife Service (1990) has done the same for the entire 100-year flood plain for the segment of the Snake River running through Teton County. However, the studies use different definitions for wetlands, which makes simple comparisons of the data difficult. An interesting finding supported by the reports is that, "to the extent in which they [wetlands] buffer streams in the valley, thereby fulfilling most of their functional value, they are less than 50% effective because many have been cut off from streams by roads, levees, pasture, and other developments" (Biota Research, 1991). Certainly, the considerable loss of wetlands due to residential development and its associated roads - which have been enabled by levee development - have been a destructive force in the effort to protect functional wetland habitat. (Biota Research, 1991)

SECTION V: ECOLOGICAL EFFECTS OF LEVEES

INTRODUCTION

The levees have had extensive ecological impacts to both the plant and animal communities associated with the Snake River. However, this report does not intend to cover the impacts to all the various animal species and plant communities. Rather, its purpose is to give a summary of impacts regarding some of the more noteworthy species of local and national concern. More detailed information on these and other species need not be repeated here and can be found in the sources cited in the bibliography and other related materials.

HABITAT LOSS

Habitat loss and modification (e.g. dewatering of flood plain, siltation of spring creeks, blockage of fish movement) caused by the levees has been extensive (See: Appendix G). A computer model (the Habitat Value Model) was developed to measure the richness of vertebrate species that depend on riparian habitat, using the vegetation and physical conditions present along the river in 1956 as a standard of comparison. The assumption was that the wildlife community in 1956 was highly diverse and occurred in abundance patterns that approximated historical norms. The model was primarily based on remotely sensed data (i.e. maps and aerial photography). (Shroeder and Allen, USF&WS; 1991)

One of the Habitat Value Model's more startling results was that one-third to one-half of the habitat value within the 500-year floodplain of the Snake River was lost from 1956 to 1986. (ACOE, Reconnaissance Report, 1993). Riparian plant and animal communities that have historically relied on the multi-channeled, widely flooding patterns of the Snake River have had to adapt to a drastically altered riparian environment. In particular, the long-term effects of levees fragmenting riparian habitat are still not adequately understood or managed. As the USF&WS states, "Although there is a general recognition that western riparian habitats are critically important to wildlife and fisheries, the maintenance and management of these areas are complex, too often over simplified, and quite often not adequately considered in the Section 404 permitting process. Riparian habitat is of high value for many fish and wildlife species and is unique and irreplaceable on a regional and national basis" (USF&WS, 1998).

Three variables were selected to measure and interpret the impacts to the habitat caused by the levees. These model variables are: 1) compare existing or future vegetation with 1956 conditions, 2) evaluate floodplain and channel complexity, 3) and assess human disturbance and its potential effect on wildlife habitat quality and connectivity within the riparian corridor (NOTE: human disturbance impacts are covered in the next section, Section VI). All model results are approximations due to the lack of past and current biological and hydrological data specific to the Snake River and Jackson Hole. (Shroeder and Allen, USF&WS; 1991)

VEGETATION COMPARISON: 1956 TO PRESENT CONDITIONS

Vegetation cover typing of the riparian and wetland habitat was initially conducted in 1989 for the 100 year floodplain. In 1993, for the purposes of the *Reconnaissance Study* (part of the *Restoration Study*), the original cover typing was field checked for accuracy and then expanded to the 500 year floodplain. Furthermore, additional classifications were added to the original ones to better define existing cover types. Changes to the classification scheme include (ACOE, Reconnaissance Report, 1993):

(a) Adding modifiers to the Palustrine emergent vegetation class in order to separate wet meadows (irrigated pastures), cattail/bulrush habitat, and open water habitat.

(b) Further defining forested riparian mixed habitat into dominant and codominant tree species.

(c) Adding two modifiers (residential and sagebrush) to the upland classification system.

Cottonwood habitats
Since the construction of the levees, there has been a 57% increase in older age forested cottonwood habitats converting from younger age class cottonwood habitats (USF&W, 1990). By analyzing the overstory only, most river segments showed declines in the coverage of young cottonwood stands (20 to 40 feet tall) and in the riparian shrub cover type, which would include seedling and sapling stands of cottonwood. The greatest losses of acreage (1,491 acre decrease) occurred in this young cottonwood cover type. There was a simultaneous increase in older age classes of cottonwoods (greater than 40 feet tall) in many river segments. Mature cottonwood is the cover type that showed the greatest increase in acreage, with a total increase of 909 acres. (USF&WS, Final Planning Aid Report, 1993)

Maintenance of mature riparian forest stands is important to many wildlife species. However, long-term replacement of these stands will be jeopardized if new ones are not continually regenerated. In the absence of periodic flooding and flood plain scouring, management actions to open the canopy and disturb the ground surface may have to be initiated. (ACOE, Reconnaissance Report, 1993)

To provide a regional context regarding the extent to which human development (of all types) has resulted in the loss of cottonwood habitat, "90% to 95% of the cottonwood-willow habitat of the Rocky Mountain West has been lost" (Biota Research, 1991). Therefore, the loss of cottonwood and riparian habitats along the Snake River due to the levees is part of a larger cumulative loss of limited wetland areas across the region and country.

