Articles

Does Invasive Common Reed in Coastal Salt Marshes Affect Dabbling Duck Food Availability?

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Abstract

Common reed, *Phragmites australis*, a nonnative perennial grass, is considered a nuisance species to land managers and wildlife biologists. Common reed thrives in areas with reduced soil salinities, increased nitrogen availability, and anthropogenic shoreline development. The expansion of nonnative common reed into tidal wetlands of North America detrimentally affects native wildlife by altering resource utilization, modifying trophic structures, and changing disturbance regimes. Thus, it also has the potential to drastically affect dabbling duck (Family Anatidae, SubFamily Anatinae, Tribe Anatini) energetic carrying capacity in salt marsh ecosystems. We assessed whether invaded monocultures of common reed in dabbling duck habitat could alter the availability of invertebrate and seed foods for the mallard *Anas platyrhynchos*, American black duck *Anas rubripes*, green-winged teal *Anas crecca*, northern shoveler *Spatula clypeata*, and northern pintail *Anas acuta* as compared with wetland type (mudflat, low marsh, high marsh, and impoundments). We compared food and energy availability in > 90% common reed monocultures with noncommon reed-invaded salt marshes in five study areas in Edwin B. Forsythe National Wildlife Refuge, New Jersey, 2015–2016. To estimate wetland-specific food energy supply, we collected sediment core samples, fixed them with formalin, and washed, dried, sorted, and weighed them for seeds and invertebrates. We multiplied biomass (g) by true metabolizable energy values to estimate species-specific dabbling duck food energy availability. We further estimated wetland-specific energetic carrying capacity (duck energy days) on the basis of known species-specific energetic demands. We determined that duck energy days/ha were greater for dabbling ducks in wetlands invaded with common reed because they contained more consumable seed energy and less consumable invertebrate energy. However, future research should explore how accessible these foods are when common reed grass is dense. To aid in restoration efforts once common reed is removed by control efforts, our results indicate that a robust seed bank exists in the soil strata, thus increasing salt-marsh seed biodiversity.

The findings and conclusions in this article are those of the author(s) and do not necessarily represent the views of the U.S. Fish and Wildlife Service.

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Introduction

The genus *Phragmites*, a group of clonal wetland grasses, has existed in North America for at least 40,000 y (Orson 1999), with endemic North American populations recognized as a unique subspecies, the common reed *Phragmites australis americanus* (Saltonstall et al. 2004). However, in the 1800s, a Eurasian genotype (haplotype M) was introduced into the East Coast of the United States and has spread across the continent (Chambers et al. 1999, Meyerson et al. 2012). The recent expansion of the common reed population along the Atlantic Coast is caused by an increase in optimal common reed habitat. Common reed thrives in soils with reduced salinities and increased nitrogen availability (Silliman and Bertness 2004); thus, high marsh, brackish impoundments, and freshwater impoundments are particularly susceptible to invasion (Amsberry et al. 2000). These conditions are further exacerbated when woody vegetation bordering salt marshes is removed via anthropogenic shoreline development (Silliman and Bertness 2004).

The expansion of nonnative common reed into tidal wetlands of North America has had detrimental consequences on the landscape. Because common reed can increase up to 20%/y until stands create complete monocultures, its presence alters local trophic structure and biodiversity, resource use by native species, and changes the disturbance regime (Chambers et al. 1999; Ailstock et al. 2001; Stanton 2005; Gucker 2008). Thus, common reed is considered a "nuisance species" and a form of biological pollution.

