

*"Wildlife Habitat Enhancement Alternatives for Golf Courses Along  
the Jordan and Provo Rivers"*



*Map: Natural Resources Department, Utah State University*

*A Case Study of Riverbend Golf Course, Riverton, Utah*

*by: Chad J. Grave Utah State University*

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WILDLIFE HABITAT ENHANCEMENT ALTERNATIVES  
FOR GOLF COURSES ALONG THE JORDAN RIVER

by

Chad J. Grave

A report submitted in partial fulfillment  
of the requirements for the degree

of

MASTER OF LANDSCAPE ARCHITECTURE

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ABSTRACT

Wildlife Habitat Enhancement Alternatives  
for Golf Courses Along the Jordan River

by

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The goal of this project was to enhance the habitat value of open space associated with golf courses along the Jordan River in Salt Lake County, Utah. The project focused on three objectives:

1. Develop a habitat enhancement plan for Riverbend Golf Course in Riverton, Utah as a case study.
2. Develop design and construction guidelines for new golf courses along the Jordan and Provo rivers based on principles deduced from the Riverbend plan.
3. Create an educational brochure describing wildlife habitat conservation and management practices for golf courses adjacent to rivers or creeks.

(162 pages)

## ACKNOWLEDGMENTS

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I would like to thank my major professor, Craig Johnson, for all his help. It was a pleasure to work with him and discuss the ins and outs of wildlife management. His one-liners and anecdotes were great for a chuckle.

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## CHAPTER ONE

### INTRODUCTION

"A great golf course doesn't simply fit into the environment, it *is* the environment....quietly observe a golf course, over the entire day and night, and you , too, will realize that a golf course is a complete environment." Dr. Michael J. Hurdzan  
*Hurdzan Golf Course Design*

This idea is especially true when a golf course is in an urban setting surrounded by development. In this situation, the golf course may be the only large green space for miles around. (figure 1).

Figure 1. Riverbend Golf Course context

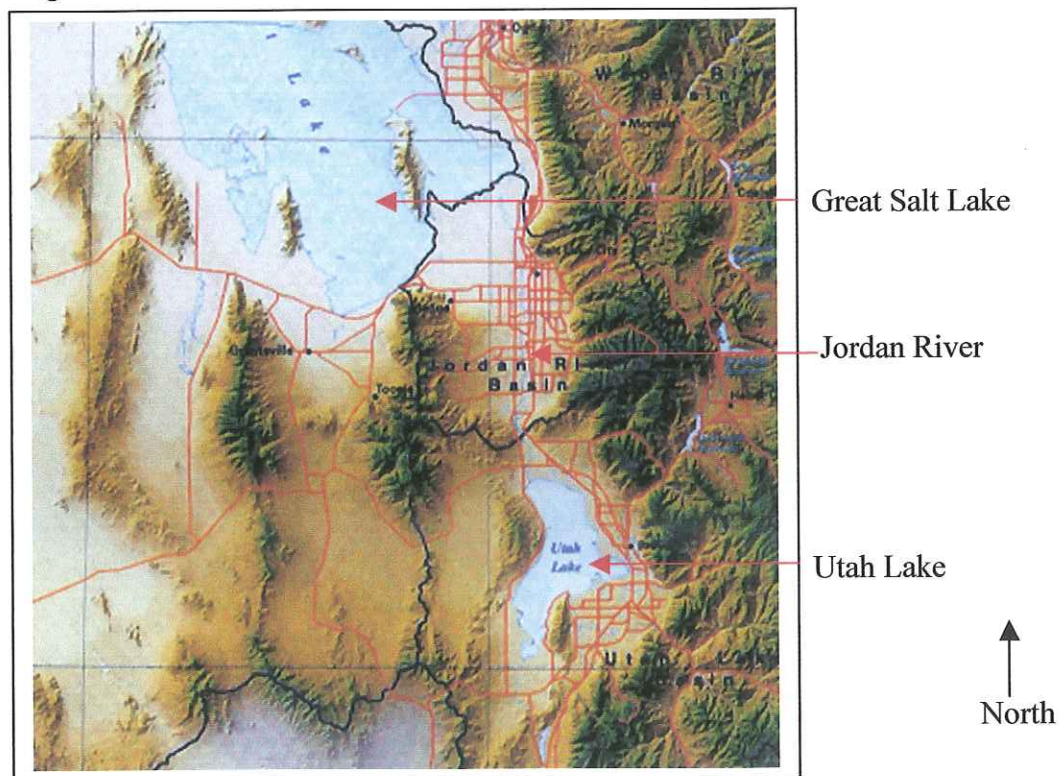


The golf course often becomes important habitat for many species of wildlife, as well as a green space amenity for humans. The Riverbend Golf Course in Riverton, Utah, the case study for this thesis, has the potential to become a haven for numerous wildlife species, contributing to existing habitat along the Jordan River. This project concerns itself with preservation of open space and wildlife habitat along the Jordan



River, in greater Salt Lake City, Utah. Specifically, it addresses issues of wildlife habitat enhancement for golf courses along the Jordan River. The project is one part of a larger Jordan River corridor conservation effort, lead by a group entitled the "Jordan River Natural Areas Forum" (JRNAF). "The Jordan River Natural Areas Forum is a voluntary coalition of local municipalities, county, state and federal agencies, non-profit organizations, local businesses, and individual citizens dedicated to promoting awareness, acquisition, management and restoration of natural areas along the Jordan River balanced with the human uses of the river corridor." (JRNAF 2002 Strategic Plan). This group and many others are concerned about the future of the Jordan River because of its role in the Great Salt Lake ecosystem. The Jordan River connects Utah Lake to the Great Salt Lake, linking the largest naturally occurring freshwater lake to the largest saline water body in the western United States. (JRNAF 2002 Strategic Plan). (figure 2).

Figure 2. Jordan River Basin



The Jordan River Corridor in Utah and Salt Lake counties is a migratory route and stop for neotropical birds, waterfowl, and shorebirds making it valuable and worthy of concern.

The goal of this thesis project is to enhance the habitat value of open space associated with golf courses along the Jordan River. Currently there are 9 golf courses along the 44 mile long river. They constitute nearly 1000 acres of open space and approximately 5 miles of river frontage. A growing Wasatch Front population and increased demand for golfing opportunities suggest that more golf courses may be built in the Jordan River corridor. The existing and future golf courses constitute a large portion of the remaining open space adjacent to critical riparian habitat along the river. It will be important to provide better habitat for wildlife and improve habitat management on existing golf courses. In addition, design principles and guidelines that accommodate wildlife needs will be essential for future golf course projects. This project will focus on three objectives:

1. Develop a habitat enhancement plan for Riverbend golf course in Riverton, Utah as a case study.
2. Develop design and construction guidelines for new golf courses along the Jordan River based on principles deduced from the Riverbend plan.
3. Create an educational brochure describing wildlife habitat conservation and management practices for golf courses adjacent to rivers or creeks.

