



Impacts of wintering redhead ducks (*Athya americana*) on seagrasses in the northern Gulf of Mexico

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ABSTRACT

While it has been well established that waterfowl can sometimes control the distribution and abundance of seagrasses, relatively little is known about their effects in the northern Gulf of Mexico (nGOM). Seagrass meadows provide critical habitat for commercially important finfish and shellfish and as winter waters continue to warm, the nGOM will likely become increasingly appealing for wintering waterfowl. We measured the impact of redhead duck (*Athya americana*) foraging on mixed shoalgrass (*Halodule wrightii*) and widgeon grass (*Ruppia maritima*) beds using caging experiments (1.5 × 1.5 m) at three locations in the nGOM. Time-lapse photography provided estimates of the abundance and feeding activities of the birds. Redhead ducks actively and regularly fed in all experimental areas; however, flock sizes were significantly smaller than previously recorded in Texas and south Louisiana. In general, there was little evidence of grazing effects on *R. maritima* biomass. *H. wrightii* biomass followed expected seasonal patterns in both grazed and ungrazed treatments, and while both grazed and ungrazed biomass increased over the two years of the study, greater biomass increases occurred in ungrazed treatments. Similar to conclusions from previously conducted studies, we found no evidence that waterfowl were overexploiting their seagrass food resources.

1. Introduction

Seagrass beds are among the most diverse and productive coastal ecosystems and are universally recognized for the high value of their ecosystem services (Costanza et al., 1997; Orth et al., 2006; Valentine and Duffy, 2006). As a large source of primary production in coastal ecosystems, seagrasses provide forage for large vertebrate and invertebrate herbivores (Valentine and Duffy, 2006), act as nursery grounds for juveniles of economically important finfish and shellfish (Beck et al., 2001; Williams and Heck Jr., 2001; Heck Jr. et al., 2003), sequester significant amounts of carbon (Duarte et al., 2005) and stabilize sediments (Orth et al., 2006). Although researchers previously thought that seagrass was infrequently grazed, evidence suggests that grazing has played an important role in both historical and modern food webs of seagrass meadows (Heck Jr. and Valentine, 2006; Valentine and Duffy, 2006). In the past, large grazers such as green turtles, manatees and waterfowl likely had important controlling influences on seagrass communities; however, as a result of human exploitation and loss of habitat, populations of many larger herbivores have dwindled to the extent that in some locations they are functionally

extinct (Thayer et al., 1984; Valentine and Heck, 1999; Jackson et al., 2001; Valentine and Duffy, 2006). Nevertheless, even at reduced population sizes these large grazers can have significant impacts on local seagrass communities (Thayer et al., 1984; Fourqurean et al., 2010). In addition, studies have consistently shown that grazing impacts tend to increase with the size of grazer populations (Kollars et al., 2017; Wood et al., 2017), and with changing climates, waterfowl populations could continue to grow in coming years resulting in greater impacts on seagrass meadows.

Previous research examining grazing impacts has produced widely varying results Bakker et al., 2016; Kollars et al., 2017; Wood et al., 2017. For example, Kirsch et al. (2002) estimated that small parrotfishes (*Sparisoma radians*) can locally consume as much as 85% of net aboveground seagrass production without obvious long-term negative effects on aboveground biomass. Valentine et al. (1997) showed that sea urchin (*Lytechinus variegatus*) grazing at intermediate levels during the growing season increased recruitment of turtle grass (*Thalassia testudinum*) shoots and aboveground biomass by 40%. Conversely, under higher rates of sea urchin grazing, turtle grass biomass was greatly reduced and some grazed patches had little regrowth in

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subsequent years (Valentine and Heck, 1991; Heck Jr and Valentine, 1995). In Bermuda and the Indian Ocean, grazing by increased populations of protected green turtles (*Chelonia mydas* Linnaeus) reduced seagrass biomass and decreased the structural complexity of seagrass meadows (Fourqurean et al., 2010; Lal et al., 2010). Similarly, dugong (*Dugong dugon* Müller), which can uproot entire plants and limit the ability of seagrass to recover following grazing, are able to reduce shoot densities by 50% even at low population densities (D'Souza et al., 2015).

Ducks, geese, and swans are common winter grazers of seagrasses within temperate latitudes, and these herbivores selectively feed on either above or belowground biomass, depending on the species of bird and seagrass (Tubbs and Tubbs, 1983; Baldwin and Lovvorn, 1994; Michot and Chadwick, 1994; Mitchell et al., 1994; Ganter, 2000; Domning, 2001; Heck Jr. and Valentine, 2006; Valentine and Duffy, 2006). Prior to massive losses of eelgrass (*Zostera marina* Linnaeus) caused by wasting disease in the 1930s, as much as 85% of Atlantic brant (*Branta bernicla* Linnaeus) diet consisted of eelgrass, and brant grazing reduced eelgrass leaf lengths and stimulated shoot production (Ganter, 2000). Furthermore, a study on brant geese and widgeon (*Anas penelope*) effects on dwarf eelgrass (*Zostera noltii*) in the northern Wadden Sea, found that waterfowl grazing reduced biomass by 45% (Nacken and Reise, 2000).