Common reed has been cited to provide avian nesting cover. The New Jersey Audubon reports that 33 bird species nest in common reed in the State of New Jersey (Kane 2001); its potential effects on marsh birds during the nonbreeding season are basically unknown. However, it is understood that common reed is not consumed by waterfowl (Livolsi 2015) and waterfowl avoid interior common reed-invaded wetlands (Benoit and Askins 1999). Thus, wetlands invaded by common reed have the potential to create energetic deserts for feeding waterfowl and reduce potential carrying capacities. One marsh bird of conservation concern, due to low populations, is the American black duck *Anas rubripes* (hereafter black ducks), a flagship species for protecting wetlands along the Atlantic Coast (USFWS 2019). Over the past decade, a priority area of research to understand this decline has focused on wintering black duck habitat quantity and food availability (Devers and Collins 2011). There are several studies quantifying food abundance in Atlantic Coast salt marshes (Plattner et al. 2010; Cramer et al. 2012; Livolsi 2015; Ringelman et al. 2018; Goldstein et al. 2016) and studies that determine the effects of anthropomorphism and sea-level rise in coastal wetlands (Livolsi 2015; Ringelman et al. 2015); however, there has been no directed research that we are aware of that addresses the effects of invasive common reed on black duck habitat and food availability. If such a relationship occurs, it is reasonable to ask whether common reed could also affect other dabbling duck species such as mallard *Anas platyrhynchos*, green-winged teal *Anas crecca*, northern shoveler *Spatula clypeata*, and northern pintail *Anas acuta*. We hypothesize that both seed and invertebrate abundance of selected food resources will decline, thus decreasing dabbling duck carrying capacity in common reed-invaded landscapes. We hope to better inform land managers about the effects and necessity for control of invasive common reed.

Study area

We conducted the research at the Edwin B. Forsythe National Wildlife Refuge (EBFNWR), which spans 77 km of the Atlantic Coast of southern New Jersey (39°41′46.68″N, 74°10′57.7194″W). In 2016, ~60% of the total population of American black ducks wintered in New Jersey (USFWS 2016) and the extensive salt-marsh ecosystem on EBFNWR provides essential feeding ground for dabbling ducks. We focused our research in five study areas within EBFNWR: Reedy Creek, Oceangate, Metedeconk, Stouts Creek, and Barnegat (Figure 1).

All five wetland and deepwater systems defined by the National Wetlands Inventory exist in our study area (i.e., marine, estuarine, palustrine, lacustrine, and riverine; Cowardin et al. 1979). Natural-resource managers and biologists use the National Wetlands Inventory because it provides detailed information on the abundance, characteristics, and distribution of U.S. wetlands. Estuaries are of particular importance to dabbling ducks wintering in the Atlantic Flyway. Within the estuarine system, there are four commonly recognized wetland types that are categorized by the tidal regime and vegetation structure: high marsh, low marsh, mudflats, and subtidal waters dominated by the *Spartina patens* and *Spartina alterniflora* plant community (Tiner 1987; Collins and Anderson 1994). Additionally, freshwater (lacustrine and palustrine) water bodies (including managed impoundments) and wetlands occurred in the study area, providing ideal conditions for common reed invasions due to the low salinity. We collected all *Phragmites* and impoundment soil core samples at two separate locations including Stouts Creek and Barnegat (Figure 1). To increase sample size of mudflat, low marsh, and high marsh, we collected additional samples at Reedy Creek, Oceangate, and Metedeconk, in addition to Stouts Creek and Barnegat.

