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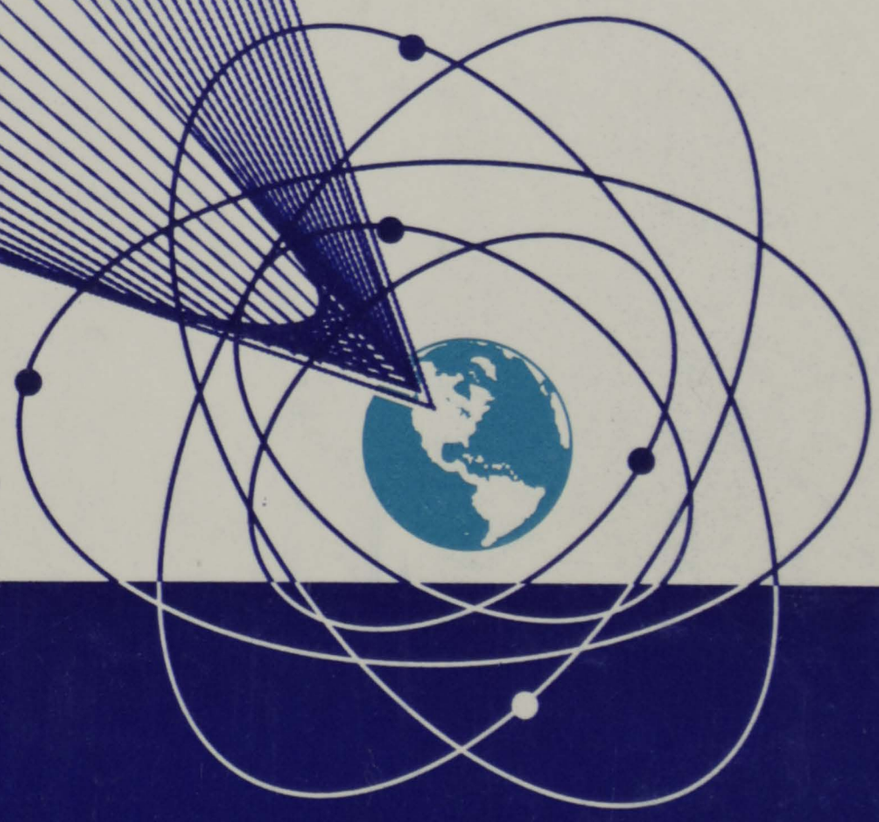

Intermountain Journal of Sciences

The Intermountain Journal of Sciences is a regional peer-reviewed journal that encourages scientists, educators and students to submit their research, management applications or view-points concerning the sciences applicable to the intermountain region. Original manuscripts dealing with biological, environmental engineering, mathematical, molecular-cellular, pharmaceutical, physical and social sciences are welcome.

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Intermountain Journal of Sciences

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Submitted by Kenneth L. Hamlin, BusinessManager - IJS

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The *Intermountain Journal of Sciences* (IJS) is a fully refereed journal.

Manuscripts are submitted to the Editor-in-Chief (EIC) for initial consideration for publication in the IJS. This review shall include, but not be limited to, appropriateness for publication in this journal, correct formatting, and inclusion of a letter of submittal by the author with information about the manuscript as stated in the "Guidelines for manuscripts submitted to the *Intermountain Journal of Sciences*" (Dusek 1995). This cover letter must also include a statement by the author that this paper has not been submitted for publication or published elsewhere. The EIC notes the date of receipt of the manuscript and assigns it a reference number, IJS-xxxx. The EIC forwards a letter of manuscript receipt and the reference number to the corresponding author. The corresponding author is the author who signed the submittal letter.

Three hard copies of the submitted manuscript, with copies of the "Guidelines and checklist for IJS referees" attached are forwarded to the appropriate Associate Editor. The Associate Editor retains one coy of the manuscript and guidelines for his/her review, and submits a similar package to each of two other reviewers. A minimum of two reviewers, including the Associate Editor, is required for each manuscript. The two other reviewers are instructed to return the manuscript and their comments to the Associate Editor, who completes and returns to the EIC a blue "Cover Form" and all manuscripts and reviewer comments plus a recommendation for publication, with or without revisions, or rejection of the manuscript. This initial review process is limited to 30 days.

The EIC reviews the recommendation and all comments. The EIC then notifies the corresponding author of the results of the review and the publication decision.

Acceptance

For accepted manuscripts, each copy of the manuscript containing comments thereon and other comments are returned to the corresponding author. Revised manuscripts are to be returned to the EIC in hard copy, four copies if further review is required, or one hard copy plus the computer disk if only minor revision or formatting is necessary. The revised manuscript shall be returned to the EIC within 14 days of the notification. Review of the revised manuscript by the Associate Editor and reviewers shall be completed and returned to the EIC within 14 days. An accepted manuscript will then be forwarded to the Managing Editor (ME) for final processing.

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Each manuscript that is rejected for publication is returned by the EIC to the corresponding author along with the reasons for rejection. The author is also advised that the manuscript may be resubmitted, provided all major criticisms and comments have been addressed in the new manuscript. The new manuscript may be returned to the initial review process if deemed appropriate by the EIC. If the manuscript is rejected a second time by either the EIC or the Associate Editor and reviewers, no further consideration will

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The identity of all reviewers shall remain anonymous to the authors, called a blind review process. All criticisms or comments by authors shall be directed to the EIC; they may be referred to the ME or the Editorial Board by the EIC for resolution.

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Each manuscript submitted by an Associate Editor shall be reviewed by the EIC and a minimum of two other reviewers with expertise in the subject being addressed. Each manuscript submitted by the EIC shall be forwarded with the necessary review materials to the Chairman of the Editorial Board of IJS, who will serve as the EIC for that manuscript.

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Only abstracts from the annual meetings of the sponsoring organizations will be published in IJS. Other submissions of abstracts shall be considered on a case-by-case basis by the Editorial Board. Sponsoring organizations shall collect abstracts, review them for subject accuracy, key or scan them onto a 3.5" diskette, and submit the diskette and hard copy of each abstract to the EIC on or before November 1. Each abstract shall be reviewed by the EIC to assure proper grammar, compliance with IJS "Guidelines for Abstracts Only" and for assignment to the appropriate discipline section. All abstracts will be published in the December issue only.

Commentary

Submissions concerning management applications or viewpoints concerning current scientific or social issues of interest to the Intermountain region will be considered for publication in the "Commentary" Section. This section will feature concise, well-written manuscripts limited to 1,500 words. Commentaries will be limited to one per issue.

Submissions will be peer reviewed and page charges will be calculated at the same rate as for regular articles.

Literature Cited

Dusek, Gary L. 1995. Guidelines for manuscripts submitted to the *Intermountain Journal of Sciences*. Int. J. Sci. 1(1):61-70.

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Mammal Use of Shortgrass Prairie and Associated Riparian Habitat in Wyoming

Abstract

Small mammal habitat relations were investigated in shortgrass prairie and riparian plant associations in southeast Wyoming in 1994 and 1995. Capture of sagebrush voles (Lemmiscus curtatus), *western harvest mice* (Reithrodontomys megalotis), *and deer mice* (Peromyscus maniculatus) *were associated with short cover or larger amounts of bare ground, habitat typical of upland areas of shortgrass prairie. Capture of prairie voles* (Microtus ochrogaster) *and dwarf shrews* (Sorex nanus) *were associated with tall cover, little bare ground, and short distances to water, habitat typical of riparian areas. Our results show what habitat features are associated with capture of individual species in a shortgrass prairie ecosystem.*

Key words: small mammals, sagebrush voles, western harvest mice, deer mice, prairie voles, dwarf shrews

Introduction

Numerous studies have investigated habitat use by small mammals in different habitats (Belk *et al.* 1988, Stroh and Fleharty 1988, Douglass 1989, Fa *et al.* 1990), but few studies have focused on high-plains shortgrass prairie (Ribble and Samson 1987). Specific information on habitat associations of the sagebrush vole (*Lemmiscus curtatus*) (Carroll and Genoways 1980) and the dwarf shrew (*Sorex nanus*) is limited. We describe habitat components of small mammals on a shortgrass prairie and associated riparian areas in southeastern Wyoming. Specific objectives were to: (1) describe relative abundance of small mammals in shortgrass prairie and riparian areas, and (2) show habitat preference by abundant small mammal species within each habitat type.

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Study Area

F. E. Warren Air Force Base is 2,375 ha in area with elevation ranging from 1,851 to 1,943 m above sea level. Mean annual precipitation is 34 cm (Martner 1986). The base was established as a cavalry fort in 1867 and has been in use by the military since. It presently serves as a support base for underground missile sites. A fish and wildlife management and habitat improvement program has been in practice since the 1950's.

Several plant associations occur on the base, but shortgrass prairie dominates. Uplands consist of rolling hills with a few small rock outcrops on slopes. Snow accumulates in the small valleys between the rolling hills and, depending on soils, some of these areas have small accumulations of moisture during the spring. Vegetation consists of short grasses, including buffalo grass *(Buchloe dactyloides)* and blue grama

(Bouteloua gracilis), and low-growing forb , such as Virginia creeper *(Phlox muscoides)*, with interspersed patches of bare ground (Knight 1994).

Crow Creek, a small perennial stream, and Diamond Creek, an intermittent stream, flow through the southern portion of the base. Due to the semi-arid climate, riparian corridors are narrow and have been substantially reduced along portions of Crow Creek by mowing and herbicide application, but these practices were halted in 1989. Currently, riparian vegetation is re-establishing along both creeks with stands of young willows (*Salix* spp.) along the majority of Crow Creek and some sections of Diamond Creek. Beaver *(Castor canadensis)* ponds in the upper portion of Crow Creek contribute to willow reestablishment. Riparian areas consisting of willows and other shrubs are interspersed with wet meadows. A few patches of bare ground in riparian habitat are often a result of human activity.

Methods

Small mammals were captured using Sherman live traps (7 x 9 x 23 cm) baited with cracked oats. Traps were placed 30 paces apart in a grid pattern. Trap grids ranged from 2 x 8 to 8 x 8 matrices, depending on the area being trapped. Trapping grids were systematically selected by random numbers from sites of appropriate size to avoid interference with military activities. Twenty grids, nine in the shortgrass prairie habitat and 11 in the riparian habitat, were trapped between 11 May and 5 July 1994, and six grids, two prairie and four riparian, were trapped between 4 and 12 August 1994. Trapping occurred on 20 grids, 14 in riparian habitat and six in shortgrass prairie, between 17 May and 25 June 1995.

Traps were opened in the evening then checked and closed the following morning before 0900 hours over four consecutive nights. Species, sex, and location were recorded for each captured animal. Animals were marked by toe clipping to determine if they were recaptured. Habitat variables were measured in 0.01-ha plots established around those locations. When habitat sampling was completed at 20 plots around capture locations of a species within a habitat type, every other capture location for that species was measured up to 30 captures. Habitat variables were measured at 10 plots located diagonally across each grid at 20 pace intervals. We started at the corner of each and proceeded 20 paces toward the opposite diagonal corner. Our trapping scheme and habitat sampling were assumed to be representative of the area.

At all plots, a 2x5 dm Daubenmire frame (Daubenmire 1959) was used to measure the proportions of bare ground, ground cover of grass-like vegetation, and cover of forbs at the center of each capture and each available plot. A Robel pole (Wight 1938) was used to measure mean height of cover at the center of each site. A single pole with marks at 10-cm intervals was used and heights were recorded at each of the cardinal directions at the edge of each 0.01-ha plot. The height of the 10-cm interval that was completely obscured by vegetation was recorded. These four readings were used to determine mean cover height for the 0.01-ha plot. The point-quarter method (Cottam and Curtis 1956) was used to determine the minimum distances to a road, building, tree, shrub, water, log, rock greater than 30 cm in diameter, and patch of bare ground greater than 30 cm in diameter in each of the four quarters. These values were averaged for each 0.01-ha plot. The maximum distance measured was 10 m because features over 10 m away probably would not influence use of a particular site by small mammals.

Habitat plots, sampled in 1994 and 1995, were compared using paired *t*-tests

to determine if data could be pooled. Several variables differed significantly between years, so separate analyses were performed for each year. Using available habitat plots, *t*-tests determined if differences existed between the habitat types. Sites where small mammals were trapped were compared with available habitat plots using *t*-tests.

An index of relative abundance (number of animals captured per trap night) was computed for each grid. Simple correlations were performed between relative abundances and means of the available habitat variables. Mean relative abundance values were figured for each habitat type. Because we observed no significant differences in captures per trap night between early and late trapping in 1994 using paired *t*-tests, we pooled data from both sampling periods. Differences in captures per trap night between habitat types were tested using *t*-tests. Alpha for all tests was set at $P < 0.05$. All statistical analyses were performed with SPSS version 4.0.1 (SPSS-PC 1990).

Results

In 1994, the means of percent bare ground, ground covered by grass, and forbs as well as mean cover height, differed between habitat types. Bare ground, grass cover and cover height also differed in 1995. In addition, distance to downed logs and distance to bare ground differed between used and available plots, but forb cover did not differ (Table 1).

During the two field seasons, 9,460 trap nights yielded 569 animals captured among 12 species (Elliott 1996). The four most abundant species were western harvest mice, deer mice, prairie voles, and sagebrush voles (Table 2). Stream-side riparian habitat consistently yielded the higher numbers of species, six in 1994 and nine in 1995, while shortgrass prairie yielded lower numbers of species (six in both years).

Table 1a. *Means of 12 habitat variables compared between habitat types (prairie and stream), 1994.*

	Means	
Variable[1]	Prairie (n=9)	Stream (n=11)
OPGR%	28.00[a]	20.80[a]
CVRGR%	48.95[a]	65.77[a]
CVRFBS%	23.47[a]	13.35[a]
CVRHGTAV	2.91[a]	7.65[a]
DROADAV	1100.00	1078.11
DBUILDAV	1100.00	1100.00
DTREEAV	1100.00	1001.34
DSHRBAV	1100.00	1001.87
DWTRAV	1100.00	1063.14
DDLAV	1100.00	1026.95
DRCKAV	1088.47	1076.21
DOPGRAV	740.10	782.99

Table 1b. *Means of 11 habitat variables compared between habitat types (prairie and stream), 1995.*

	Means	
Variable[1]	Prairie (n=6)	Stream (n=14)
OPGR%	46.13[a]	34.29[a]
CVRGR%	29.58[a]	45.54[a]
CVRFBS%	24.28	19.64
CVRHGTAV	4.47[a]	24.27[a]
DROADAV	1100.00	1090.37
DTREEAV	1100.00	931.02
DSHRBAV	1100.00	797.43
DWTRAV	1100.00	921.15
DDLAV	1099.41[a]	1039.66[a]
DRCKAV	1100.00	1088.3
DOPGRAV	821.14[a]	714.00[a]

[a] denotes pairs of habitat types with significant difference in means at $P < 0.05$

[1] OPGR% = percent bare ground, CVRGR% = percent cover by grasses, CVRFBS% = percent cover by forbs, CVRHGTAV = mean cover height, DROADAV = mean minimum distance to a road, DBUILDAV = mean minimum distance to a building, DTREEAV = mean minimum distance to a tree, DSHRBAV = mean minimum distance to a shrub, DWTRAV = mean minimum distance to water, DDLAV = mean minimum distance to a down log, DRCKAV = mean minimum distance to a rock, and DOPGRAV = mean minimum distance to bare ground.

Table 2. *Total captures, mean captures per 100 trap nights and standard deviation in parenthesis of small mammals captured in prairie and riparian habitats in 1994 and 1995.*

	1994		1995	
Species	Prairie	Riparian	Prairie	Riparian
(Total Captures)	(3072)	(2812)	(1472)	(2104)
Dwarf Shrew	0	4 (0.18 ± 0.34)	0	3 (0.20 ± 0.41)
13-Lined Ground Squirrel	9 (0.27 ± 0.38)	6 (0.11 ± 0.35)	4 (0.33 ± 0.63)	2 (0.07 ± 0.28)
Wyoming Ground Squirrel	3 (0.05 ± 0.10)	0	2 (0.13 ± 0.20)	0
Plains Pocket Gopher	0	0	0	1 (0.05 ± 0.19)
Olive-backed Pocket Mouse	9 (0.24 ± 0.39)	0	0	0
Western Harvest Mouse	0	13 (0.50 ± 0.65)	0	18 (1.01 ± 0.95)
Plains Harvest Mouse	0	0	0	9 (0.44 ± 1.67)
Prairie Vole	0	41 (1.23 ± 1.11)	2 (0.13 ± 0.32)	30 (1.87 ± 1.80)
Sagebrush Vole	33 (1.07 ± 0.74)	1 (0.02 ± 0.08)	5 (0.35 ± 0.39)	2 (0.08 ± 0.20)
Deer Mouse	228 (1.75 ± 1.90)	55 (1.82 ± 1.79)	15 (1.09 ± 0.86)	93 (4.83 ± 6.24)
Northern Grasshopper Mouse	5 (0.09 ± 0.17)	0	2 (0.13 ± 0.24)	0
Meadow Jumping Mouse	0	0	0	4 (0.19 ± 0.51)

Western harvest mice were found only in the riparian habitat in both 1994 and 1995 (Table 2), and their numbers were relatively similar (13 and 18) during both years. In riparian habitat, Western harvest mice were captured in plots that had significantly more bare ground and were further from shrubs and water than available habitat plots.

Deer mice were the most abundant mammal captured in both 1994 and 1995 in both prairie and riparian habitats. Their captures were much higher in 1994 (228 total in the prairie habitat) than in 1995 (15) (Table 2).

In 1994, deer mice were captured in plots of prairie habitat with significantly less grass cover than observed among plots describing available habitat. In 1995, deer mice were captured in prairie habitat with significantly shorter cover than was observed in available plots (Table 3).

Prairie voles were found primarily in riparian habitat (Table 2) and significantly further from roads, logs, and bare ground than was available. They were also found in plots that were significantly further from bare ground and closer to woody vegetation (trees and shrubs) than was observed among plots in available habitat (Table 3).

In 1995, prairie vole captures in riparian habitat were negatively correlated with distance to trees (r = - 0.90), shrubs (r = -91), and water (r = - 0.80), and were positively correlated with percentage forb cover (r = 0.65), distance to bare ground (r = 0.67) and cover height (r = 0.57).

