RACCOON ABUNDANCE INVENTORY REPORT

24 AUGUST 2012

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Abstract

At the time of this inventory, trapping, other than muskrat (*Ondatra zibethicus*) and beaver (*Castor canadensis*), was not allowed on Clarence Cannon and Great River National Wildlife Refuges (NWR). Raccoon (*Procyon lotor*) abundance/density on the Refuge appeared high and there is a need for the National Wildlife Refuge System (NWRS) to maintain a balance between the sanctuaries provided within refuge boundaries and the population threshold the available habitat can support. Populations above that threshold could lead to high disease transmission rates. The refuge manager felt that implementing a trapping program could maintain a healthy population. To justify allowing trapping on the Refuge the manager needed an assessment of the current population. A structured decision-making framework was used to select an inventory method to assess population metrics at the two refuges. A mark-resight was conducted to assess raccoon population abundance at Clarence Cannon NWR. A density of 90.79 raccoons per square mile was estimated at Clarence Cannon NWR and this density was used to produce abundance estimates at Great River NWR.

Introduction

Trapping has been prohibited at Clarence Cannon and Great River National Wildlife Refuges (the Refuge) in previous years for raccoons, opossum (*Didelphis virginiana*), and other mammals with the exception of beaver (*Castor canadensis*) and muskrat (*Ondatra zibethicus*). The Mark Twain Complex Comprehensive Conservation Plan (CCP) did not go into detail in regards to trapping and states that "the scope and scale of trapping within the Refuge Complex is so limited that no specific plan for this intermittent management activity will be prepared." Therefore, objectives within the CCP do not address trapping or concern for disease due to high population levels. The Refuge staff felt that populations for raccoons were above acceptable numbers and would like to allow controlled trapping on the Refuge via special use permits. An estimate of population abundance/density was needed to justify opening the Refuge to controlled trapping. During spotlight deer surveys and through daily activities raccoons have been seen in excessive numbers. Raccoons have been seen all over the Refuge throughout all times of day. It is widely accepted that raccoons are crepuscular to nocturnal animals and sightings during the day could indicate a non-typical behavior for raccoons. The Refuge staff makes the assumption that these diurnal movements are the result of a density that is above suitable conditions for the area. Populations above this threshold could lead to more disease outbreak (Pierce and McNeely). A documented case of parvovirus in a raccoon on the refuge was confirmed a number of years back (personal communication with Candy Chambers – Refuge Operational Specialist). No data was available to provide population estimates on the Refuge or in adjacent locations at the time of this study. According to the Illinois Department of Natural Resources (2006), populations of 9 to 45 raccoons per square mile are common in Illinois with some counties recording as high as 100 per square mile. Threshold levels for disease outbreak in raccoons are not well understood but through a trapping program the Refuge may reduce likelihood that populations will reach the upper bounds of the threshold. The fundamental objective for implementing a trapping program for raccoons is to maintain balance between the sanctuary provided and population threshold of raccoons to prevent high disease spread that could occur due to close proximity of high density populations on the divisions of Great River NWR and Clarence Cannon NWR. This could be accomplished through allowance of limited trapping via special use permits issued through the station manager.

Conceptually thinking about the influences that impact raccoon abundance on the refuge allows discussion of consequences and tradeoffs for implementing a trapping program versus retaining the status quo. The staff has no control over climate change which could directly affect flood duration/frequency or disease in raccoons. These variables could influence annual survival and reproductive rates. It appears that as flood duration/frequency has increased it has had little negative effect on raccoon populations. They appear successful at living in the trees in/above the flood waters, possibly even proliferating with ecological processes in the area. The staff could only affect immigration/emigration by putting a barrier around the refuge. This is not feasible or desirable; therefore, the staff has no control over those variables either. The staff could impact survival rates by implementing a trapping program that would allow harvest of some individuals within the population. All variables, directly or indirectly could influence the annual abundance/density of raccoons within the refuges.

