Censusing shorebirds in the western Great Basin of North America

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Reed, J. M., N. Warnock, and L. W. Oring. 1996. Censusing shorebirds in the western Great Basin of North America. *International Wader Studies* 9: 29-36.

The shorebird populations frequenting inland North America are poorly known, largely due to the difficulty of study at multiple and highly variable sites. One of North America's most important inland shorebird areas is the Great Basin. Censusing shorebirds in the Great Basin is different from censusing in estuarine areas. The lack of tidal influence allows standardization of census times, a chronic problem in marine environments. On the other hand, highly variable water levels pose special problems in that birds vary from being mostly dispersed to being highly clumped. Furthermore, high summer temperatures and powerful winds necessitate early morning work. With few exceptions, shorebirds are not present in the Great Basin from November through February. Here we present recommendations for census methods and monitoring plans for shorebirds breeding and migrating in the western Great Basin.

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Introduction

Concern for preserving biodiversity dictates that inventory and population monitoring receive high priority (*e.g.*, Trauger 1981; Wilson 1988; Furness & Greenwood 1993). Unfortunately, we lack adequate data on species distributions and population numbers even for relatively common species in Europe and North America (Page & Gill 1994). This lack of knowledge precludes assessment of population sizes, population trend analysis, assessment of management activities, determination of genetic variation, and identification of critical reserves. In the absence of this information, setting conservation goals and establishing priorities is impossible (Howe *et al.* 1989; Barter 1993; Morrison *et al.* 1994).

Little broad-scale shorebird work has been done in inland areas of North America (Helmers 1992; Skagen & Knopf 1994; Oring & Reed this volume; see Page *et al.* 1991 for an exception). Here we present methods for censusing and monitoring shorebirds in the western Great Basin, where wetlands usually are in short supply. Although our methods are designed for shorebirds in the Great Basin, they might serve as a guide for development of methods in other arid lands. The Great Basin wetland environment is variable compared with estuarine environments. Even important wetlands, such as Goose Lake and those in Stillwater National Wildlife Refuge, have become mostly dry in recent years. This contrasts with 1986, when all lowlands were under water, resulting in many square kilometers of wetlands. In rare wet years, shorebirds are relatively dispersed; however, in most years, most shorebirds are concentrated at a small number of important wetlands (Oring & Reed this volume).

Censusing and monitoring principles

Censusing is counting or estimating the number of individuals at a site or along a transect, whereas population monitoring is censusing over time to discern trends. Censusing typically provides an index of population size rather than an estimate of population size (Bart & Schoultz 1984). This is due to the fact that usually a fixed but unknown relationship exists between the census number and actual population size. For example, counts of breeding birds might not detect all birds present, and by themselves counts of migratory birds do not account for the turnover of individuals that stay a few days and are replaced by others. Nevertheless, if there is a fixed relationship between those counted and total numbers, the counts are an index of population size. As long as the relationship between population size and the index remains constant, indices are sufficient for assessing population trends (*e.g.*, Reed *et al.* 1988). In contrast, estimating population size requires a known relationship between census number and population size, a relationship that is exceedingly difficult to estimate for wild populations (Davis & Winstead 1980). What censuses actually give is the minimum number of individuals present.

The following principles are critical for developing surveying and monitoring schemes. 1) State a clear goal (*e.g.*, inventory all species at a given site, identify an indicator species, look for population trends in target species, test management effort, *etc.*). This includes selecting the appropriate spatial scale for the work (see below). 2) Identify target species. Census methods should accommodate differences among species, age classes, and between males and females within species, in behavior, dispersion, seasonal habitat shifts, and migration timing (*e.g.*, Burnham 1981; Howes & Bakewell 1989; Bibby *et al.* 1992). 3) Standardize methods and efforts across sites and years (Bibby *et al.* 1992). Because of logistic constraints imposed by the real world, this is often difficult (see below).

