FACTORS INFLUENCING WINTERING WATERFOWL ABUNDANCE IN LAKE WALES, FLORIDA

ROBERT D. GASAWAY, Florida Game and Fresh Water Fish Commission, Lake Wales, FL 33853
SCOTT HARDIN, Florida Game and Fresh Water Fish Commission, Lake Wales, FL 33853
JUDY HOWARD, Ridge Audubon Society, Lake Wales, FL 33853

Abstract: Waterfowl populations were monitored at Lake Wales, Florida, over a three-year period to determine factors associated with their abundance and aggregations. Monthly water level, water temperature, aquatic vegetation percent cover and percent frequency of occurrence, and chlorophyll *a* data were correlated and regressed. Significant models were derived to describe variation in total waterfowl, ring-necked ducks, canvas-backs and American coots. Interactions of introductions of two exotic species, grass carp (*Ctenopharyngodon idella* Val.) and hydrilla (*Hydrilla verticillata* Royle) with waterfowl populations were discussed. A decline in numbers of some waterfowl species was attributed to changes in hydrilla abundance as a result of the combined effects of grass carp, water level and other factors.

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Large numbers of Atlantic Flyway waterfowl winter in Florida. Historically, the state possessed some of the best wintering habitat to be found in North America; however, human activities such as channelization, wetland drainage programs, and coastal dredge-and-fill activities have altered and reduced large areas (Sincock et al. 1964; Marshall 1969). Some natural lakes throughout the state presently have large concentrations of wintering waterfowl.

Studies to determine interrelations of many wintering waterfowl species to other parts of the biotic community have not been made in Florida. Alhough food habits studies have been made for many species wintering in the southeastern states, little emphasis has been placed on habitat relationships or changes in the habitat due to waterfowl activity. Arner et al. (1974) compared the habitat quality of two waterfowl refuges in Mississippi and concluded that overall abundance of invertebrates and aquatic plants influenced wood duck (*Aix sponsa*) production. Chabreck et al. (1975) studied management units in the Louisiana coastal marsh and concluded that vegetation types, water depth, and time of year affected ducks.

Introduction of exotic plant species has altered waterfowl habitat. Ducks and coots avoid lakes covered with water hyacinth (*Eichhornia crassipes*) (Duke and Chabreck 1974). Ryan (1972) surmised that a dramatic change in rooted aquatic vegetation in Seneca Lake, New York, and the resultant takeover by Eurasian watermilfoil (*Myriophyllum spicatum*) may have influenced weight loss in diving ducks. However, Florschutz (1972) reported the importance of Eurasian watermilfoil as a waterfowl food plant in the Southeastern United States.

The problem of exotic introduction is particularly acute in Florida (Courtenay and Robins 1975). Hydrilla flourishes in several lakes in Florida, and its infestation is considered unsightly by lakefront homeowners. Additionally, water managers and agriculturalists claim that water usage has been restricted by dense weed communities (Holm et al. 1969).

Some aquatic plant managers have proposed introduction of grass carp to control hydrilla. This fish has a short digestive tract (Hickling 1966; Gaevskaya 1969), a tendency to gorge food (Cross 1969), poor mastication (Hickling 1966) and consumes over 100 percent of its body weight daily.

The purpose of this paper is to evaluate effects of grass carp and other biotic and abiotic factors on waterfowl abundance and aggregations in Lake Wales, Florida.

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DESCRIPTION OF STUDY AREA

Lake Wales, a landlocked lake in the City of Lake Wales, Polk County, Florida, has an appropriate surface area of 123 ha. It has a sand-muck bottom and a water depth of approximtely 8.5 m. Annual water levels have fluctuated between 30.2 and 31.1 m above mean sea level since the initiation of research on the lake in September 1974. Like many central Florida lakes, its water level has decreased over past years.

Over the past 3 years, hydrilla was the dominant vegetation, covering up to 95 percent of the lake and growing to the surface during summer and fall. Cattail (*Typha* sp.), maiden cane (*Panicum* sp.), umbrella grass (*Fuirena* sp.) and pennywort (*Hydrocotyle* sp.) form a band 10 to 50 m from shore in many areas.