Raccoons are prolific at inhabiting a given area with a population void. The literature widely suggests that effects of trapping raccoons in a given area will be nullified the following year by recolonization from outside the area (Chesness et al. 1968, Duebbert and Lokemoen 1980, Greenwood 1986). Therefore, if the Refuge has a population that falls within or above a healthy range in abundance/density the manager should be able to make the assumption that the surrounding area has a similar population and feel confident that allowing trapping on the refuge will not have dramatic negative impacts on raccoon populations. Literature suggests that immigration of new individuals into the population from outside the area will compensate for those that are harvested (Chesness et al. 1968, Duebbert and Lokemoen 1980, Greenwood 1986). Through permitted trapping the manager should set-back the population each year. This should not be confused for predator control efforts. Implementing a trapping program likely will not reduce the population to a level that will reduce predation effects on ground nesting birds but should sustain the population below abundance/density levels that could increase chances of a major disease outbreak (See Figure 1).

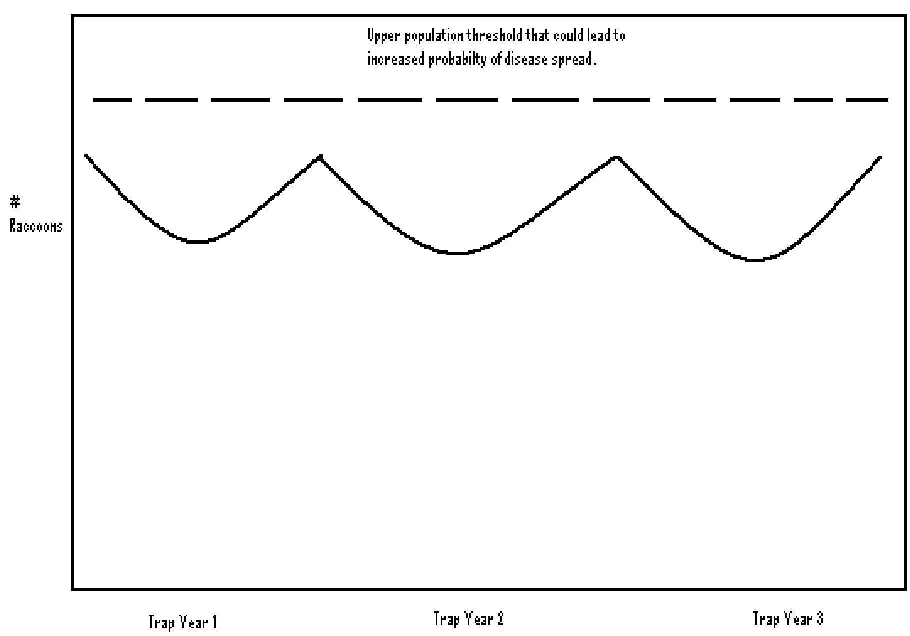

Figure 1. Conceptual diagram of raccoon population fluctuations over time after implementing a trapping program.

Management Objectives, with attributes and targets/thresholds specified:

Maintain balance between the sanctuary provided and population threshold of raccoons to prevent high disease spread that could occur due to close proximity of high abundance/density populations on the divisions of Great River NWR and Clarence Cannon NWR; therefore, with a population density between/above 9 – 45 individuals per square mile a trapping program can be safely implemented. If populations fall to less than 9 individuals per square mile on any divisions trapping should cease on the division until population is able to recover and all parameters leading to this population reduction are identified. This may arise as a concern to the staff if the population density noticeably decreases through observation. An inventory may need to be repeated at this point. It should be noted that there should be little concern that this will occur because common theories of hunting pressure and available game should indicate that trapping success will drop extremely low before the raccoon population reaches minimum levels and trapper effort will cease.