Censusing shorebirds at Great Basin sites

The Great Basin is characterized by broad sagebrush-dominated valleys distributed among 314 mountain ranges (Brussard *et al.* in press). A cold desert, it receives the majority of its precipitation as snow. Runoff drains internally, *i.e.*, there is no flow to the ocean. The most important climatic characteristic for shorebirds in this arid environment is the unpredictability of precipitation (Brussard *et al.* in press), resulting in widely varying wetland availability from year to year. We classified the Great Basin as having six major types of wetlands: narrow riparian areas, large deep lakes, shallow saline lakes and playas, complex natural and managed wetlands (*e.g.*, marshes, mountain ponds), upland bogs and wet meadows, and artificial reservoirs (Engilis & Reid this volume; Oring & Reed this volume). Because the source of water for these wetlands is primarily snow, wetlands are more extensive in spring than in fall.

No single census method works for all shorebirds or for all species in a single habitat (Bibby *et al.* 1992). Certain factors make censusing shorebirds in the Great Basin different from estuarine areas. The lack of tidal influence allows standardization of census times, a chronic problem in marine environments. On the other hand, highly variable water levels pose special problems in that birds vary from being dispersed to being highly clumped. Furthermore, high summer temperatures and powerful winds necessitate early morning work. With few exceptions, shorebirds are not present in the Great Basin from November through February.

Suitable habitat for shorebirds in the western Great Basin typically is very limited, except in occasional high precipitation years. Local surveys can result in relatively accurate counts of shorebirds with minimal need of extrapolating, but surveying all key sites in an appropriate time frame can be problematic. Species that migrate in large flocks tend to use fewer wetlands, and pose less of a logistic problem than species that breed at or migrate through the large number of highly dispersed smaller wetlands. Visibility at Great Basin sites is excellent in dry years, allowing thorough censuses at the limited wetland sites. Frequently, at small bodies of water, observers can count from a single point. Observers also can survey and identify all individuals at larger bodies of water and mudflats either from several points or by walking shoreline transects. These types of censuses might require multiple people at different sites, a few people moving about at a site to cover the area in question, or both.

In order to use censuses for trend analysis or for comparison among sites it is necessary to standardize census techniques. In the Great Basin, however, changing water levels can make this a logistic nightmare, especially on large bodies of water. For example, during wet years in the western Great Basin, most lakes (such as Goose Lake, see Oring & Reed this volume) develop into large, shallow bodies of water, creating many kilometers of shoreline difficult to effectively survey on foot. In this situation, it is best to survey by air boat or plane. During dry years (the majority of years), lakes recede dramatically. Access to the much smaller bodies of water is not possible by boat because of extensive mud flats, and surveys must be done on foot (which often requires slogging through kilometers of knee-high mud in order to get close enough to the water's edge to identify birds) or by air. This eliminates standardization of techniques among years (the same argument applies to comparison of sites with varying accessibility within a year).

So what can be done? Clearly it makes no sense to stick with a single survey method when in some years it will be impossible or inadequate. There are options, none of which is perfect, but each of which can help extract meaningful data. 1) If the relationship between number of birds censused and the actual number present is known for each method, correction factors can be developed that allow between-technique comparisons. 2) If surveys are made using different methods during different years, population trends across years can be estimated using years with the same method. For example, look at trends across dry years or trends across wet years, but do not mix wet- and dry-year estimates. 3) If neither of the above options is available, some information can be obtained about a site even with a mix of census methods. A census at a site of interest gives the minimum number of birds present. If this number is large in comparison with other sites, the site of interest is probably important to the species. On the other hand, a small census number and no information about its relationship to the actual number present tells little; it does not follow that the site is unimportant because the census might grossly underestimate the number of birds present. In summary, although standardization is important, it often is difficult or impossible in the Great Basin. When it is not possible, it is important to understand what can and cannot be obtained from a series of census numbers. Population trends and absolute numbers cannot be assessed without additional information (such as the accuracy of each census method).

