

# LAKE MATTAMUSKEET CREEL SURVEY, 2014



Federal Aid in Sport Fish Restoration  
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Final Report



Kevin J. Dockendorf  
Kathryn M. Potoka  
Chad D. Thomas

North Carolina Wildlife Resources Commission  
Inland Fisheries Division  
Raleigh

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**Abstract.**—From 1 March to 31 October 2014, we intercepted 853 angling parties consisting of 2,055 individuals during a bus route creel survey at Lake Mattamuskeet, Hyde County, NC. We interviewed bank (92.8%), boat (7.2%), and two kayak angling parties. Fish catch and harvest was mostly comprised of Black Crappie *Pomoxis nigromaculatus*, Channel Catfish *Ictalurus punctatus*, White Perch *Morone americana*, Common Carp *Cyprinus carpio*, and Largemouth Bass *Micropterus salmoides*. Estimated angler effort was 202,338 angler-hours (SE = 22,043) with most expended April–June. Anglers expended the most effort (67,557 angler-hours; SE = 9,289) for Channel Catfish, especially May–August. Estimates of catch and harvest were highest for Black Crappie, primarily sought March–May, and White Perch, primarily sought May–June. A total of 40 interviewed parties targeted Largemouth Bass, about equally by boat (N = 17) and bank parties (N = 23). Catch and harvest of Largemouth Bass ranked fifth. Of 205 Largemouth Bass reported caught, 70 were harvested for a harvest rate of 34%. A sub-sample of 37 Largemouth Bass ranged in total length from 356 mm to 503 mm TL (14 to 20 inches). Blue Crab *Callinectes sapidus* effort was 148,986 h (SE = 16,361) with an estimated catch of 220,718 (SE = 17,464) and 93% harvested. Crabbing activity was prevalent at Central Canal, Lake Landing, and South Culvert. Most (46%) parties interviewed were from five counties near the lake; 44% were from another 49 NC counties, and 10% were non-residents of 17 states. Boat and bank anglers visited Central Canal most frequently; bank anglers frequented West Pier Culvert March–June. Bank angling enhancements, such as fishing pier construction at South Culvert, would provide more access opportunities for anglers and crabbers at Lake Mattamuskeet. Exploration of alternative size and creel limits for sportfish coupled with adaptive habitat management may be beneficial to the fisheries resources and stakeholders of Lake Mattamuskeet.

Lake Mattamuskeet is the largest natural lake (16,314 ha; NCDWQ 2004) in North Carolina and represents the central component of the U.S. Fish and Wildlife Service Mattamuskeet National Wildlife Refuge (MNWR) in Hyde County. The north to south causeway segment of the NC 94 highway (Hwy 94), constructed in 1954, bisects the lake. Along this causeway, there are five culverts, which facilitate water movement between the east and west sides of the lake depending on wind speed and direction. Four major manmade canals connect Lake Mattamuskeet to the Pamlico Sound: Rose Bay Canal extending from the western shore, Outfall and Lake Landing canals from the southern shore, and Waupoppin Canal from the eastern shore (Godwin 2004). Each canal is equipped with water control structures administered by MNWR staff. Primary MNWR management objectives are to provide essential habitat for migratory waterfowl and endangered species as well as offer wildlife-related recreation and environmental education opportunities to MNWR visitors (USFWS 2008).

Given Lake Mattamuskeet is an integral component of MNWR, fishing and crabbing at Lake Mattamuskeet are popular activities. Vogelsong (2006) identified fishing as the primary activity reported by 71.1% of the visitors surveyed at MNWR from October 2004 to October 2005. Boat anglers access the lake from four improved boat ramps or by launching small vessels at select areas around the lake. Bank anglers utilize the culverts and fishing piers along the Hwy 94 causeway and canal banks around the lake as allowed by refuge access regulations. Refuge regulations limit bank angling to certain shoreline areas and close the lake to all boating activity from 1 November to 28 February to reduce disturbance of wintering waterfowl.

The North Carolina Wildlife Resources Commission (Commission) assists MNWR with fisheries monitoring and management and establishes licensing requirements as well as size and creel limits for the lake's sportfish species. Important recreational fisheries for Black Crappie *Pomoxis nigromaculatus*, Largemouth Bass *Micropterus salmoides*, Channel Catfish *Ictalurus punctatus*, sunfish *Lepomis* spp., and White Perch *Morone americana* exist in Lake Mattamuskeet and associated canals (McCargo et al. 2011). Crabbing for Blue Crab *Callinectes sapidus* is another popular recreational activity at Lake Mattamuskeet, and the crabs are highly regarded for their relatively large size. Crabbing at Lake Mattamuskeet is subject to a state regulation of a carapace length limit of 5 inches from tip to tip, and a federal refuge regulation of a daily limit of 12 Blue Crabs per licensed individual.

No formal survey to estimate angler effort, catch, and harvest at Lake Mattamuskeet has been conducted since the 1940s (Holloway 1948). As a priority research need, we designed a creel survey to encounter boat and bank anglers to describe the recreational fishery at Lake Mattamuskeet. The primary objectives of this creel survey were to: 1) estimate the overall angling and crabbing effort at Lake Mattamuskeet; 2) estimate the catch and harvest by participants of these activities, and 3) document current angler preferences to enhance recreational opportunities at Lake Mattamuskeet.

## Methods

A non-uniform probability stratified bus route access-access creel survey (Pollock et al. 1994) was conducted to estimate angler effort, catch, and harvest from 1 March 2014 to 31 October 2014 at Lake Mattamuskeet in Hyde County, North Carolina. We excluded 1 November to 28 February due to the boating closure, bank access limitations for other refuge activities,

and relative infrequency of angling activity during colder months, as observed by wildlife officers and refuge personnel.

The survey was stratified by period (month), time of day (early or late), and day type (weekday or weekend, including Fridays and holidays). Sampling periods (N = 8) represented one calendar month and included eight randomly selected weekdays (Monday through Thursday) and eight randomly selected weekend days (Friday, Saturday, and Sunday). Each creel session was randomly selected with equal probabilities for early or late route starting times and was nine hours in duration. Early sessions began one hour after sunrise, and late sessions began 9 hours prior to sunset based on sunrise and sunset times for Belhaven, NC (U.S. Naval Observatory 2013).

The bus route drive times between access areas were calibrated to establish a 9-h (540 min) interview schedule with 135 minutes of drive time and 405 minutes of waiting times at 15 identified access sites (Table 1; Figure 1). Waiting times at each access area were based on prior knowledge of angler use patterns. State and federal wildlife enforcement officers ranked access areas by the amount of observed fishing pressure from prior years. These ranks were used to assign waiting times for each access area. Waiting times for each access area were calculated by multiplying the relative proportion of rankings by the remaining available minutes of the creel day after subtraction of travel time from the entire creel period (Pollock et al. 1994). Revisions to access area wait times prior to each sampling period were necessary due to construction at water control structures, strategic replacement of culverts on the causeway, renovations of boat ramps, and scheduled refuge activities such as waterfowl and deer hunts.

The creel clerk was assigned to a predetermined bus route schedule each sample day with arrival and departure times for each access area. Direction of travel (clockwise or counterclockwise) and starting access area were randomly chosen. Upon arrival as well as departure, clerks recorded the number of vehicles and vehicles with trailers at each access area. While waiting at an access area, the creel clerk's first priority was to intercept anglers who were finished fishing, hence a completed trip. As the scheduled departure time approached for each access area, the creel clerk would then interview anglers or crabbers at random who were still actively fishing to address avidity bias (Pollock et al. 1994) or until all parties were interviewed at the access area. The result of this procedure, however, effectively "completed" all incomplete trips by anglers still fishing when the clerk exited the access area.

Angler information requested by the creel clerk for each interview included trip type, number in the party, length of time fished, species targeted, angler origin, and bait type used. The creel clerk recorded the number of each fish species kept and released as well as number of Blue Crabs kept and released; when a release was reported, the creel clerk then asked whether the fish or Blue Crab would have been legal to keep if not released (Table 2). For each fish species kept, the creel clerk weighed (kg) in aggregate all fish harvested, and measured (TL; mm) up to five individual fish of each species. Creel clerks inquired whether anglers visited other areas of the lake during their trip that day, as well as frequency of angling or crabbing at Lake Mattamuskeet in the previous month and over the 12 months prior to their interview. The creel clerk gathered name and mailing address from any individual indicating a willingness to participate in a follow-up survey. All information was recorded by the creel clerk on an interview sheet (Figure 2).

All survey points were included in a single bus route and these locations were categorized as West, East, or Culvert to decipher angler use patterns. Rose Bay, Osprey Nest, and Carawan's Turnaround were categorized as West access points, the five culvert sites were categorized as Culvert access points, and the remaining seven sites were East access points. We categorized angler origin as those anglers originating from Hyde County, regional counties (Beaufort, Dare, Tyrell, and Washington), other NC counties, or non-NC residents. Frequency of prior visits was divided into increments of 5 days; responses of 0 days were kept separate.

Calculations of effort, catch, and harvest and associated standard errors were based on direct expansion of the information collected during each interview session, which is similar to standard estimating procedures in traditional access design surveys (Pollock et al. 1994). A software program developed by North Carolina State University was modified specifically for this project by Commission staff to calculate estimates of sport fishery catch, harvest, and effort. We entered our creel survey data within the agency Portal Access of Wildlife Systems (PAWS) internal database for analysis. Calculations for effort, catch (number), and harvest (number) were based upon the formulae listed below:

$$\hat{E} = T \sum_{i=1}^n \frac{1}{w_i} \sum_{j=1}^m \frac{e_{ji}}{\pi_j}$$

where  $E$  = estimated total party-hours of effort,  $T$  = total time to complete full circuit of the route, including drive times and wait times,  $w_i$  = wait time at the  $i$ th site ( $i = 1, \dots, n$  sites), and  $e_{ji}$  = trip duration for the  $j$ th angler at the  $i$ th site

$$\hat{C} = T \sum_{i=1}^n \frac{1}{w_i} \sum_{j=1}^m \frac{C_{ji}}{\pi_j}$$

$C$  = estimated total catch,  $T$  = total time to complete full circuit of the route, including drive and waiting times,  $w_i$  = wait time at the  $i$ th site ( $i = 1, \dots, n$  sites),  $C_{ji}$  = total catch during the  $j$ th angler's trip at the  $i$ th site

$$\hat{H} = T \sum_{i=1}^n \frac{1}{w_i} \sum_{j=1}^m \frac{H_{ji}}{\pi_j}$$

$H$  = estimated total harvest,  $T$  = total time to complete full circuit of the route, including drive and waiting times,  $w_i$  = wait time at the  $i$ th site ( $i = 1, \dots, n$  sites),  $H_{ji}$  = total harvest during the  $j$ th angler's trip at the  $i$ th site

Approximate standard errors (SE) of the estimates ( $E$ ) within strata were computed as:

$$SE(\hat{E}) = \sqrt{N^2 \left( \frac{s^2}{n} \right)}$$

where  $s^2$  is the variance of the effort observations,  $n$  is the number of days sampled, and  $N$  is the number of days of that type available for sampling.

## Results and Discussion

### *Interview Summary*

During 118 interview sessions within the 245-day period, creel clerks conducted 853 interviews comprised of 110 complete and 743 incomplete angling trips; as noted in the Methods section, an “incomplete” trip designation recognizes that the angler was still actively fishing during the time of the interview. Total interviews were comprised of 792 bank angling parties, 61 boat angling parties, and two kayak angling parties (Table 3). The total number of participants associated with these parties was 2,055 comprised of 1,931 bank anglers, 119 boating anglers, and five kayak anglers. Two angling parties (N = 7 anglers) were excluded because they did not want to participate in the survey.

We conducted more weekday interviews for bank (N = 432) and boat trips (N = 37) than weekend bank (N = 358) and boat (N = 26) trips (Table 4). The total number of anglers interviewed was slightly higher on weekend days (N = 1,047) than weekday days (N = 1,008). However, more boat anglers were interviewed on weekdays in most months, except in March and May when more boat anglers were interviewed on weekend days.

Bank anglers were counted and interviewed at all available access sites (Figures 3 and 4). Bank angling parties were composed of general anglers, bank anglers with a target of Blue Crab, and bank anglers targeting fish (Table 5). Of the 792 bank angling parties interviewed, a total of 335 interviews (N = 882 anglers) were categorized as generally engaged in angling and crabbing, whereas 233 bank angling interviews (N = 589 anglers) targeted Blue Crab, and 222 interviews (N = 460 anglers) targeted one or more fish species. We identified targeted species for 165 of 222 bank parties targeting a single fish species during their trip: Black Crappie (N = 51), Channel Catfish (N = 47), White Perch (N = 44), and Largemouth Bass (N = 23). Of 648 bank angling parties that had not altered their fishing venue by the time of interview, 343 bank parties (52.9%) were intercepted at East access locations, 277 bank parties at Culvert locations (42.7%), and 28 bank parties at West lake locations (4.3%). Of 142 bank angling parties that indicated they fished or crabbled at other areas of the lake before being interviewed, 125 indicated at least one other area fished, and 17 indicated at least two other areas fished. Accounting for overlap of multiple sites visited, there were 165 prior location responses where 110 responses indicated anglers visited the East portions of the lake, 49 responses for previously fishing at the Culvert areas, and another 6 responses that anglers had visited the West portions of the lake.

Bank fishing was more prevalent on the east side of the lake given the number of access areas within the refuge complex and the amount of open bank available along the canals, especially Central Canal, East Walkabout, and Waupoppin Canal. Bank fishing activity at the culvert locations was expected to be relatively high given the relative ease of vehicular access at these sites, although construction interruptions may have influenced the relative bank fishing activity in 2014, especially July to October when three of the five culvert areas were closed for improvements. There are relatively few bank access areas on the west side of the lake and expanding open bank space along Rose Bay canal on refuge property would provide additional bank angling opportunities.

Boat anglers were interviewed at four modern boat ramps and two unimproved locations around the lake. Boat anglers primarily utilized Central Canal and Rose Bay followed by Osprey Nest, Outfall Canal, East Walkabout, and Carawan's Turnabout. Sixty of the 63 boat interviews occurred in the first 4 months of the survey and the remaining three boat interviews occurred in the months of July and September. Boating parties targeted Black Crappie (N = 36), Largemouth Bass (N = 17), Channel Catfish (N = 4), and White Perch (N = 2). Eleven boating parties reported fishing for "anything", and no boating parties interviewed targeted Blue Crab.

Observed counts of vehicles with trailers documented additional usage of access areas by boating parties, especially at Central Canal and Rose Bay. Ninety-three percent of boat parties interviewed (N = 57) advised they fished in the general vicinity of their launch location. Of these, 34 launched on the east side and 23 launched on the west side. The four boating parties interviewed that fished areas other than their launch point (3 at Rose Bay and 1 at Carawan's Turnabout) indicated also fishing at eastern areas of the lake. One kayak angling party was interviewed at a launch point at East Walkabout; the other kayak angling party was interviewed at North Culvert. These kayak anglers advised that they stayed within the vicinity of those launch points during their respective angling trips.

Lake Mattamuskeet is an extensively shallow lake and may be more challenging for most modern fishing boats less suited for shallow water environments. This situation is exacerbated with reductions in lake level, especially during summer months or unusually dry conditions. Based on USGS gage data for the survey period, mean lake level was 2.14 feet March–May, declined to 1.74 feet June–August, and returned to near 2.11 feet in September and October (Figure 5). More vehicles with trailers were counted and boat anglers interviewed at Lake Mattamuskeet in March, April, and May whereas fewer vehicles with trailers were counted June–August and months of September and October. Future surveys should be conducted to elucidate boat angler preferences in comparison to available fishing and access opportunities at Lake Mattamuskeet.

