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CHARACTERISTICS OF THE JONAH CRAB AND ROCK CRAB IN NEW YORK WATERS[1]

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ABSTRACT

Jonah crabs and rock crabs were sampled during late summer and early fall in 1980 from the inshore waters off the south shore of Long Island and from western Long Island Sound. Data on population composition, sex ratios, size frequency and size at maturity were compiled. Relationships of carapace length to weight, by species and area, were determined. Aspects of the fishery are discussed.

Jonah crabs (*Cancer borealis*) and rock crabs (*Cancer irroratus*) comprise an underused resource in New York's marine waters. The few that are currently harvested are taken mostly as a by-catch of the pot fisheries for American lobster (*Homarus americanus*) and black sea bass (*Centropristis striata*) operating out of Hampton Bays and Montauk. Most pot fishermen from these and other Long Island ports try to avoid concentrations of jonah, rock and other crabs and, with few exceptions, discard the crabs they catch. Those that do keep jonah and/or rock crabs usually just snap off the claws and sell them (mostly from jonah crabs) to a few local fish markets and restaurants. Some occasionally take these crabs home for their own and family consumption.

This has not always been the case. From 1975 through 1979, a processor at Montauk handled up to 285,000 pounds (about 129 metric tons) of jonah crabs a year (Briggs and Mushacke, 1980). But, since he suspended operations, a once promising fishery has failed to continue. By 1980, the reported landings of jonah crabs had fallen to only 22,060 pounds (10 metric tons).

Should interest in harvesting and processing jonah crabs and rock crabs be renewed, biological data would be needed to guide development and management of the fishery. For this reason, incidental catches of these

[1]A contribution of the Division of Marine Resources. The authors thank John Lheron and James Flaherty, commercial fishermen, for allowing them to collect crabs aboard their vessels.

crabs in the pots of commercial lobster and lobster-black sea bass fishermen in the inshore waters off the south shore of Long Island and in western Long Island Sound were sampled during 1980 to obtain data on population composition, sex ratios, size frequency and size at maturity.

METHODS

The samples were taken from mid-May through September in 1980. Crabs of both species were collected at two sites in the inshore waters off the south shore of Long Island: (1) at depths of 20 to 30 meters in the vicinity of Moriches Inlet Sea Buoy 28 (about 3 kilometers south of Moriches Inlet); and (2) at depths of 25 to 35 meters about 11 kilometers southeast of Shinnecock Inlet. Rock crabs only were collected at depths of 35 to 50 meters in the vicinity of Buoy 11B about 5 kilometers north of Eatons Neck in Long Island Sound. The sampling sites are shown in Figure 1. Samples from the two sites off the south shore were treated as one for

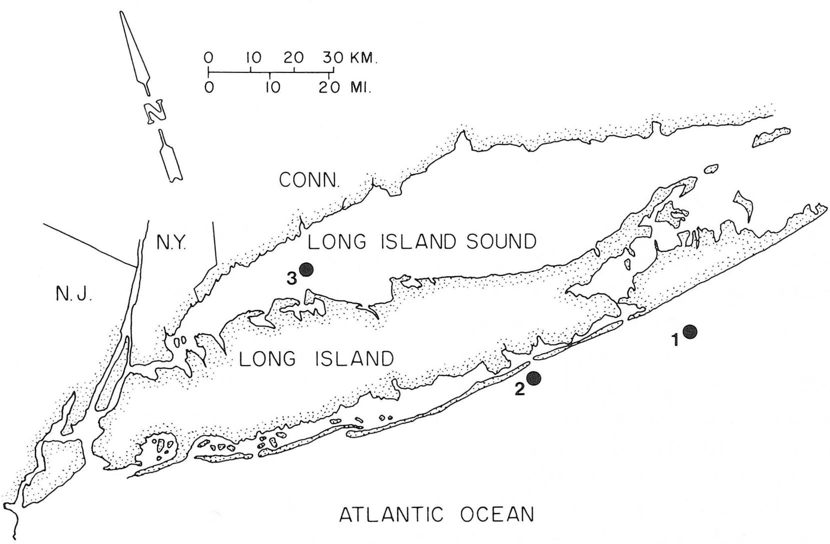

Figure 1. Map showing sampling sites: (1) southeast of Shinnecock Inlet; (2) vicinity of Moriches Inlet; (3) north of Eatons Neck.

data analysis; however, samples from these sites were not obtained in late spring or early summer because a fire damaged the cooperating fisherman's boat and left him unable to fish at that time. The sampling dates and number of pots sampled are shown in Table 1.

The cooperating fishermen used customary methods for the areas where they fished. Those working the inshore waters off the south shore of Long

TABLE 1. DATES SAMPLES WERE COLLECTED, NUMBER OF POTS SAMPLED AND CATCH OF JONAH CRABS AND ROCK CRABS IN 1980

Date	Pots sampled	Jonah crab		Rock crab	
		Number caught	Catch per pot	Number caught	Catch per pot
	South shore of Long Island				
August 6*	30	20	0.7	78	2.6
August 13*	30	37	1.2	96	3.2
August 18§	27	42	1.6	103	3.8
September 30§	62	26	0.4	133	2.1
Total	149	125	0.8	410	2.8
	Western Long Island Sound				
May 14	12	0	. .	100	8.3
June 2	18	0	. .	92	5.1
July 21	24	0	. .	95	4.0
September 17	126	0	. .	18	0.1
Total	180	0	. .	305	1.7

*At Site 1 (Figure 1).
§At Site 2 (Figure 1).

Island fished unbaited pots (primarily to reduce crab catches) in trawls of 15 to 25 pots intended for lobsters and black sea bass. Those working western Long Island Sound fished baited pots (usually with Atlantic manhaden, *Brevoortia tyrannus*) in trawls of five or six pots intended for lobsters.

The crabs collected were brought alive to the Department's marine laboratory at Flax Pond near Old Field where they were held overnight in a sea table with a flow-through seawater system at ambient temperature and salinity. The next day they were sorted by species and sex, measured to the nearest millimeter in carapace width, weighed to the nearest gram in live wet weight (provided they had all walking legs and both claws) and dissected to determine gonadal development (provided they were alive or only very recently dead and autolysis had not begun). Samples of the claws from live crabs were distributed to various co-workers in the Department to test their palatability and ease of preparation as food.

The criteria of Haefner (1976) for stages of gonadal development in rock crabs, as presented by Bigford (1979), were modified and used for both jonah crabs and rock crabs as an indicator of gonadal maturity. Haefner's "undeveloped" and "very slight" stages were combined to represent immature gonads. His "slight" and "moderate" stages were combined to represent developing, or maturing, gonads. His "well developed" and "very well" stages were combined to represent mature gonads. An additional indicator of maturity was also used for female crabs, i.e., the presence of either a "sponge" (a visible externally carried egg mass) or an "egged off" condition (the appearance of empty egg cases on the swimmerets) indicating recent hatching.

RESULTS

The number of crabs caught and the number examined in the laboratory are given in Tables 1 and 2, respectively. Of the three sites where samples were taken, both species were caught together only at those

TABLE 2. NUMBER OF JONAH CRABS AND ROCK CRABS EXAMINED IN THE LABORATORY

Item	Jonah crab		Rock crab	
	Male	Female	Male	Female
South shore of Long Island				
Measured for carapace width	124	1	336	74
Weighed (live wet weight)*	41	0	150	56
Dissected for gonadal examination	124	1	334	74
Western Long Island Sound				
Measured for carapace width	0	0	203	102
Weighed (live wet weight)*	0	0	116	69
Dissected for gonadal examination	0	0	127	99

*Specimens weighing less than 1 gram omitted.

off the south shore of Long Island where the ratio was 3.28 rock crabs to each jonah crab caught. The domination of the rock crab in the catch appeared to be similar in pots that were not sampled. The data for each species are presented separately.

JONAH CRAB

Jonah crabs were taken only off the south shore. During the short period when samples were collected, the catch per pot was highest in mid-August. Of the 125 caught, only one was a female. It measured only 12 millimeters in carapace width and weighed less than 1 gram, but had developing ovaries.

The males ranged from 10 to 159 millimeters in carapace width with a mean of 110 millimeters. The median was 124 millimeters which was more representative of the average because of the skewed and discontinuous size-frequency distribution (Figure 2). Except for a group ranging from 10 to 20 millimeters, few were smaller than 100 millimeters.

All male jonah crabs less than 30 millimeters in carapace width had immature gonads (Figure 3). Only seven (one each at 30, 35, 76, 105, 128, 137 and 139 millimeters) had developing gonads. The remainder had mature gonads. Only two of the latter (86 and 98 millimeters) were smaller than 100 millimeters. However, the size at which gonadal maturity was first attained could not be fully determined because few jonah crabs between 30 and 100 millimeters were caught. What can be said, at best, is that males less than 30 millimeters were immature and those over 100 millimeters were usually mature.

The relationship of carapace width to weight was determined for 41

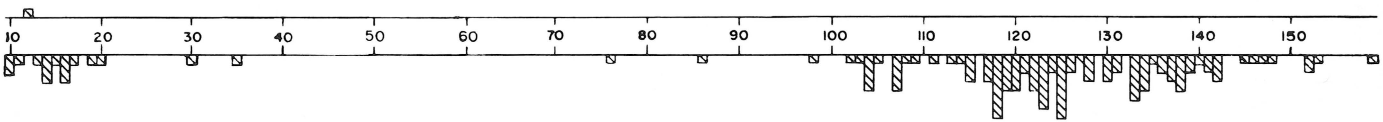

Figure 2. Size frequencies for female (above) and male (below) jonah crabs taken off the south shore of Long Island. Numerals denote carapace width in millimeters.

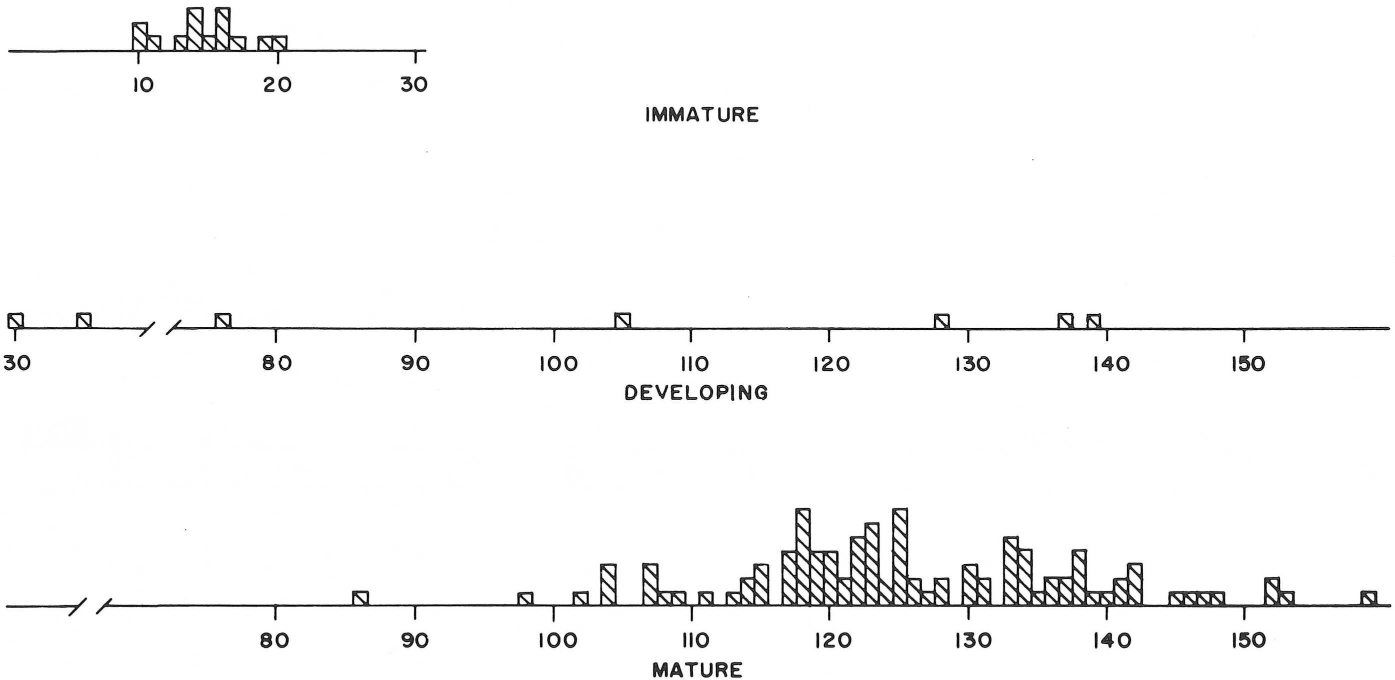

Figure 3. Size frequencies for male jonah crabs taken off the south shore of Long Island according to development of gonads. Numerals denote carapace width in millimeters.

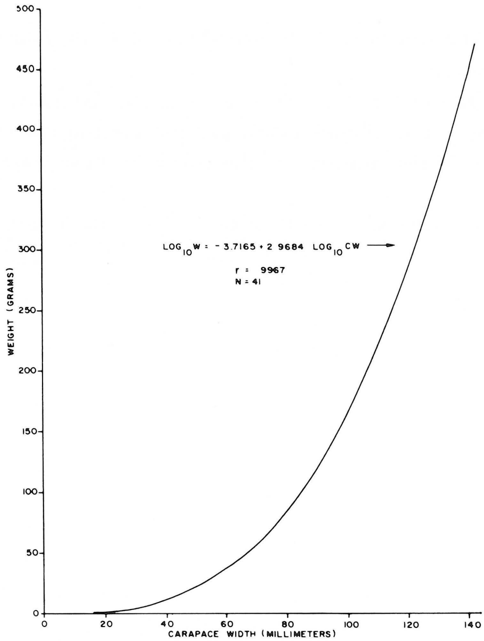

Figure 4. Carapace width-weight relationship for male jonah crabs taken off the south shore of Long Island.

male jonah crabs ranging from 16 to 142 millimeters. The small sample resulted from the fact that many of the crabs collected were either soft-shelled or had one or both claws missing. The equation, shown graphically in Figure 4, was

$$\log_{10} W = -3.7165 + 2.9684 \log_{10} CW$$

where

W = live wet weight in grams
CW = carapace width in millimeters

There was a strong indication that male jonah crabs in this area began a molting period in mid-August that was completed before the end of September. None of those collected on August 6 and September 30 was soft, paper-shelled or about to shed, whereas three (8.1 per cent) of the 37 collected on August 13, and 12 (28.6 per cent) of the 42 collected on August 18, were of this nature. Two of those collected on August 18 shed while being held overnight for dissection. Several other soft jonah crabs were observed among those caught in pots that were not sampled. None was seen on any other date.

ROCK CRAB

Rock crabs were taken both off the south shore of Long Island and in western Long Island Sound.

INSHORE WATERS OFF THE SOUTH SHORE OF LONG ISLAND There was little change in the catch of rock crabs per pot during the short time samples were collected. Males dominated the catch in these waters, about

TABLE 3. NUMBER OF FEMALES PER MALE FOR ROCK CRABS COLLECTED IN 1980

Date	South shore of Long Island	Western Long Island Sound
May 14	. .	0.1
June 2	. .	0.6
July 21	. .	1.4
August 6	0.2	. .
August 13	0.2	. .
August 18	0.3	. .
September 17	. .	0.3
September 30	0.2	. .
Total	0.2	0.5

five being caught for every female (Table 3). In the relatively short sampling period period there was no evidence of fluctuation in the sex ratio.

Male rock crabs ranged from 12 to 133 millimeters in carapace width, with a mean of 83 millimeters and a median of 105 millimeters. Except for a group between 12 and 32 millimeters, males less than 90 millimeters were scarce (Figure 5). Females were generally smaller, ranging from 14 to 93 millimeters, with a mean of 57 millimeters and a median of 73 millimeters. There were basically two size groups: one from 14 to 39 millimeters, the other from 71 to 93 millimeters. Only five females were between 39 and 71 millimeters.

Most of the males less than 30 millimeters had immature gonads (Figure 6). Developing gonads were found in a wide size range (17 to 124 millimeters) and in all of the few males between 30 and 70 millimeters. However, almost all those over 70 millimeters had mature gonads. In general, it appeared that, in these waters, male rock crabs less than 30 millimeters were immature, those between 30 and 70 millimeters were maturing, and those over 70 millimeters were mature.

Only seven female rock crabs (one each at 14, 22 and 37 millimeters, and two each at 16 and 17 millimeters) had immature gonads (Figure 7). Developing gonads were found in a wide size range (16 to 94 millimeters), and so also were mature gonads (18 to 93 millimeters). However, most of the females with mature gonads were 80 millimeters or larger. Five of the six egg bearing or egged off females (all between 73 and 83 millimeters) had developing gonads. In general, it appeared that females less than 20 millimeters were immature, those between 20 and 70 millimeters were maturing, and those over 70 millimeters were mature.

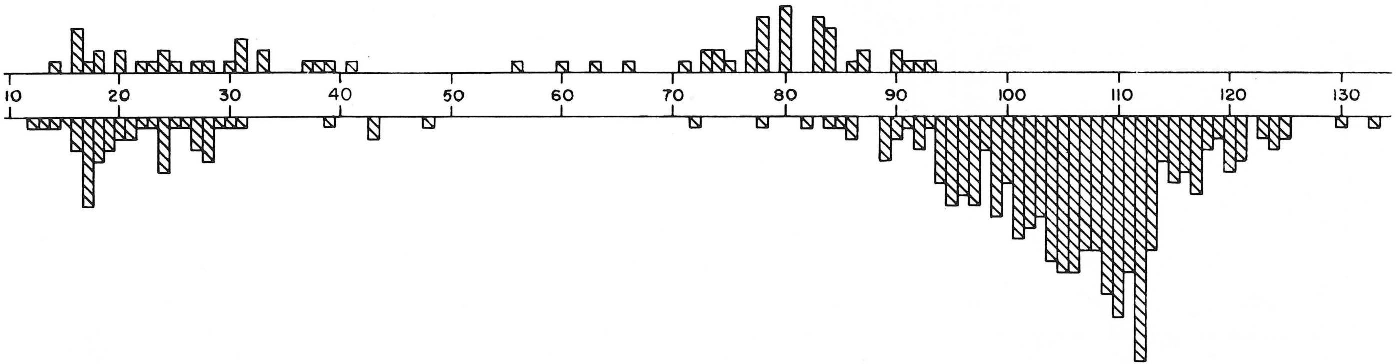

Figure 5. Size frequencies for female (above) and male (below) rock crabs taken off the south shore of Long Island. Numerals denote carapace width in millimeters.

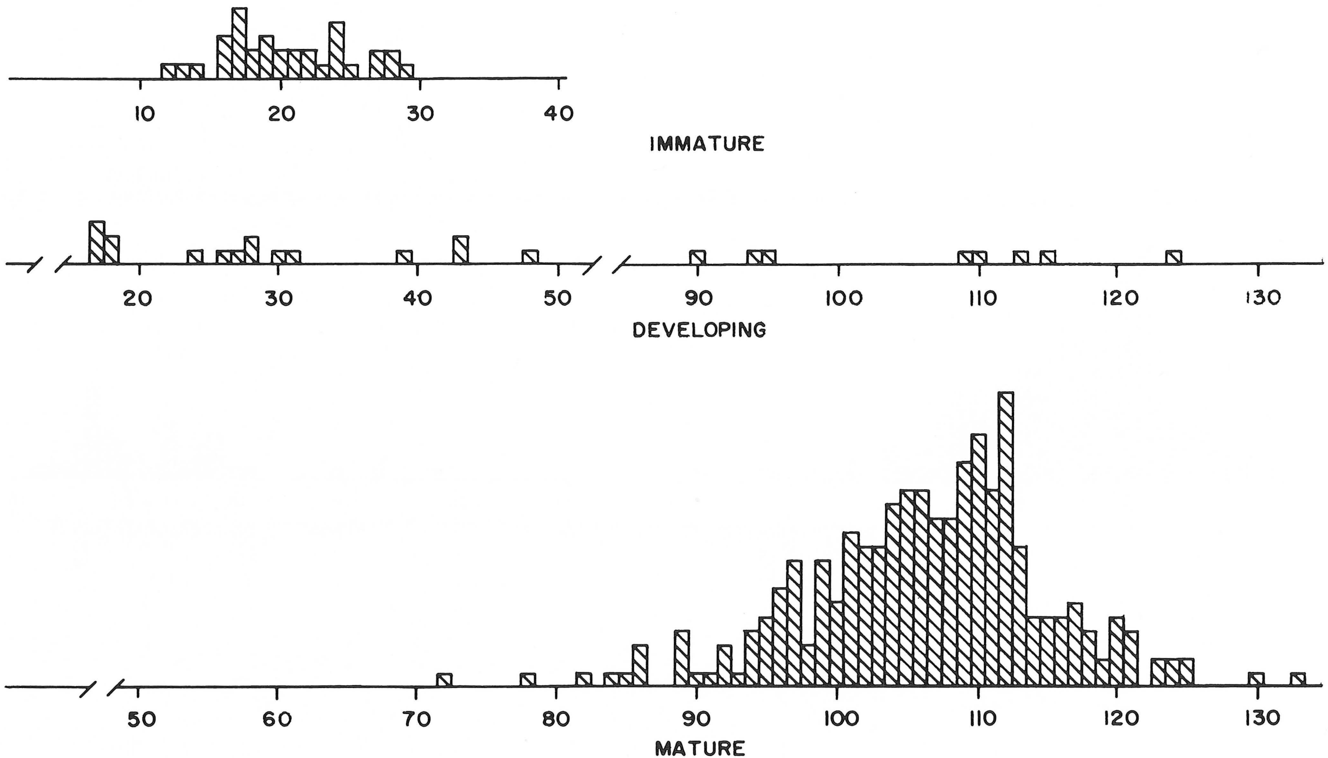

Figure 6. Size frequencies for male rock crabs taken off the south shore of Long Island according to development of gonads. Numerals denote carapace width in millimeters.

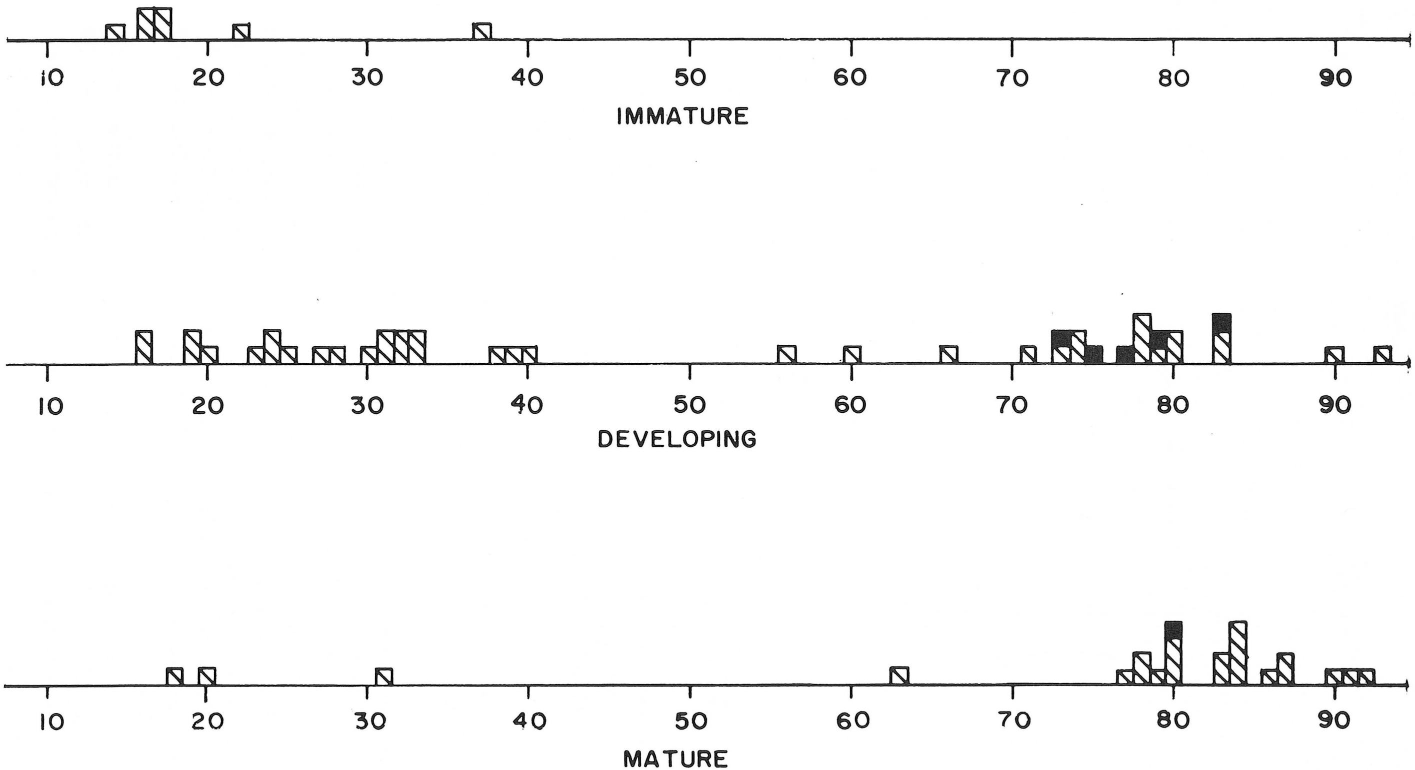

Figure 7. Size frequencies for female rock crabs taken off the south shore of Long Island according to development of gonads. Numerals denote carapace width in millimeters. Solid blocks indicate egg bearing and/or egged off females.

