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Study #2603 Monitoring American Dippers in the Black Hills

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The American Dipper
(*Cinclus mexicanus*)
in the Black Hills of South Dakota

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The American Dipper
(*Cinclus mexicanus*)
in the Black Hills of South Dakota

The American Dipper (*Cinclus mexicanus*), North America's only truly aquatic passerine, is highly adapted to living in an environment of cold, clear, fast-moving streams. As one of five species of dipper distributed worldwide it is found along the mountain chain of western North America from Alaska and the Canadian Rockies, down through the western United States and Mexico to Guatemala and Panama (Tyler and Ormerod 1994, Kingery 1996). All species of dippers are similar in general appearance, behavior and nesting habits and occupy similar habitats in different parts of world (Tyler and Ormerod 1994). Other species include the White-throated Dipper (*C. cinclus*) found in Western Europe, northwest Africa and across Russia to the Himalayas and China. The range of the Brown Dipper (*C. pallasii*) overlaps the White-throated Dipper in Asia and extends into Japan and up into China. White-capped Dippers (*C. leucocephalus*) live in the rivers of the Andes in South America while the Rufous-throated Dipper (*C. schulzi*), the rarest of all the species, exists in a narrow strip of forest in south-west Bolivia and north-west Argentina (Tyler and Ormerod 1994).

Species Description

Adult American Dippers are dark gray in color with brownish feathers covering the head. The bill is dark. White feathers on the eyelid produce a white flash when seen in the field (Goodge 1959). Described as chucky in shape with short wings and tail they are 14–20 cm long (5½–8 inches). Sexes look alike in plumage but the male is generally larger than the female (Kingery 1996). Juveniles have a lighter gray, sometimes mottled throat and chest and a pale bill. Adult plumage and bill color is attained by the first winter. Dippers dip their entire body in an up-and-down motion and dive and swim underwater to feed. Five subspecies of American Dipper are recognized with subtle differences in coloration varying geographically. Size also increases from north to south and inland birds are larger than coastal ones (Kingery 1996). Subspecies include *C. m. unicolor* (western Canada, western United States), *C. m. mexicanus* (northern and central Mexico), *C. m. anthonyi* (southern Mexico and Guatemala), *C. m. dickermani* (southern Mexico) and *C. m. ardesiacus* (Costa Rica and Panama) (Tyler and Ormerod 1994).

Habitat

Dippers occupy habitats year-round of unpolluted cold, clear, fast-moving streams that remain open during the winter months. Stream bottoms consisting of stones, rubble, gravel and sometimes sand are needed to support certain species of aquatic invertebrates, their main food source. The turbulence of flowing water provides a natural means of aerating the water for animal life, and riffle areas often have relatively diverse insect fauna (McCafferty 1998). Structures for nesting over water must also be present and include overhanging cliffs with ledges or depressions, waterfalls, crevices, rock outcrops and boulders which offer protection from predators. Perching rocks in and alongside the stream are also required. Fallen logs and tree roots provide cover during molt and are sometimes used for nesting and roosting (Kingery 1996). Dippers also make use of man-made structures such as the support structures under bridges spanning a stream, as well as nest boxes placed over water.

Dippers in the Black Hills

The Black Hills of South Dakota represent the eastern most edge of the dipper's range in the United States and Canada. Since dippers are not known to migrate, except for local altitudinal and interdrainage movements (Kingery 1996) and do not stray far from water, it is not known if the dippers have been isolated since historical water connections eroded (Backlund 2009) or are able to travel to or from neighboring mountain ranges. The next closest population is in the Bighorn Mountains of Wyoming. Since there are no connecting waterways to the west of the Black Hills dippers would have to fly nearly 100 miles across grassland and sagebrush (Backlund 2009). Price and Bock (1983) observed several interdrainage

movements near Boulder, Colorado, some long-distance. The longest movement was a straight-line distance of 75 km (46.6 miles). It was believed the dippers flew the shorter distances over ridges between drainages rather than follow waterways that were polluted and lacked a rubble substrate. They also reported that observations by Jost (1969) with the White-throated dipper (*C. cinclus*) revealed juvenile movement between watersheds, and adult dippers in Switzerland capable of flying across the high Alps.

What is known however, is that the Black Hills population of dippers has shrunk in distribution and number since dippers were first reported in 1874 (Backlund 2009). Once found on all the larger streams of the Black Hills the breeding population is now limited mainly to the Spearfish Creek watershed and portions of Whitewood Creek in the northern Black Hills. Spearfish Creek supports the largest breeding population. The species was listed as state threatened in 1996 by the South Dakota Game, Fish and Parks Commission and is listed as a species of local concern by the US Forest Service Black Hills National Forest. DNA analysis has since been carried out and indicated that the Black Hills population is genetically distinct from other sampled populations in Wyoming, Idaho and Montana (Anderson *et al*. 2008). However, further sampling of *C. mexicanus* is needed to understand the genetic population structure throughout its range (Anderson *et al*. 2008). Currently, the Black Hills population is not considered to be a separate subspecies.

To assist in gathering information on the dipper in the Black Hills a total of 52 dippers were banded from 2002 to 2005 (Table 1). Forty-three were banded on the Spearfish Creek watershed and nine on Whitewood Creek. Dippers were captured with mist nets placed across the creek, usually near their active nest location. Individuals were then weighed, measured and given a numbered aluminum US Fish and Wildlife Service band as well as one or two uniquely colored plastic bands, the combination of which was used to identify individuals during field observation. Feathers for DNA analysis were also collected beginning in 2002, and in 2005 blood samples were taken from 15 individuals. Measurement data appear in Appendix I.

Intensive field monitoring of the American Dipper in the Black Hills began in 2004 and continued through 2009. A total of 900 hours were logged in each year with the majority of time spent during the nesting seasons from March through July. The study area included up to 48 sites along Spearfish Creek and tributaries including Little Spearfish Creek, East Spearfish Creek and Iron Creek (Figures 1–2). Up to nine sites were also monitored on Whitewood Creek (Figure 3). This writing contains the results of this six-year study. Extensive field notes were maintained and the data gathered included not only nesting success but general behavior, nesting and feeding habits of adult dippers and their young. Information on dipper movement, territory, mate fidelity and longevity was also obtained as a result of observing banded dippers. A thorough review of historical accounts prior to 2004 and current status of the dipper on other streams in the Black Hills can be found in Appendices II, III and IV.

Table 1. Black Hills dipper banding information for the Spearfish Creek watershed and Whitewood Creek. Banding and DNA sampling was done by Doug Backlund, SD Game, Fish and Parks under Master Banding Permit #21966.

Dipper #	Left leg	Right leg	Location banded	Date banded	Sex	Age
1	US Fish & Wildlife Service band		Site #24 Spearfish Creek	5/2/2002	Male	Adult
2		FWS	#15 SC	5/2/2002	M	A
3	FWS	White	#16 SC	5/3/2002	M	A
4	FWS	Yellow	#16 SC	5/3/2002	Female	A
5	FWS	Red	#10 SC	5/3/2002	M	A
6	FWS	Orange	#14 SC	5/3/2002	M	A
7	White	FWS	#14 SC	5/3/2002	F	A
8	Yellow	FWS	#6 SC	7/20/2002	M	A
9	Red	FWS	#6 SC	7/20/2002	F	A
10	Orange	FWS	#22 SC	7/24/2002	F	A

Dipper #	Left leg	Right leg	Location banded	Date banded	Sex	Age
11	FWS	White/Yellow	#16 SC	7/25/2002	Unknown F (2003)	Juvenile A (2003)
12	FWS	White/Red	1 mi. S of #33 SC	8/20/2002	U M (2003)	A
13	FWS	White/Orange	#25 SC	8/20/2002	U	J
14	FWS	Yellow/White	#25 SC	8/20/2002	U F (2003)	J A (2003)
15	FWS	Yellow/Red	#22 SC	8/20/2002	U	J
16	FWS	Yellow/Orange	#22 SC	8/20/2002	U	A
17	FWS	White/Red	#10 SC	8/21/2002	U M (2004)	A
18	FWS	Red/Yellow	#14 SC	8/21/2002	U M (2003)	J A (2003)
19	FWS	Red/Orange	#14 SC	8/21/2002	U	J
20	FWS	Orange/White	1 mi. S of #33 SC	8/21/2002	U	J
21	FWS	Blue	#2 SC	10/11/2002	U F (2003)	J A (2003)
22	Blue	FWS	.4 mi. N of #14 SC	10/11/2002	M	J
23	FWS	Blue/White	#4 SC	10/12/2002	U	J
24	Blue/White	FWS	.4 mi. N of #14 SC	10/12/2002	U F (2003)	J A (2003)
25	Blue/Red	FWS	#10 SC	10/12/2002	U F (2003)	J A (2003)
26	Blue/Orange	FWS	#9 SC	7/16/2003	U	J
27	Blue/Yellow	FWS	#9 SC	7/16/2003	U F (2004)	J A (2004)
28	FWS	Blue/Red	#14 SC	7/16/2003	U	J
29	FWS	Blue/Orange	#15a SC	7/16/2003	U	J
30	FWS	Blue/Yellow	#33 SC	7/17/2003	F	A
31	Yellow/White	FWS	#20 SC	7/17/2003	U	J
32	Yellow/Red	FWS	#20 SC	7/17/2003	U M (2004)	J A (2004)
33	Yellow/Orange	FWS	#16 SC	7/18/2003	U	J
34	Red/White	FWS	#16 SC	7/18/2003	U F (2004)	J A (2004)
35	Red/Yellow	FWS	#2 Whitewood Creek	7/18/2003	U M (2004)	J A (2004)
36	Red/Orange	FWS	#2 WC	7/29/2004	U F (2005)	J A (2005)
37	Orange/White	FWS	#2 WC	7/29/2004	U	J
38	Orange/Red	FWS	#5 WC	7/29/2004	U	J
39	Orange/Yellow	FWS	#6 WC	7/29/2004	U	J
40	Orange/Blue	FWS	#6 WC	7/29/2004	M	A
41	FWS	Orange/Red	.5 mi. N of #1 WC	7/30/2004	U	J
42	FWS	Orange/Yellow	#14 SC	2/2/2005	U M (2005)	A
43	FWS	White/Blue	#2 WC	2/3/2005	U M (2005)	A

Dipper #	Left leg	Right leg	Location banded	Date banded	Sex	Age
44	FWS	Orange/Blue	.5 mi. N of #1 WC	2/3/2005	U	A
45	White/Yellow	FWS	#6 SC	4/19/2005	M	A
46	White/Red	FWS	#10 SC	4/19/2005	F	A
47	White/Orange	FWS	#20 SC	4/19/2005	F	A
48	White/Blue	FWS	#22 SC	4/20/2005	F	A
49	Missing leg	FWS	#22 SC	4/20/2005	M	A
50	Yellow/Blue	FWS	#30 SC	4/20/2005	F	A
51	FWS	Yellow/Blue	#33 SC	4/20/2005	M	A
52	Red/Blue	FWS	#5 SC	4/26/2005	U	A

Figure 1. Black Hills dipper nest sites on the Spearfish Creek watershed (lower portion).

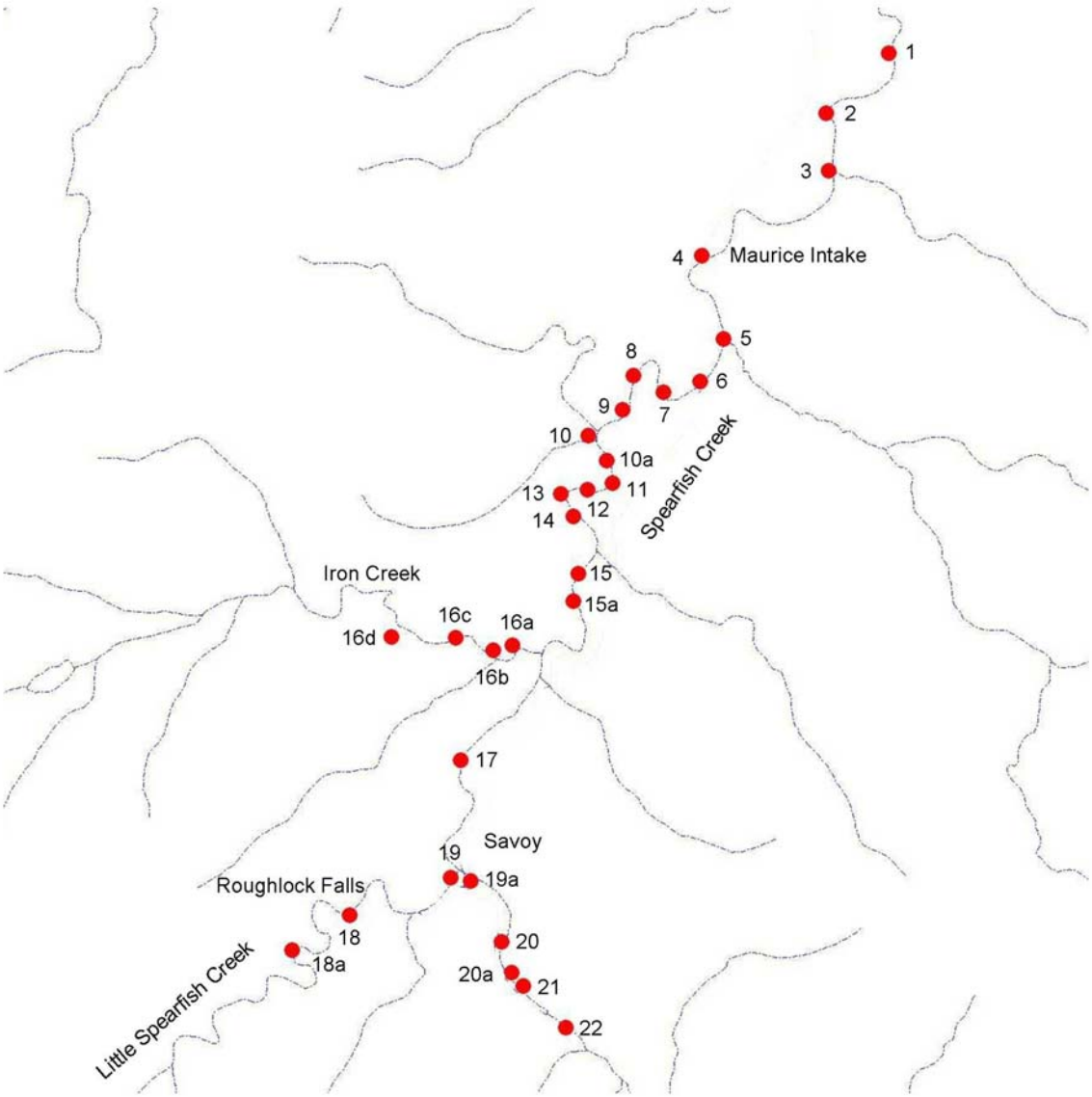


Figure 2. Black Hills dipper nest sites on the Spearfish Creek watershed (upper portion).

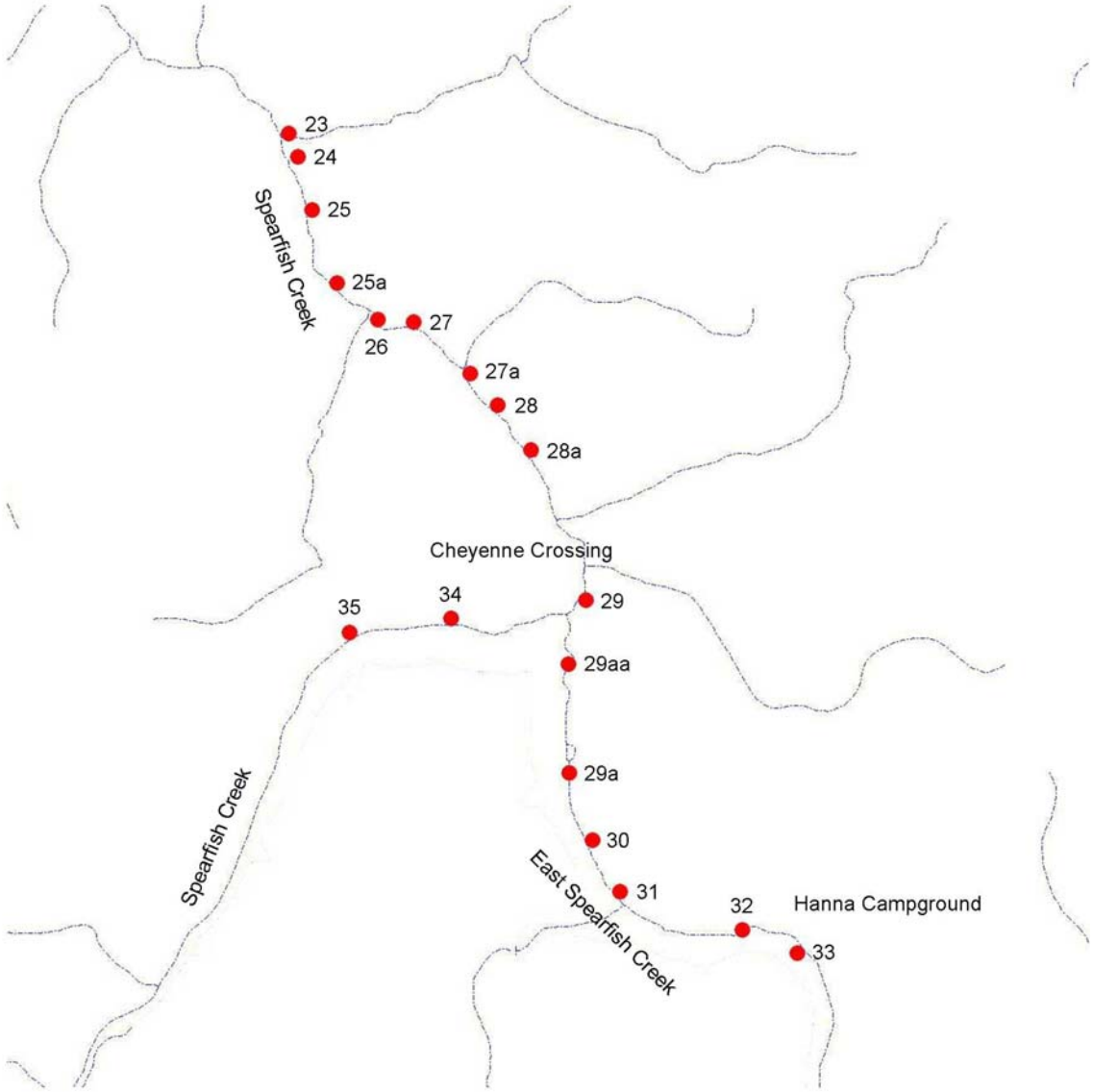
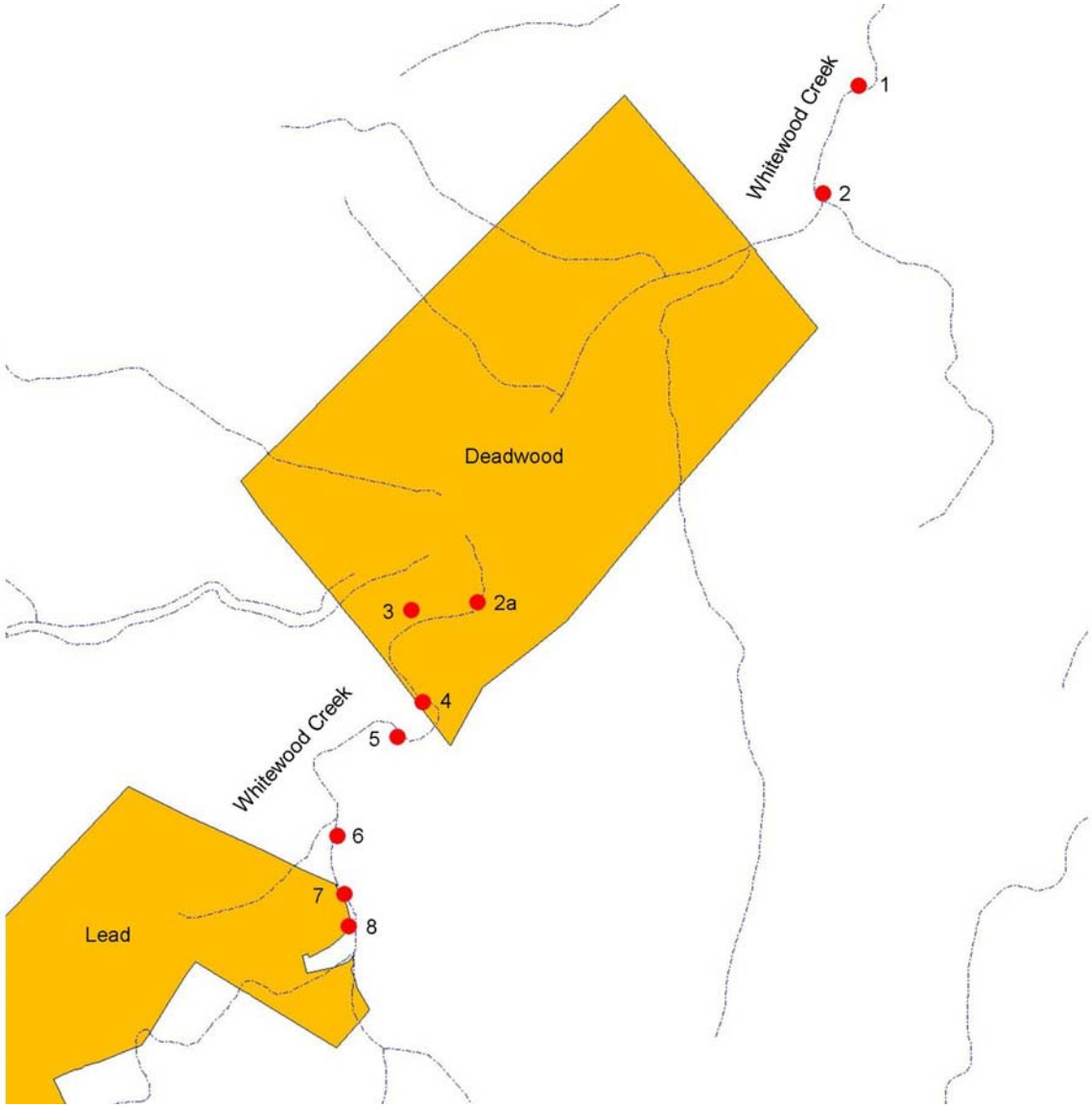