Avian census methods

Avian census methods are of two general types: point counts and transect counts (Howes & Bakewell 1989; Bibby *et al.* 1992). Under most conditions, both of these methods offer a way to sample a portion of a given area, allowing for extrapolation of densities and/or numbers of birds for the whole area under consideration. Transects often are used to sample habitat where terrain is open, visibility is good, and observers can travel easily, such as alkali flats and short grass prairies. Point counts generally are used when terrain (such as forests) is closed or obstructed and birds are difficult to see. Shorebird biologists often encounter large flocks of individuals, making direct enumeration impossible. In these situations, divide flocks into blocks, count individuals in a block, and multiply by number of blocks. Although this results in an estimate, it is more accurate (and less frustrating) than trying to count animals individually. For a thorough discussion of avian census methods, see Bibby *et al.* (1992).

Point counts or transects can be used to survey all of the birds at a single site (*i.e.*, a site count), especially when wetlands are relatively small. Site counts involve counting all of the birds at a particular area, either from one or several vantage points, or by walking a transect around the perimeter of the wetland. There are advantages and disadvantages to site counts. On the positive side, they give fairly complete coverage of species and accurate indices of population sizes, and for local studies they are relatively inexpensive. However, if all sections of a large area are being surveyed simultaneously, many experienced people are needed and ground access is needed to all suitable habitat, or an airplane is needed. Developing a survey scheme that censuses a subset of the wetland (using point or transect counts), followed by extrapolating to the rest of the wetland can alleviate some of these problems.

Site count, ground

Although site counts typically are used to census target species or entire communities in local-scale studies, multiple site counts also can be used to sample larger areas. For instance, a comprehensive shorebird census of the 1500 km^2 San Francisco Bay estuary was conducted by dividing the bay into 10 areas, each with 6 to 20 shoreline segments. Segments were designed such that all shoreline habitat within each segment could be counted by observers within 1-2 hr to minimize the effect of shorebird movements on population estimates. The south bay was covered in one day, the north bay the next day, and 183 observers were used (Stenzel & Page 1988).

Site counts can be used for estimating local trends at a given site, but these trends do not necessarily reflect broader-scale trends. For example, looking at population trends at Stillwater National Wildlife Refuge will not give information on actual shorebird population trends because shorebirds might use a larger area (Robinson & S. Warnock this volume). A decline in shorebird numbers might be a result of changing water availability altering bird distributions at a larger scale (Warnock *et al.* 1995). A local count on a particular day each year often will miss peak numbers (Stenzel & Page 1988) and species that do not migrate in large groups. This might not be a problem for extremely large-scale counts (*i.e.*, hemispheric) because individuals that have not yet arrived at a particular locale presumably are being counted elsewhere. This is a tenuous assumption for inland sites because of the large number of people needed to cover the thousands of relatively small wetlands that might exist (*e.g.*, prairie potholes) in a wet year.

One example of site counts on the ground at both local and large scales was a state-wide survey of breeding Snowy Plovers (*Charadrius alexandrinus*) in California (Page *et al.* 1991). In six weeks, a team of two biologists searched all known and suspected Snowy Plover breeding sites in the interior of the state. Planning involved mapping known historic breeding sites and unchecked appropriate habitat (alkali flats near fresh water). Each site was searched completely once in the breeding season, and data recorded included numbers of birds, their age, sex, and breeding status. This survey involved approximately 14,000 km of driving. The only reason this survey could be done with only two biologists was the limited habitat available for breeding. As it was, the validity of the survey depended on correctly identifying all potential breeding habitat *a priori* and the assumptions that non-breeders used the same habitat and that there was little movement among sites during the six weeks. Another key assumption of the survey was that detection rates at all sites were similar to those found at Mono Lake in prior surveys. In fact, detection rates probably varied greatly depending on size and physical features of sites (D. Shuford, pers. comm.). A more effective but costly method would have involved more biologists so the area could have been covered in less time.

In the Great Basin, ground surveys are most useful in dry years, or at small wetlands in any year. In wet years, wetlands can be so large that birds in the center are missed, and that surveying species around the entire perimeter in a timely fashion is costly. The one problem in dry years for some wetlands is that extensive mud can make ground travel difficult.

