# Interior Columbia Basin
# Ecosystem Management Project
## Science Integration Team
## Terrestrial Staff
## Range Task Group

Scientific Contract Report

Preface

The following report was prepared by University scientists through cooperative agreement, project science staff, or contractors as part of the ongoing efforts of the Interior Columbia Basin Ecosystem Management Project, co-managed by the U.S. Forest Service and the Bureau of Land Management. It was prepared for the express purpose of compiling information, reviewing available literature, researching topics related to ecosystems within the Interior Columbia Basin, or exploring relationships among biophysical and economic/social resources.

This report has been reviewed by agency scientists as part of the ongoing ecosystem project. The report may be cited within the primary products produced by the project or it may have served its purposes by furthering our understanding of complex resource issues within the Basin. This report may become the basis for scientific journal articles or technical reports by the USDA Forest Service or USDI Bureau of Land Management. The attached report has not been through all the steps appropriate to final publishing as either a scientific journal article or a technical report.

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## PART ONE: **RIPARIAN RESTORATION and MANAGEMENT**

"Riparian" is a word that strikes fear in the hearts of many, anger in some and feelings of peaceful surroundings to others. It is a term that has grown to mean many things to many people, but is rarely understood. It has become an emotional topic that has led to one of the key public land issues in the united States (Elmore 1989).

Riparian zones or areas have been defined in several ways, but are essentially concerned with the often narrow strips of land that border creeks, rivers or other bodies of water. Because of their proximity to water, plant species of riparian zones differ considerably from those of adjacent uplands (Elmore and Beschta 1987). This is especially the case in the semi-arid lands of the Columbia River basin and adjacent intermountain northwestern United States.

Most riparian ecosystems occupy but a small percentage of the area of a watershed, they represent an extremely important component of the overall landscape (Elmore and Beschta 1987). This is especially true for arid environments where they provide forage for domestic animals and important habitat for approximately 80 percent of wildlife species in eastern Oregon and Washington (Thomas et al. 1979). Where streams are perennial, they provide essential habitat for fish and other aquatic organisms. During times of flooding, riparian communities can diminish flood peak magnitude and prolong the duration of flow discharge through increased ground water recharge (Moseley 1983). The character and condition of riparian vegetation and associated stream channels influence the amplitude of this important function (Platts et al. 1985).

The objective of this paper is to explore the potential for improvement of typical riparian systems within the Columbia Basin area and, secondly, to focus on management techniques that will enable successional improvement within the limits of site potential. Emphasis will be directed toward livestock management.

**HISTORIC RIPARIAN ECOSYSTEMS**

In 1825, Peter Skene Ogden observed willows from side to side across the Crooked River valley of central Oregon. The Ochoco mountains take their name from a native American word meaning "streams lined with willows." (Elmore 1989). Ogden trapped beaver [Castor canadensis] for The Hudson's Bay Company throughout the intermountain region. His journals of 1827-28 and 1828-29 expeditions have been summarized by Rich et al. (1950). A keen observer, Ogden frequently noted the abundance of willow [Salix spp.] and other woody riparian vegetation throughout much of the area that is now eastern Oregon and Washington.

Griffiths (1902) reported on field observations made during July and August of 1901, in the region between Winnemucca, Nevada, and Ontario, Oregon. As the "expert in charge of field management" for the Bureau of Plant Industry, U.S. Department of Agriculture, he was keenly aware of native vegetation and land use practices. He noted that "along the moister areas in gulches one always finds a profuse growth of willows ... in the same localities extensive growths of alder [Alnus spp.] are also to be found."

**PRESENT RIPARIAN ECOSYSTEMS**

The vast majority of riparian habitats in the Columbia Basin have been altered from historic status. Deep soils along the rivers and streams have been converted through agricultural practices to raise a wide variety of irrigated crops. Actually, the extent of this irrigation has enlarged the land area which simulates and partially functions as riparian ecosystems. Orchards provide tree structure for many nesting birds once obligatory to riparian woody vegetation. Alfalfa [Medicago sativa] and irrigated pastures simulate native marshes and meadows for other wildlife.

Poorer quality lands, those with shallow soil or limited water supply, have almost universally been used for grazing livestock (Rinne 1985). Such use has often changed the plant species composition toward more simple and less diverse assemblages. Many degraded streams have suffered extensive soil loss through accelerated erosion. Channel deepening has resulted in lowered water tables and reduced riparian community size.

Free and uncontrolled grazing of domestic sheep and cattle began in this area during the 1860s. Griffiths (1902) toured this area during July and August 1901. He wrote, "To say that the southern portion (Winnimucca, McDermitt, White

Horse, and Steens Mountain) of the region is overstocked would be putting the matter very mildly ... the White Horse Mountains (Oregon Canyon Mountains) were being pastured by sheep the second time this season. They were grazed earlier in the summer, and flocks are being driven into them again from the Disaster Peak country when we were there early in August. One herder reported that the latter place was all eaten out and that he moved his flock in order to avoid trouble with other herders who were quarreling and disputing over the little grass left. The first pasturing had left the range short enough; what the second will do can be easily imagined."

The majority of both lotic (flowing waters) and lentic (standing waters, e.g. pond and lake) communities presently lack vegetative diversity -- and, consequently, a correlated animal diversity. Wetland grasses and sedges predominate on these sites. Utilization by cattle maintains a very low structural form, rather like a mown lawn (Buckhouse et al. 1981, Loft et al. 1987). Areas of soil barren of vegetation are frequent. Stream banks are often unstable and frequently cave off during periods of maximum water discharge. Stream beds are wide and shallow with riffles predominating. Pools are rare or entirely absent (Beschta and Platts 1986). High volume water flows are typical of late winter snow-melt. Discharge typically occurs in a violent flush. Flows then rapidly decrease with prolonged dry intervals during the June to November period. Many smaller streams that were once perennial dry by mid-summer (Moseley 1993). Stockwater reservoirs on these streams often rapidly fill with silt, thus lessening the water storage capacity. Water quality is often poor due to excessive silt loads. High temperatures are common during the summer due to a lack of shading and typically shallow water depths.

As a result of the foregoing riparian habitat conditions, habitat values for most wildlife species are severely lessened (Loft et al. 1987). Waters are often inhospitable for aquatic animal species -- the fish and the macro-invertebrates of which fish are dependent (Hachmoller et al. 1991). A deficiency of vegetative cover and structure lessens the carrying capacity of these habitats for most riparian dependent birds and mammals (Elgland et al. 1981). A scarcity of habitat diversity exists due to the early successional stage of all such riparian vegetative communities. Normally diversity would be high due to differing natural site potentials along the course of streams or around the shores of ponds and lakes. A lack of plant diversity equates to a lack of associated animal diversity (Medin and Clary 1990b).

**INFLUENCES UPON SYSTEMS**

Natural

Riparian systems are exceptionally dynamic. Change is the rule (Campbell and Green 1968, Reichenbacher 1984). Hydraulic actions such as flooding alter sites several times a decade. Soils are moved from one site and deposited at another. Vegetation waxes and wanes. Beaver are native to much, if not all, the area (Hall 1960). Local colonies of this rodent typically fell the majority of willow, aspen, cottonwood and alder (Dieter and McCabe 1989). The beaver then move to adjacent areas and repeat the process. These riparian tree species typically re-sprout from their stumps or roots and recreate the tree aspect within a few years (Kindschy 1985). Abandoned beaver dams are not maintained and may fail exposing flats of rich silt that are ideal sites for willow seed germination (Neff 1957, Shaw 1991). Gravel bars at water's edge provide sites for cottonwood seed germination (McBride and Strahan 1984).

Recent studies have shown that beaver ponds are effective in filtering various pollutants such as streptococci (Skinner et al. 1984) and fecal coliforms (Tiedeman et al. 1987, Miner et al. 1992). Beaver ponds also provide exceptionally favorable habitat for many birds (Teaford 1986), mammals (Medin and Clary 1990a), and fish (Munther

1981).