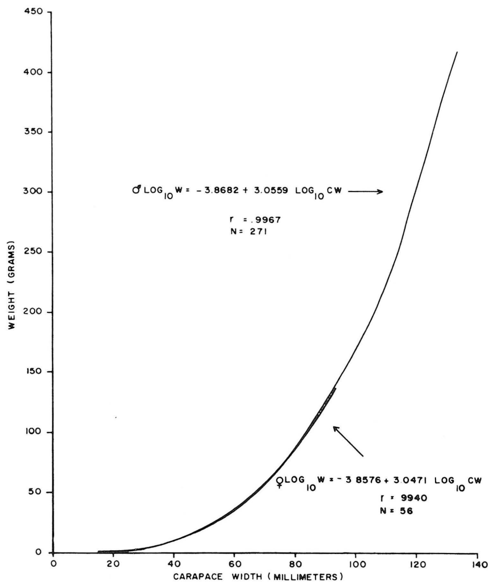

Figure 8. Carapace width-weight relationship for male and female rock crabs taken off the south shore of Long Island.

The relationship of carapace width to weight was derived for 271 male rock crabs ranging from 17 to 133 millimeters and for 56 females ranging from 16 to 93 millimeters. The equations, shown graphically in Figure 8, were

$$\text{Male:} \quad \log_{10} W = -3.8682 + 3.0559 \log_{10} CW$$
$$\text{Female:} \quad \log_{10} W = -3.8576 + 3.0471 \log_{10} CW$$

The curves for both sexes were essentially the same.

There was no evidence of a molt during the period of sampling.

WESTERN LONG ISLAND SOUND The catch of rock crabs per pot in these waters was highest in May and declined thereafter during the sampling period. While males showed a two to one dominance over females for the samples as a whole, there were wide seasonal variations in the sex ratio (Table 3). Males clearly dominated the catches in May and June, females in July, and males again in September. However, catches were low (only 14 males and four females) in the September sample.

Male rock crabs ranged from 9 to 107 millimeters in carapace width, with a mean of 75 millimeters and a median of 83 millimeters. Only 58 (28.6 per cent) exceeded 90 millimeters, the size which the former processor at Montauk felt was the minimum necessary for his operations to be

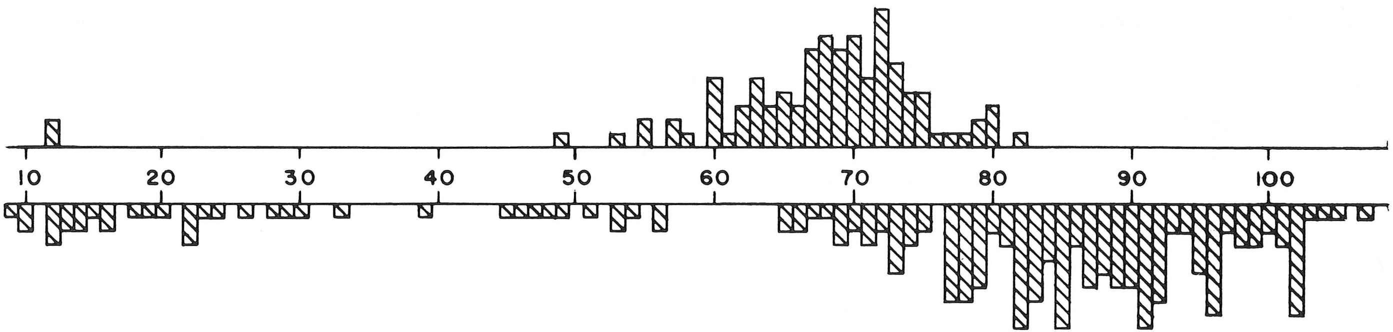

Figure 9. Size frequencies for female (above) and male (below) rock crabs taken in western Long Island Sound. Numerals denote carapace width in millimeters.

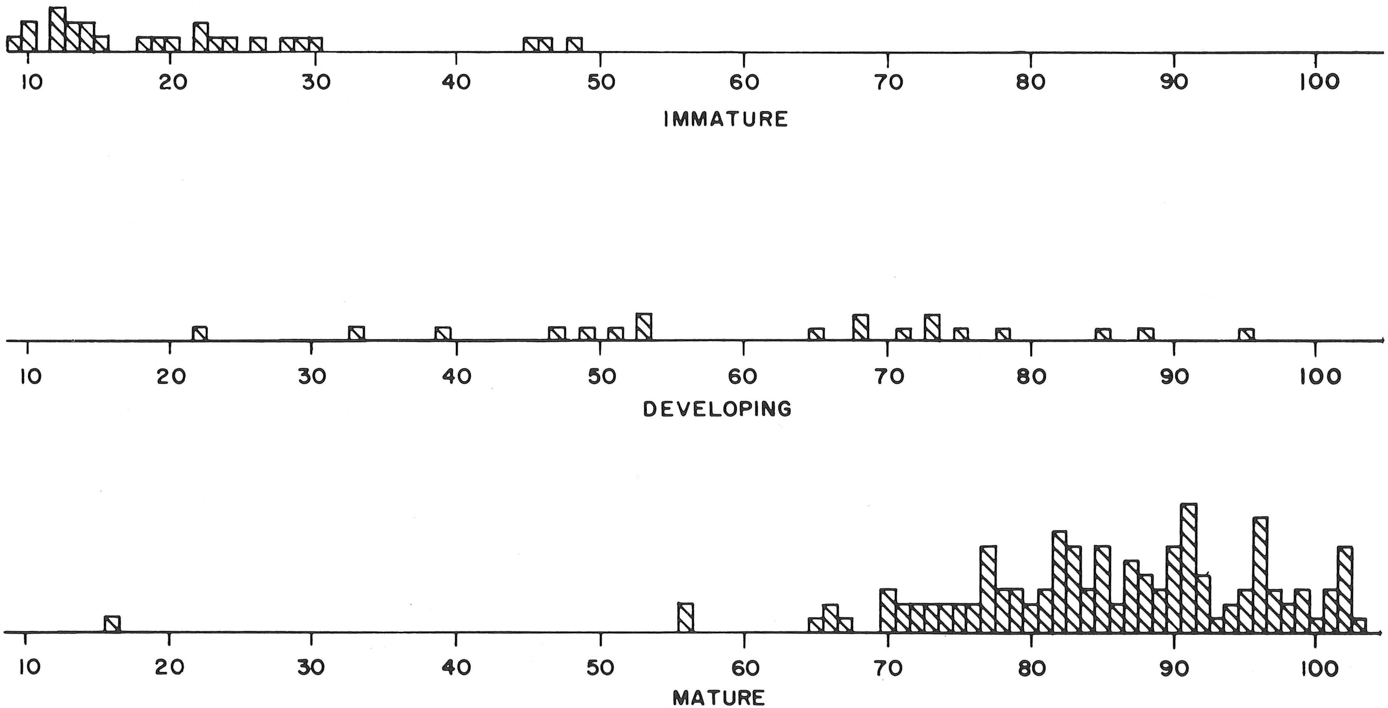

Figure 10. Size frequencies for male rock crabs taken in western Long Island Sound according to development of gonads. Numerals denote carapace width in millimeters.

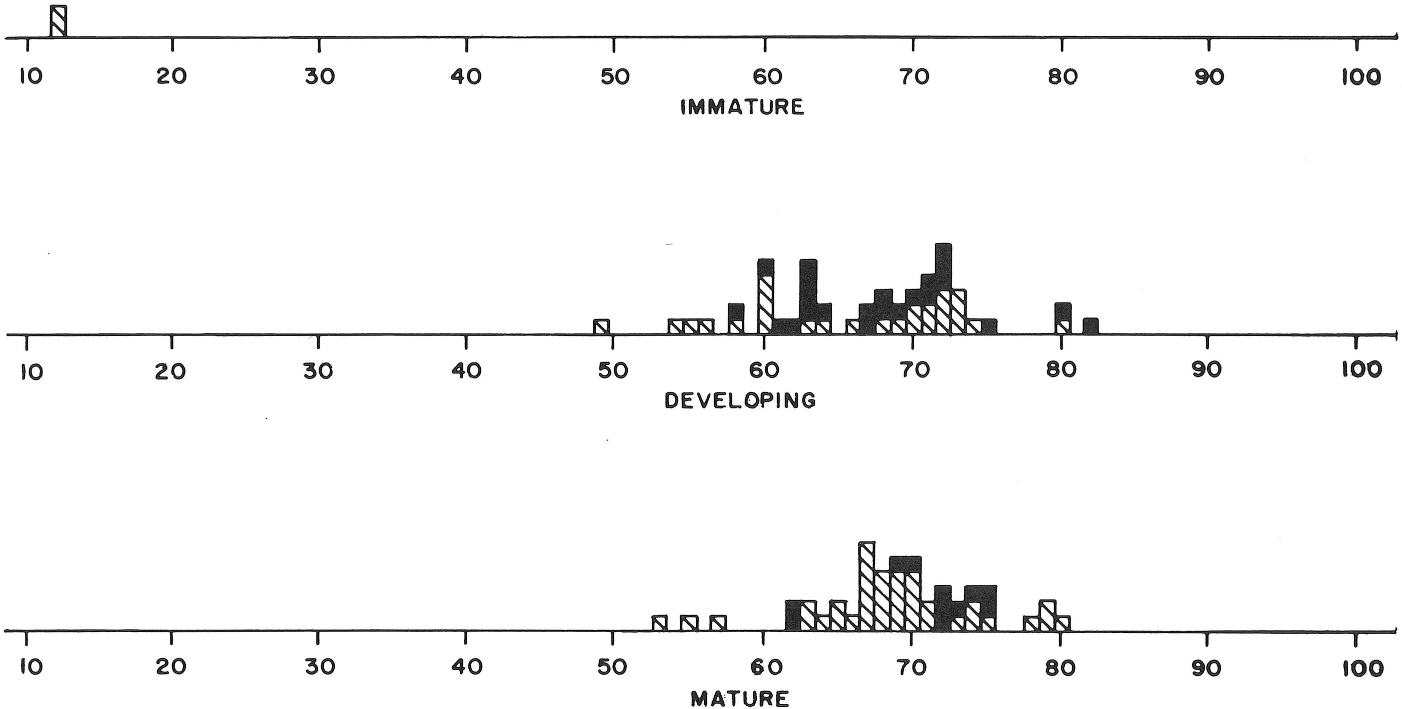

Figure 11. Size frequencies for female rock crabs taken in western Long Island Sound according to development of gonads. Numerals denote carapace width in millimeters. Solid blocks indicate egg bearing and/or egged off females.

successful with canceroid crabs (Russel Drumm, personal communication). Females were generally smaller, ranging from 12 to 82 millimeters, with a mean of 67 millimeters and a median of 69 millimeters. The length frequency distribution is shown in Figure 9.

Most of the males less than 30 millimeters had immature gonads (Figure 10). Two notable exceptions were one at 22 millimeters with developing gonads and one at 16 millimeters with mature gonads. A few as large as 48 millimeters had immature gonads. Developing gonads were found in a wide size range (22 to 95 millimeters) but mostly between 50 and 80 millimeters. Mature gonads were present in most of the males 70 millimeters or larger. In general, it appeared that almost all male rock crabs in western Long Island Sound less than 30 millimeters were immature, those between 30 and 70 millimeters were maturing, and those over 70 millimeters were mature.

The only female rock crabs with immature gonads were two 12-millimeter individuals (Figure 11). The distribution of both developing and mature gonads was rather even among the specimens 49 millimeters or larger. Many females that had recently dropped eggs or were egg bearing

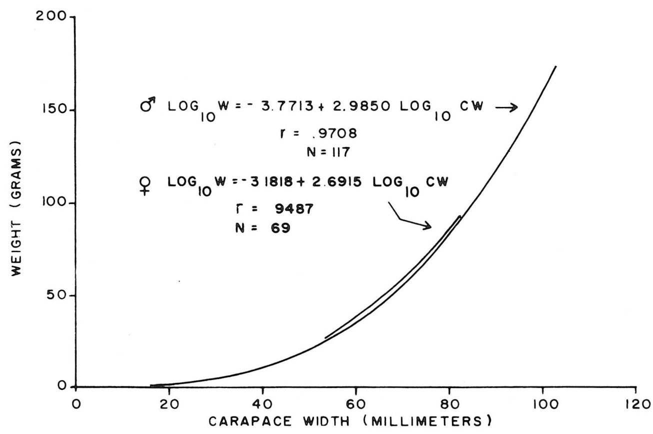

Figure 12. Carapace width-weight relationship for male and female rock crabs taken in western Long Island Sound.

had developing gonads, but many others in the same condition had mature gonads. When both gonadal development and the status of egg attachment were considered, it appeared that most of the females in these waters that were larger than about 60 millimeters were mature.

The relationship of carapace width to weight was derived for 116 male rock crabs ranging from 16 to 103 millimeters and for 69 females ranging from 53 to 82 millimeters. The equations, shown graphically in Figure 12, were

$$\text{Male:} \quad \log_{10} W = -3.7713 + 2.9850 \log_{10} CW$$
$$\text{Female:} \quad \log_{10} W = -3.1818 + 2.6915 \log_{10} CW$$

While the equation for males covers a wide range of sizes and that for females a rather restricted range, there appeared to be little difference between them.

There was no evidence of a molt during the period of sampling.

PALATABILITY

The people to whom crab claws were given for judging palatability all agreed that the meat was of fine flavor and texture. All felt that it was as good or better than that of the blue claw crab (*Callinectes sapidus*), the favored crab of commerce. However, most found cracking the claws and removing the meat quite difficult. In fact, several, including the junior author, felt that the amount of meat obtained was not worth the effort of removing it from the claws.

DISCUSSION

While the palatability of jonah crabs and rock crabs was looked upon favorably by those who were given claws to eat, the difficulties in cracking open the claws and the low meat yield (compared with that of blue claw crabs) would be problems in developing a market and fishery for them. Other problems concerning holding, marketing, consumer acceptance, ex-vessel prices and the general economics of developing such a fishery were reviewed by the Massachusetts Lobstermen's Association (undated) and Marchant and Holman (1975). Should the fishery be revived in New York, size would be an important factor.

The disparity in size between male and female rock crabs both off the south shore of Long Island and in western Long Island Sound was similar to that reported by Krouse (1972) for Maine waters and may be considered typical of the species. Since spatial distribution of rock crabs is determined by a variety of factors including crab size and sex, water depth, seasonal temperature, salinity, gravity, pressure, molting, migration etc. (Bigford, 1979; Haefner and Van Engel, 1975; Krouse, 1972), it is not surprising that there were gaps in the length-frequency distribution, fluctuating sex ratios and changing catch rates recorded, considering the few areas studied and the short sampling period. These factors probably were also responsible for the lack of female jonah crabs and the missing size groups of male jonah crabs in the catches sampled.

The data recorded indicate that all male jonah crabs may not be mature until they are about 100 millimeters in carapace width. While no female jonah crabs were caught, they probably mature at a smaller size than the males, as is the case among other crabs of the genus *Cancer*. With respect to the rock crab, the data indicate that both sexes are mature by the time they reach 70 millimeters. Thus, the minimum size of crabs that the former processor at Montauk felt would make his operation successful (i.e., about 90 millimeters in carapace width) would give an excellent measure of protection to New York's rock crab population but would be less effective for the jonah crab. As long as the two species remain at their present low level of exploitation, there seems to be no necessity for any regulations on harvesting them. But, should the degree of harvest require them, a size limit of 4 inches (about 102 millimeters) in carapace width for jonah crabs, and one of 3½ inches (about 89 millimeters) for rock crabs, would be appropriate. These size limits would assure that only mature crabs that had been able to reproduce would be taken.

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COMPARISON OF RED FOXES AND GRAY FOXES IN CENTRAL NEW YORK WITH RESPECT TO CERTAIN FEATURES OF BEHAVIOR, MOVEMENT AND MORTALITY[1]

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ABSTRACT

A total of 857 red foxes and gray foxes were captured, tagged and released on an area in central New York, of which 338 were later rehandled. In addition, data were recorded for 1,992 untagged foxes submitted from the same region by the cooperating public. Differences between the two species in the time of whelping, movement of both pups and adults, population age composition, survival and causes of mortality are discussed. Gray foxes were more seclusive, ranged less widely and had a slightly higher rate of survival, whereas red foxes had a higher rate of reproduction. The estimated ratio of 1.5 red foxes per gray fox in the population compared with a corresponding ratio of 10 to 1 reported for the same region in the 1950's. The role of disease is discussed.

From 1972 to 1977, a study of red foxes (*Vulpes fulva*) and gray foxes (*Urocyon cinereoargenteus*) was conducted on a 10-mile-square area in northcentral Cayuga County (N.Y.) during which 857 foxes were captured, tagged and released. Of these 338 were later rehandled, and 1,992 untagged specimens collected through public cooperation were examined.[2] The study area and the methods used for gathering data were described by Tullar and Berchielli (1980). This paper compares the two species with respect to certain aspects of behavior, movement and population dynamics. In general, the discussion follows a seasonal progression.

Differences in the denning habits of the two species were evidenced by the relative effectiveness of den digging as a means of capturing foxes, especially pups. During the study, 255 red fox pups and nine adults were captured by den digging, compared with only two gray fox pups and one

[1]The authors depended heavily upon the good will and cooperation of most of the landowners in the Towns of Brutus, Cato, Conquest, Mentz, Sennett and Throop in Cayuga County. Many trappers, hunters and fur dealers in Cayuga, Onondaga, Oswego, Seneca and Wayne Counties provided information about tagged foxes at their own expense. Environmental Conservation Officers E.M. Lamphere, M.L. Mobbs, W. Hasenjager, G.K. Viele and C.M. Gay also provided support. Special thanks are due Ernest Saggese (deceased), S. Van Wie, C. Barrett, D. Stalnaker, A. Martel, H. Parish and E. Davies who live trapped and tagged foxes on the study area and also collected most of the specimens obtained from fur trappers and hunters. E.J. Parks and G.H. Teidman helped plan the study and choose the study area. J. Proud, R. Loveless (deceased) and D. Smith cooperated in providing the Howland Island Wildlife Management Area as a base of operations.

[2]This paper includes data recorded through December 1980. Differences between figures given here and comparable figures in previous papers on this study by these authors represent additional records obtained during the interim.

adult. For both species, most dens were located by finding signs of pup activity. Red foxes were whelped in March and usually emerged from their dens in early April before the leaves of trees and shrubs had opened and while the grass was still short. Under these conditions, the activity of the pups was evident and made the dens easy to locate. In contrast, gray fox pups were whelped in April and emerged from their dens in late May when the leaves had opened and the grass was long, making the task of finding them virtually hopeless. The only conspicuous feature associated with occupied gray fox dens, as observed in this study, was mats of droppings (presumably puppy) within several yards of the burrows. Such "latrines", which were also noted by Trapp and Hallberg (1975) who studied foxes in California, may be an aid in future research involving the capture of small pups of this species.

For both species, the number taken by den digging was considerably less than the number taken by trapping[3]. This was partly because the best trapping period (June to early October) extended for more than 16 weeks while the optimal period for den digging was less than 8 weeks for red foxes and unknown for gray foxes. The numbers trapped, 420 red foxes and 219 gray foxes, are summarized in Table 1.

TABLE 1. NUMBER OF RED FOXES AND GRAY FOXES TAKEN BY LIVE TRAPPING ON THE STUDY AREA FROM 1972 TO 1977 AND PROPORTION THAT WERE PUPS, ACCORDING TO MONTH§

	Red fox				Gray fox			
		Pup				Pup		
Month	Adult	Number	Per cent	Total	Adult	Number	Per cent	Total
June	5	14	74	19	8	3	27	11
July	35	149	81**	184	27	13	33**	40
August	30	132	81**	162	33	40	55**	73
September	10	32	76*	42	29	32	52*	61
October	3	10	77	13	15	19	56	34
Total	83	337	80**	420	112	107	49**	219

§Includes all foxes taken by live trapping (whether for the first time or retrapped) except pups retrapped during the same summer they were initially tagged.
*Difference between species was significant ($P < 0.05$).
**Difference between species was highly significant ($P < 0.01$).

For the animals trapped, the proportion of pups among the red foxes (80 per cent) was significantly higher than that among the gray foxes (49 per cent). For the gray foxes, this proportion did not reach 50 per cent until August when the largest number of this species was caught. The differences in age ratio are believed to have been attributable to differences in the behavior of the two species. The greatest disparity occurred in June and July when red fox pups were dispersing from their dens while most of the gray fox pups seemed to have been more restricted and less vulnerable

[3]This relates to trapping for study purposes and not to trapping for fur.

TABLE 2. DISTANCE MOVED BY TAGGED RED FOXES AND GRAY FOXES REHANDLED AFTER FOLLOWING OCTOBER 1, ACCORDING TO AGE AND SEX

	Red fox			Gray fox		
		Distance moved (miles)			Distance moved (miles)	
Age and sex	Number	Range	Mean	Number	Range	Mean
Juvenile						
Male	88	0.2 - 56.0	7.6*	11	0.0 - 20.3	8.8*
Female	74	0.0 - 38.0	3.6*	8	0.2 - 13.6	4.4*
Adult						
Male	10	0.1 - 11.0	2.0	9	0.0 - 3.2	1.3
Female	19	0.1 - 2.5	0.9	4	0.6 - 2.0	1.3

*For each species the mean distance moved by juvenile males was significantly greater ($P < 0.05$) than that for juvenile females, but differences between species were not significant.

TABLE 3. DISPERSAL OF TAGGED RED FOX AND GRAY FOX PUPS RECOVERED AFTER FOLLOWING OCTOBER 1

		Miles from where tagged*					
Sex	Number recovered	0.0-1.5	1.6-4.9	5.0-9.9	10-14.9	15 or more	Dispersal§
		Red fox					
Male	88	28 (32)	15 (17)	20 (23)	15 (17)	10 (11)	50 (68)
Female	74	40 (54)	17 (23)	10 (14)	4 (5)	3 (4)	34 (50)
Total	162	68 (42)	32 (20)	30 (18)	19 (12)	13 (8)	94 (58)
		Gray fox					
Male	11	3 (27)	1 (10)	3 (27)	2 (18)	2 (18)	8 (73)
Female	8	3 (38)	3 (38)	. .	2 (24)	. .	5 (63)
Total	19	6 (32)	4 (21)	3 (16)	4 (21)	2 (10)	13 (68)

*Figures in parentheses represent percentages.
§Defined as a movement of 1.6 miles or more from the point where the animal was tagged.

to trapping. Adult red foxes appeared to virtually abandon their pups in June and range extensively, while gray fox families seemed to remain together throughout the summer.

Despite the earlier dispersal of red foxes from the den site, average subsequent movement by the two species did not differ greatly (Table 2). For both species, juveniles moved much farther than adults, and movement by juvenile males was significantly greater than that by juvenile females. Although there was no opportunity in this study to compare day-to-day movement patterns, the authors felt that those of the two species differed considerably. Based on data from Wisconsin, Richards and Hine (1953) suggested that gray foxes have smaller home ranges than red foxes.

It was possible that a greater proportion of the gray foxes than of the red foxes had travelled far enough away from the study area to have a low likelihood of being recaptured. The data for tagged foxes recovered after October 1 following the date they were tagged are summarized in Table 3 according to the distance they had moved from the original point of capture. Differences were not significant, indicating that the degree of dispersal[4] from their natal range during the fall and winter, as well as the distance travelled, tended to be similar for the two species despite probable differences in day-to-day movement patterns.

