Common Gallinule banding in Ontario

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Abstract

Between 2012 and 2017, we conducted a Common Gallinule banding study to determine the feasibility of catching and banding gallinule with an airboat in Ontario, estimate how many birds could potentially be banded and subsequently encountered, calculate an index of productivity and assess whether enough data could be obtained to inform management decisions and conservation planning. We captured gallinules using dip nets and spotlights at night from an airboat. In total, we banded 440 (approximately 28%) of the 1,564 gallinules that have ever been banded in Ontario. Five of our banded birds were subsequently encountered, four within Ontario and one in Texas. We compared our data to historical banding and encounter data for gallinules in the Americas. There have been 212 encounters of banded gallinules in the Americas; 53 were banded in Ontario. Thirty-seven of the encounters occurred within Ontario. The number of band encounters for gallinules is very low compared to other gamebirds and we conclude that studies will need to integrate multiple components, such as transmitters or surveys, into their design to obtain the best available information to inform gallinule conservation and management in North America.

Introduction

The Common Gallinule (*Gallinula galeata)* or 'swamp chicken', formerly known as Common Moorhen (hereafter 'gallinule'), is a secretive marsh bird within the rail family. It is found in the Americas with a distribution extending from northern Argentina in South America through central America to the southern parts of eastern Canada in North America (Bannor and Kiviat 2020). In North America, it breeds from the Gulf States to southern Ontario and southwestern Québec with smaller numbers found in eastern New Brunswick and western Nova Scotia (Environment and Climate Change Canada 2019a). In Canada, it uses well-interspersed emergent marshes with cattail (*Typha* spp.), bur-reed *Sparganium* spp.), bulrush (S*choenoplectus*

Common Gallinule.
Photo: Ann Brokelman

spp.), etc., but can also be found using ponds, canals and sewage lagoons. For nesting, floating vegetation is a microhabitat requirement because six to nine eggs are typically laid on a 'platform' nesting site usually in waters with a depth of 20.5-91.5 cm (Peck and James 1983).

The Common Gallinule is about the size of a small football with greyish colouration, dark rump and neck and a white stripe on the top side of its flanks; its red face shield with yellow bill tip, long yellow-greenish legs and non-lobed feet are characteristic 'give aways' that differentiate it from the American Coot (*Fulica americana*). Although both marsh birds can be easily identified by sight, identifying each of them by vocalization requires experience. This, in conjunction with an overlap in their breeding range and habitats in southeastern Canada, makes surveying them challenging.

Although gallinule are detected during the Breeding Bird Survey (BBS) (Environment and Climate Change Canada 2019a), this roadside survey is not ideal for monitoring wetland birds; it does, however, provide the most long-term, broad-based coverage of this species range in North America. In contrast, Marsh Monitoring Programs (MMP) are more regionally based (i.e., primarily around the lower Great Lakes

in Ontario and St. Lawrence River in Québec) but they specifically target secretive marsh birds through their sampling design (i.e., focus on wetland habitats) and survey methodology (multiple visits to a site and call playback). As such, MMP data are considered more reliable than the BBS for monitoring population trends of marsh birds (Tozer 2016). Lastly, provincial/territorial Breeding Bird Atlases provide periodic snapshots of changes in the breeding distribution and probability of observation of birds every 20 years. Trends from various surveys show that gallinules are declining rangewide: North America (1970-2016, -1.2% annual trend based on relative abundance from the BBS) and Canada (1970-2016, -4.7% annual trend based on relative abundance from the BBS). Trends are relatively stable in Ontario (1995-2016, -0.06% annual trend based on mean number of birds per station from MMP) and Québec (2004-2016, -0.1% annual trend based on mean number of birds per station from MMP) (Environment and Climate Change Canada 2019a). The Ontario Breeding Bird Atlases (OBBAs) also showed a decline in the probability of observation of -2.2% annually, or approximately 35% between the first (1981-1985) and second OBBAs (2001-2005). This large decline was observed despite the use of call playback by some atlassers during the second atlas (Timmermans 2007, Environment and Climate Change Canada 2019a).