Human induced

Human influence on riparian ecosystems may be grouped into 3 categories: soil disturbance, water disturbance, and vegetation disturbance.

Soils along riparian corridors are often dislodged through road construction and maintenance. Stream channels may be straightened and confined parallel to the road. Water velocity is increased due to reduction in stream bed sinuosity. Bank sloughing and erosion inject large amounts of soil into the water creating major water quality degradation. Logging practices that fail to respect the riparian corridor through repeated skidding of logs across or along the stream bed create major short-term environmental degradation (Everest and Meehan 1981). Certain mining actions, such as discharge of toxic materials into the stream channel, can adversely alter the present and future productive potential of waters (Platts 1979). Concentration of livestock along streams can cause bank failure through trampling (Bohn and Buckhouse 1985, Marlow and Pogacnik 1986).

Water disturbance can be through diversion, retention, or pollution. The former is typical of irrigation water diversion from streams although it is also applicable to ground water lowering through pumping of wells within the stream's water table (Groeneveld and Griepentrog 1985). Riparian habitats subjected to diversion are prone to dry up, creating stress on all associated life. Retention of waters behind dams floods upstream habitats and may create artificial stream flows below the impoundment. The general lack of spring season flooding below the dam often curtails reproduction of native woody plants (Szaro and Debano 1985).

Vegetation disturbance from human activities is largely the result of timber harvest or agricultural practices ... including the grazing of livestock (Theuber et al. 1985).

## MANAGEMENT TECHNIQUES FOR RIPARIAN ECOSYSTEM

Two factors are vital for accomplishing riparian management. First, managers must have a grasp of the site potential because sites vary widely in their capacity to produce riparian vegetation (Crouse and Kindschy 1981, Kovalchik and Chitwood 1990, Leonard et al. 1992). Second, the primary factor presently limiting riparian vegetation successional advancement must be identified and then lessened in magnitude (Crouse and Kindschy 1981, Odum 1988).

An option presented by the multi-million dollar rangeland rehabilitation Vale Project of the 1960s in southeastern Oregon (Heady and Bartolome 1977), was the fencing of riparian communities. Much of the effort was initially opportunistic with little regard given to potential of the site for successional advancement.

Vegetative response varies when livestock are excluded (Richard and Cushing 1982). Crouse and Kindschy (1981) evaluated the abotic variables associated with the numerous exclosures and developed a key that would enable forecasting of response of riparian vegetation as related to a specific site and how far removed the present community was removed from potential. Such guidance would allow management to get the most return for investments (Swanson 1989).

**Abotic Factors**

<u>Water</u>

- Perennial occurrence with stable flow.
- Perennial occurrence with minor fluctuations.
- Perennial occurrence with major fluctuations; scouring common.
- Intermittent occurrence; soils moist year-long.
- Intermittent occurrence; soils dry part of year.

<u>Soils</u>

- Soil absent; rubble > 15 cm (6 in) in size.
- Soil absent; stone < 15 cm. (6 in) in size.

- Soil present; of mineral (non-organic) nature.
- Soil present; partially organic; pH < 8.
- Soil present; pH > 8.

<u>Gradient of Bottom</u>

- Minor (< 1% to 5%)
- Moderate (6% to 10%)
- Steep (> 10%)

<u>Slope of Shore</u>

- Minor (1% to 10%)
- Moderate (11% to 40%)
- Steep (> 40%)

<u>Elevation of Site</u>

- 305 m (1,000 ft.) to 1220 m (4,000 ft.) elevation
- 1220 m (4,000 ft.) to 1524 m (5,000 ft.) elevation
- Greater than 1524 m (5,000 ft.) elevation

<u>Class of Water</u>

- Streams and rivers

- Lakes, ponds, and reservoirs

As previously stated, the objectives of this paper are to focus upon the impact of livestock grazing within riparian systems and to explore options to lessen or eliminate conditions which curtail healthy, functioning riparian ecosystems.

Crouse and Kindschy (1981) described the evident increasing successional advancement of plant communities with regard to increasing site potential in southeastern Oregon. Kovalchik and Chitwood (1990) conducted similar work within the forested ecosystems of eastern Oregon. Each of the stages or seres may also be the potential natural community for sites of varying site potential. For example, a canyon bottom site, where frequent high volumes of water scour, is capable of supporting sedges [Carex spp.], rushes [Juncus spp.], wetland grasses and perhaps some shrub willow, for example, Salix exiqua. Another site, without the primary limiting factor of hydrologic scouring, could support more advanced riparian vegetation such as a tree-form willow, for example Salix lasiandra, alder [Alnus incana], and black cottonwood [Populus trichocarpa].

The following associations, typical to eastern Oregon, progress from the most simple, where site potential is limited by abotic factors, to the most advanced. Successional seres often display vegetation related to sites of lesser potential. Such sites have ability to respond through successional advancement when the principal limiting factor is lessened.

Streams

1. Little or no riparian vegetative potential due to water limited to ephemeral flows. Such "dry wash" communities are abundant throughout upper tributary drainages. May support limited stands of mullen [Verbascum spp.], low sagebrush [Artemisia arbuscula], Louisiana sagebrush [A .ludoviciana], Sandberg's bluegrass [Poa secunda] and biscuit root [Lomatium] spp.

2. Limited by excessive alkalinity. Soil surface often white from concentrated salts. Bulrush [Scirpus spp.], greasewood [Sarcobatus vermiculatus], buffalo berry [Shepherdia argentea], salt cedar [Tamarix spp.], with saltgrass [Distichlis stricta], and related salt tolerant forbs.

3. Sites of high volume water discharge, such as the bottoms of confined canyons. Vegetation limited to scant stands of herbaceous species; especially sedges, forbs, and water grasses. Some flexible shrub-type willow possible.

4. Limited by sporadic water to sparse stands of willow,

mostly shrub-type; mullen, syringa [Philadelphus lewisii], and rose [Rosa spp.].

5. Most typical perennial streams where soil has deposited in low gradient relief. Tree willows, shrub willow, syringa, clematis [Clematis spp.]. Normally found < 1,524 m (5,000 ft).

6. Typical of better potential riparian bottoms where perennial water and deeper soils are present. Water fluctuations are moderate. Elevation varies from < 305 m (1,000 ft) to 1,220 m (4,000 ft). Cottonwood, tree willow, shrub willow, syringa, rose, and water birch [Betula occidentalis]. Associated with a wide variety of riparian forbs and grasses.

7. Deeper soils in higher elevation [ > 1,220 m (4,000 ft.)] stream channels. Water flows moderate with little scouring. Mountain alder, cottonwood, tree willow, limited shrub willow. Heavy stands of riparian grasses, sedges, rushes. Forbs often plentiful

. 8. Headwater areas where snow melt supplies adequate moisture throughout the year. Quaking aspen [Populus tremuloides], mountain alder, hawthorn [Crataegus douglasii], occasional cottonwood, tree willow, some shrub willow. Riparian grasses, sedges, and forbs plentiful. Normally found above 1,220 m (4,000 ft).

Lakes, Ponds, and Reservoirs

Initial colonization by plant species seems to be reflected in later dominance at a site. For example, if sedges and wetland grasses become dominant, small seeded woody riparian vegetation such as willow, aspen, and cottonwood have great difficulty becoming established. Thus it becomes difficult to forecast the ultimate vegetative community. Waterfowl and shorebirds typically transport seed of riparian vegetation to newly created sites.

1. Little or no riparian vegetation potential due to limiting factors such as lack of soil, steepness of shore gradient, and/or wide fluctuation of water level.

2. Ponds where little water fluctuation occurs. Sedges, rushes, wetland grasses initially colonized shoreline preventing establishment of small seeded woody riparian plants. Often a narrow zone.

