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Guidelines for Roadside Revegetation to Create Wildlife Habitat in Northern Utah

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GUIDELINES FOR ROADSIDE REVEGETATION TO CREATE WILDLIFE HABITAT IN NORTHERN UTAH

by

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ABSTRACT

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Wildlife Habitat in Northern Utah

by

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Many species of wildlife use roadside vegetation as habitat. The ring-necked pheasant (*Phasianus colchicus*) utilizes roadsides for all types of cover. Because pheasants are nonmigratory and generally live their entire lives within a 1- to 2-mile radius, pheasants are excellent indicator species to predict both quantity and quality of roadside wildlife habitat. Pheasants were introduced to Utah in the late 1800's. Populations climbed until pheasant habitat occupied 2-4 percent of the total land area in Utah. Populations began to decrease in the 1950's. Since 1962, pheasant populations in Cache County, Utah have dropped 2.71 percent annually. Experts believe the decline in pheasants is directly related to decreased habitat. They attribute the decrease to land use changes.

Cache County roadsides currently support 3,643 acres of wildlife habitat and have the potential to support over 15,000 acres. To evaluate roadside habitat in Cache County, a roadside vegetation inventory was conducted. This was done by conducting a windshield survey of Cache County roadsides in agricultural areas. Next, vegetation density was measured along roadside transects using a Daubenmire frame and vertical profile board.

The results showed Cache County roadsides did not support quality wildlife habitat. The exception was wetlands that contained significant stands of cattail. The

evaluation found current maintenance practices of mowing and spraying roadside vegetation has degraded the plant communities and created dense monocultures of a few grass species.

A questionnaire was completed by county weed supervisors throughout the state of Utah as well as Utah Department of Transportation personnel and other people associated with the managment of roadside vegetation. The questionnaire provided information about current roadside maintenance practices and attitudes.

As a result of the roadside vegetation data and the questionnaire, the study determined that healthier roadside plant communities are possible if current maintenance practices and standards are modified. These modifications should include 1) spot spraying herbicide to eradicate weed species, 2) mowing only 10% of the right-of-way, which will provide more residual nesting cover in the unmowed areas, and 3) allowing woody vegetation along the backslope of ditches and other areas where motorist safety is not compromised. By modifying maintenance practices and implementing diverse seed mixes, roadside plant communities will support quality wildlife habitat.

(215 pages)

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CHAPTER I

INTRODUCTION

Background

The midwestern states have seen a reduction in wildlife habitat for over 50 years. Increased corn and soybean production has been associated with the decline in nesting habitat for upland species (Warner, Joselyn, and Etter 1987). These intensified agricultural practices, along with housing development and commercial endeavors, have led to an accelerated rate of decrease in wildlife habitat (Warner et al. 1984).

Ring-necked pheasant (*Phasianus colchicus*) populations are often used as indicators of quality upland habitat. The declining survival rate of ring-necked pheasant chicks has been documented in the midwest and used as an indicator of decreased habitat area as well as low habitat quality (Warner et al. 1984; Warner and Joselyn 1986; Bryan and Best 1994). In Illinois, ring-necked pheasant populations declined steadily from 1946 to 1981. The average number of chicks per hatched nest did not change, but the survival of chicks did. The survival of chicks to 5-6 weeks of age was 78 percent during the early 1950's, 61 percent during 1965-69, and 54 percent during 1975-81 (Warner et al. 1984).

Utah has also seen a substantial decline in pheasant habitat. In the late 1930's, approximately 2-4 percent of the total land area was suitable pheasant habitat (Nish 1973). The state pheasant population remained stable until the early 1960's. Since then, a steady decrease in habitat and subsequent decline in pheasant population has been documented by the Utah Division of Wildlife Resources (UDWR) (Heath 1984). Heath (1984) estimated the rate of annual decline from 1949 to 1981 to be 1.1 percent. Roadside counts are a fairly accurate estimate of pheasant population and have been utilized since 1962 in the state of Utah. Using roadside counts, Nish (1973) estimated the annual rate of pheasant population decline to be 1.8 percent.

Cache County has experienced a similar decline in the pheasant population. The rate of annual decline from 1952 to 1981 was estimated by hunter bag counts to be 1.2 percent, while the annual rate of decline estimated by summer roadside count data from 1962 to 1981 was 2.71 percent (Roberson and Leatham 1981). The difference may be attributed to the fact that roadside counts are done during peak population months. Cache County accounts for the second largest pheasant harvest in Utah, and pheasant hunting in Utah accounts for a state revenue of over $4 million annually (Dean Mitchell, personal communication, 1996) (see Appendix A for pheasant distrubution map).

Experts believe the decline in pheasant population is directly related to a decrease in habitat (Warner et al. 1984; Olsen and Leatham 1979). They attribute this decrease in habitat to factors such as larger fields with roller irrigation and concrete ditches, which leave fewer hedgerows and weedy ditches. The development of farmlands into housing and other nonagricultural uses has further exacerbated habitat decline. All of these changes in land use decrease the amount of valuable habitat for the pheasant. Olsen (1977), Heath (1984), Meyer (1987), Larsen, Crookston, and Flake (1994), and Bruce Bonebrake (personal communication, 1996) believe winter cover to be the most critical habitat factor and nesting cover as the second most critical factor. Land use changes that reduce winter or nesting cover may contribute most significantly to the decline in pheasant populations.

As grassland habitat becomes more scarce, the importance of managing the road right-of-way (ROW) for habitat is gaining considerable momentum (Warner, Joselyn, and Etter 1987). Data gathered from the Sibley Study Area in East-Central Illinois found the pheasant nest density higher along roadsides than all other cover types (Warner, Joselyn, and Etter 1987). Nelson, Kimmel, and Frydendall (1990) believe that roadside habitat in the Midwest is essential for the survival of the pheasant. Other habitat experts have identified roadsides as essential brood-rearing habitat and have said that there is a need to

examine the quality of roadsides as brood-rearing habitat for pheasants (Warner 1979; McCrow 1982; Whitmore 1982).

The Minnesota Department of Natural Resources has sponsored a program entitled "Roadsides for Wildlife" where they encourage roadside managers to manage the roadside for wildlife habitat, particularly for birds. They estimated that for Minnesota's roadside wildlife species, 45,000 acres of high quality roadside cover is available. They also estimated that 525,000 additional acres of habitat could be provided by roadsides (Fouchi 1994). Minnesota roadsides produce one-quarter to one-half of all pheasants in Minnesota (Varland 1985). In Nebraska, approximately one-quarter of all pheasant nests are found along roadsides (Baxter and Wolf 1973). Overall, pheasant nest densities on undisturbed roadsides exceed any other habitat type (Snyder 1974).

A major obstacle in planning roadside habitat is that the habitat is often fragmented and scattered along the roadsides. Experts claim that quantity of habitat is as important as quality (Vandel and Linder 1981). Effective wildlife habitat, for pheasants in particular, needs to be linked and to provide the essentials of food, water, cover (both hiding and thermal cover), and grit and calcium (Trautman 1982). Probably the largest obstacle to providing quality habitat for the pheasant is the limited size of the home range of pheasants. Trautman (1982) stated that the typical pheasant lives and dies within a two-square-mile area. Optimally, all types of cover and food would be provided within a one-quarter-mile radius of the nesting site (Meyer 1987).

Heath (1984), Olsen (1977), and Stokes (1968) suggested that roadside habitat was critical to sustain pheasant populations in Cache County. The current roadside habitat in Cache County is estimated to be 3,643 acres, while there is a potential for 14,572 acres. No detailed studies of roadside habitat quality have been previously conducted in Cache County. County weed supervisors are responsible for managing roaside vegetation, yet no recent survey of their attitudes, opinions, or current practices has been conducted. Most of

the roadside revegetation literature focusing on providing wildlife habitat has come from the midwestern states. Finally, there are not any current roadside revegetation strategies to improve wildlife habitat for any county in Utah. Although Cache County is only 1 of 29 counties in Utah, it is believed that the guidelines provided in this study could be extended to other counties in the state.

Study Goals

The goals of this study were:

1. To estimate the quantity and quality of existing roadside habitat in Cache County.
2. To determine what may be done to improve the quantity and quality of existing roadside habitat in Cache County.
3. To provide revegetation strategies to improve the productivity of roadside wildlife habitat in Cache County.

To meet these goals, this study provided the following:

1. A literature review with a focus on:
    - Pheasant habitat requirements.
    - Habitat related causes of pheasant population decline.
    - Pheasant habitat improvement strategies.
    - Habitat evaluation techniques to determine density, species composition, and quality of cover.
2. A description of idealized pheasant habitat based on literature review.
3. Field studies of Cache County rural road ROW's, which identified plant species and vegetation density.
4. Survey results from State and County personnel in Utah and surrounding states.

5. A comparison of existing roadside vegetation and habitat quality with ideal habitat quality.
6. Strategies to improve the quality of roadside wildlife habitat.
7. Planting plans/seed mixes to meet varying microclimatic and edaphic conditions for Cache County rural road ROW's.
8. Implementation guidelines for roadside revegetation.
9. Suggested maintenance practices to insure success of the ROW as pheasant wildlife habitat.

Summary

Pheasant habitat is on the decline in the state of Utah and in Cache County. Over the last 50 years, the UDWR has initiated programs in an attempt to reverse the decline in pheasant populations. These programs have donated trees and shrubs to farmers, provided technical assistance for planting, purchased or leased hayfields for nesting cover, and included a program entitled "Acres for Wildlife" (Heath 1984). All of these programs involved soliciting the cooperation of landowners, who in most cases were farmers. These programs met with varying degrees of success for various reasons. Heath (1984) concluded that Cache County landowners held a strong aversion to government control of their land. Nish (1973) found a lack of interest and cooperation with programs he implemented while serving as upland game coordinator for the UDWR.

This study does not solicit the cooperation of individual landowners because roadsides are under the jurisdiction of either State or County roadside personnel (Attorney General State of Utah, personal communication, 1996). Rather, the success of the recommendations in this study require the cooperation of the UDWR, the Utah Department of Transportation (UDOT), and county weed supervisors in Cache County and other counties throughout Utah.

CHAPTER II

LITERATURE REVIEW

Introduction

A great deal of information relative to land use and pheasant habitat in Utah has been accumulated by Olsen (1977) and Olsen and Leatham (1976) of the Utah Department of Natural Resources, Division of Wildlife Resources (UDWR). Their research has dealt with ring-necked pheasant populations, habitat loss, and potential solutions to habitat loss in Utah. Olsen (1977) wrote a comprehensive literature review of pheasant habitat requirements and improvement methods. The review listed the general habitat requirements of pheasants. Olsen cited MacMullan's (1961) suggestion that the two main limiting factors over established pheasant range were winter cover and nesting cover. He suggested that nesting cover was the most overall significant factor throughout Utah followed by winter cover. In Olsen's review, Yeager, Low, and Figge (1956) reported that the degree of mortality to hens nesting in alfalfa determined Utah's yearly pheasant population success.

The most comprehensive literature on pheasant habitat, food habits, behavior, and history comes from C.G. Trautman. In 1952, Trautman authored a book for the South Dakota Department of Game, Fish and Parks entitled "Pheasant Food Habits In South Dakota" (Trautman 1952). Later, Trautman produced "History, Ecology and Management of the Ring-necked Pheasant in South Dakota" (Trautman 1982)

Habitat Requirements

The pheasant was first introduced to Utah from Asia in about 1890 (Heath 1984). The population grew with an intense stocking program until the late 1930's when pheasants were found in all suitable habitat in the state. According to Trautman (1982), there are four

main components of pheasant habitat: cover, food, water, grit and calcium (grit and calcium are considered one component). Cover consists of six types:

1. Winter cover
2. Loafing cover
3. Roosting cover
4. Nesting cover
5. Brood rearing cover
6. Protective cover

The six cover types were divided by Olsen (1977) into seasonal habitat requirements: winter, spring, summer, and fall habitat requirements. This literature review discusses the cover types using Olsen's literature review with Trautman's (1982) cover types descriptions and the Habitat Suitability Index Model for the ring-necked pheasant (Meyer 1987).

Winter Cover. Olsen (1977) described winter cover as cattails, bulrushes, and sedges that protect pheasants during winter storms or adverse weather. Olsen (1977) combined winter cover and protective cover as one cover type but Trautman (1982) separated the two. Gates and Hale (1974) determined that vegetative cover types used by the pheasant during winter months depended on snow depth. They found cattails to be used the most in areas of 12-15 inches of snow cover, while more herbaceous wildlflowers (asters, goldenrods, sunflowers) were utilized in areas of 8-11 inches of snow cover. Where there was no snow, sedge meadow and reed canary grass were preferred.

Larsen, Crookston, and Flake (1994) studied pheasant food plots in South Dakota. They found wetland vegetation to be the most critical winter cover type. Their population census found the greatest number of pheasants using wetland habitat for feeding and cover during the winter months. They determined that woody cover is the second most critical

habitat component because, during heavy snow events, pheasants flush to woody cover for protection.

Storm periods with strong winds, low temperatures, or heavy snow forced pheasants into more substantial cover, such as weed patches, willows, pine plantations, and shrub-carr wetlands (6-12 foot shrub growth with forb understory) (Olsen 1977). In Connecticut, Bishop (1944) observed pheasants leaving a grassy swale during heavy storms, but returning as soon as grass was again protruding through the snow. Shelter belt trees between roads and homesteads sometimes provided cover, but they typically lacked a sufficient understory (Meyer 1987; Trautman 1982).

Especially important to this thesis, Gates and Hale (1974) found ditchbanks to be the most valuable winter cover of the types of stripcover (i.e., narrow cover types such as fencelines, roadsides, ditches and railroad right-of-ways). Gates and Hale (1974) found pheasants prefered open fields with stubble during winter months, but utilized more vertical structure cover types, like wetlands, willow stands, or pine plantations, in the event of a storm or heavy snow.

Trautman (1982) noted that some pheasants traveled long distances between winter cover and a food source, but this was atypical. Most pheasants will choose winter cover located a considerable distance from a food source over a good food source with marginal winter cover (George Wilson, personal communication, 1996). The limiting distance is 1/4 of a mile radius from winter cover to a food source (Trautman 1982). The habitat suitability index model (HSI) prepared by the National Ecology Center in Fort Collins, Colorado (Meyer 1987) dissected winter cover into three types: (1) shelter belt, (2) nonlinear woody vegetation, and (3) persistent herbaceous vegetation.

Shelter belts only serve the purpose of providing winter cover if they are not inundated with snow. To achieve this, shelter belts should be wide and have shrub layering to catch the snow before it can accumulate in the interior of the shelter belt (Bue

1949). Meyer (1987) and Messmer and Mitchell (1995) suggested at least 10 rows of vegetation are necessary to achieve success of shelter belts as winter cover. One critical factor of shelter belts was stressed by Meyer (1987) who stated, "If shrubs or conifers are absent, the configuration is assumed to reflect low suitability as winter cover for pheasants." (p. 23)

Nonlinear woody vegetation is not considered a shelter belt. It is frequently a patch of shrubby plant material. This category must contain greater than 30 percent shrub canopy closure to be effective winter cover. Areas that support less than 5 percent shrub canopy cover are not considered to be of any winter cover value for pheasants (Meyer 1987).

Herbaceous vegetation can be quality winter cover if it does not fill with snow. Sather-Blair and Linder (1980) found that wetlands not supporting shrub layering experienced severe snow lodging unless they averaged greater than 50 acres (20 hectares). A minimum height of 3 feet (approximately 1 meter) is required for herbaceous vegetation to be considered suitable winter cover. However, herbaceous vegetation greater than 6 feet (approximately 2 meters) would be considered ideal winter cover (Meyer 1987).

Loafing Cover. The chief function of loafing cover is to provide protection for the pheasant to rest and preen between feeding periods (Pearce 1945; Olsen 1977). In Wisconsin, the shrub-carr wetlands were preferred loafing sites, especially with 12 inches of snow on the ground. Cattails ranked second and wildflowers as third. Sedge meadow and reed canary grass were poor loafing cover (Gates and Hale 1974).

Characteristics of good loafing cover include a minimum ground cover and an overhead canopy (Gates and Hale 1974; Weston 1954). Overall, structured woody vegetation is essential for loafing cover. Woody vegetation used for loafing cover should be concealed with an overhead canopy, as opposed to roosting cover, which needs an open canopy (Gates and Hale 1974). An overhead canopy was preferred for loafing because of

the overhead protection afforded from aerial predators, which were reported as a significant cause of mortality in Cache County (Roberson 1987).

In Utah, Olsen (1977) reported alfalfa-grass type vegetation was used during the spring for loafing with brush thickets, and shrubs and weeds used during the summer to escape from the summer heat. Loafing cover during the winter months was confined mainly to woodland cover. Wetlands were used in the winter months when woodlands were not available. During periods of heavy snowfall, larger concentrations of pheasants congregate in wooded areas for protection from the snow or because the typical herbaceous roosting or loafing cover was filled with snow.

Loafing cover was considered more critical than roosting cover by Gates and Hale (1974). Roosting cover can be satisfied in more than one vegetation type, but loafing cover is predominantly found in woody or brushy vegetation. Hanson (1958) noted that native vegetation was preferred to planted hedges for loafing cover and that roadsides usually afforded the native woody vegetation necessary for loafing.

In summary, preferred loafing cover was generally a woody vegetation type with an overhead canopy. Marshy vegetation was also used for loafing, but not as often as woody vegetation. Woody vegetation is particularly sought out during storms to provide shelter for pheasants. Because of a lack of woody vegetation, loafing cover is considered a limiting factor and more crucial than roosting cover.

Roosting Cover. According to Olsen (1977), spring and summer roosting cover was not difficult for pheasants to find. Generally, roosting cover was found in a variety of vegetation types including wetlands, ditchbanks, tall grasses and weeds. Pheasants usually did not seek roosting cover in tall trees during the spring and summer months. Beebe (1931) noted that most bird species will roost in the same locations for months if left undisturbed.

Pheasants roost in vegetation about 15 inches (38 cm) tall with stem densities between 65 to 323 stems per 10 square feet (1 square meter) (Lyon 1954). In the spring, summer, and fall, vegetation stem densities of this magnitude can be found in mixed grasses and forbs stands. In the winter, however, roosting sites are limited to areas characterized as persistant, strong vertically structured vegetation, such as cattails and bulrush. Pheasants will roost in woody cover if all other available cover is filled by snow. Roosting consumes large amounts of energy; therefore, it is ideal if roosting cover is located near winter cover so that pheasants do not overtax themselves (Meyer 1987).

Pheasants have exhibited a general movement toward lowlands as fall approaches (Sharp and McClure, 1945; Wight 1945). Green (1938) found over 50 percent of the fall roosting cover to be in cornfields, stubble fields, and short-slough grass. Willows and other woodlands, along with sweetclover, provided the rest of the roosting cover. Labisky (1956) noted an avoidance of heavy cover for roosting during the fall.

Nesting Cover. Spring is the most crucial time for nesting cover. Trautman and Fredrickson (1968) found the first clutch to be 38 percent larger than later clutches following the destruction or abandoment of the first clutch. This statistic emphasizes the critical importance of adequate spring nesting cover. Because new growth in the spring was typically not substantial enough for nesting cover, residual cover from the previous growing season, weeds, and forbs left over the winter usually provided the most nesting cover. The nesting cover in Wisconsin was divided into three cover types 1) wetlands, 2) strip cover (e.g, roadsides, fencelines, ditches, railroad right-of ways), and 3) diverted croplands or wastelands (Gates, Frank, and Woehler 1970). Olsen (1977) summarized literature on nesting features from authors throughout the country and displayed them in tabular format. The averages from the studies are shown below in Figures 1 through 3.

This study is particularly interested in the stripcover category. The line graphs show the stripcover category had the second highest percentage of nests (24%) and the

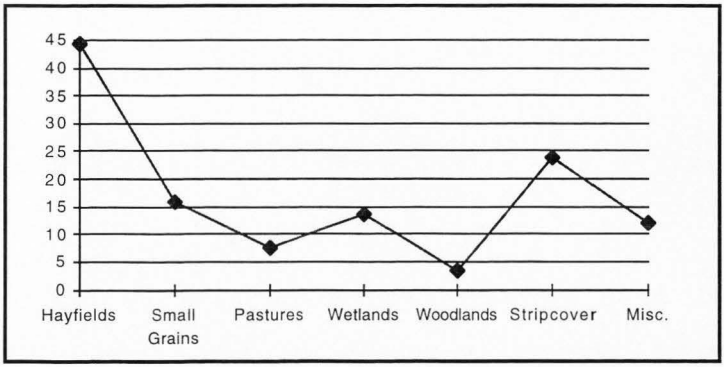


Figure 1. Percentage of nests found by vegetation type (modified from Olsen 1977).

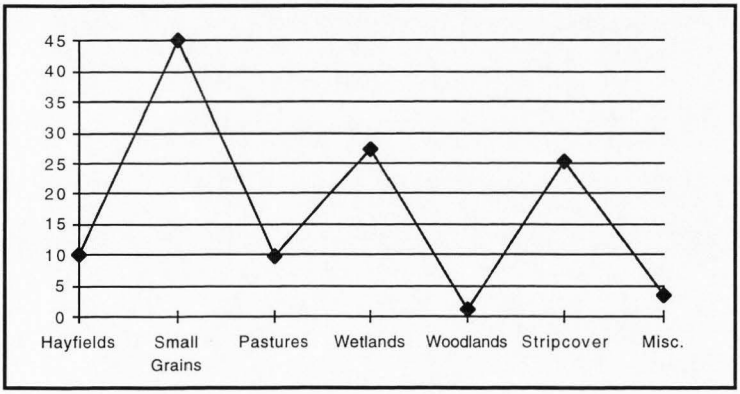


Figure 2. Percentage of chick production by vegetation type (modified from Olsen 1977).

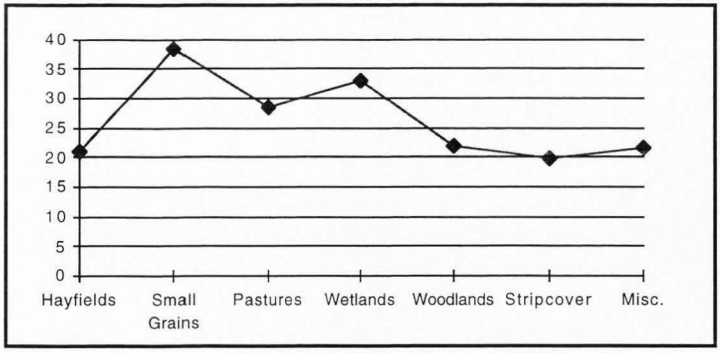


Figure 3. Percentage of hatching success by vegetation type (modified from Olsen 1977).

third highest percentage of chick production (25%) when compared to the other cover types. However, the stripcover category had the lowest percentage of hatching success (20%) of all the cover types. The reason for the low hatching success in the stripcover category may have been a result of roadside maintenance activities destroying nests or forcing hens to abandon nests before hatching.

Some literature has suggested the stripcover category to be travel lanes for predators (Randall 1939; Strode 1941; Rasmussen and McKean 1945; Baskett 1947). Joselyn, Warnock, and Etter (1968) disputed this claim with a study of an improved roadside and an unharvested hayfield. The hayfield actually showed higher predation but the difference was not statistically significant (Olsen 1977). Research done by Linder, Lyon, and Agee (1960) found 90 percent of the chicks in their study site were produced from nests in roadsides and wheat fields. Also noted in their study was the fact that roadsides totaled less than 1.5 percent of their study area, but accounted for 35 percent of all the chicks produced. This showed high nest density and success along roadsides. Hamerstrom (1936) broke down the stripcover category into three parts: railways, roadsides, and fencerows. Railways had a 35.7 percent hatching success rate, roadsides 27.5 percent,

and fencerows 20.6 percent. Gates and Hale (1974) found wider strip cover, like that found along railways and some roadsides, created a more attractive nesting site.

The pheasant reproductive season is generally from April to August. April, May, and June are the egg-laying months while July and August are generally for brood rearing (Snyder 1974; Trautman 1982; Meyer 1987). Some egg-laying occurs in the later months and is generally regarded as renesting attempts following predation or other causes of nest failure. The first clutch is often laid before most vegetation has put on any substantial growth. Therefore, hens seek residual cover from the previous year, which will afford protection from wind, rain, sun, and predators.

Snyder (1974) observed hens renesting into late June when prior nesting attempts were unsuccesful. A study by Trautman and Fredrickson (1968) showed that alfalfa was the preferred vegetative cover for nesting. Unfortunately in Utah, alfalfa does not put on substantial growth until the first of May. Mowing begins the first of June and continues every 4-6 weeks throughout the summer (Cache County Extension, personal communication, 1996). This brings high mortality of both adult pheasants and eggs that have nested in alfalfa fields (Heath 1984; Roberson 1987).

In Colorado, no significant difference in nest density was observed between unfarmed roadsides (.14 nests/acre) and seeded roadsides (.19 nests/acre). However, farmed roadsides showed a decrease in roadside nest density (.04 nests/acre) (Snyder 1974). Snyder's (1974) data showed the high nest densities found in roadside vegetation (Table 1).

Table 1 is modified from Snyder (1974) and compares pheasant density and nest density in roadsides and small grain fields. The data showed that roadsides produced more nests per acre than small grains; however, Snyder (1974) reported that nest success was typically higher in small grains than along roadsides, although no actual success rates were recorded.

TABLE 1.
Comparisons of Pheasant Density and Nest Density in Roadsides and Small Grain Fields (modified from Snyder 1974)

Location	Reference	Birds per sq. mi.	Nests per acre	
			Roadsides	Small Grain
Nebraska	Linder, Lyon, and Agee (1960)	29	1.67	0.15
Nebraska	Baxter and Wolfe (1973)	37	1.91	0.20
South Dakota	Trautman (1960)	147	1.87-2.82	0.14-0.57
Illinois	Joselyn (1970)	--	2.6 Seeded 1.2 Unmanag.	0.30
Pennsylvania	Hartman and Sheffer (1971)	40-120	--	0.04
Colorado	Snyder (1974)	20-30	0.8 Seeded 0.5 Unfarmed 0.2 Farmed	0.04

The height of vegetation was critical to early-nesting hens (Maurer 1986). Hanson (1970) found that the greater the plant height or density or both, the more hens used it for nesting. The density of the nest canopy along Nebraska roadsides was studied by Linder and Agee (1961), who found the highest roadside nest production to occur when 10 to 15 percent of the sunlight was intercepted by the nest canopy. Roadside vegetation was measured by Wiegers (1958 and 1959) and he found the predominant cover species to be 29.4 inches in 1958 and 19.6 inches in 1959. The literature agreed that denser vegetation and better nest concealment resulted in higher nest success (Olsen 1977).

Brood-rearing Cover. According to Pearce (1945), the key to brood-rearing cover was vegetation dense enough to provide protection, but not so dense as to hamper keeping chicks together. Wight (1945) and Kuck, Dahlberg, and Progulske (1970) noted that in the first 1-3 weeks of hatching, brood-rearing activities occurred near the nest. Hanson (1970) indicated that as broods grew older, the rearing area expanded. The average home range

during the nesting period was 37.2 acres and this expanded to 71 acres by August as broods became more mature (Hanson 1970).

The travel radius of the brood may range from 10 to 30 acres (Meyer 1987). Travel around the nesting site will last for approximately 3 weeks. In that time the young chicks will learn the basics of survival from the hen. Brood-rearing habitat needs are similar to nesting cover because the same level of protection is required. However, the plant density is relative to the juvenile pheasant's ability to move (Trautman 1982).

Ideal brood-rearing cover also contains more forbs, and consequently more insects, for the juvenile pheasant to feed on. Hayland, or weedy patches are ideal brood-rearing cover (Snyder 1974; Meyer 1987). In Utah, Bartmann (1966) found sagebrush to be prefered as brooding cover.

During the brood-rearing weeks, there is a general daily activity in which the pheasants participate. The morning is typically taken up by searching short grasses for droplets of dew and insects. From midday throughout the afternoon, the hens and chicks will move to heavier, taller grasses for loafing. Evening and nighttime roosting requires more unmowed, dense vegetation and an open canopy is preferred for roosting. Typically, brushy areas receive more use than tall trees or hedgerows during brood rearing. If all of the brood-rearing activities can be facilitated within 10 to 30 acres, then the habitat may be considered satisfactory brood-rearing cover (Meyer 1987). Lands adjacent to strip cover (roadsides and ditches), such as corn and wheat fields, become part of the brood-rearing area and help compose the 10 to 30 acre area needed for brood rearing.

Roadside brood-rearing habitat in Colorado was limited to spring and early summer. As the season progressed, pheasants utilized adjacent agricultural fields rather than roadsides for brood rearing (Snyder 1974). Speculation by Snyder (1974) is that pheasants moved to adjacent fields because of summer mowing maintenance along roadsides.

Food Habits of Pheasants

Trautman (1952) conducted a detailed food-habit review of both adult and juvenile pheasant in South Dakota. Figure 4 shows Trautman's (1952) findings for adult pheasants resulting in farm crops accounting for 82 percent of the yearly pheasant diet, weed seed for 7 percent, insects for 5 percent, plant foliage for 5 percent, and mineral matter for 1 percent (Figure 4). Olsen (1977) combined Trautman's (1952) food groups into vegetable, animal, and mineral, which resulted in a 94, 5, and 1 percent composition, respectively. Cottam (1929) found vegetable matter to comprise 85.5 percent of the yearly diet in Utah, animal matter as 14.5 percent. Cottam (1929) calculated the mineral uptake as a percentage of the food contents and found mineral uptake to be 26.2 percent of the food content.

In South Dakota, farm crops provided 81.7 percent of the monthly and yearly pheasant diet (Korchgen 1964). Korchgen (1964) ranked corn as the preferred food for adult pheasants, with an average of 57.2 percent of the yearly diet. Next were wheat and barley at 10.7 percent and 6.6 percent, respectively. Weed seeds were 7.1 percent of the diet. Foxtail (*Setaria lutescens* and *S. viridis*) was 2.7 percent and sunflower (mostly *Helianthus annuus*) 2.4 percent.

Korschgen (1964) compared the sexual differences of diet choices among adult pheasants. His goal was to determine first, if there was a differential amount of gravel taken between the two sexes and second, if a differential amount of calcium-bearing foods was taken during the production period. Korchgen found that plant foods were not significantly different, but that animal foods varied greatly with hens consuming greater amounts, mostly during April, May, and June. The amount of animal foods consumed by hens were 3.2, 4.7, and 6.0 percent for April, May, and June, respectively. Males took in 0.5, 2.8, and 0.2 percent animal foods during the same time period. For Utah pheasants, Cottam (1929) found grains to total 36.7 percent of the annual diet. Of the grains, he

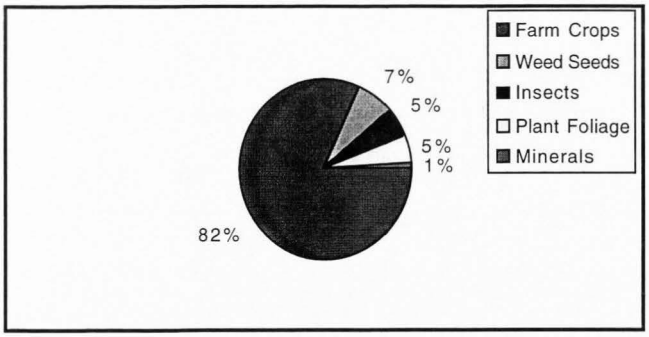


Figure 4. Food habits for adult pheasants (modified from Trautman 1952).

found wheat to be 79.7 percent, corn 10 percent, barley 10 percent, and oats 0.3 percent. Green plant material was 20.4 percent of the annual diet (Cottam 1929).

Olsen (1977) concluded his literature review of adult pheasants by stating that they are predominantly vegetarian and the staple diet consisted of corn, wheat, oats, and barley. He found the most predominant weed seeds to be ragweed (*Ambrosia spp.*), foxtails (*Setaria spp.*), smartweeds (*Polygonum spp.*), and sunflower (*Helianthus spp.*).

Juvenile Pheasants. Juvenile pheasants were found to consume insects in greater amounts than adults (Edminster 1954). Figure 5 shows the juvenile pheasant diet from Trautman (1952). Farm crops consisted of 50 percent, insects 28 percent, weed seeds 18 percent, plant foliage 3 percent, and minerals 1 percent.

Trautman (1952) determined the diets of adult pheasant consisted of 10.2 percent, 9.4 percent, and 8.3 percent animal matter during the months of July, August, and September, respectively. Juvenile pheasant diets consisted of 36.3 percent, 35.1 percent, and 22.0 percent of animal matter during the same time period. Trautman (1952) presumed that the relatively large amount of animal matter in the juvenile diet was to satisfy protein needs in the early stages of maturation.

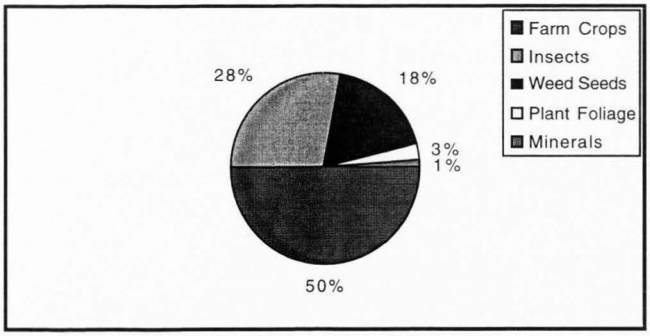


Figure 5. Food habits for juvenile pheasants (modified from Trautman 1952).

Water, Grit, and Calcium. Olsen (1977) cited Edminster (1954) as stating, "Any suitable pheasant range provides enough water for the birds' needs. They are able to get water from dew, insects, and succulent vegetation, as well as from bodies of water" (p. 30).

Olsen (1977) cited Pearce (1945) who noted pheasants preferred stream bottoms, swales, and swamp bottoms. Pearce (1945) suggested that of two similar areas, pheasants prefer a well-watered area to one that is not.

Grit was thought to be essential by some experts (Nestler 1946) and not considered "ecologically important" by others (McCann 1961; Olsen 1977). The majority of authors (McCann 1939, 1961; Dale 1955; Sadler 1961; Korschgen 1964) agreed that grit is an important source of minerals, especially calcium. Olsen (1977) felt there was enough evidence to support the idea that calcium availability is a factor in pheasant distribution and abundance.

McCann (1961) cited a distinction of uses between grit and calcium. McCann (1961 in Olsen 1977) wrote:

> For gallinaceous birds, gravel (as a grinding agent) is generally recognized as an aid to the gizzard. However, any material hard enough to act as an abrasive seems

> to suffice; therefore, in this role the need for grit seems hardly singular enough to have ecological importance. (p. 32)

In the same report, McCann (1961) used population density maps of Minnesota overlaid on soils maps and found population abundance was closely correlated with high calcium content in the soil. McCann (1961 In Olsen 1977) continued, "[G]rit of the proper chemical makeup is an ecological factor of paramount importance for the pheasant. In many situations it transcends in significance the factors of climate, cover, or any particular organic food" (p. 33).

Olsen (1977) summarized the importance of grit and calcium by concluding that grit may help in the digestive process, but is not necessary. He noted a close correlation between soil origin and pheasant distribution, with soils of recent glacial origin supporting the highest pheasant populations. He determined that calcium, although essential to pheasant reproduction and welfare, is not a limiting factor for pheasant distribution.

Dusting. Olsen's (1977) literature review found dusting to be considered a necessary part of pheasant daily hygiene (Ginn 1962). Ginn (1962) noted that loafing sites could serve as dusting grounds. In Utah, Bartmann (1966) found dusting sites among sagebrush areas. Wight (1945) believed that dusting served a purpose in feather development or hygiene.

Habitat Loss

On January 11-12, 1991, a group of at least 275 people attended a workshop in Salt Lake City called "The Future of Pheasants in Utah." Issues discussed dealt mostly with current land uses and program incentives to encourage landowners (mostly farmers) to retain pheasant habitat on their land (UDWR 1991). Workshop attendees answered questions related to Utah pheasant issues such as: "Causes, issues, or problems that result in low pheasant populations in Utah." Workshop attendees responded to the question by listing pheasant population problems. They were:

1. Lack of incentives for landowners.
2. Effects of predators.
3. No money for habitat development.
4. Deficiencies in total habitat needs.
5. Direct loss of habitat.
6. Nesting hen losses in hay.

