Management of Riparian Ecosystems

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FOREWORD

Nearly 100 wildlife biologists from state and federal agencies and private industry registered for the 1981 Annual Meeting of the Montana Chapter, The Wildlife Society, in Great Falls. The theme of the meeting--Management of Riparian Ecosystems--created enthusiasm among biologists which carried over to the news media. Papers presented at the meeting resulted in T.V. news coverage on the MTN Network and at least three articles in the Great Falls Tribune.

Faye M. Couey was named recipient of the Distinguished Service Award at the Annual Banquet.

I would like to acknowledge the cooperation of the authors of papers. They volunteered with no arm twisting and did a professional job in presentation of findings and preparation of papers for publication. Thanks also to Greg Munther, Lolo National Forest Fisheries Biologist; Terry Lonner, MDFWP Research Biologist; Robert Bigler, Bitterroot National Forest Silviculturist; and Larry Thompson, DNRC Wildlife Biologist; for their enthusiastic participation in the panel discussion on management of Riparian Ecosystems.

John H. Ormiston
Editor

THREATS TO RIPARIAN ECOSYSTEMS - AN OVERVIEW

Richard DeSimone 1/

During the last few years we have been besieged with the word riparian. We hear about riparian zones, riparian communities, riparian ecosystems, riparian habitat, riparian faunation and on and on. Interestingly enough, we do not seem to have a very good grasp of the term. We ask, "what exactly is riparian, where did the word come from, what does it mean and what exactly is the problem?"

Personally, I become a little frustrated with new words and phraseologies creeping into our vocabulary and then being used to death. For instance, the news media has worn out the words detente, rebate, Palistinian autonomy and freedom flotilla. Likewise, the scientific community is hooked on the word - riparian. I hope to expound upon this publicity and explain why I think it is to our advantage as wildlife and habitat managers to encourage this attention to riparian ecosystems.

During the last 2 years I attended several symposia concerning riparian values. A common occurrence at these meetings were long-winded discussions about how to precisely define riparian habitat. Precise definitions are difficult to develop since riparian habitat occurs from mountain tops to oceans. Many definitions have been devised. The most general is that riparian zones are those areas associated with surface water which reveal through their vegetative complex the influence of that water (Minroe and Smith 1971, Franklin and Dyrness 1973). In Montana these areas are most commonly referred to as bottomland, floodplain and streambank vegetation, but considerable amounts of riparian vegetation also occur around stock ponds, natural lakes and marshes as well as at the heads of drainages, in sedge meadows, moist swales and benches.

If I were to summarize our present knowledge of riparian habitat, the following items would emerge: riparian habitats are the most productive wildlife areas in North America; vast acreages of our original riparian areas have been and continue to be lost; and preserving the remaining riparian areas will be an enormous challenge considering the current economic pressures to overuse or develop those which are left.

Many of us are uneasy about the fuss over riparian habitat and maybe a bit frustrated that a particular habitat has been singled out and is receiving a disproportionate amount of attention. Most biologists were trained to think that individual habitat components are simply parts of a larger system (or a part of a species' home range) and to effectively manage wildlife, we must look at the entire system and not simply one part.

1/ Widlife Biologist, Mt. Dept. Fish, Wildlife & Parks, Helena, Mt.

It is my opinion that the current concern for the riparian resource can be traced to an extension of our endangered species philosophy. The best way to draw attention to wildlife is to identify it as close to extinction. A similar approach has been used for riparian areas and, like endangered species, has resulted in a sudden recognition of riparian values and the problems facing these areas. This sudden recognition is exemplified in that 85 percent of the literature concerning riparian areas has been published in the last 10 years (Motroni 1980).

Most biologists, I believe, are uncomfortable with the whole "endangered" business. Dealing with endangered things is very often dealing with a symptom and not the cause. The real cause stems from the history of land-use on this planet, which has often been a history of land-abuse. Aldo Leopold (1949) expressed this better when he stated, "The practices we now call conservation are, to a large extent, local alleviations of biotic pain, they are necessary, but they must not be confused with cures. The act of land doctoring is being practiced with vigor, but the science of land health is yet to be born." Unfortunately, biologists do not get much mileage out of telling the American public that our land-ethic stinks. But we do get enormous emotional appeal out of telling the public that immediate action is absolutely necessary because a species or habitat is threatened and at the edge of extinction.

This emotional appeal may be related to a comment often heard about the extinct passenger pigeon, "Boy, it's a shame they're all gone - wouldn't it have been nice if we could have saved a few?" This 'saving a few' theory is the current state of the art in regard to our nation's remaining riparian systems. In America we have destroyed, through neglect, mismanagement and conversion practices during the last 150 years, between 70 and 90 percent of our indigenous riparian resources and badly damaged the rest (U. S. Council on Environmental Quality 1978). The current scramble to protect remaining riparian areas may be related to another statement by Leopold (1949), "this is a plea for the preservation of some tag-ends of wilderness, as museum pieces, for the edification of those who may one day wish to see, feel, or study the origins of their cultural inheritance."

This same concept was also treated by Paul Errington (1957) when he stated, "... civilized man could show some civilization by preserving in as natural condition as possible representative types of the different plant and animal communities before they are lost." Errington went on to say, "Such would mean going farther than preserving the mountain tops that no one would find exploitable, the lands too rocky or otherwise unsuitable for cultivation, the forested lands too inaccessible for lumbering, and the odd piece of land having slight economic values ... It would mean preservation of some places with the best timber or soils or building sites, ..." He summed it up when he said, "As members of a presumably rational and enlightened society, do we need to let the destruction of our wetland values continue as long as someone feels able personally to profit thereby?"

We may be uneasy with singling out one particular habitat and giving it a great deal of attention, but choosing riparian habitat is an excellent choice. The clamor over riparian values lead to passage of some significant legislation concerning riparian areas, and putting these laws into on-the-ground practice could reverse a trend that some think may lead to riparian habitat extinction within this century (McCormick 1978).

The values of riparian areas to wildlife has been evident to biologists for many years. Although the importance is perhaps most apparent in fish, and best quantified in birds, it is clear that riparian areas are of paramount importance in producing and maintaining a great degree of biotic diversity in nature.

Studies have shown that the majority of the nation's fish and wildlife are dependent upon riparian habitats for survival (Hubbard 1977) and the United States Council on Environmental Quality (1978) has taken up the banner in stating that riparian ecosystems are essential for the survival of the nation's fish and wildlife.

In general riparian areas are uniquely characterized by a combination of high species diversity (Hubbard 1977), high species densities, high productivity and an extremely large number of endangered species (Johnson, et al. 1977). One of the highest densities of breeding birds ever recorded in North America was found in the cottonwood riparian areas of the southwestern United States (Carothers and Johnson 1975). Of all mammal species in North America, 42 percent are found in riparian communities of the western United States (Hubbard 1977). In northeast Oregon, it has been shown that about 80 percent of all terrestrial species were either directly dependent upon riparian habitat or utilized it proportionately more than any other (Thomas, et al. 1979).

Currently, the importance of riparian areas to game species is being quantified. Elk in northeast Oregon were found during summer to spend 40 percent of their time in riparian zones that made up only 7 percent of the area (Thomas, et al. 1979). Work in Idaho reported that approximately 70 percent of all forage removed by elk during the summer came from moist cover types (Hayden-Wing 1979). The Montana elk/logging studies have also pointed out the importance of moist sites to summering elk. Lonner (1980) indicated that the disproportionate use of wet meadow types to summering elk was related to the "good nutritional quality, high forage production, high security, adequate thermal cover and a diverse species composition."

Studies by Mundinger (1980) on white-tailed deer in the Swan Valley have found that deer use timbered riparian habitat for resting and security during all seasons and especially during winter. He indicated that riparian habitats on his study area were an essential habitat component for white-tailed deer.

The reasons why riparian areas are so important to wildlife are related primarily to vegetative structure including foliage height, diversity and volume. Riparian systems usually occur as an ecotone between aquatic and upland ecosystems and have distinctive vegetation and soil characteristics (Pase and Layser 1977). Water differential, topographic relief and presence of deposited soils strongly influence the extent of high water tables and associated vegetation (McCormick 1978). These factors lead to increased diversity of plant species and structural diversity in the community and contribute to an abundance of wildlife. Similarly, a microclimate that contrasts with upland areas due to higher transportation rates, increased humidity and air movement, and decreased temperature fluctuations are also responsible for high wildlife values (Thomas, et al. 1979). Although riparian areas are generally small in surface area their shapes are often linear and dendritic (Warner 1979). This linearity produces a vast distance of ecotone or edge effect.

It comes as little surprise that the enormous values of riparian areas to wildlife are the same values which have attracted man to use and abuse these areas. Today it is estimated that only 10 to 30 percent of original riparian areas present 150 years ago remain today (U. S. Council on Environmental Quality 1978). This remaining resource is being lost at an annual rate exceeding 6 percent per year to channelization, farming, flood control, grazing, hydroelectric projects, irrigation, phreatophyte control and recreation (McCormick 1978). Documentation of this loss has been, at the very least - discouraging:

- in California's Sacramento Valley by 1977, 98.5 percent of the indigenous riparian woodlands had been destroyed (Smith 1977).
- in Arizona, only 15 percent of the original riparian areas remain (McNatt, et al. 1980).
- less than 10 percent of the original riparian vegetation persists along the Colorado River (Ohmart, et al. 1977).
- in the state of Missouri, 17 percent of the riparian vegetation was destroyed by 1880, 40 percent by 1920 and by 1975 only 4 percent remained (Korte and Fredrickson 1977).
- in Arkansas, less than 47 percent of the state's riparian ecosystems remain with losses exceeding 95 percent in some counties (Sternitzke and Christopher 1970).
- in Mississippi, more than 68 percent of the state's riparian ecosystem has been destroyed with 32 percent occurring in the 25 years prior to 1970 (Sternitzke and Christopher 1970).

- 84 percent (amounting to 20 million acres) of original riparian habitat in the Lower Mississippi Valley has been destroyed (Earnest 1978).
- Over 80 percent of the more than one-half million acres of riparian ecosystems on Bureau of Land Management (BLM) administered lands, were judged to be in unsatisfactory condition in the 1970s (Bureau of Land Management 1975).

Although these statistics are perhaps staggering on a national basis, in Montana we are currently very fortunate to be in the enviable position of attempting to preserve our original riparian areas instead of trying to rehabilitate them.

A major problem for riparian habitat is who owns it. Today, some 58 percent of the land in the United States is privately owned. One can simply look at a map to realize that the majority of the towns and cities in Montana, or the nation, are adjacent to or in the floodplain of streams and rivers or along the shores of lakes. Riparian alluvial soils are America's prime agricultural lands. Streams and rivers occurring across the country provide the most economical routes for railroads, highways and pipelines. This settlement pattern lead to virtually all of the most attractive and productive riparian areas being in private ownership. It is estimated that 80 percent of all riparian lands are in private control (Warner 1979).

A recent California riparian study (Warner 1979) concluded that, "In contrast to the public lands, these private land holdings have never been subject to significant federal, state, or local land management regulations and guidelines. And because America has had a long tradition of laissez-faire ... the destruction and conversion of riparian ecosystems on private lands has been widespread, intensive and continuing ... Yet because riparian systems comprise such a small part of any particular piece of real estate, the implications of destructive changes taking place were not readily apparent. It is perhaps not surprising, when viewed in this light, that the scientific study, management and protection of riparian systems has been neglected ... Only now, at the eleventh hour, is awareness of the problem emerging."

Some uses of riparian areas are primarily regional while others occur nationally. Conversion of bottomland hardwood forests to soybean agriculture is predominately a southeastern issue (Sternitzke 1975). Loss of riparian resources to livestock grazing is primarily a southwestern concern (Carothers 1977). Draining of prairie potholes occurs most commonly in the central states (Harmon 1970). Loss of riparian habitat due to alteration of stream channels or water flow occurs nationwide.

In Montana, the majority of land-uses on private and public land affect riparian habitat. Some of these activities include:

livestock grazing, water development, timber harvest, mining, road construction, agriculture, urbanization and recreation. Discussions today and tomorrow will address most of these threats to Montana's riparian habitat.

Many riparian areas of Montana are on federally controlled lands. In this state opportunities to protect riparian values or correct problem areas are excellent. Federal acts such as the National Environmental Policy Act of 1969, the National Forest Management Act of 1976, and the Federal Land Policy and Management Act of 1976, are powerful tools if both federal and state biologists are willing to put in the necessary effort to assure that regulations specified in the laws are properly incorporated into land management activities. The current federal laws relating to wildlife values on federal lands are the strongest we have ever had. Most of these laws are the result of the environmental awareness which peaked in the 1970s, but they are useless unless put into practice. We might relate this thought to the famous Stradevarius violin whose fine qualities cannot be appreciated unless one is willing and able to use it.

We are lucky not only to be here in Montana with abundant intrinsic values to work with, but also to have excellent legal tools with which to work.

As those who understand the situation best, we can take the responsibility of riparian habitat protection another step and make it a point to inform ranchers, sportsmen and particularly our legislators, of the importance of and problems confronting riparian habitats. Considering the broad base of membership in the Montana Chapter, The Wildlife Society, we may have most legislative districts covered and thus the majority of the state's land base.

The destiny of most riparian habitat nationwide has been sealed, but here in Montana, the outlook is bright since there still are opportunities to protect existing riparian habitat and nurse those which have been abused. That we chose riparian habitat as the topic of our annual meeting, is an encouraging first step.

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TOWARD A RIVERINE RIPARIAN CLASSIFICATION SYSTEM FOR MONTANA

Ron Batchelor 1/

For the last several years a great deal of attention and concern from across the country focused on the importance of riparian environments. Riparian zones and their management are especially significant in the west where they frequently provide an oasis in otherwise arid environments.

The Rural Areas Development (RAD) Wildlife Subcommittee spent most of 1979 and 1980 becoming familiar with riparian issues in Montana. The first thing apparent to the subcommittee was the lack of baseline information characterizing riparian environments in our state. Knowledge of plant communities within riparian environments is often incomplete, especially with regard to those communities where shrubs are dominant. For example, there is question as to the ecological role of shrub communities. Which, if any, are climax? Which are seral? We cannot wait, however, until such questions are answered and data are available before we undertake to classify our remaining riparian environments.

Despite this lack of available data for use in riparian management, in the last two years many federal agencies have been directed to increase their recognition of riparian environments in the administration of their programs. Some management agencies have been directed to initiate inventories of riparian zones on lands they control.

One goal of the RAD subcommittee was to fill this void by encouraging the classifying and inventorying of Montana's riparian environments, as well as seeking possible uniformity among state and federal agencies in such an undertaking. As a start, the RAD Wildlife Subcommittee, under the leadership of Dr. Harry McNeal of Montana State University, sponsored a meeting in the spring of 1980 of agency and professional society representatives to determine interest and explore possibilities for developing a common riparian methodology for use in Montana. As a result of this meeting, a riparian program team was formed. The members represent several state and federal resource agencies.

Since classification systems exist for wetland riparian environments--marshes, potholes, ponds--, the team directed its attention to riverine riparian environments--those associated with our state's water courses. During the spring and summer of 1980 team members reviewed their agencies' efforts in the area of riverine riparian classification. The committee concluded that, but for a few site specific research projects, little has been done to date by resource agencies nationally, regionally, or by state to develop and implement workable classification

1/ Wildlife Biologist, Soil Conservation Service, Bozeman, Montana.

systems for riverine environments.

Team members agreed that a classification system adopted by state and federal agencies in Montana should be ecologically based on vegetable units and include a digital hierarchy approach. A current effort in this area in California provided initial direction to our team.

Our riparian program team has accepted this challenge and developed a working draft of a classification system for Riverine Riparian Environments of Montana. This draft is currently under review by team members and others interested in this activity. Our hope is to have an acceptable classification system available for implementation by state and federal agencies by the end of 1981.

GRAZING MANAGEMENT VS. RIPARIAN MANAGEMENT IN SOUTHWESTERN MONTANA

Lewis H. Myers 1/

Introduction

Between 1976 and 1979, more than 300 extensive analyses of riparian habitats were completed on perennial streams in preparation for an environmental impact statement (EIS). The impacts of proposed and existing livestock grazing programs on about one million acres of public lands in southwestern Montana administered by the Bureau of Land Management were analyzed in the EIS. The impacts of 3? existing grazing systems on 44 streams were discussed. Most of the existing grazing systems were implemented 10 to 12 years ago and two or three cycles have been completed.

Most streams on BLM lands in the study area are within the "foothills zone" located mid-slope between conifer-dominated upper watersheds and grass-shrub dominated valleys. Streams are typically small, with sustained summer flows of 1-20 cfs, and moderate gradients of 1 to 3%.

Stream riparian habitats are dominated by deciduous woody species, including willows (Salix spp.), aspen (Populus tremuloides), dogwood (Cornus sericea), maple (Acer glabrum), alder (Alnus sinuata), birches (Betula glandulosa, B. occidentalis), and cottonwood (Populus fremontii). Climate within the area is semi-arid. Precipitation varies from 12-16 inches annually in most foothill areas. Peak precipitation occurs in May and June, resulting in abundant green forage until about July 10. At higher elevations, the green season extends much later. Freezing temperatures may occur as late as mid-June and as early as the first week of September. The growing season varies from 90 to 120 days. Winter temperatures are quite low, commonly reaching -20 to -40° F.

