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CONSIDERATIONS FOR WOOD RIVER SCULPIN CONSERVATION: HISTORICAL OCCURRENCE AND SAMPLING EFFICIENCY

Donald W. Zaroban[1]

ABSTRACT.—Records of Wood River sculpin (*Cottus leiopomus*) from 1893 to 2003 were examined and new data were gathered in 2004 and 2006 to estimate the species' historical range and to search for evidence of changes in its occurrence. Detections of Wood River sculpin were reported in 49 subwatersheds, primarily in the Idaho Batholith ecoregion. The remainder of the Wood River basin was classified as either potential historic range or unknown. Mark-recapture sampling was conducted to estimate the efficiency of electrofishing as a method to detect this sculpin. Sampling efficiency was calculated for 1 upstream pass and 1, 2, and 3 bidirectional passes. A mean sampling efficiency of 45.9% (range 15.4%–63.0%) was achieved using 3 bidirectional passes, block nets, and 0.942 minutes of electrofishing per m^2 of stream surface. Efficiency declined an average of 38% between electrofishing passes. The rates and reduced efficiencies observed between passes suggest that multiple passes and visits are needed to reliably estimate sculpin presence or absence.

Key words: Wood River sculpin, Cottidae, historical range, sampling efficiency, sampling effort, species conservation.

RESUMEN.—Se examinaros registros observacionales de los charrascos espinosos Wood River (*Cottus leiopomus*) de 1893 a 2003 y nuevos datos fueron reunidos en 2004 y 2006 para estimar su extensión histórica y buscar evidencia de cambios en su presencia. Se ha reportado la detección de charrascos espinosos Wood River en 49 subcuencas, principalmente en la ecorregión del Batolito de Idaho. El resto de la cuenca del Wood River fue clasificado, ya sea como posible distribución histórica o como desconocida. Se llevó a cabo un muestreo de marcaje y recaptura para estimar la eficiencia de la electropesca como método para detectar el charrasco espinoso. Se calculó la eficiencia del muestreo para un pase río arriba y 1, 2 y 3 pases bidireccionales. Se alcanzó una eficiencia promedio del muestreo de 45.9% (del 15.4 al 63.0%) usando 3 pases bidireccionales, redes de bloqueo y la aplicación de corriente eléctrica por 0.942 minutos por metro cuadrado de superficie del arroyo. La eficiencia disminuyó 38% en promedio entre pases de electropesca. Las tasas y la reducción de eficiencia observadas entre pases sugieren que múltiples pases y visitas son requeridos para estimar con precisión la presencia o ausencia del charrasco espinoso.

Investigations of fish populations in Idaho and the Pacific Northwest typically focus on salmonids. To protect the biological integrity of Idaho's aquatic ecosystems, investigations of nonsalmonid taxa need to be conducted. The Wood River sculpin (*Cottus leiopomus*) is endemic to the Wood River basin of south central Idaho (Simpson and Wallace 1982). It is a protected nongame species and is considered vulnerable primarily because of its limited distribution and habitat loss (Idaho Department of Fish and Game 2005). Current threats include water quality impairment, habitat loss and fragmentation, nonnative piscivorous fish, floodplain encroachment, and flow alterations from stream channelization, diversions, and dams (Buhidar 2002, Claire 2005a, 2005b, Meyer et al. 2008).

Despite its vulnerability, the Wood River sculpin has received little study or conservation attention. No rangewide studies of Wood River sculpin occurrences have been conducted until recently (Meyer et al. 2008). Moreover, the historical record of Wood River sculpin occurrence is incomplete and much of the available information is anecdotal. Despite these limitations, an evaluation of these records can be used to estimate the potential historical range of the Wood River sculpin within the Wood River basin and may reveal temporal changes in its occurrence.

The sampling method recommended and typically used in previous Wood River sculpin investigations is electrofishing (Merkley and Griffith 1993, Abbruzzese and Henderson 1999, Meyer et al. 2008), but evaluations of electrofishing efficiency are lacking. Failure to detect a species when it is present is an issue in species conservation sampling (Bayley and Peterson 2001, MacKenzie 2005). An investigator's inability

