

PERSISTENCE OF IDAHO FESCUE ON DEGRADED JUNIPER/SAGEBRUSH/STEPPE IN CENTRAL OREGON

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INTRODUCTION

Over the past 150 years, abusive land management practices coupled with introductions of exotic weeds, as well as increases in shrubby plant species, have led to a dramatic decline in abundance of native perennial grasses. Efforts to reestablish native grasses on degraded lands has met with limited success, often due to lack of adapted, available, and competitive cultivars. There is a growing need for adapted cultivars of native grasses; however, their usefulness in restoration efforts will be determined by their ability to tolerate such factors as moderate grazing intensities, competitive pressure from both annual weeds and shrubby species, and their ability to exist under the current and future climatic regimes of central Oregon.

The purpose of this report is to summarize the findings of a long-term research project which sought to determine reasons why remnant populations of Idaho fescue (*Festuca idahoensis* Elmer.) persisted on disturbed central Oregon rangelands. We had observed that individual plants of Idaho fescue were present on certain degraded, central Oregon, sagebrush steppe sites despite these areas being accessible to heavy grazing pressures, invasion by alien weeds such as cheatgrass (*Bromus tectorum* L.), and increased densities of western juniper (*Juniperus occidentalis*) and sagebrush (*Artemisia tridentata*) (Mack 1981, Miller and Wigand 1994, Burkhardt and Tisdale 1976, Galbraith and Anderson 1971). Hypotheses designed to test the observed persistence of remnant Idaho fescue plants on degraded sites:

- 1) These populations represented grazing-tolerant ecotypes of Idaho fescue.
 - 2) These populations were composed of the most competitive ecotypes of Idaho fescue.
 - 3) These populations represented the most stress-tolerant ecotypes of the original populations.
- A series of research trials were performed to test these hypotheses.

Research Sites

Plant materials of Idaho fescue, including seeds and transplants, were collected from 5 sites in central Oregon (Fig. 1). Four sites were classified as disturbed, and one site was considered undisturbed. The undisturbed site had been previously described by Driscoll (1964) as "The Island", and is considered a pristine location. Sites were selected for their similarity: 3 of the disturbed sites had a high canopy coverage of juniper, and the undisturbed site had only a trace amount not measured in our field sampling (Table 1). Given the history of livestock production in central Oregon (Galbraith and Anderson 1971), and the palatability of Idaho fescue (Vavra and Sneva 1978, Drast and Havstad 1987), the disturbed sites had likely experienced a long-term history of grazing by livestock. Two research directions were emphasized: 1) assessment of plant response to simulated grazing trials and 2) examination of seedling growth in competitive environments with cheatgrass.

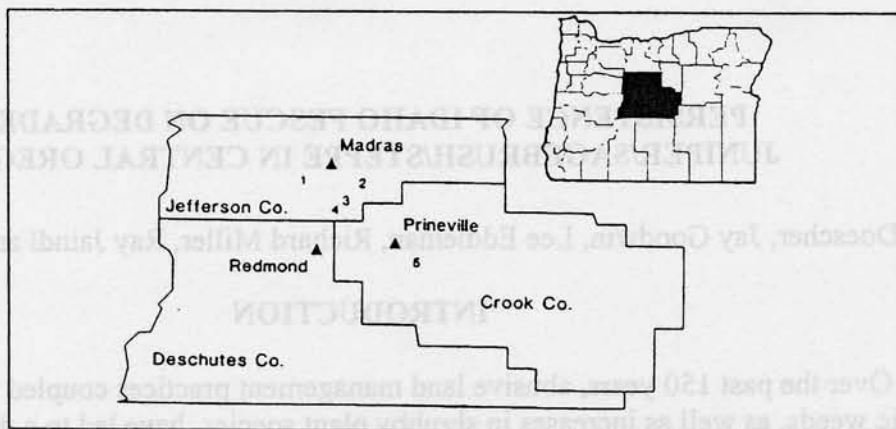


Figure 1. Location of plant material collection sites in central Oregon: 1 is the undisturbed site, 2-5 are the disturbed sites.

Table 1. Topographic edaphic and vegetation characteristics of research sites in central Oregon.