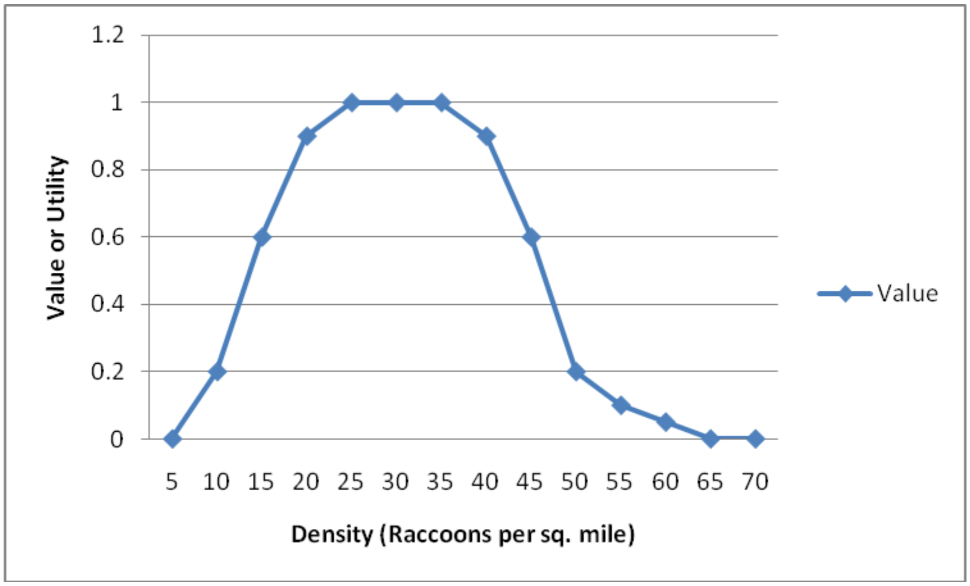

Figure 2. Utility function to depict conceptual refuge values for raccoon population densities.

Methods

Study Area

There were four areas of concern for this inventory: Clarence Cannon NWR (3750 acres), Great River NWR – Delair Division (1700 acres), Great River NWR – Long Island Division (6300 acres), and Great River NWR – Fox Island Division (2110 acres). Clarence Cannon NWR is located in Pike County, Missouri along the Mississippi Rivers Pool 25 about one mile east of the small town of Annada, Missouri. Delair is located in Pike County, Illinois along the Mississippi Rivers Pool 24 about 2 miles southeast of Louisiana, Missouri. Long Island is located in Adams County, Illinois along the Mississippi Rivers Pool 21 about 6 miles north of Quincy, Illinois. Fox Island is located in Clark County, Missouri along the Mississippi Rivers about five miles south of Keokuk, Iowa.

Data collection

A one division mark-resight was used for this project. Data obtained at Clarence Cannon was extrapolated to estimate population metrics at the three divisions of Great River NWR. This appeared to be the most cost effective and accurate assessment for this short time frame. A consequences table (see Appendix A), cost estimate analysis (Appendix B), and an assessment of final weighted scores (see Appendix C) were used to determine best inventory method.

Consequences tables were developed to determine the best alternative for sampling raccoons on the Refuge. Four objectives were developed to assess the alternatives (cost, time, accuracy, and feasibility). Cost was determined by using the cost estimate analysis. Time was determined by estimating the number of days needed to complete the inventory. Accuracy was given a ranking of 1 – 5, with 5 being the most accurate, to assess the value of the information provided from the inventory. It should be noted that the lowest value would have still provided a suitable estimate for the information needed for the problem. Feasibility was given a ranking of 1 – 5, with 5 being the most accurate, to assess the ability of the inventory method to access the area of concern and conduct the inventory.

Values were estimated to provide a rough estimate for the assessment of the objectives. The best alternative was determined for each objective (Table 1 of Appendix A). Alternatives that never ranked the highest option were eliminated from the choices (Table 2 of Appendix A). The time objective was converted to dollars by taking the number of days multiplied by 8 hours multiplied by $25 per hour to relate days to cost and reduce the number of objectives (Table 3 of Appendix A). The remaining alternatives (spotlight, mark-recapture on all divisions, and mark-resight on one division) were input into an assessment tool to determine the best alternative inventory method (Appendix C).

Cost estimate analysis (Appendix B) was determined by estimating the cost of gas, bait, and lodging to conduct each alternative inventory method. Gas costs were determined by estimating mileage from headquarters to the division and 10 miles per day needed to conduct the inventory on the area. An estimate of 15 miles/gallon was used to determine gallons of gas needed. A constant value of $3.50 per gallon was used to convert gallons into dollars. Bait costs were an estimate of bait needs based on number of days to conduct the inventory if bait was used. Lodging costs were estimated for Long Island and Fox Island divisions of Great River Refuge that were too great in distance to travel from headquarters every day the inventory was conducted. A constant value of $75 was used to multiply by the number of days needed to stay overnight to complete the inventory in order to create this estimate.