TABLE 4. SURVIVAL OF RED FOXES AND GRAY FOXES AS INDICATED BY RECOVERY OF TAGGED INDIVIDUALS§

Age and species	Number of foxes tagged†	Foxes recovered: Total		After at least 1 year‡		After at least 2 years‡	
		Number	Per cent	Number	Per cent	Number	Per cent
Pup							
Red fox	362	145	40**	37	26	12	8*
Gray fox	105	21	20**	7	33	5	24*
Adult							
Red fox	80	27	34**	8	30	0	0
Gray fox	116	18	16**	7	39	3	17

§Includes foxes trapped and tagged both on and in the vicinity of the study area.
†Includes only foxes tagged during the period from June to October each year.
‡Each year was considered to end on the anniversary of the date on which the fox had originally been trapped and tagged. This differs from treatment by Tullar and Berchielli (1980) where calendar years were used.
*Difference between the two species was significant ($P < 0.05$).
**For each age group, difference between the two species was highly significant ($P < 0.01$).

Retrapping of tagged foxes afforded information on survival (Table 4). Because of their late emergence from their dens, few gray fox pups were tagged prior to June, and data on the survival of red foxes tagged during that period would not have been comparable. Therefore, only records for red fox pups tagged in June or after were used for this purpose. For both pups and adults, the proportion of the red foxes that were retrapped was twice that of the gray foxes, suggesting that mortality or tag loss was higher among the gray foxes. However, considering only the animals that were retrapped, both the proportion that had survived at least 1 year and the proportion that had survived at least 2 years were considerably higher for the gray fox. Therefore, gray foxes may be more seclusive and less vulnerable to trapping than red foxes.

Data on the age composition of populations of the two species were obtained from foxes taken primarily by fur trappers and hunters during the fall and winter when there is the least bias in collecting. They are summarized in Table 5. The proportion of juveniles was significantly larger among the red foxes than among the gray foxes, suggesting that the red fox had a higher rate of reproduction or pup survival or both. From examination of specimens collected chiefly in central and southern New York, Layne and McKeon (1956) recorded placental scar counts of 5.4 and 4.4 for female red foxes and gray foxes, respectively. Richards and Hine (1953)

[4]Defined as a movement of 1.6 miles or more from the point where the animal was tagged.

TABLE 5. AGE COMPOSITION OF RED FOX AND GRAY FOX POPULATIONS, AND ESTIMATED ANNUAL MORTALITY, BASED ON ANIMALS TAKEN DURING THE FALL AND WINTER BY FUR TRAPPERS AND HUNTERS

Age§ (years)	Red fox			Gray fox		
	Foxes trapped†		Annual mortality (per cent)	Foxes trapped‡		Annual mortality (per cent)
	Number	Per cent		Number	Per cent	
Under 1	769	69.3*	69	386	61.5*	62
1	180	16.2	53	102	16.2	42
2	86	7.7	53	70	11.1	50
3	49	4.4	65	40	6.4	57
4	12	1.1	46	16	2.5	53
5	7	0.6	50	3	0.5	21
6	4	0.4	57	3	0.5	27
7	2	0.2	67	2	0.3	25
8	0	0.0	. .	3	0.5	50
9	0	0.0	. .	1	0.2	33
10	1	0.1	100	2	0.3	100

§Determined from tooth sections by methods described by Monson et al. (1972).

†Comprises 112 tagged and 998 untagged red foxes. In addition, 97 untagged animals of unknown age were taken.

‡Comprises 19 tagged and 609 untagged gray foxes. In addition, 157 untagged animals of unknown age were taken.

*Difference between the species was significant ($P < 0.05$).

TABLE 6. SPECIMENS ATTRIBUTABLE TO DIFFERENT CAUSES OF DEATH FOR TAGGED FOXES RECOVERED DURING THE STUDY

Cause of death	Red fox		Gray fox	
	Number	Per cent	Number	Per cent
Trapping (for fur)	100	50	17	52
Shooting§	50	25	6	18
Highway accident	30	15	3	9
Miscellaneous†	19	10*	7	21*
Total	199	100	33	100

§Includes moribund foxes that may have been destroyed by shooting.

†Includes foxes found dead or killed by dogs, and moribund foxes clubbed by people.

*Difference between species was significant ($P < 0.05$).

reported placental scar counts of 5.1 and 3.9, respectively, for red foxes and gray foxes taken in Wisconsin. The age composition of the samples collected in the present study indicate relatively high reproductive rates and a population turn-over period of about 5 years for both species. However, the proportion of the gray fox sample that were more than 3 years old (4.8 per cent) was significantly ($P < 0.01$) higher than the corresponding proportion (2.4 per cent) of the red fox sample. This supports the data in Table 4 that indicate a slightly but significantly greater survival among gray fox pups.

The causes of death for 232 tagged foxes recovered in the present study are summarized in Table 6. Trapping was the principal cause for both species and accounted for virtually the same percentage. The proportions attributable to shooting and highway accidents were slightly lower for gray foxes, suggesting that their elusiveness and generally smaller home ranges make them less likely to be seen by people and that they travel less than red foxes.

For these tagged animals, the proportion lost to miscellaneous causes was significantly greater for gray foxes than red foxes. This was not expected because, for all the red foxes examined as reported by Tullar and Berchielli (1981), 17 per cent had sarcoptic mange to which they would have succumbed had they not been killed in some other way first. Although the sample of gray foxes was small, circumstances suggested that canine distemper may have been involved. One, an adult, had been killed by a dog, an unlikely death for a healthy fox of either species. The other six were simply found dead, in good flesh, with no evidence of trauma or other contributing factor, and two of them were found to have suffered from distemper. There was no evidence of rabies in either species.

Data on the relative importance of different causes of death were also afforded by records for 1,992 untagged foxes examined from central New York during the same period (Table 7). For both red foxes and gray foxes,

TABLE 7. SPECIMENS ATTRIBUTABLE TO DIFFERENT CAUSES OF DEATH FOR UNTAGGED FOXES EXAMINED DURING THE STUDY

Cause of death	Red fox Number	Red fox Per cent	Gray fox Number	Gray fox Per cent	Total	Ratio†
Trapping (for fur)	894	74*	617	79*	1,511	1.4
Shooting	186	15**	54	7**	240	3.4
Highway accident	89	7	88	11	177	1.0
Dog	7	1	2	tr	9	3.5
Miscellaneous	31	3	24	3	55	1.3

§Totals for each species are higher than those in Table 5 because they include animals for which age could not be determined.

†Red foxes per gray fox.

*Difference between species was significant ($P < .05$).

**Difference between species was highly significant ($P < 0.01$).

more than 70 per cent of the specimens had been trapped. However, the proportion for gray foxes was significantly greater than that for red foxes. For shooting, the disparity was reversed, and the difference was also significant. Differences for other causes of death were not significant. That the proportion attributable to miscellaneous causes, with respect to both species, was much higher for the tagged than the untagged foxes suggests that the presence of a tag may often have prompted the reporting of an animal that would not otherwise have been reported.

Of particular interest is the presence of sarcoptic mange in red foxes and of canine distemper in gray foxes. Mange probably kills all infected red foxes, but it has little effect on gray foxes. Also it is easily identified in the field. On the other hand, distemper is often fatal to gray foxes, but it can be identified only in the laboratory with fresh material from unfrozen specimens. If most of the dead gray foxes attributed to miscellaneous causes did in fact succumb to distemper, then mortality from disease would have been similar for the two species. Neither disease distorts the age composition of the fox population because adults appear to have no more resistance than pups.

Both diseases are dog maladies that also affect other wild carnivores that share the same habitat with foxes. However, foxes (of both species) may be the most seriously affected and, if so, would suffer the greatest loss during outbreaks or epizootics. It seems probable that the spread of both sarcoptic mange and canine distemper among foxes usually depends on the density of the aggregate population of susceptible carnivores. For this reason and because foxes of both species are prone to feed on moribund or freshly dead animals, the incidence of these diseases is not necessarily related directly to the actual density of the fox population. In any case, disease may be the major factor governing the abundance of red foxes and gray foxes in central New York.

The ratio of red foxes per gray fox for specimens attributable to the various causes of death is also given in Table 7. In all cases, red foxes equalled or outnumbered gray foxes. The markedly lower proportion of gray foxes among the animals that had been shot indicates that this species is truly less vulnerable to hunting than the red fox. The over-all ratio of 1.4 red foxes per gray fox seems to have been the least biased estimate of the relative abundance of the two species and indicates that the proportion of gray foxes in the total fox population in central New York had increased substantially since the 1950's when Layne and McKeon (1956) reported a ratio of 10 red foxes per gray fox among those they examined.

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LONGEVITY, GROWTH AND MORTALITY OF MUSKELLUNGE IN CHAUTAUQUA LAKE, NEW YORK[1]

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ABSTRACT

Growth and mortality rates of muskellunge in Chautauqua Lake were estimated from data collected during spring netting of broodstock from 1962 to 1977. Females grew faster and had a higher survival than males. Females usually reached reproductive maturity in their fifth spring at a mean length of 77 centimeters. Most males matured by age 4 at a mean length of 67 centimeters. Growth differences between hatchery and native stocks were not significant. Mean condition factors (K) for spawning fish were 0.641 for females and 0.584 for males. Adult muskellunge exhibited a length-weight relationship of $\log W = -6.70 + 3.51 \log TL$. Pooled data from seven year classes (1961-1967) indicated survival rates of 0.85 and 0.69 for females and males, respectively.

Muskellunge (*Esox masquinongy*) are the most important sport-fishing resource in Chautauqua Lake, New York. Horn (1978) estimated that in 1975 muskellunge anglers contributed 3.2 million dollars to the economy within the watershed. Sales of the special muskellunge fishing license, required in a two-county area of western New York since 1941, have averaged 14,000 annually (1941-1977). The Chautauqua muskellunge fishery has been a focus of management by the State Department of Environmental Conservation. Their data are extensive, but there are few published analyses concerning the biology of this population, and recent declines in the catch have prompted speculation regarding its status (Bimber, 1978; Bimber and Nicholson, 1981). Analyses of data collected from 1962 to 1977 afford estimates of growth and mortality which are important factors in evaluating this fishery.

Chautauqua Lake is located in southwestern New York and is part of the Ohio River drainage. The 5,325-hectare lake is 27.9 kilometers long and from 1.6 to 3.5 kilometers wide, and it has a mean depth of 5.7 meters (Mayer et al., 1978). A stable lakewide thermocline does not develop, and oxygen concentrations approach saturation in most areas. Chautauqua Lake suffers from the effects of "cultural eutrophication" including watershed development, increasing nutrient inputs, aquatic "weed" management programs and shifting ichthyofaunal associations (Bimber, 1978).

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Aquatic macrophytes are abundant. Over 50 species of fish inhabit the lake. Major game fish, in addition to muskellunge, are walleye, bullhead and a variety of centrarchids.

METHODS

Most age and length data were collected during the annual netting of broodstock by personnel from the State muskellunge hatchery at Prendergast Point and administrative Region 9. As many as 19 trap nets and pound nets have been fished each spring at various locations around the lake since the late 1880's (Bimber, 1978). At the time of this study, five or six nets were operated during the spawning season. In addition to taking muskellunge spawn, total length and sex were also recorded for the fish netted. The fin clipping and recapture of hatchery fingerlings stocked in the lake since the early 1960's provided a substantial body of data for known-age fish upon which age, growth and mortality studies were based. During spring netting in 1976 and 1977, weights were taken and scales were collected.

For back-calculating growth, scales from 136 adult fish were taken from an area midway between the anterior insertion of the dorsal fin and the lateral line. The scales were cleaned and mounted, and distances to the annuli were measured on an enlarged scale image. The scale length-body length relationship was determined graphically by averaging five scale lengths and plotting them against the total length for each fish. Back-calculated estimates of growth were based on the assumption that the growth of the scale and growth of the fish are proportional as expressed by the equation

$$L_n = C + S_n/S\,(1 - C)$$

where

L_n = calculated length of fish when annulus n was formed
L = length of fish when measured
S_n = scale radius to annulus n
S = total scale radius
C = correction factor derived from the scale length-body length relationship

Muskellunge of age 6 or less were used in this part of the study to minimize errors resulting from analyzing the sometimes confusing scale patterns of older fish.

Annuli were determined by alterations in the spacing of circuli on the anterior scale field and anastomosis (cutting over) of the circuli in the lateral fields. Growth rates were determined separately for ages 1 to 3 (by back-calculation) and ages 4 to 15 (from empirical date for 1962-1976).

Mean annual growth rates (h of Ricker, 1975) were determined for each age period. Condition factors were computed using the equation

$$K = W \times 10^5/L^3$$

where

K = condition factor
W = weight in grams
L = length in millimeters

Catch curves were constructed from the age composition among the adults as recorded during broodstock netting. Mortality was estimated from the catch curves using methods described by Beverton and Holt (1956) and Ricker (1975), and was determined independently for males and females.

RESULTS

Back-calculated lengths (Table 1) were used to define the growth of muskellunge prior to their entry into the breeding population. A close correspondence of these lengths with empirical data was indicated. A correction factor of 16.2 centimeters was obtained from the least-squares regression ($y = 18.4 + 0.11x$) in which y represents total body length and x total scale length. Harrison and Hadley (1979) used a correction factor of 17.05 centimeters for muskellunge in the Niagara River.

Most males reached reproductive maturity by their fourth spring at a mean length of 67 centimeters. A few matured as early as age 3 or as late as

TABLE 1. MEAN TOTAL LENGTH OF FIN-CLIPPED MUSKELLUNGE FROM CHAUTAUQUA LAKE, ACCORDING TO AGE AND SEX*

Age (years)	Male		Female	
	Number	Mean total length (centimeters ± standard deviation)	Number	Mean total length (centimeters ± standard deviation)
1	50	34.6 ± 4.9	30	34.4 ± 3.7
2	50	47.8 ± 5.6	30	49.8 ± 4.1
3	50	59.1 ± 5.4	30	62.6 ± 4.6
4	1,196	67.4 ± 4.0	82	73.4 ± 3.5
5	1,305	71.8 ± 4.1	406	77.1 ± 4.5
6	820	74.4 ± 4.2	155	79.6 ± 5.4
7	691	76.8 ± 4.7	158	79.0 ± 5.8
8	330	77.7 ± 4.8	70	86.9 ± 8.2
9	220	79.7 ± 6.1	47	94.2 ± 11.0
10	206	79.7 ± 6.1	56	92.0 ± 12.2
11	106	85.1 ± 5.0	55	93.1 ± 9.9
12	46	84.9 ± 4.6	28	97.1 ± 10.4
13	7	89.8 ± 6.1	28	99.0 ± 8.2
14	4	89.2 ± 6.1	8	109.6 ± 7.7
15	2	93.4 ± 3.7	7	109.2 ± 9.4

*Lengths for ages 1-3 were derived by back-calculation from scales collected in April 1976; those for ages 4-15 were derived from empirical data collected during spring netting operations from 1962 to 1976.

TABLE 2. MEAN TOTAL LENGTH AND WEIGHT OF FIN-CLIPPED MUSKELLUNGE FROM CHAUTAUQUA LAKE IN APRIL 1976, ACCORDING TO AGE AND SEX

Age (years)	Male		Female	
	Number	Mean ± standard deviation	Number	Mean ± standard deviation
	Total length (centimeters)			
4	39	69.5 ± 3.2	5	73.5 ± 2.6
5	41	72.1 ± 4.7	47	79.4 ± 4.1
6	6	78.2 ± 2.8	3	86.8 ± 3.9
7	30	78.9 ± 4.9	10	87.4 ± 7.3
8	6	80.3 ± 6.9	2	89.2 ± 6.7
9	9	81.3 ± 4.6	5	99.7 ± 6.8
10	2	78.4 ± 3.1	4	95.9 ± 8.2
12	2	85.7 ± 2.7	2	102.9 ± 9.0
13	2	85.7 ± 0.9	2	105.4
14	0	. .	3	109.7 ± 9.2
15	1	97.8	0	. .
	Weight (kilograms)			
4	39	1.90 ± 0.30	5	2.54 ± 0.34
5	41	2.16 ± 0.61	47	3.04 ± 0.56
6	6	2.59 ± 0.38	3	4.12 ± 0.33
7	30	3.13 ± 0.68	10	4.22 ± 0.93
8	6	3.29 ± 1.16	2	4.20 ± 1.12
9	9	3.20 ± 0.59	5	6.62 ± 1.63
10	2	2.89 ± 0.56	4	6.15 ± 2.17
12	2	4.08 ± 0.16	2	7.94 ± 1.76
13	2	3.92 ± 0.86	2	7.88 ± 0.08
14	0	. .	3	11.08 ± 3.22
15	1	5.78	0	. .

age 5. Females generally reached reproductive maturity a year later than males at a mean length of 77 centimeters. Growth of muskellunge differed between the sexes, females attaining greater lengths and weights than males of the same age (Tables 1 and 2). Although not distinctive until the age of 4 or 5, increased growth of females usually appeared by age 2. Both sexes evidenced rapid growth until age 4 or 5 when a general decrease in the annual increment occurred.

Muskellunge growth was divided into two periods. Linear regression analysis indicated that growth rates of both sexes did not differ between ages 1 and 3 (Figure 1). Mean annual growth rates (h) for this period were 141 millimeters for females and 123 millimeters for males. After age 3 the differences were statistically significant ($P < 0.01$). Length and weight increments for this group were 33 millimeters and 744 grams for females and 21 millimeters and 285 grams for males. Growth potential, defined as the theoretical maximum attainable length, was estimated using a Walford line (Walford, 1946). This value for muskellunge in Chautauqua Lake was 154 centimeters for females and 110 centimeters for males.

Length and weight data were divided into four subgroups, i.e., fish of hatchery and of nonhatchery origin for each sex. Analysis of covariance revealed no significant differences ($P > 0.05$) in the length-weight rela-

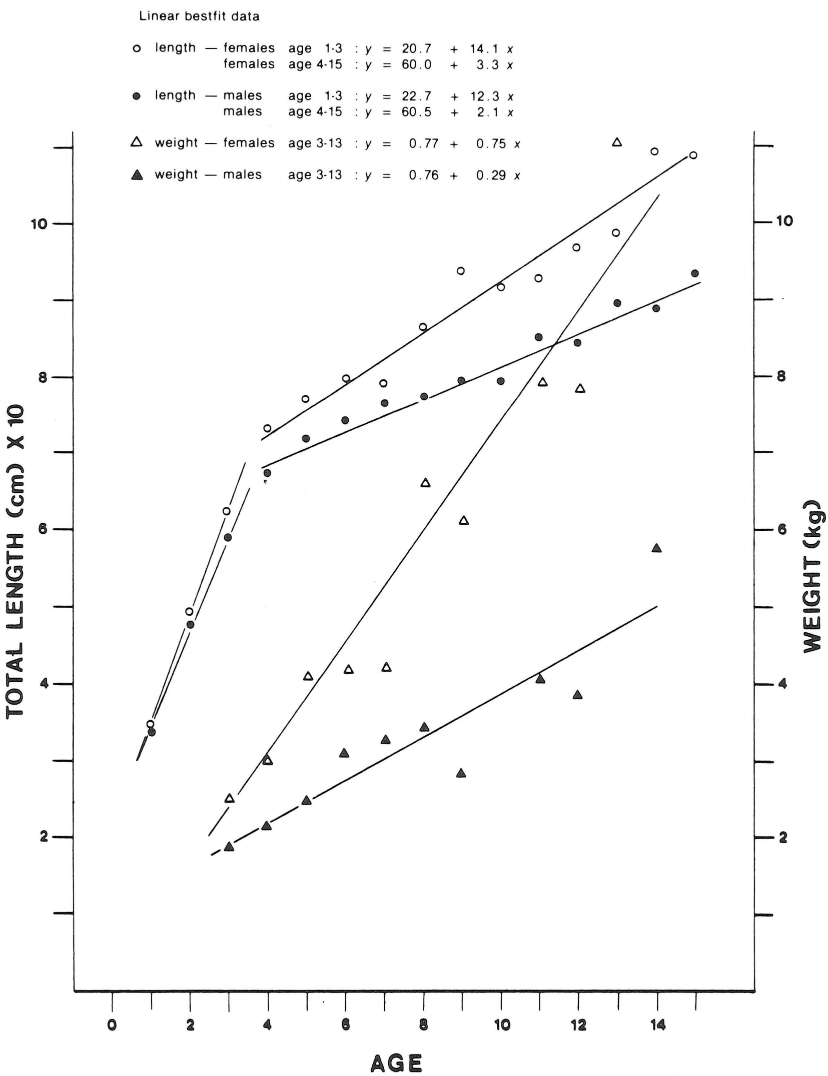

Figure 1. Growth rates of muskellunge in Chautauqua Lake, New York.

tionship among these subgroups. Consequently the data were pooled to obtain the logarithmic relation

$$\log W = -6.70 + 3.51 \log TL \ (r = +0.98)$$

where

W = weight in grams

TL = total length in millimeters

The length-weight relationship for 550 young-of-the-year hatchery muskellunge, ages 1 to 92 days, was

$$\log W = -5.5 + 3.03 \log TL \ (r = +0.998)$$

At 1, 8, 21, 43, 64 and 92 days after hatching, hatchery muskellunge averaged 9.3, 12.5, 16.3, 38.1, 65.1 and 126.9 millimeters in total length, respectively. Condition factors (K) for muskellunge captured during April 1975 ranged from 0.398 to 0.809 with a mean of 0.601 ± 0.080 (standard deviation). The mean condition factor for females (0.641 ± 0.078) was greater than that for males (0.584 ± 0.067).

Pooled data for age composition during the period from 1967 to 1977 gave survival rates ($S = e^{-Z}$) of 0.63, 0.73 and 0.59 for males, females and both sexes combined, respectively, (Table 3). Sex-specific survival

TABLE 3. ESTIMATES OF MUSKELLUNGE SURVIVAL IN CHAUTAUQUA LAKE

Basis	Sex	Instantaneous mortality rate (Z)	Survival rate (e^{-Z})
Age composition*	Male	0.464	0.629
	Female	0.316	0.729
	Combined	0.522	0.594
Year class§	Male	0.374	0.688
	Female	0.168	0.846
	Combined	0.403	0.668

*Derived from pooled data for years 1966 to 1977.
§Derived from data for stocked fish from hatchery year classes of 1961 to 1967 that were followed through the fishery until 1977.

rates are probably the more representative of mortality since Z may be biased when data from both sexes are combined.[3] Females mature and enter the broodstock later than males, and their delayed addition to the catch curve may shift its peak, yielding an unrepresentative mortality estimate. Data from an 11-year period (1967-1977) suggest that females had higher survival rates than males. Pooled data for seven year classes (1961-1967) indicate that males, females and both sexes combined had survival rates of 0.69, 0.85 and 0.67, respectively (Table 3). Catch-curve estimates of mortality derived from the age composition of the population during the 1960's and 1970's were distinct for adult muskellunge stocked as fin-clipped fingerlings. Similar survival estimates from tagging and fin-clip studies for both hatchery and native fish suggest that there was little difference among the groups and that both marking methods had little (or at least equal) influence on survival (Bimber, 1978). Mortality and survival of muskellunge as reported for other waters were similar to the findings for

[3]The Z-value represents the instantaneous mortality rate or the negative of the slope of the catch curve.

the Chautauqua Lake population, e.g., survival rates of 0.76 (Gammon and Hasler, 1965) and 0.8 (Schmitz and Hetfield, 1965), survival of 30 per cent (Muir, 1963) and total mortality of 70 per cent (Crossman, 1956) and 43.5 per cent (Spangler, 1968).

DISCUSSION

Muskellunge in Chautauqua Lake frequently attain ages of 10-15 years and older specimens (30 +) have been reported (Mooradian and Shepherd, 1973). Data from over 6,200 muskellunge examined from 1962 to 1976 indicate substantial variation in growth, a probable result of variable environmental conditions and density-dependent factors. In most age groups, females exhibit greater growth and lower mortality than males. These differences are accentuated after reproductive maturity is reached at age 5 (mean length 77 centimeters) for females and age 4 (mean length 67 centimeters) for males. Sexually dimorphic growth and mortality and indications of the density-related nature of these parameters (Bimber, 1978) suggest that a more detailed examination of these factors is desirable. Recent catch and population declines reflect instability in this population and have led to a revision of catch regulations. From 1941 to 1969, 30 per cent of the spawning female stock was protected by regulation, but from 1970 to 1977 this decreased to 11 per cent. In 1980 the minimum length for legally taken fish was raised from 30 to 32 inches (76.2 to 81.3 centimeters), which increased somewhat the protection of female spawners. However, since the ratio of males per female is proportional to population density, an increase in population numbers will be primarily the result of a disproportionate increase in the numbers of males (Bimber, 1978). Because of their slower growth, males (under the present regulations) will not reach legally catchable size until their ninth or tenth year (Table 1) and would represent a substantial loss to the fishery if a population increase should occur. Therefore, regulations should be flexible and linked to estimates of a number of population parameters in addition to the angler catch which is a potentially biased source of information concerning this fishery (Bimber and Nicholson, 1981). Length limits should reflect changes in these variables (population density and composition, growth and mortality) and their interactions in order to maximize the harvest while minimizing the possibility of overexploitation.