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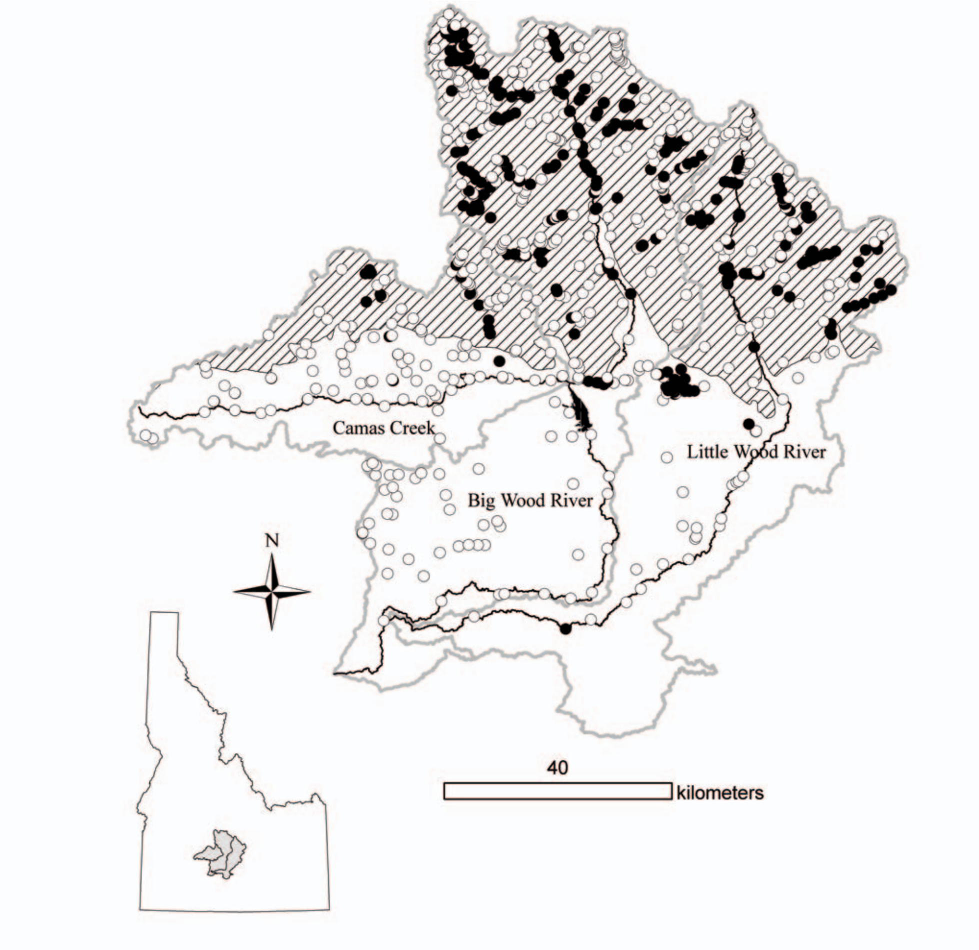

Fig. 1. Location of Wood River basin and distribution of 866 Wood River sculpin sampling events. Filled circles indicate detections and empty circles indicate nondetections of Wood River sculpin. The hatched area denotes the Idaho Batholith ecoregion and the unshaded area is the Snake River Plain ecoregion. Watershed boundaries are indicated by gray lines, and mainstem streams are indicated by black lines.

to find a species when it is present can hinder conservation efforts by failing to accurately describe occurrence. Freshwater sculpins, genus *Cottus*, are small bottom-dwelling fish that lack an air bladder, possess dark, mottled coloration, and exhibit cryptic behavior (Moyle and Cech 2000). These characteristics make them inconspicuous and reduce their capture probability (Bayley and Peterson 2001).

The goal of this study was to provide preliminary occurrence and sampling efficiency information for the Wood River sculpin. The objectives were to describe the potential historical range within the Wood River basin based on detection reports, identify areas where occurrence may have changed, estimate the efficiency of electrofishing as a method to collect Wood River sculpins, and report the effort needed to achieve that efficiency. The findings can be used to identify areas where additional presence-absence sampling is needed.

METHODS

Study Area

The Wood River basin covers approximately 8647 km^2 in south central Idaho (Fig. 1; Idaho Department of Water Resources 2007) and comprises the Big and Little Wood rivers and Camas Creek. The basin is 65% publicly owned, primarily by the Bureau of Land Management (39%) and the USDA Forest Service (22%). The Big Wood River originates in the Smoky Mountains south of Galena Summit at an elevation of 2743 m and empties into the Snake River approximately 4.8 km west of Tuttle, Idaho, at an elevation of 838 m. The basin is located on southern Idaho's Batholith and Snake River Plain ecoregions with land cover of tundra and alpine meadows at the highest elevations transitioning through grand fir (*Abies grandis* [Douglas ex D. Don] Lindl.) and Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco) forest to sagebrush steppe at the lowest elevations (McGrath et al. 2001). The Idaho Batholith portions of the basin are primarily to partially glaciated peaks, high mountains, and foothills; whereas, the Snake River Plain portions are primarily nonglaciated foothills, terraces, and alluvial fans including lava flows and basalt-capped buttes (McGrath et al. 2001). Mean annual precipitation ranges from 23 to 150 cm per year (Oregon State University 1998).

Range Estimation

To estimate the potential historical range of Wood River sculpin, I examined existing records from natural history museums, academic institutions, and public agencies from 1893 to 2006 (Table 1). A sampling event was defined as a search conducted on a specified date at a particular point or reach of a stream. The only records considered were those that explicitly stated whether Wood River sculpins were present or apparently absent and those that provided the year of collection and sufficient information to allow geographic coordinates to be assigned to the sampling event.