METHODS

Waterfowl counts were made twice monthly during daylight hours from 7 fixed stations (Fig. 1). Due to the lake's small size, observers could see the entire waterfowl

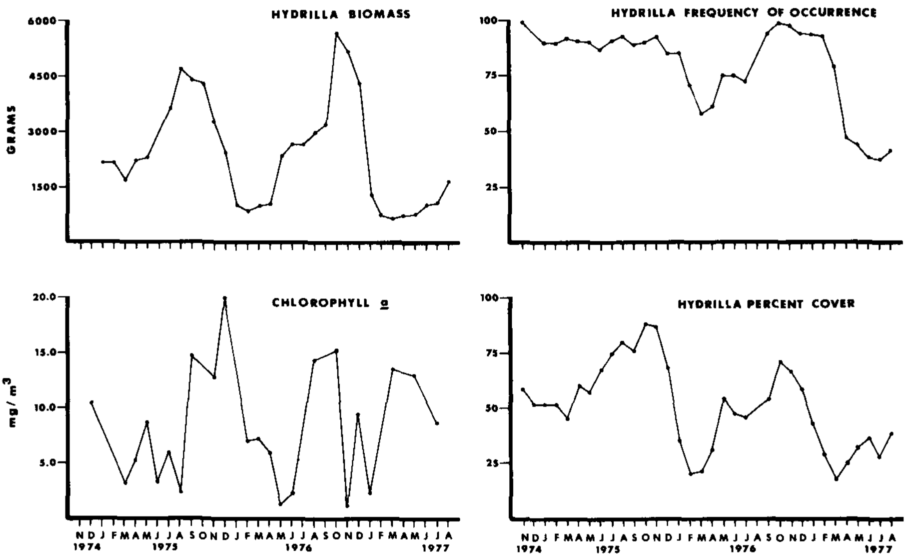

Fig. 1. Vegetation transects and waterfowl observation stations on Lake Wales, Florida.

population from any station. The population was divided into sections and counts were made of sections nearest each station. The observers (usually 3) made counts using binoculars and recorded values on data sheets. Estimates were made when total numbers prohibited actual counts of individuals.

Nine modified line transects were established in October 1974 to monitor changes in macrophytic vegetation (Fig. 1). Transects 1, 6 and 9 were sampled monthly to obtain percent cover and percent frequency of occurrence data. Transects 2 and 7 were used to establish a relationship to predict approximate hydrilla biomass. All transects were sampled at the beginning and end of the study to document overall vegetation change.

Each transect consisted of a line marked at 1 m intervals which was stretched between two permanently located buoys. At 2 m intervals along the transect a line was lowered and vegetation species contacted, vegetation height, and water depth to the vegetation were recorded. At 10 m intervals, the percent coverage of each plant species within 1 m^2 was recorded. Mean percent frequency of occurrence and mean percent relative cover were calculated from these data for each month.

To sample hydrilla biomass, a 1 m^2 frame was lowered into the water at 10 m intervals on transects 2 and 7. Hydrilla within the plot was clipped with garden shears and weighed. This biomass was regressed against vegetation height and percent cover. These data represent only the biomass of the plants above the lake bottom and do not include roots or tubers.

Shading and competition for nutrients by phytoplankton can influence densities of macrophytic vegetation. Chlorophyll *a* is an acceptable indicator of phytoplankton biomass (Edmondson 1969; Putnam et al. 1972). This parameter was measured from water samples from the entire water column which were collected monthly at five fixed stations. The samples were placed on ice, transported to the Florida Game and Fresh Water Fish Commission's Eustic Water Chemistry Laboratory for analysis.

Water temperature at the surface, mid-depth, and bottom was taken monthly at 5 fixed stations. Water level was recorded periodically from a U.S. Geological Survey water gauge in the lake.

Grass carp were introduced into Lake Wales in October 1974. Approximately 11,053 fish were stocked in 4 groups with numbers and sizes as follows:

Number	*Avg. total length*
4,872	199 mm
4,974	189 mm
586	224 mm
621	274 mm

Fish were sampled monthly using electrofishing, gill netting, and rotenone poisoning.

Means, correlation coefficients, and regression analyses were computed using Statistical Analysis System program language (Barr et al. 1976) and facilities at the Northeast Regional Data Center at Gainesville, Florida.