Gallinule are a migratory game bird harvested in both the United States (U.S.) and Canada, albeit at a much lower level compared to waterfowl, doves and woodcock (Raftovich *et al.* 2019). Due to the low number of hunters targeting these birds, annual harvest estimates vary considerably. For example, it was estimated that approximately 12,600 gallinules in 2017 and 2,400 in 2018 were harvested in the U.S., primarily in Texas and Louisiana. In Ontario, 335 and 44 rails (gallinules, Virginia Rail [*Rallus limicola*] and Sora [*Porzana carolina*] combined) were harvested in 2017 and 2018, respectively (Raftovich *et al.* 2019; Environment and Climate Change Canada 2019b). The estimates varied by over 500% in the U.S. and as a result of this uncertainty and a declining population trend, a number of priority information needs have been identified for rails, including developing a national marsh bird monitoring program in the U.S., improving harvest estimates and estimating vital rates for population modeling (Case and Associates 2009).

Generally, most gallinules and other marsh birds, such as American Bittern (*Botaurus lentiginosus*), Sora and Virginia Rail, are captured and banded as part of specific research studies rather than annual migratory bird banding programs. Some annual banding programs, such as the Ontario Cooperative Banding Program, which focuses on banding ducks, do provide a rare opportunity to band marsh birds and, more importantly, could provide an opportunity to band adequate numbers of gallinule in Ontario to inform possible future vital rate studies and/or identify broad scale movement patterns. As a result, staff from the Canadian Wildlife Service (CWS) and

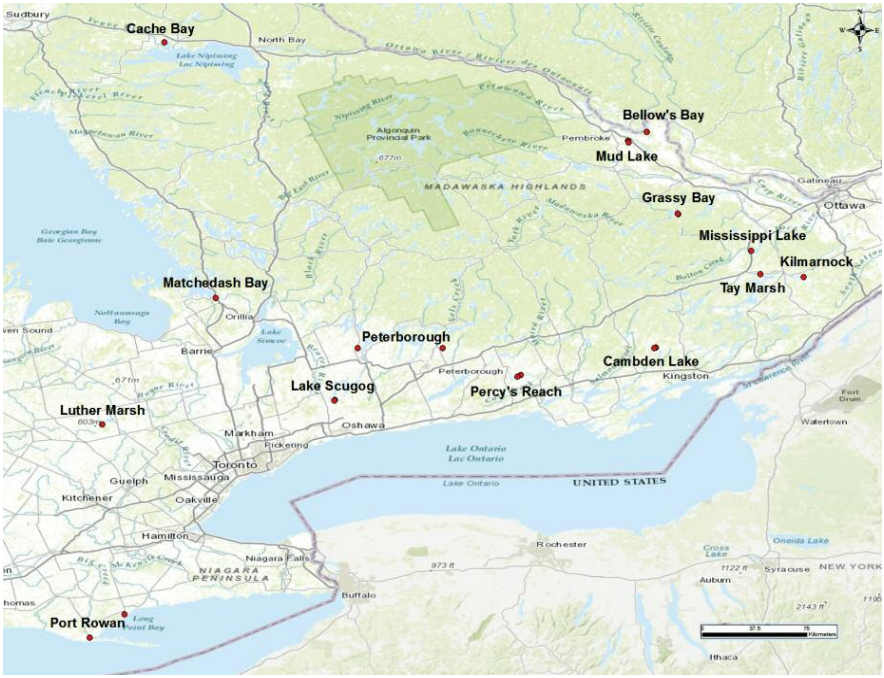

Figure 1. Locations (red dots) where Common Gallinule were banded in Ontario, 2012-2017.

Ontario Ministry of Natural Resources and Forestry (OMNRF) conducted a pre-season (i.e., prior to the duck hunting season in late September) airboat banding study of gallinules from 2012 to 2017. Our objectives included (1) determining the feasibility of catching and banding gallinules with an airboat in Ontario thereby informing capture methods for possible future studies, (2) estimating how many birds could potentially be banded in Ontario with an airboat and subsequently encountered, (3) calculating an index of productivity and (4) assessing whether enough banding and encounter data could be obtained to inform management and conservation planning decisions.

Methods

Gallinules were captured at 14 wetland sites using dip nets and spotlights at night from late August until mid-September 2012-2017 as part of the airboat banding program in Ontario (Figures 1 and 2) (for more information on airboat capture methods, see Buchanan *et al.* 2015). Although the focus of the program was to achieve pre-season duck banding goals, one dedicated gallinule capture 'run' per year (approximately 2.0 hours of effort per site) was made in each year. Once an individual gallinule was captured in a dip net, it was placed in a designated gallinule holding box until the 'run' was finished and the boat returned to shore (Figure 3). Once on

shore, a bander sexed and aged birds by colouration and morphology (e.g., face shield width and wing chord length) according to Loncarich and Krementz (2004), and placed a standard USFWS aluminum band around one of its tibia (i.e., above the joint) (Figures 4 and 5). Ageing birds (adult versus hatch year) was relatively easy but there were some that could not be aged (designated as "Unknown" in tables); sexing juvenile birds was more difficult because of the overlap in morphometric measurements between the sexes at that age; as such, most juvenile birds were classified as "Unknown" sex. Once processed, each gallinule was returned to a holding cage where it stayed until all the birds were processed. Then, birds were transported back to the wetland where they were released onto floating or emergent vegetation.