Spruce Stands
Research shows that there has been a general conversion to drier forest cover types on the west bank and a loss of these drier stands on the east bank. For example, spruce stands generally lost acreage on the east bank and increased acreage on the increasingly dry west bank. Other vegetation analyses support the theory that the levees have disrupted the westward flow of water, thereby drying out these protected areas (ACOE, Reconnaissance Report, 1993). However, in total, mixed cottonwood/spruce and spruce stands have shown an increase from a preproject level of 770 acres to 1,147 acres currently (USF&WS, 1990).

Exotic Weeds
Twenty percent of all vegetation species (23 of 116) recorded in 12 transects along the Project area were exotic weeds. The greatest percentage of exotics was located on the levees with a smaller percent located on the upland. The levees, and the activities associated with them, create a "corridor of disturbance" that initiates a shift in the herbaceous species composition from one dominated by natives to one dominated by exotic weeds. This shift is accelerated by livestock grazing. (ACOE, Reconnaissance Report, 1993)

The most common weedy species encountered throughout the sample area was black medick. It was also the most common exotic weed on the levees. Other abundant exotic weeds include the common dandelion and mullein. One native species, golden aster, was consistently found on the levees.

Riverine Cover types
The two riverine cover types (unconsolidated river bottom and unconsolidated shore) showed a general trend: unconsolidated shore acres increased, and unconsolidated river bottom acres decreased by 545 acres. This trend is largely due to the conversion of the river from a braided pattern to a larger single channel. The large expanses of unvegetated shore that currently exist in many parts of the river are not isolated from the mainland as islands as they were in the past. This

greatly reduces their value as bird nesting sites. (ACOE, Reconnaissance Report, 1993)

Palustrine Cover Types
Within the Palustrine cover types, seasonally flooded wet meadows are decreasing while semi-permanently flooded forests are increasing (549 acre increase). This shift may simply be due to beaver activity. However, increases in palustrine wetlands in other cases are the result of intentional habitat enhancements made by landowners. Examples of such enhancements include damming spring creeks and excavating ponds. (ACOE, Reconnaissance Report, 1993)

Other Cover Types
There has also been fluctuation in the mesic grassland, mesic grassland-farmed, mesic shrubland, and upland cover types. There is not a strong pattern for the whole study area because human actions have produced many of the changes. However, riparian grasses showed an overall increase of 243 acres, due primarily to residential development. In addition, there has been a 426 acre decrease in aspen stands, while sagebrush has made the greatest increases in the upland habitats of the study area. (ACOE, Reconnaissance Report, 1993)

CHANNEL AND FLOODPLAIN COMPLEXITY

The levee system's most direct impact on the Snake River's channel and floodplain complexity is due to their confinement of the water (See: Appendix E). The biggest components in measuring this impact are channel configuration, overbank flooding, and shoreline complexity. In terms of channel configuration, the drastic reduction in the braided channel pattern has resulted in a more uniform and simple channel pattern. The pool/riffle ratio, an important element in cutthroat trout habitat, was very difficult to assess using aerial photography, and so had little impact on the model's results. Overbank flooding only occurs where the levees are not present. In these unprotected areas, some overbank flooding continues to take place, which accounts for the higher habitat values from the model. The noncontinuous levee portion of the Project area exhibits the greatest shoreline complexity where vegetation is allowed to grow out to the water's edge. (ACOE, Reconnaissance Report, 1993)

SNAKE RIVER CUTTHROAT TROUT AND SPRING CREEKS

History
Before the construction of the levees, limited data was gathered on the health of the Snake River cutthroat trout populations. This was primarily because there was little need, due to the limited amount of human development in the valley at that time, to conduct fish counts or study cutthroat trout spawning use of the Snake River's main and side channels. The first State of Wyoming Fisheries Crew in Jackson was not in place until 1955. (Kiefling, John, WG&F; personal communication)

By the late 1960's, fish managers, fishermen and others had noticed that cutthroat trout numbers seemed to be declining. Intuition suggested the theory, which has now proven accurate, that the central limiting factor in trout production is the availability of suitable spawning habitat in tributary spring creeks. It was correctly assumed that, among other impacts, the channelization of the Snake River by the levees had eliminated many high-water flows needed by the various spring creeks to cleanse and recharge them with natural gravels in order to remain viable cutthroat spawning habitat (see discussion below for more detail). Biologists noticed that redds (cutthroat spawning gravel beds) were being "concentrated" to the point where they where being located on top of each other. This concentration, called superimposition, is viewed as a sign of a lack of suitable gravels for spawning habitat. Today, there is continuing concern for the cutthroat trout populations and springs creek habitats in Jackson Hole. (Kiefling, John, WG&F; personal communication)

The impacts of the levees on the Snake River Cutthroat populations are directly linked to the levees'

impacts on the numerous spring creeks related to the Snake River. However, it is also important not to underestimate the loss of fish habitat in the main channels of the Snake River between the levees. For organizational purposes, this section of the report will divide discussion of impacts on cutthroat trout into two zones - impacts between the levees and impacts outside the levees.