Figure 3. Black Hills dipper nest sites on Whitewood Creek.



Dipper Biology

Dippers are well adapted to living in a cold water environment. They have unusually dense plumage with a high number of contour feathers as well as a very heavy coat of down between feather tracts (Murrish 1970b). Feathers also cover their entire eyelid (Goodge 1960). Oil from a well developed uropygial gland near the base of the tail is utilized to assist in waterproofing feathers, and is obtained by rubbing the head or bill against the gland (Sullivan 1973). Preening takes place quite often to maintain this property. Goodge (1959) noted that dippers in captivity did not preen as often and were found to lose the water-repellent qualities of their plumage. To provide for the needs of the central nervous system and heart while diving underwater, dippers have more hemoglobin per red blood cell, increasing the oxygen capacity of their blood (Murrish 1970a). Dippers are also equipped with nasal flaps (Tyler and Ormerod 1994), and enlarged sphincter muscles of the eye make it possible to accommodate for underwater vision (Goodge 1960).

Because of their special adaptations for withstanding cold temperatures dippers are unable to tolerate a high level of heat. In a study by Murrish (1970b) dippers could maintain normal body temperatures at air temperatures between -30 to +33°C (-22 to +91.4°F), but when air temperatures rose above 33°C they could no longer do so. Body temperatures would continue to climb and would have proven fatal once air temperatures reached above 36°C (96.8°F). Poorly insulated legs and feet allow dippers the ability to dissipate excess body heat, which was found to occur four times faster in water than in air of the same temperature (Murrish 1970b). Murrish also concluded that without water to stand in they would not be able to maintain a normal body temperature at air temperatures above the upper critical level.

Dippers get their name from the characteristic vertical up-and-down movement of the entire body, repeatedly bending their legs to a crouch and standing. It is not known why they dip, although it has been speculated that it may help them triangulate their position in a complex moving environment. It may also help them to communicate, along with a blinking white eyelid, in a habitat with high background noise (Kingery 1996). It was noted that dipping was not frequently observed in captive birds (Goodge 1959). Dippers can be found dipping during activities such as courtship, feeding and agitation (Kingery 1996) but many times in the Black Hills were observed not dipping. They sometimes foraged without doing so and were often found perched motionless and at rest, almost always on one leg. Dipping then began when they were disturbed and quickened the more agitated they became. Dippers also do not dip while preening.

Diet and Feeding

The diet of the American Dipper consists mainly of larval and adult forms of aquatic insects including but not limited to caddisflies (order Trichoptera), stoneflies (Plecoptera), mayflies (Ephemeroptera) and crane flies (Diptera). Other organisms such as segmented worms (Oligochaeta) are also taken as well as small fish and fish eggs; dippers have been observed on several occasions feeding upon salmon eggs (Kingery 1996, Obermeyer *et al*. 1999). Although it could not be determined that dippers in this study were foraging upon the eggs of local fish species, they were commonly observed collecting Trichoptera, Plecoptera, Ephemeroptera and Diptera as well as small fish. Oligochaeta were taken infrequently. A dipper was also once observed collecting a large carpenter ant (Hymenoptera) to feed young in the nest, plucked from a concrete wall, and on only three occasions an individual from the order Lepidoptera was seen taken (moths and butterflies). Sampling of the macroinvertebrate community in Spearfish Creek and Whitewood Creek was carried out periodically and in 2009, percent EPT (Ephemeroptera, Plecoptera and Trichoptera) was determined at 11 nest sites. Species in these taxonomic orders can be used as biological indicators of local stream health in addition to being a major food source for dippers (Andy Burgess, Aquatic Ecologist, SD Dept. of Game, Fish and Parks, personal communication). The results of EPT sampling can be found in Appendix V.

One of several methods dippers use for foraging is diving underwater. They were observed doing so either from the air, from an emergent rock, or from floating along the surface, using their wings and feet while underwater to navigate along the rocky bottom (photo below). Dippers are able to collect more than one item at a time while underwater without losing them to the current, such as when foraging to feed hungry young. If the prey requires removal from a pebble case however, as those from the order Trichoptera, the dipper first returns to the surface and on a nearby rock, beats the case open or breaks it with its bill to extract the larva inside. Certain food items may need to be subdued before being eaten, such as large crane fly larvae and small fish. These are also taken to a rock and beaten or shaken until sufficiently immobile. On one occasion on Whitewood Creek a male was observed bringing a large crane fly larva to young in a nest. The larva apparently was not fully prepared as the female inside flew out with it instead, paused on a rock then took it downstream. When she returned it was observed folded in her mouth along with another insect. She attempted to feed the young a second time but again flew down from the nest, this time taking the larva over to the male perched on a nearby rock. The male then took hold of one end while the female held the other and as a result the larva was stretched between them, the pair pulling so hard they circled and fell into the creek. After several seconds however, the male released his grip, the female beat the larva against the rock a few times and upon returning to the nest was finally successful in feeding the young.

Rather than diving dippers will oftentimes simply wade along the shallows of a creek, sticking only their head underwater to forage (photo below) and will even flip over dead leaves, sticks and rocks to gain

access to insects. A dipper was once observed on Spearfish Creek taking three attempts from three different angles to successfully turn over a rock one-third to one-half its size. At other times dippers were found floating and paddling with the current close to the bank, climbing out to pluck insects from vegetation or from under an overhang. Insect gathering also took place along large rocks and structures such as concrete walls under bridges, and from atop of snow but they did not stray more than a few yards from the water's edge. In addition, dippers are capable of plucking insects from the air. They were observed doing so while sitting stationary, by running to chase the insect as well as by fly-catching, flying out to capture prey from the vantage point of a bridge railing.

It was observed on both Spearfish and Whitewood Creeks that dippers do not enter significantly turbid floodwater, presumably because they cannot see their prey in such conditions. Rather, they foraged along the streamside until the water became clearer. During flooding with turbid flow dippers were also observed sitting on a low branch overhanging the water and plucking insects from the surface as they drifted by.

Site #18, Little Spearfish Creek 11 July 2008
Dipper fully submerged.

Site #18, Little Spearfish Creek 11 July 2008
Dipper foraging by wading.

Movement

Dippers typically do not fly over land but instead travel low over the water, following each bend and turn of a creek. On two occasions however, birds were observed flying high over land; one flew over a flat area in the city of Deadwood at site #5 and on towards a high hill before it disappeared from sight. Three days later at the same nest site another flew out of sight up and over a high forested hill in the opposite direction. The flight path followed a power line and would have led to another section of the creek as it looped around through town, but it was not known where the dipper eventually landed. In addition, on Spearfish Creek where a nest was located on a high ledge near a waterfall, dippers could sometimes be seen flying over the tree tops to cut over to the main stream rather than following the flow from the falls to the creek.

Dippers will move within drainages and it is thought they usually do so by following connecting waterways. However, travel across divides to different watersheds also occurs by dippers of both sexes and all ages, including juveniles (Price and Bock 1983). In the Black Hills a female was found on Whitewood Creek the following spring after being banded on Spearfish Creek as a juvenile, a straight line distance of approximately nine miles (female #24 banded in 2002 on Spearfish Creek near site #14, nested on Whitewood Creek at site #4 in 2003 and 2004, and at site #6 in 2005). It is not known what route she used to arrive there as there are no direct connections between the two streams within the Black Hills. The only water connection route would have been a flight north on Spearfish Creek, then downstream on the Redwater River, downstream on the Belle Fourche River, and then south on Whitewood Creek, a distance of about 70 miles. A dipper was also found during the winter months at McNenny Fish Hatchery 11 miles northwest of Spearfish, and again briefly during a blizzard in early May (Keith Wintersteen, Hatchery Assistant Manager, personal communication). Wintersteen observed it foraging in a pond directly behind the enclosed fish runs as well as inside, gaining access by ducking under the front wall where the water flows in. Crow Creek flows nearby from the south and remains open in this area in winter, in addition to

the spring-fed ponds and discharge water around the fish runs. Crow Creek then flows into the Redwater River to the north, which flows east from Wyoming. Spearfish Creek to the east also flows from the south to the Redwater River. It is not known if dippers follow this round-about connection or if they cross drainages from streams like Spearfish Creek that offer the best habitat for nesting. Occasional dipper sightings have also been reported on other streams not known to sustain a breeding population, most likely the result of dippers searching for new territory. Without adequate nest sites, forage and open water flow year-round dippers would not be able to take up permanent residence however.

Territory

Although dispersal does take place it has been found that dippers in the Black Hills stay in the same area year after year if they are able to maintain a nesting territory (Table 2). Dippers establish such territories along the creek during nesting season which they defend from other dippers. The length of territories varies, determined by the proximity of nest sites on either side as well as on food availability and the number of competitors. Territory length throughout their range varies from 400 m to 4 km (.25 to 2.49 miles) (Kingery 1996). Along Spearfish Creek nest sites are spaced anywhere from .2 to 1.4 miles apart (322 m to 2.25 km) so territory lengths vary within this range. The sites monitored on Whitewood Creek were spaced from .2 to 2.6 miles apart (322 m to 4.18 km). Some of these territories are maintained during the rest of the year as well. On one occasion a banded male was seen giving chase to another during the month of October (2006), apparently defending the nest territory he held earlier in the year as well as the previous two years (male #2, site #15, Spearfish Creek). He was also seen just .2 miles upstream in November. Whether a territory is held throughout the year depends in large part on food availability and foraging conditions, especially during winter months when portions of the creek may ice over. Price and Bock (1983) noted that dippers in their study area were not clearly territorial in winter. Some agonistic behavior was observed but there was no clear-cut defense of a given space as seen during the breeding season. Varying forage and ice conditions in winter may not allow for exclusive territories, and in extremely cold temperatures may not be energy efficient to defend (Kingery 1996). Other reasons for leaving a territory include mate replacement, molting (to seek cover) and high water (Sullivan 1973).

Table 2. Banded dippers observed from 2004–2009 on the Spearfish Creek watershed (SC) and Whitewood Creek (WC).

Dipper # and sex	Location (site #) and year(s) observed	Location banded (site #)	Date banded	Age at banding
#1 male	#23 SC ‘04 #25 SC ’04, ‘05	#24 SC	5/2/2002	Adult
#2 male	#15 SC ’04, ’05, ’06, ‘07 #15a SC ’05, ‘06 #19 SC ‘05	#15 SC	5/2/2002	Adult
#3 male	#14 SC ‘04 #15 SC ‘04 #16 SC ‘04 #17 SC ‘04	#16 SC	5/3/2002	Adult
#4 female	#15 SC ‘04 #14 SC ‘05	#16 SC	5/3/2002	Adult
#6 male	#14 SC ‘04	#14 SC	5/3/2002	Adult
#7 female	#14 SC ‘04	#14 SC	5/3/2002	Adult
#8 male	#6 SC ’04	#6 SC	7/20/2002	Adult
#12 male	#33 SC ‘04	1 mi. S of #33 SC	8/20/2002	Adult
#14 female	#25 SC ’04, ’05, ’06, ‘07	#25 SC	8/20/2002	Juvenile
#17 male	#10 SC ’04, ’06, ’07, ‘08	#10 SC	8/21/2002	Adult

Dipper # and sex	Location (site #) and year(s) observed	Location banded (site #)	Date banded	Age at banding
#18 male	#5 SC '04 #6 SC '04 #9 SC '04 #10 SC '05	#14 SC	8/21/2002	Juvenile
#24 female	#4 WC '04 #6 WC '05	.4 mi. N of #14 SC	10/12/2002	Juvenile
#27 female	#9 SC '04, '05	#9 SC	7/16/2003	Juvenile
#30 female	#33 SC '04, '05, '06	#33 SC	7/17/2003	Adult
#32 male	#20 SC '04, '05, '06, '07, '08, '09 #20a SC '08, '09 #21 SC '09	#20 SC	7/17/2003	Juvenile
#34 female	#16 SC '04	#16 SC	7/18/2003	Juvenile
#36 female	#2 WC '05	#2 WC	7/29/2004	Juvenile
#42 male	#14 SC '05, '06	#14 SC	2/2/2005	Adult
#43 male	#2 WC '05	#2 WC	2/3/2005	Adult
#45 male	#6 SC '05, '06, '07, '08, '09	#6 SC	4/19/2005	Adult
#46 female	#10 SC '05, '06	#10 SC	4/19/2005	Adult
#47 female	#20 SC '05, '06, '07, '08, '09	#20 SC	4/19/2005	Adult
#48 female	#22 SC '05 #28 SC '06 #26 SC '06, '07, '08 #25a SC '07	#22 SC	4/20/2005	Adult
#49 male	#22 SC '05	#22 SC	4/20/2005	Adult
#50 female	#30 SC '05	#30 SC	4/20/2005	Adult
#51 male	#33 SC '05	#33 SC	4/20/2005	Adult
#52 unknown	#5 SC '05	#5 SC	4/26/2005	Adult

Mate Fidelity and Polygyny

In addition to remaining in the same territory year after year it has been documented that Black Hills dippers will stay with the same mate year after year. Of the banded pairs observed, one pair nested together for five years at the same site on Spearfish Creek and it was possible they were together for six. Male #32 was banded in 2003 at site #20 as a juvenile and female #47 was banded there as an adult in 2005. The male nested at this site with an unbanded female in 2004 so it is possible it was her as well. During the fourth year (2008) however, this male was also seen building a nest for a second brood with an unbanded female just .2 miles upstream at site #20a, while his banded mate incubated their second brood at site #20. Male #32 and female #47 raised one young earlier in the season at site #20 while an unbanded pair fledged three young at site #20a. Neither second brood attempt was successful however. In the spring of 2009, male #32 was then found nesting with an unbanded female at site #20a while at the same time nesting with female #47 at site #20. The nest was successful with the unbanded female but failed with #47. The male then attempted a second brood with female #47 at site #20 as well as an unbanded female at site #21 .3 miles upstream. The success of the nest at site #21 was deemed unknown as young disappeared before they seemed ready to fledge, but female #47's nest again failed. It was thought both failures with #47 were due to the lack of attendance by the male. Although he was seen at the beginning of each attempt; working on the nest with the female nearby for the first brood, and at the beginning of the second brood was visiting the nest but collecting insects to take upstream, he was not seen at the site thereafter; he was not seen bringing food to the nest or perched and standing guard nearby. Later in September he was found again at site #20 however, foraging next to female #47.

Dippers males are mainly monogamous but can be polygynous with two mates. Egg-laying of polygynously-paired females have been found to be spaced 13–43 days apart as well as synchronous (Kingery 1996). Price and Bock (1973) documented polygyny and found a high level of reproductive

success in such cases. Females were found to carry out most of the nest construction and males assisted in feeding both nests. The territory of polygynous males averaged larger than monogamous males. While not conclusive, it was thought a polygynous male must have several nest sites in his territory and a lack of nest sites in adjacent areas, permitting access to a larger food supply.

Three nest boxes exist in a span of .3 miles which covers sites #20, #20a and #21. The next closest nest sites are approximately .5 miles downstream and .3 miles upstream and were occupied by unbanded pairs. It was not known how long male #32's territory actually was during these events, but hypothetically splitting the adjacent territories in half with the other pairs would render a size of approximately .7 miles long. He shared part of this territory with other males in previous years however, when an unbanded pair concurrently nested at site #20a. When male #32 was able to occupy all three sites he did have access to more than the usual number of nest sites in a given area, but his probable territory size was not unusually large. Suitable nest sites with monogamous males range anywhere from .2 miles to 1.4 miles apart on Spearfish Creek. Male #32 was also seen doing more of the nest construction than the females but later did not do well at spending time at both nests. Timing of egg-laying between the two females for each occurrence was estimated to be from 7–10 days apart.

Itinerant Breeding and Effects of Elevation on Nesting

There were two occurrences on Spearfish Creek not involving polygyny where an adult moved from one territory to another between the first and second brood or brood attempts. On one occasion a male moved 2.6 miles upstream to nest at another location (male #2 from site #15, elev. 4777' to site #19, elev. 4901' in 2005) and on another, a female relocated to nest approximately 1 mile downstream (female #48 from site #28, elev. 5248' to site #26, elev. 5209' in 2006). The male however, returned to nest at his original territory the following spring while the female remained in her new territory. In both instances their first and second brood mates were unbanded so it is not known if their mates accompanied them to the new locations.

