EXTREME WATER LEVEL FLUCTUATIONS LIMIT BREEDING OF WESTERN AND CLARK'S GREBES AT SAN CARLOS LAKE, ARIZONA

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ABSTRACT: The first known nesting of Western and Clark's Grebes (*Aechmophorus occidentalis* and *A. clarkii*) at San Carlos Lake in central Arizona was confirmed in 2005 and reported in 2 subsequent years. From many personal observations, analyzing eBird data, and reviewing water level records, I have determined that the acute fluctuations in water level restrict available habitat for nesting most years at the lake. Sharp drops in water level also may reduce the number of grebes. I also detected differences in the feeding behavior of the two grebe species at this location.

Wintering and resident Western and Clark's Grebes (Figures 1 and 2) are regularly found on Arizona's larger lakes and reservoirs and have expanded their ranges in the state over the past 6 decades (Gervais-Wise 2005). Phillips et al. (1964) initially reported Western Grebes along the lower Colorado River, mainly wintering flocks with low numbers in summer. A few wintering grebes were also noted at ponds and lakes in other parts of the state. After wetland vegetation became established at the north end of Lake Havasu, the first Western Grebe nests were found there in 1966 (Rosenberg et al. 1991). They continued nesting at that location, and by the 1980s had extended their breeding to Topock Marsh, also along the lower Colorado River, and irregularly at Painted Rock Reservoir in Maricopa County (Monson and Phillips 1981; Rosenberg et al. 1991). In the 1980s, nesting was also reported at several lakes on Navajo tribal lands in Apache County (Wise-Gervais 2005). During the Arizona Breeding Bird Atlas surveys 1993-2001, more breeding territories were discovered for both Clark's and Western Grebes (following the split of Western into 2 species in 1985 [AOU 1985]). They were along or near the lower Colorado River counties and at Mormon Lake in Coconino County (Gervais-Wise 2005). *Aechmophorus* grebes, however, weren't reported breeding at 2 of the largest reservoirs in the state—San Carlos and Roosevelt lakes. Atlas surveyors visited both lakes and reported both species there with no evidence of nesting (T. Corman pers. comm.). Nesting grebes may have been missed due to the difficulty of surveying these lakes and/or timing of visits. By 2008, however, nesting by Western and Clark's Grebes was confirmed at both San Carlos and Roosevelt lakes (Jenness unpubl. data, Corman 2008), as well as Lyman Lake in Apache County (S. Healy pers. comm.)

Figure 1. Western Grebes, San Carlos Lake 15 January 2018. Photo by Doug Jenness

Figure 2. Clark's Grebe, Roosevelt Lake 15 January 2018. Photo by Troy Corman

SAN CARLOS LAKE

Like most large bodies of water in the state, San Carlos Lake is human made. Created in 1930 with the completion of the Coolidge Dam on the Gila River, the reservoir drains an area 33,375 km^2 (USGS 2019). It stretches 37 km when full, with a maximum width of 3.3 km and a capacity of 1.1 billion m^3. The U. S. Geological Survey data for water volume is measured in acre-feet. This can best be pictured by imagining a football field covered with one foot of water. One acre-foot is equal to 1,233.5 m^3. The deepest part of the reservoir is 25 m near the dam, and the mean elevation is 750 m. Surrounded by the Sonoran Desert, it borders 3 counties: Gila, Graham, and Pinal (Figure 3).

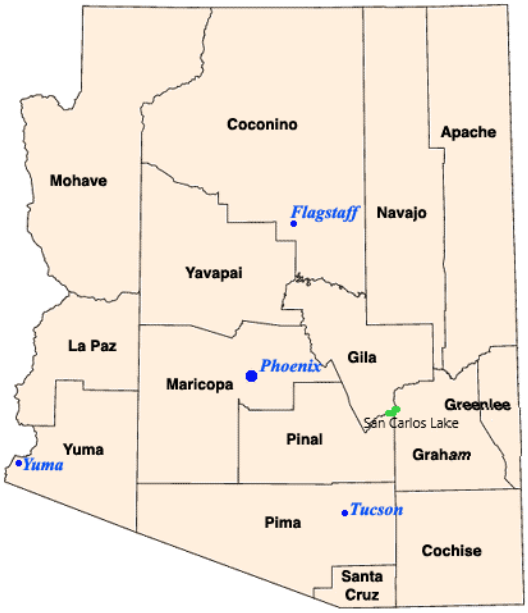

Figure 3. San Carlos Lake is located between Gila, Pinal, and Graham counties.