Impacts Between the Levees
Anecdotal information suggests that, prior to development of the levees, there was little cutthroat spawning in the main channels of the Snake River due to the fast sediment-laden waters during spring and summer runoff. Nearly all of the spawning took place in the side channels and tributary spring creeks (Keifling, John, WG&F; personal communication). Today, due to the spring releases of the Jackson Lake Dam and the channelization of the river from the levees, the main channel areas of the Snake River have become less braided, faster, and are probably devoid of any spawning habitat. Also, the high velocity of the river within the levees has diminished the amount of debris fish use for cover and has reduced available feeding areas, as fish tend to conserve energy by avoiding strong currents (Keifling, WG&F; 1986).

Impacts Beyond the Levees
Before the construction of the levee system, the Snake River's side channels and spring creeks provided the native Snake River cutthroat trout with their prime source of spawning areas, a wide variety of riffle/pool habitats, and protective cover. Annual spring floods flushed and cleansed these channels and creeks by removing recently deposited sediments and recharging spawning areas with new clean gravel. Furthermore, flood waters carried and deposited woody debris (e.g. downed trees) in various locations creating additional cover for resident and spawning fish. Currently, flood waters still carry woody debris, but in lesser amounts. (Kiefling, WG&F; 1986 & Biota Research, 1991)

Because the levees have cut off the replenishing flood waters to many of the Snake River's side channels and spring creeks, these spring creeks have lost their capacity to cleanse themselves of sediment from natural accumulation and human sources such as residential and agricultural activities. Livestock often trample through the waterways and damage the vegetation on the banks of the spring creeks. This vegetation provides cover, moderates water temperature, and provides food and habitat for insects which fall into the water and are eaten by the fish. (Biota Research, 1991)

Another major threat to the spring creeks is residential development. Under the logical assumption that the levees will be perpetually maintained, landowners and developers have seized the opportunity to build on the riparian lands protected by the levees. The greater the number of residents and business people invested in these areas, the greater the financial and political pressure will be to do whatever is necessary to preserve and extend, especially in high flood seasons, the levee system. Typical threats associated with development in riparian areas include: the direct loss of riparian habitat, increased siltation due to increased impervious surface runoff and removal of vegetative cover; water pollution from fertilizers, petroleum products and septic discharges; reduction in woody debris; increased human access and disturbance; and increased blockage of waterways by roads and inadequately maintained culverts (Biota Research, 1991).

Below is a list of the important spawning spring creeks in Jackson Hole:

- Spring Creek
- Blue Crane Creek
- Lower Bar BC Spring Creek
- Upper Bar BC Spring Creek
- Little Bar BC Spring Creek
- Three Channel Spring Creek
- Price Spring Creek

- Fish Creek (upper)
- Flat Creek / Nowlin Creek (National Elk Refuge)
- Blacktail Spring Creek
- Cowboy Cabin Creek
- Lamb's Creek

Wyoming Game and Fish (WG&F) has conducted cutthroat trout spawning studies of the above spring creeks since the late 1970's to the present. During this period, they have experimented with various methods for counting redds and fish populations, which has allowed WG&F to improve the reliability of their methodology and results. One point, however, needs to be emphasized: the number of redds and trout are *estimates*. This is more accurate for the trout numbers, which are recorded as being within an estimated minimum and maximum number of pairs, than for the redds, which are physically easier to count. The other essential point is to notice that the numbers of both redds and trout vary significantly from year to year. Therefore, it would be misleading to characterize the production of any spring creek solely on the data from a single year. The purpose of including this information (See: Appendix H) is simply to give the reader a relative idea of how many redds and fish these spring creeks typically support.

RESTORATION EFFORTS OF SPRING CREEKS

Acknowledging the fact that the levees have permanently degraded the spawning habitat in the spring creeks, WG&F initiated some habitat restoration programs in the 1970's for certain reaches of high trout production spring creeks. This effort to boost cutthroat populations has had considerable success in localized areas. The primary spring creeks being restored are Blue Crane Creek, Spring Creek, Three Channel Spring Creek, and the Bar BC and Little Bar BC Spring Creeks (Kiefling, John, WG&F; personal communication).