To supplement the exisiting records, I also conducted a systematic, rangewide field survey of Wood River sculpin occurrences in 2004 and 2006. In my survey, 166 wet stream reaches that complement the recent work of Meyer et al. (2008) were searched. Stream reaches were chosen based on a stratified randomized design with ecoregion and stream order (following Strahler 1957) as the strata. Level III ecoregion (McGrath et al. 2001) was selected as a stratum to account for physiographic, geologic, and climatic differences between the Idaho Batholith and Snake River Plain ecoregions. Stream order was selected as a stratum to help account for reported differences in sculpin distribution associated with wetted width and channel gradient (Bond 1963, Jones 1972). Streams were classified as 1st to 2nd order, 3rd to 4th order, or 5th to 6th order. Although stream order is a crude surrogate for size and gradient of a stream (Hughes and Omernik 1981), it is widely used as a stratum in study designs for regional stream surveys and appears useful if its application is confined within drainages and ecoregions (Herlihy et al. 2000, Olsen and Peck 2008). I estimated the number of stream-reach searches needed to describe contemporary Wood River sculpin occurrence by using the following inputs: the frequency of sculpin detections reported in a redband trout (*Oncorhynchus mykiss*) survey in the Big and Little Wood river drainages (Abbruzzese and Henderson 1999) and the modeled estimates of occurrence prediction accuracy (McKenney et al. 2002). The estimate was >100. Random points were selected from 1:100,000-scale hydrography performed by the Environmental Monitoring and Assessment Program staff at the Environmental Protection Agency laboratory in Corvallis, Oregon. The random points were located in the field using a GPS receiver.

Merkley and Griffith (1993) evaluated kick sampling, frame netting, and electrofishing and concluded that electrofishing was the most effective method to sample Wood River sculpins. To detect sculpins in the present study, single upstream passes were made using pulsed-DC electrofishing. Electrofishing effort averaged 11.7 minutes (range 1.5–41.2) per stream reach. The mean length of these reaches was 103 m (range 18.3–563) and mean width was 4.7 m (range 3.0–58.8). Stunned fish were dipnetted and held in buckets until the end of the pass. At the end of the electrofishing pass, all fish caught were anesthetized with 45 mg · L^{-1} tricaine methanesulfonate (MS-222). Once lethargic, all fish were counted by species, measured to the nearest millimeter for total length, and placed in a recovery bucket. Recovered fish were returned to the stream. Fish retained for taxonomic verification were identified and archived at the Orma J. Smith Museum of Natural History at the College of Idaho (Caldwell, ID).

Finally, I combined the results from my field surveys with existing records to compare detections and nondetections across time. Sampling records were aggregated by subwatershed (USGS and USDA–NCS 2009) and sorted by date. There are 99 subwatersheds delineated in the Wood River basin with a mean surface area of 8738 ha (range 3513 to 25,298 ha; Idaho Department of Water Resources 2008). To estimate potential historical range, subwatersheds were classified as to whether Wood River

Table 1. Sources consulted for historical records of Wood River sculpin detections. Year(s) is the period of record for the source.