Site Location	Elev. (m)	Slope of Aspect	Soil Series	Idaho fescue cover %	Cheatgrass cover %	Sagebrush cover %	Western juniper cover %
Island (undisturbed)	740	plateau	Agency-Meadow Complex	6	---	2	---
McCoin	1015	35% N	Prag	8	<1	---	41
Blanchard	1185	5% N	Gribble	7	11	<1	7
Lone Pine	970	40% NW	Curant-Tub Complex	2	<1	---	28
Combs Flats	1050	20% N	Lookout	1	9	5	19

¹ adapted from Goodwin et al. (1999).

SIMULATED GRAZING RESEARCH¹

Experimental Approach

This experiment was designed to test whether Idaho fescue from the disturbed sites exhibited greater tolerance to grazing than Idaho fescue from the undisturbed site. Experiments were conducted in 1989 and 1990, using plants transplanted to a common garden established at the Powell Butte location of the Central Oregon Experiment Station.

Defoliation treatments were based upon plant phenology and included: 1) no clipping (control), 2) clipping when plants were in the 3-4 leaf stage (vegetative stage), 3) clipping when plants were beginning to exert inflorescences (boot stage), and 4) clipping when plants were flowering (complete inflorescence emergence). Plants were clipped to a height of 5 cm (2 in.) above ground level. Material clipped during each treatment period was dried for 48 hours at 50 °C and weighed to estimate standing crop removed at time of clippings. In mid-August, all plants were clipped to a 5 cm height, dried and weighed to assess end-of-year biomass. Basal area of plants was also measured at this time; biomass was standardized on a basal area basis. Plant height was also recorded during the second growing season.

¹ See Jaindl et al. 1994 for more details

Results and Discussion

Significant differences in plant height and biomass were found for unclipped plants between the disturbed-site populations and the undisturbed population. Plants from the disturbed-site populations were shorter and produced less biomass per unit of basal area than plants from the undisturbed site. These results are consistent with findings from other research which have shown that long-term exposure to heavy grazing results in the genetic shift of plants to lower statured plants (Detling and Painter 1987). However, when comparing biomass of plants from all collection areas averaged across defoliation treatments, no significant differences in response were noted among the collections. Defoliation did not result in reduction in yearly aboveground biomass, regardless of time during which defoliation was applied (Fig. 2). In 1991, defoliation at the boot and anthesis stages resulted in an increased yearly biomass accumulation.

These results suggest that grazing history had no consistent influence on the response of Idaho fescue to defoliation. Idaho fescue appears to be a species with relatively high tolerance to grazing. Ability to regrow rapidly and reestablish above ground biomass is a mechanism often cited as a characteristic of defoliation tolerant bunchgrass (Caldwell et al. 1981). Unlike bluebunch wheatgrass (*Agropyron spicatum* (Pursch.) Scribn. & Smith), which has poor regrowth characteristics following heavy defoliation (Caldwell et al. 1981), Idaho fescue recovered well following defoliation.

Results of this study suggest that survival of Idaho fescue in grazed areas may not be a result of a response to grazing in terms of regrowth after defoliation or time of phenologic development, but a result of changes in plant stature. These results are consistent with findings of McNaughton (1984). Grazing may have resulted in selective survival of shorter statured plants, which would be less exposed to the grazing animal.

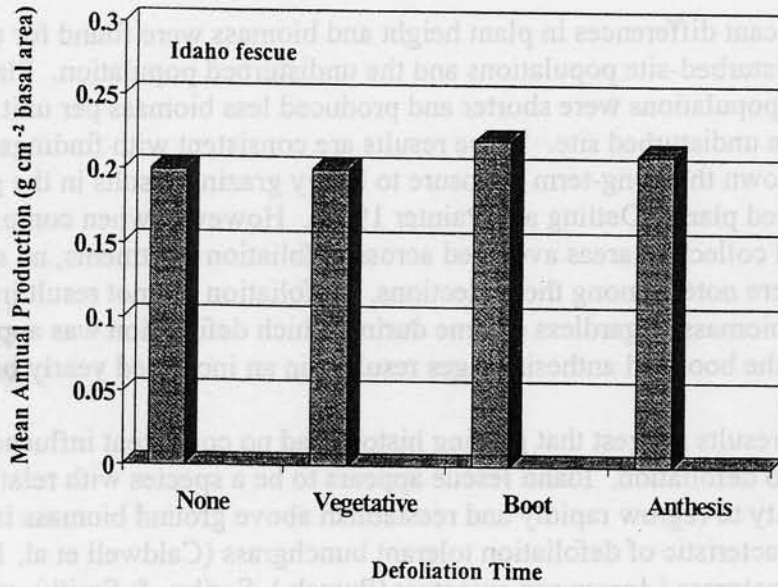
An offshoot of the results of the defoliation component of this study is the speculation that Idaho fescue may exhibit grazing tolerant characteristics even though it evolved in a biome in which large herbivore numbers did not exist (Mack and Thompson 1982). Its weakness may be its high palatability, which makes it prone to repeated defoliation during its active growing periods.

