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Comparison of the Diet, Feeding Behavior, and Habitat Use of
Mallards (Anas platyrhynchos) and Black Ducks (Anas rubripes)

An Honor's Study Presented to
The Department of Zoology
Connecticut College

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Advisor: Dr. Robert Askins
May 1, 1987

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Over the last 75-100 years the Black Duck (Anas rubripes) population has shown a steady decline in eastern North America and Canada (Wing 1943; Johnsgard 1960, 1961, 1967; Heusmann 1974, 1982; Alison and Prevett 1976; Johnsgard and DiSilvestro 1976; Figley and VanDruff 1982; Grandy 1983; Brodsky and Weatherhead 1984; Butcher 1985, 1986; Titman, unpublished). Concurrent with this Black Duck population shift has been the enormous eastward movement of the Mallard (Anas platyrhynchos). According to Johnsgard and DiSilvestro (1976) the Mallard has replaced the Black Duck as the dominant breeding and wintering duck in the eastern United States. Prior to 1900, the Mallard was listed only as an infrequent "wanderer" in New England from its western United States and Canada distribution centers. At this time, the Black Duck was still the predominant dabbling duck in eastern United States (Heusmann 1974). During the 50 year period between 1917 and 1967, however, the major line of sympatry between the Black Duck and the Mallard moved 300 miles eastward (Johnsgard 1967). By 1969 more Mallards than Black Ducks were shot in the Atlantic Flyway for the first time.

With the advent of extensive land clearing and construction of numerous farm ponds, the eastern United States has become favorable habitat for the Mallard (Heusmann 1974). Forbush (1925) notes that the release of Mallards associated with state game programs of the 1920's and 1930's may also account for the bird's increase in the

east. Eastward range expansion is not unique to the Mallard. The Ring-necked duck (Aythya collaris), American Widgeon (Anas americana), and the Gadwall (Anas strepera) were all once considered exclusively western breeding ducks. In each case, however, definite eastward range expansion has occurred (Heusmann 1974).

Synchronous with the Mallard's eastward movement has been the dramatic Black Duck decline. Using records from the Audubon Christmas Bird counts, Johnsgard and DiSilvestro (1976) showed that Black Duck numbers have been steadily decreasing relative to Mallards throughout their range. Also utilizing the Christmas Bird counts, Butcher (1986) compared winter population numbers for the two species in the central and eastern United States. Between the winters of 1945-1950 and 1982-1983 the Black Duck had declined 70%, indicating a 3.6% decline per year in the population. This downward trend was consistent from year to year. Mallard numbers were also shown to be declining overall. In the Northeast, however, the Mallard is making dramatic gains. Heusmann and Burrell (1984) have noted substantial increases in park Mallard numbers in Massachusetts. In the period between 1978 and 1983, park Mallards had increased 3.6%. During this same period, the Black Duck count was down 1%. The Mallard, thus, has successfully adopted the eastern United States as a breeding area. Because these two species are now in close sympatry, and simultaneously the Black Duck is experiencing a dramatic decline, this situation warrants

close attention.

Considering the current range overlap of the two closely related populations, competition for resources and possible genetic interchange in the form of hybridization may result. Thus, the fate of the Black Duck as a species is in doubt, and an understanding the evolutionary history of the two species is important. According to Kendeigh (1961), the North American biota was segregated during the Pleistocene. Through the combined effects of the Great Plains and repeated glacial advances from the north, the east and west formed distinctly separate habitats. The western section continued to have contact with the Eurasian biota, but the eastern section became isolated. In this way, the original ancestral population of the Mallard and Black Duck became geographically isolated. In the western population, the selective pressures were for brightly colored males, crucial for species recognition in the species rich west. This sexual dimorphism is obvious in the present day Mallard. In the east, the heavy year-round precipitation resulted in abundant post-glacial forestation. Because of the low number of closely related Mallard-like species in the east, hybridization would be rare. Selection would thus favor protective coloration and not sexual dimorphism. The result is the dark, monomorphic Black Duck, which is well suited for concealment in the dark forest ponds of the post-Pleistocene east.

Considering the close relatedness of the two species,

hybridization has been cited as a possible cause for the Black Duck decline. Analyzing studies of blood proteins, Heusmann (1982) notes that as many as 30% of Black Ducks in Massachusetts contain some Mallard genes. According to Mayr (1944) "Species are groups of actually or potentially interbreeding natural populations which are reproductively isolated from other such groups". Reproductive isolation may be achieved through geographic, habitat, or behavioral differences exhibited by two species (Lack 1971). In this way, a barrier is set up against gene flow between two populations (Dobzhansky 1937). The presence of gene flow between two populations, through hybridization, causes the "genetic integrity" (Lack 1971) of a species to slowly disintegrate. Brodsky and Weatherhead (1984) believe that as a result of the Black Duck's hybridization with the Mallard's much larger gene pool, the Black Duck as a "pure" species could eventually disappear. With the eastern movement of the Mallard and subsequent sympatry of the two species, the reproductive isolating capability of separate geography has been lost. As a result, other means of genetic isolation are crucial in order to prevent hybridization. However, the evolution of an effective, alternative isolating mechanisms (habitat or behavioral) does not appear to have taken place between the two populations.

Black Duck courtship displays by both male and females are virtually identical to Mallard displays (Johnsgard 1960,

Heusmann 1974). In addition, most pair bonding in both species occurs during the winter (Stotts and Davis 1960, as cited by Brodsky and Weatherhead 1984). Brodsky and Weatherhead (1984) reported that "Mallard drakes initiated courtship overtures to Black Ducks only after all Mallard hens had formed intraspecific pairs." In addition, Mallard drakes were shown to be competitively superior to Black Duck drakes when both are courting Black Duck hens. An equal ratio of Mallard hens to drakes would be one way of limiting interspecific pairing, since Mallard drakes show a natural preference for conspecific hens. If this were achieved, the number of unpaired Mallard drakes would be minimal. Findings by McIlhenny (1940), Erikson (1943), Petrides (1944), Yocom (1949), Martinson et al. (1968), and Brodsky and Weatherhead (1984), however, show disparate sex-ratios favoring males in northern Mallard populations. The presence of an effective prezygotic reproductive isolating mechanism, thus, may be absent between the two species. According to Phillips (1915) and Johnsgard (1960), Black Duck x Mallard hybrids from captivity and the wild are completely fertile. Hence, the efficiency of postzygotic reproductive isolating mechanisms is questionable.