Methods

To estimate food availability in common reed-invaded and -uninvaded salt-marsh systems in coastal New Jersey, we used a geographic information system (GIS, ArcMAP Version 10; Environmental Systems Research Institute, Inc., Redlands, CA) to generate 70 random points per salt-marsh type (≥ 10 m apart) across the five study areas in areas classified as common reed, freshwater impoundment, high marsh, low marsh, and mudflat. We defined common reed areas as salt-marsh regions that had > 90% common reed coverage. Forty to 50 samples are required to reduce bioenergetics variance in core samples (Ringelman et al. 2015); thus, we generated more points than were necessary to account
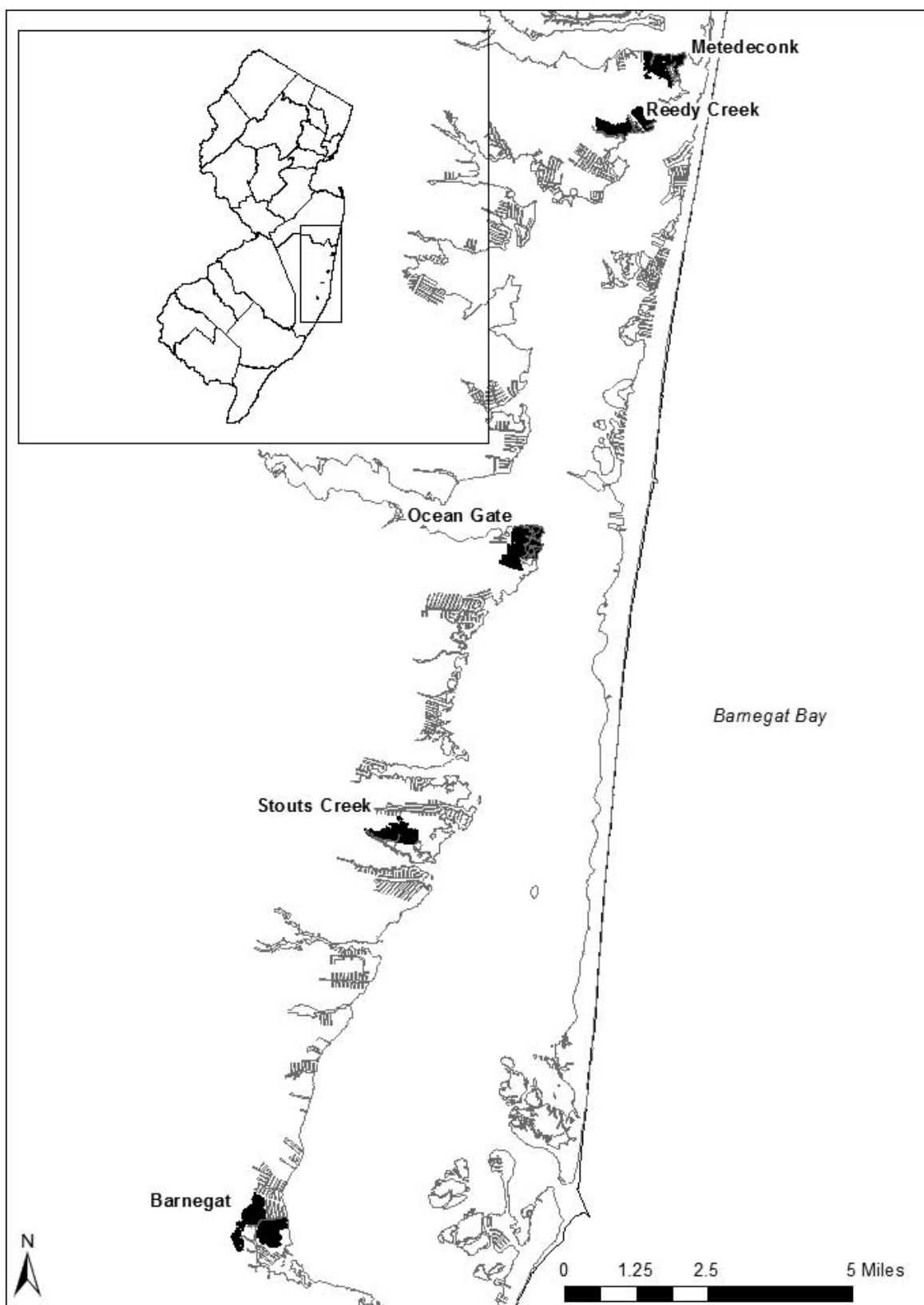
Figure 1. Study areas where dabbling duck food core samples were collected on Edwin B. Forsythe National Wildlife Refuge, New Jersey, November–March 2015–2016.

for bias in wetland classification between remotely sensed points and field observations. If we arrived at a point and it was incorrectly identified, we would travel to the next random point for sample collection. Within time and manpower constraints, we collected 21 impoundment and 50 common-reed core samples at the Stouts Creek and Barnegat study areas and 50 high-marsh, 62 low-marsh, and 41 mudflat soil core samples across all five study areas.

We collected ~17% of the samples per month between October 2015 and March 2016 to assure that our sampling was representative of the winter period. Following protocols used by Cramer et al. (2012) and Livolsi et al. (2014), core samples were 51 mm in diameter by 120 mm in length. We placed individual core samples in 946-mL plastic bags and transported them to a laboratory in a cooler for processing the same day. In the laboratory, we refrigerated samples for ≤ 3 d before sieving them with water through 500-mm (no. 35) and 2-mm (no. 10) screens. We placed sieved material in a 150-mL specimen storage cup, fixed it with 10% formalin buffer solution, and stained it with rose bengal dye for ≥ 7 d to facilitate identification of invertebrates.