GERMINATION AND COMPETITION RESEARCH²

Our initial predictions were that Idaho fescue germination characteristics and seedling competitive abilities would be better for disturbed-site populations than the undisturbed populations. Specifically, we felt seeds from the undisturbed site populations would germinate faster and be less sensitive to moisture stress than seeds collected from the disturbed site. In addition, we also speculated that seedlings from the disturbed sites would exhibit growth characteristics that showed them to be better competitors with cheatgrass than seedlings from the undisturbed site.

² See Goodwin et al. 1999 and Nasri and Doescher 1995 for further details

1990



1991

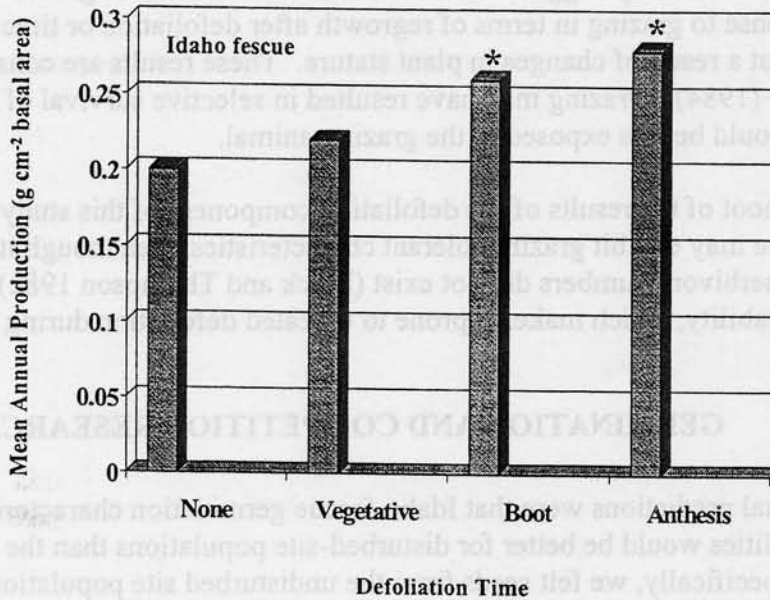


Figure 2. Plant species response to defoliation. Mean relative annual production of Idaho fescue collections from central Oregon grown in a common garden. Values represent the average of all collections: defoliation occurred at vegetative, boot, or anthesis stages of growth. Significant difference in values noted with an *. From Jaindl et al. (1994).

Experimental Approach

Seeds of Idaho fescue and cheatgrass were brought back to Corvallis, Oregon, for evaluation under greenhouse and environmental chamber evaluations. Specific research trials performed included:

- 1) Evaluation of germination characteristics to various temperature and moisture stress environments.
- 2) Evaluation of seedling root growth characteristics.
- 3) Evaluation of Idaho fescue seedlings in competition with varying densities of cheatgrass seedlings.

Results and Discussion

Results from the germination trials indicated that Idaho fescue from the disturbed sites did not represent superior ecotypes in comparison to the undisturbed site. A greater proportion of seeds from the undisturbed site germinated; they germinated faster and were no more sensitive to simulated water stress than were seeds from the disturbed sites (Fig. 3).