San Carlos's water level fluctuates, but even more drastically than most Arizona lakes. Although the lake is entirely on the San Carlos Apache tribal lands, the dam is owned and operated by the federal government, and most of the water is reserved for farmers from Coolidge and Florence to Sacaton and Casa Grande. In years when precipitation is low, agricultural consumption severely reduces the water supply, killing most of the lake's fish. Since the dam's completion 90 years ago, the lake has been nearly empty at least 21 times, including as recently as 2018, and has filled and spilled over the dam 7 times, all between 1979 and 1993 (USGS 2019). The severe flood of February-March 1980 filled the lake to its highest level—1.2-billion m^3. Dam overflows have occurred only during exceptional weather events such as Tropical Storm Octave in 1983 (NWS 1993) and an unusually high number of winter storm fronts in 1993 (MacNish et al. 1993, House and Hirschboeck 1997). The highest levels are in the 350-million to 500-million m^3 range, reached following ample summer monsoon rains and above-average snowmelt from the western New Mexico mountains into the Gila River and its tributary the San Francisco River. The annual mean level from 1987-2019 was 75-million m^3 (+/- 7% of capacity) with the highest monthly mean of 123-million m^3 in March (+/- 10% of capacity). The lake is so large that even at 1-2% of capacity it is not near empty and has more water than most lakes in the state and can accommodate thousands of migrant and wintering waterbirds.

Figure 4. Dead fish below Coolidge Dam 6 November 2019. Photo by Doug Jenness

San Carlos Lake and the adjacent desert and riparian habitat attract a wide variety of birds (231 reported species), including tens of thousands of wintering and migrant waterfowl, as well as many gulls, pelicans, cormorants, and other waterbirds (Jenness 2018a, eBird 2019). *Aechmophorus* grebes are present every month of the year, typically numbering in the hundreds and sometimes reaching 1,500-2,000 in the winter months (eBird 2019). However, when water levels are low and most fish die, grebe numbers decline. Although San Carlos Lake was historically popular with fishermen for largemouth bass (*Micropterus salmoides*), flathead catfish (*Pylodictis olivaris*), channel catfish (*Ictalurus punctatus*), black crappie (*Pomoxis nigromaculatus*), and bluegill (*Lepomis macrochirus*), it is no longer stocked unlike many other large lakes in the state. Some fish arrive naturally from the San Carlos and Gila river watersheds, which include lakes and streams with both native and introduced species. When the water level remains relatively high continuously for a couple of years, the fish may grow large. Steep declines in water level result in major fish kills, and it takes time for fish to grow large enough for recreational fishing to resume (Figure 4). However, *Aechmophorus* grebes eat small fish, which return soon after water levels start rising, and they can find food relatively quickly after a major drawdown.

No documented figures of the grebe population at San Carlos Lake before 2000 are available, mostly due to limited coverage by birders and ornithologists until the early 2000s. Since 2003, however, more than 150 visits have been made to the lake, including 2 surveys conducted by the Arizona Field Ornithologists (Jenness 2013 and 2018c). That averages about 9 visits annually, with more in recent years. The months most visited are February (n=21), April (n=18), and November (n=20). *Aechmophorus* grebes were reported on every trip (eBird 2019, Jenness unpubl. data), however, accurately counting the number is challenging. Most observers see only part of the lake's surface and miss many grebes. Those reporting large flocks are typically too far away to identify the birds to species and either indicate the number of "Clark's/Western Grebes" with an "X" on their eBird checklists or roughly estimate the number.

The reported estimates at San Carlos are likely conservative as they are made by observers inexperienced in counting large flocks. Unlike many lakes in the state where the Arizona Game and Fish Department or the US Fish and Wildlife Service conducts annual winter waterbird surveys by boat with trained observers (Corman and Juarez 2017), no such counts occur at San Carlos Lake. Even so, we have learned that both *Aechmophorus* grebe species have a permanent presence at the lake with the greatest numbers reported October-April. The numbers in these months often surpass 1,000 and may reach 2,000 some years. Up to 600 can be expected in summer months (eBird 2019).