Year(s)	Source
1893	Gilbert C.H., and B.W. Evermann. 1894. A report upon investigations in the Columbia River basin, with descriptions of four new species of fishes. Bulletin of the United States Fish Commission. Volume XIV, for 1894. U.S. Government Printing Office, Washington, DC.
1977–1978	Bruns, D.A., and G.W. Minshall. 1979. Effects of drought on the Big Wood River, Idaho. Idaho State University. Walla Walla District, U.S. Army Corps of Engineers, Walla Walla, WA.
1977	Francis, L.J., and T.C. Bjornn. 1979. Aquatic resources in The Nature Conservancy portion of Silver Creek. Forest, Wildlife and Range Experiment Station Technical Report 9, Idaho Cooperative Fishery Research Unit, University of Idaho, Moscow, ID.
1982–1983	Grunder, S.A. 1985. Biotic responses to sediment removal in a tributary of Silver Creek, Idaho. Master's thesis, Idaho State University, Pocatello, ID.
1986	Grunder, S.A., L. Barrett, and R.J. Bell. 1987. Regional fisheries management investigations: Region 4 river and stream investigations. Idaho Department of Fish and Game, Jerome, ID.
1987	Grunder, S.A., S.C. Elam, and R.J. Bell. 1989. Regional fisheries management investigations: Region 4 river and stream investigations. Idaho Department of Fish and Game, Jerome, ID.
1989	Partridge, F.E., and C.E. Corsi. 1990. Regional fisheries management investigations: Region 4 rivers and streams investigations. Idaho Department of Fish and Game, Jerome, ID.
1992	Merkley, K., and J.S. Griffith. 1993. Densities and habitat utilization of Wood River sculpin (*Cottus leiopomus*) on three Nature Conservancy preserves in Idaho, Idaho State University, Pocatello, ID.
1992	Warren, C.D., and F.E. Partridge. 1994. Regional fisheries management investigations: Region 4 rivers and streams investigations. Idaho Department of Fish and Game, Jerome, ID.
1971–1993	Partridge, F.E. 1995. Saving all the pieces: Idaho interagency conservation/pre-listing effort. Idaho Department of Fish and Game, Boise, ID.
1993	Partridge, F.E., and C.D. Warren. 1995. Regional fisheries management investigations: Magic Valley Region rivers and streams investigations. Idaho Department of Fish and Game, Jerome, ID.
1996	Griffith, J.S. 1996. Wood River sculpin (*Cottus leiopomus*): abundance and distribution on portions of the Ketchum Ranger District of the Sawtooth National Forest and the Sawtooth National Recreation Area, Ketchum, ID.
1995	Warren, C.D., F.E. Partridge, and K.A. Frank. 1997. Regional fisheries management investigations: Magic Valley Region rivers and streams investigations. Idaho Department of Fish and Game, Jerome, ID.
1999	Abbruzzese, C., and R. Henderson. 1999. Fish surveys for redband trout in the Big and Little Wood River drainages. U.S. Forest Service Sawtooth National Forest and Sawtooth National Recreation Area, Ketchum, ID.
1971–1999	U.S. Forest Service, U.S. Fish and Wildlife Service, U.S. Bureau of Land Management, Idaho Department of Fish and Game and State of Idaho. 1999. Habitat conservation assessment and strategy: Wood River sculpin (*Cottus leiopomus*) [draft]. U.S. Bureau of Land Management, Shoshone, ID.
1934–1950	University of Michigan Museum of Zoology catalog numbers: 130451, 158923, 161841, 161843, 161847.
1971–1990	Richard L. Wallace fish collection catalog numbers: 676, 704, 716, 832, 1164, 1188, 1255, 1256, 1257, 1347, 1348, 1602, 1662, 1738.
1893	National Museum of Natural History catalog number: 45389.
1893	California Academy of Sciences, Stanford University catalog number: 1178.
1991–2004	Orma J. Smith Museum of Natural History, College of Idaho catalog numbers: 68048–68049, 68051, 68053, 68124, 68126, 68129, 68155, 68243, 68317–68319, 68325, 68328–68329, 68334, 68339, 68619, 68620, 68653, 68655, 68658, 68660, 68662, 68666–68669, 68678, 68680, 68893, 68904, 68916, 68921, 69704, 69708–69710, 69712, 70029, 70042, 70245, 70275, 70433-70436, 70450, 70453, 70455–70471, 70992, 71007, 81142, 81155–81162, 81722-81724, 81729–81731, 81744.
1993–2006	Idaho Department of Environmental Quality Beneficial Use Reconnaissance Program Database.
2003	Idaho Department of Fish and Game Wood River Sculpin Status Assessment Database.
1993–2006	U.S. Geological Survey. "Fish on"-Line [online database]. USGS–NBII. Available from: http://greatbasin.wr.usgs.gov/fish/FormSearch.aspx

TABLE 2. Distribution of reported Wood River sculpin sampling events.

	Ecoregion		Stream order		
	Snake River Plain	Idaho Batholith	1st–2nd	3rd–4th	5th–6th
Dry events	126	76	135	49	18
Wet events	114	550	397	209	58
detections	58	342	201	164	35
nondetections	56	208	196	45	23

sculpins had been detected, as having potential for sculpin occurrence, or as unknown. Subwatersheds with reported detections were included in the historical range. Subwatersheds that may be hydrologically connected to or that bordered subwatersheds with detections were classified as potential range. The remaining subwatersheds contained no reported sampling events or only periodic nondetections and were classified as unknown. Land ownership was estimated for each of these range classes to help identify potential conservation opportunities and to inform managers interested in Wood River sculpin conservation. Ownership estimates were based on the "Stewardship and Conservation Status of Idaho" GIS data layer prepared by the Landscape Dynamics Lab (1999).

Sampling Efficiency

Repeated searches at a particular site are used to estimate species detection probability (MacKenzie et al. 2002, Tyre et al. 2003). Since no reports of repeated searches for Wood River sculpins were found, the efficiency of pulsed-DC electrofishing to sample sculpins was evaluated. Mark-recapture sampling was conducted in study reaches where sculpins had been detected previously. Tandem pairs of study reaches (members of a pair were longitudinally adjacent) were established by installing 3 block nets at 7 locations in 5 streams. Habitat complexity was low in these study reaches. All streams were wadeable and contained primarily riffle habitat near base flow levels with little or no woody debris, vegetation, or undercut banks. These reaches were 9.6–45.0 m long and 1.8–3.8 m wide. In each study reach, sculpins were collected, anesthetized, measured for total length, marked differentially between the paired study reaches with a right or left pectoral fin clip, and placed in an aerated recovery bucket. As they recovered, the marked sculpins were replaced in the study reach from which they were taken. One or 2 days after the release of the marked sculpins, each study reach was electrofished upstream; all fish collected were placed in an aerated bucket. The study reach was then electrofished downstream and all fish collected (including those trapped in the downstream block net) were placed in a separate aerated bucket. Electrofishing time was regularly noted during each pass to ensure equal electrofishing effort. The fish were then anesthetized, and each sculpin was inspected for a pectoral fin clip, measured for total length, and placed in an aerated recovery bucket. No mortalities were observed among the marked fish. The fish were released downstream of the paired study reaches once they had recovered, typically within 10 minutes. This recapture procedure was repeated twice, resulting in 6 removal passes through each study reach. Total electrofishing effort was 27.7–74.1 minutes per study reach.