3. Sites where soil alkalinity limits vegetation. Alkali bulrush, salt grasses and related salt-tolerant forbs. May support Russian olive (Elaeagnus angustifolia].

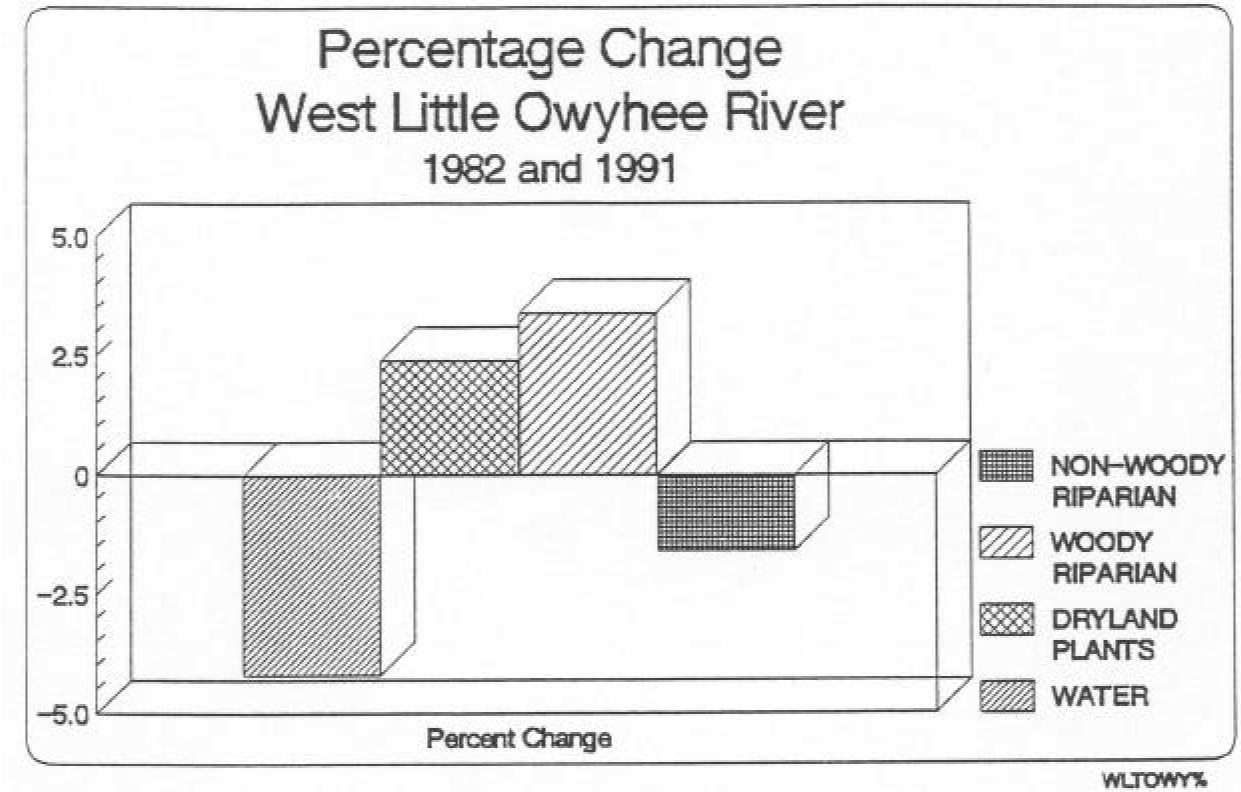
4. Perennial waters with some water level fluctuation. Shore gradient low with moist soil common throughout the year. Willow, mostly shrub type; cattails [Typha spp.], rushes and sedges.

5. Maximum potential sites where dense stands of wetland sedges, rushes, and grasses did not become established early in succession. Cottonwood, tree willow, shrub willow, wet land grasses, rushes and sedges. Plant genera and species will vary by geographic area. Nonetheless, the niche and function of each will be similar.

**A FOCUS ON LIVESTOCK GRAZING**

In natural riparian systems, vegetation is normally the single "common denominator" influencing ecosystem function (Clifton 1989). Vegetation stabilizes banks and shorelines. Debris dams of plant material create pools and cause channel diversion or sinuosity -- thus dissipating energy and subsequent erosion (Bilby and Likens 1980, Heede 1985). Vegetation shades the water in the summer increasing the potential for native fish and other aquatic life (Bowers et al. 1979, Theuber et al. 1985). Conversely, during the winter, vegetation tends to insulate against extremes of cold (Bohn 1989).

Cattle are the predominant class of livestock now grazing the rangelands of the Columbia Basin. Cattle graze or browse vegetation. They are prone to spend a disproportionately great amount of time within riparian systems (Marlow and Pogacnik 1986, Kovalchek and Elmore 1991). Such use can be, and unfortunately has been, extremely harmful (Duff


Percentage Change
West Little Owyhee River
1982 and 1991
5.0
2.5
0
-2.5
-5.0
Percent Change
NON-WOODY RIPARIAN
WOODY RIPARIAN
DRYLAND PLANTS
WATER
WLTOWY%

1977, Schluz and Leininger 1990).

Many riparian ecosystems in rangelands used by livestock suffer curtailed functions caused by herbage removal and trampling (Yoakum 1977, Kauffman et al. 1983, Kauffman and Krueger 1984). A reduction in this negative influence is possible, short of total removal of livestock (Krueger and Anderson 1985). The extent of the reduction will always be a compromise in values and functions (Kindschy 1987). Each site should be evaluated as to its potential to produce riparian vegetation and subsequent objectives set toward a desired production goal (Schmidt 1991). Prescription grazing by livestock should be able to achieve 80 to perhaps 90% of the potential vegetation and related functions of the riparian ecosystem ... if the specific site has been curtailed in successional advancement by livestock. In essence, livestock are NOT "a tool" to improve riparian ecosystems. Rather, they are a cost that may often be accomodated and still enable successional advancement of riparian vegetation and attendant functional values (Kruger and Anderson 1985, Kindschy 1987).

The physiological needs or requirements of the "key" riparian plant species must be considered. When those needs are met, including the need for population recruitment, recovery of the plant community and the associated ecosystem will occur (Gorges and Wilson 1989).

Options available for improvement of riparian communities, where livestock impacts are the primary constraining influence, all involve a change in that usage (Clary and Webster 1990, Kulla 1990). The change must provide relief for the physiological requirements of the riparian vegetation, namely growth and reproduction.

Objectives are:

1. Increase management emphasis on livestock use of riparian communities through initiation of suitable grazing systems and compliance thereto

. 2. Improve the hydrologic function of streams by:

- •Decrease the severity of short-term flooding.
- •Increase soil deposition within riparian communities through reduction of water velocity.
- Increase the time ephemeral streams discharge water.
- Decrease the average width of streams (Clifton 1989).
- Increase the average depth of streams.
- Increase the ratio of pools to riffle areas.

3. Increase production of desired fish species.
4. Increase wildlife habitat diversity and productivity for

game and non-game species of wildlife (Medin and Clary 1990b, Schulz and Leininger 1991).

5. Improve the habitat quality of lentic waters by:

- o Increase the amount and structure of wetland vegetation, both emergent and shoreline (Hoffman and Stanley 1978, Whyte and Cain 1981).
- o Increase the quality of water through the reduction of livestock fecal and urine contaminates (Green and Kauffman 1989, Miner et al. 1992).

<u>Options include:</u>

1. Changing the type of livestock. For example, domestic sheep can have little adverse impact on riparian vegetation, especially when herded and thus kept removed from the riparian community except for short duration watering times.

2. Changing the class of livestock. Yearling cattle are less apt to linger within the riparian community than are cows, especially cows with calf at side, and bulls.