The steady decline in good quality Black Duck habitat has also been cited as a possible cause of the Black Duck decline. The breeding range of the Black Duck comprises a great diversity of aquatic habitats. These habitats include acid bogs; lakes; ponds; coastal tidewater areas; salt,

brackish, alkaline, and fresh water marshes; and the margins of estuaries. Black Ducks winter primarily in the coastal tidewater areas and along the larger streams, lakes, and reservoirs of the interior (Forbush 1925, Stewart 1958). In general, the northern wintering limit is based on availability of food and open water found in these habitats (Brodsky and Weatherhead 1985). According to Ringleman and Longcore (1982), Black Duck selection of aquatic habitats is highly specific and secluded areas are preferred.

The destruction of wetlands in the Northeast may be limiting Black Duck breeding areas, and in Canada, drainage of coastal marshes for agricultural purposes in the Maritimes has destroyed suitable habitat. Substantial draining has also occurred in areas of southern Quebec and Ontario wetlands (Coulter and Mendall 1968). Currently, salt marshes along the St. Lawrence estuary are being diked for hay and pasture (Heusman 1982).

Deforestation in the Northeast has also been cited as a limiting factor of the Black Duck breeding range (Johnsgard 1961, Kirsh 1969, Davis 1976, Brodsky and Weatherhead 1984, Titman, unpublished). According to Cowardin (1969) and Ringelman and Longcore (1982) small wetlands and flooded timber areas act as very important breeding areas for inland-nesting Black Ducks. These areas serve not only as loafing points for broods during overland journeys, but also to migrants during seasonal movements. Heusmann (1974) has noted that during the mid-1800's

extensive land clearing in New England drastically altered the habitat. This deforestation not only decreased the availability of good Black Duck habitat but may have simultaneously allowed the Mallard to move eastward. Mallards tend to occupy more open areas than the secretive Black Duck (Forbush 1925, Johnsgard 1961). According to Johnsgard (1961), Heusmann (1982), and Grandy (1983), however, destruction of habitat is not a controlling factor in the Black Duck decline. They state that many good nesting areas are still available.

Black Duck mortality as a result of hunting has also been explored as a cause of the decline. The Black Duck is the most important game duck in the Canadian Provinces and along the eastern United States coast (Forbush 1925, Martinson et al. 1968, Geis et al. 1971, Heusmann 1974, Grandy 1983). According to Forbush (1925), and Geis et al. (1971), the Black Duck's sporting qualities; specifically its wariness, large size, and palatability, make it a favored game duck of hunters. Grandy (1983) argued that even though the decline has been acknowledged by the U.S Fish and Wildlife Service, the Canadian Wildlife Service, and by state organizations, hunting regulations have been made more permissive since 1968. In addition, the total number of hunters and hunter days increased between 1968 and the early 1970's. During this time it is estimated that hunting accounted for 50% to 60% of total mortality. In Massachusetts alone, the number of duck hunters rose from

12,000 in the early 1960's to 20,000 in the mid-1970's. This number has recently averaged approximately 17,500. In Quebec and the Atlantic provinces, waterfowl hunting permits increased from 77,000 in 1968 to nearly 129,000 in 1976. It was predicted that by 1985, approximately 192,000 permits would be sold annually (Heusmann 1982). Findings by Spencer (1983, as cited by Grandy 1983) indicate that the decline in Black Duck numbers is caused by the lack of breeders, not by some factor that may reduce brood size or individual fitness. Thus mortality due to hunting has reduced the number of potentially breeding Black Ducks. Grandy (1983) has noted that the significant effect hunting mortality has on the Black Duck population must be acted on now. Hunting is the only mortality factor that wildlife managers can directly control (Heusmann 1982, Grandy 1983).

Hunting would not be a key factor in the Black Duck decline if hunting mortality is compensated for by decreases in natural mortality in waterfowl (Anderson and Burnham 1975, Nichols et al. 1982). Compensatory reactions, namely increased survivorship of the remaining population, is most commonly the result of reduced intraspecific competition (Begon et al. 1986). In the case of the Black Duck, however, populations have been declined to such an extent that any intraspecific competition is minimal unless habitat destruction is the primary cause. According to Heusmann (1982), the Black Duck population is below a threshold level (the point below which a population cannot reproduce

itself), thus hunting is probably responsible for further reducing the population.

With the close genetic relatedness of the two species in addition to their current sympatry, both species may occupy similar or perhaps the same niches (Titman unpublished). Competition, thus, may be a critical factor leading to the decline of the Black Duck. Titman (unpublished) has noted that as the Mallard moved eastward it readily inhabited urbanized areas. According to Forbush (1925) "The Mallard readily adapts to civilization". In Massachusetts, urban aquatic park habitats are dominated by Mallards (Heusmann and Burrell 1984). This adaptability of the Mallard may give it a competitive advantage over sympatric Black Ducks. The Black Duck, as previously mentioned, prefers secluded habitats and is wary of human intrusion. In addition, artificial feeding associated with park settings (Figley and VanDruff 1982, Heusmann and Burrell 1984) may allow the Mallard a competitive edge over the Black Duck which feeds on its own. The resulting superior physical condition of the Mallard would give it an interspecific advantage in the acquisition of breeding partners and nest sites.

