

Population Survey for River Otters in the Rocky Mountain National Park

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By

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Abstract

Recently, reintroduction of river otters (*Lontra canadensis*) to the Grand Canyon was suggested. This, however, could result in the genetic swamping of endangered *L. c. sonora* in adjacent watersheds. A quantitative spatial model evaluating the potential of natural recolonization of the Grand Canyon by otters assumes dispersal of animals from a viable source population in the upper reaches of the Colorado River. We initiated population surveys of river otters in the Rocky Mountain National Park (RMNP) to identify latrine sites, monitor scat deposition as an index of population size, and evaluate seasonal changes in latrine use to determine preferred sampling periods. Our data indicated that use of latrines and latrine site selection by river otters in RMNP changed both seasonally and annually. A sharp decline in number of latrines per km of stream and the reduction in number of feces per site occurred in all years, suggesting that otter behavior changes seasonally (2001: spring - 2.4 sites/km of river, fall - 1.4 sites/km; 2002: spring - 2.3 sites/km of river, fall - 0.6 sites/km; 2003: spring - 2.86 sites/km of river, fall - 0.22 sites/km). While spring densities of latrines were comparable in all years, the fall densities were considerably lower (43%) in 2002 and dramatically lower (16%) in 2003. The number of feces per site, a measure of otter activity, declined through time and between spring and fall in all years (2001: spring - 10.4 feces per site, fall - 4.75; 2002: spring - 6.1 feces per site, fall - 1.9; 2003: spring - 4.4 feces per site, fall - 0.8). Our observations of latrine site selection suggest that otter activity and seasonal abundance may be related to the hydrology of the Colorado River. If true, then occasional failure to detect otter sign should not be interpreted as localized extinction. Nonetheless, because of the high sensitivity of otters to environmental disturbance, monitoring should be continued on a regular basis. A winter survey scheduled for the end of February 2004 as well as continued surveys by

the University of Wyoming Student Chapter of the Wildlife Society should provide insights into temporal changes in the abundance of otters in Rocky Mountain National Park.

INTRODUCTION

River otters (*Lontra canadensis*) are piscivorous predators, which forage near the apex of the trophic pyramid and readily accumulate high levels of pollutants (Clark et al. 1981; Halbrook et al. 1996; Duffy et al. 1994, 1996; Ben-David et al. 2001a, 2001b). Indeed, river otters in North America were reduced throughout much of their historic range by the early 1900s because of pollution, urbanization, and over harvest (Serfass et al. 1993; Larivière and Walton 1998). Consequently, numerous projects were initiated to reintroduce river otters to areas from which they were extirpated (Erickson and McCullough 1987; Polechla 1990; Ralls 1990; Serfass et al. 1993; Hartup et al. 1999).

Recently, a proposal to reintroduce river otters to the Grand Canyon was put forward. Although this proposal has large appeal, reintroducing river otters to the Grand Canyon has several limitations. The population status and current distribution of the subspecies that historically inhabited the Grand Canyon, *L. c. sonora*, is unknown. The source populations for reintroduction will likely be of different subspecies. Thus, a successful reintroduction in the Grand Canyon may lead to genetic swamping (Shields 1987; Avise 1994; Storz 1999) of the few remaining *L. c. sonora* in adjacent watersheds. In addition, such reintroduction effort will likely be costly and require numerous permits, health evaluations, veterinary care, and complicated logistics. Therefore, before such a project is initiated the feasibility of natural recolonization of river otters needs to be assessed.

Recently, N. Nibbelink, M. Ben-David (University of Wyoming), and G. M. Blundell (University of Alaska), developed a quantitative spatial model to evaluate the potential of natural recolonization of the Grand Canyon by river otters that may disperse from the upper Colorado River. The model is based on rates of dispersal, dispersal distances, and gender differences in dispersal patterns derived from DNA data collected from river otters inhabiting coastal environments in Prince William Sound, Alaska (Blundell et al., 2002). The model, using GIS coverages and individual-based rules is designed to provide the probability and time span of natural recolonization of the Grand Canyon. The basic model will be applied to different scenarios based on information provided by Melquist and Hornocker (1983) for otters inhabiting freshwater systems as well as permutations based on barriers to dispersal such as habitat quality and human disturbance.

The quantitative spatial model is based on the assumption that the source population of river otters inhabits the upper reaches of the Colorado River. Dr. J. K. Berg conducted surveys of river otters in the upper Colorado River between 1992-1997 (Berg 1999) and determined that the region was at carrying capacity and that successful reproduction was occurring. Because the spatial model assumes continuous reproduction and dispersal from the source population, it is important to establish that the trends in population levels of river otters in the Rocky Mountain National Park (RMNP) observed by Berg (1999) have not changed.