3. Changing the season of use. Studies and research have demonstrated that the most harmful impacts to riparian vegetation occur during the hot season months of summer. Livestock tend to spend extended periods of time "camped" on the water (Smith et al. 1993). Willow, and likely other

woody riparian species, are especially vulnerable to utilization during this time of their maximum growth (Kindschy 1989, Myers 1989). Conversely, grazing use made during the cool seasons of spring, autumn, and winter appears to be less harmful to the riparian vegetation (Kauffman et al. 1983).

A. Spring grazing is possibly the least harmful to the majority of plant species in the riparian system (Platts and Nelson 1985, Shaw 1991). The remainder of the year must be free of grazing use. Accumulated vegetation will function as a filter for instream and flood flows, reducing water velocity and allowing deposition of sediments. An adverse impact to associated upland vegetation, especially perennial grasses, may occur when spring season grazing is practiced annually for a number of years due to depletion of root reserves. This problem may be lessened by early spring grazing which enables regrowth of the upland grasses to the extent that food may be stored in the roots. Occasional year-long rest from grazing will benefit both the upland and riparian vegetation.

B. Autumn grazing meets the physiological requirements of both the riparian and upland vegetation. Such use, however, has the disadvantage of leaving the stream banks in a disturbed condition from herbage removal and trampling. The period of maximum hydrologic activity is normally late winter and early spring. Thus the soils are especially vulnerable to erosion following autumn grazing.

C. Winter grazing appears to have effects upon the riparian ecosystem similar to that of autumn grazing; however, soils are often frozen and thus better protected from trampling (Sedgwick and Knopf 1987). Should snow cover the grasses, sedges, and forbs, livestock are forced to available shrubs and trees. Such conditions can be extremely harmful to woody riparian vegetation.

4. Change in duration of use, for example short time period grazing with large numbers of livestock, followed by a long period during which no grazing occurs, will often achieve a limited advancement of succession in riparian vegetation, especially the herbaceous plant species. Woody vegetation reacts in a "yo-yo" manner. The gains during the rest phase are canceled by the subsequent losses during the high intensity use phase.

5. Change in number of livestock. A reduction in the number of livestock using a pasture where riparian communities are of concern will normally have little positive

effect on the wetland ecosystem (Marlow 1988, Harlow et al. 1989). The uplands will exhibit a lessened use, but the riparian community will receive excessive utilization until the reduction in livestock numbers is carried to an unacceptable extreme (Wagstaff 1986).

6. Selection of livestock that exhibit traits to graze the uplands and remain on water for but short durations. This trait in individual cattle may be genetically related or perhaps passed on from cow to calf through learned behavior.

7. Exclusion of livestock is also an option. Certain highly sensitive riparian communities may require such extreme management action. Both benefits and costs are often great. Fencing costs may average $3,750/km ($6000/mile) (Platts and Wagstaff 1984). Annual maintenance averaging from $38 to $125/km/year ($60 to $200/mile/year) is often required due to damage from high volume flows as well as pressure on the fence from livestock and recreationists. However, there are great values to be obtained from exclosures. Kindschy and Evenden (1988) stressed the following benefits in a paper presented at the annual meeting of the Society for Range Management, Corpus Christie, TX.

"Riparian exclosures are a logical, and perhaps mandatory, initial step toward improved rangeland management. Although seemingly a 'Band-Aid approach' to a major wound, the information such reference areas provide starts a healthy avalanche of events, which should culminate in improved rangeland management."

A. Enable ecological recovery to provide habitat for more species richness and diversity in and animal life (Winegar 1977).

B. Provide a reference area for managers to compare the ecological condition of adjacent and similar managed riparian habitats (Webster et al. 1985). Exclosures thus serve as benchmark reference areas. The current productivity of the managed site, relative to what that site is capable of producing, may be quantified ... whether that production be vegetation, wildlife, fisheries, water yield, soil stability, or even esthetic values (Black et al. 1985).

C. Land managers may also reference the exclosure habitats in forming realistic objectives for similar, managed, habitats. It's been aptly stated that "if you don't know where you are going (successionally) you surely won't know when you get there" (Leege et al. 1981, Schultz and Leininger 1990).

D. Riparian reference exclosures provide demonstration areas to be viewed on tours. Local residents have likely never seen riparian communities free of the impact of grazing by livestock (Duff 1977).

E. Of course other publics make similar observations and may well come to the conclusion that present livestock management is not conducive toward obtaining improved riparian ecosystem values. Such conclusions are highly appropriate for public lands, at least. The resultant opinions force land managers, whether livestock operators or land management agencies, to modify grazing techniques to better favor riparian ecosystems.

**Riparian Vegetation and Cattle Grazing Systems**

Platts (1989) discussed his views concerning the probable impacts of 17 grazing systems. Earlier, (Platts and Nelson 1985), he had observed a general tendency for cattle to avoid certain stream-side zones early in the season when the soils and vegetation may be wet.

Myers (1989) reviewed grazing and riparian management in Southwestern Montana. He observed that most grazing strategies developed to benefit upland vegetation did not accommodate riparian recovery. He observed that avoidance of summer or "hot season" grazing by cattle minimized adverse impact to riparian communities. The number of days available for vegetative regrowth following termination of livestock use was related to the amount and rate of subsequent successional advancement, namely the more growing season available following grazing, the greater the extent of riparian recovery.

Elmore and Beschta (1987) relate the success of early spring grazing on Bear Creek in the Prineville (Oregon) BLM district. Vale BLM experienced similar successes on several stream riparian communities in southeastern Oregon through "dormant season" grazing. Research by the U.S. Forest Service Intermountain Research Station (Boise) on Poal Creek, near Brogan, Oregon, has shown that early spring grazing by cattle or complete rest from grazing are superior strategies for riparian recovery when compared to season-long, summer, or autumn grazing (Shaw 1991).

Roath and Krueger (1982) observed that "shrubs (willow, etc.) use tended to increase as the season progressed. Shrub utilization was lowest when herbaceous vegetation was lush and very palatable and greatest when herbaceous vegetation was coarse and mature." They further observed that "late season grazing minimizes impact on herbaceous components but increases shrub utilization."

Kauffman et al. (1983) examined the effects of late season grazing on riparian ecosystems. They observed that willow and black cottonwood reproduction was inhibited by autumn grazing. Shrub (woody riparian vegetation) use by cattle was related to availability of herbaceous vegetation and the palatability of the particular shrub species. Late in the grazing season, vegetation growing in riparian zones generally is more palatable and of higher nutritive quality than vegetation in upland plant communities. Thus grazing pressure shifted from grasses and forbs to woody riparian vegetation with the advancement of the season.

Kovalchik and Elmore (1991) reiterated this concept. They found that as long as palatable herbaceous forage was available in the riparian zone, willow utilization would remain minor. Their observations for mid to late season grazing indicate that cattle begin using the current annual growth on willows when riparian forage use reached about 45 percent of total available forage (10 - 15 cm (4-6 inch stubble height]). Use increases again at 65 percent (5-10 cm [2-4 inches]), and cattle eat all the willows they can when utilization is 85 percent or more (< 5 cm [2 inches]) Overused willow stands show a "grazing line" where all young shoots have been grazed. With continued overuse, dead and dying plants suggest former willow abundance.

Spring or early season grazing is ranked highly by Kovalchik and Elmore (1991). They observed that in the spring cattle avoid riparian zones because of cold temperatures, soil wetness, and forage immaturity. Spring grazing encourages cattle to graze uplands where forage maturity and climate are more favorable compared to the riparian zone (Platts and Nelson 1985). As a result, spring-grazed riparian zones have less than half the cattle occupancy compared to fall use. Willow browsing is light and seedling survival is high. Response of riparian vegetation is good, even on poor condition sites. Vigorous willow and sedge regrowth provide excellent stream-bank protection and soil and water relationships remain favorable to continued willow and sedge production.

Discussing late autumn grazing, Sedgwick and Knopf (1991) found that cattle consumed fallen cottonwood leaves as forage in riparian zones in the mid-west. Yet they also noted that willows responded negatively to this grazing system.

