

Rob,
Average inside + outside
sanctuary for each year
of comparison.
→ or density

Analysis of Stillwater NWR Waterfowl Use Data 1970-Present

Introduction

As a guild, waterfowl have been one of the primary target species for which Stillwater NWR habitat management has been focused. The original refuge establishing authority (Tripartite Agreement 1948), lists provision of a public shooting ground (predominately for waterfowl hunting) as a coequal purpose with livestock grazing and the conservation of fish, wildlife, and their habitats. This 50 year agreement dissolved in November 1998, leaving the refuge with a new set of purposes (Title II of Public Law 101-618) where waterfowl management is now one component listed under management for natural biological diversity and waterfowl hunting is now coequal with five other primary public uses outlined in the National Wildlife Refuge System Improvement Act (1997). To ensure that potential adverse impacts to waterfowl populations and the hunting public through changes in management philosophy are adequately addressed, it is necessary to examine long-term waterfowl population/habitat information.

While the refuge has accumulated considerable habitat information from several different sources, the Nevada Division of Wildlife (NDOW) was consulted to acquire seasonal waterfowl population data. These data were collected using the same observer (Nevada State Waterfowl Biologist Norm Saake) and survey routes over a 22 year period. Funding and time limitations led to some inconsistency in data collection schedules but most months were sampled between 1977-present. The following are the results of a preliminary analysis of this information.

Methods and Materials

Data were organized into spreadsheet format with waterfowl species numbers by month, year, and wetland acreage recorded for years where this information was available. Values in the final spreadsheet were compared with raw data, to check for data entry errors and/or sample periods where complete surveys were not conducted. In some cases, observation limitations allowed for only a subsampling of refuge wetland habitats and these observations were subsequently truncated from the data set. Only complete observations were used in the following analyses, resulting in a data set which roughly covered 1977-1998, inclusive.

The 13 refuge wetland units were pooled into sanctuary and open area blocks, to facilitate analyses comparing species specific, seasonal distribution effects and to decrease variability in the data set. It was assumed that data collection procedures were consistent among sample sessions and that the strength of these procedures allowed for some descriptive analysis of patterns and trends. Descriptive analyses were used to examine seasonal waterfowl population trends and wetland acreage. To examine waterfowl distribution among pooled, open and sanctuary units, waterfowl density was calculated and median, monthly values among years were used. The following section explains statistical procedures incorporated in the analysis.

A set of two-factor (sanctuary [hunted and non-hunted wetlands] and month) analyses of variance (ANOVAs) were used to compare densities of aquatic migratory bird. ANOVA's were run only for those species where >50% of the surveys had values for them. Because heterogeneity of treatment variances could not be reduced by transformations, raw values were replaced with ranks to run ANOVA's (Iman 1982). If month-by-sanctuary interactions were found for these two-ANOVA's, we ran ANOVA's on smaller data sets, so results would not be confounded by them. For example, because the month-by-sanctuary interaction and sanctuary terms were significant from the two-factor ANOVA for green-winged teal, densities between sanctuary and non-sanctuary wetlands were compared separately for each month with one-factor ANOVA's. If no interaction was found, values were calculated as the median of cell (month or sanctuary and non-sanctuary wetlands) medians. Bonferroni simultaneous confidence interval and Tukey's tests were used to separate medians where differences were found for two-factor ANOVA's with and without interactions, respectively. For species with a month-by-sanctuary interaction and months where >50% of surveys had zero values (e.g., canvasbacks in August [Table 1]), Fisher's exact test was used to compare frequencies of surveys with birds recorded (>0) between sanctuary and non-sanctuary wetlands. SAS (SAS Institute Incorporated 1989) was used to run statistical tests and compute test statistics. All statistical tests were run at $\alpha = 0.050$.

Results

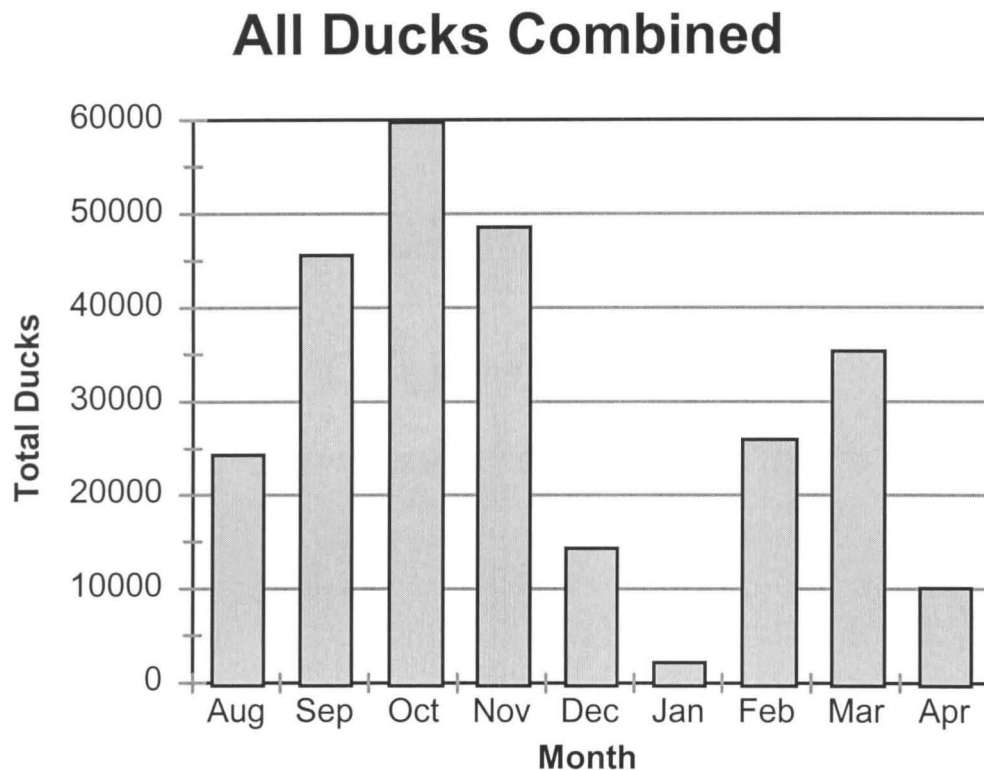
Waterfowl Population Chronology

Duck populations were censused at varying intervals from the onset of fall migration (mid-late August) through spring migration (April). Peak populations have ranged between 210,260 (15 Sept. 1995) and 0 total ducks, which occurred during a mid January freeze in 1988. Average populations by month are variable with the highest total counts occurring through the fall. Figure 1 displays the monthly peak duck population, averaged over the 22 year observation period. The number of counts used to calculate these averages are as follows:

Aug - 17	Jan - 17
Sep - 17	Feb - 9
Oct - 16	Mar - 11
Nov - 21	Apr - 10
Dec - 20	

Monthly median populations range from 2,170 (January) to 59,707 (October), with the highest average counts recorded during the fall. Of 14 counts where peak population exceeded 100,000 total ducks, 13 were recorded between August and December.