In the case of male #2, it appeared his move was due to lack of a structure on which to nest successfully. A hole in a culvert in his territory held a nest the previous season but in April was found collapsed. The pair then attempted to nest on top of the culvert but it was later found destroyed. Meanwhile, an unbanded pair occupied the site he moved to and were thought to have begun a nest behind a waterfall but after his arrival, male #2 successfully nested there instead, although the location was much lower in height and off to the side of the waterfall rather than behind it. In August a nest box was wired into the culvert in his original territory, which most likely prompted him to return and stay to nest there the following season as well as the next. He was last seen in the fall of 2007.

In the case of female #48 moving between broods, the success of her first attempt in a nest box attached to a bridge was unknown, the young disappeared before seemingly ready to fledge. Meanwhile there was not a confirmed active nest attempt earlier in the season at the site she moved to, which was also a bridge with not one, but three nest boxes. There were two dipper sightings earlier at this site but they were of adults thought to be nesting .2 miles upstream. After arrival female #48 was eventually successful, fledging one young in July. She nested at this site two more years and was last seen in August of 2008.

Itinerant breeding, or reproducing in different localities during the same season, has been documented previously in the American Dipper. Osborn (2000) observed a banded female successfully raise a brood with one male, then move to a neighboring drainage at a higher elevation to raise a successful brood with a different male. It was thought it was not the result of a death of her first mate, but an ecologically significant movement. The presence of a bridge nest site at a lower elevation offered the opportunity to nest early where no natural nest sites existed, which then allowed time for a second brood at a natural nest site in a higher elevation where the food supply was possibly more abundant. Price and Bock (1983) observed upstream movement in dippers post-breeding that could be due in part to a decrease in food availability at lower elevations and an increase at higher elevations. It was thought that more adult insects emerge later in the season at higher elevations due to the short, delayed growing season. In addition, more insect species may also have two-year larval periods under such conditions. Benthic insects at lower elevations may complete their life cycle in one year and at a time when only eggs or small instars are present, insects at

higher elevations may only be part way through their development or may be ready to emerge, thus providing better forage (Price and Bock 1983).

In the Black Hills along Spearfish Creek elevation does affect when nest activity first begins, nesting at lower elevations begins earlier than at higher elevations and thus, fledging dates are also earlier (Figures 4–9). This could be due in part to snow pack and streamside ice lingering much longer in the spring at higher elevations. There does not appear to be movement to higher elevations for a second brood however. In fact, a greater percentage of second broods occur at the lower elevations with pairs remaining in their established territories (Figure 10). The earlier start in the spring allows sufficient time for a second brood, but it may also indicate that food availability is abundant enough in the lower elevations throughout the nesting season to allow for two broods. In addition, the shortage of available nest sites to relocate to may also play a role in dippers' movement during nesting season. In the instances with male #2 and female #48, elevation differences between sites was not significant and did not appear to be a factor in their movement.

Figure 4. 2004 first brood fledging dates with site number and elevation, Spearfish Creek.

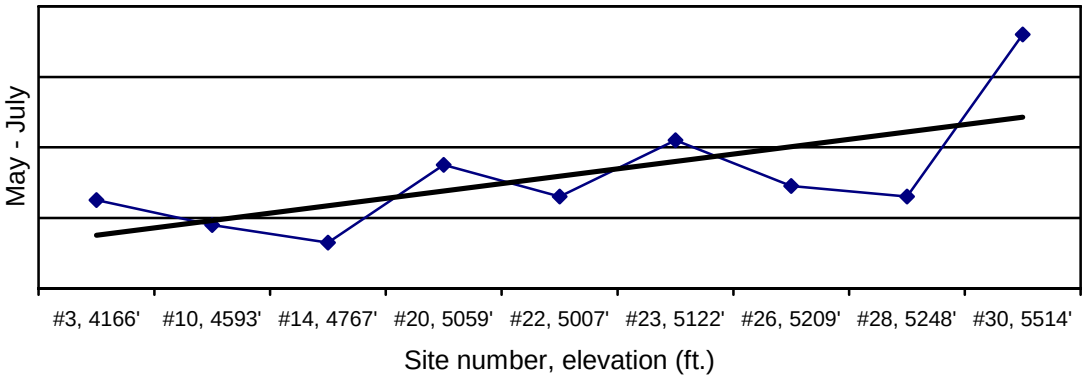


Figure 5. 2005 first brood fledging dates with site number and elevation, Spearfish Creek.

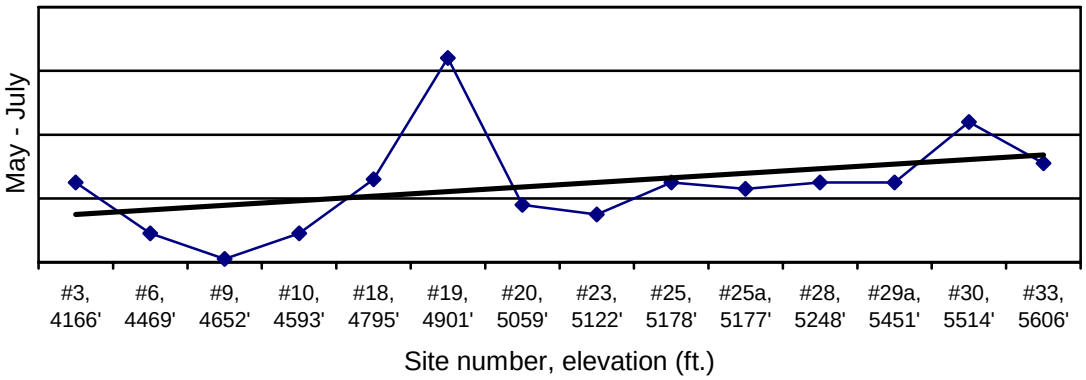


Figure 6. 2006 first brood fledging dates with site number and elevation, Spearfish Creek.

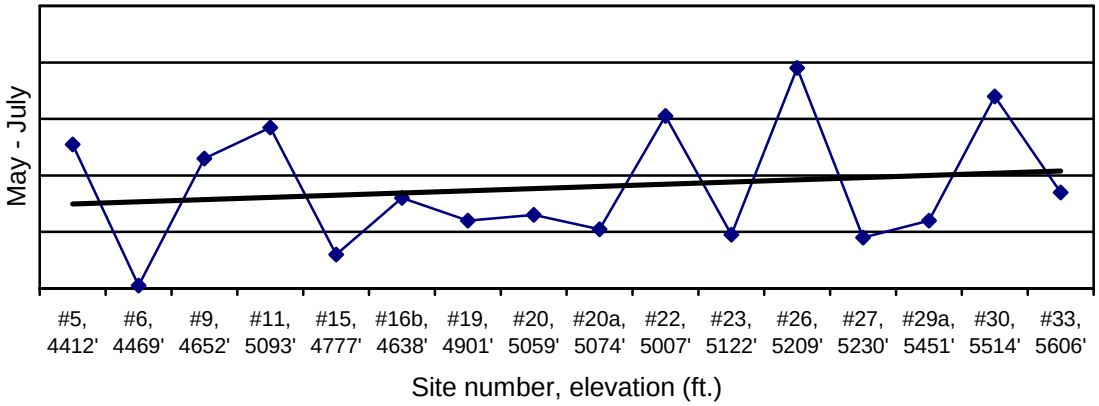


Figure 7. 2007 first brood fledging dates with site number and elevation, Spearfish Creek.

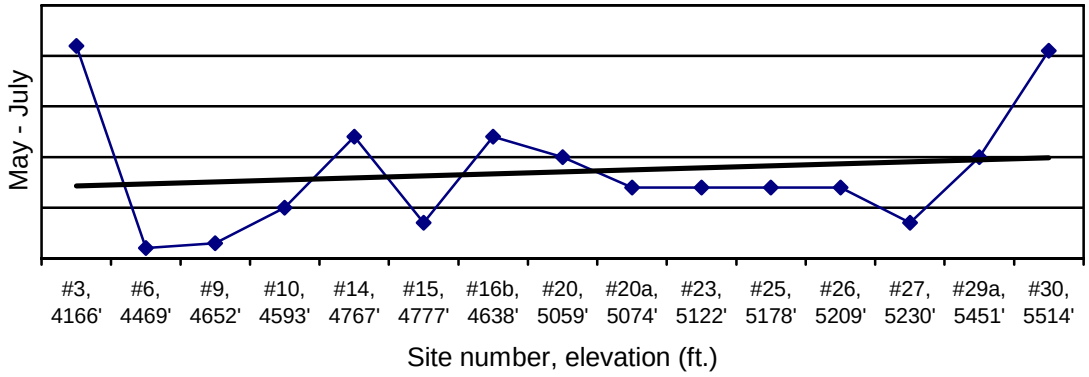


Figure 8. 2008 first brood fledging dates with site number and elevation, Spearfish Creek.

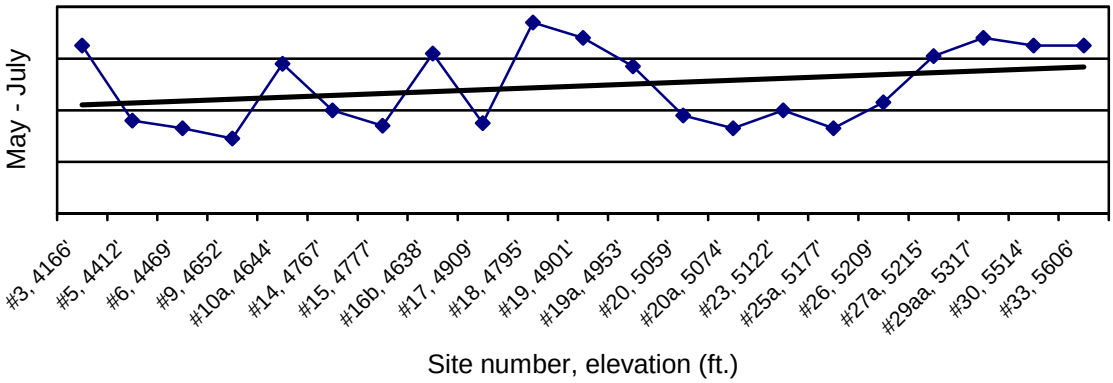


Figure 9. 2009 first brood fledging dates with site number and elevation, Spearfish Creek.

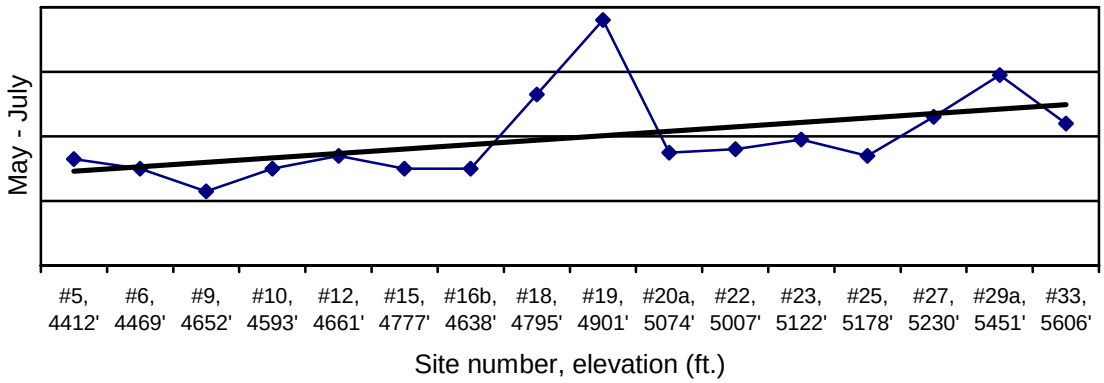
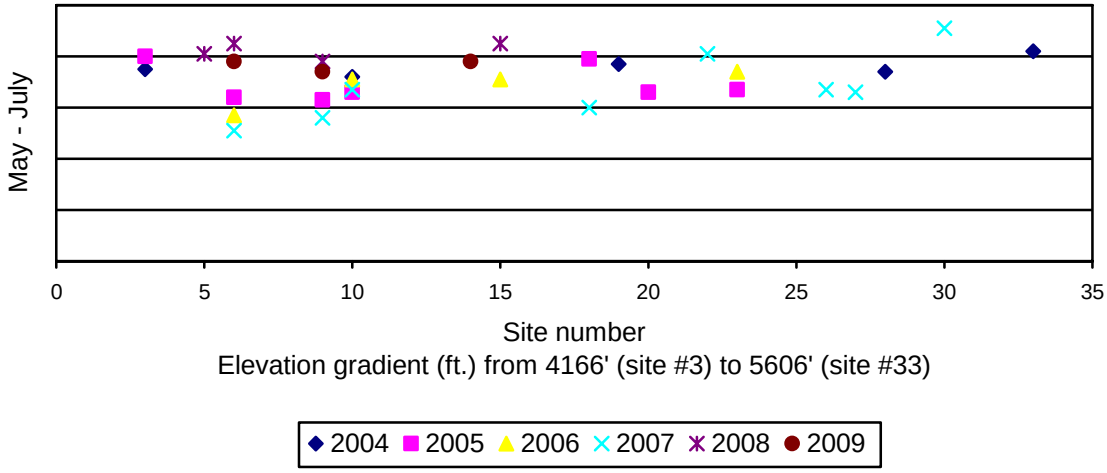


Figure 10. 2004-2009 second brood fledging dates with site number and elevation, Spearfish Creek.



Nest Construction and Placement

Nest construction was observed along Spearfish Creek and Whitewood Creek beginning in early March with both sexes carrying nest material to the chosen location. Both also participated in its building, sometimes equally but at times it was observed that one bird will merely drop the material off while the other did the majority of the construction. Kingery (1996) noted that the male may gather nest material and bring it to the female at the nest. Price and Bock (1983) also observed females performing most of the nest construction. However the opposite has also been observed on Spearfish Creek. Male #32 spent considerable time working on the interior of a nest while the female waited nearby. This occurred at two of his nest locations during more than one season. Nest material consists mainly of moss where available with grass and leaves added in, forming a large ball or dome-shaped structure. It was noted that nests along Whitewood Creek contained less moss and more grass than those on Spearfish Creek where moss grows more abundantly. The material gathered is usually wetted first, then woven together to build up the sides, floor and finally the roof, leaving an entrance in the center to lower half of the nest. A bowl-shaped nest is then built inside made of wetted Ponderosa pine needles, dead grass and leaves, with soft dry grass for lining. To offer additional protection from the elements as well as possible protection from predators, the

roof is built to slightly overhang the entrance. There were a few occasions however, when the roof was not completed. This took place when the nest was built inside a nest box, although the vast majority of time dippers will still complete the roof. It has also occurred twice under bridges where the sidewalls of the nest met the underside of the bridge, or came within inches of it. On one occasion the completed roof of a nest on a rock ledge was later found destroyed, leaving the nest bowl containing two young exposed (site #16a). The parents did not attempt to repair it and after five days only one young remained. As it neared fledging a rain storm occurred and it was not seen again. The unbanded pair then built a second nest, utilizing the base of the previous one but they did not raise a successful brood. The length of time to complete a nest varies but was once noted to take eight days. Late spring snow storms do appear to delay nest construction when already in progress, perhaps in part because nest material is not easily accessible when buried by snow. The weather may also trigger an instinctual delay.

Placement of nests are almost always over water and were found on ledges and depressions along streamside cliffs and rock outcrops, in a rock crevice, in holes along vertical embankments near waterfalls, behind waterfalls, under bridges and in nest boxes built specifically for dippers (Figures 11–12 and photos below). If given a choice along a structure which spans the width of the creek such as the support braces under a bridge, or on top of the retaining walls on either side, dippers build over the deepest water flow. Dippers have also built nests in depressions on large boulders in the center of the creek. Rather than over water they were surrounded by water on all sides but the flow had to be strong and the boulder shaped such that predators would find it difficult to climb up and gain access. Dippers have been known to utilize downed trees and exposed tree roots for nest placement (Loegering and Anthony 2006) but this has not been documented in the Black Hills. One unique nest location was once discovered in 2006 inside a building at the Maurice intake dam on top of a stud wall. It was situated over water but was not active at the time. The pair likely gained access by flying under the deck at the intake under which nests have also been built. A dipper was also once observed entering the building through a large hole in the lower side wall which has since been repaired. On rare occasions it has been reported that dippers have built nests away from water (Sullivan 1966) but this also has not been reported in the Black Hills.

Figure 11. Number and percent of nest site types used during 2004-2009 on the Spearfish Creek watershed.

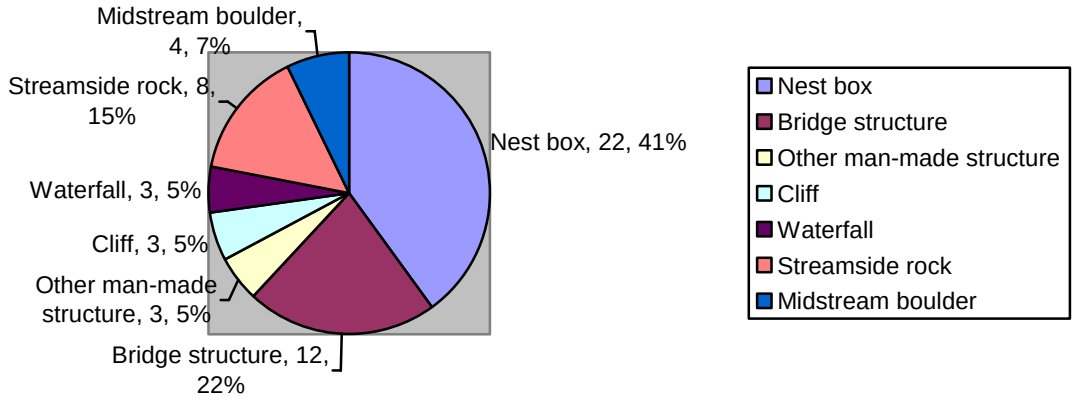
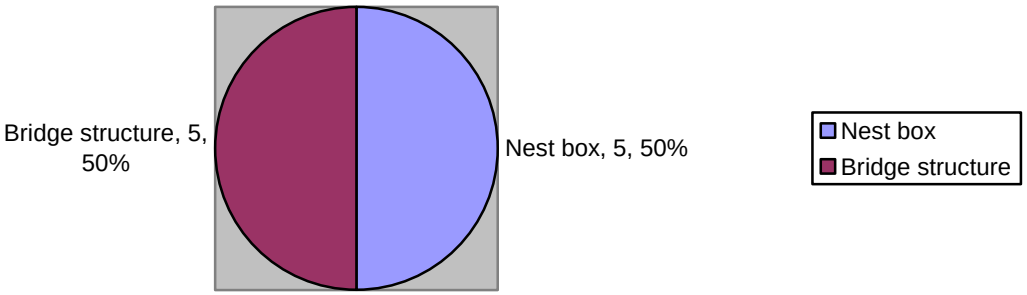


Figure 12. Number and percent of nest site types used during 2004-2009 on Whitewood Creek.



Site #10, Spearfish Creek 20 July 2009

Site #10a, Spearfish Creek 30 April 2008

Site #27, Spearfish Creek 30 June 2007

Site #23, Spearfish Creek 4 May 2007

Dippers reuse old nests from season to season and also between the first and second broods by cleaning out the interior and building a new nest bowl inside. They also add new moss and other material to build up the outer shell where needed, especially around the entrance which would have become enlarged as young from the previous brood neared fledging. If the old nest has collapsed they will simply build on top of it. Many times the interior of the nest is removed after a successful fledging even if the nest is not being immediately prepared for another brood. This does not always occur however, and thus cannot be used as the only indicator of a successful fledging. When removal does take place it happens rather quickly. One day after fledging an adult was observed removing small mouthfuls of moss from a nest built inside a box. Soon its mate took over and while clinging to the box entrance, quickly spat large mouthfuls of pine needles, grass and some clumps of moss into the water below, sometimes needing to fly to pull it out. It then went inside and continued the process, dropping material over the edge until it was satisfied the interior was clean. There were times when nestlings died inside the nest. These nests were eventually cleaned out and reused as well. On one occasion however, the entrance to a nest containing dead young was found plugged with dead leaves while the parents attempted to build a new nest a few feet away (site #9). Unfortunately the structure they chose to build on was not wide enough and the nest eventually fell into the creek.

