Urban Naturalist

No. 25 2019

Placement of a Recycling Container and Informational Signs Reduces Fishing Line and Tackle Litter at a Residential Lake: A Case Study

Reneé E. Carleton, Savannah McKenzie, Eddie Elsberry, and Chandler Klemm

The *Urban Naturalist* . . .

- A peer-reviewed and edited interdisciplinary natural history science journal with a global focus on urban areas (ISSN 2328-8965 [online]).
- Featuring research articles, notes, and research summaries on terrestrial, fresh-water, and marine organisms, and their habitats. The journal's versatility also extends to publishing symposium proceedings or other collections of related papers as special issues.
- Focusing on field ecology, biology, behavior, biogeography, taxonomy, evolution, anatomy, physiology, geology, and related fields. Manuscripts on genetics, molecular biology, anthropology, etc., are welcome, especially if they provide natural history insights that are of interest to field scientists.
- Offers authors the option of publishing large maps, data tables, audio and video clips, and even powerpoint presentations as online supplemental files.
- Proposals for Special Issues are welcome.
- Arrangements for indexing through a wide range of services, including Web of Knowledge (includes Web of Science, Current Contents Connect, Biological Abstracts, BIOSIS Citation Index, BIOSIS Previews, CAB Abstracts), PROQUEST, SCOPUS, BIOBASE, EMBiology, Current Awareness in Biological Sciences (CABS), EBSCOHost, VINITI (All-Russian Institute of Scientific and Technical Information), FFAB (Fish, Fisheries, and Aquatic Biodiversity Worldwide), WOW (Waters and Oceans Worldwide), and Zoological Record, are being pursued.
- The journal staff is pleased to discuss ideas for manuscripts and to assist during all stages of manuscript preparation. The journal has a mandatory page charge to help defray a portion of the costs of publishing the manuscript. Instructions for Authors are available online on the journal's website (www.eaglehill.us/urna).
- Co-published with the *Northeastern Naturalist* (Print ISSN # 1092-6194, Online ISSN # 1938-5307), the *Southeastern Naturalist* (Print ISSN # 1528-7092, Online ISSN # 1938-5412), and *Caribbean Naturalist* (ISSN # 2326-7119 [online]). Together these journals provide an integrated publishing and research resource for all of eastern mainland North America and the offshore waters and islands from Canada south to the Caribbean region, as well as urban areas worldwide.
- Available online in full-text version on the journal's website (www.eaglehill.us/urna). Arrangements for inclusion in the BioOne database (www.bioone.org, a collaborative effort of Allen Press, AIBS, et al.), EBSCOhost product line, and the Proquest Information and Learning databases (www.il.proquest.com) are being pursued.
- May be ordered through any major subscription service.

Cover Photograph: Bald Eagle (*Haliaeetus lecocephalus*) with captured American Coot (*Fulica american*) at a suburban lake in northwestern Georgia, USA. American Coots are among the birds found to be entangled with fishing line and tackle litter at the lake. Photograph © Gena Flanigen.

URBAN NATURALIST

The ***Urban Naturalist*** (ISSN # 2328-8965) is published by the Eagle Hill Institute, PO Box 9, 59 Eagle Hill Road, Steuben, ME 04680-0009. Phone 207-546-2821, FAX 207-546-3042. E-mail: office@eaglehill.us. Webpage: www.eaglehill.us/urna. Copyright © 2019, all rights reserved. Periodical postage paid in Steuben, ME and additional mailing offices. **Special issue proposals are welcome**. On-line secure subscription ordering: rate per year - $20 regular, $15 students, $80 organizations. **Authors**: submission guidelines are available at www.eaglehill.us/una. **Co-published journals:** The *Northeastern Naturalist* (ISSN 1092-6194 [print], ISSN 1938-5307 [online]), the *Southeastern Naturalist* (ISSN 1528-7092 [print], ISSN 1938-5412 [online]), and the *Caribbean Naturalist* (ISSN 2326-7119), journals with separate Boards of Editors. The Eagle Hill Institute is a tax exempt 501(c)(3) nonprofit corporation of the State of Maine (Federal ID # 010379899).

Placement of a Recycling Container and Informational Signs Reduces Fishing Line and Tackle Litter at a Residential Lake: A Case Study

Reneé E. Carleton[1,*], Savannah McKenzie[1,3], Eddie Elsberry[2], and Chandler Klemm[1]

Abstract - Fishing line and tackle litter pose a hazard to birds and other animals inhabiting aquatic or aquatic-associated environments. We studied a suburban lake, identified as an Important Bird Area, in northwestern Georgia, USA, to: (1) determine the extent of line and tackle litter deposited on the shoreline, (2) reduce angling-related litter there, (3) increase public awareness of the associated hazards to wildlife, and (4) determine usage of a recycling container by individuals visiting the lake. We collected and quantified line and tackle litter from the shoreline before and after installation of a fishing-line recycling container and informational signs, and made comparisons of numbers and lengths of line and tackle deposited in the container versus deposited on the shoreline. From the date of container installation to the end of the study, we documented significant decreases in both the numbers and lengths of line pieces deposited on the shoreline relative to those deposited in the recycling container. The numbers and lengths of line pieces recovered from the shoreline decreased by 70.37% and 87.45%, respectively, and the numbers and lengths of line pieces deposited in the recycling container increased by 513.33% and 810.13%, respectively. Twenty-two percent of all line pieces recovered had at least 1 hook, lead weight, or lure attached. Our results demonstrate that placement of the recycling container and associated signage can reduce, but not eliminate, fishing line and tackle litter at this particular lake. Similar measures should be considered at other suburban lakes where recreation angling is popular in order to reduce the threat to wildlife.