Figure 1: Median total duck population by month for Stillwater NWR, 1977 - 1998.



As would be expected, most individual species also experience peak populations during fall including northern shoveler (*Anas clypeata*; 13,472 - October), green-winged teal (*Anas crecca*; 9,627 - October), and all other ducks except ruddy ducks (*Oxyura jamaicensis*) and northern pintail (*Anas acuta*; 8,920 and 6,885, in March, respectively). While ruddy ducks are clearly a spring migrant, northern pintails experience similar population levels in October (6,400). Graphs for each of these species are presented in figure 2.

When examining these numbers, it is important to remember that over the last five years, we have experienced large wetland acreage associated with above normal snowpack in the Sierra Nevada mountain range. These average population statistics incorporate drought periods as well with total wetland acreage ranging from 9,341 (November) to 11,971 (April; figure 3). Duck numbers observed during the past 5 high water years are not indicative of historic waterfowl use (the last thirty years) but, could be a glimpse at population trends to be expected at completion of the water rights acquisition program.

Figure 2: Median monthly population for the most common duck species using Stillwater NWR wetland habitats, 1970-98.

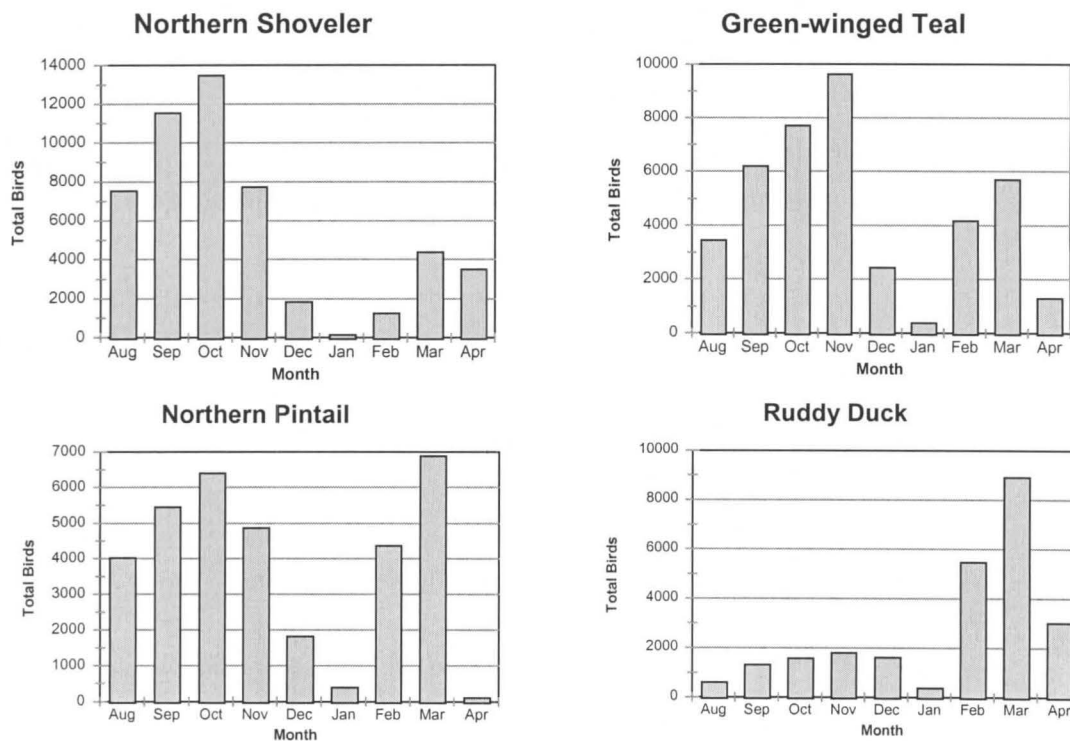
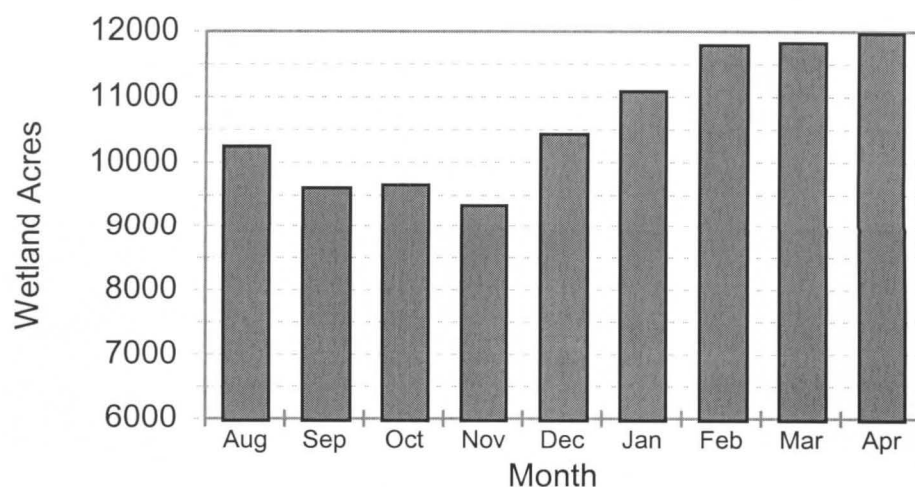