During a seven year period, Coulter and Mendall (1968) found that the addition of Mallard nests to the existing nests on the Lake Champlain islands did not increase the total number of nests except during one year. This evidence shows that nesting Mallards displace Black Ducks rather than

nest with them. Coulter and Mendall go on to state that because of the similarity of their breeding behavior, the two species are likely to be competing for nest sites in many different habitats. A similar situation existed with the invasion of the Ring-necked Duck into northeastern marshes. However, Mendall (1958, as cited by Coulter and Mendall 1968) has found that since 1935 the addition of the Ring-necked Duck has supplemented breeding populations of Black Ducks. Both species, thus, are able to coexist without one excluding the other.

With the close similarity of habitat and feeding behavior between Mallards and Black Ducks, the two species may be competing for food. Both species forage mainly in shallow water by lowering the bill under the surface to reach aquatic plants and animals. Dabbling on floating vegetation as well as grazing on terrestrial plant life are also favored methods of feeding used by both species. Mallards and Black Ducks have been found to consume a diversity of plants and seeds. The most common of these are wild rice, pond weeds, bur reeds, eelgrass, wigeon grass, and field grains. In addition, animal foods including insect nymphs and larvae; crustaceans; and small molluscs are occasionally eaten by both species (Cronon and Halla 1968, Bellrose 1976, Palmer 1976, Prevost et al. 1978, Terres 1980, Anonymous 1985). Findings by Stoudt (1944), Reinecke and Owen (1980), and Delnicki and Reinecke (1986), however, show that Mallard consumption of animal food is minimal,

with plants making up to 96% of the diet. Black Ducks, on the other hand, have been found to eat more animal food than Mallards (Forbush 1925, Coulter 1955, Reinecke and Owen 1980). In addition, animal food forms the major proportion of the diet of the downy and fully feathered young Black Duck diet (Reinecke 1979). Through this difference of diet, the two species may avoid interspecific competition for food. Each species, thus, may occupy a slightly different niche and become ecologically isolated.

The goal of this study was to test whether there is interspecific competition between Mallards and Black Ducks in coastal saltwater marshes. Two separate segments comprised this examination of interspecific competition. One segment involved a quantitative study of the diet of the Black Duck. The second segment encompassed an observational study of Black Duck feeding behavior and habitat.

METHODS:

This study is a continuation of a study completed by Elizabeth Wingate from mid-October, 1985 to mid-April, 1986 (Wingate 1986). Black Ducks were observed at Goshen Cove Harkness State Park, Waterford, Connecticut (41° 18'N 72° 06' W). The study site consists of a tidal marsh covering approximately 10 ha (Figure 2). There are four distinct sections within the study area; the eastern cove, the western cove, the mouth of the cove, and a small freshwater pond. The western cove's secluded location allows for more isolation from human contact than the eastern cove, which borders U.S Rte. 213 and the driveway to Harkness State Park. Despite this difference, the two coves form relatively similar macrohabitats. Vegetation surrounding the coves includes Spartina alterniflora, Spartina patens, and Distichlis spicata. The vegetation found in the coves is very sparse and dispersed, consisting of Ulva lactuca, Rhizoclonium tortuosum, Fucus vesiculosus, Codium fragile, and Polysiphonia sp.. The mouth of the cove forms a creek between the ocean and the cove. Areas of loose Laminaria saccharina and other floating vegetation are found here as a result of incoming tidal currents.

Using data from Wingate (1986), areas of concentrated feeding by Black Ducks were plotted on a map of the cove. Using these data as a guide, four plots were set up that covered areas that had been heavily foraged (Figure 3). Three of these plots (30 m, 40 m, and 70m in length) were

located in the east cove and the fourth (80 m) in the west cove. Each plot contained a pair of parallel underwater transects, 5 m and 10 m from shore, except in the 80 m plot, in which the second transect was 15 m from shore. To construct the underwater transects, reference stakes were initially placed at 10 m intervals along the shore edge. Using a tape measure, a stake was placed into the substrate of the cove 5 m from each corresponding reference stake on shore. A compass was then used to ensure that each underwater stake was perpendicular to the shore reference stake. Thus the underwater transect followed the contours of the shore. Twine was then used to connect the underwater stakes to mark the transect. This process was repeated for the next parallel transect (10 or 15 m from shore).

Vegetation attached to the substrate of the cove within 2 m of either side of the transect line was mapped while snorkeling along each transect. Floating vegetation was noted in some cases, but was not included in any statistical evaluations. In this way, a detailed map of vegetation types was constructed for each transect. Using blank maps of each of the transects and expanded maps of the entire cove, the location and feeding techniques of Black Ducks were plotted during visits to the cove. A pair of 7 x 35 binoculars and a 20x spotting scope were used to observe the ducks. When a duck was feeding for at least two minutes, its location and foraging technique were recorded. Foraging techniques were categorized as grazing (nipping off the

surrounding, non-aquatic, vegetation); dabbling (quick thrusts of the bill to obtain food from the water's surface); neck-plunging (submersion of the head and neck into the water); and upending (submersion of the head, neck, and forebody). At the conclusion of observations in mid-April, data from these daily maps were compiled into a summary map. Areas of the cove that were heavily foraged were thus delineated. The summary map was then compared to the original vegetation maps to better assess the specific plants each species was feeding on. Categories used for seasonal analysis included: fall (before ice formed on the cove; Nov. 12 - Dec. 15), winter (when ice was on cove; Dec. 16 - Mar. 14), and spring (after ice had melted; Mar. 15 - Apr. 10).

In addition to field observations, gizzard and proventriculus contents of 15 Black Ducks were analyzed. Combining these data with Wingate's (1986) data for Mallard and Black Duck gizzard and proventriculi contents, a comparison of diet between the two species was made. Hunter-killed ducks were obtained at the boat landing at Great Island Wildlife Management Area, Old Lyme, Connecticut. This area encompasses a large tidal marsh at the mouth of the Connecticut River. Attempts at collecting proventriculi and gizzards were made every weekend of the hunting season (Dec. 8 - Jan. 15). Samples, however, were only obtained on December 8, 1986.