Methods

In developing the extensive riparian survey, the primary goal was to provide a general assessment of the impact of livestock grazing on riparian wildlife habitats with limited time and manpower. The findings of this effort should be regarded as an empirical assessment.

Riparian surveys included assessment of: 1) deciduous woody species quantity, vigor, and age classes, 2) stream channel stability, and 3) livestock and big game use. The basic assumption was that the condition and vigor of palatable deciduous woody species was a valid indicator of overall riparian habitat condition.

1/ Wildlife Biologist, Bureau of Land Management, Dillon, Montana.

The values and ecological roles of herbaceous species are recognized, however, difficulty was experienced in analyzing these species due to their varying availability where livestock were present. In establishing trend studies on riparian habitats, all plant species are being evaluated.

Highly significant correlations were found between the basal stem diameters and ages of deciduous woody species ($p < .001$). In brief, it was found that basal diameters of 1-10 mm included plants for all deciduous woody species up to 4-5 years of age. Basal diameters of 11-15 mm included plants up to 7-9 years of age.

Woody plants are randomly selected within the upper streambank area and placed within one of three size-age classes, a height class, and a vigor class. Vigor classes include normal, heavily-hedged, decadent and dead. Heavily-hedged plants have 50% or more of the two-year leaders clipped. Decadent plants have 30% or more of the crown area dead. A minimum of 10 measurements of woody canopy coverage are made on 4 x 8 meter quadrats. Bank erosion and bank rock content are estimated by systematic ocular estimates after Pfankuch (1975). Big game and livestock droppings are counted on a two-meter wide transect extending the length of the sample area. A list of all plant species with their relative abundance and condition trend is completed as an aid to future habitat typing.

Seven stream reaches were selected which met broad wildlife habitat goals in terms of fishery and big game habitats, apparent successional stage, and nongame habitat needs. Characteristics of these reaches were analyzed to develop an index of riparian vigor.

To facilitate comparisons, all grazing systems were expanded to a four-year cycle and grazing treatments were labeled "cool season" or "hot season." Hot season is the period of about July 10 through September 1, with some altitudinal differences. Hot season is typified by dessication of livestock forage on upland sites, by air temperatures sufficient to require livestock to use shade, and by greater scarcity of water. Cool season includes spring, early summer, fall and winter. During spring and early summer, succulent forage is readily available on upland sites, temperatures are cool, and water is widely abundant. During fall and winter, forage is more available on upland south-facing slopes, and temperature inversions and snow accumulations discourage livestock use of riparian areas.

Results and Discussion

Riparian data for stream courses in each grazing system were compared using t-tests. The analysis resulted in identification of groups of sample areas with similar characteristics. The groups differed by their condition (Table 1). Groups II and III did not differ significantly in vegetative vigor, but two of the three streams in group II were subjected to persistent unauthorized use, and the systems could not be evaluated. Group I included 20 streams, group II only three streams, and group III had 21 streams. Data for streams in each group were compared with four ungrazed streams (Figure 1).

In group I, 90% of the streams rated good or excellent, and general riparian habitat management goals were met (Figure 1). In group III, only 24% of the streams met riparian habitat goals. Streams in group I compared favorably to four ungrazed streams.

On the well-managed streams in group I, young (less than five years old) woody plants greatly exceeded dead and decadent plants (Figure 1). On poorly managed streams in groups II and III, dead and decadent plants roughly equaled or exceeded young plants.

Riparian vigor scores were significantly lower ($P < .001$) and bank erosion was significantly higher ($P < .001$) in groups II and III as compared to group I (Figure 1).

Woody canopies were lower in groups II and III, and it appeared as though group I canopies were recovering, even though they remained lower than in ungrazed streams (Figure 1). Rates of recovery are not yet documented, but it is doubtful that 10 to 12 years is sufficient time for substantial canopy expansion. The great abundance of woody reproduction in group I streams suggested that recovery is still occurring. Data on ungrazed streams suggest that young woody plants decline as woody canopies approach 60%, probably due to competition for space and sunlight.

In group I, hot season treatments were either lacking, or were limited to not more than one in four years (Table 1). Group III systems had two or three hot seasons' use in four years. Cool season use was highly variable in both groups. Since the hot season treatment was the heavy use treatment by livestock, it appears as though heavy use can be tolerated by riparian habitats in only about one year of four in the study area. Various degrees of lighter use during the cool season can also be tolerated in combination with one heavy use treatment. Within group I, the best systems had no hot season use, with one or two years of rest in four years. In group II, one hot season use and three cool seasons use with no rest proved incompatible with riparian management objectives on one stream.

Each of the three groups included rest-rotation and deferred systems. There seemed to be no direct correlation between the grazing system used and the condition of the riparian habitat. Rest-rotation is a principle in grazing management and includes a great variety of systems all of which might be designed to achieve the objectives specified.

TABLE 1: Groups of Similar Grazing Systems Based on Riparian Vigor

Group	System	Number of Streams	Treatments (four-year cycle)	Mean Riparian Vigor Score
One	Rest-rotation	4	Two rests; two cool seasons use	
	Alternating Rest	5	Two rests; two cool seasons use	
	Rest-rotation	2	One rest; three cool seasons use	
	Deferred	3	Annual light, cool season use	
	Rest-rotation	6	Two rests; one hot season; one cool season use	7.5 ± 1.6
Two	Rest-rotation	2	One rest; two cool seasons, one hot season use; unauthorized use during hot season each year	
	Deferred Rotation	1	No rest; one hot season; three cool seasons use	5.3 ± 0.5
Three	Rest-rotation	11	Two rests; two hot seasons use	
	Alternating Rest	1	Two rests; two hot seasons use	
	Rest-rotation	1	One rest; two hot seasons; one cool season use	
	Deferred Rotation	7	No rest; two hot; two cool seasons use	
	Deferred Rotation	1	No rest; three hot; one cool season use	4.9 ± 1.7

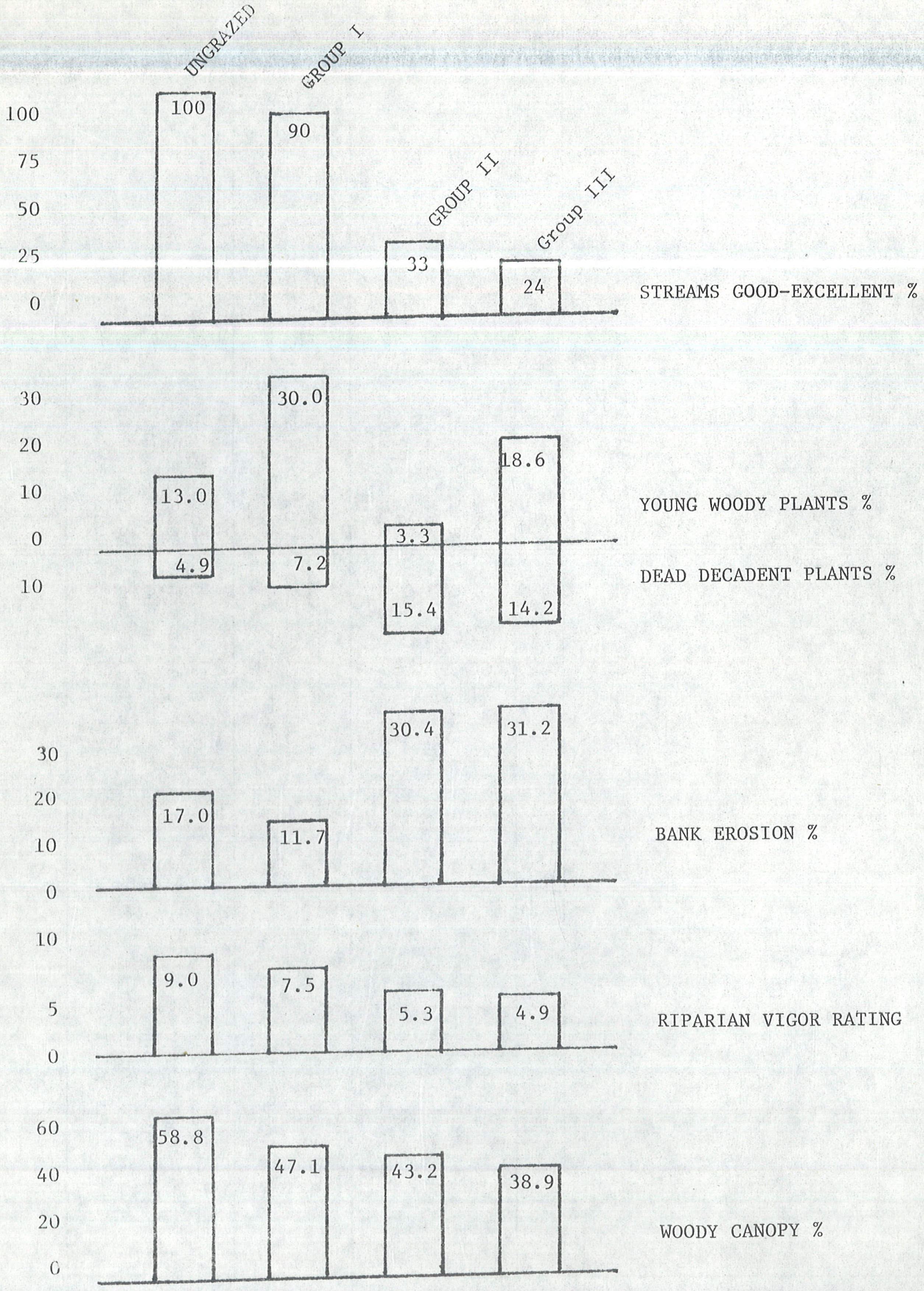

Figure 1. Woody canopy %, riparian vigor rating, bank erosion %, percent dead or decadent plants, percent young woody plants and percent of streams in good or excellent condition, by stream group, compared to ungrazed riparian areas.

Currently, there appears to be a general state of confusion and disagreement in regard to the compatibility of livestock grazing management and riparian management. Some researchers and managers think livestock and riparian areas are incompatible, while others acknowledge limited successes. In 1977, a group of managers and researchers attending a symposium on "Livestock Interactions Fish and their Environments" in Sparks, Nevada, evaulated grazing systems. They concluded that "rest-rotation grazing, without special protective measures for the stream and streambanks, will not maintain nor restore a healthy, productive riparian aquatic zone" (Platts 1978).

Assessments of grazing systems must be more specific in terms of documenting: 1) seasonal timing of livestock use, 2) duration of seasonal use, 3) intensity of use, and 4) local behavior of livestock in terms of plant phenology and weather.

Within each of the three groups there were systems which met riparian management goals and others which did not. The specific grazing system and these other factors were important in achieving riparian management goals: 1) channel resistance or vulnerability to erosion, 2) riparian quantity, 3) shade and water distribution, 4) range condition, 5) riparian condition, 6) stocking rate, 7) class of livestock, 8) salting and riding practices, 9) topography, and 10) grazing system compliance. Each of these factors must be considered in both the implementation and evaluation of grazing systems. A comparison of good and poor management systems and an evaluation of the management components appear in Table 2.

Fragile channels, exceptional aquatic values, or other factors may dictate that livestock grazing is unacceptable on certain streams. In cases where riparian quantity is minor and the stream serves as the principal water source in a large pasture, grazing may be unacceptable, except for short periods.

Range and riparian condition are very pertinent to system design. On poor condition ranges, riparian habitat may be the sole source of succulent, nutritious livestock forage. Data collected thus far suggests that better livestock management is needed to improve a poor riparian habitat than to maintain a good condition riparian habitat. The dense woody canopy on good condition riparian areas functions as a barrier to livestock, protects plant reproduction from grazing, and the root systems reduce the vulnerability of banks to trampling. Complete rest for several years may be a prerequisite to proper riparian management in some cases.

Stocking rates are important. There is a common misconception that since light stocking removes most of the herbaceous production from the riparian zone, further use is inconsequential. Livestock continue to utilize riparian areas for loafing and

TABLE 2. Examples of Good and Poor Grazing Systems on Riparian Habitat in Southwestern Montana

Management Components	Dyce Creek - Good		Watson Creek - Poor	
	Component Description	Component Impact	Component Description	Component Impact
Riparian Condition	Good	+	Poor	-
Channel Resistivity	High	++	Moderate	+
Riparian Woody Canopy	43%	+	27%	-
Riparian Quantity (miles/section)	1.4	++	0.5	+
Alternative Waters (no./section)	0.5	-	0	-
Range Condition	Good-Excel.	+	Good	+
Topography	Mountainous	-	Mountainous	-
Stocking Rate (% capacity)	70%	+	76%	+
Hot Season Dates	7/20 to 9/1	++	7/1 to 9/1	+
Hot Season Use (% of cycle)	33%	+	66%	-
Rest Treatments (% of cycle)	33%	+	0%	-
Salting and Riding Practices	Excellent	+	Fair	-
Class of Livestock	Cow-calf	-	Cow-calf	-
Drift or Move Stock Between Treatments	Move	+	Move	+
System Compliance	Excellent	+	Fair	-

watering even after herbaceous production is removed. The continued intensive use causes increased trampling damage to banks, soil compaction, utilization of woody species, fecal pollution of the water and a reduction in the amount of late summer herbaceous regrowth.

In steep topography, yearling cattle seem to disperse from stream bottoms much more than cow and calf pairs. Herded sheep offer an advantage to riparian management, since riparian areas can be avoided. Many sheepherders in the study area preferred more open ridges where sheep were more easily handled.

Salting close to riparian habitat is highly detrimental. Salting, frequent riding and alternative water developments should be used to disperse livestock from important riparian habitats. Where riparian habitat offers the only sources of shade and water, dispersal of livestock is very poor, and this alone could account for poor riparian management, despite the system used. Artificial shade structures close to alternative water developments should be evaluated as a dispersal technique.

Compliance with a grazing system is critical. When stock are moved from a pasture, a few animals are commonly overlooked. In two streams in group II, use by a few overlooked animals for most of the hot season period nullified positive riparian responses in otherwise excellent grazing systems.

Generally, livestock managers prefer not to move animals from one pasture to another, because lower weight gains result (Hormay 1970). In this analysis, riparian response seemed to be better in allotments where livestock were moved and the gates closed, compared to allotments where cattle were allowed to drift to the next pasture and two pastures were used simultaneously.

Conclusions

Livestock grazing and riparian management can be compatible on some streams if grazing systems are properly designed. No one system appears better than another. Frequency of heavy use treatments seems to be a key factor. The heavy use treatment in southwestern Montana is during the hot season, roughly July 10 to September 1. Use during this period in more than one year out of four generally results in impaired riparian condition. Varying degrees of light use (cool season) can be tolerated in combination with one heavy use treatment, depending upon many stream and range factors. Assessments of grazing systems must include documentation of the many factors which influence riparian response.

Livestock and riparian management may be incompatible on some streams due to exceptional or unique biological values, fragile channels, or rangeland phenology. The extended summer green season may be a key factor in the success of grazing systems in southwestern Montana. In areas with hot and dry summers, where green forage is largely limited to riparian areas, grazing may have to be more restricted. In wetter areas of the west, riparian grazing management is probably more successful with less intensive management.

Recommendations

1. Complete a scoping process of all management components before deciding to graze riparian habitats and before developing grazing systems.

2. If possible, identify riparian potential through the use of a riparian habitat classification system. This was not possible in this effort.

3. Establish protected study sections and transects in grazing areas for assessing riparian trend and recovery of key habitat components.

4. Evaluate a grazing system after one cycle. There should be signs of recovery, such as woody species reproduction, in as little as one to three years.

5. Consider rangeland phenology and livestock behavior in establishing systems for riparian habitats.

6. Recognize that a system designed to manage upland forage species may not be compatible with riparian species management.

7. Where riparian condition is very poor, consider several years rest before initiating grazing management.

8. Emphasize livestock dispersal techniques such as salting, alternative water sources, alternative shade sources, frequent riding, and centering streams within pastures. Do not use streams as fenced pasture boundaries.

9. Include as much stream within a pasture as possible. Small stream sections within large pastures cannot be effectively managed.

10. Move livestock between grazing treatments, rather than relying upon drift.

11. Use light to moderate stocking rates.

12. Emphasize strict system compliance.

13. Be flexible in making adjustments in grazing systems. Recognize that riparian management is a learning experience, not a science.

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FLOODWATER RETENTION VALUES OF PRAIRIE WETLANDS

Jon M. Malcolm 1/

Introduction

The primary interest of wildlifers in riparian and wetland areas is obviously in their wildlife habitat values. However, these areas possess other commonly recognized values including flood control, erosion control, pollution control, ground water recharge and alleviation of drought. The Government Accounting Office (1979) stated in a report to Congress that emphasis has been on the values of wetlands to waterfowl and other wildlife, while the other values of wetlands have been largely neglected.