In this project, we initiated population surveys of river otters in the RMNP with the assistance of the Wyoming Student Chapter of the Wildlife Society. The goals of the surveys were to identify river otter latrine sites along the upper reaches of the Colorado

River, monitor scat deposition as an index of population size, and evaluate seasonal changes in latrine use to determine the preferred sampling period.

METHODS

Sampling design

Riverbank was surveyed for latrine sites upstream and downstream of Timber Creek Campground. Surveys were conducted by multiple observers from the Student Chapters of the Wildlife Society at the University of Wyoming and Colorado State University. Teams were led by experts and all participants were trained prior to the survey. Surveys were conducted in two sampling periods over three years, spring (April 28-29, 2001; May 4-5, 2002; May 4-5, 2003) and fall (September 22-23, 2001; September 21-22, 2002; September 20-21, 2003). Total stream length surveyed in Spring 2001 was 7.41 km and 8.49 km were surveyed in fall 2001. During the spring and fall surveys of 2002, 20.0 km of river were surveyed. Because of deep snow conditions spring surveys in 2003 covered 10.5 km. In fall 2003, 18.0 km of river were surveyed.

In 2002, surveyors also sampled random sites. Random sites were systematically selected at the location of the survey group every hour on the hour. This systematic sampling began at the start of each survey period. We resorted to this sampling scheme because it was impossible to a priori select sites randomly because of error associated with converting GIS points to GPS locations (i.e., pre-chosen sites would often be located away from the river). In cases where random sites were identified as latrine sites, the site was characterized as a latrine (McDonald 2003) and the next random site was recorded an hour later.

Data collection

Latrine sites of otters were identified by trails entering the water, tracks, and feces. The location of each site was determined using handheld GPS units and recorded. Each site was then characterized with respect to topography, composition of terrestrial vegetation, composition of river substrate, and presence of feces. Vegetation and river substrate were assessed for a 10-m arc with its pivotal point at the highest concentration of otter sign (Bowyer et al. 1995, 2003). We estimated relative cover of vegetation visually. Cover was estimated for both the overstory and understory. Classes for the overstory included spruce, poplar/aspen, alder, pine, and other. The understory was classified into brush, ferns and forbs, moss, and other. Cover of more abundant vegetation types were assigned ranks of 1 to 5 (1=0-20%, 2=20-40%, 3=40-60%, 4=60-80% 5=80-100%). We used the same method to categorize river substrates into the classes sand, gravel, cobbles, small rocks, and large rocks (Bowyer et al. 1995, 2003). Stream shading was also visually estimated in the same 10-m arc. We measured vegetated slopes to the nearest 5°, with a clinometer. Aspect of the site was recorded in eight compass directions (Bowyer et al. 1995, 2003). The distance of each site to water was measured and the number of feces and fresh feces recorded.

Data analysis

Locations of otter latrine sites were plotted on a digital map of RMNP with ArcView 3.2 (Redlands, CA; Figure 1). Length of stream surveyed was calculated by measuring distances between all sample locations using ArcView.

We employed step-wise logistic regression (SPSS for Windows 7.0, Hosmer and Lemeshow 1989) to develop a model that best separated latrine and random sites. To

ensure we could pool data from the different seasons and years, we again used logistic regression. In all analyses we controlled for multicollinearity by eliminating one of any pair of variables with $r > |0.3|$. We ensured that the data did not depart from a logistic-regression model with a Hosmer-Lemeshow goodness-of-fit test. The best model was selected based on AICc scores, model goodness of fit, and correct assignment of sites (Meyer et al. *in review*). Selection for (use > availability) or against (use < availability) habitat variables was determined from the sign of the regression coefficient (Hosmer and Lemeshow 1989).

RESULTS

The 2001 field season yielded 18 (2.4 sites/km of river) and 12 (1.4 sites/km) latrine sites for spring and fall respectively. In spring and fall of 2002, 46 (2.3 sites/km of river) and 12 (0.6 sites/km of river) latrine sites were identified, respectively (Fig. 1). In spring 2003, we identified 13 latrines (1.24 sites/km of river). In addition, because snow conditions were perfect for tracking we were able to positively identify 17 slides, runs, and tracks. Therefore, the total density of otter sites per km of river was 2.86. Tracks indicated that at least 4 and possibly 6 animals inhabited the survey area at the time of our survey. At least one otter was observed and photographed during that time. In contrast, in fall 2003 we identified only 2 latrines and 2 sites with tracks for a density of 0.11 latrine sites per km and 0.22 total sites per km of river. While spring densities of latrines were comparable in all years, the fall densities were considerably lower (43%) in 2002 and dramatically lower (16%) in 2003.

The number of feces per site, a measure of otter activity, declined through time and between spring and fall in all years (ANOVA, $p = 0.014$; Fig. 2). In Spring 2001, 2002, and 2003 we collected a total of 1, 7, and 41 fresh feces for DNA analysis respectively. In Fall 2001, 2002, and 2003 we collected a total of 2, 2, and 0 fresh feces respectively.