To remove the proventriculi and gizzards from the

ducks, a small (6 to 7 cm) incision was made from the cloacal aperture up to the front of the belly. The excised organs were then placed in jars of 10% formaldehyde solution. These jars were then labelled according to species and sex.

After opening each proventriculus and gizzard, the contents were emptied into a large petri dish filled with water. Conspicuous seeds, shell fragments, and sand were removed and placed in separate, labelled vials. Vegetation and detritus were then collected in a fine plankton net for efficient identification (Montgomery 1977, Taylor 1957). An estimate of the total volume occupied by each food type for each individual stomach was then made. In addition, the wet weight of each food type was determined for each individual duck.

RESULTS:

Observations were made of the foraging behavior and habitat use of 280 Black Ducks and 14 Mallards. Data from fall and winter show no statistical seasonal differences in habitat use ($\chi^2=5.21$, $df=2$, $0.05 < p < 0.20$). Fall and winter Black Ducks fed mainly in the east cove and to a lesser extent in the west cove (Figure 3). During the spring, however, feeding Black Ducks utilized the west cove frequently, while the east cove was used infrequently. This seasonal change of habitat preference was significant for winter and spring ($\chi^2=26.8$, $df=2$, $p < 0.01$), and for fall and spring ($\chi^2=19.6$, $df=2$, $p < 0.01$), (Figure 3). Data for the mouth of the cove and the freshwater pond, for all seasons, were insufficient to make any statistical comparisons.

Black Duck microhabitat use was assessed by recording the distance from shore at which the ducks were feeding. 97% of all foraging occurred within 10 m of shore. Only rare instances of dabbling were recorded in areas nearer the center of the cove.

Foraging techniques used by Black Ducks showed significant differences in fall and spring ($\chi^2=22.6$, $df=6$, $p < 0.01$). Fall feeding behavior included frequent upending and neck-plunging. Spring foraging techniques showed an increase in upending and dabbling (Figure 4).

Fall and winter foraging techniques showed little variation ($\chi^2=0.9$, $df=2$, $0.5 < p < 0.9$). During both seasons, upending predominated while neck-plunging was occasionally

used (Figure 4).

Foraging behavior was slightly different for winter and spring. Dabbling, not observed during the winter, was infrequently recorded during the spring. This difference, however, was not significant ($\chi^2=3.95$, $df=6$, $0.50 < p < 0.90$) (Figure 4).

Black Ducks showed no significant modification in their feeding behavior with tidal fluctuations ($\chi^2=0.38$, $df=2$, $0.50 < p < 0.90$). During early spring, however, melting snow and high tides flooded the marsh borders of the cove. At this time, Black Ducks could be seen dabbling and grazing in Spartina.

Algae found in transect plots was predominantly Rhizoclonium tortuosum. These plots were grouped into two specific categories: areas of Rhizoclonium tortuosum, and areas of no attached aquatic vegetation. Black Ducks observed feeding over transect plots along the 80 m transect fed significantly more frequently over areas of Rhizoclonium sp. than areas with no attached aquatic vegetation ($\chi^2=21.4$, $df=2$, $p < 0.01$). Because of the small number of observed Black Ducks feeding over the remaining three transects, a statistical analysis could not be made.

The contents of the proventriculi and gizzards of 15 Black Ducks (Table I) were separated into four groups: algae, detritus, seeds, and animal material. The algae group consisted of Ulva lactuca, Enteromorpha intestinalis, and Rhizoclonium tortuosum. Black Ducks had a mean of 46 mg

of algae per gizzard. Components of detritus were unidentifiable, decomposed or digested plant and animal material. A mean of 1988 mg of detritus was found per gizzard. The seed group included seeds of Leguminosae, Arctium minus, Polygonum sp., Spartina sp., Acnidia cannabina, Viburnum sp., and Lupinus perennis. There was a mean of 351 mg of seeds per gizzard. Finally the animal group consisted of Cyathura polita. Animal material was found in only one gizzard. The mean weight per gizzard was 11 mg. The wet weight of each of these groups was compared to Wingate's (1986) data for Black Duck proventriculi and gizzard contents collected at the same site between December 4, 1985 and January 3, 1986. For algae ($t=-0.86$, $p=0.40$, $df=29$), detritus ($t=1.02$, $p=0.32$, $df=26.5$), and seeds ($t=-0.75$, $p=0.46$, $df=16.3$), there was no significant difference between samples from 1986 and 1987. Wingate (1986), however, found significantly more animal material. Data on wet weight for the three similar groups (algae, detritus, and seeds) was subsequently combined for the two years. The combined data for Black Ducks showed no significant difference with Wingate's Mallard data for algae ($t=-0.86$, $p=0.42$, $df=7.4$), detritus ($t=1.58$, $p=0.14$, $df=11$), or seeds ($t=1.11$, $p=0.28$, $df=34.6$). Comparing this study's 1987 Black Duck data for animal material with Wingate's 1986 Mallard data showed a significantly larger amount of animal material in Mallards than Black Ducks ($t=-2.63$, $p=0.017$, $df=18.0$) (pooled t-test).

Discussion:

Data for Mallard observations was not sufficient to statistically compare the feeding and foraging behavior of the two species. Upon analysis of observations of feeding behavior, habitat, and diet of Black Ducks, in addition to data for both species from Summerill (1985) and Wingate (1986) from the same study area, competition between Mallards and Black Ducks cannot be rejected. However, the data suggests that there are substantial differences between the two species.

Through the analysis of the foraging behavior of two species, it can often be determined whether they depend on similar sources of food for survival. If the two species indeed share some of the same foraging techniques, competition may result. During fall and winter, Black Ducks were found to mainly up-end and frequently neck-plunge. Spring Black Ducks significantly increased upending and occasionally dabbled. Dabbling was associated with the emergence of floating algae. Wingate (1986) and Summerill (1985) note that Mallard foraging techniques do not change greatly between seasons. Mallards predominantly neck-plunge and up-end to a lesser extent. In addition, Summerill observed dabbling and occasional grazing. Mallards, thus appear to be feeding generalists. Black Ducks observed during 1986-1987 dabbled only during spring and were not recorded grazing. Because Black Ducks appear to specialize to a degree in their feeding techniques, they may avoid

direct competition with Mallards. The frequent up-ending of Black Ducks may allow them to probe into the substrate for various invertebrates (Wingate 1986).