Restoration activities are centered around creating new habitats and then stocking these areas with native eggs. Past efforts to stock with fingerlings were not successful and were more expensive than eyed-egg stocking (Kiefling, John, WG&F; personal communication). Physical manipulation typically includes the placement of boulders in the creek channel, the excavation of silt materials from headgates, back-water eddies and long slow runs, channel narrowing and deepening, pool construction, placement of commercial washed gravel, and rejuvenation of gravels by dropping and flushing silt from existing natural gravel in the stream bed. It is important to remember that these habitat restorations are not permanent solutions but require continual maintenance on a five to 10 year rotation basis (USF&WS, 1990). An interesting consideration in spring creek management is the fact that the trout in southern Jackson Hole (approximately south of the Wilson bridge) spawn earlier, sometimes two or three months earlier, than the trout populations in northern Jackson Hole (north of Wilson bridge). However, all tributary restoration work is conducted in September and October after migrating spawners have left, and eggs have hatched (Kiefling, John, WG&F; personal communication).

Access for Spring Creeks

In restoring spring creeks, WG&F managers need to have adequate access to the private lands through which the spring creeks meander. This is an especially important requirement if the managers are to meet their goal of doing restoration in an integrated, system-wide manner. Their intent is to avoid restoring creek segments in the random order in which access is granted, which is not always an order that makes biological sense. Large unfragmented single-owner properties, which are typical of ranch lands in the valley, are often easier for managers to gain access to than fragmented ownership areas. Therefore, the subdivision of these ranches into many properties can greatly complicate the manager's task of having consistent and adequate access to the spring creeks. To date, many of the larger ranches and a number of the smaller residential developments have allowed WG&F habitat projects to work. In addition, some of the riparian landowners have initiated and paid for habitat restoration work on their properties. (Kiefling, WG&F; personal

communication)

Effects of Jackson Lake Dam
With no information on cutthroat trout populations prior to the construction of Jackson Lake Dam, the effects of the Dam are uncertain, although likely to be negative due to habitat damage from the relatively large unnatural releases. However, given existing conditions, it is felt that the cutthroat populations can be sustained at current numbers. The primary concern is to ensure that the Dam winter releases are adequate to meet the minimum water needs of the fish; the most critical period is between October and February. WG&F studies indicate that a minimum flow of 280 cubic feet per second (cfs) and a maximum level of 600 cfs is ideal for a healthy fish population. (Kiefling, John, WG&F; personal communication)

To help ensure an adequate flow, the State of Wyoming purchased the remaining water rights - 33,000 acre feet of storage in Palisades Reservoir - in the upper Snake River water system. If needed, this amount of storage translates to a use of 100 cfs/day for 165 days. This is junior water right, which means that it can only be filled after all the water rights in the system have been filled. However, even in the worst case scenario of the Dam only releasing this 100 cfs, it is believed that the various tributaries feeding the Snake River below the Dam would likely provide the necessary minimal flow. In considering the relationship between management of the Snake River and its repercussions for water-dependent users, it is important to remember that over 95% of the Jackson Lake Dam's reserved capacity is held by the State of Idaho. (Kiefling, John, WG&F; personal communication)

BALD EAGLES

General
Because the survival of bald eagles on the Snake River is heavily dependent on access to abundant cutthroat and sucker fish food supplies, the levees' impacts on the bald eagles are closely connected to the above discussion concerning the disruptions to cutthroat spawning opportunities in spring creeks. Therefore, without repeating the above text, it is safe to assert that any reduction in trout populations due to the levee system has had a negative impact on bald eagles. The eagle's dependency on cutthroat trout and sucker fish, both of which extensively use spring creeks for spawning, is concentrated in the spring breeding months. (USF&WS, 1990).

Most of the known bald eagle nesting sites in Wyoming are in the northwestern part of the state. In 1988, 63 pairs of bald eagles attempted to nest in the Greater Yellowstone Ecosystem (GYE). At least 21 of the pairs nest on the Snake River in Wyoming (Biota Research, 1991). The GYE population is considered to be one of the most significant bald eagle populations in the western Rocky Mountains (USF&WS, 1990).

Bald Eagles in Project Area
There are eight nesting territories which are located within the influence of the Project area. One nest occurs in Grand Teton National Park with the nesting territory extending south into the Project area. The other seven nesting territories are located on private lands immediately adjacent to the Project boundaries. Of these seven, one pair is nesting near the confluence of the Gros Ventre River (Gros Ventre pair), another is located north of the Wilson Bridge and the other five pairs are nesting south of the Wilson Bridge (Gill, Ford, Butler Creek, Munger Mountain, and near Evans). About half of the nests from Moose to the South Park bridge are oriented near a cutthroat spawning area. Each of the nests appears to be oriented toward spring creek spawning areas and close to existing levees (Dan Stevenson, WG&F; personal communication and USF&WS, 1990).