Kindschy (1987) presented a lecture series entitled Riparian Community Ecological Improvement with Livestock Use which stressed that many riparian ecosystems in rangelands used by livestock suffer curtailed functions caused by herbage removal and trampling. A reduction in this negative influence is possible, short of total removal of livestock.

Among the methods available to achieve riparian successional advancement, Kindschy suggested changing the season of use. Studies and research have demonstrated that the most harmful impacts to riparian vegetation occur during the hot season months of summer. Livestock tend to spend extended periods of time "camped" on the water. Willow, and likely other woody riparian species, are especially vulnerable to utilization during this time of their maximum growth (Kindschy 1989). Conversely, grazing use made during the cool seasons of spring, autumn, and winter appear to be less harmful to the riparian vegetation.

With regard to cattle use during the various seasons, spring grazing is possibly the least harmful to the majority of plant species in the riparian system. The remainder of the year must be free of grazing use. Accumulated vegetation will function as a filter for instream, and flood flows, reducing water velocity and allowing deposition of sediments. This same vegetation will largely be available to livestock the following spring as cured forage thus assuring feed for spring "turn-out."

A practice that is old but, unfortunately, not in much use today is that of riding the range. This often requires the use of horses or, nowadays, 4-wheelers. Riders can push cattle out of riparian communities and thereby lessen the amount of time stock spend therein. A series of such encounters between humans and cattle will soon cause stock to lessen their time in sensitive riparian habitats. Both public land ranchers and land management agencies (Forest Service and BLM) should make more use of this management technique. It has worked well in the Trout Creek Mountain area of southeastern Oregon.

Recent experimentation in the LaGrande, Oregon, area with electric ear-tags in cattle has shown that an aversion for entry into critical riparian habitat can be instilled in cattle (Quigley et al. 1990). The tags shock the cattle when they enter a radio frequency zone surrounding the riparian area. Initial results appear promising. Presently, such technique is expensive. Research and development may enable adoption of such modern technology for livestock distribution (Rose 1991).

Previous discussion was directed toward improvement of riparian vegetation and all related riparian ecosystem attributes. Once an area has recovered to the desired ecological condition, hopefully somewhere near the potential for the various sites within the area, management of livestock can become more flexible. High vigor riparian communities are very resilient. More flexibility in livestock use is therefore possible without undue degradation of habitat values. It is vital that such grazing use recognize the fundamental requirements of the "key" or important plants, namely growth and reproduction.

## WILLOW and HERBIVORY

Thomas, et al. (1979) recognized that a better understanding of the response of riparian vegetation to utilization by herbivores is needed to refine future management. Kindschy (1985) found that red willow [Salix lasiandra] annually cut by beaver but isolated from use by livestock, maintained vigor and growth characteristics similar to trees with no history of beaver use.

Kindschy (1989) reported on a study of willow response to cutting which simulated that of beaver. Stumps of 40 cm remained. A random pair of willow was thus cut each month from March through November. Cutting was accomplished using a bow saw on large wood and clippers on smaller material. Effects of cutting at various seasons of the year (March through November) upon subsequent growth response was documented.

Willow cut during the time of dormancy, both in March and in the October - November period, exhibited the most rapid growth recovery. Those cut during the heat of summer, especially during August, showed a great amount of shock which persisted in below average growth and vigor for the following 2 years. Trees cut between dormancy and August were intermediate in response.

Results indicated the following:

1. Complete removal of all but 40 cm of the basal stump greatly imbalanced the base/top ratio, which stimulated subsequent regrowth.

2. A "shock period" of approximately 30 days occurred following top removal. All willow treated, regardless of the month of cutting, exhibited no bud development during this period.

3. Adventitious buds appeared on the stump after the shock period - if seasonal temperatures enabled growth. Spring growth commenced during May of both years. Cut willow initiated growth earlier in the season than uncut willow. Growth continued into the autumn longer on cut willow than on the control. Yellowing of leaves and leaf drop following frosts was delayed. Growth was well described by a logrithemetic curve:

$$Y = -486.26 + 131.97 \ln X$$

where: X represents days since top removal.

Y represents total annual growth in cm.

5. Height and width of cut plants were within -3% to -5% of pre-treatment measurements by the cessation of the second growing season. As the ratio of base to top approached that of pretreatment, growth decreased predictably following a power curve:

$Y = 300830881 X -2.385$

where: X represents days since top removal

Y represents total annual growth in cm

6. Comparisons of growth among the 8 treatment periods disclosed considerable variability during the second growing season following top removal. Willow cut during the previous months of May, June, July, September, and October, also exhibited a minor growth spurt during October.

7. Daily growth rates were least during may and during September/October. These minimum rates appeared related to temperatures excessively low for growth.

8. Paired couplets of randomly selected plants exhibited remarkably similar growth curves.

9. No apparent difference in growth characteristics existed between willow cut in November and March. In fact, little was evident until the June period.

10. Maximum growth rate normally occurs during August,

especially for uncut plants.

11. Growth curve was nearly linear between May 20 and August 26. Cessation of growth had generally occurred by August 26. Exceptions were June-cut and July-cut willow.

12. Cutting greatly stimulated the production of subsequent growth, until the August cutting.

13. November-cut willow exhibited the greatest early spring growth (April 26-May 20).

14. June-cut and July-cut plants exhibited a linear growth response until frosts of late September. Curve slope was similar to that of late fall and early spring cut willow.

15. Plants cut August 26 or later had little opportunity for growth during the remainder of the growing season.

16. November-cut plants attained 74.76% of total elongation between June 15 and August 26. Uncut willow attained 75.99% of total elongation during the same period; however, 65.4% of this occurred during the July 29 to August 26 period. That is, 49.7% of the total annual growth occurred during the 29 July to 26 August period (28 days).

17. Autumn frosts (to -11 C) caused yellowing of leaves and leaf drop on willow cut in November, March, April, and May as well as all untreated willow. Yellowing was less on

June-cut willow and was absent on July and August-cut plant growth, all of which were bright green. Similarly, leaf drop was significantly less for June-cut plants and was nonexistent for July and August-cut willow. It may well be that the chemical composition of the sap in actively growing plants is less subject to freezing, possibly due to a higher sugar content.

Kindschy concluded that maximum growth of shoots occurred during the hottest months, especially between 15 July and 26 August when daily elongation averaged 4.1 cm (1-6 in). This rapid growth was most evident on trees cut during dormancy and helped explain how beaver harvested trees were able to annually produce such great quantities of wood with no apparent ill effect. Beaver harvest is normally restricted to times of willow dormancy, especially during October and November at the study site.

Herbivory upon willow can have extreme effect on resultant recovery and subsequent production. Beaver use normally occurs during a time when willow are least subject to adverse impact. Use by livestock, which may occur during the hot summer months along desert riparian habitats, would be especially inhibiting for subsequent regrowth. This is particularly true where beaver have cut the main tree during the previous autumn and then the regrowth is browsed by livestock during the following summer.

These data suggest that where livestock, especially cattle, are to graze riparian communities supporting willow, season of use should avoid the hot summer months.

**A CASE HISTORY**

Oncorhynchus clarki henshawi, the Lahontan cutthroat trout is one subspecies of a wide-ranging species that includes at least 14 recognized forms in the western United States. Many of the basins in which cutthroat trout occur contain remnants of much more extensive bodies of water which existed during the wetter period of the late Pleistocene.

Lahontan cutthroat trout historically inhabited most cold waters of the Lahontan Basin of Nevada and California, including Quinn River and its tributary McDermitt Creek, which enters Oregon. In November 1991, the Willow-Whitehorse cutthroat trout was determined to be "genetically indistinguishable from the Lahontan cutthroat trout." The manner by which this subspecies crossed the divide between the Lahontan Basin and that of the Whitehorse Desert area is unknown. Likely humans transported fish from McDermitt

Creek or a tributary across the mountain summit to willow and Whitehorse Creeks sometime around the turn of the century.