Before sorting the stained material, we washed samples twice with water and separated the sample on the basis of size and density of its substrates using a 2-mm (no. 10) and 0.251-mm (no. 60) screen. We then separated each core into large material (material too large to pass through the no. 10 sieve) and small material (material too large to pass through the no. 60 sieve). To reduce time in sorting, we used subsampling methods described by Livolsi et al. (2014), where we sorted through 100% of the large material and 10% of the small material to remove seed and invertebrate foods.

We identified seeds to genus or species, and invertebrates to the lowest taxonomic level possible. We dried seeds and invertebrates in an oven at 50–58°C for 48 h, and then weighed each sample to the nearest 0.0001 g. We removed dabbling duck selected seed and invertebrate foods by sorting core samples under a ×6-magnification dissecting microscope. We excluded bivalves too large for consumption by waterfowl (> 21.4 mm; Cramer et al. 2012). We included in our analysis only samples of taxa that we identified as foods used by species-specific wintering dabbling ducks in mid-Atlantic marsh (Cramer 2009; Livolsi 2015) because including nonfood items in models of carrying capacity may overestimate energy density by as much as 30% (Hagy and Kaminski 2012). We multiplied biomass of foods in the 10% subsample by 10 to estimate the biomass in the small material portion, and added it to the biomass in the large portion to estimate total biomass for each food item in the soil core (Livolsi et al. 2014).

We tested the null hypothesis that animal and seed food energy would not differ between common reed-invaded areas and -uninvaded salt marshes organized by type. We summarized energetic resource availability (kcal/ha) by multiplying the biomass of seed and invertebrate items by true metabolizable energy values (kcal/g [dry]) taken from Livolsi (2015). True metabolizable energy values represent the amount of energy available to a bird from a given food, corrected for endogenous urinary and metabolic fecal energy (Sibbald 1976). The summed mean energy for each core sample was further extrapolated to the hectare level (kcal/ha). We assessed the normality of wetland type and duck-specific food energy data using Kolmogorov–Smirnov test for normality, and found that all data were not normally distributed (SPSS Statistics; IBM Corporation 2016). Therefore, we tested for differences in food energy among wetland types using nonparametric independent-sample Kruskal–Wallis with Mann–Whitney pairwise comparisons (matching the methodology of similar energetic carrying-capacity research, Fino et al. 2017). Despite the use of nonparametric statistics, we still present means $\pm$ standard error for ease of readability.

For wintering waterfowl, carrying capacity is often represented by duck energy days (DEDs), or the number of individuals that can be supported on the landscape for a single day on the basis of energy availability and expenditure (Reinecke and Loesch 1996; Williams et al. 2014). Because common reed primarily invades high marsh and freshwater impoundments, we tested the null hypothesis that common reed-invaded wetlands would not affect the energetic carrying capacity via available DEDs (per ha) as compared with noninvaded salt-marsh dabbling duck habitat. To inform DEDs, we first assumed average daily energy expenditures calculated by Livolsi (2015) for the five species over winter months in Delaware (mallard = 349.79 kcal bird^{-1} d^{-1}, black duck = 338.92 kcal bird^{-1}d^{-1}, green-winged teal = 111.84 kcal bird^{-1} d^{-1}, northern shoveler = 192.69 kcal bird^{-1} d^{-1}, and northern pintail = 258.58 kcal bird^{-1} d^{-1}). We divided the average energy availability per hectare by daily energy expenditures and then multiplied by the number of days in the nonbreeding season on the basis of dabbling duck migration chronology (1 September–31 March, 212 d) at EBFNWR (Ringelman et al. 2018).

Results

Extrapolating core samples to available dabbling duck energy, all five dabbling duck species showed differences in total food energy, animal food energy, and seed food energy across wetland types ($H \geq 11.86$, $P \leq 0.018$; see Table S1, *Supplemental Material*, for full data set). For combined foods selected by mallards, common reed and mudflat core samples had greater total energy than low marsh and high marsh (common reed: $U \geq 39.80$, $P \leq 0.03$; mudflat: $U \geq 56.71$, $P \leq 0.001$, Table 1). Examining the effects of common reed on animal food energy only, common reed core samples had less energy than mudflat and impoundments ($U \geq 43.66$, $P \leq 0.03$). However, for seed food only, common reed core samples also had more energy than low marsh and high marsh ($U \geq 49.89$, $P < 0.002$).