In addition to behavioral differences, habitat differences allow species to avoid interspecific competition. Black Ducks were observed mainly using the east cove during fall and winter. Wingate (1986) notes that Mallards primarily used the cove mouth during both seasons. In addition, Mallards were frequently found in the freshwater pond. Fall and winter represent seasons of low abundance of food. With this segregation of habitat during a season of scarce food, the two species may avoid competition when the possibility of competition would be greatest. Spring Black Ducks (1987) were found to forage mostly in the west cove. This switch from predominant foraging in the east cove to the west cove may represent a reaction to the extremely high water levels of the entire cove during the spring. The combined effects of melting snow and spring tides causes frequent flooding of the cove banks. Black Ducks were often seen in the flooded ditches of the extensive west cove marsh, feeding on Spartina. The east cove does not offer as large an amount of suitable habitat during high water.

Upon comparison of microhabitat of Black Ducks and Wingate's (1986) data for Mallards, there is no clear difference between species. Both foraged mainly in areas 0-10 m from shore, where the water level was approximately 30-

45cm.

Data for proventriculi and gizzard contents of 15 Black Ducks were pooled with corresponding data for Wingate's (1986) 16 Black Duck gut contents. This combined data was then compared to the proventriculi and gizzard contents of 7 Mallards from Wingate's study. However, one segment of Black Duck data that was not pooled with Wingate's (1986) Black Duck data was the category of animal material because 1987 Black Duck proventriculi and gizzards had a significantly lower amount of animal material than Black Ducks from 1986. Consequently, 1987 animal material data was compared independently 1986 data for Mallards.

According to Stoudt (1944), Reinecke and Owen (1980), and Delnicki and Reinecke (1986), Mallard consumption of animal food is minimal, with plants making up to 96% of the diet. Wingate (1986), however found that Mallards consumed approximately equal amounts of both foods, which is not consistent with previous studies. Black Ducks, on the other hand, have been found to eat more animal food than Mallards (Forbush 1925, Coulter 1955, Reinecke and Owen 1980). Animal material, however, was found in only 1 gizzard in the Black Ducks in the 1987 sample. This accounted for an extremely small mean of 11 mg of animal material per gizzard. It should be noted that one Mallard stomach from 1986 contained 100% barnacles. This fact, together with the extremely low amount of Black Duck animal material, may have skewed the data considerably.

There was no significant difference between species in the remaining three categories of food items (algae, detritus, seeds). Despite the significant homogeneity of these classes, slight differences were evident. Using the values for 31 Black Ducks, a mean of 213 mg of algae was found. Mallards, on the other hand, showed a mean of 744 mg of algae. Other differences were found in the amount of seeds and detritus in the two species. Black Ducks showed a mean of 553 mg of seeds and 1634 mg of detritus per gizzard. Mallards, on the other hand, had a mean of 215 mg for seeds and 618 mg for detritus. Higher amounts of seeds and detritus in Black Ducks may be related to their foraging technique. Black Ducks were found to be mostly up-enders. By up-ending, Black Ducks are better able to reach the substrate surface to probe for food where large amounts of seeds and detritus are found. Mallards, which predominantly neck plunge and dabble, are not able to reach into the substrate. Thus, lower amounts of detritus and seeds may be expected. Data for algae is inconclusive. Black Ducks were found to forage slightly less than Mallards on algae. However, algae does appear to be important to Black Ducks. Transect data indicated that Black Ducks predominantly fed over algae beds of Rhizoclonium tortuosum.

Additional factors may be involved in interspecific competition between Black Ducks and Mallards. Competition for mates may be important. According to Brodsky and Weatherhead (1984), Mallard males will court Black Duck

females when all Mallard females have formed intraspecific bonds. In addition, Mallard drakes were shown to be competitively superior to Black Duck drakes when both were courting Black Duck females. If equal sex ratios were found in Mallards, the frequency of Mallard males attempting to pair with Black Duck females would be low. Northern populations of Mallards have more males than females, however (McIlhenny 1940, Erikson 1943, Petries 1944, Yocom 1949, Martinson et al. 1968, Brodsky and Weatherhead 1984).

The destruction of wetlands in the Northeast may also pose special competitive problems for the Black Duck. Coulter and Mendall (1968) point out that sympatric Mallards are better competitors for nesting sites than Black Ducks. The breeding range of the Black Duck include areas of acid bogs; lakes; ponds; coastal tidewater areas; salt, brackish, alkaline, and freshwater marshes; and the margins of estuaries (Forbush 1925, Stewart 1958). Black Duck selection of aquatic habitats is highly specific and secluded areas are preferred (Ringleman and Longcore 1982). Mallards, on the other hand, use a wider variety of breeding habitats and are generally found in more open environments (Girard 1941). In addition, Titman (unpublished data) notes that Mallards can be found in both open, human altered habitat and in unaltered environments. Thus, competition for nesting sites or territories may be important.