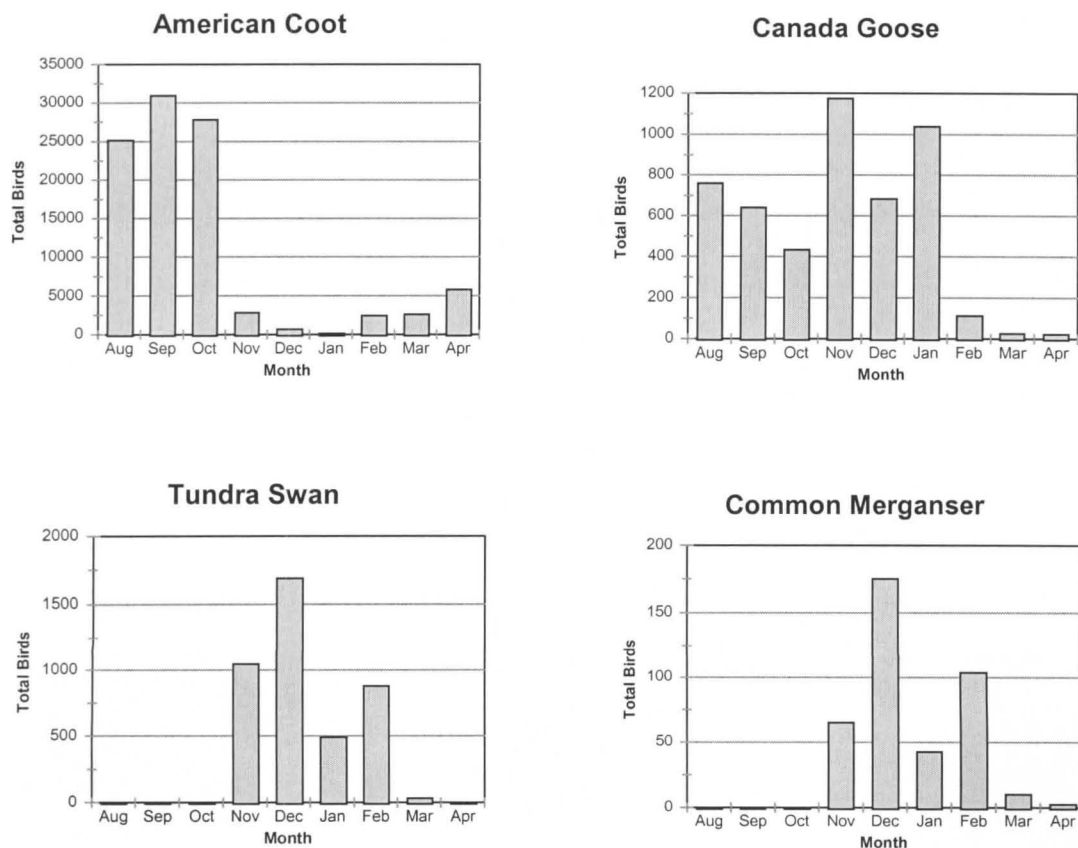
Figure 3: Average monthly wetland acreage at Stillwater NWR recorded from 1977-98.



When averaging the past five years, wetland acreage ranged from 8,727 (November) to 14,048 (April) which includes seasonally flooded habitats in the Big Water Unit and at the Carson river delta in Fallon NWR. Wetland acreage estimates were inconsistently recorded; therefore, only a subset of wetland acreage estimates were used in this analysis covering roughly 14 years within the 22 year period.

While duck species were the primary focus of these surveys, other waterfowl species including geese, mergansers (*Mergus merganser*), coots (*Fulica americana*), and swans (*Cygnus columbianus*) were censused (figure 4). Similar to most other duck species, the coot peak population was recorded during fall (30,910 - September). Canada geese (*Branta canadensis* var. *moffiti* and var. *parvipes*) and tundra swans were primarily winter residents, both experiencing population peaks in November and December (1,175 and 1,038, respectively). Mergansers were similar in winter representation, but appear to stay for longer periods, eventually building to a median peak population of 175 in December. Mergansers were not surveyed outside of September - April.

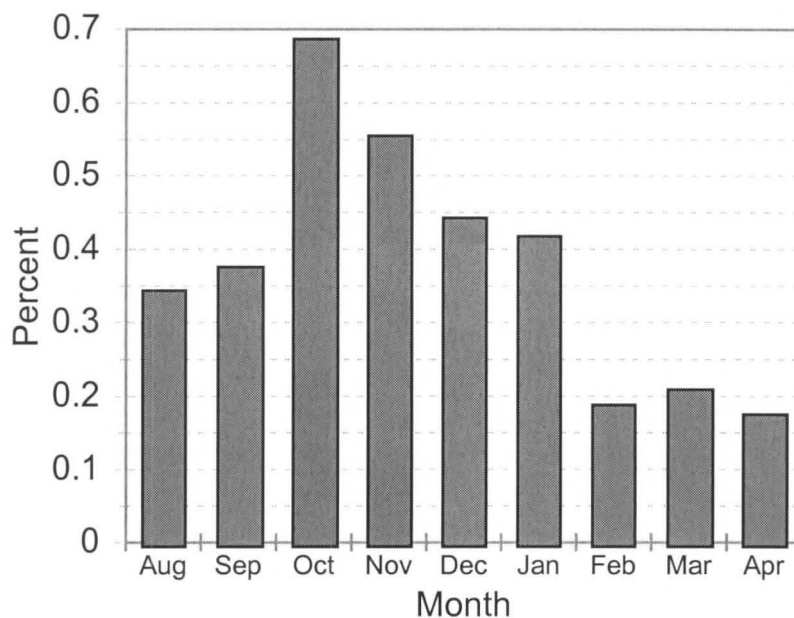
Figure 4: Median population of other waterfowl species censused on Stillwater NWR, 1977-98.



Seasonal Distribution of Duck Species

To provide some initial information on seasonal distribution of waterfowl among sanctuary and open public use wetland units, an analysis of total waterfowl using each area by month was performed (figure 5). Percentages ranged from 0.175 (April) to 0.687 (October) with hunting season apparently having an effect on distribution. Over 61% of the total waterfowl population was surveyed on sanctuary wetland units during hunting season compared to 28% during non-hunted months.

Figure 5: Median monthly percentage of duck species using sanctuary habitats at Stillwater NWR, 1977-98.