The relative abundance of sagebrush vole in prairie habitat was positively correlated (r = 0.77) to the percentage of bare ground and negatively correlated (r = -0.71) to cover height whereas prairie voles and dwarf shrews, species typical of wetter habitats, were associated with taller cover and greater distance from bare ground.

Discussion

Shortgrass prairie was the dominant habitat type within the Ba e. This habitat was subject to disturbance from equipment and provided little protection from harsh weather (wind and snow in winter and rain, drought, and hail in summer) or predators, especially raptors. Small mammal occurring on shortgrass prairie are adapted to a harsh environment.

The sagebrush vole was most strongly associated with shortgrass

Table 3. *Comparison of used habitat to available habitat for small mammals by habitat in prairie (P) and riparian (R) habitat in 1994 and 1995. Only relations significant at $P < 0.05$ are included.*

	Western Harvest Mouse				Deer Mouse				Prairie Vole				Sagebrush Vole			
	1994		1995		1994		1995		1994		1995		1994		1995	
Variables[1]	P	R	P	R	P	R	P	R	P	R	P	R	P	R	P	R
OPGR%				+[2]		+		+								
CVRGR%					-[3]											
CVRFBS%																
CVRGHTAV																
DROADAV						+				+						
DTREEAV								+								
DSHRBAV				+				+								
DWTRAV				+				+								
DDLAV										+						
DRCKAV																
DOPGRAV										+		+				

[1] *OPGR% = percent bare ground, CVRGR% = percent cover by grasses, CVRFBS% = percent cover by forbs, CVRHGTAV = mean cover height, DROADAV = mean minimum distance to a road, DTREEAV = mean minimum distance to a tree, DSHRBAV = mean minimum distance to a shrub, DWTRAV = mean minimum distance to water, DDLAV = mean minimum distance to a down log, DRCKAV= mean minimum distance to a rock, and DOPGRAV = mean minimum distance to bare ground*

[2] *+ denotes greater use of a habitat feature than its availability*

[3] *- denotes less use of a habitat feature than its availability*

prairie (Table 2). Others have reported its occurrence in shortgrass prairie (O'Farrell 1972) but it is more associated with sagebrush (Hall 1928, Mullican and Keller 1986). In this study, sagebrush voles were associated with large amounts of bare ground and short cover, demonstrating the variety of habitats in which this species occurs.

Others have recognized deer mice as a generalist species (Maxwell and Brown 1968, Hallett *et al.* 1983, Lemen and Freeman 1986, Olson and Knopf 1988). We captured them in both shortgrass and prairie riparian habitats but their microhabitat associations (shorter cover and shorter distances to bare ground) (Table 3) were more typical of shortgrass prairie than riparian areas (Elliott 1996). The lack of association with tall ground cover was similarly reported by Wywialowski (1987), Foster and Gaines (1991), and Crompton (1994). A generalist strategy may give them a competitive advantage in the highly variable shortgrass prairie habitat, particularly when habitat is subject to disturbance.

Prairie voles have been associated with dense grass areas having little bare ground (Lemen and Freeman 1986, Stokes 1995). We noted an avoidance of bare ground and an association with woody vegetation.

Western harvest mice, which were strongly associated with riparian areas (Table 2), inhabited areas with more bare ground and fewer trees than was generally available within riparian areas. The dependence of western harvest mice on tall grass (Stroh and Fleharty 1988, Heske *et al.* 1994), and avoidance of trees (Ribble and Samson 1987) is well established.

Finally, dwarf shrews had a higher abundance in areas with taller ground

cover and a high proportion of forb cover. Dwarf shrews commonly occur in rocky areas at high elevations (Brown 1967, Thompson 1977) but also occur in wetter habitats at lower elevations (Martin 1971). We found little information on the microhabitat associations of this species, especially at lower elevations.

Overall, species richness (12 species) and composition on the base were similar to those reported in other studies in similar habitats, but the species found in riparian areas differed from those reported from other areas (Table 2). Olson and Knopf (1988) captured only two species (deer mouse and western harvest mouse) in the stream-side riparian zone of the South Platte River, but trapping effort was much lower than in this study. Both species were found on the Base. In another riparian site in a foothills zone, Olson and Knopf (1988) captured five species, including three species (deer mouse, western harvest mouse, and prairie vole) found on the base. Grant and Birney (1979) report five species of small mammals in a shortgrass prairie within the South Platte River drainage, including three (thirteen-lined ground squirrel, deer mouse, and northern grasshopper mouse) found on the base. Maxwell and Brown (1968) captured 12 species in mixed grass habitat of east-central Wyoming including seven species (deer mouse, thirteen-lined ground squirrel, prairie vole, western harvest mouse, plains harvest mouse, olive-backed pocket mouse, and northern grasshopper mouse) found on the base.

Our trapping scheme sampled small mammals at trap sites. We assumed that a capture in a trap represented a preference by the animal for the habitat surrounding the trap. Because this has been shown to be invalid for deer mice (Douglass 1989), we recognize that bias may exist. However, our results did provide some clear patterns, and depending on the bias created by the traps, may reflect true habitat associations.

It appears that the common small mammals within the base were predominantly microhabitat generalists associated with variable features of shortgrass prairie with some species primarily associated with riparian habitat. The adaptable deer mice and sagebrush voles predominated in the shortgrass prairie. The deer mouse was also common in riparian habitat but selected microhabitats that were similar to shortgrass prairie. In riparian habitat, prairie voles and western harvest mice demonstrated microhabitat specialization, thereby reducing competition by segregating themselves from other species. Dwarf shrews utilized a microhabitat that was not heavily used by other small mammals, so they may also be microhabitat specialists.

Acknowledgments

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Literature Cited

Belk, M. C., H. D. Smith, and J. Lawson. 1988. Use and partitioning of montane habitat by small mammals. J. Mammal. 69:688-695.

Brown, L. N. 1967. Ecological distribution of six species of shrews and comparison of sampling methods in the central Rocky Mountains. J. Mammal. 48:617-623.

Carroll, L. E., and H. H. Genoways. 1980. *Lagurus curtatus.* Mammal. Species 124:1-6.

Cottam, G., and J. T. Curtis. 1956. The u e of distance measures in phytosociological sampling. Ecology 37:451-460.

Crompton, B. J. 1994. Songbird and small mammal diversity in relation to timber management practices in the northwestern Black Hills. M.S. Thesis, Univ. Wyoming, Laramie. 202 pp.

Daubenmire, R. 1959. A canopy-coverage method of vegetational analysis. Northwest Sci. 33:43-64.

Douglass, R. J. 1989. The use of radio-telemetry to evaluate microhabitat selection by deer mice. J. Mammal. 70:648-652.

Elliott, A. G. 1996. Diversity and factors affecting diversity of small mammals, stream macroinvertebrates, amphibians, and reptiles on F.E. Warren Air Force Base, Cheyenne, Wyoming. M. S. Thesis, Univ. of Wyoming, Laramie. 118 pp.

Fa, J. E., Lopez-Paniagua, F. J. Romero, J. L. Gomez, and J. C. Lopez. 1990. Influence of habitat characteristics on small mammals in a Mexican high-altitude grassland. J. of Zool. 221:275-292.

Foster, J., and M. S. Gaines. 1991. The effects of a successional habitat mosaic on a small mammal community. Ecology 72:1358-1373.

Giant, W. E., and E. C. Biney. 1979. Small mammal community structure in North American grasslands. J. Mammal 60:23-36.

Hall, E. R. 1928. Notes on the life history of the sagebrush meadow mouse *(Lagurus).* J. Mammal. 9:201-204.

Hallett, J. G., M. A. O'Connell, and R. L. Honeycutt. 1983. Competition and habitat selection: test of a theory using small mammals. Oikos 40:175-181.l

Heske, E. J., J. H. Brown, and S. Mistry. 1994. Long-term experimental study of a Chihuahuan desert rodent community: 13 years of competition. Ecology 75:438-445.

Knight, D. H. 1994. Mountains and plains. The ecology of Wyoming landscapes. Yale Univ. Press, New Haven, Connecticut. 338 pp.

Lemen, C. A., and P. W. Freeman. 1986. Habitat selection and movement patterns in sandhill rodents. Prairie Nat. 18:129-141.

Martin, R. A. 1971. New record of the dwarf shrew from South Dakota. J. Mammal. 52:835-836.

Martner, B. E. 1986. Wyoming climate atlas. Univ. of Nebr. Press, Lincoln. 432 pp.

Maxwell, M. H., and L. N. Brown. 1968. Ecological distribution of rodents on the high plains of eastern Wyoming. Southwestern Nat. 13:143-158.

Mullican, T. R., and B. L. Keller. 1986. Ecology of the sagebrush vole *(Lemmiscus curtatus)* in southeastern Idaho. Canad. J. of Zool. 64:1218-1223.

O'Farrell, T. P. 1972. Ecological distribution of sagebrush voles, *Lagurus curtatus,* in south-central Washington. J. Mammal. 53:632-636.

Olson, T. E., and F. L. Knopf. 1988. Patterns of relative diversity within riparian small mammal communities. Platte River watershed, Colorado. Pp. 379-386. *In* R. Szaro, K. Severson, and D. Patton tech. coords. Proceedings of the symposium on management of amphibians, reptiles, and small mammals in North America. U.S. For. Ser. Gen. Tech. Rep. RM-166, Flagstaff, AZ.

Ribble, D. O., and F. B. Samson. 1987. Microhabitat associations of small mammals in southeastern Colorado, with special emphasis on *Peromyscus* (Rodentia). Southwest. Nat. 32:291-303.

SPSS-PC. 1990. Statistical software, release 4.0.1 version SPSS Inc., Chicago, IL.

Stokes, M. K. 1995. Selection of refuge

sites by sympatric *Microtus ochrogaster* and *Sigmodon hispidus*. J. Mammal. 76:83-87.

Stroh, J. C., and E. D. Fleharty. 1988. Microhabitat utilization and the effect of species removal on a population of *Peromyscus maniculatus* and *Reithrodontomys megalotis*. Transactions of the Kansas Academy of Science 91(3-4):132-138.

Thompson, L. S. 1977. Dwarf shrew *(Sorex nanus)* in north-central Montana. J. Mammal. 58:248-250.

Wight, H. M. 1938. Field and laboratory techniques in wildlife management. Univ. of Michigan Press, Ann Arbor.

Wywialowski, A. P. 1987. Habitat structure and predators: choices and consequences for rodent habitat specialists and generalists. Oecologia 72:39-45.

William R. Gould

A Summary of Information on Sturgeon Chub in Montana

Abstract

The sturgeon chub (Macrhybopsis gelida) *is a Montana species of special concern and a candidate species for federal listing. It has been reported as having limited distribution and numbers in Montana. However, recent surveys show sturgeon chub are present in long reaches in the Powder, Yellowstone and Missouri rivers in Montana and number in the hundreds. Chub were collected at sites with average depths of 0.1 - 6.4 m over bottoms composed of sand to cobble. Most of the presumed ripe fish were collected in July. Forty eight species of fish are reported as associates of sturgeon chub with flathead chub* (Platygobio gracilis) *the most frequent. The average fin ray and lateral line scale numbers of specimens from the Powder, Yellowstone and Missouri rivers, respectively, were within one unit of each other and indicated no subspecific differentiation in chub among rivers. I concluded that sturgeon chub in Montana are more widespread in secure habitats and are not as rare as earlier believed.*

Key Words: sturgeon chub, distribution, habitat, biology, meristics.

Introduction

The sturgeon chub (*Macrhybopsis gelida*) is indigenous to the Missouri and Mississippi river basins (Bailey and Allum 1962, Brown 1971, Lee *et al.* 1980, Baxter and Stone 1995). It was designated a species of special concern in Montana because it appeared to be rare, have a limited distribution and little was known about its biology (Holton 1980, Hunter 1994, Holton and Johnson 1996). It is also a candidate for federal listing (Werdon 1993). Recently Werdon (1993) reported sturgeon chub seemed to have declined in abundance and appeared to have been eliminated from parts of its former range in southeastern Montana.

Since Werdon's (1993) assessment, important information has been collected on sturgeon chub in Montana. Some of these data are presented in a variety of reports and some were obtained only recently from specimens in collections at Montana State University (MSU) and have not been presented elsewhere. The purpose of this summary is to consolidate and update the data on sturgeon chub in Montana. This will permit interested parties to evaluate the status of sturgeon chub in Montana and the needs for further studies.

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Materials And Methods

I obtained information on the distribution and habitat of sturgeon chub in Montana from the literature, reports and by seining 26 sites in Montana in 1994 (Gould 1994). Additional information on the distribution and biology of sturgeon chub was obtained from examination of collections in the Vertebrate Museum of MSU.

I measured specimens to the nearest 1 mm in total length (TL), and dissected them to obtain data on sex ratios, sexual condition and evaluate size at sexual maturity. Meristic values were obtained following the methods of Hubbs and Lagler (1964).

Results And Discussion

Distribution

Prior to 1978, sturgeon chub were known only from four sites in Montana: one at an unknown location in the Milk River (Bailey and Allum 1962), one each at the mouths of the Tongue and Powder rivers, (Bailey and Allum 1962, Brown 1971) and one in the lower Yellowstone River (Brown 1971). Since then, biologists have extended the sturgeon chub's known range significantly. In southeastern Montana, Rehwinkle (1978), Elser *et al.* (1980) and Gould (1994) found sturgeon chub throughout the Powder River and Tews (1993), Bramblett (unpublished collection records) and Liebelt (1996) have extended the known range down the Yellowstone River into North Dakota (Figure 1).

In northcentral Montana, Gardner and Berg (1982) reported sturgeon chub near the mouth of the Teton River and in the middle Missouri River from Great Falls to Fort Peck Reservoir. Subsequently, Grisak (1996) extended their Missouri River distribution downstream to Fort Peck Reservoir and Tews (1993) and Liebelt (1996) lengthened it from the Missouri River below that reservoir to Lake Sakakawea in North Dakota (lower Missouri River), which isolates Montana headwater populations from those downstream. Taken together, the collection sites are situated over 600 km in the Powder, lower Yellowstone (Miles City to mouth) and middle and lower Missouri rivers. This is a much greater distance than Werdon (1993) cited in her species status report of sturgeon chub in Montana.

In addition to the distribution presented in Figure 1, Elser *et al.* (1980) also reported sturgeon chub from the Little Missouri River drainage in Montana. I have not included this record in the known distribution of sturgeon chub in Montana because I consider it dubious. I examined the site and found it had a mud bottom and

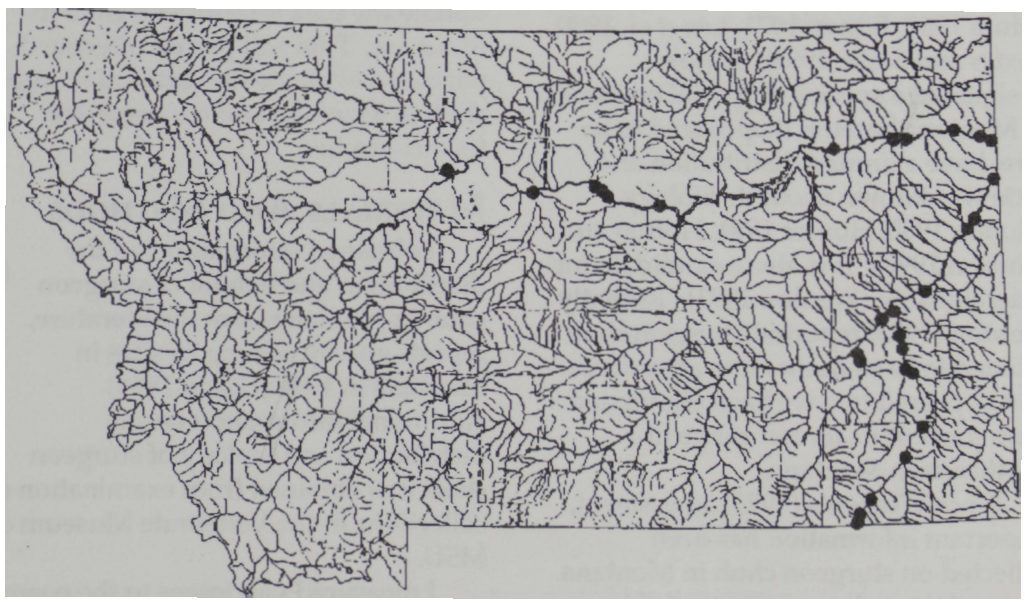

Figure 1. *Collection sites of sturgeon chub in Montana reported by Brown (1971), Elser* et al. *(1977, 1980), Rehwinkle (1978), Gardner and Berg (1982), Werdon (1993), Gould (1994), Tews (1994), Liebelt (1996) and in fish collections at Montana State University. There are more actual collection sites than circles show because one circle may cover the location of two adjacent collection sites.*

little current. These conditions make it an unlikely site for sturgeon chub (Stewart 1981). Also, Barfoot (1993) and Guzevich (1993) surveyed two Little Missouri River tributaries in Montana and did not find sturgeon chub.

The distribution of sturgeon chub in the Powder, Yellowstone, and Missouri rivers represents a secure, core habitat for the species in Montana. Specimens differing in sizes have been collected in these areas over several years (including some drought years) showing continued reproduction and recruitment. The rivers are located in different areas of Montana such that the species is not at risk from a catastrophic event occurring in one area. Furthermore, the above mentioned rivers are not likely to be dammed further, thereby reducing sturgeon chub habitat.

In addition to the core area populations, emigrants apparently invade areas adjacent to the core areas such as the mouths of the Tongue and Teton rivers as conditions permit, but do not establish permanent populations there. Neither of these sites included chubs in my 1994 sampling, probably because of dewatering and drought.

Abundance

Our baseline knowledge of the abundance of sturgeon chub has improved with recent surveys. Brown (1971), Holton (1990) and Holton and Johnson (1996) considered sturgeon chub to be rare to uncommon in Montana. In quantitative assessments using electrofishing and seining, Rehwinkle (1978) found sturgeon chub composed 3.8 percent (95 specimens) and 1.5 percent (11 specimens) of fish samples on the Powder River during 1975 and 1976, respectively. Tews (1994) captured 47 sturgeon chub in 18 seine hauls on the lower Missouri River in 1993. On the middle Missouri River, Grisak (1996) found sturgeon chub made up only 0.2 percent (8 specimens) of the seining catch in 1994. However, when he sampled by trawling he discovered strugeon chub composed 19 percent (260 specimens) in the same area. In collections from netting the Intake Canal in 1996, the Bureau of Reclamation (memo) reported sturgeon chub made up 12.9 percent of the catch. Whereas no numbers of specimens were given in the memo, Mark Albers (Bureau of Reclamation, personal communication) stated several hundred specimens of sturgeon chub had been taken. In the Yellowstone River below Intake, Mike Ruggles (Montana Fish, Wildlife and Parks, memo) reported sturgeon chub made up 7.2 percent (230 specimens) of the fish taken in his survey. These recent surveys show sturgeon chub are much more abundant in the Missouri and Yellowstone rivers than previously believed.