Water level influences grebe numbers at the lake. For example, a particularly acute drop occurred in the summer of 2018. Before monsoon rains began in late summer, the water was at one of its lowest levels in 2 decades (Figure 5). Only two shallow ponds connected by a small rivulet remained. The lake was at less than 0.0006 % capacity, or less than 600,000 m^3, between 29 June and 20 July (USGS 2019). Jenness and Kamper (2018) observed only 7 *Aechmophorus* grebes on 16 July the lowest recorded number. The entire diminished-surface area of the lake could be observed from one location, so this was an accurate count. Typically, 300-500 grebes are reported in July (eBird 2019). Interestingly, Pearson and Wilder (2018) reported more than 2,000 earlier the same year in February with many engaged in courtship behavior. By June this number had dropped to an estimated 270 at the lake (Jenness 2018b). Following the July low of 7, I counted130 *Aechmophorus* grebes on 26 September (Jenness et al. 2018) and numbers gradually increased through the fall and winter as precipitation runoff continued to refill the lake.

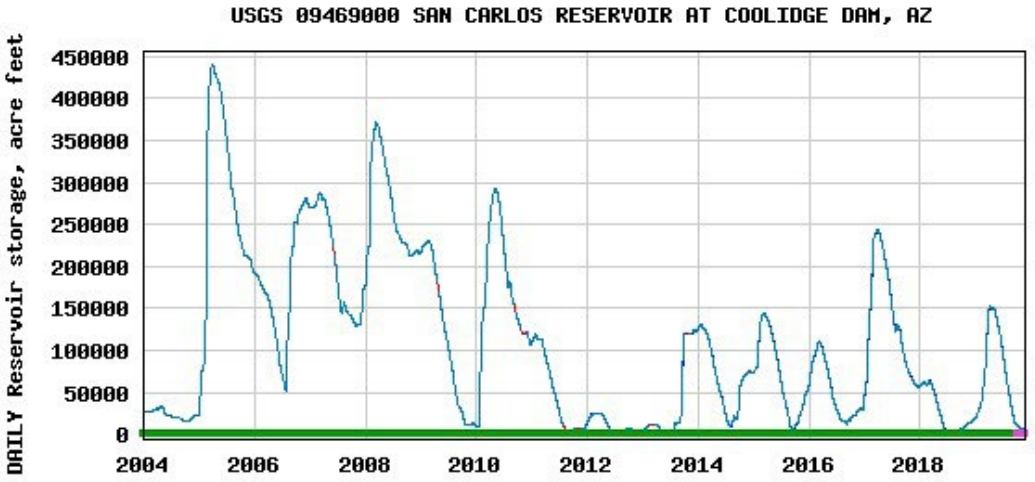

Figure 5. Water levels at San Carlos Lake 2004-2019 fluctuated greatly. 400,000 acre-feet (495-million m^3) is 45% capacity. Source USGS 2019

Following the near emptying of the lake in early 2018, heavy summer and winter rains increased water level to higher than normal into May 2019 and grebe numbers continued to grow. However, due to low rainfall during the 2019 monsoon season and substantial outflow for irrigation demands, the water level declined steadily through November. I conducted 3 surveys of the grebe population in June, July, and November 2019, stopping at a series of lookouts that collectively offered an overview of nearly all the lake. In June grebe numbers had reached nearly 600 and remained at about 500 in July through November (eBird 2019). Normally, grebe numbers would increase into the late fall and winter as the lake level rose, but in 2019 they remained consistently lower than normal for late fall.

NESTING

One feature of the fill-it-up/draw-it-down cycle is that parts of the lake sometimes have extensive mudflats, especially at the eastern end where the Gila and San Carlos rivers flow into the lake from the east and north, respectively. Steadily altering water levels from spring through fall, typically curtails cattails (*Typha* spp.) and bulrushes (*Scirpus* spp.) from becoming established, but tamarisk (*Tamarisk* spp.) shrubs do emerge in these areas. When flooded by rising water levels, they die and provide fertile habitat for small fish, which supply food for grebes. When partially flooded, established tamarisk stands offer suitable nesting structures for the grebes and are the primary nesting sites for these grebes at San Carlos, Roosevelt, and other reservoirs with greatly fluctuating water levels through the year. Elsewhere, the lakeshore is steep and rocky, especially at the western half of the lake, and aquatic vegetation suitable for nesting is not established. *Aechmophorus* grebes utilize a wide variety of emergent vegetation for nesting, nearly always in water > 25 cm (Nuechterlein 1975). In Arizona, cattails and bulrushes are commonly used, but flooded tamarisk clumps are used when the former are unavailable (Wise-Gervais 2005).