Objective number one is to develop a habitat enhancement plan for Riverbend golf course in Riverton, Utah. In the arid West, riparian habitat covers less than 1% of

the land, yet its role in the landscape is so significant that it has been referred to as the "aorta of an ecosystem." (Gardener et al.) "Over 80% of all cold desert vertebrate species utilize riparian areas at some point in their life cycle." (Johnson et al , 2000). In urban areas, riparian areas are at risk of fragmentation and loss to development. Urban riparian areas are disappearing along the Wasatch Front and those that remain are badly degraded.

Riverbend golf course shares a border with the Jordan River on its eastern boundary. The site offers views to the Wasatch and Oquirrh mountains. Within the golf course itself various native plant communities persist including: riparian, wetland, shrub steppe, and grasslands. During construction of the course, every effort was made to conserve these valuable remnants. Careful routing, design, and construction saved low lying wetland areas, large expanses of canopy trees, and important slope features. Unfortunately, at the present time, many of the wetlands are degraded and over run with noxious weeds. Some large patches are disconnected from the river and other open spaces. The grasslands are being mowed or are near a monoculture. The shrub steppe is in very good condition on the hillside, but the upland patches are degraded. The riparian areas are missing important elements and are invaded by exotic plants.

As part of the habitat enhancement plan, the various plant communities were evaluated and a plan devised to restore and enhance them to functioning levels that will provide valuable habitat for wildlife. In addition, long term habitat management strategies will need to be created to prevent future degradation.

Objective number two is to develop design, construction, and management guidelines for new golf courses along the Jordan River based on principles derived from

the Riverbend plan. The plan for the Riverbend Golf Course case study will produce design and construction guidelines and management strategies that will lead to the restoration of plant communities to a functioning level beneficial to biodiversity. With this goal in mind, and a long range plan that will include recommendations for changes in course layout, principles can be deduced that will guide new course layout to preempt any changes and degradation in the future. Construction issues for new courses along the Jordan River will deal with riparian setbacks, wetlands, bank slopes, drainage, and irrigation and how these affect the river and plant and wildlife communities associated with it.

Objective number three is to create an educational brochure describing the conservation efforts on the golf courses to create understanding of the golf course/river relationship. "A better understanding of a golf courses diversity, and the necessary integrated management with its surroundings, can enhance the golfer's enjoyment of the game." Dr. Kimberley S. Erusha. Major goals of the brochure will be to create awareness about benefits golf courses can have to wildlife and to offer guidelines for new golf courses being contemplated for the river corridor.

Since the 1970's, golf courses have rightly or wrongly had a reputation of creating significant negative impacts to the environment. This may have been the case 30 years ago, but major advances in design, construction, and maintenance have produced golf courses that in fact enhance habitat values and increase other ecosystem functions. An educational brochure that gives a quick background of such conservation efforts for Riverbend Golf Course and the Audubon Cooperative Sanctuary Program, and is geared

towards local conservation efforts, will shed light on the positive relationship golf courses can have with the environment.

## **METHODS**

### **HABITAT ENHANCEMENT ALTERNATIVES MASTER PLAN**

The master plan for Riverbend Golf Course will incorporate recommendations for the future renovation of the course to provide for maximum biodiversity of plant and wildlife species. It will do so through conclusions drawn from literature review, case studies, site inventory and site analysis.

#### **Methodology for Riverbend Golf Course Habitat Enhancement Alternatives**

1. Literature Review
  - a. Existing Habitat Enhancement Programs
  - b. Case Study Review
  - c. Wildlife Species Modeling
2. Program Development
  - a. Pre-Analysis
  - b. Goals
  - c. Site Inventory
  - d. Site Analysis
3. Plan Synthesis
  - a. Minimum Conservation
  - b. Maximum Conservation
4. Formulate design, construction, and management guidelines
  - a. For Existing Courses
  - b. For Future Courses
  - c. Recommend Monitoring Strategies
5. Brochure Design

## **Literature review**

The literature review focused on four primary subjects. These included: wildlife habitat criteria for species of concern, revegetation techniques for identified plant communities, golf course habitat enhancement programs, and golf course design and construction methods. The purpose was to identify existing methods and programs that would be beneficial to Riverbend, while also offering principles that can be applied to new courses along the Jordan River, and also for other areas as well. Chapter two will detail the primary sources used in this report.

### Review existing programs for golf course habitat conservation

Many programs for the enhancement of habitat on golf courses exist today. Many are in partnership with the United States Golf Association (USGA), the governing body of professional golf. The programs that are relevant to this project are:

- Wildlife Links
- Audubon Cooperative Sanctuary Program (ACSP)
- Audubon Signature Program
- Arbor Links

Each will be detailed in chapter two.

### Case study review of existing golf courses with conservation plans

The role of the case studies is to develop a list of attributes that have been successful in habitat restoration. A broad range of examples were researched to show the many options available for golf courses. Many of the examples will be from certified courses that have finished the ACSP program. Others will be from exemplary courses that are at the forefront of research and experimentation.

### Wildlife Species Modeling

Habitat models were created for the most abundant and least abundant avian species in the Jordan River corridor today. The primary purpose was to identify the habitat requirements that are not being met. The models can be found in Appendix E.

### **Program Development**

#### Pre-Analysis

The purpose of pre-analysis is to obtain a first impression and identify problems, opportunities, and other related issues on a study site, in this case the Riverbend Golf Course. We can look to the examples set forth in the case studies to determine if the site is capable of supporting habitat enhancements. Methods will be adapted from Toth, 1974, to understand and define the elements surveyed in the pre-analysis. My observations from the initial site visit will be listed and then deemed beneficial, compatible, conflicting, or detrimental. (Toth, 1974).

#### Goals

The goals listed below were derived at the inception of this project and reflect the conservation direction of the JRNAF group and other stakeholders. In the program development, these goals will be expanded based on findings in the site inventory and analysis.

- Enhance wildlife habitat on golf courses along Jordan River
- Create guidelines for construction of new golf courses along Jordan River
- Restore plant communities along course riverbanks
- Develop management plan for Riverbend golf course
- Add to database of JRNAF projects
- Make findings available to community for education of conservation efforts

### Site Inventory

The site inventory phase includes vegetation and habitat inventory as a major focus. The vegetation inventory will determine communities present on site. Analysis will then be performed to indicate the relative abundance and health of the existing plant communities. Any areas that will need vegetative manipulation will be delineated. Habitat analysis will be done using protocol developed by the NRCS. (Johnson et al 2000) The Johnson et al publication includes a worksheet titled, Existing Corridor Inventory. This will be applied to each community type on site to determine the condition of existing on-site habitat. Worksheet evaluations will be useful in determining management recommendations and establishing baseline conditions for future monitoring programs. They can be found in Appendix C.