Concerning the flood control values of wetlands, the same report (P. 25) said, "The contribution to flood control provided by wetland preservation may constitute a significant benefit, but to date this value has not been fully determined." However, there is increasing evidence that wetlands can play an important role in flood water retention. Horwitz (1978) discussed the flood control values of wetlands in general and singled out the Charles River Watershed in Massachusetts as a case in point. In that watershed, some 8,100 ha of undeveloped wetlands protected downstream areas from flood damages, and 3,442 ha of key wetlands were recommended for acquisition by the Corps of Engineers as a natural flood control measure. Cernohous (1979) cited nine references from the U.S. and Canada with data indicating that wetlands can have substantial flood control benefits. Malcolm (1979) reported on field studies to assess the impact of wetland drainage on flooding and water quality in the Souris River Basin in northcentral North Dakota. This slide illustrated paper reports on a portion of those studies.

Study Areas

Study areas were located in the lower North Dakota portion of the International Souris River Basin where artificial drainage of wetland basins for agricultural purposes has been extensive and widespread. The Souris-Red-Rainy River Basins Commission (1972) estimated that 65,803 ha of wetland basins had been drained in the 21,756 Km^2 North Dakota portion of the Souris Basin by 1967. Another 24,440 ha were projected for drainage by 1980.

Specific study areas included the Russell Diversion drainage project with a 58.3 Km^2 watershed area, and four smaller study blocks which included 12.6 - 15.9 Km^2 portions of tributary watersheds. The Russell Diversion watershed was 95 per cent non-contributing prior to the construction of a main drainage collector ditch approximately 13 Km long, which provided a surface outlet to the Deep River, a tributary to the Souris.

1/ Wildlife Biologist, U.S. Fish and Wildlife Service, Billings, MT.

Outlet ditches from approximately 280 ha of wetland basins on 18 separate quarter-sections led to the main collector ditch.

The small study blocks were located along natural drainages where portions of the watershed could be isolated. Two blocks without any drained basins or channel cleaning where selected as controls. The remaining two blocks were situated on areas where natural drainages were partially channelized and adjacent wetland basins were ditched into the main drainage.

In 1978, the year preceding these field studies, spring run-off in the vicinity was very light, with discharge of major tributaries running from 10 to 30 per cent of normal (Malcolm 1978). Hence, wetland basins received very little recharge and all, whether drained or undrained, were empty prior to the 1979 run-off.

Methods

Sites for measuring streamflow discharge on the study areas were selected and inspected almost daily as the commencement of run-off approached. Discharge measurements were made from the beginning to the end of spring run-off using equipment and techniques similar to those employed by the U.S. Geological Survey. Discharge hydrographs were prepared and total discharge volume was calculated for each site. Measurements were made daily at a site near the confluence of the Russell Diversion main ditch and the Deep River. Inflow and outflow discharge of natural drainages passing through the four smaller study blocks were made at an average frequency of once every 36 hours. Perimeters were checked to insure that all points of inflow and outflow to the blocks were measured.

In addition, aerial oblique slides were taken three times to provide photographic documentation of the run-off chronology. Land use and wetland basin acreages were also determined using the slides and SCS aerial photographs.

Results

Russell Diversion Drainage Project: As run-off commenced on April 20, snow melted first from the shallower drain ditches in the upper portion of the watershed. This allowed water from the drained basins to flow eastward into the lower portion of the watershed where the main collector ditch was approximately 3.7 m deep and still blocked with snow. This caused water to back-up, and an undetermined amount spread over fields to the north, spilling into an adjacent watershed. In addition, water spilled south across fields and collected in a depression just west of the discharge measurement site. A county road was nearly overtopped, forcing farmers to pump water over it into the main outlet ditch. Peak discharge of approximately 1.7 m^3/s (60 cfs) occurred at that time.

Water did not flow as designed through the main ditch until snow was removed with a backhoe. A second peak of 1.1 m^3/s (40 cfs) was recorded at the discharge site a few days later due to pumping activities in the watershed. Flows ceased by May 15, with a total volume of 1,266 dam^3 (1,026 acre-feet) flowing through the ditch during the run-off period. This water would have been retained in the natural basins of the watershed if their water retention capabilities had been left intact.

Small Study Blocks: Flows at measurement sites on the small study blocks were first noted on April 17 and continued through May 2. A summary of the results of streamflow measurements is presented in Table 1.

In the undrained control study blocks, natural basins in the watershed area and those situated along the natural drainage retained not only the run-off from within the study block watersheds, but also reduced streamflow volumes by 24 and 58 per cent, respectively. Corresponding reductions in peak discharges were 67 and 55 per cent. Conversely, total flow volumes were increased by 61 and 122 per cent, respectively, due to wetland drainage and channelizing on portions of the natural drainages in the drained study blocks. Peak discharges between points of inflow and outflow on the drained blocks increased by 278 and 62 per cent, respectively.

This occurred despite some land use differences which might have been expected to affect run-off volumes. For example, the proportion of a study block in summer fallow or clean fall-tilled condition was highest (74 per cent) in the Westhope Coulee Undrained Control Block. Shelterbelts are another factor that could result in increased run-off due to snowbanks. However, the Stone Creek Drained Block had the lowest area in shelterbelts of any block (0.3 per cent of total area), yet produced the greatest increase in streamflow of the areas studied. The data indicate that wetland drainage was the most important single land use factor affecting streamflow volumes in these study areas.

Discussion

The results of these studies clearly indicate that wetland drainage can have a substantial impact on streamflows and flooding problems. As illustrated, these impacts can be quite local and occur on a small scale. One landowner's solution to a problem can quickly create a problem for interests immediately downstream. However, it appears that the cumulative effects of widespread drainage can also have substantial impacts on a large watershed basis and add significantly to problems in larger river valleys. The degree of this impact depends on a number of factors, including watershed size, extent and density of drained and natural wetlands, and magnitude and speed of

Table 1. A comparison of inflow and outflow of streams passing through portions of watersheds with and without wetland drainage on four study blocks in Bottineau County, North Dakota during spring run-off in 1979.

Study Block	Total Area ha	Natural Wetlands ha	Drained Wetlands ha	Peak Discharge-m^3/s(cfs)		Total Volume - dam^3 (Acre-Feet)			
				Inflow	Outflow	Inflow	Outflow	Difference	%
Landa Coulee Undrained Control	1,315	87	--	0.44 (15.5)	0.15 (5.2)	168 (136)	127 (103)	-41(-33)	-24
Westhope Coulee Undrained Control	1,266	83	--	0.28 (10)	0.13 (4.5)	134 (109)	57 (46)	-77(-63)	-58
Westhope Coulee Drained Block	1,555	78	73	0.13 (4.5)	0.48 (17)	57 (46)	91 (74)	+34(+28)	+61
Stone Creek Drained Block	1,768	137	219	4.67 (165)	7.59 (268)	892 (773)	1,985 (1,609)	+1,093(+886)	+122

run-off. Additional data available for the Souris Basin run-off in 1979 indicates a serious impact due to wetland drainage.

Using the work of Crosby (1975) as a guide, it appears that floods on major North Dakota tributaries in the lower Souris Basin went up to the 25-year frequency range. According to the U.S. Geological Survey (1980), the Souris River discharge into Manitoba from January through June of 1979 was approximately 674,725 dam^3 (547,000 acre-feet). This also represents a flood of approximately 25-year frequency. Floods of this frequency occurred despite the fact that precipitation from October 1978 through May 1979 was only about 10 per cent above normal for the lower Souris Basin vicinity. A late and rapid snowmelt undoubtedly influenced the run-off volume, but wetland drainage was also a major factor.

According to records from U.S. Geological Survey gauging stations (U.S. Geological Survey 1980) and discharge measurements of the U.S. Fish and Wildlife Service on ungauged tributaries (Malcolm 1979), approximately 370,050 dam^3 (300,000 acre-feet) of run-off occurred in the North Dakota portion of the Souris Basin during 1979. Previously discussed data from the Souris-Red-Rainy River Basins Commission (1972) indicates that roughly 81,000 ha of wetland basins were probably drained in this area prior to 1979. Cernohous (1979) presented data indicating that wetland basins can store an average of 3 dam^3 per wetland ha (1 acre-foot per wetland acre). If this is true of the estimated 81,000 ha of drained wetlands, then approximately two-thirds of the 1979 flood run-off from the North Dakota portion of the Souris Basin can be attributed to wetland drainage.

Conclusion

Although the primary interest of wildlife people in wetlands naturally lies in the wildlife habitat values, support for wetland preservation is often difficult to obtain based on these values alone. Wildlifers have been remiss in over-emphasizing wildlife habitat values of wetlands, while neglecting the other values to local communities and society as a whole.

This and other studies have demonstrated that flood reduction values of wetlands can be very significant in areas where the number, size or density is of sufficient magnitude. This benefit of wetlands, along with other non-wildlife values should be given more emphasis in seeking support for preservation.

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BUREAU OF LAND MANAGEMENT WETLAND DEVELOPMENTS IN MONTANA

Ray Hoem 1/

The Bureau of Land Management (BLM) is responsible for the management of about 8 million surface acres and several million subsurface mineral reserve acres in Montana. Part of these public lands include approximately 30,000 acres of small wetlands on which many waterfowl are dependent.

Montana is divided into the Central and Pacific Flyways. The central flyway has waterfowl habitat commonly referred to as the prairie potholes. The BLM Lewistown District developed the Prairie Pothole Habitat Management Plan for the management of fishery and waterfowl habitat. The plan was developed under the Sikes Act with concurrence of the Montana Department of Fish, Wildlife and Parks. Project development has expanded during the past year and may continue for the next several years.

With the BLM providing money for "on-the-ground" project development, Montana's duck factories are getting some assistance in waterfowl habitat development.

The objectives of this Habitat Management Plan for waterfowl habitat development are:

1. To provide islands for geese on all suitable retention and pit-retention reservoirs.
2. To provide habitat for diving ducks such as scaup, canvasback and redhead as well as the dabbling ducks.
3. To provide residual cover around reservoirs by implementing grazing allotment management plans, fencing, planting, etc.
4. To maximize waterfowl production on desirable areas through the support of properly designed grazing systems.
5. To construct new reservoirs and islands for ducks and geese.
6. To improve the quality and increase the quantity of breeding, nesting and brood-rearing habitat for waterfowl.
7. To increase the "Hi-line" breeding goose population on public lands by 500 percent through expansion of goose nesting habitat by 500 percent and increasing nesting success by 60 percent.
8. To increase the duck production on public lands by 70 percent through expanding duck nesting habitat 60 percent and increasing nesting success by 50 percent.

1/ Wildlife Biologist, BLM, Billings, Montana.

Willet Reservoir was constructed for a cost of approximately $3,600 using about 7,000 cubic yards of material. The reservoir is approximately 5 acres in size. The islands will provide excellent nesting areas for ducks and geese, particularly after establishment of vegetation.

I should note here that this past year was an excellent year for construction of waterfowl habitat. Because of the drought, nearly all the areas normally flooded were dry or at a very low level allowing for machinery to construct dams, islands, etc. Normally, monies become available to construct wildlife habitat but because of unfavorable environmental conditions, equipment cannot work in the area.

An island was constructed in a bay of a lake which is normally flooded. Geese have nested along the shore of the lake and it is hoped the island, along with others, will provide more nesting areas. A large island cost about $450 to build compared to a small island which cost about $300. We found that a series of islands could be constructed for about $250 each. Dragline construction of islands was the most expensive means of island development because of the problem of mobility. The least expensive islands were built with a scraper when the sites were close together and/or there was other work nearby. Islands were riprapped in winter or during low water. The islands were seeded with a native grass mixture and some hardstem bulrush rootstock was transplanted during construction.

A 171-acre reservoir, named Dibbler reservoir, was constructed for a cost of about $18,500. It began to fill immediately following construction. Approximately $10,000 worth of islands were constructed within the reservoir site. In addition, a fence was built around the reservoir and water, below the reservoir, was provided for livestock. The fencing and watering device cost about $2,700. For a total cost of about $31,200, we had a multipurpose reservoir.

Not all the money was spent in the "Duck Factory" area. The potential waterfowl habitat in old meanders of a stream were developed in the Dillon area. The water table was just below the ground surface and with differing patterns of charges potholes were formed which were oblong or trenchlike, round or with islands in the center. The potholes were scattered along the old stream bed so they were not right on top of one another.

The potholes were made very cheaply using detonating cord, a blasting cap, one-half stick of dynamite and ammonium nitrate. Obviously, some care must be exercised when utilizing this method. Don Childress from the Montana Department of Fish, Wildlife and Parks was good enough to lend us his expertise and help bring about these projects.

Nesting platforms were installed in some of the areas during the winter in hopes some birds may use them. So far none have and some of the biologists believe this may be due to the fact that on this flat landscape, these platforms can be seen for miles. Perhaps the birds will get used to them over a two- or three-year period.

The objective of all this is, obviously, the creation of habitat which produces waterfowl. Waterfowl, as you all know, are produced for aesthetics and to satisfy the demand for sport hunting.

Not all of our money was spent on waterfowl development. Fence modifications were made to allow for safe passage of deer and antelope along BLM fences.

To build a waterfowl project requiring water, the BLM is required to obtain a water right. Planning for this can entail as much as [illegible] months of time and makes waterfowl reservoir projects a long-range planning project. We are finding that there appears to be more and more resistance to large waterfowl reservoir projects. Almost all water rights requests are challenged immediately if the request is for fish or wildlife. This puts a 90-day delay in the water right request, and if the water right is eventually granted, the project itself is protested. The reasons given vary from contributing to the saline seep problem, contributing to waterfowl depredation on grain crops and loss of livestock water. I believe the Bureau, and all of us that are contributing to fish and wildlife management, must convince the private landowners that these projects benefit him as well. There are, obviously, those who will never listen, but if we spend the little extra effort to visit with most landowners and managers, I believe we can convince them we are working with them, rather than against them.

The other point I would like to make is a very sore subject with many fish and wildlife professionals. However, it is becoming more and more evident that we must justify our expenditures of fish and wildlife funds. While I do not necessarily agree, let me give an example of one project in our Judith Resource Area.

We constructed approximately 100 islands for waterfowl nesting costing about $14,500 including estimated maintenance costs. During the first year there were 220 geese fledged which were directly attributable to those islands. This number may increase or decrease with the population of geese and the water conditions, but by using this number as an average we can actually show a substantial benefit for those dollars spent.

The 220 geese fledged times an estimated 20 percent of the geese harvested times an estimated 10 hunter days per goose times an estimated $12 per hunter day is equal to $5,280/year. These islands will have paid for themselves in three years. If the islands have a life of 20 years, there is an estimated benefit to the project of approximately $100,000. Now this is only a crude estimate not utilizing inflation factors, recognizing this is probably the lowest level of production we will see. There are obviously many problems in such an analysis but, based on signals we are getting from Congress and our governmental staffs, both federal and state, we may have to start looking at projects from this standpoint.

CONSIDERATION OF RIPARIAN HABITAT IN EVALUATION OF ENERGY-RELATED DEVELOPMENT

Gary Hammond 1/

One of the major questions facing resource managers today is: To what extent is a choice being forced between energy development and the maintenance of environmental quality?

The energy resources of the Rocky Mountain region will obviously assume a major role in this country's energy future. The region has approximately 43 percent of the recoverable reserves of this nation's coal; 95 percent of the uranium; 7 percent of the crude oil; 11 percent of the natural gas liquids and 8 percent of the natural gas. The region also contains billions of barrels of oil thought to be recoverable from oil shale deposits. At the same time, this region contains about 20 percent of the nation's cropland, 58 percent of the grazing land, 17 percent of the forest land, and an important water resource. Demands for use of agricultural and recreational resources may be in direct conflict with energy development.

The U.S. utility industry is facing a continuous growth in electrical power demand. During the past 30 years, loads have grown at an average rate of approximately 7 percent per year, doubling every 10 years. However, many experts believe the use of electrical energy cannot continue to increase indefinitely, and that growth in per capita consumption of electrical energy will decrease in succeeding decades.

A recent study by the National Academy of Engineering (1972) showed that Sweden used about 35 percent less energy per capita than the U.S., owing mainly to government policies concerning transportation and the heating of homes. Another study estimated that it would be possible to double the efficiency of energy consumption by the end of the century through the implementation of technological substitutions that are not only feasible, but also more cost-effective than increasing energy production.

The Committee on Energy and the Environment estimated the annual expenditure to conform to federal legislation relating to health and the environment to be $14 to $30 billion for 1975, or one to two percent of the gross national product. By 1984, these costs are projected to rise to $20 to $40 billion (still 1 to 2% of GNP).

The majority of this paper will center around the major regulations which might concern industry (MPC) in considering riparian habitat.

1/ Wildlife Biologist, Montana Power Company, Butte, Montana.

