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Impoundment Drawdown and Artificial Nest Structures as Management Strategies for Snowy Plovers

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This paper presents preliminary work on two potential management techniques that might enhance populations of Snowy Plovers (*Charadrius alexandrinus*). Large tracts of suitable plover nesting habitat are being degraded by vegetation encroachment at Great Salt Lake, Utah. Therefore, we used impoundment drawdown to create shorebird nesting habitat by eliminating unwanted vegetation at a diked wetland. Twenty-two pairs of Snowy Plovers, four pairs of American Avocets (*Recurvirostra americana*), and one pair of Long-billed Curlew (*Numenius americanus*) nested in a 12-ha drawdown impoundment. Also, some apparently suitable nesting macrohabitats (sparsely vegetation salt flats) were not used by breeding plovers. We thought increasing the availability of potential nest-site microhabitats in these suitable macrohabitats might increase their use. We placed 1-m^2 gravel pads on selected barren salt flats at Great Salt Lake, and Snowy Plovers readily used these artificial substrates; 50% of 32 small-grained structures were used for building scrapes and three structures had clutches initiated on them. These strategies represent potential management techniques that should be field tested by land managers to determine their effectiveness to enhance Snowy Plover populations.

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Introduction

Western Snowy Plover (*Charadrius alexandrinus nivosus*) populations on the Pacific coast recently were listed as threatened by the U.S. Fish and Wildlife Service (Federal Register 1993), yet little has been published on management strategies for this species (but see Wilson-Jacobs 1986). Page *et al.* (1989) reintroduced hand-reared chicks into the wild. This technique could be used to reestablish wild populations although further research would have to be conducted to fine-tune methods and assess feasibility (Marshall & Black 1992). This paper addresses preliminary tests of two other types of management techniques applied to interior populations: impoundment drawdown and artificial nest substrates.

There are probably more Snowy Plovers nesting around the shores of Great Salt Lake, Utah, USA, than anywhere else in the United States (*i.e.*, an estimated 10,000 birds in 1992; Page *et al.* 1995). There are several possible threats facing this large concentration of plovers. These include 1) high predation rates of eggs by mammalian predators; annual nest success was as low as 5% at some sites (Paton 1995); 2) the loss of suitable nesting habitat due to the natural encroachment of marsh vegetation onto sparsely vegetated salt flats (Paton 1994); 3) increased urbanization of the east side of the lake, which would result in habitat loss and increased disturbance of breeding birds; and 4) the loss of flowing freshwater into the lake due to increased human consumption and agricultural interests.

Great Salt Lake water levels rose dramatically in 1983 due to heavy precipitation, and reached peak levels in 1987. As lake levels subsequently receded due to evaporation, large expanses of barren salt flats were exposed. Snowy Plovers usually nest only in areas that are sparsely vegetated (Wilson-Jacobs & Meslow 1984; Page *et al.* 1985; Paton 1994), therefore these barren areas represented prime nesting habitat. Gradually, precipitation leached salts out of these areas, allowing salt-tolerant vegetation to become reestablished (Paton 1994). This vegetation encroachment diminished the amount of suitable nesting habitat from 1990 to 1993 (Paton 1994). Our first potential management technique involved creating foraging and nesting habitat by eliminating vegetation and exposing mud and sand through impoundment drawdown (*i.e.*, human-induced fluctuations in water levels). Impoundment drawdown has long been suggested to provide food and nesting cover for waterfowl (*e.g.*, Low & Bellrose 1944; Kadlec 1962). Recently, literature on vegetation, invertebrate, and vertebrate responses to drawdown has been summarized for North America (Cross 1988; Smith et al. 1989; Meredino *et al.* 1990; Meredino & Smith 1991; Payne 1992). Most of this research emphasizes waterfowl useage, but drawdown recommendations are available for shorebirds and other nongame species (*e.g.*, Rundle & Fredrickson 1981; Fredrickson & Taylor 1982; Eldridege 1990; Helmers 1992). The majority of research with drawdown techniques for shorebirds have been developed in the midwestern United States, and focus on increasing aquatic invertebrate production and availability (Fredrickson 1991; Eldridge 1992; Payne 1992).