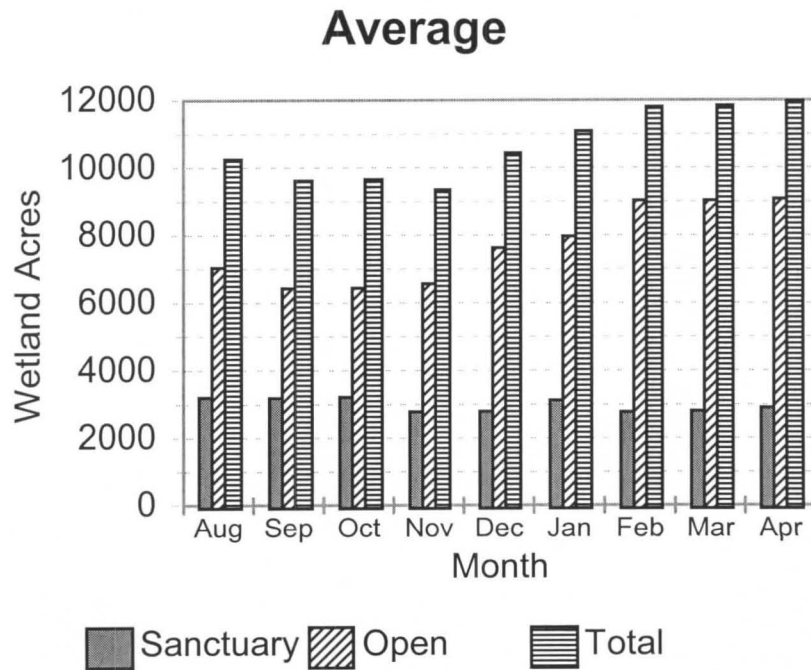
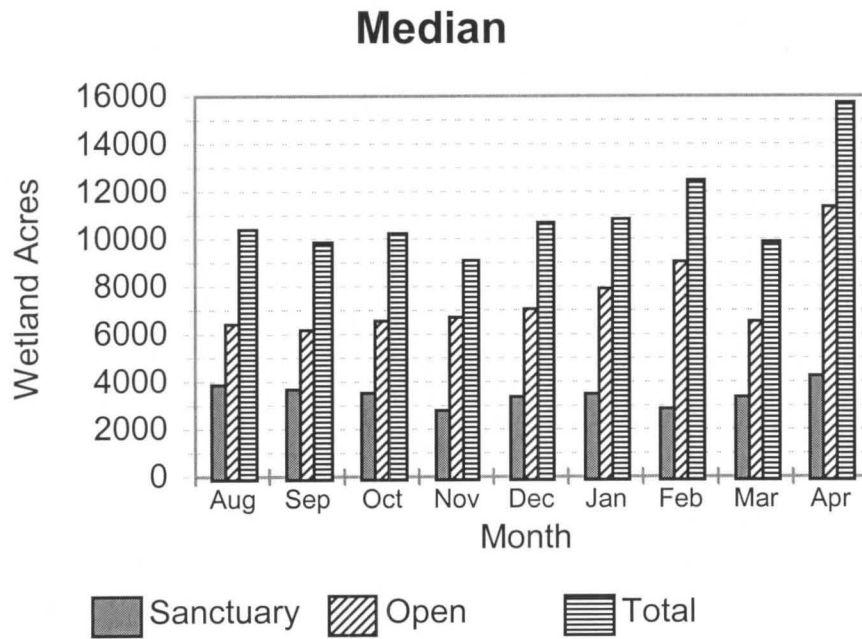


*Density?
account for diff. acreage*

It should be understood that these percentages are associated with total waterfowl numbers and do not consider acreage provided between the compared habitat blocks (open and sanctuary). On average, sanctuary wetlands incorporate roughly 1/3 of total wetland acreage, thus, the 35% frequency in August would represent equal proportions of waterfowl species using sanctuary and open areas (figure 6). Conversely, approximately 69% of waterfowl species frequent sanctuary habitats during October, which becomes more profound when waterfowl density is incorporated in the calculations.

Figure 6 examines the seasonal acreage provided in both sanctuary and open public use units. Average seasonal wetland acreage ranges from 9,341 acres in November to 11,972 acres in April while median values range from 7,793 in March to 15,724 acres in April. Wetland acreage was calculated from a subset of years in which total acreage was estimated, and the set of years recorded vary by month. For example, March estimates were calculated from a set of seven

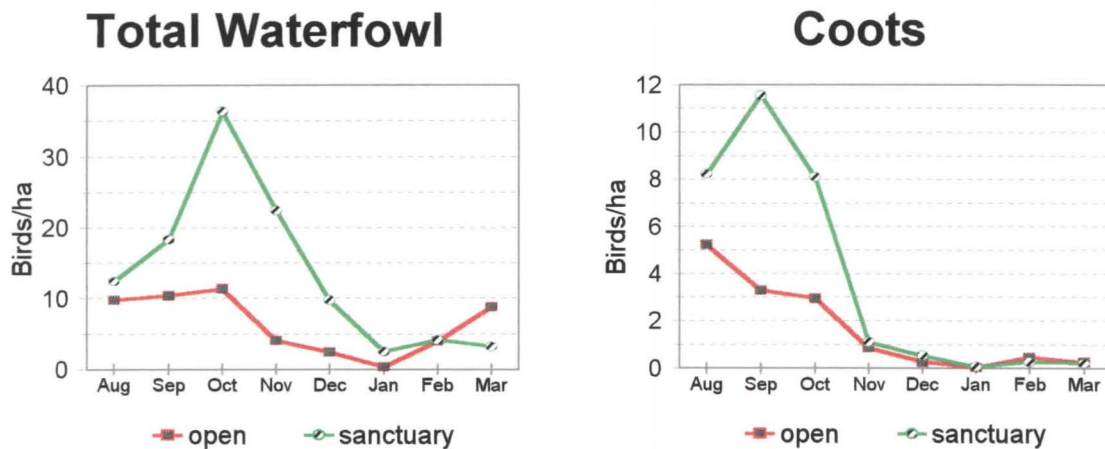
Figure 6: Median and average monthly wetland acreage recorded for Stillwater NWR and pooled, open and sanctuary habitats.



on waterfowl density estimates.

Total waterfowl density varied by month and unit with a low of 0.35 birds/ha (0.86 birds/ac) recorded on open habitats in January, and a high of 36.33 birds/ha (89.77 birds/ac) in sanctuary habitats during October (figure 7). American coots account for roughly 25% of this total with waterfowl species peaking at 20.67 birds/ha (69.76 birds/ac), also in October sanctuary habitats. When total species are examined, all months except March have experienced higher waterfowl densities on sanctuary habitats.

Figure 7: Median, monthly total waterfowl and coot density on open and closed public use habitats at Stillwater NWR, 1977-1998.



Other species displayed mixed seasonal responses with all species exhibiting an increased preference for sanctuary habitats during hunting season (Table 1). Green-winged teal, northern shoveler, northern pintail, and gadwall (*Anas strepera*) appear to utilize sanctuary and open area habitats with equal frequency prior to hunting season (figure 8). However, mallards (*Anas platyrhynchos*), redheads (*Aythya americana*), and Canada geese exhibit higher densities within sanctuary habitats across all seasons (figure 9). For all species, sanctuary density increases during hunting season months, but it would appear that sanctuary habitats are preferred throughout the year by at least the herbivorous waterfowl species (figure 10).

Table 1. Median densities (number/ha) for species of aquatic migratory birds in sanctuary and hunted wetlands at Stillwater National Wildlife Refuge, northwestern, Nevada, August - March, 1977-98.