Introduction

Recreational fishing is a popular outdoor pastime, with an estimated global participation of nearly 10% of a given industrialized country's adult population, equating to between 200 million to 700 million anglers worldwide (Arlinghaus and Cooke 2009, Cooke et al. 2016). An increase in participation is expected as more individuals living in countries with emerging economies engage in the activity (Cooke et al. 2016). In 2016, recreational anglers in the United States numbered over 35 million and spent an estimated $46 billion on related purchases (USDOI-USFWS 2017). In addition to increasing a participant's quality of life through recreational enjoyment, benefits of recreational fishing include an increased

[1]Department of Biology, Berry College, 2277 Martha Berry Highway NW, Mount Berry, GA, 30149, USA. [2]Office of Environmental Compliance and Sustainability, Berry College, 2277 Martha Berry Highway NW, Mount Berry, GA 30149, USA. [3]Current address - Medical College of Georgia, 1120 15th Street, Augusta, GA 30912, USA. [*]Corresponding author - rcarleton@berry.edu.

Manuscript Editor: Travis Ryan

awareness of biological diversity and recognition of the importance of aquatic ecosystems (Arlinghaus and Cooke 2009, Kirchhofer 2002).

A number of negative environmental issues are associated with recreational fishing (Arlinghaus and Cooke 2009). Impacts include increased pressures on certain fish species through overtake or disruption of reproduction, direct or indirect mortality from sub-lethal injuries to fish during catch and release or break-offs, littering and other forms of pollution, and shoreline erosion and compaction (Lewin et al. 2006, NOAA 2014, O'Toole et al. 2009). Marine, freshwater, riparian, and littoral non-fish vertebrates also suffer injuries and mortality from interactions with abandoned or improperly disposed of fishing line and tackle (Borkowski 1997, Dau et al. 2009, Forbes 1986, Heath et al. 2017, Laist 1997, Pokras and Chafel 1992, Scheuhammer and Norris 1995).

Entanglement with fishing line and/or associated discarded tackle poses a threat of acute or long-term injuries or death for numerous species of waterfowl, wading birds, and shorebirds including pelicans and gulls. Injury or death can also occur following incidental ingestion of hooks and lead weights (Carapetis et al. 2010, 2014; Dau et al. 2009; Folk et al. 2001; Franson et al. 2003; Heath et al. 2017; Laist 1997; Lewin et al. 2006). Birds of prey that feed on waterfowl and fish can also sustain injuries or suffer direct or indirect mortality if they become entangled or ingest line when capturing or feeding on entangled prey (Beatty and Driscoll 1996, Laist 1997).

Lead toxicity following ingestion of lead weights has been associated with mortality in *Haliaeetus leucocephalus* (Bald Eagle), *Gavia immer* (Common Loon), *Cygnus* spp. (swans), *Mergus merganser* L. (Common Merganser), and a number of species of Anatidae (ducks) in North America (Anderson et al. 2000, Franson et al. 2003, Locke et al. 1982, Pokras and Chafel 1992, Scheuhammer and Norris 1995). In England, the deaths of thousands of *Cygnus olor* (Gmelin) (Mute Swan) were attributed to lead sinker ingestion and subsequent toxicity (Kelly and Kelly 2004, Simpson et al. 1979). A rebound of populations of Mute Swan was attributed to a ban on the use of lead weights in England in 1987 (Kelly and Kelly 2004). Oxidation of lead weights deposited in substrates also poses a pollution effect that may extend through multiple trophic levels (Scheuhammer and Norris 1995).

A number of federal and state agencies (e.g., United States Fish and Wildlife Service, Florida Fish and Wildlife Conservation Commission, California Division of Boating and Waterways, New Mexico Energy, Minerals, and Natural Resources Department), and private organizations (e.g., National Marine Life Center, Fly Fishers International, BoatUS Foundation) actively promote anti-littering and fishing line recycling campaigns. Website content for many of these entities include information about the hazards to wildlife posed by fishing line left in the environment and plans for a simple recycling container constructed from PVC. An example of a recycling campaign is the Texas Monofilament Recovery and Recycling Program, which was credited with removing over 350 kg, equivalent to ~1700 km, of monofilament fishing line litter from the environment between 2006 and 2014 (SeaGrant Texas 2014).