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RELATION OF MANDIBLE LENGTH TO AGE AND ITS RELIABILITY AS A CRITERION OF SEX IN WHITE-TAILED DEER[1]

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ABSTRACT

Three separate mandible length measurements were taken from the jaws of 98 white-tailed deer for which the age and sex were known. For all three measurements, the mean for males was significantly greater than that for females. Also, the means for yearlings were lower than those for older deer, but there was no significant difference between those for deer 2½ years old and deer older than that. Comparison of yearlings and adults (2½ years old and older) showed that, although the mean values for males were significantly greater than those for females in each group, the actual distributions of the two sexes overlapped substantially in each case. Only jaws with the longest or shortest measurements could be assigned a sex with at least a 90 per cent probability that it would be correct. It was concluded that none of the mandible measurements evaluated would be a reliable criterion of sex for deer in New York.

One method that has been used to obtain information concerning white-tailed deer (*Odocoileus virginianus*) in New York is to ask successful hunters to mail to the Department one half of the lower jaw of deer taken. In some cases jaws from antlerless deer only have been requested, in others jaws from any deer taken together with a record of the sex. The validity of relationships derived from such material depends to a large extent on the degree to which the jaws sent in represent the population category specified, or to which the sex as reported by the hunter is correct. Severinghaus (1957) found that many hunters did not accurately report either the sex or the age (adult or fawn) of deer they killed, but the magnitude of such errors in New York is unknown. If some characteristic of the jaw of a deer differed consistently between males and females, the sex of specimens could be determined independently by the investigator and more accurate data would result. Such a means of differentiation would also be useful with respect to records of highly scavenged carcasses encountered during dead-deer surveys, as well as in connection with some law enforcement cases.

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Bergerud (1964) found the length of the mandible (i.e., lower jaw) to be related to sex and age in caribou (*Rangifer tarandus*) in Newfoundland. Sauer (1976) indicated that mandible length was sexually dimorphic in white-tailed deer but recommended further evaluation with larger samples. Therefore, the length of the lower jawbone was chosen for the present study.

METHODS AND MATERIALS

Only mandibles from deer of known age and sex were used. They were selected from the Department's collection of jaws from deer that had been trapped and ear tagged as fawns with tags that provided for a reward for return of the jaw upon recovery of the deer through hunting or other mortality. Specimens considered atypical or for which data were faulty were excluded. Also, since mail surveys are primarily made to obtain data for age groups older than fawns, only mandibles from yearling or older deer were used. A total of 98 were measured for study.

Three separate measurements were made of each mandible (Figure 1). References to teeth conform to the standard dentition terminology as given by Riney (1951).

1. From the most anterior point of the dentary bone, excluding teeth, to the posterior angle of the ramus. This measurement was used by Bergerud (1964) to separate male and female caribou. Since many jaws are chipped or broken at the anterior end of the dentary bone either at the time of death of the deer or during subsequent handling and storage, the most anterior point of this bone is at times difficult to determine exactly.

2. From the posterior angle of the ramus to the most lateral point of the alveolar margin of the canine socket. This measurement was used by Rees (1969) for white-tailed deer. Since little if any bone damage due to killing or handling the deer occurs near the canine socket, it is more objective and easier to replicate than that of Bergerud.

3. From the posterior angle of the ramus to the most anterior point of the alveolar margin of the socket of the second premolar. By subtracting this from Measurement 2, the diastema length (Bergerud, 1964), i.e., the distance between the most lateral point of the margin of the canine socket and the most anterior point of the alveolar margin of the socket of the second premolar, was calculated. The latter was used as the third measurement in the analyses.

A plastic measuring device consisting of a base and two end blocks at right angles to it (Figure 2) was constructed to simplify procedures. Jaws were placed against one end and, with the aid of a drafting triangle, the measurements were read to the nearest millimeter on a scale bonded to the base. For each measurement, three replicates were made and the arithmetic mean was calculated.

To determine the relationship of mandible length to age, two-way analyses of variance were performed on each of the three sets of measurements. Because there were few specimens for ages 3½ years and older, these were grouped together for this phase of the study. Thus, for each sex, three age groups (1½ years, 2½ years, and 3½ years and older) were used. The numbers in these groups were unequal and not appropriately proportional for a straightforward two-way, unequal-sample-size, analysis.

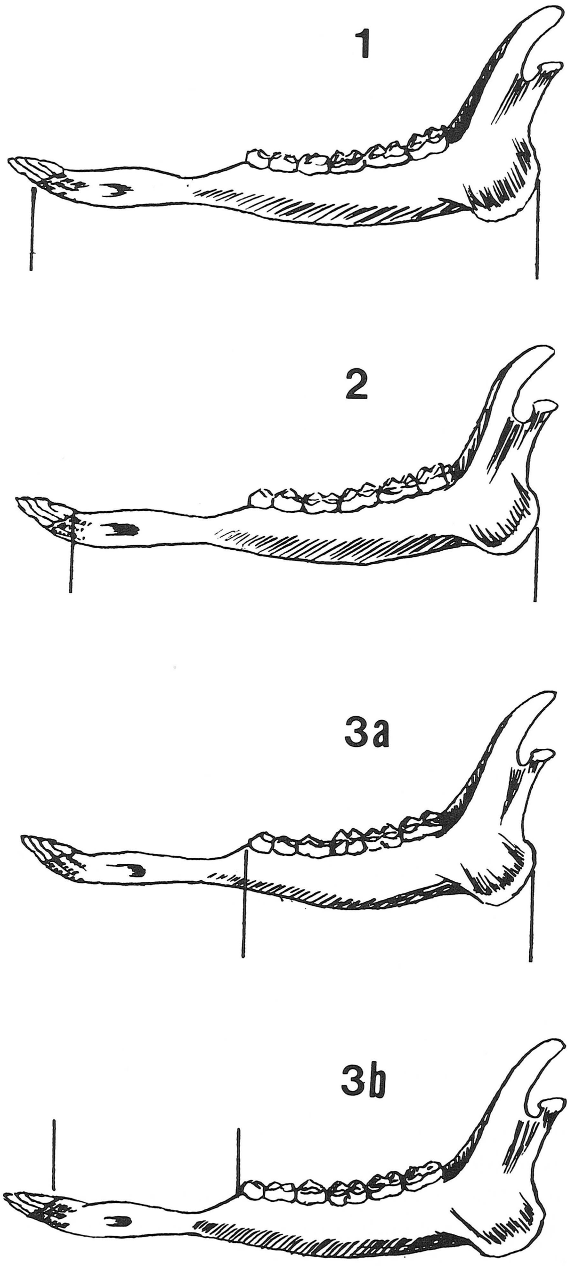

Figure 1. Measurements used to assess relationship of mandible length to age and sex of deer: (1) mandible length after Bergerud (1964); (2) mandible length after Rees (1969); (3a) length of mandible from second premolar to angle of ramus; (3b) diastema length.

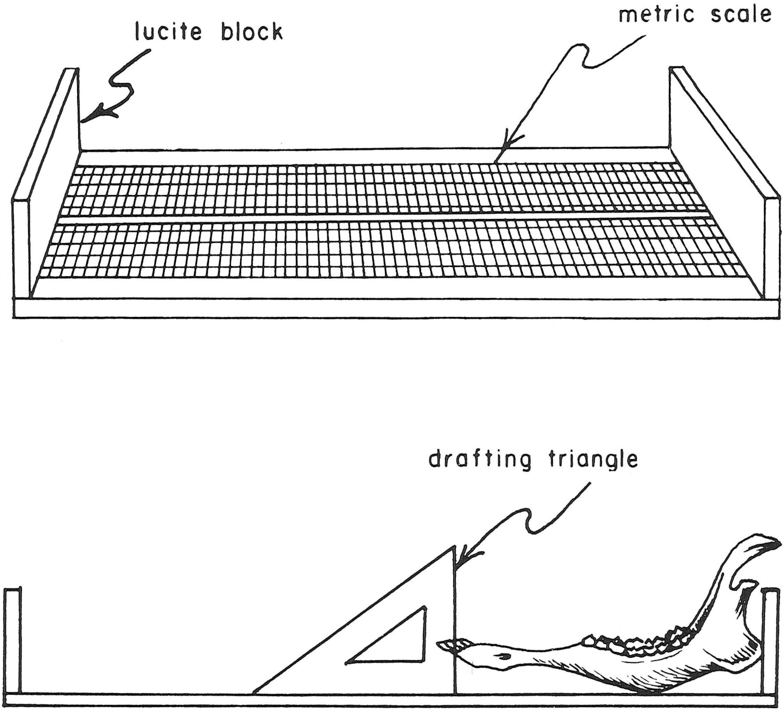

Figure 2. Mandible-measuring device and manner in which measurements were taken.

Therefore, in order to test for age and sex differences, either a more complex, unequal-number, analysis or a subsampling procedure had to be employed. The latter was chosen because it allows more direct tests on specific differences between means than do the usual unequal-number procedures. In addition, the reduction in power resulting from the smaller sample requires that differences in mandible length be greater in order to be statistically significant. This is an advantage since small differences, even though statistically significant, may not be as useful for determining sex. Accordingly, subsamples of five were drawn from each group.

Subsequent analyses of differences between age groups were done by the least significant difference procedure (Steele and Torrie, 1960) using the mean values for the subsamples. Tests for differences between sexes in each group were made by orthogonal contrasts (Steele and Torrie, 1960). Based on the findings of Bergerud (1964) and Sauer (1976), the hypotheses to be evaluated in these tests were: (1) mandible length increases with the age of the deer; and (2) within an age group, mandible length is greater in male than in female deer.

All references to a significant difference represent the 95 per cent level of probability.

RESULTS AND DISCUSSION

The jaws used for this study are summarized by age and sex in Table 1, and the two-way analyses of variance for the means of the three measurements evaluated are shown in Table 2. For each measurement, the

TABLE 1. NUMBER OF JAWS FROM DEER OF KNOWN AGE AND SEX USED FOR ANALYSIS OF MANDIBLE LENGTH

Age (years)	Sex		Total
	Male	Female	
1½	40	13	53
2½	22	9	31
3½	4	2	6
4½	1	1	2
5½	0	1	1
6½	0	1	1
7½	0	3	3
8½	0	0	0
9½	0	0	0
10½	0	1	1
Total	67	31	98

TABLE 2. ANALYSIS OF VARIANCE, SEX VS. AGE, FOR THREE MANDIBLE MEASUREMENTS*

Source	Degrees of freedom	Mandible length (millimeters)				Diastema length (millimeters)	
		Definition 1		Definition 2			
		Mean squares	*F*	Mean squares	*F*	Mean squares	*F*
Between sexes	1	1140.00	17.58	989.69	12.63	217.09	6.90
Between ages	2	1081.46	16.68	1403.26	17.91	285.25	9.06
Sex vs. age	2	97.86	1.51	133.82	1.71	23.43	0.74
Error	24	64.85	. .	78.34	. .	31.47	. .
Total	29	xxx	. .	xxx	. .	xxx	. .

*See text for definitions of measurements.

differences between sexes and between ages were significant. In all cases, the mean length was greater for males than for females. With respect to age, further analysis by the least significant difference procedure showed that for all three measurements mean length was less for yearlings than for older deer, but there was no significant difference between the 2½-year-old and the 3½-year-old and older deer. Therefore, only two age groups, i.e., yearling and adult (2½ years and older), were considered for further evaluation of the data.

For these two age groups, the data for the subsamples of each sex were compared by the orthogonal contrast tests (Table 3). In each group, mean length for males was significantly greater than that for females. This difference between the sexes was similar to that reported for caribou by Bergerud (1964) and for white-tailed deer by Roseberry and Klimstra

TABLE 3. COMPARATIVE MEAN MANDIBLE MEASUREMENTS* FOR SUBSAMPLES§ OF MALE AND FEMALE DEER IN YEARLING AND ADULT AGE GROUPS

Age group	Mandible length (millimeters) Definition 1		Mandible length (millimeters) Definition 2		Diastema length (millimeters)	
	Male	Female	Male	Female	Male	Female
Yearling	202.87	196.93	192.73	189.27	65.26	63.40
Adult	225.13	209.61	218.46	202.97	76.13	69.00

*See text for definitions of measurements.
§Five specimens each, see text.

TABLE 4. COMPARATIVE MEAN MANDIBLE MEASUREMENTS*, ACCORDING TO AGE AND SEX, TOGETHER WITH CONFIDENCE INTERVALS AND RANGE OF MINIMUM AND MAXIMUM LENGTHS

Age and sex	Number	Mean ± standard deviation	Confidence interval§	Range Minimum	Range Maximum
Mandible length, definition 1 (millimeters)					
Yearling					
Male	40	205.7 ± 8.6	±2.8	189.67	233.33
Female	13	197.9 ± 8.9	±5.4	183.33	211.00
Adult					
Male	27	220.5 ± 9.6	±3.8	202.00	245.33
Female	18	208.4 ± 7.6	±3.8	190.00	218.33
Mandible length, definition 2 (millimeters)					
Yearling					
Male	40	198.3 ± 9.0	±2.9	182.00	231.00
Female	13	190.8 ± 8.9	±5.4	176.00	203.67
Adult					
Male	27	213.6 ± 9.8	±3.9	196.33	241.33
Female	18	201.9 ± 8.0	±4.0	184.00	212.33
Diastema length (millimeters)					
Yearling					
Male	40	66.8 ± 5.6	±1.8	56.00	85.33
Female	13	63.2 ± 3.9	±2.4	58.33	71.33
Adult					
Male	27	74.0 ± 5.2	±2.1	66.67	94.00
Female	18	68.3 ± 5.3	±2.6	56.33	76.00

*See text for definitions of measurements; values differ from those in Table 3 because they represent all specimens.
§Represents 95 per cent confidence interval with respect to mean.

(1975) and Rees (1971a). That the differences with respect to age were significant only between yearlings and adults was similar to the findings of Roseberry and Klimstra (1975), except for the diastema length. They reported significant differences in this measurement between each age group through 3½ years for males and through 5½ years (except for 2½ vs. 3½) for females.

However, for practical use as a criterion of sex, there should be not only a significant difference in mean mandible length between males and females but also a minimal overlap or complete separation of the measurements of the two sexes in each age group considered. To evaluate such overlap in the present study, all the jaws of known age and sex were used. The mean values for the three measurements according to age and sex, together with associated confidence intervals and the range of minimum and maximum lengths, are given in Table 4. These data show that in each case the lengths overlapped to some extent. This contrasts with the minimal overlap reported for caribou by Bergerud (1964).

TABLE 5. PROBABILITY OF A JAW BEING FROM A MALE ANIMAL, BASED ON MANDIBLE LENGTH ACCORDING TO DEFINITION 1*

Length (millimeters)	Probability§			Distribution of sample examined	
	Minimum	Point estimate	Maximum	Male	Female
Yearling					
180-182	4	13	25	. .	. .
183-185	6	15	29	. .	2
186-188	9	19	32	. .	. .
189-191	14	24	35	3	1
192-194	20	30	39	1	1
195-197	29	36	42	4	1
198-200	38	43	47	3	2
201-203	45	50	55	3	2
204-206	52	57	63	7	2
207-209	57	64	72	7	1
210-212	60	71	81	3	1
213-215	64	76	87	6	. .
216-218	67	81	91	2	. .
219-221	70	85	94	. .	. .
222-224	73	89	97	. .	. .
225-227	76	91	98	. .	. .
228-230	80	93	98	. .	. .
231-233	80	96	99	1	. .
Adult					
190-192	1	4	12	. .	2
193-195	2	6	14	. .	. .
196-198	4	9	18	. .	. .
199-201	7	12	22	. .	. .
202-204	10	17	26	1	2
205-207	16	23	31	1	2
208-210	25	30	37	3	4
211-213	34	39	45	1	4
214-216	43	48	54	2	2
217-219	52	58	64	3	2
220-222	61	67	73	5	. .
223-225	67	75	82	5	. .
226-228	72	81	88	2	. .
229-231	77	87	93	1	. .
232-234	81	90	96	2	. .
235-237	84	93	97	. .	. .
238-240	87	96	98	. .	. .
241-243	90	97	99	. .	. .
244-246	92	98	99	1	. .

*See text.
§Calculated by Bayes Formula; values in per cent.

TABLE 6. PROBABILITY OF A JAW BEING FROM A MALE ANIMAL, BASED ON MANDIBLE LENGTH ACCORDING TO DEFINITION 2*

Length (millimeters)	Probability§			Distribution of sample examined	
	Minimum	Point estimate		Male	Female
		Yearling			
175-177	8	16	31	. .	2
178-180	12	20	34	. .	. .
181-183	16	25	37	2	. .
184-186	22	30	40	1	2
187-189	30	36	43	4	1
190-192	39	42	46	3	2
193-195	45	49	53	3	. .
196-198	51	55	61	7	4
199-201	55	62	69	8	. .
202-204	58	68	77	4	2
205-207	61	73	83	4	. .
208-210	64	78	88	2	. .
211-213	67	82	92	1	. .
214-216	70	86	94	. .	. .
217-219	73	89	96	. .	. .
220-222	75	91	97	. .	. .
223-225	76	93	98	. .	. .
226-228	81	95	99	. .	. .
229-231	83	96	99	1	. .
		Adult			
180-182	1	5	15	. .	. .
183-185	2	6	16	. .	2
186-188	4	9	19	. .	. .
189-191	5	12	22	. .	. .
192-194	9	15	26	. .	. .
195-197	13	20	30	1	2
198-200	19	26	34	1	2
201-203	26	32	39	3	3
204-206	35	40	45	1	5
207-209	43	48	53	3	1
210-212	51	56	61	1	3
213-215	56	64	69	5	. .
216-218	63	71	78	5	. .
219-221	68	77	85	3	. .
222-224	72	82	90	1	. .
225-227	75	87	93	2	. .
228-230	79	90	96	. .	. .
231-233	82	93	97	. .	. .
234-236	86	95	98	. .	. .
237-239	88	96	99	. .	. .
240-242	89	98	99	1	. .

*See text.
§Calculated by Bayes Formula; values in per cent.

To evaluate the probability of correctly judging the sex of a specimen of a given age, Bayes Formula (Schor, 1968)[2] was used to derive values for males over the range shown in Table 4 for each measurement. The calculated probabilities that a measured jaw was from a male are given in

[2]The derivation of this formula, and the mechanics of its use in this application, have been described by Powers and Rasmussen (unpublished).

TABLE 7. PROBABILITY OF A JAW BEING FROM A MALE ANIMAL, BASED ON DIASTEMA LENGTH ACCORDING TO DEFINITION 3*

Length (millimeters)	Probability§ Minimum	Point estimate	Maximum	Distribution of sample examined Male	Female
		Yearling			
49-50	4	11	30	..	..
51-52	5	15	32	..	..
53-54	8	18	35	..	..
55-56	12	22	37	1	..
57-58	17	27	40	4	1
59-60	24	32	42	..	4
61-62	34	38	45	2	1
63-64	43	45	49	4	2
65-66	48	52	56	8	3
67-68	54	59	64	5	1
69-70	56	65	74	7	..
71-72	58	71	81	4	1
73-74	61	76	87	4	..
75-76	64	80	91	..	..
77-78	66	84	94	..	..
79-80	68	88	96	..	..
81-82	70	91	98	..	..
83-84	72	92	98	..	..
85-86	75	93	99	1	..
		Adult			
54-55	1	4	14	..	..
56-57	2	6	16	..	1
58-59	3	8	20	..	..
60-61	6	12	24	..	1
62-63	9	16	28	..	2
64-65	14	22	32	..	..
66-67	22	29	37	2	4
68-69	33	37	41	3	1
70-71	41	46	51	3	4
72-73	50	55	60	5	3
74-75	59	64	69	6	1
76-77	65	74	79	5	1
78-79	68	79	87	1	..
80-81	73	84	92	1	..
82-83	77	89	95	..	..
84-85	80	92	97	..	..
86-87	83	95	98	..	..
88-89	87	96	99	..	..
90 and over	89	97	99	1	..

*See text.
§Calculated by Bayes Formula; values in per cent.

Tables 5 to 7 for yearlings and adults with respect to each of the three measurements recorded. For the two measurements pertaining to the entire jaw, 3-millimeter intervals in length were used, while for the diastema length the interval was 2 millimeters. Three probability values are given. The point estimate represents the probability (as a percentage) that the jaw came from a male deer, and the minimum and maximum values represent the range within which there is a 95 per cent chance that the true probability lies. The probability that the jaw was from a female is 100 per cent minus the probability that it was from a male. The tables also show the corresponding numbers of jaws from deer of each sex in the present study that were in each length interval.

Based on the point estimates, only jaws with the longest or shortest measurements can be assigned a sex with at least a 90 per cent probability that it will be correct. For example, using the values for adults in Table 5, only the three jaws with mandible lengths of 232 millimeters or more could be definitely classed as males. Conversely, only the two with mandible lengths of 190-192 millimeters could be definitely considered females. These five specimens constituted only 11.1 per cent of the 45 jaws from deer 2½ years old or older.

The findings of this study indicate that none of the mandible measurements evaluated would be a reliable criterion of sex for deer in New York. However, Rees (1971a, 1971b) suggested that both mandible length and diastema length vary between subspecies and/or populations of white-tailed deer. Further consideration of the technique would require extensive additional study.

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DIET OF STRIPED BASS IN THE HUDSON RIVER ESTUARY[1]

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ABSTRACT

Striped bass were collected from the Hudson River estuary by beach seine and bottom trawl from April to November in 1974 and with a haul seine during April and May in 1976 and 1977. The stomach contents for those taken in 1974 were analyzed according to four length groups. Striped bass less than 200 millimeters in total length fed on small invertebrates primarily, but took some fish. Larger individuals were almost totally piscivorous, consuming the young of such species as blueback herring, Atlantic tomcod, bay anchovy, white perch, banded killifish and mummichog. Striped bass collected just prior to and during the spawning season in 1976 and 1977 had fed, but only 27 per cent of the stomachs examined contained food and no cannibalism was observed. Few specimens more than 200 millimeters in total length that were collected at this time had taken invertebrates. A higher proportion of the stomachs of mature bass contained fish and a lower proportion invertebrates than was the case for immature bass. There was no apparent long-term (several weeks) cessation of feeding associated with spawning.

The striped bass (*Morone saxatilis*) is an important fish caught by commercial and sports fishermen on both coasts of the United States. The species has been the object of intensive studies on the west coast in the Sacramento-San Joaquin River system, and on the east coast in the Chesapeake Bay area and North Carolina. The life history of the Hudson River population was studied during the early 1950's (Raney, 1952; Raney et al., 1954; Rathjen and Miller, 1957) and, since studies of the impact of power plants were begun during the mid-1960's, more extensive efforts have been made to describe the Hudson River strain and its contribution to the striped bass population of the Atlantic coast (Texas Instruments, 1976c; Berggren and Lieberman, 1978; McLaren et al., 1981; Klauda et al., 1980).

Striped bass reside in the Hudson River as young of the year and yearlings, while many older fish return to the Hudson to overwinter and/or spawn during the spring. They have an influence on the aquatic community throughout the year that may result in increased competition for food as well as predation on other fish species. The diets of striped bass popula-

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tions on the west coast have been studied by Scofield and Bryant (1926), Scofield (1931), Shapovalov (1936), Johnson and Calhoun (1952), Heubach et al. (1963), Stevens (1966) and Thomas (1967), while on the east coast studies have been made by Hildebrand and Schroeder (1928), Hollis (1952), Trent and Hassler (1966), Markle and Grant (1970) and Manooch (1973), and inland populations have been studied by Goodson (1964), Harper et al. (1968), Gomez (1970) and Ware (1971). However, only a few investigations have been reported for the Hudson River population (Texas Instruments, 1976b, 1977, 1980).

This paper reports on the stomach contents of striped bass collected in the Hudson River estuary. Changes in diet among young-of-the-year, yearling and 2-year-old fish were examined because such changes reflect the fish's ability to consume different numbers and sizes of prey. Feeding prior to and during the spawning season is indicative of the short-term influence of the adults on the Hudson River ecosystem.

METHODS

All the striped bass examined were collected in the Hudson River between Croton Bay (river kilometer 53) and the Bear Mountain Bridge (river kilometer 74) as indicated in Figure 1. Young-of-the-year, yearling and 2-year-old specimens were taken in beach seines and otter-type bottom trawls from April to November in 1974. Striped bass 2 years old and older (larger than 200 millimeters in total length) were obtained from fish caught at night with a 900-foot haul seine during the spring spawning run (April and May) in 1976 and 1977. Young-of-the-year fish were preserved whole in 10 per cent formalin, and older specimens were injected through the esophagus with 10 per cent formalin to arrest digestion and preserve food organisms. Upon dissection in the laboratory, the preserved contents were sorted, identified to the lowest taxon possible and counted. Items such as detritus and uncountable animal and plant remains were noted as being present or absent.