For analyses, all banding and band encounter data for gallinules in the Americas were downloaded from GameBirds (United States Geological Survey 2019) and supplemented with banding data from the Canadian Bird Banding Office when necessary (i.e., pre-1960 records). Banding and band encounter data were summarized by year, location, sex and age; for encounter data, we also summarized how the band was 'obtained' (e.g., 'shot,' 'found dead,' 'banding mortality,' etc.). For gallinules banded in Ontario between 2012 and 2017, we included all the banding data from Ontario regardless of whether it was banded as part of the CWS-OMNRF gallinule banding study. For all band

Figure 2. Airboat capture crew, 2012. *Photo: Barb Campbell*

encounters, the distance between banding and encounter coordinates was calculated using a tool in Google Earth. Lastly, we calculated the percentage of juveniles banded during our study as an index to productivity and examined productivity at Mud Lake (our best capture site) in relation to average monthly precipitation from 1 May to 31 July for each year from weather data collected in Pembroke (Environment and Climate Change Canada 2020).

Top: **Figure 3. Common Gallinule observed from an airboat (a) and in holding cages (b).** *Photo: Barb Campbell*

Bottom left: **Figure 4. Airboat crew member with a Common Gallinule.** *Photo: Tore Buchanan*

Bottom right: **Figure 5. Previously banded Common Gallinule showing location of band placement above tibia-tarsus joint.** *Photo: Shawn Meyer*

Results

Gallinule bandings from CWS-OMNRF Airboat Banding Study

From 2012 to 2017, 440 gallinules were banded at 14 locations by CWS and OMNRF staff, volunteers, contractors and others (Figure 1, Table 1). Gallinules were banded at sites covering an area from Cache Bay on Lake Nipissing, east to Kilmarnock on the Rideau River, west to Luther Marsh and south to Port Rowan (Figure 1). The highest and lowest annual number of gallinules were banded in 2017 (N= 94) and 2015 (N= 49), with an average of 73 birds banded per year over this time frame. Mud Lake (45.733117 N, 77.029196 W; Figure 1), near Pembroke, Ontario, had the highest average number of gallinules banded across all years ($\bar{x}$ = 51 birds/year), with a range between 34 (2012) and 82 (2017) per year. All sites had at least one gallinule banded over the six years but only one site, Mud Lake, had birds banded every year. Five other sites, namely Bellow's Bay, Camden Lake, Matchedash Bay, Percy's Reach and Tay Marsh (Figure 1) had birds banded in four of the six years (≤13/site/year; Table 1).

Table 1. Banding data for Common Gallinule in Ontario from 2012 to 2017, excluding band recaptures.

	Gallinule Banded			
Year/Location	Adult	Juvenile	Unknown	Total
2012				
Camden Lake	0	5	0	5
Mississippi Lake	3	3	0	6
Mud Lake	0	34	0	34
Port Rowan	0	7	0	7
			Subtotal	**52**
2013				
Bellow's Bay	1	1	0	2
Camden Lake	0	0	1	1
Grassy Bay	0	0	1	1
Kilmarnock	0	0	1	1
Luther Marsh	1	2	0	3
Matchedash Bay	0	1	0	1
Mud Lake	5	44	0	49
Peterborough	1	1	0	2
Tay Marsh	7	5	1	13
			Subtotal	**73**
2014				
Bellow's Bay	0	3	0	3
Cache Bay	1	4	0	5
Kilmarnock	0	0	1	1
Lake Scugog	1	2	0	3
Luther Marsh	1	1	0	2
Matchedash Bay	0	3	0	3
Mud Lake	13	43	0	56
Percy's Reach	5	5	0	10
Tay Marsh	5	4	0	9
			Subtotal	**92**
2015				
Bellow's Bay	7	2	0	9
Luther Marsh	0	1	0	1
Matchedash Bay	0	2	0	2
Mud Lake	4	28	0	32
Percy's Reach	3	0	0	3
Tay Marsh	0	0	2	2
			Subtotal	**49**
2016				
Bellow's Bay	5	5	0	10
Camden Lake	1	5	0	6
Kilmarnock	1	2	0	3
Lake Scugog	0	2	0	2
Matchedash Bay	1	0	0	1
Mud Lake	15	35	4	54
Percy's Reach	0	1	0	1
Tay Marsh	1	2	0	3
			Subtotal	**80**
2017				
Camden Lake	0	1	0	1
Grassy Bay	0	0	1	1
Lake Scugog	1	5	0	6
Mud Lake	14	67	1	82
Percy's Reach	1	2	0	3
Port Rowan	0	1	0	1
			Subtotal	**94**
			TOTAL	**440**