We recovered the dessicated remains of a fishing line-entangled *Fulica americana* (American Coot) foot and wing from a Bald Eagle nest in Floyd County, GA, USA, in August 2015 (Fig. 1). Since 2012, a pair of eagles had occupied the nest, the first to be documented in the county (Ozier 2010), and successfully raised 3 broods of eaglets. The hazards posed by fishing line to both the adult eagles, their young, and the numerous other birds visiting the lake, prompted us to: (1) investigate the extent of fishing line and tackle litter at a local lake frequented by the birds, (2) reduce the amount of litter deposited there, (3) bring public attention to the negative effects of improperly discarded line and tackle, and (4) determine usage of the recycling container by individuals visiting the lake. Given that fishing is possible year-round due to the generally mild temperatures of the region and the sport is quite popular in this area (Georgia Department of Natural Resources 2017), we expected to recover quantities of discarded line and tackle during each collection visit. We also expected to document a difference between line litter deposited on the shoreline and that deposited into the recycling container.

Study Site and Methods

Lake Conasauga (34°17′20.7″N, 85°14′14.6″W) is a 14.83-ha, man-made reservoir located within a residential subdivision near Rome, GA (Fig. 2). The shoreline is 1.88 km in length; 0.262 km is privately owned with the remainder being public property. The lake, 2 small parking areas located on opposite sides of the lake, and a small (<1 ha) park are accessible by 2 non-connected residential streets. An asphalt-paved walking path parallels the entire shoreline, which is mostly void of vegetation except for a few trees and shrubs. Three metal trash receptacles, including 1 within the park, are located along the path and maintained by the city.

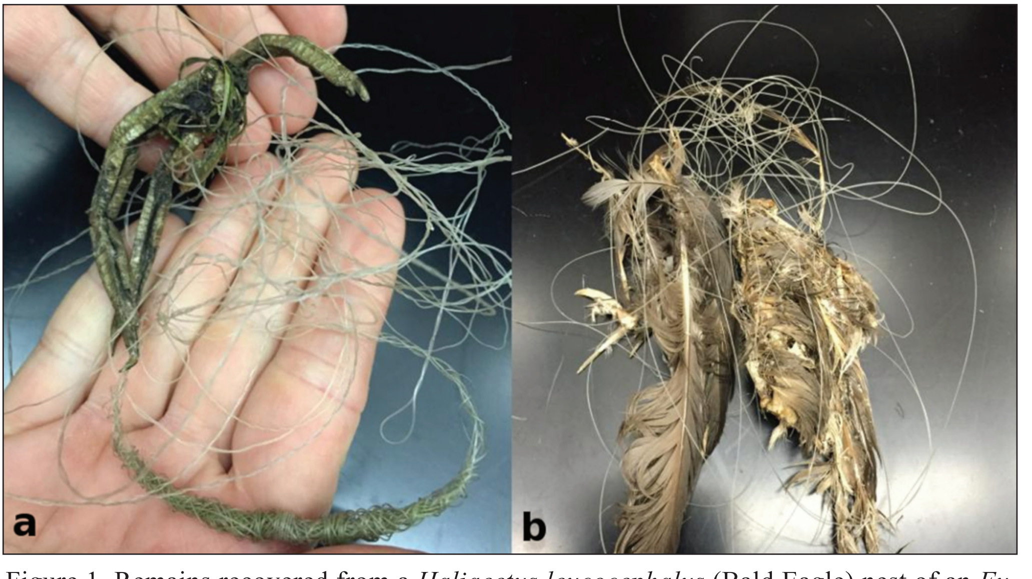

Figure 1. Remains recovered from a *Haliaeetus leucocephalus* (Bald Eagle) nest of an *Fulica americana* (American Coot) (a) foot and (b) wing entangled in fishing line.

Subdivision residents and non-residents use the walking path for recreation and exercise as well as access to the shoreline for fishing. In 2008, the lake was designated as a National Audubon Society Important Bird Area (IBA) as it hosts more than 20 species of over-wintering and migrating waterfowl including coots, dabbling and diving ducks, and mergansers (Table 1; National Audubon Society 2013). These birds and the fish inhabiting the lake attract Bald Eagles and *Pandion haliaetus* (Osprey) in search of prey. Anglers also frequent the lake to fish for *Ameiurus* spp. (catfish), *Lepomis* spp. (sunfish), and *Micropterus* spp. (bass) from the shoreline. Motorized boats are not permitted on the lake.