*Reported Catch.*—Lake Mattamuskeet anglers caught 10 fish species, fish generally identified by anglers as either sunfish or catfish, and Blue Crab during the creel period (Table 6). A total of 3,414 fish (52.0%) and 3,151 crabs (48.0%) was reported caught. For angler reported fish catch, Black Crappie was highest for all fish species (38.9%), followed by White Perch (29.6%), Channel Catfish (18.4%), and Largemouth Bass (6.0%). The remaining 6.2% of the reported catch was comprised of Common Carp *Cyprinus carpio*, Bluegill *Lepomis macrochirus*, Yellow Perch *Perca flavescens*, White Catfish *Ameiurus catus*, American Eel *Anquilla rostrata*, Bowfin *Amia calva*, and Longnose Gar *Lepisosteus osseus*.

*Observed Harvest.*—Lake Mattamuskeet anglers harvested 82% of the reported fish and crabs in the overall catch with a total of 2,460 fish and 2,957 Blue Crabs reported caught also observed harvested. Blue Crab comprised the majority of observed harvest by number (54.6%) compared to fish species (45.4%). Harvest of fish species was dominated by Black Crappie (41.5%), followed by White Perch (31.1%), Channel Catfish (20.9%), and Largemouth Bass (2.8%). The remaining 3.6% of the observed fish harvest was comprised of Common Carp, Bluegill, American Eel, Bowfin, Longnose Gar, and fish generally identified as sunfish and catfish.

*Common Carp.*—We report here observed angler harvest of Common Carp due to the recent interest in removal of this nuisance species while excluding them from further analysis

due to the relatively low frequency of occurrence in the data set. Of a total of 50 Common Carp harvested in the creel survey, 42 Common Carp were measured between 14 and 30 inches (355–761 mm; Figure 6); the other eight were not measured. A total of 43 Common Carp weighed in aggregate 101.1 kg (222.8 lb); seven were not weighed. With 13 Common Carp reported caught and released, almost 80% of Common Carp caught were harvested. The effects of Common Carp on the aquatic habitat within Lake Mattamuskeet has been discussed for decades and the concern for Common Carp removal can be traced back to the establishment of MNWR (Cahoon 1953). Novel approaches for removal conducted in prior years, such as haul seining for fee fishing ponds and a bowfishing tournament on refuge property, yielded little success as Common Carp persists as a nuisance population. Perhaps the exploration of a Common Carp fishing derby held during certain times of the year with a nominal bounty paid to anglers for each Common Carp removed from the lake may be another approach to reduce the Common Carp biomass within the lake (see Orth and Peoples 2014). Removal programs are often challenging to initiate, labor intensive, and could be cost prohibitive, although development of specific goals and objectives that evaluate the effectiveness of such programs at Lake Mattamuskeet are warranted.

#### *Estimates of Effort, Catch, and Harvest*

*Estimated Effort.*—An estimated 351,324 (SE = 27,406) angler-hours of effort were expended for both fish and crabs during the 8-month creel survey (Figure 7); effort expended on weekend days was 202,274 angler-hours (SE = 27,408) and was greater, especially in May, than 149,050 angler-hours (SE = 16,019) expended during weekdays. Effort expended for fish was 57.6% of the total effort, or 202,338 angler-hours (SE = 22,043) (Figure 8; Appendix 1) compared to 148,986 (SE = 16,631; Figure 9) hours for Blue Crab, or 42.4% of overall estimated effort. Estimated targeted effort for fish primarily comprised Channel Catfish 25.6%, then Black Crappie 18.5%, White Perch 16.0%, and Largemouth Bass (7.9%). The remaining proportion of effort was attributed to general angling activity at Lake Mattamuskeet. Angler effort in a Lake Gaston creel survey (Rundle 2009) was 335,562 angler-hours (SE = 17,414) and is comparable to estimated effort expended at Lake Mattamuskeet in 2014. However, the majority (78%) of angler effort at Lake Gaston effort was expended on Largemouth Bass, whereas the majority of effort expended at Lake Mattamuskeet on a single species was Blue Crab; Largemouth Bass ranked fourth in effort of fish species targeted. Largemouth Bass effort at Lake Mattamuskeet was also less than effort expended for Largemouth Bass at B.E. Jordan Reservoir (Commission, unpublished data), yet higher than Roanoke Rapids Reservoir (Rundle et al. 2015). Estimated effort expended for Black Crappie at Lake Mattamuskeet, however, was relatively similar to estimated effort for crappie at B.E. Jordan Reservoir (Figure 10).

*Blue Crab.*—An estimated 220,718 (SE = 18,204) Blue Crabs were caught with an estimate of 204,350 (SE = 17,465) Blue Crabs harvested (Figure 11; Appendix 2). The calculated catch rate based on these estimates was nearly 1.5 Blue Crabs per hour with a harvest rate of almost 93%. Relatively few maximum Blue Crab bag limits (12 crabs per day) were observed (N = 26) and most crabbers (61.2%) harvested only 1-4 crabs/angler (72%). It was rare to find crabbers that released legal crabs; less than 20 crabbing trips that reported catching at least one crab (4.6%) chose not to harvest a Blue Crab. One trip was observed to harvest more than the legal limit of

12 Blue Crabs per angler. Anglers indicated that 141 of 156 Blue Crabs caught and released (90%) were undersized which suggested that the remaining 10% released were legal size. The estimates of Blue Crab catch, effort, and harvest observed in Lake Mattamuskeet during 2014 cannot be compared with any past surveys, or with any other Blue Crab populations in the geographic area as no other prior information was available. Blue Crabs likely utilize Lake Mattamuskeet as a spawning habitat due to the lower salinity requirements associated with spawning and recruitment stages of their life cycle (see Van Den Avyle 1984). Migration through the water control structures could be important to the life cycle of Blue Crabs associated with Pamlico Sound. Ongoing migration studies of Blue Crab in Lake Mattamuskeet should provide insight on timing and utilization of the lake, canals, and water control structures of these highly sought crustaceans (Harris 2013).

*Channel Catfish.*—Anglers expended the most effort (67,557 angler-hours, SE = 9,289) for Channel Catfish (Figure 12). An estimated 38,596 (SE = 4,801) Channel Catfish were caught (0.6 Channel Catfish caught/angler-hour) with an estimated 31,920 (SE = 3,976) harvested, or 83% (Figure 13; Appendix 3). Length frequency distribution (N = 285) of Channel Catfish harvested ranged from 240 mm to 780 mm (9 inches to 31 inches; Figure 14). Channel Catfish ranked first in observed harvest by weight with a total of 321 Channel Catfish that weighed 397 kg (875 lb). Relative abundance of Channel Catfish at Lake Mattamuskeet is unknown with few sampled in recent surveys (McCargo et al. 2011; Potoka et al. 2014); however, anglers harvested more than 500 Channel Catfish as recorded by the creel clerk during the creel sessions. Continued assessments of catfish populations through future surveys are necessary to elucidate a better understanding of the dynamics of this popular fishery.

*Black Crappie.*—An estimated 37,412 (SE = 5,057) angler-hours were expended for Black Crappie (Figure 15), with 71,573 (SE = 11,053) caught and 54,814 (SE = 8,355; 76.5%) harvested. Catch rate of Black Crappie was 1.9 fish/angler-hour. The majority of the catch (73.8%) and harvest (75.6%) occurred during March, April, and May, especially on weekend days in April (Figure 16; Appendix 4). A subsample of 350 Black Crappie measured during the survey revealed the majority were 10 inches (254 mm) and ranged 6 to 14 inches (152–355 mm; Figure 17). A total of 863 Black Crappie was weighed for an aggregate total of 291.9 kg (643.5 lb). Nearly 75% of Black Crappie caught were harvested. Relatively few 20 fish bag limits (5 anglers in 3 trips) were observed and most anglers (72%) kept 1-10 crappie/angler (72%). Less than 20 trips (14%) harvested more than 10 crappie per angler as observed by the creel clerk. No trips were observed to harvest more than the legal limit. For 259 Black Crappie reported released, the majority (N = 182) were reported as being legal size with the remaining 77 less than the legal length limit. The majority of the fish harvested ranged between 9 and 11 inches in total length, although we documented five Black Crappie caught and harvested less than the legal length limit. Based on the measurements of Black Crappie harvested, 345 Black Crappie were 8 inches or greater. Potoka et al. (2014) identified fast growth rates of Black Crappie at the lake with average mean length at age calculations suggesting Black Crappie may reach 8 inches in total length by age 1. Of the 345 Black Crappie measured, 220 (63.8%) were also greater than 10 inches. Based on the 2013 and 2014 Black Crappie age distribution (Potoka et al. 2014, Potoka and McCargo in press), the 2012 year class was dominant and likely contributed to the harvest of fish 10 inches and greater. A hypothetical 10-inch minimum length limit would have allowed for a vast majority of Black Crappie to be harvested while also protecting Black Crappie less



than 10 inches that may be available to spawn in another year. Elevated salinity levels that may exceed survival thresholds for Black Crappie at Lake Mattamuskeet may influence successful recruitment. Because Black Crappie are subject to cyclic population dynamics (Allen and Miranda 2001), adaptive lake level management to optimize spawning conditions (Maceina and Stimpert 1998) while minimizing saltwater intrusion could augment Black Crappie cohorts available to anglers at Lake Mattamuskeet.

*White Perch.*—Anglers expended an estimated 50,200 angler-hours fishing for White Perch with most hours expended during April, May, and June (Figure 18). An estimated 69,970 White Perch (SE = 18,415) were caught (1.39 caught/angler-hour) with 55,803 (SE = 17,878) harvested (Figure 19; Appendix 5), or nearly 80%. Creel clerks weighed 444 White Perch at 110.2 kg (242.9 lb) and measured 255 White Perch from angler harvest that ranged 5–14 inches (127–355 mm; Figure 20). Because White Perch are semi-anadromous, they tend to migrate from brackish water and congregate during their spawning run in fresh water, although this spawning run does not require migration to the ocean. Godwin (2004) documented the upstream migration and passage of White Perch through the culverts during the months of March, April, and May. Godwin (2004) also noted that White Perch were the most numerous fish species found utilizing the MNWR water control structures during his study. As could be expected, the MNWR canals likely provide migration routes between Pamlico Sound and Lake Mattamuskeet. Thus, passage through the water control structures is likely critical for White Perch populations at Lake Mattamuskeet. White Perch migration should be accounted for when considering opening and closing the water control structures at Lake Mattamuskeet. Potoka et al. (2014) suggested nest or egg predation by White Perch might influence recruitment of other fish. Further study on ecological interactions among fish species at the lake is warranted. While native to the coastal region, White Perch have the tendency to become overpopulated in a lacustrine environment such as Lake Mattamuskeet. However, anglers at Lake Mattamuskeet harvested a large percentage of White Perch caught regardless of size; thus promoting liberalized harvest of White Perch is likely beneficial to minimize potential negative ecological interactions and to reduce the likelihood of stunting.

*Largemouth Bass.*—Largemouth Bass ranked fifth in effort (15,591 angler-hours; SE = 3,859), catch (11,726; SE = 2,712), and harvest (3,110; SE = 979) at Lake Mattamuskeet in 2014 (Figures 21 and 22; Appendix 6). Catch rate was 0.75 Largemouth Bass caught/angler-hour and Largemouth Bass harvest (N = 70) was 34% of the reported catch (N = 205). Sixty percent of the observed Largemouth Bass harvested was attributed to angling trips targeting Largemouth Bass. Length frequency distribution (Figure 23) of a subsample of the harvested Largemouth Bass (N = 37) ranged from 13 to 20 inches (330–508 mm). The aggregate weight of 50 Largemouth Bass harvested was 53.95 kg (118.9 lb). Anglers released 135 Largemouth Bass with 48% reported as legal size.

The abundance and availability of Largemouth Bass at Lake Mattamuskeet is important to anglers, fisheries managers, and stakeholders. Our survey results indicated effort and catch rates of Largemouth Bass were relatively low at Lake Mattamuskeet in 2014. Still, the harvest rate for Largemouth Bass was over 30% and higher than an estimated harvest rate of 27% on the Chowan River 2001–2002 (Dockendorf et al. 2004) suggesting an appreciable number of anglers will keep Largemouth Bass when caught. Catch and release rates of Largemouth Bass from other systems (Allen et al. 2008; Myers et al. 2008) often trend much higher than the

approximate value of 70% observed in this study. Our results confirm current regulations for Largemouth Bass remain necessary considering a relatively high proportion of Largemouth Bass caught were harvested. A tagging study to determine current exploitation rates of Largemouth Bass would complement our creel survey findings (Bonvechio et al. 2014).

Potoka et al. (2014) suggested that the variability associated with Largemouth Bass year class strength likely influences abundance estimates and length frequency distributions in the Lake Mattamuskeet population. Similar to the ecology of Black Crappie, Largemouth Bass recruitment is likely dependent upon minimal salinity intrusion to Lake Mattamuskeet and associated canals during the spring months. With the exception of June when Rose Bay WCS gates were clogged with debris, salinity readings taken at the four WCS access locations did not suggest elevated salinities were detrimental to Largemouth Bass reproduction at Lake Mattamuskeet during 2014 (Figure 24). Telemetry studies on the utilization of the canal and lake habitats by Largemouth Bass would provide additional insight on the spatial and temporal distribution of Largemouth Bass at Lake Mattamuskeet, and available spawning habitats.

#### *Additional Characterization of Angling and Crabbing*

*Angler Origin.*—Survey results yielded angler origin information for 2,032 anglers, whereas origin information was not defined for 24 anglers. The vast majority of anglers providing origin information were North Carolina residents representing 54 counties (90%; N = 1,828) and the remaining 10% were non-residents from 17 states (Table 7; Figure 25). Of the 90% of NC residents responding to angler origin, about 44% were from NC counties not defined as either regional or local counties; 30% of anglers were from a regional county (Beaufort, Dare, Tyrell, or Washington) with 16% from Hyde County. With the exception of two boat anglers from Virginia and one boat angler from Pennsylvania, boat anglers were from North Carolina (Figure 26). Channel Catfish was the most targeted fish species by bank and boat anglers from states other than North Carolina or with an NC county origin other than Hyde County where Black Crappie was the most targeted species by bank and boat anglers. Largemouth Bass either tied with or was the lowest targeted species by anglers of the four origin categories (Table 8).

*Bait type.*—Overall, we captured 1,053 bait type responses from 783 interviews that were related to all activity types. Live bait, such as worms or minnows, represented 41.6 % (N = 439) of the responses. Frequency of responses associated with cut bait, such as cut shrimp or cut fish, was 25.0% at Lake Mattamuskeet (N = 263). Natural baits other than live or cut bait, such as chicken parts, were primarily used for crabbing, although chicken livers were also used by 23.3% of the angling parties (N = 246). Artificial lures (9.6%; N = 102) were less common responses compared to the natural baits, and use of artificial flies was documented (N = 3; 0.3%). Regarding the 461 responses pertaining to crabbing methods, 89% (N = 412) of crabbers used hand lines with the remaining 11% preferring crab traps. Crab lines were used throughout the 8-month period, whereas crab traps were used in April, May, June, and July.

*Trip frequency information (prior month, prior 12 months).*—We collected 735 responses pertaining to prior month fishing trips and 495 responses for prior month crabbing trips taken to Lake Mattamuskeet (Table 9). The number of affirmative responses given by anglers indicating that they had fished the lake the previous month ranged from 58 in September to 187 in May. For crabs, only six respondents interviewed in March reported crabbing the

previous month, while the high occurred in May as 101 crabbers indicated they had also crabbed in April. The number of days fished or crabbed during the previous month was usually reported between 1 and 5 days (fished, 62.8%; crabbed, 54.9%). About 26% and 35% of the responses were attributed to not having fished or crabbed at the lake in a prior month, respectively. Remaining responses indicated visit counts that exceeded 5 days of fishing or crabbing in a previous month, with few (N = 3) responses advising that they either fished or crabbed as many as 26 to 30 days in the previous month.