Site count, aerial

When broad-scale surveys are required, or if wetlands are particularly large, some species can be counted effectively from the air (*e.g.*, Dunne *et al.* 1982; Morrison 1983; Morrison & Ross 1989a; Harrington 1993a). Morrison & Ross (1989a, b) used aerial surveys to count shorebirds along the coast of South and Central America, Point Reyes Bird Observatory surveyed shorebirds in the Great Salt Lake (Shuford *et al.* 1994), and Harrington (1993a, b, 1994) conducted aerial surveys of western Mexico. On the plus side, this method gives relatively accurate estimates of populations for some species, requires only small numbers of *trained* people, and allows rapid coverage of large areas that are inaccessible by foot. On the down side, aerial surveys are expensive, many small shorebirds cannot be identified to species, birds with dispersed distributions (*i.e.*, locally rare birds) are poorly counted, ground truthing (*i.e.*, surveying portions of the site from the ground to determine the accuracy of the aerial surveys) is required to establish effectiveness, survey teams must fly 30-70 m from the ground, and highly trained surveyors are required (see also Howes & Bakewell 1989). This method can be effective for species that have a clumped distribution, live in open habitat, and have strong contrasting plumage patterns.

If one does rely on aerial surveys, it is desirable to derive correction factors by ground truthing areas. Aerial flights generally underestimate numbers, produce more accurate data from open habitats, and miss or undercount small and rare species (Morrison & Ross 1989a, b). For example, Spotted Sandpipers (*Actitis macularia*) on the wintering grounds could not be surveyed this way because of their size and their tendency to disperse widely in low numbers (as inferred by Morrison & Ross' 1989b data). In the Great Basin, ground truthing is especially important when large numbers of small sandpipers [Least and Western sandpipers (*Calidris minutilla* and *C. mauri*), Dunlin (*C. alpina*)] are found. Because these species often occur in mixed flocks and are almost impossible to distinguish from one another in the air, they generally are lumped as "peeps" or small shorebirds on aerial surveys (*e.g.*, Morrison *et al.* 1992). Ground observers should sample the ratios of the different species in various flocks (*e.g.* 75% westerns, 20% leasts and 5% Dunlin) and apply these to the totals obtained on the aerial survey.

Site count, boats

Site counts using boats might also be quite effective in some cases (see advantages and disadvantages in Howes & Bakewell 1989). This method has been used in the western Great Basin for counting phalaropes on large saline lakes (Jehl 1988; Rubega & Inouye 1992). Boat surveys are necessary when the body of water is large enough that there is difficulty seeing to the middle, especially on hot days when heat waves reduce visibility. Airboats can be used to census shallow areas of wetlands with no foot access or difficult access (*e.g.*, some sections of Stillwater NWR) as has been done on the vast mudflats of the Copper River Delta in Alaska (M. A. Bishop, pers. comm.). However, the high winds that are common in the Great Basin often create conditions too hazardous for surveys.

Sampling for dispersed breeding shorebirds

Great Basin shorebirds that disperse across a wide area, such as upland grasslands, are difficult to census and monitor, because few individuals will be counted for a given unit of survey effort. As a consequence, these species are more costly to survey. This type of species requires a census scheme that involves sampling only a subset of the available habitat. For example, most breeding Arctic shorebirds disperse widely across the landscape. Connors *et al.* (1979) and Troy & Wickliffe (1990) censused these species using transect lines placed systematically throughout their study sites.