Nest Failures

In addition to losing nests off ledges lacking sufficient depth, failures have occurred when the nest was placed on a structure over water but was accessible to predators, such as on top of a culvert, certain rock outcrops along a stream bank, and bridge supports that were climbable and offered an uninterrupted path to the nest. Failures also took place when nests had to be abandoned after Rock Pigeons (*Columba livia*) took over by placing their nest material on top of the dippers' nests, which were built upon a sloped concrete ledge under a bridge. This occurred on Whitewood Creek in Deadwood at site #6. In one instance dippers had used the nest for at least two years for their first brood (2004 and 2005) followed by a second brood in a nearby nest box, but in the spring of the third year (2006) Rock Pigeons were found building upon it instead where they raised a successful brood. Dippers no longer had the nest box as an option as it had been vandalized at the end of the previous season. The second instance occurred in the spring of the fourth year (2007). Dippers had chosen another sloped ledge under the bridge on which to build and were in the process of completing the lining inside when Rock Pigeons again took over. It was noted that the first stolen nest no longer occupied the ledge, possibly slipping off under the pigeons' weight and leaving them with no other alternative on which to build.

Many failed nests were simply found in disarray after the female had begun to brood. It is possible that predators were the cause but it was also observed that a nest is gutted and started anew after a male takes over another male's territory. This occurred noticeably in 2004 on Spearfish Creek when one banded male (#18) displaced three different males at three sites during a two-week time period from 19 April–3 May. One of the resident females was banded and could be confirmed staying to re-nest with him after he arrived. Working his way upstream the nest sites disrupted covered an area roughly 1.2 miles in length (sites #5, #6 and #9). At the second site broken eggshells were even found below the nest that he was rebuilding. He eventually settled at site #9 with the banded female but the nest was ultimately not successful. The following year he nested at yet another site (site #10) with a different female where he raised two successful broods, but was not seen again when the next season arrived. Sullivan (1973) found that females can also participate in forcing another to abandon her nest. This was witnessed in Montana when a pair nested too close to another's established territory. The resident female was observed pulling feathers from the intruding incubating female as well as pine needles from inside her nest. After weak efforts to fight back, the incubating female left the nest, leaving the resident female to further destroy it. The intruder never returned.

In 2004 mate switching occurred at one site during nesting that did not result in total loss of the current active nest. In fact, the intruding male was observed feeding a nestling not believed to be his. To the author's knowledge this has never been documented before. In all other cases observed where a male takes over another male's territory, the interior of the nests are removed and started anew, presumably with the resident female. This is usually to the detriment of any brood she may have already started. Besides broken eggshells found below a nest taken over on Spearfish Creek, possible infanticide has been reported in

Oregon. Dead nestlings were found in a stream after an intruding male drove away a resident male (Kingery 1996). In the account below one of two nestlings did disappear about the time a new male took over. It is possible infanticide took place but one was spared.

On Spearfish Creek at site #14 the season began in mid-March with male #6 and female #7 building a nest on a ledge to the right of an old nest. On 5 April while the female was incubating the male was observed working on the old nest. By 26 April it was confirmed that the young had hatched as both parents brought insects to the nest. On 1 May two young were seen at the entrance but on 3 May only one could be seen. Also on this day there was no sign of male #6 but instead an unbanded bird was present with the female. She was once observed making an appeasement display (Kingery 1996), lowering herself, facing away from him and fluttering her wings. Later she used what could be considered a threat display towards him, stretching up and spreading her wings out to him but courtship displays also include this posture and are performed by both males and females (Morse 1979, Kingery 1996). The next day this new male was seen gathering moss and began building a new nest on top of the old one on the left. A few times he would hover at the entrance of the active nest with the female and remaining nestling inside, causing the nestling to think it was getting fed, but he didn't feed it. Sometimes he would peck into its mouth however. The female then exited and the male came to her with an insect. She lowered herself and fluttered her wings and he fed it to her, but rather than swallowing it she fed it to her nestling. She then proceeded to feed it more insects. On 10 May the unbanded male was then observed feeding the nestling several times. Three days later it had fledged and was found being fed by the female. May 18 brought another surprise when female #7 and male #3 were found adding new lining to the previous active nest and again three days later. However, an unbanded male was again found with the female on 26 May, the same day male #3 was found at site #15 .4 miles upstream. He was also seen at site #16 over 1.1 miles upstream on 29 May. On 4 June the female was seen inside the right nest making young vocalizations and being fed insects the unbanded male picked off the nest rock. Activity at the nest eventually ceased though, before any young were seen or heard. Female #7 was last observed feeding, bathing and preening on 22 June while the unbanded male was last seen on 2 July. Male #3 eventually nested at site #17 2.1 miles upstream. He was discovered on 23 June along with newly hatched young. It was not known if nesting was successful because the nest was found empty on 13 July before nestlings should have been ready to fledge. No fledglings were found. At site #14 it was thought the unbanded male was likely displaced from site #5 or #9 as a result of male #18's disruptive activity described earlier.

Nests have also been lost due to a major flood event. In 2007 two nest boxes washed away on Spearfish Creek along with a nest located at a natural site on a rock ledge (sites #20a, #15 and #14). A fourth was thought to have been lost as well as it was situated under a wood deck at an intake dam where the water level appeared to reach the underside of the platform (site #4). The flood occurred at the beginning of June when three, possibly four of the pairs were beginning their second broods. Those in boxes did not have an alternative structure on which to re-nest until new boxes were installed in February of the next year. Nesting on the rock ledge did not take place again until the following spring, but the dippers at the dam tried once more immediately after the flood. If it was the same unbanded pair nesting at the site since the beginning of spring the re-nest marked their third attempt of the season.

Survival of fledged young at the Maurice intake dam was never observed during the time of this study. Adult dippers would build nests under the deck, gaining access by squeezing around the boards in front, but fledglings were not seen to find their way out. Instead, they were thought to be pulled with the current through a tunnel five miles long to the city of Spearfish, ending at a small pond before the water continues on to the hydro plant. This was confirmed when a dead fledgling was found on approximately 8 June 2009 mixed in with debris at the pond, at the same time feeding activity at the nest ceased (Steve Hanson, Hydro Electric Plant Operator, personal communication). In the future, boards leading under the deck will be adjusted each spring in an attempt to increase fledging success.

Unfortunately nest boxes have been destroyed due to vandalism with all incidents taking place on Whitewood Creek. It occurred in 2005 at site #1 northeast of Deadwood and also at site #6 in town. In 2006 one box was torn from the wall under the bridge at site #5 and in 2007 the second one was removed as well, only this time it was occupied; a female with newly hatched young was observed the week before. A box also disappeared from site #7 that same year. In 2008 while checking bridges further upstream from site #7

it was discovered that two boxes had been mounted under a concrete bridge at one time but they too, were vandalized with only the backboards remaining attached to the wall.

Incubating and Young

Dipper females typically lay up to five eggs and only the females incubate. Eggs are white, smooth and glossy, are oval to sub-elliptical in shape and average 25.23 mm x 18.15 mm in size (Kingery, 1996). Females usually lay one egg per day and begin incubating when the last egg is laid, or with the penultimate egg (Price and Bock 1983, Sullivan 1973). A large, centrally located brood patch develops on the incubating female (Sullivan 1973). During this study it was observed that she can sometimes appear well camouflaged when sitting within her darkened nest, until an occasional blinking white eyelid revealed her presence. In addition, depending on how often brooding females were exposed to human presence, some were not easily disturbed when approached within a few yards while others flushed on sight. In a few instances the female was aggressive, calling out a warning while flying toward the author before flying away. Prolonged human presence such as fishing too close to a nest could result in dire consequences to eggs or young if the female is easily frightened away, especially when the air temperature is low. While brooding eggs and very small young she will leave the nest for brief periods of time to feed and bathe but only for approximately ten minutes. The male also brings food for her to eat. If young were present she was seen to take the food from the male and give it to the young instead, although usually she moved out of the way and the male fed them directly. When not out foraging the male stations himself below the nest or close by, guarding the female and his territory from intruders.

Young hatch after approximately 16–17 days and are naked except for sparse down on just a few areas of the body. Down then covers the body by day seven (Sullivan 1973). Food for the young includes aquatic insect larvae and mature forms as well as other items eaten by adults. Both parents feed them and instinctively know to feed nestlings prey appropriate to their size. They may receive small caddisfly larvae or tiny winged insects when small and as they grow are able to take large crane fly larvae, small fish, or several insects at a time. The presence of newly hatched young could sometimes be determined by observing the size of insects brought to the nest, in addition to the amount of time the parent spent feeding them. Parents took more time when delivering food to very small young. Food items are given to just one young per visit, although once a parent returned with two small fish and fed them to two different individuals. Gathering large mouthfuls of winged insects along the stream bank appeared faster and more efficient many times than searching for larval forms underwater. This especially was the case when certain insect species were emerging all at once and were readily abundant, and also when insects congregated in newly melted open areas after a snowfall. On two occasions at two different sites an adult was observed chasing Song Sparrows (*Melospiza melodia*) while collecting food for nestlings. At one of the sites (#5, Spearfish Creek) the sparrow was a few yards from the nest location but at the other (site #4, Spearfish Creek) two sparrows were chased separately from a foraging area among rapids located far from the nest across a large pond.

As the young mature feathers begin to form, unsheathing on days 8–10. Natal down becomes less prominent while feathers lengthen and by day 20, the down has all but disappeared, the young appearing fully feathered (Sullivan 1973). The female will continue to brood until the nestlings reach around 12–13 days old, the time spent lessening as they grow (Tyler and Ormerod 1994). When she is not present and the nest is approached young instinctively flatten themselves down to hide if possible, which made counting difficult, and will leap from the nest if the entrance is breached. As soon as they are coordinated enough nestlings do not soil their nest but will turn to defecate out the entrance. This sometimes still requires clean-up by the adults which they do so by carrying the fecal sacs to the creek and rinsing their mouth afterwards. At one site however, at least one adult did not take fecal sacs to the creek but either deposited them or dropped them over the edge of a small dirt knob just below and to the side of the nest. It then wiped its beak on the dirt. This took place next to a falls where the water flow created a strong wind current that affected the adult's flight path. It is possible the dipper found it quicker and easier to dispose of waste in this manner.

Nestlings do beg for food but are usually quiet until an adult is within viewing range, after which they can be heard quite loudly and seen leaning far out of the entrance to compete. Although it has been noted that

young will rotate positions in the nest allowing others the opportunity for better access, especially when they must turn to defecate (Kingery 1996), smaller and weaker nestlings could still be at a disadvantage. In the Black Hills even when an average of five eggs were laid it was rare to find five young surviving until fledging. At times dead young were visible in the nest while live young were still present, and on one occasion a nestling approximately 17 days old was found dead along a stream bank below a nest box. It was not known if it fell out or was accidentally pushed, eventually succumbing to exposure, or had possibly died while in the nest and was discarded. As nestlings mature many times one will appear larger or more developed than the others but they were never observed fighting amongst themselves. Sullivan (1973) noted that one nestling may lag behind for approximately two weeks if incubation began with the penultimate egg, resulting in one hatching one day later than the rest.

Fledging

When nearing fledging nestlings begin to take an active interest in their surroundings, sitting at the nest entrance and observing any activity below. Insects flying by or landing near the nest also draws their attention but they do not attempt to capture them. Older nestlings about to fledge were also observed dipping and on a couple of occasions, echoing their parents' alarm call. Once a nestling on Whitewood Creek began a series of alarm calls and it was the parent who followed suit. Young normally fledge between the ages of 24–26 days (Kingery 1996) and this was observed in the Black Hills as well. When leaving the nest dippers leap out and land in the water but quickly flap their wings and swim to the nearest bank. After the first one leaves the others usually follow within 1–2 days, although occasionally fledging took up to four days. In the beginning fledglings stay in close proximity to each other and the nest site but after a couple days disperse, the parents often dividing the brood and their territory to tend them. Fledglings will continue to be fed by the parents for up to 24 days while they learn to forage for themselves (Kingery 1996), although the time spent together may be closer to a few days to two weeks (Price and Bock 1983, Sullivan 1973). This was also observed in the Black Hills. Two weeks after leaving the nest fledglings could be found at times, following and begging from adults, sometimes being fed by them but sometimes ignored, forcing the fledglings to forage for themselves. Protective behavior by a parent was once observed when a House Sparrow (*Passer domesticus*) got too close to a fledgling four days out of the nest on Whitewood Creek. The sparrow was curious as the fledgling was begging towards it but soon the dipper parent came and chased it away. On another occasion on Whitewood Creek an adult attempted to chase off a pair of Common Grackles (*Quiscalus quiscula*) near the creek side several yards downstream from a fledgling. One resisted and showed aggression back to the dipper but eventually flew away. On two occasions however, newly fledged young were observed being rejected by a parent. One had just left the nest when the female approached it and jumped at it with her feet, even while it feebly opened its mouth to beg. The male came and fed it however. At another site the fledgling hopped and swam over to the parent to beg but the parent jumped on its back until it returned to the rock it came from.

Depending on the age at which they leave the nest some newly fledged young are capable of flying short distances while others can only walk and hop along the stream bank. If they fall into the current they are able to reach the bank as when they first left the nest. Fledglings, like nestlings, beg loudly when an adult is nearby and will sometimes attempt to follow the parent as it forages. Many times they were located by this activity and it is possible predators were also drawn to the sound. However, fledglings can be well adept at sitting still or hiding among rocks and vegetation when danger is present, and when able, fly short distances or use the creek to escape if needed. Newly fledged young are not known to dive however, and when foraging stay in the shallows along the bank. It is thought their feathers do not fully acquire their water-repellent properties until sometime after fledging and possibly not until after their postjuvenal molt (Goodge 1959).

Double Brooding

Black Hills dippers will begin a second brood if time permits, although not all pairs do. The previous nest is cleaned out and new lining is put in place within days of the first brood fledging. Sometimes when another nest location was just a few feet away, such as another nest box, dippers began working on the next nest up to a week before their first brood fledged. Many times they just waited and used the same box however. Second broods usually begin from mid to late May through the middle of June and end before the time of

molt begins. On one occasion it appeared a third brood was attempted by the same pair after a second brood was lost due to flooding (site #4, Spearfish Creek, 2007). It could not be confirmed as the nest was hidden from view and the pair was unbanded, but was likely to have occurred based on observations of the timing of food items and nest material being carried to the location.

Molting

Molting typically takes place in August (Kingery 1996) when nesting is complete and fledglings are no longer dependent on their parents. Sullivan (1973) found this period to extend anywhere from July through September. Dippers differ than other passerine birds but are similar to aquatic species such as ducks, grebes and some rails in that they molt their flight feathers all at once, during which time they lose their ability to fly (Tyler and Ormerod 1994). When this occurs they are vulnerable to predators and are thus more secretive, foraging and hiding along rocks and stream bank vegetation. Like other aquatic birds when in the flightless condition however, they do have the ability to enter the water to escape in addition to the advantage of having a food supply available without flight (Tyler and Ormerod 1994). The time of no flight lasts for approximately four days to two weeks (Kingery 1996). Directly before and after this period they are able to fly short distances low over the water but only when pressured to do so. On one occasion on 24 August a dipper preferred to run along the bank on Whitewood Creek before flying to escape, and at a site on Spearfish Creek on 13 August a dipper swam to nearby tree roots before making an attempt to fly a distance of a few yards. On another occasion on Spearfish Creek a dipper in molt was observed running back and forth to catch flying insects. She also foraged by wading and hopping among rocks without using her wings, and only flew a short distance when pressured. This occurred on 11 August. On all three occasions the dippers did not want to leave the protection of the bridges they were underneath. In addition, most noticeable were their short or ruffled rectrices (flight feathers of the tail). Sullivan (1965) also noted that rectrices as well as remiges (flight feathers of the wing) were extremely short during the flightless condition and that dippers could be captured by hand or with a fish net, although they did attempt to evade capture by hiding or swimming away on or under the water. Juveniles do not undergo a complete molt. Body feathers are replaced including the gray head feathers being replaced by brown, but the remiges and rectrices are retained allowing the bird to remain capable of flight (Sullivan 1965, 1973, Kingery 1996). The head and chest of the juvenile take on a mottled appearance during this process (see photos below). As mentioned earlier, Goodge (1959) noted that juvenal plumage may not fully acquire water-repellent qualities until sometime after fledging and possibly not until after the postjuvenal molt.

Site #16a, Iron Creek Juvenile dipper in partial molt. 22 August 2009

Nest Parasites

American Dippers have been found parasitized by blowfly larvae of the genus *Protocalliphora* as well as the northern fowl mite of the genus *Ornithonyssus*. Blowfly larvae parasitize nestlings of nidicolous birds (those that remain in the nest for some time after hatching) whereas mites parasitize all ages of birds. Both feed by sucking blood from their hosts (Halstead 1988). In California Halstead (1988) found nestlings where two to six blowfly larvae were embedded subcutaneously on the head, wings and legs. Ten to 40 puparia were also found in some nests after fledging. Specimens were identified as *P. aenea* or *P. braueri*. One nestling died as a result and it was thought that the loss of blood in those that survive could contribute

to nestling stress and a reduction in post-fledging survival. Halstead (1988) also reported records of dipper nestlings parasitized by blowflies in Utah and Colorado. To investigate whether blowflies could be present in Black Hills dipper nests five nests from along Spearfish Creek were collected in 2004 and sent in for examination (Terry L. Whitworth, Entomologist, Puyallup, WA, personal communication). One nest was collected after finding maggots inside, which were later identified as carrion maggots (site #9). Another nest was collected after a first brood fledged (site #23) and contained a large amount of white, flaky, feather shaft-like material. The remaining three were collected after second broods, two of which fledged successfully (sites #28 and #33) and one was unknown (site #32). All results were negative for blowflies, although further testing of more nests over time could reveal a different outcome.

Halstead (1988) also searched for fowl mites, finding one nest containing 400 *O. sylviarum*. Most were in the nest but were also on the feathers and skin of the nestling. Feather lice have been found on dippers as well, which are generally host-specific and feed on feathers on specific parts of the body. A healthy bird can probably keep the lice numbers in check by preening and possibly by bathing (Tyler and Ormerod 1994). On more than one occasion nests in the Black Hills were found to contain tiny ectoparasites of unknown identity, discovered when reaching into a nest soon after fledging and having one's hand covered by them. In addition, nestlings ready to fledge from a second brood nest in early July were observed on two occasions shuddering frequently, as if trying to rid themselves of an excessive amount of parasites. On another occasion an adult was seen preening on a rock, then looking down around its legs and between its toes, eating what it was finding. It was thought they were parasites that dropped off during preening. To date there have not been studies to determine what species of fowl mites and/or feather lice inhabit the Black Hills dipper population.