### Site Analysis

The site analysis will graphically depict the problems and opportunities defined in the previous sections. It will detail problems and opportunities pertaining to wildlife habitat and its existing condition and potential future condition.

### **Plan Synthesis**

#### Develop 3 Enhancement Alternatives

- a. *Status Quo*
- b. *Minimum Conservation*
- c. *Maximum Conservation*

#### *Status Quo*

This alternative will discuss the future condition of the golf courses, the corridor, and Riverbend Golf Course, if no conservation programs are created. It will focus on



wetland degradation, invasion of exotic species, sedimentation, chemical runoff and water quality, and the effects of Jordan River channel morphology.

#### *Minimum Conservation*

The minimum conservation alternative has one goal, and that is to develop a management plan that will work towards gaining certification in the Audubon Cooperative Sanctuary Program. This program has six elements that must be met before being certified as a sanctuary. The elements are: Environmental planning, Wildlife and habitat management, Chemical use reduction and safety, Water conservation, Water quality management, and Community outreach. ([www.audubonintl.org](http://www.audubonintl.org))

#### *Maximum Conservation*

This alternative assumes no budget, time, or plausibility constraints. It identifies the maximum level of conservation and works towards this goal. The primary benefit of this alternative is to offer ideas and advice that can be implemented in stages while still attributing the success of each project to the primary goal i.e. a long term desired future condition.

#### **New Golf Course Design and Construction Guidelines**

Many principles gathered from case studies and conservation programs as described above can be implemented during the design phase. Since the many principles and conservation efforts are local to the Jordan River, the guidelines will be site specific. Special care was taken to analyze the proposed site and select principles appropriate to the area. The guidelines will consider the elements and issues that are relevant to the

Jordan and Provo rivers and offer principles that can be followed that will produce a playable course as well as habitat for the wildlife of the region.

### **Educational Brochure**

The target audience for the educational brochure will be one that is familiar with the Jordan River and has a vested interest in it. This would include local golfers, local homeowners, Jordan River Parkway users, etc. The contents will give a general description of the conservation efforts and planning undertaken by the golf courses and the beneficial relationship they can have with the river. The brochures content is open ended because it can be tailored to a specific audience depending on the use intended by the producer. For future brochures, a set of contents may include:

1. History of Jordan River Corridor
2. General problems associated with degradation of the Jordan River corridor
3. Species of concern birding list
4. Conservation efforts undertaken by golf courses
5. Role of community members
6. Volunteer organizations and opportunities
7. Information contacts

The brochure developed for this project will be a starting point. In the future, revisions will have to be made to include new data from monitoring programs, conservation efforts to date, and to include or exclude items for a particular audience.

### Uses of guidelines and brochure

The following is a list of potential users of the materials found in this project. A list of organizations and individuals who could benefit from this information is included.

*Habitat Enhancement Plan*

1. Golf course superintendents
2. Land managers of surrounding open lands
3. JRNAF conservation report
4. Golf course architects
5. County planners
6. Division of Wildlife Resources
7. Conservation groups ex. Audubon society
8. Local municipalities
9. Golf courses in general with careful deduction of principles for their particular site

*Educational Brochure*

1. JRNAF presentations
2. Conservation groups
3. Schools
4. Local municipalities
5. Utah Golf Association
6. Golf courses marketing personnel

The combination of a habitat conservation plan coupled with construction guidelines for new courses will be beneficial to the open space conservation efforts along the Jordan River. Creating new habitat on existing golf courses and designing new golf courses with this in mind will greatly add to the conservation efforts along the river and create a valuable resource for wildlife, plant life, and human life alike.

## CHAPTER TWO

### LITERATURE REVIEW

#### LITERATURE REVIEW

This chapter will briefly describe various programs, techniques, and methods of habitat and ecosystem enhancement with relevance to the Riverbend golf course and Jordan River. The literature review topics centered around four primary subjects. These included: wildlife habitat criteria for species of concern, re-vegetation techniques for identified plant communities, golf course habitat enhancement programs, and golf course design, maintenance, and construction methods. The purpose was to identify existing methods and programs that would be beneficial to Riverbend, while also offering general principles that can be applied to new courses along the Jordan River, as well as existing courses.

#### LITERATURE REVIEW OBJECTIVES

A golf course typically is a near mono-culture vegetation type that consists of high maintenance grass varieties. Also included are various tree and shrub species that are highly manicured and consist of one canopy layer with turf underneath. As a general rule, this composition of vegetation facilitates the game of golf better for the largest group of players abilities and helps to speed the pace of play. Unfortunately it also negatively affects native wildlife species while favoring exotic generalists.

Riverbend golf course is unique however; a golf course with diverse plant communities, habitat types, and wildlife. It is composed of wetlands, ponds, rivers, riparian community, and a distinct upland plant community. Presently, the remaining native vegetation communities are becoming degraded. The ground work exists for

habitat enhancement, so analysis of current habitat enhancement programs will dictate a direction for conservation of Riverbend Golf Course.

The objectives for the literature review were:

1. Identify programs relevant to Riverbend golf course for habitat enhancement
2. Identify habitat enhancement methods
3. Identify principles applicable for future golf courses

## LITERATURE REVIEW ABSTRACTS

### Books

Practical Golf Course Maintenance by Whitteveen, Bavier, 1998.

This is a general overview of golf course maintenance, including: drainage, trees, landscaping, and golfer traffic. It is a resource applicable to fine tuning the maintenance and management plan for Riverbend. The resource will also be useful in the development of new golf course design principles as we can create and preserve natural areas that do not hinder the maintenance routine.

Golf Course Management and Construction, Environmental Issues Balogh, Walker, 1992

Extensive collection of environmental issues and their relationship to golf courses. Some chapter examples are: Water resource conservation, fertilizer and pesticides, IPM programs, wildlife, wetlands, and water toxicity. This resource was very valuable in creating a management plan for Riverbend golf course.

Wildlife-Habitat Relationships Concepts and Applications Morrison et al 1998

Conceptual description of wildlife habitat relationships to the patch and corridor matrix. Describes dynamics of wildlife behavior in a scientific way, therefore principles are deduced for Riverbends management plan. The final chapter expands on

management principles for ecosystem context and will be beneficial for the Jordan River corridor.

Species Survival in Fragmented Landscapes Settele, et al

A collection of case studies and scientific papers describing specific research on fragmented landscapes and wildlife interaction. Various concepts and principles were abstracted from the readings. Of special interest was an entry entitled: "Bird population dynamics in relation to habitat quality".

Managing Wildlife Habitat on Golf Courses Ronald G. Dodson, 2000.

This book was written by the founder of Audubon International which developed the Audubon Cooperative Sanctuary Program for golf courses. This resource is a practical guide to management, landscaping, and habitat enhancement for wildlife. It offers suggestions for projects as well as management options and plans.