Within the Oregon Canyon and Trout Creek Mountains the recent severe decline in trout populations has been attributed to several factors including drought, poor watershed and riparian habitats due to over-utilization by livestock, a major flood event in the early spring of 1984, and excessive recreational fishing.

Declining trout numbers were a concern of the owner of the Whitehorse Ranch in 1971. He asked the Oregon Game Commission and Bureau of Land Management (BLM) to view Big Whitehorse and Doolittle Creeks on a horseback trip. The writer, then wildlife biologist for the Vale district, participated in that trip. I observed poor riparian habitats with little willow, alder, or aspen reproduction in all but the most rugged and inaccessible sites. Subsequently, a habitat management plan was written which resulted in planting of some 40 thousand willow cuttings along the streams. In addition, a number of "trash catcher dams" were placed in Cottonwood and Fifteenmile Creeks. Unfortunately summer-long cattle grazing was practiced at that time and nearly all plants were browsed to death.

Deep snow covered the region during the winter of 1983-

84. Late in the winter, in February or early March, a "chinook" rain and wind caused massive melting and subsequent discharge of all streams. Not only was the ill-protected riparian zone unable to stem the flow but massive scouring and cutting was common. A great many trout, probably thousands, washed out of the canyons onto the Whitehorse Ranch fields and the adjacent desert.

Since 1985, deep snows have not accumulated in the Oregon Canyon mountains. An unusually prolonged series of mild winters and, in cases, reduced precipitation, have diminished the discharge of all streams. Many of the smaller creeks have become excessively low for trout.

Environmental groups became increasingly interested and involved in the management of the Oregon Canyon mountains, especially concerning trout habitat. Members of the Oregon Watershed Improvement Coalition (OWIC), especially Doc and Connie Hatfield (ranchers from Brothers, Oregon), helped in forming a "working group" comprised of local ranchers, environmentalists, and government land managers. This group became known as the "Trout Creek Working Group."

A series of field trips and meetings among the participants eventually resulted in acceptance of the Whitehorse Butte Allotment Management Plan ... which had been written by managers and scientists of the Vale District, Bureau of Land Management. The process and results are well documented in Holbert (1991) and Hatfield and Hatfield (1991).

Higher elevation rangeland was split into two large pastures each of which is grazed during the spring for two years and then rested for two years. Season of grazing is weather dependent for cattle entry but gathering must be completed by 15 July. Riparian plants are able to regrow until mid-October of most years.

**Riparian Community Monitoring**

Kadlec (1988) discussed monitoring *w*etland responses over time. He listed color and infra-red aerial photograph as well as ground level photography as monitoring techniques. Kadlec also discussed sampling techniques with replication over distance, time, or both.

Recognizing vegetation as a primary factor in riparian ecosystem health, monitoring of plants is highly appropriate (Popolizio et al. 1994). Use of line-intercept data from permanent transects has proven beneficial in providing quantitative data which, over time, represents successional trend of vegetation (Kindschy 1984). The appendix to this paper contains several graphs from actual data gathered in the Trout Creek Mountain area concerning change in riparian ecosystems. Although photography is an excellent manner of illustrating change, it is not quantitative. Both line-intercept and low-level photos provide measurable change in vegetative composition and land barren of vegetation. Such data is important for management decisions as well as conflict resolution in the event of litigation (Findley 1984, Kindschy 1984, Elmore and Cuplin 1984, Cuplin 1985, Batson et al. 1987).

**Management Implications**

Once the potential capability of riparian sites has been identified, it is vital that the factors limiting attainment of that capability are also determined. A lessening of these constraints, especially if they are human induced, can result in successional advancement of the vegetation and attendant attributes of the ecosystem.

Livestock grazing has been ... and likely will continue to be ... a primary use of much of the land area of the Columbia Basin. Experience has shown that recovery of riparian zones is possible when grazing systems that meet the biological requirements of key riparian plant species are met. These requirements center on reproduction and growth. Grazing that avoids or minimizes the summer hot season appears to be least detrimental to the welfare of riparian vegetation. Where high elevation or other factors preclude avoidance of summer use by livestock, year-long rest, preferably for 2 years in sequence, can also enable recovery of riparian ecosystems.

Once riparian zones are nearing the potential plant community desired by management, more flexibility in grazing management is possible. Riparian communities are exceptionally resilient when in high vigor and ecological condition.

Monitoring of change in vegetation within the riparian community is highly desirable for all areas. It becomes mandatory in sensitive environments or those held to be especially controversial. Quantitative data is of more use in monitoring evaluation than purely qualitative material, such as "snap-shot" photographs. However, the latter is better than personal opinion.

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**Additional Literature**

Allen Thomas and associates, Idaho BLM state office, Boise, have compiled excellent bibliographies of riparian topics emphasizing the Intermountain West.

Thomas, A.E., and C. Wentzell. 1986. A bibliography of riparian topics with emphasis on the Intermountain West. USDI Bu. Land Manage., Idaho, Tech. Bull. 86-4. 70 pp.

Clifton, C., and A.E. Thomas. 1988. A bibliography of riparian and related topics with emphasis on the Intermountain West. USDI Bu. Land Manage. , Idaho, Tech. Bull 88-2. 69 pp.

Fisher, H.M., and A.E. Thomas. 1990. Riparian communities: An annotated bibliography of ecosystem and management topics with emphasis on the Intermountain West. USDI Bu. Land Manage., Idaho Tech. Bull. 90-7. 77 pp.

**Appendix Illustrating Monitoring Data**

Successional change in riparian vegetation can be illustrated with photographs taken from a fixed point over time. Such documentation is qualitative. The viewer is aware of an apparent trend. In environments where quantitative data is anticipated to be required, sampling over time is necessary. Measurement of vegetation through line-intercept transects is a successful method of quantifying such change.

Land managers, be they private or public, are the "target" of such trend information. Detailed tables or complex graphs are often dismissed due to normally brief times available for analysis. Kindschy (1984) developed a technique of displaying one numerical figure, a "succession factor," which portrays successional trend of vegetation ... and likely many of the associated attributes of the riparian ecosystem such as stream-bank stability, shading of waters, water flow characteristics, and habitat value for wildlife.

**Succession Factor = Riparian vegetation (both woody and non-woody) of a transect divided by the sum of non-riparian vegetation + barren intercept.**

Over time, this ratio should change with moderating constraints on the environment. The following graphs show actual data from the Trout Creek Mountain area of southeastern Oregon. "Pie-graphs" may also be used to illustrate the change in specific transect components.

An analysis of **WHY** change has occurred is desirable. Drought, flooding, trespass livestock, fire, recreational use, insects, and many other factors can influence vegetational change.

**APPENDIX: Captions for Graphs**

Big Whitehorse Creek site #1 illustrates line intercept data expressed as a percentage of the total transect length. Data collection was initiated in 1988, at the time of permanent closure to livestock use. Most recent data from August 1994, may be compared with original transect composition as well as that of 1990 and 1992. Note especially the decrease in soil barren of vegetation and the highly important increase in woody riparian vegetation.