Anting

Anting is a behavior observed among more than 200 species of passerine birds whereby a bird picks up an ant, usually a species which sprays formic acid as a defense, and rubs it through its feathers. Often the ant is eaten afterwards. Known as active anting, birds have also been seen engaged in passive anting, where the bird sits with its wings extended and allows ants to crawl into its feathers (Judson and Bennett 1992). Various hypotheses exist as to why birds ant. It may be a way to rid the ant of the toxic formic acid prior to consumption (Judson and Bennett 1992); thermogenic properties of chemicals released by ants could soothe skin during new feather growth (Potter 1970, Potter and Hauser 1974); ant secretions may inhibit the growth of fungi and bacteria on the skin (Ehrlich *et al*. 1986); or it may help to rid the body of ectoparasites (Groskin 1950). Anting by an American Dipper has been observed once before (Osborne 1998). It occurred in Montana on 12 July 1997 with no obvious signs of molting in progress. It also could not be determined if the bird ate the ants afterwards.

Anting was observed on at least two occasions at site #4 on Spearfish Creek. On 18 June 2008 an adult was observed flying to a rock embankment near its active nest where it proceeded to pluck ants and rub them along the underside of its remiges, under wing coverts and axillaries, as well as its chest, abdomen and near its legs. After a few seconds a new ant was collected and it appeared the ants were swallowed afterwards. The dipper then walked down to the water to forage but soon walked back up the embankment to ant again, zigzagging back and forth to locate and chase down the ants. It repeated this routine three times, walking to the water's edge and returning to ant and when done, flew under the wood deck at the dam where the nest was located. It was not seen to have anything in its bill. Two days later the embankment was investigated and only one species of ant was found. They were medium-sized and black and were later identified as *Formica* cf. *subsericea* Say (Richard T. Carter, personal communication). On 5 June 2009 anting was again observed at the same location with an active nest in progress. An adult was preening on a rock near the center of the creek; then flew to the rock embankment where it plucked ants and rubbed them along the underside of its remiges and under wing coverts. It repeated this several times with a new ant each time but it was not clear if the ant was eaten afterwards. It also did not rub the ants on any of its body feathers. Afterwards it flew upstream along with its mate and they both returned with forage for the nestlings.

A possible anting episode also occurred on 27 April 2007 at this same location, discovered when reading back through field notes. It was stated that a dipper was perched, then began investigating the embankment, eating insects perhaps a couple of times but would mostly preen. In addition on 28 May 2009 a fledgling at

site #8 thought to have left the nest upstream five days earlier was seen exhibiting similar behavior. It was found on a midstream log where it plucked what appeared to be a large carpenter ant from the log which it rubbed on its chest twice before eating it. Although the insect could not be confirmed the fledgling seemed to mimic the anting behavior seen before. The behavior of a fledgling may not be developed enough to draw any conclusions but it seems to support more than one hypothesis; preparing the ant for consumption, but it's also possible that it was soothing its skin from recent feather growth as well as finding relief from ectoparasites. Dozens of parasites have been found in nests soon after fledging so it is likely fledglings also host a high number of them. In the anting episodes with the adult dippers, soothing skin from new feather growth does not appear to be a factor however, as adults do not molt and grow new feathers in the spring but between the months of July and September (Sullivan 1973). In addition, the dippers observed could have been foraging and preparing the ants for consumption but they did not do so to feed the young. Instead, in the case of the adult in 2009, it was thought anting was done to assist in preening as it appeared to be a continuation of the preening process which began on the midstream rock. More observation is needed to draw firm conclusions.

Vocalizations

Dipper vocalizations are quite varied and loud enough to overcome an environment with high background noise. Included is a song that is described as sweet and bell-like with a medley of single notes, repeated notes and trills. Singing is most frequently heard in late fall and winter as birds establish winter territories, and also in the spring to attract mates and form breeding territories (Kingery 1996). In the Black Hills dippers are usually found singing while perched quietly on a midstream rock or along the streamside. At times they will also sing immediately after feeding fledglings. While still in close proximity to the young and with their full attention it is thought that the adult is teaching them the song (Kingery 1996). A short song can be heard when a pair greets each other, usually near the nest, and also before mating. Another variation can be heard while one dipper chases another. Greeting vocalizations can also come in the form of a 'grack' or a 'jeeb' sound and occurs when the male arrives at the nest with the female inside, and on occasion when a parent greets nestlings. Other vocalizations include young begging for food but this sound coming from a nest is sometimes being made by the female when the male arrives to feed her. She was also observed begging from the male outside of the nest when foraging near him. Perhaps one of the most common vocalizations heard is the 'jit' alarm call, made in rapid succession or single notes spaced apart when possible danger is near. Dippers also occasionally 'jit' while flying along the creek, perhaps as a result of danger but possibly also to announce its presence.

Predation

Predation of Black Hills dippers was never witnessed directly but possible predators were observed in the vicinity of nests. Mammals included Mink (*Mustela vison*), American Marten (*Martes americana*) and a common house cat. An American Marten was twice seen moving in the direction of a nest where young were loudly and actively begging. It was not known if the nest was the destination as it changed course due to human presence. Great Blue Herons (*Ardea herodias*) were also found several times near active nests located under bridges, making adult dippers highly agitated and vocal with alarm calls. A Great Blue Heron was once observed capturing and eating a dipper in northern California (Parker 1993). The dipper landed within 2–3 meters of a heron, then dove in the water to forage whereby the heron quickly walked over and lunged after it. Dippers can also be prey for trout; a fledgling dipper was once found in the stomach of a ten inch long Brook Trout (*Salvelinus fontinalis*) (Johnson 1953). Another possible predator of dippers may include the Western Terrestrial Garter Snake (*Thamnophis elegans*) as their diet can include small birds. These snakes are frequently found along Spearfish Creek and on one occasion one was found with a large bulge in its stomach next to a bridge where fledging was occurring. Various birds of prey can also pose a danger to dippers. In one instance an adult fed nestlings; then perched on a rock at the top of a small area of rapids (site #16b). It alarm-called as a result of the author's presence but soon the alarm became very loud and urgent. The dipper then leapt down below the rock as an unidentified hawk flew directly over. Upon inspection there was no perch below the rock; the dipper had plunged into the water to escape. Dippers will also flatten themselves on the surface of the water to avoid detection by predators. To do so they extend their heads and necks and depress their retrices, and remain motionless until danger has passed (Sullivan

1973). Sullivan (1973) once observed a dipper remaining motionless for approximately two minutes after a hawk flying overhead disappeared.

Longevity

The lifespan of the American Dipper has been recorded at seven years, two months (Lutmerding and Love 2009). In the Black Hills one male came close to that record and another almost tied the record before they disappeared. Male #2 was banded as an adult in May of 2002 and was last seen in September of 2007, making him at least six years, three months old (photo below). Male #17 was banded in August of 2002 as an adult, and at the minimum age of seven was last seen at the end of May 2008. Ages are calculated based on the USGS Bird Banding Laboratory guideline which uses a June hatching date for all species. The ages of male #2 and male #17 are based on the assumption they hatched in June of 2001, although it could have been earlier, perhaps even a year or more earlier. As of this writing another male is also nearing the longevity record. Male #32 was banded as a juvenile in July of 2003 and was still present and nesting in 2009 (photo below). He was last seen alive and well in September 2009 at the age of six years, three months. All of the oldest birds were/are located on Spearfish Creek.

Site #15, Spearfish Creek 1 May 2007
Male #2

Site #20a, Spearfish Creek 18 May 2009
Male #32

Nesting Success of the Black Hills Population

Site productivity for the Spearfish Creek watershed is summarized in Table 3. From 2004–2009 successful first broods confirmed totaled 98 with 194 fledglings found. There were 34 successful second broods with 51 fledglings found. The total number of fledglings for all six years of study was 245, an average of 40.8 per season. A nesting attempt was deemed successful if fledglings were observed in the nest vicinity, or if fully feathered young were visible in the nest ready to fledge at any moment. However, the total number of fledglings represents only those actually found after leaving the nest, and thus may be lower than the actual number fledged. The number of adult dippers seen each season averaged 52.8 (Lovett 2009).

Of the 48 sites monitored on the Spearfish Creek watershed 40% were natural nest sites and 60% were man-made, most of which consisted of nest boxes and support structures under bridges. Use of man-made sites resulted in the most productivity for first broods, accounting for 70% of nest successes and 76% of the total number of fledglings. Second brood nesting was similarly more productive using man-made structures and accounted for 68% of successful broods and 67% of fledged young.

Table 4 lists site productivity for the section of Whitewood Creek monitored. From 2004–2009 successful first broods confirmed totaled 16 with 34 fledglings found. There were only three successful second broods with seven fledglings found. The total number of fledglings for all six years of study was 41, an average of 6.8 per season. The number of adult dippers seen each season averaged 8.2 (Lovett 2009). All nine sites monitored on Whitewood Creek were man-made nest sites consisting of nest boxes and support structures under bridges.

Table 3. Site productivity for the Spearfish Creek watershed from 2004–2009.

Site #	Nest site N = Natural M = Man-made	Number of years monitored	Number of years active	Successful first broods confirmed	Total first brood fledglings	Successful second broods confirmed	Total second brood fledglings	*Total fledglings found*
1	M	6	1					
2	N	6	0					
3	N	6	6	4	7	2	3	10
4	M	6	6					
5	M	6	6	3	4	1	1	5
6	M	6	6	5	14	5	12	26
7	N	6	1					
8	N	6	0					
9	M	6	6	5	13	4	7	20
10	N	6	6	5	12	4	4	16
10a	N	5	2	1	2			2
11	N	6	2	2	2			2
12	N	6	2	1	1			1
13	N	6	0					
14	N	6	6	3	4	1	2	6
15	M	6	6	4	7	2	4	11
15a	N	5	1					
16a	N	6	2					
16b	N	6	5	4	8	1	3	11
16c	N	3	2	1	2			2
16d	N	1	1					
17	M	6	6	1	1			1
18	N	6	6	3	2	2	4	6
18a	N	5	1					
19	N	6	6	4	6	1	1	7
19a	N	2	2	1	1			1
20	M	6	6	5	15	1	2	17
20a	M	5	5	5	12	1	1	13
21	M	6	1					
22	M	6	6	3	7	1	1	8
23	M	6	6	6	16	2	2	18
24	M	6	1	1	3			3
25	M	6	6	3	5			5
25a	M	5	2	2	3	1		3
26	M	6	6	4	7	1		7
27	M	6	6	3	6	1	1	7
27a	M	2	2	1	1			1
28	M	6	4	2	2	1		2
28a	M	2	1	1	1			1
29	M	6	2					
29aa	M	2	1	1	2			2
29a	M	6	5	5	12			12
30	M	6	6	5	9	1	2	11
31	M	6	0					
32	M	6	3					
33	M	6	5	4	7	1	1	8
34	M	5	3					
35	M	3	1					
Totals	N=19 M=29			98	194	34	51	245

Table 4. Site productivity for Whitewood Creek from 2004–2009.

Site #	Nest site N = Natural M = Man-made	Number of years monitored	Number of years active	Successful first broods confirmed	Total first brood fledglings	Successful second broods confirmed	Total second brood fledglings	*Total fledglings found*
1	M	6	5	3	5			5
2	M	6	5	3	5	1	5	10
2a	M	2	1	1	3			3
3	M	6	4	3	9			9
4	M	6	2	2	3	1	1	4
5	M	6	4	1	1			1
6	M	6	4	3	8	1	1	9
7	M	6	1					
8	M	1	0					
Totals	N=0 M=9			16	34	3	7	41

Successful nesting declined on Whitewood Creek over the course of this study, most likely due in part from vandalism of nest boxes (2005, 2006, 2007), Rock Pigeons using dipper nests to build upon (2006, 2007) and also from temporary destruction of the creek bed at site #4 during hotel re-construction, which began in the fall of 2006. Nesting at this site resumed in 2009 after the creek was allowed to resume its natural course. There may be additional factors contributing to the decline however, as sites #1 and #2 were not adversely affected by the above occurrences. A nest box was vandalized at site #1 but there were other places on the bridge structure on which to build a nest. Weather may have also played a role in the decline. Heavy snowfall continued late into spring in both 2008 and 2009. Table 5 lists the fledging dates on Whitewood Creek for each year of study, reflecting this reduction in nest success since the first year of monitoring in 2004.

Table 5. First brood/second brood fledging dates on Whitewood Creek from 2004–2009.

Site #	Elevation	2004	2005	2006	2007	2008	*2009*
1	4028’	5/17	6/22		5/7		
2	4030’	5/17, 6/30	6/27			7/6	
2a	4641’					6/10	
3	4685’	5/13	6/6	6/15			
4	4688’	5/5, 6/22					5/22
5	4684’		5/19				
6	4757’	5/17, 6/30	6/7				6/5
7	4759’						
8	4689’						
unknown	unknown				found 5/16		
unknown	unknown				found 6/3		

Successful nesting on the Spearfish Creek watershed did not show a decline like on Whitewood Creek but the late spring snow storms in 2008 and 2009 did delay nesting; first brood fledging occurred later on average than in previous years resulting in a reduced amount of second broods in the higher elevations above 5000 feet. Table 6 lists the fledging dates for each year of study. Five nests were discovered late in the season so it is not known if they were indeed first or second broods (site #29a in 2004, site #11 and site #20a in 2005, site #28a in 2007 and site #16c in 2009). In addition, the successful nesting that occurred at site #24 in 2007 was most likely a second brood by the pair that nested earlier at site #23. It could not be confirmed as the dippers were unbanded.

Table 6. First brood/second brood fledging dates on the Spearfish Creek watershed from 2004–2009.

Site #	Elevation	2004	2005	2006	2007	2008	*2009*
1	4161’						
2	4159’						
3	4166’	5/25, 7/14	5/25, 7/19		6/11	7/4	
4	4277’						
5	4412’			6/20		6/5, 7/20	6/2
6	4469’		5/9, 7/3	5/1, 6/26	5/2, 6/20	6/2, 7/24	5/30, 7/17
7	4473’						
8	4493’						
9	4652’		5/1, 7/2	6/15	5/3, 6/25	5/29, 7/17	5/23, 7/13
10	4593’	5/18, 7/11	5/9, 7/5	-, 7/10	5/10, 7/6	7/24	5/30
10a	4644’					6/27	
11	5093’		7/8	6/26			
12	4661’						6/3
13	4666’						
14	4767’	5/13			5/24	6/9	-, 7/17
15	4777’			5/12, 7/10	5/7	6/3, 7/24	5/30
15a	5020’						
16a	4637’						
16b	4638’			6/1	5/24	7/1	5/30, 7/17
16c	5050’						7/16
16d	5056’						
17	4909’					6/4	
18	4795’		5/26, 7/18		-, 6/29	7/13	6/22
18a	4775’						
19	4901’	-, 7/16	7/3	5/24		7/7	7/15
19a	4953’					6/26	
20	5059’	6/4	5/18, 7/5	5/26	5/20	6/7	
20a	5074’		7/6	5/21, 7/17	5/14	6/2	6/4
21	4932’						
22	5007’	5/26		6/30	-, 7/20		6/5
23	5122’	6/11	5/15, 7/6	5/19, 7/13	5/14	6/9	6/8
24	5134’				7/11		
25	5178’		5/25		5/14		6/3
25a	5177’		5/23, 7/17			6/2	
26	5209’	5/29		7/17	5/14, 7/6	6/12	
27	5230’			5/18	5/7, 7/5		6/15
27a	5215’					6/30	
28	5248’	5/26, 7/13	5/25				
28a	5309’				7/17		
29	5259’						
29aa	5317’					7/7	
29a	5451’	7/16	5/25	5/24	5/20		6/28
30	5514’	7/11	6/13	7/7	6/10, 7/30	7/4	
31	5544’						
32	5550’						
33	5606’	-, 7/21	5/31	6/3		7/4	6/13
34	5410’						
35	5434’						
unknown	unknown				found 6/20		

An analysis of annual survival and reproductive rates on the Spearfish Creek watershed and Whitewood Creek can be found in Appendix VI.

Concerns and Management

Dippers in the Black Hills were observed on more than one occasion during this study with injuries or illness. On Spearfish Creek in 2006 near site #29 an adult dipper was discovered with two very large orange/yellow lobules growing from the toes on one foot, with the foot and leg enlarged overall. The dipper was able to forage, even putting weight on the foot, but was unlikely to have survived long with this condition. In 2008 at site #22 a male dipper was found with a similar affliction. Outgrowths were not present but toes on his right foot were light orange in color and enlarged (see photo below). Over the following month it did not appear to worsen as he foraged normally and fed the female at the nest. The nesting attempt failed however, and he was not seen thereafter. Earlier at this same site in 2005 a male dipper was captured during banding and was missing his left tarsus and foot, amputated below the joint (photo below). Unfortunately he was not seen again after banding (#49). In 2004 on Whitewood Creek a fledgling was found near site #4 with a significant scratch and missing feathers on its head. It was the only fledgling found out of five thought to have fledged from the nearby nest. When observed again five days later being fed by the female the injury appeared to be healing however, although new feather growth was not yet visible. Also on Whitewood Creek that same year a dead banded adult dipper (#35) was found on the steps of a casino in Deadwood. It was collected and sent in for testing as the bill was also noted to be deformed. Photos and results of testing appear in Appendix II.

Site #22, Spearfish Creek 23 May 2008
Male with infected toes on right foot.

Site #22, Spearfish Creek 20 April 2005
Male with amputated leg.
(photograph by Doug Backlund)

In the Black Hills dippers were generally found to be tolerant of human activity when not excessive. On one occasion four bridge timbers were replaced above an active nest box and on another, a bridge railing was reattached but neither resulted in nest abandonment. Dippers were also accustomed to vehicle traffic above their nests under bridges. However, normally active nest sites on two occasions were not used when road and home construction took place nearby. Prolonged use of heavy equipment was the likely cause. Fishing and other activities often took place in the vicinity of active nests. As stated earlier, female dippers at sites not frequented by visitors were easily frightened off their nests when approached. If the intrusion near the nest is prolonged, it could result in dire consequences to eggs and small young. Once young fledged it was noted that they dispersed quickly or were often not found at all at sites where people were present, especially when the people were accompanied by dogs.

Bridge structures and placement of nest boxes over water gives dippers opportunities for nesting where no natural nest sites exist. At any given location boxes should be placed over the deepest water flow. In addition, it was observed that boxes attached under bridges were more successful than those attached to an exposed side rail of a bridge. Nest box interior dimensions of 20 cm wide, 18 cm deep and 16 cm high used by Hawthorne (1979) have been recommended along with a slight overhanging roof, a front lip and drain holes. However, an additional 2–3 cm in width and height would give dippers the capacity to build larger if they desired, especially in height when nest material from previous nests begins to accumulate in the bottom. Caution should be used when determining the height of the front lip. It was discovered that those built too high inhibited normal behavior of nestlings and parents. As nestlings mature they begin to sit at the edge of the nest bowl and look down for arriving parents, leaning out and downward to receive food as parents fly up to meet them. They are also able to quickly pull back and hide if danger is present. With boards too high in front nestlings were observed either sitting on the outside of the nest or on the edge of the board to have better access and were thus more vulnerable to predators, and to possibly falling out of the box. Nestlings also had difficulty defecating out of the nest and waste would accumulate if parents could not keep up with removing it. Incubating females prefer full view of the creek below as well and are restricted with a tall board. It was thought a nest was once built on top of box rather than inside because of this problem. It is the author's recommendation that the total height of the front lip should be no more than 3 cm and in fact, may not be necessary at all. Many nest boxes currently in place would benefit from adjustment. Nest boxes should also be cleaned out periodically.