Bird Conservation on Golf Courses Scott W. Gillihan, 2000.

This publication is partly a product of the Wildlife Links program through the USGA. It's a manual for designing and enhancing wildlife habitat on golf courses. Contained within are bird lists, enhancement projects for many scales, habitat basics, highlighted birds, nuisance birds, and plant lists for birds. The resource is a very useful step by step manual for golf course architects, superintendents, and land planners. The Wildlife Links program offers funding for research projects concerning golf courses and wildlife. The program is explained in detail in the later part of this chapter.

IPM Handbook for Golf Courses Schumann et al,

Introduction and management guide for implementing an Integrated Pest Management Plan for golf courses. Looks at issues such as cultural, biological, and

chemical control strategies, pest management, and how to get started at your own course. Also included are regional case studies of courses and their programs. This book will be beneficial to tailor an IPM program that will be beneficial to the wildlife conservation efforts.

Golf Course Design Graves and Cornish

This resource covers all aspects of golf course design and construction. It will be beneficial to preserve the aspects of the golf course that must be kept in order to play the game of golf. It will also be beneficial to identify areas that are out of play and can therefore be enhanced for wildlife habitat. Other beneficial chapters include: Planning Major Changes, Drainage, Construction methods, Practice Facilities, Short Courses, and Cayman Golf.

Conservation Corridor Planning at the Landscape Level: Managing for Wildlife Habitat

Johnson et al 1999

An extensive resource describing habitat based on corridor and patch matrix principles. The publication starts with an overview of habitat fragmentation and ways to alleviate this by large scale planning. It describes the benefits of corridors, and planning and design principles, and concludes with processes for area wide planning and conservation planning. Also included are case studies of implemented projects at large scales. It is a beneficial document because it asks the designers to consider the golf course in the context of a larger landscape. It also presents useful principles to alleviate the fragmentation that is associated with golf course environments.

A Handbook of Riparian Restoration and Revegetation for the Conservation of Land Birds in Utah with Emphasis on Habitat Types in Middle and Lower Elevations Gardner et al, 1999.

This is a very informative source of information on riparian birds and associated nesting and foraging guilds specific to Utah. It offers details as to foraging substrate, nest types, beneficial vegetation, and abundance. This resource is a great starting point to understanding the avian species that inhabit riparian areas. The worksheets included help to assess the status and health of the riparian area presently and dictates a conservation direction.

Wetland Restoration, Flood Pulsing and Disturbance Dynamics Middleton, 1999)

This book is a great resource that defines and explains the importance of dynamics in the wetland ecosystem. It gives examples for wetland restoration such as flood pulsing, succession, invasion, and wetting and draw down. It explains how these work and their importance to a properly functioning wetland system. Case studies are also included.

**Journal Papers**

Restoration of Riparian Forest Using Irrigation, Artificial Disturbance, and Natural Seedfall Friedman et al 1995

The goal was to test the hypothesis that establishment of Cottonwood and Willow stands are failing to reproduce downstream of dams because of absence of bare, moist substrate. With effects of sod removal (disturbance), irrigation, and addition of seed, the results demonstrate the feasibility of restoring cottonwood forests using natural seed fall.

Creating and Restoring Wetlands Mitsch and Wu 1998



Looks at wetland development including: "vegetation cover, algal community, water column productivity, nutrients, benthic invertebrate community, and birds." Discusses what is necessary to create wetlands and what constitutes a successful restoration.

Can anyone build this bird a home? Milius 1991

Considers a case study example of the problems associated with trying to recreate a wetland that was destroyed by construction of a new highway in San Diego. Although the new wetland that was created looked good, it did not function correctly because of design flaws. This article is justification for saving existing wetlands or habitat communities and planning new golf courses around and away from these existing ecosystems.

Revegetating the Riparian Floodplain for Wildlife Anderson et al

This two phase study investigated the correlation of vegetative structure and bird response. It identified characteristics both positive and negative relating to bird species numbers and conducted a revegetation site study and discovered correlation's between plant composition and types and species populations.

Planning for Avian Wildlife in Urbanizing Areas in American Desert/ Mountain Valley Environments Johnson 1987

Promotes planning for urban wildlife in the design phase. Often planners displace wildlife species through poorly planned and designed development and mismanagement of urban vegetation. This article suggests enhancement and rehabilitation processes for wildlife habitat with specific recommendations.

Western Riparian and Wetland Ecosystems Rieger 1992

Investigates riparian and wetland restoration in the West. The article states examples of restoration projects and their success. It also identifies historical problems associated with wetland mitigation. Of importance to this project are the findings of today's most pressing riparian degradation issues, namely that of exotic species invasion.

Linking Habitat Restoration to Meaningful Units of Animal Demography  
(Smallwood, 2001)

This article made a case for the failed restoration of a site because of spatial problems and no connections to surrounding lands. Although the habitat may provide the correct structure, it can still fail to support the species. (Smallwood, 2001.) The author's primary point was that of defining a minimum patch size that could sufficiently provide habitat for various sized populations. The presence of a species is not sufficient to conclude the restoration a success, as it could be acting as a sink. Beneficial principles of patch size and connectivity, (corridors), were obtained from this article.

Breeding productivity considerations: What are the appropriate habitat features for management? (Martin, 1989)

The primary concept in this article is "appropriate features are those that most directly influence fitness components (reproduction, survival)." (Martin, 1989). An interesting finding from the research was that predation is more common in deaths to birds than starvation. With this knowledge, managers can implement a parasite management plan and designers can create habitats that reduce nest predation and parasitism. The text offers examples of methods to relieve pressure from these issues by properly planting or managing vegetation components.

Natural Links: naturalistic golf courses as wildlife habitat (Terman, 1997)

In this paper, the author concluded that naturalistic golf courses can complement existing open spaces and reserves by providing wildlife habitat. This is especially true in urban areas and on degraded sites where golf courses are a very beneficial land development type. The benefit of golf courses as wildlife reserves is "because golf courses are self-supporting economic units that come with a well-organized maintenance staff capable of caring for natural areas as well as for turf." (Terman, 1997.) The best suggestions and concepts from this text are based on new golf course construction and gives guidelines that will be detailed in chapter 5 of this thesis.

## **PROGRAMS FOR WILDLIFE ENHANCEMENT ON GOLF COURSES**

### **Audubon Cooperative Sanctuary Program**

This program is a joint venture between the Audubon International and the USGA. It seeks to recognize golf courses that are becoming stewards to the earth. It does this by offering assistance to golf courses in developing management and enhancement plans. The golf courses pay an annual fee of \$100.00 and from this receive a resource handbook to help with conservation and a monthly newsletter.