There were 726 responses pertaining to the number of fishing trips taken in the previous 12 months, and 480 responses for crabbing trips taken to Lake Mattamuskeet in the previous 12 months (Table 10). The range of responses between monthly sampling periods was similar to the information pertaining to frequency of trips in the previous 12 months. Most responses could be categorized as visiting MNWR between 1 and 30 days in the previous 12 months to fish (73.1%) or crab (62.3%). About 20.1% and 29.6% responses indicated no visits to the lake in the prior 12 months for fishing or crabbing, respectively.

### *Survey Design Limitations*

Estimates of angler effort, catch, and harvest were based on complete and incomplete trips obtained at the open access areas during daylight hours at Lake Mattamuskeet. Effectively, incomplete trips, regardless of duration, were included in the data analysis as completed trips to assure each fishing or crabbing trip was accounted within the examination of trends observed at Lake Mattamuskeet during our creel survey. The result of this procedure, established prior to beginning the creel survey, effectively “completed” any incomplete trips when the clerk exited the access area enroute to the next scheduled stop. We accepted the bias associated with this decision as it allowed for all interviews associated with angling and crabbing, regardless of whether the trips were classified as “complete” or “incomplete”, to be included throughout the survey analysis.

Anglers and crabbers that visited Lake Mattamuskeet often were intercepted during our survey as were anglers and crabbers that were on their first trip to Lake Mattamuskeet. Avidity bias (Thomson 1991) may be present when frequent anglers are encountered in unequal proportions compared to infrequent anglers. Our creel clerks interviewed anglers as they were encountered at each access area and within the waiting time for each access area. In the event not all angling parties could be interviewed due to a large number of angling parties or creel clerk activities (e.g. measuring and weighing fish), creel clerks prioritized any completed trips and then randomly selected angling parties during the remainder of the access area wait time. While angler origin counts may be influenced by individual anglers intercepted numerous times during the survey period, all angler effort, catch, and harvest was included to account for fishing and crabbing activity at Lake Mattamuskeet.

While our sampling design accounted for the vast majority of the available public access areas at Lake Mattamuskeet, our survey did not include private piers, Jarvis Canal, or undefined areas where anglers may attempt to fish or crab. Private piers may have been utilized to access Lake Mattamuskeet for fishing or crabbing. Similarly, Jarvis Canal is a private canal with bank or boat launches by permission only; boat anglers may access Jarvis Canal from the lake when traversing the open water in ideal conditions. Creel clerks also observed angling and crabbing

activity along the riprap shoreline of the Hwy 94 causeway, yet these anglers were not interviewed due to the creel survey design. In addition, there was bank angling activity occurring at the lake during the late fall and winter months. Therefore, estimates of angling effort, catch, and harvest were likely conservative as fishing and crabbing activity may have occurred outside the surveyed access areas or during nighttime hours on the Hwy 94 causeway. However, refuge areas are off limits to fishing and crabbing after sunset.

Seven Commission employees (three temporaries and four permanent staff) participated over the 8-month time period to ensure this survey was completed. Four, 10-hour workdays each week were scheduled to balance the needs of the creel survey design, administrative requirements of the Commission, and personnel availability. We optimized training opportunities and minimized coverage concerns during staff transitions; however, we recognize that intricacies of the survey instrument, data collection, and interaction with anglers may have been less efficient than the utilization of a single creel clerk throughout the entire survey.

#### *Future Survey Design Considerations.*

Participants in 569 interviews (67%) were generally interested in participating in a follow-up questionnaire regarding fisheries management at Lake Mattamuskeet. Given that the vast majority of the anglers were from North Carolina, further exploration regarding specific angling and boating preferences may be conducted via a survey conducted by the Commission.

Our bus route creel survey was based on 15 defined access areas at Lake Mattamuskeet. Certain access areas were not entirely accessible to anglers throughout the survey period and were assigned wait times only when scheduled to be open. Therefore, depending on access area closures and renovations, available sites were included and wait times were adjusted for each daily bus route; however, drive times between the 15 sites were consistent through the survey. Given the logistics associated with effectively covering up to 15 access areas, future survey designs should incorporate multiple bus routes to accommodate the full suite of access areas available. Potential routes may include one route within the refuge complex, a second route along the causeway, and a third route around the outer perimeter of the lake that would also include Jarvis Canal.

Improvements to access areas occurred during our creel survey and may influence creel survey designs in the future. In June, renovations to two of the culverts on the Hwy 94 causeway were completed, although the other three remained closed between July and October. In July, the Commission improved the boat ramps at both Outfall Canal and Rose Bay. In October, a volunteer group working under the coordination of MNWR upgraded Wooden Bridge to improve stability. In fall 2014, MNWR began development of an additional boat trailer parking area at Rose Bay following completion of the boat ramp renovation; however, the parking area was not completed by the end of our survey period. During renovations of the middle culvert on Hwy 94, referred to in the survey as “No Pier Culvert”, the culvert design included widening the center section. This relatively wider section may allow, albeit a high risk in certain conditions, for small boats and kayaks to migrate between the West and East side of the lake; this navigation challenge was observed by creel clerks on at least two occasions and would influence inquiries pertaining to access areas and subsequent areas fished on the lake in future surveys.

## Management Recommendations

Mattamuskeet National Wildlife Refuge is an ecologically diverse asset to the state of North Carolina. Anglers and crabbers came from more than 54 NC counties and 17 states to enjoy the fishing and crabbing at Lake Mattamuskeet, the state's largest natural lake. This creel survey provided useful baseline data that characterized angling and crabbing activities over the 8-month period. Estimates reported in this document will become more useful for management decisions when accompanied by the perspective of additional years of future creel surveys. Mattamuskeet fisheries in 2014 were predominantly subsistence based with high harvest percentages for most species; enhancements to sustain fish populations while providing additional fishing or crabbing areas should consider these angler preferences while promoting new opportunities. Specific recommendations are:

1. Conduct an updated bus route creel survey in 2018 to assess angling and crabbing activity following access and habitat enhancement. Include economic and harvest disposition components of crabbing and fishing activities occurring at Lake Mattamuskeet. Schedule access area counts for angling activity prior to the next survey with Commission and MNWR staff to improve wait times and time of day probabilities.
2. Increase the Black Crappie minimum length limit to 10 inches and maintain the 20-fish bag limit. Conduct a tagging study for Black Crappie to determine exploitation rates coupled with independent surveys to assess fishing and natural mortality rates.
3. Maintain the Largemouth Bass minimum length limit of 14 inches and 5-fish bag limit. Conduct telemetry studies to evaluate movement of Largemouth Bass in response to environmental conditions. Assess fishing and natural mortality rates to assess applicability of alternative management regulations.
4. Develop a survey instrument to be mailed to anglers who indicated a willingness to participate in a follow-up questionnaire. This questionnaire could fill management gaps identified in Commission fisheries dependent and independent surveys.
5. Post updated signage related to fish identification and current bag and length limits on refuge property at pertinent kiosks and locations.
6. Construct a fishing and crabbing pier in proximity to the South Culvert, then at least one fishing pier at each culvert area on Hwy 94 within 10 years and a 20-year goal of one fishing pier on both sides of the causeway at each culvert area. Improve the wooden walkway at Lake Landing Canal for crabbing opportunities.
7. Conduct a survey to determine fish consumption by anglers. Anglers and crabbers harvested a large proportion of fish and Blue Crabs caught during their angling trip. We did not directly inquire with angling parties regarding the direct disposition of their harvest during this survey.
8. Establish a habitat enhancement plan for Lake Mattamuskeet, with a focus on strategic habitat enhancements around the existing access areas to improve angler success.

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TABLE 1.—Drive and wait times (minutes) associated with each monthly period (N = 8) for the Lake Mattamuskeet Creel Survey. Wait times at each access area changed by month depending on angler use patterns and availability. Drive times were constant for each daily route; the numbers in minutes refers to the drive time from the selected access site to the next access site on the list. Access sites and starting times were selected at random for each creel day. Total drive time was 135 minutes and total available wait time was 405 minutes.

Access Site	Drive Time	March	April	May	June	July	Aug	Sep	Oct
Rose Bay	15	50	40	40	20	30	30	30	30
Osprey Nest	6	20	25	25	5	20	30	30	30
North Culvert	2	30	30	30	40	0	0	0	0
East Lake Pier	2	0	0	0	40	60	60	60	60
West Lake Pier	2	30	30	30	40	0	0	0	0
No Pier Culvert	3	0	0	0	40	60	60	60	60
South Culvert	3	30	30	30	40	5	5	5	5
Carawan's Turnabout	10	40	30	30	10	10	20	20	20
Steel Bridge	2	20	30	30	20	20	20	20	20
Wooden Bridge	1	25	30	30	20	20	20	20	20
Central Canal	15	60	60	60	40	60	60	60	60
East Main Canal	3	40	40	40	20	20	20	20	20
Outfall Canal	10	20	20	20	20	20	30	30	30
Lake Landing Canal	15	20	20	20	20	40	30	30	30
Waupoppin Canal	46	20	20	20	30	40	20	20	20



TABLE 2. —Fishing regulations for Lake Mattamuskeet and associated canals during the 2014 creel survey. MNWR prohibits boating in the lake and canals from 1 November to 28 February, but designated areas are open to bank fishing year-round, including the Culvert areas. Fishing regulations are established by North Carolina Wildlife Resources Commission, except for flounder regulations established by North Carolina Division of Marine Fisheries (NCDMF) and Blue Crab regulations established by United States Fish and Wildlife Service (USFWS). A fishing license issued by the Commission is required to fish and crab on Lake Mattamuskeet.

Species	Minimum Total Length Limit	Daily Creel Limit
Largemouth Bass	14 inches	5
Crappie	8 inches	20
Sunfish	None	30 in combination
Striped Bass	18 inches	3
Yellow Perch	None	None
White Perch	None	None
Catfish	None	None
Flounder (established by NCDMF)	15 inches	6
Blue Crab (established by USFWS)	5 inches	12
Alewife and Blueback Herring	Statewide Harvest Moratorium	

TABLE 3. —Summary of characteristics from observed interviews from Lake Mattamuskeet Creel Survey during 118 creel day sessions from 1 March to 31 October 2014 (245 days).

Characteristic	Bank interviews	Boat interviews	Totals
Interviews	792	63	855
Weekday	433	37	470
Weekend	359	26	385
Number of anglers	1,931	124	2,055
Weekday	934	74	1,008
Weekend	997	50	1,047
Angler activity	1,931	124	2,055
Fishing Only	460	102	562
Crabbing Only	589	0	589
Fishing and Crabbing	882	22	904
Angler Origin*	1,909	118	2,032
Local (Hyde County)	305	25	330
Regional**	612	9	621
NC county	801	81	887
Non-resident	191	3	194

(\*) – Based on angler interviews from each daily session; may include repeat anglers

(\*\*) – Regional NC counties bordering Hyde County (Beaufort, Dare, Tyrell, Washington)

TABLE 4. —Summary of observed interviews for bank and boat activity at Lake Mattamuskeet Creel Survey during 118 creel day sessions from 1 March to 31 October 2014 (245 days).

Period	Characteristic	Bank	Bank	Bank	Boat	Totals
		interviews General Angling Activity	interviews Targeting Blue Crab	interviews Targeting Fish Species	interviews	
Overall	Interviews	335	233	222	63	853
	Weekday	174	140	118	37	469
	Weekend	161	93	104	26	384
March	Weekday	7	0	21	8	36
	Weekend	11	0	30	12	53
April	Weekday	28	18	37	18*	101
	Weekend	9	7	16	3	35
May	Weekday	43	39	26	4	112
	Weekend	46	39	26	10	121
June	Weekday	26	20	10	5*	61
	Weekend	8	5	4	0	17
July	Weekday	14	18	3	1	36
	Weekend	30	11	5	1	47
August	Weekday	16	16	6	0	38
	Weekend	25	18	13	0	56
September	Weekday	16	15	5	1	37
	Weekend	16	5	2	0	23
October	Weekday	24	14	10	0	48
	Weekend	16	8	8	0	32

(\*) – Includes 1 kayak interview fishing for anything

TABLE 5. —Summary of anglers encountered during each month for bank and boat activity at Lake Mattamuskeet Creel Survey during 118 creel day sessions from 1 March to 31 October 2014 (245 days).

Period	Characteristic	General Bank Angling Crabbing	Bank interviews Targeting Blue Crab	Bank interviews Targeting Fish Species	Boat interviews - Fishing	Totals
Overall	Anglers	882	589	460	124	2,055
	Weekday	400	314	220	74	1,008
	Weekend	482	275	240	50	1,047
March	Weekday	14		42	13	69
	Weekend	28		72	23	123
April	Weekday	69	43	76	38*	226
	Weekend	25	15	32	6	78
May	Weekday	90	78	52	8	228
	Weekend	148	119	58	20	345
June	Weekday	61	45	14	11**	131
	Weekend	36	16	6	0	58
July	Weekday	39	49	5	2	95
	Weekend	95	27	15	1	138
August	Weekday	36	42	11	0	89
	Weekend	72	64	38	0	174
September	Weekday	33	30	7	2	72
	Weekend	36	13	3	0	52
October	Weekday	58	27	13	0	98
	Weekend	42	21	16	0	79

(\*) – Includes 1 kayak interview fishing for anything

(\*\*) – Includes 1 kayak interview fishing for anything

TABLE 6. —Summary of species composition from observed interviews with number of participants involved in the catch and harvest from Lake Mattamuskeet Creel Survey during 118 creel day sessions from 1 March to 31 October 2014 (245 days). Totals for Interviews and Anglers/Crabbers may include duplicate counts as some anglers fished for more than one species.

Species	Interviews	Anglers/Crabbers	Number Reported Caught	Number Observed Harvested	Number Calculated Released
Black Crappie	132	282	1358	1021	337
Largemouth Bass	65	140	205	70	135
White Perch	169	416	1012	766	246
Channel Catfish	220	573	629	515	114
Common Carp	33	90	63	50	13
Other Fish			149	38	111
Total Fish	619	1501	3416	2460	956
Blue Crab	377	999	3149	2957	192
Overall Totals	996	2500	6565	5417	1148

TABLE 7. —Details of angler origin determined during each month for bank and boat activity at Lake Mattamuskeet during 118 creel sessions from 1 March to 31 October 2014 (245 days).

Period	Origin	Bank General	Bank Blue Crab	Bank Fish Species	Boat Fishing	Totals
March	Hyde	3	0	15	6	24
	Near Hyde	18	0	52	8	78
	Other NC	19	0	39	20	78
	Non-NC	2	0	7	2	11
April	Hyde	10	25	22	4	61
	Near Hyde	34	11	48	1	94
	Other NC	47	22	35	38	142
	Non-NC	0	0	3	1	4
May	Hyde	34	51	10	12	107
	Near Hyde	76	69	28	0	173
	Other NC	112	60	67	16	255
	Non-NC	14	9	4	0	27
June	Hyde	7	15	4	2	28
	Near Hyde	24	10	5	0	39
	Other NC	44	23	9	8	84
	Non-NC	22	13	0	0	35
July	Hyde	10	13	1	1	25
	Near Hyde	41	20	12	0	73
	Other NC	62	29	6	2	99
	Non-NC	21	14	1	0	36
August	Hyde	21	14	3	0	38
	Near Hyde	35	29	12	0	76
	Other NC	36	27	30	0	93
	Non-NC	16	36	0	0	52
September	Hyde	8	11	3	0	22
	Near Hyde	25	18	2	0	45
	Other NC	31	1	5	2	39
	Non-NC	4	13	0	0	17
October	Hyde	11	11	3	0	25
	Near Hyde	22	15	6	0	43
	Other NC	63	14	20	0	97
	Non-NC	4	8	0	0	12
		876	581	452	123	2032

TABLE 8. —Details of angler origin and targeted fish species for bank and boat activity at Lake Mattamuskeet during 118 creel sessions from 1 March to 31 October 2014 (245 days). Anglers may have indicated more than one targeted species.