Habitat and Biology

Sturgeon chub inhabit areas with current, rocky and sandy substrates and substantial turbidities (Table 1). This is consistent with other reports of sturgeon chub habitat in the northern part of their range (Bailey and Allum 1962, Cross 1967, Brown 1971, Stewart 1981, Werdon 1992).

Sturgeon chub seem to be negatively phototropic. Stewart (1981) found chub were absent from a clear water section of the Powder River in Wyoming but common in otherwise similar turbid areas. Liebelt (1994) did not collect sturgeon chub in the clearest and coldest section he sampled on the lower Missouri River although he did in sections with higher turbidities. Gould (1994) reported taking them from shallow water in the extremely turbid Powder River but Grisak (1996) reported sturgeon chub were rare in the shallow, less-turbid waters of the middle Missouri River and more abundant in deeper water.

Forty eight species of fish have been reported captured with or in areas near sturgeon chub collection sites (Elser *et al.* 1977, Rehwinkle 1978, Elser *et al.* 1980, Tews 1993, Gould 1994, Grisak 1996,

Table 1. *Habitat characteristics at sites or sections in which sturgeon chub have been collected in Montana.*

Site and date	Average depth (cm) (capture method)	Bottom velocities (cm/s)	Turbidity	Temperature (C)	Substrate	Source
Powder River (4 sites) July, 1994	15-30 (seining)	27-34[a]	>1000 JTU at all stations	point measurements 20-25	rocks and sand	Gould 1994
Middle Missouri River (4 sections) July-August, 1995	92-641 (trawling)	27-112	28[b] cm Secchi disk	22[b]	rocks and sand	Grisak 1996
Lower Missouri River July and August, 1995	3.7, 3.3 (trawling)		averages 16, 13 cm Secchi disk		sand, gravel, cobble, boulder	Liebelt 1996
Lower Yellowstone River July and August, 1995	1.8, 3.3, 2.7 (trawling)		17, 11, 16 cm Secchi disk		sand, gravel and cobble	Liebelt 1996
Lower Missouri and Yellowstone rivers, 1994 and 1995	< 150 (seining)					Liebelt 1996

[a] Three averages.
[b] Point measurement at one site.

Liebelt 1996). The most frequently collected associates were flathead chub (*Platygobio gracilis*) (Rehwinkle 1978, Werdon 1992, Gould 1994, Tews 1993, Grisak 1994), (*Hybognathus* sp.) (Rehwinkle 1978), longnose dace (*Rhinichthys cataractae*) (Werdon 1992) and suckers (Liebelt 1996).

The 59 sturgeon chub from the collections at MSU that I dissected consisted of 31 males and 28 females, indicating a 1.1:1.0 sex ratio.

Nine males had swollen testes with widths of 0.9 mm or greater and 22 males had testes widths of less than 0.5 mm. Fish in the former group were designated as probably ripe. They were 42-85 mm TL; eight were collected in July and one in August. The group with narrower testes contained specimens 43-88 mm TL and were considered to be non-ripe. They also were collected in July and August.

A few randomly chosen sturgeon chub stomachs were examined for food contents. Most of the materials were classified only as insect parts. However, some were identified as simulid and chironomid parts. Stewart (1981) only listed insects as sturgeon chub food.

Meristic

The ranges of comparable measured meristic features were within 2 units of each other (Table 2) and similar to those reported by Bailey and Allum (1962) in South Dakota, Cross (1967) in Kansas, Pflieger (1975) in Missouri, and Stewart (1981) and Baxter and Simon (1995) in Wyoming. Application of the 75 percent rule (Mayr 1969) to the samples from the Powder, Yellowstone and middle Missouri Rivers (Table 2) showed they were not distinctive from each other. The 75 percent rule requires that 75 percent of the individuals of one population must be distinctive from "all" (=97%) the individuals in the

Table 2. *Selected meristics of sturgeon chub* Macrhybopsis gelida *from three rivers in Montana. Number of specimens in parentheses.*

Statistic	Pectoral fin rays	Pelvic fin rays	Dorsal fin rays	Anal fin rays	Lateral line scales	Pharyngeal teeth
			Powder River			
RANGE	15-16 (18)	8-9 (18)	8 (18)	8-9 (18)	39-46 (18)	1,4-4,1 (8)
AVE.	15.7	8.1	8.0	8.1	42.7	1,4-4,1
S.D.	0.5	0.2	0.0	0.2	2.0	0.0
			Yellowstone River			
RANGE	14-17 (32)	8 (33)	8 (33)	7-8 (33)	40-45 (30)	1,4-4,1 (22)
AVE.	15.3	8.0	8.0	7.9	41.8	1,4-4,1
S.D.	0.7	0.0	0.0	0.2	1.4	0.0
			Middle Missouri River			
RANGE	14-17 (14)	7-8 (14)	8 (14)	8-9 (14)	40-45 (12)	1,4-4,1 (12)
AVE.	15.1	7.8	8.0	8.1	42.3	1,4-4,1
S.D.	0.7	0.4	0.0	0.3	1.6	0.0

compared population for them to be designated different subspecies. The sample (N=5) from the lower Missouri River was considered to be too small for comparison.

Conclusions

Newly obtained baseline information shows sturgeon chub populations in Montana are more widely distributed and often contain more individuals than previous reports indicated. Many of the populations appear to be located in secure habitat because they are situated in rivers unlikely to be altered further. The new information on population sizes and the additional evidence that populations are self sustaining require that the status of sturgeon chub in Montana be re-evaluated.

Acknowledgments

The field information available on the sturgeon chub in Montana was collected largely by biologists of the Montana Department of Fish, Wildlife and Parks and MSU graduate students of the Montana Cooperative Fishery Research Unit, while working on a variety of projects. These projects were financed by the U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, U.S. Bureau of Land Management, Utah International and Montana Department of Fish, Wildlife and Parks. I thank the reviewers for their helpful suggestions and criticisms.

Literature Cited

Bailey, R., and M. Allum. 1962. Fishes of South Dakota. Museum of Zoology, University of Michigan. Ann Arbor. 131 pp.

Barfoot, C. 1993. Longitudinal distribution of fishes and habitat in Little Beaver Creek, Montana. M. S. Thesis. Montana State University, Bozeman. 66 pp.

Baxter, G., and M. Stone. 1995. Fishes of Wyoming. Wyoming Game and Fish Department. Cheyenne. 290 pp.

Brown, C. 1971. Fishes of Montana. Big Sky Books, Montana State University. Bozeman. 207 pp.

Cross, F. 1967. Handbook of fishes of Kansas. Museum of Natural History, University of Kansas. Lawrence. 357 pp.

Elser, A., R. McFarland and D. Schwehr. 1977. The effect of altered streamflow on fish of the Yellowstone and Tongue Rivers, Montana.

Technical Report No. 8, Yellowstone Impact Study, for Old West Regional Commission. Helena. 180 pp.

Elser, A., M. Gorges and L. Morris. 1980. Distribution of fishes in southeastern Montana. Report to Bureau of Land Management. Miles City. 136 pp.

Gardner, W., and R. Berg. 1982. An analysis of the instream flow requirements for selected fishes in the wild and scenic portion of the Missouri River. Report to the Bureau of Land Management District Office. Lewistown. 111 pp.

Gould, W. 1994. The recent distribution of sturgeon chub *(Macrhybopsis gelida)* in Montana. Report to The Montana Department of Fish, Wildlife and Parks. Helena. 15 pp.

Grisak, G. 1996. The status and distribution of sicklefin chub in the middle Missouri River, Montana. M. S. Thesis. Montana State University. Bozeman. 77 pp.

Guzevich, J. 1993. The relationship of physical habitat to the distribution of northern pike and walleye in two Montana prairie streams. M. S. Thesis. Montana State University, Bozeman. 94 pp.

Holton, G. 1980. The riddle of existence: fishes of special concern. Montana Outdoors 11: 2-6, 11.

Holton, G., and H. Johnson. 1996. A field guide to Montana fishes. Montana State Parks and Wildlife Interpretive Association. Helena. 104 pp.

Hubbs, C., and K. Lagler. 1964. Fishes of the Great Lakes Region. The University of Michigan Press. Ann Arbor. 213 pp.

Hunter, C. 1994. Fishes of special concern list update. Montana Outdoors 25(5): 32-33.

Lee, S., C. Gilbert, C. Hocutt, R. Jenkins, D. McAllister and J. Stauffer. 1980. Atlas of North American freshwater fishes. North Carolina State Museum of Natural History. Raleigh. 867 pp.

Liebelt, J. 1996. Lower Missouri River and Yellowstone River pallid sturgeon study (1994-1995 report). Report to U.S. Bureau of Reclamation and Western Area Power Administration. Montana Department Fish, Wildlife and Parks. Helena. 57 pp.

Mayr, E. 1969. Principles of systematic zoology. McGraw-Hill. New York. 428 pp.

Pflieger, W. 1975. The fishes of Missouri. Missouri Department of Conservation. Jefferson City. 343 pp.

Rehwinkle, B. 1978. Powder River aquatic ecology project. Report to Utah International, Inc. Salt Lake City. 119 pp.

Stewart, D. 1981. The biology of the sturgeon chub *(Hybopsis gelida* Girard) in Wyoming. M.S. Thesis. University of Wyoming. Laramie. 54 pp.

Tews, A. 1993. Pallid sturgeon and shovelnose sturgeon in the Missouri River from Fort Peck Dam to Lake Sakakewea and in the Yellowstone from Intake to its mouth. Report to The U. S. Army Corps of Engineers, Planning Branch. Omaha. 87 pp.

Werdon, S. 1992. Population status and characteristics of *Macrhybopsis gelida, Platygobio gracilis* and *Rhinichthyes cataractae* in the Missouri River Basin. M. S. Thesis. South Dakota State University. Brookings. 55 pp.

Werdon, S. 1993. Status report on sturgeon chub *(Macrhybopsis gelida)*, a candidate endangered species. U. S. Fish and Wildlife Service, Ecological Services, North Dakota State Office. Bismarck. 58 pp.

Scott M. Fitzpatrick

An Application of a Bicultural Model to a Russian-American Immigrant Case Study[1]

Abstract

Russian-Americans have lacked the advantage of continuous immigration to the United States. This is in contrast to many other ethnic groups who have been able to maintain a constant rate of immigration throughout the twentieth century. For Russian-Americans, this lack of continuous immigration has caused a number of problems. Lack of central communities, deficiency in English, and other social problems all have contributed to an inability to adjust rapidly to American society. In addition, conflicts are provoked by differential adjustment between the children and their parents, which strain the resources available to facilitate resettlement. The application of deAnda's (1984) bicultural model to Russian-American immigration in two Northwest communities with one specific case study, is used to examine the conflicts that can arise within the family, and demonstrates the importance of the individual variables that can promote or discourage effective adaptation.

Key words: Russian-Americans, Northwest, Biculturalism, Differential Adjustment, Immigration

Introduction

The United States has a long history of attempting to assimilate a large and constantly inflowing stream of immigrants. As a result, it has become a heterogeneous nation of peoples from all over the world. This has created problems, not only for Americans who have historically had to bear the burden of assisting immigrants by providing aid and relief, but also to the immigrants who faced the hardship of settling and supporting themselves in a country that was new and often hostile.

Many factors play a role in determining why immigrants leave their home country and go to another. Regardless of whether refugees choose to leave their country of birth voluntarily or are forced into exile by an acute refugee situation, the need for a support network is essential in promoting successful adaptation. Probably no other factor has more influence on the degree of satisfactory resettlement by immigrants than cultural compatibility between their background and the new society they confront (Kunz 1973, Cohon 1981).

The new wave of recent immigrants from Russia illustrates what can occur if certain fundamental social institutions are not present in the host country. deAnda's (1984) bicultural model discusses the processes that take place when one cultural group comes into contact with another. deAnda suggests that if no cultural compatibility exists, and the adjustment between family members is differential, then problems arise as a result of the immigrant's inability to assimilate successfully.

The differential adjustment, such as the differing rates and levels of intensity of cultural and social adjustment

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[1] The real names of the individuals referred to in this case study have been changed to protect their identity.

between sex and age-grades of family members, particularly between adolescents and their parents, is the focus of this research. New immigrant families, specifically those of Russian ethnicity, rely upon the educated and skilled members within the family to facilitate adaptation. When this does not occur, less adaptable members of the family confront major difficulties in adjusting to the cultural, political, linguistic, and gender roles that are present in the United States (Sluzki 1979, Aronzowitz 1984). As Gold (1989) has noted, many of these problems are linked to the differential adjustment experienced by members of new immigrant families.

In this study I use deAnda's (1984) derivation of Valentine's (1971) bicultural model to analyze the association between the United States majority society and immigrant Russian-Americans, and seek to demonstrate the importance of the variables that can promote or discourage effective adaptation. Because Russian immigration was restricted between the 1920s and the 1990s, the social and cultural characteristics of new Russian immigrants, together with the changes that have occurred in American society, have had profound adaptive implications for those families. A case study that I conducted of two Russian-American juveniles is used as an example of how the model is applied in relation to the historical factors that have played a role in the bicultural process.

Historical Background

As early as 1747, Russian colonists searching for a better climate and a more fertile soil than Siberia afforded, crossed the Bering Sea and traveled along the Alaskan coast, finally settling on Kodiak Island (Davis 1922). Later, after the sale of Alaska, many Russians returned home while others went to California. As a result of their influence, California became one of the earliest settling grounds for Russians in America (Davis 1922).

From 1872 to the beginning of the 20th century, the number of Russian immigrants entering the United States was around 1,000 per year. From 1899 until the beginning of World War I in 1913, Russian immigration increased steadily, reaching a peak of 57,926 according to the 1910 census. It should be noted, however, that this number reflects those who considered Russian their primary language (Davis 1922).

In part, the industrial revolution, brought such profound changes within Europe that large numbers of people were forced by circumstances beyond their control to relinquish their ancestral roots and look for work elsewhere. With the prospect of a better life in America and the increasing economic hardship, religious intolerance, and political upheaval in their home country, Russians immigrated in large numbers (Rozek 1980, Simon 1985, Simon and Simon 1985).

The number of immigrants from the Russian empire in the 1910 census reveals a peak in the number of immigrants, nearly 1.6 million. Those numbers decreased rapidly as World War I began, and continued as the new communist government began prohibiting emigration. Only ten years later, the number of immigrants from the U.S.S.R. to the U.S. dropped to 921,000, then to 62,000 in the 1930 census, and to 1,356 in the 1940 census (Dinnerstein and Reimers 1975). Until 1973 the number of these immigrants never surpassed pre-1900 levels, with a low of 254 in 1969. Census data listed here was drawn from the nation of origin, such as U.S.S.R., and was not broken down by individual republic (Dinnerstein and Reimers 1975). However, the trend of decreasing immigration from the U.S.S.R. was considered adequate for demonstrating

Russian immigration levels because of its high population density.

Only in 1977 did emigration levels begin to increase again as the Soviet Union reassessed their emigration policy. This came after the Jackson-Vanik amendment was passed in 1974, linking U.S.-Soviet trade to free emigration during 1974-76. By the late 1970s, emigration increased dramatically from 16,736 in 1977, to 28,864 in 1978, and 51,320 in 1979 (Salitan 1989).

Soon after World War II, Americans assumed that the "melting pot" succeeded in assimilating immigrants from many nations. The end of free immigration during the 1920's, and the shared experiences of the War and the Depression, seemed to have blended all the ethnic elements together at last (Dinnerstein and Reimers 1975). Non-whites, particularly blacks, remained unassimilated, but in the 1950s, even these groups appeared likely to merge eventually into the new mixture that made up the American people (Dinnerstein and Reimers 1975).

Later, Americans learned the strength of the emotional ties that "ethnics" had to their cultural past and to their origins and group identities. These immigrants, having in all parts of the country found and demarcated their community boundaries, began more than ever in the years following World War II, to cultivate and retain their unique cultural, historical, and political identities. This, in turn, tended to solidify these boundaries and the importance of one's ethnic background was stressed more than ever (Dinnerstein and Reimers 1975). This constant flow of peoples has enabled many ethnic groups like those from Germany, Greece, Spain, and the West Indies, to establish central communities in which new immigrants can usually settle with relative ease. This has not been the case, however, for immigrant Russians, especially those of non-Jewish affiliation (Walter 1995, Associated Press 1997). The fact that Russians in the past had long been denied emigration, and virtually cut off from the United States as well, raises some interesting questions concerning acculturation and assimilation in U.S. society.

The Bicultural Model

The "new immigrants" as some researchers have referred to them (Hutchinson 1966, Bryce-LaPorte 1980), belong to racial and ethnic groups that have not previously migrated to the receiving country in large numbers. Although many immigrants possess a variety of characteristics that facilitate their rapid adjustment to the United States, many Russian-Americans simply are not as skilled, educated, or experienced enough in Western lifeways to readily adjust to American society (Simon and Simon 1985, Gold 1989).

deAnda's (1984) bicultural model, in conjunction with the principle of differential adjustment among family members, seeks to explain the advantages and possible disadvantages that a particular ethnic group has in attempting to incorporate themselves into a new society. The bicultural model is a vehicle for understanding the degree to which minority groups assimilate and socialize within a majority culture. The model holds great promise for understanding the social and cultural boundaries that an individual learns to operate within, and the coexistence of the minority culture within the majority society.

The bicultural model as proposed by deAnda (1984), discusses six factors that affect the degree to which a member of a minority ethnic group can adjust to the culture of a country to which they have immigrated. These are 1) the degree of commonality between the two cultures, including the norms, beliefs, and morals; 2) the availability of cultural interpreters and mediators; 3)

the amount of negative or positive feedback provided by the host society in an attempt to produce normative, assimilative behavior; 4) the problem-solving approaches that the minority member uses to decipher the valued styles of the majority culture; 5) the degree of bilingualism; and 6) the degree of dissimilarity in physical appearance from typical members of the majority culture including skin color and facial features.