RESULTS

Waterfowl populations

American coot (*Fulica americana*), canvasback (*Aytha valisineria*), ring-necked duck (*A collaris*) and common gallinule (*Gallinula chloropus cachinnans*) were the predominant species utilizing Lake Wales (Fig. 2). Peak coot densities were 96, 100 and 140

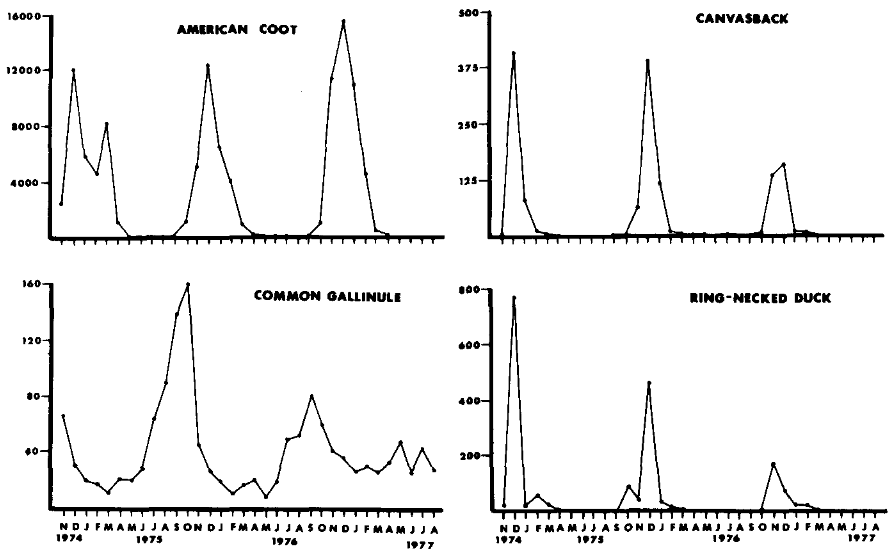

Fig. 2. Numbers of four species of waterfowl observed on Lake Wales, Florida, from November 1974 through August 1977.

birds per ha for years 1, 2 and 3 respectively. Although some coots were present on the lake throughout the year, the main population was migratory. Canvasbacks were present during winter months, with peak densities of 3, 5 and less than 0.1 birds per ha for the 3 study years. Ring-necked ducks were also a migratory population. Peak densities for the 3 years were 6, 6 and 2 birds per ha. Common gallinules were local populations breeding on the lake in the warmer months. Peak population densities were 0.8, 1.8 and 0.9 birds per ha for years 1, 2 and 3 respectively. Ruddy ducks (*Erismatura jamaicensis* *rubida*), American wigeon (*Mareca americana*), blue-winged teal (*Anas discors*), green-winged teal (*A carolinensis*) and redhead ducks (*A americana*) occurred in low numbers during all these years.

American coot, canvasbacks and ring-necked ducks were positively correlated with each other (Table 1). Bent (1923) described feeding activity of American coots, canvasbacks and American wigeons on aquatic vegetation illustrating synergism between these species. The senior author observed feeding aggregations in Lake Wales comprised of these species as well as ring-necked ducks and gallinules. Canvasbacks and ring-necked ducks fed on reproductive parts of hydrilla while other species fed on vegetative parts of the plant. Tubers and turions of hydrilla have been reported in the gullets of ring-necked ducks and canvasbacks, but leaves and stems were not found. D. Colle per. comm.; R. Montegut per. comm.; R. Land per. comm.) The positive correlation between these species probably reflects this feeding association.

Table 1. *Significant correlation coefficients among selected waterfowl species from November 1974 through August 1977,* Lake Wales, Fla.

	Ringneck	*Canvasback*	*Common gallinule*	*Month*	*Year**
Am. coot	0.53**	0.58**	−0.24*	—	—
Ring-necked ducks		0.91**	—	0.36**	−0.30**
Canvasbacks			—	—	−0.20
Common gallinule					—

No asterisk—$P < 0.10$
*$P < 0.05$
**$P < 0.01$

Aquatic vegetation

Vegetation transect data indicated that hydrilla is the dominant plant in all study years (Fig. 3). Seasonal fluctuation is clearly evident with mean percent cover and mean frequency of occurrence reduced in winter and early spring. Comparison of these data for the 3 winters studied indicate a progressively larger winter reduction. Correlations