The distribution of latrines in fall 2002 changed from the distribution in fall 2001 and spring 2002. In fall 2002, latrines were concentrated in the upper reaches of the river in an area of dense beaver ponds and also at the lower reaches of the river (Fig. 1). In contrast, in fall 2001 and spring 2001 and 2002 latrines were more evenly distributed along the stream (Fig 1). In 2003, sites were evenly distributed in spring but in fall all 4 sites were found between Timber Creek Campground and Never Summer Ranch.

Models comparing differences in seasonal habitat use differed greatly between 2001 and 2002. Because of snow conditions in spring that obscured habitat features and the low number of sites in fall we did not include data from that year in our analyses. The 2001 logistic-regression model identified brush, cobbles, and stream shading as the variables most significant in discriminating between latrine sites used in spring and fall (90% correct classification; Table 1; Fig.3). In contrast, the 2002 logistic-regression model identified width and slope as the significant variables correctly identifying 87.72% of all locations to their proper affiliation (Table 1; Fig. 4).

Comparison of habitat variables of latrines for the same season between years revealed additional differences. When spring sites were compared alder, gravel, and spruce were the variables best discriminating between 2001 and 2002 with the model correctly identifying 85.94% of all locations to their proper affiliation (Table 1; Fig 5).

The fall model, in turn, identified brush and sand as the variables best discriminating between years (correct classification of 69.57% of all locations; Table 1; Fig. 6). Results from this model, however, should be interpreted with caution due to small sample sizes (12 sites each year). Close examination of the spring and fall models suggests that there was no real difference in latrine characteristics between the 2 years. In 2002, surveys extended to the lower reaches of the Colorado River (Fig. 1). Those lower reaches were characterized by reduced cover of spruce and higher densities of alder, brush, and open meadows. Stream substrate also decreased in size in the lower reaches from gravel to sand. Thus, alder and brush as well as sand and gravel, those variables that appeared in both models, can be considered interchangeable variables.

Because of the seasonal and annual differences in latrine characteristics, we were unable to pool data and explored latrine site selection separately for each season and year. When random sites ($n = 70$) were compared to latrine sites, river otters appeared to select sites with alder, brush, grass, gravel, sand, and spruce in greater amounts than their availability for both 2001 and 2002 (Table 1; Figs. 5 & 6). During 2002, river otters appeared to use sites with the variables alder, brush, and sand in a higher proportion than in 2001. Spruce was the only variable, which river otters consistently selected for in all seasons and years (Table 1).

DISCUSSION

Our data indicated that use of latrines and latrine site selection by river otters in RMNP changed both seasonally and annually. A sharp decline in number of latrines per km of stream and the reduction in number of feces per site occurred in all years,

suggesting that otter behavior changes seasonally. Such seasonal change, possibly related to the waning of the breeding season has been documented in other studies (Humphrey and Zinn 1982, Kruuk 1992). Nonetheless, the annual decline in both density of latrines in fall as well as in number of feces per site in both spring and fall, suggests that other factors may affect the abundance and behavior of river otters in Rocky Mountain national Park.

A possible explanation for the decline in latrine use as well as for the change in latrine site characteristics we observed in fall 2002 could be related to the hydrology of the Colorado River (Table 2). Water levels during the fall 2002 survey were the second lowest ever recorded since 1953 at that site (lowest mean stream flow in September was recorded in 1956 at 0.33 m³/sec; Table 2, http://waterdata.usgs.gov/co/nwis/monthly/?site_no=09010500). Similarly, the low density of latrines in fall 2003, may be related to a flood event that washed many beaver dams earlier in the summer (T. Johnston and M. Daniel, Pers. comm.).

That otter activity and potentially even seasonal abundance may be affected by the hydrology of the Colorado River is also evident from results of the seasonal site selection models. Because fish distributions are affected by stream hydrology it is likely that river otters chose sites according to the distribution of fish; the most prevalent prey species in their diet (Berg, 1999). Other studies identified prey availability as one of the most important factors regulating otter behavior and habitat use (Melquist and Hornocker 1983, Kruuk et. al 1993, Reid et al. 1994, Ruiz-Olmo et al. 2001). In RMNP, higher stream shading in fall and predominance of cobbles correspond with colder water temperatures and escape cover for trout (*Oncorhynchus* spp; Grost et al. 1990, Meyer and Griffith 1997, Young et al. 1999). That these variables best separated spring and fall

sites in 2001, suggests that otters changed the location of latrines in relation to the seasonal change in trout distribution.