Table 2. Numbers of Common Gallinule banded at various locations in the Americas, 1925 to present *(source: GameBirds, United States Geological Survey 2019).*

Location	Number of Common Gallinule Banded	
"At Sea"		1
Bahama Islands		1
Bermuda		3
Brazil		9
Canada -Total		**2,017**
Ontario	1564*	
Quebec	440	1
New Brunswick	7	
Nova Scotia	6	
Lesser Antilles		1
Panama		12
United States-Total		**4,352**
Louisiana	2,058	
Michigan	462	
New York	419	
Florida	381	
Ohio	124	
Wisconsin	120	
South Carolina	120	
Massachusetts	118	
California	89	
Missouri	70	
Georgia	59	
Iowa	52	
Texas	50	
Pennsylvania	45	
New Jersey	40	
Delaware	32	
Arizona	22	
Arkansas	11	
Mississippi	11	
Illinois	10	
Indiana	9	
Maryland	9	
Vermont	9	
Tennessee	8	
North Carolina	7	
Maine	5	
Virginia	4	
Kansas	3	
Connecticut	1	
Minnesota	1	
Nebraska	1	
New Mexico	1	
West Virginia	1	
		TOTAL 6,396

(*)includes 440 bands from CWS-OMNRF Study (2012-2017)

Of known-aged birds, juveniles comprised an average of 77.0% (range: 68.4% [2016] – 94.2% [2012]). During the study, 2012 was the driest spring/early summer ($\bar{x}$ = 39.6 mm of rain) while 2017 was the wettest ($\bar{x}$ = 143.8 mm). There was no relationship between average monthly precipitation from May to July for each year and the index of annual productivity at Mud Lake (calculated as the percentage of juveniles among total known aged banded birds; $R^2 = 0.0024$, $p = 0.9$).

Gallinule bandings across the Americas

The first gallinule banded in the Americas occurred in October 1925 in Massachusetts, U.S. In Ontario, the first gallinule (one of two) was banded in October 1937 in Prince Edward County with three more banded in 1938 and five in 1939. Since 1925, 6,396 gallinules have been banded across the Americas from Brazil to Canada (Table 2). Of these, 68.0% were banded in 33 states in the U.S., 31.5% in four provinces in Canada with the remaining 0.5% in five countries and one area (Table 2). Within the

Figure 6. Banding locations of all Common Gallinule banded in the Americas from 1925 to 2019
(sources: GameBirds, United States Geological Survey 2019).

U.S., most gallinules were banded in Louisiana (2,058), Michigan (462), New York (419) and Florida (381) while in Canada, 77.5% of the gallinules (1,564/2,017) were banded in Ontario with most of the rest banded in Québec. In the Americas, 33.1% of gallinules were banded between 1925 and 1955, 49.3% between 1956 and 1985, and 17.6% between 1986 and 2019 while in Ontario, these percentages were 14.3%, 53.5% and 32.2% respectively.

Gallinule encounters from CWS-OMNRF Airboat Banding Study

Over six years (2012-2017), only five of the 440 gallinules (approximately 1.1%) that were banded during the study have been reported (to date) as encountered (Table 3) and the encounter rate averaged 1.3±0.3% per year (combined direct and indirect encounters). Of the five band encounters, four were in Ontario and one was in Texas. In Ontario, three were recaptured during banding operations and one was 'found dead.' Of the three recaptured gallinules, two had been banded as juveniles at Mud Lake and were recaptured two years later at Mud Lake while one was banded at Bellow's Bay as a juvenile in 2012 and was recaptured one year later at Mud Lake, approximately 11.0 km to the southwest (Table 3). Of the two birds 'found dead,' both were banded as juveniles; one was banded on 23 August 2014 and encountered on 26 September 2014 near Round Lake, Ontario, approximately 34 km southwest of the banding site and the other was banded on 9 September 2016 and encountered on 15 October 2016 near Port Bolivar in Texas, U.S., approximately 2,380 km away; this represents the first encounter of a banded gallinule in Texas.