In the Great Basin, impoundment drawdown is primarily used to manage vegetation, carp, and ice (Green *et al.* 1964; Smith & Kadlec 1986; Kadlec & Smith 1989; Huener & Kadlec 1992); but subsequent foraging waterfowl concentrations and increased invertebrate production are secondary responses in some drawdown types (Nelson & Dietz 1966; Kadlec & Smith 1989; VCB, unpubl. data). We report here for the first time using impoundment drawdown near Great Salt Lake, Utah to create foraging and nesting habitat for Snowy Plovers and other species of shorebirds [*e.g.*, American Avocet (*Recurvirostra americana*), Black-necked Stilt (*Himantopus mexicanus*), Long-billed Curlew (*Numenius americanus*)].

At Great Salt Lake, there are large tracts of seemingly suitable nesting habitat with no nesting Snowy Plovers (PWCP, pers. obs.). We felt that one way to increase plover use of these areas might be increase the availability of appropriate nest-site microhabitat. Snowy Plovers often nest near small objects (*e.g.*, shrubs, rocks, bones), in small depressions, or on top of gravelly substrates (Wilson-Jacobs & Meslow 1984; Page *et al.* 1983, 1985; Grover & Knopf 1982; Paton 1994). Previous research suggests that plovers select these cryptic microhabitats as a anti-predator strategy (Purdue 1976; Page 1985). The second management technique we experimented with involved the construction of artificial nest substrates to increase microhabitat availability on salt flats at Great Salt Lake.

Study area and methods

Impoundment drawdown

We conducted fieldwork for four years (1990-1993) in the 350 ha Hooper Hot Springs Unit (HHS) at Howard Slough Waterfowl Management Area (1,215 ha; 41°09'N, 112°09'W), on the eastern shores of Great Salt Lake, Davis Co., Utah (Paton 1994). The Utah Division of Wildlife Resources (UDWR) actively manages HHS for breeding and migrating waterfowl using 10 diked impoundments. Historically, HHS was a salt grass (*Distichlis spicata*) pasture. In 1990, UDWR purchased HHS when the vegetation was recovering from Great Salt Lake inundation during the 1980s. It was dominated by dry salt flats and interspersed with small patches of salt-tolerant plants of the family Chenopodiaceae, including greasewood (*Sarcobatus vermiculatus*), seepweed (*Suaeda* spp.), summer cypress (*Kochia scoparia*), bassia (*Bassia hyssopifolia*), and pickleweed (*Salicornia rubra*). By late 1993, UDWR had developed six freshwater impoundments at HHS. Emergent marsh vegetation [alkali bulrush (*Scirpus maritimus*), cattail (*Typha* spp.)] increased dramatically in these impoundments by 1995.

From 1990 through 1993, HHS was surveyed by one (1990) to two biologists (1991-1993) for shorebirds at least twice weekly from 15 March through 31 August. A 2-km long transect at HHS was surveyed weekly for Snowy Plovers and other species of shorebirds. This transect passed by Impoundments #1 and #2 (Figur e 1). We surveyed this transect from 1 April to 31 July. Ground nests were found by