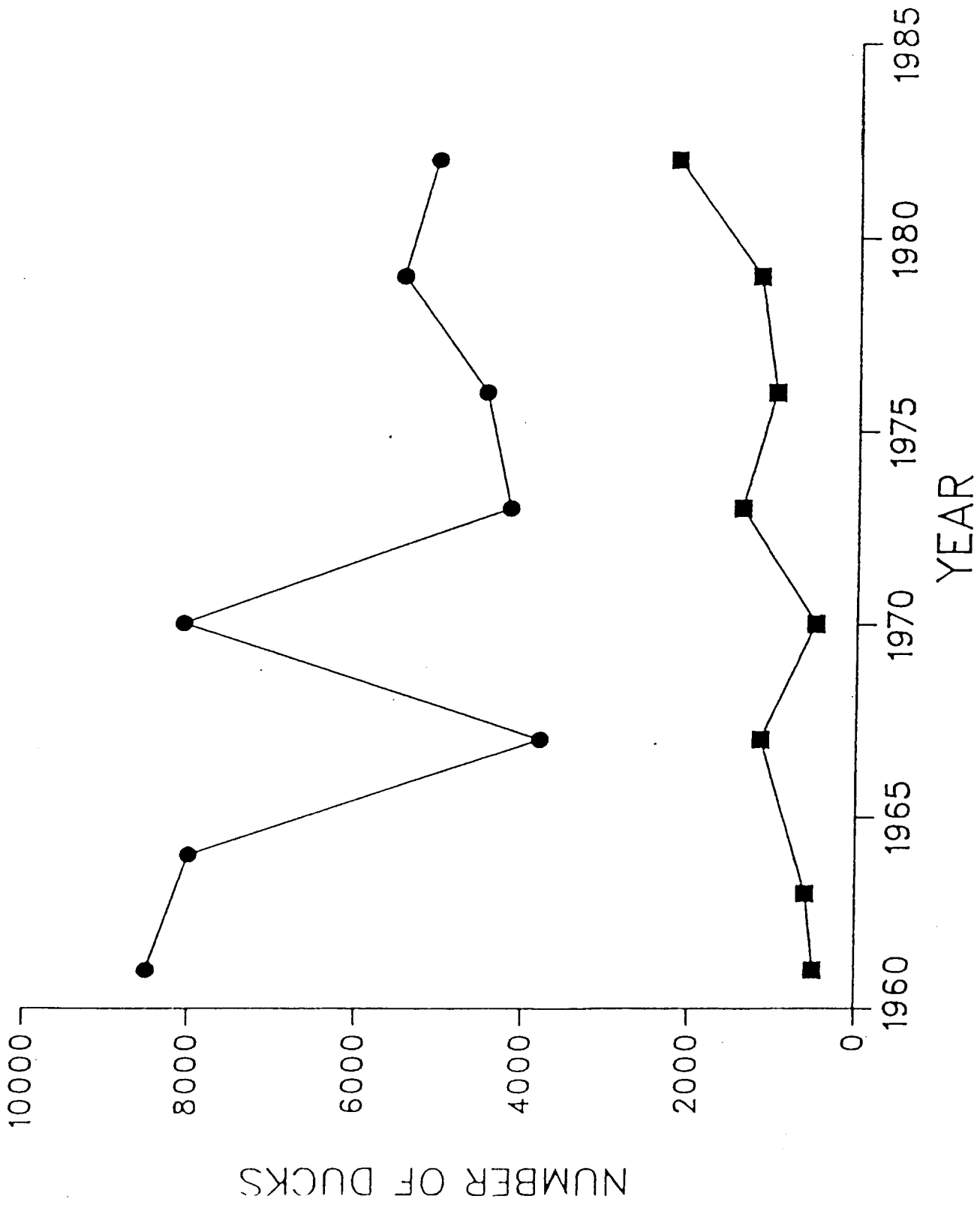
The hypothesis regarding Black Duck and Mallard competition must be studied further. Additional gizzard

content analysis must be done along with continued observational study of the feeding techniques and habitat preferences of the two species.

The conclusions of this study give no solid answer to the extent of competition between Mallards and Black Ducks. Overlap appears to exist with regard to foraging technique and diet. Comparison of habitat use of Black Ducks in 1986 and in 1987, however, suggests that there is a certain degree of isolation in habitat use. The fact that not enough Mallards were observed for any statistical comparison is good evidence that both species utilize different habitats.

The additive effects of competition, hybridization, and game management practices has had a definite deleterious effect on the Black Duck population. Of particular importance is habitat destruction. The current destruction of forest and marsh habitat has simultaneously made the Northeast favorable to the Mallard while eliminating possible Black Duck breeding and nesting areas. In addition, since habitat destruction causes the problems of competition and hybridization to become more acute, it is important that studies of interspecific competition between the Mallard and Black Duck pay particular attention to loss of habitat.