Table 3. Encounters of Common Gallinule banded in Ontario during CWS-OMNRF Airboat Banding Study from 2012 to 2017 (A) and from 1925 to 2012 (B,C) *(sources: this study; United States Geological Survey 2019).*

A. Encounters 2012 to 2017

Recovery date	Approximate recovery location	Recovery state/province	How band was obtained	Banding date	Banding location
2013-09-08	Mud Lake	Ontario	Banding Recapture	2012-08-27	Bellow's Bay
2015-09-15	Mud Lake	Ontario	Banding Recapture	2013-09-08	Mud Lake
2014-09-26	Near Round Lake	Ontario	Found Dead	2014-08-23	Mud Lake
2017-09-18	Mud Lake	Ontario	Banding Recapture	2015-09-15	Mud Lake
2016-10-15	Port Bolivar	Texas	Found Dead	2016-09-09	Mud Lake

B. Encounters in Ontario, Pre-2012

September 1954	Godrey	Ontario	No Information	August 1954	Odessa
June 1958	Hamilton	Ontario	Found Dead	September 1954	Whitby/Oshawa
August 1957	Whitby/Oshawa	Ontario	Banding Recapture	August 1955	Whitby/Oshawa
August 1960	Whitby/Oshawa	Ontario	Banding Recapture	August 1955	Whitby/Oshawa
October 1957	Whitby/Oshawa	Ontario	Banding Mortality	August 1957	Whitby/Oshawa
September 1959	Prince Edward County	Ontario	Shot	August 1957	Whitby/Oshawa
October 1957	Courtice	Ontario	Shot	September 1957	Whitby/Oshawa
July 1960	Whitby/Oshawa	Ontario	Banding Recapture	August 1959	Whitby/Oshawa
May 1965	Whitby/Oshawa	Ontario	No Information	July 1963	Whitby/Oshawa
September 1963	Whitby/Oshawa	Ontario	Drowned	July 1963	Whitby/Oshawa
August 1963	Whitby/Oshawa	Ontario	Caught in Snare/Trap	August 1963	Whitby/Oshawa
August 1963	Whitby/Oshawa	Ontario	Found Dead	August 1963	Whitby/Oshawa

Recovery date	Approximate recovery location	Recovery state/province	How band was obtained	Banding date	Banding location
August 1963	Whitby/Oshawa	Ontario	Drowned	August 1963	Whitby/Oshawa
September 1963	Whitby/Oshawa	Ontario	Found Dead	September 1963	Whitby/Oshawa
Spring 1965	Campbellford	Ontario	Caught in Snare/Trap	January 1964	Florida
August 1965	Whitby/Oshawa	Ontario	Banding Mortality	August 1965	Whitby/Oshawa
September 1965	Whitby/Oshawa	Ontario	Banding Mortality	August 1965	Whitby/Oshawa
June 1966	Port Colbourne	Ontario	Found Dead	August 1965	Port Colbourne
August 1966	Whitby/Oshawa	Ontario	Banding Mortality	August 1966	Whitby/Oshawa
September 1966	Whitby/Oshawa	Ontario	Banding Mortality	August 1966	Whitby/Oshawa
September 1966	Whitby/Oshawa	Ontario	Banding Mortality	September 1966	Whitby/Oshawa
September 1966	Whitby/Oshawa	Ontario	Banding Mortality	September 1966	Whitby/Oshawa
September 1966	Whitby/Oshawa	Ontario	Banding Mortality	September 1966	Whitby/Oshawa
September 1966	Hamilton	Ontario	Found Dead	September 1966	Hamilton
May 1969	Whitby/Oshawa	Ontario	Found Dead	August 1968	Whitby/Oshawa
August 1968	Whitby/Oshawa	Ontario	Banding Mortality	August 1968	Whitby/Oshawa
September 1968	Whitby/Oshawa	Ontario	Banding Mortality	September 1968	Whitby/Oshawa
October 1968	Hamilton	Ontario	Striking Tower/Wire	September 1968	Hamilton
August 1970	Hamilton	Ontario	Banding Recapture	October 1969	Hamilton
September 1970	Whitby/Oshawa	Ontario	Banding Mortality	September 1970	Whitby/Oshawa
August 1971	Whitby/Oshawa	Ontario	Found Dead	August 1971	Whitby/Oshawa
September 1971	Whitby/Oshawa	Ontario	Banding Mortality	September 1971	Whitby/Oshawa
October 1973	Havelock	Ontario	Caught by Hand	August 1973	Whitby/Oshawa