Specimens collected in 1974 were grouped according to the total length of the fish in millimeters as follows: under 76, 76-150, 151-200 and 201-275. For each stomach containing food, the number of organisms of each countable food item was recorded and its percentage frequency was calculated in terms of the total for all food items present in that stomach. Then, for the specimens in each length group each month, the percentages for the individual items were summed and the mean was calculated in terms of the total number of stomachs with at least one countable food item. The latter procedure is similar to the one used by Mathur (1977) to calculate the proportion (as volume) of food items eaten. Mean percentage frequency is useful as an indicator of trends in the relative abundance of food items in all stomachs.

Specimens collected in 1976 and 1977 were grouped according to the

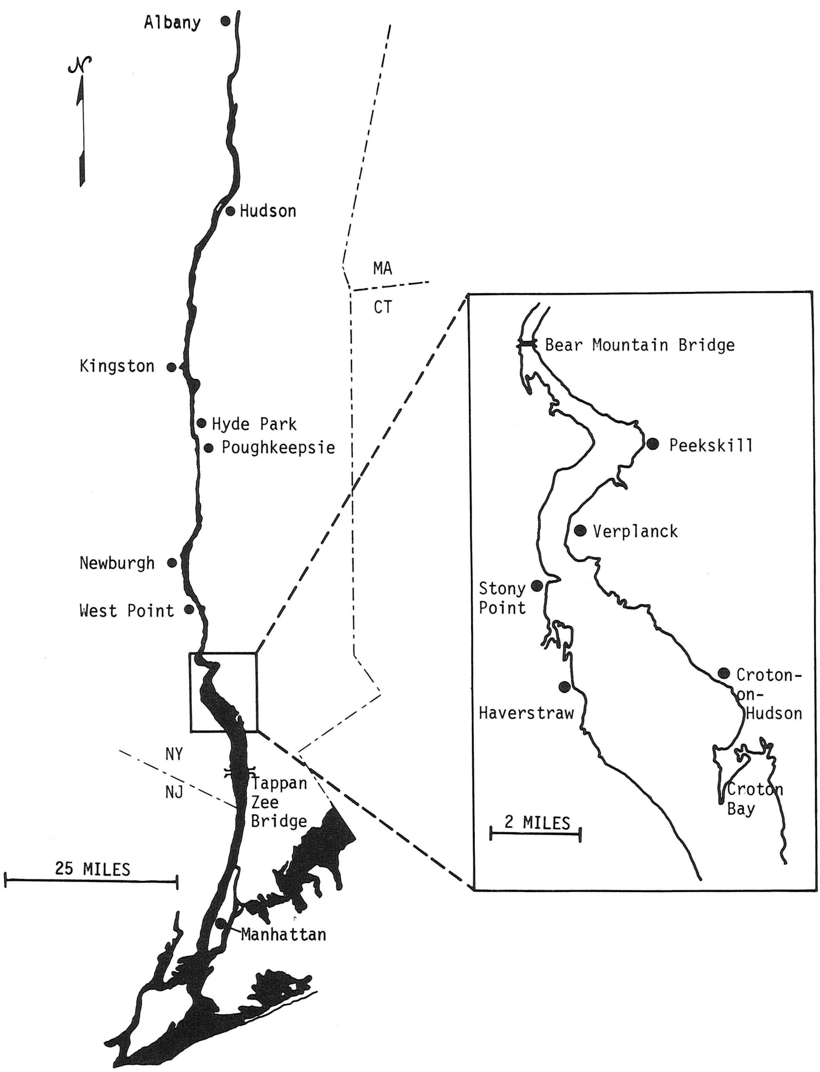

Figure 1. The Hudson River estuary and detail of area where striped bass were collected for diet analysis in 1974 and 1976-1977.

total length of the fish in millimeters as follows: 200-399, 400-599, 600-799 and 800 or over. Their degree of maturity was also noted when it could be determined.[4] For these stomachs, the recognizable food items identified were recorded merely as being present regardless of the number of organ-

[4]Mature striped bass were defined as those which were ripe, ripe and running, partially spent or spent (Texas Instruments, 1980) and would have spawned or did spawn that spring.

isms. The percentage frequency of each item, for each length group and maturity category, was calculated directly as the percentage, of the total stomachs containing recognizable food items, that contained that item.

RESULTS AND DISCUSSION

The data for striped bass collected in 1974 are presented separately from those for fish collected in 1976 and 1977. Length is given as total length unless otherwise stated.

DIET OF BASS COLLECTED IN 1974

During 1974, a total of 514 striped bass were examined. The stomachs of 422 (82.1 per cent) contained food (countable and/or uncountable) items, while 92 (17.9 per cent) were empty (Table 1).

TABLE 1. SUMMARY OF STRIPED BASS STOMACHS EXAMINED FROM THE HUDSON RIVER

Source	Stomachs examined	Stomachs containing food				Stomachs empty	
		Countable items		Uncountable items*			
		Number	Per cent	Number	Per cent	Number	Per cent
April-November, 1974							
Beach seine	428	317	74.1	35	8.2	76	17.8
Bottom trawl	86	65	75.6	5	5.8	16	18.6
Total	514	382	74.3	40	7.8	92	17.9
April-May, 1976 and 1977							
1976	138	16	11.6	88	63.8	34	24.6
1977	242	14	5.8	196	81.0	32	13.2
Total	380	30	7.9	284	74.7	66	17.4

*Includes uncountable food items and/or detritus only.

As they grow in size, striped bass are able to consume larger prey and they exhibit dietary shifts from small invertebrates to larger invertebrates and fish. Since the collections by beach seine from shore areas in 1974 afforded sufficient samples of all length groups, these fish were used to assess seasonal dietary changes. The data are summarized in Table 2. As considered in this table, major food items were the eight (if that many countable items were consumed) in each length and month category that ranked highest in mean frequency, although in the case of ties more were included.

Young of the year less than 76 millimeters long consumed a variety of invertebrates. Amphipods of the genus *Gammarus*, calanoid copepods and cladocerans were the major foods eaten, while other amphipods, polychaetes, chironomid larvae, other copepods and isopods were also taken. While investigating fish in the Hudson River, Curran and Ries (1937) concluded that 80 to 100 per cent of the diet of small striped bass consisted of *Gammarus fasciatus* which were abundant in the river. They also found

Table 2. Major Countable Food Items in Stomachs of Striped Bass Collected in Beach Seines in the Hudson River Estuary from April to November in 1974, According to Month and Length of the Fish

Length group* (millimeters)	April			May			June		
	Number§	Food item	Mean frequency (per cent)	Number§	Food item	Mean frequency (per cent)	Number§	Food item	Mean frequency (per cent)
Under 76	2	Cladocera	50.0	0			3	*Gammarus*	66.8
		Calanoida	48.9					Calanoida	32.2
		Gammarus	0.6					Harpacticoida	0.8
		Chironomidae (larvae)	0.6					Chironomidae (larvae)	0.2
76-150	7	*Gammarus*	59.7	3	*Gammarus*	100.0	51	*Gammarus*	34.3
		Calanoida	24.1					*Microgadus tomcod*	21.9
		Chironomidae (larvae)	10.9					Calanoida	11.6
		Cassidinia	2.9					*Cyathura*	9.6
		Chirodotea	2.4					*Leptocheirus*	9.1
								Chironomidae (pupae)	4.0
								Chironomidae (larvae)	2.9
								Lironica ovalis	2.0
								Cladocera	2.0
151-200	0			0			3	*Alosa aestivalis*	33.3
								Microgadus tomcod	33.3
								Clupeidae	33.3
201-275	0			0			0		

TABLE 2. (continued)

Length group* (millimeters)	July Number§	July Food item	July Mean frequency (per cent)	August Number§	August Food item	August Mean frequency (per cent)	September Number§	September Food item	September Mean frequency (per cent)
Under 76	0			0			29	*Gammarus*	54.7
								Leptocheirus	10.4
								Polychaeta	8.6
								Corophium	6.4
								Chironomidae (larvae)	5.7
								Calanoida	3.4
								Cyclopoida	3.0
								Cyathura	2.8
76-150	21	*Gammarus*	34.8	30	*Gammarus*	39.1	38	*Gammarus*	47.3
		Cyathura	27.6		*Corophium*	23.7		*Crangon*	6.6
		Chironomidae (larvae)	14.6		Chironomidae (larvae)	9.7		*Anchoa mitchilli*	6.4
		Harpacticoida	7.4		*Rhithropanopeus*	8.6		Chironomidae (larvae)	5.3
		Clupeidae	4.8		*Neomysis*	6.1		*Fundulus diaphanus*	5.3
		Chironomidae (pupae)	2.8		Fish remains	5.8		Diptera (larvae)	4.4
		Insect remains (adult)	2.7		*Fundulus diaphanus*	3.8		*Corophium*	3.8
		Leptocheirus	2.4		Diptera (pupae)	0.8		Polychaeta	3.7
		Polychaeta	2.4						
151-200	9	Polychaeta	43.8	7	Fish remains	57.1	4	*Gammarus*	37.5
		Cyathura	29.8		*Microgadus tomcod*	25.7		Clupeidae	25.0
		Crangon	11.1		*Corophium*	12.4		*Neomysis*	21.2
		Anchoa mitchilli	11.1		*Gammarus*	4.8		Fish remains	4.9
		Chironomidae (larvae)	2.3					*Microgadus tomcod*	4.9
		Leptocheirus	1.8					*Crangon*	4.2
								Cyathura	1.5
								Rhithropanopeus	0.8
201-275	0			1	Fish remains	100.0	2	*Cyathura*	50.0
								Microgadus tomcod	37.5
								Gammarus	12.5

TABLE 2. (continued)

Length group* (millimeters)	October			November			All months combined†		
	Number§	Food item	Mean frequency (per cent)	Number§	Food item	Mean frequency (per cent)	Number§	Food item	Mean frequency (per cent)
Under 76	26	*Gammarus*	56.5	7	Calanoida	67.7	67	*Gammarus*	50.2
		Corophium	10.8		*Gammarus*	15.9		Subclass Copepoda	14.6
		Monoculodes	6.3		*Cyathura*	14.3		Other Amphipoda	9.2
		Leptocheirus	5.4		Cyclopoida	1.9		*Corophium*	7.0
		Polychaeta	4.9		*Cassidina*	1.0		Order Diptera	5.8
		Cyathura	4.2					Phylum Annelida	5.6
		Chironomidae (larvae)	3.7					Suborder Isopoda	5.1
		Cyclopoida	3.4					Other Crustacea	1.5
76-150	37	*Gammarus*	63.7	19	*Gammarus*	44.9	206	*Gammarus*	45.5
		Fish remains	7.9		Calanoida	24.0		Class Osteichthyes	12.4
		Chironomidae (pupae)	6.0		Oligochaeta	5.3		Order Diptera	8.9
		Rhithropanopeus	5.5		Nemertea	4.6		Subclass Copepoda	7.4
		Cyathura	4.4		*Neomysis*	4.2		Suborder Isopoda	7.1
		Leptocheirus	2.9		Fish remains	3.9		Suborder Decopoda	5.0
		Calanoida	2.6		Polychaeta	3.2		*Corophium*	4.4
		Monoculodes	1.8		*Crangon*	3.1		Other Amphipoda	3.9
151-200	4	*Morone saxatilis*	25.0	4	*Fundulus heteroclitus*	50.0	31	Class Osteichthyes	52.9
		Chirodotea	25.0		Clupeidae	25.0		Phylum Annelida	12.7
		Gammarus	20.8		*Neomysis*	24.5		Suborder Isopoda	12.1
		Clupeidae	16.7		*Crangon*	0.5		*Gammarus*	8.6
		Fundulus diaphanus	12.5					*Neomysis*	5.9
								Suborder Decopoda	3.9
								Corophium	2.8
								Order Diptera	0.7
201-275	8	Clupeidae	62.5	2	*Morone*	50.0	13	Class Osteichthyes	85.6
		Fish remains	37.5		*Crangon*	31.2		Suborder Isopoda	7.7
					Clupeidae	18.8		Suborder Decapoda	4.8
								Gammarus	1.9

*Total length
§Number of stomachs containing at least one countable food item.
†Food items grouped taxonomically.

chironomids and copepods to be important in the diet of striped bass less than 100 millimeters in standard length. In California, Scofield and Bryant (1926) analyzed the food of striped bass having a mean length of about 75 millimeters and found that crustaceans and annelids composed most of their diet. Fish appeared to be unimportant in the diet of young-of-the-year striped bass in the Hudson River, as was also true in the Sacramento-San Joaquin River system (Heubach et al., 1963).

Striped bass 76 to 150 millimeters long (primarily yearlings and some young-of-the-year fish) ate mostly *Gammarus*. During the summer and fall a variety of fish such as Atlantic tomcod (*Microgadus tomcod*), banded killifish (*Fundulus diaphanus*) and bay anchovy (*Anchoa mitchilli*) were eaten. The tomcod constituted a substantial (mean frequency = 21.9 per cent) part of the diet of yearlings during June. Since it is a winter spawner in the Hudson River, young-of-the-year tomcod (60-80 millimeters long) would be available prey for yearling striped bass during spring and early summer (Texas Instruments, 1976b). Markle and Grant (1970) studied Virginia tidal rivers and noted that when they reached 70 millimeters in fork length striped bass began feeding on larger invertebrates and fish when available. Ware (1971) reported that striped bass less than 150 millimeters long stocked in Florida inland waters consumed mosquito fish (*Gambusia* sp.) and molly (*Poecilia* sp.). Harper et al. (1968) studied striped bass cultured in freshwater ponds in Oklahoma and found that fish did not enter the diet until the bass reached 69 millimeters in standard length and were not important until the bass were at least 90 millimeters in standard length.

Striped bass 151 to 200 millimeters long (primarily yearlings and 2 year olds) collected from June through November became increasingly piscivorous. Fish such as blueback herring (*Alosa aestivalis*) and other clupeids, tomcod, bay anchovy, banded killifish, mummichog (*Fundulus heteroclitus*) and other species composed a major part of their diet. One instance of cannibalism was noted during October when a 151-millimeter bass ate another of unknown length. Striped bass continued to feed on invertebrates such as dipterans, copepods, isopods, decapods and amphipods, indicating a continued reliance on smaller food organisms while becoming more piscivorous. In a freshwater population, Ware (1971) found that threadfin shad (*Dorosoma petenense*) and other shad dominated the diet of striped bass 150 millimeters or more in length. Manooch (1973) found that among striped bass less than 305 millimeters long from Albemarle Sound in North Carolina 96 per cent of the stomachs contained juvenile fish, primarily blueback herring. Stevens (1966) found that fish (chiefly threadfin shad and smaller striped bass) became increasingly important in the diet of yearling and age II striped bass in the Sacramento-San Joaquin delta.

For 13 striped bass 201 to 275 millimeters long (primarily 2 year olds) collected from August through November in the Hudson River, the major fish eaten were tomcod, unidentified clupeids, white perch and other striped bass. One specimen 201 millimeters long had eaten two unidentified fish (*Morone* sp.) of unknown lengths. An isopod (*Cyathura* sp.), amphipods (*Gammarus*) and a shrimp (*Crangon* sp.) were taken to a lesser extent by these larger striped bass. Goodson (1964) examined striped bass 205 to 225 millimeters in fork length collected in Millerton Lake in Califor-

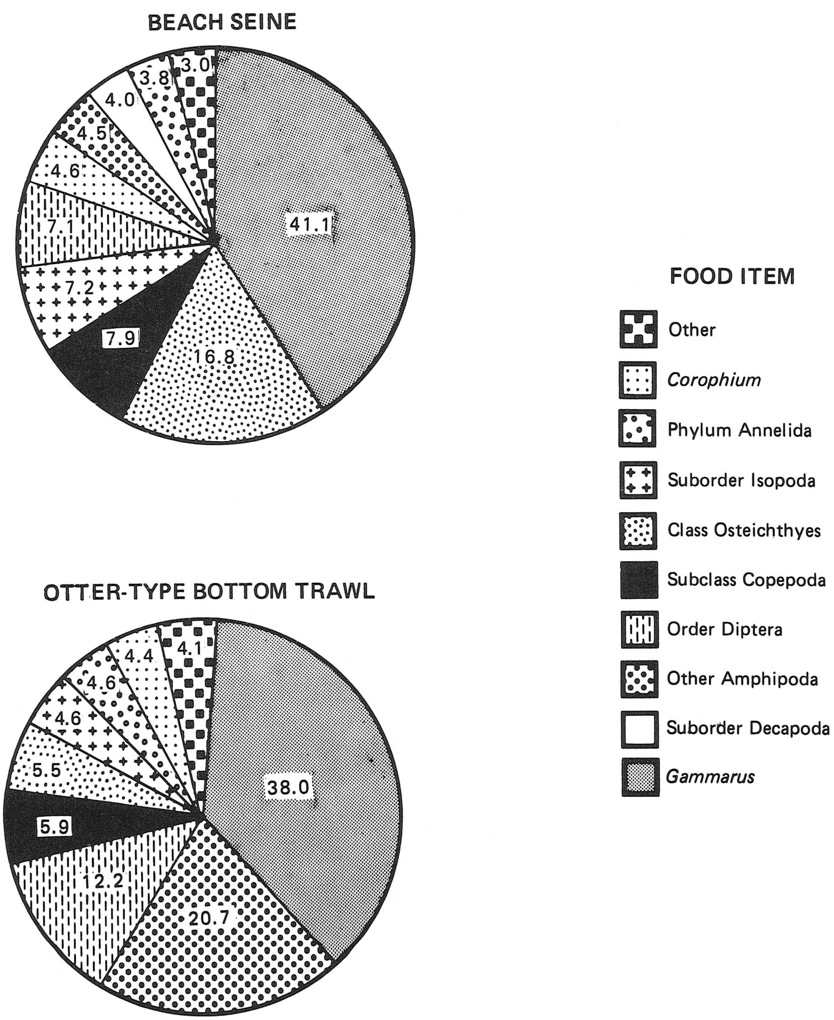

Figure 2. Taxonomic groups, and their percentage frequency, of foods eaten by striped bass collected by beach seines and by otter-type bottom trawls in the Hudson River estuary in 1974. Based on fish containing at least one countable food item: seine—317; trawl—65.

nia from April through November and found that they consumed primarily shad, sculpin and other fish.

Despite their reliance on fish in the Hudson River, only a few instances of cannibalism among striped bass were noted in 1974. Cannibalism has been reported for striped bass on the west coast (Scofield, 1931; Stevens, 1966; Thomas, 1967) and on the east coast (Manooch, 1973). Manooch reported a low incidence of cannibalism on nursery grounds and found that striped bass preferred soft-rayed fish over spiny-rayed fish, taking such species as the bay anchovy and blueback herring. Almost all fish consumed by striped bass in the Hudson River in 1974 were soft-rayed species except for perch and bass. The high availability of soft-rayed species (e.g., blueback herring, bay anchovy, spottail shiner (*Notropis hudsonius*), banded killifish and mummichog) in the Hudson River (Texas Instruments, 1976a) may reduce cannibalism. While cannibalism may not be as frequent among striped bass in the Hudson River as in populations on the west coast, the dietary progression of those in the Hudson from small invertebrates to larger food organisms such as fish was similar to that found in other populations.

The foods eaten by striped bass collected in channel areas in otter-type bottom trawls during 1974 were similar to those eaten by bass collected in shore areas by beach seines (Figure 2). Bass from both habitats consumed amphipods (*Gammarus*) primarily. However, fish were eaten in larger proportions by those in shore areas. This apparent difference in diet is difficult to interpret since striped bass larger than 200 millimeters long from channel areas were not available for analysis, and these larger fish would be more likely to take larger prey such as fish.

DIET OF BASS COLLECTED IN 1976 AND 1977

During 1976 and 1977, a total of 380 striped bass larger than 200 millimeters in total length were collected during the spawning season. The stomachs of 314 (82.6 per cent) contained countable or uncountable items, while 66 (17.4 per cent) were empty (Table 1). Of those with ingested material, 102 contained recognizable food items and 212 contained detritus[5] only (Table 3). Data for the two years were combined to describe differences in feeding habits of fish in different length and maturity categories.

These collections were made just prior to and during the spawning season each year. The data indicated no cessation of feeding by large striped bass, i.e., more than 200 millimeters long, at this time. Fish were the major food consumed by bass in all length and maturity groups (Table

[5]"Detritus" is defined as inorganic material (sand) and decomposed organic material unidentifiable as either vegetative or animal matter. The frequent presence of detritus in striped bass stomachs should not be misinterpreted as indicating that the species feeds on such material.

Table 3. Comparison of Food Items Eaten By Striped Bass in Different Length and Maturity Categories Collected By Haul Seine in the Hudson River During the Spawning Season in 1976 and 1977, Together With the Proportion of Stomachs That Contained Recognizable Food

Item	Total length (millimeters)				Maturity			All fish
	200-399	400-599	600-799	800 +	Immature	Mature	Undetermined	
	Food items eaten (percentage frequency)							
Fish								
Fish remains	26.9	50.9	71.4	78.6	41.7	66.7	48.1	50.0
Fish eggs	. .	. .	14.3	. .	. .	. .	3.7	1.0
White perch	. .	5.5	. .	7.1	. .	11.1	3.7	3.9
Atlantic tomcod	3.8	1.8	. .	. .	2.1	3.7	. .	2.0
Clupeidae (unidentified)	. .	. .	. .	7.1	. .	3.7	. .	1.0
Blueback herring	. .	. .	. .	7.1	. .	3.7	. .	1.0
Spottail shiner	. .	. .	. .	.71	. .	3.7	. .	1.0
Total	30.8	50.9	71.4	85.7	43.8	70.4	48.1	52.0
Invertebrates								
Isopoda (*Cyathura*)	15.4	1.8	. .	. .	10.4	. .	. .	5.9
Nematoda	. .	3.6	14.3	. .	6.3	. .	. .	2.9
Decapoda	. .	1.8	. .	. .	. .	. .	3.7	1.0
Amphipoda (other than *Gammarus*)	. .	1.8	. .	. .	. .	. .	3.7	1.0
Gammarus	3.8	. .	. .	. .	2.1	. .	. .	1.0
Insect remains	. .	1.8	. .	. .	. .	3.7	. .	1.0
Total	19.2	10.9	14.3	. .	18.8	3.7	7.4	11.8
Plant remains	61.5	47.3	71.4	36.4	54.2	37.0	55.6	50.0
	Number of stomachs							
With recognizable food items	26	55	7	14	48	27	27	102*
With detritus only	94	89	22	7	123	27	62	212*
Empty	32	24	6	4	31	17	18	66*
Total examined	152	168	35	25	202	71	107	380

*Percentage as follows: with food – 26.8; with detritus only – 55.8; empty – 17.4.

3). Species eaten included white perch (*Morone americana*), tomcod, spottail shiner and blueback herring and other clupeids. Although cannibalism by large striped bass during the spawning season has been reported in the Hudson River (Dew, 1981) none was observed in this study. A total of 73.2 per cent of the stomachs were either empty (17.4 per cent) or contained detritus only (55.8 per cent), a condition typical of large striped bass during the spawning season according to Scofield (1931), Woodhull (1947), Hollis (1952), Stevens (1966), Trent and Hassler (1966) and Manooch (1973).

Larger striped bass were more piscivorous than smaller individuals. The frequency of fish in the stomach contents increased consistently from the smallest to the largest length group. In general, the frequency of invertebrates and plant remains was less for the larger bass. Although only 12 stomachs contained invertebrates, their frequency in the smallest length group was 19.2 per cent. Isipods (*Cyathura*) and nematodes were the only invertebrates found in more than one stomach. Vegetative material occurred in half the stomachs that contained food, but probably was taken incidentally to the capture of prey.

Comparison of mature and immature individuals revealed that the frequency of fish was higher and that of invertebrates and plant remains lower in mature bass than in immature bass. Mature bass generally feed less during the spawning season (Hollis, 1952; Stevens, 1966; Trent and Hassler, 1966). However, there is no apparent reason why only 23.8 per cent of the immature specimens (48 of 202) were feeding unless, perhaps, active feeding by all individuals had not yet begun after the overwinter senescence. Samples of mature bass were not large enough to be representative with respect to the foods eaten by fish immediately before (ripe and running) or during (partially spent) spawning. Since the bulk of spawning occurs in May, and mature fish were collected during April and May, examination of mature individuals reflected dietary relationships over several weeks and would not reveal any daily cessation of feeding while spawning.

The data for both collection periods indicate that the diet of striped bass in the Hudson River estuary varies with the season as well as with the length and sexual maturity of the fish. Striped bass appeared to be opportunistic feeders, preying on the most abundant food available. They consumed invertebrates when young and became increasingly piscivorous as they grew, feeding primarily on soft-rayed species. These findings are similar to those reported from other studies of striped bass on both the east coast and west coast.