Despite the significant increase in visits to the lake, and observers reporting courtship displays each season, evidence of grebes' nesting has been reported in only 3 years—2005, 2015, and 2017 (eBird 2019, Jenness unpubl. data).

2005

The first confirmed nesting at the lake was 3 July 2005. On that date I observed 4 family groups of *Aechmophorus* grebes with young. Two groups were Western Grebes and 2 were Clark's Grebes. The first Western group included one adult with a nearly full-grown young bird, begging for food. The juvenile was slightly smaller than the adult. The second family included 3 juveniles with one adult. The juveniles were roughly one-half to two-thirds the size of the adult. One of the Clark's Grebe families included 2 immature birds with one adult. The juveniles were two-thirds the size of the adult. The second family included 2 adults and 3 juveniles. The downy young were no more than one-third grown and were still all white. A conservative estimate placed 400+ Western and 100+ Clark's Grebes on the lake that day (Jenness unpubl. data).

Later that summer, on 28 August 2005, I observed 2 families of Western Grebes at the east end of the lake. The first group comprised one adult with 2 nearly full-grown young. The juveniles were somewhat smaller than the adult. The other group contained an adult with 2 downy young, about one-fourth the size of the adult. I saw an estimated 500 Western and 100 Clark's Grebes on the lake that day (Jenness unpubl. data).

Judging from the size of the juveniles at the 2 dates, the nearly full-grown young on 3 July likely hatched in April from eggs laid in March. The 2 downy young on 28 August likely hatched in late July or early August from eggs laid in June. Typically for both species, eggs hatch after 24 days of incubation and young are full-size and independent 6-7 weeks after hatching (Storer and Nuechterlein 1992, LaPorte et al. 2013). They don't fly until about 10 weeks (Bent 1965).

2015

Juvenile grebes weren't reported again until 2015 despite many visits to the lake. On 9 May Dunn (2015a) photographed a pair of Clark's Grebes with 2 downy young. Farther to the east, on the opposite side of the lake, he reported an adult Clark's Grebe with 2 young (Dunn 2015b; Figure 6). Another observer reported juvenile Clark's and Western Grebes on 17 May (McCabe 2015), although no numbers were specified. On 22 May, I observed 12 downy Western Grebes (Jenness 2015a). An estimated 450 *Aechmophorus* grebes were present on that date. On 3 July, Dunn (2015c) reported at least 20 *Aechmophorus* grebes on

Figure 6. Clark's Grebe with downy young, San Carlos Lake 9 May 2015. Photo by Ed Dunn

nests near the mouth of the San Carlos River, one of them confirmed as Western. He reported an unspecified number of juveniles in the vicinity. Two weeks later, on 13 July, I found an estimated 100 nests near the same location. The nests were in shallow water among flooded dead tamarisk clumps. Most were Western, but at least 10 of the nests positively identified as Clark's, although there were likely more. I did not observe young, but adults were sitting on some nests, and I witnessed active nest-building or nest repair with grebes carrying sticks to nests anchored to tamarisk. The nests were 3-6 m apart and the water depth was about 0.3 m (Jenness 2015b, Jenness unpubl. data). I observed several adult Western Grebes with young on the opposite side of the lake earlier in the day. The first young reported that year must have hatched near the end of April from eggs laid in March. Nesting was still occurring in mid-July, but by then the water level was falling rapidly, and unfortunately, no follow-up trips were made to determine whether the July nesting was successful.

2017

In 2017, observers saw young grebes on 3 dates. Kamper (2017) reported an unspecified number of downy Western Grebes on 13 May. A month later, I found 7 downy Western Grebes (Jenness 2017). On 7 July, Kamper and Jenness (2017) reported 2 groups—a single adult Western Grebe with 2 downy young on its back and an adult Clark's Grebe catching fish and feeding them to a half-grown juvenile. The young seen in May likely hatched in April from eggs laid in March. The July young probably hatched in June from eggs laid in May.