C. Encounters Outside of Ontario, Pre-2012

December 1940	Homestead	Florida	Shot	September 1940	Prince Edward County
November 1955	Cordova	South Carolina	Shot	August 1954	Whitby/Oshawa
September 1955	Hillsboro	Maryland	Struck by Vehicle	August 1955	Whitby/Oshawa
October 1955	Okeechobee	Florida	Shot	August 1955	Whitby/Oshawa
November 1955	Mud Lake	Louisiana	Shot	August 1955	Whitby/Oshawa
October 1961	Lakeland	Florida	Found Dead	August 1955	Whitby/Oshawa
January 1960	Edisto Island	South Carolina	Shot	August 1959	Whitby/Oshawa
October 1959	Offshore	Bermuda	Caught--Exhaustion	August 1959	Whitby/Oshawa
September 1962	Charleston	South Carolina	Found Dead	August 1960	Whitby/Oshawa
April 1965	Buffalo	New York	Found Dead	August 1963	Whitby/Oshawa
February 1971	Lansing	New York	Banding Recapture	August 1967	Whitby/Oshawa
October 1967	Woodbridge Township	New Jersey	Caught due to Injury	October 1967	Hamilton
October 1969	Chardon	Ohio	Found Dead	August 1969	Whitby/Oshawa
January 1970	Chesapeake Bay	Virginia	Found Dead	August 1969	Whitby/Oshawa
January 1971	Cherry Hill	South Carolina	Found Dead	August 1970	Whitby/Oshawa

Gallinule encounters across the Americas

As of 2019, 212 banded gallinules have been encountered, 166 in the U.S., 42 in Canada and one each in Bermuda, Cuba, the Dominican Republic and an unknown location (Table 4). Of these, 108 (50.9%) were encountered in Louisiana, 37 (17.4%) in Ontario, 12 (5.7%) each in Florida and New York and seven in South Carolina. The category 'recaptured previously banded birds' comprised the most encounters (72 records, 34.0%), followed by 'shot' (59, 27.8%), 'found dead' (33, 15.6%) and 'banding mortalities' (12, 5.7%). The number of encounters per band location was 154 encounters (3.5%) for the U.S., 58 encounters (2.9%) for Canada and 53 encounters (3.4%) for Ontario. The first recorded encounter of an Ontario banded gallinule was that of a bird banded in September 1940 in Prince Edward County and recovered in December of the same year near Homestead, Florida. The first recovery of a banded gallinule in Ontario was a bird found dead in September of 1954 near Godrey that had been banded near Odessa during August of the same year. For the 53 encounters of gallinules that were banded in Ontario, 37 were encountered in Ontario while 15 were encountered along the eastern seaboard

Table 4. Encounter types and locations of Common Gallinule banded in the Americas from 1925 to 2019 *(source: GameBirds, United States Geological Survey 2019).*

Location	Sub-total by method	Sub-total by location	Total
Bermuda			**1**
Caught due to exhaustion	1		
Canada			**42**
Manitoba		**1**	
Shot	1		
Ontario		**37**	
Band or band number only obtained No further information available	2		
Banding Mortality: due to trap, holding device or handling	12		
Caught by hand	1		
Caught by or due to: traps or snares other than devices used to catch birds for banding	2		
Caught due to striking: radio, TV, high tension, etc wires or towers, or ceilometers	1		
Drowned	2		
Found dead	8		
Previously banded bird trapped and released during banding operations	7		
Shot	2		

Location	Sub-total by method	Sub-total by location	Total
Quebec		4	
Previously banded bird trapped and released during banding operations	3		
Shot	1		
Cuba			1
Shot	1		
Dominican Republic			1
Shot	1		
United States			166
Band or band number only obtained No further information available	4		
Caught by hand	2		
Caught by or due to cat	2		
Caught by or due to: traps or snares other than devices used to catch birds for banding	2		
Caught due to striking or being struck by: motor vehicle	2		
Caught due to striking: radio, TV, high tension, etc wires or towers, or ceilometers	1		
Caught due to striking: stationary object other than wires or towers	1		
Caught due to: injury	3		
Caught or found dead due to: weather conditions	1		
Code discontinued (Caught by or due to: dog)	2		
Code discontinued (Caught by or due to: hawks, owls, or other captors)	1		
Found dead or injured on highway	2		
Found dead	21		
Found dead: band with skeleton or bone only	1		
Illegally taken	6		
Previously banded bird trapped and released during banding operations	62		
Shot	53		
Unknown Location			1
Found dead	1		
		TOTAL	**212**