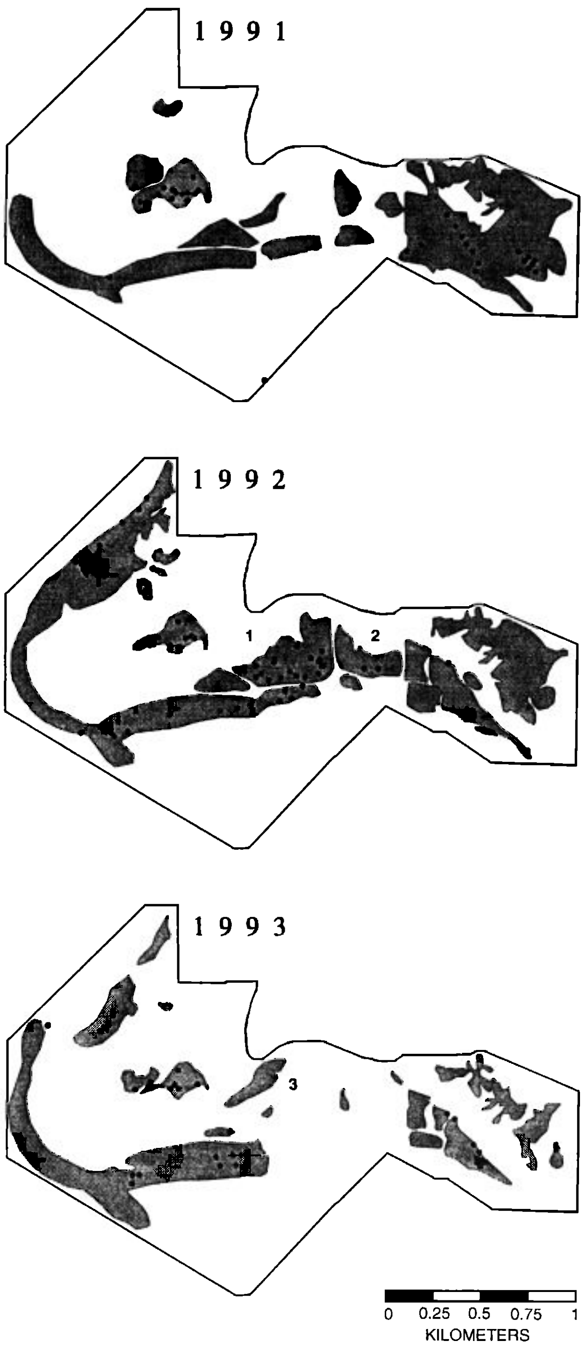

Figure 1. Impoundments used for drawdown (numbered ponds) at the Hooper Hot Springs Unit of Howard Slough Waterfowl Management area, Davis Co., Utah. Stippled areas represent suitable nesting habitat for Snowy Plovers, and dots show the distribution of Snowy Plover nests.

scanning nesting habitat from distances of 100-150 m to look for incubating adults, walking through nesting habitat looking for adults flushing off of nests, or systematically searching areas for nests. Nest initiation dates were calculated by floating eggs in water (Westerkov 1950; Alberico 1995).

Annual fluctuations in the geographic distribution of nesting habitat were quantified from mid-June black and white aerial photographs (photo scale: 1 cm = 100 m) from 1990-1993. Areas were classified as potential Snowy Plover nesting habitat if (1) dead or live vegetation accounted for <25% of the ground coverage of a habitat patch, and (2) the habitat patch was 0.1 ha in size (Wilson-Jacobs & Meslow 1984; Page *et al.* 1985; Paton & Edwards 1990; Paton 1994). Barren areas dominated by soft mud (e.g., next to the lake) were not classified as potential nesting habitat because plovers nest only on relatively hard, dry substrates (PWCP, unpubl. data). Potential nesting habitat was digitized from aerial photographs and analyzed using ARC/INFO software (Environmental Systems Research Institute, Redlands, California).

The availability of potential nesting habitat at HHS declined dramatically from 1990 (147 ha) to 1991 (85 ha; Paton 1994). Therefore, we implemented an experimental drawdown of two impoundments at HHS in 1992 to increase the amount of potential shorebird nesting habitat. Impoundment #1 (12 ha) water averaged <10 cm depth on 1 May 1992, when subjected to completed drawdown. This pond's floor soil surface remained dry throughout summer. The water in Impoundment #2 (5.3 ha) was > 25 cm deep on 15 May 1992, when it was drained incompletely. Residual water remained in borrow pits throughout the summer. Both ponds' soils were severely saline and alkaline, with Impoundment #1 having some well drained loam or sand and Impoundment #2 having poorly drained silty clay. These ponds were slowly refilled starting 1 September 1992 and were unavailable as nesting habitat during 1993. Another drawdown was attempted on 1 May 1993 in Impoundment #3 (3.1 ha) to duplicate 1992 results. However, due to late-