"The ACSP program for golf courses seeks to address golf's environmental concerns while maximizing golf course opportunities to provide open space opportunities." ([www.audubonintl.org/programs/acss/golf.htm](http://www.audubonintl.org/programs/acss/golf.htm)). Participation in the program means that projects must be completed in six categories which are:

1. Environmental Planning
2. Wildlife and Habitat Management
3. Chemical Use Reduction and Safety
4. Water Conservation
5. Water Quality Management

## 6. Outreach and Management

Once this is completed to the satisfaction of the Audubon International group, the course becomes a certified sanctuary. It then receives recognition through the program.

Presently, of the approximately 16,000 golf courses in the United States, around 2300 have signed up for membership. Of these, only 100 have become certified. In Utah, at this time only a handful have membership and none are certified.

Associated with the program is a Managed Lands Database that is accessible through the website. Its purpose is to be a library of reports, maps, data, and research that pertains to golf courses and their habitat enhancement projects. This is a beneficial resource for all golf course superintendents and land managers.

### **Audubon Signature Program**

This is associated with the same entities as the above program except that it caters to new golf courses. The planning is also more intense and expensive. The landowners are required to complete a Natural Resource Management Plan under supervision of the Audubon International group. "They need to identify wildlife and habitats during and after construction; protect water quality during and after construction, including drainage; and design and manage the course in a manner that minimizes intense maintenance."

Nancy Richardson, (Bergsman, 2001, p. 86). Also considered in the management plan is an efficient irrigation system, a properly functioning maintenance facility, native vegetation, and proper turf grasses for the region and conditions. The program has an extensive monitoring program which watches water quality, wildlife, habitat quality, etc. Throughout the planning and construction phases reports must be filed and site audits are done to ensure compliance with the program. The program costs \$9,500 and is therefore

for courses that can economically justify it, although this is usually an insignificant amount in a golf courses design and development budget. This program will be beneficial to the Jordan River corridor by way of protecting the important and necessary systems in the planning phase of new golf courses yet to be developed.

### **Wildlife Links**

This program is a cooperative effort between the National Fish and Wildlife Foundation and the USGA. It's purpose is to fund research, management, and education projects proposed for golf courses. A golf course can submit a request for funding to an advisory board that reviews the submission. To date, 13 projects have been funded with a total price tag of \$800,000. Many of the projects are books. The projects are not to exceed \$30,000 per year but multi year contracts are available. The JRNAF group would benefit greatly by applying for a grant to monitor the success of golf course enhancements on the Jordan River. The grants are for research or findings which will benefit the golf course industry as a whole and the research should be on a regional level.

### **Arbor Links**

This is a very new program and not much information exists on it. It is a program operated in conjunction with the USGA and the National Arbor Day Foundation. Two parts of the program are currently in final stages of development and should be ready in 2003. The two parts deal with habitat on golf courses set aside for wildlife. Part one is to quantify the approximate number of acres on golf courses set aside for wildlife. The second will be a five year timeline to increase the acreage set aside for wildlife by 1 acre per golf course. This is a daunting task but is an admirable goal. Currently, Arnold Palmer is involved with the program through a course his

company designed in Nebraska City, NE, called Arborlinks Golf Course. It is an environmental and educational project that will be a big news maker in the near future. At the present time it has just opened and no research or monitoring exists. In an article in *Golf Course Management*, September, 2002, Palmer was quoted as saying, "Golfers must always understand that golf courses won't always look like Augusta, Oakmont, or Winged Foot. Our mission is to get the word out that golf is doing the right things for the right reasons." This is also the mission of Arborlinks Golf Course, the lessons of which should be considered in all educational and environmental planning.

### **Safe Harbor Program**

This program is not restricted to golf courses alone but is applicable to as well. It is operated through the U.S. Fish and Wildlife Service and provides services to landowners who enhance habitat on their land. The program is basically an agreement that ensures the landowner that no new restrictions will be imposed if an endangered species takes up residence in their properties enhanced habitat. It eases development restrictions related to endangered species if the landowner protects the habitat of the species during the breeding season. Currently this program is only available in the Sandhills region of North Carolina. The concept is worthy of further research and can be adapted to the Jordan River for private landowners and golf courses. An example of this program in effect can be seen on Pinehurst Golf Club. The golf course includes habitat for the endangered red cockaded woodpecker. "What Pinehurst did was very progressive. It opened the eyes of other large landowners to the fact that they could contribute to the conservation of other species without compromising their objective of maintaining a nationally recognized golf course." Michael Bean, Chairman of the

Wildlife Program for the Environmental Defense Fund. (Lipse, et al, 1999.) The golf course habitat is beneficial to the bird and therefore the course is perfect habitat for it. The program is currently expanding to other states and other species, but is not available in Utah at this time.

### **CASE STUDIES OF GOLF COURSES WITH CONSERVATION PROGRAMS**

This section will present an overview of golf courses that have implemented conservation programs or projects. It will offer a broad scope and scale to inform of the possibilities for short and long term goals. Unless otherwise stated, case study information came from [www.audubonintl.org](http://www.audubonintl.org). The format will include an overview of the course and its projects.

#### Carolina National Golf Club, Bolivia, N.C.

*Type:* 18 Hole public golf course and golf community on 1100 acres.

*Project:* Naturalization of 30 acres

*Specifics:* Many areas of the 30 acres were set aside during construction and not sodded.

The other areas were maintained as turf and chosen by the superintendent to naturalize.

Sod was removed and planted with native plants on 12" centers with mulch added.

Some native plants were harvested from on site and transplanted. Current maintenance

includes periodic weeding, which will continue until the density of natives is great

enough to choke out weeds, and burning, which promotes top growth and flowering.

"If you reduce manicured turfgrass by 30 acres, you can save up to \$1800 (if your treatment costs are \$60/acre) by eliminating pre-emergent herbicides. Add to this the cost of fertilizer (\$40/ acre) and mowing (\$15/ acre) etc., and you can see that over time

this can result in significant savings. This does not include the cost of added wear on equipment or time lost for other maintenance duties." ([www.audubonintl.org](http://www.audubonintl.org))

Colonial Acres Golf Course, Glenmont, New York

*Type:* Public nine hole golf course on 35 acres

*Project:* naturalization of the course (one-third)

*Specifics:*

- Converted two acres of previously maintained turf to naturalized "no-mow" areas
- Added berry-producing shrubs and bluebird nest boxes to increase food and cover sources for birds
- Built a 10,000 sq. ft. naturalized area with fill from an irrigation pond project and seeded with fescue grasses
- Planted 40 native trees
- Maintain a wildlife inventory which includes 32 species of birds and 15 species of mammals
- Expanded irrigation pond by 1,000,000 gallons, which is fed by run-off and rain. This supplies 100% of irrigation water
- Hosts a golf tournament to pay for naturalization projects
- Prints a quarterly newsletter to inform members of projects and wildlife
- Works with a nine-person Resource Advisory Committee which includes four staff and five regular golfers

Cordillera Mountain Course, Edwards, Colorado

*Type:* 18 Hole resort/ semi-private golf course

*Project:* pond shoreline renovation with aquatic plants

*Specifics:* A 3 to 4 foot buffer around a 1.5 acre pond was created to enhance wildlife habitat, for aesthetics, and to help with water quality. Sod was removed and area was roto-tilled to prepare the seed bed. Shrubs, wetland plants, border perennials, and wildflowers were planted in an area that was out of play. The plants included cattail, three square bulrush, hairy sedge, torrey rush, pink yarrow, columbine, aster, and gilia. Maintenance involves hand pulling weeds, mulching, and replacing dead plants. Plantings were natives of Colorado and were chosen to help provide duck habitat. The



superintendent recommends planting shoreline and aquatic natives during construction to avoid tearing out turf. The total cost with labor was \$10,000.