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UPSTREAM DISPERSAL OF FALL-STOCKED BROWN TROUT IN CANAJOHARIE CREEK, NEW YORK

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ABSTRACT

A large proportion of fall-stocked fingerling brown trout in Canajoharie Creek consistently dispersed upstream within a few days after stocking. Subsequent sampling in the immediate vicinity of the release sites would have given misleadingly low estimates of survival. If this is a general pattern of behavior for fingerling brown trout stocked in the fall, it should be considered in connection with the stocking of these fish and in evaluating their contribution to trout fisheries.

The stocking of fingerling trout in the fall is a potentially useful fishery management technique in situations where natural reproduction is inadequate and where these fish will survive and grow well enough to provide a worthwhile fishery. Where comparable population densities of catchable fish can be maintained, stocking fingerlings in the fall is generally superior to stocking yearlings in the spring because it is less expensive and because fish that have lived longer in the stream before being harvested are considered more desirable by many anglers. Unfortunately, most studies indicate that the survival and contribution to the fishery of trout stocked as fingerlings are likely to be poor (Schuck, 1948; Shetter et al., 1964). The findings presented here suggest that, at least in the case of brown trout (*Salmon trutta*), some investigators may have inadvertently been looking for surviving fall-stocked fish in the wrong locations or may have based their evaluations wholly or partly on stream sections where high densities of these fish would be unlikely.

The authors became aware of possible migratory tendencies in fall-stocked fingerling brown trout as a result of an experimental rotenone treatment of the Ten Mile River, a tributary of the Delaware River, in 1969, (Engstrom-Heg and Loeb, 1971). A marked lot of 650 fingerling brown trout (mean total length = 114 millimeters) was released in a 150-meter section of the stream on September 22, 1969. Downstream emigration was prevented by a temporary barrier used in the reclamation study. Electrofishing surveys 3 days after stocking, plus recovery of dead trout after the rotenone treatment on October 1, showed that only 10 per cent of the fingerlings were present in the stocked section. No mortality of the hatchery fingerlings was observed prior to the rotenone introduction. Therefore it was assumed that most of these fish moved upstream. The general nature of this pattern for brown trout from the Department's Catskill Fish Hatchery was confirmed by three years of data obtained in Canajoharie Creek as part of a broader study to evaluate the performance of fingerling brown trout stocked during the fall in New York streams.

STUDY AREA

Canajoharie Creek, a tributary of the Mohawk River, flows generally northeast through Otsego and Montgomery Counties in central New York. Stocking and sampling were concentrated in a 5-kilometer section in the upper part of the drainage (Figure 1). The stream had a mean gradient of 0.1 per cent through the study section and ranged from 3 to 9 meters wide (average 5.5 meters) Limestone formations underlie its headwaters, so the water is hard. Specific conductance averaged 650 micromhos per centimeter. Most of the stream flowed through pasture and planted fields associated with dairy farming.

A policy of stocking fall fingerling brown trout was established for the upper reaches of Canajoharie Creek in 1951, and fingerlings were released annually from 1951 to 1964. Extensive bulldozing in 1964 destroyed most of the trout habitat, and stocking was not resumed until 1975. There is little evidence of trout reproduction in Canajoharie Creek, although brown trout of wild origin have occasionally been taken during electrofishing surveys on the stream and its tributaries.

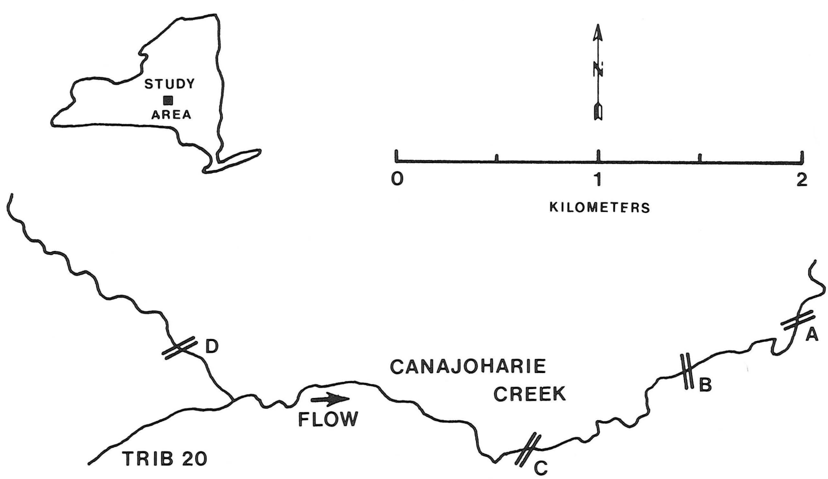

Figure 1. Study area on Canajoharie Creek, near the village of Cherry Valley, used to evaluate movements of fall-stocked brown trout from 1978 to 1980. Sites A, B, C and D represent highway bridge crossings where fish were stocked in one or more years of the study. A twin culvert at Site C impeded upstream movement of fish. Population estimates were made on a 1-kilometer section immediately upstream from Site C in 1978 and 1979, and on four 150-meter sections between Sites A and C in 1980.

Four stocking sites, all near highway bridges over the stream, were used in one or more years of the study. These sites were designated A, B, C and D, with A being the farthest downstream. A twin culvert that created a vertical fall approximately 0.5 meter high during most flow conditions was located at Site C. Some fish could pass upstream through this culvert, but it was a nearly total barrier to upstream migration. A second culvert was located at Site D, 2.1 kilometers upstream from Site C. This culvert created very little drop, and fish could readily pass through it. There were no natural barriers to upstream or downstream movement in the remainder of the study section.

PROCEDURES

The study was carried on in 1978, 1979 and 1980. It consisted of stocking hatchery fish and subsequently making surveys by electrofishing to determine their distribution and survival. In many cases the fish were marked. The dates on which stocking was done, the number stocked, their size and the marks applied to them are summarized in Table 1.

1978

Two lots of brown trout fingerlings were stocked in 1978. The first consisted of 3,650 fish that were distributed over 9.2 kilometers of stream on September 26. These fish originated in the U.S. Fish and Wildlife Service hatchery system and were reared at the former State hatchery at Cold

TABLE 1. STOCKING DATA FOR BROWN TROUT RELEASED IN CANAJOHARIE CREEK FROM 1978 TO 1980

Date	Number stocked	Mean total length* (millimeters)	Mean weight§ (grams)	Marks applied	Release sites
1978					
September 26	3,650	127	22	none	unknown
October 19	120	109	17	cold brand "S"	C
October 19	120	145	48	cold brand "L"	C
1979					
April 25	350	199	91	cold brand "Y"	C
September 24	4,015	110	16	none	B, D
September 28	236	117	23	cold brand "S"	B, C
September 28	236	135	37	cold brand "L"	B, C
November 1	236	117	23	cold brand "SL"	B, C
November 1	236	145	48	cold brand "LL"	B, C
1980					
October 15	3,000	139	36	fin clip (adipose)	A
October 20	1,000	139	36	fin clip (rt. vent.)	C
October 20	1,700	139	36	none	D

*Usually obtained by measuring 80 to 100 individual fish, but those for September 26, 1978 and September 24, 1979 were estimated from hatchery length-weight conversions.

§Derived from records of total weight stocked.

Spring Harbor from March 16 to September 25. They were transported from Cold Spring Harbor and released in Canajoharie Creek on the same day. None of these fish was marked prior to stocking. Precise distribution points are not known as all stocking was done by hatchery personnel. It is assumed that fish were released at most of the eight bridge crossings in the part of the stream that received fish.

The second lot, consisting of 240 fingerlings reared from domestic brood stock held at the Catskill Fish Hatchery, was released in a 1-kilometer section immediately above Site C on October 19. These fish were marked by cold branding with liquid nitrogen (Mighell, 1969) prior to stocking. Fingerlings less than 127 millimeters in total length were branded with an "S" between the dorsal fin and the lateral line, while longer fish were branded with an "L". There were 120 fish of each size. The fish were scatter planted through the section at eight approximately equally spaced sites.

A Petersen mark-and-recapture estimate of the population was conducted in the study section above Site C on October 24 and 26. A four-person crew captured fish using 230-volt DC electrofishing gear powered by a portable generator. For identification during subsequent surveys, partial fin clips were applied to all trout handled. Also, exploratory electrofishing surveys were made by a two-person crew using a back-pack DC electroshocker in areas upstream and downstream from the population-estimate section on October 30 and November 6.

1979

In 1979 both spring yearling (age 1+) and fall fingerling brown trout were stocked in Canajoharie Creek. The yearlings were stocked to supplement the population of trout available for fishing. This was considered necessary because fingerlings from the Cold Spring Harbor hatchery that were stocked in 1978 had poor survival. During their holding period at Cold Spring Harbor these fish were diagnosed as having infectious pancreatic necrosis and furunculosis (Robert H. Griffiths, State Department of Environmental Conservation, personal communication). The extended period of time these fish were in transit before stocking, possibly 8-10 hours, may also have reduced their viability.

On April 25, 350 cold-branded yearlings from the Catskill hatchery were scatter planted in the lower portion of the population-estimate section above Site C. On May 2 and 8 electrofishing surveys were conducted to examine the distribution of both the fingerlings stocked in 1978 and the recently stocked yearlings. They were made by a four-person crew in the same section above Site C that had been used in the fall of 1978, and the fish collected were used to derive a Petersen estimate of the population. Additional exploratory electrofishing surveys, with a two-person crew, were made on May 4, 7 and 14 in the same portions of the creek upstream and downstream from the study section that had been used the previous fall.

Cold-branded fingerlings from the Catskill hatchery were stocked on September 28 and November 1. On each date 322 were released at Site C and 150 at Site B. Each group consisted of equal numbers of small (less than 127 millimeters in total length) and large fish. They were marked to distinguish size (small or large), time of stocking (early or late) and stocking location (B or C). In addition to the marked fingerlings, 4,015 unmarked fish of Catskill hatchery origin that were reared at the Van Hornesville hatchery were stocked on September 24 over the same 9.2-kilometer section where the fish from Cold Spring Harbor had been stocked in 1978. Within the study section, fish from this lot are known to have been stocked at Sites B and D. Collections by electrofishing on November 14 and 15 were used to derive an estimate of the fall population in the study section above Site C. From November 19 to 21 electrofishing surveys were made on 2.2 kilometers of the creek upstream from the population-estimate section and on 0.6 kilometer below it.

1980

No spring yearlings were stocked in 1980 because it was felt that the population of brown trout in Canajoharie Creek was adequate to provide fishing during the coming season. A Petersen estimate could not be conducted in the spring due to insufficient personnel. Exploratory electrofishing surveys were made on five days between April 22 and May 14 over 2.9 kilometers of stream immediately above Site C and over 0.5 kilometer between Sites B and C. In addition, a 0.8-kilometer section of a tributary to Canajoharie Creek (Tributary 20 as designated in Anonymous, 1936), located 1.8 kilometers upstream from Site C, was sampled.

Fingerlings were stocked in the fall, but procedures were modified on the basis of experience in 1978 and 1979. Fin clips rather than cold brands were used because brands could not always be identified on fish that had been at large for more than a year in the stream. Early (September) stocking was eliminated because results from 1978 and 1979 indicated poorer survival for such fish compared with late-stocked fingerlings. Further, the prior results suggested that there was no consistent difference in survival between small and large fingerlings, so no size distinction was used. The fingerlings stocked were standard production fish from the Catskill hatchery. No fingerlings from other hatcheries were stocked in the study portion of Canajoharie Creek in 1980.

On October 15, 3,000 fingerlings were released at Site A, all of which had adipose fin clips. The remainder of the stocking was done on October 20 when Site C received 1,000 fingerlings with right ventral fin clips, while 1,700 unmarked fish were released at Site D. On both dates the fish were mass released at the lower boundary of the stocking section in each case. On October 23, several areas between Sites A and C were electrofished briefly to check for dispersal of the fingerlings stocked 8 days earlier.

A new set of sections was established for making population estimates, primarily to examine the distribution of fingerlings in a confined portion of the stream. Four sections, each approximately 150 meters long, were delineated between Sites A and C. The previous work showed that the twin culverts at Site C were nearly total barriers to upstream migration; therefore, it was expected that most of the surviving fingerlings would be located in the 1.9 kilometers of stream between the Site A stocking location and the culverts. Petersen estimates were made by a four-person crew in each of these four sections on November 13 and 14. Partial fin clips were applied to distinguish the fish captured in each section.

RESULTS

Electrofishing data used for the Petersen estimates are presented as point estimates of the population, whereas data obtained from the other surveys are reported as unexpanded numbers of fish captured. The efficiency of the electrofishing surveys is not known, hence accurate expansion of the number of fish captured is not assured. These approaches are followed for all years of the study (1978-1980).

1978

The branded fingerlings from the Catskill hatchery showed a general upstream movement soon after stocking. The fall population estimate made 5 days after stocking revealed that 29 per cent (69 of 240) of those released were still present in the stocked section above Site C. The efficiency of electrofishing for branded and unmarked fingerlings on the marking run (number marked divided by point estimate) was 40 per cent, and on the recapture run (marked fish recaptured divided by marked fish at large) it was 43 per cent. On surveys conducted 20 days after stocking, 25 branded fingerlings were captured in a 1.4-kilometer section immediately upstream from the population-estimate area. No branded fish were recovered in a 0.2-kilometer stream section immediately downstream from Site C.

1979

The spatial distribution of branded fingerlings stocked in 1978 and captured by electrofishing in the spring of 1979 was similar to that obtained the previous fall, but few fish survived over the winter. Only 12 branded fish were estimated to be present in the population-estimate section above Site C. Electrofishing efficiency was 33 per cent on the marking run and 22 per cent on the recapture run. Nine branded fingerlings were handled in surveys on 1.4 kilometers of stream just above the population-estimate section. One branded fingerling was recaptured approximately 0.7 kilometer downstream from the Site C culvert. The recently stocked yearling brown trout were present within the stocked section above Site C and in areas as much as 1.4 kilometers downstream from there. No branded yearlings were recovered upstream from the section where they were stocked.

Both early- and late-stocked fingerlings released in the fall of 1979 dispersed predominantly upstream. Neither size at stocking nor time of stocking seemed to influence the distance they travelled upstream, but late-stocked fish were nearly twice as abundant in the fall electrofishing catches (both estimate and survey) as early-stocked fish. The 1.0-kilometer population-estimate section above Site C contained 19 per cent (123 of 644) of the branded fish released at Site C. Electrofishing efficiencies for stocked fingerlings during the marking and recapture runs of the Petersen estimate were 62 and 50 per cent, respectively. On surveys made over 2.2 kilometers of the creek immediately upstream from the population-estimate section, 94 branded fingerlings were captured, some of which were known to have moved nearly 3 kilometers upstream within 14 days after their release at Site C. Three fingerlings released above the Site C culvert were recovered just downstream from there. Two branded fingerlings stocked at Site B, which was 0.9 kilometer downstream from Site C, were captured just above the Site C culvert.

The unmarked fingerlings released in 1979 by personnel from the Van Hornesville hatchery apparently migrated upstream. These fish were virtually absent from catches by electrofishing in sections below Site B, a known release point. A total of 42 unbranded fingerlings were captured in a 0.2-kilometer section just below the Site C culvert, but only four were present in the population-estimate section above Site C. Unmarked fingerlings were also abundant above the Site D culvert, with 35 being captured in 0.8 kilometer of stream above that point. The concentration of unmarked fingerlings upstream from Sites B and D strongly suggested an upstream dispersal, even though the precise stocking points for individual fish could not be determined.

1980

Although population estimates were not attempted, electrofishing surveys in April and May indicated little change in the distribution of fish from the previous fall. Fingerlings released at Site C in 1979 were recovered up to 3.0 kilometers upstream from that point. One fish that had been stocked above the Site C culvert was recaptured approximately 0.2 kilometer downstream. The presence of branded fingerlings in Tributary 20 was surprising, 10 fish stocked above Site C in the fall of 1979 being taken there in 1980.

The November population estimates showed that fingerlings stocked at Site A distributed themselves throughout the stream between Sites A and C. On the four added survey sections, population estimates ranged from 32 to 76 clipped fingerlings per section, the lowest estimate being for the section closest to the Site A stocking point and the highest for a section 1.1 kilometers upstream from Site A. Electrofishing efficiencies ranged from 40 to 87 per cent and averaged 60 per cent during the population estimates. One fingerling that had been released above the Site C culvert was recaptured in the population-estimate section immediately downstream from Site C. An exploratory electrofishing survey 8 days after stocking showed a particularly dense concentration just below the Site C culvert of fingerlings that had been marked by clipping the adipose fin and released at Site A. Apparently there had been some redistribution of these fingerlings between the October 23 survey and the November 13 population estimate.

DISCUSSION

The pattern of upstream movement of recently stocked fall fingerling brown trout was consistent for all three years of observation. Variables such as time of stocking, relative size at stocking, release by mass planting or careful scatter planting, or area of stream stocked did not alter the migratory tendency. The upstream movement was observed as soon as 5 days after stocking. In 1979, separate lots of fingerlings that had been at large in Canajoharie Creek for 58 and 13 days, respectively, showed similar distributions. This suggests that the stimulus for migratory behavior diminished fairly soon after stocking. The similarity in spatial distribution between fall and spring fish collections further suggests that this behavior pattern occurred for only a fairly brief time after the fish were released in the stream.

Most reports on trout fingerlings stocked in streams in late summer or autumn indicate poor survival, based on both electrofishing samples and angler harvest (Schuck, 1948; Shetter, 1949; Vestal, 1954; Shetter et al., 1964). These studies have generally focused evaluation efforts on the section where fingerlings were actually stocked. Millard and MacCrimmon (1972) reported an upstream movement in one of two lots of age 1+ brown trout stocked in October and recaptured 5 months later. Upstream migrations of 3 kilometers were recorded in their study, but it is not known how soon after stocking this occurred. Extensive movements out of the zone of stocking have not been reported for age 0+ brown trout stocked in the fall. In other trout species, fingerling brook trout (*Salvelinus fontinalis*) released in August (Shetter, 1949) and rainbow trout (*Salmo gairdneri*) released in October (Shetter, 1967) showed no mass movements in their first months at large in Hunt Creek, Michigan. Phinney (1975) examined the repopulation of trout in a stream section treated with rotenone and found that age 0+ wild brook trout moved downstream from the untreated upper part of the stream.

Instream movements by salmonids occur in response to stimuli such as deterioration of the physical habitat (Cargill, 1980), increased water levels (Huntsman, 1945) and possibly high population density. The fall fingerlings we stocked were released in stream sections where suitable habitat was available and resident brown trout were scarce. In 1978 there was no substantial waterlevel fluctuation in the 5 days between stocking and electrofishing. Mense (1975) tested for a positive correlation between the density of yearling or older wild brown trout and their degree of upstream movement. He reported little movement for the majority of the population studied in two years, during which the density of trout was 210 and 86 fish per hectare, respectively. The lowest stocking density tested in the present study was 395 fingerlings per hectare, when branded fish were scatter planted over a section that had probably been stocked 25 days earlier with unmarked fish. Less than a week after the branded fish were stocked, the density of all fingerlings was 348 per hectare, with branded fish making up half of that number. These densities exceeded those reported by Mense in numerical terms, if not in terms of biomass for the available habitat. Studies have shown older wild brown trout to be essentially non-migratory except for spawning movements (Schuck, 1943; Horton, 1961). The life history and usual age-specific distribution of these fish in streams suggest that density-dependent dispersion, where it occurs, should be in a predominantly downstream direction. In any case, for hatchery fish, stocking would be a reduction, not an increase, in population density. This could be expected to induce a shift from schooling to essentially territorial behavior (Kalleberg, 1958), necessitating some dispersion, but there would be no reason to expect an almost exclusively upstream movement.

The cause of upstream dispersion in fall fingerling brown trout remains unknown, but in the present study the phenomenon was real and predictable. It could, perhaps, be quite general for other strains of brown trout. Movement was often great enough for many fish to be excluded from sampling efforts centered on the zone of stocking. Erroneous conclusions about short-term survival of the strain tested would have occurred if recapture efforts had been confined to the stocked section of the stream.

The findings also have management implications. For optimal distribution, stocking of fall fingerling brown trout should extend to the downstream end of the section being stocked. Release sites should have at least 2 hectares of accessible water upstream. Efforts expended in scatter planting such fish may have relatively little value, except to avoid extreme concentrations, since the fish can be expected to disperse quite rapidly.

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EFFECTS OF DISTURBANCE BY SNOWMOBILES ON HEART RATE OF CAPTIVE WHITE-TAILED DEER[1]

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ABSTRACT

Captive white-tailed deer exhibited increased heart rates in response to controlled tests of the effect of disturbance by snowmobiles conducted from December through March. Peak rates averaged 2.5 times pre-stimulus rates when the snowmobile moved tangentially to the deer, and 2.9 times when it circled the deer. There was no evidence of habituation, either in the magnitude of the response or in the time required for the heart rate to return to a pre-stimulus or stabilized level.

Seasonal changes in metabolism and energy-conservation adaptations of white-tailed deer (*Odocoileus virginianus*) in the winter have been observed in field and laboratory studies of deer energetics (Moen, 1976, 1978). Low intensities of snowmobile use in Minnesota resulted in a significant negative correlation between the numbers of deer seen along a 10-kilometer trail and the numbers of snowmobiles registered for travel (Dorrance et al., 1975). These authors also reported an obvious trend toward larger home ranges for the deer during periods of disturbance by snowmobiles. However, Eckstein et al. (1979) did not see differences in home-range size and habitat use with or without such disturbance. Since deer exhibit their lowest heart rates of the year during the winter, with a concomitant reduction in activity and ecological metabolism (Moen, 1978), disturbances by snowmobiles in wintering areas have the potential to increase energy expenditure of the deer, contrary to their long-term energy-conservation adaptations.

In the winter of 1976-77, a study of the heart rate and behavioral responses of captive white-tailed deer to disturbances by snowmobiles was conducted at the Wildlife Ecology Laboratory at Cornell University. Tests were made weekly from December through March to evaluate the

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magnitude of the responses and evidence of habituation to the snowmobile. Changes in heart rate were monitored by telemetry in relation to the position of the snowmobile throughout each run, and changes in behavior were observed visually.

METHODS

Some 10 to 20 deer were being kept in a 2.4-hectare yard at the Laboratory for experimental purposes. Several of these were trained to wear the equipment used to monitor cardiac activity (Moen and Chevalier, 1977). A six-month-old male was monitored through the entire study, and another male fawn was used as a companion to the experimental animal. These deer were confined to 30 × 30-meter telemetry pen of wood-slat snowfence located near the center of the yard (Figure 1). The west side of the yard was marked every 6 meters so the position of the snowmobile in relation to the pen could be observed from the mobile research unit which housed the telemetry receivers and recorders. A large window allowed constant observation of the monitored deer, and they could see the snowmobile and the other deer in the yard at all times during the test runs as their vision was only slightly impaired by the wooden slats in the snowfence.

Tests were conducted one day each week when snow was present (13 of 17 weeks) between December 2 and March 24, starting at 9:00 a.m. They were made on three separate, parallel trails (T_1, T_2 and T_3) that were 40, 20 and 2 meters, respectively, from the telemetry pen when directly opposite it (Figure 1). Beginning at Points A_1 - A_3, runs included passes to the far end of the yard at Points E_1 - E_3, and returns to the starting points. A fourth run began at Point A_3 and circled the pen. Velocities of the snowmobile varied with snow conditions, maximums of 30 to 40 m.p.h. being reached between Points B and C on the initial pass and between D and C on the return. However, although tests were conducted during all 13 weeks, some runs did not yield usable data because static from outside sources (such as a tractor, airplane or radio station) disturbed the operation of recording equipment. The number of runs on each trail that did furnish usable data varied from 9 to 11.

Pre-run heart rates were recorded prior to any preparations for each day's tests when possible. The snowmobile was then brought through the gate and heart rates were again recorded, following which the runs were made. Runs were not started until the heart rate had stabilized or reached the pre-run rate after a response to a previous stimulus or run, and the time required for such recovery was recorded in each case. Measured heart rates were evaluated on a second-to-second basis for each run, and rates were expressed as beats per second.