Attendees were then asked to develop solutions to the effects of predation. The overwhelming response was to reduce predation by habitat manipulation. In other words, improve the pheasant habitat so that pheasants would be less susceptible to predation. The next question was "How do we develop funding for habitat development?" Again the majority of workshop attendees were in agreement and the solution was to develop a habitat stamp to fund habitat improvement programs. In 1995, the habitat stamp fund produced $250,000 for habitat restoration (Dean Mitchell, personal communication, 1995). The final question relating to habitat improvement was, "How do we increase the quality and quantity of pheasant habitat?" The conclusion was that pheasant habitat should cover the basic needs of nesting, feeding, and winter cover, and should have the right plants for the right areas (UDWR 1991).

Pesticides. The effects of pesticides (both insecticides and herbicides) on pheasants are difficult to quantify, but easy to detect. Larson (1991) found actual mortality due to pesticides is difficult to tell, but effects of pesticides are apparant. Larson (1991) partially attributed the decline of pheasants in Utah since the 1960's to the increased use of pesticides in pheasant habitat. Inhalation or direct ingestion of recently applied pesticides can cause reproductive problems, egg-thinning, or mortality. Researchers have documented weight loss in pheasants and quail when fed a diet containing Diazinon (trademark brand) (UDWR 1991). Herbicides are not considered directly harmful to pheasants; however, an indirect correlation for poor pheasant health is attributed to

herbicide applications. Herbicides reduced the plant material that housed insects, the main diet for juvenile pheasants (Potts 1986). Insecticides reduced the insect population and this affected juvenile pheasants. Herbicides reduced protective and roosting cover. In Utah, it was common to spray roadsides with herbicides and this reduced the useful habitat (Larson 1991).

Predation. Pheasants have many natural predators, including owls (*Asio spp.*), hawks (*Buteo spp.*), ravens (*Corvus spp.*), coyotes (*Canis latrans*), skunks (*Mephitis mephitis*), red foxes (*Vulpes vulpes*), and racoons (*Procyon lotor*). Mitchell (1990) believed increased predation on pheasants was a direct result of habitat loss and that in the last 33 years, 28 percent of Utah's pheasant habitat had been lost. To elaborate further, Roberson (1987) wrote that in Utah, the principal upland game bird preyed upon by crows, ravens, and magpies is the pheasant. Predation occurs when the young pheasants take flight or flightless pheasants can be taken on the ground. The second type of predation is nest predation. Avian predation, from those species noted above, destroyed a higher percentage of nests in April and May (Roberson 1987).

High predation is a direct result of poor quality and limited quantity of pheasant habitat. Mammalian predation on pheasant populations is lower than avian predation, but is growing in Utah (Roberson 1987). The pheasant population is devastated by avian predators due to poor nest site selection and poor protective or escape cover in winter months (George Wilson, personal communication, 1996).

Pheasant Habitat Improvement

Trautman (1982) wrote that with the increasing demand for more food to supply the increasing human population, pheasant habitat on farm lands would continue to decrease. He said that land under public control will afford the best long-term pheasant habitat. Possibly a change in roadside management could provide a significant effect on roadside

habitat quality and quantity. Camp and Best (1994) found the density of bird nests in Iowa roadsides to be greater than those found in croplands; however, low success and high predation were found in the roadside habitat as well. They proposed that seeding native prairie plants and using prescribed burns to maintain the native prairie plants would greatly improve pheasant habitat in Iowa. The manipulation of roadside cover was studied during a 4-year period in Illinois by Joselyn, Warnock, and Etter (1968). They studied three different types of roadsides: 1) seeded and not mowed, 2) not seeded and not mowed, and 3) not seeded and mowed. Their study showed that nest density and success was greater in the seeded unmowed roadsides (3.0 nests/acre), as opposed to the second roadside (2.0 nests/acre) and the third roadside (1.5 nests/acre). Joselyn, Warnock, and Etter (1968) maintained that the seeded, unmowed roadsides seemed to be more attractive to pheasant hens, which resulted in higher nesting densities.

Habitat Evaluation Techniques

The horizontal sampling method chosen for this study followed Daubenmire's (1959) recommendations. In Daubenmire's paper, "A Canopy-Coverage Method of Vegetational Analysis," he outlined the reasons for developing the "Daubenmire frame," an 8-inch wide (20 cm) by 20-inch long (50 cm) and 3/8-inch (.95 cm) thick metal frame. He noted that when sampling grasses or low-lying vegetation under or close to 3 feet (1 meter) tall, six critical factors should be considered to create an accurate sample of the ecosystem as a whole.

1. The two-dimensional plot is superior to linear or plotless techniques.
2. A series of small samples is superior to a single large stand.
3. Sampling of a stand is better achieved by increasing the number of plots rather than their size.

4. Elongated plots are superior to isodiametric shapes in that there is less possibility of a single plot coinciding with, or completely missing, the scattered isodiametric families by which most taxa are represented in a stand.
5. Large estimation classes are reasonably good assurances against significant personal error.
6. The series of plots used to sample one stand of vegetation must all fall within an area so uniform that intrinsic environmental diversity cannot be suspected as causing variation from place to place (Daubenmire 1959).

Daubenmire (1959) believed the 8-inch x 20-inch (20 x 50 cm) plot had proven accurate. Any larger, and the eye was forced to move around the plot, which introduced technician memory as a significant error factor. A smaller plot was too small to make an accurate estimate of the vegetative cover.

To determine the vertical structure and habitat quality along roadsides, this study chose to follow Nudds (1977). Nudds (1977) believed the vertical profile board (VPB) accurate in quantifying vegetative microhabitat used by birds and rodents. Chapter III explains the dimensions and use of the VPB.

Revegetation Techniques

For all state or federal highway revegetation projects in Utah, UDOT has followed a manual written by Hansen and McKell (1991) titled "Native Plant Establishment Techniques for Successful Roadside Revegetation." The manual specifically targets Utah roadsides and uses native plants to satisfy roadside engineering concerns such as erosion control, safety, ease of maintenance, etc. Hansen and McKell (1991) excluded roadside wildlife habitat as part of their revegetation strategies.

Another excellent source of revegetation information is a manual prepared for Salt Lake County Division of Parks and Recreation titled "Nature Area Revegetation Manual"

(Ecotone 1995a). Other sources for roadside revegetation techniques include "Applicability of Using Native Species for Highway Planting in Utah" by Carlson (1977) and "Interstate 215 Landscape Evaluation and Monitoring Report" by Landmark (1992).

Site Clearing and Preparation. Site clearing may consist of removing existing vegetation and stockpiling topsoil. Often overlooked is the aspect (orientation) of the topsoil before disturbance. After site disturbance occurs, the topsoil should be replaced for seedbed or planting bed preparation. Topsoil should be placed in the same aspect (orientation) as pre-disturbance for the native seedbank to have the best possible success.

Sometimes brush removal is necessary for revegetation techniques to be successful. If this is the case, the shrubbery should be chopped or shredded and amended to the existing soil to aid in soil conservation and contribute to the native seedbank (Hansen and McKell 1991; Ecotone 1995a). Other methods of removing undesirable plant material includes the use of herbicides such as Roundup or Rodeo (glyphospate, trademark brands) (Ecotone 1995a).

Seedbed Preparation. The ideal seedbed for direct seeding is very firm, but not compacted below the seeding depth; is well pulverized and has friable soil on top; does not have a cloddy or puddled surface; is free from live resident plant and weed competition; and contains moderate amounts of mulch or dead plant material within the soil surface. Soils that lack one or more of these charactersitics should be modified prior to planting (Hansen and McKell 1991). Seedbed preparation improves soil aeration, erosion control, and potential for adequate contact between the seed and soil; increases water infiltration; reduces excessive soil compaction; and provides a looser, cooler, more moist soil for seed germination (Ecotone 1995a).

The seedbed should be at least 3 to 4 inches in depth, deeper on drier or akaline sites. It should also be compacted so as to be firm. This is often accomplished by running

a tracked vehicle on the seedbed. This technique is known as cat-tracking and is recommended on steep slopes (Hansen and McKell 1991).

Seeding. For typical revegetation, adjacent undisturbed seed sources provide a significant amount of native seed. Unfortunately, many of the roadsides that could be targeted for wildlife habitat have been disturbed for years with mowing, spraying, and other maintenance techniques. Therefore, the native seed source is insufficient, non-existent, or consists of undesirable plant material. Direct seeding is considered the best method for revegetation because of this condition.

In the past, typical seed mixes used by UDOT for roadside revegetation included crested wheatgrass (*Elymus cristatum*), tall wheatgrass (*Elymus elongatum*), Siberian wheatgrass (*Agropyron sibericum*), alkali sacaton (*Sporabolus airoides*), and sand dropseed (*Sporabolus cyrptandrus*). The list has been expanded to include the above species with the addition of sideoates grama (*Bouteloua cirtipendula*), Indian ricegrass (*Orzopsis hymenoides*), and Sanberg bluegrass (*Poa sandbergii*). These grasses were mainly used for their erosion control properties (UDOT 1994). These grasses provide some elements of habitat for pheasants. However, crested wheatgrass and tall wheatgrass have typically been the most heavily used and the monoculture created by these species does not provide satisfactory habitat for pheasants.

Because purchasing plant material is a standard procedure for most revegetation projects, correct species selection is essential. The following criteria to determine appropriate seed species is modified from Ecotone (1995a):

1. Species must be adapted to site conditions, including the seasonal and total available moisture, soil restrictions that may be present (i.e., high akalinity/salinity) and climate.
2. Planting material or seed should be available, reasonably priced, and of good quality (or purity and viability in terms of pure live seed, PLS).

3. Barring extenuating circumstances, the use of native species is preferred (Thornburg 1982).
4. Mixtures of species should be used rather than single species to provide diversity and improve revegetation success. Additionally, species should not be overly aggressive, thereby reducing species diversity.
5. Selected materials should readily establish from seed and have good potential for self-propagation.
6. Seed should be free of noxious weeds and meet quality requirements of state laws. In addition, selected species should not pose potential weed problems to adjacent lands.
7. Legume species (plants in the pea family such as clover) purchased commercially must be properly inoculated with nitrogen-fixing bacteria in order to enhance the development of nitrogen-fixing root nodules.

The criteria for seed selection that applies to creating or enhancing habitat for pheasants in general is found in Trautman's (1982) review. Utah pheasant habitat requirements are found in Olsen's (1977) literature review and Heath's (1984) thesis.

Seeding Techniques. There are two main seeding techniques: broadcast application and drilling. Broadcast seeding is less effective than drilling therefore, the broadcast seeding rate should be twice the drilled rate (Ecotone 1995a). Broadcast application is useful in small areas, steep topography, or otherwise inaccessible to drill seeding equipment. This technique requires raking (by hand in steep or small areas), chaining, harrowing, or cultipacking to ensure seed coverage. The germination rate is not as high as drill seeding but the diversity in horizontal structure is greater because of the random nature of seed coverage and dispersal.

Broadcast seeding can be accomplished by three basic methods: hand seeding, machine broadcast, and hydroseeding. Hand seeding is effective for small areas, machine

broadcast is the most effective method for large areas, and hydroseeding is effective for inaccessible areas due to slope or other causes and when small seeds are used.

Drilling is the preferred method of seeding. This method of seeding must be done along the contour of the slope to prevent runoff from flowing down the drill row and causing erosion. The most significant advantages to drill seeding include improved seed coverage, reduced seeding rates, accurate seed metering and calibration, and the ability to seed into stubble. Some limitations to this method are that drilling cannot occur on slopes greater than 3:1, hard soil or rocks prevent proper seed placement, increased competition of seedlings in the drill row, and the drill rows may be aesthetically unpleasing (Ecotone 1995a).

For drilling, two types of drills are commonly used: the rangeland drill and the Brillion seeder (trademark brand). The rangeland drill is considered to be the most effective and able to handle difficult terrrain and fluffy seed. The disadvantage to this equipment is that typical row spread is too great to provide sufficient erosion control. The Brillion seeder (trademark brand) places the rows of seed much closer than the rangeland drill but it cannot handle difficult terrain or compacted, rocky soils (Munshower 1994).

The window for seeding is critical. The optimal seeding window in Nothern Utah is after mid-September but before snow accumulation. This allows for the most soil moisture available to the seedlings and also allows for seed scarification during the winter months. Seeding can occur in the spring or summer but with less effective results. If seeding does occur in the spring or summer, additional irrigation is required, but this is not the case with a fall seeding. More specific information on equipment calibration, planting depth, and seeding rates can be found in Ecotone (1995a) and Hansen and McKell (1991).

Planting. Container-grown plant material has typically not been utilized extensively for revegetation because of the additional costs. Thornburg (1982), however, indicated that the extra cost is offset by the increased survival rate. Perhaps the accelerated rate of

erosion control and plant establishment are added incentives. Plant materials for revegetation typically come as pole, sprig, bareroot, or containerized stock. Pole plantings consist of taking an existing sapling from another site, cutting it near the base, removing all lateral branches, and placing the sapling or pole into a small hole drilled to a depth below mean water table elevation in the desired location. In areas of shallow water tables with rocky, gravelly or sandy soils, this method has been successful (Ecotone 1995a).

Sprig stock is similar to the pole method except that stems are cut from hydrophytic shrubs rather than cutting the main stem (Ecotone 1995a). Bareroot means exactly that, the plant material has no growing medium around the roots. Bareroot plants are typically larger than the other types and cost less. A disadvantage is that they are difficult to plant correctly and it can take 2 years of advanced planning to have them ready for a project. Finally, containerized plants (plants grown in pots, cans, or packs of various shapes and sizes), which have had the highest success rates (Hansen and McKell 1991), are also the most expensive, but this can sometimes be offset by their availability and the increased flexibility they afford in the planting schedule. The optimal season for planting of containerized and bareroot trees and shrubs is the spring. If spring is not possible, fall is an acceptable alternative; however, lower survival rates should be expected due to poor root-to-soil contact throughout the winter (Hansen and McKell 1991). Quality tree and shrub plant material are available as containerized stock, typically in 3- or 10-cubic inch cone containers.

Maintenance. Motorist and maintenance personnel safety is an important factor when determining roadside maintenance procedures. The typical clear zone is 30 feet from the pavement, but this dimension varies greatly. Most of Utah's roadside managers prefer to clear all broadleaf vegetation from fenceline to fenceline. This is typically done by blanket spraying herbicide such as 2,4-d (Steve Dewey, personal communication, 1996). Mowing is the second most used maintenance tool. The current standard for county road

departments is to mow from the edge of pavement to the fence line (see Chapter V). Although this strategy alleviates safety concerns, it also eliminates wildlife habitat and stresses some species of grasses and forbs. The most detrimental effect of mowing and spraying is the reduced winter cover and residual nesting cover for the following spring (Olsen 1977; Heath 1984; Bruce Bonebrake, personal communication, 1996).

The timing of these maintenance practices greatly affects roadside wildlife habitat. Most roadside maintenance programs begin mowing roadsides in June and continue through September. Spraying usually begins before mowing sometime in May, weather permitting (see Chapter V). As noted previously, ideal nesting time for pheasants is from mid-May through June, and second or third attempts will occur through August (Olsen 1977; Trautman 1982). The current maintenance practices destroy pheasant nests and reduce all types of cover along roadsides.

Conclusion

In summary, the literature showed that winter and nesting cover were the most critical for pheasant habitat. Adequate food did not appear to be a limiting factor. However, adequeate food close to winter cover appeared to be very important for survival. The habitat needs between adult and juvenile pheasants were very similar, but the food habits varied, with juveniles requiring more insects than adults in their diet.

Revegetation strategies included broadcast seeding and drill seeding, with drill seeding being the most efficient, but not always possible in difficult terrain. Native species were the most successful in revegetation. Maintenance practices such as mowing and spraying affected pheasant populations more than any other factor. For roadsides to provide quality wildlife habitat, roadside plant communities must be managed in a way to support healthy, viable plant community and decrease roadside mowing and spraying practices.

CHAPTER III

METHODOLOGY

Background

The first step in this study was to gather data on existing roadside conditions throughout Cache County, Utah. The total acreage for the Cache Valley area was 503,162 acres. Irrigated cropland made up 117,340 acres, nonirrigated cropland or pasture 110,865 acres, and range and woodland 275,142 acres (Erickson and Mortensen 1974). Roadside acreage was estimated using Geographic Information Systems (GIS) data (Appendix A) to be approximately 15,000 acres.

Survey Techniques and Equipment

Windshield Survey. A windshield survey, often used by wildlife biologists to determine habitat or wildlife conditions (Crabtree, Broome, and Wolfe 1989), was selected for this study because of the extensive number of roadway miles evaluated. The windshield survey consisted of driving the majority of roads in Cache County (greater than 50%) and classifying the roadside plant communities into categories that accurately represented the dominant and most common roadside vegetation types. This was done by visually looking for similar plant community types such as wetlands, riparian areas, grassy swales, etc. After visually evaluating the roadside vegetation, categories were created to classify the vegetation into representative groups.

The roadside vegetation was classified into six representative categories that approximated 85 percent of the roadside vegetation in Cache County. The categories were:

1. Agricultural Seasonally Wet Ditch Bank
2. Agricultural Mixed Grasses
3. Wetland
4. Riparian

5. Grassland
6. Woodland

The roadside vegetation was divided into these categories because critical factors such as water or land use caused distinct plant material to be found in each of these categories. The GIS maps (Appendix A) show the locations of the study plots, watercourses, roadways and vegetation classifications in Cache County.

Sample transects were planned for each plant community. A linear transect was selected as recommended by Daubenmire (1959). The specific beginning location of each transect were selected randomly by tossing a small object over the shoulder along the right-of-way. From the location of the object the transect would begin and was always adjacent to the roadway. The transects were sampled once each month during the months of July, August, and September of 1995 and January of 1996. The number of transects for both the Daubenmire frame and vertical profile board (VPB) (see Plant Transect Equipment) were determined by trial and error. In July, only three plots were sampled along the transect for both the Daubenmire frame and the VPB. After analyzing the initial data, it was determined that three plots were insufficient for the Daubenmire frame but adequate for the VPB. Twenty more plots were sampled during August for the Daubenmire frame and three sample plots were measured with the VPB. The July and August data were then combined for both the Daubenmire frame and the VPB. In order to match the data, 23 plots were sampled along the transect with the Daubenmire frame in September and 3 plots were sampled with the VPB. In January, the Daubenmire frame was not used due to the severe snow lodging of the grasses. Only the VPB was used and it measured three plots in the same manner as the summer measurements. After sampling the initial six plant communities in June, it was determined that another wetland site needed to be included in the sample because the first wetland site (Wetland #1) did not support the diversity of vegetation typically found in roadside wetland sites.

Plant Transect Locations. The Agricultural Seasonally Wet Ditch Bank was the first study plot and was located on Highway 6, 1 mile west of the intersection of Highway 6 and 1000 West of Logan. The transect was situated on the north side of the highway. The Agriculturual Mixed Grasses transect was located .3 miles south of the intersection of Highway 30 and Highway 23 in Petersboro, Utah. The transect was conducted on the east side of the road.

Wetland #1 was located 5 miles west of the previously described intersection of Highway 6 and 1000 West of Logan and was located on the north side of the road. Wetland #2 transect was located in an area referred to as "The Barrens." The study plot was located .6 miles from the Amalga intersection where the county road crosses the "old railroad grade" and is directed west to Newton. The study plot was located on the north side of the road.

The Riparian transect was located where the Bear River and 3800 North intersect. This intersection is .5 miles north of the 3400 North and 2900 West intersection in Benson (a church house is on the north side of the intersection). The Riparian study plot was located on the north side of the road and on the east side of the river. Since conducting the transect for the Riparian study plot in the summer of 1995, the site has been converted into a boat ramp and parking lot, thus eliminating the riparian vegetation.

The Grassland transect was located along 5000 North in Benson. The site was 2.6 miles north of the intersection of 3800 West and 3800 North in Benson. The study plot was located on the north side of the road. The Woodland transect was located adjacent to an unnamed county road .10 miles west from where it intersected with Highway 30. The Woodland transect was conducted on the south side of the road.

Plant Transect Equipment. The equipment utilized to measure the existing roadside vegetation were a Daubenmire frame and a vertical profile board (VPB). Photographs of the roadside vegetation were taken during each transect visit to document seasonal changes.

The Daubenmire frame is approximately an 8-inch wide by 20-inches long (20 x 50 cm) by 3/8-inch (.95 cm) thick, steel rectangle. The percentage of vegetation filling the frame was estimated by the person collecting the data using the Ocular Estimation of Cover technique as described by Meyer (1987). Samples of the vegetation were taken and identified by the Utah State University Herbarium. Daubenmire (1959), in describing the use of the frame, recommended utilizing as many plots as possible. The test plots were linear along the roadside, spaced every 15 feet (approximately 5 meters). Twenty-three plots were measured in each vegetation category (3 in July, 20 in August, and 23 in September). The method of using the frame followed the original research done by Daubenmire (1959).

The VPB was placed in the same beginning locations as the Daubenmire frame and were spaced every 32 feet (approximately 10 meters). Three readings were taken of the VPB along each transect in each vegetation category following the method described by Nudds (1977). Similar to Nudds' (1977) method of reading the board, the VPB was viewed at 15, 32, 50, and 65 feet (approximately 5, 10, 15, and 20 meters) and it was determined that 32 feet (10 meters) provided the most consistency in data collection (Nudds chose 15 meters or 50 feet). The vegetation was scored from 1 to 5 depending on the amount of profile board obscured at 32 feet. The 1 to 5 ranking corresponded to the percentage of the obscured board (i.e. 1 corresponded to the range of 0-20 percent, 2 corresponded to the range of 21-40 percent, etc.) (Nudds 1977).

The VPB was constructed of plywood 7 feet 6 inches long by 1 foot wide and 1/2 inch thick. Figure 6 shows the dimensions of the VPB. Each block was 18 inches long and corresponded to the above ranking system starting at the bottom with a score of 1.

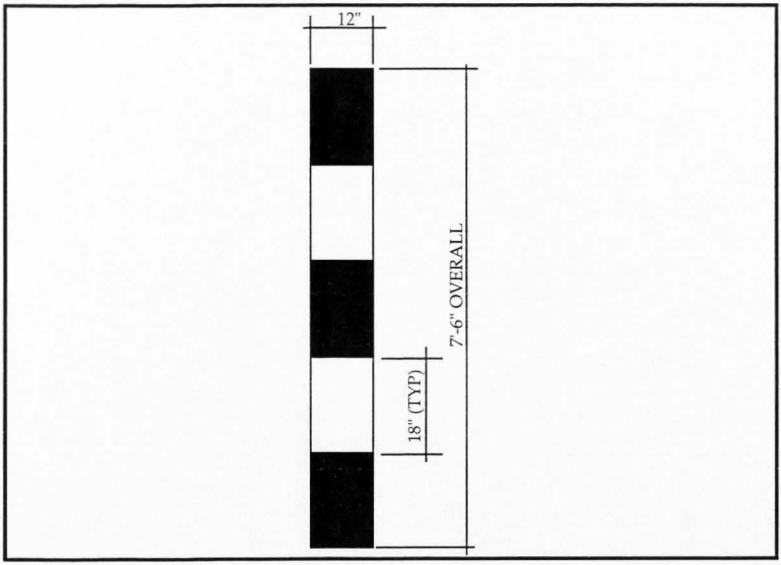


Figure 6. Vertical profile board (VPB) dimensions (modified from Nudds 1977).

Statistical Analysis

The Daubenmire frame density measurements were averaged (mean) and the standard deviation (SD) calculated for each species of grass located in the transect. The standard deviation measures how far "on average" a typical observation is from the mean of all the observations. In other words, standard deviation measures the variability of observations around the mean. If the percent of cover is high, it shows that the species is abundant in the category, and vice versa if the mean number is low. The standard deviation shows the relative uniformity of the species in the defined category across the total number of sampled points. For example, if the standard deviation is high, that shows the species occurred in patches and not throughout the transect. If the standard deviation is low, then the species occurred consistently throughout the transect.

Calculating the standard error is useful to determine the accuracy of the sample estimate. Standard error measures how far "on average" the sample mean is from the "true" mean. This can be calculated by simply dividing the mean number found for each species by the number of observations, which for this study was 23. This approach could be useful if one wanted to determine if the sample vegetation densities were representative of the entire plant community. In this study, it is more important to understand the standard deviation and how it applies to the uniformity found in each vegetation category because standard deviation most accurately displays species variability in the transect.

Questionnaire Sampling

After collecting roadside vegetation data concerning Cache County, a questionnaire was developed to determine roadside maintenance policies and practices for Cache County and for the rest of Utah. The type, timing, and frequency of existing roadside maintenance practices were determined from responses to the questionnaire that were sent to county weed supervisors statewide. A second questionnaire was sent to wildlife biologists, habitat specialists, UDOT representatives, and conservation groups in Utah, as well as in neighboring states. One intent of the questionnaire was to determine what types of roadside wildlife habitat programs may exist elsewhere. The results and discussion of the two questionnaires are found in Chapter V, and a sample questionnaire, with the corresponding results, is found in Appendix B.

Study Limitations

As with any research on vegetation or wildlife, this study has limitations. One of the obvious limitations is the sample size. This study will draw conclusions about Cache County roadside habitat in general while only sampling a fraction of the existing roadside vegetation and habitat. The small sample size was due to the lack of resources available to

gather data. However, results from this study can be used to draw conclusions concerning the existing plant materials that constitute roadside plant communities in Cache County.

Another limitation in determining the correct percent cover with the Daubenmire frame is that the field technician must estimate the percent cover inside of each sample plot using the Ocular Estimation of Cover method (Meyer 1987). This is a crude method, but it is still thought to be one of the best. Only one field technician conducted the data collection in order to provide the best consistency possible.

The questionairre provided data not only for Cache County, but for the entire state of Utah. Limitations concerning the questionnaire included small sample size and a relatively low return rate.

CHAPTER IV

RESULTS AND DISCUSSION

Background

This chapter reviews and discusses the results of the vegetation data collected on the previously described roadsides in Cache County, Utah. The nomenclature of the vegetation and descriptions follow Welsh (1993). Descriptions of existing roadside vegetation and photographs of each vegetation category (Figures 8-28) provide an assessment of the roadside plant communities and their surrounding context. The existing vegetation was evaluated using the results of the density measurements from the Daubenmire frame and the vertical profile board (VPB) found in Figures 29-31. These were rated and compared to ideal roadside habitat vegetation as described by Trautman (1982), Olsen (1977), Meyer (1987), and Messmer and Mitchell (1995). The ideal habitat is targeted for ring-necked pheasants and Utah conditions. Plan and section drawings to visually compare and contrast existing and proposed roadside habitat features are provided in this chapter.

The elevation of the valley floor where the transects were conducted ranges from 4,400 feet to 5,200 feet. The valley is surrounded by peaks reaching 9,980 feet. Annual precipitation ranges from 15 to 20 inches. The surrounding mountains typically receive 50 inches. Highest precipitation comes in the spring and winter seasons (Hull and Hull 1974). Geologically, the valley is a graben with the Bear River Range on the east and the Wellsville Mountains and Clarkston Mountain on the west.

Historical Plant Communities in Cache Valley

Descriptions of Cache Valley vegetation date back to the early 1800's. In 1832, Ferris wrote: "One of the most extensive and beautiful vales of the Rocky Mountain range

. . ., producing everywhere most excellent grass. . ." (Ferris 1940 in Hull and Hull 1974 p. 27). The initial planned use of the valley by the early settlers was livestock grazing, both cattle and sheep (Hull and Hull 1974).

Agricultural practices greatly affected the native vegetation of Cache Valley. Hull and Hull (1974) described the presettlement condition of the valley as an immense grassland. Native grasses originally found in the valley included (in order of abundance) beardless bluebunch wheatgrass (*Agropyron spicatum* var. *inerme*), streambank wheatgrass (*Agropyrum riparium*), Great Basin wildrye (*Elymus cinereus*), Junegrass (*Koeleria cristata*), Sandberg bluegrass (*Poa secunda*), western wheatgrass (*Agropyrum smithii*), and various species of bluegrass (*Poa spp.*). Sandy areas and ridge tops supported grasses such as Indian ricegrass (*Oryzopsis hymenoides*), needle and thread (*Stipa comata*), and sand dropseed (*Sporobolus crytandrus*).

Native forbs are thought to have been abundant on northern exposures and other favorable sites with sufficient moisture. These forbs included (in order of abundance) arrowleaf balsam-root (*Balsamorhiza sagittata*), little sunflower (*Helianthella uniflora*), stone seed (*Lithospermum ruderale*), flax (*linum lewisii*), lupine (*Lupinus spp.*), cleft-leaf balsam (*Balsamorhiza macrophylla*), hawksbeard (*Crepis spp.*), yarrow (*Archillea lanulosa*), and penstemon (*Penstemon spp.*).

Trees and shrubs were an important part of the original grasslands. Hull and Hull (1974) reported large patches of trees and shrubs located in various areas of the valley. The woody vegetation originally found in Cache Valley included (in order of abundance) sagebrush (*Artemisia tridentata*), bitterbrush (*Purshia tridentata*), rabbitbrush (*Chrysothamnus spp.*), chokecherry (*Prunus spp.*), serviceberry (*Amelanchier alnifolia*), wild rose (*Rosa spp.*), bigtooth maple (*Acer grandidentatum*), and Utah juniper (*Juniperus osteosperma*). The woody vegetation found along stream corridors has changed little, except for the intrusion of exotic species such as Russian olive (*Eleagnus angustifolia*) and

salt cedar (*Tamarix spp.*). The native grass species discussed previously were also native in the riparian plant communities.

The composition of these plant communities changed drastically with intense grazing by livestock. As grasses were cropped close to the ground, sagebrush (*Artemisia tridentata*) was able to more effectively compete for resources, and soon dominated the previous grasslands. Hull and Hull (1974) wrote: "Within 40 years after settlement, sagebrush was abundant and the settlers could count the migrating bands of sheep by the clouds of dust" (p. 27).

Plant Communities Surveyed in Cache Valley

After completing the windshield survey as described in Chapter III, six categories of vegetation were identified which described the type of vegetation found on roadsides in Cache County. These six types were:

1. Agricultural Seasonally Wet Ditch Bank
2. Agricultural Mixed Grasses
3. Wetland
4. Riparian
5. Grassland
6. Woodland

Approximately 85 percent of the roadside vegetation in Cache County was classified into these six categories. Figure 7 shows the estimated percentages of the vegetation types studied. This estimation is a result of the previously described windshield survey.

The pie chart in Figure 7 shows the Agricultural Mixed Grasses category covered the most area of any category with 30 percent (4,372 acres), followed by Agricultural Wet Ditch Bank category at 25 percent (3,643 acres), and the Grassland category at 20 percent

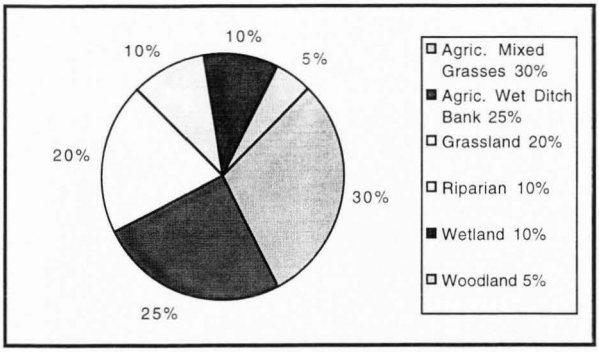


Figure 7. Percentage of roadside plant communities in Cache County, Utah.

(2,914 acres). Both the Riparian category and the Wetland category comprised 10 percent (1,457 acres) of the roadside vegetation in Cache County. Finally, the Woodland category comprised only 5 percent (728 acres) of roadside vegetation in Cache County. These areas were found primarily in draws and on north to northeast facing slopes where adequate soil moisture could sustain woody vegetation. Individual species descriptions of plant material found on Cache County roadsides can be found in Appendix D.

Species Density

The vegetation density of each roadside plant community in Cache County was measured using a Daubenmire frame and a vertical profile board (see Chapter III for methodology). The species density will be discussed with each roadside vegetation category in this chapter.

Agricultural Seasonally Wet Ditch Bank Category

Site Conditions. This vegetation type was located in the area between the road and adjacent fields. An irrigation ditch typically ran parallel to the roadway and contained seasonal running water, which supported the type of vegetation found in this category.

Ditches averaged 5-8 feet in width and 3-4 feet in depth. The overall ROW width averaged 30 feet from asphalt to fenceline. Because the water in the ditches was used for crop irrigation, water was nearly always present throughout the spring, summer, and early fall.

Community Description. Reed canary grass (*Phalaris arundinacea*) dominated the samples in this category. Frequently, reed canary grass formed monocultures along the ditch banks; few, if any trees or shrubs were observed (Figures 8 and 9). Farmers typically cleaned the ditches (usually with a backhoe or other large equipment) in the fall or early spring to remove sediment and vegetation growing along the ditch banks. The soil along the ditch bank was a silty loam abundant in nutrients, likely due to the annual cleaning of the ditches where the sediment from the ditch was heaped on the ditch banks.

Vertical Vegetation Structure. Heavy snows flattened the grasses found in this plant community (Figure 10); however, reed canary grass scored a 2 in the VPB readings throughout the summer, which demonstrated that this community provided fair protective and loafing cover for pheasants during spring, summer, and fall months.

Species Density. Reed canary grass (*Phalaris arundinacea)* averaged 38.7 percent of the area measured with the Daubenmire frame in July/August and 53.7 percent of the area sampled in September. Bare ground averaged 61.3 percent of the samples in July/August and 46.3 percent in September. The reed canary grass became more dense as the growing season progressed. Because of the aggresive nature and high density of this species, no other species of grasses were present in any of the transects taken throughout the growing season. It appeared that reed canary grass was able to choke out competing species. Other species observed in the wet ditch banks, but not occurring in the transects, included common rush (*Juncus effusus*), cattail (*Typha latifolia*), Hardstem bulrush (*Scirpus acutus*), and sedge (*Carex spp.*).

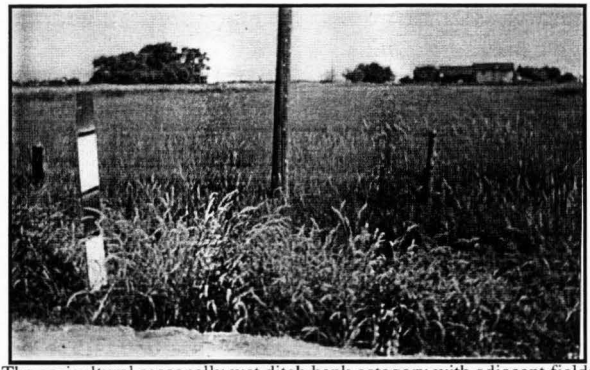


Figure 8. The agricultural seasonally wet ditch bank category with adjacent fields nearby (picture taken July 1995).

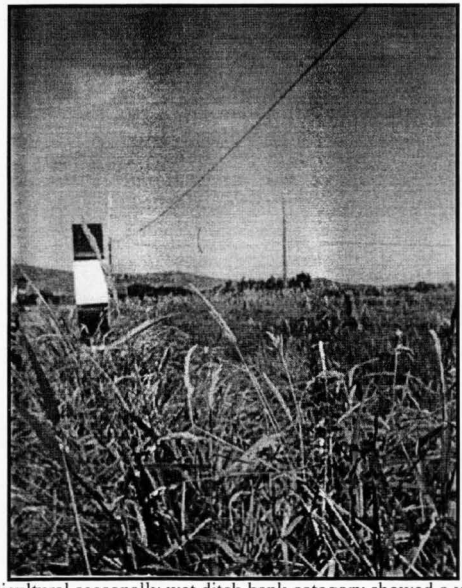


Figure 9. The agricultural seasonally wet ditch bank category showed a vertical profile board score of 2 (picture taken July 1995).

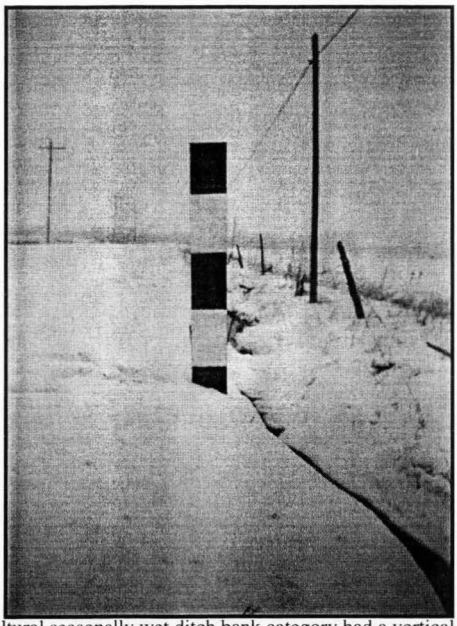


Figure 10. The agricultural seasonally wet ditch bank category had a vertical profile board score of 0 in the winter (picture taken January 1996).