This bicultural model provides an adequate framework for analysis of family member relations among immigrants. The analysis of familial interaction regarding bicultural socialization can be thought of as a fusion model of cultures. Biculturalism, the integration and union of two cultures, occurs as the majority and minority cultures meet and interact. In this social interaction, the majority and minority cultures must adapt to each other. This adaptation takes place within the sphere of the six factors of the model and determines if one can successfully become bicultural. The bicultural model, in association with the concept of differential adjustment, also explains the problems that can arise within the family and how they are solved or escalated. The ability of children to learn English more quickly, and the difficulty or unwillingness of the parents to do so is also taken into account.

The Commonality of the Two Cultures

The first factor relating to the degree of biculturalism achieved, is the measure of commonality between the two cultures with regard to norms, values, beliefs, and perceptions. Glazer (1983) noted that there are many differences between various ethnic groups in their educational achievement and in the broader cultural characteristics in which these differences reside. If we take Glazer's remarks seriously, that Russian-American cultural differences may be rooted within their lifestyle, then many social changes and assimilation problems are likely to occur in Russian families when they come to the United States.

The "new society" that erupted in Russia out of the Stalinist era in the 1940s was a blend of factory managers, army officers, technicians, intellectuals, and highly skilled workers (Lawrence 1957). Men and women doing forced labor in concentration camps had become a well-established feature of the Soviet social structure. The organization of Soviet life was such that everyone might expect to have purpose, albeit even if only in a concentration camp (Lawrence 1957). Equality of opportunity was attempted in Stalinist Russia, but was rarely achieved. For immigrants who came out of this social environment, expectations were high that a job would be found in the United States (Dinnerstein and Reimers 1975, Gold 1989, Walter 1995). This was especially true after the fall of communism and the opening of Russia's borders. However, as Russians have attempted to merge, conforming to U.S. society has proved difficult.

A representative of Missoula's World Relief Office has noted that Russian families have many misconceptions about life in the U.S. One perception is that jobs are plentiful, which many Americans know is not always the case. The level of technology in a capitalist society, like that of the United States is far beyond what was available to most Russian citizens. The result has been a large portion of families receiving welfare or other public assistance, because of their lack of technical qualifications in the job market, an increased widening of the language barrier and, hence, a desire by parents to have their children support the family. An article in the Spokesman-Review about Russian-Americans in Spokane, Washington (Walter 1995) also

discussed these problems, noting that isolation, language barriers, and unemployment are major concerns for many of these new immigrants.

Differences in values relating to education and familial responsibility between parents and children can lead to conflict when minority individuals entering mainstream educational institutions are exposed to the beliefs and expectations of the mainstream culture (deAnda 1984). Many parents have become intolerant of their children's adoption of American customs and values, and have sometimes become excessively dependent to the point that they seek to prevent their children from adjusting to American life on their own terms (Cohon 1981, Gold 1989). This is especially true for adolescents, where their world has been shaped by seeing their parents unable to find jobs and resorting to supporting themselves on welfare. This causes a feeling of hopelessness on the part of these children, and despite the fact they are only infrequently ostracized for their economic status, they exhibit shame for their situation (Thompson, personal communication). This is illustrated by my case study of Ivan and Mikhail, which will be discussed later in the paper.

Translators and Mediators

According to deAnda (1984), a translator is an individual from a minority individual's own ethnic or cultural group who has had considerable success at dual socialization. In a sense, the concept of dual socialization, in which people attempt to develop and sustain the new and old cultures in their lives, frequently occurs in most Americans who maintain an ethnic identity within the broader homogenized American culture (deAnda 1984).

A cultural translator, who would facilitate understanding and correct perception of the majority culture, is not often seen in Russian-American families because of their recent immigration and the lack of previously established communities. For example, an individual who attends a school of higher education would be in a good position to help others familiarize themselves with that particular institution.

The availability of cultural translators, mediators, and models plays a major role in differential adjustment within the family. Gold (1989) notes that new Russian immigrant families have supported themselves through the inclusion of distant relatives and unrelated persons as parts of their extended family unit. This, however, has been observed most frequently in Russian Jewish families who have consistently had more success in assimilating (Gitelman 1978, Jacobs 1981, Simon and Simon 1985). For the most part, this has not appeared to be the case with Russian immigrants of non-Jewish affiliation.

Corrective Feedback

Corrective feedback is important when considering positive and negative responses by the minority member toward the majority society. Although an individual may become familiar with the norms of a particular culture by observing the behavior of members in the majority culture, the shaping of his or her behavioral repertoire requires corrective feedback to conform more accurately to the majority culture (deAnda 1984). An individual's behavior will conform more accurately to cultural norms if there is a greater availability of corrective feedback (deAnda 1984). Without this corrective feedback, an individual may engage in certain behaviors that the person assumes is suitable, but which, in reality, are perceived by the members of the majority culture as improper (deAnda 1984).

A World Relief Office representative suggests that criminal activity in Missoula, Montana, predominantly stealing, is a result of a lack of positive integration with their American peers and, thus, has led to a segregation of some Russian-American adolescents in the public school system. Corrective feedback in both of these instances has been particularly important in clarifying which behaviors are appropriate in particular contexts. This can then be related to the importance of "learning" a culture if one is to assimilate into the majority culture.

Problem-Solving Skills

Problem solving is a process by which an individual discovers a combination of previously learned rules that can be applied to achieve a solution for a novel problem situation (Gagne 1970, deAnda 1984). Lack of appropriate problem solving skills hampers the ability of Russian-American families to adapt to U.S. society because of a lack of adequate analytical approaches to the process of dual socialization (deAnda 1984).

The degree of bicultural socialization that can possibly be achieved by the minority person may be affected by the dominant cognitive style cultivated within their culture and that of the mainstream culture (deAnda 1984). The cognitive style relates to the most valued approach for understanding and comprehending one's own environment. Individuals from the minority culture that nurture the majority cognitive style of adaptation are the most likely to be successful in relations with the majority culture. The interaction between cultures is analyzed in a manner similar to that of the Empowerment Group Work model in that there is an increasing utilization of social support networks in problem-solving within different ethnicities (Chau 1991). The more economic and social resources that the minority culture has, the higher the probability that an individual will interpret successfully the demands of the majority culture (deAnda 1984).

There exists in Russian-American groups, a "nonconcious ideology" (Kidder 1981). In other words, an individual or a group often may be unaware that they are utilizing their own set of beliefs in an atmosphere of contradictory or different beliefs. The degree to which concepts and rules are contextually embedded may affect the ability of the minority individual to understand and adequately overcome the social demands of the majority culture (Valentine 1968, 1971).

Children in Russian-American immigrant families have had difficulty in adjusting because of the problem-solving approaches that their parents employ. For example, many parents are frustrated that their children cannot be assimilated within the public school system. Their reaction to initial failure to assimilate is to stress other means of existence within the social framework. Most often, family economic support is stressed (Freeman 1986). Conflicts sometimes erupt because the children resent having their lives planned by their parents (Aronzowitz 1984, Gold 1989). In Gold's (1989) study, resettlement workers commented on adolescents who became depressed and lonely because they worked and lived with their parents without really having a social life with friends (Gold 1989, Nguyen and Henkin 1984). These issues have also been addressed recently among Asian-Americans in Seattle (Associated Press 1997). Hence, the problem-solving approaches taken by both parties in these situations only exacerbate the continuing problems that influence adjustment.

The Degree of Bilingualism

The extent of an individual's proficiency in the language of a culture to which they have immigrated can

either enhance or impede the socialization process (deAnda 1984). An individual that is, or becomes, conversant in the language of the majority culture is more likely to be exposed to a wider range of cultural mediators and translators, and to a wider range of educational and employment opportunities. This would likely lead to an increase in economic stability through higher wages, and would benefit the family. Equal ability of new immigrants in two languages is not prevalent in many ethnic minorities. This also pertains to Russian immigrants.

In a linguistically strange environment, the immigrants might find themselves excluded and isolated from human contact. If, in contrast, the immigrants find a sufficient number of people who speak their language, share the same values, lifestyle, traditions, religion, political views, and food habits, and they are able to evaluate and anticipate their hosts actions and responses, the integration will be accelerated and eventual identification with the new country assured (Kunz 1973).

On January 2, 1968, the Bilingual Education Act was enacted as legislators took their first direct step into the world of bilingual education. This law was enacted to bring "access to opportunity, [and] to give minorities a desire to be part of the nation and its ideology" (Epstein 1977). This "Americanizing" force has, however, often resulted in a declining commitment among ethnic group members to their ethnic language and culture, once they have moved into the economic mainstream. Moreover, intrusions of incorrect English grammatical structures and of accents serve to further accentuate and continually reinforce the dissimilarities between the two cultures and the belief that minority individuals cannot display the competence necessary to meet mainstream norms (deAnda 1984).

The United States is currently facing the dilemma of how to establish effective bilingual educational criteria (Erickson and Omark 1981). Despite the commitment by the U.S. government of attempting to implement a more structured, effective system for teaching minority and immigrant groups English, the goal has not yet been reached. In Russian-American families, the parents' unwillingness to learn English has impeded their societal adaptation. Because of their recent immigrant status, most have not yet shown a decline in commitment to the Russian language. Competence in the majority language can determine, to some extent, the socialization experiences available to the individual, limiting, for example, access to institutions of higher education or favorable job markets. "It is obvious that monolingual minority individuals have the least opportunity to learn the norms of the majority culture, as the lack of any working knowledge of the mainstream culture automatically shuts off important sources of socialization" (deAnda 1984). The limitations of language also relates to the problem-solving factor in the model, and the lack of mediators and translators to enable more frequent access to societal benefits.

Thompson, of the World Relief Office, has noted that because many parents choose to rely on their children for support, the chances that they will not learn English increase. Many studies, for example, have demonstrated that there is a significant difference between age groups in learning the phonology of another language, suggesting that children can learn languages more quickly and retain the information more easily than adults (Asher and Garcia 1969).

The fact that language ability occurs differentially in Russian-American families should be attributed to the family structure, set in the belief that most elderly immigrants are simply not willing to learn the language. The

ability of children to more easily learn English should also be taken into account. In response, parental reliance on their children is more the focus, and of greater importance. Children who learn English quickly and attain job skills are usually more employable, and often become responsible for the economic, social, and emotional needs of parents, grandparents, and siblings (Gold 1989). However, it appears that many young Russian-Americans often feel resentment for being deprived of the extended adolescence and consumption patterns they observe in Americans. Gold (1989) has also observed this trend in Vietnamese families, in which the youths "reacted to this burden in passive-aggressive ways by spending little time at home, refusing to talk to parents, adopting disdained American habits, or not eating mother's cooking" (Montero 1979, Nguyen and Henkin 1984). As a result, economic adjustment of Russian immigrant families in the Northwest has been facilitated by the employment of children at the cost of family stability.

The Degree of Dissimilarity in Physical Appearance

The socialization experiences of a minority individual can be affected by their differences in physical appearance from members of the majority culture (deAnda 1984). This can, in turn, be an obstacle for the process of bicultural socialization. Historically, pronounced identifiers such as skin color or distinguishing facial features have made it more difficult for many minority members to assimilate into mainstream U.S. society (Valentine 1971, Chau 1991, Omi and Winant 1994). The bicultural model explains that because there can be a substantial variation in physical appearance within ethnic groups, those members who most closely resemble the members of the majority culture, will have more mobility within the mainstream. Physical similarities in appearance have made it easier for European immigrants to blend into American society (deAnda 1984), and phenotypical problems do not appear to affect the degree of success of adaptation for Russian-Americans.

A Case Study

A case study that I completed in 1993, while working at the Spokane County Juvenile Justice Center (SCJJC), illustrates the use of the bicultural model, and shows the effects of a lack of adaptation and the extent of bicultural socialization as a result of differential adjustment. Two Russian brothers with whom I worked in SCJJC had recently immigrated to the United States and had difficulty adapting to American society. Having predominantly associated with a group of juveniles whose social interaction sphere centered around criminal activity, positive-corrective feedback was almost nonexistent. The fact that they had perceived stealing, for example, as "no big deal", was indicative of a lack of good influence among their peers, and eventually led to their incarceration.

Ivan was born in Vladivostok, near Mongolia, in what had been the USSR in Krasnodar, Russia. He is the youngest of ten children in a family that also includes three sisters and six brothers. Ivan came to the United States in 1990, after his parents applied to leave the Soviet Union. All members of their family were consequently stripped of their Russian citizenship for doing so. The mother explained that they left Russia because her husband was a Baptist pastor, and was, therefore, the subject of persecution in their homeland. Ivan also remarked that in typical Socialist fashion, his father had had many other occupations including fireman and truck driver, and also served three years in the Russian army as a paratrooper. Previous to fleeing Russia, Ivan's father had also been in training to be a detective in the police

force. An organization known as Cavitas assisted the family in their defection through Eastern Europe to Italy. In Italy, they applied for refugee status with the U.S. consular in Rome, and stayed there for about three months.

From there they flew to San Diego, California where his father sought work in vain. After staying there for one year trying to survive on public assistance, the family moved to Idaho where the father found work in an auto detailing shop. Ivan noted that his parents felt pressure by the employer of the shop to convert to Mormonism, and that his father was constantly tormented by fellow employees who pulled pranks on him such as locking him in a car after he had sprayed the interior with an aerosol cleaner. After about one year there, the family moved to Spokane, Washington.

The father is also trained as a chauffeur and heavy equipment operator, but his inability to speak or write English has been a major factor in his inability to find work. The mother was also unemployed, although she had previously worked as a seamstress and raised animals on a farm in Russia. At the time of this study the family was living mostly on public assistance.

Also in the home is an older brother, 18 years of age at the time of study, who had just found work at an alloy company fabricating truck trailers. He is competent in English, and this has been an asset not only for getting the job, but for helping to support the family, as well. Three brothers and one sister and their respective families live in the Spokane area. The rest of the children live in Germany, and one other sibling returned to Russia.

The mother refers to her youngest sons, Ivan and Mikhail, as "good boys". She explained that she and her husband were very frustrated with the type of friends Ivan and Mikhail had met at school. Mikhail explained that he had "survived" at high school the year before, but upon moving to a different school in Spokane, he was a "loner", and the only people who would accept him readily were kids "living on the edge".

The conflicts between family members reached a crisis level when Mikhail and his father got into a physical altercation that resulted in Mikhail being left with a scar over his left eye. This seemed to visibly upset Ivan, and both boys ran away from home. They were sheltered by friends, and were later apprehended with them after they became involved in criminal offenses. Their arrests brought counts of second degree burglary, second degree malicious mischief, and three counts of second degree vehicle prowling. Although Ivan and Mikhail had no previous criminal records, they admitted that these were not the only crimes they had ever committed. It seemed evident that because Ivan and Mikhail had two major barriers to overcome, a different language, and disparate social interactions at home, their peers had great influence over them. The mother and father continuously tried to "set them straight," but at times their tempers overstepped acceptable bounds. The fact that both parents have virtually no knowledge of English has contributed to their inability to stay in touch with Ivan and Mikhail.

Upon arriving in Spokane from Idaho, Ivan was placed in Middle School, and according to School District staff, he did well and completed the 1991-92 school year. After moving to a local high school the following year, his performance dropped dramatically and he was dropped from enrollment when he ran away. Ivan readily blames this on the continuous fighting with his parents. According to completed diagnostic reports by SCJJC, Ivan's key offense factors were 1) classic conflict between parents with Old World values and coping skills versus a desire to be accepted by American peers; 2) naive

belief that he would not be caught; and 3) compromising his own values in order to survive on the run.

Upon further investigation of problem-related incidents in Russian-American families, Thompson of the World Relief Office in Missoula, Montana, notes that differential adjustment within families like this is common among Russian immigrants in Missoula. Thompson notes that in many instances of émigré adaptation, the elderly have a more difficult time adjusting to American culture and society. The burden put on the children to help support the family is often tremendous. Though children sometimes accept that English is a necessity, many elderly émigré's do not place the same emphasis on language ability. This results in manipulation of the parents by the children as a result of this language barrier, and parental control over their children is diminished. This also appeared to be the case with Ivan and Mikhail, eventually leading to an increase in familial conflict.

Discussion And Conclusions

With the possible exception of physical characteristics, the problems that can occur for Russian-American immigrants to the U.S. during socialization are demonstrated by deAnda's (1984) bicultural model. The results of this study suggest that this model can be successfully used in attempting to analyze Russian-American immigration processes.

Surveys of Russian immigrants from the late 1970's listed many reasons for immigrating to the U.S. These included discrimination on the basis of nationality, cultural or political motivations, and economics (Salitan 1989). These reasons reveal a striking similarity to those given at the height of immigration in the late 1800's and early 1900's. Today, many Russian-Americans attribute their less than desirable position in the social scale to their overly high expectations of what economic resources would be available. This is not as common as Russian Jews, however, who typically are more highly educated and assimilate into Jewish communities to a large extent (Rozek 1980, Simon 1985, Zenner 1988, Gold 1989).

While similarities exist between the generations of Russian-Americans of yesterday and today, there are many more challenges for those families who have recently immigrated. It is true that certain members of Russian families do have the resources, skills, and opportunities to facilitate rapid adjustment to American life, but there are many others who face difficulties in coping with the new setting. Problems that affect these Russian-American immigrant families can include a loss of status, generational conflict, role reversals, and dependency on the young by the old (Gold 1989). The different rates of adjustment of members of new immigrant families can lead to conflict as some individuals, usually adolescents, forge a new life quickly, while others, such as the parents, remain isolated and dependent (Simon 1985, Gold 1989). In turn, conflicts provoked by differential adjustment and socialization problems strain the family-based resources that new immigrants use to facilitate resettlement. Difficulties of adjustment that develop early on may adversely affect the younger members of immigrant families, and not become fully evident for several years (Aronzowitz 1984, Gold 1989).

This case study of Ivan and Mikhail shows that the bicultural model can be used to examine and begin to explain the conflicts that can arise from an inability of immigrants to adapt effectively to mainstream society. To help remedy these situations, intervention techniques that are geared

toward the well-being of the 'bicultural' immigrant will be the most beneficial. One must distinguish among different immigrant groups and the particular policies that govern them, and attempt to create a positive socialization process that recognizes the need for a smooth adaptive route into mainstream society, as well as the retention of ethnic and cultural heritage (deAnda 1984). The understanding of processes that surround the quality and extent of assimilation are, however, essential in order for gaining a more detailed perception of biculturalism within Russian-American families. Only then can effective assimilation be more clearly organized and administered.