The Montana Major Facility Siting Act (MFSA)(DNRC 1979) states that power and energy conversion facilities may not be constructed or operated within this state without a certificate of environmental compatibility and public need. Facilities may include transportation links of any kind, aqueducts, diversion dams, reservoirs, transmission lines (a minimum of 69-kV and 10 miles in length) and any other device or equipment associated with the production or delivery of energy.

The act exempts, however, any aspect of a facility over which a federal agency has exclusive jurisdiction (BPA, WAPR, for example). Montana Power Company contends that since licenses of new dams must be obtained through the Federal Energy Regulatory Commission, and, as such, does not require licensing under Montana's MFSA. This issue will apparently be resolved through litigation.

A MFSA application is through the Energy Division of the DNRC. Initially, MPC posts a filing fee with the DNRC. The applicant, MPC in this case, then conducts the environmental assessment work, which includes baseline inventory data, impact analysis and recommends mitigative measures.

Consultation with federal, state and local agencies must be included in the report. MPC's final environmental report is presented to the DNRC, which then writes an Environmental Impact Statement (EIS) based largely on this information, depending on its quality and completeness. MPC's filing fee is used for the preparation of the EIS. An example where riparian habitat will be given the utmost attention is the siting of a 115-kV transmission line from Great Falls to Conrad. In this largely treeless area, the riparian type assumes an especially important role, as it is unique to very localized areas only, and disruption of even a small area would be critical.

Concerning Federal Regulations, under Federal Energy Regulatory Commission guidelines for relicensing or otherwise amending an existing hydro license, an Exhibit 'E' is required. In an Exhibit 'E' projected impacts and mitigative measures pertaining to water quality, fish, wildlife and botanical resources must be addressed. A description of any measures or facilities recommended by agencies consulted for the mitigation of impacts on fish, wildlife and botanical resources, or for the protection or improvement of those resources must be included. An explanation of why the applicant has rejected any measures or facilities recommended by an agency must be included.

All applications of major projects (those in excess of 2000 hp) must contain an environmental report which complies with the National Environmental Policy Act of 1969 under Part 1 of the Federal Power Act. This report is called an Exhibit 'W'.

Important references included in an Exhibit 'W' that might apply to riparian habitat include the following: 1) Consultation with appropriate Federal, State, and Local agencies during the preliminary planning stages of the proposed action to assure that all environmental factors are identified; 2) Describe the existing environment, including important plant and wildlife communities and associations that might be affected by construction, operation and maintenance of the proposed facility; 3) Take measures to enhance the environment or to avoid or mitigate adverse environmental effects; and 4) Discuss all significant environmental effects which cannot be avoided by measures previously outlined.

An example where NEPA requirements would be indirectly met could be the case of Western Energy, which is a subsidiary of MPC, applying for coal leases on federal lands. In this case, application would be through the Federal Office of Surface Mining (OSM). The OSM would be required to meet NEPA requirements, with input from Western Energy.

Another federal regulation, which may have an influence on riparian vegetation, is the Corps of Engineer's Section 404 permit which falls under the Federal Water Pollution Control Act (Amendments of 1972). This permit regulates the discharge of dredged or fill material into navigable waters. The regulation applies to freshwater wetlands (freshwater wetlands includes those areas that are periodically inundated and that are normally characterized by the prevalence of vegetation that requires saturated soil conditions for growth and reproduction). The degradation or destruction of aquatic resources by filling operations in wetlands is considered the most severe environmental impact covered by the guideline. The activities covered by this regulation shall be accomplished in a manner so as to minimize any adverse impact on fish, wildlife, and natural environmental values and to minimize any degradation of water quality.

Finally, Department of the Interior guidelines for the preparation of Environmental Reports for Fossil-Fueled Steam Electric Generating Stations suggests input similar to the NEPA regulations which, again, makes reference to animal and plant communities and associations which may be affected by an energy-producing facility.

In summary, the environmental awareness of industry has been heightened by the regulations largely initiated by local, state and federal regulatory agencies. That is, initially, industry did primarily what it was required to do by law. However, I think that in some cases industry has realized that it is good business (i.e., good public relations) to act in a positive manner in dealing with environmental issues.

However, I think that the realism still exists that it is largely up to regulatory agencies to provide guidelines for industry to follow, as well as to provide information on ways to minimize impacts, and recommend mitigative measures in cases where it is deemed necessary to build energy development facilities.

To end this talk on a positive note, I would like to read several statements from Duke Power's annual report: "For an electric utility to succeed in the 1980s, it must assume a greater control over its own destiny. It must influence events which affect it rather than simply react to them. It must have the good judgment to recognize opportunities, and the courage to force its challenges head on."

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THE HARDWOOD DRAWS OF SOUTHEASTERN MONTANA: THEIR IMPORTANCE TO WILDLIFE AND VULNERABILITY TO MAN'S ACTIVITIES

Jon E. Swenson 1/

Introduction

Hardwood draws occur in association with live springs, creeks and mesic coulees on the prairies in southeastern Montana. Because such sites are very limited in this semiarid region, the occurrence of well-developed hardwood riparian habitats on the uplands is also very limited. In this paper, I define hardwood draws as upland riparian sites containing boxelder (*Acer negundo*) and/or green ash (*Fraxinus pennsylvanicus*) as characteristic species. Plains cottonwoods (*Populus deltoides*) and American elm (*Ulmus americana*) occur in some draws and may codominate. Vegetational development and species composition varies with the size and hydrology of the draws, but the following shrubs are often present: buffaloberry (*Shepherdia argentea*), wild plum (*Prunus americana*), chokecherry (*Prunus virginiana*), hawthorn (*Crataegus* sp), roses (*Rosa* spp), western snowberry (*Symphoricarpos occidentalis*), red osier dogwood (*Cornus stolonifera*), western serviceberry (*Amelanchier alnifolia*), wild grape (*Vitis vulpina*) and currants and gooseberries (*Ribes* spp). Aspen (*Populus tremuloides*) and river birch (*Betula fontinalis*) are present in some very mesic draws. These draws are very productive, due to their mesic nature, and provide wildlife with a well-developed vegetational structure for cover, a high edge-to-area ratio, and succulent foliage, fruits, buds and prey animals for food.

The occurrence and extent of hardwood draws is poorly documented in southeastern Montana. The results of vegetation mapping on 16 areas revealed that this type occupied from 0 to 5.5% of the areas, and averaged 1.2% (Fig. 1, Table 1). Boldt et al. (1979) estimated that these riparian stringer woodlands probably occupy less than 1% of the upland area on the northern high plains.

Here I present data on the importance of the hardwood draw habitat type to wildlife, based primarily on a one-year study I conducted in eastern Dawson County (Swenson 1978). I also discuss the vulnerability of this habitat type to man's activities.

Study Area and Methods

The primary study area included 207 km^2 adjacent to, and south of, the Yellowstone River about 24 km northeast of Glendive, Dawson County, Montana (No. 13 in Fig. 1). The climate was continental and semiarid. Topographic features were the result of erosion of the sedimentary plains; elevation varied from 600 to 760 m. The uplands were flat to rolling.

1/ Montana Department of Fish, Wildlife and Parks, Box 36, Rosebud, Montana 59347.

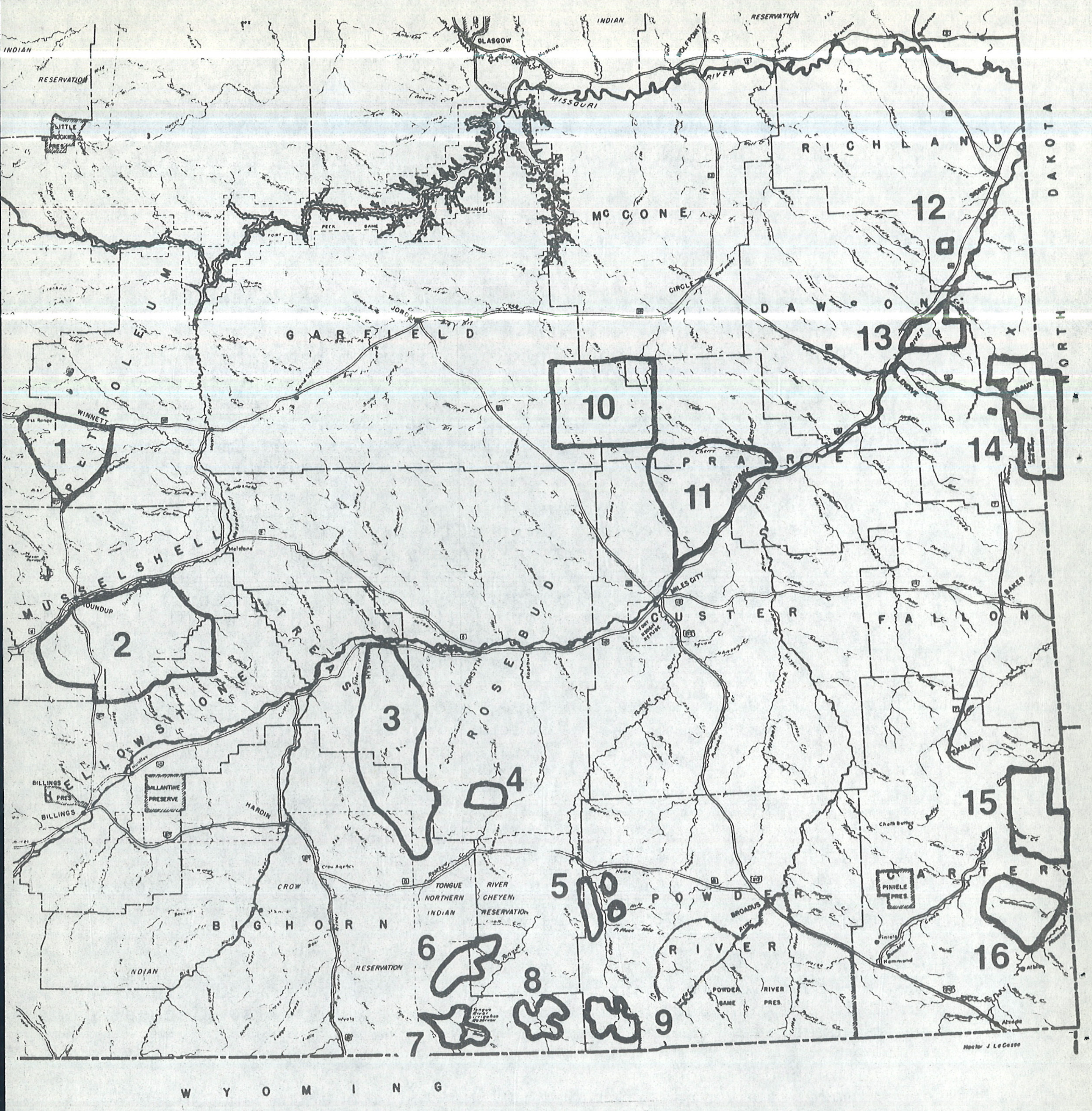

Figure 1. Map of southeastern Montana showing the 16 study areas reporting vegetative composition. Numbers correspond to those in Table 1.

Table 1. Proportion of study areas in southeastern Montana occupied by hardwood draw habitats.

Number [a]	Size of Area (km^2)	Percent in Hardwood Draw	County	Source
1	690	3.7[b]	Petroleum and Fergus	Jorgensen (1979)
2	1792	0	Musselshell and Yellowstone	Dusek (1978)
3	1202	2.5	Big Horn and Treasure	Martin (1980a)
4	78	<0.05	Rosebud	ECON (1978)
5	217	0.3[b]	Powder River	Knapp (1977)
6	240	1.0	Big Horn and Rosebud	Knapp (1977)
7	179	1.9	Big Horn	Knapp (1977)
8	252	0	Big Horn	Knapp (1977)
9	217	0	Powder River	Knapp (1977)
10	1036	0	Garfield and Prairie	Wentland (1971)
11	650	0	Prairie and Custer	Dood (1980)
12	10	0	Richland	Morman (1979)
13	207	5.5	Dawson	Swenson (1978)
14	502	2.0	Wibaux and North Dakota	Matthews (1979)
15	495	3.0	Carter	Dusek (1980)
16	387	0	Carter	Campbell (1970)
	8180	1.2		

a Corresponds to numbers on map (Figure 1)
b Somewhat overestimated, due to inclusion of other deciduous types.

Ten major habitats were delineated on the study area. Riparian woodland (6.7% of the study area) was found on the islands and floodplain of the Yellowstone River and was characterized by plains cottonwood, American elm, green ash and an abundance of understory shrubs. Hardwood draws, as described above, occupied 5.5% of the study area. Juniper breaks (3.1%), corresponding to Brown's (1971) Juniperus-Agropyron community, were typically found in deeply eroded draws. Upland grassland (42.7%) representative of the western wheatgrass-grama-sedge type described by Hanson and Whitman (1938) occurred on flat and rolling topography. Silver sagebrush (Artemisia cana) grasslands (16.4%), corresponding to the sagebrush type described by Hanson and Whitman (1938), occurred on bottomlands and many small upland swales. The sparsely vegetated badlands (11.9%) were characterized by an Atriplex-Artemisia community (Brown 1971). A dense Wood's rose (Rosa woodsii) - western snowberry community (0.7%), with no overstory, occurred on the riverbottom. Upland cropland (7.4%) consisted of dryland cereal crops. Bottom cropland (4.2%), on the low benches and riverbottom, was dominated by dryland and irrigated cereal crops. Hayfields (1.4%) included alfalfa (Medicago sativa) and introduced grasses along the river bottom. A more detailed description of habitats is found in Swenson (1978).

Wildlife use of habitat types was observed using semimonthly aerial surveys following systematic routes and ground surveys, by vehicle and foot. The study was conducted from December 1976 through November 1977. The data were divided into four seasons: winter (1 December - 28 February), spring (1 March - 31 May), summer (1 June - 31 August) and fall (1 September - 30 November).

Birds were also surveyed in the various habitat types during June using standard three-minute counts, a modification of the Breeding Bird Survey technique (Robbins and Van Velzen 1967), i.e. counts were made in as uniform an area as possible and only birds seen and/or heard in the habitat type being censused were counted. These counts were used to determine species composition and relative abundance of birds in the different habitat types. Two indices of avian community structure were calculated from these data, a diversity index (Shannon and Weaver 1963) and a community dominance index (McNaughton 1967). These indices were considered to be gross indications of avian community structure.

A total of 4,200 trapnights of small mammal trapping effort was accomplished. Traplines consisted of 20 stations with two traps per station, spaced at 15 m intervals, and were trapped for three consecutive nights. Peanut butter was used as bait during winter; rolled oats were added to the bait prior to summer trapping.

Whether a habitat type was selected for by a species was determined statistically using a chi-square (X^2) test and the formula

$X^2 = 4d^2/n$ (Snedecor and Cochran 1967) where d= the absolute value of the deviation between the number observed and number expected and n= the total number of observations.

The Importance of Hardwood Draws to Wildlife

Mule Deer: Hardwood draws were selected by mule deer (*Odocoileus hemionus*) during three seasons; spring, summer and fall (Table 2). The selection of this type was probably related to the longer period of forb succulence in this mesic type. Heavy use of riparian areas by mule deer in response to forb desiccation has been noted in many areas of eastern Montana (Allen 1968, Dusek 1980, Martin 1980a). The selection of hardwood draws in the spring may be important for fawn survival, since Dood (1978) found lower rates of predation on mule deer fawns in timbered than in open habitat types. The use of hardwood draws in fall may not only be due to the presence of succulent forbs, but also because it is important escape cover during the hunting season (Swenson in prep.). On the Intake study area, use of hardwood draws increased 39%, from 18% before the season to 25% during the hunting season (Table 3). After the hunting season, use returned to 18%. The use of juniper breaks increased more dramatically, but this xeric type is less important for food in fall. Prairie mule deer are relatively more vulnerable to hunting than mule deer in other areas because of the limited amount of cover (Swenson in prep.).

Table 2. Seasonal habitat use by mule deer on the Intake Study Area.

Habitat Type	Winter (405)[a]	Spring (446)	Summer (153)	Fall (384)
Upland grassland	70[b] (S)[c]	60 (S)	56 (S)	41
HARDWOOD DRAWS	8	14 (S)	15 (S)	21 (S)
Juniper breaks	10 (S)	9 (S)	3	17 (S)
Sagebrush grassland	8	5	18	12
Badlands	tr	4	5	3
Upland cropland	2	7	3	4
Riparian woodland		tr	1	1
Bottom cropland				1
Rose-snowberry				tr

[a] Sample size

[b] Percent

[c] Use greater than expected ($p < 0.05$).

Table 3. Use of habitat types by mule deer on the Intake Study area in relation to the hunting season as determined from nine semimonthly aerial surveys (from Swenson, in prep.).

Habitat Type	Preseason (101)[a]	Hunting Season (109)	Postseason (102)
HARDWOOD DRAWS	18[b]	25	18
Juniper breaks	9	30	0
Riparian woodland	4	0	0
Subtotal-timbered	31	55	18
Upland grassland	42	34	79
Silver sagebrush grassland	23	8	3
Badlands	5	3	0
Subtotal-treeless	69	45	82

[a] Sample size

[b] Percent

The hardwood draw habitat was deemed critical to mule deer on the Intake area because of its value in providing succulent foliage during the growing season and escape cover from predators and hunters. Severson and Carter (1978) and Martin (1980a) also considered upland riparian types to be the most critical habitat for mule deer on their study areas in South Dakota and Sarpy Creek, Montana, respectively. This is reinforced by the recent indications that prairie mule deer are cover-limited, rather than food limited (Picton and Mackie in press).