Agricultural Mixed Grasses Category

Site Conditions. The Agricultural Mixed Grasses category was found along roadsides throughout Cache County. This plant community was located between the road and the agricultural crop/fields such as wheat, alfalfa, or corn. On average, the roadside was 30 feet wide. The gowing conditions were generally dry throughout the growing season and there was usually a slight swale between the roadside and the fields (Figures 11 and 12). This retained runoff from the fields as well as from the road.

Community Description. This category contained the largest variety of grasses found in the Cache County roadside survey. No trees or shrubs were found in this category. This was probably due to the farming practices of the adjacent landowners and

maintenance activities of county weed control personnel. Much of the ROW in this category was mowed as hay in late summer or early fall. The soils ranged extensively from sandy loam to clay.

Vertical Vegetation Structure. The overall snow lodging in this plant community was severe with a VPB average of .33 in January 1996 (Figure 13). The VPB averages in the transect were 1.25 in July/August and 2.3 in September, showing that even in the summer months this plant community did not provide quality vertical vegetative structure for wildlife.

Species Density. This category contained eight grass types, including cheatgrass (*Bromus tectorum*; 50.2% July/August and 43.5% September), smooth brome (*Bromus inermis*; 4.7% July/August and 16.5% September), western wheatgrass (*Elymus smithii*; 0% July/August and 6.1% September), Great Basin wild rye (*Elymus cinereus*; 1.0% July/August and 4.3% September), goatgrass (*Aegilops cylindrica*; 0% July/August and 3% September), crested wheatgrass (*Elymus cristatum*; 1.7% July/August and 2.2% September), tall wheatgrass (*Elymus elongatum*; 0% July/August and 0.9% September), and quackgrass (*Elymus repens*; 0.5% July/August and 0% September). Bare ground comprised 33.3 percent and 24.3 percent of the survey plots sampled in July/August and September, respectively.

Wetlands Category

Site Conditions. This category included both standing and flowing water and moist, hydrophytic soil. The description of the wetland community follows that given by the Corps of Engineers' Wetlands Delineation Manual. Wetlands are "those areas that are indundated or saturated with surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditons" (33 CFR 328.3(b) in Ecotone 1995b p. 3).

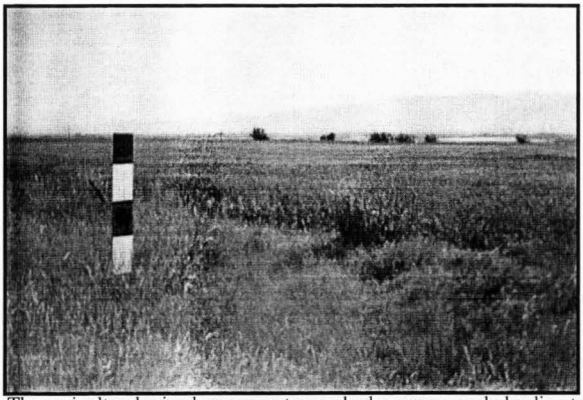


Figure 11. The agricultural mixed grasses category had a grassy swale leading to the adjacent wheat field (picture taken July 1995).

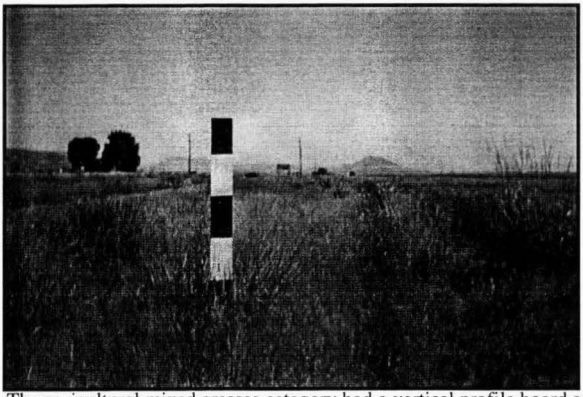


Figure 12. The agricultural mixed grasses category had a vertical profile board score of 1 during this sample period (picture taken July 1995).

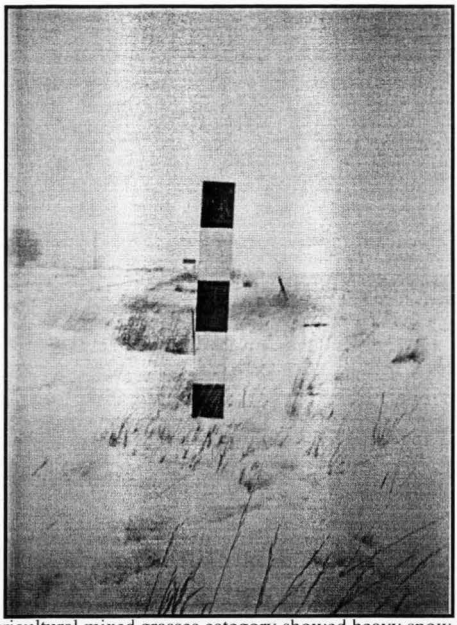


Figure 13. The agricultural mixed grasses category showed heavy snow cover with a vertical profile board average of .33 (picture taken January 1996).

To be considered jurisdictional wetlands, the area must exhibit three characteristics: wetland hydrology, hydrophytic vegetation, and hydrophytic soils. If an area does not meet these parameters, it is considered uplands or nonjurisdictional wetlands (Ecotone 1995b). The wetlands included in this study were considered jurisdictional wetlands because they exhibit all three parameters described above.

Community Description. Wetlands are a significant part of roadside vegetation because many of the wetlands in many times (Appendix A). Two wetlands in different parts of the county were evaluated Cache County are expansive and are bisected by roadways because the vegetation can differ greatly based on soils, hydrology, and adjacent seed source.

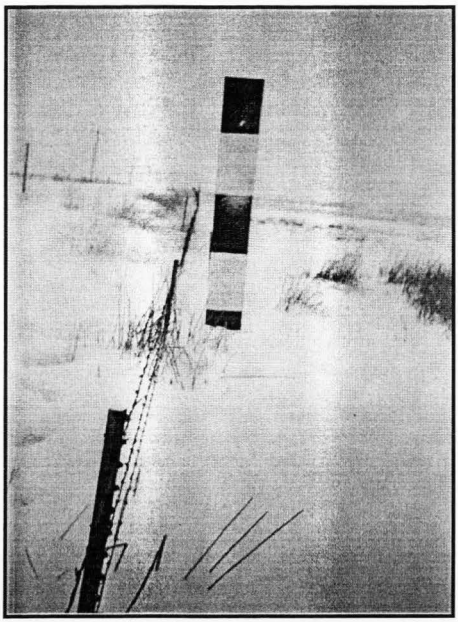


Figure 14. Wetland #1 showed severe snow lodging of bulrush with a VPB score of 0 (picture taken January 1996).

Wetland #1 (Figure 14) was located in the south part of Cache County and adjacent to a highway. Cattle grazed in this wetland, which affected the vegetation measurements because of trampling. In July and August of 1995, standing water was present. A month later, the water was absent and much of the vegetation was dried out. This wetland has a varying topography that included wetland areas and also fragmented upland areas. This type of topography created a varied edge that would have provided good wildlife habitat (Trautman 1982; Messmer and Mitchell 1995). Unfortunately, Wetland #1 was dominated by hardstem bulrush (*Scirpus acutus*; 15.4% July/August and 26.3% September), with a moderate variety of grasses. This alone would not have created poor habitat conditions,

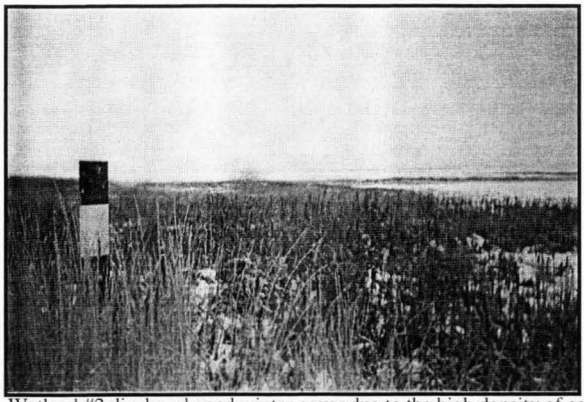


Figure 15. Wetland #2 displayed good winter cover due to the high density of cattail. The VPB averaged score was 3.0 (picture taken January 1996).

Figure 16. Wetland #1 contained dominant bulrush vegetation (picture taken July 1995).

but the vegetation trampled by cattle, coupled with a monoculture of bulrush, combined for poor habitat conditions.

Wetland #2 (Figure 15), in the northern part of Cache County, was situated along a dirt farm road abutting agricultural fields. The water flowed, but at a slow velocity and the wetland was wet throughout the summer months.

When comparing the two wetland study areas, Wetland #1 had more diverse vegetation, but also more open area (both bare ground and open water; 49% July/August and 50.2 % September). Wetland #2 had less diversity, but the vegetation was significantly more dense. For example, cattails (*Typha latifolia*) in Wetland #1 averaged 15.4 percent of the survey plots sampled in July/August and 7 percent in September. Cattails in Wetland #2 averaged 42 percent in July/August samples and 64 percent in the September sample. Other plants found in this plant community, but not in the transects sampled, included bluegrass (*Poa spp.*), Indian ricegrass (*Oryzopsis hymenoides*), little sunflower (*Helianthella uniflora*), lupine (*Lupinus spp.*), and yarrow (*Archillea lanulosa*).

Vertical Vegetation Structure. To compare the snow lodging of wetland vegetation in Wetland #1 and Wetland #2, see Figures 14 and 15. The snow lodging in Wetland #1 was severe, while the resistance to snow lodging by Wetland #2 was adequate for quality winter cover. Figure 16 shows the monoculture of hardstem bulrush in Wetland #1, which explained the severe snow lodging. Figure 17 shows a VPB reading and trampling of the wetland vegetation by cattle. Trampling severely reduced the quality of wildlife habitat in this wetland.

Species Density. The plant material found in Wetland #1 were cattail *(Typha latifolia*; 15.8% July/August and 7.0% September), hardstem bulrush *(Scirpus acutus*; 15.4% July/August and 26.3% September), reed canary grass (*Phalaris arundinacea*; 7.8% July/August and 2.6% September), cheatgrass *(Bromus tectorum*; 7.4% July/August and 12.6% September), bulbous bluegrass *(Poa bulbosa*; 2.8% July/August and 0.0%

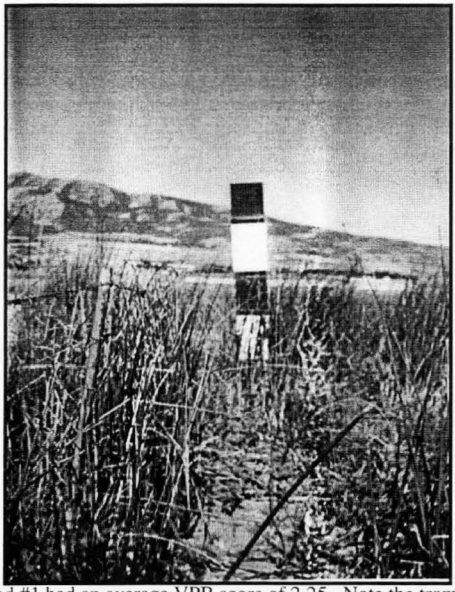


Figure 17. Wetland #1 had an average VPB score of 2.25. Note the trampled vegetation due to cattle in the wetland (picture taken July 1995).

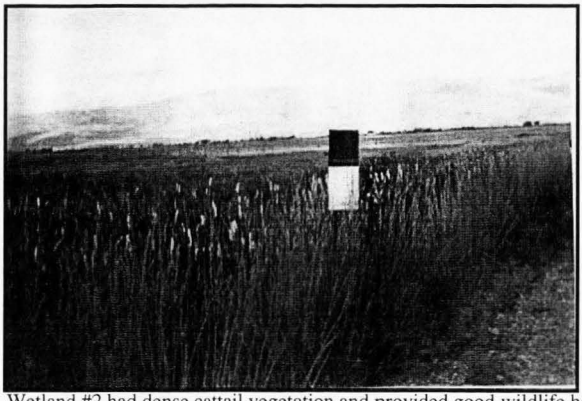


Figure 18. Wetland #2 had dense cattail vegetation and provided good wildlife habitat. (picture taken July 1995).

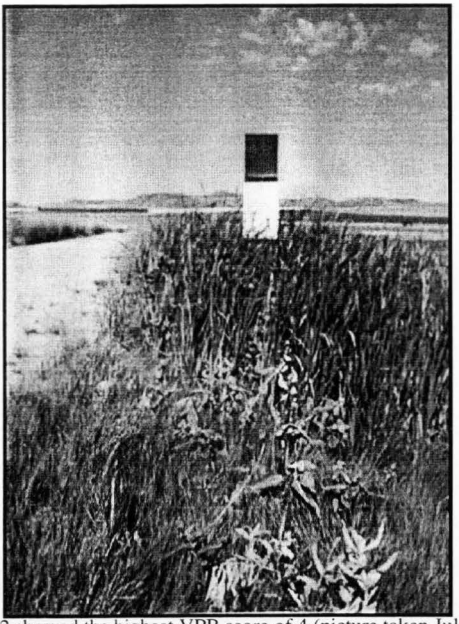


Figure 19. Wetland #2 showed the highest VPB score of 4 (picture taken July 1995).

September), and intermediate wheatgrass (*Elymus intermedium*; 0.4% July/August and 0.0% September). Bare ground or open water in Wetland #1 averaged 49 percent of the survey plots sampled in July/August and 50.2 percent in September.

Wetland #2 had cattail (*Typha latifolia*; 42.0% July/August and 64% September) as the most dominant vegetation type in the plant community (Figures 18 & 19). No hardstem bulrush (*Scirpus acutus*) was found in the study transect. The next most dominant vegetation found in this wetland was saltgrass (*Distichlis stricta*; 25.9% July/August and 20% September).

An abundance of teasel was found near Wetland #2 but was on the opposite side of the road (south side) where the transect occurred. Other grasses that did not fall within the

transect but were still located in the wetland were prairie cordgrass *(Spartina pectinata)*, alkali sacaton *(Spirabilis eroetis)*, foxtail barley *(Hordeum jubatum)*, red top *(Agrostis stolonifera)*, tufted hairgrass *(Deschampsia cespitosa)*, alkali bluegrass *(Poa nevadensis)*, and Canada bluegrass *(Poa compressa)*.

Riparian Category

Site Conditions. Riparian vegetation occurred in various places throughout the valley where roads paralleled or bisected river corridors. In most locations it was the Bear River riparian corridor bisected by roads. This category was typified by a raised roadway with steep banks leading down to the riparian area. The ROW was typically 30 feet on either side of the roadway with slopes ranging from 5:1 to 2:1 and in some cases 1:1 slopes. Soils varied, but were mostly a clay loam, presumably deposited from flood events.

Some wildlife biologists at the Utah Division of Wildlife Resources believed riparian vegetation to be the best winter cover available in Cache County (George Wilson, personal communication, 1996). This study found riparian vegetation to be dense and diverse, but lacking good intermediate to tall grass structure in many places. Intermediate to tall grass structure is what comprised quality protective, loafing, and winter cover in Cache County. Roosting, nesting, and brood-rearing cover seemed to be fair quality along roadside riparian plant communities.

Community Description. Riparian vegetation in Cache County contained a diversity of trees, shrubs, and grasses. The sites were typically moist during the summer, becoming drier into the month of September and into the fall.

Vertical Vegetation Structure. Great Basin wild rye (*Elymus cinereus*) provided the most vertical structure of any grasses during both winter and summer seasons (see Figures 20, 21, & 22); however, the trees and shrubs provided the best winter cover (Figure 22).

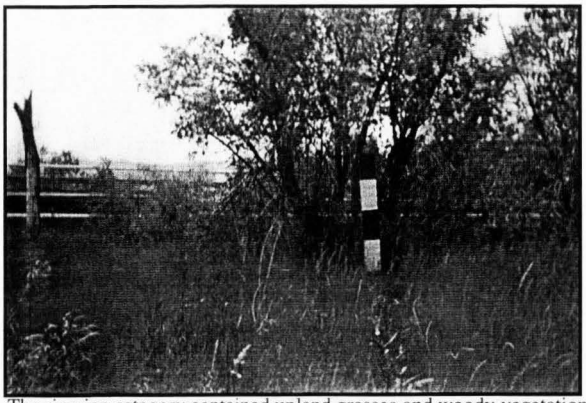


Figure 20. The riparian category contained upland grasses and woody vegetation (picture taken July 1995).

Figure 21. The VPB in the riparian category averaged a score of 1.5 (picture taken July 1995).

Figure 22. The riparian vegetation provided good structure during heavy winter snow, but the VPB still showed a score of 0 due to the snow lodging of grasses (picture taken January 1996).

Species Density. Vegetation found in the transect included Great Basin wild rye (*Elymus cinereus*; 48.5% July/August and 54.1% September), quackgrass (*Elymus repens*; 6.1% July/August and 0.0% September), narrow- leaf willow (*Salix exigua*; 3.9% July/August and 5.2% September), cheatgrass (*Bromus tectorum*; 2.2% July/August and 6.3% September), reed canary grass (*Phalaris arundinacea*; 0.4% July/August and 0.0% September), and meadow foxtail (*Alopercus pratensis*; 3.9% July/August and 1.1% September). Bare ground averaged 38.7 percent and 32.4 percent of the survey plots in July/August and September, respectively.

Vegetation identified in this category but not found in the transects sampled, included salt grass (*Distichlis stricta*), foxtail barley(*Hordeum jubatum*), Japanese brome (*Bromus japonica*), Rabbitfoot (*Polypogon monospeliensis)*, Russian olive (*Eleagnus angustifolia*), narrow-leaf cottonwood (*Populus angustifolia*), red-twig dogwood (*Cornus stolonifera*), and wild rose (*Rosa woodsii*).

Grassland Category

Site Conditions. The Grassland plant community was found in the ROW adjacent to nonproductive agricultural fields. The adjacent fields had been harvested in the past but were fallow at the time of this study. The plant community was a large percentage (25%) of the vegetation found along roadsides in Cache County. The ROW was typically 5 feet of bare ground from the pavement, followed by a 10 foot grassy swale and a 15 foot bank sloping gradually up to the adjacent agricultural fields.

Community Description. The grassland community was typically dry and the roadside vegetation appeared not to have been mowed or sprayed for some time (perhaps 3-4 years). The grasses were dry and tall and the soil was parched and cracked during the summer months. The soil varied greatly, but was generally a clay/loam mix.

Vertical Vegetation Structure. Grasses were dominant and trees and shrubs had not yet colonized the roadsides in this category (Figures 23 and 24). If trees and shrubs were part of this category, the habitat value would increase dramatically. The grasses did show some resistance to winter snow lodging (Figure 25). This provided some winter cover; however, woody cover with vertical structure was not close enough to consider this good habitat for the ring-necked pheasant (Meyer 1987).

Species Density. The Grassland category consisted of cheatgrass (*Bromus tectorum*; 40.4% July/August and 43% September), tall wheatgrass (*Elymus elongatum*; 18.7% July/August and 29.8% September), goatgrass (*Aegilopscylindrica*; 0.0% July/August and 4.8% September), Great Basin wild rye (*Elymus cinereus*; 2.0% July/August and 0.0% September), smooth brome (*Bromus inermis*; 0.0% July/August and 2.2% September), intermediate wheatgrass (*Elymus intermedium*; 1.3% July/August and 0.0% September), Japanese brome (*Bromus japonicus*; 1.1% July/August and 1.1% September), and bulbous bluegrass (*Poa bulbosa*; 1.1% July/August and 0.0% September).

Figure 23. This grassland contained tall stands of grasses and low-lying cheatgrass. This plant community lacked woody cover (picture taken July 1995).

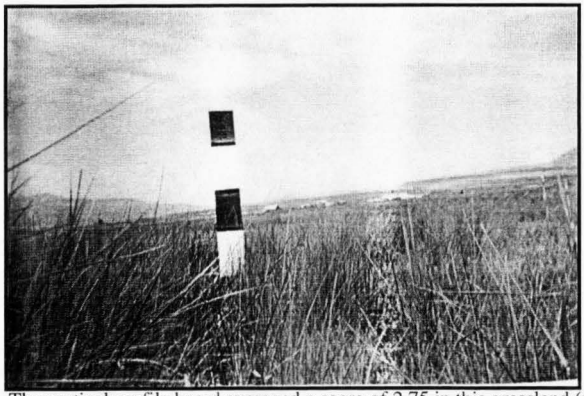


Figure 24. The vertical profile board averaged a score of 2.75 in this grassland (picture taken July 1995).

Other species of grasses in this plant community not found in the transect samples included western wheatgrass (*Elymus smithii*), quackgrass (*Elymus repens*), crested wheatgrass (*Elymus cristatum*), and goatgrass (*Aegilops cylindrica*).

Woodland Category

Site Conditions. The extent of the Woodland category was limited when compared to the other vegetation categories found in Cache County (only 5% of the roadside vegetation). In fact, it was challenging to find a woodland suitable for a transect during the windshield survey. Woodland vegetation did exist along roadsides in Cache County, but it was extremely sparse and fragmented. This vegetation type was found mostly on sites with a north to northeast aspect and was generally in some type of ephemeral drainage that provided enough moisture to support trees and shrubs. In some cases, high or perched water tables, as well as irrigation runoff, provided an area for woodland vegetation to grow.

Community Description. The dominant vegetation found in this roadside plant community were grasses, even though trees, such as narrow-leaf cottonwood and Russian olive, were found nearby (Figures 26 and 27). Shrubs such as wild rose (*Rosa woodsii*), basketbush (*Rhus aromatica*), and chokecherry (*Prunus virginiana*) were frequently found in association with the trees.

Vertical Vegetation Structure. The winter snow lodging of this plant community was minimal due to the woody cover and the tall wheatgrass (*Elymus elongatum*; Figure 28). The VPB averaged a score of 3 because of the tall wheatgrass.

Species Density. The transects ran parallel to the road and measured wild rose (*Rosa woodsii*; 0.9% July/August and 0% September), the only shrub found near the road. Grasses found along the transects included tall wheatgrass (*Elymus elongatum*; 30.4% July/August and 38.3% September), cheatgrass (*Bromus tectorum*; 23.5% July/August and 19.6% September), western wheatgrass (*Elymus smithii*; 0% July/August and 2.6%

Figure 25. The grassland category showed a resistance to snow lodging. The VPB averaged a score of 3 in the winter (picture taken January 1996).

Figure 26. The woodland category contained quality woody cover and upland grasses for good wildlife habitat (picture taken July 1995).

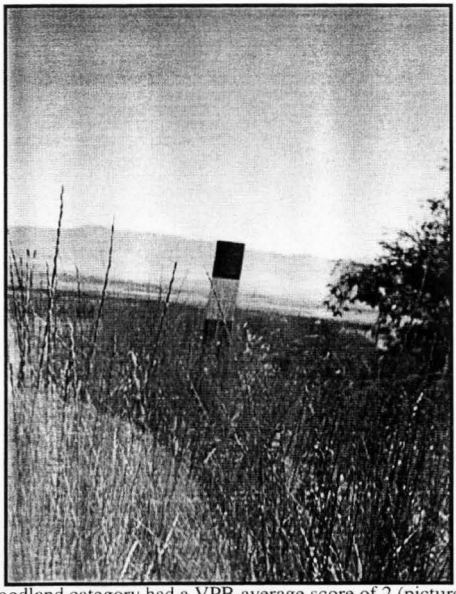


Figure 27. The woodland category had a VPB average score of 2 (picture taken July 1995).

Figure 28. The woodland category showed winter snow lodging of cheatgrass. However, the tall wheatgrass resisted lodging resulting in a VPB average of 3 (picture taken January 1996).

September), and Great Basin wild rye (*Elymus cinereus*; 1.7% July/August and 2.6% September).

Other grasses found in the area but not included in the transects were Japanese brome (*Bromus japonica*) and wild oats (*Avena spp*). Basketbush (*Rhus aromatica*) was a shrub found near the roadside plant community, but was not included in the transect. The area chosen for the transects had been reseeded for erosion control (Mike Curto, personal communication, 1995) which explained the monoculture near the roadside.

The Woodland category was significant because of the cover and food it provided for pheasants. All welfare factors were found within this category and the near absence of this plant community along Cache County roadsides needs to be addressed.

Habitat Analysis

The purpose of measuring the existing vegetation, and describing the type of vegetation found in Cache County, was to permit a comparison between existing habitat and what was considered "ideal" habitat for pheasants. In the previous literature review (Chapter II), the pheasant habitat requirements were described. This chapter discusses the specific habitat currently available on Cache County roadsides.

According to Trautman (1982), there are four main components of habitat. They are cover, food, water, and grit and calcium. Cover has been identified as the most limiting factor for pheasant populations, with the other components following in order of importance. Trautman (1982) suggested there are six cover components. These are protective cover, nesting cover, brood-rearing cover, loafing cover, roosting cover and winter cover. Winter cover was considered to be the most crucial cover component for pheasants in Utah, with nesting cover being the second most limiting factor (Nish 1973; Heath 1984; Bruce Bonebreak, personal communication, 1996; George Wilson, personal communication, 1996).

Protective Cover. The main function of protective cover is to facilitate pheasant movement and escape. In Cache County and elsewhere, there are three main types of protective cover: upland cover, lowland cover, and wetland cover.

The performance of roadside plant community types with respect to protective cover was based on the structure of vegetation found along existing roadsides in Cache County. Agricultural Seasonally Wet Ditch Bank, Wetland #2, and Riparian categories provided tall, dense vegetation so a rating of excellent was assigned. Wetland #1, Grassland, and Woodland categories provided tall vegetation, but it was not dense enough for protective cover. They recieved a rating of fair. The Agricultural Mixed Grasses category did not support tall nor dense vegetation and a rating of poor was assigned for protective cover.

Nesting Cover. To be considered quality nesting cover, roadside vegetation needed to provid mid-height cover, withstand snow lodging, and contain enough residual vegetation for nest protection. In Cache County, no roadside vegetation recieved an excellent rating. Nesting cover was rated fair for Wetland #2, Grassland, and Woodland categories, and poor for the Agricultural Seasonally Wet Ditch Bank, Agricultural Mixed Grasses, Wetland #1, and Riparian categories. This was a result of poor residual vegetation in all the categories. If the vegetation was able to withstand snow lodging, and provided mid-height cover, it was rated as fair.

Brood-rearing Cover. Ideal brood-rearing habitat should be semi-dense vegetation that allows the broods to move around. It should also provide short grasses for the morning feeding on insects and taller, heavier grasses to escape predators and the afternoon sun. Brood-rearing habitat along roadsides in Cache County was excellent in the Riparian and Grassland categories. Both of these plant communities provided residual tall, but not dense vegetation during spring and early summer months. This is when pheasants utilize roadsides most for brooding cover (Snyder 1974). Agricultural Mixed Grasses, Wetland #1, Wetland #2, and Woodland categories were fair. These ratings were given because

either the plant community was too dense for brood rearing, like the Wetland and Woodland vegetation, or the community did not support tall vegetation, for example the Agricultural Mixed Grasses category. Brood rearing was poor in the Agricultural Seasonally Wet Ditch Bank category because the vegetation in this plant community was too dense for brood-rearing activities.

Loafing Cover. Loafing cover consists of shrubs and weeds during the summer months and brush thickets during the winter. An overhead canopy is essential to escape aerial predators (Roberson 1987). Wetland #2 and the Woodland categories provided excellent loafing cover because the vegetation provided quality structure and did not fill with snow. Tall vegetation in Wetland #2 provided overhead protection from predators. In the Woodland plant community, an overhead canopy of woody vegetation allowed pheasants to elevate above the snow for loafing. Agricultural Seasonally Wet Ditch Bank, Wetland #1, Riparian, and Grassland categories all provided fair loafing cover. These were rated as fair because they provided good loafing cover for most of the year, but did not provide loafing cover in conjunction with winter cover. The Agricultural Mixed Grasses category was poor because no tall vegetation or overhead protection was provided by this plant community.

Roosting Cover. Trautman (1982) stated that pheasants prefer to roost year round if suitable roosting sites are available. Spring and summer roosting cover should be about 15 inches tall (Lyon 1954). Fall and winter roosting cover needs medium dense to dense brush and small trees.

The Woodland and Riparian categories were rated as excellent for roosting because they provided roosting opportunities all year. Wetland #1, Wetland #2, and the Grassland plant communities were fair because they provided roosting cover during spring, summer and fall. Wetland #2 provided some roosting cover in the winter, but this was due to the lack of woody vegetation nearby that would have been prefered (Trautman 1982).

Roosting cover was rated poor in the Agricultural Seasonally Wet Ditch Bank and the Agricultural Mixed Grasses categories. At no time during the year did these plant communities support mid-height vegetation with an open canopy for roosting.

Winter Cover. Winter cover is what Trautman (1982), Olsen (1977), George Wilson (personal communication, 1996) and Bruce Bonebreak (personal communication, 1996) believed was the most rapidly disappearing habitat component, thus the most important to conserve or create.

The most significant factor when evaluating the effectiveness of winter cover is distance from a food source. If the cover is fragmented and located away from food sources, such as residual crops and fields, then the cover is of limited value (Bryan and Best 1994). As noted in Chapter II, the average traveling distance for pheasants is a 1/4 mile radius (Trautman 1982).

The best winter cover along roadsides observed in Cache County was provided by Wetland #2. Wetland #2 exhibited tall, dense residual vegetation. Overhead protection was provided mostly by the tall cattail (*Typha latifolia*). The Woodland category also received an excellent rating because grasses such as tall wheatgrass (*Elymus elongatum*) were dense, residual vegetation, and the adjacent trees provided quality overhead protection. The same would be true for the Riparian category, except the overhead protection from woody cover was too far from the roadside to be considered part of roadside habitat; therefore, the Riparian category contained fair winter cover. Wetland #1 contained an enormous amount of bulrush (*Scirpus acutus*), which is normally good cover, but the bulrush was severely lodged by drifting snow and trampled by cattle, so it was also rated as fair winter cover. The Agricultural Seasonally Wet Ditch Bank and Agricultural Mixed Grasses categories were poor in winter cover because of complete snow lodging.

Habitat Cover Analysis

Habitat cover components have been analyzed and compared with existing vegetation structure to determine the habitat value of roadside vegetation in Cache County. A Daubenmire frame was used to quantify horizontal density and a vertical profile board was used for vertical density (see Chapter III for methodology). The mean scores were combined and shown in Figure 29 for July/August 1995 data and in Figure 30 for September 1995 data. Figure 31 shows the vertical profile board data for July/August 1995 data, September 1995 data, and January 1996 data. The horizontal and vertical density data were evaluated by assigning whole numbers to either their percentage scores for horizontal density or to their height values taken from the vertical profile board for the vertical density values. Neither horizontal nor vertical densities have direct unit measurements such as meters or feet but are relative to the percentage of cover for horizontal densities or the percentage of obscured profile board for vertical densities (see Chapter III for methodology).

Table 2 shows the horizontal and vertical density conversions. The percentages for horizontal density came from Daubenmire frame readings. Cheatgrass (*Bromus tectorum*) was excluded from the density calculations because it was not considered valuable as wildlife habitat in any of the six cover types (Cronquist et al. 1977). It is very extensive in Cache County and was found in nearly every plant community. Snyder (1974) also excluded cheatgrass (*Bromus tectorum*) densities in his study of roadside nesting success (Table 1, Chapter II).

The vertical density measurements (Table 2) were assigned whole number scores directly from their combined scores (an average of all the readings) of vegetation height shown in Figure 31. Table 3 shows the combined whole number scores for each plant community surveyed. The total scores in Table 3 indicate a composite score taken from the

JULY 8-23 & AUGUST 19-21, 1995

	Agricultural Seasonally Wet Ditch Bank	Agricultural Mixed Grasses	Wetland #1	Wetland #2	Riparian	Grassland	Woodland
Bulbous Bluegrass			2.8% SD 8.6			1.1% SD 5.2	
Cattail			15.8% SD 31.4	42.0% SD 37.6			
Cheatgrass		50.2% SD 33.8	7.4% SD 20.5		2.2% SD 10.4	40.4% SD 31.3	23.5% SD 19.0
Crested Wheatgrass		1.7% SD 8.3					
Goatgrass							
Great Basin Wild Rye		1.0% SD 5.2			48.5% SD 37.9	2.0% SD 8.4	1.7% SD 8.3
Hardstem Bulrush			15.4% SD 24.0				
Intermed. Wheatgrass			0.4% SD 2.1	2.2% SD 7.4		1.3% SD 6.3	
Japanese Brome						1.1% SD 5.2	
Meadow Foxtail					0.2% SD 1.0		
Narrowleaf Willow					3.9% SD 8.9		
Quackgrass		0.5% SD 2.1			6.1% SD 15.3		
Reed Canary Grass	38.7% SD 17.6		7.8% SD 20.9		0.4% SD 2.1		
Saltgrass				25.9% SD 35.1			
Smooth Brome		4.7% SD 8.9					
Tall Wheatgrass			1.3% SD 6.3	3.9% SD 13.1		18.7% SD 27.4	30.4% SD 34.4
Western Wheatgrass							
Wild Rose							0.9% SD 4.2
Open	61.3% SD 17.6	33.3% SD 23.9	49% SD 28.2	26% SD 20.4	38.7% SD 33.4	35.4% SD 18.5	43.5% SD 25.0

Figure 29. Daubenmire frame readings for July and August 1995 showing percent of horizontal density. Blank spaces show a mean of 0 (0).

SEPTEMBER 16-23, 1995

	Agricultural Seasonally Wet Ditch Bank	Agricultural Mixed Grasses	Wetland #1	Wetland #2	Riparian	Grassland	Woodland
Bulbous Bluegrass							
Cattail			7.0% SD 11.5	64% SD 30.9			
Cheatgrass		43.5% SD 34.7	12.6% SD 21.6		6.3% SD 13.7	43% SD 30.4	19.6% SD 21.8
Crested Wheatgrass		2.2% SD 8.5					
Goatgrass		3% SD 11.1				4.8% SD 12.0	
Great Basin Wild Rye		4.3% SD 20.9			54.1% SD 41.2		2.2% SD 10.4
Hardstem Bulrush			26.3% SD 22.6				
Intermed. Wheatgrass				2.2% SD 7.4			
Japanese Brome						1.1% SD 5.2	
Meadow Foxtail					1.1% SD 5.2		
Narrowleaf Willow					5.2% SD 12.7		
Quackgrass			1.3% SD 4.6				
Reed Canary Grass	53.7% SD 19.4		2.6% SD 12.5				
Saltgrass				20% SD 36.6			
Smooth Brome		16.5% SD 22.3				2.2% SD 8.5	
Tall Wheatgrass		0.9% SD 4.2		0.9% SD 4.2		29.8% SD 27.0	38.3% SD 37.9
Western Wheatgrass		6.1% SD 14.4					2.6% SD 6.9
Wild Rose							
Open	46.3% SD 19.4	24.3% SD 19.0	50.2% SD 29.8	15.1% SD 11.6	32.4% SD 35.9	20.2% SD 13.2	37.3% SD 26.5

Figure 30. Daubenmire frame readings for September 1995 showing percent of horizontal density. Blank spaces show a mean of 0 (0).

	Agricultural Seasonally Wet Ditch Bank	Agricultural Mixed Grasses	Wetland #1	Wetland #2	Riparian	Grassland	Woodland
July 8-23 & August 19-21, 1995	**2** SD 0.0	**1.25** SD 1.0	**2.25** SD 1.5	**3.75** SD 0.5	**1.5** SD 1.0	**2.75** SD 0.5	**2.5** SD 0.5
September 16-23, 1995	**2** SD 0.0	**2.3** SD 0.6	**1.67** SD 1.5	**3.66** SD 0.6	**2** SD 1.0	**3** SD 0.0	**3** SD 0.0
January 26, 1996	**0** SD 0.0	**0.33** SD 0.6	**0** SD 0.0	**3.0** SD 0.0	**0** SD 0.0	**3** SD 0.0	**3** SD 0.0

Figure 31. Vertical profile board readings for July-September 1995 and January 1996. The numbers represent the height of the vegetation relative to the percentage of obscured board.

sum of the plant community whole number rating system. The composite total was then used to analyze habitat cover by plant community based on vegetation density scores.

Habitat Cover Analysis Results. Wetland #2 ranked the highest in the plant community habitat analysis (Table 3) with a combined score of 15.8. When evaluated with the cover type characteristics in Table 4, Wetland #2 provided excellent protective cover, loafing cover, winter cover, and fair roosting cover. Nesting cover and brood-rearing cover were not supported by Wetland #2 because they require mid-height vegetation and Wetland #2 contained tall, rank vegetation.