Similarly, the variables best discriminating seasonal differences between latrine sites for the 2002 model (width and slope) most likely reflect the change in distribution of fishes due to reduced water flow in the Colorado River (Table 2). Overall the river was much narrower in fall 2002 than spring 2002 probably forcing fish into deep pools (Binns 1994). This change in fish distribution likely elicited change in use of latrine sites by river otters as was seen in Eurasian otters (*Lutra lutra*) inhabiting drought prone areas in the Iberian Peninsula (Ruiz-Olmo et al. 2001). In 2002, latrine sites in RMNP were characterized by steep banks that are usually associated with deep in-channel pools (Fig. 4). Such pools have previously been documented as important features for identifying otter activity sites (Swimley et al. 1998, Ruiz-Olmo et al. 2001).

That latrines in fall 2002 were located in an area of dense beaver ponds and also at lower reaches of the river, further supports our conclusion that otter activity was concentrated around deep pools. Beaver ponds provide an abundant supply of prey for river otters, stable water levels important during times of drought, escape cover, den sites, and refuge from human disturbance (Newman and Griffin 1994). In fact, Newman and Griffin (1994) found river otters visited beaver ponds much more frequently than man-made impoundments. As for denning, Melquist and Hornocker (1983) found that old beaver dens made up to 32% of all river otter den sites in Idaho. Therefore, it is likely that the destruction of beaver dams and ponds by the flood in summer 2003 was the cause for the low number of sites we observed in fall as well as the alarming low number of feces per site.

Although the distribution of prey may be a key component in habitat selection of river otters, previous studies documented the reliance of otters on riparian vegetation for cover (Melquist and Hornocker 1983, Swimley et al. 1998). In RMNP, the only variable consistently selected for by river otters in all seasons and years was high cover of spruce. This finding coincides with that of Swimley et al. (1998) who also identified conifers as an important feature for identifying otter latrine sites. Bowyer et al. (1995) postulated that the complex root systems of large conifers provided otters with denning sites as well as escape cover. In addition, such root systems may provide thermoregulatory refuge, especially on hot summer days.

Despite the seemingly high reliance of otters on cover provided by conifers (Bowyer et al. 1995, 2003; Swimley et al. 1998), otters have been observed along streams without such cover (Boyd and Ben-David 2002). It is possible that in such habitats other forms of cover, such as dense brush or beaver lodges compensate for the lack of conifers. We hypothesized that the occurrence of dense understory at river otter latrines during spring 2001 was related to protection from predators (Ben-David et al. 2002). During fall understory brush is covered in leaves, which are absent during the spring. Thus otters may require a denser understory in the spring to compensate for lack of leaves in order to obtain higher safety from predators.

Selection of understory by otters in both 2001 and 2002, however, was not consistent between seasons. We believe that this variability was an artifact of the difference in the length of stream surveyed and may again be related to lower water levels of the Colorado River in fall 2002. In 2002, we surveyed an additional 10 - 12 km of the lower reaches of the river, those same reaches that were heavily used by otters

during that fall because they harbored large pools. Brush and sand, the variables that best discriminated between fall 2001 and 2002, were more prevalent on the lower reaches of the river and associated with deep pools.

Our observations suggest that otter activity and seasonal abundance may be related to the hydrology of the Colorado River. If true, then occasional failure to detect otter sign should not be interpreted as localized extinction. Nonetheless, because of the high sensitivity of otters to environmental disturbance, monitoring should be continued on a regular bases. A winter survey scheduled for the end of February 2004 as well as continued surveys by the University of Wyoming Student Chapter of the Wildlife Society should provide insights into temporal changes in the abundance of otters in Rocky Mountain National Park.

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Table 1. Results of logistic regression models exploring seasonal and annual changes in latrine site selection of river otters in Rocky Mountain National Park, Colorado, USA in 2001 and 2002.

Model	Variable	Correct classification		p-value
2002 between seasons		41.7%	100%	
	Stream slope			0.031
	Stream width			0.061
2001 between seasons		75%	100%	
	Brush			0.014
	Cobbles			0.022
	Stream shading			0.06
Spring 2001 and 2002		91.3%	72.2%	
	Alder			0.03
	Gravel			0.0001
	Spruce			0.01
Fall 2001 and 2002		63.6%	75%	
	Brush			0.035
	Sand			0.08
Random and used Spring 2002		76.9%	60.9%	
	Grass			0.002
	Gravel			0.082
	Spruce			0.023
Random and used Fall 2002		100%	27.3%	
	Alder			0.082
	Brush			0.056
	Sand			0.1
	Spruce			0.037
Random and used Spring 2001		95.4%	66.7%	
	Alder			0.022
	Grass			0.018
	Gravel			0.0013
	Spruce			0.003
Random and used Fall 2001		98.6%	50.0%	
	Brush			0.035
	Spruce			0.0002

Table 2. Water flow Colorado River in m³/s as measured at Grand County, Colorado (Hydrologic Unit Code 14010001; Latitude 40°19'33", Longitude 105°51'22" NAD27; Drainage area 138.3 km²; Gage datum 2,667 meters above sea level). Adapted from data published at http://waterdata.usgs.gov/co/nwis/monthly/?site_no=09010500.