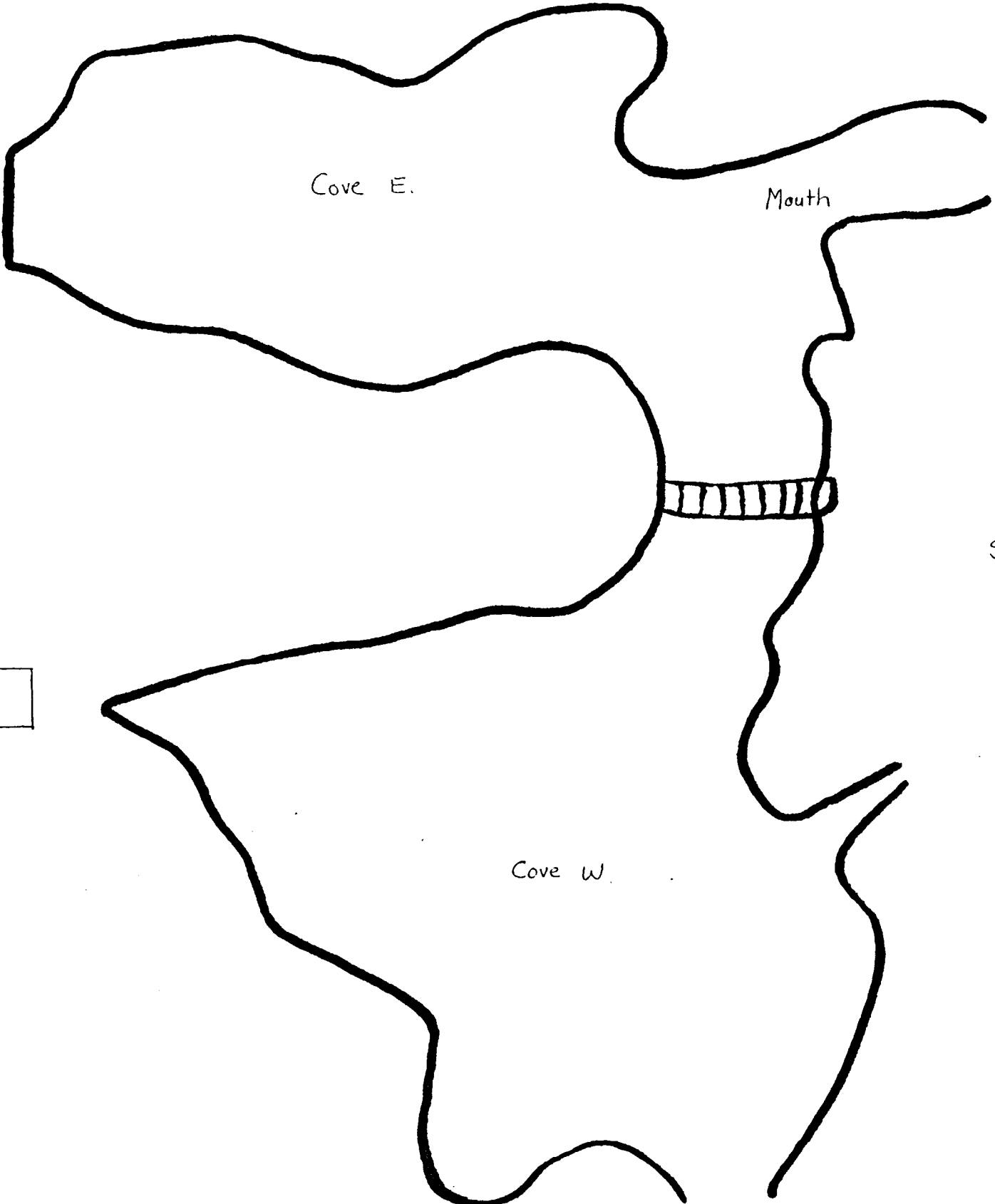
Figure 1. Three-year averages for populations of Black Ducks and Mallards recorded in Connecticut on the Midwinter Waterfowl Survey (Anonymous, 1983).



Legend
● BLACK DUCK
■ MALLARD

Figure 2. Map of Goshen Cove, Harkness State
Park, Waterford, Connecticut.

E



Cove E.

Mouth

N

S

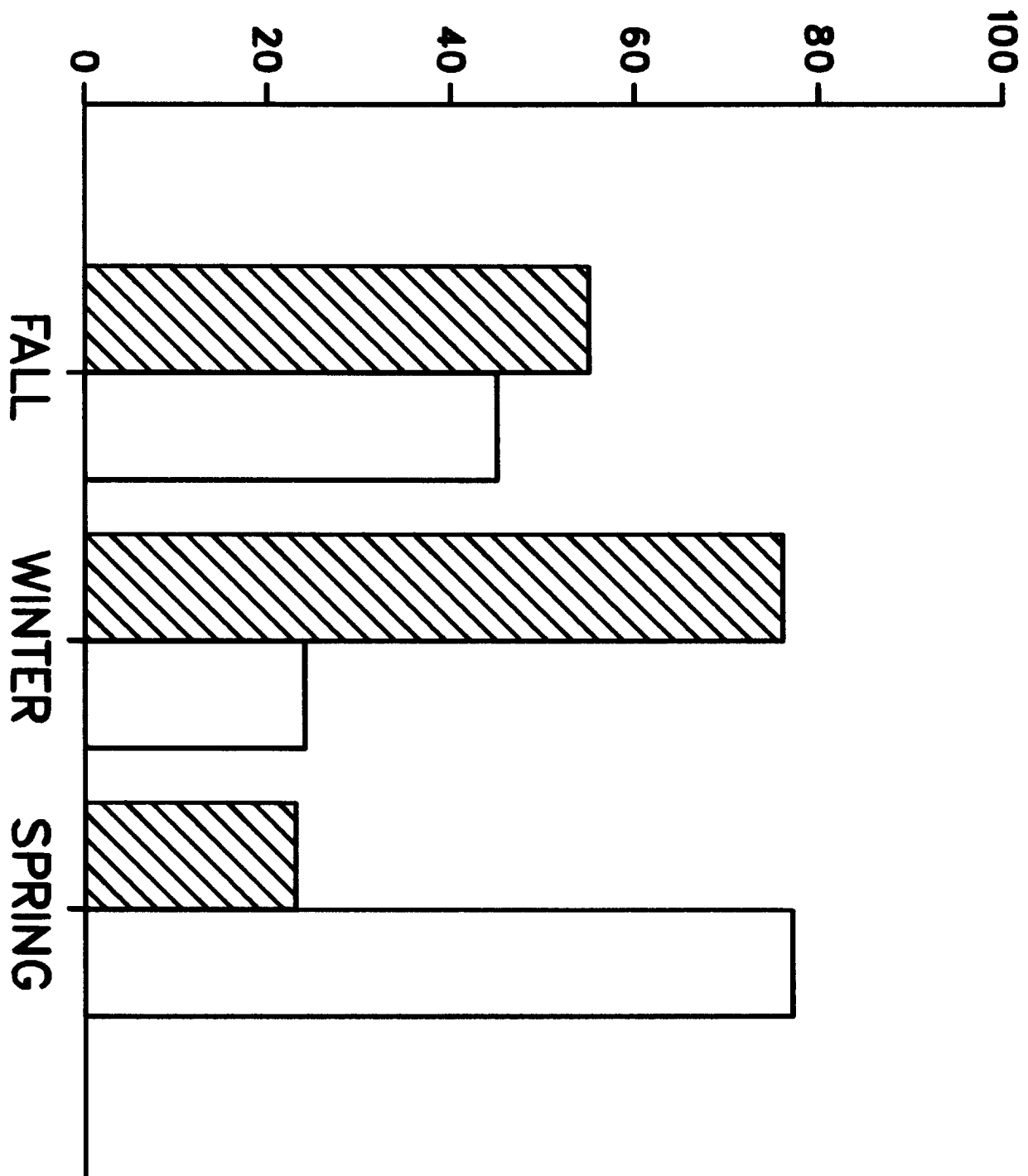
Pond

Cove W.