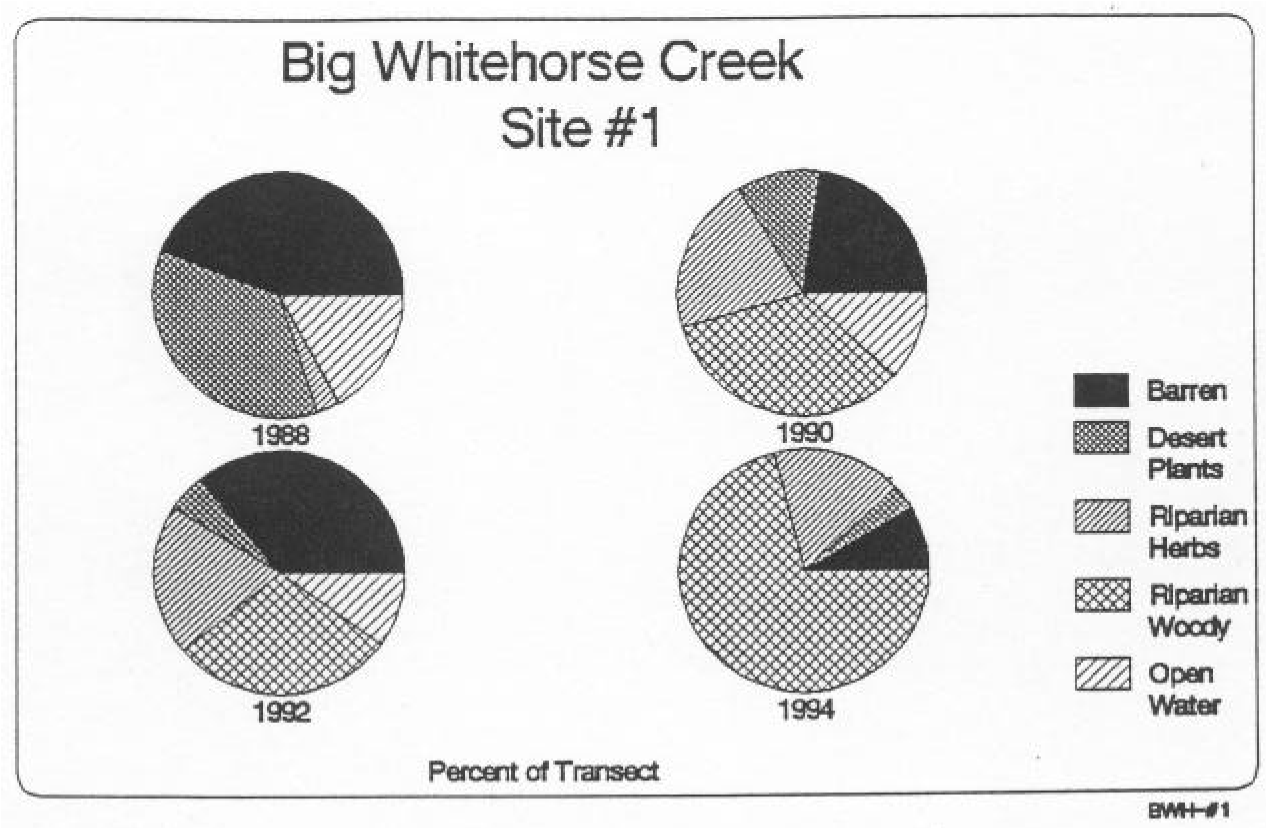
Willow and dogwood cover, Big Whitehorse Creek utilizes trend line smoothing to show change (trend) of woody riparian vegetation at 3 study sites. It is evident that this valued component of riparian ecosystems changed from < 5% of the line intercept to > 50% at Site #1. Riparian managers can quickly assimilate such graphic information.

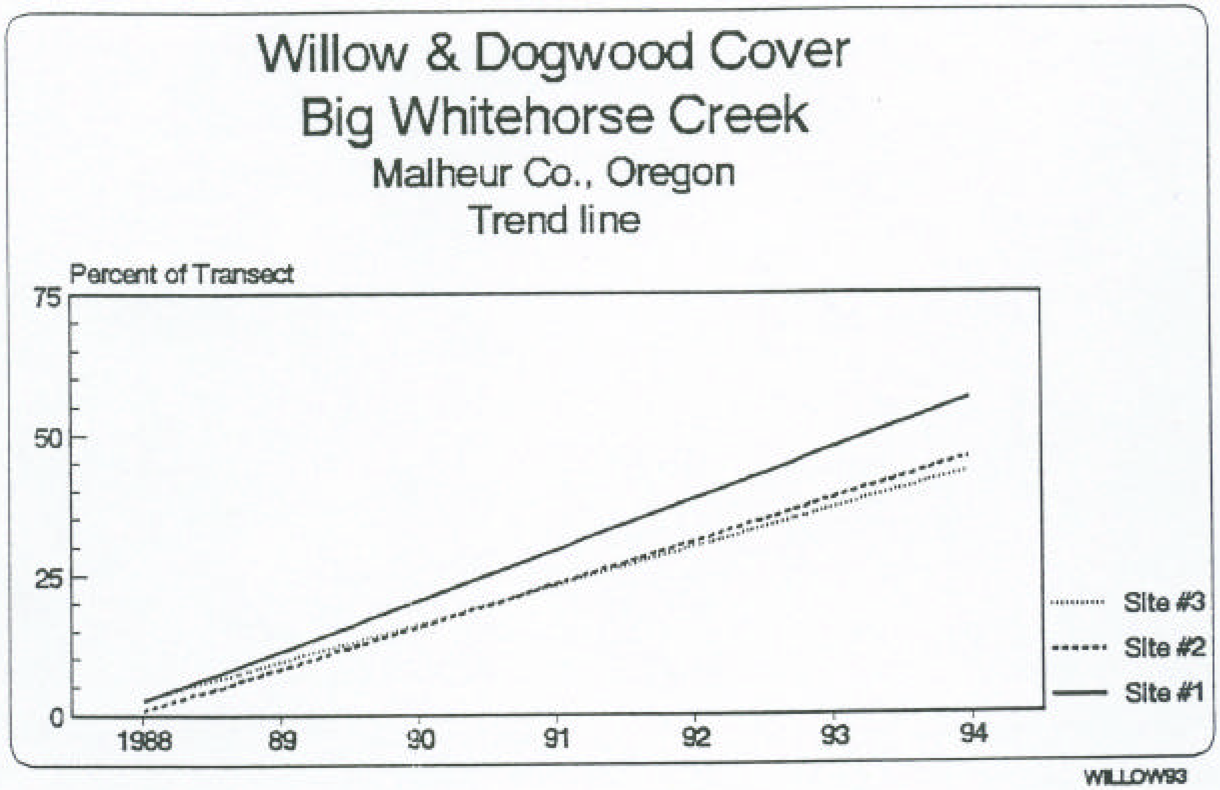
Percentage Cover, Sage Creek reflects data obtained through analysis of low-level aerial photography. In this case it is apparent that little change had occurred in the 6 years between flights. There are numerous methods available for quantifying aerial imagery. Here, 10 sites were randomly selected on the photo sequence. Quadrilaterals were drawn on a clear plastic overlay utilizing readily identifiable features to enable exact replication on the subsequent flight photos. The percentage of the total quadrilateral occupied by the 4 components ... water, dryland plants, woody riparian plants, and non-woody riparian plants ... was then determined.