A decision tool was used to assess final weighted scores (Appendix C) to determine the best alternative inventory method. Scores were normalized so the assessment could relate the objectives to the different alternatives. The formula [(value – min)/(max – min)] was used to normalize a score that maximization of the objective was the desired outcome. The formula 1 – [(value – min)/(max – min)] was used to normalize a score that minimization of the objective was the desired outcome. The objective values for each alternative were added together to receive the sum of all scores. Each objective was valued the same for this exercise; therefore, the objectives were weighted evenly. A one division mark-recapture was determined to be the best alternative based on its weighted score (Figure 3).

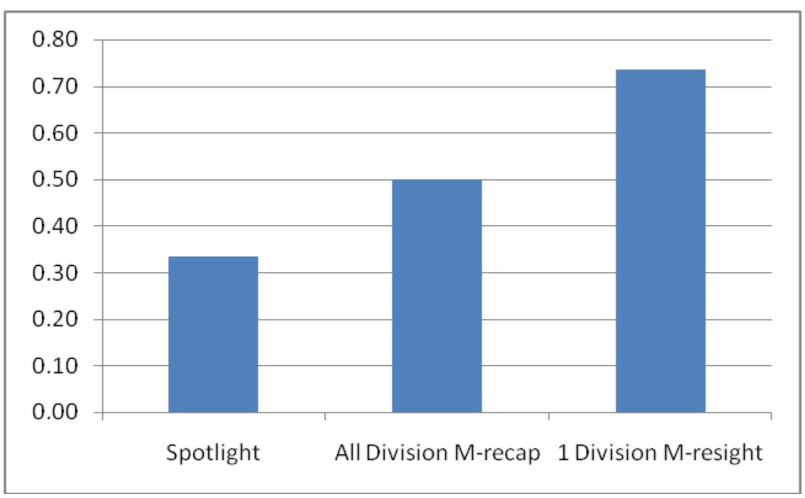

Figure 3. Chart of weighted scores for three alternatives to inventory raccoon population on the refuges.

Twenty-seven (the number of traps readily available) trap locations were determined from a random sampling method to ensure that the traps were located around the Refuge in a manner that is representative of the entire Refuge division. A block grid was created with points in the center of each block for each portion of the

Refuge. Blocks were 50 meters square therefore spacing traps at least 50 meters apart (Beasley and Rhodes 2008). Standard approved live traps within the size range appropriate for raccoons were used for this study (Approximately 32” x 12” x 12”). Traps were baited with cat food, bread, and molasses and set for one night. Traps were deployed between 5 April 2011 and 13 April 2011. An attempt was made to seek conditions when temperatures and weather conditions first warmed up for the season and raccoons activity started to increase. The following morning traps were checked so that all captured animals could be identified, marked, and released. Traps were reset the same day at new trapping locations in the same fashion that was used previously. Traps were checked again the following morning. All animals caught on the second day were identified in a similar fashion as the previous day and recorded as marked or unmarked. Any unmarked animals were marked and released to add to the marked population. This was repeated until the ratio of animals caught to animals marked was sufficient to obtain a population estimate. Population estimation methods will be discussed later in further detail. Effort to recatch marked individuals was greater than one week; therefore, a resight was used in place of recatch to obtain data for a population estimate. During resight observations all roads and levees were traveled with a spotlight to identify marked and unmarked individuals.

Marking of animals consisted of spray painting a small portion of the animal’s fur through the trap to create an identifiable mark on the animal. Pauley and Crenshaw (2006) used oil-based paintballs to mark mountain goats in Idaho and the markings persisted for at least 71 days. Paint used for this project was all-weather livestock paint. Animals were not physically handled by researcher; however, leather gloves, long sleeve shirt, pants, and boots were worn for protection. All traps were designed to release the animal from a safe distance by a string mechanism to reduce danger to the researcher. When traps were approached time was taken to identify whether the trap is empty or contains an animal. Once it was determined that trap was occupied, species and health of animal was assessed. One sick animal was immediately euthanized. The animal depicted signs of distemper and for safety reasons in regards to the investigator and to reduce risk of disease spread the animals was put down.