Origin	Targeted Species	Bank Anglers	% Anglers	Boat Anglers	% Anglers	Overall Anglers	% Anglers
Hyde	Black Crappie	40	36.4	11	68.8	51	40.5
	Channel Catfish	29	26.4	1	6.3	30	23.8
	White Perch	30	27.3	0	0.0	30	23.8
	Largemouth Bass	11	10.0	4	25.0	15	11.9
Regional	Black Crappie	31	10.1	9	69.2	40	12.5
	Channel Catfish	161	52.4	0	0.0	161	50.3
	White Perch	108	35.2	2	15.4	110	34.4
	Largemouth Bass	7	2.3	2	15.4	9	2.8
NC	Black Crappie	78	19.8	49	56.3	127	26.5
	Channel Catfish	165	42.0	5	5.7	170	35.4
	White Perch	130	33.1	0	0.0	130	27.1
	Largemouth Bass	20	5.1	33	37.9	53	11.0
Non-Resident	Black Crappie	7	15.6	1	25.0	8	16.3
	Channel Catfish	18	40.0	1	25.0	19	38.8
	White Perch	10	22.2	2	50.0	12	24.5
	Largemouth Bass	10	22.2	0	0.0	10	20.4

TABLE 9. —Summary of responses to number of days spent fishing or crabbing at Lake Mattamuskeet during the previous month.

Period	Responses	Number of Days Fishing or Crabbing in Previous Month							
		0	1-5	6-10	11-15	16-20	21-25	26-30	>31
Fishing Trips									
March	76	5	64	5	0	1	1	0	0
April	83	25	52	4	1	1	0	0	0
May	187	45	117	15	6	4	0	0	0
June	74	24	43	1	2	2	0	2	0
July	83	21	55	5	0	2	0	0	0
August	94	36	52	3	0	3	0	0	0
September	58	28	23	2	2	2	0	1	0
October	80	11	56	10	2	1	0	0	0
Total	735	195	462	45	13	16	1	3	0
Crabbing Trips									
March	6	0	6	0	0	0	0	0	0
April	21	12	8	1	0	0	0	0	0
May	101	47	45	7	1	1	0	0	0
June	56	22	29	0	2	1	0	2	0
July	83	21	55	5	0	2	0	0	0
August	90	34	50	3	0	3	0	0	0
September	58	28	23	2	2	2	0	1	0
October	80	11	56	10	2	1	0	0	0
Total	495	175	272	28	7	10	0	3	0



TABLE 10. —Summary of responses to number of days spent fishing or crabbing at Lake Mattamuskeet during the previous 12 months.

Period	Responses	Number of Days Fishing or Crabbing in Past 12 Months							
		0	1-30	31-60	61-90	91-120	121-150	241-270	331-360
Fishing Trips									
March	55	7	44	3	1	0	0	0	0
April	107	12	94	0	0	1	0	0	0
May	177	35	129	5	0	7	1	0	0
June	73	18	49	3	1	2	0	0	0
July	83	20	58	4	0	0	1	0	0
August	94	26	57	4	1	4	1	1	0
September	57	20	33	0	1	2	0	0	1
October	80	8	67	4	1	0	0	0	0
Total	726	146	531	23	5	16	3	1	1
Crabbing Trips									
March	6	2	4	0	0	0	0	0	0
April	19	9	9	0	0	1	0	0	0
May	91	40	43	4	0	4	0	0	0
June	55	18	32	3	1	1	0	0	0
July	83	20	58	4	0	0	1	0	0
August	90	25	54	4	1	4	1	1	0
September	56	20	32	0	1	2	0	0	1
October	80	8	67	4	1	0	0	0	0
Total	480	142	299	19	4	12	2	1	1

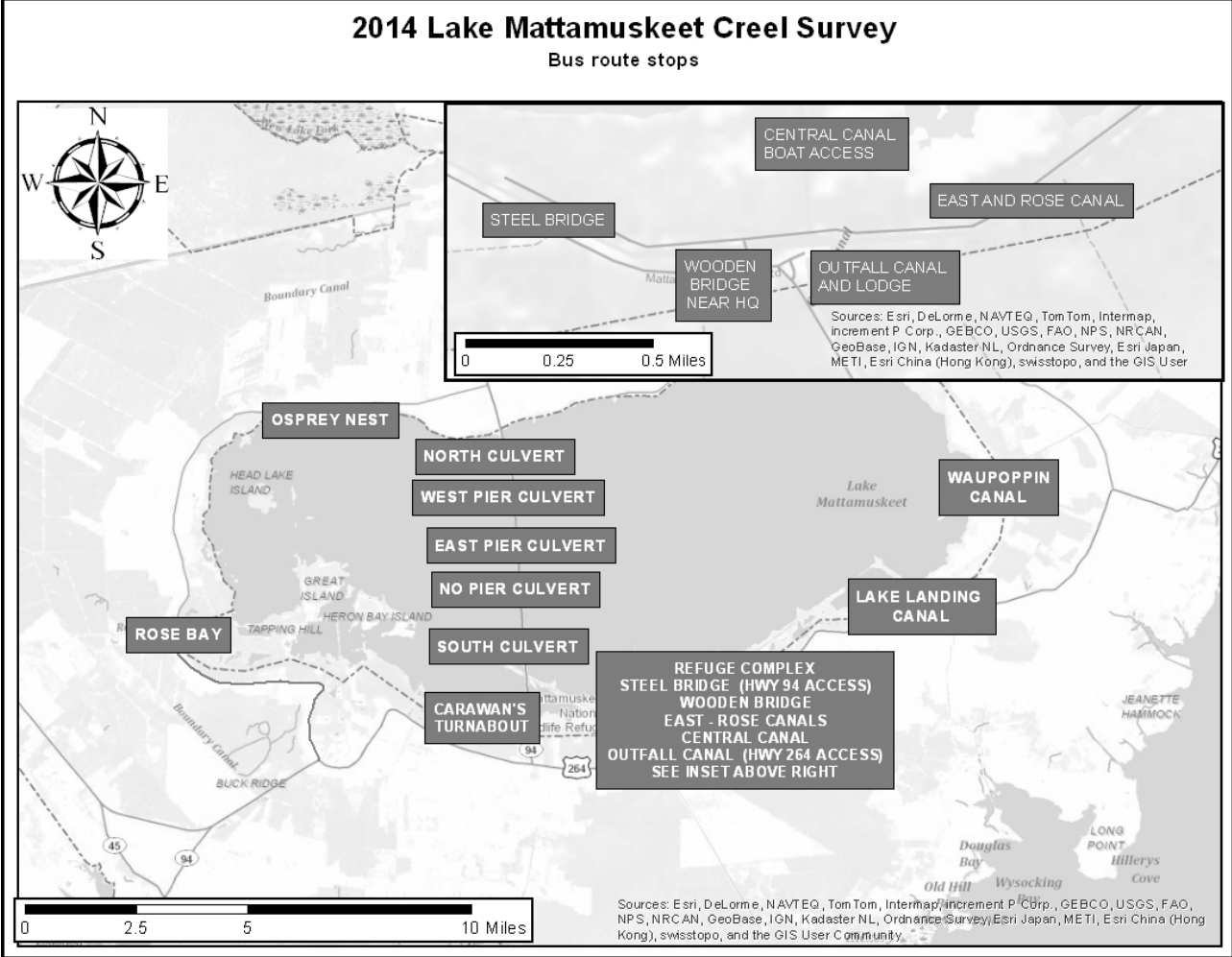


FIGURE 1. —Map of Lake Mattamuskeet with 15 access sites for the bus route creel survey conducted from 1 March to 31 October 2014.

**Lake Mattamuskeet Creel Survey** Angler Interview Sheet #: \_\_\_\_\_

Interview Date \_\_\_\_/\_\_\_\_/2014 Access Area: \_\_\_\_\_  
Month Day

CHECK TRIP TYPE FOR THIS INTERVIEW  Boat  Kayak  Bank  Wading

**EFFORT:** As you approach the party, Record Time of Interview: \_\_\_\_\_

**What TIME did you start fishing today?** Record Angler Time Started \_\_\_\_\_

**How many anglers fishing in your party today?** Record the Number of Anglers in Party: \_\_\_\_

**Are you done fishing/crabbing for the day at the Lake?**  Yes  No

**DID YOU FISH OR CRAB ANYWHERE ELSE ON THE LAKE TODAY?** (Check all that apply)

West Lake  West Canals  Hwy 94 Culverts  East Lake  East Canals  No

What did you fish for today? Catch Any? Keep Any?				Total Weight (kg)	May I measure any fish kept?
Species	Targeted	#Caught	#Kept		Individual Total Lengths in mm (up to 5 by species)
Black Crappie	<input type="checkbox"/>	_____	_____	_____	_____
Largemouth Bass	<input type="checkbox"/>	_____	_____	_____	_____
Bluegill	<input type="checkbox"/>	_____	_____	_____	_____
Channel Catfish	<input type="checkbox"/>	_____	_____	_____	_____
White Perch	<input type="checkbox"/>	_____	_____	_____	_____
Striped Bass	<input type="checkbox"/>	_____	_____	_____	_____
_____	<input type="checkbox"/>	_____	_____	_____	_____
_____	<input type="checkbox"/>	_____	_____	_____	_____
Anything that bites	<input type="checkbox"/>	_____	_____	_____	_____
Blue Crab	<input type="checkbox"/>	_____	_____	_____	_____

**What method did you use to catch Blue Crabs?**  
 Handline  Hand trap  Other

Were any species below released? (Write counts in blanks) How many less than length limit? How many at or greater than length limit?			What fishing bait or method did you use?	What county are you from? If not NC, what state are you from? (Enter # anglers; e.g. 3 Pitt + 2 VA)
Species	Too small	Legal		
Black Crappie	<8 _____	≥8 _____	<input type="checkbox"/> Live _____	____ Hyde ____ Tyrrell
Largemouth Bass	<14 _____	≥14 _____	<input type="checkbox"/> Cut _____	____ Dare ____ Beaufort
Striped Bass	<18 _____	≥18 _____	<input type="checkbox"/> Artificial	____ NC County _____
_____	_____	_____	<input type="checkbox"/> Fly rod	____ NC County _____
Blue Crab	_____	_____	<input type="checkbox"/> Bow/Arrow	____ Out-of-State _____
			<input type="checkbox"/> Other	____ Not Given _____

How many days did you fish at the Lake last month? \_\_\_\_\_ How many days in last 12 months? \_\_\_\_\_

How many days did you crab at the Lake last month? \_\_\_\_\_ How many days in last 12 months? \_\_\_\_\_

**Would you participate in a follow-up survey on fish management at the Lake?**

YES - NEW  YES - REPEAT  NO

Any Yes, write in: **Angler's first and last name:** \_\_\_\_\_

If Yes - New, write-in: **Street Address:** \_\_\_\_\_

If Yes - New, write-in: **City, State and Zip Code:** \_\_\_\_\_

Thank you for your time and cooperation!

FIGURE 2. —Creel survey instrument utilized to capture interview data during the Lake Mattamuskeet Creel Survey from 1 March to 31 October 2014.

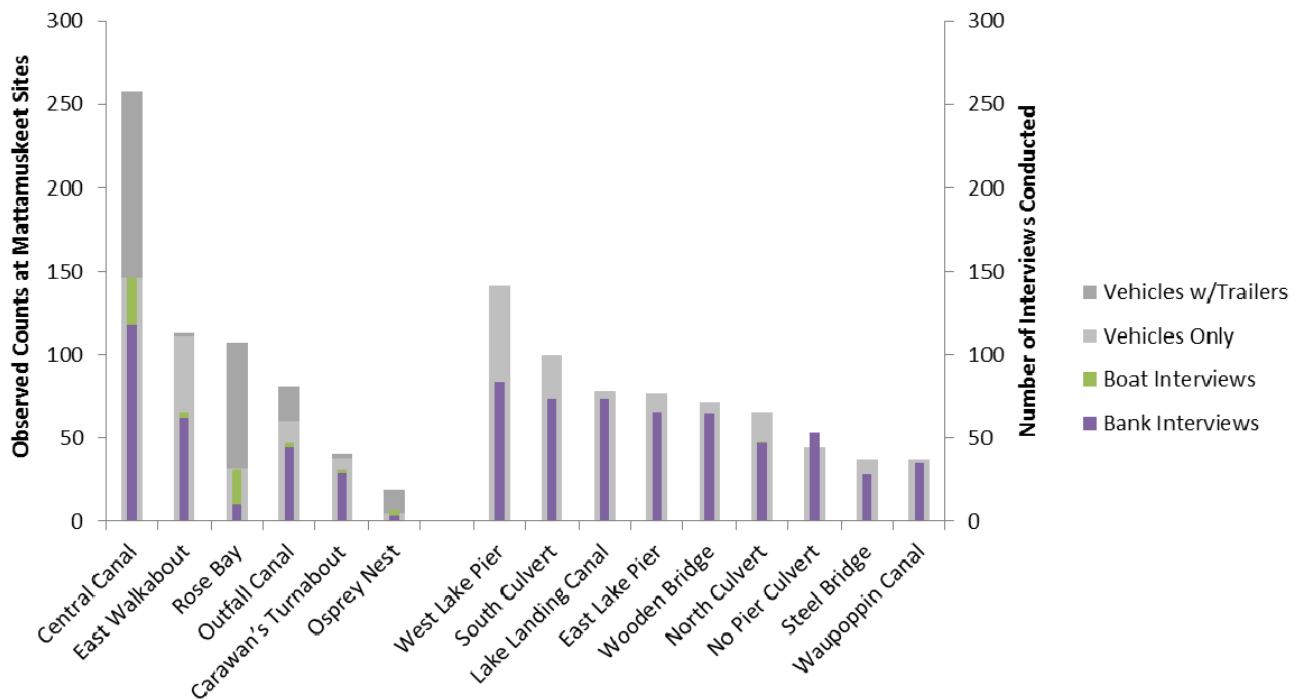


FIGURE 3. — Observed counts of vehicles (light gray) and vehicles with trailers (dark gray) at time of arrival at access site as well as boat (green) and bank (purple) interviews conducted by access area during 118 creel sessions from 1 March to 31 October 2014 (245 days) on the Lake Mattamuskeet Creel Survey. Sites left of the break on the X-axis provide both bank and boat access, whereas sites to the right of the break are primarily for bank angling, although a canoe or kayak could be launched near these sites.