The next highest scores belonged to the Woodland category (9.6) and the Grassland category (9.5). These scores were higher than the others because the vertical density readings found in all three evaluation periods were higher. Both of these categories provided good habitat structure for all six cover types. Protective cover, loafing cover, roosting cover, and winter cover were provided by tall, dense residual cover, while nesting

and brood-rearing cover were provided by mid-height vegetation mixed with tall vegetation.

The Agricultural Seasonally Wet Ditch Bank category scored a 9 because it exhibited dense horizontal vegetation and summer mid-height vertical density. The Riparian category scored a 8.3 mostly due to the relatively high horizontal density readings in the summer months. This community type did not display consistantly tall vegetation nor did the vegetation persist through the winter. Cover components provided by this community type were excellent protective and roosting cover, fair loafing cover, and poor winter and nesting cover. However, this community type was considered excellent as brood-rearing cover because the tall vegetation was not dense.

Wetland #1 scored a 7.5 and provided some protective cover, loafing cover and roosting cover, but the vertical structure was not considered tall enough to provide high quality cover. Winter cover was not provided by any of the last three categories (Agrictural Seasonally Wet Ditch Bank, Riparian, or Wetland #1) because the vegetation was severely lodged by snowfall. Nesting cover and brood-rearing cover were not well suited in these community types either because the horizontal density of the vegetation was too great.

The Agricultural Mixed Grasses category scored the lowest ranking with a 5.5. The vertical structure was insufficient to provide protective cover, loafing cover, roosting cover, or winter cover. The horizontal density did provide adequate brood-rearing cover, but the lack of residual vegetation made for insufficient nesting cover.

Table 4 summarized the findings from the plant community habitat analysis rating each plant community type as containing excellent, fair, or poor habitat cover. The cover types were protective, nesting, loafing, roosting, winter, and brood-rearing. An excellent rating was assigned if the plant community meet or exceeded the cover type characteristics described in the table. A fair rating was assigned if the plant community partially met the cover type characteristics or met the characteristics during one of the seasons. A rating of

TABLE 2.
Vegetation Density Measurement Conversion Table for Both Horizontal and Vertical Densities

Horizontal Density		Vertical Density	
0	0%	0	0
1	1-10%	1	.1-.5
2	11-20%	2	.6-1
3	21-30%	3	1.1-1.5
4	31-40%	4	1.6-2.0
5	41-50%	5	2.1-2.5
6	51-60%	6	2.6-3.0
7	61-70%	7	3.1-3.5
8	71-80%	8	3.6-4.0
9	81-90%	9	4.1-4.5
10	91-100%	10	4.6-5.0

TABLE 3.
Plant Community Habitat Analysis. Total Scores Reflect Combined Horizontal and Vertical Density Readings to Determine a Relative Habitat Quality for Each Plant Community Type

Community Types	Vegetation Density: Horizontal (Jly/Aug & Sep)	Vegetation Density: Vertical (Jly/Aug ,Sep.& Jan)	Total
Agric.- Seas. Wet Ditch Bank	5	4	9
Agric.- Mixed Grasses	2.5	3	5.5
Wetland #1	4.5	3	7.5
Wetland #2	8.5	7.3	15.8
Riparian	6	2.3	8.3
Grassland	3.5	6	9.5
Woodland	3.6	6	9.6

poor was assigned if the plant community did not meet the cover type characteristics. This is not to say that the cover types did not exist in these plant communities, but rather the plant community did not support the major characteristics describing the cover type as presented by Trautman (1982) and Meyer (1987).

Table 4 indicates that winter cover and nesting cover are the least well provided for by existing roadside conditions. Other types of cover did exist along roadsides, but their quality was generally only fair to poor. The only plant community that provided quality habitat overall was Wetland #2. Wetland #2 provided quality wildlife habitat because it contained a diversity of vegetation and quality winter cover with cattail.

Existing vs. Ideal Roadside Habitat. Ideal habitat was compared to existing habitat to determine the adequacies and deficiencies as habitat for pheasants. As discussed earlier, ideal pheasant habitat contains all welfare factors (cover, food, water, and grit and calcium) within a 1/4-mile cruising radius (Trautman 1982; Meyer 1987). Figure 32 shows a typical square mile of existing habitat taken from maps provided by the Natural Resource Conservation Service in Logan, Utah. The existing vegetation provided enough habitat for approximately three cruising radii of pheasants. Of course, more than one pheasant may live in this area, but this map shows an approximate distribution of pheasants over the area. Figure 33 shows that if winter cover were provided along roadsides in the same square mile, 10 cruising radii would be accommodated.

Agricultural Seasonally Wet Ditch Bank Category. The structure of this category was an extreme monoculture of reed canary grass (*Phalaris arundinacea*) (Figure 34). This resulted from the aggresive nature of the species. The ideal vegetation model for this category (Figure 34) shows trees and shrubs on the backslope of the ditch. This would provide winter cover, loafing cover, roosting cover, and brood-rearing cover. The adjacent land uses (agricultural crops) and the existing grasses would provide nesting cover and a

TABLE 4.
Habitat Quality Ratings by Plant Community Type

Habitat Cover Types	Cover Type Character-istics	Agric. Seas. Wet Ditch Bank	Agric. Mixed Grass.	Wet-land #1	Wet-land #2	Rip-arian	Grass-land	Wood-land
Protective Cover	Tall, dense vegetation	Excel.	Poor	Fair	Excel.	Excel.	Fair	Fair
Nesting Cover	Mid-height, residual vegetation	Poor	Poor	Poor	Fair	Poor	Fair	Fair
Loafing Cover	Tall veget-ation with overhead protection	Fair	Poor	Fair	Excel.	Fair	Fair	Excel.
Roosting Cover	Mid-height vegetation with open canopy	Poor	Poor	Fair	Fair	Excel.	Fair	Excel.
Winter Cover	Tall, dense residual vegetation with over-head protec-tion	Poor	Poor	Fair	Excel.	Fair	Fair	Excel.
Brood-rearing Cover	Tall, but not dense veget-ation	Poor	Fair	Fair	Fair	Excel.	Excel.	Fair

source of food and water. The ditches themselves would support the trees and shrubs and provide an excellent travel corridor between habitat patches.

Agricultural Mixed Grasses Category. Cheatgrass (*Bromus tectorum*) dominated this category and provided very little winter cover for wildlife. The ideal habitat struture for this category would consist of trees and shrubs mixed with grasses to provide the structure necessary for winter cover (Figure 35). The adjacent agricultural fields were an excellent food source, but did not provide the necessary cover to sustain long-term

Figure 32. Number of cruising radii for pheasants in existing habitat structure.

Figure 33. Number of cruising radii for pheasants in improved habitat structure by proper planning of roadsides.

pheasant populations. By establishing the trees and shrubs shown in the ideal habitat cross section (Figure 35), permanent habitat for all cover types (nesting, roosting, protective, loafing, brood-rearing, and winter cover) could be provided.

Wetland Category. The wetlands category consisted of two wetlands in distinct locations. The vegetation in Wetland #1 (Figure 36) was a virtual monoculture of hardstem bulrush (*Scirpus acutus*). The ideal habitat structure for this category would diversify the vegetation to include cattail (*Typha latifolia*) and forbs. Diverse wetlands provide better wildlife habitat (Olsen 1977; Trautman 1982; Meyer 1987).

Wetland #2 contained more diverse vegetation (Figure 37). The ideal structure for this location, and locations similar to it, would be to maintain existing wetland vegetation and promote diversity.

Riparian Category. The riparian category contained vegetation that was fair to good roadside wildlife habitat (Figure 38). This was primarily due to the narrow-leaf willow (*Salix exigua*) growing near the river and along the roadside. Great Basin wildrye (*Elymus cinereus*) provided good structure for wildlife during both winter and summer sampling periods. The ideal vegetation for this category would consist of trees and a layering of shrubs between the trees and grasses. The element missing in this plant community is a layering of shrubs between the tree canopy and lower grasses.

Grassland Category. The vegetation found along the roadside in the grassland category lacked woody structure to provide cover types. Nesting, brood-rearing, loafing, and limited winter cover were provided by the tall wheatgrass (*Elymus elongatum*). The addition of trees and shrubs, as shown in Figure 39, would provide more structure for roosting and protective cover, and improve existing structure for winter and loafing cover. Smaller shrubs could provide a food source with their berries, while taller trees could afford protection.

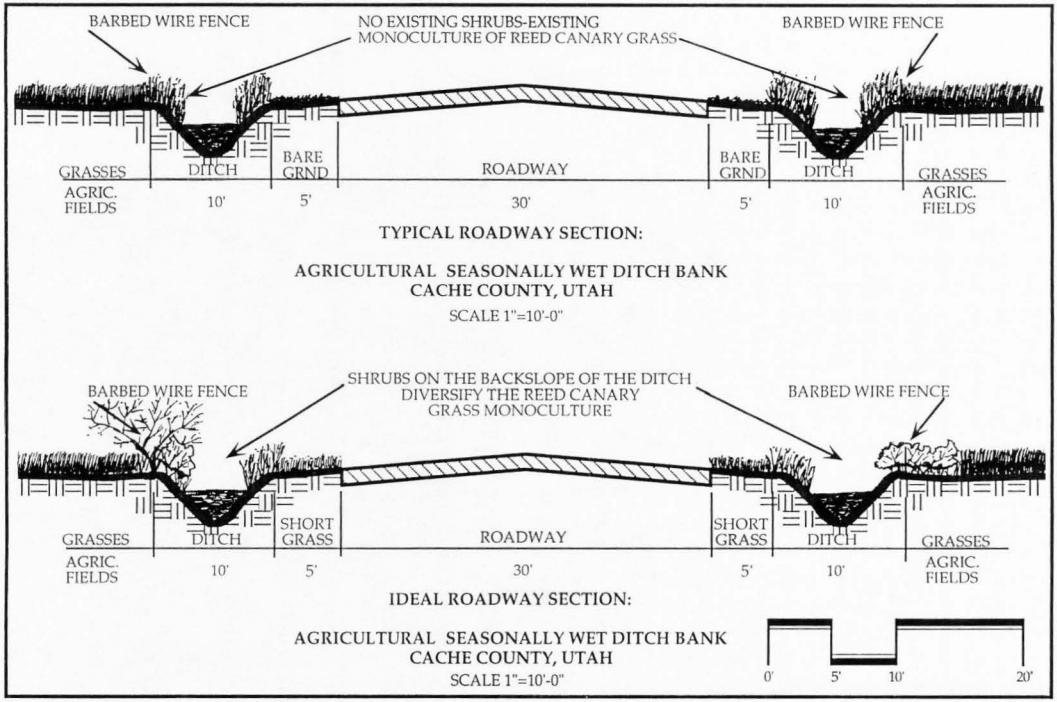


Figure 34. Existing vs. ideal habitat structure for the agricultural seasonally wet ditch bank category.

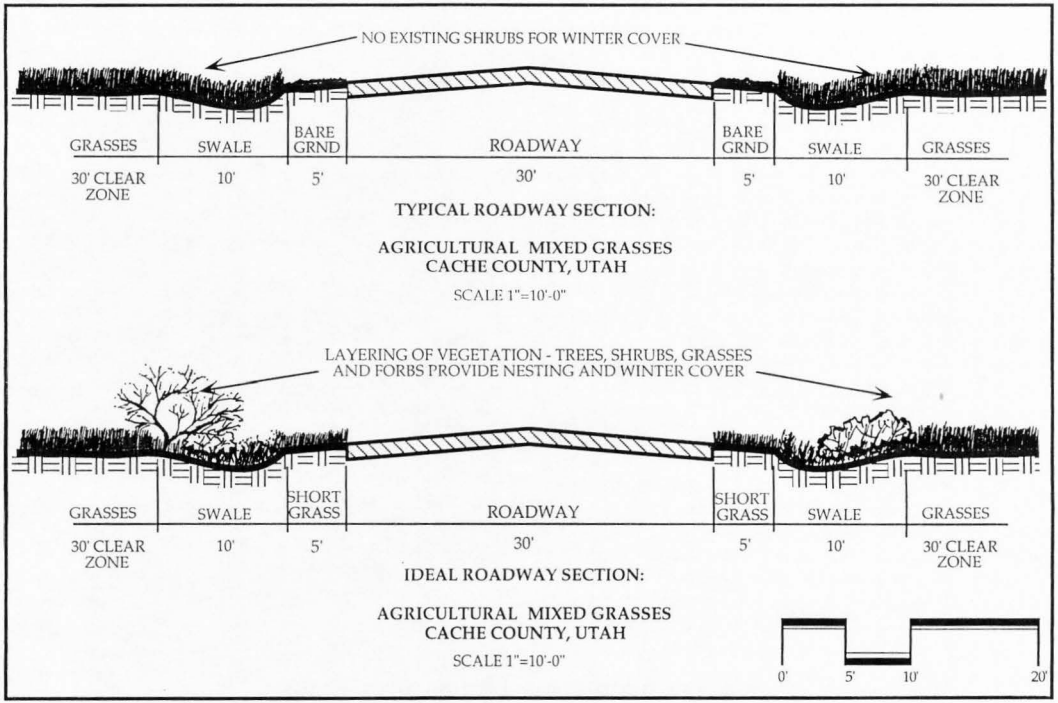


Figure 35. Existing vs. ideal habitat structure for the agricultural mixed grasses category.

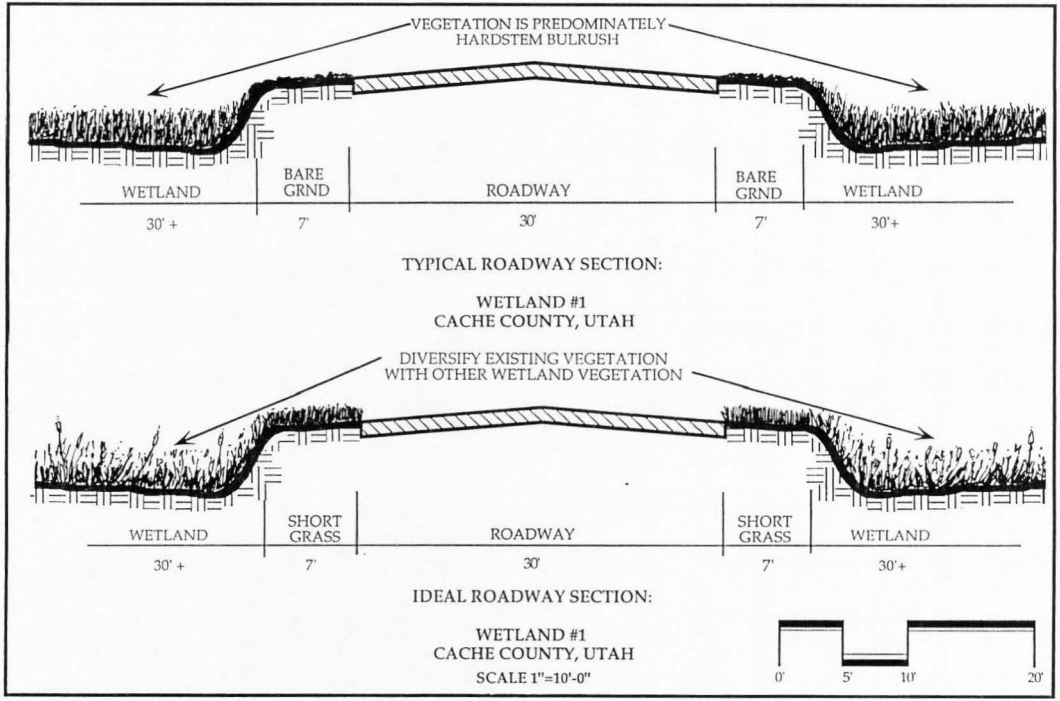


Figure 36. Existing vs. ideal habitat structure for wetland #1.

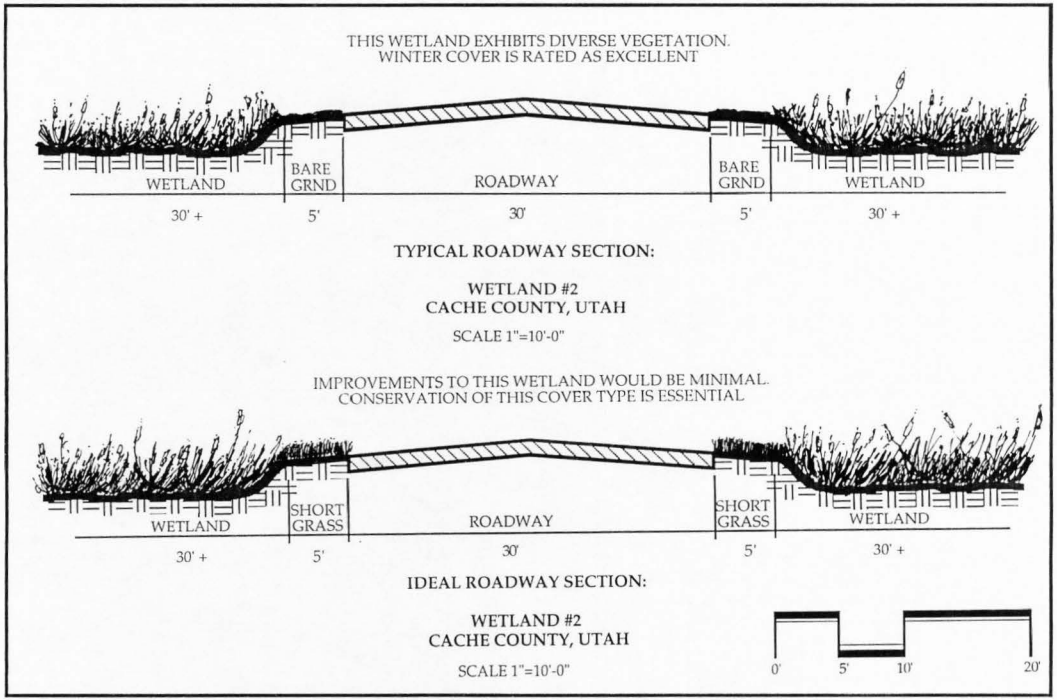


Figure 37. Existing vs. ideal habitat structure for wetland #2.

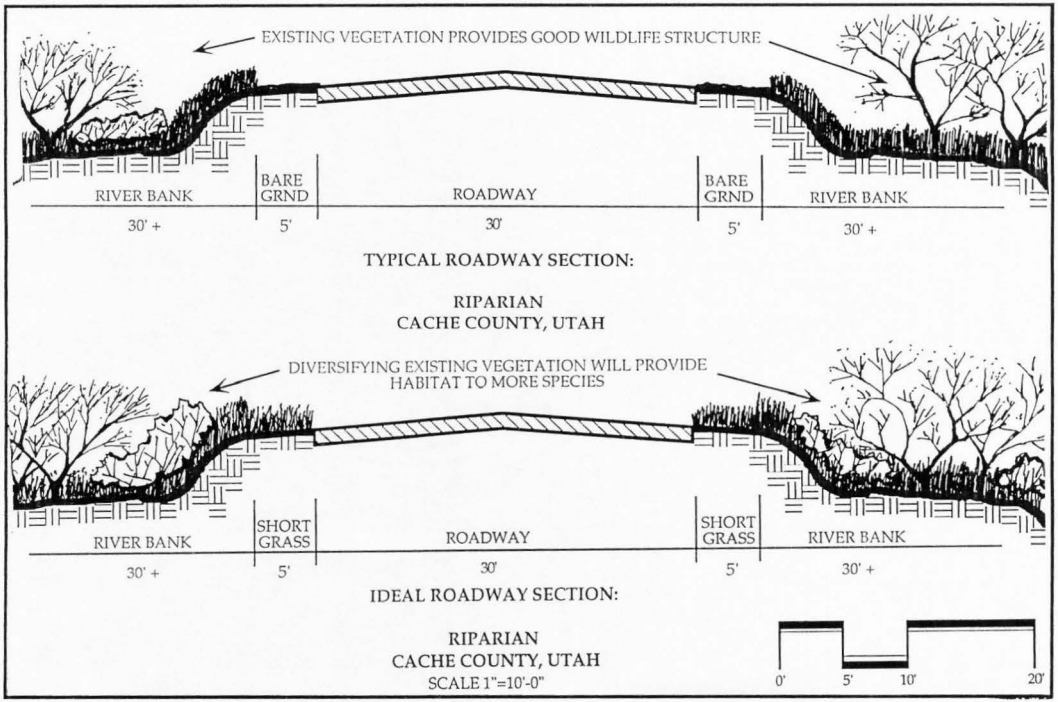


Figure 38. Existing vs. ideal habitat structure for the riparian category.

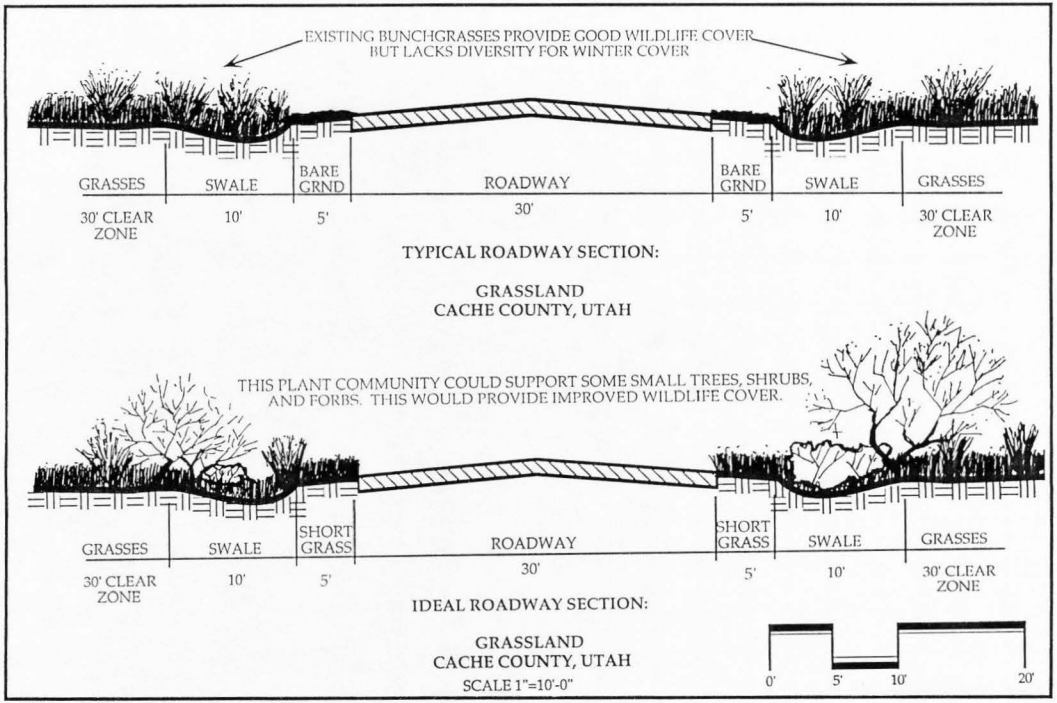


Figure 39. Existing vs. ideal habitat structure for the grassland category.

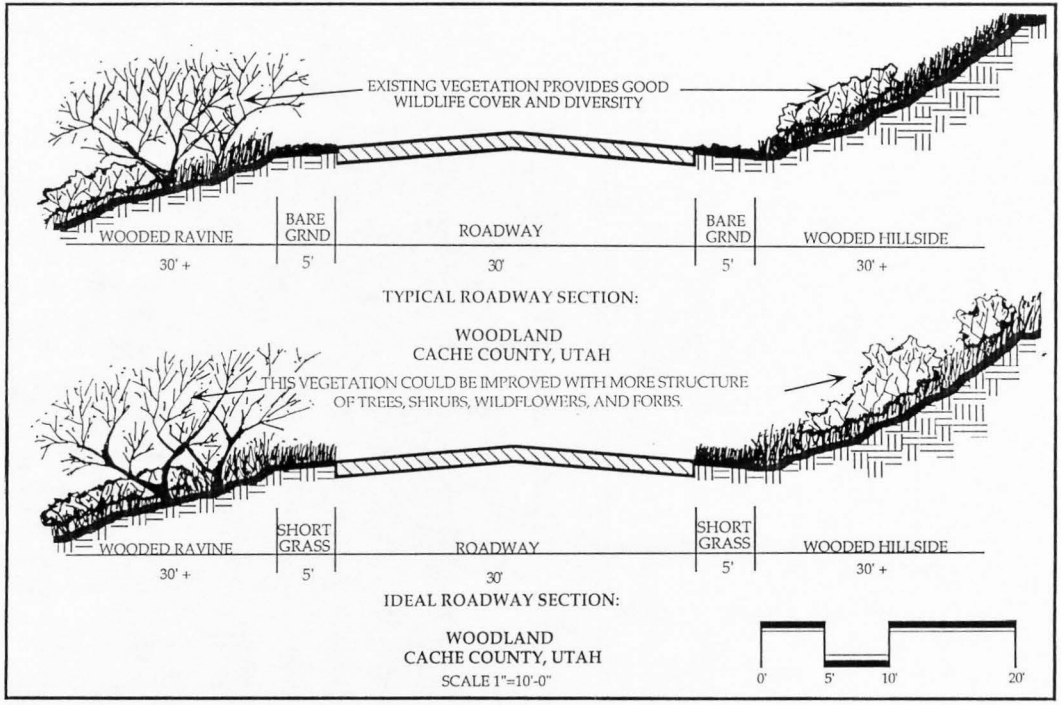


Figure 40. Existing vs. ideal habitat structure for the woodland category.

Woodland Category. The woodland category had good habitat structure and provided all six cover types (loafing, roosting, winter, protective, brood-rearing, and nesting). The immediate roadside consisted of tall wheatgrass (*Elymus elongatum*) with cheatgrass (*Bromus tectorum*) mixed in it. The wooded hillside and wooded ravine contained excellent understory vegetation as well as some tall trees to provide overstory protection. A food source was provided by adjacent fields of wheatgrasses, alfalfa, and corn. The ideal habitat for this category would contain groups of tree and shrub closer to the roadside, with grasses in the open areas (Figure 40).

Summary

The data gathered from July through September of 1995, and January of 1996, showed that cheatgrass (*Bromus tectorum*) is the predominant grass along Cache County roadsides. The next most dominant grass is tall wheatgrass (*Elymus elongatum*), followed by Great Basin wild rye (*Elymus cinereus*) and reed canary grass (*Phalaris arundinacea*). These findings are significant because they showed that native grasses were not successfully competing along Cache County roadsides (with the exception of Great Basin wild rye). They also suggest that there is limited plant species diversity on Cache County roadsides. In addition, the value of roadside habitat is reduced when grasses of limited value form monocultures along the roadsides.

The quality of habitat along Cache County roadsides varied greatly. Wetlands with high vegetation diversity and strong winter structure provided the best habitat. Woodland and grassland plant communities followed next with fair to good quality of wildlife habitat. Tall wheatgrass (*Elymus elongatum*) provided the best winter structure of grasses in these communities. Riparian and wet ditch banks, along with lower quality wetlands, provided fair to poor quality habitat primarily because of a lack of vegetation diversity and weak winter structure. Mixed grasses between the roadside and adjacent fields provided the

poorest quality of habitat. It is suggested that these areas have the poorest quality of habitat because of current roadside maintenance practices and frequent disturbances.

Winter and nesting cover are the limiting factors for pheasants in Cache County, Utah (Nish 1973; Olsen 1977; Heath 1984; Messmer and Mitchell 1995; George Wilson, personal communication, 1996). This study supports their findings. Interspersion of cover types is essential for pheasant success. The optimum distance between cover types providing nesting cover, brooding cover, and winter cover is less than a 1/4-mile radius. Habitat suitability declines substantially as distances between cover types become greater (Meyer 1987). Cover must also be in close proximity to food and water sources (Trautman 1982; George Wilson, personal communication, 1996).

To improve roadside habitat quality, the roadside vegetation should be more diverse. Winter cover provided by trees and shrubs are crucial. The Habitat Suitability Index model suggests 30 percent tree and shrub canopy cover with a minimum vegetation height of 3 feet (Meyer 1987). This would mean that on average, .3 of every mile of roadside would include some woody vegetation.

Naturally, not every mile of roadside could sustain woody vegetation. In the areas that woody vegetation is not practical, tall grasses and forbs could provide other components of wildlife habitat. Adjacent land uses must also be evaluated to determine the best locations for additional woody cover along roadsides. The amount of wildlife habitat along the roadsides could be increased by diversifying the vegetation and modifying current maintenance practices.

CHAPTER V

QUESTIONNAIRE RESULTS AND DISCUSSION

Introduction

Two separate types of questionnaires (Appendix B) were mailed to distinct groups: county weed supervisors, and personnel in various state agencies concerned with roadside issues. Agency personnel surveyed included wildlife biologists from the states of Utah, Colorado, Idaho, Nevada, Arizona, Oregon, California, and Wyoming. In addition, Utah Department of Transportation representatives and the Utah State University extension weed specialist were surveyed. The results of the two surveys will be supplemented with data gathered by Mitchell (1990).

The main points raised by the survey could be summarized by stating that county weed supervisors and state wildlife biologists are at opposite ends of the spectrum when it comes to managing roadsides. Only 31 percent of weed supervisors responded positively to using roadsides as wildlife habitat while 78 percent of the wildlife biologists responded positively. Department of Transportation representatives fall in the middle of the spectrum. They generally believed that using roadsides for wildlife habitat is a good idea but were skeptical that a program could be implemented.

The results of this survey showed that current maintenance practices used by county weed supervisors were detrimental to pheasants and their habitat. It also showed that wildlife biologists and other experts believed right-of-ways to be important wildlife habitat in Utah and surrounding states. The final conclusion was that something should to be done to maintain and restore wildlife habitat to roadsides.

Participation

Weed supervisors in all 29 counties in the state of Utah were surveyed. Ten responded (34%) to the initial mailing. Because of the low response rate, a second mailing

was sent out. Six more responses were returned, which combined for a total of 16 responses (55%). Survey results have been combined and calculated. Twenty-four surveys were sent to state agency personnel (state biologists and UDOT representatives) with a response of 18 (75%). Many of the questions were similar, but responses varied greatly between the two groups.

Roadside Maintenance

One of the main functions of the questionnaire was to determine existing methods of roadside maintenance. The county weed supervisors were asked questions pertaining to the specific roadside treatment of vegetation in their county. The predominant methods of controlling roadside vegetation were herbicide applications and mowing. Figure 41 shows the methods and seasons they were used.

Figure 41 shows 38 percent of roadside mowing occured between April and June. This kills hen pheasants and destroys nests. Between April and June is the time that first nesting takes place. Trautman (1982) believes that first clutches are 38 percent more successful than second or third clutches. If the first clutch is unsuccessful, hens will re-nest up to three times (Trautman 1982). This will occur through July. County weed supervisors showed their highest frequency of mowing during the summer (81%), which hampers second or third nesting attempts.

Also critical during the summer months is brood rearing. If the first clutch is successful, juvenile pheasants will be learning how to survive on their own. The primary predators of juvenile pheasants are avian (Roberson 1987). Mowing removes their protective cover for juvenile pheasants, making them more vulnerable to predation. Mowing in the fall is also detrimental because it destroys residual vegetation that is needed for winter cover and spring nesting. Forty-four percent of county weed supervisors reported they mow in the fall between October and November.

METHOD	Spring Apr.-June	Summer July-Sept	Fall Oct-Nov
Mowing	38%	81%	44%
Herbicide	94%	56%	56%
Insecticide	6%	6%	0%
Burning	0%	0%	13%

Figure 41. County weed supervisors' current maintenance practices.

Herbicides play a significant role in habitat reduction for the pheasant. The survey showed that 94 percent of county weed supervisors sprayed herbicide in the spring. This is precisely when hens are consuming insects to gain the necessary protein to establish their first clutch. Ingesting or inhaling herbicide, whether by eating sprayed insects, plant material, or by direct contact, has been proven to cause mortality or at least egg-shell thinning in pheasants (Larson 1991). Spraying throughout the summer and fall extends the mortality and egg-shell thinning experienced by the pheasant population.

County weed supervisors did not widely use insecticides (6%). Burning is only done by 13 percent of the respondents and only in the fall. However, poor timing of burning can be detrimental, especially in the fall, because residual vegetation important for winter cover and spring nesting cover is eliminated.

One-hundred percent of the county weed supervisors did not consult with a state wildlife agency for recommendations regarding maintenance. Only three states, Colorado, Wyoming, and Idaho, responded that they encourage county governments to maintain roadside ditches for habitat. A lack of communication between agencies responsible for managing the ROW and those responsible for managing the wildlife resources was evident.

It appeared that county weed supervisors did not feel roadsides should provide wildlife habitat and wildlife biologists did not explain the need and potential for wildlife habitat along the roadsides to the people responsible for maintaining them.

Allowing landowners to mow roadside ditches for hay is a practice criticized by wildlife biologists, yet 44 percent of the county weed supervisors responded that their county allowed this practice. The state personnel were asked if they encouraged private landowners to maintain roadside ditches for habitat. Only 11 percent of those surveyed answered "yes." It has been documented by Snyder (1974) that allowing landowners to mow roadside ditches for hay is a practice detrimental to establishing roadsides as wildlife habitat. Warren Snyder (personal communication, 1996) commented in his response to this survey, "Most roadsides are farmed to the shoulder in our primary pheasant range."

Thirty-one percent of the county weed supervisors responded that their annual roadside budget is between $20,000 and $50,000 and another 31 percent responded that their roadside maintenance budget is between $5,000 and $10,000. These figures can be misleading because counties handle their roadside maintenance departments on an individual basis. Those that responded in the $5,000-$10,000 range may spend that amount on spraying and mowing alone, while another county may have reported $20,000-$50,000 for roadside maintenance and this could include pot-hole repair, ditch cleaning, etc. Therefore, while this question in the survey provided ball park figures, a more specific breakdown of costs would be necessary to compare county expenditures of roadside vegetation maintenance.

Roadsides for Wildlife

When investigating how to best develop a roadsides for wildlife program, it seems logical to investigate what components of wildlife habitat roadsides may provide. In the survey sent to state agency personnel, they were asked to check (√) those pheasant habitat

components they believed roadside ditches provided and indicate with an asterisk (*) which of those functions they believed to be most important. The results are shown in Figure 42.

The results from Figure 42 show the majority of respondents believed roadsides provided a travel corridor and nesting cover. Forty-two percent of the respondents indicated nesting cover as the most important component of pheasant habitat. Travel corridor received the next highest rank (25%). When compared together the two categories were inversely related. Nesting cover was first in "importance" and second in "most provided by roadsides," while "travel corridor" was first in "most provided by roadsides" and second in "importance." The state agency personnel believed roadsides were an important link to food sources for the pheasant, such as agricultural fields. Interestingly, winter cover ranked low, even though pheasant experts believed winter cover to be the limiting factor for Utah pheasants (Olsen 1977; Bruce Bonebrake, personal communication, 1996; George Wilson, personal communication, 1996).

As part of the state personnel group, questionnaires were sent to state wildlife representatives in the states of Utah, Colorado, Arizona, Nevada, Idaho, Wyoming, and Oregon. All of the state representives answered "no" when asked if they had a roadsides for wildlife program in their state. No program existed (at the time of this questionairre) in Utah or surrounding states in spite of past efforts to implement them (Nish 1973; Snyder 1974). This begs the question: "Why did past efforts fail and what can be done so that future efforts do not experience a similar destiny?" Perhaps the answer lies in the responses by county weed supervisors. When questioned if they participated in roadside revegetation, all counties responded that they did not. However, for a roadside habitat program to be successful, county weed supervisors must be involved.

Some of the state agency personnel did respond with revegetation strategies. However these strategies were designed "principally for erosion control, not providing

Habitat Components Most Important: *	Provided by Roadside Ditches: √	
42%	**54%**	Nesting cover
8%	50%	Brooding cover
13%	33%	Roosting cover
8%	33%	Loafing cover
17%	33%	Winter cover
8%	46%	Food source
25%	**58%**	Travel corridor
0%	4%	Other (please explain)
		Source of grit

Figure 42. State agency personnel response to the importance of habitat components along roadsides.

wildlife cover" and the information was rarely transferred to the county level. When revegetation strategies did reach the county they were often ignored. Such was the case in Wyoming, where a respondent wrote, "We do frequently recommend to WDOT and county road departments that cover be maintained for pheasants, but we get lots of excuses why they can't do it." It appears that the same occured in Utah, as one state biologist wrote, "We encourage departments of transportation in Utah to delay mowing until the end of July. Some do, some don't."