Figure 7. Encounter locations of Common Gallinule banded in Ontario from 1937 to 2019 *(sources: this study; GameBirds, United States Geological Survey 2019).*

of the U.S. and one in Bermuda (Figure 7, Table 3). Proportionally, more Ontario-banded gallinules have been encountered in the Atlantic Flyway (81.3%) than in the Mississippi Flyway (18.7%). The largest source of encounters (69.8%) was Ontario (n=37), where 19 were related to banding operations (12 mortalities, seven recaptures), nine birds were 'found dead,' two birds each were 'shot,' 'lacking information' or 'drowned,' and one bird was listed in each of the categories 'caught by hand,' 'in a trap or snare' and 'after striking a wire, tower, etc.'. Of the 15 encounters from the U.S., seven were 'found dead' or 'injured on a highway,' five were 'shot' (two in South Carolina, November and January; two in Florida, October and December; and one in Louisiana, November) and the remaining were 'caught' by various methods. Conversely, only one bird has been encountered in Ontario that was banded in Florida. This bird was 'caught in a trap or snare' in 1965 along the Trent River near Campbellford, Ontario.

Discussion

Gallinules have been banded across the Americas from as far south and east as Porto Alegre, Brazil, as far west as California, U.S. and as far north as Rimouski, Québec. By far, Louisiana is the location with the largest number of bandings, which is not surprising given gallinules have a relatively 'high abundance' in this state (as derived from eBird data) and reside there year-round (Bannor and

Kiviat 2020). Surprisingly, few have been banded in Florida, which also has a high abundance of year-round gallinules. Instead, areas at the northern extent of the breeding range of gallinules in North America, such as Ontario, Michigan, Québec and New York, accounted for almost 50% of the total gallinule banded in the Americas. The creation of new habitat, such as retention ponds, dyked wetlands, sewage lagoons and ponds, with urbanization and agricultural development may explain the northward range expansion of gallinules during the mid twentieth century (Bannor and Kiviat 2020). Anecdotal evidence also suggests that gallinules were common in Ontario during this time (Curry 2006). This may explain why these northern areas account for many bandings particularly during the 1955 to 1985 time frame. Since then, the loss of wetlands, particularly in southwestern Ontario, the Toronto and Niagara areas (Ducks Unlimited Canada 2010) may explain why the number of bandings has declined over time. For example, from 1955 to 1970, almost all of the encounters from Ontario banded gallinules occurred from birds banded in the Whitby/Oshawa area. Since 1985, there have been no nest records reported in this area although some birds are still being reported on eBird (Birds Canada 2020). High counts of gallinules in the Oshawa area ranged as high as 100 birds in 1969, but in the last decade the highest single count recorded was 17 birds in 2011 (eBird 2020).

Very few banded gallinules are encountered. Since 1925, only 3.3% of all gallinules banded have been encountered. For known banding locations, the total percentage encountered was 3.5% for the U.S., 2.9% for Canada and 3.4% for Ontario. Our study's average annual encounter rate (approximately 1.3%) was lower than these cumulative historical rates as well as annual encounter rates reported for other game birds (e.g., American Black Duck [*Anas rubripes*] 4-9%/year; Roy *et al.* 2015), geese (2-17%/year; Luukkonen and Leafloor 2017) and doves (1.8-3.5% direct recoveries per year; Sanders and Otis 2012, Environment and Climate Change Canada 2017). However, it is comparable to encounter rates for other rails (Arnold *et al.* 2016) and higher than rates reported for neo-tropical migrant passerines (approximately 0.5%) (Brewer *et al.* 2000, Dunn 2001).

One interesting observation with regard to our encounters was the number of gallinules recaptured during banding operations, with most at the same site as they were banded. This is similar to historical gallinule banding, for which the highest number of encounters is from birds recaptured during banding operations. The recaptures at original banding location shows fidelity of gallinules to specific wetlands. Other studies (see Bannor and Kiviat 2020 for a synopsis) have also shown how specific wetland characteristics, such as the amount of hemimarsh, presence of robust emergent vegetation, floating vegetation mats and number of muskrats (*Ondatra zibethicus)*, affect the number of gallinule using a wetland, particularly during the breeding season. Many of these characteristics are present at Mud Lake (e.g., diversity of

Common Gallinule with young, Port Rowan, Ontario. *Photo: Graham Wood*

both floating and emergent vegetation, presence of muskrats, etc.) which likely explains the relatively high number of gallinules that we banded (and observed) there during our study compared to other sites. On numerous occasions, we observed gallinules with broods of six to 10 chicks at Mud Lake that we did not attempt to band because of concern about separating the brood members, given the young age of the chicks. The number of broods explains the high site-level productivity at Mud Lake (~81.8% of all of bands at Mud Lake were placed on juveniles) and why this site accounted for over two-thirds the total number of banded birds over our study. Future studies could deploy transmitters to shed light on movement and habitat use questions to provide data where banding data are insufficient.