Although limited in scope, the present study provides preliminary insight into the bicultural socialization of Russian-American immigrants. More research is needed, however, to more accurately assess how these processes take place, especially on a temporal scale. Future studies that incorporate a larger population to increase statistical validity should help to provide a more detailed picture of issues involved with Russian-American immigration.

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Literature Cited

Aronzowitz, M. 1984. The social and emotional adjustment of immigrant children: a review of the literature. Int. Mig. Rev. 18(2): 237-257.

Asher, J., and R. Garcia. 1969. The optimal ages to learn a foreign language. Mod. Lang. J. 53: 334-341.

Associated Press. 1997. Cultural differences complicate parenting. Eugene Register-Guard, Sept. 20, 1997.

Bryce-Laporte, R. S. (ed.) 1980. Sourcebook on new immigration. Transaction Books, New Brunswick, NJ. 511 pp.

Chau, K. L. 1991. Ethnicity and biculturalism. The Haworth Press, New York, NY. 133 pp.

Cohon, J. D. Jr. 1981. Psychological adaptation and dysfunction among refugees. Int. Mig. Rev. 15(1): 255-275.

Davis, J. 1922. The Russian Immigrant. The MacMillan Co., New York, NY. 219 pp.

deAnda, D. 1984. Bicultural socialization: Factors affecting the minority experience. Soc. Wk. March-April, pp. 101-107.

Dinnerstein, L., and D. M. Reimers. 1975. Ethnic Americans: A history of immigration and assimilation. Dodd, Mead & Co. New York. 184 pp.

Epstein, N. 1977. Language, ethnicity, and the schools: Policy alternatives for bilingual-bicultural education. Institute for Educational Leadership, Washington D.C. 104 pp.

Erickson, J. G., and D. R. Omark. 1981. Communication assessment of the bilingual, bicultural child: Issues and guidelines. University Park Press. Baltimore, MD. 373 pp.

Freeman, G. P. 1986. Migration and the political economy of the welfare state. Annals 485: 51-63.

Gagne, R. M. 1970. The conditions of learning. Holt, Rinehart & Winston, New York, NY. 407 pp.

Gitelman, Z. 1978. Soviet immigrants and American absorption efforts: A case study in Detroit. J. Jew. Comm. Srvc. LV: 77-82.

Glazer, N. 1983. Ethnic dilemmas: 1964-1982. Harvard University Press, Cambridge, MA. 359 pp.

Gold, S. J. 1989. Differential adjustment among new immigrant family members. J. Cont. Ethn. 17: 408-34.

Hutchinson, E. P. 1966. The new immigration: An introduction. Annals 367: 1-3.

Jacobs, D. N. 1981. Introduction. pp. 1-10. *In* D. N. Jacobs and E. F. Paul (eds.) Studies of the third wave: Recent migrations of Soviet Jews to the United States. Westview. Boulder, CO.

Kidder, L. H. 1981. Selltiz, Wrightsman, Cook's research methods in social relations. Holt, Rinehard, and Winston, NY 483 pp.

Kunz, E. F. 1973. Exile and resettlement: Refugee theory. Int. Mig. Rev. 15(1): 42-51.

Lawrence, J. 1957. Russia in the making. George Allen & Urwin LTD., London. 335 pp.

Montero, D. 1979. Vietnamese Americans: patterns of resettlement and socioeconomic adaptation in the United States. Westview, Boulder, CO. 218 pp.

Nguyen, C. T., and A. B. Henkin. 1984. Vietnamese refugees in the United States: adaptation and transitional status. J. of Ethn. Stud. 9(4): 110-116.

Omi, M., and H. Winant. 1994. Racial formation in the United States. Routledge, NY. 201 pp.

Rozek, F. 1980. The role of internal conflict in the successful acculturation of Russian Jewish immigrants. Unpublished Ph.D. dissertation. University Microfilms, Ann Arbor, MI.

Salitan, L. 1989. Domestic pressures and the politics of exit: trends in Soviet emigration policy. Pol. Sci. Qtr. 104: 671-87.

Simon, R. J. 1985. New hires: The adjustment of Soviet Jewish immigrants in the United States and Israel. Lexington Books, Lexington, KY. 190 pp.

Simon, R. J., and J. L. Simon. 1985. Social and economic adjustment to the United States. pp. 13-45. *In* R. J. Simon (ed.) New lives: The Adjustment of Soviet Jewish immigrants in the U.S. and Israel. Lexington Books, Lexington, MA.

Sluzki, C. E. 1979. Migration and family conflict. Fam. Proc. 18(4): 381-394.

Valentine, C. A. 1968. Culture and poverty. University of Chicago Press. Chicago. 216 pp.

Valentine, C.A. 1971. Deficit, difference, and bicultural models of Afro-American behavior. Harv. Edu. Rev. 41: 137-157.

Walter, J. 1995. Journey of Faith. Spokesman-Review special report, Feb. 19, 1995. 6 pp.

Zenner, W. P. (ed.). 1988. Persistence and flexibility: Anthropological perspectives on the American Jewish experience. State University of New York Press, Albany, NY. 298 pp.

Abstracts

Biological Sciences - Aquatic

Whites Gulch Stream Stabilization and Fisheries Enhancement Project [AFS]

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In 1995, a portion of an Upper Missouri Westslope cutthroat (UMWCT) stream, currently one of the two remaining in the Big Belts Range east of Canyon Ferry Reservoir, Broadwater County, Montana, was reclaimed. Turn of the century ground sluicing followed by massive gold dredge operations in the mid-1 940's had left 3,000 feet of Whites Gulch perched in a ditch between some 100,000 cubic yards of overburden material and the north valley slope. The south side of the valley remained deeply excavated, filling with water and later, with brook trout (*Salvelinus fontinalis*). Thus, the hydrologic and ecological balance at the site remained precariously altered for years. The inevitable consequence was a massive headcut above the dredged valley triggered by springtime rainstorms in 1993. The result was 700 feet of deeply incised channel marked by 20 to 30 foot vertical walls that provided ponded nonnative brook trout direct access into cutthroat habitat immediately upstream. At this scale, reclamation planning and implementation demanded the combined resources of local, state, and federal agencies working in concert with private consultants. Recognizing the unstable conditions and on-going degradation in Whites Gulch and the value of local UMWCT, the only viable option was to restore long-term hydrologic stability by recreating the valley floodplain and channel to historic geomorphic conditions. To protect and preserve the remnant cutthroat (*Oncorhynchus clarki lewisi*) population from invasive brook trout, project planners had to include provisions for a barrier to segregate the two species. Valuable lessons in stream restoration planning and implementation are always in store for all parties involved in reclamation efforts at this level. Whites Gulch was not without its problems. More emphasis on building flexibility into construction scheduling including funding for post-construction design adjustments and maintenance are absolutely necessary to ensure that QC/QA considerations are met. However, determined efforts by all parties to reach well defined goals at Whites Gulch are paying off. Early monitoring indicates this project to be a conservation success for the physical and biological aspects in and above the project area.

Title footnote indicates organization, location and date presentation was made:

AFS *Montana Chapter of the American Fisheries Society Annual Meeting, Bozeman, MT, Feb. 5-6, 1997*
MAS *Montana Academy of Sciences Annual Meeting, Billings, MT, April 11-12, 1997*
TWS *Society of American Foresters Joint Annual Meeting with TWS as above.*
Montana Chapter of the Wildlife Society Annual Meeting, Missoula, MT, March 5-7, 1997
SAF

Distribution of Whirling Disease in Montana[AFS]

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The detection of whirling disease (WD), a parasitic infection of salmonids, in the Madison River, southwest Montana, in December 1994 and its subsequent link to a 90% decline in the river's wild rainbow trout, prompted a statewide testing program to map the disease's distribution in Montana's streams, rivers, lakes, ponds and reservoirs. More than 400 sites were tested by fall 1996. Whirling disease is more widespread than anticipated; at least 42 waters in the Clark Fork, Flathead and upper Missouri drainages are infested. Testing failed to detect WD-positive waters in the Yellowstone, Kootenai and St. Mary's drainages. Whirling disease is moving downstream from known headwater outbreaks in the Missouri and Clark Fork drainages. However, within the disease's current distribution, are isolated positive sites that are surrounded by "clean" waters. Infected hatchery fish and fish-eating birds have likely contributed to the introduction and spread of WD in Montana. Other transport mechanisms are possible but unlikely.

Efficacy of Special Regulations on the Big Hole River [AFS]

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Three Big Hole River study sections, southwest Montana, were analyzed to determine the efficacy of a special regulation in increasing numbers of larger brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) over the 1981 - 1996 period. The regulation requires the release of trout in the 13 - 22 inch range and restricts the method to the use of artificials. Boat-mounted mobile anode electrofishing sampling was conducted annually in March in two study sections to determine brown trout populations. Rainbow trout sampling was conducted in September in three study sections. Population estimates were determined by log - likelihood analysis of mark - recapture data. Brown trout density and standing crop fluctuated in the control section but exhibited increasing trends under special regulation. Thirteen inch and larger and 18 inch and larger brown trout were higher in the special regulation section. Brown trout data suggest that the "slot limit" was effective in increasing the percentage of the standing crop accounted for by both 13 inch and larger and 18 inch and larger fish. Rainbow trout densities and standing crops fluctuated with recruitment in all three sections. Numbers of 13 inch and larger rainbow trout exhibited increasing trends within all three sections. Sixteen inch and larger rainbow trout attained the highest densities and increase in the control section. Data suggest that the "slot limit" was ineffective in increasing the percentage of the standing crop accounted for by the 13 inch and larger or 16 inch and larger rainbow trout.

Riparian and Wetland Ecological Health Evaluation of Selected Streams on the Charles M. Russell National Wildlife Refuge [TWS]

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Between August 7 and October 15, 1995, the Riparian and Wetland Research Program of the University of Montana evaluated 113 stream segments on the Charles M. Russell National Wildlife Refuge (CMR NWR) in northcentral Montana. The evaluations provided USDI Fish and Wildlife Service managers on the CMR NWR with information to help them appraise their current management practices, and to help them develop strategies to meet objectives regarding riparian and wetland health on the refuge. Sixteen factors relating to hydrology and streambank, geology and soils, and riparian vegetation were scored for each stream reach. Based on the scores, the reach was classified as functioning, functioning at risk, or nonfunctional. Sixty-nine percent of evaluated stream segments scored in the nonfunctional category. Evidence from livestock exclosures and adjacent ownerships suggests that current livestock grazing practices may be inappropriate for some CMR NWR streams given the fragile soils that occupy much of the land area. Other factors affecting health scores may include water removal (via stock ponds and upstream irrigation withdrawals) and the absence of beaver (*Castor canadensis*).

Sustainable versus Unsustainable Conservation Efforts Along the Peruvian Coast [TWS]

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In December 1996, a study was initiated with the goals of balancing the needs of marine wildlife (fur seals, sea lions, and penguins) with the needs of a local artisanal fishermen at Punta San Juan, Peru (15° 22' S 75° 11'W). Original plans were to collect data on 1) foraging locations of those marine predators are most heavily exploited (directly and indirectly) by the fishery and 2) locations where local fisherman capture their marine resources (i.e. fish, eggs, mollusks). With these data we planned to identify locations of heaviest overlap and interaction, and propose regulations to limit fishing in areas of marginal productivity value for the fisherman, yet high mortality rates for the wildlife, especially in the case of the Humboldt penguin, a species listed under CITES appendix I. Despite our ability to accurately collect data, integrate them into a simple, easily understandable series of overlap charts, and derive legal regulations prohibiting fishing under certain conditions, this approach will be received with scepticism. I will now outline a newer approach to conservation of the Peruvian marine ecosystem, which attempts to better integrate the ideas and life-styles of the local fishing community. I will describe the history of the

conservation of the living resources of the marine upwelling system in Peru, and provide examples of how small attitude changes in the conservationist can produce a large change in the desired results.

Assessing Functional Health of a Riparian Site [TWS]

Bill Thompson, Paul L. Hansen, Tom Parker, R. C. Ehrhart, and Bill Haglan
Riparian and Wetland Research Program, School of Forestry,
University of Montana - Missoula 59812

An increased public awareness of the benefits of the need for ecosystem functional health has driven a movement to identify factors that operate on the landscape to enhance or degrade natural ecologic function. In cooperation with various agencies, we have developed a rapid assessment procedure for evaluating functional health of a stream reach and its associated riparian zone. The procedure quantifies an array of parameters indicating the ability of different aspects of the system to function. These quantities are weighted and factored into a formula to produce a comparative rating of riparian functional health. A land manager can use the evaluation to: 1) assess present functional health of a stream reach, 2) identify specific factors needing remedial attention, and/or 3) through repeated evaluation as a monitoring tool for assessing effectiveness of management change. The procedure, designed for use by land management professionals as well as landowners with minimal training, can be used to evaluate health of a 200 ft representative reach of stream in about 2 hours. The evaluation does not require precise measurements, but instead relies on visual estimations of readily observable parameters grouped into three categories of factors: vegetation, soils/geology, and hydrology/streambank. Estimates of ten such factors are used to develop an overall health rating. With minimal training, evaluators using this procedure have demonstrated success at calibrating their observational skills to attain consistent and repeatable results.

Biological Sciences - Terrestrial

Who gets parasitized by Brown-headed Cowbirds?
The importance of everyday host activity [TWS]

Alison J. Banks, Graduate Student
Montana Cooperative Wildlife Research Unit
University of Montana - Missoula 59812

The recent range expansion of the Brown-headed Cowbird (*Molothrus ater*) in North America has introduced brood parasitism as a new selective force for many host species. High parasitism rates cause greatly reduced reproductive success for many species. Parasitism rates vary dramatically among species, but factors affecting the probability of parasitism remain poorly understood. Cowbirds are thought to find nests by watching adult behavior, and nest defense behavior correlate with parasitism rates among some species. Other more prominent behaviors (e.g. nest-

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Biological Sciences - Terrestrial

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building visits, mate-feeding, vocalizations) centered around the nest during early nesting phases may also serve as cues to nest searching cowbirds. I test an "everyday activity" hypothesis in which pairs more active around their nests during the early nesting phases have a higher probability of being parasitized than less active pairs. I measured behaviors of American Redstarts (*Setophaga ruticella*), Yellow Warblers (*Dendroica petechia*), Dusky Flycatchers (*Empidonax oberholseri*), and Warbling Vireos (*Vireo gilvus*) nesting in the same habitat but differing in parasitism rates. I find a positive correlation between male singing rates near nests and parasitism across species. Within species, too, parasitized males sing more than unparasitized males. Female activity and frequency of nest visitation appear uncorrelated or inversely correlated with parasitism. These data suggest that cowbirds may exploit male behaviors when searching for nests and that we might expect the frequencies of such behaviors to change over time in response to parasitism pressure.

Dispersal and Genetic Relationships of Recolonizing Wolves in the Rockies [TWS]

Diane K. Boyd and Daniel H. Pletscher
Wildlife Biology Program, School of Forestry
University of Montana - Missoula 59812

Stephen H. Forbes
Division of Biological Sciences
University of Montana - Missoula 59812

Gray wolves (*Canis lupus*) have recently recolonized western Montana, southeastern British Columbia, and southwestern Alberta, 50 years after their systematic extirpation from the region. Recovery of recolonizing wolf populations depends on successful dispersal from source populations, subsequent reproduction, and maintenance of genetic variation. We tagged 56 wolves in the Glacier National Park area during 1984-1996. We used a combination of telemetry and field data to determine the characteristics of dispersers, including age, sex, season of dispersal, longevity, dispersal distance, direction traveled, temporary associations with other packs, and reproductive success. Thirty-two of the tagged wolves dispersed 20-832 km from their natal home range. Fourteen dispersers produced at least one litter of pups each. Gene flow due to dispersal must be maintained to prevent a population bottleneck and consequent reduced genetic variation. We used DNA microsatellite genotyping to examine the genetic relationship of recolonizing Rocky Mountain wolves. For genetic analyses, we combined samples from adjacent Canadian wolf studies, Montana wolves tagged by the U.S. Fish and Wildlife Service, and our data (n=91). We found high genetic variation, measured in terms of heterozygosity and allelic diversity, indicating a lack of a founding population bottleneck. To maintain high genetic variation, gene flow between wolf subpopulations must be assured through dispersal. Combining field data with genetic analyses yielded information that neither study alone could determine, including the synergetic synthesis of long dispersal distances, high dispersal rates, and adequate gene flow among colonizers.

Spatial Changes In Habitat Use By Elk In Western Montana [TWS]

Milo Burcham and C. Les Marcum
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Comparing radio locations of cow elk (*Cervus elaphus*) taken from 1977-1983 and 1993-1996 revealed changes in landscape use. Yearlong, calving season, summer, rut, and hunting season patterns of use for two adjacent elk herds were examined by comparing the relative use of grid cells overlaid upon the study area. These changes span the time frame from before logging was initiated in the upper Chamberlain Creek drainage, in westcentral Montana, through 15 years of logging activity to the present. This presentation represents only a portion of the Chamberlain Creek Elk Study, which is investigating the long-term effects of habitat fragmentation on elk habitat use and home ranges.

Small mammals in burned and unburned habitats on the Beartooth Wildlife Management Area [TWS]

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Small mammal trapping was conducted on the Beartooth Wildlife Management Area near Wolf Creek, Lewis and Clark County, Montana, to determine species occurrence by habitat type, and to survey for special interest or concern species. Seven traplines using Sherman live traps, snap traps, and pitfall traps were run during August and September, 1996. Three traplines were located in areas that were partially or severely burned during the 1990 fire. A total of 414 mammals were captured with eleven species represented. Captures/100 trap-nights ranged from 3.1 in burned ponderosa pine forest to 46.3 in willow-riparian habitat. Species richness was highest in unburned cottonwood riparian (n=6) and burned aspen habitats (n=7), lowest in intermountain grassland habitat (n=3), and intermediate in unburned Douglas-fir-ponderosa pine forest (n=5) burned ponderosa pine (n=4) and unburned willow-riparian habitats (n=4). Trapping results compared favorably with those from studies conducted by the Montana Nongame Program in similar unburned ponderosa pine habitats. Results suggest that small mammal productivity and diversity in burned habitats is variable, but generally comparable with similar unburned habitats in Montana. However, forest obligates such as the Red-backed Vole (*Clethrionomys gapperi*) were absent from 6-year post-burned areas. Riparian and aspen habitats supported the highest diversity and density of small mammals, further emphasizing the importance of properly managing these habitats to maintain their high species diversity and productivity.