Recent research indicates that bald eagles have nearly saturated available nesting habitat in the Project area. The two latest nesting territories were established in areas that biologists did not believe could support more eagles. This suggests that local bald eagle populations are doing as well

as can be expected, which is consistent with the fact that bald eagle numbers in the GYE are experiencing similar improvements. An interesting phenomenon is the discovery that bald eagles are attempting to establish nests in previously marginal habitat areas such as the upper reaches of the Gros Ventre River. However, such nesting attempts have not proven very successful. (Dan Stevenson, WG&F; personal communication)

According to the Greater Yellowstone Eagle Working Team (GYEWT, 1983), probably the most severe impact the levees are having on bald eagles is the promotion of human settlement in their habitat. Eagles are quite sensitive to human disturbance and will often abandon nests or move to less than optimal nesting territories if humans and/or pets encroach. Also, as mentioned before, residential development can have serious siltation impacts on the spring creeks. As the GYEWT states: "The importance of these tributaries should not be taken lightly, for as the tributaries go, so goes the Snake River [fishery]" (USF&WS, 1990).

Another negative long-term impact to bald eagles could result from the lack of regeneration of cottonwood stands in riparian areas. Eagles within the Project area nest almost exclusively in old tall cottonwood trees. The consequence of the levees reducing the regeneration of cottonwoods is that in the future there will be few new mature trees to replace the existing old trees. This would make it more difficult for the eagles to find nesting and roosting sites close enough to their water-dependent food sources. The levees have also reduced the number of suitable mature cottonwoods between the levees. (Dan Stevenson, WG&F; personal communication, and USF&WS, 1990)

OTHER ANIMAL SPECIES

Osprey
Ospreys have endured human habitat alterations and disturbances far better than other large birds of prey. Nevertheless, like bald eagles, two components of habitat quality are critical: waterbodies sustaining quality fisheries with accessible fish and sites for nesting, perching, and roosting nearby. Generally speaking, osprey are less selective about nesting sites than bald eagles. Some reports have shown that ospreys nesting near people reproduce poorly; others have found no negative effects. The majority opinion, however, is that the timing and frequency of human activity and the degree to which ospreys become habituated to such activity early in the nesting season are the criteria important in determining the effect of human activity on ospreys. (Biota Research, 1991) There have been no extensive studies on the effects of the levees in Jackson Hole on the resident ospreys.

Trumpeter Swans
Current trumpeter swan breeding habitat in Jackson Hole appears to be almost saturated (See Appendix I). Most nesting sites in Jackson Hole are in habitat considered to be marginal in comparison to swan habitat elsewhere, primarily because of climatic limitations (i.e. frozen water in winter) and the occurrence of more suitable nest sites at lower elevations in prairie habitats (Biota Research, 1991). Annually, approximately 100-120 trumpeter swans winter on the Snake River outside of Yellowstone National Park. Fish Creek is the most important and heavily populated of the wintering sites (ACOE, EIS; 1990). In terms of the levees' impacts on trumpeter swans, it seems that levee-induced sedimentation and changes in vegetation succession within spring-fed creeks have been beneficial to the swans, as well as to certain other species. The reason for this habitat enhancement is that the changes in spring creek habitats have sometimes provided wetland cover types more suitable for swan foraging and reproduction (Schroeder, Allen, USF&WS; 1991).

SECTION VI: HUMAN IMPACTS IN PROJECT AREA

HUMAN DISTURBANCE AS MEASURED BY MODEL

For the purposes of the model, three human disturbance levels were identified to compare 1986 conditions to 1956 conditions: high, medium, and low. High disturbance includes the following land uses/activities: industrial, commercial, high-density residential (greater than 1 unit / 3 acres), paved highway, and active quarry. Medium disturbance includes: levee with public access, golf course, low-density residential (less than 1 unit / 3 acres), gravel road, inactive quarry, and cropland. Medium disturbance levels affected the most acres, almost double that for high disturbance for 1986. Low disturbance includes: dirt road, levee with limited access, recreation areas, rangeland, and native pasture. Low disturbance affected the least acreage of the three disturbance levels. (ACOE, Reconnaissance Report, 1993)

Proportionally, from 1956 to 1986, there was an 84 percent increase in medium disturbance activities, an 88 percent increase in high disturbance activities, and a 28 percent increase in low disturbance activities (ACOE, Reconnaissance Report, 1993).

Humans disturb all river segments at one or more levels. River segments are disturbed the most if there is easy vehicular access to the floodplain. Quarry operation also adds significantly to high disturbance. Traffic along gravel roads and residential activities cause most medium levels of disturbance, and the low disturbance areas are located primarily near levees with limited access. (ACOE, Reconnaissance Report, 1993)

HUMAN DISTURBANCE - CUMULATIVE IMPACTS

As discussed in previous sections, the increase of residential and commercial uses in the riparian areas protected by the levees has significant short and long-term consequences. For example, residential housing not only directly eliminates habitat with houses and roads, but indirectly eliminates or diminishes habitat by the broader occupation (i.e. pets, children, landscaping/lawns) of that land. Once natural habitat is converted into somebody's property, habitat values are usually sacrificed for the narrower desires of the landowner.