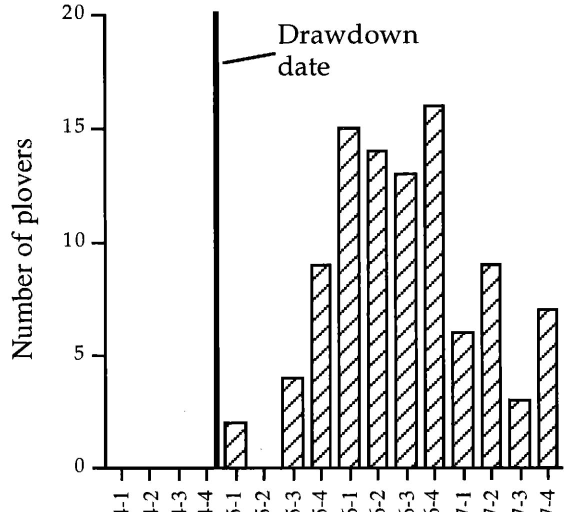

Figure 2. Number of Snowy Plovers counted in drawdown Impoundment #1 at Hooper Hot Springs in 1992.

May flooding, this impoundment received some excess water and was not completely drained until 20 June.

Artificial microhabitats

We constructed 107 nest structures in 1993 on sparsely vegetated salt flats at HHS to determine if plovers used artificial microhabitats. Nest structures were constructed from 0.2 m³ of gravel spread over a 1-m diameter area and were placed approximately 30 m apart. Structures were scattered across the landscape to mimic the distribution pattern of natural Snowy Plover nests at Great Salt Lake, where birds were semi-colonial with active nests an average of 36 m apart (range = 7.5-90 m; Paton 1994). Artificial substrates were placed on a salt flat on 13 and 14 May, which is the beginning of the peak nest initiation period in northern Utah; plovers initiate nests from 10 April to 18 July at Great Salt Lake (Paton 1995). Seventy-five nest structures were placed on a salt flat with the aid of an all-terrain vehicle. These structures consisted of multicolored, 3-10 cm diameter gravel, mixed with 20% light, brown soil (hereafter large-grained substrate). Thirty-two structures were placed in the same area on 22 June 1993, which was about one week before the last peak of nesting attempts at Great Salt Lake (Paton 1995). These latter structures were made from tan-colored, 2 to 3 cm diameter gravel, intermixed with 1-cm diameter gravel (hereafter small-grained structures).

Results

Impoundment drawdown

After 1 May 1992, drawdown Impoundment #1 consisted of dry mudflats, dead vegetative stubble (primarily salt grass), and a few patches of dried algal mats. Plovers were first observed at Impoundment #1 on 3 May and use gradually increased during May, with peak numbers during June (Figure 2). Observed bird numbers coincided with nest initiation chronology (Figure 3) and 22 nests were found on this drawdown area, of which 17 had eggs that hatched. The first nest was initiated only 11 d after drawdown, with peak nest initiation beginning 1.5 months after pond drainage (Figure 3). One pair of Long-billed Curlew also nested successfully in the drawdown area of Impoundment #1. Four pairs of American Avocets nested unsuccessfully in Impoundment #1, apparently depredated by red fox (*Vulpes vulpes*) based on tracks near nests. By 1 September, the northern half of Impoundment #1 had >35% vegetative coverage, which consisted of summer cypress, bassia, pickleweed, alkali bulrush, seepweed, and goosefoot (*Chenopodium* spp.), whereas the southern half of the pond had <10% cover. During and after refill, shorebird and waterfowl useage of Impoundment #1 was similar or improved when compared to other comparably sized, stable water impoundments.

After a gradual drawdown, Impoundment #2 consisted of algal mats, water in adjacent borrow pits, and dried cracked mud. Two Snowy Plover

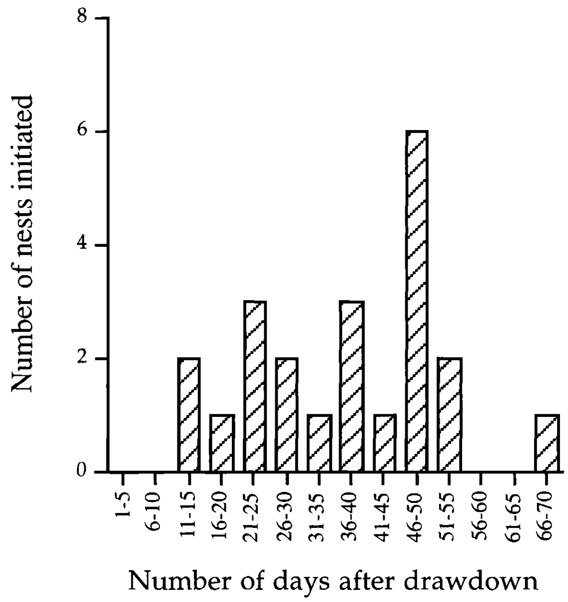

Figure 3. Snowy Plover nest initiation chronology in drawdown Impoundment #1 at Hooper Hot Springs in 1992.