We initiated the study in January 2016 by first repairing an existing but dilapidated wooden kiosk and placing informational signs on each side. One of the signs featured images taken at the lake of waterfowl entangled in fishing line (Fig. 3 a,b). The sign also displayed information about a fishing line recycling program established through a cooperative effort between the National Oceanic and Atmospheric Administration, National Fish and Wildlife Foundation, and BoatsUS Foundation (BoatsUS Foundation 2016). The second sign featured a list of 27 bird species documented at the lake, images of several of them, and information about the lake's

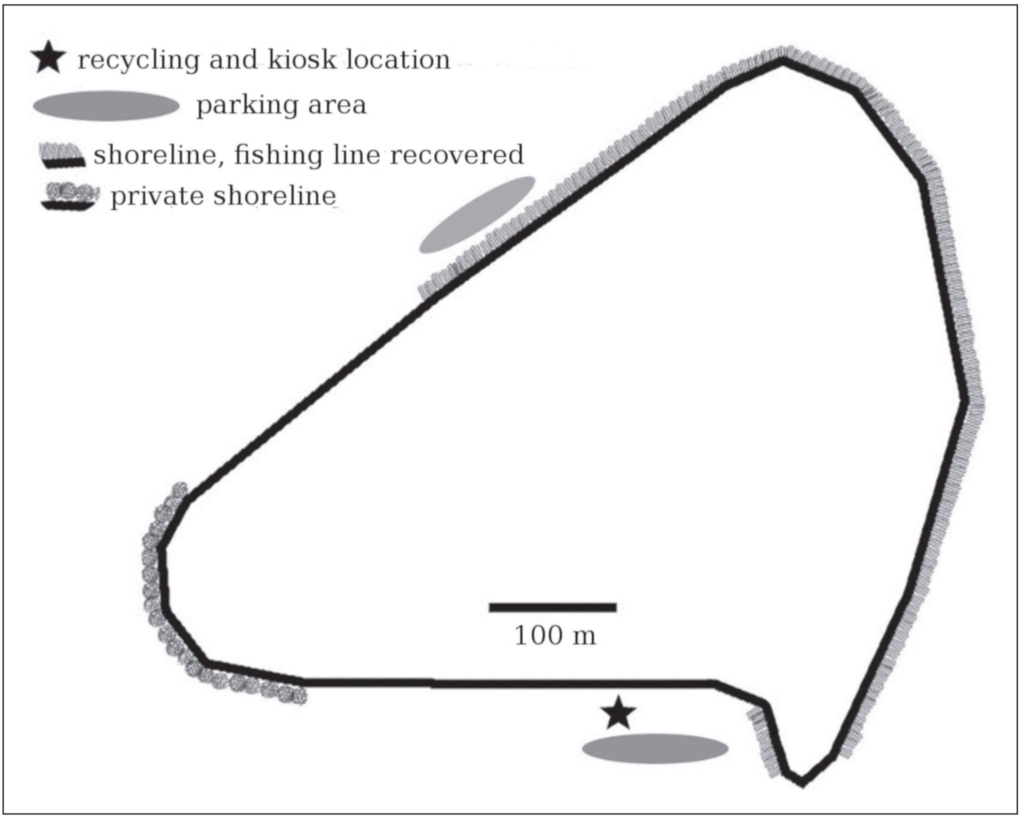

Figure 2. Map of Lake Conasauga showing location of informational kiosk with fishing line recycling container and shoreline where discarded fishing line was recovered. Entire shoreline was searched for angling-related litter approximately monthly between January and April 2016 and once in December 2016.

Table 1. Waterfowl, shorebirds, and water-associated birds of prey documented at Lake Conasauga, Floyd County, GA, USA, an Important Bird Area, with season (M = migration during March–May and September–November; W = winter from December–February; R = year-round resident) and frequency of occurrence (very common: >25 birds reported each month of season, common: 1–25 birds reported each month of season, occasional: 1–25 birds reported at least 2 months of season, infrequent: <10 birds reported up to 2 months of season, and rare: fewer than 3 total reports) based on eBird.org records.