Current seed mixes, as reported by respondents, did not match the ideal seed mixes for roadside habitat very closely (see Chapter VI). The respondents indicated that they primarily used wheatgrasses for roadside revegetation. The most commonly used wheatgrass is crested wheatgrass (*Elymus cristatum*), because it is considered to be unpalatable to cattle and deer. However, a UDWR wildlife biologist refuted this claim (Randall Thacker, personal communication, 1996). Next in planting popularity in decreasing order were tall wheatgrass (*Elymus elongatum*), intermediate wheatgrass (*Elymus intermedium*), and bluebunch wheatgrass (*Elymus inerme*). Yellow sweet clover

(*Melilotus officinalis*) and alfalfa (*Medicago sativa*) were extensively used as well, and have been found favorable because they readily self-propagate, while others feel they are overly aggressive (Ira Bickford, personal communication, 1996). Switchgrass (*Panicum virgatum*) was used in Colorado where snow was not a factor in blocking roads.

When asked to indicate what method of seeding works best along roadsides, drill seeding was indicated as the preferred method by all the respondents who have experience in the area of revegetation. Broadcast and hand seeding were also indicated as typical methods.

The maintenance and revegetation of roadsides is a complex issue that involves various agencies. The results of the survey showed a lack of communication among the agencies involved. Current maintenance practices and revegetation guidelines reduce wildlife habitat along Utah roadsides. Cooperation among the agencies with maintenance and revegetation guidelines suited to increasing roadside wildlife habitat appears to be a possible answer.

Problems and Concerns with Roadside Habitat

Wildlife biologists believed roadsides provide quality habitat for species such as the pheasant. County weed supervisors unknowingly have destroyed roadside habitat, principally by mowing and applying herbicide. Both groups noted problems and concerns with using roadsides as wildlife habitat.

The most repeated objection by county weed supervisors to managing roadsides as wildlife habitat was the idea of increased road kill. One county weed supervisor wrote, "We feel that a program of that type would lead to more road kill of an already scarce bird." Another expressed his opinion by writing, "Well traveled roads are no place for pheasants or any other wildlife, unless you like road kill." These types of responses were typical. Oetting and Cassel (1971) conducted a study of wildlife killed on a section of highway in

North Dakota. Traffic killed 42 animals along the highway when all the vegetation was mowed. One year later, the same stretch of right-of-way was left unmowed and surveyed during the same time of year and 37 dead animals were found. They concluded that wildlife killed by vehicles was a function of movement patterns and/or population fluctuations and not unmowed vegetation along the right-of-way.

Biologists in the state of Virginia found that the vehicle-wildlife collisions were actually reduced with quality roadside habitat because the "critters" felt more secure in the improved cover and did not flush as frequently (Bristow 1990). Reijnen and Foppen (1994) found no difference in death rates between willow warblers breeding near a highway and those breeding elsewhere. However, they did find roadside habitat to be lower quality for willow warblers and attributed this to vehicle noise distorting the young males' song to attract females.

The state of Indiana assembled a team of wildlife biologists to flush wildlife and document what species utilized the right-of-way and the direction they flushed. They concluded that 93 percent of the wildlife flushed straight along the right-of-way or toward the tree and shrubs plantings on the inside back slope of the ditch. Their conclusion was that if right-of-ways were managed for wildlife, and contained good cover like that provided by trees and shrubs, right-of-ways could support large numbers of wildlife without increasing road kill (Showalter 1990).

The most thorough study of road-killed pheasants was done by Joselyn, Warnock, and Etter (1968), where a 4-year time period failed to show any noticeable changes between a mowed strip of roadside and an unmowed strip of roadside. The average road kill in the study was 0.2 per mile in the summer.

Deer and other large mammals are a problem associated with roadside habitat. This study does not recommend providing roadside habitat for deer. It appears that current maintenance practices actually promote deer along roadsides (Crossley and Peterson 1990;

Randall Thacker, personal communication, 1996). Deer are attracted to new growth because of the tender vegetation found there. Frequently mowed roadsides provide this tender vegetation. Unmowed, taller grasses will discourage deer. However, motorists still need to be alert. Ten percent of the right-of-way should be mowed to provide a clear zone that allows motorists to see deer before deer enter the roadway. A study done by Oetting and Cassel (1971) found no difference in deer/auto collisions when comparing a roadside with dense shrubs and later removing the shrubs to the typical clear zone. Varland (1987) wrote in a letter, "Deer-vehicle collisions occur just as easily at areas where roadsides are mowed as they do where they are not mowed" (p. 1). He continued by stating that "A combination of legume planting and frequent roadside clipping may well be promoting vehicle accidents rather than preventing them" (p. 1).

There is literature which stated that white-tailed deer are more likely to cross roads near heavy cover such as timber or marshes (Bouta 1989). Michael (1980) believed wildlife are more likely to cross roads with wide medians containing woody cover. However, both authors admit that right-of-way management does not change deer movement patterns and that highway mortality is density dependent.

Some respondents to the questionaire felt that if wildlife cover were enhanced, roadsides could become corridors for predators and weed seed affecting farmers' fields and other areas. Four years of observation between seeded unmowed roadside vegetation and mowed roadside vegetation failed to show a significant difference in predation on pheasant nests along roadsides (Joselyn, Warnock, and Etter 1968). Many experts believed that: 1) improved nesting cover would enhance nesting success, and 2) the predators were usually migratory.

Noxious weeds and weed seeds could be controlled with effective spot spraying along roadsides. This study suggests that "fenceline to fenceline" spraying of herbicide is not necessary to control noxious weeds. In fact, current maintenance practices promote

noxious weeds by providing bare ground and reduced competition from non-weedy species (IRVM 1994).

Decreased motorist safety by obscuring vision and clear zones was a concern expressed by county weed supervisors. As stated earlier, one mower width along the shoulder would be mowed and sight lines at intersections and signage should be maintained (see Chapter VII). Increased number and depth of snow drifts along the roadside were cited by county weed supervisors as safety hazards associated with unmowed roadsides. Oetting and Cassel (1971) studied snow depth on the same 23-mile stretch of highway used for the deer-vehicle collision study noted previously. They measured snow depth at 48 stations. Approximately one-half of the 23-mile stretch was left unmowed while the other half was mowed frequently the previous summer and fall. Three areas were measured at each station: the edge of the driving surface, ditch bottom, and fence or outer boundary. Measurements in the mowed vegetation averaged 3.8 inches on the top of the in slope, 11.6 inches on the in slope, and 13.1 inches at the outer boundary. The unmowed vegetation averaged 4.2 inches, 14.5 inches, and 15.2 inches in the same locations. The unmowed vegetation did catch more snow, but the increased amount was considered insignificant and caused no snow build-up difficulties for the North Dakota Highway Department.

Some respondents to the questionaire felt that unmowed vegetation along roadsides would distract motorists. Oetting and Cassel (1971) interviewed motorist at a rest area located at the west end of the twenty-three mile stretch of road previously discussed. Motorists drove by both unmowed and mowed vegetation blocks and were asked four questions: 1) Have you noticed the mowed and unmowed right-of-way condition? 2) Which do you prefer? 3) Why? 4) Do you prefer the mowed treatment in the face of high mowing costs?

The results showed 82 percent of the motorists interviewed did not notice a difference between the mowed and unmowed sections of roadway. After concluding their

survey, Oetting and Cassel (1971) recommended publicity programs, such as signage along the roadway and at rest areas, to inform the public as to why the right-of-way was not mowed, i.e., to improve its value as habitat.

One county weed supervisor felt that poaching along roadsides would increase if a roadsides for wildlife program were initiated. This is a potential problem; however, it is considered to be insignificant because the opportunities for poachers to hunt along roadsides would be severely limited due to passing motorists. This is not to say that poaching would not occur, rather that poaching would be a limited problem.

The problems and concerns raised by county weed supervisors and state agency personnel are valid and pertinent to a roadside habitat program. However, the majority of the concerns are not founded on research and many have been proven to be relatively insignificant by researchers. Just as with any wildlife management program, there are both possibilities and problems. Wildlife response to habitat are to a certian extent unpredictable. However, research supports the idea that the benefits of a roadside wildlife program in Cache County outweigh the liabilities.

Conclusion

County weed supervisors did not feel roadsides should be managed as wildlife habitat. The following county weed supervisors' comments demonstrated the general feelings towards using roadsides as wildlife habitat: "We don't lack for pheasant cover anywhere," and "I am also a hunter and I feel the success to pheasant population is in doing more predator control." The later comment may have some validity and is currently being researched by Utah State University biologists.

The state agency personnel comments strongly disagreed with those of the county weed supervisors. In response to the question of roadside importance as habitat, "absolutely," and "without a doubt," were typical comments. Wildlife biologists recognized the opportunities and benefits of managing roadsides as wildlife habitat. The

two groups have not communicated or shared ideas about how to manage roadsides for wildlife habitat. Unfortunately, Utah's pheasants and other species are the apparent lossers in this situation.

Current roadside revegetation and maintenance techniques are detrimental to pheasants and other wildlife that utilize roadsides for cover. By simply modifying seed mixes, and allowing woody vegetation to grow along roadsides, great strides can be taken toward establishing roadsides as permanent wildlife habitat. By modifying maintenance schedules, or greatly curtailing mowing and spraying regimes, the pheasant population in Cache County would benefit. As a by product of these modifications to vegetation management, maintenance costs will be reduced and the aesthetic quality of Cache County roadsides will be enhanced.

The largest obstacle to maintaining roadsides as wildlife habitat appears to be political. County weed supervisors do not feel this type of program is compatible with their mandate of weed suppresion, safety, and erosion control. The key to success of roadside wildlife habitat program is convincing county personnel that wildlife habitat can be maintained while reducing roadside maintenance costs.

CHAPTER VI

DESIGN GUIDELINES AND REVEGETATION RECOMMENDATIONS

Introduction

The Utah Department of Transportation (UDOT) provides information to counties with respect to seed mixes, seeding and planting methods and maintenance practices. Counties in Utah, such as Cache County, will typically follow the directions offered by UDOT (Ira Bickford, personal communication, 1996). UDOT is primarily responsible for revegetation of state or federal highway roadsides and counties typically do not revegetate county roadsides (see Chapter V).

This chapter provides design guidelines that are the basis for revegetation recommendations. The guidelines should be considered before a roadside revegetation project has begun. General revegetation techniques follow the guidelines. These are applicable to a variety of roadside conditions and include site preparation, seedbed preparation, fertilizers and soil amendments, seeding, planting, plant spacing, mulching, and monitoring.

Specific roadside revegetation strategies follow the general techniques and correspond to the six general roadside plant communities found in Cache County. These six categories were Agricultural Seasonally Wet Ditch Bank, Agricultural Mixed Grasses, Wetland, Riparian, Grassland, and Woodland.

Design Guidelines

Safety. Safety is the primary objective of UDOT and county roadway officials. Revegetation efforts must conform to safety guidelines if they are to be implemented. Although safety can be limiting in an effort to provide wildlife habitat or aesthetics, they can coexist. Sightlines at intersections should be maintained so as to not hamper the

visibility of motorists (UDOT 1994). Signage should not be blocked by vegetation and hazardous trees should be removed. Snow drifting onto roadways will sometimes remain on the road, blocked by tall, dense vegetation at the pavement's edge. To avoid this problem, 10 percent of the road right-of-way should be mowed next to the pavement. For example, if the right-of-way is 15 feet in an area, then 1.5 feet in from the pavement should be mowed.

Living snow fences have been effective in Colorado and Iowa (Snyder 1974; IRVM 1996). Snow fences "catch" or slow down drifting snow forcing wind above the plant material and snow to fall out behind the plantings. This is effective when the plants are placed on the backslope of ditches and at a distance far enough away from the road to drift the snow into the ditch and not on the roadway. In Utah, snow drifts behind plantings are generally 2 to 3 times longer than the height of the planting. If the planting stands 3 feet tall, the snow drift will extend roughly 6 to 9 feet behind the planting (Johnson and Becker 1976).

Tall grasses, however, work differently than shrub or tree plantings. Because wind blows through tall grasses, they can actually catch snow, working as a filter and snow will not drift behind them (MnDOT 1995).

Roadside plantings can aid in roadside safety as well. The American Association of State Highway Officials, AASHO, (1970) reported that appropriate right-of-way plantings will reduce headlight glare from other motorists.

Erosion Control. The use of vegetation to provide erosion control has long been practiced by UDOT (Hansen and McKell 1991). Both wind erosion and water erosion can be slowed by roadside vegetation. Buffer strips adjacent to fields have been advocated by the Soil Conservation Service since the 1930's (Stewart and Nielsen 1990). These buffer strips can slow wind and water velocity so that soil erosion is minimal. Buffer strips also increase water quality by taking up excessive nutrients and waste often associated with

agricultural practices (Stewart and Nielsen 1990). To provide optimum erosion control in roadside plant communities, vegetation diversity should be expanded and desired vegetation promoted by the use of favorable maintanence practices.

Fire. Fire can be both destructive and useful. Burning is a viable maintenance practice and is discussed as a maintenance tool in Chapter VII. Short, mowed grasses typically have reduced combustibility (Allen Rasmussen, personal communication, 1996). This result is not due to the type of grasses, but rather their height as a function of flame length. As tall bunch grasses burn, the flame length increases fire spread. Although bunch grasses do reduce fuel continuity, this is usually overcome by fuel height and flame length (Allen Rasmussen, personal communication, 1996). For fire prevention, low, mowed bunch grasses would provide the least risk of fire spread; however, this would also provide the least desirable results for wildlife.

The Ohio Department of Transportation evaluated the cost of mowing and spraying roadside vegetation to suppress fire potential versus the cost of fire damage and suppresion after the fire had started. The conclusion was that the cost of extinquishing roadside fires and repairing any damage was significantly less than the cost of mowing or spraying to reduce fire potential (Hottenstein 1970).

Aesthetics. Simonson (1970) described roadside aethetics as a "sense of fitness." He further explained that roadsides should combine with road structures and integrate as part of the landscape and not be "forced upon it." Simonson (1970) admitted that this may be difficult, but can be accomplished through design techniques using aerial photography and perspective sketches to achieve a "complete highway." A complete highway combines quality aesthetics with safety and utility. Simonson (1970) believed that quality roadside design features could reduce driver tension, making roads safer for motorists.

Some roadside design features include the use of woody vegetation, such as trees and shrubs, along roadsides to define the edge of the road for motorists. Simonson (1970)

reported that woody vegetation aids drivers in times of fog or snow storms because they act as landmarks for orientation. Woody vegetation can also justify turns or bends in roads, making the motorist aware of curves ahead. Snow (1959) proposed that right-of-way plantings not only provide aesthetic and erosion control functions, but can also buffer traffic noise and guide the motorist's eye forward.

Revegetation Techniques

To establish habitat requirements along roadsides in Cache County, a typical plant schedule and a planting plan (both plan view and cross section) for each of the six roadside plant communities is provided in this chapter. A description of the specific planting techniques required to revegetate each category is included. General revegetation techniques are applicable to all categories and should be viewed as general guidelines.

Site Preparation. Site preparation may consist of clearing the area of unwanted vegetation, tilling or cultivating the soil, and grading. It may also consist of restoration mowing or spot spraying of herbicide to prepare the area for seeding or planting. If the site is bare, newly graded, or more than 50 percent noxious weeds, then the site should be tilled, plowed, or graded to a depth of no less than 3 inches before seeding or planting.

If the site contains good quality vegetation, then prepare only those areas that should be seeded or planted to improve the quality of the roadside habitat. If the site needs more grasses, the existing grasses should be mowed (see Restoration Mowing Chapter VII) after August 31 and the new seed drilled into the stubble (see Interseeding Chapter VI). This will allow for reduced sunlight competition between existing and new grasses.

If the site needs woody cover, grasses should also be mowed to allow the planting of seedlings or tublings into the grass stubble. The locations where the trees or shrubs will be planted should be spot sprayed with a herbicide to create small bare areas for planting (see Appendix C for herbicide recommendations).

Seedbed Preparation. Sites chosen for revegetation should exhibit the following properties in the seedbed:

1. Be firm, but not compacted below the seeding depth.
2. Be pulverized, with friable soil on top.
3. Does not have a cloddy or puddled surface.
4. Be free from live, resident plant competition.
5. Be free from seed of competitive weed species.
6. Contain moderate amounts of mulch or dead plant material within the soil surface (Hansen and McKell 1991).

Existing cover should be left in place for its value as mulch. Prepared seedbeds should not be completely bare soil (MnDOT 1995). By preparing the seedbed to have these characteristics, soil aeration, water infiltration, and erosion control capabilities are improved. More importantly, the possibility of quality seed to soil contact has been improved. Approximately 50 percent of the soil surface should be visible through the mulch or plant debris.

Fertilizer and Soil Amendments. It is difficult to predict what ratio of N/P/K (nitrogen, phosphorus, potassium) is best for revegetation in Cache County. Soil samples from the potential site where a revegetation project may take place should be analyzed by a competent laboratory.

Often, roadsides have low levels of soil nutrients. This is partially due to the past maintenance practices of soil sterilization along the road shoulder. Other contributors include the lack of topsoil along roadsides, and road construction materials (mostly gravel) that are often incorporated into the ROW in an effort to drain water away from the road surface. Typically, nitrogen and phosphorus are deficient, followed by potassium and sulfur. Cool season grasses and forbs, such as those recommended by this study, generally benefit from nitrogen fertilization. Woody species, also recommended by this

study, generally benefit most by phosphorus applications. Phosphorus has a low solubility and therefore should be incorporated into the soil during seedbed preparation (Hansen and McKell 1991).

Other soil amendments, such as gypsum and limestone, are typically used to adjust the pH of soils. Gypsum can amend sodic soils but is a costly and time-consuming process involving the application of gypsum and leaching it with water. Limestone can raise low pH in soils (pH below 5.5) by rapidly dissolving its main components (calcium and magnesium carbonates) into the soil substrate. However, this is seldom a problem in Utah (Hansen and McKell 1991). Both of these methods are expensive and not necessary if the native plant species recommended by this study are used.

Lynn Zubeck (personal communication, 1996) and IRVM (1994) suggested incorporating 60 lbs/acre of nitrogen before drill seeding grasses or forbs. UDWR (n.d.) suggested no fertilizer additions are necessary because native plants have the ability to uptake necessary nutrients from the soil more efficiently than cultivated varieties. Minnesota DOT (MnDOT 1995) suggested a fertilizer consisting of 6-24-24 (% N-P-K) to be disced into the soil prior to seeding at a rate of 200 lb/acre. This study recommends following the advice offered by the soil testing lab after the soil is tested for making fertilizer and soil amendment decisions.

Seeding

There are two basic types of seeding: drilling and broadcasting (Ecotone 1995a). Roadsides should be drill seeded if the terrain allows such methods. Drill seeders are capable of seeding on slopes less than 3:1. Slopes greater than this are considered too dangerous for drill seeder operation. Broadcast seeding, either by hand, mechanical spreader, or hydraulic seeding (hydroseeding), is acceptable on steeper slopes. Figure 43 summarizes the limits and capabilities of drill seeding, broadcast seeding, and hydroseeding.

	Slopes > than 3:1	Slopes < than 3:1	Rocky Soils	Wet Soils	Loamy Soils
Drill Seeding	NO	YES	NO	NO	YES
Broadcast Seeding (Machine or by hand)	YES	YES	YES	YES	YES
Hydroseeding	YES	YES	YES	YES	YES

Figure 43. Seeding methods, limits, and capabilities.

Drill Seeding. A drill seeder is a mechanical device with a minimum of two seed boxes: a fine seed box and a box for fluffy/large seed. Disc furrows open the soil and the seed is drilled to the specified depth. The drilled row is covered and packed with a packer assembly attached to the drill seeder (MnDOT 1995). Ideally the drill rows should be spaced 6 or 7 inches apart and a maximum of 8 inches. If a deep-furrow drill is used, the spacing should be 12 to 14 inches apart to prevent covering the seed too deeply when the soil is thrown from the adjacent furrow. Wider spacing is not recommended because of the increased competition of weeds between the drill rows (Cook et al. 1970).

If drill seeding is to be done in existing vegetation, such as a cover crop, trash rippers should be used. These will slice through the vegetative mat with a furrow approximately 1 inch wide and 1/2 to 1 inch deep. The seeds should be drilled into the furrow (MnDOT 1995). Cook et al. (1970) reported that seed drilled into poor sites will require more viable seed than well prepared sites.

Hansen and McKell (1991) suggested that large seeds (usually grasses) and small seeds (usually wildflowers and forbs) be placed in different boxes on the drill seeder and placed at different depths. This would aid in a diverse seedling stand, instead of favoring one size of seed over the other. Lynn Zubeck (personal communication, 1996) reported

that it is better for seed to be too shallow than too deep. He also noted that a practical "rule of thumb" used to determine seed depth is to drill the seed into the soil three times the size of the seed. For example, if the seed size is .1 inch in diameter, the seed should be drilled between .25 and .30 inches deep.

Broadcast Seeding. Broadcast seeding is any method that scatters the seed directly on the soil surface without soil coverage (Cook et al. 1970). It is important to note that broadcast seeding should be applied at twice the recommended rate in the planting schedules and can be combined with drill seeding (MnDOT 1995). For best results, the broadcast seed should be covered with a thin layer of soil by either harrowing or raking, and then slightly compacted, preferably with a culti-packer or equivalent.

Hydroseeding. Hydraulic seeding, commonly refereed to as hydroseed, includes a slurry tank with an agitation system to keep seed, mulch, and tackifer in suspension. The slurry is blown onto the prepared soil with an engine powered pump and hoses or gun tower (IRVM 1994). Some hydroseed units can spray up to 230 feet or more. Tank capacities range from 300 gallons to 3,500 gallons, depending on the trucks used to tranport the tanks. The agitation system used to keep the slurry mix in suspension is either mechanical paddles and/or recirculating water through a pump (IRVM 1994). It is important to note that paddle agitators cause less seed damage than pump agitators in keeping seed suspended in the slurry mix (IRVM 1994).

Seeding specifications from the UDWR (n.d.) suggested the slurry contain specified seed with 60 lb/acre of tackifier and 400 lb/acre of wood fiber mulch. The first application should be followed with a second application containing no seed, 60 lb/acre of tackifier and 2,000 lb/acre of wood mulch. These specifications agree with IRVM (1994) specifications, which suggested 1,500-2,500 lb/acre of wood fiber mulch and 3 percent (45-75 lb/acre) of tackifier.

Without sufficient moisture to keep the mulch and seed wet for two to three weeks after the seeding, hydroseed has had limited success. One solution is to apply seed only in a broadcast method, cover with soil and apply mulch over the soil to hold in soil moisture. This has been successful in the arid west (Cook et al. 1970). Costs of hydraulic seeding have been estimated at $1,000/acre (IRVM 1994).

Interseeding. Interseeding is a revegetation technique that utilizes the previously described methods of drill seeding or broadcast seeding (either by hand, machine, or hydroseeder). Interseeding is usually done with a drill seeder and involves seeding into plant stubble. Site preparation includes mowing existing vegetation down to a height of 4 inches. This process may need to be repeated 3 times or more depending on the density of weeds in the site. Interseeding occurs after the final mowing and drills the seed to the same soil depths as for bare ground revegetation.

The greatest advantage to interseeding is that the site does not become stripped of existing vegetation. This reduces both wind and water erosion. Mowing the weeds before planting stresses the weeds to a point where they will not effectively compete with the new seedlings. The disadvantages to interseeding are 1) the timing of the mowing must occur before the optimum seeding window is reached, 2) sometimes the type of weeds in the site may outgrow the drilled seed and shade the seedlings, and 3) interseeding can be labor intensive when dealing with small areas and large machinery is not easily accesible.

Seeding Window. The timing of seeding is critical for success. Cook et al. (1970) suggested the ideal time for seeding in Utah is between September 15 and November 15. The next best time for seeding is either early fall, August 15 to September 15, or early spring, March 15 to April 15. Seeding dates between April 15 and August 15 have failed in nearly every trial. Lynn Zubeck (personal communication, 1996) and UDWR (n.d.) also reported the most succesful seeding in Utah was in the fall. UDOT (1994) under section 625.3.1 specified the following seeding window:

Elevation	Seeding Window
Below 4,000'	Oct. 1st - Dec. 15th
4,000' - 6,000'	Sept. 15th - Dec 1st
Above 6,000'	Sept. 1st - Nov. 15th

Seeding should occur shortly after site preparation. If the time between site preparation and seeding is more than a few weeks, then additional site preparation may need to be repeated before seeding occurs.

Planting

Trees and shrubs should be an integral part of roadside revegetation if the goal is to provide wildlife habitat. The trees and shrubs recommended in this study could be planted by seed, but a lower germination would result. Instead, it is recommended that trees and shrubs be planted as nursery stock.

Nursery Stock. Nursery stock is plant material propogated in a nursery to be later transplanted. Nursery stock is also commonly refered to as tublings. In this study they are the same. Nursery stock should be in 3-cubic-inch or 10-cubic-inch cone containers, depending on the type of plant material. Nursery stock should be planted in the spring when soil moisture is greatest (UDWR n.d.). Containerized plant materials have a competitive advantage over bare-root or seed because they come with beneficial soil microorganisms such as mycorrhizae already incorportated into the soil. Also, the timing of planting is more flexible than for non-containerized stock or transplants (Hansen and McKell 1991). Other types of planting that have had limited succes along roadsides include transplants, cuttings, bare-root, plugs, and rhizomic plants.

Transplants. Transplants are plant material recovered from one site and taken to another with soil and plant intact. Transplants can be successful if they are planted during plant dormancy. Soil should be slighlty compacted around the roots after transplanting.

Shoots spaced 2, 3, 4, 6, 10, 12, 13, and 15 feet apart will achieve 10888, 4840, 2722, 1210, 436, 302, 258, and 193 plants per acre, respectively (UDWR n.d).

Cuttings. Cuttings are plant material cut from existing vegetation and then planted in a new location. Cuttings have been successful when dealing with woody riparian species such as cottonwood or willow. Stems should be cut at lengths of 12 to 18 inches and from 1- to 3-year-old stock. The angle of the cut should approximate 30 to 45 degrees at the basal end. Lateral branches and leaves must be removed. The basal end can be dipped in indolybutyric acid prior to planting to aid initial root development. The treated end should be placed in the soil to the depth of the water table (UDWR n.d.).

Bare Root. Bare root plantings are plant material usually grown elsewhere and tranported to the new site without any soil around the roots. These type of plantings should be stored between 34-39 degrees Fahrenheit for one week. This "hardens" the plant material before installation. The planting hole should be large enough to extend all the roots of the plant without binding or circling. It is imperative that the fine root hairs of the bare-root plants do not air dry in the process of preparation and installation (UDWR n.d.).

Plugs and Rhizomes. Plugs and rhizomotous plants are usually excavated from existing stands of plants with either a shovel or a front-end loader and then planted in the new site. They should be handled such that the moist soil remains packed firmly around the roots. All but one stem of a woody rhizomotous transplant should be removed to allow for better root development. Both plugs and rhizomotous plants should be placed in a hole similar in size to the one they were excavated from.

Timing for Planting. The sequence and timing of planting is crucial. Nursery stock installation should follow the establishment of desired grasses and forbs. After the grasses and forbs are established, a spot application of a glyphosphate herbicide, such as Roundup or Rodeo (both trademark brands) should be applied in locations where the nursery stock will be planted. This will eliminate local competition and provide for a higher success rate

of the stock. Five days should elapse between herbicide application and nursery stock installation (IRVM 1994), although Steve Dewey (personal communication, 1996) believes that plantings could be installed immediately after herbicide application. Some believe that fall planting of nursery stock is best because of the higher soil moisture levels throughout the winter and spring (Hansen and McKell 1990). Others believe that in Utah, spring is the best timing for planting nursery stock (UDWR n.d.; Cook et al. 1970).

Plant Spacing. Plant spacing is an important aspect to planting nursery stock. The Habitat Suitability Model for Ring-Necked Pheasants (Meyer 1987) suggests that 30 percent of the measuring unit be in winter cover of trees and shrubs. For example, if 1 mile of roadside is to be revegetated, .3 miles of the section should be put into trees and shrubs. If 10 miles of roadside is to be revegetated, 3 miles should be put into trees and shrubs.

Trees and shrubs should be spaced in groups and blocks. The groups of trees and shrubs should be located near a pheasant food sources, such as adjacent fields typically planted to row crops of corn, wheat, etc. The recommended grasses should be used to fill the areas between the blocks of woody cover. This would provide areas for habitat components such as food and nesting, brood-rearing, and loafing cover.

Mulching

Mulching has two purposes: erosion control and moisture conservation (Hansen and McKell 1991). Mulch can be chopped and shredded plant material from on-site vegetation; however, more often it is imported from off site. Hansen and McKell (1991) believed mulches provided the following benefits:

1. Retards evaporation
2. Increases infiltration of rainwater
3. Protects the soil and seed against impact of raindrops

4. Intercepts surface runoff
5. Reduces soil temperature
6. Generally increases seedling establishment.

Wood fiber mulch, like that used in hydraulic seeding, has been 80-100 percent successful in erosion control on slopes less than 2.5:1 (IRVM 1994). Wood fiber mulch is thought to be superior to paper mulch because of longer fiber length and increased water holding capacity (IRVM 1994). In Utah, Burroughs and King (1989) rated wood fiber mulch as a 3 on a scale of 1 to 10, but the application rate was only 1200 lb/acre and no tackifier was used. Along Lake Tahoe roadsides, wood fiber mulch helped produce the highest success of grass seed establishment (Leiser et al. 1974).

Vegetation Monitoring

Monitoring the revegetation process is crucial for success. Hansen and McKell (1991) believed a monitoring program to be the most overlooked part of roadside revegetation, yet they recognized the potential for cost savings if a monitoring program is implemented. The monitoring program should consist of site visits and proper documentation of vegetation progress, erosion control or other problems that may need to be corrected. A minimum of two site visits for the first 2 years is recommended. After that, a minimum of one site visit for three more years is recommended. Upon completing the 5-year monitoring process, most vegetation planted at the time of revegetation has had the opportunity for success. Hansen and McKell (1991) suggest two methods for monitoring: reconnaissance and quantitative.

The reconnaissance method simply consists of observations and note taking of deficiencies, soil stability, seedling condition (alive or dead), and the presence of noxious weeds. A camcorder or photographs are typically used for this method.

The quantitative method involves actually counting the number of plants in a specified area. For example, the number of seedlings in a drill row for a certain distance. This same row could be counted year after year to determine survival rates and competition, or invasion of other species. Whichever method is employed, care should be taken to ensure the monitoring occurrs at the same location every year. By so doing, a comparative analysis from the same vantage point is assured.

The following plant schedules contain specific plant species for each of the 6 vegetation categories found in Cache County. A category specific description of the seedbed and planting bed preparation, as well as any other specific instructions related to that vegetation category, are also included. The specific species prescribed in each plant schedule come from a variety of sources including Ecotone (1995a), UDWR (n.d.), and Landmark (1992).

Agricultural Seasonally Wet Ditch Bank Category

Seedbed Preparation and Seeding. Rough terrain is characteristic of this vegetation category. The seedbed should be prepared with hand-operated tools such as rototillers or machinery small enough to operate along the ditch bank (Ecotone 1995a). Seedbed preparation should take place in the fall or early spring before irrigation water (which is typically found throughout the summer in the ditches) begins flowing. It is likely that broadcast seeding will be necessary along the seasonally wet ditches because typical slopes exceed 3:1. Broadcast seeding should be applied at twice the amount specified in the planting schedule.

Planting. Trees and shrubs are typically discouraged along ditch banks because it is thought that trees and shrubs consume the water in the ditches. This is true and can be viewed as a disadvantage. However, the existing grasses (*Phalaris arundinacea)* consume more water than the trees and shrubs. Evapotranspiration rates for existing grasses range

from 13.0-24.15 inches of consumptive water use, while the proposed trees and shrubs average 17.1 inches (Johns 1989).

The trees, shrubs and grasses recommended in the planting schedule (Tables 5 and 6) will provide erosion control more effectively than existing grasses because their roots extend much further. Water quality will be enhanced because of their sediment catchment abilities and the wildlife habitat value of seasonally wet ditch banks will be increased by providing winter, roosting, and protective cover.

The planting pattern and spacing should follow the diagram in Figure 44. The planting should occur in groups and in locations where motorist safety would not be compromised. The plantings should also be near a food source such as corn fields or wheat fields. Because the Agricultural Seasonally Wet Ditch Bank category generally occurred in rural areas along county roads, it seems reasonable that wildlife typically found in rural settings, such as the pheasant, would benefit from the implementation of the planting recommendations.

Agricultural Mixed Grasses Category

Seedbed Preparation and Seeding. Vegetation in this category was typically found growing in a gentle swale. Water was a limiting factor and was provided by runoff from the roadway and adjacent farmers' fields. Because of existing noxious weeds, most of the Agricultural Mixed Grasses plant communities need extensive revegetation. This would include seedbed preparation involving herbicide application to existing vegetation and then discing the soil to a depth of 3 inches. The recommended grasses should be drill seeded into the seedbed and then slightly compacted by a culti-packer to ensure good soil to seed contact.

Seeding should be done in the fall so that new seedlings can take advantage of the high spring soil moisture. The vegetation recommended for this category (Tables 7 and 8) is adaptable to a variety of site conditions and should establish quickly in these areas.

TABLE 5.
Plant Schedule for the Agricultural Seasonally Wet Ditch Bank Category

Species	Cultivar or Variety	Seed Application Drilled Rate (PLS lb/acre)*	Planting Depth (if drilled inches)
Grasses:			
Streambank wheatgrass *(Agropyron riparium)*	Sodar	3.0	0.5
Redtop *(Agrostis alba)*		3.0	0.5
Bluejoint reedgrass *(Calamagrostis canadensis)*	Sourdough	1.0	0.25
Tufted hairgrass *(Deschampsia cespitosa)*		1.0	0.5
Blue wildrye *(Elymus glaucus)*		2.0	0.5
Graminoids			
Nebraska sedge *(Carex nebrascesis)*		0.5	0.5
Forbs:			
Blue-leaf aster *(Aster glaucodes)*		1.0	0.5
Marsh Indian paintbrush *(Castilleja exilis)*		0.5	0.25
Northern sweetvetch *(Hedysarum boreale)*		0.5	0.25
Rocky Mountain iris *(Iris missouriensis)*		1.0	0.5
Total		13.5	

* PLS = Pure live seed. Seeding rates should be doubled if broadcast.

TABLE 6.
Plant Schedule (Trees and Shrubs) for the Agricultural Seasonally Wet Ditch Bank Category

Botanical Name	Common Name	Size
Cornus stolonifera	Red-osier dogwood	10 cu in.
Ribes aureum	Golden current	10 cu in.
Rosa nutkana	Wild Rose	10 cu in.
Salix exigua	Sandbar willow	10 cu in.
Salix lutea	Yellow willow	10 cu in.

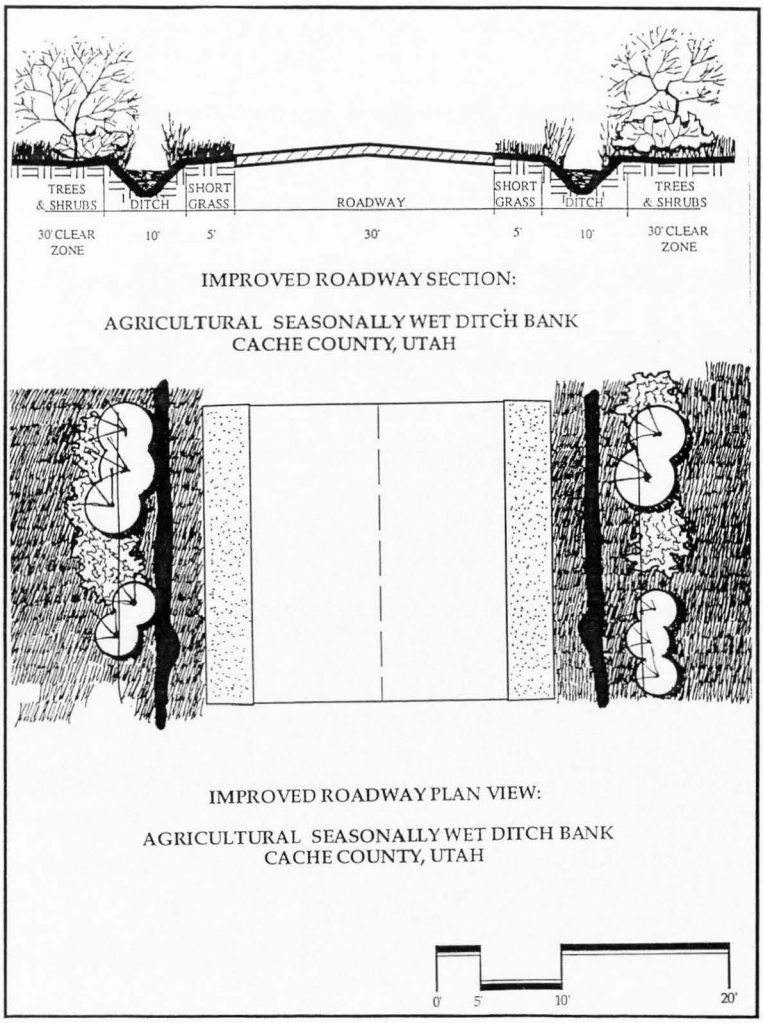


Figure 44. Planting plan and section view for the agricultural seasonally wet ditch bank category.