Observed sampling efficiency was calculated as the number of marked sculpins recaptured in each removal pass divided by the number of marked fish available (Peterson et al. 2004). Sampling efficiency was calculated for one upstream pass and 1, 2, and 3 bidirectional passes. Large fish are more susceptible to electrofishing than small fish (Reynolds 1996). To assess size bias, the marked fish were classified as small (≤59 mm) or large (≥60 mm). The statistical significance of differences in sampling efficiency between these size classes was evaluated with a 2-sample *t* test. The significance of differences in mean total length between the first, second, and third upstream-downstream passes was evaluated with ANOVA. The effort needed to achieve the efficiency levels I observed was calculated as the mean minutes of electrofishing per square meter of stream reach sampled.

RESULTS

Records from 866 sampling events were obtained and compiled by ecoregion and stream order (Table 2). Sampling covered the years from 1893 to 2006 but only 92 sampling events (11%) occurred prior to 1990. Wood River

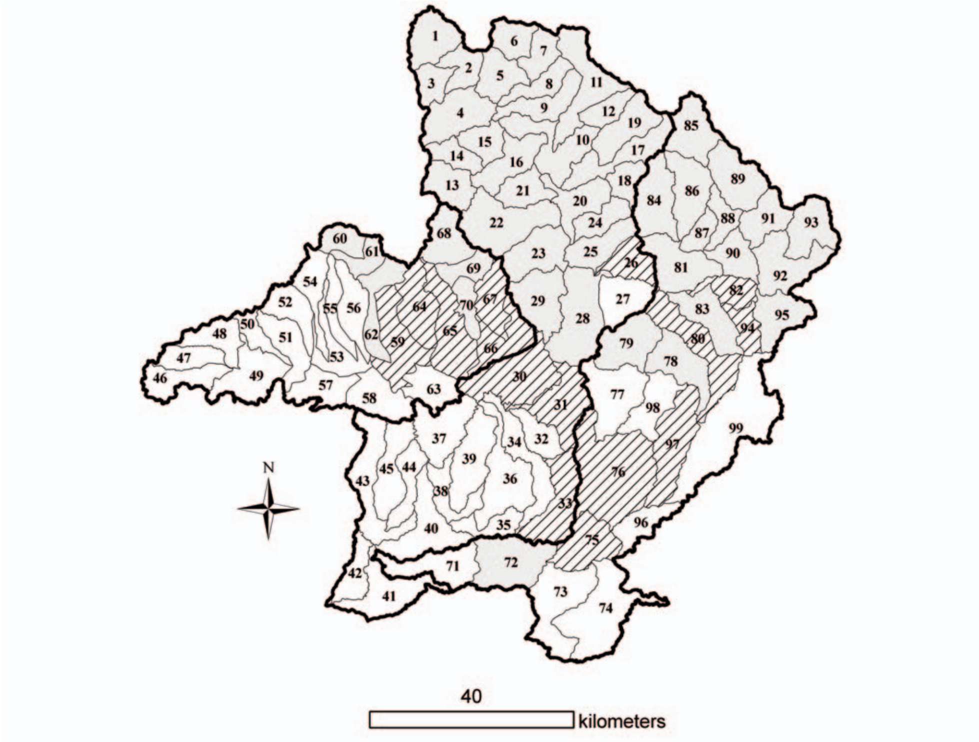

Fig. 2. Estimated historical range of the Wood River sculpin based on subwatershed aggregations of reported detections. Shaded subwatersheds contain reported detections. Potential range subwatersheds (hatched subwatersheds) border or may be hydrologically connected to those containing detections. Subwatersheds classified as unknown (unshaded subwatersheds) contain either no reported sampling events or a majority of sampling events at dry sites. Subwatershed boundaries are denoted by gray lines. Numbers refer to subwatersheds named in Table 3.

sculpins were detected in 400 of these events, with the majority of detections within or just downstream of the Idaho Batholith ecoregion (Fig. 1). Dry streams were reported in 53% of the Snake River Plain events and 12% of the Idaho Batholith events. The percentage of dry streams varied little by stream order: 25% for 1st- to 2nd-order, 19% for 3rd- to 4th-order, and 24% for 5th- to 6th-order streams. Sculpin detections in the Snake River Plain ecoregion were concentrated in the Big Wood River near Stanton Crossing and in Silver and Fish Creeks of the Little Wood River watershed. Idaho Batholith nondetections typically were in headwater stream reaches or small tributaries. The percentage of sampling events in which sculpins were detected was highest for 3rd- to 4th-order streams (78%), followed by 5th- to 6th- (60%) and 1st- to 2nd- (51%) order streams.