nests were initiated in Impoundment #2, 31 and 40 d after drawdown; both nests were located on dried algal mats in the cracked mudflats. Compared to other similar sized impoundments, concentrated numbers of waterfowl, avocets, and phalaropes [i.e., both Wilson's (*Phalaropus tricolor*) and Red-necked Phalaropes (*P. lobatus*)] foraged in Impoundment #2 throughout drawdown and refill. Regrowth of vegetative cover was estimated at <5% in late August. In Impoundment #3, no nesting shorebirds were observed; yet, it had large numbers of foraging avocets and stilts. In addition, some vegetative cover increased, particularly alkali bulrush.

Artificial nest substrates

We found no evidence from 1 April to 14 May 1993 to suggest that Snowy Plovers were initiating nests on natural substrates in our experimental area at HHS, nor did plovers initiate nests on natural substrates in this area after we constructed artificial substrates. Snowy Plover built scrapes on 5% of 75 large-grained substrates compared to 59.4% of 32 small-grained substrates ($G^2 = 34.1$, $P < 0.001$; Figure 4). After artificial substrates were in place for 20 d, 50% of small-grained nest structures had plover scrapes. In addition, three nests were initiated on small-grained substrates; one nest was established 5 d after gravel placement, one after 15 d and one after 17 d. Only one nest hatched eggs successfully, while the other two were probably depredated by mammals. On large-gravel substrates, one pair of Killdeer (*Charadrius vociferus*) and one American Avocet pair nested unsuccessfully, with both depredated by unknown predators.

Discussion and recommendations

Snowy Plovers have abandoned 59 of 87 historic breeding sites along the Pacific coast (Federal Register 1992); coastal plover populations have experienced an 18% decline from 2,300 birds in the late 1970s to 1,900 birds in late 1980s (Page *et al.* 1991). Reasons for Snowy Plover extirpation from certain nesting beaches include increased recreational use by humans and their pets, new housing developments near plover habitat, loss of nesting habitat due to the encroachment of beach grass (*Ammophila arenaria*), and raking beaches to remove seaweed that provides substrate to dipteran prey (Page *et al.* 1995). Yet, simultaneously agricultural waste water impoundments in the San Joaquin Valley and the Salton Sea have created Snowy Plover habitat (Page *et al.* 1991). No information is available on Snowy Plover population trends in the interior of western North America; the current population estimate for this region is 16,000 birds [3,500 in California, 1,100 in Oregon, 1,400 in Nevada and 10,000 at Great Salt Lake (Page *et al.* 1995)].

One potential limiting factor for Snowy Plovers in western North America may be the availability of suitable nesting habitat. We successfully used impoundment drawdown to create sparsely vegetated habitats that were used by four shorebirds species. Snowy Plovers nesting in the interior of western North American appear to be fairly selective in nest site characteristics, usually nesting on sparsely vegetated salt flats near hypersaline lakes (Grant 1982; Page *et al.* 1983, 1985, 1991; Paton 1994). American Avocet, Black-necked Stilt (*Himantopus mexicanus*), Long-billed Curlew, and Killdeer usually select sparsely vegetated habitats if available (Paton & Dalton 1994; PWCP, unpubl. data). Based on her studies on the Oregon coast, Wilson-Jacobs (1986:17) suggested cover should be reduced to <11% within 25 m of potential Snowy Plover nest sites, and <1% live vegetation. At Great Salt Lake, dead and live vegetation usually never exceeded 25% coverage within 15 m of plover nests (Paton 1994). Using impoundment drawdown to create sparsely vegetated nesting or foraging habitats may be useful at other similar wetlands throughout the Great Basin and some other areas where water levels can be manipulated to create this habitat. There was limited