Species	Sanctuary ^a	August	September	October	November	December	January	February	March	All Months ^b
American Widgeon	N	0.143(1) ^c	0.333(3)	0.745(1)	0.253(2)	0.029(4)	0(6)	0.064(1)	0.053(1)	0.104A ^d
	Y	0.218(0)	0.645(0)	1.892(0)	0.626(0)	0.080(2)	0.028(4)	0.050(1)	0.019(2)	0.149B
	N and Y ^e	0.181abc ^f	0.489bd	1.319d	0.440ad	0.055cd	0.014d	0.057cd	0.036cd	
Cinnamon Teal	N	0.886(0)	0.282(0)	0.028(2)	(8) ^g	(8)	(8)	0.017(2)	0.159(1)	0.022A
	Y	0.369(0)	0.271(0)	0.155(3)	(8)	(7)	(10)	0.007(2)	0.113(0)	0.060A
	N and Y	0.628a	0.277ab	0.092cd	e	ef	e	0.012dfg	0.136bcg	
Green-winged Teal	N	0.416(0)Aab	2.291(0)Aa	1.211(0)Aa	0.678(1)Aab	0.524(1)Aab	0.049(2)Ab	1.429(0)Aab	2.417(0)Aab	
	Y	0.209(1)Aab	0.666(0)Abc	6.489(0)Bd	7.437(0)Bd	1.710(1)Aabd	0.140(3)Aac	0.775(1)Aabd	0.719(0)Aabd	
Gadwall	N	0.499(1)	0.990(2)	0.786(0)	0.137(2)	0.060(2)	(6)	0.058(1)	0.086(0)	0.112A
	Y	0.693(0)	0.810(0)	2.639(0)	0.763(0)	0.159(1)	(7)	0.093(1)	0.066(1)	0.426B
	N and Y	0.596ab	0.900a	1.713a	0.450bc	0.110c	def	0.076ce	0.076cf	
Mallard	N	0.116(1)Aa	0.111(0)Aa	0.150(0)Aa	0.063(1)Aa	0.154(0)Aa	0.034(0)Aa	0.214(0)Aa	0.066(0)Aa	
	Y	0.357(0)Aab	0.549(1)Aab	1.931(0)Bc	1.678(0)Bac	1.414(0)Bac	0.349(0)Bbd	0.449(0)Aabc	0.097(0)Ab	
Northern Pintail	N	0.767(0)	0.931(1)	1.409(0)	0.675(1)	0.563(0)	0.081(1)	0.493(0)	1.357(0)	0.721A
	Y	0.487(0)	0.728(0)	3.519(0)	1.958(0)	1.567(1)	0.213(2)	1.334(0)	0.755(0)	1.045B
	N and Y	0.627ab	0.830bc	2.464bc	1.317bc	1.065ab	0.147a	0.914bc	1.056bc	
Northern Shoveler	N	1.402(0)	1.876(0)	3.830(0)	1.216(2)	0.382(1)	0.007(4)	0.303(1)	3.035(0)	1.309A
	Y	1.011(0)	1.877(0)	6.632(0)	2.753(0)	0.457(0)	0.119(2)	0.037(1)	0.259(0)	0.734A
	N and Y	1.207abc	1.877ad	5.231d	1.985ad	0.420be	0.063fg	0.170egh	1.647abch	
Canvasback	N	(7)*a ^h	(8)*a	0.042(3)Aab	0.079(3)Aab	0.019(3)Aab	(6)*ab	0.266(1)Ab	0.053(0)Aab	
	Y	0.006(5)*a	0.072(3)*ac	3.345(0)Bbd	4.068(0)Bb	1.630(0)Bb	0.037(2)*ac	0.386(1)Aab	0.486(0)Bbce	

Species	Sanctuary ^a	August	September	October	November	December	January	February	March	All Months ^b
Redhead	N	0.247(0)Aab	0.188(3)Aabc	0.103(3)Abc de	0.009(4)Abcd	0.009(4)Acf	(6)*df	0.072(1)Abcd	0.115(1)Abcd	
	Y	0.494(0)Bab	0.783(0)Ba	0.827(0)Ba	0.117(1)Abc	0.031(2)Acd	(7)*d	0.031(1)Acd	0.032(1)Acd	
American coot	N	5.227(1)	3.281(1)	2.954(0)	0.853(2)	0.268(1)	0.045(3)	0.460(1)	0.260(1)	0.657A
	Y	8.223(0)	11.548(0)	8.093(0)	1.103(0)	0.536(1)	0.070(2)	0.276(2)	0.226(1)	0.820B
	N and Y	6.725a	7.415a	5.524a	0.978bc	0.402b	0.058d	0.368bcd	0.243bcd	
Ruddy duck	N	0.032(1)	0.063(2)	0.061(0)	0.079(1)	0.110(2)	0.025(4)	0.393(1)	1.144(0)	0.071A
	Y	0.039(1)	0.096(0)	0.529(0)	0.249(1)	0.387(0)	0.043(2)	0.485(0)	0.437(0)	0.318B
	N and Y	0.035abc	0.080acdef	0.295dg	0.164abdg	0.249cg	0.034be	0.439fg	0.791g	
Canada Goose	N	0.041(2)Aa	0.017(4)Aab	(6)*bc	(8)*b	0.019(2)Aac	(6)*bc	0.012(1)Aab	0.003(0)Aab	
	Y	0.292(0)Bab cd	0.302(2)Bbc	0.277(0)**b cf	1.057(0)**c	0.815(0)Bc	1.059(0)**bc	0.043(1)Adefg	0.002(2)Ag	
Tundra Swan	N	(11)*a	(13)*a	(9)*ab	0.010(4)Abc	0.295(1)Ade	0.016(3)Abcd	0.170(1)Ace	0.004(2)Aace	
	Y	(11)*a	(13)*a	(9)*ab	0.602(0)Bc	0.905(0)Bc	0.439(0)Bcd	0.167(1)Acd	0.020(1)Ad	

^aWetlands that were hunted and not hunted (sanctuary) were classified as N and Y, respectively.

^bBecause no month-by-sanctuary interaction ($P \geq 0.0783$) was found for a species, months were combined to compare densities between sanctuary and non-sanctuary wetlands. Values were calculated as the median of cell (months) medians.

^cNumber of surveys with zero recorded for a species is in parentheses.

^dMedians with the same upper-case letter did not differ ($P \geq 0.05$) between sanctuary and non-sanctuary wetlands for a species.

^eBecause no month-by-sanctuary interaction ($P \geq 0.0783$) was found for a species, sanctuary and non-sanctuary wetlands were combined to compare densities among months. Values were calculated as the median of cell (sanctuary and non-sanctuary) medians.

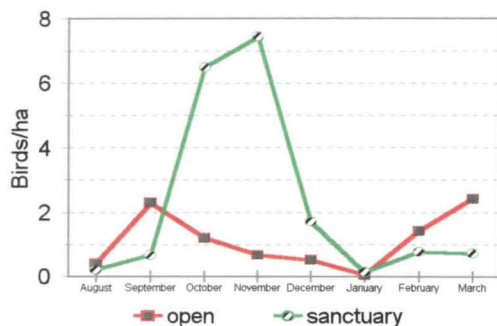
^fMedians with the same lower-case letter did not differ ($P \geq 0.05$) among months for a species.

^gNo median was calculated if >50% of surveys had zero recorded for a species.