Common Name	Species	Season	Frequency
American Black Duck	*Anas rubripes* Brewster	W	Occasional
American Coot	*Fulica americana* Gmelin	M, W	Very common
American White Pelican	*Pelecanus erythrorhynchos* Gmelin	M	Rare
American Wigeon	*Mareca americana* Gmelin	M, W	Very common
Bald Eagle	*Haliaeetus leucocephalus* L.	R	Common
Blue-winged Teal	*Spatula discors* (L.)	M, W	Common
Bonaparte's Gull	*Chroicocephalus philadelphia* Ord	W	Infrequent
Bufflehead	*Bucephala albeola* (L.)	W	Common
Canada Goose	*Branta canadensis* L.	R	Very common
Canvasback	*Aythya valisineria* Wilson	M, W	Occasional
Common Goldeneye	*Bucephala clangula* (L.)	W	Occasional
Common Loon	*Gavia immer* (Brunnich)	W	Occasional
Double-crested Cormorant	*Phalacrocorax auritus* (Lesson)	M	Occasional
Forster's Tern	*Sterna forsteri* Nuttall	M	Rare
Gadwall	*Mareca strepera* (L.)	M, W	Very common
Glossy Ibis	*Plegadis falcinellus* (L.)	M	Occasional
Great Blue Heron	*Ardea herodias* L.	R	Common
Great Egret	*Ardea alba* (L.)	M, W	Occasional
Greater White-fronted Goose	*Anser albifrons* Scopoli	W	Occasional
Greater Scaup	*Aythya marila* L.	W	Occasional
Green Heron	*Butorides virescens* (L.)	M	Rare
Green-winged Teal	*Anas crecca* (L.*)*	M, W	Occasional
Herring Gull	*Larus argentatus* Pontoppidan	W	Rare
Hooded Merganser	*Lophodytes cucullatus* L.	M, W	Common
Horned Grebe	*Podiceps auritus* (L.)	W	Occasional
Killdeer	*Charadrius vociferus* (L.)	R	Occasional
Lesser Scaup	*Aythya affinis* Eyton	M, W	Common
Long-tailed Duck	*Clangula hyemalis* (L.)	M	Rare
Mallard	*Anas platyrhynchos* (L.)	R	Very common
Northern Pintail	*Anas acuta* (L.)	W	Occasional
Northern Shoveler	*Spatula clypeata* L.	M, W	Common
Osprey	*Pandion haliaetus* L.	R	Occasional
Pied-billed Grebe	*Podilymbus podiceps* L.	M, W	Very common
Red-breasted Merganser	*Mergus serrator* L.	M, W	Occasional
Redhead	*Aythya americana* Eyton	M, W	Very common
Ring-billed Gull	*Larus delawarensis* Ord	M, W	Common
Ring-necked Duck	*Aythya collaris* Donovan	M, W	Very common
Ross's Goose	*Anser rossii* (Cassin)	W	Occasional
Ruddy Duck	*Oxyura jamaicensis* (Gmelin)	W	Common
Snow Goose	*Anser caerulescens* (L.)	W	Occasional
Spotted Sandpiper	*Actitis macularius* L.	M	Occasional
White-winged Scoter	*Melanitta deglandi* (L.)	M	Rare
Willet	*Tringa semipalmata (*Gmelin)	M	Rare
Wilson's Snipe	*Gallinago delicata* Ord	M	Occasional
Wood Duck	*Aix sponsa* L.	R	Common

IBA status. We also constructed a fishing line recycling container of PVC pipe following instructions given on the recycling program website (BoatsUS Foundation 2016) and attached it to the kiosk. The local municipal government assisted with the scheduling of a lake clean-up event that coincided with completion of the kiosk and placement of the recycling container.

Volunteer participants collected pieces of fishing line, tackle, and litter discarded on or near the walking path or in the lake but within reach of the publicly accessible shoreline during the clean-up event. This effort coincided with the installation of the recycling container and allowed us to then compare any later collections from the shoreline with those from within the container. Recovered line and tackle was taken back to our laboratory for quantification. We removed any attached artificial lures, hooks, or lead weights from the fishing line and separated and quantified them by type (hooks, lead weights, hard plastic lures, and soft plastic lures). Because fishing line is produced by many manufacturers in multiple thicknesses, tensile strengths, and composition, we elected not to categorize recovered lengths of line by type. For individual pieces of fishing line shorter than 1 m in length, we measured each to the nearest 0.01 m using a standard meter stick. For pieces longer than 1 m in length, we removed a 1-m section and weighed it to the nearest 0.001 g using a digital scale (Ohaus Corporation, Parsippany, NJ, USA). After weighing the entire piece, we calculated its length by dividing the total mass by the mass of the 1-m section. Approximately every 30 days for 3 months (February, March, and April 2016) and then the 11th month after the initial collection (December 2016), we searched for and collected discarded line and tackle from the shoreline (including the shoreline designated as private property), noted the shoreline location from which pieces were collected, and quantified the recovered material as previously described.

Figure 3. Waterfowl entangled in fishing line at Lake Conasauga: (a) *Branta canadensis* (Canada Goose; photograph © Earlene Cameron) and (b) *Fulica americana* (American Coot: photograph © Gena Flanigen).

We removed all line, tackle, and other refuse from the recycling container each time we visited the lake to conduct shoreline collections, with the exception of the initial collection date when the container was placed on site. Line and tackle removed from the container were kept separated from that collected from the shoreline. We quantified and measured line and tackle from the container using the same methodology as for the material recovered from the shoreline. At the end of the project, we shipped all collected monofilament line to a manufacturer to be recycled.

We calculated percent differences for lengths of fishing line pieces and numbers of pieces recovered by each collection type (shoreline and recycling container), excluding shoreline collections in January before the container was in place, to evaluate changes following the installation of the recycling container. To test our hypothesis of no difference between numbers of line pieces deposited on the shoreline vs. that deposited in the recycling container after its installation, we conducted a likelihood ratio chi-squares test. We conducted a Student's t test to compare average line lengths between shoreline and recycling container collections. Analyses were conducted in JMP v. 9 (SAS Institute, Cary, NC, USA) ($\alpha = 0.05$).

Results

Line and some tackle were recovered from the shoreline during each of our collection visits and from the recycling container beginning with second collection visit. We recovered a combined total of 261 pieces of fishing line of various compositions, thicknesses, and tensile strengths from the shoreline and recycling container (Table 2). Most of the line (98.3%) was of monofilament composition, whereas line composed of braided nylon made up only a minor portion (1.7%). The total length of all line pieces was 1954.22 m.