TABLE 7.
Plant Schedule for the Agricultural Mixed Grasses Category

Species	Cultivar or Variety	Seed Application Drilled Rate (PLS lb/acre)*	Planting Depth (if drilled) (inches)
Grasses:			
Bluebunch wheatgrass *(Agropyron spicatum)*	Secar	3.0	0.5
Great Basin wildrye *(Elymus cinereus)*	Trailhead	2.0	0.5
Idaho fescue *(Festuca idahoensis)*	Joseph	2.0	0.5
Prarie junegrass *(Koeleria cristata)*		1.0	0.25
Indian ricegrass *(Oryzopsis hymenoides)*	Paloma	1.0	1.0
Sandberg bluegrass *(Poa sandbergii)*		2.0	0.5
Forbs:			
White yarrow *(Achillea millefolium)*		1.0	0.5
Rocky Mountain beeplant *(Cleome serrulata)*		0.5	0.5
Plains coreposis *(Coreopsis tinctoria)*		0.5	0.25
Northern sweetvetch *(Hedysarum boreale)*		0.5	0.25
Blue flax *(Linum lewisii)*		1.0	0.25
Wasatch penstemon *(Penstemon cyananthus)*		1.0	0.5
Alsike clover *(Trifolium hybridum)*		1.0	0.25
Total		15.5	

* PLS = Pure live seed. Seeding rates should be doubled if broadcast.

Planting. Trees and shrubs have typically been discouraged along roadsides because it was thought that trees and shrubs posed a safety hazard to motorists (see Chapter V for safety concerns). To avoid this conflict, this study is recommending planting trees and shrubs only along the backslope of the swale. Planting should be done after grasses and forbs have been established. Any plantings should be nursery stock and installed after

TABLE 8.
Plant Schedule (Trees and Shrubs) for the Agricultural Mixed Grasses Category

Botanical Name	Common Name	Size
Prunus americana	American plum	10 cu in.
Rhus aromatica	Basket bush	10 cu in.
Rhus typhina	Staghorn sumac	10 cu in.
Ribes aureum	Golden current	10 cu in.
Rosa nutkana	Wild rose	10 cu in.
Rosa woodsii	Woods rose	10 cu in.
Symphoricarpos albus	Common snowberry	10 cu in.

spot spraying of herbicide to prepare the planting locations. Irrigation of the plantings would provide higher success, but is usually not practical.

The plantings should be placed in blocks and spaced randomly instead of in linear rows or a grid system (Figure 45). This will ensure a more natural appearance and provide better wildlife habitat.

Wetland Category

Seedbed Preparation and Seeding. The seeding recommendations (Table 9) in this category were designed to add diversity to the wetlands. Often, wetlands will be colonized by bulrush and cattail if enough water is present. The recommended seed mixes provide a diversity of plant material to help prevent a monoculture similar to the existing conditons.

Drill seeders will generally not function well in wetland sites, therefore, broadcast seeding grasses and forbs is recommended. In this case, seeding rates should be double the amount specified in Table 9. Revegetation of this category will occur in disturbed wetland sites and will typically be interseeded among other wetland vegetation. Tublings species planted in wetlands, such as bulrush (*Scirpus spp.*), rush (*Juncus spp.*), sedges (*Carex spp.*), and others should be planted as described in the following manner (Sherman 1996):

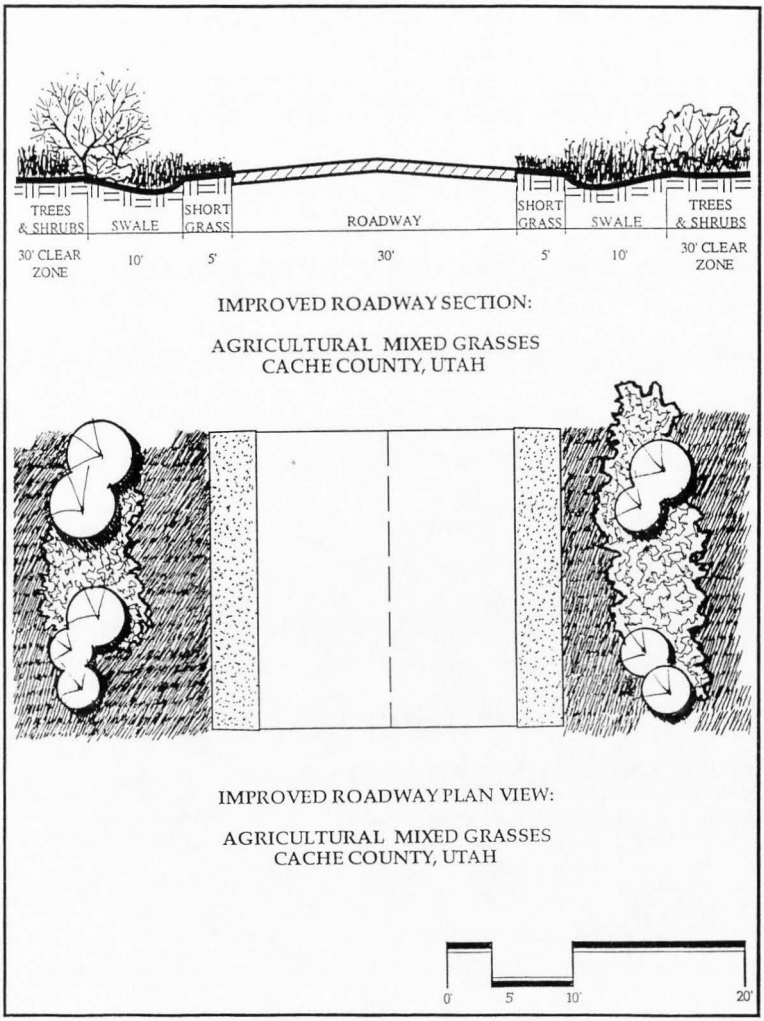


Figure 45. Planting plan and section view for the agricultural mixed grasses category.

1. Plant tublings in a dormant state in early spring (April to mid-May), before the years' shoot growth begins.
2. Remove, by hand, any vegetation growing within 2 feet of the tubling.
3. Auger hole approximately 2 inches in diameter, and the depth of the tubling root mass plus 2 inches.
4. Remove plant from container and place in augured hole.
5. Tamp soil around seedling to eliminate voids and air pockets.
6. Create a small water harvesting/retaining basin around each plant.

Planting. Trees and shrubs are not a part of the revegetation strategy for the wetland vegetation category (Figure 46). For the management of trees and shrubs near a wetland plant community refer to the Riparian category.

Riparian Category

Seedbed Preparation and Seeding. Generally, grasses and forbs were the dominant vegetation along roadsides that ran adjacent to or bisected riparian corridors. If the area to be revegetated is more than 50 percent bare ground or noxious weeds, removal of noxious weeds and seedbed preparation is necessary. Seedbed preparation should be done by discing or rototilling to a depth of 3 inches and then drill seeding or broadcast seeding (hydroseeding or mechanical) the specified grasses and forbs (Table 10). If the area is less than 50 percent bare ground or noxious weeds, interseed the specified grasses and forbs (Table 10) into the existing vegetation.

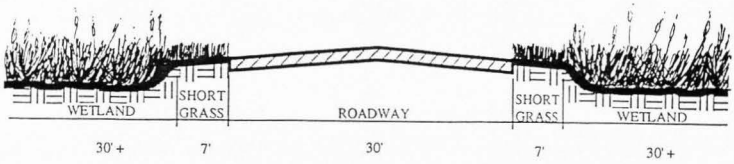
Many of the roads near riparian areas are elevated to either cross bridges or avoid flooding. Therefore, steep slopes are common with this vegetation type. Broadcast seeding is likely to be more plausible on the steep slopes rather than drill seeding. In such cases, the seed application rate should be double the rate specified for drill seeding.

TABLE 9.
Plant Schedule for the Wetland Category

Species	Cultivar or Variety	Seed Application Drilled Rate (PLS lb/acre)*	Planting Depth (if drilled) (inches)
Grasses:			
American sloughgrass *(Beckmannia syzigachne)*	Egan	4.0	0.25
Graminoids:			
Beaked sedge** *(Carex rostrata)*		2.0	0.5
Alkali bulrush** *(Scirpus maritima)*		2.0	0.5
Cattail *(Typha latifolia)*		0.5	0.25
Forbs:			
Missouri iris *(Iris missouriensis)*		1.0	0.5
Blue-eyed grass *(Sisyrinchium bellum)*		0.5	0.5
Total		10.0	

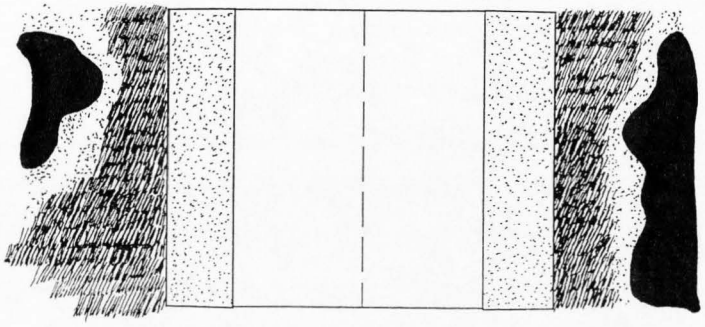
* PLS = Pure live seed. Seeding rates should be doubled if broadcast.
** If in the area, these species will self seed.

Planting. Trees and shrubs (Table 11) are natural parts of riparian systems. It is recommended that the riparian plantings be brought to the backside of the right-of-way (Figure 47), providing less fragmentation of the riparian habitat. In areas of high water table, the trees and shrubs should be planted by augering a hole down to the water table and then placing the tree or shrub in the hole. If cuttings are used, place the cut end down to the water level. If nursery stock is used, then simply fill the hole in with the augered soil and plant the stock level with the existing terrain. By augering the soil first, root penetration to the water table by nursery stock is more likely.



IMPROVED ROADWAY SECTION:

WETLAND
CACHE COUNTY, UTAH



IMPROVED ROADWAY PLAN VIEW:

WETLAND
CACHE COUNTY, UTAH

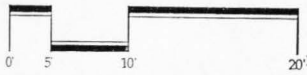


Figure 46. Planting plan and section view for the wetland category.

TABLE 10.
Plant Schedule for the Riparian Category

Species	Cultivar or Variety	Seed Application Drilled Rate (PLS lb/acre)*	Planting Depth (if drilled) (inches)
Grasses:			
Streambank wheatgrass *(Agropyron riparium)*	Sodar	3.0	0.5
Redtop *(Agrostis alba)*		3.0	0.5
Bluejoint reedgrass *(Calamagrostis canadensis)*	Sourdough	1.0	0.25
Tufted hairgrass *(Deschampsia cespitosa)*		1.0	0.5
Blue wildrye *(Elymus glaucus)*		2.0	0.5
Graminoids:			
Nebraska sedge *(Carex nebrascesis)*		0.5	0.5
Forbs:			
Blue-leaf aster *(Aster glaucodes)*		1.0	0.5
Marsh Indian paintbrush *(Castilleja exilis)*		0.5	0.25
Northern sweetvetch *(Hedysarum boreale)*		0.5	0.25
Lemon mint *(Monarda citriodora)*		0.25	0.25
Alsike clover *(Trifolium hybridum)*		0.5	0.25
Total		13.25	

* PLS = Pure live seed. Seeding rates should be doubled if broadcast.

Grassland Category

Seedbed Preparation and Seeding. Just as in the Agricultural Mixed Grasses category, this plant community was typified by a gentle swale that dipped from the road down into the right-of-way and up to the adjacent fields. Water was again a limiting factor and was provided by runoff from the roadway and nearby fields. This category was

TABLE 11.
Plant Schedule (Trees and Shrubs) for the Riparian Category

Botanical Name	Common Name	Size
Cornus stolonifera	Red-osier dogwood	10 cu in.
Populus angustifolia	Narrowleaf cottonwood	10 cu in.
Prunus americana	American plum	10 cu in.
Prunus virginiana	Chokecherry	10 cu in
Ribes aureum	Golden current	10 cu in.
Salix exigua	Sandbar willow	10 cu in.
Salix lutea	Yellow willow	10 cu in.
Sambucus cerulea	Blue elderberry	10 cu in.

distinct because the fields next to the right-of-way had been abandoned and were out of production. This allowed for a continuation of the roadside vegetation into the grassland, and increased the habitat value of the roadside. The first step in revegetating this category is to determine bare ground or weed coverages. If bare ground or weed coverage exceed 50 percent, then total revegetation should take place. This involves removing weeds by chemical treatment with a glyphosphate herbicide and then discing the area. In cases of bare ground, no chemical treatment is necessary, but discing to a depth of 3 inches is still recommended. Following seedbed preparation, drill seed the specified grasses and forbs (Table 12) into the seedbed and slightly compact with a culti-packer to ensure good soil to seed contact. If the roadside does not equal 50 percent weed coverage or bare ground, then interseed the recommended grasses and forbs (Table 12) thus reducing erosion potential and soil disturbance.

Planting. To avoid safety conflicts, trees and shrubs (Table 13) should be planted along the backslope of the swale, and continued to the furthest extent of the right-of-way, away from the road (Figure 48). The plantings should be in groups and spaced 4 feet apart.

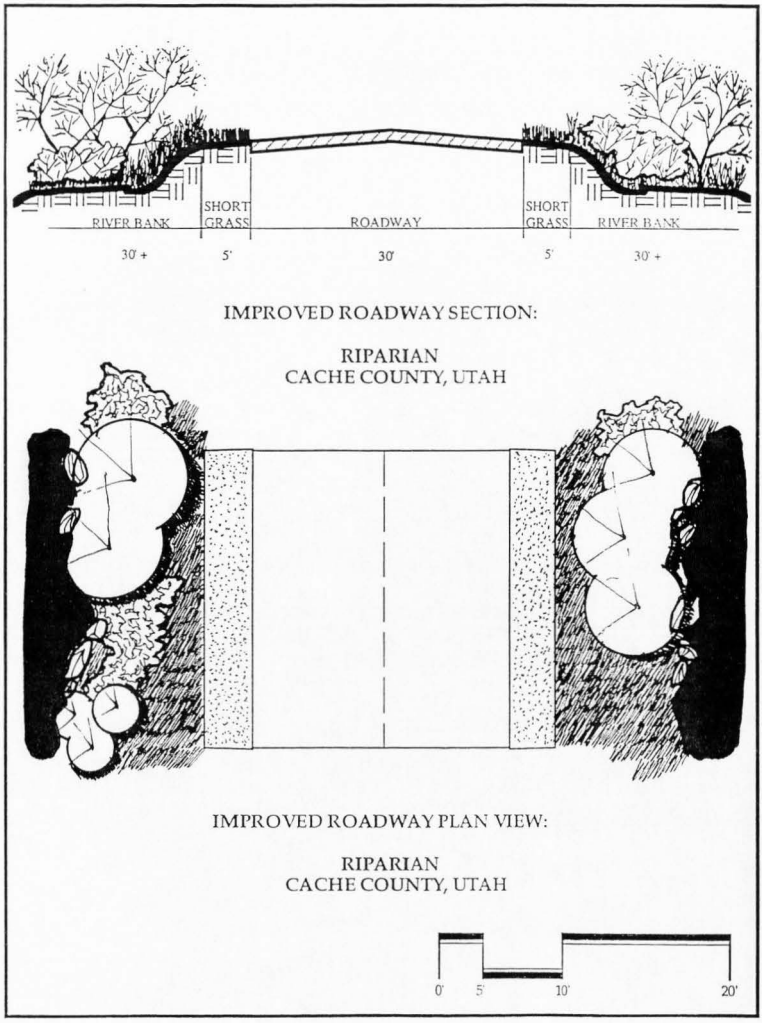


Figure 47. Planting plan and section view for the riparian category

TABLE 12.
Plant Schedule for the Grassland Category

Species	Cultivar or Variety	Seed Application Drilled Rate (PLS lb/acre)*	Planting Depth (if drilled) (inches)
Grasses:			
Bluebunch wheatgrass *(Agropyron spicatum)*	Secar	3.0	0.5
Great Basin wildrye *(Elymus cinereus)*	Trailhead	2.0	0.5
Idaho fescue *(Festuca idahoensis)*	Joseph	2.0	0.5
Prairie junegrass *(Koeleria cristata)*		1.0	0.25
Indian ricegrass *(Oryzopsis hymenoides)*	Paloma	1.0	1.0
Forbs:			
White yarrow *(Achillea millefolium)*		1.0	0.5
Rocky Mountain beeplant *(Cleome serrulata)*		0.5	0.5
Plains coreposis *(Coreopsis tinctoria)*		0.5	0.25
Northern sweetvetch *(Hedysarum boreale)*		0.5	0.25
Blue flax *(Linum lewisii)*		1.0	0.25
Wasatch penstemon *(Penstemon cyananthus)*		1.0	0.5
Alsike clover *(Trifolium hybridum)*		0.5	0.25
Total		14.0	

* PLS = Pure live seed. Seeding rates should be doubled if broadcast.

Woodland Category

Seedbed Preparation and Seeding. Grasses and forbs were typically found along the roadsides in the woodland category. The shoulder averaged 10-12 feet along the right-of-way. This would allow for drill seeding the specified grasses and forbs (Table 14). As in the other categories, fall implementation is optimum for success. If the plant community contains greater than 50 percent noxious weeds or bare ground, extensive revegetation may

TABLE 13.

Plant Schedule (Trees and Shrubs) for the Grassland Category

Botanical Name	Common Name	Size
Crataegus douglasii	Douglas hawthorne	10 cu in.
Prunus americana	American plum	10 cu in.
Prunus virginiana	Chokecherry	10 cu in.
Rhus aromatica	Basket bush	10 cu in.
Rhus typhina	Staghorn sumac	10 cu in.
Ribes aureum	Golden current	10 cu in.
Rosa nutkana	Wild rose	10 cu in.
Rosa woodsii	Woods rose	10 cu in.
Symphoricarpos albus	Common snowberry	10 cu in.

be necessary. The sequence would consist of spot spraying herbicide to eradicate weeds, discing to a depth of 3 inches, drill seeding, and slightly compacting the seedbed with a culti-packer. In areas of steep slope, broadcast seeding is recommended at twice the specified rate. Hand raking the seed into the seed bed is recommended for areas that are broadcast seeded and where the hydroseed method is not practical. When seeded in the fall, no additional irrigation should be required. When the plant community contains less than 50 percent noxious weeds or bare soil, interseeding the specified grasses and forbs is recommended (Table 14).

Planting. Trees and shrubs are what make a woodland vegetation type what it is. This type of vegetation only occured where there was enough natural moisture to sustain trees and shrubs. Typically, adequate moisture is found in ravines and on north to northeast facing slopes. Roadsides that fit these criteria should be planted with the recommended tree and shrub plantings (Table 15). Figure 49 shows the recommended plant spacing for this category. Planting trees and shrubs in this category would include spot spraying herbicide in the desired planting locations, prepare the planting hole, and planting the tree and shrub.

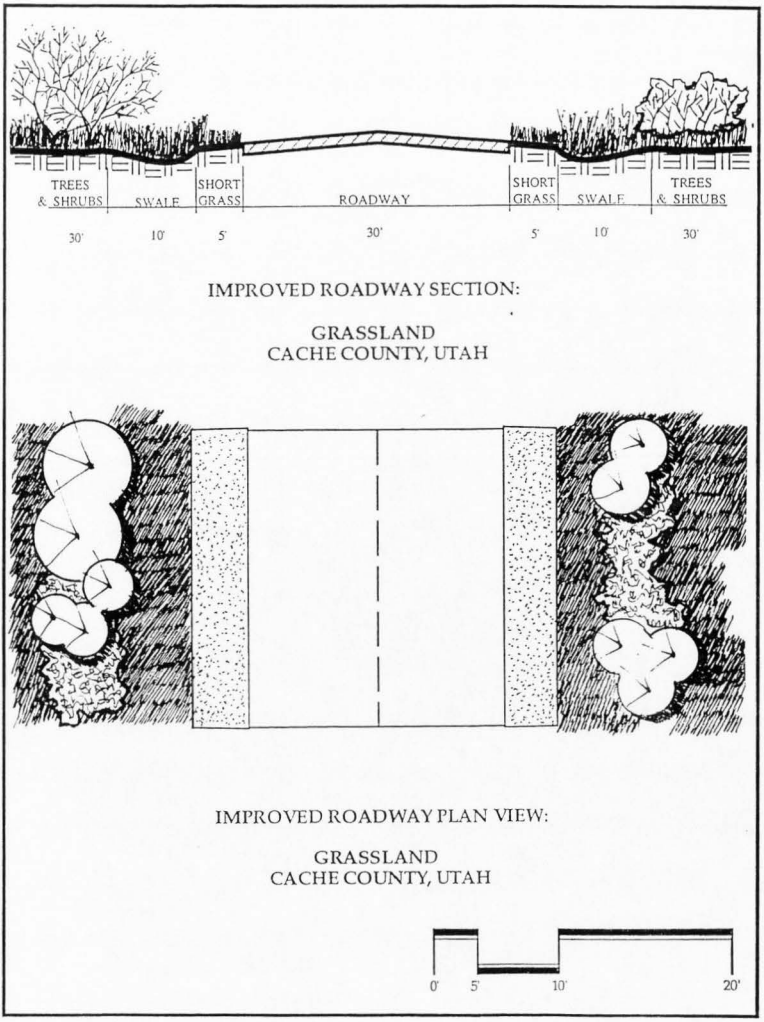


Figure 48. Planting plan and section view for the grassland category.

TABLE 14.
Plant Schedule for the Woodland Category

Species	Cultivar or Variety	Seed Application Drilled Rate (PLS lb/acre)*	Planting Depth (if drilled) (inches)
Grasses:			
Bluebunch wheatgrass *(Agropyron spicatum)*	Secar	3.0	0.5
Great Basin wildrye *(Elymus cinereus)*	Trailhead	2.0	0.5
Idaho fescue *(Festuca idahoensis)*	Joseph	2.0	0.5
Prarie junegrass *(Koeleria cristata)*		1.0	0.25
Indian ricegrass *(Oryzopsis hymenoides)*	Paloma	1.0	1.0
Forbs:			
White yarrow *(Achillea millefolium)*		1.0	0.5
Rocky Mountain beeplant *(Cleome serrulata)*		0.5	0.5
Plains coreposis *(Coreopsis tinctoria)*		0.5	0.25
Northern sweetvetch *(Hedysarum boreale)*		0.5	0.25
Blue flax *(Linum lewisii)*		1.0	0.25
Wasatch penstemon *(Penstemon cyananthus)*		1.0	0.5
Total		13.5	

* PLS = Pure live seed. Seeding rates should be doubled if broadcast.

Cost Estimates for Revegetation

The cost estimates for the six roadside plant communities were prepared in the summer of 1996. Plant material and seed prices change every season depending on availability and other market driven factors. The seed estimates came from Granite Seed (trademark brand) in Lehi, Utah. The tree and shrub estimates came from Bitterroot Nursery (trademark brand) in Corvallis, Montana. The estimates were based on lb/acre for seed. Trees and shrubs were based on cubic inch size specified in the plant schedule and a

TABLE 15.
Plant Schedule (Trees and Shrubs) for the Woodland Category

Botanical Name	Common Name	Size
Crataegus douglasii	Douglas hawthorne	10 cu in.
Prunus americana	American plum	10 cu in.
Prunus virginiana	Chokecherry	3 cu in.
Rhus aromatica	Basket bush	3 cu in.
Rhus typhina	Staghorn sumac	10 cu in.
Ribes aureum	Golden current	3 cu in.
Rosa nutkana	Wild rose	3 cu in.
Rosa woodsii	Woods rose	3 cu in.
Symphoricarpos albus	Common snowberry	3 cu in.

plant spacing of 4 feet on center to create a 30 percent canopy coverage per acre. Table 16 shows a summary of cost estimates for each roadside plant community.

Conclusion

Revegetation efforts to improve roadside habitat in Cache County can be accomplished by following the proposed planting strategies, seed mixes, and implementation techniques provided in this chapter. The primary goals of motorist safety, erosion control, noxious weed suppression, and aesthetics remain the same. The addition of wildlife habitat to the list of goals does not interfere with the achievement of the other goals. With the introduction of the specified plant material, roadside plant communities will be more diverse and have an increased ability to defend against insect infestation, plant disease, exotic invaders, and noxious weeds.

The proper sequence of revegetation events is crucial for success. Interseeding is the preferred method for roadside revegetation where noxious weeds or bare ground are below 50 percent. Seedbed preparation is necessary where interseeding is not practical and

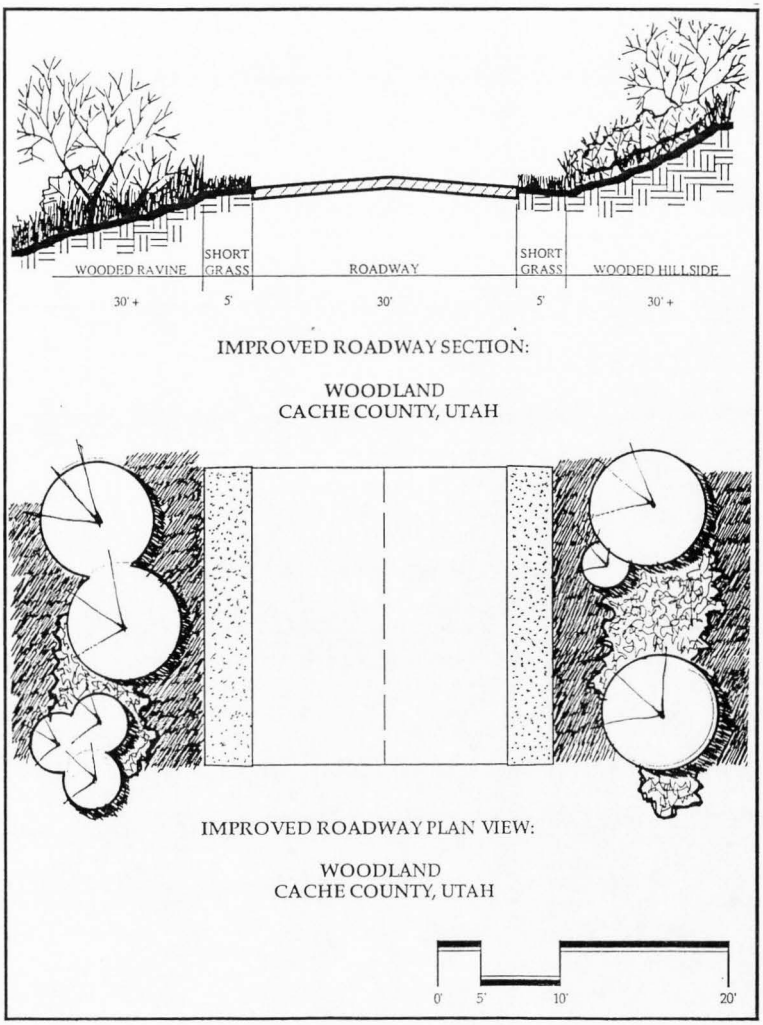


Figure 49. Planting plan and section view for the woodland category.

TABLE 16.
Cost Estimates for Revegetation of Six Roadside Plant Communities in Cache County, Utah (Plant Material Only)

Plant Community	Seed	Trees and Shrubs	Total
Agricultural Seasonally Wet Ditch Bank	$464/acre	$734/acre	$1198
Agricultural Mixed Grasses	$240/acre	$734/acre	$974
Wetland	$350/acre	N/A	$350
Riparian	$498/acre	$734/acre	$1232
Grassland	$ 240/acre	$734/acre	$974
Woodland	$189/acre	$734/acre	$923

involves discing or rototilling (for small sites) the soil to a depth of 3 inches, then drill seeding (where possible), hydroseeding, or broadcast seeding the prepared areas.

To create wildlife habitat that can sustain wildlife populations year round, trees and shrubs should be incorporated into roadside vegetation. Design guidelines (safety, erosion control, fire, and aesthetics) must be considered before planting trees or shrubs in the right-of-way. When planting trees and shrubs in the right-of-way, the planting location should be prepared by spot spraying a glyphosate (Roundup or Rodeo, both trademark brands) to eliminate competition in the area, and then digging the hole and planting the stock. Because of high costs and high maintenance, no irrigation for right-of-way plantings is recommended. Therefore, it is imperative that planting locations take advantage of natural soil moisture conditions or existing watering sources. The maintenance of roadside plant communities is discussed in the following chapter.

CHAPTER VII

MAINTENANCE RECOMMENDATIONS

Introduction

The Utah State Department of Highways Manual of Instruction, Part 13 Maintenance Section 13-1005.1, Roadsides, states (UDOT 1990):

> Highway roadsides should be kept clean, neat, attractive, and safe. Sight distance must be preserved. Noxious weeds must be exterminated. Dangerous trees removed. Raw cut and embankment slopes require vegetative cover to prevent erosion. Vegetation that fosters these objectives should be preserved and maintained in the proper areas and removed from hazardous locations. (p. 1)

County road managers echo the same objectives as UDOT for roadside vegetation management (Chapter V).

Traditionally, springtime (March-June) has seen the use of herbicides to control roadside vegetation. The current method in Cache County is to "bare ground" with a non-selective herbicide for 5-6 feet from the roadside. Then, a broadleaf herbicide is applied from "fence line to fence line." This method generally eradicates any broadleaf vegetation along the roadside, which in turn controls the spread of noxious weeds (Cache County Weed Supervisor, personal communication, 1995). Summer (June-August) is the time when the majority of the roadside mowing takes place. The current policy is to mow between the fence lines when possible. The areas that cannot be mowed, such as wet ditch banks and slopes, are sprayed with a glyphosate, nonselective herbicide.

Native grasses, wildflowers, forbs, trees, and shrubs are eliminated by these types of maintenance procedures. The following guidelines describe various alternative methods of roadside vegetation management, including weed control by spot spraying, biological control agents, mowing, restoration mowing, and prescribed burning. The use of signage and limiting animal damage along roadsides is also discussed.

Weed Control

Herbicides. Herbicides have often been used along roadsides for the control of weeds. Along roadsides, undesired vegetation is labeled as a weed. "Weeds of the West," by Whitson et al. (1992, p. ix), defined a weed as "a plant that interferes with management objectives for a given area of land at a given point in time." The Commissioner of Agriculture under Section 4-17-3, Utah Noxious Weed Act, has listed weeds considered "noxious" in the state. They include:

Bermudagrass (*Cynodon dactylon*) which is not considered a weed in Washington County, Utah.

Bindweed or Wild Morning-glory (*Convolvulus spp.*).

Broad-leaved Peppergrass or Tall Whitetop (*Lepidium latifolium*).

Canada Thistle (*Cirsium arvense*).

Diffuse Knapweed (*Centaurea diffusa*).

Dyers Woad (*Isatis tinctoria*).

Perennial Sorghum, including but not limited to Johnsongrass (*Sorghum halepense*) and Sorghum Almum (*Sorghum almum*).

Leafy Spurge (*Euphorbia esula*).

Medusahead (*Taeniatherum caput-medusae*).

Musk Thistle (*Cardus nutans*).

Quackgrass (*Agropyron repens*).

Russian Knapweed (*Centaurea repens*).

Scotch Thistle (*Onopordium acanthium*).

Spotted Knapweed (*Centaurea maculosa*).

Squarrose Knapweed (*Centaurea squarrosa*).

Whitetop (*Cardaria spp.*).

Yellow Starthistle (*Centaurea solstitialis*).

The best method to control or eliminate weed populations is to maintain and promote a healthy plant community. Weeds grow best in disturbed or neglected areas and are quick to colonize bare ground (IRVM 1994). To control the spread of weeds along roadsides, herbicides should be used on a selective bases. The types of herbicides used for controlling weeds vary greatly. Generally, a selective herbicide like 2,4-d is used for broadleaf weeds, and a nonselective glyphosate like Roundup or Rodeo (trademark brands) is used for grasses or forbs (Steve Dewey, personal communication, 1996). Appendix C contains specific herbicide controls for the noxious weeds already discussed.

Spot Spraying. Spot spraying, although more time consuming, is more effective for controlling noxious weeds than indiscrimenant "fence line to fence line" spraying. The extra time costs can eventually be offset by the savings obtained by spot spraying. Spot spraying with a back-pack sprayer involves identifying the weedy species and spraying the individual plant. This allows desirable vegetation to occupy the ground vacated by the weed. Eventually spot spraying of the area will not be needed because desirable vegetation will be established.

An alternative to traditional herbicide treatment is the relatively new use of hot water to kill weeds. Hot water treatments use no chemicals and are safe to surrounding populated areas, ground and surface water, and soil. Because there is no risk for drift or dilution, weed control can be done in windy or rainy weather conditions (IRVM 1994). Spot treatments are done within 100-230 feet of the vehicle and have proven to be as effective as herbicide. In New Zealand, the Waipuna (trademark brand) system defoliated weeds within 2 days of application and a glyphosate took 15 days to yellow the same weeds. Within 49 days, both treatments had killed all the annuals and most of the perennials studied (IRVM 1994).

In some cases, hand eradication of certain species is the best approach. Hand eradication is highly effective in the elimination of most annuals and biennials (IRVM 1994). Perennials are more difficult and generally require herbicide for eradication.

Biological Control Agents (BCA's)

Biological control agents have been defined as the (Goeden 1977)

> deliberate use of natural enemies [phytophagous (plant-feeding) or phytopathogenic (disease-inciting) organisms] to control weeds. Its goal, based on sound principles of population ecology, should not be weed eradication, but rather, reduction of a weed's abundance to economically or aesthetically tolerable levels. (p. 4)

Biological control agents attack certain weed species without harming other plant species. When used properly, BCA's should do the following (modified from IRVM 1994):

1. Thrive in the new habitat.
2. Locate the target weed.
3. Kill or prevent reproduction of the weed.
4. Not be subject to indigenous predators of the new habitat.
5. Not disturb any other species.

Biological control agents come in many different forms and may be effective in various ways. One example of a noxious weed that does not respond well to herbicide control, but does respond to BCA's, is leafy spurge (*Euphorbia esula*). Leafy spurge is estimated to have infested more than 2.5 million acres in the United States. It does well in the arid climate of Utah. Mowing leafy spurge can double stem densities in a short amount of time. Burning has had some effect if it is burned three times a year for 3-5 years continually. Herbicides have had very little effect and "the cost of spraying outweighs the benefits by as much as 10 to 1" (IRVM 1994, p. 5). However, BCA's have had a promising effect on leafy spurge. Grazing goats and sheep in infested areas have reduced

stem densities by 21 percent. And there are seven species of insects that feed on the roots and shoots of leafy spurge, including beetles, moths, and midges (IRVM 1994).

Effective BCA's can be inexpensive, nonpolluting, and highly specific, and do not need repeated treatments (IRVM 1994). Some experts believe BCA's to be noneffective and need more testing before allowing BCA's to be used (Whitson et al. 1992). Others believe BCA's are a useful tool in some situations and require more research to identify their potential (James et al. 1991).

Mowing

Reducing the area within a roadside that is mowed would allow more native vegetation to establish itself and would also conserve wildlife habitat. Mowing for problem areas or for safety reasons, such as near intersections or road shoulders, is still needed. Figure 50 is taken from the Roadside Vegetation Management Handbook (UDOT 1990) and shows the current typical mowing standard for a two-lane highway and adjacent roads. Figure 51 shows a reduced mowing policy where roadside vegetation is allowed to grow on the backside of ditches and next to fencelines. Mowing should still occur near intersections and within one mower width from the edge of pavement. If mowing must occur elsewhere, it is recommended mowing be delayed until after August 31. This would allow nesting birds to complete the incubation process. When mowing, a height of 8-12 inches should be maintained. This would leave stubble for nesting birds the following spring. Nest success is enhanced in stubble because of increased residue to build the nest and a greater ability to avoid nest predation (Trautman 1982). To determine the amount of roadside to mow, a good rule of thumb is to not mow more than 10 percent of the right-of-way.

Perhaps a more significant motivation to raise mower height is that less debris would be thrown by the mower. This is safer to mower operators and passing motorists.