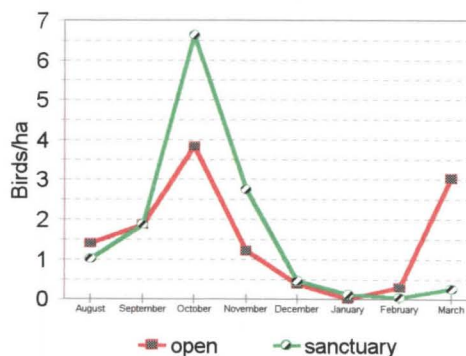
^hThe frequency of surveys with birds recorded for a species with the same number of asterisks did not differ ($P \geq 0.05$) between sanctuary and non-sanctuary wetlands.

Figure 8: Density (birds/ha) estimates for species showing no apparent preference for sanctuary or open area habitats prior to hunting season at Stillwater NWR, 1977-1998.

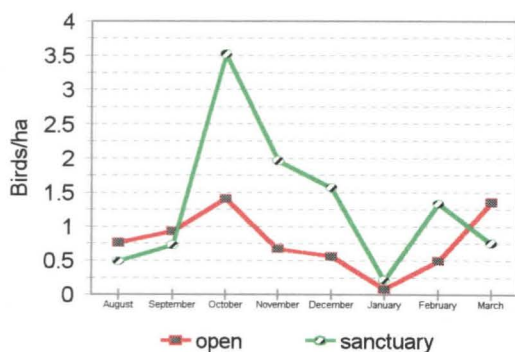
Green-winged Teal



Northern Shoveler



Northern Pintail



Gadwall

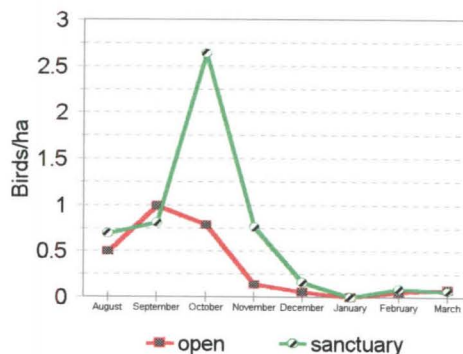


Figure 9: Density (birds/ha) estimates for species showing an apparent preference for sanctuary habitats prior to hunting season at Stillwater NWR, 1977-1998.

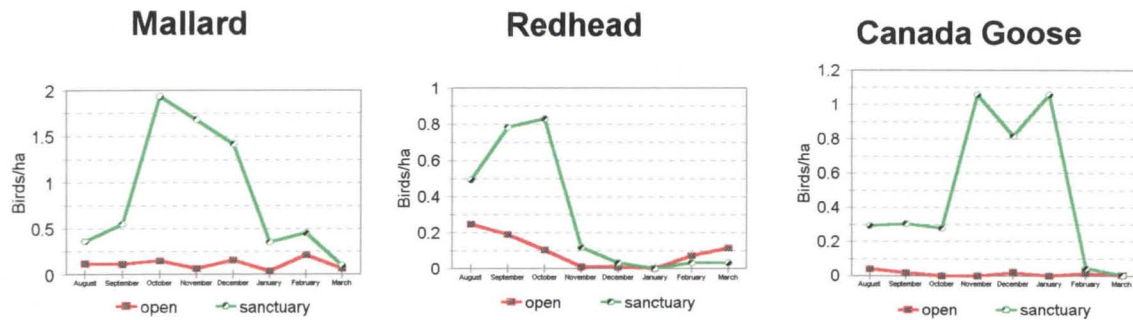
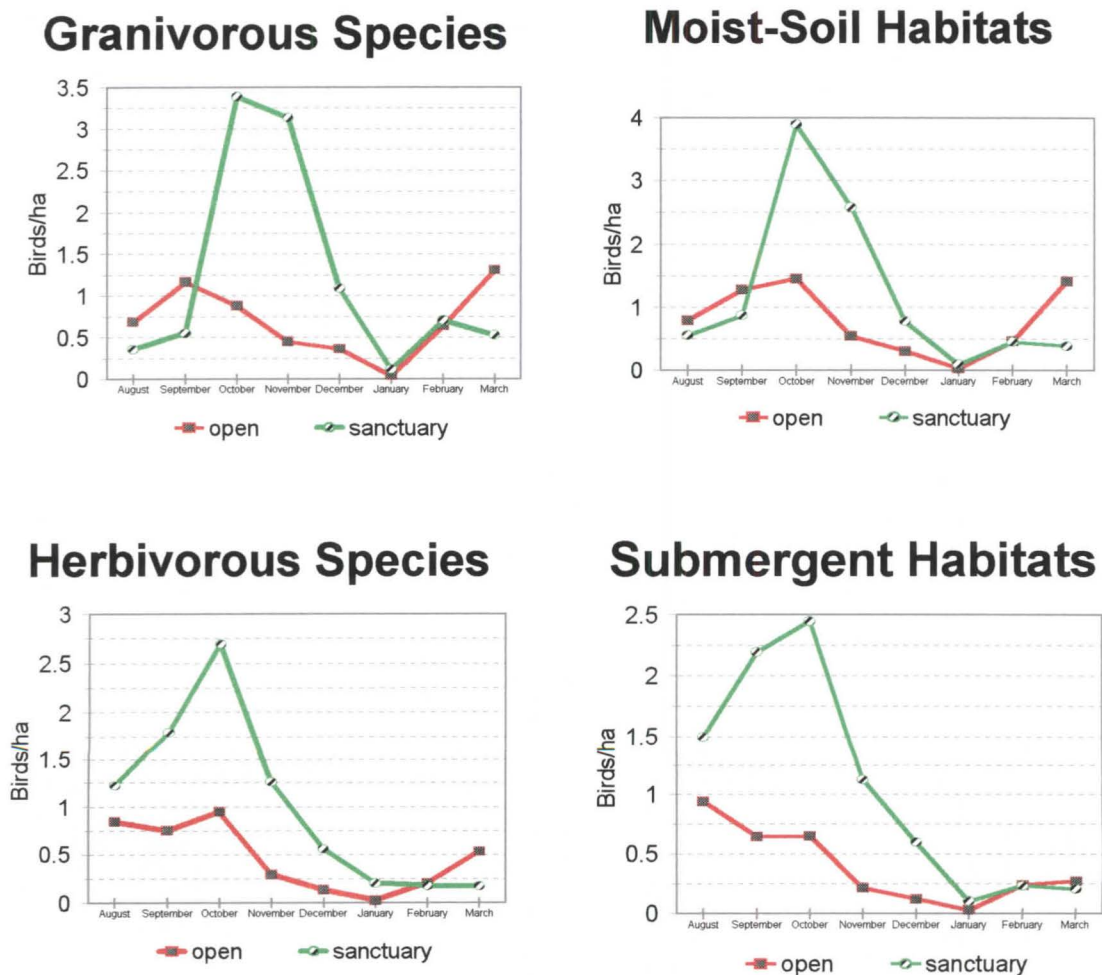


Figure 10: Density of waterfowl using sanctuary and open public use units, by foraging guild and habitat type preference, at Stillwater NWR, 1977-1998.