W

Figure 3. Habitats used during the fall, winter,
and spring by Black Ducks at Goshen Cove,
Waterford, Connecticut.

PERCENT OF OBSERVATIONS



Legend
▨ EAST COVE
□ WEST COVE

Figure 4. The foraging techniques used during the fall, winter, and spring by Black Ducks at Goshen Cove, Waterford, Connecticut.

PERCENT OF OBSERVATIONS

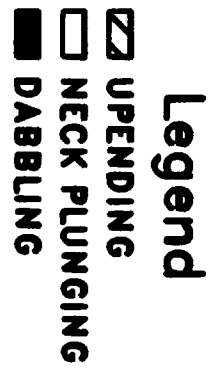
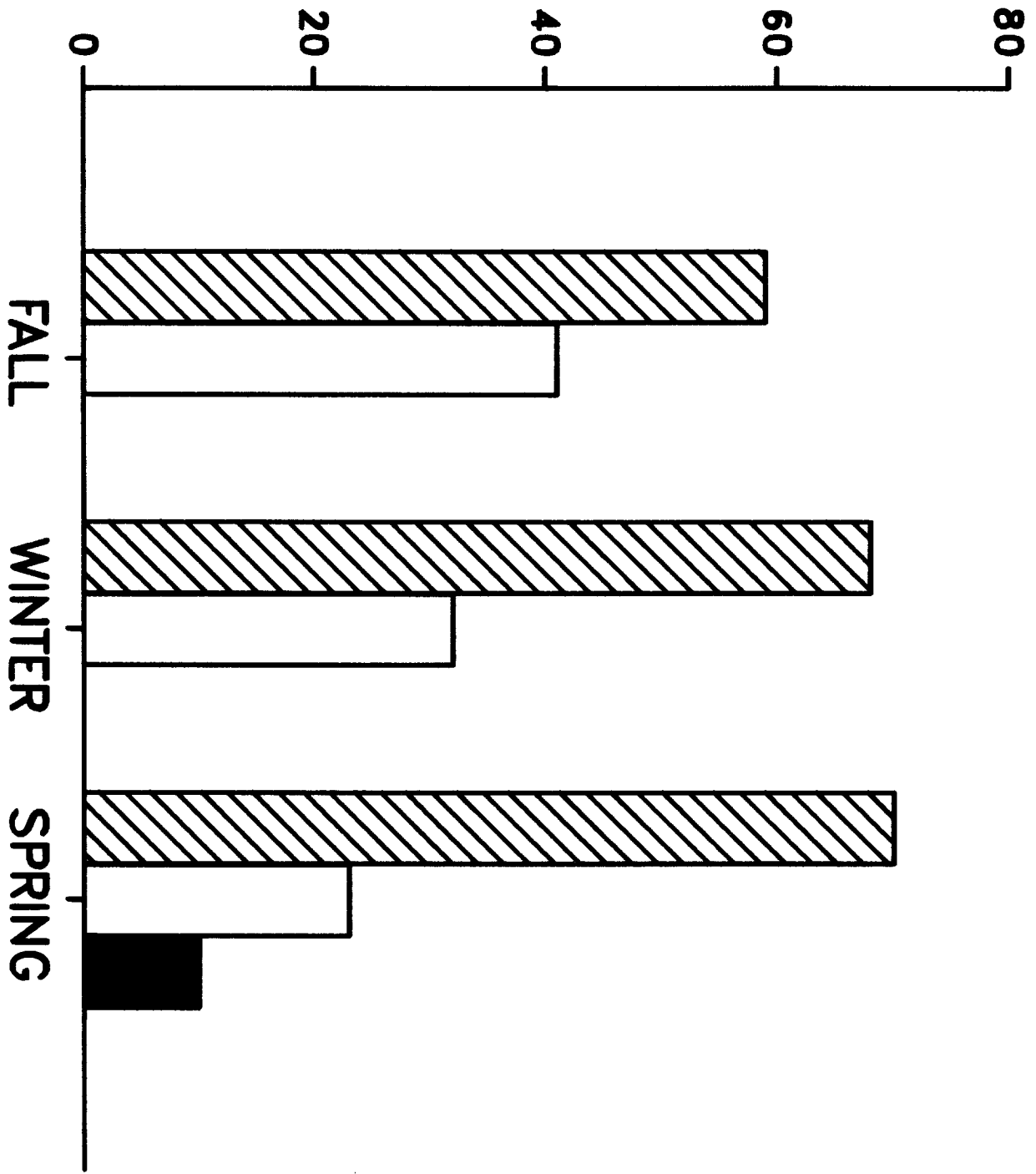


Table I.

Representation of different types of food in
stomach contents of Black Ducks

<u>Item</u>	<u>% of total weight</u>	<u>% occurrence</u>
detritus	58	93
corn	28	7
<u>Acnidia cannabina</u>	6	67
<u>Polygonum</u> sp.	2	33
yellow pellets	0.9	47
<u>Leguminosae</u>	0.9	53
clear pellets	0.6	33
shell fragments	0.6	20
<u>Viburnum</u> sp.	0.5	13
<u>Rhizoclonium tortuosum</u>	0.5	7
<u>Enteromorpha</u> sp.	0.4	7
<u>Cyathura polita</u>	0.3	7
<u>Ulva lactuca</u>	0.3	7
miscellaneous	0.2	33
<u>Spartina</u> sp. (seeds)	0.2	27
<u>Lupinus perennis</u>	0.1	7
<u>Arctium minus</u>	0.1	20
unknown seeds	0.1	13

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