For combined foods selected by black ducks, common reed core samples were not different from other wetland types; however, mudflat had greater energy than low marsh, high marsh, and impoundment ($U \geq 41.61$, $P \leq 0.03$, Table 1). Examining selected animal food, common reed core samples had less energy than mudflat and low

Table 1. Energy availability (kcal/ha) of selected invertebrate animal and seed foods for five species of dabbling ducks (mallard *Anas platyrhynchos*, American black duck *Anas rubripes*, green-winged teal *Anas crecca*, northern shoveler *Spatula clypeata*, and northern pintail *Anas acuta*) in *Phragmites* monocultures vs. mudflat, low marsh, high marsh, and freshwater impoundment at Edwin B. Forsythe National Wildlife Refuge, New Jersey, November–March 2015–2016.

			Energy (kcal/ha)									
			Mallard		American black duck		Green-winged teal		Northern shoveler		Northern pintail	
Wetland type	N	Selected foods	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Mudflat	41	Animal	19,406.3	5,154.3	20,437.5	5,407.7	15,990.0	4,111.8	17,308.1	4,644.9	471.6	325.4
		Seed	429,835.9	105,308.7	331,278.0	93,641.4	227,683.9	64,502.9	326,672.7	105,325.1	853,092.2	227,364.4
		Total	449,242.2	104,283.4	351,715.5	93,045.1	243,673.8	64,117.4	343,980.8	104,699.1	853,563.8	227,365.0
Low marsh	62	Animal	9,673.8	2,803.9	14,962.7	3,112.4	11,121.3	1,956.9	6,991.8	1,952.9	0.0	0.0
		Seed	76,416.2	17,014.8	71,337.0	15,154.3	48,754.8	11,105.1	30,692.4	10,068.4	116,396.5	26,894.5
		Total	86,090.0	17,480.1	86,299.7	15,473.9	59,876.1	11,243.6	37,684.2	10,229.1	116,154.8	27,337.9
High marsh	50	Animal	19,160.7	7,825.8	22,338.0	8,093.0	19,054.0	6,614.4	17,766.7	7,222.1	6,369.2	3,696.7
		Seed	60,757.3	14,128.1	70,370.0	12,841.3	48,023.8	9,568.8	33,307.1	11,227.4	93,847.6	26,282.4
		Total	79,917.9	15,527.6	92,708.0	15,479.8	67,077.8	11,378.8	51,073.8	13,262.1	100,216.8	26,358.8
Impoundment	21	Animal	16,683.0	6,979.9	12,180.9	4,965.8	11,104.2	4,390.5	10,422.3	3,883.3	2,582.8	2,383.4
		Seed	148,162.6	53,697.4	64,891.8	21,246.7	50,176.4	19,097.2	30,548.3	11,403.8	64,445.9	25,036.1
		Total	164,845.6	53,141.4	77,072.7	24,775.4	61,280.6	21,857.8	40,970.7	11,308.9	67,028.7	24,997.3
Common reed	50	Animal	2,188.1	915.0	3,823.3	1,078.1	4,514.8	1,829.6	1,155.4	496.5	0.0	0.0
		Seed	2,36150.1	51,762.9	211,026.7	46,738.3	198,246.4	63,939.5	266,800.1	74,083.3	419,162.8	113,902.7
		Total	238,338.1	51,718.5	214,850.0	46,758.9	202,761.2	63,780.4	267,955.5	74,073.8	419,162.8	113,902.7

marsh ($U \geq 39.48$, $P \leq 0.02$). Additionally, examining selected seed energy, common reed core samples also had more energy than low marsh ($U = 42.80$, $P = 0.007$).

For combined foods selected by green-winged teal, common reed core samples were not different from other wetland types; however, mudflat had greater energy than low marsh and high marsh ($U \geq 41.52$, $P \leq 0.035$, Table 1). Examining selected animal foods, common reed core samples had less energy than mudflat and low marsh ($U \geq 44.10$, $P < 0.004$). Additionally, examining selected seed energy, common reed core samples also had more energy than low marsh ($U = 43.95$, $P = 0.005$).