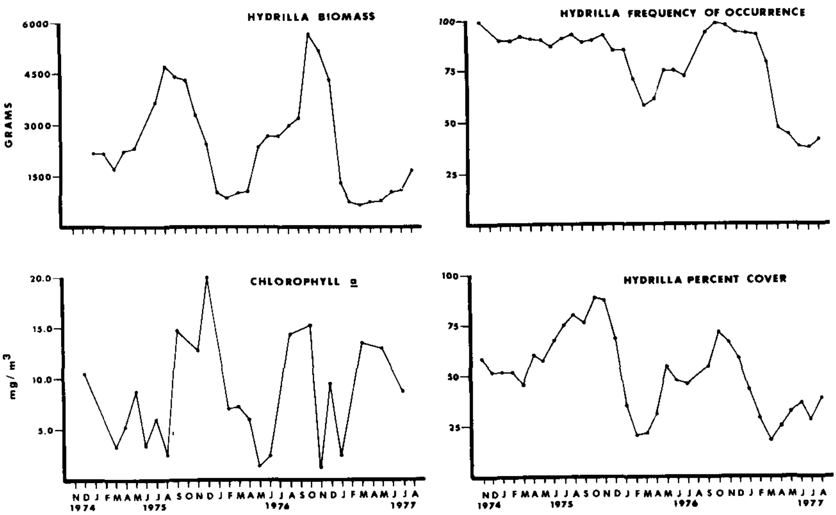

Fig. 3. Hydrilla percent cover, percent frequency of occurrence, and biomass, and chlorophyll a concentrations (in phytoplankton) in Lake Wales, Florida, from November 1974 through August 1977.

revealed a highly significant negative relationship between years and hydrilla (Table 2); however, in the late summer and early fall samples each year, the plant returned to dominant proportions. Comparison of graphs of vegetation percent cover and frequency of occurrence reveals that changes in percent cover (during winter months) precede reduction in the frequency of occurrence.

Mean predicted hydrilla biomass per m^2 of lake bottom declined over the 3 year study period. Mean values for hydrilla biomass were 2,444 g/m^2 in year 1, 2,345 g/m^2 in year 2, and 2,383 g/m^2 in year 3. Although hydrilla biomass was negatively correlated with years, (Table 2), extreme season variation in plant growth (Fig. 3) coupled with an increase in water level somewhat masked this change.

Table 2. Significant correlation coefficients among selected parameters from November 1974 through August 1977—Lake Wales, Fla.

	Water temp.	*Hydrilla % cover*	*Hydrilla* freq. occ.	*Hydrilla biomass*	*Grass Carp biomass*	*Chlorophyll a*	*Month*	*Year*[a]	*Time*
Water level	−0.25*	—	—	0.20	0.58**	—	0.29*	0.46**	0.56**
Water temperature		—	−0.33**	—	—	—	—	—	—
Hydrilla % cover			0.63**	0.58**	−0.37**	—	0.62**	−0.63**	−0.45**
Hydrilla frequency of occurrence				0.58**	−0.51**	—	—	0.63**	−0.57**
Hydrilla biomass							0.74**	—	—
Grass carp biomass							0.22	0.90**	0.98**
Chlorophyll *a*							0.50**	—	—

No asterisk—$P < 0.10$.

*—$P < 0.05$.

**—$P < 0.01$.

[a]Includes only November and December in 1974, January through August, 1977.

Chlorophyll a

Chlorophyll a was not correlated significantly with years; however, concentrations were significantly positively correlated with ring-necked ducks and canvasbacks (Fig. 3, Table 2) which could be due to nutrient release from the birds or decaying vegetation. Dilution due to increasing water level influenced this parameter.

Water level and temperature

Although water level fluctuated seasonally, this parameter was positively correlated with years indicating an overall increase in water level through the study period (Table 2). Water temperature displayed typical seasonal fluctuation and did not correlate significantly with years.

Grass carp

Grass carp biomass data were derived from weights of sampled fish. A regression of average weight of individual grass carp captured against month was used to predict grass carp biomass when monthly sampling weights were not available:

where

$$Y = -875.3 + 452.4X$$

Y = grass carp biomass (g)

X = month (1-31)

The coefficient of determination (R^2) was 1.0. Since the species does not usually reproduce in lakes or ponds and displayed linear growth over the study period, weight change of sampled fish is assumed to reflect the biomass increase in the entire population.