Wood River sculpins were detected in 49 subwatersheds (Table 3). Among subwatersheds containing no reported detections, 15 were classified as potentially being within the historical range, and 35 were classified as unknown (Fig. 2). In subwatersheds with sculpin detections, 5 had only nondetection sampling events following a detection (Table 4). In 12 of the 15 subwatersheds classified as potential historical range, 87% of the sampling events occurred on dry streams (Table 4). Nine subwatersheds classified as unknown contained no sampling events, and among the other subwatersheds, 82% of the sampling events were at dry sites. Primary landowners in subwatersheds containing sculpin detections are the USDA Forest Service (47%), private individuals or organizations (25%), and the Bureau of Land Management (23%). In subwatersheds classified as potential range or unknown, the primary landowners are the Bureau of Land Management (49% and 52%, respectively), private individuals or organizations (44% and 42%, respectively) and the state of Idaho (5% in both categories).

TABLE 3. Reported occurrence of Wood River sculpin in the Wood River basin by U.S. Geological Survey subwatershed. Map number refers to numbered areas in Figure 2.

Map no.	Subwatershed name	USGS code	Occurrence
1	Big Wood River Headwaters	170402190101	detected
2	Anderson Creek–Big Wood River	170402190102	detected
3	Prairie Creek	170402190103	detected
4	Baker Creek	170402190104	detected
5	Boulder Creek–Big Wood River	170402190105	detected
6	Amber Gulch	170402190106	detected
7	Murdock Creek–Big Wood River	170402190107	detected
8	Eagle Creek–Big Wood River	170402190201	detected
9	Lake Creek–Big Wood River	170402190202	detected
10	Elkhorn Gulch–Big Wood River	170402190203	detected
11	Trail Creek	170402190204	detected
12	Corral Creek	170402190205	detected
13	Placer Creek–Warm Springs Creek	170402190301	detected
14	Castle Creek–Warm Springs Creek	170402190302	detected
15	Rock Creek–Warm Springs Creek	170402190303	detected
16	Red Warrior Creek–Warm Springs Creek	170402190304	detected
17	East Fork Big Wood River	170402190401	detected
18	Cove Creek	170402190402	detected
19	Hyndman Creek	170402190403	detected
20	Indian Creek–Big Wood River	170402190501	detected
21	Greenhorn Creek	170402190502	detected
22	Deer Creek	170402190503	detected
23	Croy Creek	170402190504	detected
24	Quigley Creek	170402190505	detected
25	Slaughterhouse Creek–Big Wood River	170402190601	detected
26	Seamans Creek	170402190602	potential
27	Dry Creek	170402190603	unknown
28	Poverty Flat–Big Wood River	170402190604	detected
29	Rock Creek	170402190605	detected
30	Magic Reservoir	170402190606	potential
31	Wedge Butte	170402190701	potential
32	Cottonwood Reservoir–Big Wood River	170402190702	unknown
33	Kinzie Butte–Big Wood River	170402190703	potential
34	Gwinn Cave	170402190704	unknown
35	Milner Gooding Canal–Big Wood River	170402190705	unknown
36	Black Butte Hills	170402190706	unknown
37	Schooler Creek–Thorn Creek	170402190801	unknown
38	High Line Canal–Thorn Creek	170402190802	unknown
39	Preacher Creek	170402190803	unknown
40	Turkey Creek–Big Wood River	170402190901	unknown
41	Tuttle–Big Wood River	170402190902	unknown
42	Fuller–Big Wood River	170402190903	unknown
43	Dry Creek	170402190904	unknown
44	Dog Creek	170402190905	unknown
45	Black Canyon Creek	170402190906	unknown
46	Sheep Creek–Camas Creek	170402200101	unknown
47	Malad River	170402200102	unknown
48	Wildhorse Creek	170402200103	unknown
49	Camas Creek–Camas Prairie	170402200104	unknown
50	Cow Creek	170402200201	unknown
51	No Named Creeks–Camas Creek	170402200202	unknown
52	Chimney Creek	170402200203	unknown
53	Camas Creek	170402200204	unknown
54	Corral Creek	170402200205	unknown
55	Threemile Creek	170402200206	unknown
56	East Fork Three Mile Creek	170402200207	unknown
57	Dairy Creek	170402200301	unknown
58	McKinney Creek	170402200302	unknown
59	Lower Soldier Creek	170402200303	potential
60	Upper Soldier Creek	170402200304	detected
61	Middle Soldier Creek	170402200305	detected
62	Lower Soldier Creek	170402200306	detected
63	Spring Creek	170402200307	unknown

TABLE 3. Continued.