For combined foods selected by northern shovelers, common reed and mudflat core samples had more energy than low marsh and high marsh (common reed: $U \geq 46.58$, $P \leq 0.004$; mudflat: $U \geq 58.65$, $P \leq 0.001$, Table 1). Examining selected animal food, common reed core samples had less energy than mudflat and impoundments ($U \geq 47.52$, $P \leq 0.008$). However, examining selected seed energy, common reed core samples had more energy than both high marsh and low marsh ($U \geq 55.22$, $P \leq 0.001$).

For combined foods selected by northern pintails, common reed core samples had significantly more energy than low marsh ($U = 35.15$, $P = 0.047$) and mudflat had greater energy than low marsh, high marsh, and freshwater impoundments ($U \geq 50.37$, $P \leq 0.010$) (Table 1). Examining the effects of common reed on animal food energy only, we found no consumable selected animal foods items. However, common reed core samples also had more seed food energy than high marsh ($U = 54.44$, $P = 0.001$).

Rejecting the null hypothesis that common reed invasion per hectare into high marsh would not affect DEDs, we found that common reed would produce 509–1,743 more DEDs/ha (232–525% increase) across the five

species over the 212 d of the nonbreeding season (on the basis of dabbling duck migration chronology at EBFNWR, 1 September–31 March; Ringelman et al. 2018; Table 2). Further, areas converted from freshwater impoundment to common reed would produce 297–1,925 more DEDs/ha (145–654% increase) across the five species. Northern pintails and green-winged teals' potential carrying capacity/ha was most increased by greater common reed invasion.

Discussion

Invasive common reed populations are increasing and threatening the health of natural salt marshes (Silliman and Bertness 2004; Stanton 2005; Chambers et al 1999). There is special concern for expansive and ecologically important landscapes, such as EBFNWR, because this ecosystem shift can modify the local biodiversity and trophic structure, alter resource utilization by native species, and change the disturbance regime (Chambers et al. 1999; Ailstock et al. 2001; Stanton 2005; Gucker 2008). In addition to the potential effects to dabbling duck food energetics, as per the focus of this study, we encourage future researchers to also investigate the broader trophic effects on invertebrate biodiversity surrounding these wetlands as well as a full array of secondary consumer effects.

We hypothesized that there would be less selected duck food energy available in common reed-invaded wetlands compared with -uninvaded wetlands composed of high marsh, low marsh, mudflat, and impoundments. Surprisingly, regions invaded with common reed had a greater or equal amount of seed food energy available in the low marsh, high marsh, and impoundments for nearly all the dabbling duck species. Because of the dense stands and massive stolons caused by the common reed plant (Larson 1993), we hypothesize that

Table 2. Energetic carrying capacity (duck-energy days [DEDs]/ha; calculated from species-specific energy supply from selected invertebrate and seed foods and daily energy expenditure) for five species of dabbling ducks (mallard *Anas platyrhynchos*, American black duck *Anas rubripes*, green-winged teal *Anas crecca*, northern shoveler *Spatula clypeata*, and northern pintail *Anas acuta*) in *Phragmites* monocultures vs. high marsh and freshwater impoundments at Edwin B. Forsythe National Wildlife Refuge, New Jersey, 1 September–31 March (221 days).

Species	Daily energy expenditures (kcal bird^{-1} d^{-1})	DEDs/ha				
		High marsh	Impoundment	Common reed	% Change from high marsh to common reed	% Change from impoundment to common reed
Mallard	349.79	322	666	962	298	145
American black duck	338.92	387	321	896	232	279
Green-winged teal	111.84	848	775	2,562	302	331
Northern shoveler	192.69	375	301	1,966	525	654
Northern pintail	258.58	548	366	2,291	418	625

this monoculture may likely be acting as a trap that captures seeds of many other plant species circulating on the wind or from the water at extreme high tides. Thus, this increased seed availability is not a function of actual native plant biodiversity in regions invaded by common reed, but rather an artifact of the common reed structure.

Past research shows conflicting results on the effects of common reed invasions on invertebrate assemblages, with some showing a significant effect (Angradi et al. 2001; Robertson and Weis 2005), whereas others suggest that some or many invertebrate taxa are unaffected (Fell et al. 1998; Warren et al. 2001; Gratton and Denno 2005). We found that selected dabbling duck food invertebrate total energy was drastically reduced (as a direct result of reduced biomass) in common reed-invaded wetlands. This may also be due to two reasons. First, as a nonnative species, invertebrate consumers of vegetation may not consume common reed because they did not evolve to select this food source. Second, the dense mats of this monoculture (Holm et al. 1977; Gallagher and Plumley 1979) may not allow enough space for invertebrates to thrive. Supporting the latter, Murkin et al. (1982) found that the abundance and diversity of invertebrate taxa were greatly reduced in thick mats of cattails, as compared with treatments of reduced vegetation density. This was likely due to reduced decomposition and associated microbes thus reducing the food source for invertebrate consumption. If this relationship also holds true for common reed, it provides more evidence for the trophic degradation described in Chambers et al. (1999).