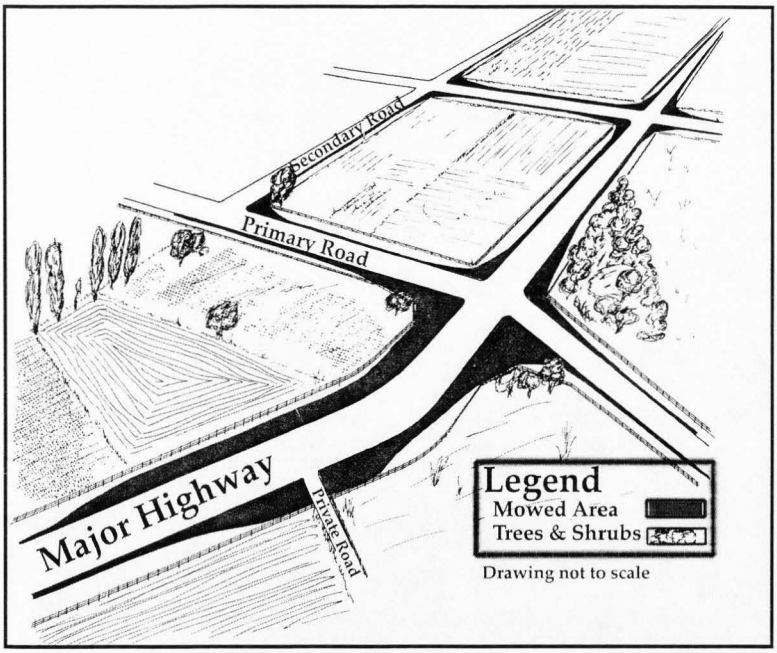


Figure 50. Typical mowing recommendations for a two lane highway and adjacent roads (UDOT 1990).

Slopes steeper than 3:1 should not be mowed at all. This would reduce the number of accidents involving "rolled" equipment.

The current budget for mowing state and federal highway right-of-ways in Utah is $1 million annually (Ira Bickford, personal communication, 1996). In Utah, Ira Bickford (personal communication, 1996) estimated a potential statewide savings of $100,000 to $200,000 annually by reducing the amount of right-of-way mowed. Ohio has implemented a reduced mowing policy and estimated a statewide savings of $1 million annually (Ruble 1990).

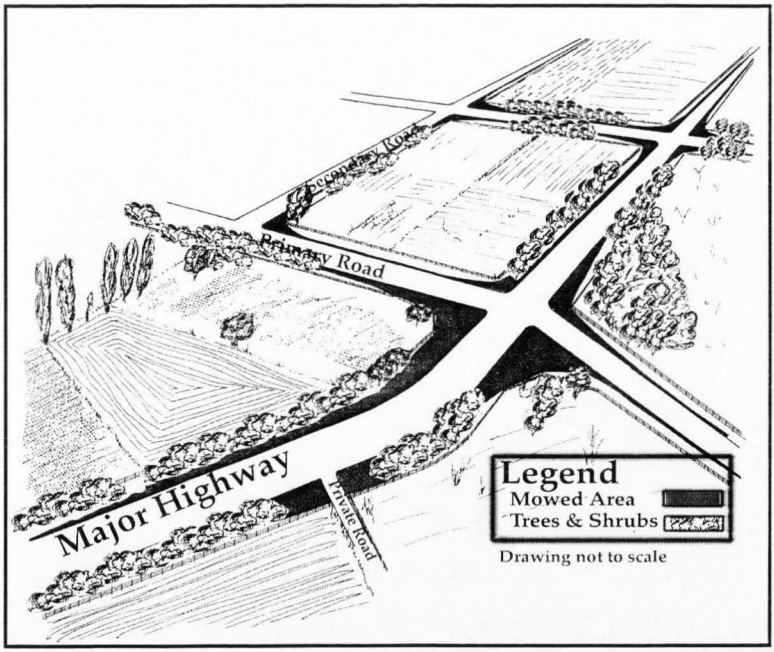


Figure 51. Improved mowing recommendations to enhance roadside habitat capabilities (drawing modified from original UDOT 1990).

Restoration Mowing

Restoration mowing involves the use of mowing along right-of-ways to restore plant community vigor. After plant establishment, mowing is recommended to revitalize perennial bunch grasses and reduce woody plant encroachment along road shoulders and the bottom of ditches (Catherine Fouchi, personal communication, 1996). The recommended rotation time for Utah roadsides will vary on the succession of the plant community; however, a general guideline is every 3-5 years. Not all the mowing should be done along a stretch of roadside at one time. No more than one half mile of a 2-mile stretch

should be mowed in any one year. This allows wildlife to relocate into the taller, dense grasses that are not mowed (Catherine Fouchi, personal communication, 1996).

Burning

As a vegetation management tool, burning has a long history in the tallgrass prairies of central North America (Stewart 1951). Typically, burning has been viewed as a tool to increase vigor in warm-season grasses and reduce the vigor of cool-season grasses (Benning and Bragg 1993). In the past, burning has been used to stimulate seral tallgrass prairie species and to increase the carrying capacity of rangeland for cattle production (Mitchell et al. 1995).

Some research contends that burning is not effective as a management tool. In Idaho, fire was shown not to affect bunchgrass, but rather the vigor of plant material was determined by microenvironmental conditions created following fire. Perhaps more significant was the conclusion that the return to vigor following fire relied on available soil moisture and the plant's ability to compete for water (Defosse and Robberecht 1996). A study of tallgrass prairies in Oklahoma found the effects of fire on community composition was not significant for more than one year and the community returned to prefire status (Engle et al. 1993). The same study did find, however, that brush was reduced significantly by fire and this allowed perennial grasses to more effectively compete for resources. In Wyoming, shrubs such as true mountain mahogany (*Cercocarpus montanus*), antelope bitter brush (*Purshia tridentata*), and serviceberry (*Amelanchier alnifolia*) were initially reduced by fire, but rebounded with twig production higher in protein. This increase created a higher browsing potential by large ungulates (Cook, Hershey, and Irwin 1994).

Perhaps one of the most detailed studies involving burning and the effect it has on wildlife nest density was done near Jamestown, North Dakota. After 7 years of studying fire, Kruse and Bowen (1996) concluded that burning decreased plant vigor and nest

densities. The control fields not burned remained attractive to nesting waterfowl throughout the study period. Fire was found to decrease insect availability for sage grouse habitat in southeastern Idaho. Fire, typically used in the area to remove sagebrush, did not enhance sage grouse habitat (Fischer, Reese, and Connely 1995). To prevent the decrease in insect populations, the Integrated Roadside Vegetation Management manual (IRVM 1994) suggested not burning large areas in a single burn event.

Many believe burning reduces weed seed and disease organisms in tallgrass plant communities (Rasmussen, Rickman, and Douglas 1986). However, inadequeate and non-uniform fire temperatures may prevent this. Surface temperatures need to exceed 170 degrees Celsius to destroy disease organisms or weed seeds. Temperatures below 120 degrees Celsius failed to destroy either. Soil temperatures need to be uniform to achieve successful elimination of weed seed and disease organisms, and accumulated leaf litter does not raise soil surface burn temperatures (Rasmussen, Rickman, and Douglas 1986).

Iowa's Roadside Vegetation Management plan (IRVM 1994) involves the use of "spot torching" noxious weeds. They found this method to cost one-fifth the cost of herbicide treatment. Total cost of this method is one man hour/acre.

Timing. The timing of burning can greatly influence the degree of success found in using it as a management tool. Spring has been a traditional time for burning because it was thought to increase production of grasses for cattle grazing (Benning and Bragg 1993). In testing this hypothesis, Benning and Bragg (1993) found that optimum burn times vary greatly depending on environmental or physiological changes in the plant materials that make up the community. They found that in as little as a 4-day time period, big bluestem went from no increased vigor after burning to a great deal of increased vigor after burning.

In Iowa, spring burning in the months of March to April was optimum for reducing cool-season annuals and favoring warm-season perennials and forbs (IRVM 1994). Spring burning in other states favored western wheatgrass, buffalograss, and sand

dropseed, while discouraging Japanese brome and green needlegrass. Spring burning had no effect on threadleaf sedge (Whisenant and Uresk 1990). Some wetland species thrive under spring burning, like *phragmites*, while this same plant (*phragmites*) suffers under summer burning. The decrease of phragmites under a summer burning regime was found to increase plant diversity in the community (Thompson and Shay 1988).

In Utah, Smith and Kadlec (1985) found wetland vegetation unchanged in the long term under a spring burning regime. However, waterfowl preferred burned wetlands, presumably for a higher protein content found in burned plant communities. Vogl (1973) suspected that waterfowl preferred burned areas for foraging because of less ground litter. Other benefits of spring burning include greater soil fertility, decreased leaf litter, decreased summer fire hazard, and greater soil warming due to decreased leaf canopy (IRVM 1994).

Spring Burning. Late spring burning was found to reduce cool-season grasses and favor seral tallgrass prairie species (Mitchell et al. 1995). Consistently, spring burning was found to increase forb production by as much as two fold (Engle et al. 1993; Cook, Hershey, and Irwin 1994; Kruse and Bowen 1996). Late spring burning was also shown to be effective in controlling some species of grasses, such as smooth brome (Blankspoor and Larson 1994). Blankspoor and Larson (1994) found that prescribed burning was more effective in the control of smooth brome during wet years and that failing to burn in dry years spread smooth brome extensively.

Summer Burning. Summer burning reduced dry matter yields of tallgrass prairie in North Dakota. Yet forbs doubled on burned plots versus unburned plots, just as in the late spring burning scenarios (Kruse and Bowen 1996).

Fall Burning. Fall burning had no change on a phragmites plant community (Thompson and Shay 1988). However, grasses in Idaho were significantly higher in seed production for as many as 5 years after a fall burn event (Patton, Hironaka, and Bunting 1988). The study found grasses, including bluebunch wheatgrass (*Agropyron spicatum*),

Idaho fescue (*Festuca idahoensis*), and Columbia needlegrass (*Stipa columbiana*) had increased inflorescenses, which attributed to a higher seed production after fall burning.

Management Implications. Burning along roadsides would increase plant vigor of warm-season perennials and forbs (Patton, Hironaka, and Bunting 1988; Benning and Bragg 1993; Mitchell et al. 1995; Kruse and Bowen 1996). Burning along roadsides may be effective in controlling invasive grasses, such as cheatgrass (*Bromus tectorum*). To be effective, burn temperatures must uniformly exceed 170 degrees Celsius (Rasmussen, Rickman, and Douglas 1986). For the management of roadsides as wildlife habitat, the timing of the burn event is crucial. Early spring burning, when soil moisture is still high, appears to be the best timing suited for weed control and increase of tallgrass perennials and wildflowers. Burning in small patches will alleviate the concern of eliminating wildlife habitat while reducing the attractiveness of burned areas for large ungulates. A 5-year rotation of burned plots is recommended (Patton, Hironaka, and Bunting 1988). When roadsides are dominated by weedy species, and native species are not abundant enough to fill in burned areas, burning is not recommended (Rosburg 1993).

Past responses of waterfowl to burned areas has been positive (Smith and Kadlec 1985). Burned areas provide more forage and nesting opportunities (Vogl 1973; IRVM 1994) and greater protein in the vegetation itself. Seed production is also higher (Patton, Hironaka, and Bunting 1988). The use of herbicides after burning has been effective in controlling certain species of grasses, but the use of herbicides in this manner is not recommended when the management objective is for wildlife habitat (Engle et al. 1993). In some cases, burning will cause increased vigor in weed species, which allows for more effective use of spot spraying for that species (IRVM 1994). In such cases, limited herbicide use is recommended (IRVM 1994). Fertilizer on burned areas showed a 25 percent increase in plant production, which was considered minimal production for the amount of chemical used (Mitchell et al. 1995).

The burning of vegetation as a management tool is a complicated process. Varying degrees of success will accompany the management objectives. Any management practice may enhance some wildlife and vegetation species while hampering others (Kruse and Bowen 1996). The use of burning to control vegetation should be determined on site-specific data and individual situations.

Signage

The largest concern of state and county highway departments with a reduced mowing/spraying alternative is the public perception of the maintenance departments. Mowing and spraying have occurred for many years. Often a reduced mowing/spraying policy is thrown out when a few citizens call and complain about the "untidiness" of unmowed or unsprayed roadsides. Most motorists do not notice any difference (see Chapter V). The state of Virginia found their answer to this problem in communicating with the public through signage (Bristow 1990). Virginia has implemented a program using signs such as "Unmowed Wildlife Cover" and "Wildlife Nesting Cover." These signs were accompanied with larger more detailed signs at state line entrances and rest areas. It is believed that similar signage in Cache County would reduce citizen concern related to unmowed roadsides and increase support for improving roadsides as habitats for wildlife.

Animal Damage Control

Animal damage to newly revegetated sites has been a significant problem in Cache County habitat projects (George Wilson, personal communication, 1996). Grazing animals are attracted to the succulent and tender vegetation found in revegetated areas. Grazing diminishes the ability of the new plantings to compete following defoliation due to the lack of carbohydrate reserves (Hansen and McKell 1991). Hansen and McKell (1991) stated

that newly revegetated areas should be protected from grazing for at least two growing seasons.

Wildlife damage to new plantings is typically more severe than livestock damage. The usual participants of roadside vegetation damage are rodents, rabbits, and deer (Hansen and McKell 1991). Rodents and rabbits have caused the most severe damage to revegetation efforts in Cache County (George Wilson, personal communication, 1996). Plastic mesh tubings have been effective in deterring rodents and rabbits from destroying tree and shrub plantings (Robert Schmidt, personal communication, 1996). However, these methods are expensive. Overplanting of new species appears to be the most cost-effective and simple method of establishing new seedlings (Robert Schmidt, personal communication, 1996). The control of animal damage is dependant on many factors, such as planted species, wildlife species causing the damage, site location, and budget. Each revegetated area should be evaluated to determine which method or methods would work best.

Conclusion

In conclusion, maintenance techniques have the most significant effect, either positive or negative, on revegetation efforts. Untimely mowing/spraying can severely decrease the viability of a plant community and its value to wildlife. The best method to control or eliminate weed populations is to maintain and promote a healthy plant community. Weeds grow best in disturbed or neglected areas and are quick to colonize bare ground (IRVM 1994).

Continual mowing is a disturbance. If mowing is delayed until after August 31, native plantings will have the opportunity to set seed and propagate naturally. Wildlife will then have completed the nesting and incubation process. A reduction in mowing area will save time and money for agencies responsible for maintaining roadsides. Mowing equipment will last longer, and perhaps equipment formerly used for mowing can be used

for other tasks that may not have been accomplished otherwise. For areas that continue to be mowed in the interest of safety, the height of the mowers should be raised from 4 inches to 8-12 inches. This accomplishes many objectives. First, less debris will be thrown from the mowers, resulting in greater safety for operators and passing motorists. Second, mowing equipment will last longer and the operation will take less time due to the increased mower height. And third, wildlife will have increased nesting opportunities in the residual vegetation found in the spring.

Spot spraying of herbicide, as opposed to blanket spraying, will also enhance existing roadside vegetation. The initial labor costs of spot spraying will be greater while the costs of herbicide applied will be less. In the long run, plant communities will be able to outcompete exotic invaders if they are not eliminated or stressed when herbicide is applied (Steve Dewey, personal communication, 1996). Alternatives such as hot water treatments should be explored as potential weed control tools. Table 17 shows a potential maintenance schedule, including all aspects of roadside maintenance involving roadside evaluation, roadside revegetation, burning, spot spraying, and spot mowing.

Biological control agents have the potential to attack targeted weed species without harming any other species. When the BCA becomes established, the BCA population will decrease with the weed population until an equilibrium is reached. Grazing animals have also been effective as BCA's in some regions of the country. BCA's need further research to determine best managment practices for their use.

Signage is recommended to educate the public regarding a reduced or delayed mowing program. Signage will reduce public complaints concerning "untidy" roadsides. Possibly, the agencies will receive praise from wildlife conservation groups interested in establishing quality wildlife habitat. And finally, animal damage control is required to reduce plant losses to grazing livestock and wildlife. Physical protection is expensive and

TABLE 17.
Potential Maintenance Schedule for Roadside Plant Communities in Cache County, Utah to Minimize Adverse Impacts on Wildlife

Month	Roadside Evaluation	Revegetation	Burning	Spot Spraying	Spot Mowing
Jan					
Feb					
Mar	■	■	■		
Apr	■	■	■		
May		■			
June				■	
July				■	
Aug				■	■
Sep		■		■	■
Oct		■		■	■
Nov		■			
Dec					

time consuming, while overplanting, which allows for some damage to occur, may be a more cost-effective method.

CHAPTER VIII

CONCLUSION

Background

Pheasant (*Phasianus colchicus*) populations have been used as indicators of both quantity and quality of wildlife habitat for many years. The midwest has seen a decline in pheasant populations since 1946 (Warner, Joselyn, and Etter 1987) and Cache County has seen a decline since the late 1950's (Nish 1973). Cache County pheasant populations have declined between 1.2 percent and 2.71 percent per year from 1962 to 1981 (Roberson and Leatham 1981; Heath 1984). Continuing the rate of decline to 1996, pheasant populations have dropped between 40.8 percent and 92.14 percent since 1962. Changes in land use have led to the loss of habitat and are the main reasons for pheasant population decline overall (Olsen and Leatham 1979; Warner, Joselyn, and Etter 1987). In Cache County, the limiting factor for pheasants is primarily lack of winter cover and its proximity to a food source, and secondly, lack of permanent nesting cover suitable for first nesting success (Olsen 1977; Heath 1984; George Wilson, personal communication, 1996).

Roadside right-of-ways in Cache County have the potential of providing approximatley 11,000 acres of additional roadside habitat. Roadside habitat can provide nesting, winter, roosting, brood-rearing, protective, and loafing cover. Roadsides can also function as travel corridors between habitat patches, food and water sources, and a place to find grit and calcium (Joselyn, Warnock, and Etter 1968; Snyder 1974; Trautman 1982). Roadsides alone cannot reverse the decline in pheasant population experienced in Cache County, but roadside habitat can aid in arresting the decline by providing quality habitat. Pheasants will not spend their entire lives along roadsides, but critical habitat at critical seasons provided along roadsides will help pheasants disperse across the agricultural landscape.

Other states have seen roadsides as very productive wildlife habitat. Minnesota roadsides produce one-quarter to one-half of all pheasants in the state (Varland 1985). In Nebraska, approximately one-quarter of all pheasant nests are found along roadsides (Baxter and Wolf 1973). Overall, pheasant nest densities on undisturbed roadsides exceed any other habitat type (Snyder 1974). Research has shown that predation and roadkill numbers do not rise when improving roadside habitat (Joselyn, Warnock, and Etter 1968; Oetting and Cassel 1971; Varland 1987; Bristow 1990; Showalter 1990).

Roadside Vegetation Management

Existing Vegetation. The most dominant grass along Cache County roadsides was cheatgrass (*Bromus tectorum*) followed by tall wheatgrass (*Elymus elongatum*). Some native species, like Great Basin wildrye (*Elymus cinereus*), were high in density, but only in riparian areas and under other favorable growing conditions.

The reasons for monotypic plant communities and the lack of native plant material appeared to be the annual disturbances caused by mowing and herbicide applications. If these maintenance practices were modified, roadside plant communities could support a higher diversity of plants, and consequently, a higher quality of wildlife habitat.

Existing roadside vegetation in Cache County did not support high quality or quantity of wildlife habitat. Some patches of high-quality roadside wildlife habitat were scattered across Cache County, but these were typically isolated patches. Wetland plant communities studied along roadsides generally provided high-quality winter cover in Cache County, as did some woodland patches. But, the majority of roadside plant communities supported monocultures of short, annual grasses that lodged severely under the weight of snow.

Revegetation Strategies. Before the restoration of a plant community is undertaken, specific design guidelines should be considered. These guidelines (safety, erosion control,

fire, aesthetics) address the basic issues faced when dealing with the management of roadside vegetation.

Next, the proper revegetation technique should be chosen. This may vary from entire revegetation to simply maintaining the existing vegetation. The method of revegetation is dependent on existing site conditions such as vegetation, topography, soils, climate, aspect, location, and adjacent land use. To revegetate Cache County roadsides, the appropriate plant community must be identified and then referred to specific plant community specifications.

Maintenance. The maintenance of roadside plant communities greatly affects the function of roadsides as wildlife habitat, as well as their ability to be self-sustaining communities and resist exotic plant invasion. The survey of county weed supervisors in Utah showed that safety, erosion control, and weed suppression are the main reasons for current maintenance practices. These current practices caused a continual disturbance of the plant communities. Disturbance limits the ability of native plants to compete against invaders such as noxious weeds or cheatgrass (IRVM 1994).

Modifications of current maintenance practices will yield better erosion control and weed suppression while not compromising safety. These modifications include spot mowing troublesome areas, but leaving good, healthy stands of grasses.

The spot spraying of roadside weeds with herbicides or other promising materials or methods, such as hot water treatments or hand eradication, should be practiced. These methods will eventually lead to healthier roadside plant communities and lower maintenance costs. Wildlife habitat will also benefit from these modified maintenance practices.

The use of biological control agents (BCA's) and periodic burning along roadsides have potential as management tools for increasing plant vigor and reducing weed species. These methods, however, need expert consultation before applying them.

Summary

By improving roadside plant communities, increased numbers of pheasant populations may utilize roadsides as permanent nesting and winter cover. Enhanced roadsides may also provide protective, brood-rearing, loafing, and roosting cover. Travel lanes between habitat patches will be improved and food, water, and grit and calcium will be more accessible.

Roadside habitat improvement is not the complete answer to the declining pheasant population. Landowner cooperation in this and other habitat conservation programs is essential (Nish 1973; Heath 1984). How the cooperation will occur is beyond the scope of this study.

The key to success of a roadside wildlife habitat program in Utah is the communication and cooperation of public agencies (and private landowners in some cases) that manage roadsides. Together, the Division of Wildlife Resources, the Utah Department of Transportation, individual counties, and individual landowners can manage roadsides to create quality wildlife habitat and maintain healthy roadside plant communities.

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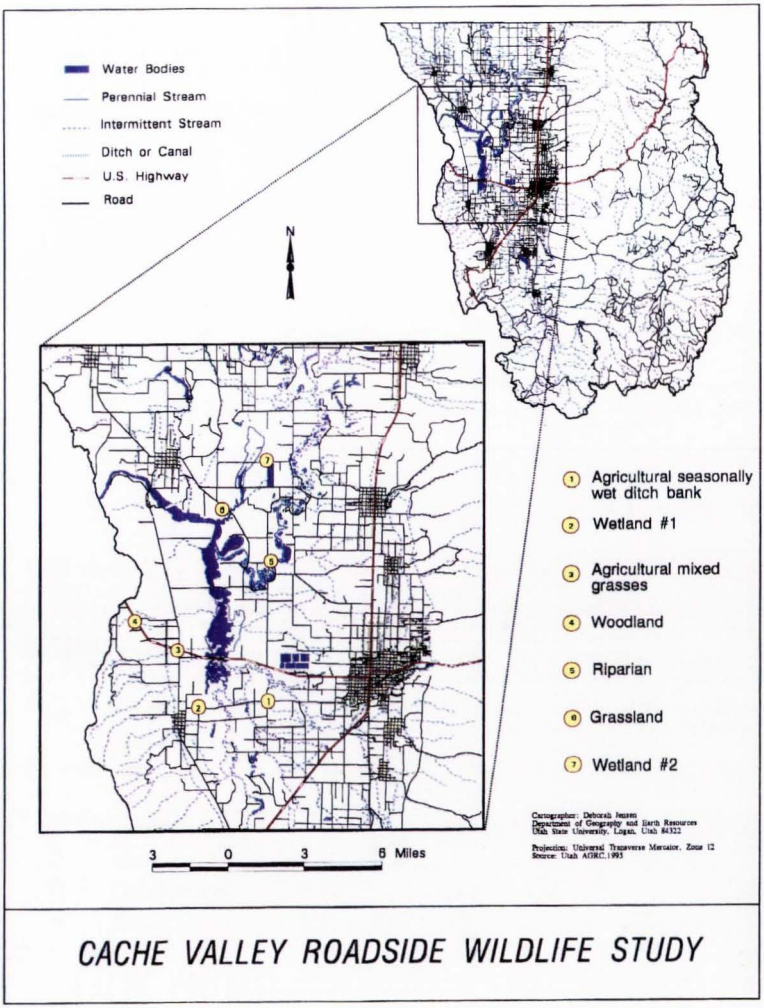
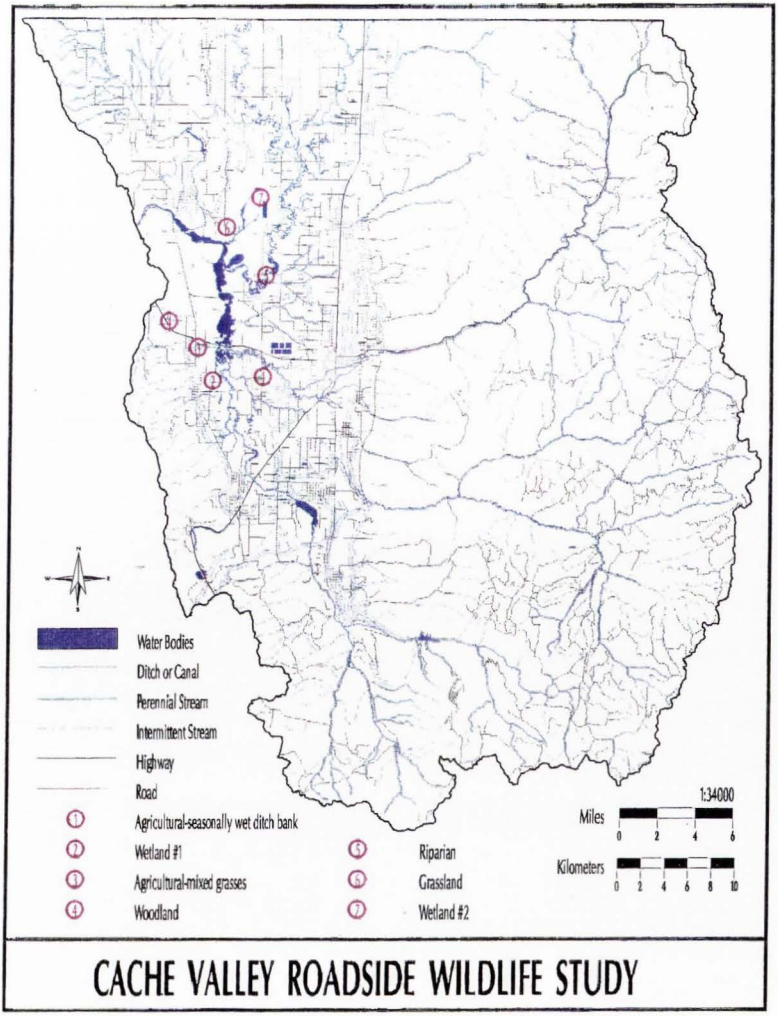
APPENDICES

Appendix A.

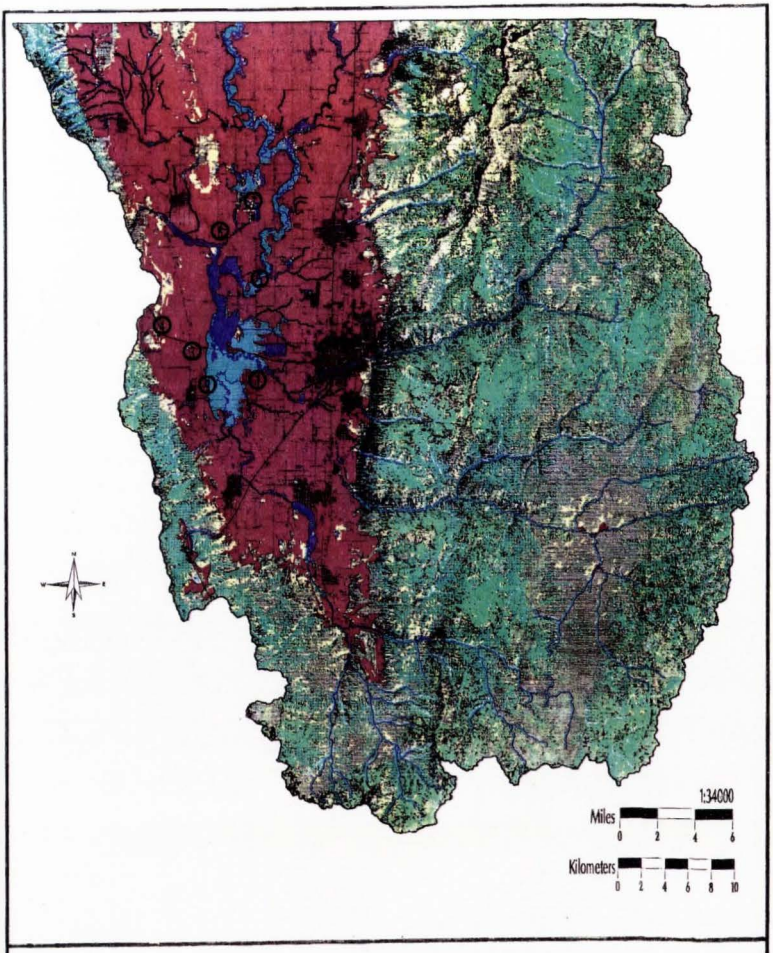
GIS Maps of Cache Valley Roads and Water Bodies, Cache Valley Vegetation, and Utah Pheasant Distribution Map



CACHE VALLEY ROADSIDE WILDLIFE STUDY

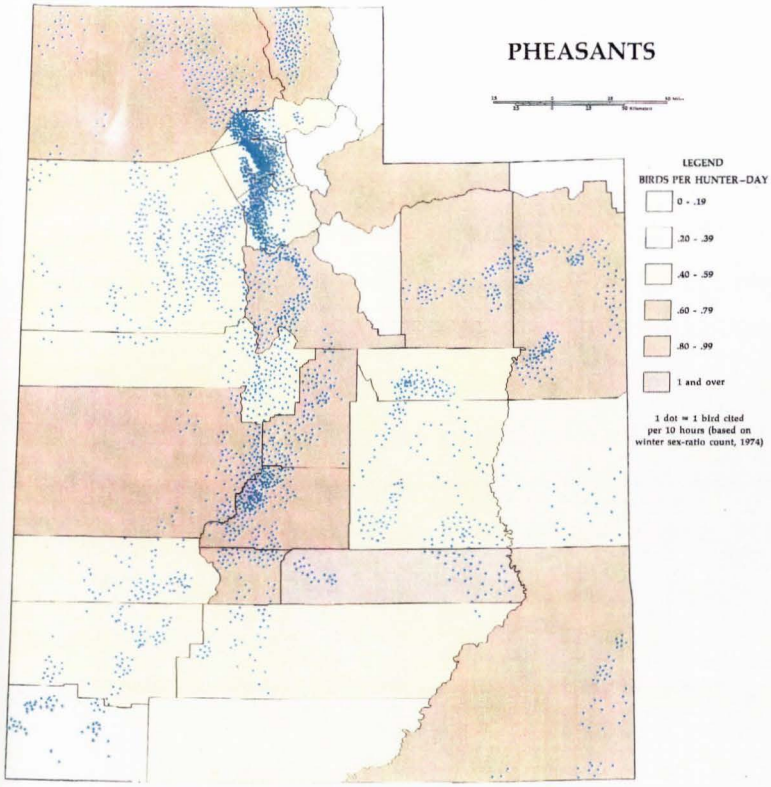


CACHE VALLEY ROADSIDE WILDLIFE STUDY



CACHE VALLEY VEGETATION

CACHE VALLEY VEGETATION


PHEASANTS
LEGEND
BIRDS PER HUNTER-DAY
0 - .19
.20 - .39
.40 - .59
.60 - .79
.80 - .99
1 and over
1 dot = 1 bird cited per 10 hours (based on winter sex-ratio count, 1974)

Appendix B.

Questionnaire and Results for State Agency Personnel and County Weed Supervisors

STATE AGENCY PERSONNEL

November 07, 1995

Survey Recipient:

I am currently a graduate student in Landscape Architecture at Utah State University working on a thesis entitled "Guidelines for roadside revegetation to create wildlife habitat in Northern Utah". My specific focus is to investigate the potential for protecting, enhancing, or restoring roadside habitat for the Ring-Necked Pheasant. As part of my thesis project, I am conducting a survey to determine whether or not roadside habitat programs exist in other intermountain states. I would appreciate your responses to the following questions.

Thank you,

Lars Anderson
Graduate Student
Utah State University

1. Do you consider roadsides (more specifically, rural roadsides) as important wildlife habitat? Y N

Please check (√) those pheasant habitat components you believe roadside ditches provide and indicate with an * which of these functions you believe to be most important.

- ❑ Nesting cover
- ❑ Brooding cover
- ❑ Roosting cover
- ❑ Loafing cover
- ❑ Winter cover
- ❑ Food source
- ❑ Travel corridor
- ❑ Other (please explain)

2. Do you have a "Roadsides for wildlife" program in your state?

Y N

4. Do you have any programs that encourage private landowners to maintain roadside ditches for habitat? Y N

5. Do you have any programs that encourage county governments to maintain roadside ditches for habitat. Y N

6. Do you have any roadside revegetation strategies?
(If so, please explain what they are and give any recommendation you feel may be applicable) Y N

7. If you provide seed for revegetation, or funding to purchase seed, what seed mix or mixes do you recommend?

8. What method of seeding, if any, do you recommend?

9. If you have a roadside habitat program, what is the annual level of funding for the state?

$0-10,000
$10,000-20,000
$20,000-50,000
> than $50,000

12. Would you be interested in recieving a summary of my survey results?

Y N

If yes, please leave your name and address here.

Thank you for taking the time to answer these questions. If you have a roadside habitat program please send any information or literature about it.

Please leave any additional comments here.

COUNTY WEED SUPERVISORS

November 07, 1995

To whom it may concern:

I am currently a graduate student in Landscape Architecture at Utah State University working on a thesis entitled "Guidelines for roadside revegetation to create wildlife habitat in Northern Utah". My specific focus is to investigate the potential for protecting, enhancing, or restoring roadside habitat for the Ring-Necked Pheasant. As part of my thesis project, I am conducting a survey to determine whether or not roadside habitat programs exist in other inter mountain states. I would appreciate your responses to the following questions.

Thank you,
Lars Anderson
Graduate Student
Utah State University

1. Do you consider roadsides (more specifically, rural roadsides) as important wildlife habitat? Y N

2. What is the most common method of maintenance used along the roadsides?

3. Do you consult a wildlife biologist from the state wildlife agency regarding roadside maintenance practices?

Y N

4. Do you use any of the following methods to control roadside vegetation? (If yes please explain how often, or quantity used)

METHOD	Spring Apr.-June	Summer July-Sept	Fall Oct-Nov
Mowing Y N			
Herbicide Y N			
Insecticide Y N			
Burning Y N			

5. Does the county permit landowners to mow the roadside ditches for hay?

Y N

6. Does the county permit landowners to seed roadsides with grasses of their choice?

Y N

If yes, what grasses are approved?

7. Does the county do any roadside revegetation?

Y N

If yes, what species are planted and what seeding methods are used?

8. What, if any, objections would the county have to managing roadsides as habitat for pheasants?
(Briefly describe what those objections are.)

9. What is your annual county budget for roadside maintenance?

$0-5,000
$5,000-10,000
$10,000-20,000
$20,000-50,000
> than $50,000

10. Would you be interested in receiving a summary of my survey results.

Y N

If yes, please leave your name and address here.

Thank you for taking the time to answer these questions. If you have a roadside habitat program please send any information or literature about it.

Please leave any additional comments here.

SURVEY RESULTS FOR BOTH COUNTY WEED SUPERVISORS AND STATE AGENCY PERSONNEL

February 06, 1996

Survey Recipient:

The following is a summary of the survey I sent to you recently.

SURVEY RESULTS

This package contains two separate questionnaires sent to different personnel groups- county weed supervisors and state personnel. The state personnel were a diverse group consisting of wildlife biologists from the states of Utah, Colorado, Idaho, Nevada, and Wyoming. Also surveyed were upland game habitat specialists, conservation groups, Utah Department of Transportation officials, and an extension weed specialist.

The purpose of the questionnaires was to test for existing opinions and concerns regarding a roadside wildlife habitat program in Utah and general knowledge of pheasant habitat requirements (which is being used as the indicator species in the study).