Edgewood Country Club, Rivervale, N.J.

*Type:* 27 hole private country club

*Project:* Naturalization of 30 acres and provision of nest boxes

*Specifics:* This golf course has a very tight layout as does Riverbend, so the selection of naturalization areas was difficult. On this golf course they naturalized a great deal of rough with wildflowers and native grasses. Many of the areas chosen were highly diseased and hard to maintain. Another interesting feature was the naturalization of tee and bunker banks with more than 8,000 plants including little bluestem and weeping love grass. Many of the plants were grown in the golf courses own greenhouse. 30 bird boxes were also installed and 5 years later, 20 were occupied by bluebirds, tree swallows occupied five, and wrens were in three. Many new species of wildlife have been spotted on the golf course including fox which can help control the geese population. The cost of this project was \$4,500 for seed, mulch, and labor.

Gainesville Golf and Country Club, Gainesville, FL

*Type:* Private country club

*Project:* Gained certification in one year after joining Audubon International

*Specifics:* The following list is from the audubonintl.org website

Stewardship activities for certification:

- Created corridors of native pines, oaks, and prairie areas throughout the course
- Added aquatic plants to enhance pond habitat
- Removed exotic, invasive vegetation to promote regionally native habitat
- Maintains 15 nest boxes for cavity nesting birds
- Maintains a detailed wildlife inventory of over 75 species

- Reduced disease occurrence and improved playing conditions by decreasing irrigation
- Created no-spray zones around all ponds to prevent nutrient loading
- Establishes water quality monitoring program for surface waters on the course
- Maintain clean, organized, environmentally responsible maintenance facility
- Give presentations to local homeowners associations to invite participation in ACSP activities
- Publish regular newsletter articles about environmental projects and Audubon participation
- Highlight natural areas on scorecard
- Created an Audubon display to educate members about environmental activities and progress.

### Giants Ridge Golf Course, Biwabik, MN

*Type:* 18 hole resort course

*Project:* Reclamation of an iron-ore mine site

*Specifics:* This golf course has won numerous awards for its environmental stewardship.

The management plan and design phases were extensive and included all phases of the Audubon Signature Program. The concepts used on the course can be very useful for new golf courses built along the Jordan and Provo rivers. The course was designed to collect all runoff and retain it on course. It uses vegetative buffers and small wetlands to filter water, which is becoming standard practice on golf courses built near water according to golf course architect Jeff Brauer. Other features on the course that can become guiding principles for new courses are:

- Course routing to stay at least 100' away from identified sensitive plants, patches, wetlands, or other important features.
- Engineered subgrade to minimize leaching to groundwater.
- During construction sod around wetlands to minimize sediment runoff in water
- IPM program initiated during construction.

### **2002 ENVIRONMENTAL LEADERS IN GOLF AWARDS**

This section details the projects that won awards in 2002 and will offer examples to help with goals and objectives for the future of conservation on golf courses along the

Jordan and Provo rivers. Each winner will be cited along with a brief description of the primary environmental enhancement project that can be beneficial to Riverbend Golf Course. All examples can be implemented on new courses, and many on existing courses.

Blackhorse Golf Club, Cypree, TX

This course is almost entirely built in a 100 year floodplain. It contains 30 acres of man made wetlands that retain runoff and rainfall. This course won an award because of its efficient irrigation system which is computer run, a drainage recycling pump which refills the onsite ponds, and its IPM program.

Great Hope Golf Course, Westover, MD

This course has set explicit thresholds for pests and diseases and will not treat chemically until those are reached. It also captures rainfall in seven interconnected retention ponds. An aquifer is rarely used for irrigation. An outreach program to neighboring schools is also beneficial to all involved.

Countryside Golf Club, Mundelein, IL

This golf course includes 27 acres of wetlands, 7 acres of woodland, and extensive patches of natural plant communities. As with the above courses, rainwater and runoff are collected and allowed to slowly discharge through managed filters. It also includes buffers around wetlands and ponds that are no mow zones. Weeds in natural areas are controlled by fall burning and mowing, a method that must be timed for species living on the course.

## **CONCLUSIONS**

All of the examples from the case studies, environmental awards, and literature review give a broad view of the projects that can be used for enhancement along the Jordan and Provo rivers. They help in understanding the scope, complexity, and phases which make up a project of this size and importance. Care should be taken to understand the context of these case studies in adapting them to the local conditions of Utah courses.

## CHAPTER THREE

### PROGRAM DEVELOPMENT

#### INTRODUCTION

This project is part of a large conservation effort coordinated by the Jordan River Natural Areas Forum. The inception of the idea to coordinate with golf courses along the Jordan River evolved with the Conservation Corridor Report created by the JRNAF committee. Within the report exists program elements the Forum would like to see attained by the Riverbend Golf Course project. From this conceptual beginning, these elements were expanded and it is the intent of this chapter to detail these and offer goals pertinent to the success of the project.

#### PRE-ANALYSIS

"The intent of the Pre-Analysis is to achieve an early grasp of the project, in order to determine what issues will have to be addressed in the analysis of the project and the types of data needed for future work." (Toth, 1974). The first step, prior to any site specific goals, was to take a regional look at the Jordan River Corridor to discover the problems involving the direction of golf course planning along the Jordan River corridor. Two primary problems were identified.

1. Lack of a conservation direction involving the Jordan River golf courses as a group.
2. Lack of new golf course design and construction guidelines in relation to river corridors

#### **1. LACK OF A CONSERVATION DIRECTION**

Several golf courses have accomplished conservation projects, namely River Oaks and Riverbend. "The River Oaks Golf Course is a privately owned golf course that includes mitigation permitted by the U.S. Army Corps of Engineers. River Oaks Golf Course has set aside wetland acreage next to the golf course that could be considered a reserved area. River Oaks has also set aside and created riparian and wetland habitat that is considered a reserved area." (Jordan River Natural Conservation Corridor Report 2000). During construction, Riverbend preserved and also enhanced wetlands on the golf course. Also associated with Riverbend golf course are gabions that were installed to protect the banks of the course that are being eroded. These gabions and the bank erosion were not planned for and should have been addressed in the design phase. Beneficial projects like this are occurring along the river, but tend to address necessity rather than pre-emptive planning. It would be beneficial to the river corridor to prepare a comprehensive management plan to guide projects in a holistic rather than the current piecemeal manner.