White-tailed Deer: White-tailed deer (*Odocoileus virginianus*) use of hardwood draws was low, from 1 to 4% per season. Some whitetails inhabited larger hardwood draws year around, but most use was in fall and winter, when the deer used the draws as travel lanes from the riparian woodlands to the upland winter wheat fields. However, the presence of the very dense population of whitetails on the Yellowstone River bottom (17/km^2 or 44/mi^2 in summer 1977) (Swenson 1979) may have masked the importance of the hardwood draw types.

In upland areas of southeastern Montana, prime whitetail habitat appears to be areas of interspersion between cultivated fields and upland riparian habitats (Thompson 1978, Munson 1977) or more mesic ponderosa pine forests (Dusek 1980). During the winters of 1976-77, 1977-78 and 1978-79, intensive aerial deer surveys were conducted over 75,783 km^2 of southeastern Montana (Swenson 1980a). Wintering areas were identified that included 11,457 whitetails, or 85.3% of the 13,430 which were counted. These wintering areas occupied only 5.6% of the area surveyed. The results (Table 4) show that creek and hardwood draw riparian types wintered about as many whitetails in southeastern Montana as did river riparian areas. In both types the deer preferred areas near agricultural cover types. The deer occurred at a greater density on the riverbottom types, but these results emphasize the great importance of upland areas to white-tailed deer in southeastern Montana, where creek and draw riparian areas are clearly the most important wintering areas (Table 4).

Sharp-tailed Grouse: Sharp-tailed grouse (*Pedioecetes phasianellus*) use a mixture of grasslands and brushy, deciduous cover (Brown 1971). Sharptails on the Intake area used hardwood draws year around, but only showed a statistically significant selection for them in fall and winter (Table 5). The selection in fall may have been due to the relative abundance of succulent forbs there. Croplands and hardwood draws were very important during winter (Table 5). Since the grain in croplands quickly becomes unavailable during periods of snow cover, I analyzed semimonthly habitat use by sharptails from 1 December through February in relation to snow cover. The results indicated that sharptails appeared to prefer to feed in grainfields but they moved to hardwood draws when forced by snow to leave the fields (Figure 2). Therefore, hardwood draws constituted critical winter habitat. A late frost in spring 1976, caused a berry failure that year, so the use of grain may have been abnormally high during my study (Evans 1968). Thompson (1978) noted that in McCone County, trees and tall shrubs were more important for sharptails during a severe winter than a mild one, which supports my results.

If hardwood draws are as critical as this study indicates, it would be reasonable to expect to find a relationship between the abundance of hardwood draws and the density of sharptails. The results of 5 studies in southeastern Montana (Table 6) showed a marginally significant positive correlation ($0.10 < p < 0.05$, $r = 0.833$) between percentage of the area occupied by hardwood draws and density of lekking males. The amount of hardwood draw habitat explained 69% (r^2) of the variation in grouse densities, even though many other factors were variable, such as years of study, length of study, grazing rates, amount of cultivated land and numbers of nonlekking males. Presence and abundance of hardwood draws appears to be a very significant component of sharp-tailed grouse habitat in southeastern Montana.

Ring-necked Pheasant: The 2 major types of ring-necked pheasant (*Phasianus colchicus*) habitat in southeastern Montana are dryland grain fields interspersed with hardwood draws, and irrigated farmland, which is primarily along the major rivers (Weigand

Table 4. Distribution of white-tailed deer on identified wintering areas by major habitat type in southeastern Montana (from Swenson 1980a).

Major Habitat Types	All Whitetails (11,457)[a]	Upland Whitetails (6,679)
River riparian	41.7[b]	
Creek/draw riparian	41.7	71.5
Mesic ponderosa pine	14.3	24.5
Grasslands	2.3	4.0

a Sample size

b Percent

Table 5. Seasonal habitat use by sharp-tailed grouse on the Intake Study area.

Habitat Type	Winter (1220)[a]	Spring[b] (942)	Summer (278)	Fall (419)
Upland grassland	28[c]	54 (S)	63 (S)	55 (S)
Upland cropland	36 (S)[d]	37 (S)	27 (S)	16 (S)
HARDWOOD DRAWS	15 (S)	4	2	12 (S)
Bottom cropland	15 (S)			4
Juniper breaks	2	1		1
Silver sagebrush grassland	2	4	8	12
Riparian woodland	3			

a Sample size

b Excluding observations of lekking males

c Percent

d Use greater than expected ($p<0.05$).

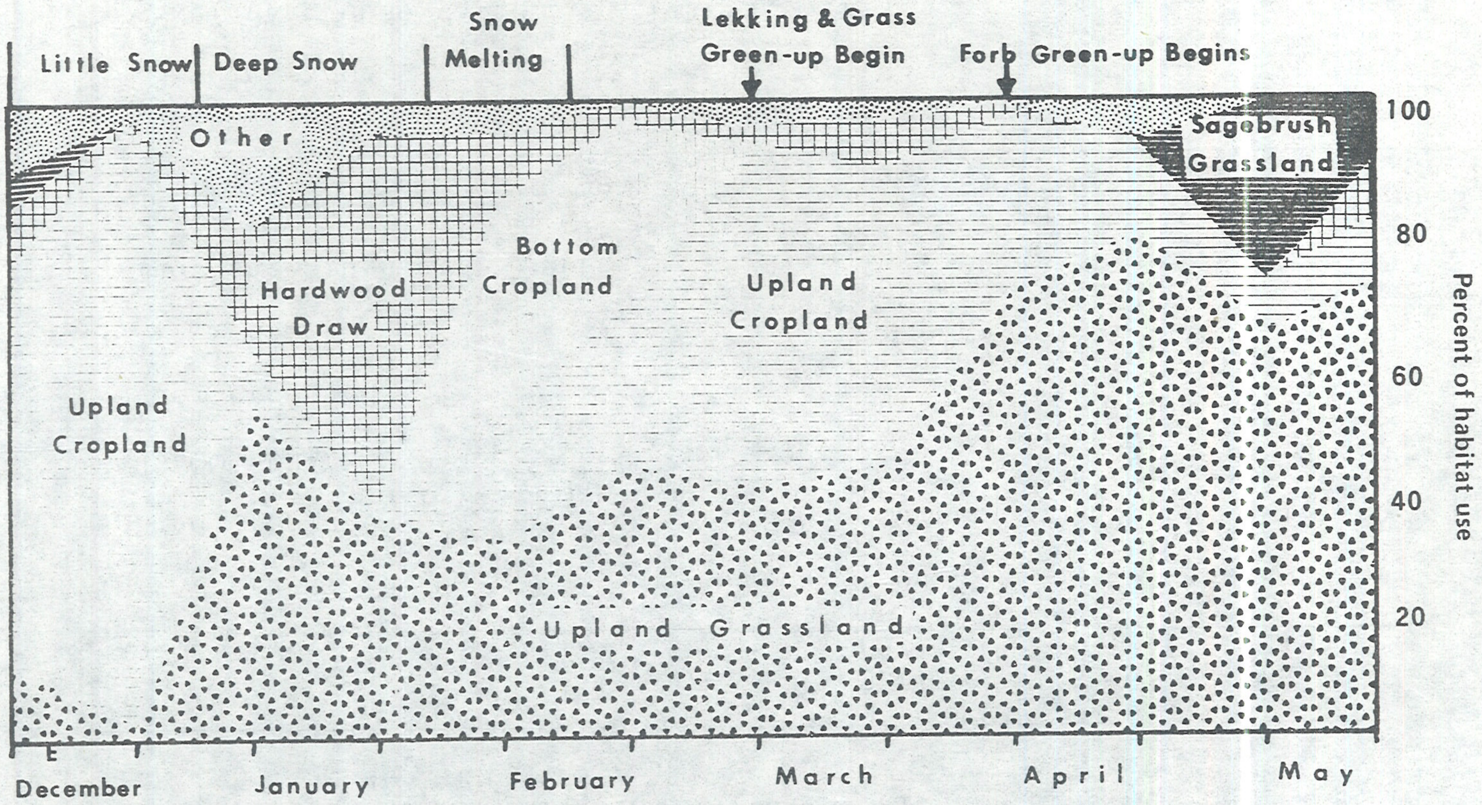

Figure 2. Habitat use by sharp-tailed grouse on the Intake Study Area during semi-monthly periods in winter and spring.

Table 6. The relationship between sharp-tailed grouse density and occurrence of hardwood draws on five study areas in southeastern Montana.

Study Area	Density of Lekking Males	Occurrence of Hardwood Draws	Source
Intake	1.01[a]	5.5%	Swenson (1978)
Wibaux-Beach	0.57	2.0%	Munson (1979)
Peabody	0.36[b]	0.04%	ECON (1978)
Sarpy Creek	0.28[c]	2.5%	Martin (1980a)
Savage	0	0	Morman (1979)

a In males per km^2.

b Mean of 5 years.

c Mean of 4 years.

and Janson 1976). The Intake Study Area consisted primarily of the latter type and riverbottom types, such as bottom cropland, hayfields, riparian woodland and rose-snowberry were most important to pheasants (Table 7). Hardwood draws were used at, or greater than, the proportion of their occurrence during every season, but were selected only in fall. The use of cover types was greater than reported here due to observability biases.

The results of nine standard Department of Fish, Wildlife and Parks pheasant crowing routes (Gates 1966) censused in southeastern Montana from 1974 to 1980 were compared for routes along creekbottoms and along riverbottoms (Knapp and Swenson 1980). The average of 29 riverbottom routes was 14.6 crows/stop, the average for 28 creekbottom routes was 19.1 crows/stop. Similarly, I recorded 16.2 crows/stop along the Yellowstone River near Intake (Swenson 1978) and Munson (1979) counted 19.9 crows/stop along Beaver Creek near Wibaux. Combining all of these routes, the average is 14.6 for riverbottom routes and 19.1 for creekbottom routes, a statistically significant difference ($p < 0.05$, 2-tailed t test). The riverbottom routes probably represent the average condition along the Yellowstone, Tongue and Powder Rivers. The creekbottom routes were along creeks with better pheasant habitat--Sarpy, Rosebud, Otter and Beaver Creeks. Still, it is interesting that the better hardwood draw areas support higher spring pheasant densities than our average riverbottom areas in southeastern Montana.

Coyote: Hardwood draws received the greatest use by coyotes (*Canis latrans*) in fall (Table 8). Martin (1980a) also found that coyotes used the creek riparian types most during fall on Sarpy Creek. This may be related to the movement of many other wildlife species to the mesic hardwood draws during fall and the presence of fruits, which are heavily used by coyotes in late summer and fall where they are available (Schladweiler 1980).

Nongame Birds: A total of 141 species of birds was observed on or immediately adjacent to the Intake Study Area during the study. Of these, 30 were aquatic birds, primarily migrants. I evaluated the habitat requirements and use of the 111 species of upland birds to determine if their populations would be adversely affected if the hardwood draw habitat type were eliminated. The number of species adversely affected would be: 49 of 80 species (61%) which breed on the area, 14 of 27 species (52%) which winter on the area, and 12 of 18 species (67%) which migrate through the area, for a total of 59% of the 111 species observed using the area. This is a significant number of species that would be negatively impacted if a habitat type covering 5.5% of the study area were removed. The hardwood draw habitat appears to be most important to migrating birds, in terms of number of species, and least important to wintering birds. This decreased importance to wintering birds was a reflection of the open habitat used by many winter migrants. Of the resident

Table 7. Seasonal habitat use by ring-necked pheasants on the Intake Study area.

Habitat Type	Winter (1246)[a]	Spring (170)	Summer (44)	Fall (168)
Bottom cropland	84[b] (S)[c]	23 (S)	5	12 (S)
HARDWOOD DRAWS	6	11	14	23 (S)
Riparian woodland	1	13	9	26 (S)
Hayfields	3	3	30 (S)	4
Rose-snowberry	tr	3	2	11 (S)
Silver sagebrush grassland	3	32 (S)	32 (S)	23
Upland grassland	1	5	9	
Upland cropland	2	5		tr
Juniper breaks				tr

[a] Sample size

[b] Percent

[c] Use greater than expected ($p < 0.05$).

Table 8. Seasonal habitat use by coyotes on the Intake Study area.

Habitat Type	Winter (38)[a]	Spring (33)	Summer (24)	Fall (54)
Upland grassland	21[b]	61 (S)	54	49
Riparian woodland	39 (S)[c]	15	29 (S)	16
Hayfields	11		4	
Rose-snowberry	8		4	
HARDWOOD DRAWS	3		4	18
Silver sagebrush grassland	13	15	4	
Juniper breaks				4
Upland cropland	3	6		2
Bottom cropland		3		
Badlands	3			4

a Sample size

b Percent

c Use greater than expected ($p < 0.05$)

species, 10 of 14 (71%) would be negatively impacted by the loss of hardwood draws. Some of these species, such as black-capped chickadees (Parus atricapillus), white-breasted nuthatches (Sitta carolinensis), woodpeckers and pheasants use the draws year around, and others, such as sharp-tailed grouse and black-billed magpies (Pica pica) (Swenson 1980b), use them seasonally.

The breeding bird communities were studied in each habitat type (Table 9). The hardwood draw type had the second highest number of species per stop and number of total species, had the lowest community dominance index and shared the highest diversity index with riparian woodland (Table 9). The high species and diversity values were due to the positive relationship between foliage height diversity and bird species diversity (MacArthur and MacArthur 1961, Willson 1974). The low community dominance index indicates that the community was not dominated by a few very numerous species. The most common species were: yellow warbler (Dendroica petechia) (1.1/stop), rufous-sided towee (Pipilo erythrophtalmus) (1.1), mourning dove (Zenaidura macroura) (1.1), field sparrow (Spizella pusilla) (0.9), American goldfinch (Spinus tristis) (0.9), house wren (Troglodytes aedon) (0.8) and American robin (Turdus migratorius) (0.8).

The great importance of riparian areas to breeding and migrating birds in the semiarid West is well documented (Stevens et al. 1977, Hehnke and Stone 1978) and many species have a low tolerance for habitat alterations (Stauffer and Best 1980). On the Intake Study area the riparian woodland and the hardwood draws ranked first and second in number of bird species.

Other Mammals: The hardwood draw type appeared to be important for several medium-sized mammals, such as desert cottontail (Sylvilagus audubonii), porcupine (Erethizon dorsatum), eastern fox squirrel (Sciurus niger), bobcat (Lynx rufus), raccoon (Procyon lotor) and striped skunk (Mephitis mephitis). However, snap trapping revealed the lowest mammal density in this type, and only deer mice (Peromyscus maniculatus) were captured there (Table 10). Thus, in sharp contrast to most other wildlife species, hardwood draws appeared to be relatively unimportant to small rodents on the Intake area during the study period. In McCone County, Thompson (1978) also trapped only deer mice in the boxelder-ash hardwood draw type, although in higher numbers than here. However, Martin (1980b) found the highest small mammal density in this type on Otter Creek and Matthews (1979) found the second highest density in this type on Beaver Creek. Geier and Best (1980) determined that thinning or removing deciduous trees from riparian areas in Iowa would increase the populations of 4 small mammal species, not affect 3 species and reduce the populations of only 2 species.

Table 9. Bird community parameters from the breeding bird survey on the Intake Study area.

Habitat Type	No. of Counts	Mean Species/Stop	Mean Birds/Stop	Total No. Species	Diversity Index[a]	Community Dominance Index[b]
Riparian woodland	11	11.8	18.5	35	4.51	0.23
HARDWOOD DRAWS	18	8.9	13.1	31	4.53	0.16
Silver sagebrush grassland	12	6.2	13.4	23	3.38	0.47
Upland grassland	30	5.8	13.8	26	3.19	0.58
Hayfields	9	5.7	12.2	17	3.03	0.53
Upland cropland	18	5.5	21.6	18	2.51	0.70
Bottom cropland	7	5.0	15.1	12	2.34	0.72
Juniper breaks	16	4.5	7.2	19	3.41	0.40
Rose-snowberry	5	3.4	5.6	5	2.17	0.57
Badlands	13	2.4	3.0	11	2.99	0.44

a Shannon and Weaver (1963).

b McNaughton (1967).

Table 10. Comparison of small mammal densities by habitat type as determined by snap-trapping on the Intake Study area.