Year	Monthly mean stream flow, in m ³ /s	
	April	September
2001	0.71	0.56
2002	0.84	0.36
Overall (1953 - 2002)	0.78	0.77

Figure legends -

Figure 1. Location map for river otter activity sites in spring 2001 and 2002, in Rocky Mountain National Park, Colorado, USA.

Figure 2. Number of feces per site (mean $\pm$ SE) counted at river otter activity sites in RMNP spring and fall 2001, 2002, and 2003.

Figure 3. Values (mean $\pm$ SE) of habitat variables identified by logistic regression as best separating river otter activity sites between spring ($n = 18$) and fall ($n = 12$) in 2001 in RMNP (Table 1).

Figure 4. Values (mean $\pm$ SE) of habitat variables identified by logistic regression as best separating river otter activity sites between spring ($n = 46$) and fall ($n = 12$) in 2002 in RMNP (Table 1).

Figure 5. Values (mean $\pm$ SE) of habitat variables identified by logistic regression as best separating river otter activity sites in spring 2001 and 2002 and random sites in RMNP (Table 1).

Figure 6. Values (mean $\pm$ SE) of habitat variables identified by logistic regression as best separating river otter activity sites in fall 2001 and 2002 and random sites in RMNP (Table 1).

Figure 1.

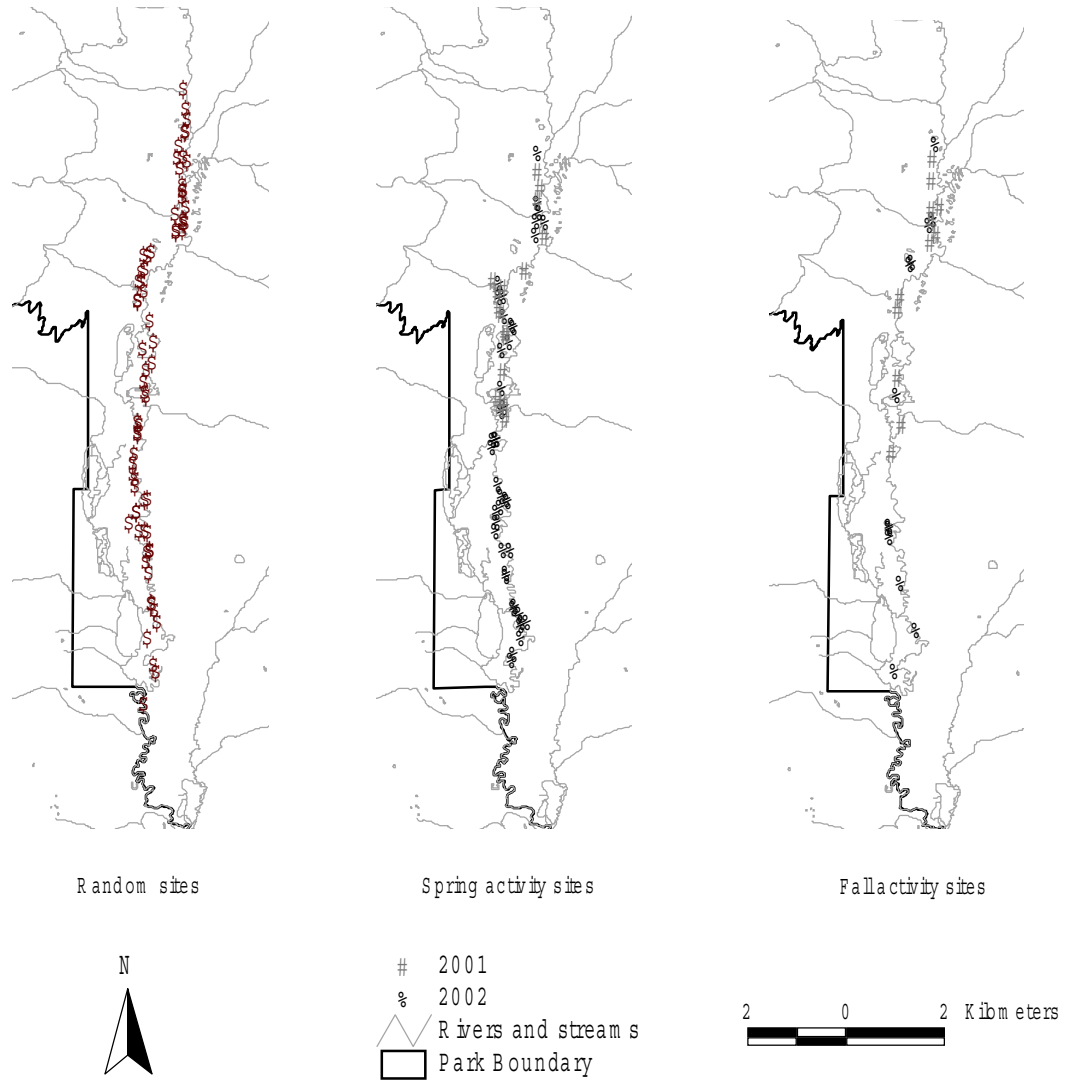


Figure 2.