Limiting factors for the American Dipper in the Black Hills are available nest sites and streams capable of providing good forage and water flow year-round. Negative impacts on the quality of streams have greatly reduced available habitat for dippers in the Black Hills. Past and current threats include the following:

- Pollution from a variety of human activities, whether discharged directly into streams or as a result of run-off, adversely affects the aquatic insect population, the health of dippers and their ability to forage. Sources include mining waste, municipal and residential sewage, agricultural practices and other commercial or industrial processes.
- Loss of water flow downstream from dams and diversions affects dippers and their forage. Aeration is reduced, water temperature increases, freeze-over may occur in winter and streams may become dry altogether.
- Damage to stream banks results in widening of the stream, reduced water flow and increased temperatures. Reduction of surrounding trees and other foliage can also increase water temperatures.
- Sedimentation of streams is a serious threat as it destroys the habitat of aquatic insects that are the main food source for dippers. Causes include the building of roads and homes near streams, overlogging, overgrazing and stream bank degradation.

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Unless streams in the Black Hills that once provided good habitat for dippers become suitable again, the Black Hills population of dippers will have no room to expand beyond their present territory. Numbers will remain low, putting them at great risk for extirpation should an event occur that significantly impacts their habitat and food source. Every effort should be made to protect this unique and fascinating bird from further decline.

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All photographs are by the author unless otherwise noted.

Cover Photos:
Top left – Adult dipper with food for nestlings at site #16b, Iron Creek on 29 May 2009
Top right – Adult dipper feeding nestlings at site #27, Spearfish Creek on 29 May 2009
Bottom left – Nestlings nearing fledging at site #16b, Iron Creek on 14 July 2009
Bottom right – Fledgling at site #27, Spearfish Creek on 15 June 2009

APPENDIX I

Measurements of American Dippers Banded in the Black Hills of South Dakota

by Doug Backlund

Most dippers were sexed based on nesting activity; only females incubate. Some juveniles were not sexed until they were found nesting, these are indicated in ( ). Dippers with wingchord over 91mm are generally male, 90 mm and lower are generally female.

Dipper #	Date Banded	Wgt (g)	Wing (mm)	Culmen (mm)	Exposed Culmen (mm)	Tarsus (mm)	Tail (mm)	Age	Sex	Recaptures and Comments
1	5/2/2002	55	93	12.1	15.6	27.3	55	A	M	
2	5/2/2002	60	95	12.9	15.5	28	52.1	A	M	wgt. 58.0 7/16/03
3	5/3/2002	55	96	10.6	14.9	28.5	51.2	A	M	
4	5/3/2002	50	88	11	14.9	27.7	51.4	A	F	
5	5/3/2002	57	98	11.8	16.2	28.5	54.6	A	M	
6	5/3/2002	57	98	12.8	16.2	29	51.5	A	M	wgt. 55.6 7/16/03
7	5/3/2002	51	90	11.5	15.3	27.5	46.7	A	F	
8	7/20/2002	59.5	96.5	11.6	15.4	28.5	54	A	M	
9	7/20/2002	48.7	85.5	11.1	15.3	28.9	46	A	F	
10	7/24/2002	52.4	90	11.9	18.4	29.6	50	A	F	
11	7/25/2002	53.2	81.5	10.5	14.8	27.6	49	J	U (F)	
12	8/20/2002	58.4	91.5	11.1	14.8	29.5	No tail	A	U (M)	wgt. 53.0; wing 90; 7/17/03; feeding young with female
13	8/20/2002	54.4	86.5	11	14.2	26.2	47	J	U	
14	8/20/2002	48.1	85.5	9.6	13.4	27.8	48	J	U (F)	
15	8/20/2002	68.3	95.5	10.1	13.6	30.3	52	J	U	
16	8/20/2002	59.5	93	11.5	14.1	30.3	52 (partially molted)	A	U	
17	8/21/2002	61.3	85 (outer primaries molted)	11.6	15.1	30.3	No tail	A	U (M)	Recap. 2/2/2005 wgt. 63, wing 98.5, tail 55, culmen 12.4, exposed culmen 16.5, tarsus 28.2
18	8/21/2002	62.2	94	10.7	14.3	28.6	51	J	U (M)	
19	8/21/2002	54.8	85	11.1	13.5	28.3	51	J	U	
20	8/21/2002		87	11.1	14.5	27.7	49	J	U	
21	10/11/2002	52.5	85.5	11.2	15.8	28.8	48	J	U (F)	
22	10/11/2002	58.2	94	11.5	16	28.7	51	J	U	
23	10/12/2002	56.5	91	10.8	14.8	29.2	48	J	U	
24	10/12/2002	56.3	87	10.8	14.3	28.2	46	J	U (F)	
25	10/12/2002	53.1	91	11.2	14.1	28.5	51	J	U (F)	wgt. 50.4; wing 88; 7/17/03
26	7/16/2003	48.3	86	10.5	14	27.8	52	J	U	
27	7/16/2003	50.7	85.5	11.4	16.3	27.2	49	J	U (F)	Recaptured 4/26/2005 wgt. 54
28	7/16/2003	43.8	79.5	9.5	13.6	26.5	42	J	U	
29	7/16/2003	42.2	74.5	9.6	13.9	26.4	40	J	U	
30	7/17/2003	48.9	89	12	16.5	26.8	50	A	F	

Dipper #	Date Banded	Wgt (g)	Wing (mm)	Culmen (mm)	Exposed Culmen (mm)	Tarsus (mm)	Tail (mm)	Age	Sex	Recaptures and Comments
31	7/17/2003	53.9	88	10.8	14.9	27.2	47	J	U (M)	
32	7/17/2003	56.1	94	11.2	13.2	27.7	53	J	U	
33	7/18/2003	57	95	12.8	15.4	28.2	57	J	U	
34	7/18/2003	53.4	85	10.5	14.8	25.6	52	J	F (F)	
35	7/18/2003	52.4	93	10.3	14.6	28.2	57	J	U (M)	Found dead in Deadwood,
36	7/29/2004	56	87.5	11.5	15.6	29.1	45	J	U (F)	Recap. 2/3/2005, wgt. 56, wing 90, tail 50, culmen 11.4, exposed culmen 16, tarsus 28.9
37	7/29/2004	63	93	12	15.7	31.9	53	J	U	
38	7/29/2004	60	94.5	12.4	16.1	29.2	36 partial	J	U	
39	7/29/2004	51	85	9.9	12.9	25.4	38 partial	J	U	
40	7/29/2004	63	96	12.1	15.2	31.2	52	A	M	
41	7/30/2004	57	85.5	11.2	14.2	27.7	51	J	U	
42	2/2/2005	59	92	13	16.2	28.3	56	A	U	
43	2/3/2005	59	91.5	12.4	16.1	28.5	50	A	U (M)	
44	2/3/2005	61	87.5	11.7	16.2	27.6	50	A	U	
45	4/19/2005	58	97	10.8	14.5	29	52	A	M	
46	4/19/2005	55	88	11.8	15.6	28.2	49	A	F	
47	4/19/2005	54	89	11.8	14.5	29	50	A	F	
48	4/20/2005	70	87	10.8	15.3	29.3	50	A	F	
49	4/20/2005	56	93	11.8	15.2	28.2	52	A	M	
50	4/20/2005	54	90	10.5	14.2	26.6	50	A	U	
51	4/20/2005	60	96	11.2	16	28.3	50	A	M	
52	4/26/2005	53	86	10.1	13.8	26.8	51	A	F	

APPENDIX II

Historical Accounts of Dippers on Black Hills Streams and Current Status on Streams Outside the Study Area

Compiled by Doug Backlund (2010)

French Creek

Dippers once thrived on French Creek. F. A. Patton reported finding six nests, four with young, in a one mile section of stream in early June (Patton, 1924). This is a very high density for nesting dippers and indicates that French Creek was a very different stream than it is now. Most recent efforts to document the presence of dippers in the French Creek watershed have been negative (Backlund, 1994; Hays *et al*., 1996; Hays and Hays, 1997b; Draeger and Johnson, 2001). The author also checked The Narrows in 1999 with no success (1999 monitoring report).

On August 25, 2008 Doug Backlund and Chad Lehman, wildlife biologist for Custer State Park, surveyed the French Creek Primitive Area, downstream from The Narrows, in Custer State Park. Two old nests were found and possibly a third. The nests appeared to be at least two to three years old. No dippers were seen on French Creek. This is further evidence that American Dippers are good dispersers. However, if no suitable habitat exists outside of the currently occupied habitats, further expansion of the Black Hills population is unlikely. French Creek is marginal habitat at best and is unlikely to support a breeding population in its current condition.

Probable causes for the loss of a breeding population of dippers is pollution, construction of the Stockade Lake Dam, heavy sedimentation, and the presence of many small rock dams. Stockade Lake has a history of being highly eutrophic (Froiland, 1978).

One of the old dipper nests found on French Creek in 2008. (photograph by Doug Backlund)

Rapid Creek

The Rapid Creek watershed is the largest watershed in the Black Hills both in terms of watershed size and stream flows (Stewart and Thilenius, 1964). The American dipper was once common on Rapid Creek in Dark Canyon and in the Pactola area. There are many reports of dippers in South Dakota Bird Notes (see Appendix II). Dippers were regularly seen on Rapid City Christmas Bird Counts until 1985. The author has interviewed numerous people who remember seeing dippers on Rapid Creek in the past but very few people have seen dippers in recent years. Hays found no dippers and no evidence of nesting (Hays *et al.* 1996 and Hays and Hays 1997b). Hays did report that one resident had seen a dipper briefly on April 28,

1996. No evidence of nesting has been reported in recent years with a few exceptions. A partially built dipper nest was found in a nest box in the spring of 2001 (Michael Melius, personal communication). Panjabi found no dippers on Rapid Creek during a breeding bird survey of the riparian habitat in 2001 (Arvind Panjabi, personal communication). R. Draeger and L. Johnson were contracted by SD Dept. of Game Fish and Parks during the summer of 2001 to survey several Black Hills streams for dippers, including Rapid Creek. They found no dippers but they found old dipper nests at Thunderhead Falls and talked to the owners of this tourist attraction. According to the owners, dippers nest every year at the falls. This may be the only site left on Rapid Creek that provides suitable winter habitat. Low, steady winter flows out of Pactola Dam and sometimes erratic flows during the rest of the year may have eliminated dippers from most of the stream. Draeger and Johnson found abundant and apparently suitable habitat in Dark Canyon but no dippers and no evidence of dipper nests with the exception of the Thunderhead Falls site (Draeger and Johnson, 2001). Occasional sightings of dippers on Rapid Creek are known but numbers of nesting pairs remains very low, one or two pairs at best, despite the presence of numerous potential nest sites at bridges and cliffs.

On August 26, 2008 Doug Backlund and Kristie Lovett checked five bridges on Rapid Creek at the historic nesting site near Thunderhead Falls and Hisega. Two old nests were found on a high ledge under one bridge near Thunderhead Falls. One bridge near Hisega lodge revealed a very old nest on a ledge. In addition, an area along Rapid Creek west of Rochford upstream to Black Fox campground and Black Fox Canyon was also investigated with no success. No dippers were seen.

An additional threat to dippers and the entire aquatic ecosystem of Rapid Creek is the excessive growth of a naturally occurring diatom, *Didymosphenia geminata.* The abnormal growth of this diatom was first reported in 2002 and in recent years it has formed large mats from Pactola Dam downstream to Hisega. A good synopsis of this diatom and the problems it can cause is available at this link: http://www.epa.gov/region8/water/didymosphenia/index.html

Box Elder Creek

American dippers have rarely been reported from Box Elder Creek. A nesting pair was discovered in the summer of 1993 (Terri Hildebrand, personal communication) but surveys in 1996 and 1997 by Tom Hays and in 2001 by Draeger and Johnson had negative results. Hays reports that the stream is heavily silted in many areas and currently provides poor habitat despite the fact that there are many good natural nest sites (Hays *et al*., 1996; Hays and Hays, 1997b).

On August 26, 2008 Doug Backlund and Kristie Lovett investigated bridges and rock faces along Nemo Road near Benchmark Road, Cold Spring Road, the Civilian Conservation Center and Boxelder Forks Campground but no dipper activity was observed. Boxelder Creek was the main creek running through these areas. Although there are abundant suitable nest sites, no old dipper nests were seen and no dippers were observed.

Elk Creek

George Bird Grinnell made the first report of American dippers in the Black Hills in 1874 based on an observation made on Elk Creek (Ludlow, 1875). Today, Elk Creek is poor dipper habitat. Dippers are occasionally seen on Elk Creek (Michael Melius, personal communication) but Hays reported serious problems with sediment and low flows (Hays and Hays, 1996) as did Draeger and Johnson in 2001 (personal communication). Like Box Elder Creek and Rapid Creek, Elk Creek has probably become a population sink for dippers.

Bear Butte Creek

Dippers were not historically reported from Bear Butte Creek. Hays and Hays (1997b) surveyed the stream from Highway 385 to the town of Galena and found no dippers. Hays found good habitat and felt that the stream had potential for nesting dippers. Draeger and Johnson did locate 2 nests and at least one dipper, possibly 2 dippers, in the summer of 2001, downstream from the town of Galena. One nest had a lining but no eggs and the other had no lining and some dried fecal sacs on a nearby ledge. The latter may have been a successful nest. Shelly Deisch (SD Game Fish and Parks) reported dippers on the creek several times in

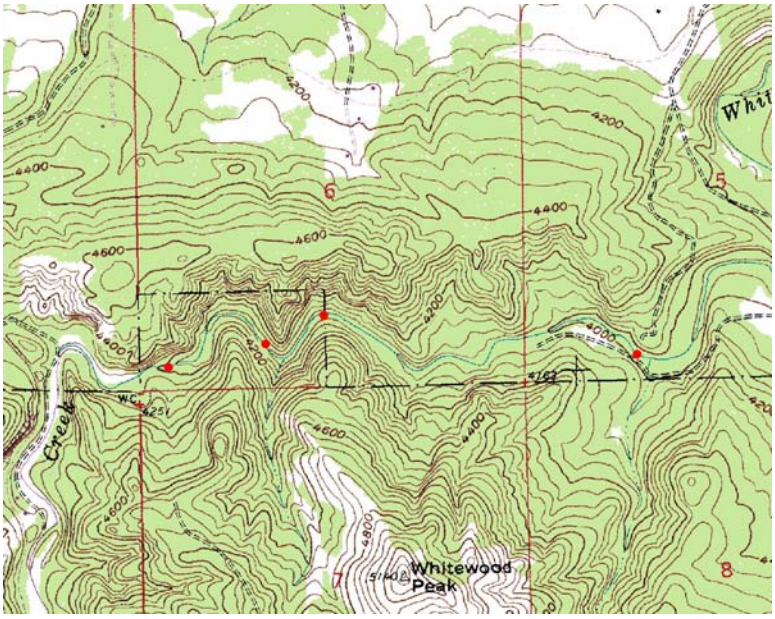
2000. Bear Butte Creek is impacted by mining pollution from old mining operations and from the current problems with the Brohm Mine (May *et al*., 2001; Sorenson, 1998). Sediment is also a problem. However, this stream has the potential to hold a small breeding population of dippers. There are no major dams and much of the lower section is in undeveloped Forest Service land.

Whitewood Creek

Historically, much of Whitewood Creek downstream of Lead/Deadwood was dry by late summer. Mining activities by the Homestake Mining Company and other smaller mines have resulted in many changes to this stream. Homestake diverted water from Rapid Creek, Elk Creek, and Spearfish Creek for mining operations. For many years, this water was then discharged, untreated, directly in Whitewood Creek. City sewage was also discharged untreated. Whitewood Creek was a dead stream, heavily polluted with city sewage, fine mine tailings, heavy metals, arsenic, and mercury. Gradually, pressured by the Environmental Protection Agency, the State of South Dakota, and many private interests, the stream was cleaned up. By 1984, Homestake had taken care of the most serious problems resulting from mining. City sewage was now being treated. The first report of dippers using Whitewood Creek came in 1985.

The mine tailings have over the years filled in the swallow zones of the streambed and now the stream runs year-round with the additional water from the diversions. Mine tailings, laden with arsenic and heavy metals, remain in heavy deposits along Whitewood Creek to the Belle Fourche River and even downstream on the Belle Fourche and the Cheyenne River for a considerable distance. Arsenic concentrations in sediments range from 417 µ g/g of dry sediment near Gold Run Creek up to concentrations of 1,083 µ g/g on the plains north of the Black Hills. EPA Ecotox threshold for arsenic is 8.2 µ g/g. Mercury concentrations in the sediments of Whitewood Creek are 3 to 6 times the EPA Ecotox threshold of 0.15 µ g/g (May *et al*., 2001). The stream is extremely muddy after heavy rains and during spring snow melt.

Dippers nest and winter along Whitewood Creek in small numbers. Despite the environmental problems, in 2004 nesting success on Whitewood Creek was higher than nesting success on Spearfish Creek. Homestake Mining Company placed dipper nest boxes under three bridges along Whitewood Creek in 2000. These nest boxes, other bridges with suitable ledges, and natural cliff sites are used by as many 12 pairs of nesting dippers.



Four unmonitored nest sites on lower Whitewood Creek, last observed on 4/27/2004.

A dipper that was banded on Whitewood Creek as a juvenile in July of 2003 was found dead in Deadwood on April 5, 2004. This dipper had a normal bill when banded but the bill was deformed when recovered in 2004. The carcass was sent to the USGS National Wildlife Health Center for diagnosis. It was discovered that selenium levels in the kidney and liver were in the toxic range, at 21.2 ppm wet weight in the kidney and 34.5 ppm wet weight in the liver.

American Dipper from Whitewood Creek, bill deformity. (photographs by Doug Backlund)

History of Whitewood Creek Pollution

- In 1965, the SD Department of Game, Fish and Parks concluded that aquatic bottom organisms were absent in Whitewood Creek downstream from the waste discharge sites.
- Use of mercury amalgamation was discontinued in 1971.
- Since 1977, no mine tailings have been discharged into Whitewood Creek.
- In 1984, a water treatment plant went into operation to remove cyanide from mine water discharge.
- First report of dippers on Whitewood Creek is in 1985.

Spearfish Creek

The largest and most productive dipper population in the Black Hills is found in the Spearfish Creek watershed.

Other Black Hills Streams

No verifiable reports of nesting dippers are known for Spring Creek, Battle Creek, Iron Creek in the southern hills, or Beaver Creek in the southern hills. In 2001 Rocky Mountain Bird Observatory conducted breeding bird surveys on 35 transects in riparian habitat of Black Hills streams. Counts were conducted at 433 points on the transects. One-hundred and seven species were recorded but no dippers were observed (Panjabi, 2001). Panjabi speculated that the lack of dipper observations was due to the species biology and scarcity. Brad Phillips (Wildlife Biologist, USFS, personal communication) reported a dipper sighting on Beaver Creek in the west-central hills. This is the Beaver Creek that flows west into Wyoming and into Stockade-Beaver Creek. There are numerous small streams in the Black Hills that dippers undoubtedly visit periodically in their search for new territories during the post-breeding dispersal period. Dippers have been seen on Spring Creek, Sand Creek in Wyoming, and on Crow Creek near McNenny Fish Hatchery in recent years. Most of these birds probably perish during winter or they may return to their natal stream.

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APPENDIX III

American Dipper Reports from South Dakota Bird Notes Prior to 1996

Compiled by Doug Backlund (2009)

SDBN 2(3):36-38. Sept. 1950. Cecil Haight reported two feeding in Spearfish Canyon on June 10. Also, Cecil reported that a local Forest Ranger stated the Water Ouzel was a resident of Spearfish Canyon.