Twenty-two percent of all fishing line pieces had 1 or more pieces of tackle attached. We collected 15 soft plastic lures with single hooks, 5 hard plastic lures with treble hooks, 33 individual metal hooks (varying from 1.6 cm to 4.5 cm from eye to end of the straight portion of the shank), 12 plastic bobbers, and 2 metal treble hooks. Thirty-one soft plastic lures without hooks and 3 bobbers had

Table 2. Lengths of fishing line collected from the shoreline (SH) and a fishing line recycling container (CO) at a small, residential lake in northwestern Georgia, USA, 2016. Collections from the recycling container began in February 2016, and no collections took place between May and November 2016

	Fishing line metrics							
	No. pieces		Min–max lengths (m)		Avg. length (m) ± SE		Total length (m)	
Month	SH	CO	SH	CO	SH	CO	SH	CO
Jan	27	-	0.003–29.08	-	3.65 ± 1.23	-	94.92	-
Feb	11	15	0.75–31.08	0.012–36.21	6.61 ± 2.58	6.12 ± 2.45	72.74	85.66
Mar	10	20	1.33–8.77	0.012–58.29	4.15 ± 0.84	13.34 ± 3.85	37.45	266.82
Apr	8	70	0.21–4.89	0.12–30.80	1.67 ± 0.71	8.45 ± 2.84	13.37	591.73
Dec	8	92	0.13–5.61	0.10–65.34	1.64 ± 0.68	8.57 ± 1.41	11.91	779.62
Total	64	197					230.39	1723.83

no line attached. Of 25 lead weights collected, 18 weighed <2 g (min–max = 0.58 −57.43 g).

Average length of line ($t(231) = -2.50$, $P = 0.013$) and numbers of pieces ($\chi^2(1) = 138.38$, $P < 0.001$) collected from the container were significantly different than that collected from the shoreline (Table 2). From the first collections following installation of the container to the end of the study, there was a 70.37% decrease in the numbers of line pieces discarded along the shoreline while the number of pieces deposited in the recycling container increased by 810.13% over the amount deposited in the first month (Fig. 4).

No angling-related litter was found on shoreline bordering private property or within the immediate vicinity of the small park where the kiosk and recycling container were located. Over 90% of discarded line and tackle was collected from ~0.940 km of shoreline on the northeastern to southeastern aspect of the lake (Fig. 2).

Discussion

Given the popularity of recreational fishing and the global problem of fishing-related littering, our recovery of numerous pieces of abandoned or discarded fishing line and tackle from the shoreline was not unexpected. One study determined that 2–3 m of line per angler per outing was improperly discarded (Bell et al. 1985). The 230 m of line we recovered from the lake shoreline was greater than the 127 m of

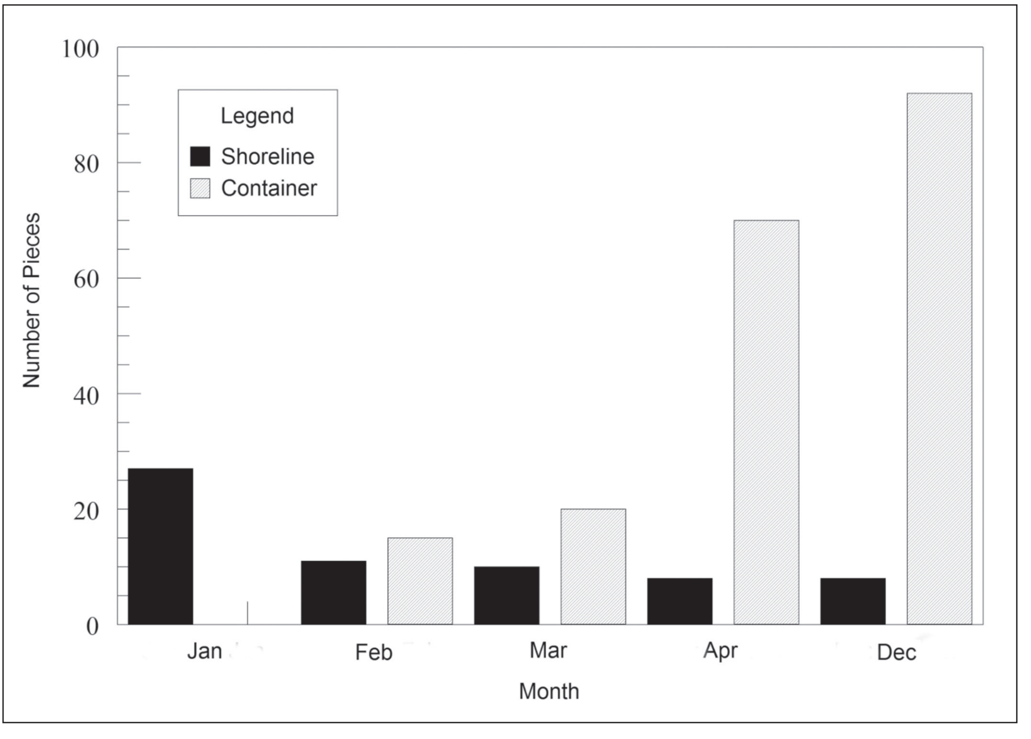

Figure 4. Numbers of pieces of fishing line discarded along the shoreline or placed into a recycling container at a residential lake by month.