Habitat Type	Sample Size[a]	All Mammals	Peromyscus spp[b]	Prairie Vole	Western Harvest Mouse	House Mouse	13-lined Ground Squirrel	Olive-Backed Pocket Mouse	Common Shrew
Rose-snowberry	240	8.8[c]	5.4	2.1	–	–	–	–	1.3
Upland cropland:									
edge	360	6.7	0.8	1.0	3.0	–	–	0.6	–
infield	240	1.2	–	–	0.4	–	–	0.8	–
Bottom cropland[d]	240	6.6	2.5	1.2	1.7	0.4	–	0.8	–
Badlands	360	6.4	6.4	–	–	–	–	–	–
Silver sagebrush grassland	480	4.2	3.6	–	0.4	0.2[e]	–	–	–
Juniper breaks	360	2.5	2.5	–	–	–	–	–	–
Upland grassland	720	2.1	2.1	–	–	–	–	–	–
Riparian woodland	360	1.7	1.4	–	–	0.3	–	–	–
Hayfields	360	1.7	0.8	–	0.6	–	0.3	–	–
HARDWOOD DRAWS	480	1.6	1.6	–	–	–	–	–	–

a Trapnights
b Includes *Peromyscus maniculatus* and *P. leucopus*; the latter was only identified from the river valley floor, but not all specimens were identified to species.
c Mammals caught per 100 trapnights
d Edge
e Taken near a haystack

The Vulnerability of Hardwood Draws to Man's Activities

Ranching: Overgrazing has a severe impact on riparian vegetation because livestock concentrate in these areas for shade, water and succulent vegetation and because the resulting overgrazing eliminates the understory herbaceous layer and stand reproduction (Behnke and Raleigh 1978, Tubbs 1980). Removing the vegetative canopy subjects the draw to water erosion, which produces a gully. The water table drops and the water-dependent riparian vegetation is replaced with more xeric species. In southwestern North Dakota, Boldt et al. (1979) reported that many hardwood draws have already disappeared and many more are in a serious state of decline with a decadent tree overstory and no reproduction. Some draws, however, contained healthy, reproducing trees and shrubs. They reported that cattle emerged as the most conspicuous factor in the deterioration of hardwood draw vegetation. Gjersing (this symp.) also thought grazing by cattle was preventing reproduction of many trees and shrubs in northeastern Montana. Due to the widespread importance of ranching in southeastern Montana, overgrazing is probably the greatest threat to the hardwood draw habitat there.

Some livestock interests maintain that grazing by the original herds of bison (*Bison bison*) degraded the western ranges (Behnke and Raleigh 1978). However, historical accounts indicate that well-developed hardwood draws were present in southeastern Montana when white men arrived. In 1832-34, Alexander Philip Maximilian noted little thickets of oak, ash, negundo maple (boxelder), birdberry (buffaloberry ?) and other woody plants in the ravines near the confluence of the Yellowstone and Missouri rivers (Brown 1961). During an expedition in the lower Yellowstone Valley in 1873, Allen (1874) reported that cottonwood and boxelder were the two most common trees along the streams. He also considered chokecherry, buffaloberry and snowberry to be common and hawthorn, serviceberry, currants and gooseberries to be less common along the streams. Visher (1914) studied the vegetation in northwestern South Dakota in 1910-12. He found hardwood draws with overstories of cottonwood, boxelder, ash, hackberry (*Celtis* sp.) and elm and understory shrubs consisting of plum, chokecherry, buffaloberry, dogwood, snowberry, hawthorn, serviceberry, blackhaw (*Viburnum* sp.), gooseberries and currants. These descriptions fit the well-developed hardwood draws found today in southeastern Montana.

The bison clearly overgrazed areas, but they were migratory and reports indicate that areas were allowed to recover, sometimes for a few years, before the area was again overgrazed (Larson 1940). Also, periods of wet climatic conditions promote the growth and range expansion of woody plants and restrict range fires, which hinder shrub and tree growth (Vogl 1974). Perhaps the natural rest-rotation grazing and the 20% greater annual precipitation present in the mid-1800s (Wahl and Larson 1970) allowed the woody vegetation in the hardwood draws to maintain itself. It seems incriminating for cattle that Boldt et al. (1979) noted that most trees in decadent hardwood draws were 60 to 70 years old, indicating that they had established themselves around 1905-1915, because the cattle boom, which began in eastern Montana in the 1880s (Malone and Roeder 1976), reached the pre-World War II peak in numbers statewide around 1918-1919 (Herbert et al. 1978). Presently, there are twice as many cattle in Montana as in 1918-1919 (Herbert et al. 1978).

Farming: Saline seep areas, which are characterized as boggy sites and water with high concentrations of dissolved solids, are caused by inadequate utilization of water in fallowed dryland farmed areas. These areas are expanding at a rate exceeding 10% per year in Montana and pose a serious threat to the water quality in the state (Montana Bur. Mines & Geol. and U.S. Geol. Surv. 1978) and to the associated riparian vegetation.

Water Use: In most of southeastern Montana, the Tongue River Member contains several important coal seams and sandstone beds and lenses that form the shallowest aquifers. The discharge of these shallow aquifers occurs as springs and seeps which produce hardwood draws. Unfortunately, these shallow aquifers are the most heavily utilized source of groundwater, and overuse can depress water levels. For example, oil field flooding to increase oil production caused the water level to be depressed over 100 feet in 7 years, the maximum was 133 feet, along Cabin Creek in southeastern Montana (MBMG & USGS 1978). Industrial withdrawals have since decreased in that area and the water level has increased somewhat. The potential for serious impacts on hardwood draw vegetation is evident when the water table is so susceptible to rapid depletion and increased demands are being placed on our ground water for domestic, agricultural and industrial uses, especially since our native deciduous trees are very susceptible to drought (Ellison and Woolfolk 1939, Albertson and Weaver 1945).

Coal Mining: During coal mining operations, some springs can dry up and there can locally be great increases in dissolved solids. Although these impacts would apparently only be a problem during mining (MBMG & USGS 1978), that is long enough to have serious consequences for the affected hardwood draws.

Offstream Water Storage: Greatly expanded plans for energy-related developments in southeastern Montana have resulted in plans for offstream storage reservoirs. The Montana Department of Natural Resources and Conservation (1977) listed 18 proposed offstream storage reservoirs for industrial use in the Yellowstone Basin in southeastern Montana. Although many of these would inundate hardwood draw habitat, the effects on that habitat would probably be less severe on a regional basis than those mentioned above.

Conclusion

From the results of the Intake study and other wildlife studies in southeastern Montana, it is evident that the hardwood draw habitat type is of major significance to the wildlife populations of the region, even though it only occupies about 1% of the area. This type is second only to the riverbottom cottonwood riparian woodland in overall productivity, diversity and importance to wildlife.

Although the hardwood draw habitat type remained intact during the natural grazing regime of the bison and associated ungulates, it appears to be most seriously threatened by overgrazing by domestic livestock, especially cattle. Other major threats are the lowering of the water table and resulting loss of springs caused by increased withdrawals of ground water and degradation of water quality due to saline seeps. Localized threats may be caused by coal mining and offstream water storage. Together, these factors pose a major threat to a very vulnerable and limited habitat.

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THE ECOLOGY OF CANADA GEESE ON THE LOWER YELLOWSTONE RIVER, MONTANA

Thomas Hinz 1/

During the past thirty years, the number of Canada geese breeding on the prairies of eastern Montana has increased tremendously. The increase is the result of expansion of irrigated and dryland agriculture and construction of numerous stock-watering reservoirs. Similar developments have occurred in other western states and Canadian provinces. The developments have allowed the expansion of the ranges of eastern Montana geese to places and seasons which were formerly unoccupied.

The Canada geese most common to eastern Montana are members of the Hi-Line population, which is composed of giant Canada geese (Branta canadensis maxima), Great Basin Canada geese (B. c. moffitti), or possibly hybrids of these two races. In 1960, the Hi-Line population was estimated at about 10,000 geese. The population is now in excess of 80,000 birds. The increase is due largely to the increase in breeding geese in eastern Montana. A significant part of this breeding flock now nests, or originated from geese nesting, along the lower Yellowstone River.

The physiognomy of the Yellowstone River in eastern Montana is quite variable as is the value of the system to Canada geese. The river is a typical slow-moving, braided prairie stream cutting its way through erosive soils and exhibiting flood and low flow periods which result in erosion and building of islands. The islands range in size from a few square yards to hundreds of acres in size, and from no vegetative cover to almost jungle-like growth. Different types of islands serve different functions for geese utilizing the river. Some stretches of the river are therefore heavily utilized by geese at certain times of the year, while these same stretches may not be used at all at other times.

The unique ways in which Canada geese utilize the Yellowstone River and adjacent agricultural lands can best be illustrated by dividing goose utilization of those habitats into winter, spring migration, nesting, brood-rearing, early fall, and fall migration seasons. The numbers, distribution, activity, and composition of the goose flock of the Yellowstone River changes dramatically between seasons.

Geese are restricted to areas of open water on the lower Yellowstone during winter. In winters with extended sub-zero periods, less than 100 geese may attempt to over-winter along the few open stretches. In mild winters, most of the river between

1/ Wildlife Biologist, Mt. Dept. of Fish, Wildlife & Parks, Miles City, MT.

Miles City and Billings is ice free and 6,000 geese may winter there. Goose feeding areas in severe winters is usually limited to cornfields with stalks exposed above the snow and livestock feed lots where corn silage is spread on the ground. In mild winters, all fields are available for feeding geese due to light snow cover. Large dryland wheat fields on benches above the river where newly sprouted winter wheat is abundant are then important. Wintering geese are in areas where they were most abundant in late fall prior to the last migrations.

By late February and early March, the wintering flocks are joined by large numbers of migrant geese stopping on their way to northern breeding areas. During the migration period, 10,000 to 20,000 geese may be in the lower Yellowstone Valley at one time. Most of the geese are breeders of the Hi-Line population returning to nest on the Yellowstone or further north into Montana and the southern Canadian prairies. Some lesser Canada geese (B. c. parvipes) of the shortgrass prairie population which nests in northern Canada will also stop on their way north. The spring migrants usually stay only a few days before moving north again. Flocks of a thousand or more are commonly observed crowding grainfields, hayfields and pastures along the river and congregating on the Yellowstone's barren loafing islands.

By late March, the arrival and departure of spring migrant flocks has become a less common sight on the Yellowstone and the predominant geese along the banks and islands of the river are the resident breeders and their young from the previous year. As the days become longer and warmer, river ice and snow cover disappears and goose breeding activity becomes vigorous. Birds of non-breeding age congregate in flocks which will migrate to northern molting areas by the end of May. The breeding pairs meanwhile engage in lengthy territorial squabbles, defending the most favorable nesting sites along the river. The most highly preferred nesting sites are on the islands but some pairs do nest on peninsulas, cliffs and in trees along the banks. In upper stretches of the river where ice cover was light during the winter, geese will nest on islands with little vegetation and on larger islands with limited forest and/or shrubby cover. High banks of the largest, most heavily-vegetated islands where the nest can be situated immediately above the water will also attract some nesting pairs. In downstream reaches of the river where ice jamming during the winter covers most of the more open, lower relief islands with ice until after nest initiation, geese have adapted to nesting in higher, more heavily-vegetated areas on the more permanent islands.

The peak of nest initiation usually occurs in late March and early April with the peak of hatching one month later. Nesting success ranges between 60 and 90 percent in most stretches of the river. An island which raised ten broods of geese in a given year may raise none the next should a coyote happen out onto the island. Coyote predation is not directed at the nests but at the hens. Those that are not killed and eaten on the nests desert their clutches because of the presence of the coyote on the island. Fox predation is usually similar in effect but does not usually result in as much nest desertion. Raccoon predation is the most common loss of eggs but only infrequently causes desertion. Generally, raccoons and successfully nesting geese will be found on the same islands.

Once the young geese are hatched, the parents lead them away from the nesting islands (which are still being actively defended by other nesting pairs) to secluded brood-rearing areas along the banks and the larger heavily-wooded islands. Brood-rearing areas may be riparian areas with heavy shrubby growth, open cottonwood forests with a lush growth of grasses and forbs, or fields of barley, corn or other crops. They are usually immediately adjacent to the water affording quick escape to the geese if threatened. About nine weeks are spent in these areas feeding on the lush vegetative growth as the goslings grow to flight stage and the adults experience a flightless period while they complete wing and tail feather molt.

By mid-July, most of the geese along the Yellowstone will be capable of flight if threatened. Once able to fly, the birds' seasonal range increases to a size which is greater than it has been since the onset of territory establishment. Their movements now become extensive, with some birds leaving the Yellowstone moving north to prairie wheat-growing areas and associated reservoirs and even as far as into Alberta and Saskatchewan. Most, however, will move less than 100 miles and will remain within the Yellowstone drainage.

Whether the geese at this time select a prairie stockpond or river island as a loafing area, the feeding areas associated with these loafing sites become an essential part of this seasonal range. Newly combined wheat fields with their abundance of waste grain provide the energy-rich food which the young birds and adults need to complete feather growth and replenish depleted body tissues. Two flights are made daily from loafing areas to feeding fields, in early morning and late evening when the heat of the day is less intense. However, on rainy days, geese will be found in the fields most or all of the day. By late August, cornfields in the valley are being cut for silage and barley fields are being combined, providing other highly preferred feeding areas for geese. Many, however, rather than using the river's loafing bars and nearby cornfield feeding areas, will remain in large flocks of up to 1,000 birds in remote prairie areas.

Although the same feeding and loafing area may be utilized by a group of geese for several weeks in late summer, the fall brings more erratic goose movements with a particular field or loafing area being used perhaps only one time. This is particularly true once the hunting season begins around October 1 and the hunters disrupt goose feeding patterns. As a result, the geese become increasingly more wary and mobile. By late October, migrant geese from northern breeding areas begin to enter the Yellowstone Valley. Some local goose flocks begin to leave the river for the wintering grounds while the presence of those remaining is hidden by the influx of migrant flocks into the same feeding and loafing areas. By this time the prairie water areas have usually frozen over, and most stopping waterfowl make their way onto the Yellowstone. Migrant geese, intermingled with resident flocks make their way to feeding areas in surrounding benchland wheatfields, and corn, barley, and hayfields in the valley where they provide excellent hunting opportunities. As colder weather moves into the area and the river starts to freeze over, migrant and resident flocks begin to depart for wintering areas in Wyoming, Colorado, New Mexico and Texas. However, should a warm winter occur and the weather remain favorable, the geese stay along open stretches of the river into the winter period. And so, the yearly cycle of the Yellowstone goose flock is completed.

The size of the Yellowstone River flock is currently unknown despite banding efforts. The complex nature of the river and the associated prairie habitat which harbor different segments of the population during different times of the year causes difficulty in determining the size of the Yellowstone River flock in spite of banding efforts. There are about 400 to 500 breeding pairs on the lower Yellowstone. However, there is probably a similar number of pairs which do not successfully defend a territory and nest each year due to their age and inexperience, competition for nest sites, and other factors. In addition, the population contains a large number of other unpaired nonbreeders which move through the Yellowstone Valley in the spring and are not censused during breeding surveys.

In recent years, the annual harvest of Canada geese in counties along the lower Yellowstone has varied between 500 and 1,000 geese. Much of this harvest is taken from flocks of migrant geese and it is impossible to estimate what proportion of the harvest represents resident geese of the Yellowstone flock. Banding studies on the Yellowstone River since 1972 have not been successful enough to conclusively indicate the flock's mortality. Banding methods and data interpretation are improving, however, and should provide a more accurate picture of the degree of exploitation of the population. The two major areas of harvest are in the Yellowstone Valley and the wintering areas of northcentral Colorado. The harvest in the latter area is much greater and may be limiting the growth of the Yellowstone flock.

Through cooperation between the other states and provinces within the range of the Hi-Line population, the Yellowstone River flock's status will improve and their numbers continue to grow. This is contingent upon realization by the people of the state of Montana, and those living along the Yellowstone River that that habitat is unique and deserves preservation. Outside energy interests, agricultural exploitation, and other water uses must all be dealt with in such a way that the river does not become dewatered or channelized. Only through maintenance of the river's physiognomy and flow regimen will its islands and general character survive and the Yellowstone River goose flock continue to flourish.

PRELIMINARY RESULTS OF OWL CENSUSES IN RIPARIAN AND UPLAND HABITATS IN SOUTHEASTERN MONTANA

Clif Youmans 1/, Jon Swenson 2/ and Steve Knapp 3/

Introduction

The relationship and importance of riparian ecosystems to owls is largely unstudied, not only in Montana, but in the western United States. In southeastern Montana, where riparian habitats are increasingly threatened by land use practices, information on the importance of such habitats to wildlife is urgent. Scarcity of information on owl population dynamics and ecology has been acknowledged by several researchers (Adamcik et al. 1978, Johnson et al. 1979, Smith 1969). The inherent difficulty of censusing and monitoring a nocturnal species has greatly contributed to this paucity of information.

The utilization of intensive nest searches to census breeding densities of owls (Craighead and Craighead 1956, Orians and Kuhlman 1956) is often impractical due to constraints of time and accessibility. Censusing owls on the basis of number of hooting males is often more practical and has been done by several researchers (Baumgartner 1939, Fitch 1940, 1947, Rusch et al. 1972, Holmberg 1979). However, this method underestimates the population because some males do not hoot during the listening period (Fitch 1949, Lundberg 1974, Holmberg 1979).