If you would like more information regarding this survey, or other aspects of a roadsides for wildlife program in Utah please contact me at:

Department of Landscape Architecture
and Environmental Planning
c/o Lars Anderson
Utah State University,
Logan, Utah 84321-4005

Sincerely,

Lars Anderson
Graduate Student

The following questionnaire was sent to county weed supervisors throughout the state of Utah. All twenty-nine counties were surveyed with ten responses (35%). A second mailing went to county weed supervisors because of the low response rate which resulted in a total response of sixteen (55%). Survey results have been combined and calculated. The following is the original mailed survey with the written and calculated responses following the question.

November 07, 1995

Survey Recipient:

I am currently a graduate student in Landscape Architecture at Utah State University working on a thesis entitled "Guidelines for roadside revegetation to create wildlife habitat in Northern Utah." My specific focus is to investigate the potential for protecting, enhancing, or restoring roadside habitat for the Ring-Necked Pheasant. As part of my thesis project, I am conducting a survey to determine whether or not roadside habitat programs exist in other inter mountain states. I would appreciate your responses to the following questions.

1. Do you consider roadsides (more specifically, rural roadsides) as important wildlife habitat? Y (31%) N (69%)

2. What is the most common method of maintenance used along the roadsides?
   - -Mowing and spot spraying of noxious weeds. It is much better kept short for vision purposes.
   - - Spraying to 4 1/2' then mowing
   - - Mowing and herbicides (7 responses)
   - - Weed control
   - - Herbicides, grading, mowing (3 responses)

3. Do you consult a wildlife biologist from the state wildlife agency regarding roadside maintenance practices?

   Y (0%) N (100%)

4. Do you use any of the following methods to control roadside vegetation? (If yes please explain how often, or quantity used)

METHOD	Spring Apr.-June	Summer July-Sept	Fall Oct-Nov
Mowing Y N	38%	81%	44%
Herbicide Y N	94%	56%	56%
Insecticide Y N	6%	6%	0%
Burning Y N	0%	0%	13%

5. Does the county permit landowners to mow the roadside ditches for hay?

Y (44%) N (56%)

6. Does the county permit landowners to seed roadsides with grasses of their choice?

Y (13%) N (87%)

If yes, what grasses are approved?

-None

7. Does the county do any roadside revegetation?

Y (0%) N (100%)

If yes, what species are planted and what seeding methods are used?

-None

8. What, if any, objections would the county have to managing roadsides as habitat for pheasants?

(Briefly describe what those objections are.)

- Safety is our first and main objective
- Roadkill and animals on highways would be a negative situation for the project here in this county.

- Liability from increased vegetation obstructing vision, and clear zones for emergencies and fire hazard.
- Problems in Millard Co. are:
  #1 Seagulls- both in the egg and small bird range
  #2 Skunks- the same, especially eggs
- Too many poachers
- We do not have that much roadside where pheasants would nest (not wide enough).
- No habitat needed in Duchesne Co. with all the russian olive trees and swamps we have.
- If any, I'd say they'd be a distraction to drivers. If it's a narrow dirt lane, pheasants have a tendency to follow ditches and fencelines on roadsides because of that. But well traveled roads are no place for pheasants or any other wildlife, unless you like road kill.
- We feel that a program of that type would lead to more road kill of an already scarce bird.

9. What is your annual county budget for roadside maintenance?

$0-5,000	(19%)
$5,000-10,000	(31%)
$10,000-20,000	(6%)
$20,000-50,000	(31%)
> than $50,000	(13%)

10. Would you be interested in receiving a summary of my survey results.

Y (44%) N (56%)

If yes, please leave your name and address here.

Thank you for taking the time to answer these questions. <u>If you have a roadside habitat program please send any information or literature about it.</u>

Please leave any additional comments here.

-We don't lack for pheasant cover anywhere.
- I also am a hunter and I feel the success to pheasant pop. is in doing more predator control.

STATE AGENCY PERSONNEL

The next questionnaire was sent to state personnel. Twenty-four surveys were sent with a response of eighteen (75%).

1. Do you consider roadsides (more specifically, rural roadsides) as important wildlife habitat? Y (78%) N (22%)

- The department (UDOT) doesn't necessarily support that philosophy (roadsides for wildlife). Large birds that fly in front of vehicles traveling at highway speeds are definitely a hazard, causing broken windshields and possible more serious accidents due to swerving to miss the bird, but hitting other vehicles.

- But only on secondary roads. Interstate and freeways have too much traffic to consider these habitat important - highway mortality is increased along these corridors and often wildlife populations eliminated.

Please check (✓) those pheasant habitat components you believe roadside ditches provide and indicate with an * which of these functions you believe to be most important.

*	✓		
42%	54%	❑	Nesting cover
8%	50%	❑	Brooding cover
13%	33%	❑	Roosting cover
8%	33%	❑	Loafing cover
17%	33%	❑	Winter cover
8%	46%	❑	Food source
25%	58%	❑	Travel corridor
0%	4%	❑	Other (please explain) - Source of Grit

2. Do you have a "Roadsides for wildlife" program in your state?
Y (0%) N (100%)

4. Do you have any programs that encourage private landowners to maintain roadside ditches for habitat? Y (11%) N (89%)

5. Do you have any programs that encourage county governments to maintain roadside ditches for habitat. Y (17%) N (83%)

6. Do you have any roadside revegetation strategies?

(If so, please explain what they are and give any recommendation you feel may be applicable) Y (22%) N (78%)

- Principally for erosion control, not providing wildlife cover

- We do recommend frequently to WDOT (Wyoming) and county road departments that cover be maintained for pheasants, but we get lots of excuses why they can't do it.

- Sort of. We (Idaho) work with counties as they re-align roads, or construct new roads, we cost-share on vegetation. So far only 3 counties have expressed interest.

- We encourage departments of transportation in Utah to delay mowing until the end of July. Some do, some don't.

- We are providing seed, drill, etc., in cooperation with Pheasants Forever Chapters in extreme N.E. Colorado in a couple of counties. They are seeding most road shoulders to smooth brome on their own- we won't help fund it.

7. If you provide seed for revegetation, or funding to purchase seed, what seed mix or mixes do you recommend?

- We (UDOT) use a lot of crested wheatgrass (unpalatable to cattle, deer, etc.). Also some alfalfa and yellow sweet clover (we find quite a bit of this propagates naturally).

- Bunch grasses, sod forming grasses, and legume mix

- Delar small burnette, yellow sweet clover, intermediate wheatgrass, tall wheatgrass, bluebunch wheatgrass.

- Switchgrass where snow is not a factor in blocking roads. Wheatgrass/alfalfa mixes.

8. What method of seeding, if any, do you recommend?

- High disturbance followed with broadcast seeding.
- Generally drilled (broadcast-hydroseeding)
- Drill, hand broadcast, and mulch
- Drilling preferred, also broadcasting

- Complete destruction of existing vegetation and drilling into a firm seed bed- preferably with compatible herbicides.

9. If you have a roadside habitat program, what is the annual level of funding for the state?
(No responses)

$0-10,000
$10,000-20,000
$20,000-50,000
> than $50,000

12. Would you be interested in receiving a summary of my survey results?
Y (67%) N (33%)

Thank you for taking the time to answer these questions. If you have a roadside habitat program please send any information or literature about it.

Please leave any additional comments here.

- I would not be in favor of a roadside wildlife habitat program if it poses any obstacle or restriction on efforts to control noxious weeds. Transportation corridors are a primary source of spreading noxious weeds, and control on roadside rights-of-way is a key element of any weed management plan.

More pheasants on roadsides means more auto/pheasant accidents. More risk of auto and personal injury, and higher pheasant mortality. I'm not sure the negatives outweigh the benefits.

- I am also an avid pheasant hunter. I commend you for your project to improve habitat conditions. Sadly, the habitat is rapidly diminishing in Utah due to development of housing, sprinkler irrigation, etc. Birds usually don't stay long adjacent to highways due to traffic noise, etc. We have had an exception on SR-89 through Sevier and Sanpete counties where the highway is adjacent to Railroad right-of-way for most of the route.

- Traffic needs to be an important consideration when improving roadside habitats. Too much traffic (i.e., interstates) dictates strategies that should make habitat less attractive to wildlife such as planting undesirable plants along ROW's. Less traveled county roads could definitely be enhanced, however, increased exposure from vehicle access should be considered- do not want to improve "roadside hunting" opportunities or create situations that make wildlife populations more vulnerable to highway mortality or predation.

- We worry about roadside habitat because of damage to motorists as well as the wildlife.

- Most roadsides (in Colorado) are farmed to the shoulder in our primary pheasant range. Nothing left to manage or we would.

Appendix C.

Noxious Weed Control Specifications

(Specifications modified from Ecotone 1995a)

Bindweed (Wild Morning-glory; *Convolvulus spp.*).

Ecology. Bindweed is a perennial plant with arrow-shaped leaves arranged alternately along the stem. Flowers are pink or white and funnel-shaped (similar to morning glory). The stems lie along the ground and twine about objects, giving the plant its descriptive common name. Stems often form dense, tangled mats. Bindweed reproduces by seeds and extensive, creeping rhizomes. The roots grow in all directions and can penetrate the soil to depths of 6 to 8 feet. Buds along the rhizome send up new shoots. The seeds can survive in the soil for over 60 years. In addition, this plant has a remarkable adaptability to different environmental conditions. The large, fleshy, deep-seated tap root, which can penetrate the soil to 10 feet, makes this plant difficult to eradicate.

Control. Complete eradication of this plant is possible but difficult and requires a persistent effort over a period of time. Top growth is easily controlled by cultivation. 2,4-d or dicamba (Banvel™) may be used where this weed is associated with grasses. A combination of these two herbicides is the most effective. Best control is achieved when applied to weeds that are actively growing in the post-bloom stage. The herbicide should be applied in late summer or fall but prior to a killing frost. Infestations should be sprayed twice a year. Perennial sod-forming grasses provide excellent competition that resist invasion by bindweed.

Picloram (Tordon™), a restricted-use herbicide, may also be used to control bindweed. However, it is registered only on rangeland, permanent pastures, and fallow agricultural land. Timing of application is not critical, but the most consistent results occur when treatment is made in early bud to full bloom stages. This herbicide should be applied as a coarse, low-pressure spray. Only ground applications should be used. Treatment should not extend 10 feet beyond the infestation.

Glyphosate (Roundup™) will control bindweed, grasses, and other vegetation in the treated areas. This chemical should be selectively applied at full bloom to early seed stage. Application on fall regrowth may provide some control Plants must be thoroughly wetted but spray runoff must be avoided. Repeat treatments may be required for complete control. Control is improved if the treated area is tilled 2 to 3 weeks after treatment.

Broad-leaved Peppergrass (Tall whitetop; *Lepidium latifolium*)

Ecology. This plant is a vigorous perennial that grows over 3 feet tall and may reach heights of up to 6 feet. The stems are branched and have lance-shaped leaves that are bright green to gray-green in color. Leaves are arranged on alternated sides of the stem. White flowers are densely clustered at the top of the stems. The plant reproduces by the rootstock and seeds. This plant has a deep-seated rootstock and a waxy layer covering the leaves and stems. These features make it difficult to control.

Control. Chemical control with 2,4-d amine should be applied at the bud stage of growth, with repeat treatments as needed. Alternately, chlorosulfuron (Telar™) may be applied to non-cropland areas. Good sprayer agitation is necessary, and spray should be mixed with a non-ionic surfactant. Use mixture within 24 hours. Good grass cover will help control this species by eliminating opportunities for broad-leaved peppergrass colonization.

Canada Thistle (*Cirsium arvense*)

Ecology. This aggressive perennial thistle grows upright 2 to 4 feet high. The leaves are very crinkly, dark green, and alternate in placement from one side of the stem to the other. Numerous sharp spines occur on the outer edges of the leaves as well as on the branches and main stem.

Canada thistle flowers are small, light pink to rose purple in color, and have a brownish taint at maturity. They occur in flat-topped clusters at the top of the stems. The seeds are small and attached to a small tuft of hairs, which permits the wind to assist in scattering. The plant also develops via an extensive, coarse, and branching horizontal underground root system that gives rise to many new shoots- particularly if the above ground portion of the plant is cut off.

Control. For species such as Canada thistle, chemical control is the most effective method since mechanical methods such as mowing or rouging only encourage roots to spread. Clopyralid (Curtail™) is a non-aquatic chemical herbicide with 90-day residual that works effectively on Canada thistle. It is easy on the root zones and on grasses, but cannot be used where it can come into direct contact with the water table (i.e., on the inside banks of ditches or around ponds). This herbicide should be applied to target plant(s) using a handgun when the thistle reaches a height of 4 to 6 inches. The herbicide should not be used as a general spray. Do not let this herbicide contaminate water. Application is necessary only once per year.

Aquatic herbicides that work effectively on Canada thistle include 2,4-d (aquatic label) and Rodeo™. The latter will eliminate all grasses and forbs. Herbicide treatment should occur when the plant is actively growing and approximately 12 inches tall in the spring of the year. Fall treatment can be achieved if mowed and allowed to regrow before applying herbicide.

Biological control with weevils and gall flies can aid in control of this plant. However, control by this method takes considerable time.

Dyers Woad (*Isatis tinctoria*)

Ecology. This plant is a member of the mustard family and has a distinctive blue-green color on the leaves and stems. It has been described as a winter annual, a biennial, or short-lived perennial plant. The plant grows up to 3 feet tall. The stems are woody. The leaves are oblong to lance-shaped, alternate, and have a white nerve on the upper surface of the blade. The plant germinates in the spring and forms a rosette of basal leaves. From one to several stems arise from the basal rosette. Flowers are a distinct yellow and are arranged in a flat-topped inflorescence. The seed pods are distinct: they are slightly pear-shaped, one-celled, and winged all around. The plant has a large, fleshy taproot from which it may reproduce asexually. The tap root may extend down to 5 feet. The plant will regenerate from roots if the leaves are removed.

Control. The most important aspect to remember is this: Do not let this plant go to seed! Dyers woad plant can be effectively controlled by rouging or hand pulling if infestations are not too extensive; however, cutting plants off at the root will only encourage new sprouts. Rouging needs to be done 2 to 3 times each year for 2 to 3 years.

Cultivation can effectively control this weed. There are two critical periods. The first is early spring before the plant goes to seed. The second is in late fall. Use of herbicides in areas with trees and shrubs should be limited to foliar-applied herbicides to prevent damage to woody plants. Glypohosate (Roundup™) or paraquat (Gramozone Extra™), may be used. 2-4,d amine or ester provides excellent control when applied to plants in the rosette stage. Treatments should occur after seedlings have started growth in the fall. Repeated treatments are required for control.

If used, the combination of 2,4-d and dicamba (Banvel™) should be applied in the bud or bloom stage or in the fall after seedlings have germinated. Plants must be actively growing at the time of treatment. With this chemical application combination, the chemical

must not be allowed to contaminate water. It must also not be used in areas with a shallow water table.

Diffuse Knapweed (*Centaurea diffusa*), Russian Knapweed (*Centaurea repens*), Spotted Knapweed (*Centaurea maculosa*), Squarrose Knapweed (*Centaurea squarrosa*) and Yellow Starthistle (*Centaurea solstitialis*)

Ecology. Knapweeds and starthistle are members of the sunflower family and share many of the same characteristics.

Diffuse knapweed is a bushy annual or biennial that grows up to 2 feet tall. A rosette forms the first year and the flowering stalk elongates the second year. Leaves are grayish-green and arranged alternately. The upper leaves are smaller than those closer to the ground. Leaves are covered with fine hairs. The stem is erect and hairy. There is a single main stem from the rootstock. Flowers are usually white but may be pink, rose, or lavender. The seedhead bracts end as sharp, rigid spines. The taproot is elongated.

Russian knapweed is a perennial plant that has extensive, slender rhizomes that may penetrate more than 8 feet into good soils. The stems are erect, openly branched, and reach up to 3 feet tall. The leaves are oblong-lanceolate. Leaves of newly emerging plants are toothed and covered with fine hairs. These give it the appearance of knap and the blue-green color. The flowers are pinkish-purplish and are borne in solitary, thistle-like heads at the end of the stems.

Spotted knapweed, a biennial or short-lived perennial forb, thrives under a wide range of conditions. This plant reproduces by seeds, which germinate whenever the growing conditions are favorable. Spotted knapweed usually remains in a rosette of basal leaves the first year. Stems of the flowering stalk grow up to 3 feet high the second year. Flowers are pink to purple (rarely white) and held in black-tipped bracts. The leaves have an alternate arrangement on the stem and are covered with fine hairs. This plant is highly

aggressive and can infest large areas quickly releasing a chemical compound that can suppress the germination of other plants.

Squarrose knapweed is a long-rooted perennial that has the same characteristics as the other knapweeds.

Control. Control of Russian knapweed with picloram (Tordon™) can occur at any time during the growing season from when the plants are in the early flower stage up to the first killing frost. Competition with grasses following treatments is important to maintaining long-term control. Spot application of this herbicide should be applied to the foliage. Picloram is a restricted-use herbicide and should not be used near water. Many broadleaf plants are sensitive to this chemical. A treatment of glyphosate (Roundup™), applied to the actively growing Russian knapweed at late bud to early flower state, is usually effective at eliminating most plants. Respraying will be necessary the second year to control the plants not killed by the first spraying. Glyphosate is a non-selective herbicide and should be used with caution.

Both spotted knapweed and diffuse knapweed are susceptible to chemical control methods. Both species may be treated with herbicide application of picloram, 2,4-d, or dicamba (Banvel™) and 2,4-d. With picloram, application should occur from rosette to mid-bolt stage. Treatment should be applied selectively, and if done at recommended rates, should not damage perennial grasses. In addition, most broadleaf crops are sensitive to this herbicide. Picloram is a restricted-use herbicide that should not be allowed to contaminate water. Fall application should occur only when adequate moisture is available. Application of 2,4-d should occur at the early stage of flower stem elongation (late April to early May). However, this treatment will only control plants that emerged at the time of spraying. Drift must be avoided. Dicamba application to actively growing rosettes (but before the knapweed bolts) should occur in the spring. Selective treatment will not injure

established grasses. Water must not be contaminated with this herbicide. Diffuse and spotted knapweed may also be affected using biological control with gall flies. Some fungal pathogens have effectively controlled spotted knapweed in Montana, and are still being studied.

Squarrose knapweed is not effectively controlled by mowing, but it does not tolerate tillage. Chemical control of small seedlings can be accomplished by 2,4-d or clopyralid (Curtail™ or Stinger™). Nearly 100% control of mature plants was achieved for 3 years in Juab County using clopyralid (Curtail™) and picloram (Tordon™).

Yellow starthistle reproduces only by seed and is susceptible to biological control by weevils. Means of chemical control include control with metasulfuron (Ally™), clopyralid (Curtail™ or Stinger™), picloram (Tordon™) and 2,4-d, or just 2,4-d. This plant does not tolerate tillage. Mowing, on the other hand, will delay but not prevent flowering and seed development. Pulling or digging can be an effective means of control.

Leafy Spurge (*Euphorbia esula*)

Ecology. This perennial plant has extensively spreading, branched rhizomes and can also reproduce by seed. The roots can penetrate the soil to considerable depth, sometimes as much as 15 feet. Numerous pink buds on the roots may reproduce new shoots or roots. The stems are erect and up to 3 feet tall, slender, and unbranched except for the inflorescence. The leaves are alternately arranged along the stem, and narrowly linear. There are a number of flowering stems borne at the tops of the stems as well as a single one in the axil of the upper leaves. The flowers are small and greenish-yellow. They are subtended by a pair of broad, heart-shaped yellow-green bracts. The seeds are contained in capsules, which explode when dry. This can throw seeds as far away as 20

feet. Seeds may remain viable in the soil for up to 8 years. This, and the extensive root system which contains large nutrient reserves, makes this plant difficult to control.

Control. Herbicide treatment should occur when the plant is actively growing and in the early bud stage. Fall or spring treatments are possible with picloram (Tordon™) and 2,4-d ester. Picloram, a restricted-use herbicide, may be applied at any time during the growing season up to the first frost. This product gives excellent control if follow-up treatments are used. The herbicide can persist for up to 2 years at higher application rates. Picloram must not be allowed to contaminate water. Many broad-leaf crops are sensitive to this chemical.

Lower rates of 2,4-d ester can prevent seed formation in the bud and early bloom stage. Higher rates should be used in early spring applications. This chemical may also be used when infestations are near surface water or over shallow water tables. When mowing is possible, this chemical should be sprayed on new regrowth 2 weeks after mowing.

Leafy spurge is also susceptible to biological control methods using the hawkmoth, flea beetle, mining long-horned beetle, and gall fly.

Musk Thistle (*Carduus nutans*) and Scotch Thistle (*Onopordium acanthium*)

Ecology. **Musk thistle** is a winter annual or more often a biennial plant with stems up to 6 feet tall. Stems are winged from leaf bases. The leaves are dark green with a light green midrib, deeply lobed, and spiny margined. In the basal rosette, the leaves have a wavy, white margin, a large light green midrib, and a smooth upper leaf surface. The large (up to 3 inches wide), nodding flower head occurs singly at the end of the stem. Flowers are deep rose, violet, or purple. Occasionally they may also be white. The bracts beneath the head are broad and have a spine-pointed tip. The aggressive nature of this plant allows it to spread rapidly and form very dense stands that crowds other species. It reproduces only by seed but can produce in excess of 20,000 seeds per plant, of which 90

percent are generally viable. Ninety percent of the seeds may germinate in the first two years. However, seeds may remain viable in the soil for 10 years or more.

Scotch thistle is quite large (up to 9 feet tall) and is a coarse, branching biennial. As a biennial, it forms a basal rosette of leaves the first year and sends a stem up from the basal rosette the second year. The stems are broadly winged and spiny. The leaves are large, toothed or slightly lobed, and the herbage is gray to nearly white with soft, woolly hairs. The basal leaves may be up to 2 feet long and 1 foot wide. Flower heads are solitary, numerous and 1 to 2 inches in diameter. The flower receptacle is flat and honey-combed, and flowers are violet to reddish in color. The bracts are sharply spine-tipped. This plant reproduces only by seed and may form stands sufficiently dense to prevent penetration by livestock.

Control. Chemical control is effective for these thistle species. Application of picloram (Tordon™), a restricted-use herbicide, should occur in the spring before the thistles produce seed stalks. Follow-up applications will be needed to control new seedlings and escaped plants. Soil residuals may last over 1 year. Broadleaf species are sensitive to picloram, and the herbicide should not be used near water.

Alternately, a combination of clopyralid and 2,4-d amine (Curtail™) may be applied to these thistle species after seedlings and rosettes have emerged but before the flower stem had fully developed. Lower herbicide rates may be applied if plants are growing rapidly or growing in areas with good soil moisture. Enough total spray volume should be applied to ensure good coverage. This herbicide combination should not be applied when temperature inversions exist.

Also, the musk thistle weevil, which feeds on the seeds, can limit the spread of musk thistle plant through biological control. Another species of weevil attacks the rosettes and interrupts the apical dominance of the plant.

Perennial Sorghums including Johnsongrass (*Sorghum halepense*) and Sorghum Almum (*Sorghum almum*)

Ecology. Perennial sorghums are typically vigorous grasses arising from coarse, creeping rhizomes. For Johnsongrass, the erect stems reach from 3 to 8 feet tall, have a sugary juice and prominent nodes. The leaves are flat and open, nearly 1 inch wide. The mid-vein is conspicuous. The flowering portion is a panicle with spreading branches arising in whorls. The color tone of the inflorescence is reddish to purple. The spikelets occur in groups of two, with the lower one forming the grain and bearing a twisted and bent awn. The plant reproduces by seeds or rhizomes.

Control. Pulling is ineffective and mowing is almost useless for control of these plants. No biological agents are known. There are several methods of chemical treatment. If used, broadcast treatment of dalapon (Dowpon™) should be applied in the spring when sorghum is growing rapidly. A repeat application at 2-week intervals provides the best control. Pre-plant treatments plowed before seeding will usually reduce weed competition with little crop injury if proper waiting intervals (up to 6 weeks) follow. Caution: prolonged skin contact may cause irritation. Alternately, glyphosate (Roundup™) applied as a spray or by a wiper method is effective on these weeds. A third method is application of sethoxydim (Poast™). This herbicide can be used as a selective foliar spray on sites where broadleaf species are abundant.

Quackgrass (*Agropyron repens*)

Ecology. This erect perennial grass will grow readily in most soils; it is salt tolerant but will not grow on heavily saline areas. The stems are unbranched and up to 3 feet tall. The leaf blades are flat, thin, and up to 1/2 inch wide. The leaf sheaths and blades may be thinly covered with soft hairs. The flowering heads resemble wheat but are more slender.

From 20 to 30 viable seeds are produced in each head. The roots are shallow but may penetrate as much as 8 inches in cultivated soil. Rhizomes are usually yellowish-white, extend away from a parent plant for several feet, and branch extensively to form a tough, interwoven mass. This plant may be allelopathic. Broken rhizome segments can grow and produce new plants.

Control. Broadcast treatment of dalapon (Downpon™) should be applied in the spring when quackgrass is growing rapidly. A repeat application at 2-week intervals provides best control. Pre-plant treatments plowed before seeding will usually reduce weed competition with little crop injury if proper waiting intervals (up to 6 weeks) follow.

Amitrole (Amitrol-T™, Amino Triazole™, Weedazol™) may be applied when the grass is making rapid spring growth and is 6 to 9 inches tall. Foliage must be thoroughly wetted, and addition of a non-ionic surfactant provides the best results. Amitrole commercial uses were designated as restricted in 1985, and this herbicide is not registered for use on grazing lands.

Another method of chemical control is with glyphosate (Roundup™) using a broadcast treatment. The herbicide should be applied during fallow periods when quackgrass is in the late boot stage to early flowering stage. A thorough wetting of foliage is necessary, but runoff should be avoided as this is a non-selective herbicide. Follow-up treatments may be necessary for complete control.

Whitetop (*Cardaria spp*)

Ecology. This perennial plant competes aggressively with other plants and often forms dense, pure stands. The four-petaled white flowers, which occur in a dense and flat-topped inflorescence, make this plant easy to recognize. This plant spreads via extensive, coarse rhizomes and seeds. The stems are erect to spreading and up to 2 feet tall. The

overall color of the plant is somewhat grayish due to the dense hair covering. Leaves are oval or oblong in shape, with the upper stem leaves narrower and lacking petioles. Flowers are numerous, small, and white. They occur in a flat, broad inflorescence at the tope of the stem. The fruit is a round- to heart-shaped pod. This species is common in alkaline, disturbed soils.

Control. This species can be effectively controlled with herbicides. 2,4-d low volatile ester or amine applied in the early growth stage provides control. Little control is provided after bud stage, however. When possible, the herbicide should be applied in the spring. Respray should occur in the fall if new growth appears. Amitrol (Amitrol-T™, Amino Triazole™, Weedazol™) may be applied before the first bloom appears. Thorough foliage wetting is necessary.

Caution: all commercial uses of amitrole were designated as restricted in 1985.

Bermudagrass (*Cynodon dactylon*) and Medusahead (*Taeniatherum caput-medusae*)

These species of noxious weeds are not considered a problem species in Cache County.

Appendix D.

Existing Roadside Plant Material Descriptions

Goatgrass (*Aegilops cylindrica*)

Goatgrass, also referred to as jointed goatgrass, is a weedy annual that thrives along dry farmed wheat fields. It readily hybridizes with wheat. It was introduced from Southern Europe and Central Asia. Aside from its nuisance to wheat farmers, goatgrass is not considered a weed out of control (Cronquist et al. 1977). It has some wildlife food value, but stands along Cache County roadsides were small and dispersed, limiting its availibility to wildlife. The stem of goatgrass is short and flexible, similar to cheatgrass, allowing for severe snow lodging in the winter.

Meadow Foxtail (*Alopercus pratensis*)

Meadow foxtail is a perennial found in moist meadows, ditches, and streams. It was introduced from Europe and has become established across Cache County. Although not well known for its beauty, it is an attractive grass due to the seedhead and is a food source for wildlife.

Smooth Brome (*Bromus inermis*)

Smooth brome is a perennial introduced from Eurasia during the 1890's. Its original purpose was to be used as hay and pasture grass. In the last 100 years it has spread to fields and meadows as it prefers moist soil, but has also exhibited drought tolerance. Smooth brome is a sod-forming grass that starts growth in early spring. *Bromus inermis* has since mixed with *Bromus purpurascens* which causes difficulty in identification. *Bromus purpurascens* is found in the same relative locations as *Bromus inermis* (Cronquist et al. 1977).

Smooth brome is of some value as nesting cover, but the low density found throughout the transects showed that it is scattered and in small patches. This limits the value as wildlife habitat.

Japanese Brome (*Bromus japonicus*)

Japanese brome is a native annual found in moderately moist to dry weedy sites. It was not found to be prevalent in the transects during the July-August readings and was not found in the September transect. The wildlife value offered by Japanese brome is insignificant and the structure does not resist lodging. Therefore, Japanese brome is not thought to be necessary for roadside wildlife habitat, but should not be eradicated because it does not pose any threat of invasiveness.

Cheatgrass (*Bromus tectorum*)

Cheatgrass composed the largest percentage of grass found throughout the county. Cheatgrass is a short annual introduced from Eurasia. It does best in dry, disturbed areas and has the ability to overtake entire landscapes. Cheatgrass is more abundant than is apparent in a windshield survey. This is because cheatgrass grows low to the ground and typically fills in around taller bunchgrasses, such as tall wheatgrass.

The wildlife value for cheatgrass is poor and lodging is severe in the winter. The flexible structure of cheatgrass accounts for the severe lodging and subsequent lack of cover for wildlife (Cronquist et al. 1977; Meyer 1987).

Saltgrass (*Disthichlis stricta*)

Saltgrass is a short, dark green grass which can grow in highly saline conditions. The saltgrass found in Wetland #2 grew in the water and along the banks among the cattails. Saltgrass provided little cover for wildlife along Cache County roadsides, but is valuable as a food source to pheasants and other wetland wildlife species, such as passerine birds. The seed is eaten by some wildlife species and stands of saltgrass harbor abundant insect populations; a food source for many other wildlife species (Olsen 1977; Trautman 1982).

Great Basin Wild Rye (*Elymus cinereus*)

Great Basin wild rye is a clump-forming perennial which can grow in a variety of edaphic conditions including uplands, stream banks, gullies, and roadsides. It is much more extensive in the Riparian category.

Great Basin wild rye is one of the few native grasses found along roadsides. Pioneers described this grass as "stirrup-high" when first entering the valley. It is valuable to livestock and has good soil stabilization properties (Cronquist et al. 1977). Native Americans used this grass as a food source before the pioneers arrived. The most recent nomenclature for Great Basin wildrye is *Leymus cinereus* (Granite 1996)

Great Basin wild rye is generally considered valuable as wildlife habitat providing nesting, hiding, and brooding cover. It also provides a good food source (Cronquist et al. 1977). However, this grass was not dominant enough in most plant communities to be a strong factor in roadside habitat quality.

Crested Wheatgrass (*Elymus cristatum*)

Crested wheatgrass is a perennial used for hay, pasture grass and erosion control. This grass has a reputation for overtaking hillsides, especially along the Cache Valley benches. In the lower valley, crested wheatgrass is not nearly as prevalent, as seen in the density measurements (1.7% July/August and 2.2% September). This wheatgrass was only found in the Agricultural Mixed Grasses plant community.

Introduced from Russia, crested wheatgrass has been used primarily for soil stabilization, and this use has aided its proliferation. In areas of high density, crested wheatgrass resists the weight of snow and stands upright through the winter providing some wildlife cover. Along roadsides in Cache County the density was too low for crested wheatgrass to be a food source or a cover component for wildlife.

Because of its toughness, crested wheatgrass is not considered a desirable summer range grass for livestock and does not do well on hard clay or coarse, sandy soils

(Cronquist et al. 1977). Fairway variety is considered the most widely used variety of crested wheatgrass in Utah.

Tall Wheatgrass (*Elymus elongatum* or *Elytrigia pontica*)

Tall wheatgrass is a tall, course vigorous bunchgrass well-suited to alkaline soils or high water tables and is extensively used for erosion control. It was introduced from the Mediterranean region for this purpose and has the ability to choke out surrounding grasses. It is thought to provide little food value to wildlife because of the height to seed (4-5 feet), but has a strong structure and resists lodging better than any other roadside grasses in Cache County. Because of the tall dense structure, tall wheatgrass provided excellent winter cover, protective cover, and loafing cover. It was too dense for nesting or brood-rearing cover, however, these cover types were usually provided in nearby grasses mixed with tall wheatgrass.

Intermediate Wheatgrass (*Elymus intermedium*)

Intermediate wheatgrass is a perennial seeded in pasture and rangeland, and is valuable to both livestock and wildlife. Although it is sparse along Cache County roadsides, pheasants utilize this grass as a food source and cover, particularly residual nesting cover.

Quackgrass (*Elymus repens*)

Quackgrass is a well-known soil binder which grows along ditch banks and roadsides at nearly all elevations. It was found in the Wetland and Riparian categories as well as the Agricultural Mixed Grasses category. It is native to Europe and Asia. Some view quackgrass as a valuable forage grass that has turned into an undesirable weed (Cronquist et al. 1977). It can be valuable to wildlife as a secondary food source and is valuable as hiding cover and perhaps nesting cover because of its structure. However, the low density of this grass in plant communities limits its value to wildlife.

Western Wheatgrass (*Elymus smithii*)

Western wheatgrass is a perennial that historically has been thought to be the dominant wheatgrass in Cache County. However, in the transects sampled for this study, western wheatgrass was not found to be extensive. It is of poor livestock value but good for erosion control, which is now its primary use along roadsides (Cronquist et al. 1977).

The structure of western wheatgrass is sufficient to provide some winter cover, but due to the sparse density, its value was limited as wildlife cover. Western wheatgrass provides some food qualities for wildlife, but should be considered a supplemental food supply instead of a primary food source for wildlife (Cronquist et al. 1977). The most recent nomenclature for western wheatgrass is *Pascopyrum smithii* (Granite 1996).

Reed Canary Grass (*Phalaris arundinacea*)

Reed canary grass is a rhizomatous and aggresive perennial which was introduced to Utah as a hay grass and thrives in moist areas such as stream banks and ditches (Cronquist et al. 1977). It was originally used in moist pastures for grazing or cut as hay for farm animals. Since the introduction of reed canary grass, it has colonized many wet ditches in Cache County.

Bulbous Bluegrass (*Poa bulbosa*)

Bulbous bluegrass is a low-growing, short perennial which makes its home in pastures and disturbed areas. Introduced from Europe, bulbous bluegrass has no known benefit to livestock or wildlife, with the exception of sheep, which feed on bulbous bluegrass during the spring (Cronquist et al. 1977).

Wild Rose (*Rosa woodsii*)

Wild rose is a deciduous shrub that grows between 2 and 6 feet tall. The habit is loose and spreading and can establish quickly on disturbed sites. Some livestock find wild

rose palatable, but wildlife find it indispensable. The forage and berries provide much needed winter cover and food for birds and small mammals.

Narrow-leaf Willow *(Salix exigua)*

Narrow-leaf willow is a native tree of Utah and stands about 65 feet tall when fully grown. No willows this tall occurred along the roadside transects. Willows about 3-5 feet tall were recorded in the transects and were common along roadside riparian plant communities. Narrow-leaf willow actively spreads by means of underground runners. They are typically found in sites along watercourses, seeps, and springs. The winter cover they provide for pheasants may be considered their highest value to pheasant habitat, but they also provide roosting cover and loafing cover, and are a host for many insects eaten by pheasants.

Hardstem Bulrush (*Scirpus acutus*)

Hardstem bulrush is a perennial that typically grows 3-5 feet tall but can reach 10 feet. It grows in marshy areas, along muddy shores, and tolerates alkali in the soil and is also considered an obligate wetland plant (Ecotone 1995b). It is similar to cattail in its value to wildlife providing spring, summer and fall cover and an area with vertical structure. The seeds from hardstem bulrush are an important food source for waterfowl. The bulrush, which is predominant in Wetland #1, succumbed to severe snow lodging and provided very little winter cover.

Cattail (*Typha latifolia*)

Cattail is a native, broad-leaved perennial found in marshy areas. It is considered an obligate wetland plant. This means that this vegetation type occurs almost always (>99%) under natural conditions in wetlands (Ecotone 1995b). It is significant in wildlife habitat because it provided hiding cover, winter cover, loafing cover and roosting cover (Olsen 1977). No real food value is found in the vegetation itself, but it did provide an area

for many insects, which compose a large part of the pheasant's diet, especially juvenile pheasants (Olsen 1977; Trautman 1982). The cattail in Wetland #2 resisted lodging by heavy snow and provided effective wildlife cover after heavy snowfall and drifting.