Most of the young grebes observed in the 3 years of confirmed nesting, including those still back-brooding, were in inlets or open water 3-4 km from the east end of the lake where the 2015 nesting colony was found and where nesting in other years likely occurred. This movement of adults with dependent flightless young from nesting colonies to habitat with more available food is consistent with observations in other areas (Rosenberg et al. 1991, Storer and Nuechterlein 1992, LaPorte et al. 2013). *Aechmophorus* grebes can lay up to 4 eggs (Storer and Nuechterlein 1992) but we only observed 2 young per pair with one exception of 3.

Comparing water levels during nesting years with those in proximate years when nesting was not detected reveals an interesting pattern (Figure 5):

- In 2005, when downy young were first observed, the water level was well above normal between 1 March and 1 October, remaining stable at around 493-million m^3 March-June. However, the year before, the level was never high enough to flood potential nest-building vegetation. The water level needed for suitable vegetation to emerge for nesting is 123-million m^3. Levels only ranged between 19.5-million m^3 and 41.9-million m^3 the entire year and we observed no young. In 2006, the water level was above normal in the spring ranging from 213-million m^3 on 1 March to 128-million m^3 on 1 June. Although, the level was high enough to flood vegetation, it may have dropped too rapidly to sustain a stable level long enough at any location.

- In 2015, the water level was above normal between January and late September and remained stable above 173-million m^3 March through May and above 123-million m^3 until 1 July. In contrast, the water level in 2014 was above normal January into March at about 148-million m^3 but dropped rapidly in April until August. In 2016 the water level was average for the entire year peaking at 123-million m^3 in early March, and rapidly declining after that.

- In 2017, the last year nesting was detected, the water level was well above average most of the year, peaking above 308-million m^3 in March and remaining stable through May. In 2018, however, the water level was well below average for the entire year reaching a high of only 74-million m^3 in March and dropping rapidly in April.

- Water levels for the years 2007-2013 were well over 250-million m^3 during March-June 2007, 2008, 2009, and 2010. However, precipitous up-and-down fluctuations occurred during those months. From 1 April 2011 through mid-September 2013, the water level never reached 123-million m^3. Relatively stable water at that level or higher for at least 3 months offer enough time for constructing nests, incubating eggs, and hatching young. In all 3

nesting years—2005, 2015, and 2017—the water level remained above 123-million m^3 for at least 3 months, in all cases March-May. These conditions appear not to have been met in other years, except for July-September 2008 where water levels remained roughly between 278-million and 308-million m^3. Unfortunately, no visits to San Carlos Lake occurred during that period.

In most years when breeding was not confirmed, adult pairs were engaging in courtship displays. However, no suitable habitat was available for nesting or nests failed because they were left high and dry as water levels dropped. Even with some rainfall many of these nests would have been inaccessible to the adults, and subsequent renesting efforts likely would have had similar fates. This has been observed at Ganado Lake on Navajo Tribal lands, Roosevelt Lake, and Painted Rock Reservoir (T. Corman pers. comm.). If grebes can find vegetation that allows their nests to drop as water levels fall, they would have a better chance of success. However, nests placed in tamarisk as they are at San Carlos are rigid and not likely to remain afloat.

In the spring and early summer of 2019, when conditions at the east end of the lake appeared propitious for nesting, I observed what appeared to be a search by grebes for nesting habitat. At the end of June many hectares of vegetation were partially flooded. The water level dropped to about 0.3 m in a large area with dead tamarisk at the mouth of the San Carlos River (Figure 7). I saw approximately 150 *Aechmophorus* grebes swimming around and around in this area, without diving or feeding. They may have been evaluating the area for nesting. However, they didn't build nests, possibly sensing that by the time they constructed them, incubated eggs, and hatched young, the area would be dry, and it was by the end of July (Jenness 2019a, Jenness unpubl. data). The above described observations raise important questions. Why hadn't grebes nested earlier where large vegetated areas were submerged in water at the east of the lake? What do breeding pairs of grebes do when they can't find suitable habitat at the lake for nesting? Do they go elsewhere, or do they remain and forgo raising young that year?

Figure 7. Possible breeding habitat in dead tamarisk at mouth of San Carlos River 25 June 2019. Photo by Doug Jenness

ROOSEVELT LAKE

Larger than San Carlos Lake, Roosevelt Lake is 64 km to the northwest and was created by damming the Salt River in 1911. It is also subject to water level fluctuations, though typically not as extreme as at San Carlos. *Aechmophorus* grebe numbers may be higher than at San Carlos, as high as 3,400 in some years (Corman and Juarez 2017). The first confirmed nesting of *Aechmophorus* grebes was 18 July 2008, when Corman (2008) observed many downy young of both species, ranging from one-fourth to nearly adult size. Breeding also took place in 2009, 2011, 2016, 2017, and 2019 (eBird 2019; Figure 8). Nests reported so far at Roosevelt Lake, as at San Carlos, were constructed in tamarisk (T. Corman pers. comm.).