In competition experiments with cheatgrass, results discounted the hypothesis of greater competitiveness in disturbed site Idaho fescue seedlings. In one experiment (Goodwin et al. 1999) where seedlings of Idaho fescue were grown with varying proportions of cheatgrass seedlings, Idaho fescue from the undisturbed site exhibited a higher above ground growth and greater below ground growth than seedlings from the disturbed sites (Table 2). For instance, seedlings from the undisturbed site produced approximately 3.5 times the root length of disturbed site seedlings. However, in a related experiment (Nasri and Doescher 1995) growth of Idaho fescue from the undisturbed site without competition from cheatgrass produced 1.7 times as much shoot biomass as disturbed site populations. But, addition of 5 cheatgrass seedlings around the Idaho fescue seedlings reduced shoot biomass of the undisturbed site seedlings by 35%. No decrease in biomass was found for disturbed site seedlings in comparison to their response in the absence of cheatgrass competition.

Root growth response was also different among the Idaho fescue collections. In a comparison of root growth characteristics of Idaho fescue and cheatgrass grown in root tubes, it was found that Idaho fescue from the undisturbed site had roughly 3 times greater root length than undisturbed sites seedlings (Goodwin et al. 1999). However, one major difference was found among the Idaho fescue collections. Seedlings from the undisturbed sites concentrated root growth in the upper soil profile, while disturbed site seedlings had a greater concentration of root biomass in the lower soil depth. Cheatgrass had both greater root biomass, root length, and root mass at all depths compared to the Idaho fescue seedlings.

Table 2. Size and allocation patterns in Idaho fescue seedlings from disturbed and undisturbed sites, and in cheatgrass seedlings.¹

	Idaho fescue				Cheatgrass	
	Undisturbed ¹		Disturbed		Mean	Se
	Mean	SE	Mean	SE		
Emergence (days)	7.00a	1.31	11.00b	0.66	4.80	1.31
Total Root Length (cm)	963.32a	158.10	273.09b	72.54	16348.88	769.43
Total Leaf Area (cm ²)	11.66a	1.47	3.44b	0.67	125.42	6.27
Root Biomass (mg)	27.85a	3.44	8.57b	1.58	890.13	72.57
Shoot Biomass (mg)	71.15a	6.82	17.76b	3.07	707.10	43.51
Root Weight Ratio ⁴	0.29a	0.05	0.33a	0.02	0.55	0.03

Within a row, different letters indicate significant differences ($\alpha=0.05$)
¹n=4
²n=19
³n=5
⁴Root weight ratio = g root/g root+shoot

¹from Goodwin et al. 1999

INTERPRETATION AND CONCLUSION

Given that greater competitive ability does not explain the persistence of Idaho fescue on degraded sites, we reject Hypothesis 2. Instead, Hypothesis 3 and in part Hypothesis 1 offer the most likely explanations for the persistence of remnant plants. Our results suggest the following:

- 1) That although all Idaho fescue populations exhibited a high degree of defoliation tolerance (as shown by high regrowth response), there has been a genetic shift to shorter statured plants. Shorter statured plants would be less exposed to grazing animals, which would allow them to maintain a greater proportion of their leaf area available for photosynthesis.
- 2) That disturbed site Idaho fescue have persisted on grazed and invaded sagebrush-steppe because of greater tolerance to moisture stress. A slow, largely invariable rate of growth typically accompanies stress-tolerance, whereas the capacity for rapid production of roots and leaves in response to transient resource enrichment (such as high soil moisture) confers competitive ability (Grime 1979).

We believe Idaho fescue has persisted on grazed and invaded sagebrush-steppe because of an ability to withstand relatively high levels of grazing, drought tolerance to moisture stress such as that imposed by drought or competition with other species, but not greater competitive ability. Disturbed-site Idaho fescue populations likely represent stress tolerant ecotypes resulting from intensified selection pressures, from shrub increases and introductions of alien species. Our germination results suggest that recruitment of Idaho fescue seedlings is infrequent on invaded sites, and persistence of these populations requires longevity of established genotypes or recruitment of new individuals or both. Seeds remain important to long-term survival and evolution of the populations because of new genotypes generated through sexual reproduction. However, between episodes of seedling recruitment, clone formation by adapted genotypes is, we believe, key to the persistence of Idaho fescue on invaded sagebrush-steppe. Proper grazing management is also essential to long-term survival of Idaho fescue. Understanding the biology

of Idaho fescue and other native perennial grasses provides a foundation for proper rangeland management, having implications that extend from sustainable grazing management to conservation and restoration.

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