SDBN 3(3):45. Sept. 1951. Drs. Frank and Mary Roberts, Spirit Lake, Iowa reported a pair of Water Ouzels nested and raised a brood under the bridge between Spearfish Canyon and Spearfish Canyon Camp. Three were also seen further down the canyon near the Homestake Power Plant, two were fighting, later an abandoned nest was found here.

SDBN 3(4):54. December 1951. Cecil Haight writes a long paragraph on the Water Ouzel. Described as "a permanent resident here and can be seen along streams any month in the year."

SDBN 4(2):28. June 1952. R.L. Mixter, Wheaton College, Wheaton, Ill., reports a list of birds seen in Rapid Canyon from 1939-1951. Water Ouzel is listed.

SDBN 5(2):26-28. June 1953. In a guide to birding hotspots in SD, O.S. Pettingill writes that dippers are to be found along Rapid Creek in both South Canyon and Dark Canyon. He writes that along Spearfish Creek "nearly every bridge crossed has a pair of Dippers nesting beneath it." Also, Pettingill states of the Roughlock Falls "It is almost a certainty that a pair of Dippers will have a nest behind this 30-foot drop of water and will be searching for food in the series of cascades below."

SDBN 6(1):18. March 1954. A letter to SDOU from Mrs. G.W. Robertson states that "the friendly water ouzel usually shows up and we watch it snatching food in the water and listen to its clear, sweet song." The location is Rapid Creek west of Rapid City along Rimrock Highway.

SDBN 6(2):31. June 1954. A report on the fifth annual meeting says "the Water Ouzels which had intrigued Dr. F.N. Matteson on many fishing trips helped him put on a perfect show with the dippers doing their calisthenics, walking underwater, flying through spray, and with nests empty and with young. Every person on the trip could add this interesting bird to his life list." This is at Roughlock Falls and Spearfish Canyon.

SDBN 7(2): 31. June 1955. A Catalog of Eggs, an article by N.R. Whitney, lists eggs in a collection at SD School of Mines and Technology. Dipper eggs were in this collection:

Collection 1-July 5, 1926. On Rapid Creek under wagon bridge between hogback and Bear Gulch above Pactola. Set of 4 eggs, collected when last egg was perhaps only 1 or two days old. A.C. McIntosh, collector.

Collection 2-N. Dark Canyon, Rapid City. June 15, 1928. Nest 4 feet above the surface of pool 4 feet deep on wall of overhanging rock. Incubated, parent on nest. Henry E. Lee, collector.

SDBN 6(4): 60-61. December 1954. 1954 Rapid City CBC reported one Ouzel.

SDBN 8(1): 10-11. March 1956. 1955 Christmas Bird Count reported 2 Ouzels at Rapid City.

SDBN 8(4):60-61. December 1956. CBC reported one Dipper at Rapid City.

SDBN 10(1):78-79. March 1958. In article "Birding in the Black Hills" by Whitney and Karen Eastman, both Rapid Creek and Spearfish Creek are recommended as places to find dippers.

SDBN (10):3: 36. Sept. 1958. Summer Records from the Black Hills, by Daniel L. Carter. On July 20, the author reported finding the expected dippers at Roughlock Falls, three were seen.

Also in this issue, dippers are reported as occurring on the Rapid City CBC on 3 out of the 5 counts conducted up to that time.

SDBN 14(1):10 March 1962. A group of young naturalists see their first water ouzel, near Hisega, on Rapid Creek.

SDBN 16(3):72. Sept. 1964. One dipper reported on Rapid City 1963 CBC.

SDBN 19(2):34. June 1967. 1966 CBC, one dipper at Rapid City.

SDBN 28(2):41. June 1971. In 1971 Winter Season Report one dipper was reported wintering on Rapid Creek in Rapid City.

SDBN 28(4):94. December 1971. South Dakota Nesting Season Report (1971). Dipper nest under bridge at Thunderhead Falls on 7-18 and 7-25. Esther Serr and Doris Knecht.

SDBN 24(3):56. Nesting Season Report 1972. Tom Hays reported seeing six dippers in a 15 m (mile or minute?) drive ride in Spearfish Canyon on June 6, also one nest. Willis Hall reported two at Roughlock Falls on June 7, one carrying food.

SDBN 27(1):11. Two dippers reported on Rapid City 1974 CBC.

SDBN 27(3): 49. Sept. 1975. Dippers reported in 1975 Summer Report: One in Lawrence County on 7-18, by Jocie Mortimer. Two in Pennington County on 7-19 by Rich Hill.

SDBN 27(4):75. December 1975. Aug, 17, seven adults and immatures in Spearfish Canyon, Nat Whitney. One adult and one immature reported 9-10 to 11-30 by Leighton and Ruth Palmerton, almost daily (I assume this is another Rapid Creek report, but location is not given).

SDBN 28(3):51. Sept. 1976. One dipper reported in Spring Migration Report, singing at dusk near Rapid City, on March 2. Leighton and Ruth Palmerton.

SDBN 29(1):13. March 1977. One dipper reported on Rapid City 1976 CBC. Also, page 20, Fall Migration Report, dipper reported on Rapid Creek on Nov. 22 by Leighton and Ruth Palmerton.

SDBN 29(2):34. June 1977. 1976-77 winter report, one dipper seen almost daily throughout the period, Rim Rock Highway west of Rapid City, Leighton and Ruth Palmerton.

SDBN 29(3): 60. Sept. 1977. One dipper seen about twice a week from 3-1 to 5-26 near Rapid City by Leighton and Ruth Palmerton.

SDBN 29(4):80. December 1977. 1977 Nesting Season Report. Dippers reported: Seven in Custer County!, on July 2, by Rich Hill and 2 in Pennington County on July 6, by Gertrude Bachman.

SDBN 30(1):14. March 1978. Three dippers seen in Spearfish Canyon on 8/13 by Nat Whitney.

SDBN 30(2):36. June 1978. 1977-1978 Winter Report. Dec. 5, One dipper seen about twice a week west of Rapid City, Leighton and Ruth Palmerton. Also, dipper reported in Lawrence County Feb. 3, by Jocie Mortimer.

SDBN 31(2):30-31. June 1979. One dipper seen at Spearfish on 1978 CBC.

SDBN 31(4):70. December 1979. 1979 Nesting Season Report-Dipper nest with 4 eggs on June 14 in Spearfish Canyon, Dan L. Bjerke.

SDBN 33(4): 87. December 1981. 1981 breeding season report, 2 nests reported in Lawrence Co. on 23 May, N.R. Whitney.

SDBN 35(2):28-29. June 1983. Two dippers on Rapid City 1982 CBC.

SDBN 36(2):34. June 1984. Two dippers reported on Spearfish 1983 CBC.

SDBN 36(4):83. December 1984. In 1984 Breeding Season Report, 4 dipper nests are reported in Lawrence County, by Willis Hall.

SDBN 37(2):41. June 1985. One dipper reported on Rapid City CBC and two on Spearfish CBC for 1984.

SDBN 39(2):50. June 1987. One dipper reported on 1986 Spearfish CBC.

SDBN 40(2): 60. June 1988. 1987-88 Winter Season Report, dipper reported 10 January, in Pennington County, by Michael Melius. Also, one dipper report on Spearfish CBC for 1987 on page 64.

SDBN 41(4):63. December 1989. American Dippers in Spearfish Canyon. Doug Backlund. Notes on sightings and nests of dippers in 1989.

SDBN 46(1):6-9. March 1994. Nest Sites of the American Dipper in the Black Hills. Doug Backlund. Notes on dipper nests in the northern Black Hills and historical nesting on French Creek.

SDBN 48(2):46. June 1996. 1995-96 Winter Season Report. Todd Jensen reported dipper(s) in Lawrence County, no further information.

SDBN 48(3):32. Sept. 1996. 1996 Spring Season Report. One nest on Whitewood Creek April 10, Tom Chapman; 24 May Spearfish Creek, 2 nests, Doug Backlund.

SDBN 48(4):108. December 1996. 1996 Summer Season Report. Confirmed Breeding: 12 July Lawrence County, fledged young, George Prisbe; 14 July , Lawrence County, nest with young, George Prisbe.

APPENDIX IV

Results of Spring 2003 Nesting Survey

Compiled by Doug Backlund

In April and May of 2003 twenty-one biologists and volunteers searched Black Hills streams for dippers and dipper nests. The Spearfish Creek watershed, the watershed with the largest dipper population in the Black Hills, including Iron Creek, Squaw Creek, Annie Creek, East Fork and Little Spearfish Creek were thoroughly searched. Whitewood Creek was also thoroughly covered. Rapid Creek and French Creek, streams that historically had large dipper populations, were extensively searched. Only one nest could be found on Rapid Creek and no nests or dippers were found on French Creek. Bear Butte Creek, Elk Creek, Little Elk Creek, and Boxelder Creek were searched in selected areas of suitable habitat but no dippers and no sign of dippers was found. Sand Creek in Wyoming was also checked with negative results.

We confirmed around 35-37 active nests going into the early breeding season indicating a breeding population of approximately 70-74 dippers. There is some evidence of polygyny on Spearfish Creek so that drops the number down a few, but we probably missed a few nests somewhere, too. However, it is unlikely that there are many nests that were missed. There may be some non-breeding dippers roaming around. It is impossible to take an exact count of all dippers in the Black Hills. The bottom line is that outside of Spearfish Creek and Whitewood Creek, there are few dippers, even on large streams like Rapid Creek, which once was and still should be capable of supporting a large dipper population. A conservative estimate of the spring Black Hills dipper population appears to be <100 birds.

Spearfish Creek Watershed

Rimrock Lodge Segment- Found one active nest 4/26/2003 and checked again on 5/11/2003 with the same results.

Spearfish Creek- Found 18 active nests from the lowest diversion dam upstream to Cheyenne Crossing on April 28. Another nest was verified earlier. Thirty dippers seen, including a number of the color banded dippers. Nineteen active nests on this segment.

Little Spearfish (Roughlock Falls) and Iron Creek- Confirmed one and found one probable nest. Probably 2 active nests on these streams.

East Fork Spearfish Creek (Hanna Creek)- Two active nests, possibly 3. 5/12/2003

Spearfish Creek from Cheyenne Crossing along Hwy 85- Found one active nest, 6 dippers, and four nests that didn't appear to be active (5/8/2003 and 5/13/2003). Dippers were seen at two nests so these nests may prove to be active nests later in the spring. One, possibly 3 nests on this stream segment.

Squaw Creek- Found one active nest and four dippers (5/15/2003).

Annie Creek- Found three old nests (5/6/2003). No dippers. One dipper near the confluence with Spearfish Creek, this dipper flew to Spearfish Creek and probably was only feeding on Annie Creek (5/14/2003). No active nests this year. Surveyor reported the stream running very muddy.

Total active nests in Spearfish Creek watershed-26, possibly 28.

Sand Creek, Wyoming

Checked the stream and saw no dippers. The surveyor has been birding this area for years and has never seen a dipper here. 5/4/2003

Whitewood Creek
Checked all of Whitewood Creek on April 28 and 29. Eight active nests were found and 22 dippers seen. There may be a couple more that couldn't be accessed. One banded dipper was found on Whitewood Creek, banded on Spearfish Creek in the summer of 2002.

Bear Butte Creek
Checked Bear Butte Creek on 4/28/2003 from the sinkholes upstream to the Double Rainbow Mine. No dippers, 3 old nests. No active nests on this stream, but evidence of previous use.

Boxelder Creek
Checked this stream on April 29. All bridges and potential cliff nest sites that were accessible were checked from Benchmark downstream to the swallow zone were checked. No dippers were seen and no sign of old or new nests were found.

No active nests found on this stream. No evidence that dippers occupy Boxelder Creek. Same results as in past surveys.

Elk Creek
Walked the lower canyon area where dippers have been seen in winter. Found one old nest but no dippers. 5/22/2003

Little Elk Creek
Checked the area and found no sign of dippers or old dipper nests.

Rapid Creek
Thoroughly checked the creek from Dark Canyon upstream to Hisega, the Thunderhead Falls area, and from Canyon City to Silver City. One active nest with five eggs was found on April 29 and this nest was still active on May 15th, chicks were in the nest. Despite availability of many good nest sites there appears to be only one pair of dippers on the stream. There was no sign of old nests at the many apparently suitable nest sites that were checked except at Thunderhead Falls. The owners of Thunderhead Falls reported that dippers did not nest there last year or this year, but a dipper nest is visible just inside the tunnel. The tunnel was gated when we checked on April 29, preventing access to the site by dippers.

Spring Creek
Surveyed a large portion of Spring Creek, above and below Sheridan Lake, downstream to the Storm Mountain area, 5/10/2003. No dippers or evidence of dipper nests reported, same results as past surveys.

French Creek
French Creek from Hazelrodt Picnic Ground to the Horse Camp in Custer State Park on May 4th. Saturday May 10, 2003 - 11:30 to 4:00. On May 10 French Creek within the French Creek Natural Area of Custer State Park from French Creek Horse Camp downstream to trail #1 alternate that leaves the South side of the natural area and comes out at CSP road #2 ("Fisherman's Flat" on many Custer State Park maps.) An estimated 7 miles of creek. Walked within 20 ft. of the creek at all times. No dippers, no sign of new or old nests. On May 17, covered French Creek from Fisherman's Flat area out to the east side of the Primitive Area. No evidence that dippers occupy French Creek. Same results as previous surveys.

APPENDIX V

Dippers and EPT Taxa on Spearfish and Whitewood Creeks

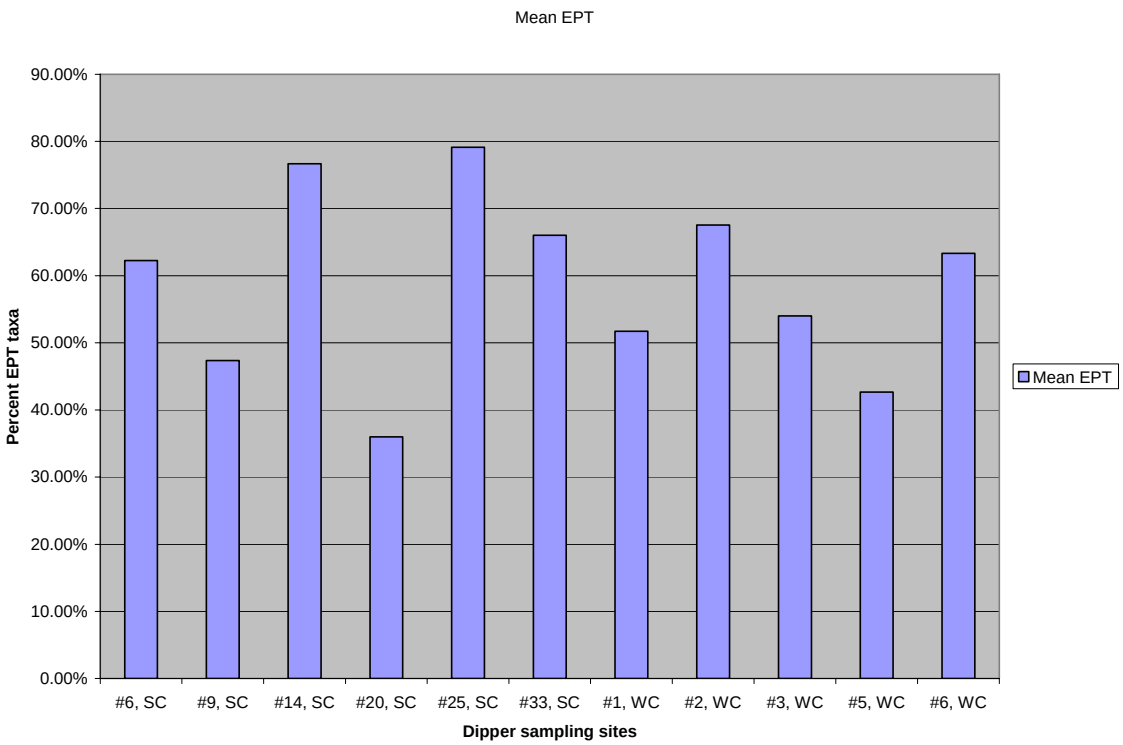
by Andy Burgess

Aquatic macroinvertebrates have been used as biological indicators of water quality for a number of years (Hillsenhoff 1987). Because many species in the taxonomic orders belonging to Ephemeroptera, Plecoptera, Trichoptera (EPT) taxa are intolerant of poor water quality conditions associated with pollution and sedimentation they are frequently used in this way as biological indicators of local stream health (Merritt *et al*. 2008). It has also been shown that dippers preferentially target some species within these orders as a food source (Feck and Hall 2004). We hypothesized that the abundance of dippers on two streams would be associated with the abundance of EPT taxa relative to other species in the overall macroinvertebrate community (%EPT). We compared the %EPT of two nearby streams which have very different abundance of dippers; Whitewood Creek and Spearfish Creek in the Black Hills. We hypothesized that if this was due to decreased water quality there would be lower %EPT in Whitewood Creek and as a result lower abundance of dippers.

The percent of the total macroinvertebrate community consisting of the taxonomic orders Ephemeroptera, Plecoptera, Trichoptera differed between Spearfish and Whitewood creeks (Figure 1). Scores on Spearfish Creek ranged 36 – 79% EPT with a mean of 61.23% +/- 16.80%. The wide range in values may be explained by the low %EPT score at one site undergoing road construction activity (Birchcrest Lane). Scores on Whitewood creek were generally lower (43 – 68%) with lower mean score as well as standard deviation (55.86% +/- 9.84%).

These results show that there may be an effective difference in the macroinvertebrate community abundance and composition between Whitewood creek and Spearfish Creek. These results are similar to those found by (Feck and Hall 2004) who found a negative relationship between macroinvertebrate community composition and dipper home range and fledging success on streams in Wyoming. Though our sampling data lacked sufficient replication to show statistical significance our results suggest that additional research to better understand the relationship between macroinvertebrate community composition, water quality and American dipper populations may be warranted on these streams. Such research would benefit by additional sampling replication and the identification of macroinvertebrate taxa to the genus level to discern relationships between dipper distributions, stream water quality and macroinvertebrate communities.

Figure 1. Percent EPT taxa at 11 sites on Spearfish Creek (SC) and Whitewood Creek (WC).



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APPENDIX VI

An Age-structured Model for the American Dipper Population in the Black Hills of South Dakota

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Introduction

A truly aquatic songbird, the American Dipper, *Cinclus mexicanus*, is found along mountain streams in western North America from Alaska to Panama (Kingery 1996). Strongly attached to fast-flowing streams, they depend upon permanent, clean, cold water that remains unfrozen in winter. They rarely stray more than a few yards from water and even in flight tend to follow the meandering path of the stream (Backlund 2009). American Dippers are not migratory, but short-range dispersal and movement to lower elevations in winter does occur (Price and Bock 1983). Out-of-range records are rare (Kingery 1996) most likely due to the species' aversion to flying over land. Overall population size and current population trends are uncertain (Kingery 1996), but because of its restrictive habitat requirements, numbers cannot be large.