In the Great Basin, dispersed breeders include Long-billed Curlew (*Numenius americanus*), Common Snipe (*Gallinago gallinago*), Willet (*Catoptrophorus semipalmatus*), Wilson's Phalarope, Spotted Sandpiper, Snowy Plover, and Killdeer (*Charadrius vociferus*). Census methods applied to some of these species in less arid environments generally should apply in the Great Basin. For example, Redmond *et al.* (1981) surveyed breeding Long-billed Curlews and assumed that spot mapping territorial birds yielded the best annual density estimates, even though this method was time consuming and the spatial scale was limited by personnel availability. They used spot mapping to compare the effectiveness of two transect methods. Redmond *et al.* (1981) found that before eggs hatched females were underestimated whereas during the incubation period, males were overestimated because of their mobbing behavior. They found that the best estimates of males was provided by fixed-width transects stratified by habitat. The best census method for curlews is to survey for males early in the breeding season. This is sufficient for an index of birds, but not a total count. Curlews also have been censused using playback at point counts (Allen 1980), and this might be effective for Willets.

Common Snipe are difficult to census because breeders are dispersed and single pairs sometimes nest in small, isolated seeps or wetlands (Ryser 1985). For this species, surveying for winnowing males in selected habitat is the most effective census method (Green 1985a). Another method for counting dispersed breeders is to systematically search for nests in appropriate habitat, either by rope-dragging or flushing incubating birds (Connors 1986), as has been done for Common Snipe (Green 1985b) and Upland Sandpipers (*Bartramia longicauda*) (Bowen & Kruse 1993).

Recommendations for censusing breeding and migrating shorebirds in the Great Basin are highly variable depending on habitat and season. These recommendations are summarized in Table 1.

Turnover times and population estimates at stopover and staging areas

A common goal of censusing projects is to accurately estimate population sizes of shorebirds using different areas during migration. Skagen & Knopf (1994) distinguish between two types of stopping sites for migrating shorebirds, staging and stopover sites. Staging areas generally are traditional sites where migratory birds stop and accumulate fat over extended periods of time. In the western Great Basin, there are probably few true staging areas for shorebirds. These include Mono Lake (California) for Wilson's and Red-necked phalaropes and American Avocets, Stillwater NWR (Nevada) and Carson Lake (Nevada) for American Avocets, Long-billed Dowitchers and Wilson's Phalaropes, and Lake Abert (Oregon) for Wilson's and Red-necked phalaropes and American Avocets. Most interior sites in the Great Plains of the central U.S.A. and the Great Basin are better described as stopover sites because birds normally do not fatten up; rather, they are resting and refueling for short periods of time. In any given year, depending on precipitation, numerous small bodies of water throughout the Great Basin might be available and used by large numbers of shorebirds, but these areas might be dry the next year.

To accurately estimate population sizes of shorebirds using stopover and staging areas requires determining the turnover rate of individuals, *i.e.*, the average staying time for members of a species. For example, if a census were conducted every other day for 10 d, and on each census day 10,000 birds were counted, how many birds used the site during the 10-day period? If the average individual stayed 10 d, then 10,000 individuals used the site; if the average stay was 2 d, the population estimate is 50,000 birds. Turnover times might vary as a function of sex and age (Holmgren *et al.* 1993).

There are several methods that can be used to determine turnover rates, but the best ones are direct, involving the recording of radio-tagged, color banded, or dyed birds. Radio-marking shorebirds potentially is the best way to determine movements of shorebirds (Warnock & Warnock 1993; Warnock *et al.* 1995) and estimate turnover rates (Skagen & Knopf 1994; Iverson *et al.* 1996). Skagen & Knopf (1994) found that Semipalmated Sandpipers had turnover rates of 3.4 to 9.7 d at stopover sites in the Great Plains, whereas White-rumped Sandpipers (*Calidris fuscicollis*) turned over every 7 d on average.

Table 1. Shorebirds of the western Great Basin (excluding very rare species), primary habitat, and the most effective census methods for local spatial scales.