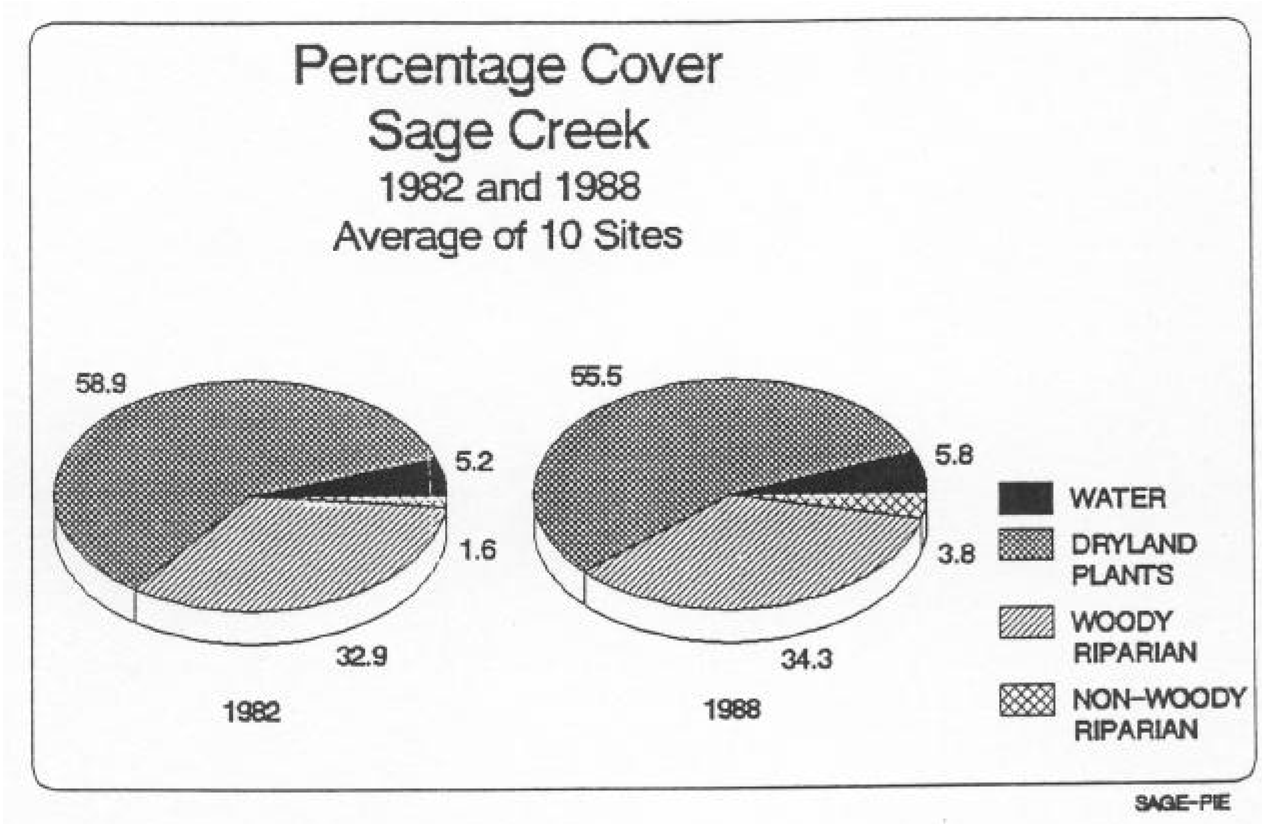
Succession Factors. Sage Creek provides a powerful means of illustrating trend of vegetation over time. Each of the 10 sites analyzed on low-level aerial photos is here compared at 2 time intervals. A "Succession Factor" was calculated by adding the percentage the quadrilateral occupied by riparian vegetation (both herbaceious and woody) and then dividing this total by the sum occupied by non-riparian (xeric) vegetation and land barren of all vegetation (Kindschy 1984).

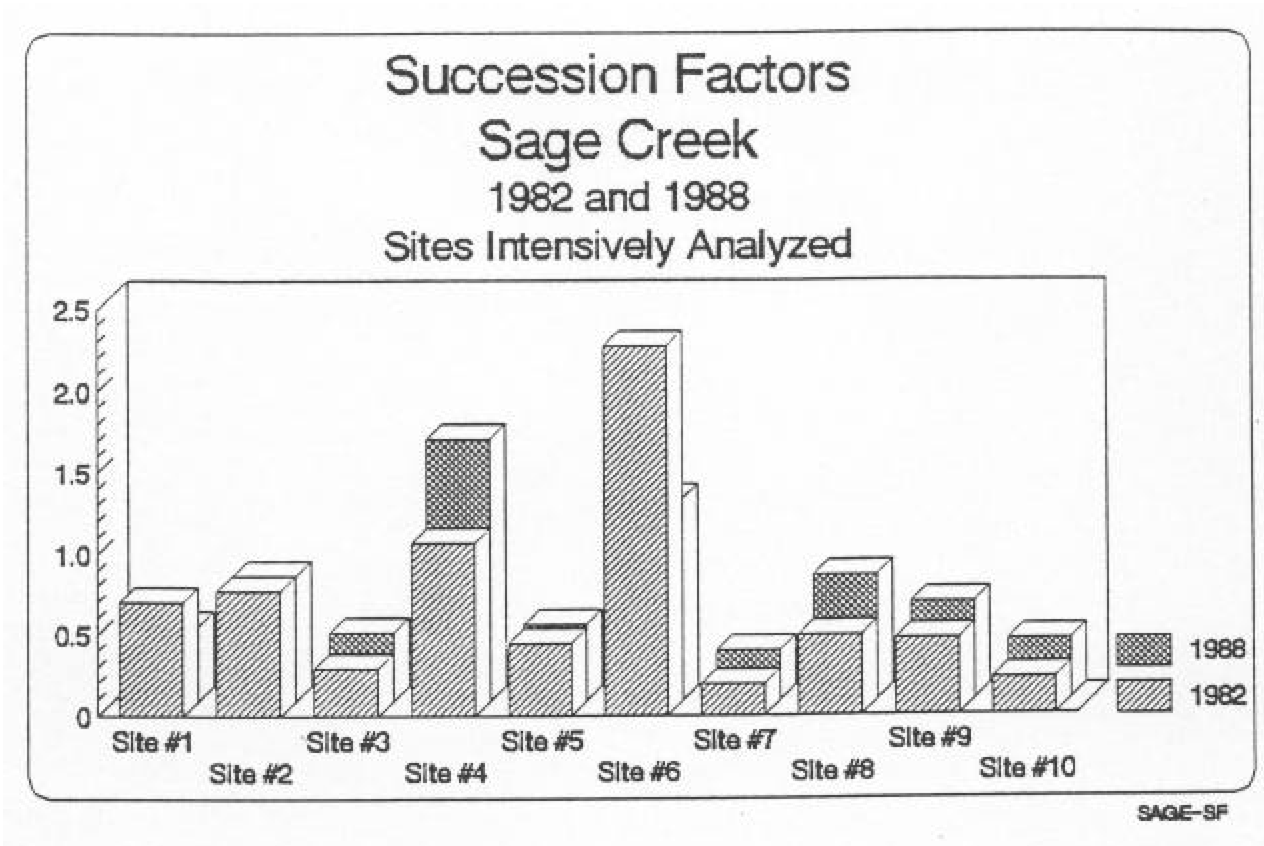
SF = Riparian vegetation / Non-riparian veg. + Barren

Percentage Change, West Little Owyhee River, 1982 and 1991.A powerful method of illustrating change is through percentage of change 4 between observations. Data was taken from low-level aerial photos where identical quadrilaterals were evaluated. In this case both dryland (non-riparian) vegetation and woody riparian plants showed increase while nonwoody sedges, rushes, wetland grasses, and forbs decreased. Water also decreased ... which could have been due to stream narrowing with ecosystem improvement ... but actually was due to prolonged drought. Field personnel still must evaluate **WHY** successional change occurs!


Big Whitehorse Creek
Site #1
1988
1990
1992
1994
Barren
Desert Plants
Riparian Herbs
Riparian Woody
Open Water
Percent of Transect
BWH-#1


Willow & Dogwood Cover
Big Whitehorse Creek
Malheur Co., Oregon
Trend line
Percent of Transect
75
50
25
0
1988
89
90
91
92
93
94
Site #3
Site #2
Site #1
WILLOW93


Percentage Cover
Sage Creek
1982 and 1988
Average of 10 Sites
58.9
5.2
1.6
32.9
1982
55.5
5.8
3.8
34.3
1988
WATER
DRYLAND PLANTS
WOODY RIPARIAN
NON-WOODY RIPARIAN
SAGE-PIE


Succession Factors
Sage Creek
1982 and 1988
Sites Intensively Analyzed
2.5
2.0
1.5
1.0
0.5
0
Site #1
Site #2
Site #3
Site #4
Site #5
Site #6
Site #7
Site #8
Site #9
Site #10
1988
1982
SAGE-SF