discarded line recovered from 14 river- and lake-based fishing sites by O'Toole et al. (2009), but less than the 56,000 m of line collected from a lake by Forbes (1986). The small size of most of the lead weights and many of the hooks we recovered is of concern because these items could have been ingested by dabbling ducks frequenting the lake. Hooks still attached to some of the line pieces we recovered are also a concern since these could have become embedded into a bird entangled in line. It is likely that some line and tackle present in the lake was entangled on rocks or other submerged structures and not recovered since we only collected material that was easily accessible from the shoreline.

The decrease in amount of line and tackle collected from the shoreline and increase of that deposited in the recycling container suggests that placement of the recycling container and informational signs reduced, but not eliminated, improperly discarded and abandoned angling litter at this particular lake. A few individuals we encountered at the lake during collection visits commented that they frequently collected and placed line into the container and appreciated our efforts. It was beyond the scope of this study to investigate the motivations, or lack thereof, of individuals placing discarded line into the recycling container. In a review of recycling practices, Schultz et al. (1995) noted multiples studies concluding that of the general population, environmentally aware individuals were more likely to recycle waste when some effort was required. While we could not directly assess effectiveness of the informational signs as an adjunct to the recycling container, prompting in written form has been shown to increase participation (Schultz et al. 1995).

Case studies, such as this one, can document the extent, characteristics, and potential hazards to wildlife of angling litter deposited in and around individual bodies of water. This study was limited in scope since we collected line and installed a recycling container and informational signs at only a single lake site. Additionally, we were permitted installation of only 1 recycling container, so replication on site was not possible. We did, however, document the presence and extent of improperly discarded line and tackle along the shoreline, present evidence of wildlife injury from line entanglement, and provide informational signage about the hazards of line and tackle litter. We also documented a decrease in shoreline angling litter following the installation of a recycling container. A broader study including multiple lake sites, both with and without line-recycling containers would, however, be necessary to determine the actual effectiveness of their installation in reducing improperly discarded angling litter.

Acknowledgments

The authors are grateful for the assistance of M.H. Thornton, Director, Keep Rome–Floyd Beautiful; C. Jenkins, Director, City of Rome Public Works Division; and several volunteers during the initial shoreline litter recovery. We thank J. White for assistance with subsequent collections, and E. Cameron and G. Flanigen for use of their photographs. Funding for the recycling container and informational signs was provided by the Berry College Office of Environmental Compliance and Sustainability and Keep Rome–Floyd Beautiful.

Literature Cited

Anderson, W.L., S.P. Havera, and B.W. Zercher. 2000. Ingestion of lead and nontoxic shotgun pellets by ducks in the Mississippi flyway. Journal of Wildlife Management 64:848–857.

Arlinghaus, R., and S.J. Cooke. 2009. Recreational fisheries: Socioeconomic importance, conservation issues, and management challenges. Pp. 39–58, *In* B. Dickson, J. Hutton, and W.M. Adams (Eds.). Recreational Hunting, Conservation and Rural Livelihoods: Science and Practice. Blackwell, Oxford, UK.

Beatty, G.L., and J.T. Driscoll. 1996. Arizona Bald Eagle nestwatch program: 1994–1995 management recommendations. Nongame and Endangered Wildlife Program Technical Report 84. Arizona Game and Fish Department, Phoenix, AZ, USA. 21 pp.

Bell, D.V., N. Odin, and E. Torres. 1985. Accumulation of angling litter at game and coarse fisheries in South Wales, UK. Biological Conservation 34:169–179.

BoatsUS Foundation. 2016. Reel in and recycle program. Available online at http://www.boatus.org/monofilament. Accessed 10 January 2016.

Borkowski, R. 1997. Lead poisoning and intestinal perforations in a Snapping Turtle (*Chelydra serpentina*) due to fishing gear ingestion. Journal of Zoo and Wildlife Medicine 28:109–113.

Carapetis, E.R., A. Machado, and A.R. Byard. 2010. Lethal consequences of ingested foreign material in seabirds. Forensic Science Medicine and Pathology 6:242–243.

Carapetis, E.R., A. Machado, K. Braun, and A.R. Byard. 2014. Recreational fishing-related injuries to Australian Pelicans (*Pelecanus conspicillatus*) and other seabirds in a South Australian estuarine and river area. International Journal of Veterinary Health Science and Research 2:24–27.

Cooke, S.J., R. Arlinghaus, B.M. Johnson, and I.G. Cowx. 2016. Recreational fisheries in inland waters. Pp. 449–465, *In* J.F. Craig (Ed.). Freshwater Fisheries Ecology. Wiley, NY, USA.