An average heart rate for each run was calculated, and the highest rate, reached when the snowmobile was closest to the deer (Point C) on the in-

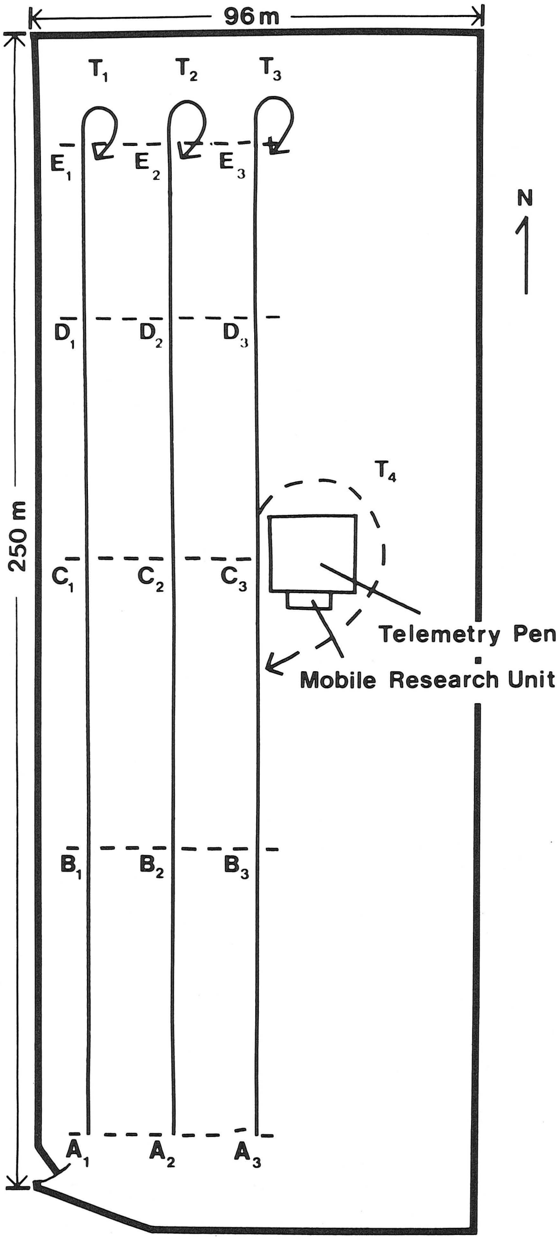

Figure 1. The deer yard showing position of the telemetry pen and the trails used for snowmobile runs as referred to in the text.

itial pass up the trail, as well as the next highest, which generally occurred when the snowmobile was closest to the deer on the return, were determined. The highest and next highest peaks were called the primary peak and secondary peak, respectively. Muscle artifacts made it impossible to read the signal for seven secondary peaks (see Table 1). Each of the two peaks and the average rate for each run were expressed as multiples of the predicted pre-run rate to account for seasonal rhythms in the heart rate (Moen, 1978). The pre-run rates, which it was possible to measure prior to any preparatory activities on only some of the days, were used as a baseline because they did not differ significantly (t = 0.15, d.f. = 15) from those predicted with equations given by Moen (1978) for various activities on the test days.

RESULTS

Heart rates, measured on a second-to-second basis, were dynamic as illustrated in Figure 2 for a 46-second run on Trail 1 and a 30-second post-run period. Changes in activity from walking to standing to running were accompanied by an increase from 115 beats per minute during the pre-run period to 209 b.p.m. (primary peak) in 16 seconds, followed, as the snowmobile moved away from the deer, by a rapid decline to a low of 123 b.p.m. 10 seconds after the peak. A similar pattern occurred as the snowmobile returned; the heart rate reached 180 b.p.m. (secondary peak) when the machine was closest to the deer, declined momentarily to 143 b.p.m.,

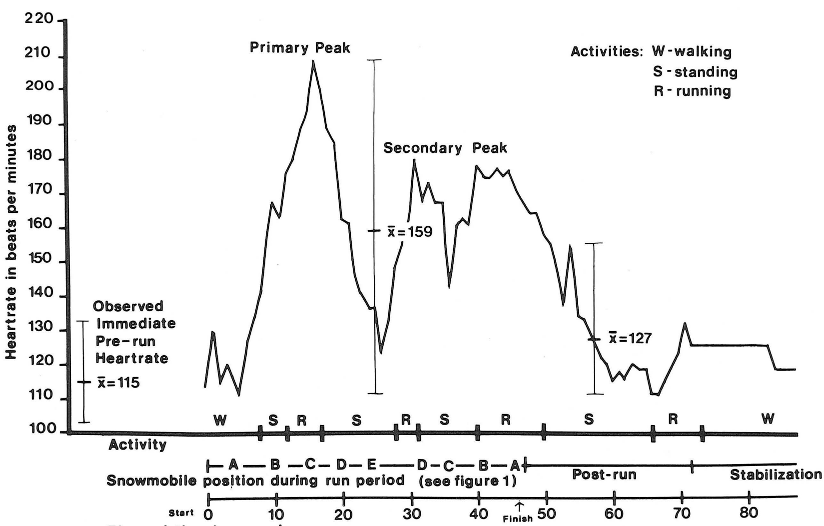

Figure 2. Rapid change in heart rate in relation to position of the snowmobile during one of the test runs.

TABLE 1. AVERAGE VALUES* FOR THE HEART RATE OF THE DEER STUDIED, WITH RESPECT TO THE MAJOR INDICES RECORDED DURING EACH RUN OF THE SNOWMOBILE, FOR EACH TRAIL AND ALL TRAILS COMBINED

Index	Trail 1		Trail 2		Trail 3		All trails combined§
	Number of runs	Average value	Number of runs	Average value	Number of runs	Average value	
Primary peak	12	2.62	12	2.44	12	2.44	2.50
Secondary peak	9	1.78	9	1.57	11	1.80	1.72
Average rate†	. .	1.63	. .	1.55	. .	1.64	1.62

*Figures represent multiples of the predicted pre-run rate in each case, i.e., the rate actually recorded divided by the pre-run rate.

§Does not include Trail 4.

†Average of the averages for the complete individual runs.

then fluctuated around 175 b.p.m. for 6 seconds as the machine returned to the starting point, and stabilized at 118-125 b.p.m. 25 to 30 seconds after the run was over. The pattern of heart rate response shown in Figure 2 was typical of nearly all those recorded during the runs observed.

The average values, in terms of multiples of the predicted pre-run rates, for the primary peaks, secondary peaks and the over-all average rates for the runs recorded on each trail are given in Table 1 together with the average for the three trails combined in each case. For none of the three multiples was there a significant difference between the trails. The data for the three trails combined are shown graphically in Figure 3.

Heart rates were higher when the snowmobile circled the telemetry pen on Trail 4 than when it passed by on the other trails. For the primary peak, the average multiple value was 2.87, significantly higher ($P < 0.01$, t =

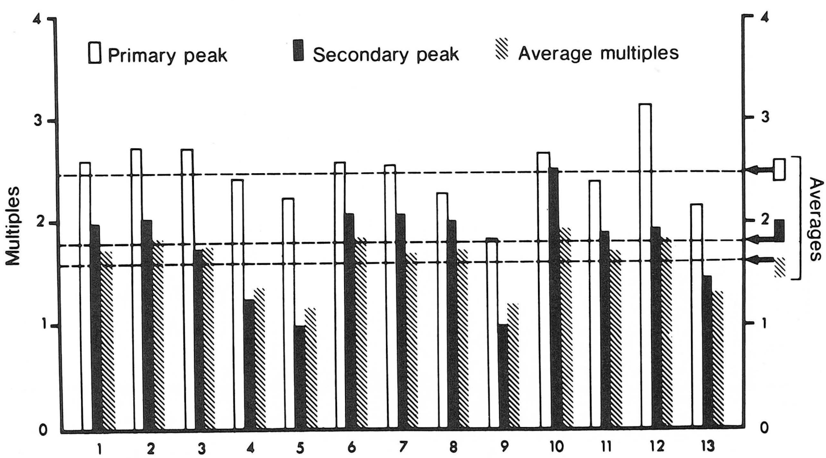

Figure 3. Average values, as multiples of the baseline pre-run heart rates, for the primary peak, secondary peak and average for all runs (combined data for Trails, 1, 2 and 3) during each of the 13 test days between December 2 and March 24. Horizontal dash lines represent averages for all tests.

2.98, d.f. = 10) than that (2.50) for Trails 1-3. A secondary peak did not occur when the snowmobile circled the pen and returned to the starting point. The over-all average was 2.05, significantly higher ($P < 0.01$, t = 6.68, d.f. = 11) than that (1.62) for all of the runs on the other trails.

These data demonstrated that the primary and secondary peaks were not different between Trails 1, 2 and 3. Further, the average heart rates for each run on each trail, expressed as multiples of the pre-run rates, were not statistically different. Apparently the snowmobile had as much effect on the deer's heart rate when it passed no closer than 40 meters from the pen (Trail 1) as when it passed within 2 meters (Trail 3). The response was greater, however, when the snowmobile circled the pen than when it simply passed by it.

Changes in the behavior of the deer were not dependable indicators of the effects of disturbance by snowmobiles on their heart rates. The monitored deer remained either bedded or standing on 11 of the 13 test days, but there were increases in the heart rate each time without overt changes in behavior. The rates for the primary peak ranged from 1.50 to 3.21 (mean = 2.27) times the predicted pre-run rates, while those for the secondary peak ranged from 1.01 to 2.14 (mean = 1.71), and the over-all average ranged from 1.14 to 1.79 (mean = 1.51).

Regular exposure of these deer to snowmobile runs raises the possibility of habituation. If habituation occurred, then the multiples for the primary peak, secondary peak and over-all average for each run should have declined as the winter progressed. The slopes of regression lines expressing these multiples over time were statistically zero in all three cases, however; no habituation was evident.

The time necessary for heart rates to stabilize or return to pre-run levels after the machine had stopped varied from a few seconds to over 11½ minutes and averaged 2 minutes. The average time did not decline as more tests were conducted, again indicating that habituation to the snowmobile or controlled test conditions did not occur.

DISCUSSION

Initial heart rate responses to the starting of the snowmobile and responses to its moving by indicated that deer can react to stimuli without changes in their overt behavior. When the snowmobile circled the pen, the deer showed greater heart rate and behavioral responses. Other deer in the yard also showed greater fright responses when the snowmobile approached them directly than when it moved tangentially to their activity area.

It is important to realize that it is not the snowmobile noise *per se* that affects the deer. Chain saw engines emit a similar noise, but deer learn to associate that noise with the felling of trees and new supplies of forage. Eckstein et al. (1979) considered the location and timing of logging operations to be one of the main factors in determining winter home range, activity patterns and habitat use. Chain saws, however, do not move through the woods at 30 or more miles per hour, while snowmobiles appear to be predators with unlimited kinetic energy. Disturbances may be unintentional on the part of the operator but real to the deer when the machines move through their winter range. One important factor to consider in interpreting the results reported by Eckstein et al. (1979), who did not recognize differences in home-range size and habitat use between areas with and without snowmobiling, is that logging operations were going on at the same time the snowmobile tests were conducted. They concluded that "Deer probably became accustomed to the noise of machinery and power-saws, and this decreased their reaction to snowmobiles."

Eckstein et al. (1979) observed that deer within 61 meters of a trail (21 meters farther than in the tests reported here) moved farther away in 11 of 21 encounters but remained where they were in the other 10. In 22 encounters beyond 61 meters, the deer moved away in five instances, remained in nine and moved closer in eight. The movement toward the snowmobile trails from over 61 meters may indicate that the deer associated the noise with logging operations and that curiosity caused them to move closer to possible forage supplies. In Minnesota, free-ranging deer in an area with no logging moved out of their usual winter range to more secluded areas that were free from disturbance by snowmobiles when traffic levels were high on weekends (Dorrance et al., 1975).

The 2-minute average time observed in the present study for a return to pre-stimulus or stable heart rates may not seem long, but, when expressed on a distance basis, snowmobiles travelling 30 m.p.h. could be ½ mile apart and yet go by a deer every 2 minutes. Distances less than ½ mile between machines are not unlikely in areas with heavy snowmobile traffic. Further, operators often travel in groups, and a prolonged stimulus may add to the total response time of the deer. Such responses are certain to cause an increase in the energy expenditure of deer at a time when energy conservation is a more likely biological response (Moen, 1976, 1978).

Increases in heart rate and additional movements caused by encounters with snowmobiles must increase rather than decrease energy expenditures by deer. Such increases have the potential to affect the productivity of individuals and, ultimately, of the population. Management should take into consideration the basic biological characteristics of wildlife species, and it is evident that disturbance by snowmobiles is contrary to long-term energy-conservation adaptations of white-tailed deer.

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DEGREE TO WHICH PARTICIPANTS IN THE 1978 HUNTER TRAINING COURSE SUBSEQUENTLY BOUGHT A HUNTING LICENSE[1]

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ABSTRACT

Responses to a questionnaire sent to a sample of those taking New York's hunter training course indicated that 87 per cent were actually committed or potential hunters.

Personnel of the State Department of Environmental Conservation who are responsible for the hunter training program in New York have suspected that many people taking a hunter training course do not actually go on to hunt or drop out of the hunting ranks soon after completing it. For outdoor recreationists generally, Driver (1976) noted that their behavior "can be . . . exploratory, or trial and error. . ." Knowing the extent of such behavior among hunters is important when using estimates of recruitment from training courses in planning programs for future hunter populations, as well as in determining the effort that should be devoted to designing courses that will best serve to encourage the participants to become active, committed hunters (i.e., license buyers). Projections of decreasing hunting license sales nationally (Hendee and Potter, 1976) also warrant concern about inconsistent license-buying behavior.

Several studies have dealt with the hunter-desertion issue specifically. Klessig (1970) studied hunter initiation and desertion in Wisconsin to identify the effects of residence and social class on hunting activity. In New Jersey, Applegate (1977) found that, while nine out of 10 hunters were recruited before age 25, half of them deserted by age 25. Peterle (1977) found that Ohio hunters who were resampled after a 14-year period had become less interested in hunting as evidenced by their decreased participation in the activity. Bouchard and Lerg (1977), investigating age as a parameter in the population dynamics of Michigan hunters, found that two age groups (17-18 year olds and 20-26 year olds) bought proportionately more licenses than other age groups, indicating their potential as a license market. Langenau and Mellon (1980) stressed that a dynamic approach to understanding hunting participation over time requires concentration on the younger hunters because they are the ones who will comprise

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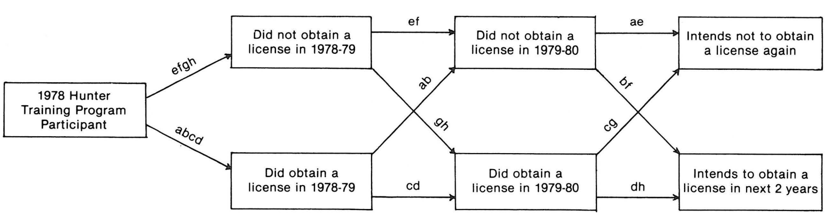
[1]Funded by New York Federal Aid in Fish and Wildlife Restoration project W-146-R. The authors express their appreciation to D.L. Hustin, research support specialist, for her assistance in the study.

the hunting population of the future. However, heretofore no study had been made of the license-obtaining behavior of hunter training course participants—people who had never hunted before.

In 1980, the Department of Environmental Conservation sponsored such a study (Brown et al., 1981), a primary objective of which was to determine the incidence of various types of license-obtaining behavior among participants in hunter training courses. During the spring of that year, a sample of 1,992 people who had registered for these courses in 1978 were sent a mail-back questionnaire. Up to three follow-ups were sent to non-respondents. Also, 75 non-respondents were interviewed during a telephone follow-up survey. Of the 1,992 questionnaires sent, 264 (13.3 per cent) were undeliverable. For those that were deliverable, 1,095 (63.4 per cent) were returned and 1,085 (62.8 per cent) were codeable. However, only 1,020 of the returned questionnaires and 63 of the telephone interviews included useable answers to the questions on which this analysis is based. The high rate of undeliverable questionnaires was expected because the mailing list was two years old.

It was first planned to consider six hunter-participation groups according to license-obtaining behavior: continuous hunters, late starters, sporadic hunters, potential hunters, deserters and non-hunters. A diagram "defining" these groups is shown in Figure 1, and the corresponding distribution of the respondents and those interviewed by telephone is given in Table 1.

The groups were based solely on license-obtaining behavior from year to year and constituted a reasonable conceptual starting point for categorizing participants in the hunter training program according to an indirect



Non-hunter	(e)	had not obtained a license and probably will not.
Potential hunter	(f)	had not obtained a license, but probably will in the future (includes those too young to buy a license).
Continuous hunter	(d)	obtained a license annually from 1978-79 (or first legal opportunity) on and will continue.
Late starter	(h)	did not obtain a license in 1978-79 (and could have legally), but did obtain a license in 1979-80 and will continue.
Sporadic hunter	(b)	obtained a license in 1978-79, did not obtain license in 1979-80, but will in the future.
Deserter	(a, c, g)	obtained a license in 1978-79 or 1979-80, but does not intend to in the future.

Figure 1. Dynamics of license-obtaining behavior of hunter training course participants, in terms of the status in 1980 of those who took the course in 1978.

TABLE 1. DISTRIBUTION OF RESPONDENTS AND THOSE INTERVIEWED BY TELEPHONE ACCORDING TO LICENSE-OBTAINING BEHAVIOR

Group*	Respondents		Telephone survey	
	Number	Per cent	Number	Per cent
Continuous license obtainer	699	68.5	28	44.4
Potential license obtainer	114	11.2	12	19.1
Sporadic license obtainer	77	7.5	10	15.9
Non-hunter§	51	5.0	4	6.3
Late starter†	44	4.3	0	. .
Deserter‡	35	3.5	9	14.3
Total	1,020	100.0	63	100.0

*Six groups originally used.
§Did not obtain a license and did not intend to.
†Delayed obtaining a license.
‡Obtained a license, but then stopped hunting and had no intention of obtaining another in the next few years.

and imperfect measure of their "commitment"[2] to hunting (where obtaining a license is considered an index of that commitment). However, data from the survey suggested a modification that would produce a more logical and functional grouping for purposes of analysis.

It seemed appropriate to divide late starters into two groups, i.e., those who, at the time they took the course, were underage for the license they desired and those who were not. The former group could then be considered continuous hunters who simply took their training early, while the latter group would be a subdivision of sporadic hunters. The late starter group would thus be eliminated as shown in Figure 2, leaving a total of five groups that represent three general categories of hunter commitment, i.e., committed hunters (continuous and sporadic hunters), potential hunters, and uncommitted hunters (deserters and non-hunters). The redistribution of the data on this basis is given in Table 2.

Also shown in Table 2 are adjusted percentages derived by combining weighted values for the data from respondents and non-respondents interviewed by telephone. The weighted values were calculated from the ratio (i.e., 63:37) of respondents to non-respondents for the mail questionnaire. For respondents the proportion (63) was multiplied by the percentages for the different hunter groups, and the same was done for non-respondents using the corresponding proportion (37). For each type of license buyer, the resultant values were added together to give the adjusted percentage.

The adjusted values are the authors' best estimate of the actual degree to which participants in hunter training courses in 1978 subsequently bought hunting licenses. While the majority were the type of hunter for whom the hunter training program was developed, a significant percentage of those

[2]Commitment in hunting includes considerably more dimensions than license-obtaining behavior. The term is used here for convenience.

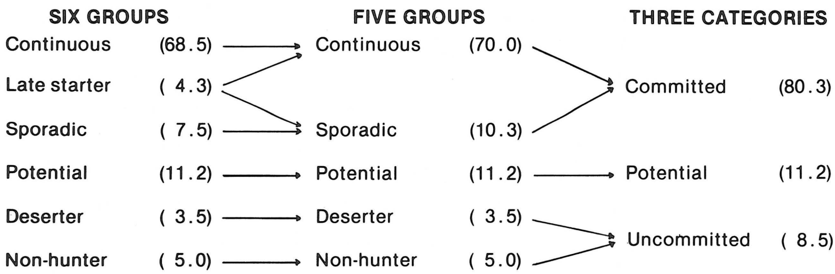


Figure 2. Redistribution of respondents from six to five groups according to license-obtaining behavior, and then to three general categories of hunting commitment. "Late starters" are considered to consist of those underage for the license desired (36 per cent) that are added to the "continuous" group and others (64 per cent) that are added to the "sporadic" group. Figures in parentheses are percentages as given in Tables 1 and 2.

TABLE 2. REDISTRIBUTION OF RESPONDENTS AND THOSE INTERVIEWED BY TELEPHONE ACCORDING TO COMMITMENT TO HUNTING AND LICENSE-OBTAINING BEHAVIOR

Commitment and behavior	Respondents		Non-respondents interviewed by telephone		Adjusted percentage*
	Number	Per cent	Number	Per cent	
Committed					
Continuous	715	70.0	28	44.4	60.5
Sporadic	105	10.3	10	15.9	12.4
Sub-total	820	80.3	38	60.3	72.9
Potential	114	11.2	12	19.1	14.1
Uncommitted					
Deserter	35	3.5	9	14.3	7.5
Non-hunter	51	5.0	4	6.3	5.5
Sub-total	86	8.5	13	20.6	13.0
Total	1,020	100.0	63	100.0	100.0

*Represents combination of data from respondents and non-respondents interviewed by telephone (see text).

taking the courses could be considered as doing so "inappropriately"; that is, although they took the hunter training course, they were not hunters.

This, together with other findings (Brown et al., 1981), indicates that the hunter training program might be redirected in terms of audience, especially the potential and uncommitted hunters. There are two general alternatives[3], which differ considerably in their approach. The first would be to take the position that the program is only for those having the greatest probability of becoming committed hunters. Under this alternative the approach would be to discourage as many as possible of those who

[3]Langenau and Mellon (1980) discussed some additional considerations and approaches for wildlife agencies in formulating policy regarding the general concept of retaining or recruiting new hunters.

wish to take the course but who will not go on to hunt. However, this would require a means of identifying such candidates in advance. The second alternative would be to maintain or try to increase participation by potential and uncommitted hunters as a means of educating people about wildlife management and perhaps persuading some to become hunters. A compromise might be to try to limit hunter training courses to those having the greatest potential to become committed hunters and to undertake separate courses on wildlife management and hunting (e.g., the 4-H Club shooting sports program) for non-hunters. This or a similar approach would help to meet the information and training needs of many young people who are interested in the wildlife resources of the State.

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FISHES OF THE ALLEGHENY RIVER ABOVE KINZUA DAM[1]

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ABSTRACT

Completion of Kinzua Dam on the Allegheny River in 1967 blocked further immigration of fish from downstream. The 79 species recorded in the drainage above the dam since 1900 are listed, of which 72 have been reported since 1967. The status of the infrequently collected species is summarized. Sixteen species that are strictly river fishes have had a significant part of their habitat flooded by the dam.

The Allegheny River drainage is the only part of the Ohio-Mississippi River system that lies in New York. Kinzua Dam about 18 kilometers south of the New York-Pennsylvania boundary was completed in 1967 and blocked the upstream migration of fish to the drainage above it. This drainage embraces an area of some 5,640 square kilometers, about half of which lies in Cattaraugus and Allegany Counties in New York and the rest in Warren, McKean and Potter Counties in Pennsylvania. The major tributary systems within New York are the Olean Creek-Oil Creek-Ischua Creek drainage, the Five Mile Creek drainage and the Great Valley Creek drainage. Another major system, the Tunungwant Creek drainage, is located partly in New York and partly in Pennsylvania. The dam created the Allegheny Reservoir that extends upstream to the vicinity of Salamanca (N.Y.).

Because the dam isolated the drainage above it from further immigration of fish, a record of the species currently inhabiting these waters or known to have been present in recent time is important. This paper summarizes the records known to the authors that pertain to the period since 1900, principally in the publications of Fowler (1906, 1907, 1908, 1910, 1919), Fowler and Carlson (1927), Hankinson (1927), Dence (1928), Greeley (1938), Raney (1939) and Liegey et al. (1955). In addition to records in the literature, data were furnished by Wayne Hadley of the

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[1]The authors are indebted to William Shepherd, Stephen Mooradian, James Pomeroy and Charles Frisa of the New York State Department of Environmental Conservation and John Andersen of the U.S. Fish and Wildlife Service for information on fish stocking in the area. Appreciation is also extended to Wayne Hadley formerly of the State University at Buffalo for information on his collecting activities and to Dr. Robert Schoknecht of Cornell University for data on collections by his associates. A grant to Dr. Eaton from the American Wildlife Research Foundation helped in completing this paper.

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State University at Buffalo and Dr. Robert Schoknecht of Cornell University. The chief sources of recent information have been records of sport fisheries collections from the State Department of Environmental Conservation, collections made from 1950 to 1980 by personnel associated with St. Bonaventure University and collections in 1979 and 1980 by Environment Consultants (Dallas, Texas). The 440 collections by university personnel are housed at St. Bonaventure University. Most are preserved in 5 per cent formalin in glass-lid jars and have been sorted but left as field collections. The majority were made in the vicinity of the university (which is located near the river in the Town of Allegany in Cattaraugus County) and in conjunction with a graduate course in ichthyology.