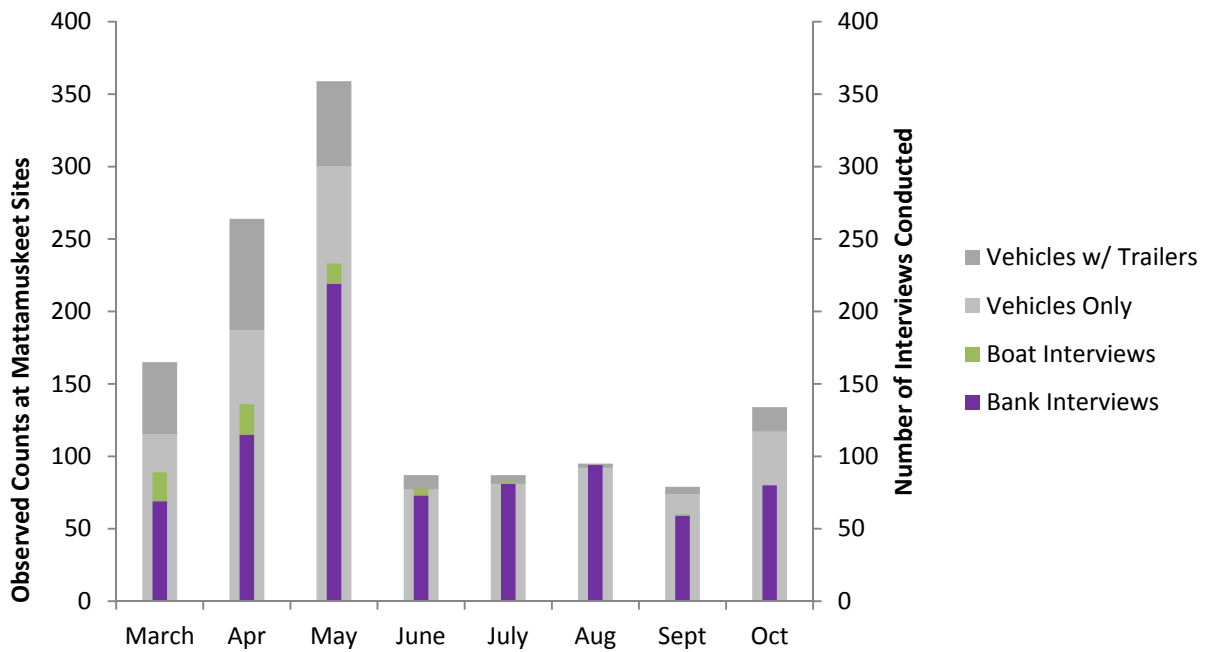


FIGURE 4. —Observed counts of vehicles (light gray) and vehicles with trailers (dark gray) at time of arrival at access site as well as boat (green) and bank (purple) interviews conducted by month during 118 creel sessions from 1 March to 31 October 2014 (245 days) on the Lake Mattamuskeet Creel Survey.

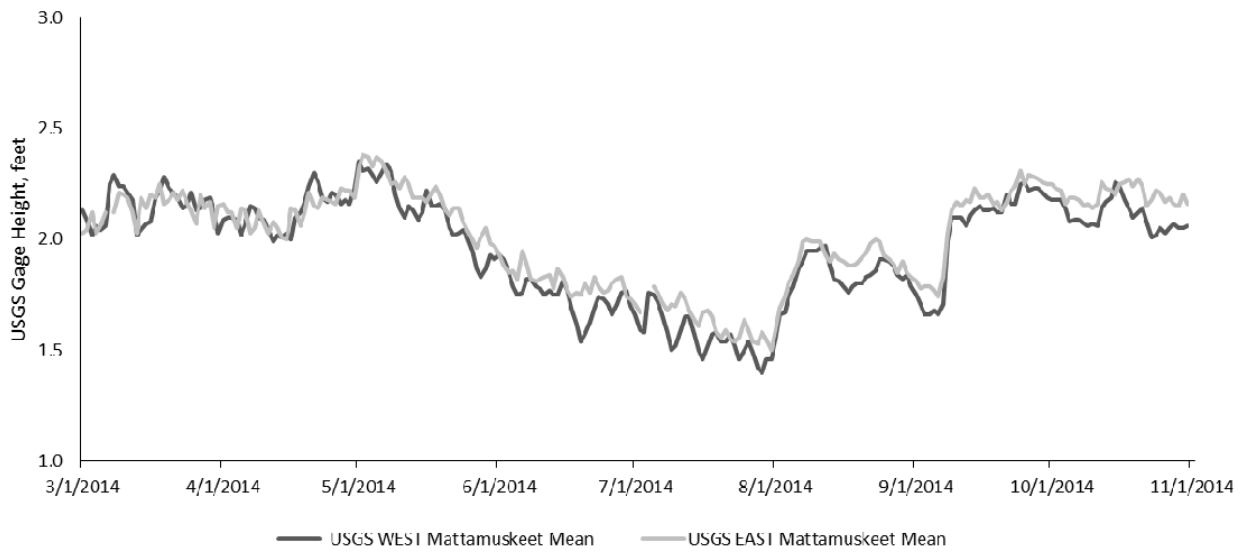


FIGURE 5. —Mean USGS gage height on the east and west sections of Lake Mattamuskeet from 1 March to 31 October 2014.

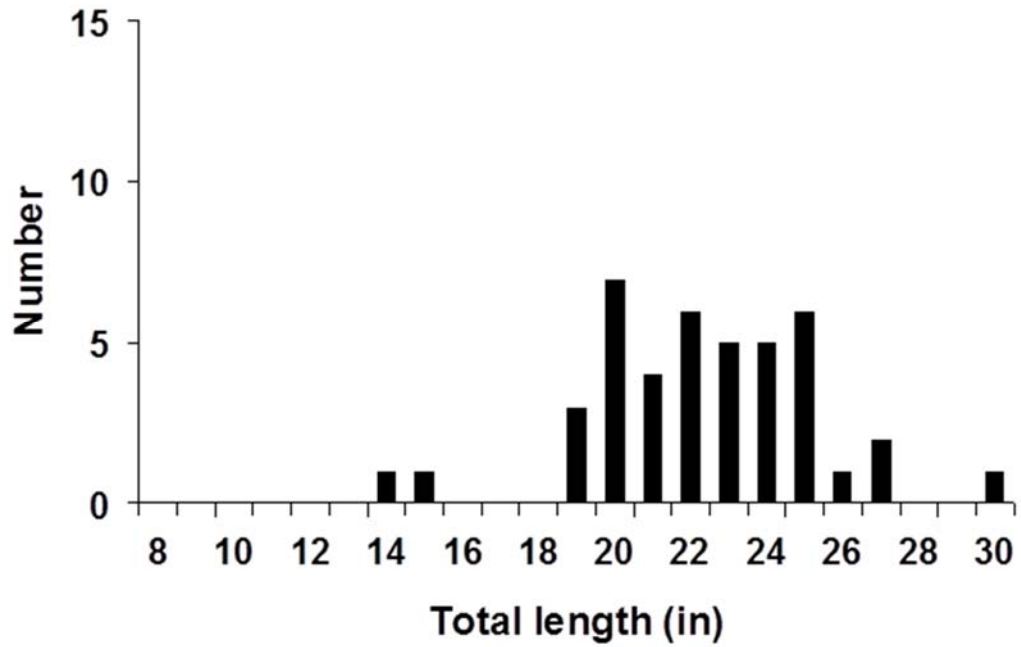


FIGURE 6. —Length distribution of a subsample (N = 42) of Common Carp harvested by anglers and measured by creel clerks during the Lake Mattamuskeet Creel Survey from 1 March to 31 October 2014. Common Carp have no minimum length limit or bag limit at Lake Mattamuskeet.

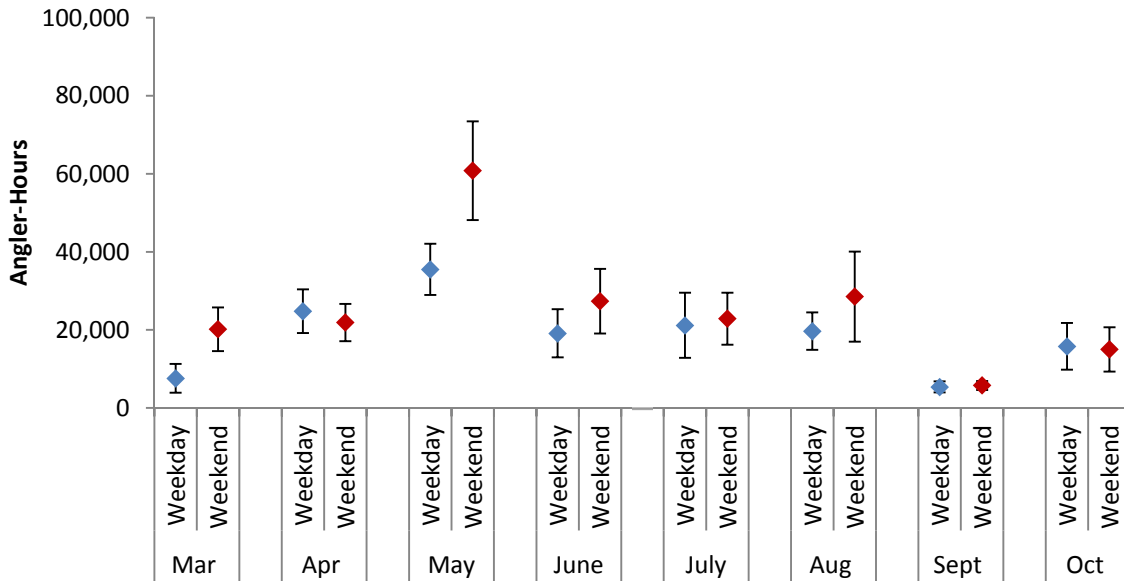


FIGURE 7. —Estimated total number of angler-hours of angling and crabbing by month and daytype , weekday (blue) and weekend (red), from the Lake Mattamuskeet Creel Survey conducted between 1 March and 31 October 2014. Error bars are  $\pm 1$  SE.

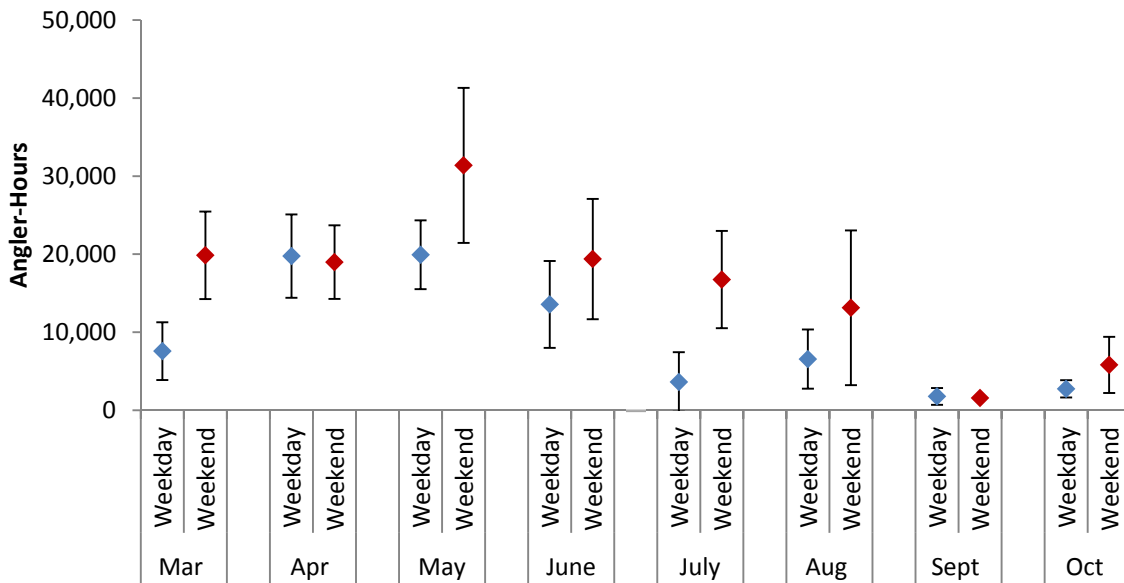


FIGURE 8. —Estimated angler-hours expended by anglers for month and daytype from the Lake Mattamuskeet Creel Survey as calculated from weekday (blue) and weekend (red) interviews conducted between 1 March and 31 October 2014. Error bars are  $\pm 1$  SE.



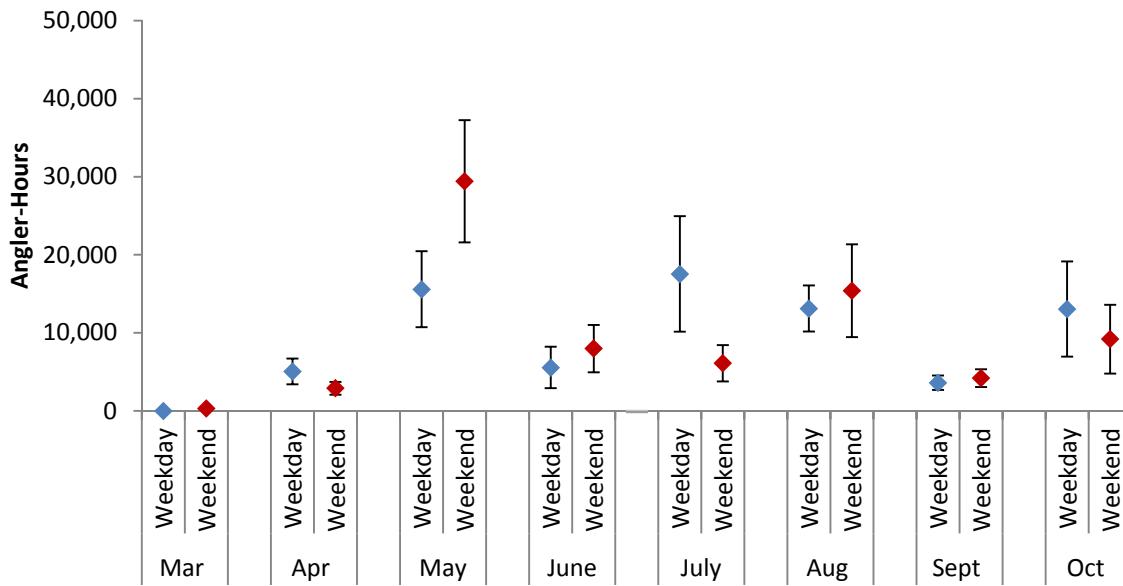


FIGURE 9. —Estimated angler-hours expended by crabbers for month and daytype for Blue Crabs at the Lake Mattamuskeet Creel Survey as calculated from weekday (blue) and weekend (red) interviews conducted between 1 March and 31 October 2014. Error bars are  $\pm 1$  SE.

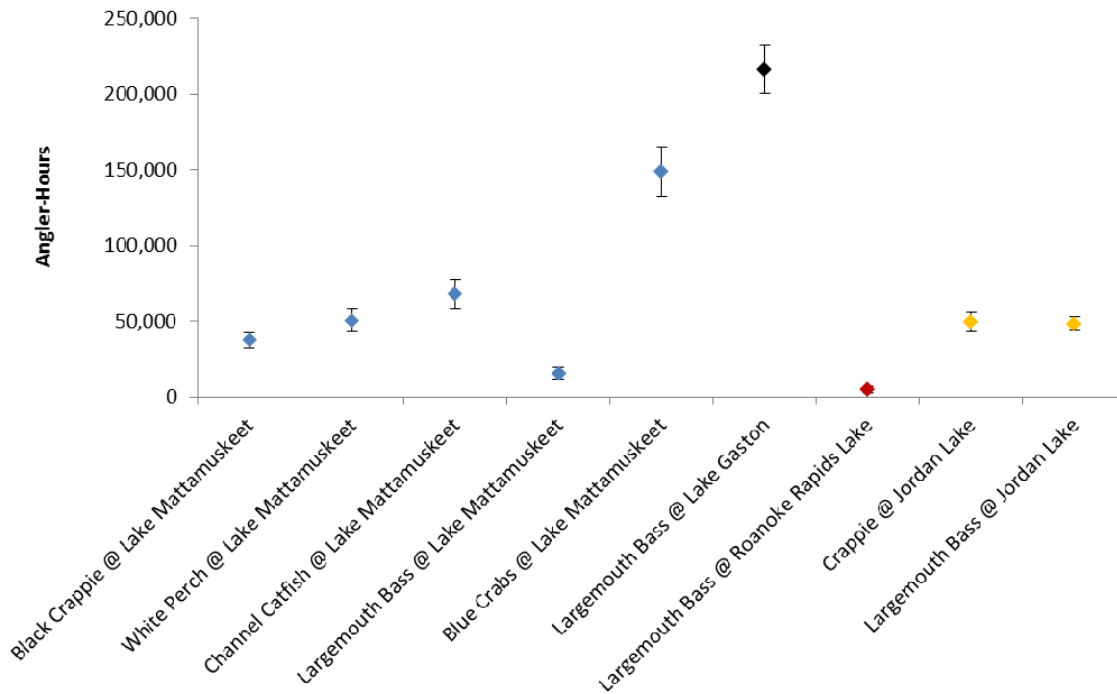


FIGURE 10. —Relative angler effort expended for Black Crappie, White Perch, Channel Catfish, Largemouth Bass, other fish, and Blue Crab at Lake Mattamuskeet during the 2014 creel survey. Angler effort for Largemouth Bass at Lake Gaston (Rundle et al. 2009), Largemouth Bass at Roanoke Rapids Reservoir (Rundle et al. 2015), and Crappie and Largemouth Bass at Jordan Lake were included for comparison (Commission, unpublished data).