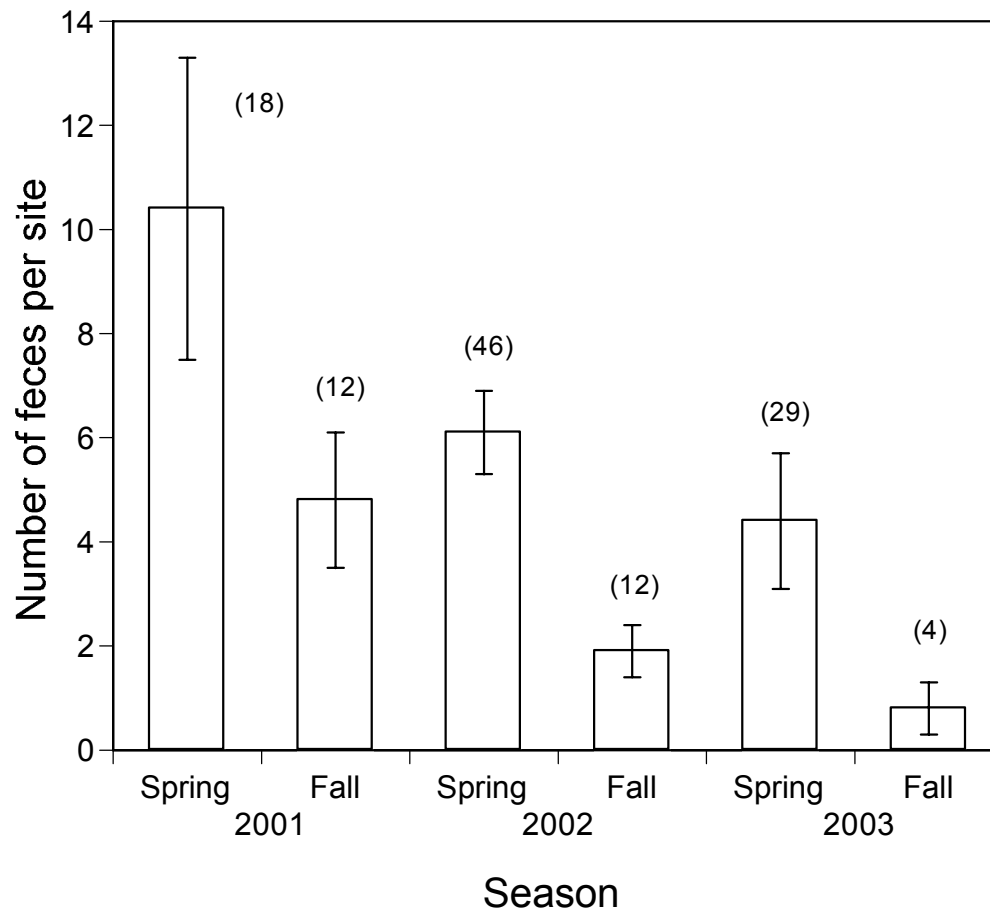


Figure 3.