Carson Lake and Stillwater Marsh

Lahontan valley is comprised of three primary wetland areas including Stillwater NWR, Carson Lake, and the Fallon Paiute-Shoshone tribal wetlands, along with scattered irrigation reservoirs, canals, drains, and hydrated playas. Of these areas, Stillwater NWR and Carson Lake are likely the most important relative to waterfowl. These two areas differ somewhat in management style; however, the combined efforts lend to provision of a Lahontan Valley wetland habitat complex which provides for the seasonal requirements of a variety of waterbirds.

Totals for each area and the Lahontan Valley tend to mirror previous trends, with peak duck counts occurring in October, and then dropping through the remainder of the winter (Fig. 11). The average peak Lahontan Valley total is 114,380 (October) with Stillwater NWR holding approximately 75% (85,179) of this total. Carson Lake does, however, maintain similar to slightly higher spring populations which results in higher duck densities when considering that Stillwater typically has approximately _____ more acres on an annual basis. Species composition is somewhat different between the two areas, with Carson Lake populated by proportionally more dabbling ducks and Stillwater Marsh receiving the higher proportion of diving duck use. These trends are further displayed by observing waterfowl foraging guild preferences during the fall months (September - October; Fig. 12).

Figure 11: Lahontan Valley, Stillwater NWR, and Carson Lake average duck counts for the period from August to March, annually.

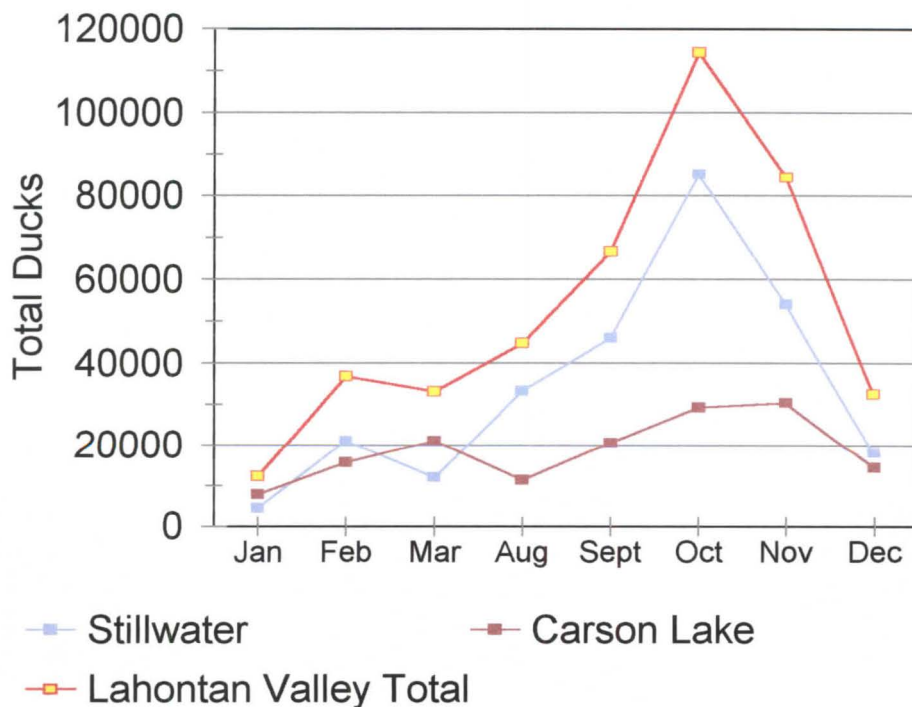
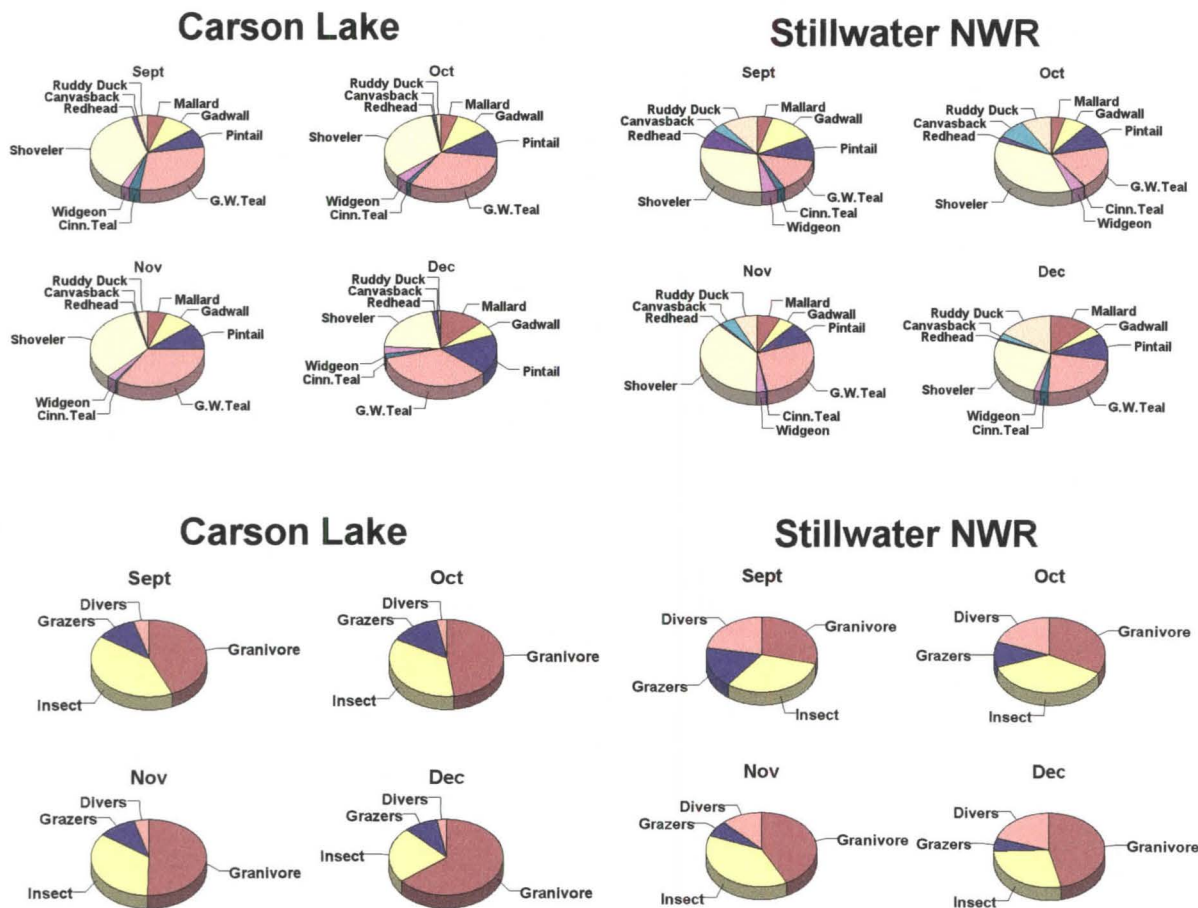


Figure 12: A comparison of species specific and foraging guild composition between Carson Lake and Stillwater NWR during fall months (September - December, 1970-98).