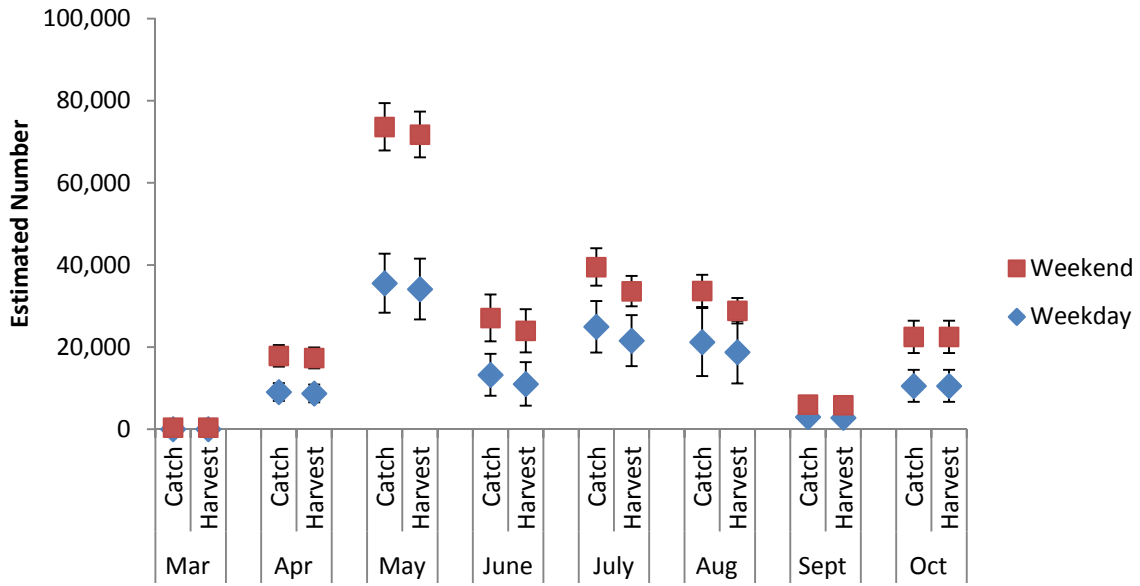


FIGURE 11. — Estimated number of Blue Crabs caught and harvested during the Lake Mattamuskeet Creel Survey as calculated from weekday (blue) and weekend (red) interviews conducted between 1 March and 31 October 2014. Error bars are  $\pm 1$  SE.

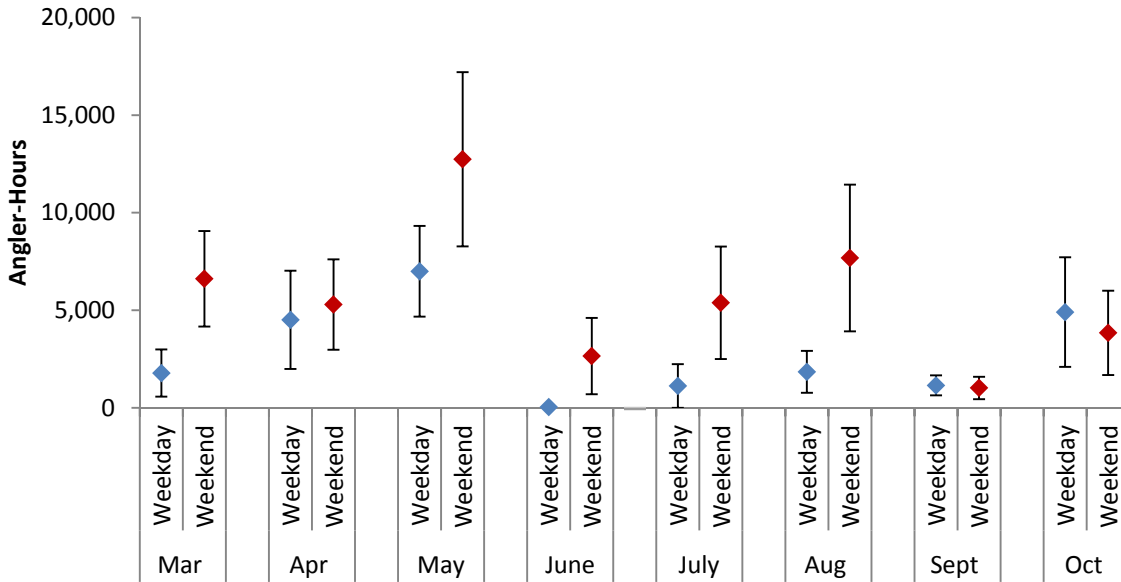


FIGURE 12. —Estimated effort (angler-hours) expended for Channel Catfish during the Lake Mattamuskeet Creel Survey as calculated from weekday (blue) and weekend (red) interviews conducted between 1 March and 31 October 2014. Error bars are  $\pm 1$  SE.

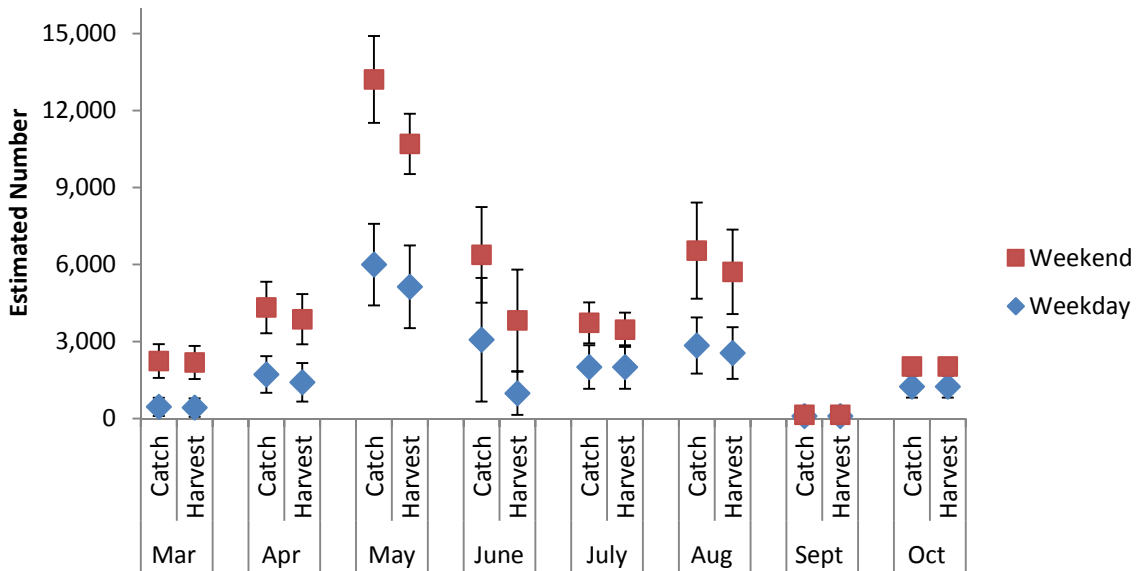


FIGURE 13. —Estimated number of Channel Catfish caught and harvested by anglers during the Lake Mattamuskeet Creel Survey calculated from weekday (blue) and weekend (red) interviews conducted between 1 March and 31 October 2014. Error bars are  $\pm 1$  SE.

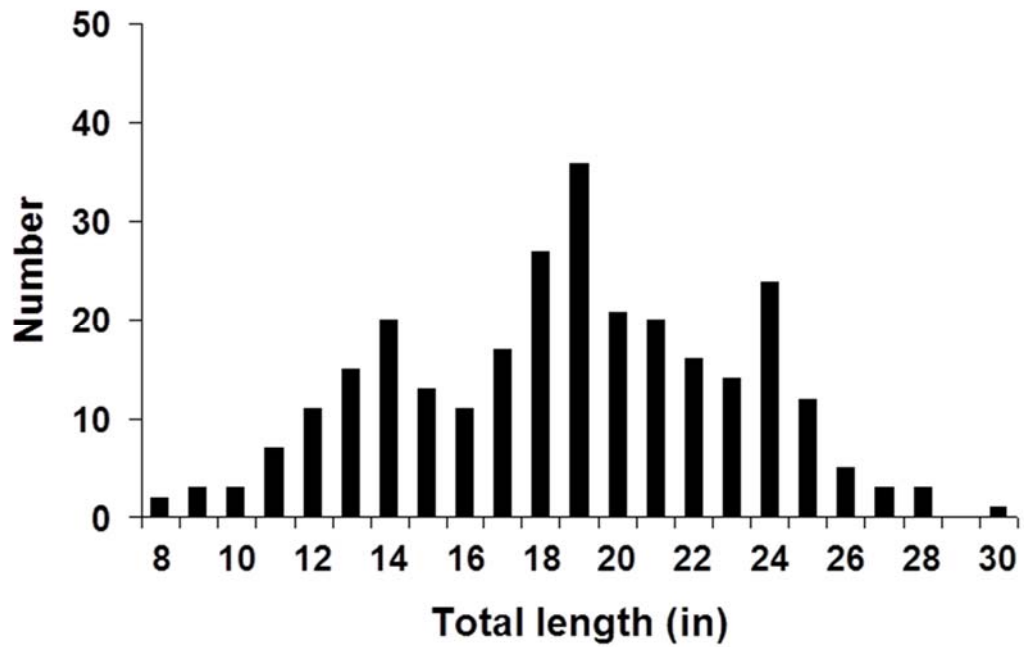


FIGURE 14. —Length distribution of a subsample (N = 285) of Channel Catfish harvested by anglers and measured by creel clerks during the Lake Mattamuskeet Creel Survey from 1 March to 31 October 2014. Channel Catfish have no minimum length limit or bag limit at Lake Mattamuskeet.

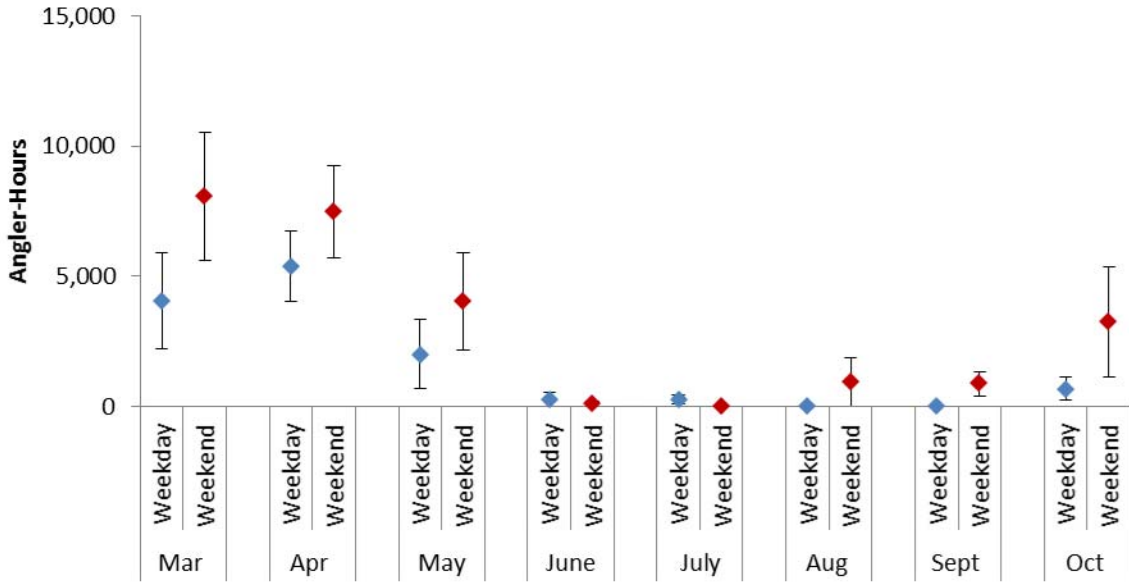


FIGURE 15. — Estimated effort for Black Crappie by month during the Lake Mattamuskeet Creel Survey calculated from weekday (blue) and weekend (red) interviews conducted between 1 March and 31 October 2014. Error bars are  $\pm 1$  SE.

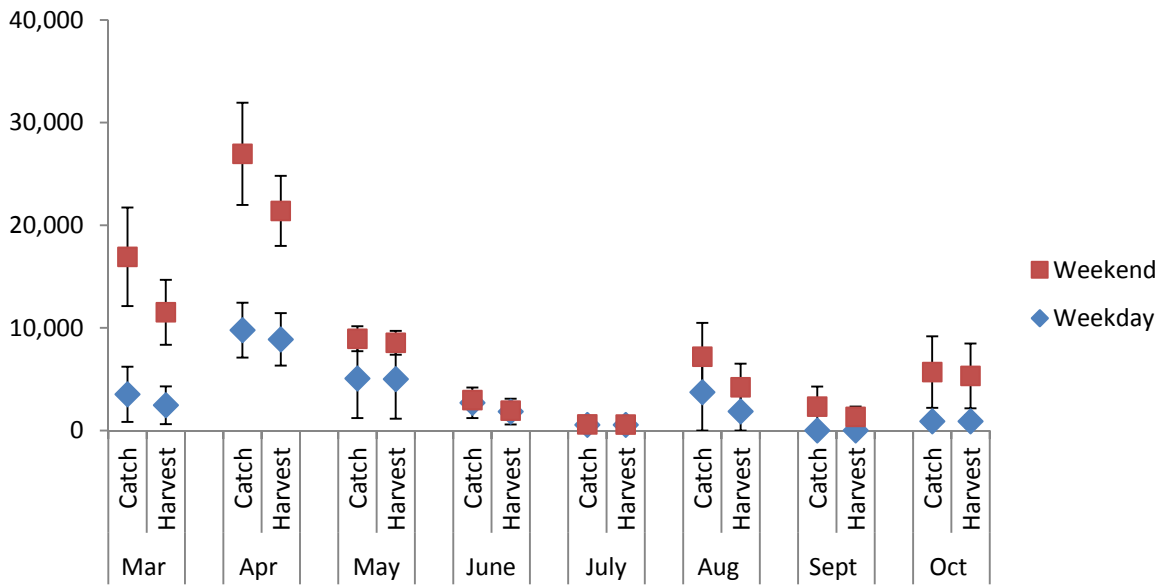


FIGURE 16. — Estimated number of Black Crappie caught and harvested by anglers during the Lake Mattamuskeet Creel Survey calculated from weekday (blue) and weekend (red) interviews conducted between 1 March and 31 October 2014. Error bars are  $\pm 1$  SE.