The Black Hills of western South Dakota and northeastern Wyoming form an isolated mountain range within the Great Plains. They are separated from the Big Horn Mountains in Wyoming and other mountain ranges to the west and southwest by over 240 kilometers of dry grassland and sagebrush. The American Dipper occupies the eastern edge of its overall distribution in the Black Hills. It is hypothesized that the dispersal of dippers to the Black Hills resulted from water connections between the Black Hills and the Rocky Mountains during the last ice age (Backlund 2009). The Black Hills population of American Dipper is now believed to be isolated from Rocky Mountain populations as a result of extensive intervening grasslands and a lack of water connections between the Black Hills and Rocky Mountains (Backlund 2009). The Black Hills population is genetically distinct from other populations to the west (Anderson *et al.* 2008) further supporting the hypothesis that the population is isolated. American Dippers historically inhabited several permanent streams in the Black Hills. Presently, breeding populations are found only on Spearfish and Whitewood creeks. The species was listed as state threatened in 1996 (Backlund 2009). Dippers are important indicators of water quality and population declines may signal potential environmental problems such as stream pollution and degradation, sedimentation, reduced stream flows, and a lack of available nest sites (Feck and Hall 2004).

In this study, we consider a discrete-time, age-structured model for the American Dipper population in the Black Hills of South Dakota. Annual survival and reproductive rates are estimated from data from this population (see for example Lovett 2008) and the results are used to explore the potential persistence or decline of the population.

Model Development

Consider a closed (no emigration or immigration) population consisting of two age-classes, juveniles (inexperienced breeders) and adults (experienced breeders). Let J_n and A_n be the number of juvenile and adult females at time n respectively. We assume here that there is a 1:1 ratio of males to females in the population or, more realistically, that there are at least a sufficient number of males to pair and mate with all available females. Since American Dippers are known to be polygamous (Price and Bock, 1983) this seems to be a reasonable simplifying assumption. The basic discrete-time model described here incorporates differential annual survival and

reproductive rates within the two classes. Let λ_j and λ_a denote the reproductive rates (number of female offspring per adult female per year) and s_j and s_a the annual survival rates of juveniles and adults, respectively. If population size is measured each year immediately prior to reproduction, we obtain the first-order, linear, recursive system given by

$$J_{n+1} = s_j(\lambda_j J_n + \lambda_a A_n)$$

$$A_{n+1} = s_a(J_n + A_n).$$

Population growth occurs if the dominant eigenvalue of this system is greater than 1. The magnitude of this eigenvalue then represents the long-term growth rate of the population and the corresponding eigenvector gives the steady-state age distribution of the population. In the special case where there is no difference between juvenile and adult reproductive rates, we denote them both by λ and this requirement for population growth is given by

$$s_j\lambda + s_a > 1.$$

If we further assume that the annual survival rates of juveniles and adults are equal and denoted by s our condition for growth of the population further simplifies to

$$s(1+\lambda) > 1.$$

Estimation of Annual Survival

Between 2002 and 2005, Backlund (unpublished data) captured and uniquely color-banded four cohorts of American Dippers along Spearfish and Whitewood creeks in the northern Black Hills of South Dakota. When possible, the age, (juvenile or adult), and sex of each bird was identified. This population was intensively surveyed (33 sites along 28 km of Spearfish Creek and 7 sites along 7 km of Whitewood Creek) by Lovett (see for example Lovett 2008) during the spring and summer months each year from 2004 through 2009 and all sightings of color-banded birds were recorded. The annual survival rate of the Black Hills population of the American Dipper was estimated for all individuals (pooled juveniles and adults), adult females, adult males, and all adults (male and female combined) in each cohort (Table 1) by fitting an exponential decay curve to these data (Figure 1).

Comparing the one-year, post-capture survival rates of juveniles (7/12 = 0.583) and adults (11/13 = 0.846) from the 2002 cohort group, it appears that juvenile survival may be lower than that of adults. A modified two-tailed comparison of the two population proportions (Agresti and Coffo 2000) showed no significant difference (p = 0.184) between these rates, most likely due to the relatively small sample sizes. The one-year, post-capture survival rates of juveniles and adults in the other three cohorts could not be compared due to insufficient numbers of juveniles (0 in 2005) or adults (1 in 2003 and 0 in 2004) in the cohort. Juvenile survival in the 2003 and 2004 cohorts was 4/9 (0.444) and 1/5 (0.200) respectively. Both are lower than the one-year, post-capture rate observed for adults in the 2002 cohort further suggesting that juvenile survival may be lower than that of adults. The 95% confidence interval for the pooled estimate of all juveniles gives $s_j = 0.4615 \pm 0.1917$.

Estimation of the Reproductive Rate

The reproductive rate, λ, was estimated (Table 2) from data on the dipper population obtained from annual surveys by Lovett of known nest sites along Spearfish and Whitewood creeks from 2004 through

2009 (see for example Lovett 2008). The number of nesting attempts, as well as the number of observed young in each nest and the number of fledged young at each nest site, were recorded for both the first and second broods. Insufficient data regarding the age of the individuals at the time of nesting precluded estimation of separate reproductive rates for adults (i.e. experienced breeders) and juveniles who were nesting for the first time. Net reproduction was calculated as both the ratio of observed young in each nest to adult females and also as the ratio of fledged young at each nest site to adult females. To determine the number of adult females we counted the number of distinct nest sites for all first broods each year, the assumption being that each involved a distinct female. In a few cases individual color-banded females were known to have initiated multiple broods – presumably because of a failed first nesting attempt. If this was known this female was only counted once. Some females that were not color-banded were potentially counted more than once in our total and we have no estimate of the number of potential non-nesting females present in the population. Observed young in the nest and fledged young at the nest were determined by adding the totals of the first and second (if applicable) broods at each site. The number of observed young in the nest probably overestimates the reproductive rate since not all birds will survive to fledging. Using the number of fledged young probably underestimates the reproductive rate since in some cases dispersal away from the nest site may have occurred preventing a full count of the fledglings. For simulation in the model, we assume a 1:1 ratio of males to females both in the nest and after fledging and divide each ratio by two since we are here only tracking the female population.

Simulation Results

Stella (version 9.0.2, iseesystems, Lebanon, NH) was used to run all simulations of the model. To introduce a stochastic element, both the reproductive rate and the annual survival rate were allowed to vary annually according a normal distribution. The simulation results presented below are based on the average values obtained from 250 runs of the model over a 50-year time interval using the specified parameters and an initial population of 25 juvenile and 35 adult individuals. These initial conditions closely approximate the average number of adult females and fledged juvenile females (assuming a 1:1 sex ratio among fledglings) observed in the population (see for example Lovett 2008). Since we are primarily interested in the persistence of the population, the simulation results presented give the probability of the population being reduced by 50% and 75% from its initial size.

We first consider the special case $\lambda_j = \lambda_a = \lambda$, and $s_j = s_a = s$ (i.e. that there is no age-structured difference in either the reproductive or survival rates). Under this assumption, the model exhibits population growth provided the dominant eigenvalue $s(1+\lambda) > 1$. Using the estimated annual survival rate of $s = 0.5931$ (calculated from all individuals in the 2002 cohort) and our estimated annual reproductive rate of $\lambda = 0.6973$, the dominant eigenvalue *s (1+λ)* is 1.0067, which indicates a less than 1% annual growth in the population. Calculation of the corresponding eigenvector indicates a stable age-structure in the population of 41% juveniles and 59% adults (Figure 2A).

Since juvenile survival may be lower than that of adults (see Estimation of Survival) we next consider the case where $s_j \neq s_a$. Population growth then requires that $s_j\lambda + s_a > 1$. Using the estimated annual survival rate of $s_j = 0.4615$ (pooled estimate for all juveniles) and $s_a = 0.6374$ (adults from the 2002 cohort) and $\lambda = 0.6973$, the dominant eigenvalue is found to be $s_j\lambda + s_a = 0.9592$. This indicates an approximate 4% annual decay in the population. Calculation of the corresponding eigenvector indicates a stable age-structure consisting of 34% juveniles and 66% adults (Figure 2B).

Discussion

Intensive surveys of the dipper population in the northern Black Hills from 2004-2009 seem to indicate a relatively stable (over the short term), but small, population size. Breeding season estimates of the number of adult birds ranged from 57-66 during the six years of survey work (see for example Lovett 2008). We have here investigated an age-structured, discrete-time model to assess the long-term prospects for the

persistence or decline of this population using estimates of the annual reproductive and survival rates from color-banded cohorts and nesting surveys.

Price and Bock (1983) estimated adult survival (during two years) of dippers in Colorado as 50% and 39% under the conservative assumption that breeders that did not return had died (some birds may have simply dispersed to new areas). Ealey (1977) found the one-year survival rate of 32 banded dippers in Alberta to be 44%. Our estimates are considerably higher, ranging from 50% (2004 cohort) to 74% (2005 cohort). It is not clear if this is simply due to the lack of dispersal in the Black Hills dipper population (i.e. that the counting is better), or if it could also indicate a more stable food supply, or the availability of higher quality winter habitat. We found that juvenile survival seemed to be lower than that of adult birds. This is consistent with the results presented by Price and Bock (1983) although again our estimated juvenile survival rate (46%) is higher than their more conservative calculation (33% and 23% during two years). Since most mortality occurs during the winter months (Price and Bock 1983), it would seem that the Black Hills population of American Dipper is not severely limited by the availability of winter stream habitat or food supplies.

We estimated the net reproductive rate as 1.395 fledged offspring per adult female and as 1.774 hatched nestlings per adult female. Previously reported breeding success rates (see Kingery 1996) were 47 to 69% fledged young per egg and 57 to 86% hatchlings per egg. Assuming an average of 4.1 eggs per clutch, these values would result in approximately 1.9-2.8 fledged young per adult female and 2.3-3.5 hatched nestlings per adult female. Since some females produce second broods these estimates are almost certainly on the low side. Hence, it seems that the net reproductive rate of dippers in the Black Hills is considerably lower than the range of values reported elsewhere. Additional study of this population is needed to determine if this lower reproductive rate is due to a limited availability of suitable nest sites, limited food supply during the breeding season, disturbance, low genetic variability (i.e. inbreeding) resulting from low population size, or other factors.

Our calculations suggest that the Black Hills population of the American Dipper has higher survival rates and lower reproductive rates than those from other populations. We have presented a simplified age-structured model to investigate the potential persistence or decline of this small, isolated population. Neglecting age-structured differences between juveniles and adults, our estimates of the annual survival and reproductive rates suggest a less than 1% annual growth rate in the Black Hills population of the American Dipper. Simulations of the model in this case indicated an approximately 14% probability of a 50% reduction in the population over the next 25 years. When age-structured survival was taken into account, our estimates would result in a 4% annual decline in the population and model simulations indicated a 77% probability of a 50% population decline over the next 25 years. These simulations should, however, be considered illustrative only. The parameter estimates are certainly not robust enough to make definitive conclusions. The best case and worst case scenarios that would be obtained using the 95% confidence intervals for the parameter estimates cover the range from a less than 1% chance of population decline to a greater than 99% probability of decline. The average estimates calculated here appear to indicate a population that is right on the edge between sustained growth and decline. Because of this, the relatively small size of the population and given its very limited habitat in the Black Hills, the population may be particularly susceptible to random catastrophic events such as flooding or extreme and prolonged winter stream freezing.

To better predict the long-term trend in the dipper population in the Black Hills additional study is needed. There are a number of potentially important factors that we have not included in our simplified age-structured model presented here. More complex models which we are now investigating include adding in additional age classes (we here considered only two), sex-structure (we neglected males here), and dispersal between two adjacent subpopulations (Spearfish Creek and Whitewood Creek). Perhaps most importantly density dependence in the reproductive rate needs to be considered very closely, since nest site availability has been suggested as the most significant limiting factor for American Dipper populations (Price and Bock, 1983). This is consistent with the lower net reproductive rates observed for the dipper population in the Black Hills. More detailed data are needed to estimate the parameters of these more complex models. Data on the age of individuals at the time of nesting is needed to better estimate more detailed age-structured reproductive rates and larger cohorts of color-banded birds would allow for

estimation of age-structured survival rates. Additionally, these data need to be collected over a sufficiently long time period in order to develop estimates for the range of the annual variation in the model parameters.

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Figure 1 – An exponential curve fit to the number of surviving American Dippers from the 2002 color-banded cohort is used to estimate the annual survival rate as $s = e^{-0.519} \approx 0.595$

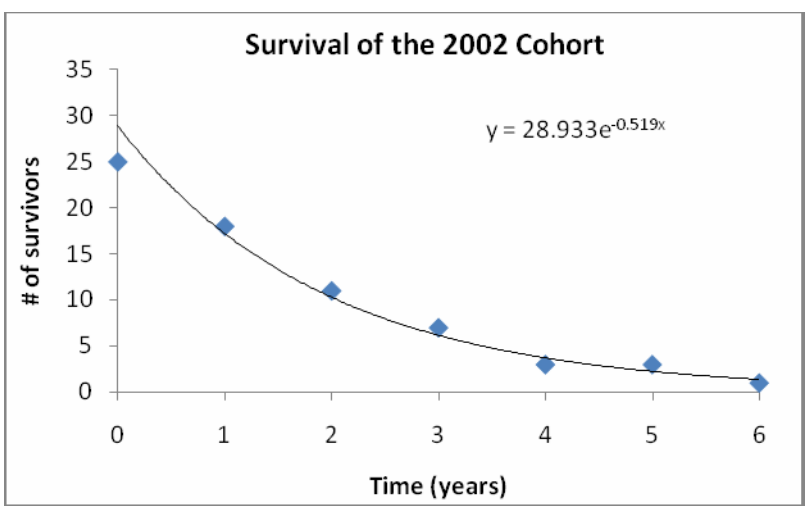

Table 1 – The survival rate s, lower and upper limits of the 95% confidence interval, and the standard error (SE) of the regression on the semi-log transformed data is calculated for various subgroups within each cohort. Sample size is N and Years indicates the number of years included in the regression. Also given is the proportion of each subgroup that survived the year-after-banding (YAB).

2002 Cohort	**N**	**Years**	**YAB**	**s**	**Lower 95%**	**Upper 95%**	**SE**
All Individuals	25	7	0.7200	0.5931	0.5294	0.6644	0.2338
Adult Females	4	4	0.7500	0.6335	0.4785	0.8388	0.1458
Adult Males	8	7	1.0000	0.6931	0.6154	0.7807	0.2449
Adult Unknown	1	1	0.0000				
Adults Combined	13	7	0.8462	0.6374	0.5696	0.7133	0.2314
Juveniles Combined	12		0.5833				
2003 Cohort	**N**	**Years**	**YAB**	**s**	**Lower 95%**	**Upper 95%**	**SE**
All Individuals	10	7	0.5000	0.6697	0.5806	0.7725	0.2939
Adult Females	1	4	1.0000				
Juveniles Combined	9		0.4444				
2004 Cohort	**N**	**Years**	**YAB**	**s**	**Lower 95%**	**Upper 95%**	**SE**
All Individuals	9	3	0.3333	0.3333	0.3333	0.3333	0.0000
Adult Males	3	3	0.6667	0.5774	0.2010	1.6585	0.1174
Adult Unknown	1	1	0.0000				
Adults Combined	4	3	0.5000	0.5000	0.5000	0.5000	0.0000
Juveniles Combined	5	2	0.2000				
2005 Cohort	**N**	**Years**	**YAB**	**s**	**Lower 95%**	**Upper 95%**	**SE**
All Individuals	8	5	0.5000	0.7364	0.6003	0.9033	0.2031
Adult Females	5	5	0.6000	0.6960	0.5836	0.8300	0.1750
Adult Males	3	5	0.3333	0.8027	0.5361	1.2020	0.4012

Table 2 – The net reproductive rate, λ, defined as the average number of offspring per adult female is estimated as the number of nestlings per adult female, N/A, and as the number of fledglings per adult female, F/A. The annual count was based on combined data from the two observational sites, Spearfish Creek and Whitewood Creek, as well as from the first and second broods.

Year	Adult Females (A)	Nestlings (N)	N / A	Fledglings (F)	F / A
2004	35	63	1.800	44	1.257
2005	34	55	1.618	52	1.529
2006	32	65	2.031	41	1.281
2007	35	74	2.114	63	1.800
2008	36	47	1.306	42	1.167
2009	36	64	1.778	48	1.333
	Average		1.774		1.395
	Std. Dev.		0.292		0.232
	Lower 95%		1.468		1.151
	Upper 95%		2.081		1.638

Figure 2A – The probability of a 50% (blue) and 75% (pink) reduction in overall population size by year with no difference between juvenile and adult survival or reproduction. Results are based on 250 runs of the model with initial conditions $J_0 = 25$, $A_0 = 35$ and parameters $\lambda = Normal(0.6973, 0.1162)$ and $s = Normal(0.5931, 0.1)$.

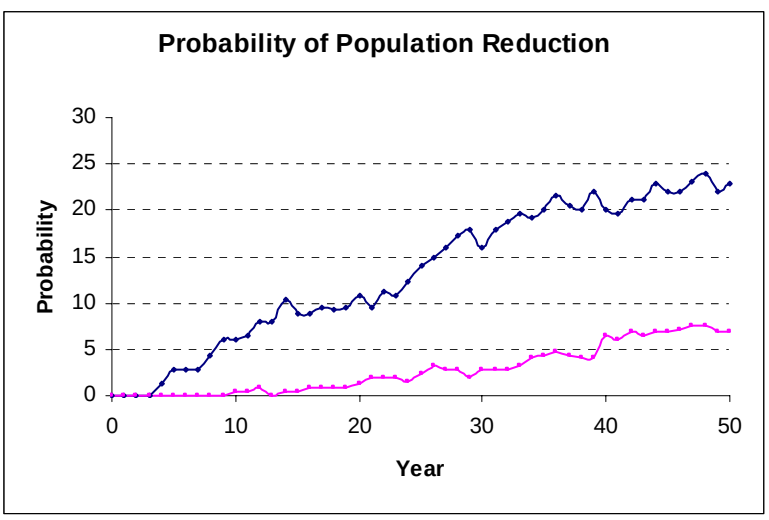
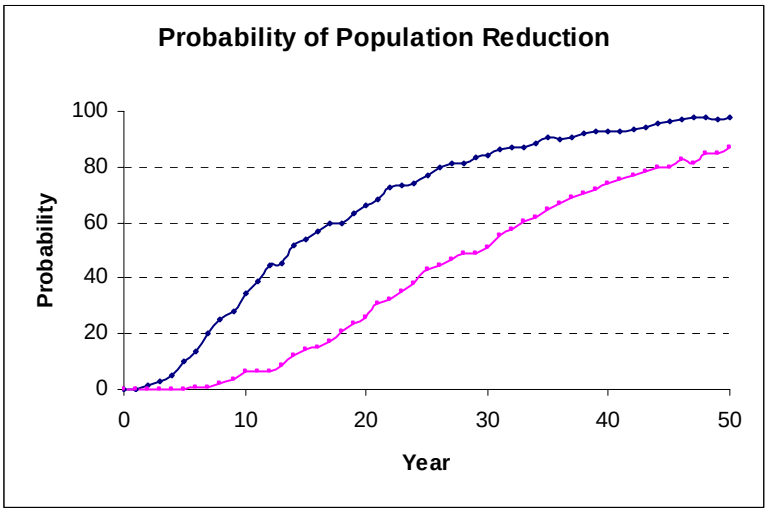
Figure 2B – The probability of a 50% (blue) and 75% (pink) reduction in overall population size by year with age-structured survival rates and no difference between juvenile and adult reproduction. Results are based on 250 runs of the model with initial conditions $J_0 = 25$, $A_0 = 35$ and parameters $\lambda = Normal(0.6973, 0.1162)$, $s_j = Normal(0.4615, 0.1)$ and $s_a = Normal(0.6374, 0.1)$.