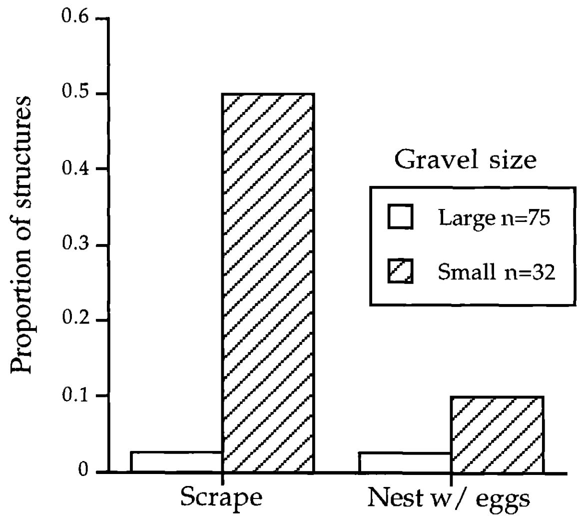

Figure 4. Snowy Plover use of artificial nest structures at Hooper Hot Springs in 1993. Gravel size was either large (3-10 cm diameter gravel and mixed with soil) or small (2-3 cm diameter, and mixed with pea-sized tan-colored rocks).

use of Impoundment #2 as nesting substrate for shorebirds, primarily because most of the exposed pond-bottom was unsuitable as a nesting substrate. Most of the pond's bottom consisted of dried mud, with relatively large cracks. Snowy Plovers generally nest on smooth surfaces at Great Salt Lake, although they will occasionally use rough terrain (PWCP, unpubl. data).

We believe that impoundment drawdowns, which create shorebird nesting and foraging habitat, can be compatible with many other Great Basin wetland management strategies. Unfortunately, drawdown recommendations specific to shorebirds in the Great Basin are limited. Based on our experience at Great Salt Lake and relevant literature, we propose the following drawdown recommendations for nesting and foraging shorebirds. We prefer a small (<50 ha), proportional, well drained, mixosaline drawdown area located adjacent to stable water areas and within large wetland complexes. The area should not have high waterfowl or colonial waterbird nesting densities or a history of botulism disease. Our recommended drawdown is a slow, evaporative or seepage spring drawdown started on 15 March, depending on location. Incoming water should be diverted to stable areas within the local wetland complex. The drawdown area should be completely dewatered by 1 May via gradual opening of outlet headgates or slow pumping if necessary. The area floor should be dry throughout the summer. If water is available, a slow continuous refill should start in late August from stable water sources.

This drawdown chronology (i.e., initiated 15 March, dry pond bottom by 1 May, and refilling in late August) we propose would 1) control ice damage to dikes, vegetation, and soil (VCB, pers. obs) by only slightly reducing water levels the winter prior to 15 March drawdown initiation; 2) increase avian use throughout spring waterfowl and early spring shorebird migration due to improving invertebrate availability as water levels slowly decrease in March and April (Fredrickson & Taylor 1982; Fredrickson 1991; Eldridge 1992; Helmers 1992); 3) increase the diversity of waterfowl and shorebirds using the wetland by providing varying water depths and types of substrate (*e.g.*, dry soil to mud) for different foraging guilds as water levels decrease (Fredrickson 1991; Eldridge 1992; Helmers 1992); 4) retain nutrients (Reinicke *et al.* 1989; Fredrickson 1991), invertebrates (Fredrickson 1991; Huener & Kadlec 1982), and seed banks (van der Valk 1981; Smith & Kadlec 1986), and reduce turbidity (Weller 1994) because of slow water loss; 5) create sparsely vegetated areas for attracting nesting shorebirds, while also establishing some annual vegetation for birds preferring >10% nest site cover; 6) maintain efficient use of water by diverting drawdown water to maintain stable water areas during low summer flow, and refilling the drawdown in August and September when flows increase as temperatures or upstream irrigation demands diminish (VCB, unpubl. data); and 7) increase avian utilization during fall migration for both waterfowl and shorebirds by refilling in late summer to provide water borne foods via importation from nearby stable water sources of invertebrate brood stock (Euliss & Grodhaus 1987; Helmers 1992; Huener & Kadlec 1992).