Euthanasia Method

Two options were considered for euthanasia if needed. The first option was to expose the animal to CO2 gas through a chamber that was created prior to the study. A second method that was considered if available was a lethal gunshot. For this method Refuge LE officer Gary Poen would have to be notified and respond to put down an animal. This was only feasible dependant on Gary’s availability. By these means the animal was never physically handled and a humane method was used to put down any necessary animals.

Results and Discussion

Assumptions were made that the population was closed (e.g. does not have immigration, emigration, births, or deaths during the period of study) because the time frame from start to end of the study was a short window (8 days) and the assumption was that over time these variables cancel each other to create an equilibrium. Assumptions were also made that there was no bias in trap response for individuals. This included sex, age, and previously caught biased trap responses; therefore, all individuals had the same opportunity of being caught. With these assumptions one could assume the population was closed and obtain a population estimate for a snapshot in time.

Thirty-eight raccoons were captured and marked between 5 April 2011 and 13 April 2011 prior to spotlight procedures conducted to resight marked or unmarked individuals. All available roads and levees throughout the Refuge were traveled by observer after sunset between 21:05 and 22:40 on the evening of 13 April 2011. A distance of 13.5 miles was traveled over a period of 1.5 hours. Sixteen raccoons and three opossum were observed while spotlighting. Of those, thirteen raccoons and all opossums were determined not marked. Two raccoons were not able to be determined whether they were marked or not. One raccoon was determined marked.

A simple closed population mark-resight model using a Lincoln-Peterson (Lukacs 2008) estimate was used to calculate an estimate of 532 raccoons. A population estimate was not calculable for opossum since no marked individuals were observed. Traps were randomly distributed; therefore, the estimate was for the entirety of Clarence Cannon NWR. Density was calculated by dividing the estimate by the number of acres within the

Refuge boundary. Density for Clarence Cannon was estimated at 90.79 raccoons per square mile. This estimate is relatively conservative and could underestimate the true abundance by as much as 37 percent (Robson and Reiger 1964). The density estimate from Clarence Cannon was used to calculate raccoon abundance on the three divisions of Great River NWR with the following results: Delair – 241, Long Island – 894, Fox Island – 298 (table 1).

Table 1. Values from field data collected and calculations made to attain estimates. Density calculated for Clarence Cannon NWR used to estimate abundance for Delair, Long Island, and Fox Island divisions.

Formula	Description	Value
n_1	Animals Marked	38
n_2	Animals Sighted	14
m_2	Animals Resighted	1
$N = n_1 n_2 / m_2$	Clarence Cannon Population Abundance Estimate	532
N/Sq. Miles	Density (per sq. mile)	91
Acres/640	Clarence Cannon Square Miles	5.86
Acres/640	Delair Square Miles	2.66
Acres/640	Long Island Square Miles	9.84
Acres/640	Fox Island Square Miles	3.28
Density * Sq. Miles	Delair Population Abundance Estimate	241
Density * Sq. Miles	Long Island Population Abundance Estimate	894
Density * Sq. Miles	Fox Island Population Abundance Estimate	298

Management Implications

The assumption is that population densities on Clarence Cannon NWR are similar to all divisions of Great River NWR. The estimate of 90.79 raccoons per square mile is well above the average of 9 – 45 individuals per square mile across Illinois. Trapping is allowed on all other lands in the surrounding area and is considered a form of compensatory mortality, thus the effects of trapping are not drastically reducing raccoon abundance. The manager can assume that unless trapping effort is much higher on the Refuge than surrounding landscapes that densities will not be adversely affected. Therefore, the manager can feel confident in a decision to implement a trapping program. Trapping harvests should help maintain the balance between the sanctuary provided and the population threshold of raccoons in an attempt to prevent high disease spread that could occur due to close proximity of high abundance/density populations on the divisions of Great River NWR and Clarence Cannon NWR. If populations fall to less than 9 individuals per square mile on any divisions trapping should cease on the division until the population is able to recover and all parameters leading to this population reduction are identified. Annual surveys do not need to be conducted to monitor this; however, concern may arise to the staff if the population density noticeably decreases through observation. In this scenario an inventory may need to be repeated. It should be noted that there should be little concern that a trapping program will lead to this situation because common theories of hunting pressure and available game should indicate that trapping success will drop extremely low before the raccoon population reaches minimum levels and trapper effort will cease.