A LANDSCAPE PERSPECTIVE ON THE EFFECTS OF CLEARCUTTING ON BIRDS IN CEDAR/HEMLOCK FORESTS [TWS]

Sallie J. Hejl
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Landscape patterns in cedar/hemlock forests in northern Idaho have been modified by clearcutting. I investigated the effects of these changes in landscape patterns on birds by examining bird distribution and nesting success (1992-1994) in three landscapes: (1) a continuous old-growth forest landscape, (2) an old-growth landscape with recently embedded clearcuts, and (3) a landscape composed of selectively harvested forest fragments and older clearcuts. Three species (Brown Creeper (*Certhia familiaris*), Winter Wren (*Traglodytes traglodytes*), and Golden-crowned Kinglet (*Ragulus satrapa*)) were clearly associated with continuous old-growth cedar/hemlock; these may be interior forest species. Twenty species were associated with landscapes fragmented by clearcuts. Surprisingly, many forest species were as abundant or more abundant in clearcut landscapes as in continuous forest. Probability of daily nest success did not differ significantly between the continuous and modified old-growth landscapes for five species. The trend for four of these five species (all cavity-nesters), however, was lower nesting success in the modified landscape, with lower nesting success on clearcut edges than in interiors. Management recommendations are tentative, because the nesting success data is based on small samples and only two landscapes. Maintaining continuous, unlogged, old-growth cedar/hemlock forest is a reasonable, conservative strategy for maintaining interior-associated birds. But this study indicates that more research is needed on nesting success of birds, especially cavity nesters, in clearcut landscapes to ascertain whether leaving trees and snags in clearcuts is a good universal strategy for maintaining cavity nesting birds.

HABITAT USE AND BEHAVIORAL ACCLIMATION BY BIGHORN SHEEP INTRODUCED IN NORTH UNIT OF THE THEODORE ROOSEVELT NATIONAL PARK [TWS]

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Nineteen radio-collared California bighorn sheep (*Ovis canadensis californiana*) (14 ewes/5 rams) were introduced in the North Unit (Mckenzie County, North Dakota) on January 26, 1996 and monitored at 2-3 day intervals with the use of telemetry equipment for one year. Since their introduction, sheep have slowly increased their range inside and outside the park boundaries. The predictions of the North Unit bighorn sheep Geographical Information System (GIS) habitat model were generally validated by field observations. Sheep activities were focused in *Stipa comata/Carex filifolia* and *Artemesia tridentata/Agropyron smithii* habitat types. Vegetation analysis suggests percent utilization for areas used by sheep averaged 62% before the study animals moved to other foraging territories. Plant species composition in sites identified as used was highly variable. The physiographic type most frequently used

by the sheep was the Badlands type. Feeding was heaviest during the mid-morning and late evening hours for the entire year. Bighorn sheep interaction with other ungulate species (*Bison bison* and *Odocoileus hemionus*) and predators was frequent and rare, respectively. Sheep generally habituated to the presence of humans. Fourteen adult ewes produced eight lambs in 1996, three of which died of undetermined causes.

Assessing Gray Wolf Restoration in Idaho: Progress after Two Years [TWS]

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Valpa Asher and Alice Whitelaw
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Mike Jimenez
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At least 29 of 35 gray wolves (*Canis lupus*) translocated to central Idaho and released on-site at selected backcountry locations in 1995 and 1996 have survived into winter, 1997. Two wolves died as a result of human-caused mortality; 1 of apparent starvation, 1 wolf death remains under investigation, and the status of 2 wolves is unknown. Of 29 regularly monitored wolves, at least 18 have joined with other radioed and non-radioed wolves (N=4) to form 11 potential breeding pairs. Three potential breeding pairs are located north of the Salmon River and 8 potential breeding pairs are distributed to the south. Nine wolves of reproductive age remain alone within the experimental area: a male and female remain north of the Salmon River and 5 males and 2 females are south. Translocated wolves did not reproduce in 1995 but 3 litters were produced during 1996. Radioed wolves have been located from fixed-wing aircraft every 10 days (approximate) since July, 1996 but once every 3 weeks prior to that time. Wolves moved extensively within the experimental area from 1995 through winter, 1996. However, only 5 of 33 wolves have permanently vacated or dispersed long distances outside the experimental area. Paired wolves were increasingly predictable in their movements during summer, 1996 but less so during winter, 1996-1997. Wolves preyed on elk (*Cerus elaphus*), moose (*Alces alces*), mule deer (*Odocoileus hemionus*) , beaver (*Castor canadensis*), and domestic sheep and cattle. We responded to 9 livestock depredation incidents; 3 were confirmed wolf depredations. The distribution of Canadian wolves released in Idaho is similar to the distribution of historical wolf reports during the past 70 years. Surveys in 8 areas where wolves were known to occur in 1996 found hunter and outfitters were accepting or positive about their return to Idaho. On the ground management following wolf restoration has proven more complex and time consuming than anticipated.

Production and Survival of Elk Calves in Response to Habitat Improvement in Northwest Montana: Methodology [TWS]

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The purpose of my study is to learn the effects of winter range habitat improvement on elk (*Cervus elaphus*) pregnancy rates and calf survival in the Southfork of the Flathead river. Habitat enhancement is often done to mitigate losses to wildlife. The enhancement at Firefighter Mountain, completed in the summer of 1996, was done to mitigate the loss of elk winter range that resulted from the construction of Hungry Horse Dam. Determination of pregnancy uses a radio-immuno assay of fecal steroids. These assays successfully determined pregnancy in 10 elk during my first field season. Vaginal implants are being used to find out timing and location of birth sites in adult cow elk. Previous use of vaginal implants by researchers on ungulates has met with mixed and often poor results. Recently, a new type was developed for white-tailed deer (*Odocoileus virginianus*) and used with high success. This new design has been adopted and adjusted for elk. The implants consist of an inert plastic base from a progesterone implant, designed for domestic swine, attached to a radio transmitter. Although my sample size was small (n=5), retention rates were 100%, and I could determine time and place of parturition. Preliminary results are positive on the effectiveness of these methods.

Trends in Bison Management: What it Means for the Species [TWS]

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We have observed several common trends in recent literature and conferences on commercial bison production. These include: artificial seeding of native range, pest/parasite treatment, feedlot "finishing", dehorning, small herd sizes, highly skewed sex ratios, and culling or other selection based on subjective characteristics. The rationale for these activities is rarely articulated, and appears to be a carry over from the livestock industry. However, these techniques add unnecessary expense and labor when applied to bison. We argue that they are biologically and ecologically counterproductive as well. The history of ungulate domestication and management suggests that producers are forcing a native ungulate adapted to North American grassland ecosystems, with few pests/parasites/diseases, high reproductive

capability and low natural mortality into an artificial, expensive, labor intensive management system. We recommend producers adapt specific management strategies and activities to bison ecology and behavior, rather than vice versa. These strategies include: large herds on adequate acreages of native range, natural sex ratio , maintaining older age classes, exchange of yearlings between herds, random harvest strategies, and minimizing disease treatments. Strong artificial selection will likely result in another poorly adapted, less successful ungulate. Managers of public bison herds are in a unique position to preserve bison as a wild ungulate becau e they are not under the economic constraints of private producers. However, a review of public herd management shows there is a need to apply knowledge of conservation biology to bison management on public lands.

Dietary overlap of wolves and cougars within and near Glacier National Park, Montana [TWS]

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We compared patterns of prey selection among wolves *(Canis lupus)*, cougars *(Puma concolor)*, and humans to ascertain the effects of wolf recolonization and multiple predators on prey and on each other. Characteristics of prey selected by wolves and cougars in the same ecosystem have not been reported. White-tailed deer *(Odocoileus virginianus)* made up the greatest proportion of both wolf (0.83) and cougar diets (0.87), but elk *(Cervus elaphus)* and moose *(Alces alces)* made up a larger proportion of wolf (0.14, 0.03, respectively) than cougar (0.06, 0.02, respectively) diets. Wolves and cougars selected the same age classes in both deer and elk. They both selected older and younger deer and elk than human hunters did. They both selected fewer males than hunters did and they both selected more fawns and more males than expected based on availability. Cougar predation on elk was more male-biased than was wolf predation on elk. Cougars generally killed animals in poorer condition than wolves did, especially in elk. These data may be used by predator/prey managers to anticipate effects of wolf and cougar presence on populations of prey and may also be used to determine potential impacts of one predator on the other. We suggest possible management alternatives to mitigate effects.

The Effects of Wolf Colonization on Coyote Behavior, Movements and Food Habits [TWS]

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The Flathead area in western Montana is one of the last ecosystems in the United States still containing a full complement of mammalian predators and their prey. Recolonizing wolves (*Canis lupus*) may affect congeneric coyotes (*C. latrans*) by altering food habits, social behavior, movements and habitat use. We examined the effects of colonizing wolves in northwestern Montana on the resident coyote population. Radio-collared wolves and coyotes were monitored from June 1994 through December 1996 to determine home ranges and movements. Home ranges for eleven coyotes were distributed between the two wolf pack territories or on the edge of the territories, and did not overlap with core wolf areas. Locations for a 24-hour period on one canid were used to determine if temporal partitioning occurred between the canids. Coyote movement was the greatest between 1100-1400 and wolf movement between 0200-0400 hours. Some food partitioning does occur in that coyote diets consist of small mammals (i.e. snowshoe hare (*Lepus americanus*) and microtines), however, white-tailed deer (*Odocoileus virginianus*) are also consumed. Elk and white-tailed deer comprise the main diet of the wolf packs. Complex interrelationships between the predators in the North Fork occurs as well as interrelationships between the predators and the prey. Predators in fact account for 80 percent of the coyote mortality in the North Fork. Wolf presence may be beneficial to coyotes as a source of additional food through scavenging, but it also appears that the wolves are affecting coyote distribution and survival.

Tracking Elk Hunters with the Global Positioning System [TWS]

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In a study of elk-hunter behavior in western Montana, we used battery powered Global Positioning System (GPS) units to record hunter locations at 15-second intervals during 99 hunting expeditions in 1993, 1994, and 1995. Subsequent analysis within a Geographic Information System (GIS) enabled us to determine time and motion budgets for hunter effort, estimate the departure distance from roads and hunting camps, and evaluate the influence of closed roads on elk hunting techniques. Hunter locations were overlaid on other GIS layers to determine time spent in different vegetation classes and identify topographic situations selected for hunting. Hunters averaged 4.7 hours per hunt, while moving at a speed of 40 m/min for a distance of 10.7 km. Only half of all hunters got more than 2.5 km from their starting point, and only 5 percent went more than 5 km. The average distance from the nearest road while hunting was only 267 m, and hunters on foot spent 26 percent of their hunting time on roads. Hunters who spent the most time on roads also

recorded the greatest distances from their starting points. Sixty percent of all hunting was done on slopes less steep than the study area average, and westerly aspects were favored. Among the forest types available to them, hunters selected open Douglas-fir and Western Larch while avoiding Lodgepole pine and Sagebrush.

Demography and Trend of a Local Grizzly Bear Population in a Source-sink Landscape. [TWS]

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Demographic characteristics and local population trend of grizzly bears *(Ursus arctos horribilis)* were studied in the Swan Mountains of western Montana during 1987-1996 using capture and telemetry methods. We captured 50 grizzly bears in 108 capture episodes (1 bear/72 snare-nights). Using radio collared bears only, there were between 19 and 30 bears in the 1,457 km^2 study area each year (=1.6 bears/100 km^2). Density of bears in a 692 km^2 high-use area termed the Core Area averaged 2.5 bears/100 km^2. Twenty-eight cubs were produced from 17 litters for a mean litter size of 1.64 $\pm$ 0.12 cubs/litter. The reproductive rate for female cubs was estimated to be 0.389 $\pm$ 0.104. We obtained 170 bear/years of censored telemetry data from all classes of radioed grizzly bears, 25 of which died. The observed annual total mortality rate of 13.4 percent for all classes was higher than those found in expanding brown bear populations. Most mortalities occurred in roaded areas near private lands at the edge of the study area (Rural Zone) that exhibited a lower bear density than the Core Area. Dispersal movements of young females were confined to areas near the natal home range, away from the Rural Zone, while young males were more likely to utilize the Rural Zone. Using a derivation of Lotka's equation, our estimate of lambda during the entire study was 1.009 (95 percent confidence interval = 0.896 - 1.096). There was a 59 percent probability that the population was stable to increasing, a 55 percent probability that the population was increasing, and a 41 percent probability of population decline. The spatial occupancy of the Core Area suggested that the study area was at or near capacity under present landscape conditions. Differential bear densities within the study area, movement patterns, spatial occupancy, and vital rate characteristics suggested a "source-sink" situation.

Effects of Selective Hunting on Pronghorn Behavior at Fort Belknap Indian Reservation [TWS]

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Sport hunting usually is not considered to impact wildlife populations negatively. However, trophy hunting, a highly selective form of hunting, raises some concern among biologists because a distinct group of males is removed from the population. Among other effects, selective hunting can produce changes in breeding patterns. The objective of this study was to investigate effects of a selective hunt, which occurred during the breeding season, on behavior patterns of male pronghorns (*Antilocapra americana*). We compared demographic variables, activity patterns, and interaction rates among individually recognized males that were subjected to light, moderate and heavy amounts of hunting pressure at Fort Belknap Indian Reservation in northcentral Montana. Although group size, time budgets and interaction rates changed from the prerut time period to the rut, males living in areas subjected to the three treatments did not vary significantly in the amount of time they spent active, walking or reclining, nor did they vary in interaction rates. The number of fawns present in a male's group, however, was lowest in areas that received the heaviest hunting pressure. We conclude the trophy hunt, which is restricted to a maximum of 100 tags, did not adversely affect the reproductive activity of pronghorns in this population. However, biologists should continue to monitor age structure, sex ratio, and productivity in order to detect any changes that may occur as a result of the hunt. Furthermore, genetic diversity should be monitored to detect any changes that may result from a loss of prime males from the population.

Montana Black-footed Ferret Reintroductions, 1994-1996 [TWS]

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Black-footed ferrets *(Mustela niaripes)* reached the brink of extinction in the 1980s. Successful captive-breeding efforts have produced ferrets for release in the wild in 4 states since 1991. Montana reintroductions to establish a wild population began in 1994 with the release of 40 ferrets, another 36 in 1995, and 43 in 1996. Releases were on black-tailed prairie dog *(Cynomvs ludovicianus)* colonies on the UL Bend National Wildlife Refuge in southern Phillips County, northcentral Montana. Five wildborn kits from 3 litters were observed during 1995 and 18 from 7-8 litters in 1996. Approximately 35 animals were in this population during December 1996. Many variables affected success including; ferret age and rearing method, predator management, and habitat quality. Ferret kits pre-conditioned prior to release survived better than naive counterparts. Short-term ferret survival was apparently increased by exclusion of coyotes *(Canis latrans)* from release sites with electrified netting and/or lethal coyote control, but significantly higher survival through the following breeding season was not evident. We present and discuss results from these reintroductions and current assessments of techniques to establish wild black-footed ferret populations .

Cougar Food Habits, Prey Selection, and Predation Rates in the Northern Yellowstone Ecosystem [TWS]

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Cougar (*Puma concolor*) predation was studied from 1987 to 1996 in northern Yellowstone National Park and vicinity. Eighty-eight cougars were captured, 84 were radio-collared, and kills of 46 individuals were documented. Elk (*Cervus elaphus*) and mule deer (*Odocoileus hemionus*) comprised 98 percent of prey biomass and 81 percent of 302 cougar kills. Bighorn sheep (*Ovis canadensis*), moose (*Alces alces*), and pronghorn (*Antilocapra americana*) represented less than 5 percent of cougar kills. Among deer and elk, elk calves were the most important prey, mule deer were intermediate, and cow and bull elk were the least important prey relative to their availability. Predation rates averaged 9.4 days per ungulate kill and varied by cougar hunting experience (measured by age), weight, and ambient air temperature. Cougars killed only 2-3 percent of elk and 3-5 percent of deer on the study area each year. Migratory behavior, habitat use patterns, and the size of prey reduced the effects of cougar predation. Cougars did not effectively limit growth rates of elk and moose populations on the study area, because cougars selected their young preferentially to adults. Strong limitation of mule deer populations was more likely, because all sex-age classes were preyed upon more equitably. Our results indicated that altering the structure of cougar populations (e.g., by hunting) could change the influence of cougars on the numbers and sex-age structure of their ungulate prey. In other words, if the age structure of a cougar population in an area is skewed toward adults, cougar predation would more likely occur on larger ungulates such as elk over deer.

[1]Deceased

Numerical and Functional Responses of a Generalist Predator: Field Examination of a Simple Predator-Prey System [TWS]

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Many predators exhibit numerical and functional responses to fluctuating prey densities. Although it is often practical to measure the numerical response in field settings, functional responses are usually determined in laboratory experiments

because quantifying the components of predator consumption rates (handling time, search rate) in the field is difficult when predation events are rarely observed. However, more field testing is needed because some species show variable functional responses as ecological conditions (resource distribution, age composition of foraging groups) change. Understanding predator behavior is also prerequisite to interpreting the consequences of predator-prey interactions on community dynamics. We determined the numerical and functional responses of bald eagles (*Haliaeetus leucocephalus*) feeding on spawning kokanee salmon (*Oncorhynchus nerka*) at an autumn migratory concentration in west-central Montana. Bald eagles tracked the fluctuating number of salmon during four of five years. This ability was manifest in immigration and emigration rates, which were similar across years, and appeared facilitated by behavioral (group foraging, communal roosting) and physical attributes (keen eyesight) of bald eagles. Eagles exhibited a Type II functional response. Handling time remained constant across the range of prey densities, whereas attack rate increased with increasing salmon numbers. Functional responses differed between eagle age classes and among foraging modes, which reflected age-specific foraging behavior and suggested that eagles view live and dead salmon as alternative prey types. Overall, bald eagle predation on kokanee salmon is inversely density-dependent over most prey densities.