Figure 8. Courtship ritual of Western Grebes, Roosevelt Lake 27 March 2019. Photo by Caleb Strand, Macaulay Library at Cornell Lab (ML 147727231)

Particularly noteworthy was a pair of Clark's Grebes with 2 downy young 14 January 2011 (Corman and Burger 2011). This indicates a nesting period from March through November with downy young from April through January, virtually the entire year. Although longer than the nesting period confirmed so far at San Carlos Lake, this pattern is consistent with reports from other parts of the state. Rosenberg et al. (1991) noted an account from the Imperial National Wildlife Refuge along the lower Colorado River of a back-brooding downy young Western Grebe on 1 January, and Detwiler (2006) reported a pair of Western Grebes at Martinez Lake (Yuma County) with 3-4-week-old young and an adult Clark's Grebe carrying 2 downy chicks on its back on 16 January 2006.

This long breeding period was not recognized when *Aechmophorus* grebes were first studied in North America, primarily at northern inland lakes that freeze over annually. There, only a spring-summer nesting pattern existed. However, Parmalee and Parmalee (1997) discovered a different pattern of grebe nesting at Lake Mead, a large reservoir on the Colorado River between Nevada and Arizona with fluctuating water levels. They concluded that at lakes with a year-round hospitable environment and adequate fish, grebes adapt to unfavorable changes in water levels by extending their breeding season. Roosevelt and San Carlos lakes generally fall into this category with the caveat that water level fluctuations are so extreme at San Carlos that favorable breeding habitat is only occasionally produced.

DIFFERENCES IN FEEDING BEHAVIOR

Reports from many observers in the past 2 decades shows that Western greatly outnumber Clark's Grebes at San Carlos Lake. In my 2019 surveys I found that +/-75% were Western. No seasonal differences have been identified in the ratio between the 2 species at the lake, but this has not been studied. Although each species tends to associate with its own kind, they may forage in mixed groups. As already noted, they nest in mixed colonies.

One difference, however, observed in my 75 visits to the lake since 2003 is that Western Grebes generally prefer deeper water, and Clark's favor shallower water for feeding. Western Grebes dominate at the deeper western end of the lake, where Clark's are seldom observed. Typically, the majority of Clark's occupy the eastern half of the lake and most often the far eastern end, where the water is the shallowest. The same behavior has been observed at Roosevelt Lake where Clark's greatly outnumber Western Grebes in the shallower inflows of Tonto Creek and the Salt River as well as several coves (T. Corman pers. comm.).

The disparity in the water depth where the 2 species feed has been studied elsewhere. However, some of these observations contrast with the experience at San Carlos and Roosevelt lakes. Nuechterlein (1979) speculated that the 2 color morphs of Western Grebe that would soon be split into Clark's and Western, although reproductively isolated, were virtually indistinguishable ecologically. He considered this to be "one of the best avian examples" of an exception to the competitive exclusion principle. That rule specifies that 2 species of nearly the same food habits are not likely to remain evenly balanced in the same region. One, better fitted for the local conditions, will crowd out the other (Grinnell 1904). Nuechterlein (1981) and Ratti (1985) began to revise this view when they observed that Clark's Grebes at Upper Klamath Lake in Oregon tended to feed farther from shore than Western Grebes. Nuechterlein (1981) also noted that Clark's Grebes were more likely to use springing dives, in which they leap out of the water before submerging in pursuit of prey. He hypothesized that this was related to the depth the bird dived, as springing would impel it farther down. This would produce niche segregation between the 2 species. These studies were indecisive as distance from shore at these lakes did not necessarily imply deeper water. Ratti (1985) noted that Upper Klamath Lake had uneven depth contours, which might conceal connections between depth and distance. Subsequently, Nuechterlein and Buitron (1989) investigated the diving differences between Clark's and Western Grebes at Upper Klamath Lake and nearby Lake Ewauna, measuring the depths at each dive point and observing whether springing dives were used. Their data showed that Clark's Grebes more frequently dove at deeper depths and engaged in springing dives. The contrary experience at 2 Arizona reservoirs suggests that more study of the feeding behavior of these 2 closely related species is needed.