Perhaps the biggest problem stemming from settlement of the riparian lands is the cumulative impact of these developments. If analyzed on the scale of a single house, then each new development appears to only have a negligible affect on wildlife habitat (i.e. one moose "might" be impacted). Under such a limited perspective, few people can argue that a single house will independently threaten the future survival of moose, cutthroat trout or bald eagle *populations* in that area. However, it can be persuasively proven that this single house, when more broadly viewed as an incremental addition to previous housing development impacts, will contribute to the cumulative degradation of wildlife habitat - and it is to this cumulative degradation that wildlife populations must try to adapt. Animal populations do not adapt to individual backyards one at a time in isolation from previous adaptations to previously altered backyards. Layers of behavioral changes due to habitat alterations accumulate to the point where the population numbers drop and/or the animals abandon that area. As the USF&WS notes, "Small discontinuous blocks [of riparian habitat] may not fulfill the needs of many species, causing reductions in numbers and, possibly, extirpation of some populations attempting to use highly fractured riparian habitats as movement corridors" (USF&WS, 1998). When this habitat fragmentation occurs, each house is as responsible as the next for the collapse. Distinguishing between impacts to individual animals and populations is important because conservation of species is not done at the individual member level but, at minimum, at the population level. The recent trend is to implement conservation measures at the habitat level.

Teton County Cumulative Impact Analysis

The Teton County Comprehensive Plan's Natural Resources Overlay (NRO), which is only

advisory, is a good example of not using cumulative impact analysis to regulate development in sensitive areas. All the NRO requires is that the landowners provide a general inventory of the likely impacts to individual animals of a limited number of species: moose, bald eagles, elk, mule deer, trumpeter swans, and cutthroat trout (Teton County Land Development regulations). Recommendations for minor mitigation measures are usually offered as well. However, no effort is made to determine where these impacts fit into the expanding causal chain of cumulative impacts threatening these species. Theoretically, the last bald eagle nest on earth could be on a landowner's property, and the NRO process would simply acknowledge that a single eagle pair might be impacted by the proposed development. In other words, there is no personal or community-wide accountability for the true loss of wildlife habitat.

A similar criticism can be made of the County's Environmental Analysis (EA) process. No where does the Comprehensive Plan require that cumulative impacts to wildlife, scenic or human resources be considered. For example, the County regulations state that "An Environmental Analysis shall describe the existing conditions of the land, describe the development proposal and the rationale of proposed development, and a description of how the proposal meets all the applicable standards and objectives of this Article and the Jackson/ Teton County Comprehensive Plan" (p. III-7, III-8). Recently, a debate has surfaced over the technical differences between the words "assessment" and "analysis". Some environmental consultants involved in the EA process maintain that the County regulations only require an "assessment", which simply involves conducting an inventory of resources and including basic recommendations for mitigating development impacts. They contrast this level of study with an "analysis", which is more comprehensive and includes detailing indirect and, perhaps, cumulative impacts (Collins, Bill, TCPD; personal communication). Given that the County regulations are vague regarding which level of environmental scrutiny is intended, the path of least resistance has predictably lead to cumulative impacts being ignored by, in particular, local elected officials.

Given the vital importance of cumulative impact analysis in conserving wildlife habitat, it is logical that accurate and current data is needed in order to implement this kind of analysis. For example, the County should at least know how many houses currently exist in the riparian areas, how many houses are approved but not built, and how many more are permitted by zoning. This information is the minimum needed in order to provide a foundation to responsibly manage floodplain development. Unfortunately, the County does not have this information available (Teton County Planning Staff, personal communication). Consequently, nearly all of the land use and demographic information used for the *Restoration Study* is not specific to the Project area or even, necessarily, the Snake River riparian lands in Teton County (ACOE, Reconnaissance Report,1993).

The primary reason the County does not currently have riparian-specific data, or cannot easily assemble such data, is because the information that does exist is dispersed in various governmental departments. Other necessary information simply does not exist. The County Planning Department has partially transferred building permit data from the Building Department to the Planning Department which will enable the number of dwellings in the riparian corridor to be estimated. This transfer should be completed in the near future. Yet, even accomplishing this data transfer would not fully answer the question because building permits were not required in Teton County until 1978. More historical information is needed. The reality is that a wide spectrum of information sources (e.g. certificates of occupancy, tax assessor's information, aerial photography) would have to be integrated before a reliable estimate of dwelling units, land uses and human population could be made. Fortunately, the County is planning to have new aerial photographs of the Snake River corridor taken as part of a larger effort to better identify development in the flood plain areas. (Teton County Planning Staff, personal communication)

SECTION VII: RECOMMENDED FUTURE PROJECTS

A) INVENTORY OF PRIVATE LANDS DEVELOPMENT IN SNAKE RIVER AND/OR GROS VENTRE RIVER CORRIDORS

There is a need to accurately estimate the amount of development in the riparian areas of Teton County, especially along the Snake River. Helpful information would include: the number of dwelling units, population (human and pets), impervious surface cover, land uses (e.g. irrigated acres, number of cattle), number of approved but not built dwelling units, number of dwelling units permitted by zoning, identification of all easements, septic tank leakage rates, assessment of gravel operations/ponds, assessment of effects of fencing on wildlife movement and, the number of rezonings to more intensive uses. Of course, there are other possible areas of concern.