Dabbling ducks comprise from 95-98% of the Carson Lake total while diving ducks range from 12-22% of the Stillwater total. Primary species at each site are similar with northern shoveler, green-winged teal, and northern pintail dominant in fall counts; however a more equal percentage of the various dabbling duck species appears to occur at Stillwater NWR. When species composition is considered relative to seasonal requirements and forage/habitat type preferences, this difference becomes even more apparent.

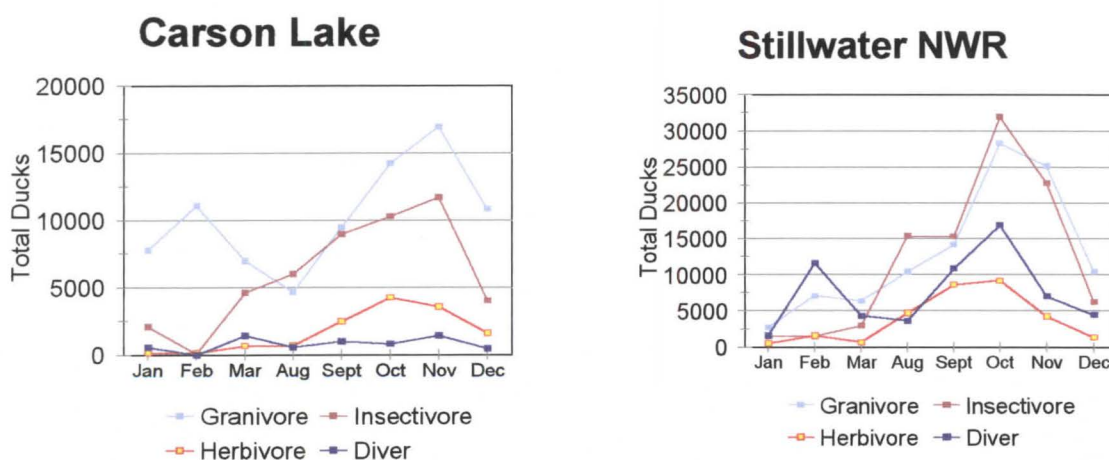
To examine forage preferences, species were placed into four specific foraging guilds based on feeding ecology research for the species present in the Lahontan Valley. While this research is not directly related to Lahontan Valley wetlands, and many of the species considered are opportunistic and can easily adapt to a variety of habitats, four guilds were subjectively selected to represent the preferred habitat and forage items for the species during migration periods (Bellrose 1982). Guilds include granivores (mallard, northern pintail, green-winged teal), insectivores (northern shoveler, cinnamon teal), herbivores (American widgeon, gadwall), and

diving ducks (redhead, canvasback, and ruddy ducks). Cinnamon teal appear to be more granivorous throughout their life history cycle; however, it is believed that aquatic invertebrates comprise a large percentage of their diet during the August - September peak use period in Lahontan Valley and they are often observed foraging in similar habitats as northern shoveler during early fall. Piscivorous species such as the common merganser (*Mergus merganser*) display a strong preference for Stillwater NWR habitats; however, peak counts only average near 1,000 total birds (December and January) and are, therefore, not considered in this analysis.

Granivorous species range from 43-64% of the Carson Lake total (compared to 29-47% of the Stillwater NWR total) with insectivores (24-41%), herbivores (9-14%), and divers (3-4%), rounding out the Carson Lake duck population during fall. Conversely, a more even distribution among foraging guilds is apparent for Stillwater NWR with granivores (29-47%), insectivores 28-38%), divers (12-22%), and grazers (6-18%) nearly equal during September. Grazers tend to drop off from October to December at Stillwater NWR, possibly shifting to Carson Lake habitats where grazers are well represented throughout fall months.

Fewer data are available for a spring analysis; however, Carson Lake population totals appear to be similar to slightly higher than Stillwater NWR. Carson Lake is strongly dominated by dabbling ducks (nearly 99%) during February with March numbers displaying a more proportional mix among foraging guilds (Fig. 13). As will be considered in the discussion section, these differences are strongly related to differences in management focus during spring, with pasture irrigation likely related to the proportionally high use by dabbling ducks..

Figure 13: Monthly average duck populations by foraging guild, for Carson lake and Stillwater NWR, August through March, 1970-1998.



Discussion

Waterfowl Population Chronology

Waterfowl use at Stillwater NWR becomes quite complicated when you consider that individual species vary in timing of use and preference for refuge habitats. For example, mallards and Canada geese can be observed on the refuge during any month of the year, only absent when the wetlands completely freeze. Other species such as green-winged teal and American widgeon can be observed in the wetlands in all but summer months, while cinnamon teal, arrive in late spring, breed at the refuge, and then have migrated south by early October. Even with these species-specific chronological differences, the results of this analysis indicate that the largest waterfowl populations are present on Stillwater NWR between August and October.

Reasons for waterfowl population declines following October are unclear, but are likely related to a combination of natural migratory response, increasing public use pressure, depleted food reserves, and availability of other habitats in or adjacent to Stillwater NWR. With cinnamon teal, migration typically occurs before the onset of hunting season, thus increased public pressure beginning in early October and/or depleted food supplies would not appear to have much of an effect. During premigration periods (mid-August - late September), cinnamon teal appear to prefer submergent habitats where they consume sago pondweed leaves and seeds along with annual grass seeds (Bellrose 1980:291).

Species such as mallards are actively foraging on a combination of foods while redheads, American coots, American widgeon, gadwalls, and other species are selectively foraging in submergent vegetation. It has been hypothesized that increased foraging efforts in submergent habitats during the August-October peak use period, lead to depleted seed reserves (Bill Henry, pers. comm.). This would provide one viable reason for decreasing waterfowl numbers following October.

Additionally, other Lahontan Valley areas such as Carson Lake, focus on fall habitat provision (Norm Saake, pers. comm.). The data indicate as Stillwater populations are declining, there is an increase in the Carson Lake waterfowl population, which continues until the wetlands freeze over, often occurring around mid-December. Considering that many waterfowl species, particularly large-bodied species, tend to migrate only as far south as weather conditions dictate (Simpson, 1985:537, Ringelman et al. 1989:325), population declines through October cannot easily be attributed to weather conditions.