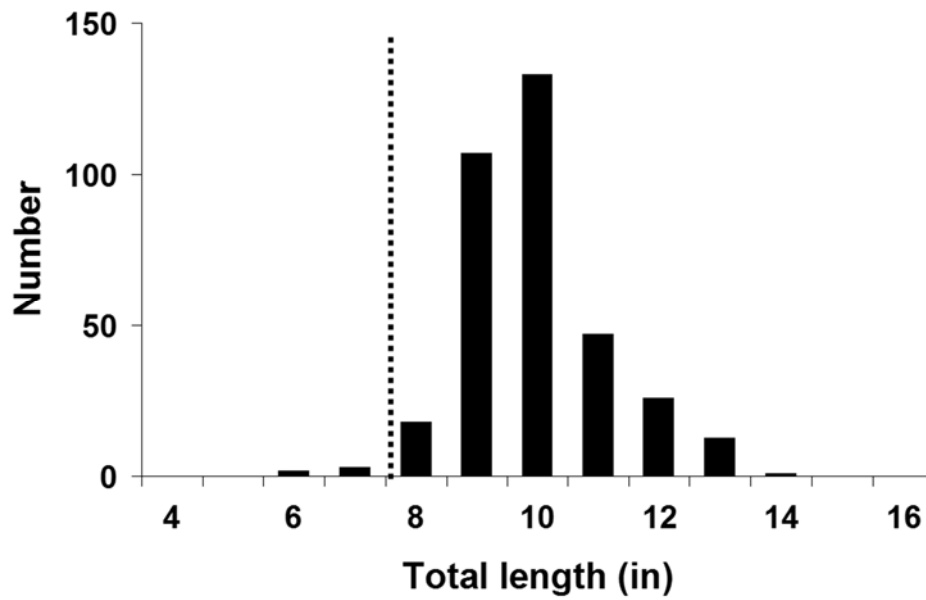


FIGURE 17. —Length distribution (N = 350) Black Crappie harvested by anglers and measured by creel clerks during the Lake Mattamuskeet Creel Survey from 1 March to 31 October 2014. Dotted line represents the 8-inch (203-mm) minimum size limit in effect during the entire creel survey.

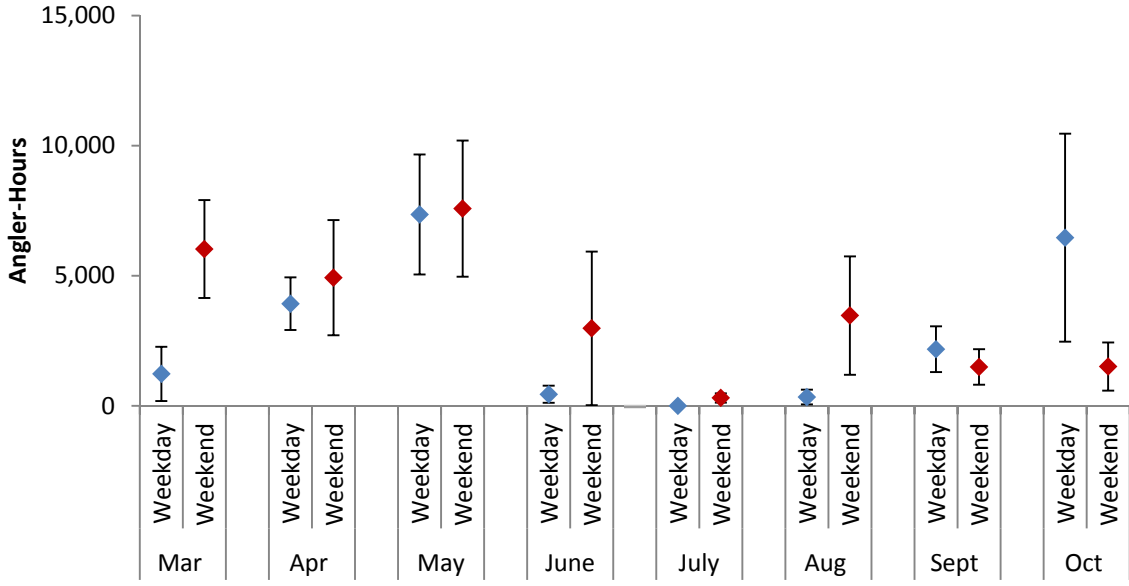


FIGURE 18. —Estimated angler-hours expended for White Perch by anglers during the Lake Mattamuskeet Creel Survey calculated from weekday (blue) and weekend (red) interviews conducted between 1 March and 31 October 2014. Error bars are  $\pm 1$  SE.

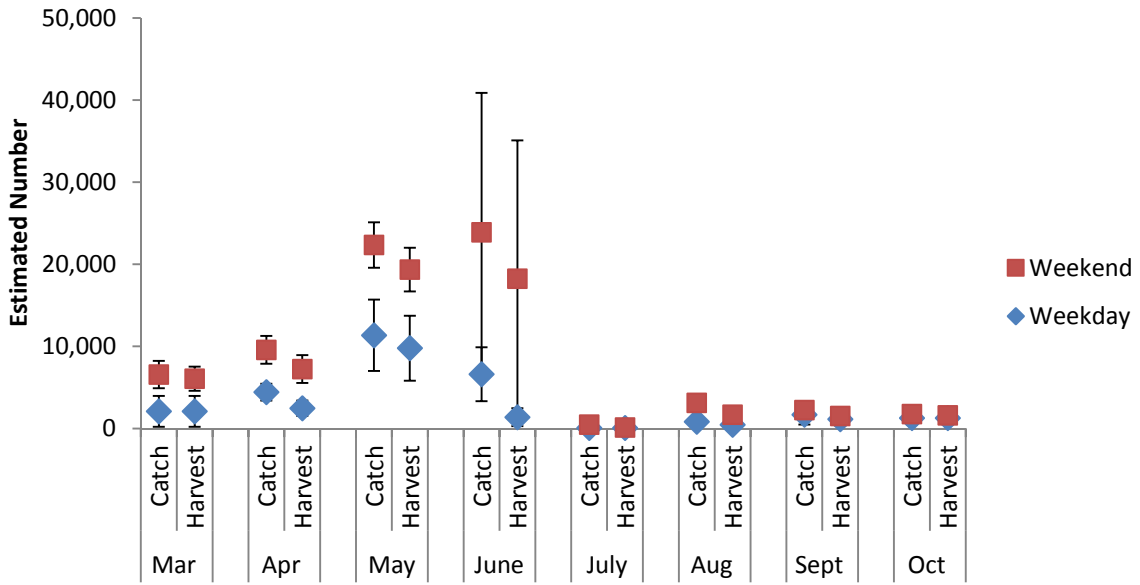


FIGURE 19. —Estimated number of White Perch caught and harvested by anglers during the Lake Mattamuskeet Creel Survey calculated from weekday (blue) and weekend (red) interviews conducted between 1 March and 31 October 2014. Error bars are  $\pm 1$  SE.



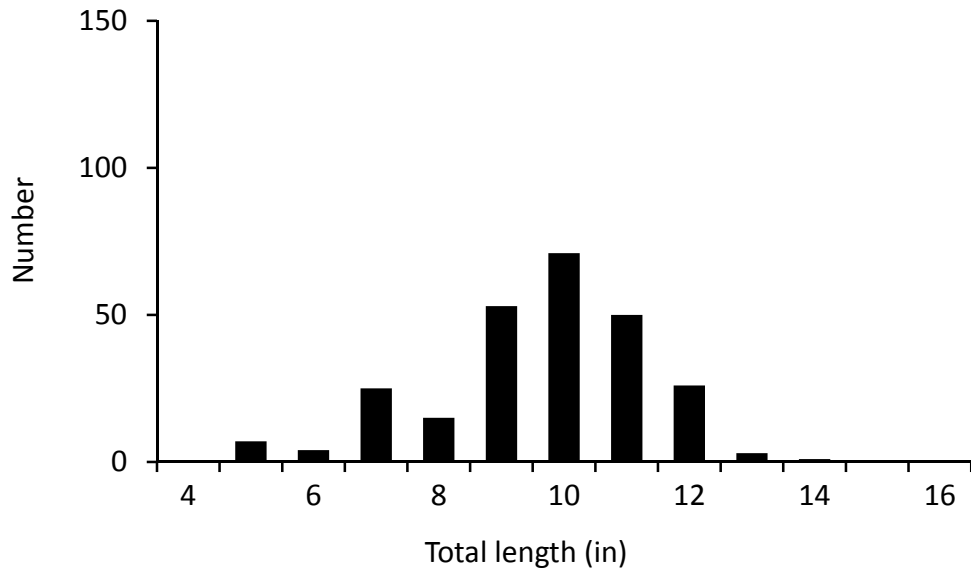


FIGURE 20. —Length distribution (N = 255) of White Perch harvested by anglers and measured by creel clerks during the Lake Mattamuskeet Creel Survey from 1 March to 31 October 2014. White Perch have no minimum length limit or bag limit at Lake Mattamuskeet.

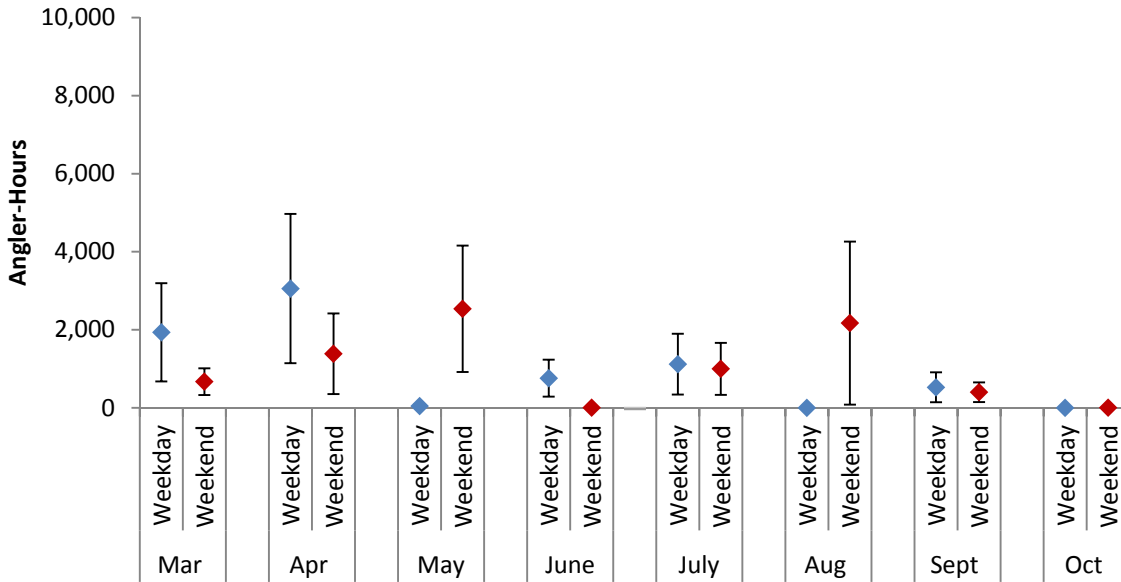


FIGURE 21. —Estimated angler-hours expended for Largemouth Bass during the Lake Mattamuskeet Creel Survey calculated from weekday (blue) and weekend (red) interviews conducted between 1 March and 31 October 2014. Error bars are  $\pm 1$  SE.

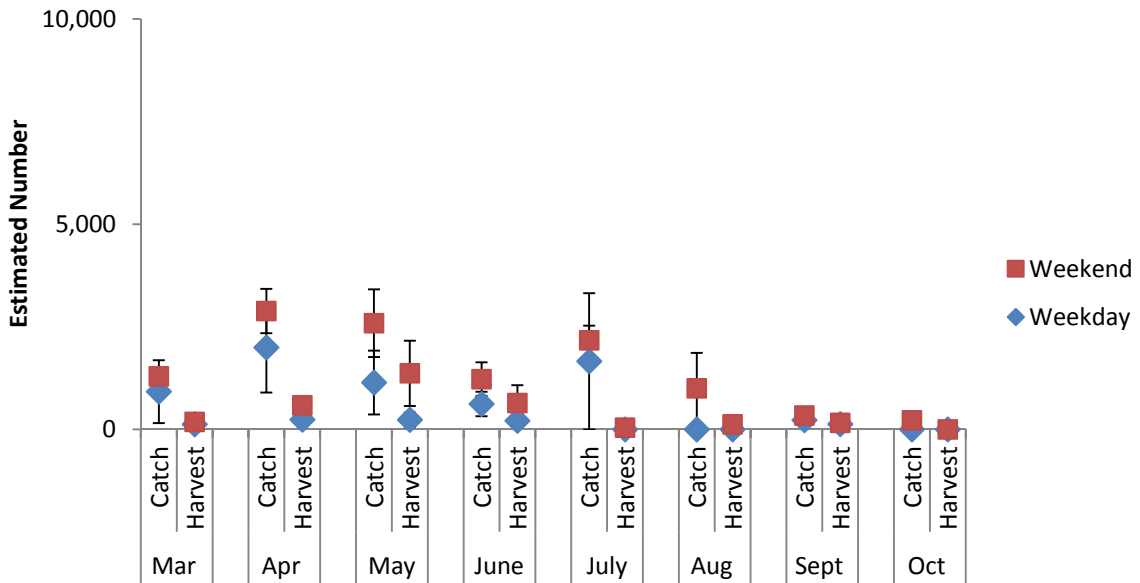


FIGURE 22. —Estimated number of Largemouth Bass caught and harvested by anglers during the Lake Mattamuskeet Creel Survey calculated from weekday (blue) and weekend (red) interviews conducted between 1 March and 31 October 2014. Error bars are  $\pm 1$  SE.

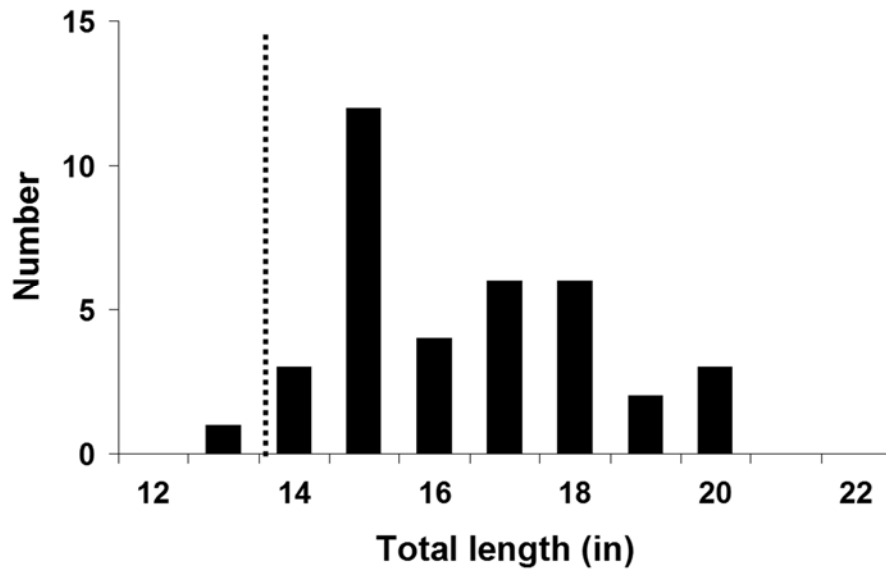


FIGURE 23. —Length distribution (N = 37) of Largemouth Bass harvested by anglers and measured by creel clerks during the Lake Mattamuskeet Creel Survey from 1 March to 31 October 2014. Dotted line represents the 14-inch (356-mm) minimum size limit regulation for Largemouth Bass in effect during the entire creel survey.