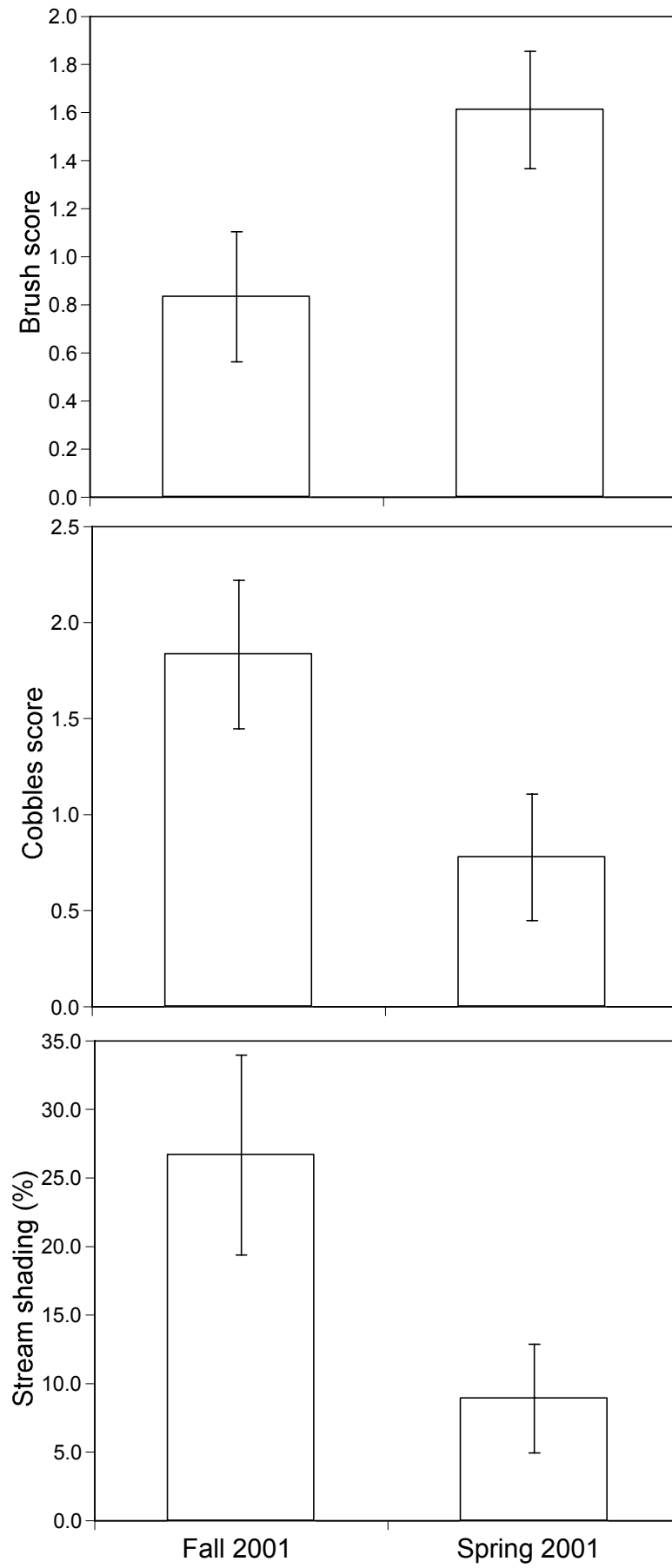


Figure 4.