An acoustical lure (a tape recording of a hooting male) has been used successfully to elicit responses from three of four telemetered pairs of spotted owls (Strix occidentalis) (Forsman et al. 1977) and 80 to 90% of the actual number of males in a dense population of little owls (Athene noctura) in Germany (Exo and Hennes 1978). Published accounts of the use of this technique in North America are limited to the screech owl (Otus asio) (Nowicki 1974, Cink 1975) and the spotted owl (Forsman et al. 1977).

Methods

During February and March of 1980, we censused great horned owls (Bubo virginianus) in three composite habitat types broadly typical of the deciduous riparian and upland pine vegetative communities of southeastern Montana. The Isaac Homestead Wildlife Management Area (WMA) on the Yellowstone River near Hysham, Montana, was censused in March 1980 for screech owls, saw-whet owls (Aegolius acadicus), long-eared owls (Asio otus), and short-eared owls (Asio flammeus). An acoustical lure was used to elicit a vocalization from territorial males in all censuses.

1/ Ecological Consulting Service, Forsyth, Montana.
2/ Mt. Dept. of Fish, Wildlife and Parks, Rosebud, Montana.
3/ Mt. Dept. of Fish, Wildlife and Parks, Broadus, Montana.

Census routes were established and sampled using a point transect method similar to that described by Holmberg (1979). The acoustical lure was broadcast from a parked (engine and lights off) vehicle at .25-mile intervals along a five-mile route (20 point transect). An effort was made to establish routes within homogeneous habitats. When transect points were adjacent to atypical habitat or structures such as farm houses, the point was deleted, and when possible the transect was extended to encompass 20 points.

Following broadcast of the acoustical lure, the direction and relative distance of vocalizing owls from the transect point were recorded. Sex of great horned owls was determined by length and frequency of calls (Peterson 1941). Effective listening distance for great horned owls and most small owls appeared to be about .25 mile. Vocalizing owls which could be heard from more than one transect point were noted as recounts which were excluded from the computation of abundance indices. A minimum of two listeners recorded responding owls. All census routes were conducted at night when winds were less than 10 mph. Owl responses to the acoustical lure did not appear to be influenced by time of night.

Study Areas

Census routes were established in three habitat type categories:

Riverbottom habitat category: Transects in this category were adjacent to the Yellowstone and Tongue Rivers. The Yellowstone River transect was conducted on the Isaac Homestead WMA and immediate vicinity, Treasure county (T 6N, R 35E). The Tongue River transect was conducted 12 miles north of Birney, Rosebud county (T 3&4S, R 44E). The overstory in both areas is mature plains cottonwood (*Populus deltoides*). Wooded areas are associated with a brushy understory and are adjacent to irrigated cropland, cultivated fields, or sagebrush (*Artemisia cana*) lowlands.

Creekbottom habitat category: Three creekbottom habitats were censused in Rosebud County; West and East Forks of Armell's Creek (T 3&4N, R 40E and T 1N, R 40E) and Rosebud Creek (T 1S&1N, R 42E). Creekbottom habitats varied by proportion of deciduous overstory. Both East Fork and West Fork of Armell's Creek supported stands of scattered plains cottonwood with shrubby underbrush largely absent from the understory. Rosebud Creek supported the most extensive riparian zone, with a mature box elder (*Acer negundo*) overstory along its edge.

Ponderosa pine category: Two transects were located in ponderosa pine habitat; the Lemonade Springs area in Powder River county (T 3&4S, R 47E) and Greenleaf Ridge in Rosebud county (T 1N, R 41E). The Lemonade Springs area is characterized by a pine overstory interspersed with grassland parks and small draws with deciduous vegetation. The understory varies from snowberry

(Symphoricarpos spp.) and Oregon grape (Berberis repens) to grassland.

The topography of Greenleaf Ridge is characterized by high ridges, flat-topped mesas and steep, unstable slopes tapering to lower benches bisected by small coulees. Ponderosa pine is largely restricted to side slopes and small coulees. Flat-topped mesas are dominated by skunkbush sumac (Rhus trilobata) and wheatgrasses (Agropyron spp.). Sandstone ridges and outcrops, often capped with porcelanite (clinker) are closely associated with the coniferous overstory.

Results and Discussion

Great horned owls: The greatest number of great horned owl hooting males per unit distance was found in the riverbottom category; the creekbottom category was intermediate and the ponderosa pine category was lowest (Table 1). Indices of great horned owl abundance exhibited a high degree of consistency within each habitat category. The two riparian categories supported higher densities of great horned owls than did the ponderosa pine category. Baumgartner (1939) determined that great horned owls preferred large stands of deciduous timber bordering bodies of water and surrounded by openings in the form of grasslands, brush or cultivated fields. On their study area in the shortgrass prairie of northeastern Colorado, Olendorff and Stoddart (1974) located 80.5% of great horned owl nests in creekbottom habitats. Petersen (1979) determined that habitat use by great horned owls in Wisconsin was not random, and that upland and lowland hardwood habitat types received disproportionately high use in contrast to other habitat types.

Our owl census results are presented as an index of the total population and should not be interpreted as density estimates of breeding pairs. To our knowledge, no other great horned owl censuses employing acoustical lures are recorded in the literature; therefore comparison of density data must be done with caution. Conversion of relative abundance indices for the riverbottom habitat category (Table 1) yields densities of 12 to 13 territorial males per mi^2. It is unknown what proportion of those owls are breeding pairs. However, Henny (1972) summarized literature indicating the nonbreeding proportion of great horned owl populations is about 25%. Weller (1965) suggests that most great horned owls do not mature sexually until at least two years of age.

The percentage of nonbreeding birds has been shown to be strongly influenced by snowshoe hare abundance in boreal forest ecosystems (Adamcik et al. 1978, Rusch et al. 1972). It is unknown to what extent great horned owls in more diverse ecosystems respond to prey density changes.

Table 1. Differences in relative abundance of great horned owls among three categories of habitat in southeastern Montana, February-March 1980.

Category	Points Sampled	Date	# Pairs*	Total Males*	Males/ Stop*	Males/ Mile*
River bottom						
Yellowstone R.	20	25/2	5	37	1.85 (1.18)+	7.40
Tongue R.	20	26/2	7	33	1.65 (1.04)	6.60
Subtotal	40		12	70	1.75	7.00
Creek bottom						
W. Fork Armell's Cr.	20	26/2	8	31	1.55 (0.60)	6.20
E. Fork Armell's Cr.	8	6/3	1	12	1.50 (0.75)	6.00
Rosebud Cr.	20	26/2	2	27	1.35 (0.93)	5.40
Subtotal	48		11	70	1.46	5.83
Ponderosa pine						
Lemonade Springs	20	26/2	1	13	0.65 (0.81)	2.60
Greenleaf Ridge	39	26/2	1	10	0.26 (0.44)	1.03
Subtotal	59		2	23	0.39	1.56

* Excluding owls heard more than once
\+ Standard Deviation

Other owl species censused: Screech, saw-whet, long-eared, short-eared and great horned owls were censused on the Isaac Homestead WMA (Table 2). Screech owls were the most abundant small owl (2.33 per transect mile). Saw-whet owls were intermediate (1.33 per transect mile) and long-eared and short-eared owls least abundant (1.0 per transect mile). Screech owls were censused on two occasions (19 and 28 March 1980) and identical results were obtained. We observed a consistent positive relationship between the presence of screech owls and woodland near the sampling point. Other researchers have documented the importance of deciduous habitat to screech owls (Nowicki 1974, Cink 1975, Johnson et al. 1979). Screech owl density on the Isaac Homestead WMA was approximately 2.54 per mi^2. Using an acoustical lure to census screech owls in Michigan, Nowicki (1974) estimated densities of 1.4 per mi^2. Density increased to 6.1 per mi^2 when only results from wooded portions of his study area (22% woodland) were considered. Cink (1975) obtained considerably lower screech owl densities (0.40 per mi^2) in woodland areas of southeastern Kansas using an acoustical lure. However, Cink (1975) demonstrated a highly significant ($p = .001$) relationship between the percent woodland in four areas and the number of owls censused in each. Isaac Homestead WMA is approximately 45% woodland while the most heavily wooded area censused by Cink (1975) was 34% woodland.

Riparian habitats in arid and semiarid climates appear to be especially important to owls, serving as virtual refugia for some species. On Isaac Homestead WMA a minimum of 13 territorial owl species per linear mile was recorded (Table 2). Johnson et al. (1979) reported screech owl pairs spaced at 50-yard intervals in optimum cottonwood-mesquite riparian habitat along the Salt and Verde rivers in Arizona. Such densities were estimated to be 36 times greater than those in surrounding uplands (Johnson et al. 1979).

Information on saw-whet, long-eared, and short-eared owls in Montana is very limited. Further research on these species is clearly warranted in light of our preliminary findings. It is our expressed desire to encourage other biologists to actively seek such information.

Summary and Conclusions

Riparian habitats in southeastern Montana support a high diversity and abundance of nocturnal raptors. Preliminary research suggests these areas support disproportionately higher densities of owls than other upland habitat types.

The use of an acoustical lure is a reliable census method for the total population of territorial males and may be a valuable tool in determining owl population trends. However, more information is needed before breeding density estimates can be obtained from this method.

Table 2. Relative abundance of small owls on Isaac Homestead Wildlife Management Area, Hysham, Montana as determined through census with an acoustical lure in March 1980.

Species	Number Recorded*	Owls per Stop*	Owls per Mile*
Screech Owl	7	0.58 (0.51)+	2.33
Saw-whet Owl	4	0.33 (0.49)	1.33
Long-eared Owl	3	0.25 (0.45)	1.00
Short-eared Owl	3	0.25 (0.45)	1.00
Total	17	1.42	5.67
Great Horned Owls			7.40
TOTAL OWLS			13.07

* Excluding owls heard more than once
\+ Standard deviation

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EFFECTS OF GRAZING ON RIPARIAN ZONES IN NORTHCENTRAL MONTANA

Frank M. Gjersing 1/

Before 1900, riparian zones in northcentral Montana were limited primarily to the Milk and Missouri rivers and the intermittent and permanent streams of their watersheds. With the settlement of the area by man, reservoirs developed for livestock and domestic purposes were constructed. Both of these riparian "types" are extremely valuable from a wildlife standpoint and are heavily impacted by livestock.

The purpose of this paper is to discuss the effect of various grazing management practices on the vegetation of these two types.

Study Area

One study area was located in Phillips County approximately 12 miles south of Malta. The area included 33 reservoirs within a five-pasture rest-rotation grazing system. Vegetation of the riparian zones was dominated by bluestem (Agropyron smithii), slender spike-sedge (Eleocharis acicularis), longstem spike-edge (Eleocharis macrostachya), and foxtail barley (Hordeum jubatum). The results of this study were reported earlier by Gjersing (1975).

The second study area was located in Hill County, 6 miles west of Havre. This area included 4.5 airline miles of the Milk River, one reservoir, and three river oxbows. Vegetation of the riparian zones along the river was dominated by willow (Salix spp.) and plains cottonwood (Populus deltoides). Other woody plants typical of the riverbottom were present but are not included in this report. Herbaceous vegetation changed so dramatically over the period of study that the reader is asked to refer to the result section for clarification.

Mean annual precipitation of both areas was under twelve inches.

Methods

The division of the Phillips County study area into a five-pasture rest-rotation system was completed in fall 1966. Before this the area had been continuously grazed for at least 6 months each year. The grazing plan essentially followed that of Hormay (1961) and was adhered to fairly well from 1968-1972, the period of study. Five reservoirs were selected outside the system to compare reservoirs in pastures under normal grazing with those under rest-rotation grazing.

Cattle were removed and no grazing was allowed on the Hill County study area from August of 1976-1980, the period of study. Two sections of river one-half mile long and one reservoir were

1/ Wildlife Biologist, Mt. Dept. of Fish, Wildlife & Parks, Havre, Montana.

selected adjacent to the area to compare sites under normal grazing to those under no grazing.

Evaluation of the effects of grazing on the riparian zones was a modification of Daubenmire (1959). Twenty 2x5 dm plots were placed along a 100-foot tape at 5-foot intervals. One end of the plot frame was removed to facilitate recording taller vegetation (Gjersing 1976). Within these plots the canopy coverage of each major taxon of herbaceous vegetation was visually estimated and recorded by percentage classes. Individual plants of cottonwood and willow occurring within each frame were counted. Transects were established in the various vegetation zones along the shoreline of each reservoir, throughout the low "beach" areas along the river, and adjacent to the water's edge of one of the river oxbows. Data was supplemented by photo plots and vegetative cover maps made on the areas whenever possible.

Results

Phillips County Study Area: Increases in herbaceous vegetation in the riparian zones on the rest-rotation area were dramatic. Reservoirs within the system had predominately bare, mud shorelines during spring and early summer 1968. By 1972, shoreline vegetation was abundant on all retention-type ponds over 3 years of age and had appeared in small amounts on some pit reservoirs. Slender and longstem spike sedge had increased to a canopy coverage of 41 and 60 percent respectively by 1970. The effects of cattle grazing between pastures were still evident. Within a period of 2 weeks after cattle had been turned into a pasture, grazing and trampling had reduced most of the vegetation within 15 yards of the shore to a height of 3 inches or less. No cattail and only one stand of bullrush (*Scirpus validus*) was present on the area. It approximately tripled in area over the 5-year period but the effects of grazing on this species were hard to determine because it was located in an area where cattle were able to graze only during periods of low water in late fall. No increase in vegetation was noted on any of the control reservoirs.

Cottonwood seedlings were observed at 42 instances within the riparian zones of the rest-rotation system. All were in pastures which were being rested from grazing and were destroyed by cattle within two weeks after cattle were turned into the pasture. No cottonwoods were noted on any of the control reservoirs.

Hill County Study Area: Increases in herbaceous vegetation occurred with the absence of cattle on this area. Greater increases in vegetation (in canopy coverage, height and species composition) were recorded here than on any areas of the rest-rotation system. When cattle were removed from the area in

1976, grazing had impacted the reservoir and oxbow site to such a degree that only traces of vegetation existed within the riparian area. By the fall of 1980, stands of bullrush averaged a canopy coverage of 21%, sloughgrass (Bechmannia syzigachne) 80%, cattail (Typha lattifolia) 86.7% and spike sedge 92%. Stands of cottonwood and willow measured by counts of individual plants in the plot frames increased from 0 in 1976 to 2.7 and 5.1 per frame, respectively.

No increase in vegetation was noted on the control reservoir except during the summer of 1980 when cattle were removed because of drought conditions. At this time scattered patches of slender spike-sedge appeared along the shoreline. Only traces of canopy coverage were measured.

No seedling cottonwoods or willows were recorded on any of the river transect sites during 1976. By 1980 counts of individual plants within the plot frames averaged .9 for cottonwood and 6.3 for willow on the area of no grazing. Numerous seedling cottonwoods and willows attempted to establish on the river control areas but were destroyed their first year by grazing livestock. The upstream control area was leased by the Department of Fish, Wildlife and Parks in 1979 and cattle were subsequently removed. No seedlings of cottonwood or willow were present on the area at that time. By the fall of 1980, seedling willows were evident and seemed to be well established. One stand averaged 1.8 plants/plot at that time.

No measurements of herbaceous vegetation were made on the river in 1980.

Discussion

The negative effects of cattle grazing on riparian zones has been well documented. Holsher and Woolford (1953), Gunderson (1968), Van Velson and Winigar (1977), Marcuson (1977), Claire and Storch (1977), Armour (1977), Duff (1977), Severson and Boldt (1978), Crouch (1979), Platts (1979), and Boldt, Uresk and Severson (1979), all reported declines in riparian vegetation when grazed by livestock. The decline in vegetation is particularly obvious in riparian zones because cattle tend to concentrate in these areas. In the semi-arid regions such as northcentral Montana, the only water and frequently the only green vegetation during summer and fall is found along these zones. The resistance of herbaceous and woody vegetation to cattle grazing in this study was different enough to merit separate discussion.

Herbaceous Vegetation: The increase of herbaceous vegetation on the rest-rotation system and the complete rest area was expected due to the physiology of the plants. Rest from grazing allows herbaceous plants to recover vigor, produce seed, seedlings to become established and, for perennials and most rhizomatous plants, to replenish their food storage. The growth of herbaceous plants is not affected significantly by grazing after reserves are stored because the food reserves are out of reach of the animals. Once these reserves are replenished, the plant can stand grazing for a year or more (Hormay 1970).

No increase in herbaceous vegetation on the intensively grazed control areas was noted and none was expected. Unless the plants are allowed to rest and continue necessary life processes, no increase is possible and they will eventually die (Hormay 1970).

The dramatic decrease in height of vegetation after cattle were turned into a pasture was expected due to the attraction of the riparian zones to cattle. The advantage of the rest-rotation system was that it enabled the plants to obtain the physiological requirements necessary for regrowth when cattle were removed.