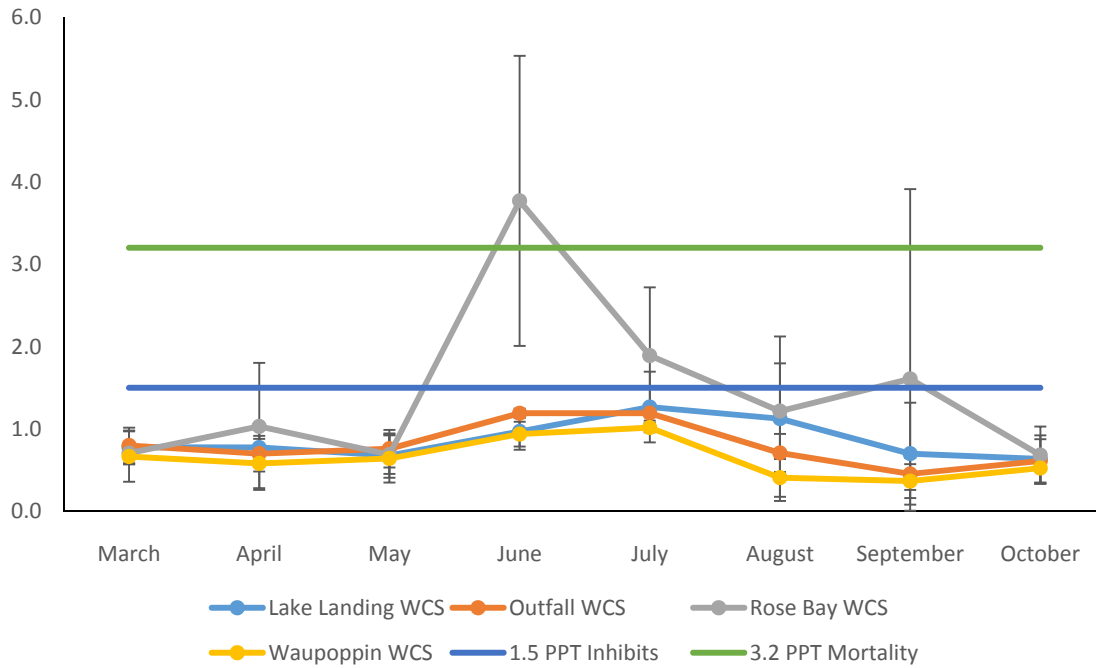


FIGURE 24. —Mean salinity measurements ( $\pm 1$  SD) during each month (period) at the lake side of the four water control structures at Lake Mattamuskeet. During the month of June, the gates at Rose Bay WCS were open due to clogged debris. Reference lines are provided in parts per thousand (ppt) that inhibit survival of Black Crappie (Blue line at 1.6 ppt) or are detrimental to eggs and fry of Largemouth Bass and Bluegill (Green line at 3.2 ppt).

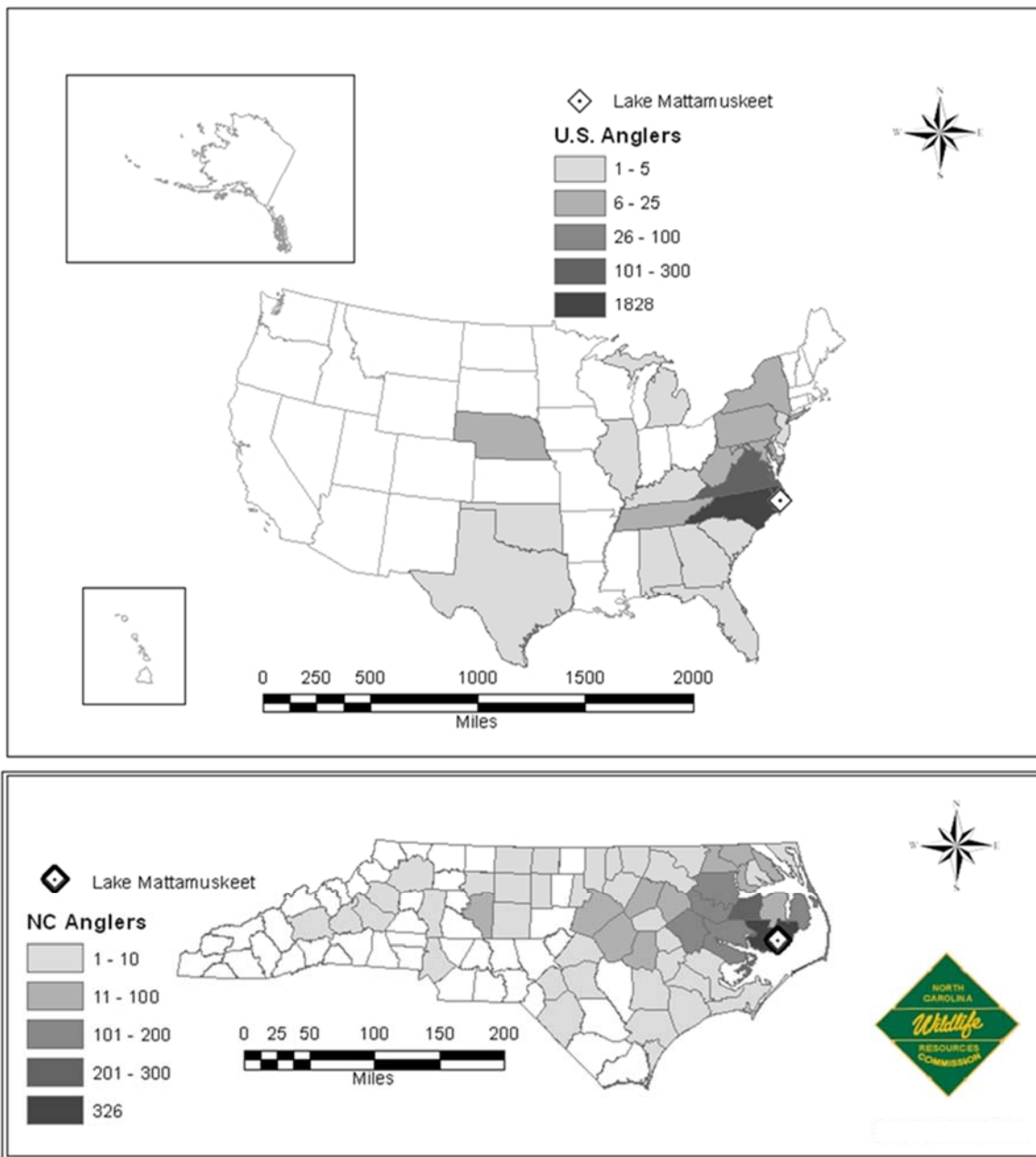


FIGURE 25. —Origin of anglers and crabbers interviewed at Lake Mattamuskeet during a Creel Survey with 118 creel sessions from 1 March to 31 October 2014 (245 days).

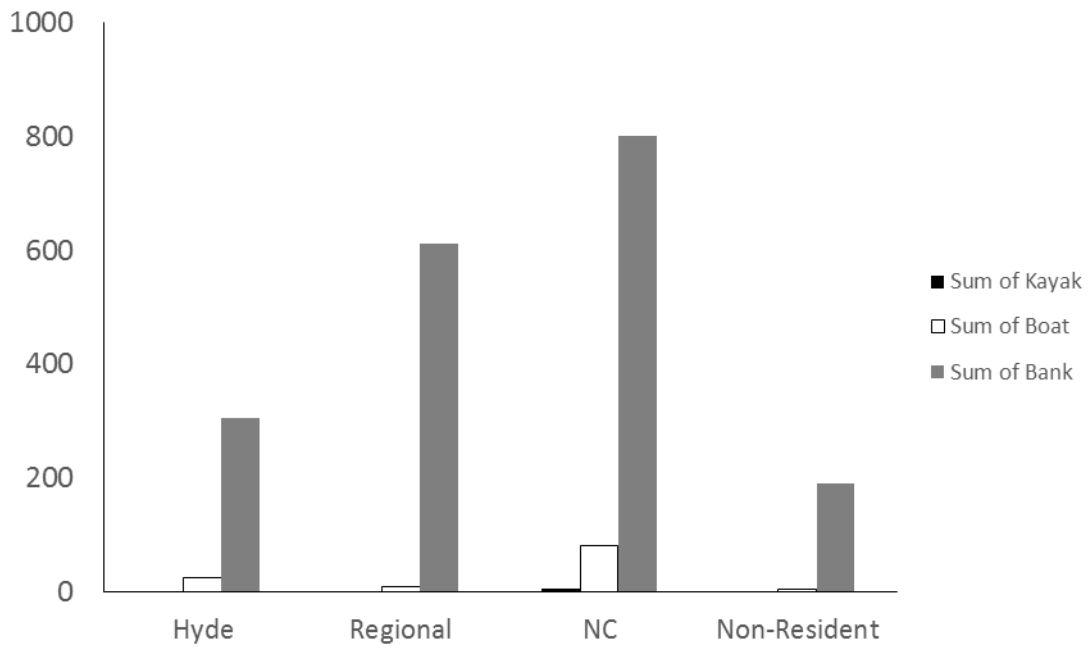


FIGURE 26. —Relative frequency among trip type and four angler origin groups of Hyde County, four regional counties near the lake, other North Carolina counties, and non-residents.

APPENDIX 1. —Estimated effort (angler-hours; SE) expended by month and type of day for Largemouth Bass, Black Crappie, Channel Catfish, White Perch, and Blue Crab from the Lake Mattamuskeet Creel Survey conducted 1 March–31 October 2014.

Period	Type	Largemouth Bass	SE	Black Crappie	SE	Channel Catfish	SE	White Perch	SE	Blue Crab	SE
Mar	Weekday	1,934	1,260	4,061	1,830	1,781	1,207	1,226	1,042	-	-
	Weekend	668	342	8,080	2,464	6,614	2,447	6,024	1,882	296	198
Apr	Weekday	3,056	1,912	5,385	1,376	4,508	2,515	3,925	1,013	5,057	1,650
	Weekend	1,384	1,034	7,465	1,769	5,292	2,314	4,923	2,214	2,892	819
May	Weekday	43	43	2,012	1,319	6,997	2,321	7,357	2,306	15,588	4,872
	Weekend	2,536	1,619	4,043	1,872	12,740	4,465	7,578	2,616	29,414	7,830
June	Weekday	759	472	272	272	41	41	444	328	5,558	2,654
	Weekend	-	-	106	106	2,650	1,958	2,976	2,953	7,979	3,037
July	Weekday	1,118	778	254	180	1,120	1,120	-	-	17,552	7,404
	Weekend	997	666	-	-	5,383	2,880	302	178	6,103	2,324
Aug	Weekday	-	-	-	-	1,841	1,075	337	282	13,121	2,945
	Weekend	2,170	2,089	923	923	7,680	3,761	3,468	2,277	15,395	5,940
Sept	Weekday	526	382	38	38	1,149	510	2,177	880	3,606	919
	Weekend	400	251	869	454	1,017	575	1,491	682	4,189	1,130
Oct	Weekday	-	-	670	449	4,905	2,808	6,464	3,998	13,054	6,100
	Weekend	-	-	3,234	2,124	3,840	2,163	1,507	925	9,183	4,411

APPENDIX 2. —Estimated catch and harvest of Blue Crab by month and type of day from the Lake Mattamuskeet Creel Survey conducted 1 March–31 October 2014.

Period	Blue Crab	Weekday	SE	Weekend	SE
March	Catch	-	-	389	186
	Harvest	-	-	389	186
April	Catch	9,057	2,151	8,792	2,629
	Harvest	8,707	2,152	8,655	2,558
May	Catch	35,553	7,185	38,099	5,758
	Harvest	34,124	7,406	37,663	5,580
June	Catch	13,239	5,111	13,866	5,720
	Harvest	11,020	5,306	12,960	5,257
July	Catch	24,952	6,283	14,562	4,571
	Harvest	21,557	6,222	12,075	3,697
August	Catch	21,213	8,291	12,482	3,902
	Harvest	18,779	7,622	10,079	3,115
September	Catch	2,975	758	3,053	893
	Harvest	2,801	742	3,053	893
October	Catch	10,554	3,890	11,933	3,921
	Harvest	10,554	3,890	11,933	3,921



APPENDIX 3. —Estimated catch and harvest of Channel Catfish by month and type of day from the Lake Mattamuskeet Creel Survey conducted 1 March–31 October 2014.

Period	Channel Catfish	Weekday	SE	Weekend	SE
March	Catch	2,088	1,885	4,480	1,668
	Harvest	2,088	1,885	3,978	1,466
April	Catch	4,429	1,026	5,146	1,697
	Harvest	2,465	933	4,773	1,698
May	Catch	11,354	4,337	10,995	2,768
	Harvest	9,776	3,964	9,582	2,660
June	Catch	6,609	3,277	17,295	16,977
	Harvest	1,376	1,084	16,858	16,858
July	Catch	54	54	406	338
	Harvest	54	54	57	57
August	Catch	827	376	2,288	993
	Harvest	455	240	1,215	785
September	Catch	1,671	1,182	563	339
	Harvest	1,125	750	395	263
October	Catch	1,273	792	491	199
	Harvest	1,273	792	331	203

APPENDIX 4. — Estimated catch and harvest of Black Crappie by month and type of day from the Lake Mattamuskeet Creel Survey conducted 1 March–31 October 2014.

Period	Black Crappie	Weekday	SE	Weekend	SE
March	Catch	2,088	1,885	4,480	1,668
	Harvest	2,088	1,885	3,978	1,466
April	Catch	4,429	1,026	5,146	1,697
	Harvest	2,465	933	4,773	1,698
May	Catch	11,354	4,337	10,995	2,768
	Harvest	9,776	3,964	9,582	2,660
June	Catch	6,609	3,277	17,295	16,977
	Harvest	1,376	1,084	16,858	16,858
July	Catch	54	54	406	338
	Harvest	54	54	57	57
August	Catch	827	376	2,288	993
	Harvest	455	240	1,215	785
September	Catch	1,671	1,182	563	339
	Harvest	1,125	750	395	263
October	Catch	1,273	792	491	199
	Harvest	1,273	792	331	203

APPENDIX 5. — Estimated catch and harvest of White Perch by month and type of day from the Lake Mattamuskeet Creel Survey conducted 1 March–31 October 2014.

Period	White Perch	Weekday	SE	Weekend	SE
March	Catch	2,088	1,885	4,480	1,668
	Harvest	2,088	1,885	3,978	1,466
April	Catch	4,429	1,026	5,146	1,697
	Harvest	2,465	933	4,773	1,698
May	Catch	11,354	4,337	10,995	2,768
	Harvest	9,776	3,964	9,582	2,660
June	Catch	6,609	3,277	17,295	16,977
	Harvest	1,376	1,084	16,858	16,858
July	Catch	54	54	406	338
	Harvest	54	54	57	57
August	Catch	827	376	2,288	993
	Harvest	455	240	1,215	785
September	Catch	1,671	1,182	563	339
	Harvest	1,125	750	395	263
October	Catch	1,273	792	491	199
	Harvest	1,273	792	331	203

APPENDIX 6. — Estimated catch and harvest of Largemouth Bass by month and type of day from the Lake Mattamuskeet Creel Survey conducted 1 March–31 October 2014.

Period	Largemouth Bass	Weekday	SE	Weekend	SE
March	Catch	2,088	1,885	4,480	1,668
	Harvest	2,088	1,885	3,978	1,466
April	Catch	4,429	1,026	5,146	1,697
	Harvest	2,465	933	4,773	1,698
May	Catch	11,354	4,337	10,995	2,768
	Harvest	9,776	3,964	9,582	2,660
June	Catch	6,609	3,277	17,295	16,977
	Harvest	1,376	1,084	16,858	16,858
July	Catch	54	54	406	338
	Harvest	54	54	57	57
August	Catch	827	376	2,288	993
	Harvest	455	240	1,215	785
September	Catch	1,671	1,182	563	339
	Harvest	1,125	750	395	263
October	Catch	1,273	792	491	199
	Harvest	1,273	792	331	203