Species	*Status*[1]	*Primary Habitat*	*Census Method*[2]
Breeding:			
Snowy Plover	Br	saline flats with freshwater inflow, beaches, dry mud	sc
	Mi	open ponds/mudflats	sh, sc
Killdeer	Br	islands, shorelines, dikes, roads, sage brush-scrub near water	sh, sc
	Mi	shorelines, mudflats, fresh to saline water, open fields	sh, ae in open fields
Black-necked Stilt *Himantopus mexicanus*	Br	fresh to saline water, vegetated islands, dikes, marshes	sh, sc
	Mi		sh, sc, ae
American Avocet *Recurvirostra americana*	Br	fresh and saline water bodies, islands, shorelines, dikes	sh, sc
	Mi	also mudflats	sh, sc, ae
Willet	Br	upland fields, sedge/grass meadows, and upland fields near water, freshwater bodies	lt, pc, male flight displays
	Mi		sc, sh, ae
Spotted Sandpiper	Br, Mi	fresh water ponds, lakes, rivers	sh, sc
Long-billed Curlew	Br	short grass, sedge/grass meadows usually near water, and adjacent upland fields freshwater bodies, fields	lt, pc, male flight displays
	Mi		ae?, lt, pc, sc, sh
Common Snipe	Br, Mi	low-stature freshwater marsh	count winnowing males, rope drag to flush birds
Wilson's Phalarope	Br	fresh water ponds, marshes in sedge/grass meadows	lt, sc, rope drag
	Mi	freshwater and saline ponds and lakes	sc, boat transects, ae[4]
Migrating:	*Abundance*[3]		
Black-bellied Plover *Pluvialis squatarola*	R	shoreline, mudflats, fields	sh, sc, ae
Semipalmated Plover *Charadrius semipalmatus*	U	shoreline, mudflats	sh, sc
Greater Yellowlegs	C	shoreline, mudflats	sh, sc
Tringa melanoleuca	U-C	shoreline, mudflats, flooded fields	
Lesser Yellowlegs *T. flavipes*	R	shoreline, mudflats, flooded fields	sh, sc
Marbled Godwit *Limosa fedoa*	R	shoreline, mudflats, flooded fields	sh, sc
Sanderling *Calidris alba*	R	shoreline, mudflats, flooded fields	sh, sc
Western Sandpiper	C	shoreline, mudflats, flooded fields	sh, sc, ae[4]
Least Sandpiper	C	shoreline, mudflats, flooded fields	sh, sc, ae[4]
Dunlin	R-U	shoreline, mudflats, flooded fields	sh, sc, ae[4]
Long-billed Dowitcher *Limnodromus scolopaceus*	C	shoreline, mudflats, flooded fields	sh, sc, ae
Red-necked Phalarope *Phalaropus lobatus*	C	fresh to saline water bodies	sh, sc, boat transects, ae[4]

[1]Br=breeding, Mi=migrating
[2]ae=aerial, lt=line transect, pc=point count, sc=site census from ground, sh=shoreline census
[3]abundance: when searching for this species in the appropriate habitat during the correct time of year, C=common=should see on every trip, U=uncommon=should see on most trips, R=rare =see on only a few trips
[4]counted as "small shorebird" or "peep"; ground truthing required

They also found significant yearly differences in turnover rates. With larger shorebirds, such as curlews, tracking by satellite is possible.

Using color-banded birds, Holmgren *et al.* (1993) estimated that fall migrating Dunlin in southeastern Sweden had turnover rates ranging from 2.6 to 9.1 d, depending on the age of the bird and its stage of molt. Dyes can be used to mark and facilitate the following of shorebirds (*e.g.*, Warnock *et al.* 1995). Different colors can be used several days apart, or different areas of a bird's plumage (*e.g.*, left or right breast, *etc.*) can be dyed. Researchers then can look at attrition rates of particular colors or combinations. This method has been used on Wilson's Phalaropes in the western Great Basin, although dyes faded as quickly as a week (Jehl 1988). Therefore, turnover rates must be rapid for this method to work. For all direct methods, however, it is important to determine the effect of handling on turnover rates. If handling a bird increases its likelihood of leaving (or staying), then turnover rates will be overestimated (or underestimated). The best way to control for this is to mark birds at a site, follow the birds to the next site, and determine turnover rates there and at subsequent stopping areas (*e.g.*, Iverson *et al.* 1996).