HYBRIDIZATION

Determining whether Western and Clark's Grebes exploit different ecological niches relates to the integrity of their separation into 2 species. Since Western Grebe was split into 2 species (AOU 1985), questions remain as to whether the two forms are truly separate and are diverging. Field studies in Califonia and Oregon in 2009 (Konter 2011), Utah in 2010 (Konter 2012), and Washington (Mlodinow and Leukering 2018) show hybridization regularly occurs. They have also shown that hybrids are fertile and can back cross (Konter 2011). Konter (2011) found that the rate of mixed breeding pairs (both pure Western and pure Clark's crosses and crosses between one or other pure form and a hybrid) varied between nesting sites. Of the 8 lakes he studied in northern California and southern Oregon, the aggregate proportion of the grebes classified as intermediate between Western and Clark's was ~3.5%. At Lake Alamanor in Plumas County, California, however, the rate of mixed breeding pairs was 7.5%. In Utah, individuals with clearly intermediate traits at 19 sites represented 6.5%; another 7.6% were debatable Western or Clark's Grebes (Konter 2012). Comparing his data with reports more than 3 decades earlier in the same areas, Konter concluded that intermediates were increasing in California, Oregon, and Utah. He stated that this would tend to show that incompatibilities between the 2 species are not being reinforced. A 2009 study at Potholes Reservoir in Grant County, Washington, showed 2.5% pairs were mixed and 1.9% of individuals were hybrids (Mlodinow and Leukering 2018). In San Diego County, Unitt (2005) reported hybridization was common among the 2 species and suggested that each grebe's preference for its own species may emerge only where the number of each in a colony is large.

Figure 9. Clark's/Western Grebe hybrid, San Carlos Lake. Bright yellow bill and narrow hind-neck stripe indicates Clark's Grebe, but the black cap touches the eye both from behind and above and the loral stripe is black as in Western's Grebe 4 October 2017. Photo by Doug Jenness

Figure 10. Western Grebe (l), Clark's Grebe (r). Apparent pair and based on the size difference the Western appears to be a female, the Clark's a male, San Carlos Lake 13 June 2015. Photo by Ed Dunn

To date, observers reported 2 dozen intermediate or hybrid *Aechmophororus* grebes in Arizona (eBird 2019), with 7 at San Carlos Lake (Figure 9). A systematic survey would likely show that the number of mixed pairs and hybrids is higher (Figure 10). Determining whether grebes are intermediate is difficult, partly because many are too distant to observe key characteristics, and most observers aren't looking at these finer points of identification. Western Grebe typically has a greenish-yellow bill; Clark's differs in having an intense yellow to yellow-orange bill with a more sharply defined black culmen. In breeding plumage, the black cap of Western extends below and covers the eyes; on Clark's the white sides of the head extend above the eyes and the lores are white. The Clark's back tends to be paler and the black stripe down the back of the neck is narrower. The skin under the white throat feathers is bright yellow on Clark's and blackish in Western (Storer and Nuechterlein 1985). In basic plumage, however, important features of both merge towards those of the other, and posture can sometimes obscure whether the black cap reaches the eye or not (Mlodinow and Leukering 2018). Hybrids typically show characteristics of both species and can easily be identified when in breeding plumage.

SUMMARY

The regular presence of *Aechmophorus* grebes at San Carlos Lake in all seasons is well established. Except for the occasions of very low water levels, the grebes find this lake a hospitable location for feeding. However, nesting occurs infrequently and irregularly due to the abrupt changes in water level and the difficulties in finding emergent vegetation for constructing and anchoring nests. I recommend research to accurately determine the number of grebes that nest at the lake and how often. Behavior of breeding-age grebes when they cannot find suitable nesting habitat at the lake also warrants research. The observation of different feeding behaviors of Western and Clark's Grebes at both San Carlos and Roosevelt lakes appears to contradict studies in other parts of their range and poses broader questions for study.

ACKNOWLEDGMENTS

I appreciate Troy Corman's patience in answering many questions I've had in preparing this article and for helpful suggestions to the final draft. I'm also grateful to Roy May, Steve Mlodinow, and Dave Stejskal for reviewing and making improvements to the article.

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Accepted 5 June 2020