DISCUSSION

Stepwise regression analysis using waterfowl as the dependent variable yielded the following equation.

$$Y = 583.91 + 31.95X_1 - 5.95X_2 - 3.75X_3 - 0.02X_4$$

where

Y = waterfowl (excluding common gall nules

X_1 = month (1-12)

X_2 = water level (feet MSL)

X_3 = water temperature (°F)

X_4 = grass carp biomass (g)

The coefficient of determination (R^2) for the model was 0.66 with all variables significant at the 0.1 level.

Waterfowl were positively related to month (X_1) and water level (X_2). Peak waterfowl migrations occur in the later months (November and December) when water level reaches its annual maximum.

Waterfowl are negatively related to water temperature (X_3) and grass carp biomass (X_4). Water temperature was lowest during winter months when waterfowl are present in highest numbers. The negative relationship to grass carp biomass may be due to grass carp feeding on hydrilla. Hydrilla percent cover and hydrilla frequency of occurrence were not significant at the 0.1 level.

A stepwise regression analysis substituting hydrilla biomass for percent cover and percent frequency of occurrence yielded a similar model with the same variables included above significant at the 0.5 level. The coefficient of determination (R^2) was 0.67 and hydrilla biomass was not significant at the 0.1 level. A masking effect by grass carp biomass likely caused the omission of hydrilla percent cover and hydrilla biomass from the models.

Stepwise regressions using coots, ring-necked ducks, and canvasbacks as dependent variables yielded the following:

$$Y = 583.91 + 31.95X_1 - 5.95X_2 - 3.57X_3 - 0.02X_4$$

where

Y = ring-necked ducks
X_1 = month (1-12)
X_2 = water temperature (°F)
X_3 = hydrilla percent cover
X_4 = grass carp biomass (g)

The coefficient of determination (R_2) was 0.45 with all variables significant at the 0.01 level. The negative relationship with hydrilla percent cover suggests a reduction in the plant with peak ring-necked duck abundance. Canvasbacks and coots were not significantly related to grass carp biomass or hydrilla percent cover.

When hydrilla biomass was included as a variable instead of hydrilla percent cover, both canvasbacks and ring-necked ducks were negatively related to hydrilla biomass as well as water temperature and grass carp biomass; both species were positively related to months. The equation obtained for coots included the same variables occurring in the preceding model for all waterfowl. Hydrilla biomass was not significant at the O.1 level in the coot model.

The above models indicate that abundance of certain waterfowl species is related to several factors, including hydrilla and grass carp. Although ducks consumed a considerable portion of hydrilla, uneaten stems which remained after departure of the waterfowl maintained a high value for hydrilla frequency of occurrence. The plant achieved the largest percentage cover during the summer and fall of 1975.

Grass carp are known to initially increase plant density by a "grazing effect". After an increase in hydrilla percent cover following grass carp stocking, a sharp reduction in the plant occurred in winter 1976, possibly due to the cumulative effects of grass carp and waterfowl. This could have curtailed waterfowl wintering activity.

During summer 1976, hydrilla percent cover was lower than in previous years, perhaps as a result of grass carp feeding. However, increased water level along with chlorophyll a concentrations may have contributed to the reduction by decreasing light penetration. By winter 1977, hydrilla was considerably reduced in coverage, but increased water level and corresponding vertical plant growth maintained high biomass level. Variation in waterfowl abundance may be related to the reduction of hydrilla.

Trends in Florida waterfowl abundance for the winter of 1977 were mixed. In recent years, ring-necked ducks wintering on Federal waterfowl refuges in Florida have declined but canvasbacks have increased (J. Baker, Merritt Island National Waterfowl Refuge, personal communication).

Ring-necked duck and canvasback populations recorded in Florida by the office of Migratory Bird Management, U.S. Department of the Interior, Laurel, Maryland, were:

	1975	*1976*	*1977*
Ring-necked duck	30,300	17,400	17,200
Canvasback	3,000	5,900	9,600

The winter of 1977 was among the coldest on record and "shortstopping" along the Atlantic Flyway by migrating ducks probably decreased, which could have influenced population numbers.

Gasaway and Drda (1977) concluded grass carp stocked at 67 kg/ha degraded waterfowl habitat in 4 Florida lakes. Models derived from Lake Wales data suggest a negative influence of grass carp on waterfowl. The decline in ring-necked ducks and canvasbacks in Lake Wales in the third winter was probably due to a combination of factors, but these models indicate grass carp introduction played a part in the reduction.

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