Woody Vegetation: Cottonwood and willow reproduction in this area appears to depend on several factors. Ideal seedbed conditions for these two plants are apparently obtained when predominately bare soils undergo occasional flooding. These conditions occur almost every year around stockponds and during most years in the low beach areas adjacent to river channels. These were the areas which produced the greatest amount of seedling establishment and where the transects were established. In the higher areas of the river floodplain which may be subjected to flooding only every 10 to 20 years, establishment of seedlings was limited to ditches and potholes where runoff provided standing water for at least a portion of the spring. If a dense stand of herbaceous vegetation existed in these areas, establishment of these two woody plants appeared to be more difficult. The mature cottonwoods which occur in areas of this higher floodplain apparently needed similar conditions for establishment. Some aging work on beaver-cut trees indicated that these trees established when heavy runoff caused overbank flooding of the river into these areas.

When seedlings become established their survival depends on protection from grazing by domestic livestock. As soon as cattle were allowed to graze the rest pastures within the rest-rotation system, the seedlings were destroyed. Numerous seedlings were found throughout the study period on the river control areas, but they were destroyed their first year by cattle. The physiological reason for the inability of woody plants to survive grazing should be understood. The herbaceous plants are not affected significantly by grazing after food reserves are stored because the reserves are out of reach of grazing animals. In woody plants, reserves are exposed and grazing anytime, even during dormancy, can harm them (Hormay 1970). Only when riparian zones were rested completely were seedlings able to survive. The period of rest before cattle can be allowed to graze without damaging the young plants probably depends on the area. Duff (1977) found that even after 4 years of rest, 6 weeks of grazing returned the vegetation to pre-rest conditions. Woody vegetation such as willow and cottonwood must be tall and sturdy enough to resist mechanical damage of trampling, rubbing, etc.

How seedlings survived to produce the mature cottonwoods of this area is speculative but it is known that most of the lands adjacent to the riverbottoms which are now used for grazing were farmlands in the past. Because of this they were grazed only during late fall and winter, if at all. Severson and Boldt (1978) found that winter grazing did not seem to be particularly harmful to deciduous stands in the western Dakotas. Cattle numbers may also have been a factor. Cattle numbers in northcentral Montana climbed from 1919 to 1935, fell to a record low in 1940, and more than doubled by 1970 (Weigand 1976).

Another factor which apparently is having a negative effect on cottonwoods and willows is water level manipulation. Efforts by the Western Area Power Administration (formerly U.S. Bureau of Reclamation) to prevent downstream flooding by the use of Fresno Dam is effecting one of the basic requirements for ideal seedbed conditions. Crouch (1979) found water management to be the most important factor effecting cottonwood recruitment along the South Platte River in Colorado.

Stands of cottonwood and willow are likely to decline in the future if present practices continue. Unless some recruitment occurs, the older plants will complete their life cycle and no younger plants will replace them. Rest-rotation systems, as presently practiced in this area, will apparently increase herbaceous vegetation. However, cottonwoods and willows, which are of high value to wildlife and necessary for bank stabilization, will not reproduce. Platts (1977) indicated that the high livestock densities caused by rest-rotation systems on riparian zones may cause more damage to woody vegetation than former grazing systems. This apparently was controlled by modification of one system in an area of higher rainfall (Myers 1981). In northcentral Montana, it is apparent that land managers will have to change the treatment of riparian zones if they wish to maintain them.

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SOME EFFECTS OF RIVER FLOW REGULATION ON RIPARIAN HABITATS

Larry S. Thompson [1]

Since 1900, a good measure of the riparian habitat in the western United States has been destroyed or drastically altered. That loss continues at an alarming rate (McCormick 1968), and increasing concern for this diminishing resource has recently engendered a considerable body of literature (see, for example, Johnson and Jones 1977, Johnson and McCormick 1978, and Graul and Bissell 1978). One of the most important influences on riverine habitat is man-imposed flow regulation, including flood control and hydroelectric development, which has affected most of the major rivers of the world (Stanford and Ward 1979). Although much research has been conducted on the effects of regulation on aquatic organisms, there is little information on its effects on riverine habitats used by wildlife.

The major upstream effect of impoundment--flooding of terrestrial habitats by reservoir waters--is spectacular, easily documented, and usually receives the most attention. Downstream effects, however, though more subtle, may be far more extensive, sometimes affecting a river all the way to its mouth. This paper is a summary of some of the known effects of river flow reulation on riverine habitats, especially on the floodplain gallery forest, and identifies some of the topics in which more research is badly needed.

Upstream Effects of Impoundment

Flooding of Vegetation: The immediate effects of inundation are generally direct and obvious: upland plant communities are flooded and killed over an area as large as the reservoir, and a new shoreline is established upslope. There have been many studies on the tolerances of various plant species to inundation (see, for example, Green 1947, Yeager 1949, Ahlgren and Hansen 1957, Hosner 1960, Rhoades 1967, Gill 1970, Franz and Bazzaz 1977, Teskey and Hinckley 1978a and b, Walters et al. 1980), but few of these are applicable to Montana, since Montana has no upland plants that can tolerate permanent inundation. Trees and shrubs are generally removed from the beds of larger reservoirs before filling (although dead trees surrounded by water offer ideal nest sites for herons, cormorants, and osprey). The nature and extent of new shoreline vegetation that becomes established along a reservoir is largely a function of drawdown regime, as discussed below.

Drawdown: What shoreline vegetation will become established along a reservoir depends on the yearly pattern of reservoir filling and drawdown, which varies greatly among dams. Tolerances of plants to changes in surface or subsurface water level

1/ Mt. Department of Natural Resources and Conservation,
32 S. Ewing, Helena, MT. 59620.

are strongly influenced by the season and duration of the change (Wakefield 1966, Walters et al. 1980, Teskey and Hinckley 1978a, Gill 1970). Either submergence or exposure will have a far greater effect on plant survival during the growing season than in winter; the lower limits of willow along a shore, for example, are apparently determined by the period of exposure to air during the growing season but are little affected by winter inundation. Some plants may require a particular day length to break bud dormancy before inundation if they are to survive (Wakefield 1966). Vertical distribution of riverbank shrubs along Montana rivers is closely related to growing-season water level but is relatively independent of the much lower winter level. Often, the height of the plant at the time of flooding--and hence the amount of leaf area exposed above water--determines survival following temporary inundation.

Most large storage dams show a general pattern of summer filling and winter drawdown, resulting in large annual water level fluctuations. Lake Koocanusa, for example, exhibits annually a vertical shoreline fluctuation on the order of 50 m (Ciliberti 1980). The zone between high and low water marks, called the "eulittoral" (Baxter 1977) or "aridal" zone (Lindstrom 1973), is typically barren of vascular vegetation, although weedy annuals may become established near the higher shoreline. Since the new upper shoreline is located on a slope rather than a floodplain or terrace, and since the water level does not reach this upper shoreline until well into the growing season and remains there for a relatively short time, phreatophytes do not become established along most of the reservoir margin. The eulittoral zone receives little use by wildlife, especially during drawdown, when the reservoir margin is a great distance from cover.

Run-of-the-river irrigation dams, such as Toston Dam, are often maintained at a constant pool level during the growing season then abruptly drawn down in the fall. The vertical distribution of shoreline vegetation is determined by the normal operating pool level experienced in summer. Since drawdown occurs in winter, ice scour does not affect the shoreline vegetation that developes over the summer, and vigorous stands of emergent vegetation (such as cattail and bulrush) become established along the shoreline. The drawdown zone at Toston Dam is composed of a heavy organic muck without vegetation; the winter drawdown apparently prevents establishment of rooted aquatics.

Some run-of-the-river hydroelectric dams are managed to maintain a constant pool level yearlong. Theoretically, this could result in a shoreline vegetation pattern similar to that along the irrigation dams mentioned in the preceding paragraph. However, five such run-of-the-river hydroelectric reservoirs examined near Great Falls showed virtually no riparian vegetation except at tributary deltas, since much of their shorelines abutted steep, rocky cliffs. Where shorelines are more gradual, emergent vegetation would be likely to develop, providing favorable habitat for duck boods and muskrats (Martin 1977). Ice scour would exert a greater influence on shoreline vegetation where pool level is constant yearlong than where there is a winter drawdown; the effect of this winter ice scour on the vertical distribution of emergents along reservoir shorelines is unknown.

Shoreline stabilization could result in establishment of rooted aquatic vegetation as soon as siltation establishes a suitable substrate (McKern 1976). That vegetation, which is important to ducks, would also increase breeding and estivation habitat for frogs and other amphibians, which are conspicuously absent from widely fluctuating rivers such as the Kootenai and Columbia (Montana DNRC 1979, McKern 1976).

Sedimentation: Reduced water velocities at the upper end of a reservoir cause the river to deposit its sediment load, creating a delta of fine-grained sediment. At the upper end of Toston Reservoir several meters of sediment have been deposited on a submerged island and on the first river terraces. Cattails, bulrush, sedges, and willow now grow on the built-up surfaces, creating a very unusual riverine marsh habitat. Where small tributary drainages enter a reservoir, smaller deltas aggrade into the reservoir, since there are no high flows to wash the sediments downstream.

Other Effects: Impoundments can have other upstream effects on wildlife habitat. Reservoir ice-over may prevent wintering piscivores, such as the bald eagle, from using fish in the reservoir as a food source. In a study in western Washington, Taber and Raedeke (1976) found that reservoirs created a "warm bowl" effect, raising the temperature in the vicinity of the reservoir and increasing the rate of snowmelt adjacent to the reservoir. This warming could influence shoreline vegetation, but so far there has been no documentation of such influence.

Downstream Effects of Impoundment

The most extensive effects of impoundment result from the influence of large storage reservoirs on downstream flow regime and channel morphology. Flood control, changes on channel morphology, and changes in eulittoral habitats--the three major types of influence--will be discussed below.

Flood Control: River floodplains are dynamic and ever-changing systems, and much floodplain vegetation is in the earliest stages of primary succession. Floodplain forests are apparently a "pulse-stabilized" system, maintained in a continual disclimax through the pulse of periodic flooding (Odum 1971, Johnson et al. 1976). Scouring by flood waters maintains unvegetated gravel bar habitats and creates fresh alluvium, which is optimum habitat for establishment of seedlings of cottonwood, willow, and other pioneer woody species. Seeds of these species germinate almost exclusively on recently-deposited, fully-exposed alluvium (Smith 1957, Foote 1965, Tuinstra 1967, Wikum and Wall 1974, Johnson et al. 1976). Also, when a river leaves its banks at flood stage, water velocity decreases sharply and sediments are deposited on the floodplain. This "nutrient pulse" is also believed to influence floodplain cottonwood forests (Johnson et al. 1976).

Many observers are concerned about these floodplain cottonwood forests, which are generally regarded as "the most productive and highly diversified ecosystem in the West" (Beidleman 1978) and "our most endangered habitat" (Mustard 1978). The high structural diversity of these forests contributes to their use by a diverse animal community.

Flood control is an objective of nearly all large storage reservoirs (run-of-the-river impoundments do not have this capability), whether their primary purpose is to store water for irrigation or to generate electricity. The annual May-June discharge peak characteristic of free-flowing rivers is typically replaced after impoundment by lower discharge peaks, sometimes occurring at different times of the year; flood discharges are eliminated altogether. This new pattern has important effects on floodplain forest vegetation. Seeds of cottonwoods and some willows germinate most readily in recently-deposited alluvium, and cannot reproduce where they are overstory dominants (Johnson et al. 1976). Because a rapid lateral movement of the riverbed is essential for establishment of cottonwoods, reduction in meander rate because of flood control resuces the numbers of cottonwood seedlings and saplings. The cottonwood forests that today border many eastern Montana rivers developed over centuries as a result of spring floods and rapid meandering. Conditions below large dams do not favor long-term perpetration of gallery forest ecosystems, and the cottonwood forests we see there today are relics that will probably be absent a century from now. The riverine cottonwood forest cycle has a period of about 150-250 years (Johnson et al. 1976), but the oldest large dams in Montana are only about 70 years old; therefore, we are now seeing only the earliest stages of these downstream effects.

Flood control can lead to decreases in diameter growth of several major floodplain tree species and to higher seedling-sapling mortality of some species, probably because surface soil conditions are more xeric in the absence of flooding (Johnson et al. 1976).

A reduction in dominant discharge, coupled with elimination of floods, tends to stabilize bars and islands, which may allow willows to extend further down the shore. Encroachment of dense willows into open habitats eliminates waterfowl loafing sites and goose nesting habitat (Hinz 1977, Kellerhals and Gill 1973). However, the lower limit of some riverbank plants is determined by the tolerance of the plants to mechanical damage by ice or floating debris (Wakefield 1966). Along many Montana rivers, ice scouring removes any invading willows or other shrubs from gravel bars and shorelines up to the "trim line," above which well-developed shrub stands abruptly appear, and below which woody vegetation is virtually absent. Thus, shrubs may be eliminated by ice scour from areas where conditions (e.g. growing-season water level) would otherwise be suitable.

Flood control can indirectly affect riverine forests by encouraging forest clearing for agricultural or residential purposes (Martin 1977).

<u>Changes in Channel Morphology</u>: Since tailwaters have lower sediment loads than water entering a reservoir, they tend to pick up a new sediment load below the dam, cutting the main channel deeper and largely restricting flow to the main channel. This eliminates braided channels and meanders and reduces the number of islands. A lowering of floodplain water table may result, further affecting floodplain vegetation. Impoundment of the Bighorn River by Yellowtail Dam in 1965 has resulted in a 77% loss in gravel bar area, a 23% reduction in area of vegetated islands, and a 31% reduction in number of islands. This resulted in reduced habitat suitability for beaver in the Bighorn River as compared to the free-flowing Yellowstone (Martin 1977). The changes also adversely affected goose and great blue heron nesting habitat. However, creation of oxbow lakes and backwaters in abandoned meanders encourages growth of emergent and rooted aquatic plants, which can increase duck brood rearing habitat (Hinz 1977).

Under a controlled flow regime, tributary deltas tend to aggrade into the river channel, causing the river to shift away and erode the opposite bank. This has been observed in the Kootenai River below Libby Dam (Ciliberti 1980).

<u>Changes in Eulittoral Habitats</u>: River impoundments not only modify peak discharge patterns; they also affect the frequency, timing, and periodicity of river stage fluctuations. These changes can affect the nature of the area between low and high water marks, often referred to as the "eulittoral zone." Natural river discharges are generally most variable in spring and early summer and are fairly stable in fall and winter. Hydroelectric dams often increase the daily discharge variation and also increase the seasonal variation in maximum daily discharge. At Libby Dam, downstream discharge variation following river closure is ten to twelve times as great as that observed before impoundment (Ciliberti 1980). The change in daily variation reaches an extreme with power peaking facilities, where discharges may vary from a few hundred cfs to up to 35,000 cfs or more several times a day. These violent fluctuations create a eulittoral zone virtually uninhabitable by plants and animals,

since few local organisms are adapted for a "freshwater intertidal" life (Hanson and Eberhardt 1971, Payne et al. 1976). Stranding of benthic insects on a wide eulittoral zone can be lethal during exposure periods of 24-28 hours; Ephemeroptera, a kay food source of the dipper (Mitchell 1968), are especially intolerant to short-term exposure (Brusven et al. 1974). One would expect little or no vascular vegetation to persist in such a eulittoral zone, although documentation of vegetation response to peaking is lacking. The south fork of the Flathead River below Hungry Horse Dam has become a "biological desert" because of violent discharge fluctuations (May and Huston 1979).

Although most hydroelectric dams in Montana are operated as baseload or "quasi-peaking" facilities, the availability of new coal-fired baseload power will increase the attractiveness of peaking at many existing Montana hydro facilities. More investigation of downstream effects of peaking on Montana riverine habitats is badly needed.

Research Needs

Many gaps exist in our knowledge of the effects of flow regulations on riverine habitats. Some of the areas where future research would be most useful are:

1. Effects of peaking on riverine vegetation and the eulittoral zone;
2. Specific inundation tolerances of Montana riparian plants at different seasons and different periods of inundation;
3. The relationship of vertical distribution of shoreline vegetation to different discharge and drawdown regimes;
4. Effectiveness of mitigating measures, including vegetation establishment on aridal zones (see Silmer 1948), and perpetuation of the cottonwood disclimax community by artificial scouring of alluvium.

Summary

Alteration of natural flow patterns affects riverine habitats both upstream and downstream from the impoundment. Reservoir effects, including flooding of vegetation, creation of an "aridal" zone through drawdown, and sedimentation, are the most dramatic, and generally receive the most attention. Downstream effects, though more subtle, can be far more extensive. Flood control eliminates the periodic "pulse" of scouring and floodplain siltation that maintains floodplain forests as an early-successional disclimax. There is some evidence that flood control prevents the establishment of new cottonwood seedlings, and that the floodplain gallery forest is no longer perpetuating itself below large dams. Impoundment also affects downstream channel morphology; as tailwater picks up a new sediment load, it cuts the main channel deeper, eliminating many meanders and islands. Peaking has an especially severe effect on shoreline habitats, as it prevents vegetation and invertebrates from becoming established in the eulittoral zone.

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