All of our energy values for selected black duck foods in mudflat, low marsh, high marsh, and freshwater impoundment were approximately one half of the "all data" values recently reported for a meta-analysis of the southern portion of EBFNWR (Ringelman et al. 2018). Our study area in the northern portion of EBFNWR is part of a lagoon-type estuary, with lower tidal range and water exchange than the area studied by Ringelman et al. (2018). In addition, the more southern impoundments are managed for waterbirds, whereas the northern impoundments are not. Despite the fact that data collected in our study areas during the winter of 2015–2016 were low compared with the 2010–2014 data of Ringelman et al. (2018), the comparison of common reed

with other wetland types within our study area during the same timescale remains a unique and important comparison. We encourage a larger spatial and temporal data set of common reed-dominated areas to refine energy availability and properly extrapolate to landscape carrying capacity.

Future research studying dabbling duck behavior will confirm use of these areas and reveal the positive or negative landscape effects on carrying capacity. Despite the possibly increased seed food availability, Benoit and Askins (1999) found that waterfowl did not use the interior of common reed-invaded wetlands. Anecdotally, dabbling ducks have not been observed foraging within common reed-invaded wetlands at EBFNWR (P. Castelli, personal observation) similar to cattail-dominated marsh systems (Kaminski and Prince 1981), although we do acknowledge that tall and thick stem density would make waterfowl viewing difficult. Therefore, although our data suggest that common reed may trap natural salt-marsh foods from tidal flow and theoretically increase energetic carrying capacity per hectare, physical exclusion could effectively lower carrying capacity. We encourage future researchers to carefully measure waterfowl accessibility to food resources and subsequent feeding behavior and potentially create a correction factor to energetic carrying capacity.

Management and control of invasive common reed is a multimillion dollar per year endeavor by private and state organizations across the United States primarily through herbicide, fire, and flooding (Martin and Blossey 2013). Further, one of the central aims of this control is to restore native flora in marsh ecosystems (Ailstock et al. 2001; Martin and Blossey 2013; Hazelton et al. 2014). Although it was not the aim of this paper to compare management techniques to control common reed in salt marsh (although see Michigan Department of Environmental Quality 2014), our results do provide some evidence for restoration success. First, if biologists were interested in improving accessibility of wintering waterfowl foods to increase energetic carrying capacity, we would encourage use of herbicides and fire during the summer when waterfowl are at low abundance, followed by targeted mechanical removal treatments in fall/winter to open areas to waterfowl for foraging. Second, for restoration of native plant biodiversity in salt marshes, if common reed could be successfully eradicated from an

area, our results show that there is a large biomass of native salt-marsh seeds accumulated in the soil strata, thus providing the potential for an active seedbank.

Supplemental Material

Please note: The *Journal of Fish and Wildlife Management* is not responsible for the content or functionality of any supplemental material. Queries should be directed to the corresponding author for the article.

Table S1. Mass (g) and energy (kcal) per sample of preferred invertebrate animal and seed foods for five species of dabbling ducks (mallard *Anas platyrhynchos*, American black duck *Anas rubripes*, green-winged teal *Anas crecca*, northern shoveler *Spatula clypeata*, and northern pintail *Anas acuta*) in *Phragmites* monocultures vs. mudflat, low marsh, high marsh, and freshwater impoundment at Edwin B. Forsythe National Wildlife Refuge, New Jersey, November–March 2015–2016.

Found at DOI: https://doi.org/10.3996/JFWM-20-007.S1 (72 KB XLSX).

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Found at DOI: https://doi.org/10.3996/JFWM-20-007.S8 (1.39 MB PDF); also available at https://digitalcommons.lsu.edu/cgi/viewcontent.cgi?article=5081&context=gradschool_dissertations.

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Acknowledgments

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