Dau, B.K., K.V.K. Gilardi, F.M. Guilland, A. Higgins, J.B. Holcomb, J. St. Leger, and M.H. Ziccardi. 2009. Fishing gear-related injury in California marine wildlife. Journal of Wildlife Diseases 45:355–362.

Folk, M.J., S.A. Nesbitt, and M.G. Spalding. 2001. Interactions of Sandhill Cranes and Whooping Cranes with foreign objects in Florida. Pp. 195–197, *In* D.H. Ellis (Ed.). Proceedings of the Eighth North American Crane Workshop. North American Crane Working Group, Seattle, WA, USA.

Forbes, I.J. 1986. The quantity of lead shot, nylon fishing line, and other litter discarded at a coarse fishing lake. Biological Conservation 38:21–34.

Franson, J.C., S.P. Hansen, T.E. Creekmore, C.J. Brand, D.C. Evers, A.E. Duerr, and S. DeStefano. 2003. Lead fishing weights and other fishing tackle in selected waterbirds. Waterbirds 26:345–352.

Georgia Department of Natural Resources. 2017. Fishing. Available online at https://gadnr.org/fishing. Accessed 15 October 2017.

Heath, S.A., S. Dahlgren, D. Simon, and D.M. Brooks. 2017. Monofilament fishing line as a threat to American Oystercatchers (*Haematopus palliatus*) on the Texas Coast, USA. Waterbirds 40:123–126.

Kelly, A., and S. Kelly. 2004. Fishing tackle injury and blood lead levels in Mute Swans. Waterbirds 27:60–68.

Kirchhofer, A. 2002. The role of legislation, institutions, and policy making in fish conservation in Switzerland: Past, present, and future challenges. Pp. 389–401, *In* M.J. Collares-Pereira, I.G. Cowx, and M.M. Coelho (Eds.). Conservation of Freshwater Fish: Options for the Future. Blackwell Science, Oxford, UK.

Laist, D.W. 1997. Impacts of marine debris: Entanglement of marine life in marine debris including a comprehensive list of species with entanglement and ingestion records. Pp. 99–139, *In* J.M. Coe and D.B. Rogers (Eds.). Marine Debris: Sources, Impacts, and Solutions. Springer-Verlag, New York, NY, USA.

Lewin, W-C., R. Arlinghaus, and T. Mehner. 2006. Documented and potential biological impacts of recreational fishing: Insights for management and conservation. Reviews in Fisheries Science 14:305–367.

Locke, L.N., S.M. Kerr, and D. Zoromski. 1982. Lead poisoning in Common Loons (*Gavia immer*). Avian Diseases 26:392–396.

National Audubon Society. 2013. Important bird areas. Available online at http://www.audubon.org/important-bird-areas/garden-lakes. Accessed 20 January 2016.

National Oceanic and Atmospheric Administration (NOAA). 2014. Entanglement of marine species in marine debris with an emphasis on species in the United States. Final report, NOAA, Marine Debris Program, Silver Spring, MD, USA. Available online at https://marinedebris.noaa.gov/sites/default/files/publications-files/Entanglement_of_Marine_Species_Emphasis_Species_in_US.pdf. Accessed 15 November 2017.

O'Toole, A.C., K.C. Hanson, and S.J. Cooke. 2009. The effect of shoreline recreational angling activities on aquatic and riparian habitat within an urban environment: Implications for conservation and management. Environmental Management 44:324–334.

Ozier, J. 2010. Bald Eagle. Pp. 126–127, *In* Schneider, T.M., G. Beaton, T.S. Keyes, and N.A. Klaus (Eds.). Breeding Bird Atlas of Georgia. University of Georgia Press, Athens, GA, USA.

Pokras, M.A., and R. Chafel. 1992. Lead toxicosis from ingested fishing sinkers in adult Common Loons (*Gavia immer*) in New England. Journal of Zoo and Wildlife Medicine 23:92–97.

SeaGrant Texas. 2014. Monofilament recovery and recycling program: Reducing human impacts on aquatic ecosystems. Available online at http://texasseagrant.org/assets/uploads/resources/HealthyCoastalEcosystems-Monofilament.pdf. Accessed 26 July 2018.

Scheuhammer, A.M., and S.L. Norris. 1995. A review of the environmental impacts of lead shotshell ammunition and lead fishing weights in Canada. Occasional Paper Number 88. Canadian Wildlife Service. Ottawa, ON, CA. 52 pp.

Schultz P.W., S. Oskamp, and T. Maineiri. 1995. Who recycles and when? A review of personal and situational factors. Journal of Environmental Psychology 15:105–121.

Simpson, V.R., A.E. Hunt, and M.C. French. 1979. Chronic lead poisoning in a herd of Mute Swans. Environmental Pollution 18:187–202.

US Department of the Interior, US Fish and Wildlife Service (USDOI-USFWS). 2017. 2016 National survey of fishing, hunting, and wildlife-associated recreation. Available online at https://wsfrprograms.fws.gov/subpages/nationalsurvey/national_survey.htm Accessed 5 November 2017.