Indirect methods also have been used to look at turnover rates. Jehl (1988) combined censuses with weight and molt scores to indirectly estimate turnover rates of Wilson's Phalaropes. He calculated that female adults stayed up to 2.5 mo, while juveniles spent as little as a week. Basing turnover on weight gain, however, requires caution because factors other than turnover might prevent observing weight gain over time (Rubega & Inouye 1994).

In the western Great Basin, determination of species-specific turnover rates should be a priority. Without these data accurate estimates of population sizes are not possible.

Monitoring shorebirds in the western Great Basin

Decisions that must be made in designing any monitoring plan include the frequency of censusing, spatial scale for distributing census sites, and number of years. These decisions depend on species being surveyed and the goals of the study. If a manager's goal is to determine the maximum number of birds using a particular site (as might be desired for determining Western Hemisphere Shorebird Reserve Network classification), censuses should be made during the breeding season (if the species breeds there) and during spring and fall migrations. Because water availability can vary dramatically from year to year, these censuses need to be done in several years, including at least one dry and one wet year. It is important that the censuses cover an adequate portion of the target wetland, for example using a stratified sampling scheme (such as sampling near freshwater inlets, as well as away from them) (*e.g.*, Bibby *et al.* 1992), and that survey methods be consistent from year to year. Water availability, finances, and logistic help all vary from year to year. As a consequence, managers must anticipate these problems and develop a survey plan that minimizes inter-year variability in censusing effort and accuracy. For example, if funding fluctuates greatly, it would be a mistake to develop a census scheme that required aerial surveys.

If a manager's goal is to monitor population trends, inter-year sampling methods must be comparable (i.e., controlled for sampling effort, coverage, *etc.*). Because of large inter-year variation in population counts due to varying precipitation, a large number of years ($\geq$ 10 years or more?) are required to detect population trends. In the western Great Basin, the number of years needed to detect trends will vary with precipitation patterns. For example, if there are 10 sequential years with similar precipitation, a trend might be detected; when a trend is not detected, statistical power must be calculated to determine confidence in the conclusion (see below). If the 10 years have wet and dry years, it might be appropriate to look for trends using only dry-year or only wet-year data.

There are many methods available for analyzing trend data. Because this topic was recently reviewed for birds (Sauer & Droege 1990), we limit our comments to some of the more useful methods. The most common methods for analyzing trends involve regression. Linear and non-linear regressions have been applied to bird population data (*e.g.*, Geissler & Noon 1981; Geissler & Sauer 1990; Johnston & Hagan 1992; Reed & Oring 1993), as have nonlinear nonparametric methods (James *et al.* 1990). Regardless of the method used, if no significant trend is detected, statistical power should be reported (*e.g.*, Reed & Oring 1993; Reed & Blaustein 1995). Power estimates the ability to detect a trend if it is present (Cohen 1988), and it is likely that many studies that do not find a trend have insufficient power. This means population declines often are not detected because of an inadequate sample size (*i.e.*, number of years) rather than a lack of decline.

Acknowledgments

We thank C. Elphick for discussions of the topics presented in this manuscript, and D. Shuford for a thorough review of the manuscript. We thank S. Warnock for assistance in making figures and for commenting on the ms. We also thank D. Shuford for pointing out to us that it is possible to distinguish Least and Western sandpipers from aircraft. JMR's work was funded by the Biological Resources Research Center, University of Nevada, Reno, the U.S. Forest Service, and NSF DEB-9322733 (JMR, LWO). NW's work was funded by the Department of Environmental and Resource Sciences, University of Nevada, Reno, the Canadian Wildlife Service, and Simon Fraser University. LWO's work was funded by two U.S.D.A. Hatch grants via the Nevada Agricultural Experiment Station, the Jay Dow, Sr. Wetlands, NSF DEB-9196050 and DEB-9322733 (JMR, LWO) and an NSF EPSCoR subcontract via North Dakota. The Biological Resources Research Center, University of Nevada, Reno provided logistic support and funding. This is Contribution No. 51 of the Nevada Biodiversity Initiative.

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