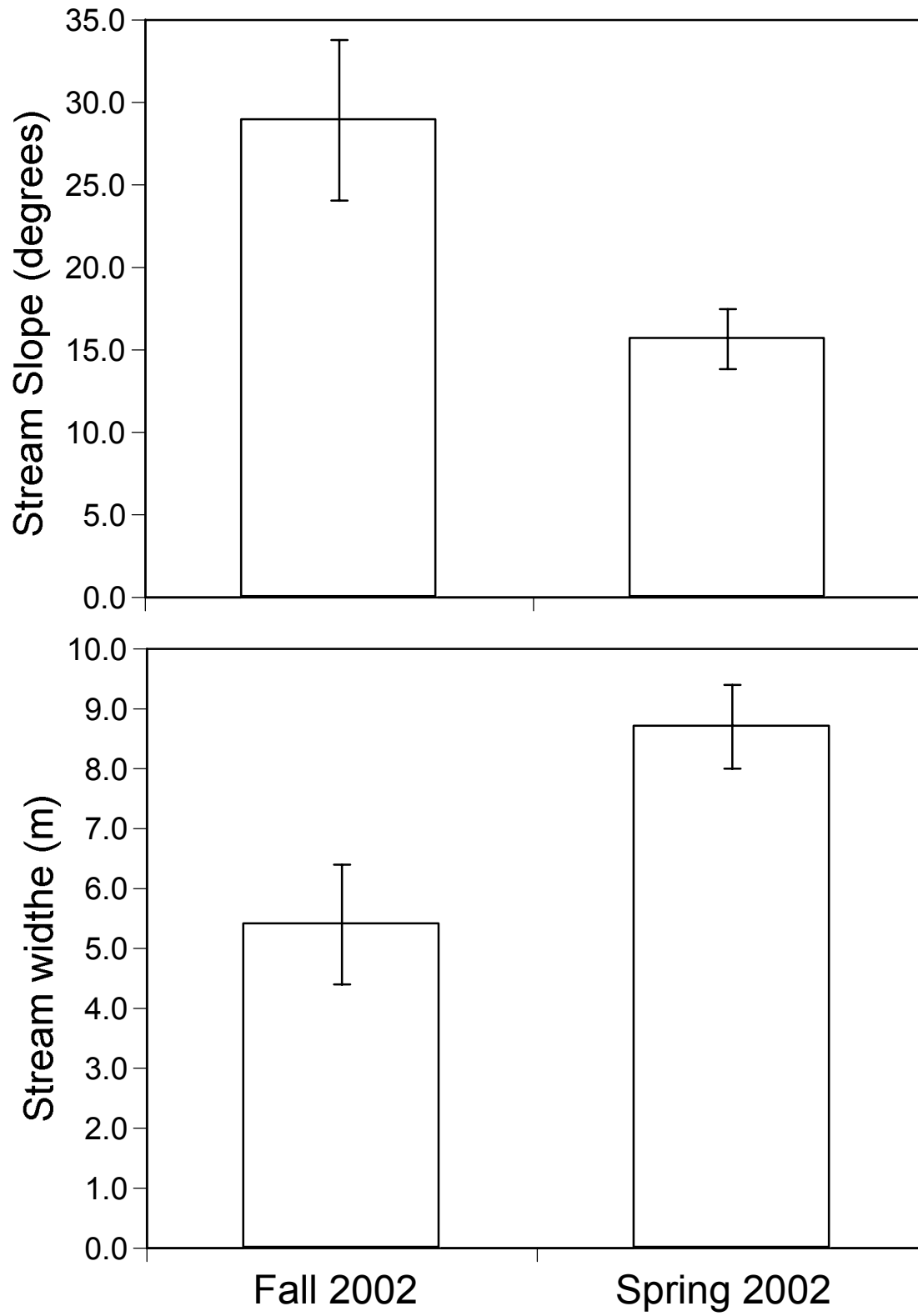


Figure 5.

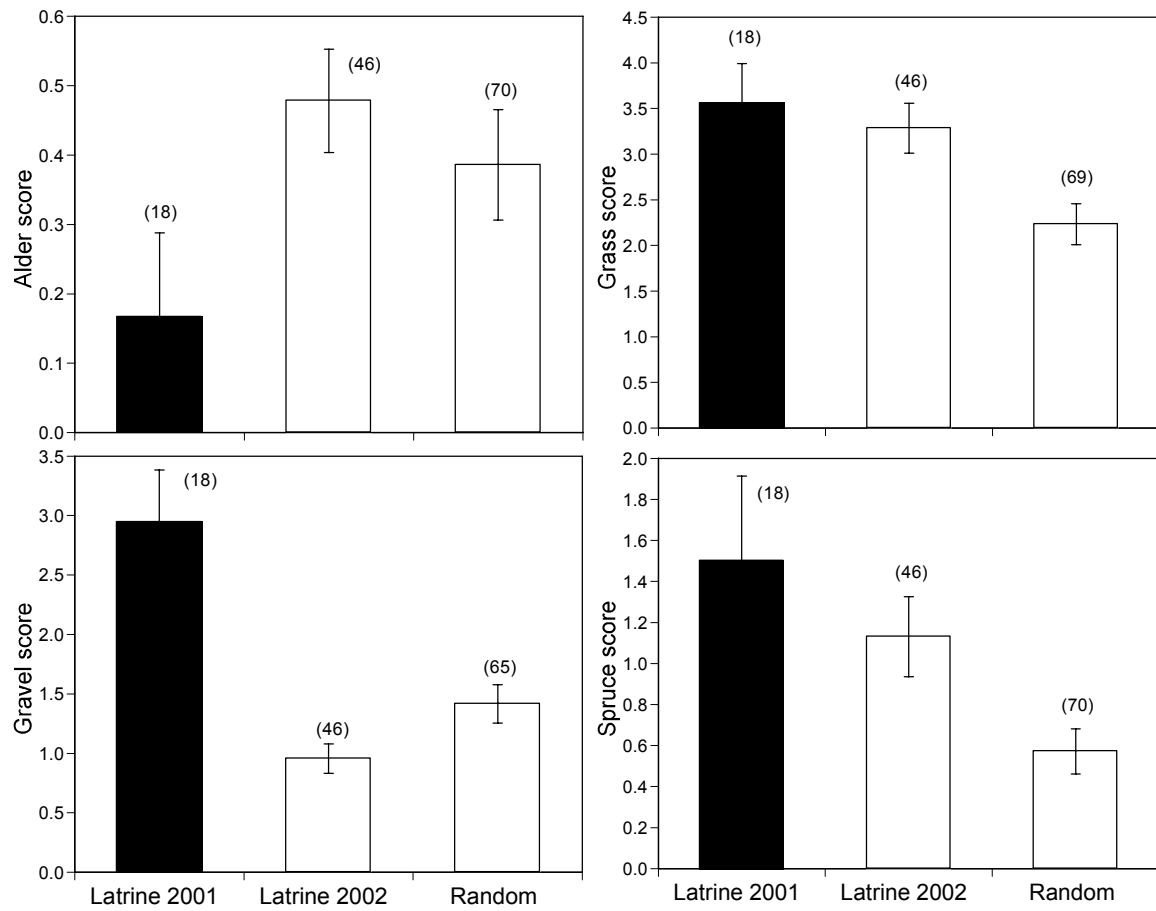


Figure 6.