Map no.	Subwatershed name	USGS code	Occurrence
64	Deer Creek	170402200402	potential
65	Elk Creek	170402200403	potential
66	Camas Creek–Poison Creek	170402200404	potential
67	Camp Creek	170402200405	potential
68	Upper Willow Creek	170402200501	detected
69	Middle Willow Creek	170402200502	detected
70	Lower Willow Creek	170402200503	detected
71	Gooding	170402210101	unknown
72	Lower Little Wood River	170402210102	detected
73	Shoshone SW	170402210103	unknown
74	Star Lake	170402210104	unknown
75	Dietrich	170402210201	potential
76	Main Canal	170402210202	potential
77	Shoshone Ice Cave	170402210203	unknown
78	Lower Silver Creek	170402210301	detected
79	Upper Silver Creek	170402210302	detected
80	Little Wood River	170402210401	potential
81	Little Wood River Reservoir	170402210402	detected
82	Howard Reservoir	170402210403	potential
83	Upper Little Wood River	170402210404	detected
84	Baugh Creek	170402210501	detected
85	Upper Little Wood River	170402210502	detected
86	Lower Little Wood River	170402210503	detected
87	Brown Creek	170402210601	detected
88	Lower Muldoon Creek	170402210602	detected
89	Upper Muldoon Creek	170402210603	detected
90	Lower Friedman Creek	170402210701	detected
91	Upper Friedman Creek	170402210702	detected
92	Lower Fish Creek	170402210801	detected
93	Upper Fish Creek	170402210802	detected
94	Huff Lake	170402210901	potential
95	Fish Creek	170402210902	detected
96	Lower Dietrich Main Canal	170402211001	unknown
97	Upper Dietrich Main Canal	170402211002	potential
98	Tapper	170402211003	unknown
99	Pagari	170402211004	unknown

The proportion of marked sculpins recaptured was calculated for a single upstream pass (1up) and 1 (1updn), 2 (2updn), and 3 (3updn) bidirectional passes to compare efficiency between electrofishing approaches (Table 5). Mean sampling efficiencies were 0.151 (range 0.000–0.267), 0.286 (0.000–0.444), 0.398 (0.077–0.593), and 0.459 (0.154–0.630) for 1up, 1updn, 2updn, and 3updn passes, respectively. These efficiencies were achieved with averages of 0.164, 0.322, 0.638, and 0.942 minutes of electrofishing per m^2 of stream surface area, respectively. Sampling efficiency consistently declined with each subsequent pass ($\bar{x}$ = 38%). Sampling efficiency was significantly greater for large sculpins ($t = 2.39$, $P = 0.012$), and the mean total length of sculpins recaptured in the first pass was significantly greater ($F = 8.83$, $P < 0.001$) than in subsequent passes. No significant differences were observed in mean total length between fish recaptured in the second and third passes.

DISCUSSION

The sampling events reveal differences in Wood River sculpin distribution between the Idaho Batholith and Snake River Plain ecoregions. Unsurprisingly, most observations were made in Idaho Batholith streams because most sites in the Snake River Plain ecoregion were dry. All but one of the subwatersheds that contain Wood River sculpin detections are at least partially within the Idaho Batholith. The exception is the Little Wood River subwatershed near Shoshone where the lone sampling event occurred in 1893 and from which 2 specimens were retained to describe the species (Gilbert and Evermann 1894). Of the 5 subwatersheds where detections have been followed by only

TABLE 4. Subwatersheds (USGS codes in parentheses) where additional searches are recommended to ascertain Wood River sculpin occurrence. A summary of the findings from the subwatershed assessment is provided as rationale for additional searches. Subwatersheds listed under no subsequent detections are those where sculpin detections have been followed by nondetections in all of the subsequent sampling events. Subwatersheds listed under potential range are those that border or may be hydrologically connected to subwatersheds with reported detections.

Subwatershed	Rationale
NO SUBSEQUENT DETECTIONS	
Rock Creek (170402190605)	2 detections between Kent Canyon and Dry Gulch, 1989; 7 events since (2003–2006), 4 dry
Prairie Creek (170402190103)	2 detections below Miner Canyon, 1949 & 1993; 9 events since (1999–2006), 0 dry
Cove Creek (170402190402)	1 detection in Finley Gulch, 1986; 8 events since (1993–2006); 4 dry
Little Wood River (170402210404)	1 detection between Little Fish Creek and Carey, 1950; 4 events since, 3 dry
Silver Creek (170402210301)	1 detection below Kilpatrick Bridge, 1976; 3 events since, 0 dry
POTENTIAL RANGE	
Powell Creek (170402200303)	Adjacent to Soldier Creek; 12 events, 2001–2004, 11 dry
Deer Creek (170402200402)	Camas Creek tributary between Soldier and Willow Creeks; 8 events, (1996–2004), 8 dry
Elk Creek (170402200403)	Adjacent to Willow Creek; 7 events, 1976–2005, 6 dry
Camp Creek (170402200405)	Adjacent to Willow Creek; 4 events, 1996–2004, 3 dry
Poison Creek (170402200404)	Adjacent to Willow Creek; 7 events, 1976–2006, 4 dry
Magic Reservoir (170402190606)	Detections at Stanton Crossing; 4 events from tributaries, 2003–2005, 4 dry
Big Wood River (170402190701)	Mainstem below Magic Reservoir; 3 events, 1976–2003, 2 dry
Big Wood River (170402190703)	Mainstem between Lincoln Bypass Canal diversion and Highway 75; 3 events, 1976–1996, 2 dry
Seamans Creek (170402190602)	Detections in Big Wood River; 1 event, 1995, dry
Little Wood River (170402210401)	Detections above Carey; 4 events between Carey and Silver Creek, 2003–2004, 4 dry
Little Wood River (170402211002)	Detections above Carey and at Shoshone; 6 events between Silver Creek and Jim Byrns Slough, 1976–2004, 0 dry
Little Wood River (170402210202)	Detections above Carey and at Shoshone; 8 tributary events between Cottonwood Slough and Jim Byrns Slough, 8 dry
Little Wood River (170402210201)	Detection at Shoshone; 3 events between Cottonwood Slough and Shoshone, 1976–2003, 0 dry
Little Fish Creek (170402210403)	Little Wood River tributary above Carey; 1 event, 2003, 0 dry
Fish Creek (170402210901)	Detections in upper Fish Creek; 2 tributary events, 2003–2004, 2 dry