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Appendix A – Raccoon Inventory Consequences Assessment Tables

Table 1

			Alternatives				
Objective	Attribute	Direction	Spotlight	All Division M-resight	All Division M-recap	1 Division M-recap	1 Division M-resight
Cost	$	Min	571	1351	1522	98	66
Time	Days	Min	3	20	30	10	7
Accuracy	Rank 1-5	Max	1	4	5	3	2
Feasibility	Rank 1-5	Max	1	2	3	4	5

Table 2

			Alternatives				
Objective	Attribute	Direction	Spotlight	All Division M-resight	All Division M-recap	1 Division M-recap	1 Division M-resight
Cost	$	Min	571	1351	1522	98	66
Time	Days	Min	3	20	30	10	7
Accuracy	Rank 1-5	Max	1	4	5	3	2
Feasibility	Rank 1-5	Max	1	2	3	4	5

Table 3

			Alternatives				
Objective	Attribute	Direction	Spotlight	All Division M-resight	All Division M-recap	1 Division M-recap	1 Division M-resight
Cost	$	Min	1171	5351	7522	2098	1466
Time	Days	Min	3	20	30	10	7
Accuracy	Rank 1-5	Max	1	4	5	3	2
Feasibility	Rank 1-5	Max	1	2	3	4	5

(red)	Best Option
(light blue)	Non-Factor
(green)	Converted to Dollars

Appendix B – Cost Estimate Analysis

Spotlight

	Cannon	Delair	Long	Fox
Gas	$7	$49	$63	$77
Bait	$0	$0	$0	$0
Lodging	$0	$0	$150	$225
Total		$571		

All Division M-resight

	Cannon	Delair	Long	Fox
Gas	$12	$82	$231	$151
Bait	$50	$50	$50	$50
Lodging	$0	$0	$300	$375
Total		$1,351		

1 Division M-recap

	Cannon	Delair	Long	Fox
Gas	$23	$0	$0	$0
Bait	$75	$0	$0	$0
Lodging	$0	$0	$0	$0
Total		$98		

1 Division M-resight

	Cannon	Delair	Long	Fox
Gas	$16	$0	$0	$0
Bait	$50	$0	$0	$0
Lodging	$0	$0	$0	$0
Total		$66		

All Division M-recap

	Cannon	Delair	Long	Fox
Gas	$16	$114	$91	$46
Bait	$70	$70	$70	$70
Lodging	$0	$0	$450	$525
Total		$1,522		

Appendix C – Assessment of Final Weighted Scores

CONSEQUENCE MATRIX		Alternatives			
Objectives	**Goal**	**Spotlight**	**All Division M-recap**	**1 Division M-resight**	**Units**
Cost	Min	1171	7522	1466	$
Accuracy	Max	1	5	2	Rank 1-5
Feasibility	Max	1	3	5	Rank 1-5

NORMALIZED SCORES		Alternatives		
Objectives	**Goal**	**Spotlight**	**All Division M-recap**	**1 Division M-resight**
Cost	Min	1.000	0.000	0.954
Accuracy	Max	0.000	1.000	0.250
Feasibility	Max	0.000	0.500	1.000

"1" = the best, "0" = the worst

by row (objective)

To normalize (max): [(value – min)/(max-min)]

To normalize (min): 1-[(value – min)/(max-min)]

WEIGHTED SCORES		Alternatives			
Objectives	**Goal**	**Spotlight**	**All Division M-recap**	**1 Division M-resight**	**Weight**
Cost	Min	0.333333333	0	0.317850207	0.333333333
Accuracy	Max	0	0.333333333	0.083333333	0.333333333
Feasibility	Max	0	0.166666667	0.333333333	0.333333333
Sum of Weights (for all objectives)					1
Sum of weighted scores (for each alternative)		0.33	0.50	0.73	
Final Score (sum wtd scores/sum weights)		**0.33**	**0.50**	**0.73**	