One possibility for this type of project would be for someone to work closely with, or for, the County as the person to actually manage the transfer of relevant information from the various governmental departments to the Planning office.

B) ANALYSIS OF FEMA'S FLOOD PLAIN DESIGNATION FOR JACKSON HOLE (data on actual flood frequency)

There has been some concern that certain Snake River residential properties are flooding more often than their "100-year" or "500-year" floodplain designation would indicate. The concern is that we are permitting development in areas that are too flood prone because our existing flood plain mapping is inadequate. Predictably, allowing such development means that the landowners will become more aggressive in their restraint of the River, causing further unnecessary ecological damage. As far as is known, no federal or local agencies have collected data on how often certain properties or areas (e.g. Bear Island) flood. In order to make a convincing case for better flood plain management, it would be necessary to demonstrate that current flood plain designations are not realistic - if that is in fact the case.

Finding this information may be difficult. Perhaps one strategy would be to coincide this project with FEMA's next local visit to update their 1989 Flood Insurance Rate Maps. Perhaps FEMA will discover relevant information pertaining to this information gap or the Alliance could persuade them to try to fill this gap. FEMA's visit is dependent on State and local request and could happen anytime.

C) ANALYSIS OF CORPS MONITORING AND ENFORCEMENT OF PERMIT VIOLATIONS

Segments of the public have expressed concern over the ability or willingness of the Corps to hold permit violators accountable for their actions. To our knowledge, there is little information regarding the number, kind and consequences of permit violations in Teton County. Gathering such information would allow the public to have a better idea of the level of protection the Snake River is receiving.

TERMS AND DEFINITIONS

Aggradation - The building up of cobbles, gravel, or sediment in the river bed, resulting in the elevation of the river bed.

Alluvial - Areas (i.e. river bed and bank) that are composed of sediment transported by the river.

Avulsion - The rapid alteration of a river's course through channel diversion.

Base Flow - The relatively constant discharge of a river or stream which is punctuated by flood events.

Bed Load - Includes all material (e.g. sediment, gravel, cobbles) rolling or sliding along the channel bed.

Braided Channel - The division of a river's flow into multiple channels, usually separated by gravel bars, which can also be vegetated.

Degradation - The loss of gravel, sand or sediment in the river bed, resulting in the lowering of the river bed.

Channel Plug - A blockage of a waterway, usually a side channel of a larger waterway. Channel plugs can be absolute or they can have culverts/headgates to allow controlled flows into protected area.

Floodway - The areas in the "active" river channels that receive strong water flows during floods.

100 year Flood plain - The area surrounding a waterway that has a 1 percent annual chance of flooding.

Left Bank - The river bank on a person's left as they face downstream.

Pools - The deeper parts of stream that typically have a bed of finer caliber than riffles. The flow of water is slower in pools than in riffles.

Project - Refers to the entire levee system, including both Federal and non-Federal levees, under the jurisdiction of the Corps.

Reach - A segment of river.

Redd - The gravel nest of a cutthroat trout.

Riffles - The shallow areas in streams formed by high points in the channel bed.

Right Bank - The river bank on a person's right as they face downstream.

Riparian zone - The riparian zone of a river, stream, or other body of water is the land adjacent to that body of water that is, at least periodically, influenced by flooding.

Spring Creek - Spring creeks are relatively small streams fed by groundwater discharges of clean, clear water of relatively uniform annual temperature.

Thread of the River - The middle of the main channel.

LIST OF CONTACTS & SOURCES

Bob Ablondi, Jorgensen Engineering and Land Surveying, 733-5150

Don Barney, Teton County Road and Levee Superintendent, 733-7190

Bergman Photographic Services, Inc. 7816 SE 13th Ave, Portland, OR 97202. (503) 239-6010. Contact: Robert Burdick

Tom Campbell, Biota Research and Consulting, Inc. 733-4216

Bill Collins, Teton County Planning Director. 733-5939

Rik Gay, Teton County Natural Resource District, 733-2110

Michael Gierau, Teton County Commissioner & Local Representative for County for Local Cooperation Agreement with Corps. (w) 733-5671, (h) 733-6549

Rich Greenwood, PLS. (GIS mapping services), (307) 733-0203

John Keifling, Wyoming Game & Fish, 733-2321

Dr. John Liou, Federal Emergency Management Agency, Hydrologist, (303) 235-4836

Bill McDonald, Army Corps of Engineers, Walla Walla District, Walla Walla, WA 99362-1876, (509) 527-7253