TABLE 5. Stream surface area sampled, number of sculpins marked, minutes of cumulative electrofishing effort, and proportion of marked fish recaptured in a single upstream (1up) pass and in 1 (1updn), 2 (2updn), and 3 (3updn) bidirectional passes.

			Cumulative effort (minutes)				Sampling efficiency (proportion)			
Reach	Area (m^2)	Marked sculpins	1up	1updn	2updn	3updn	1up	1updn	2updn	3updn
1A	160.0	23	12.3	24.6	49.3	74.0	0.130	0.217	0.261	0.304
1B	56.4	13	5.3	10.6	21.0	31.4	0.000	0.000	0.077	0.154
2A	78.4	27	13.7	23.8	47.4	68.0	0.259	0.444	0.593	0.630
2B	85.6	64	8.8	17.7	35.4	53.1	0.078	0.234	0.344	0.406
3A	35.6	68	10.0	19.2	37.6	54.6	0.132	0.353	0.544	0.588
3B	40.2	100	6.4	12.6	25.2	37.4	0.050	0.150	0.310	0.410
4A	26.3	18	7.7	15.2	29.4	43.7	0.167	0.389	0.444	0.611
4B	50.1	26	8.5	16.9	33.3	50.2	0.115	0.231	0.385	0.423
5A	62.4	177	7.7	15.5	31.3	46.6	0.243	0.316	0.418	0.492
5B	48.3	131	6.8	13.3	26.5	40.0	0.267	0.344	0.496	0.557
6A	34.8	30	6.3	12.9	27.2	40.2	0.233	0.367	0.500	0.500
6B	48.1	25	7.2	14.6	29	43.3	0.200	0.240	0.320	0.360
7A	61.2	53	11.6	21.6	41.6	57.0	0.245	0.340	0.377	0.491
7B	27.8	8	4.6	9.3	18.4	27.7	0.000	0.375	0.500	0.500

nondetections, Prairie Creek and lower Silver Creek appear to have the greatest probability of sculpin occurrence today because of more persistent flow. Among subwatersheds classified as potential historical range, the Little Wood River between Silver Creek and Shoshone and Little Fish Creek possibly have the greatest probability of containing sculpins. Additional sampling is needed in these subwatersheds to confirm or refute occupancy.

Estimating sampling efficiency is particularly important in reducing the probability of overlooking species when they are present (Johnson and Sargeant 2002, MacKenzie and Royle 2005). The sampling efficiency observed in this study was similar to sampling efficiences reported by other researchers investigating electrofishing efficiency for sculpins. Based on 2-pass electrofishing using direct current, Heimbuch et al. (1997) reported capture probabilities of 0.393–0.507 for 3 sculpin species. Utzinger et al. (1998) observed electrofishing efficiencies of 0.184 and 0.314 from recaptures of marked bullheads (*Cottus gobio*) after 3 or 4 upstream passes at 2 sites. The range of efficiencies observed among the sampling approaches and the decline in efficiency between passes indicate that multiple passes during each sampling event and multiple events at each site are needed to estimate absence with a known confidence. Even though sampling efficiency does not equate to detection probability, these results are consistent with MacKenzie and Royle's (2005) recommendation of a minimum of 3 searches when the probability of detecting the species of interest is ≥ 0.5, and more searches if the probability is <0.5. Further work on efficiency of electrofishing sampling for Wood River sculpins in wadeable habitats should account for fish abundance, size, and habitat complexity (Reynolds 1996, Peterson et al. 2004). Investigators may also consider using and evaluating the efficiency of electrofishing discrete channel units with framed devices as described by Bain et al. (1985) and Fisher (1987). Alternative sampling methods may be needed in nonwadeable habitats. Baited minnow traps have been used to collect Shoshone sculpin (*Cottus greenei*) from nonwadeable springs (Rick Wilkison, Idaho Power Company, personal communication). The efficiency of any alternative sampling method needs to be estimated from a known number of individuals (Dunham et al. 2009).

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