Because of the large acreage of open space that golf courses consume, they can be proactive and assume a level of responsibility for the health of the ecosystem they inhabit. With nine golf courses along the Jordan River consuming over 1000 acres of open space, many beneficial outcomes can be realized through comprehensive conservation planning. Some sample benefits are: Runoff filtration from housing developments and roads (already being performed near Murray City Golf Course), courses acting as patches in an urban fabric connecting Utah Lake and the Great Salt

Lake, and river restoration where the river adjoins or bisects golf courses. These are a few benefits, with many more possible.

## **2. LACK OF NEW GOLF COURSE DESIGN AND CONSTRUCTION**

### **GUIDELINES**

With a population expected to double over the next thirty years in several counties around the Jordan River, coupled with an ever growing enthusiasm for the game of golf, there will inevitably be more golf courses built in the valley. With this in mind, conservation plans and guidelines for construction can be implemented on new golf course designs to avoid any further degradation and fragmentation of wildlife habitat. Programs such as the Audubon International Signature Program, principles deduced from the Riverbend case study, and lessons learned from other golf course studies, will have a great impact on the future viability of the river corridor.

Taking a more local approach, we look at the opportunities for single golf courses, set forth by the JRNAF report. Within the Corridor report are various statements that provide a basis for the creation of a design program. "...Areas that are primarily for human use such as trails, golf courses and parks will be managed, to the extent possible, to complement the wetlands, native vegetation and wildlife habitat of the natural conservation corridor." (Jordan River Natural Conservation Corridor Report, 2002). More detail was added to this statement to arrive at Issue D of the reports Issues and Recommendations chapter.

Issue D: Coordination with Golf Courses

There are numerous golf courses by the Jordan River and others are being contemplated. While golf courses provide open space, as traditionally landscaped they do not maximize wildlife habitat potential.

#### Recommendation

D1. Encourage golf courses to incorporate wetlands and native vegetation, which support native wildlife, in their plans and management. Golf courses that are being planned should strongly consider the Audubon International Signature Program. Currently operating golf courses should strongly consider programs such as the Audubon Cooperative Sanctuary program. These programs facilitate appropriate environmental stewardship of a golf course.

With regional and local issues defined, a closer look at the case study course, Riverbend, will indicate problems and opportunities that can be addressed in the goals, site analysis, and eventually in the management plans sections.

Upon first visiting the site, I made notes of interesting features I thought would influence the wildlife both positively and negatively. I then used methods from Toth, 1974, to understand the role these issues will have in the management plan. Each feature or issue is listed below and deemed beneficial, compatible, conflicting, or detrimental. From this designation, goals and objectives can be created.

Table 1. Riverbend features analysis

Feature	Beneficial	Compatible	Conflicting	Detrimental
-Geese on course			X	
-Stream banks eroding				X
-Wetlands are degraded and are invaded by exotic vegetation			X	
-Ponds have no vegetative buffer			X	
-Maintenance vehicle paths through remnant patches			X	



-Shrub steppe on hillsides	x			
-Extensive maintenance in out of play areas			x	
-Riparian buffer is narrow and full of exotics		x		
-Areas of native vegetation left during construction	x			
-Uplands not connected by corridors to lowlands				x
-Few offsite natural connections existing			x	
-Slope has only two vegetative layers			x	
-Exotics are invading whole course				x
-High edge ratio and narrow patches			x	
-Course layout is tight		x		
-Drain tiles daylight into river			x	
-Natural spring on site	x			
-Sufficient water on site for wildlife	x			
-Many degraded native vegetation patches		x		

The results of the above analysis will be developed into objectives to fulfill various goals.

With the recommendations from the Corridor report, the regional problems identified, and the objectives clear, a list can be created of goals relating to Riverbend Golf Course.

### GOALS

The goals specified for Riverbend Golf Course will satisfy the three objectives stated in chapter one. These again are: 1. Develop a habitat enhancement management

plan for Riverbend golf course in Riverton, Utah as a case study, 2. Develop design and construction guidelines for new golf courses along the Jordan and Provo rivers based on principles deduced from the Riverbend plan, and 3. Create an educational brochure.

- Goal 1. Enhance wildlife habitat on golf courses along Jordan River
  - Objective A. Control geese population
  - Objective B. Enhance wetlands and wetland vegetation
  - Objective C. Develop non-human and no-mow areas
  - Objective D. Develop buffers around pond
  - Objective E. Develop movement corridors in non-human areas
- Goal 2. Create Guidelines for construction of new golf courses
  - Objective A. Develop on site drainage retention
  - Objective B. Guidelines for minimum widths of various buffers
  - Objective C. Design for patches and corridors
- Goal 3. Restore Plant communities along course riverbanks
  - Objective A. Regrade eroding stream banks and ponds
  - Objective B. Widen stream riparian buffer in select areas
  - Objective C. Connect existing healthy vegetation patches in corridors
- Goal 4. Develop management plan for Riverbend Golf Course
  - Objective A. Maintain new enhancements actively
  - Objective B. Manage for wildlife species in residence
  - Objective C. Tailor IPM program to new plan
  - Objective D. Preserve offsite connections
- Goal 5. Add to JRNAF database
  - Objective A. Bound thesis for library
  - Objective B. Detailed case studies with Riverbend becoming one
- Goal 6. Make findings available to community
  - Objective A. Develop educational brochure
  - Objective B. Develop presentation CD for JRNAF presentations

These goals and objectives will be addressed in the enhancement plans

## **SITE INVENTORY**

The site inventory for Riverbend Golf Course contains two parts. Part one is a general site history and site description. It includes a comparison of historic and present vegetation and wildlife patterns. Part two of the site inventory is an examination of the

effectiveness of the existing vegetation as wildlife habitat, utilizing the NRCS worksheets discussed in chapter one and also found in appendix C.

## **Part One Historical Vegetation and Wildlife**

### Site History

The project site is within the Jordan River corridor, which encompasses most of the remaining open lands, wetlands, and wildlife habitat between Utah Lake and the Great Salt Lake. This riparian ecosystem was very important historically in the Salt Lake valley to many species of wildlife and vegetation. Today there remains but a remnant of the once extensive system. This fragment warrants protection from over development.

Historically, the Jordan River would handle flows from many different sources and deposit them in the Great Salt Lake. The rivers that flowed into Utah Lake, Utah Lake itself, and the Jordan Rivers own tributaries, each contributed to the once dynamic Jordan River corridor. Historically, the disturbance regime of the river consisted of flood levels, bank full, and low flows depending on the season. This fluctuation was important in the support of a wide and fertile flood plain that supported many important plant communities. "Commonly, during the spring, the river would be at flood stage due to snowmelt in mountainous headwaters of the basin. Because of the large land area contributing flow to Utah Lake and the Jordan River, it is likely during most spring seasons the river discharge exceeded channel capacity, and flowed onto the adjacent floodplain." (JRNAF report, 2000).