We included waterfowl useage in our recommended summer drawdown because most Great Basin wetlands with water regulation capabilities are managed for waterfowl. The water regime on most of these wetlands has been stabilized traditionally in summer for waterfowl production, even though stability eventually results in loss of waterfowl production and use (Nelson & Dietz 1966; Smith & Kadlec 1986; Kadlec & Smith 1989; VCB unpubl. data). Our recommendation is meant to alleviate Great Basin waterfowl manager's concerns with drawdown potentially increasing noxious vegetation or botulism and temporarily reducing or displacing desirable vegetation, invertebrates, and vertebrate populations (Nelson & Dietz 1966; Kadlec & Smith 1989; Helmers 1992; Huener & Kadlec 1992; VCB pers. obs.). If the drawdown is small, proportional, and of the described type, the negative impacts to a wetland community are probably negligible. This includes breeding waterfowl and other wildlife use, as they are well adapted to fluctuations (Linde 1969; Kadlec & Smith 1989).

We believe smaller, proportional summer drawdown for shorebirds can be compatible with effective waterfowl management and will have long-term benefits for the wetland complex. The compatability has been noted in other areas in western North America (Nelson & Dietz 1966; Heitmeyer *et al.* 1989; Kadlec & Smith 1989; Helmers 1992,) and the midwest (Fredrickson & Taylor 1982; Weller 1994). The interval between the drawdown of a specific area should probably be 5 years (Kadlec & Smith 1989) or less in order to maintain productivity. However, the interval should be greater than 5 years in salt grass (Kadlec & Smith 1989; VCB, unpubl. data) and rush meadows (de la Cruz & Hackney 1980) if the drawdown is combined with burning and deep flooding because of the elimination of residual cover, extensive vegetative control, and prolonged recovery (>3 years) in these usually desirable nesting habitat types.

Our experimental work with artificial nest structures suggests another potential management technique for Snowy Plovers. This strategy would probably be most useful in situations where a manager wanted to attract plovers to an area where they could be more easily managed. It might even be possible to attract birds to a large fenced area, where mammalian predation could be minimized, rather than building nest exclosures around individual nest sites (*e.g.* Melvin *et al.* 1992). Suitable microhabitats may be limited in barren salt flats, which is why Snowy Plovers often nest near small objects (Grover & Knopf 1982; Page *et al.* 1985; Paton 1994). Wilson-Jacobs (1986) found that Snowy Plovers readily nested in dredged shell fragments placed in stands of European beachgrass. Since plover readily nest near objects, an alternative technique would be to place woody debris or clumped vegetation in selected areas to see if plovers might increase their use of easily-managed sites. Although we used relatively small (1-m diameter) patches of gravel, this was primarily for logistical considerations. We did not have easy access to a gravel pit with suitable gravel, nor did we have a large truck to place the material directly onto the salt flat. We constructed only 32 of the small-gravel structures on the salt flat, but we suggest more artificial nest structures might be used as a management strategy. Predators could learn to search gravel pads for nests if only a few artificial nest structures were available. An alternative strategy would be to increase the size of gravel pads to increase predator search time. Finally, it might be possible to fence off an area from mammalian predators and then place gravel into the fenced area to create relatively safe nesting habitat for Snowy Plovers. However, this would not exlude avian predators, which are the primary cause of egg loss in coastal Oregon (Wilson-Jacobs & Meslow 1984).

Long-term solutions must address habitat conditions and use management techniques to restore plover habitat, while simultaneously altering habitat to depress predator populations. We suggest that the methods presented here be treated as hypotheses, to be tested with proper experimental controls (*e.g.*, Elphick, this volume). For example, we do not know if impoundment drawdown and providing artificial nest microhabitat actually increased the number of nests present, or if birds breeding in these test sites merely shifted from other sites. Therefore, the effectiveness of each of these treatments on net nesting success for the entire area is unknown. Preliminary results presented here, however, provide an excellent basis for experimenting with different management schemes.

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