The Gulf of Mexico is an important waterfowl wintering ground, especially for the seagrass-consuming redhead duck (*Aythya americana*) (Weller, 1964; Bellrose, 1980, in Woodin and Michot, 2006). Each year about 80% of the *A. americana* population migrates from Canada and the Great Basin of the United States to feed on seagrass in the shallow waters along the Gulf coast from Texas to Florida (Weller, 1964; Woodin, 1996; Michot, 2000). A study in Laguna Madre, Texas, revealed that *A. americana* grazing resulted in a 26–33% reduction of *H. wrightii* rhizomes in localized areas (James, 2006), and *H. wrightii* can make up as much as 84% of *A. americana* gut contents (McMahan, 1975; Michot and Nault, 1993; Michot et al., 2008). *A. americana* feed primarily on belowground biomass (roots and rhizomes), as aboveground biomass is scarcely present in their guts (McMahan, 1970; Cornelius, 1977; Marsh, 1979; Michot and Nault, 1993; Michot and Chadwick, 1994; Woodin, 1996; Michot et al., 2008). Some *A. americana*, also consume minor amounts of animal matter, predominantly gastropods, which may help them grind rhizomes in the gizzard (Michot et al., 2008). In south Texas, Mitchell et al. (1994) showed that in areas heavily grazed by *A. americana* *H. wrightii* rhizome biomass loss was significantly greater than in areas with less grazing, and the heavily grazed areas showed reduction in rhizome biomass the following year.

Little is known regarding the relationship between *A. americana* grazing and seagrass biology, ecology and sustainability within the north central Gulf of Mexico, where seasonal changes in temperature and day length are greater than at the previously investigated Gulf study locations in south Texas (Mitchell et al., 1994). Warming winter temperatures in the northern Gulf may make locations in coastal Mississippi, Alabama and northwest Florida increasingly attractive to wintering redheads, and recent accounts of *A. americana* heavily grazing shoalgrass from coastal Alabama from property owners suggested that an assessment of redhead use of, and potential effects on, shoalgrass nursery habitats of the northern Gulf of Mexico would be informative.

Therefore, in this study we (1) estimated the impact of seagrass grazing that occurs during winter months when *A. americana* are present in the north central Gulf of Mexico; (2) examined the recovery of *H. wrightii* and *R. maritima* after winter grazing by *A. americana*; and (3) compared our results with similar studies done several decades ago in Texas and Louisiana.

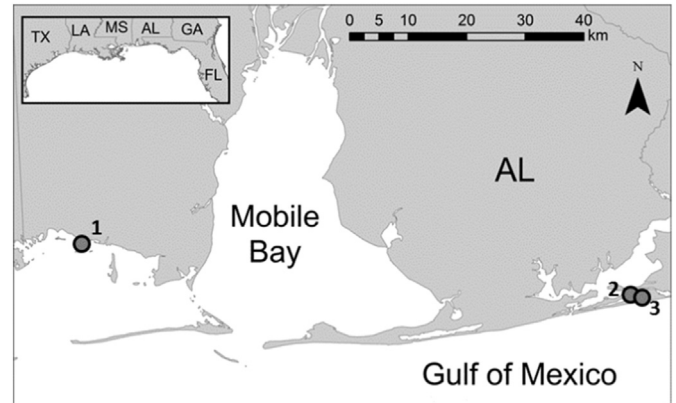


Fig. 1. Study sites. From west to east: 1. Point aux Pins, 2. Ono Island, 3. Rabbit Island.

2. Methods

2.1. Study area

This study was conducted at three locations along the northern Gulf of Mexico, from Perdido Bay AL to Grand Bay, AL (Fig. 1). More specifically the three sites were: (1) Rabbit Island (30.30014, –87.45140); (2) Ono Island (30.29919, –87.46979); and Point aux Pins (30.38693, –88.29749). Locations were selected based on previous waterfowl observations and the presence of submerged aquatic vegetation (SAV). All sites contained mixed beds of *H. wrightii* (shoalgrass) and *R. maritima* (widgeon grass) and all seagrass occurred in depths of less than one meter. While the Rabbit Island and Ono Island sites are close geographically, they were not part of the same continuous seagrass bed, so we considered them to be separate and independent locations. Tides are diurnal in this microtidal portion of the Gulf, with a mean daily range of approximately 0.5 m.

2.2. Study design

At the beginning of the study in year 1, replicate sites, containing three control plots and three grazer exclusion plots, were established at each of the three study locations. Both control and exclusion plots were 2.25 m² (1.5 × 1.5 m) and were placed haphazardly at each study site. All plots were approximately 5 m apart. The frames of cages constructed to exclude grazers were made of PVC pipe, and the tops and sides of the frames were covered with bird mesh (1 × 1 cm) to deter waterfowl grazing. The frames were driven into the sediment until the top of the bird mesh was approximately 20–30 cm above the sediment surface (Fig. 2). These cages were designed to ensure there would be no waterfowl grazing within them, a problem that had plagued previous studies (Mitchell et al., 1994). While other herbivorous grazers (pinfish, *Lagodon rhomboides*, green sea turtle, *Chelonia mydas*, and West Indian manatee, *Trichechus manatorum latirostris*) do occur in the study area, they are not present during winter months (Nelson et al., 2013; Musick and Limpus, 1997; Fertl et al., 2005). While the exclusion cages did experience some biofouling, it was minimal due to the colder temperatures of the water, however, when camera batteries were changed, cages were cleaned if necessary. Control areas were defined by placing only two PVC poles at opposite corners of the 2.25 m² plots to reduce the possibility of poles acting as a deterrent to *A. americana* grazing.

The Ono Island sites had one replicated set of three control and three caged plots, while the Rabbit Island study location had two replicated sets, and the Point aux Pins had three sets, for a total of eighteen exclusion and control plots. This design was necessary to accommodate the different amounts of seagrass available at each site. In addition, we did not establish plots in water deeper than 1 m to ensure

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