Harlequin Duck (*Histrionicus histrionicus*) Behavior and Habitat Use in a Northern Rocky Mountain Stream [TWS]

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The harlequin duck is a valuable case study for behavioral research because only 110 harlequin duck pairs are known to breed in Montana (Genter 1992). In spite of this regional rarity, McDonald Creek, in Glacier National Park (GNP) has the highest known density of harlequins in the intermountain region. The harlequin duck has been listed as Category 2 status, declining trend, under the Endangered Species Act. The USDA Forest Service lists the harlequin duck as a "Sensitive Species" in Region 1 USDA and Montana of Fish, Wildlife and Parks lists it as a "Species of Special Concern". The harlequin duck's vulnerability creates the urgent need to characterize the species habitat use, and define effective riparian assessment practices. Harlequin duck range throughout North America has decreased dramatically from the historical record. Solutions to this decrease are likely to be as varied as the biomes in which the species lives. This study is an initial component of a multidisciplinary, multiorganizational approach to harlequin conservation. This study site is important for harlequin duck research because of the extensive historic data collection at the site during 1973-75 and 1992-1994). This 2-year study began in fall, 1994 with initial habitat use surveys. Observed behavioral responses by males during the breeding season showed significant sensitivity to human presence. Responses by males varied from immediate flight, to stress behaviors such as physical positioning of the male between the intruder and the female, accompanied by repeated headbobbing. Males engaged in courtship displays culminating in mating and intraspecies aggression were significantly less sensitive to human presence. Observed behavioral responses by females during the breeding season, nesting and broodrearing showed less

sensitivity to human presence than the males, although flight or drift responses still occurred at ranges of less than 100 m. Immature ducks before full flight showed less sensitivity to human presence than the females, with flight or drift responses still occurred at ranges of less than 70 m. All classes of harlequin ducks used riparian habitat features such as exposed, in channel boulders for loafing. No classes of this species used study stream reaches with substrates smaller than large gravel.

Rare Carnivores and Highways: Management Problems and Solutions [TWS]

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The impacts of highways is a serious conservation issue facing rare carnivores (grizzly bear, *Ursus arctos;* gray wolf, *Canis lupus;* wolverine, *Gulo gulo;* lynx, *Lynx canadensis;* fisher, *Martes pennanti*). Carnivores are vulnerable to highways because of their large spatial requirements, which require frequent crossings of busy roads. Highways are habitat and ecosystem issues. Highways affect carnivores by increasing direct and indirect mortality, habitat loss, habitat fragmentation, and displacement. The impacts of highways on carnivores are permanent and severe. The author hypothesizes that: 1) there is an increasing effect on carnivores as the standard of road or highway is increased and 2) that extirpation of rare carnivores in the lower 48 states is partially a factor of highway density. Suggested priorities for reducing highway impacts on carnivores include: 1) educating agency personnel, biologists, engineers, and the public on highway/wildlife impacts; 2) emphasis on research; 3) identification and protection of land corridors; 4) implementation of highway crossing structures; and 5) improving wildlife/highway mitigation policies.

Integrating Wildlife Conservation And Ecosystem Health: An Example From The Columbia River Basin, USA [SAF]

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The theory and practice of ecosystem management is pivotal to the debate over how to sustain the health and productivity of our environment. Despite substantial and recent effort to implement ecosystem management in the United States and elsewhere, to date considerable uncertainty remains about how to evaluate the historic and natural spatial-temporal variation in ecosystems, secure present and future management options by maintaining essential parts of an ecosystem (including wildlife), analyze wildlife information—habitat, distribution and abundance—that often is insufficient at the ecosystem scale, predict wildlife habitat and other requirements at the ecosystem level to satisfy national and agency legal and policy requirements, and offer recommendations that vary with taxa to ecosystem change—historic and future (i.e., restoration)—at an ecosystem scale that matches both planning strategies and implementation opportunities of land and resource management agencies. Our central goal in assembling this paper is to examine these five aspects—in essence the concept of ecosystem health and its relation to wildlife management—in a contemporary landscape, the Columbia River Basin in the Pacific Northwest of the United States. Our Interagency Working Group report begins with brief description of the extent and ecological significance of the major departures in the nature, distribution and structure of vegetation since intensive European settlement. Second, all vertebrate wildlife species within the Basin are evaluated based on trend, habitat and other information to identify those in need of consideration in management to meet legal and policy requirements. Third, given the lack of habitat and other natural history information for many species, we

describe a process to build and evaluate species' habitat information, recognizing that effects of environmental change on individuals is more easily detected than on populations (although the latter are often needed to meet legal and policy requirements under the Endangered Species Act, the National Forest Management Act and similar legislation). The fourth aspect is not a trivial task whether in scale, theory or practice. Specifically, characterize the distribution and abundance of habitats for species groups (related to geographic scale and species-specific ecology and behavior) and/or individual species; and determine whether such habitats may serve as "sources" of individuals—a consideration to the maintenance of viable species populations—or "sinks" where populations may be expected to decline without regular immigration; and map the results of task four. Unfortunately, most available wildlife and ecosystem theory and scientific literature addresses ecosystem management at a scale far less than that needed to implement, greatly increasing the difficulty in developing reasonable implementation ecosystem management strategies. We conclude with lessons learned in linking ecosystem health and wildlife management.

Hunter Management Strategies Utilized by Montana Ranchers [TWS]

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A survey of private ranches was conducted to identify practices used in Montana to manage hunters. A questionnaire was sent to 989 ranchers from a population identified as typical working ranches larger than 400 ha. Respondents (42% return) indicated 80 percent had no restrictions or simple permission to hunt on most of their land. Twelve percent of the respondents indicated their ranch was closed to hunting and 12 percent had fee hunting operations or leased to outfitters. Past damage by hunters (42%) and conflicts with hunters (33%) were reasons most cited for closing ranches to hunting. Combinations of strategies were utilized with vehicle restrictions, advanced reservations and check in/out being most common. Ranch size influenced management strategies with 63 percent of ranches under 4000 ha requiring only simple permission to hunt compared to 28 percent of ranches larger than 4000 ha. Sixteen percent of the smaller ranches had 50 percent or more of their land closed compared to 5 percent of the larger ranches. Implications of study results include a need for programs to address landowner concerns and programs to impress upon hunters the importance of their behavior in affecting public access to private land.

Nesting Success in Deciduous Riparian Habitat: How Landscapes Affect Nest Predation and Brood Parasitism [TWS]

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Effective wildlife conservation programs depend on a thorough understanding of the processes that limit population growth and the scale at which these processes change. In the case of migratory birds, two of the primary processes that limit breeding productivity are nest predation by a host of predators, and brood parasitism by brown-headed cowbirds (*Molothrus ater*). The importance of these processes depend on the behaviors of the predators and brood parasites interacting with their environments over large spatial scales. We examined the relationship between patch size, edge effects and landscape composition in determining nest predation and brood parasitism rates for species nesting in deciduous riparian areas in western Montana. Predation and parasitism were monitored in sixteen riparian areas surrounded by different landscapes, eight of which are primarily forested, and eight of which are dominated by agriculture. Parasitism was strongly related to the density of farms and feedlots, and was higher in the agriculture treatment. However, predation pressure was consistently higher in forested landscapes. Parasitism may be more clearly related to certain landscape metrics because it reflects the behaviors and habitat use of a single species, the brown-headed cowbird. In contrast, predation rates are determined by interactions between predator community composition, predator behaviors, and the nesting patterns of potential prey in different landscapes, creating a more complex system.

Elk On The Urban Fringe: A Credibility Challenge For Wildlifers [TWS]

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Plausibly 100,000 free-roaming elk (*Cervus elaphus nelsoni*) habitually occupy human settlements or activity centers across western North America on an occasional or seasonal basis. If elk that are conditioned to human presence realize increased survivorship by occupying residential areas and other refugia during hunting season, then numbers of conditioned elk probably are increasing more rapidly than other segments of the Rocky Mountain subspecies. While wildlife managers advocate retention of natural habitats to prevent elk displacement from urban fringe areas in Montana, elk populations are expanding beyond management control in the face of extraordinary human population growth along the Front Range of Colorado. Land developers and governing bodies may find it increasingly difficult to accept the concept of elk habitat loss, and wildlife managers may find the concept increasingly difficult to explain, as the public gains awareness of conditioned elk responses. We present a conceptual framework for understanding and assessing elk responses to urban expansion, based on literature review and experiences with open space

conservation in and around Missoula, Montana. Conflicting observations of elk tolerance and intolerance in response to humans and habitat alterations may be reconciled by understanding that elk adapt behaviorally to maximize reproductive fitness. Elk behavioral responses to human developments may be predicted with improved reliability if managers correctly identify the most important factors that influence reproductive fitness under a given set of circumstances. Input in planning processes should be linked with clearly communicated goals, recognizing that elk survival may be less at issue than diverse human desires.

Deer Mouse Population Stability, Synchrony, and Biomass Loss in Western Montana, 1994-1996 [TWS]

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Small mammal abundance has been speculated to have causal links to ecological processes ranging from human outbreaks of Hantavirus Pulmonary Syndrome (HPS) to predation on cervid fawns. During a study of hantavirus and deer mouse (*Peromyscus maniculatus*) ecology, we live-trapped 18 one-hectare grids at six sites in western Montana. We trapped monthly during the summers of 1994-1996. During 1994, the monthly minimum number alive (MNA) of deer mice on all grids ranged from 207 to 498 mice and monthly site average MNAs ranging from 0 to 66.7 mice. In 1995 populations were much lower, with monthly grid total MNAs ranging from 84 to 119 mice and monthly site average MNAs ranging from 0 to 16.7 mice. In 1996, populations increased with monthly grid total MNAs ranging from 141 to 452 mice and monthly site average MNAs ranging from 0 to 71.7 mice. In 1994 and 1996 the peak grid MNAs were at Polson and most grid populations increased to a peak in August or September. In 1995 the peak grid MNAs were at Cascade and most grid populations were bimodal with early and late summer peak MNAs. Within-site and between-site population synchrony will be examined. Values for monthly deer mouse biomass loss will be presented and discussed in terms of population stability.

Wildlife Management on the Fort Belknap Reservation [TWS]

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The goal of wildlife management on Fort Belknap Reservation is to maintain populations within habitat carrying capacity. Harvest management objectives are established within the constraints of the population objectives. Hunting regulations are the primary tool used to fulfill management objectives. Hunting fees for tribal members are set a level comparable to Montana state resident fees. Non-member hunting license fees are market driven. An estimate of receipts for 1995 is $86,500. Other examples of hunting regulations, income generated through license sales and evaluation of harvest management results are provided. Habitat management, law

enforcement, and education are also important components of wildlife management on Fort Belknap. The Fish and Wildlife program has grown from one full-time employee to 6 full-time employees during the past decade.

Identifying Landscape Elements in Relation to Elk Kill Sites in Western Montana [TWS]

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The landscape elements that influence elk (*Cervus elaphus*) vulnerability during the hunting season were studied in the Chamberlain Creek area of western Montana. Locations of 84 hunter killed elk sites were compared to live elk locations and random points using discriminant function analysis. Elk kill sites could not be differentiated from random points, but locations of live elk were readily differentiated from both elk kill sites and random points. Elk selected elements of the landscape that 1) were not in close proximity to open roads, 2) had low road densities, and 3) contained forested cover in large patches that had not sustained timber harvest treatment within the past 10 years and provided substantial hiding cover.

There's a Mouse in the House!: The Ecology of the Deer Mouse in Peridomestic Settings [TWS]

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Deer mice (*Peromyscus maniculatus*) are the principle reservoir of the Sin Nombre virus (SNV) that is the etiological agent of hantavirus pulmonary syndrome (HPS). Several studies of SNV in sylvan populations of deer mice are ongoing. However, most human cases of HPS are contracted in buildings (i.e., houses, trailers, barns, granaries, etc.). Unfortunately, virtually nothing is known about the ecology of deer mice in buildings. In October, 1996 we initiated a study to investigate the ecology of deer mice in peridomestic settings in western Montana. These data will be used to further our understanding of the SNV infection cycle in humans. The results of the first 6 months of our research will be discussed.

Body Composition and Migration Potential of Army Cutworm Moths Taken from Alpine Aggregation Sites in Glacier Park [TWS]

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Grizzly bears (*Ursus arctos horribilis*) consume army cutworm moths (*Euxoa auxiliaris*) from late June through mid-September on alpine talus slopes in Glacier National Park, Montana. To better understand the nutritional importance of army cutworm moths to grizzly bears in Glacier National Park, we determined temporal abundance patterns, body mass, total moisture, total nitrogen, total lipid, and gross energy of moths collected from alpine moth aggregation study sites throughout the summer. Army cutworm moths arrived in the alpine of Glacier National Park in early July in 1994 and in late June in 1995. We did not capture any army cutworm moths after 10 August in 1994 or after 30 July in 1995. Army cutworm moths showed a marked increase in body mass, total moisture, total lipid, and gross energy, and a decrease in total nitrogen over the course of the summer. We calculated that an army cutworm moth flying in late summer through still air, presumably at a speed that minimizes cost of transport, could fly 140 km using body lipid reserves alone.

Environmental Sciences and Engineering

Preliminary Study of the Beaverhead River and the Effects of the Dillon Community: Biology [MAS]

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Aquatic macroinvertebrate diversity and abundance are often used as a barometer of the health of riparian ecosystems. Aquatic macroinvertebrate counts, in conjunction with chemical analyses of specific stream reaches, may be useful harbingers of stream degradation. Sixty-two students from the 100 level biology class at WMC-UM participated in the field collection and in the laboratory identification of aquatic macroinvertebrates (to Order) sampled from four stations along the Beaverhead River in southwestern Montana. Stations were approximately 20 feet in length and located within the low water marks in areas with riffles and cobbles. Students collected 3 replicate samples of macroinvertebrates, with a surber stream bottom sampler, within each of the four river stations in January and again in February of 1997. Histograms were plotted to allow comparison of the distribution of invertebrate Orders within and across each of the four river sites. Two species

richness indices, the number of species in a defined sampling unit (S) and Margalef's index (Dmg) and one proportional species abundance index, Simpson's (D) were calculated for each of the four river sites for both January and February. S and Dmg show relatively little change across all four river sites while D indicates a loss of diversity and a shift in species dominance/ evenness characteristics at our most downstream site (below a sewage treatment plant). At this site, aquatic nematodes (Nematoda) are 6 times more abundant than any other aquatic invertebrate Order.

Preliminary Study of the Beaverhead River and the Effects of the Dillon Community: Chemistry [MAS]

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Students in two Freshman-level college chemistry classes studied water quality of the Beaverhead River, which flows through Dillon, Montana, as a lab component of their classes. This activity had several goals -- to involve beginning-level chemistry students in real scientific research, to offer the community planning boards information that would otherwise not be available, and to provide data for a longer term monitoring of Beaverhead River water quality. Many of the students at this college are studying to become public school teachers, so an additional goal was to provide a model for student research in science classes. Four collections sites were chosen: two upstream from Dillon, one just within the town, and one just downstream of town. Chemical analyses were done using a HACH portable water chemistry lab, with EPA-approved equipment and test procedures. Analyses performed at the water-collection sites included temperature, pH, dissolved oxygen, conductivity, and total dissolved solids. Samples were transported back to the lab and immediately analyzed for ammonium, nitrate, sulphate, and phosphate ions and alkalinity. One group tested the reliability of the results using chemical standards. Our analyses show that the river water is well within drinking-water standards for the analytes studied. It has healthy dissolved oxygen and pH levels and is well buffered. The results of this project provide a "clean" base level for planned continued monitoring of the river.

Chemical Characterization of Clark Canyon Reservoir, Montana [MAS]

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A preliminary study of the water chemistry of Clark Canyon Reservoir, Montana, was begun. Clark Canyon is located 20 miles south of Dillon, and is filled by Red Rock River and Horse Prairie Creek, and is the source of the Beaverhead River. Clark

Canyon is a rich and popular fishery. Samples were taken at the deepest part of the lake (near the dam) depths of: surface, 5 m, 10 m, 15 m, 20 m, and bottom (approx. 25 m). During the winter, holes were drilled in the ice and a water sampler used. Temperature, pH, dissolved oxygen were measured on site, and the samples were immediately transported back to the lab for analysis. All analyses were done within 48 hours of sampling. Analysis was done with a HACH DR/2000 Spectrophotometer following EPA protocols. Results obtained for several analyses are reported here. The concentrations reported are ranges and averages of samples taken on four different dates. Calibration standards were run to check for accuracy, and all reported results have errors of less than 10%. Sampling dates: 1/5/97, 1/31/97, 2/23/97, 4/17/97. All concentrations are in mg/L except pH and where otherwise noted. Temperature: range 1-6°C, average 4°C. Dissolved oxygen: range 4.7-4.8, average 9.3. Nitrate: range 0.44-1.63, average 0.77. Nitrite: range 0.013-0.030, average 0.020. Sulfate: range 66-88, average 76. Phosphate: range 0.33-2.86, average 0.89. Iron: range 0-0.71, average 0.14. Fluoride: range 0.10-0.69, average 0.40. Chloride: range 6.6-16.5, average 9.8. Ammonia: range O.12-0.37, average O.22. Calcium hardness: range 112-185, average 151. pH: range 7.56-8.64, average 8.10.

The Atmospheric Missing Link - Where Has All of the CO^2 Gone? MAS

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Being able to accurately estimate the global carbon budget is critical to the estimation of future environmental conditions. Comparing known CO^2 sources and sinks, modelers have recorded an annual net imbalance of approximately 2.2 gigatons of carbon. It was hypothesized that the oceans were sequestering the "missing" carbon, but testing has resulted in the rejection of that hypothesized. It is assumed that the potential sink must be large and have global distribution to account for such a massive quantity of carbon. After the oceans, the next largest potential sink appears to be the soil. This research analyzed soil samples from a Kansas State University experimental site that had been established for the purpose of examining the effects of elevated CO^2 levels on soil carbon content. Treatments examined were ambient and two-times ambient CO^2 levels. Particulate Organic Matter (POM) was isolated from whole soil samples using a dispersing agent and mild mechanical disruption of aggregate structure. The POM was then treated with a series of density extractions to isolate distinct phases of the degradation continuum. Dry weight examination revealed increasing POM recovered with exposure to elevated CO^2. SEM revealed that the density extraction procedure successfully isolated distinct POM fractions. Carbon analysis revealed that soil carbon levels increased significantly under enhanced CO^2 conditions - Rough calculations indicate the deposition of an additional 0.2 kg C/g whole soil per m^2 to a depth of 5 cm.