Gallinule banding should be integrated with site-level nesting ecology studies or surveys in order to obtain more accurate information on productivity and habitat use. Undoubtedly, our productivity estimates were biased high because of the difficulty in capturing adult birds with an airboat in relation to their availability and our avoidance of catching very young chicks in some years. For example, in 2012 when the pilot study commenced, not one adult gallinule was captured while 34 juveniles

were banded. This was likely due to the easy availability of juveniles for capture, inexperience of netters to capturing gallinules and wariness of adult birds. To illustrate this bias, one need only examine the hypothetical availability of juvenile versus adults based on nest productivity statistics. Peck and James (1983) showed that gallinules lay six to nine eggs. If we use an average of 7.5 eggs per gallinule for clutch size, an average of 67% hatching success rate (range 51% to 83%) and chick survival of 60% to day 10 and 70% survival of those remaining chicks to day 25 (Bannor and Kiviat 2020), one would expect a juvenile to adult ratio of approximately 2.1:1 at the time of banding. Although annual variability will change this ratio, we obtained an overall ratio of approximately five juvenile birds for every adult at our best site, Mud Lake; only in 2016 did we come close to achieving this hypothetical ratio; we were 2.3:1. As such, our productivity ratios should be viewed with caution especially given the slightly declining population trend for Common Gallinule in Ontario and elsewhere.

Our results show that Mud Lake provides high quality breeding habitat for gallinules in comparison to other wetlands. This may be due to its geographical location in Ontario and landscape and local characteristics such as watershed and surrounding habitat. The location of Mud Lake just south of the Ottawa River within Bird Conservation Region 13 places it at the northern extent of the range of gallinules in Ontario (Timmermans 2007). Located in a landscape dominated by farmland (mostly hayfields), Mud Lake is immediately surrounded by forest, which buffers the effect of surface run-off while allowing some nutrients to enter the wetland, thus affecting plant and invertebrate diversity. The immediate forest surrounding it, its location approximately 2.5 km upstream of Highway 17 and thick cover of floating and emergent vegetation reduces anthropogenic disturbance during the breeding season. This and the natural presence of predators such as raccoon (*Procyon lotor*), American mink (*Neovison vison*), American Crow (*Corvus brachyrhynchos*), snakes and common snapping turtle (*Chelydra serpentina*), makes Mud Lake an excellent research site for a gallinule nesting ecology study in Ontario. Going forward, it would be interesting to compare the nesting ecology of gallinules at Mud Lake to MMP survey results and banding data to help inform current data gaps and assumptions (e.g., species detectability and breeding pair density).

Results from our study show that relatively large numbers of gallinules can readily be caught with a dip net and spotlight at night from an airboat. While catching success depended on the site (e.g., amount and diversity of wetland vegetation) and capture conditions (e.g., new moon), it should be possible to catch over 100 gallinules at Mud Lake annually. More importantly, we estimate that a dedicated crew could easily catch 150-200 gallinules in a given year over a broad geographical range of sites in southern Ontario. However, costs of a banding program of this scale may be prohibitive as operating an airboat for a

night can cost over one thousand dollars, and might only be feasible if these costs can be shared among programs (e.g., duck and marsh bird banding/feather isotope studies). The low number of encounters of banded birds represents another and larger obstacle to gaining useful information for management decisions, such as calculating harvest pressure or identifying important breeding, staging or wintering locations. For example, even if 200 gallinules were banded in a given year, we predict the number of encounters would be only two to three per year and mostly related to recapturing adult birds at the same sites as banded. Consequently, a simple banding program for gallinules would likely not yield the desired information required to make informed management decisions. A more fruitful approach would be to mark a small number of birds over a large geographical area using new technologies, such as nanotags or light weight GPS transmitters. This approach may provide sufficient new information to improve our knowledge of this secretive marsh bird in Ontario, Canada and North America.

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