Bob Meyer, Army Corps of Engineers, Walla Walla District, Walla Walla, WA 99362-1876, (509) 527- 7627, Mapping Division

Virginia Motoyama, Federal Emergency Management Agency, Senior Flood Specialist, (303) 235-4830

Chandler Peter, Army Corps of Engineers, Regulatory Branch Omaha District, (307) 772-2300

Mary Shouf, Assistant Planner, Teton County Planning Office, 733-5939

Dan Stevenson, Wyoming Game & Fish, 733-2321

Teton County Library, 733-2164. (RE: old Snake River photograph files)

US Army Corps of Engineers - Wyoming Regulatory Office (Cheyenne), (307) 772-2300
-Walla Walla District, (509) 527-7253

Valley Air, Caldwell, ID. (208) 454-1344, Contact: Dick Gravell (Aerial photos of Snake River during 1997 spring flood)

BIBLIOGRAPHY

US Army Corps of Engineers. Final Environmental Impact Statement, Snake-Gros Ventre River Levee Maintenance. April 1990.

US Army Corps of Engineers. Jackson Hole, Wyoming, Flood Damage Reduction and Fish and Wildlife Habitat Restoration - Reconnaissance Report. June 1993.

Referenced Studies included in Reconnaissance Report Appendix:

US Fish & Wildlife Service, Ecological Services, Wyoming State Office, Cheyenne, WY. Jackson Hole Flood Protection Project River and Wetlands restoration Reconnaissance Study. Final Planning Aid Report. May 4, 1993.

Shroeder, Richard L. & Allen, Arthur W., US Fish and Wildlife Service, National Ecology Research Center. Wildlife Community Assessment for the Snake River, Jackson, Wyoming. December 1991.

US Fish & Wildlife Service. Biological Opinion on Section 7 of Endangered Species Act for the Jackson Hole, Wyoming, Snake River Levee Maintenance Project. July 10, 1990.

Keifling, John W., Spring Creek Spawning Habitat Restoration. Wyoming Game & Fish. December 1, 1986.

Keifling, John W., Restoration of a Spring Creek. September 1984.

US Army Corps of Engineers, Walla Walla District. Recent Erosional Processes and Trends Affecting the Snake River Channel Within and Downstream of the Federal Levee Project. August 24, 1992.

US Army Corps of Engineers. Jackson Hole, Wyoming, Environmental Restoration. Feasibility Study, Cost Sharing Agreement and Project Study Plan. July 1996.

US Army Corps of Engineers. Jackson Hole, Wyoming, Environmental Restoration Feasibility Study. February 1998.

US Army Corps of Engineers. Special Public Notice. Nationwide Permit Reissuance Request For Comments And Announcement of Public Hearings. July 8, 1998.

Federal Emergency Management Agency. Flood Insurance Study, Teton County, Wyoming and Incorporated Areas. May 4, 1989.

Federal Emergency Management Agency. Flood Insurance Rate Map. Teton County, Wyoming and Incorporated Areas. May 4, 1989.

Minta, Steven C. & Campbell, Thomas M. III. Wildlife-Habitat Assessment and Analysis with Reference to Human Impacts in Jackson Hole, Wyoming. First Edition. July 1, 1991.

Local Cooperation Agreement Between the Department of the Army and Teton County, Wyoming for operation and Maintenance of the Jackson Hole, Wyoming Local Protection Project. September 4, 1990.

Cooperative Agreement Between the US Army Corps of Engineers, Walla Walla District and Teton County, Wyoming for Operation and Maintenance of the Jackson Hole, Wyoming Local Protection Project. Task Order FY 98.

Cooperative Agreement No.1 Between US Army Corps of Engineers Walla Walla District and Teton County, Wyoming for Operation and Maintenance of the Jackson Hole, Wyoming, Local Protection Project.

US Army Corps of Engineers, Omaha District. Announcement of Regional General Permit Issued, Public Notice. March 16, 1998.

US Army Corps of Engineers, Omaha District. Joint Public Notice, US Army Corps of Engineers and Wyoming Department of Environmental Quality - Nationwide Permits.

US Army Corps of Engineers, Omaha District. Protecting Wyoming Waters. A Cooperative Effort: by YOU, the Wyoming Department of Environmental Quality and US Army Corps of Engineers. Information and Joint Application Procedures for Section 401 of the Clean Water Act, Sections 404 of the Clean Water Act, Section 10 of the Rivers and Harbors Act of 1899.

US Army Corps of Engineers, Omaha District. Caring for our Nation's Waters (pamphlet).

United States Fish and Wildlife Service, Montana Field Office, Comments Regarding US Army Corps of Engineers Public Notice Application #199890112, Park County, Montana. April 3, 1998.