The Integration of the Sciences at Western Montana College, Dillon, Montana [MAS]

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Western Montana College is a small (1200 students) liberal-arts college located in southwestern Montana. Starting in the fall semester of 1996, the science departments joined forces to form an interdisciplinary department of environmental sciences. This move was motivated by a desire to create an undergraduate program that involves meaningful integration of the sciences. As a result, we eliminated the traditional departments (e.g., biology, chemistry, geology, and physics), and formed a single department focused on field-based, environment-specific education. In order to obtain sufficient background in a particular science discipline, each student will choose a track in biology, chemistry, or geology. However, to provide integration, students will also take several field courses that require them to work as part of an interdisciplinary research team. In addition, each student will do a senior project or professional internship that incorporates several science disciplines. This approach has been tested through several projects incorporating more than five classes. Studies have been started on the effects of past mining in the Birch Creek drainage in the Pioneer Mountain Range, and the effects of the Dillon community on the Beaverhead River. We have also had one student in an internship with the USFS in a study of riparian zones. Another student completed a semester of research at Argonne National Lab in Chicago, IL. That work was in an environmental sciences lab studying the soil as a possible carbon sink for global emissions.

Forensic Sciences

Adventures in Baby-sitting: How Not to Treat Your Ward!!! [MAS]

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Perhaps one of the saddest and most tragic cases in recent times occurred during the evening hours of September 9, 1995 in Kalispell, MT. Two and a half year old Joshua Scott Norman died as the result of intentional poisoning at the hands of his teenage (15 years old) baby sitter. Early efforts at denial of any wrong doing on the part of the baby sitter were quickly dispatched through the combined efforts of the State Crime Lab's Medical Examiner, Toxicology Section, and Chemistry Section. The lab was able to show that young Joshua Norman had succumbed to lethal levels of codeine and phenol (one of the active ingredients found in Pine-Sol). The lab's

analytical results provided the investigators of the Kalispell Police Department the necessary tools to challenge the baby sitter's questionable participation. After 10 days of compassionate, though painstaking, interviews the baby sitter confessed to intentionally "dosing" her young ward. Consequently, the baby sitter was remanded to adult court where she pled guilty to homicide. This case, though tragic and heartbreaking as it was, may not have had a successful conclusion if not for the combined efforts and close communications between the State Crime Lab, the Kalispell P.D., the Flathead County Coroner's Office, and the Flathead County Attorney's Office.

Alcohol: Three Case Studies [MAS]

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A discussion of three recent cases analyzed at the State Crime Lab is presented with relevant scene descriptions, results of the autopsies, and analyses of the samples:

Case 1. The victim is described as an alcoholic 41 year old male who was found with his trousers and underwear around his ankles and dead in a closet of his trailer house. There was no evidence of trauma noted on the body and there was an absence of pornographic materials ruling out an autoerotic episode. Cause of death was not determined at the scene or during the autopsy. Analysis of submitted samples at the laboratory indicated high levels of methanol (0.27 gm/dL; Lethal Levels = 0.02-0.04 gm/dL). Investigating officers returned to the scene and found a gallon bottle of windshield washer fluid that contains 35% methanol under the kitchen sink. Cause of death in this case was due to methanol poisoning and manner of death was suicide.

Case 2. The victim is described as a 75 year old female who was found dead lying in the snow between her residence and her car. Small patches of fresh blood were noted in the snow around her, but there was no evidence of trauma. A cause of death was not determined at the scene or during the autopsy. Analysis of submitted samples indicated the presence of ethanol in both the blood (0.12 gm/dL, Legal Intoxication = 0.10 gm/dL) and urine along with significant glucosuria. Cause of death was attributed to hypothermia and manner of death was accidental with alcohol (ethanol) as a contributing factor.

Case 3. The victim is described as a 36 year old non-drinking female who was found dead lying on the front porch of her home with her coat for a pillow. A small amount of fresh blood was noted oozing from one ear during the autopsy, but no visible signs of trauma were noted. Again in this case no cause of death was apparent at autopsy. However, at autopsy a large fatty liver and brain atrophy were noted. Analysis of submitted samples in this case indicated a very high blood alcohol concentration (0.43 gm/dL; Legal Intoxication = 0.10 gm/dL) and the presence of caffeine in the blood. High levels of glucose were also detected in the urine even though the patient was not diabetic. Cause of death was attributed to hypothermia and manner of death was accidental with acute alcoholism as a contributing factor.

Mathematics, Statistics and Computer Sciences

Optimizing an Unconventional Schedule: A Linear Programming Model [MAS]

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Scheduling tutors for the Developmental Mathematics Laboratory as well as laboratory assistants for the computer laboratories of Computing and Information Services and Mathematics Department creates an immense scheduling problem each semester. The individuals who schedule these laboratories, no matter the methods used, waste hours composing semester schedules. All the schedules consist of one-hour shifts; however, restrictions are put on these schedules: students' available hours, placement preference of work study versus non-work study students, possible symmetry or blocking of weekly hours for each student's schedule, and more than one students working the same shift. The complexity of these schedules is directly derived from the scheduler's goal to remain within their budget and to work around their employee's class schedules. Composing these unconventional schedules, by hand, poses different methods of solution and the possibility for reaching a financial or efficient "best" schedule is limited. The method of solution is combining these three sets of scheduling difficulties, with their peculiar requirements, into a linear programming assignment model using LINGO. The model will be implemented by an interface written in Visual Basic.

Mathematical Infallibility: A Consideration of Crowe's Ten Misconceptions About Mathematics [MAS]

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In recent decades, questions have been raised about the rules of evidence for verifying mathematical truth. Does the use of computer technology expand our options? When is a historical problem such as Fermat's Last Theorem or the Four Color Map Problem considered to be solved? Can modern technology help us to prove the Goldbach Conjecture? Michael J. Crowe, in his "Ten 'laws' concerning patterns of change in the history of mathematics", challenges traditional views of the nature of mathematical truth. He does not, for example, deny that deduction plays a major role in mathematical methodology, but he asserts that it cannot be the sole method of mathematics. He points out that many errors have occurred in work published by mathematicians, thereby raising a question about one aspect of infallibility. He questions the claims that mathematical knowledge has developed in a strictly cumulative manner and that standards of rigor have remained uniform. Rather, he sees strong parallels between the methodology of mathematics and the hypotheticodeductive methodology of science. The history of mathematics has focused on western developments with less attention to non-western mathematics. In

the spirit of Greek mathematics as the beginning of the era of deductive mathematics, it is natural to charge that non-western contributions are "less mathematical". I claim that denigration of the contributions of non-western mathematicians, both in terms of their results and their methodologies, renders a disservice to an understanding of ways of thinking mathematically and will hinder us in our efforts to advance mathematical knowledge.

Molecular Biology

Cuticular Hydrocarbons in Caribbean Fruit Flies MAS

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A population of Caribbean fruit flies, *Anastrepha suspensa*, was accidentally transported to Florida in 1965. They have since been a serious pest of many common tropical and subtropical fruits grown in Florida, including citrus fruits. The flies have become a threat to the production of citrus fruits, and every measure possible is being taken to prevent their reproduction. I propose that a sexual dimorphism exists between the cuticular hydrocarbon makeup of males and females. If there is such a dimorphism, then it is likely the result of the existence of sex-pheromones or sex-pheromone components. This would lead to the possibility of controlling *A. suspensa* via a pheromone-synthesis inhibitory compound. The cuticular hydrocarbons of *A. suspensa* males and females were analyzed using simple gas chromatography, mass spectrometry, and dimethyl disulfide derivatives. Possible sex-pheromone compounds were identified as alkadienes from this data in conjunction with bioassays of courtship behavior. Their biosynthetic pathway will be examined to better understand how alkadienes are formed in fruit flies.

Identification of Novel E-Selectin Ligands Expressed on Human and Bovine Lymphocytes MAS

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Here, we describe novel E-selectin ligands expressed on human and bovine lymphocytes. Leukocyte extravasation into the underlying tissue involves a multi-step process requiring many molecular interactions. E-selectin, a member of the selectin family, is up-regulated and expressed on activated endothelial cells and mediates leukocyte rolling on the activated endothelium via E-selectin ligands expressed on the circulating leukocyte. In this report, we used an E-selectin/Fc chimera to analyze bovine γδ T cell and human lymphocyte E-selectin ligands.

E-selectin chimera specifically stained bovine and human leukocytes by FACS analysis. Immunoprecipitation of biotinylated γδ T cell lysates with chimera resulted in two ligands of 200kD and 250kD. Additionally, chimera immunoprecipitation of biotinylated human lymphocyte lysates resulted in three potential ligands of 120kD, ~220kD, and 260kD. E-selectin ligand immunoprecipitation was specifically inhibited by blocking the chimera with function blocking monoclonal antibody. Lymphocyte E-selectin ligands have proven to be difficult to define in the past, therefore, we have provided preliminary information regarding lymphocyte E-selectin ligand expression.

Electrophoretic Characteristics of the Lectin from Grasshopper [MAS]

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Grasshopper lectin (GHA) is a C-type (calcium stabilized) glycoprotein that is purified from the insect's hemolymph by means of affinity chromatography and high performance liquid chromatography procedures. The protein is an immunomolecule and serves to opsonize fungal blastopores and perhaps other pathogens toward hemocytic clearance from the hemocoel. This work contributes to the physicochemical characterization of the molecule. Denaturing polyacrylamide gel electrophoresis (SDS-PAGE) is used to study the molecular weight of the homodimer and the (reduced) monomeric subunits. The amount of carbohydrate is estimated by performing SDS-PAGE on enzymatically deglycosylated GHA. The nature of the carbohydrate is examined with Western blotting and specific lectin probes. Results show GHA to be a 72 kD dimer composed of identical 36 kD monomers. Carbohydrate accounts for about 4% by weight of the molecule and is likely composed of 8-10 hexose units per monomer. The carbohydrate is attached via N-linked asparagine.

Solution Properties of the Partially Oxidized Tetracyanoplatinate(II) and Bis(Oxalato)Platinate(II) [MAS]

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Partial Oxidation of the tetracyanoplatinate(II) and the bis(oxalato)platinate(II) results in copper colored needle like crystals where the platinum atoms are stacked on top of one another like a roll of coins with considerable Pt-Pt bonding characteristics. The platinum atoms in these complexes are in non-integral oxidation states varying from +2.2 to +2.4. These needle like crystals have interesting anisotropic physical properties, most notably they conduct electricity along the Pt-Pt chain some 105 greater than perpendicular to the chain. While the solid state properties of these complexes have been well documented the solution properties

have only recently been studied to any great extent. The use of ^{195}Pt nmr and UV-Vis spectroscopies determined the different species present in the reaction solutions. The bis(oxalato)platinate(II) solutions have been thoroughly characterized. These solutions contain various oligomeric platinum species including dimers, trimers, tetramers and pentamers where the platinum oxidation state decreases as the oligomers size increases. The tetracyanoplatinate(II) also consist of oligomeric platinum species in solution. In these solutions only the Pt(III) dimer has been characterized; however, there is some evidence of a paramagnetic trimer. Understanding the solution properties of these oxidation reactions are crucial for controlling the polymerization of the platinum complexes.

cDNA Sequence, Amino Acid Sequence, and Molecular Model of Grasshopper Lectin (GHA) MAS

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Grasshopper lectin (GHA) is an immuno-molecule with a role in defense and protection mechanisms of the insect. Molecular cloning and DNA sequencing procedures are used to characterize the lectin molecule. A cDNA library constructed in a lambda gt11 expression vector yielded an antibody-positive clone that contained a 300 bp cDNA that was labeled and used to isolate additional positive clones by hybridization to DNA lifts. An 879 bp cDNA fragment coding for the amino portion of the GHA protein was isolated, cloned, and sequenced. The carboxyl region of the protein was obtained through 3' RACE procedures to yield an entire open reading frame coding for a protein of 324 amino acids, followed by a 147 nt 3' NTR. A 1000 nt 5' NTR was identified by 5' RACE procedures. The deduced amino acid sequence shows familial homology when aligned with that of other C-type lectins. The GHA molecule is novel among the invertebrate lectins in that it contains two carbohydrate recognition domains (CRD), presumably having arisen by a gene duplication event. A 3D homology model of one CRD has been generated based on the crystalline structures of two related vertebrate lectins.

Hydrocarbon Identification and Characterization in *Galerucella calmariensus*, a Biological Control Agent, on *Lythrum salicaria*, a Noxious Wetland Weed MAS

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Galerucella calmariensis, a chrysomelide beetle native to Europe, has been introduced into North American wetland ecosystems as a biological control against *Lythrum salicaria* (purple loosestrife), a native of Eurasia. Frequently, exotic plants, removed from natural environmental limitations, aggressively invade and dominate

plant communities. Among other advances, biologists have propagated and relea ed five natural enemies in an attempt to reduce the distribution and impact of Lythrum. Galerucella is a hostspecific, defoliating beetle, which inflicts its greatest damage to plant vigor and seed production during larval stages. Field observations indicate that Galerucella aggregate throughout their life span, but particularly as teneral adults, prior to dispersal, a more thorough understanding of this behavior may prove expedient for integrating biological, chemical, and mechanical control efforts against Lythrum. Toward an end to isolate the aggregation pheromone(s), we have combined gas chromatography and mass spectrometry to characterize cuticular hydrocarbons. To date, 20 to 25 compounds have been identified. Further efforts have centered around isolating the aggregation pheromone(s) by developing an effective method for bioassaying responses to chemical attractants. Here, these measures are described in addition to applicable rearing details.

NEUROSCIENCES

THE ROLE OF NT-3 IN THE FORMATION OF THE DORSAL ROOT GANGLION MAS

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The goal of this study is to examine the mechanisms involved in the developing avian Dorsal Root Ganglion (DRG) prior to target-mediated programmed cell death. Previous research has shown the expression of Trk C on a discrete subset of migrating neural crest cells (st. 19). Prior to programmed cell death for post-mitotic neurons (st. 24, E4) Trk C is also expressed on the majority of cells in the developing DRG. We wanted to examine the function of NT-3 on the developing DRG's prior to target-mediated programmed cell death. First we injected NT-3 into embryos and found no increase in cell numbers in brachial DRG (limb-innervating). However, in Cervical DRG (non-limb bud innervating) there was a substantial increase (40%) due to the exogenous NT-3. In a separate set of experiments, we transected the wing buds as soon as they appeared. This resulted in a decrease in cell number in the developing brachial DRG compared to the contralateral DRG with an intact limb bud. Since NT-3 has also been shown to be expressed in the developing limb-buds during DRG differentiation (Hallbook and Lefcort, unpublished results), our results suggest a normal function for NT-3 in maintaining survival and/or promoting proliferation of DRG precursor cells. We are now investigating directly how NT-3 elevates DRG cell numbers and why limb bud ablation decreases cell numbers.

Pharmacology and Toxicology

Screening of Peruvian Ethnobotanicals for 5HT1a and 5HT2a Receptor Binding Activity [MAS]

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Late in 1995, plants of ethnobotanical importance were collected in southeastern Peru. Many of these plants have been used by natives for treatment of headache. Since headache, especially migraine, is thought to involve serotonergic mechanisms, we have started to screen crude 70% ethanol extracts for *in vitro* receptor binding activity in two systems, 5HT1a and 5HT2a. About two dozen specimens have been examined. Only three of these specimens have significant activity at 5HTla receptors, but nearly half of the specimens demonstrate substantial binding activity at 5HT2a receptors. As quantified by displacement of tritiated ketanserin, three specimens give approximately 90% binding at 1/100 dilution of the crude extract. These samples have also been tested for concentration-dependent binding and are considered to be lead samples at this time. Protocols for identification of active principles from these high priority samples involve standard solvent partitioning followed by HPLC fractionation. HPLC fractions are then retested pharmacologically. The single highest priority plant, *Petiveria alliacea*, has shown outstanding activity following fractionation. The long-term goal of this work is to develop superior anti-migraine drugs.

Differential Activation of C6 Glioma Protein Kinase C Isoforms by a Phorbol Ester and Trimethyltin [MAS]

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Trimethyltin (TMT) is a potent neurotoxin that produces delayed, irreversible damage. Damage is usually not evident for 48 hours. Activation of Protein Kinase C (PKC) has been implicated in the neurotoxicity produced by TMT. In a neuronal cell line, TMT causes translocation and activation of PKC within 30 minutes. We used a rat C6 glioma cell line to determine the ability of PKC to translocate in the presence of phorbol 1 2-myristate 1 3-acetate (PMA) or TMT. Further studies were conducted to differentiate specific isozyme involvement. Isoforms were separated by gel electrophoresis and identified by Western blotting with specific monoclonal antibodies. We have identified the presence of the α, β, γ, δ, ε, θ, ζ, λ, and μ isozymes

in our C6 cell line. These isozymes of PKC were evaluated on their responses to PMA and TMT exposure. All of the cPKC and nPKC isoforms translocated to the cell membrane following PMA exposure. The aPKC isozyme were not translocated by this treatment. TMT exposure for up to 1 hour did not translocate any of the PKC isoforms. PKCs α, δ, and ζ were also evaluated after 24 hours of treatment with PMA and TMT. PKCs a and d had down-regulated with the PMA treatment, while no translocation was detected with TMT treatment on any isoform.

Assessment of Cardiovascular Risk in a Pharmaceutical Sciences Laboratory Course [MAS]

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The current study assessed blood lipid levels in pharmacy students by 4 methods. The measurements were made by a commercial laboratory, by the O-T-C product Advanced Care ™, by the Cholestech ™ LDX Auto-Analyzer System, and by Sigma Kits #352-20 and #352-5 for total cholesterol and HDL fraction, respectively. The possibility that the lipid profiles of male and female pharmacy students might differ from each other and from the general population was also explored. All methods of determining blood total cholesterol and other lipid fractions were comparable and observed differences were attributed to gender. Male pharmacy students (N= 88) had total cholesterol levels of 185.84 ± 1.17 mg/dL which did not differ from those of female students (N= 84) which were 185.60 ± 0.73 mg/dL. Female pharmacy students (N= 77) had higher HDL-C levels (59.64 ± 0.78 mg/dL) than did males (44.47 ± 0.46 mg/dL). Because female students had greater HDL-C levels than their male peers, they also had lower cardiovascular risk ratios defined as the ratio of total cholesterol to HDL-C. Female students (N= 54) also had lower blood triglyceride levels (120.05 ± 6.74 mg/dL) than those (163.6 ± 3.00 mg/dL) of males (N= 55). Our conclusions are that the methods of measuring blood lipids are comparable, that female pharmacy students have a better cardiovascular lipid profile than their male counterparts, and that both groups have a better cardiovascular lipid profile than the general U. S. population.