Today, the river has been changed detrimentally due to flood control projects and the use of its water for irrigation purposes. It no longer receives peak flows in the spring which are so important in supporting a diverse community. Because of this change, the Jordan River has been disconnected from its historical flood plain and is now a single channel that has down-cut and lowered the water table, leaving remnant wetlands that are converting to drier plant communities. This was not the case historically where the Jordan River was a highly meandering, braided stream that supported a great wealth of wetland and riparian habitat, and diverse species of wildlife. Migratory species used the Jordan River as a stop-over point and breeding area. In the past, disturbance regimes affected the river in a positive way, supporting an important cottonwood-willow dominated plant community.

The future for this river depends on active management. Without peak flow, scour, deposition, and channel meandering, the floodplain will continue to be very narrow. Through active management, we can achieve a balance, but the primary problem involves the restricted flow in the river.

#### Historical vegetation

The historical vegetation, as relevant to this project, consisted of the river corridor riparian communities transitioning into higher elevation native grasslands and low desert shrub steppe. This is still evident today on the Riverbend Golf Course. The Jordan River meandered back and forth across its flood plain supporting vast marshes and wetlands. Species included: bullrushes, reeds, sandbar willow, peachleaf willow, cattails, Fremont cottonwood, reed canary grass, rushes, and sedges. The transition area

into the drier zones consisted of: native bunchgrasses, rabbitbrush, big sagebrush, western wheatgrass, saltgrass, muhly scratchgrass, alkali dropseed, and American alkali grass. The species presented were Pre-European and many were dependent on the disturbance regime of the river. (JRNAF Conservation Corridor Report, 2000)

Today, development has changed the dynamic of the river and it no longer supports the diversity of wildlife and vegetation it once did. Many invasive exotics have capitalized on the stream degradation and the effect it has on natives. Such species are: Tamarisk, Russian Olive, and various annual and perennial forbs such as whitetop. The management of these species will be discussed in the alternative plans.

Since settlement days, the river has changed dramatically. It is at a stage where the river cannot fix itself and active management will be needed. Without flood dynamics, riverbank restoration plantings will be needed as well as supplementing native seed sources. With proper management, golf courses along the river can restore some of these historical vegetation species and bring a level of function back to the river.

#### Historical Wildlife

For this project, the historical avian species will be reviewed. Avian species were used to facilitate ease of future monitoring. One of the greatest uses of the Jordan River is that of a migratory stop over point. Neotropical passerines refuel and rest in the lowlands during migration. Historically, a diverse mix of species would use the area. Common riparian-dependent species of the past included: American redstart (*Setophaga ruticilla*), black tern (*Sterna nigra*), common yellowthroat (*Geothlypis trichas*), warbling vireo (*Vireo gilvus*), willow flycatcher (*Empidonax traillii adastus*), yellow-billed cuckoo

(*Coccyzus americanus occidentalis*), and yellow-breasted chat (*Icteria virens*). (JRNAF 2000). These species are either not present or not breeding in the valley today. Presently in the valley, generalists have taken over and are now abundant. This is attributed to degradation of the stream and its associated habitat as well as human interaction in the flood plain and the effect on the river buffer. The most abundant species along the river today are: black-billed magpie (*Pica pica*), Western meadowlark (*Sturnella neglecta*), red-winged blackbird (*Agelaius phoeniceus*), song sparrow (*Melospiza melodia*), killdeer (*Charadrius vociferus*), barn swallow (*Hirundo rustica*), ring-necked pheasant (*Phasianus colchicus*), mourning dove (*Zenaida macroura*), American robin (*Turdus migratorius*), Mallard (*Anas platyrhynchos*), and American goldfinch (*Carduelis tristis*). The fact that these generalists are present speaks to the degradation of appropriate habitat for once abundant birds. Population levels of generalists can have an effect on specialists populations.

Habitat models of these species were created and can be found in Appendix E. The intent was to discover the limiting factors involved in the disappearance of the specialists, and the influx of the generalists.

## **Part Two Existing Site Description**

### Site Description

"Riverbend opened in 1994 and quickly drew national attention when it was ranked one of the top 10 golf courses in Utah by Golf Digest. Fairways are lush and well groomed, the greens smooth and true. Riverbend features a spacious country setting different from what you might expect in a municipal golf course. The course follows the

bends and curves of the Jordan River as it presents golfers with a variety of challenges. Elevated tee shots, scenic overlooks, natural wetlands and strategic bunkering add to the beauty and difficulty of the course. The challenging 6,876 yard layout is playable year round. The course features bent grass greens, rolling hills, large waste bunkers, ponds and streams and a variety of local wildlife." (Golf Media Group 2002). This description comes from marketing material aimed at recruiting new golfers and it does its job well. It paints a romanticized picture of golf that is reminiscent of the great courses seen on T.V. such as Augusta National or Pebble Beach. However, it fails to reveal the real beauty of the course and the abounding opportunities it has in store.

Riverbend Golf Course is unique; a course with diverse plant communities, habitat types, and wildlife. It is located in the lowlands of the Salt Lake Valley, associated with the Jordan River corridor. The golf course abuts the Jordan River on its east property line. Working to the west, the course gains in elevation to reveal the front nine holes which are composed of upland shrub-steppe and grassland habitat. Throughout the course, five plant community types are present. These include: riparian, shrub steppe, remnant woodland/ mountain brush, grassland, and wetland/wet meadow.

To describe the course, it will be broken into four distinct regions with each representing a different vegetation condition. (see figure 3, p.42) These are: the uplands (holes 1-7, and 9), the slope, the lowlands, and the river buffer. The uplands vegetation consists of various willows around the ponds, a sage brush dominated shrub steppe community, cattail and bulrush in the drainages, and tall canopy trees, such as boxelder, decadent cottonwoods, and elms. The slope is primarily dominated by Russian

Olive and Siberian Elm. The slope consists of canopy trees with a weedy herbaceous understory. The lowlands vegetation is primarily centered around the canal and ponds. This area is also dominated by Russian Olive with various weedy species in the wet meadow. Rush is present in the meadow, along with teazle. The last vegetation region is the river buffer. The dominant type is again Russian Olive with a select few areas of willow. Tamarisk can also be found. In some areas along the river one can find Phragmites in large stands.

The above mentioned regions will be evaluated using methods detailed in NRCS worksheets. The worksheets and findings can be found in Appendix C.

#### **SITE ANALYSIS**

As mentioned earlier, the site analysis will be a graphical depiction of the problems and opportunities defined in the pre-analysis and goal section. (See figure 3).