The location of Kinzua Dam and the river system above it are shown in Figure 1. The 79 species known to have inhabited these waters during the present century are listed in Table 1 according to whether they were present before or after completion of the dam or both.

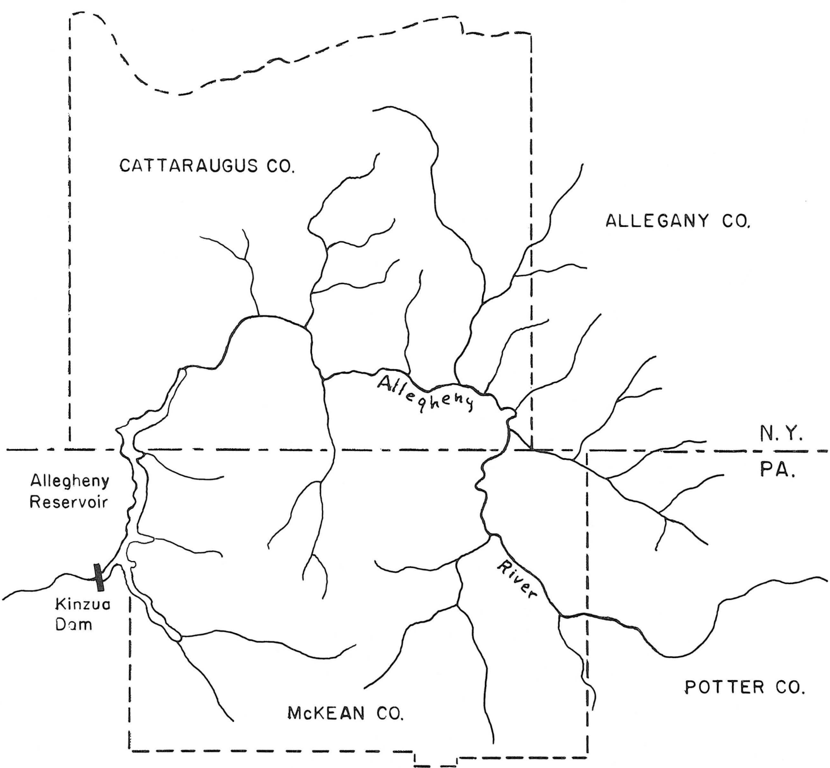

Figure 1. Map showing Kinzua Dam and the Allegheny River system above it.

Ten species (coho salmon, brown trout, rainbow trout, lake trout, northern pike, carp, goldfish, emerald shiner, spot-tailed shiner and channel catfish) have been introduced, although the last three may have been naturally present at one time because they are native farther downstream. Another, the American eel, which was reported from Potter County (Pa.) by Fowler (1919) but not from New York waters by Greeley (1938), was stocked by the Pennsylvania Fish Commission in 1963 (Ronald Lee, personal communication). The only eel in our collection is a 783-millimeter specimen caught by a fisherman at Olean (N.Y.) in 1967.

Five species (paddlefish, grass pickerel, white bass, spotfin shiner and red-bellied dace) have been reported only from the Pennsylvania part of the drainage upstream from New York, although white bass have appeared in the Allegheny Reservoir. Fowler (1919) recorded the paddlefish from the Allegheny River in McKean County, but it has not been seen in recent years and is considered extinct above Kinzua Dam. Raney (1939) noted that the spotfin shiner had a peculiar discontinuous distribution in northwestern Pennsylvania.

The remaining native species are believed to have immigrated from the Mississippi drainage basin into this headwater area since the Pleistocene Epoch (Liegey et al., 1955). None can definitely be shown to be relict from pre-Pleistocene time. Half of the area considered here was never covered by glacial ice and may have been able to support some type of fish life during the Ice Age. But, if so, such fish, being so close to the ice front, would have had to be able to withstand arctic temperatures, and no such species are present today.

Sixteen of the species that are typically river fishes have restricted ranges or are not commonly found in this part of the drainage. Furthermore, about one-fourth of their habitat in New York waters of the Allegheny river system was permanently flooded by the Kinzua Dam. Seven of these, i.e., the river carpsucker, river redhorse, gravel chub, tonguetied minnow, longhead darter, variegate darter and bluebreast darter are not found in any other drainage in New York. The others are the quillback, silver redhorse, black redhorse, golden redhorse, shorthead redhorse, river chub, channel darter, gilt darter and banded darter. Also, the gravel chub, river redhorse, gilt darter and bluebreast darter are rare in this drainage. Although not uncommon, the quillback and river carpsucker have been collected almost exclusively in the Allegheny River. However, the latter was not recorded by Greeley (1938). The gravel chub was also found exclusively in the river and is rare.

Four of the darters have rarely been collected in the drainage area. The longhead darter was taken by St. Bonaventure collectors in the Allegheny River at Westons Mills and Olean. It was also recorded in the river by Greeley (1938) and by Cornell University collectors in 1962 as well as by field personnel from Environment Consultants in 1979. One specimen of

TABLE 1. SPECIES OF FISH RECORDED AS HAVING INHABITED THE ALLEGHENY RIVER DRAINAGE ABOVE THE KINZUA DAM SINCE 1900 IN RELATION TO COMPLETION OF THE DAM IN 1967, TOGETHER WITH THE SOURCES OF THE RECORDS FOR EACH

Species	Prior to 1967							1967 and after				
	Fowler (1907, 1919) and Fowler and Carlson (1927)	Hankinson (1927)†	Dence (1928)†	Greeley (1938)	Cornell collectors	Raney (1939)	St. Bonaventure collectors	St. Bonaventure collectors	Hadley‡	Cervone (1978)	Environment Consultants‡‡	Species stocked since 1966§
*Ohio lamprey (*Ichthyomyzon bdellium*)	††						x	x	x		x	
American brook lamprey (*Lampetra appendix*)	††			x		x	x	x			x	
*Paddlefish (*Polyodon spathula*)	x											
Coho salmon (*Oncorhynchus kisutch*)												x
Brown trout (*Salmo trutta*)				x		x	x	x	x	x	x	x
Rainbow trout (*Salmo gairdneri*)				x		x	x	x		x		x
Brook trout (*Salvelinus fontinalis*)	x	x		x		x	x	x		x	x	x
Lake trout (*Salvelinus namaycush*)		x										x
Northern pike (*Esox lucius*)	x	x	x					x		x	x	x
*Muskellunge (*Esox masquinongy*)				x		x	x	x	x		x	x
Grass pickerel (*Esox americanus*)	x											
*Quillback (*Carpoides cyprinus*)				x	x			x	x		x	
*River carpsucker (*Carpoides carpio*)								x		x		
*Silver redhorse (*Moxostoma anisurum*)	††			x				x		x	x	
#*Black redhorse (*Moxostoma duquesnii*)	††			x				x			x	
*Golden redhorse (*Moxostoma erythrurum*)	††			x			x	x	x	x	x	
*Shorthead redhorse (*Moxostoma macrolepidotum*)	††			x			x	x			x	
River redhorse (*Moxostoma carinatum*)										x	x	

Northern hog sucker (*Hypentelium nigricans*)	x			x	x	x	x	x	x	x	x	
White sucker (*Catostomus commersoni*)	x			x	x	x	x	x	x	x	x	
*Carp (*Cyprinus carpio*)		x	x	x		x	x	x	x	x	x	
Goldfish (*Carassius auratus*)		x	x	x			x	x				
Golden shiner (*Notemigonus crysoleucas*)	x			x	x	x	x	x		x	x	
*River chub (*Nocomis micropogon*)	††			x	x	x	x	x	x		x	
*Bigeye chub (*Hybopsis amblops*)				x	x	x	x	x				
*Streamline chub (*Hybopsis dissimilis*)	x	x		x	x	x	x	x	x	x	x	
#*Gravel chub (*Hybopsis x-punctata*)§§					x		x	x		x	x	
Blacknose dace (*Rhinichthys atratulus*)	x			x	x	x	x	x	x	x	x	
Longnose dace (*Rhinichthys cataractae*)	x			x	x	x	x	x	x	x	x	
Northern creek chub (*Semotilus atromaculatus*)	x	x	x	x	x	x	x	x		x	x	
Pearl dace (*Semotilus margarita*)		x	x	x		x	x	x				
*Tonguetied minnow (*Exoglossum laurae*)	x	x	x	x	x	x	x	x				
Redside dace (*Clinostomus elongatus*)	x	x	x	x	x	x	x	x		x	x	
Emerald shiner (*Notropis atherinoides*)		x	x					x		x	x	x
Silver shiner (*Notropis photogenis*)		x	x	x	x		x	x	x	x	x	
Rosy faced shiner (*Notropis rubellus*)	x	††		x	x	x	x	x	x	x	x	
Common shiner (*Notropis cornutus*)	x			x		x	x	x	x	x	x	
Striped shiner (*Notropis chrysocephalus*)##				x	x		x	x				
Eastern bigmouth shiner (*Notropis dorsalis*)	x	x	x	x		x						
Spot-tailed shiner (*Notropis hudsonius*)	x							x			x	x
Sand shiner (*Notropis stramineus*)	x		x	x	x	x	x	x	x	x	x	
Mimic shiner (*Notropis volucellus*)				x	x	x	x	x		x	x	
Spotfin shiner (*Notropis spilopterus*)	x	x	x									
Red bellied dace (*Phoxinus erythrogaster*)	x		x									
Northern fathead minnow (*Pimephales promelas*)	x			x		x	x	x		x	x	
Bluntnose minnow (*Pimephales notatus*)	x			x	x	x	x	x	x	x	x	
Stoneroller minnow (*Campostoma anomalum*)	x			x	x	x	x	x	x	x	x	
*Channel catfish (*Ictalurus punctatus*)		x	x					x			x	x
*Yellow bullhead (*Ictalurus natalis*)		x	x				x	x		x	x	
*Brown bullhead (*Ictalurus nebulosus*)	x			x		x	x	x		x	x	
Stone cat (*Noturus flavis*)	x			x	x	x	x	x	x		x	
*American eel (*Anguilla rostrata*)	x							x				
Trout-perch (*Percopsis omyscomaycus*)	x			x	x	x	x	x	x		x	
Burbot (*Lota lota*)											x	
White crappie (*Pomoxis annularis*)			x					x		x	x	x
Black crappie (*Pomoxis nigromaculatus*)				x			x	x	x		x	x

TABLE 2. (continued)

Species	Prior to 1967							1967 and after				
	Fowler (1907, 1919) and Fowler and Carlson (1927)	Hankinson (1927)†	Dence (1928)†	Greeley (1938)	Cornell collectors	Raney (1939)	St. Bonaventure collectors	St. Bonaventure collectors	Hadley‡	Cervone (1978)	Environment Consultants‡‡	Species stocked since 1966§
White bass (*Morone chrysops*)	x											
*Rock bass (*Ambloplites rupestris*)	x			x	x	x	x	x		x	x	
*Smallmouth bass (*Micropterus dolomieui*)	x			x	x	x	x	x	x	x	x	
*Largemouth bass (*Micropterus salmoides*)	x			x		x	x	x		x	x	x
Bluegill (*Lepomis macrochirus*)		x		x			x	x		x	x	
Pumpkinseed (*Lepomis gibbosus*)	x			x	x	x	x	x	x	x	x	
*Walleye (*Stizostedion vitreum*)	x			x		x	x	x			x	x
Yellow perch (*Perca flavescens*)				x			x	x		x		
*Blackside darter (*Percina maculata*)	x	x	x	x	x	x	x	x	x	x	x	
*Channel darter (*Percina copelandi*)								x	x		x	
#*Longhead darter (*Percina macrocephala*)				x			x	x	x		x	
#*Gilt darter (*Percina evides*)				x							x	
*Log perch (*Percina caproides*)	x			x	x	x	x	x	x	x	x	
Johnny darter (*Etheostoma nigrum*)	x	x	x	x	x	x	x	x	x	x	x	
Greenside darter (*Etheostoma blennioides*)	x	x	x	x	x	x	x	x	x	x	x	
*Banded darter (*Etheostoma zonale*)	x			x	x	x	x	x	x	x	x	
*Variegate darter (*Etheostoma variatum*)	x			x	x	x	x	x	x		x	
Rainbow darter (*Etheostoma caeruleum*)		x	x	x	x	x	x	x	x	x	x	
#*Bluebreast darter (*Etheostoma camurum*)								x				

Fantail darter (*Etheostoma flabellare*)	x	x	x	x		x	x	x			x
Mottled sclupin (*Cottus bairdi*)	x	x	x	x		x	x	x	x	x	x
Slimy sclupin (*Cottus cognatus*)•				x	x						
Brook stickleback (*Culea inconstans*)	x	x		x		x	x	x	x		x

*Species primarily a river inhabitant.
#Species classed as follows by N.Y.S. Department of Environmental Conservation: gilt darter and bluebreast darter—endangered; black redhorse—threatened; gravel chub and longhead darter—special concern (Dept. order adopted 1982).
§Information furnished largely by John Andersen of the U.S. Fish and Wildlife Service.
†Both Hankinson and Dence sampled only the smaller tributaries in and near Allegany State Park, so the river fishes were missed.
‡Records reported by Wayne Hadley of the State University at Buffalo (personal communication), specimens at Buffalo Museum of Science.
‡‡Records from final environmental impact statement in Southern Tier Expressway Study made for N.Y.S. Department of Transportation in 1980 by Environment Consultants.
††Identification confused in earlier records and clarified by later studies. Correlation with current nomenclature used here is according to the best judgement of the authors.
§§First described in 1966.
##Separated from *Notropis cornutus* in 1961.
•See text.

the channel darter was reported from the Allegheny River just west of Portville (N.Y.) on October 27, 1975 (W.F. Hadley, personal communication), and three additional specimens have since been taken by St. Bonaventure collectors near Olean and Salamanca. The gilt darter and bluebreast darter are the rarest of the darters in this drainage. The gilt darter was taken at three localities in 1937 (Greeley, 1938), but it was not found by St. Bonaventure collectors. A male bluebreast darter, the first report of this species in New York[4], was taken by St. Bonaventure collectors in a fast, deep riffle of the Allegheny River near Westons Mills on September 20, 1973.

The remaining river species appear to be more abundant than the foregoing. However, they all are found in a limited part of the drainage and their populations merit monitoring. Several other species, not strictly river inhabitants, are also of special interest. They are the Ohio lamprey, eastern bigmouth shiner, slimy sculpin and brook stickleback.

The Ohio lamprey was not recorded by Greeley (1938) and was either missed by subsequent collectors or has immigrated into these waters since 1937. It was first identified in the Allegheny River above Kinzua Dam on June 6, 1966 when one specimen was taken by St. Bonaventure collectors near Vandalia (N.Y.). Since then it has been collected occasionally in the river and in Olean Creek.

The eastern bigmouth shiner was first reported in the headwaters of the Allegheny River near Port Allegany (Pa.) by Fowler (1908). Greeley (1938) recorded four specimens from upper Ischua Creek and one from Oil Creek in New York in 1937. Dence (1928) listed it as present in Sawmill Run, Bone Run and Pierce Run, but its habitat in these streams is now flooded by the Allegheny Reservoir. The species was not taken by St. Bonaventure collectors.

The slimy sculpin was reported to have been taken in 1937 in Red House Creek in Allegany State Park (Greeley, 1938). The authors have examined this specimen and feel that it is actually a mottled sculpin. However, the slimy sculpin was also reported from Wolf Run and the Allegheny River near Allegany State Park by S.C. Bishop (field collection sheets on file at Cornell University). The species was not taken by St. Bonaventure collectors, and the authors feel that its presence in the drainage is questionable.

The brook stickleback was taken by St. Bonaventure collectors in the South Vandalia Oxbow near Vandalia (N.Y.) and in the oxbow near Turtlepoint (Pa.). It was also found in a small pool connected at high water to Ischua Creek about 3 kilometers south of Machias (N.Y.). Dollard and Ranken (1978) collected a specimen in waters adjacent to Five Mile Creek near its mouth west of Allegany (N.Y.). Specimens have also been

[4]Identification of this specimen has been confirmed by Dr. C.L. Smith of the American Museum of Natural History.

taken in waters adjacent to Tunungwant Creek near its mouth (Cervone, 1978).

The most intensive study of the fishes present in these waters was the biological survey conducted in 1937 by the State Conservation Department (Greeley, 1938). Species that this survey either failed to record or that immigrated into this area after that time are the Ohio lamprey, river carpsucker, river redhorse, American eel, burbot, channel darter and bluebreast darter. Some of these may have been brought in by man.

The U.S. Fish and Wildlife Service manages the fishery in the Allegheny Reservoir, and from 1966 to 1977 stocked substantial numbers of walleye, largemouth bass and northern pike, as well as smaller numbers of rainbow trout, muskellunge, channel catfish, emerald shiner and spot-tailed shiner. Coho salmon and lake trout have been introduced but not a part of any management plan. The State Department of Environmental Conservation manages the fishery upstream from the boundary of the Seneca Indian Reservation at Vandalia and has stocked brown trout, rainbow trout, brook trout, muskellunge, black crappie and white crappie. The tiger muskellunge (norlunge), a sterile cross between the northern pike and muskellunge, has also been stocked in the Allegheny River, Olean Creek and Cuba Lake.

Of the 79 species of fish known to have inhabited the Allegheny River drainage above the site of the Kinzua Dam since 1900, seven of the typically river fishes are not known from any other drainage in New York, and several are rare in this drainage. The gilt darter, as well as the eastern bigmouth shiner and slimy sculpin, have not been recorded since 1937. All of the latter are especially sensitive to man-wrought changes (Trautman, 1957). A total of 72 species have been recorded in these waters since immigration from downstream was blocked by the dam in 1967. Because these populations can no longer be replenished by such immigration and because the impoundment above the dam flooded some of the best river habitat, it is important that preservation of the limited remaining river habitat be given serious consideration in formulating management programs.

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SEX AND AGE COMPOSITION OF WINTER-KILLED DEER IN THE CENTRAL ADIRONDACK REGION OF NEW YORK[1]

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ABSTRACT

Data for the sex and age of 1,822 winter-killed deer found in some 50 wintering areas in the central Adirondacks from 1930-31 to 1950-51 were correlated with the relative severity of the winter during which the deer died. Nearly two-thirds of the specimens were fawns. The sex ratio among winter-killed fawns during both mild and severe winters averaged 84 males per 100 females, which was significantly different from the average fall ratio of 106.2 males per 100 females. For adults there was little differential in the fall sex ratio, but among winter-killed animals the ratio averaged only 50 males per 100 females. Winter losses were heavier among females than males for deer of all ages.

Winter mortality is an important factor in the ecology of deer populations on their northern range. To understand the effect of such losses, a knowledge of their sex and age composition is essential, and reliable data can only be obtained by examining carcasses of winter-killed deer that are sufficiently intact for sex and age to be determined. In recent years, dead-deer surveys in the Adirondacks have been made in mid- to late spring and a large proportion of the carcasses found have been carrionized, principally by bears, coyotes and bobcats, to such an extent that the needed information could not be obtained.

However, prior to the early 1950's, coyotes were very scarce in the Adirondacks (Severinghaus, 1974a, 1974b). So also were bobcats. The carcasses of winter-killed deer were seldom carrionizied during the winter so that specimens found on winter and early-spring surveys were usually intact. Records of dead deer found during such surveys on some 50 different wintering areas in the central Adirondacks from 1930-31 to 1950-51 afforded reliable data on the sex and age composition of such losses.

The surveys were made by the strip method described by Severinghaus (1961) in which observers walk a strip or strips through a wintering area and record the dead deer found. In the present analysis, all deer considered to have died as a result of hunting were excluded. Also, all predator-killed deer were excluded because of the very low population of coyotes and bobcats. A total of 1,822 winter-killed deer were found for which age could be determined. From 1930-31 to 1942-43, age was recorded only as fawn or adult. From 1943-44 to 1948-49, the lower jaw of each deer was collected and labelled, and the ages of these were later

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[1]These records were gathered by personnel of the New York State Conservation Department: under general funding from 1930-31 to 1937-38 and under Federal Aid in Fish and Wildlife Restoration Projects 1-R, Supp. C from 1938-39 to 1944-45 and W-28-R from 1945-46 to 1950-51. Funds for analyzing the data were provided by the Department under Project W-124-R and by the College of Agriculture and Life Sciences at Cornell University through the Wildlife Ecology Laboratory (A.N. Moen, principal investigator).

TABLE 1. DISTRIBUTION OF WINTER-KILLED DEER FOUND DURING DEAD-DEER SURVEYS IN THE CENTRAL ADIRONDACKS FROM 1930-31 TO 1950-51, ACCORDING TO SEX, AGE AND SEVERITY OF THE WINTER

	Severity of winter§						Total	
	Mild		Severe		All			
Age*	Male	Female	Male	Female	Male	Female	Number	Per-cent
Fawn								
4 - 5+	18.6	8.0	3.4	11.0	22.0	19.0	41.0	
6 - 6+	98.8	160.8	68.2	65.0	167.0	225.8	392.8	
7 - 8+	130.0	146.5	62.6	82.6	192.6	229.1	421.7	
9 - 11+	115.0	104.8	13.4	27.0	128.4	131.8	260.2	
Sub-total	362.4	420.1	147.6	185.6	510.0	605.7	1,115.7	61.2
Yearling								
13 - 16+	10.0	19.2	1.5	1.6	11.5	20.8	32.3	
17 - 19+	10.0	10.6	6.6	4.9	16.6	15.5	32.1	
20 - 24	. .	. .	3.3	3.8	3.3	3.8	7.1	
Sub-total	20.0	29.8	11.4	10.3	31.4	40.1	71.5	3.9
Older adult								
2½ - 3	12.6	10.9	5.8	13.8	18.4	24.7	43.1	2.4
3½ - 4	17.2	31.5	2.9	5.1	20.1	36.6	56.7	3.1
4½ - 5	20.6	16.6	5.1	4.3	25.7	20.9	46.6	2.6
5½ - 6	. .	22.2	6.7	11.4	6.7	33.6	40.3	2.2
6½ - 7	. .	5.6	5.8	17.3	5.8	22.9	28.7	1.6
7½ - 8	13.9	27.9	15.1	11.9	29.0	39.8	68.8	3.8
8½ - 10	40.4	39.1	9.7	36.3	50.1	75.4	125.5	6.9
10½ +	24.5	114.7	23.7	62.1	48.2	176.8	225.0	12.3
Sub-total	129.2	268.5	74.8	162.2	204.0	430.7	634.7	34.9
Total	511.6	718.4	233.8	358.1	745.4	1,076.5	1,821.9	100.0

*In months for fawns and yearlings; in years for older adults. Ages of fawns may have been underestimated by up to 6 weeks because of retarded tooth eruption in this region.

§Severe winters were those of 1930-31, 1933-34, 1939-40, 1943-44 and 1947-48.

assigned by month for fawns and yearlings and by year for older adults according to the method described by Severinghaus (1949). After that, age was recorded in the field by the same method. Specimens of known sex but unknown age were prorated according to the age frequency of those of the corresponding sex for which the age was known. The records were also correlated with the relative severity of the winter during which the deer died, i.e., mild or severe as defined by Severinghaus (1947, 1972).

The sex frequencies of the dead deer during mild and severe winters are compared according to age in Table 1. More dead deer were found during mild winters because there were 16 such winters and only five severe ones. For both sexes combined, nearly two-thirds (61.2 per cent) were fawns, about 4 per cent were yearlings and 35 per cent were older deer. Among the latter, the proportions for prime-age deer (i.e., 2½ to 6½ years old) were about 2 to 3 per cent. Frequences for older age groups were somewhat higher.

In the Adirondacks the chief cause of overwinter mortality among deer is starvation. Most of the specimens examined had a low fat content of the bone marrow, which is characteristic of malnutrition and starvation

(Cheatum, 1949). Malnutrition retards tooth replacement in young deer, and in the central Adirondacks such retardation may be as much as 6 weeks (Severinghaus and Cheatum, 1956:94). Therefore, in the present study, the ages in months assigned to the fawns and yearlings found dead cannot be used to determine whether late-born fawns were more susceptible to death from starvation than early fawns. In terms of the average for several years, male fawns lived slightly longer during mild winters than during severe winters (8.1 vs. 7.4 months). The corresponding figures for female fawns were 7.9 vs. 7.6 months. These differences represented a longer survival, in mild winters as compared with severe winters, of about 20 days for males and 9 days for females.

The sex ratios and age ratios for the dead deer are summarized in Table 2. There was little difference between the sex ratios for mild and severe winters. With respect to age, however, the ratio of fawns to adults was narrower during severe winters indicating that proportionately more adults

TABLE 2. SEX AND AGE RATIOS OF WINTER-KILLED DEER FOUND IN THE CENTRAL ADIRONDACKS FROM 1930-31 TO 1950-51, ACCORDING TO SEVERITY OF THE WINTER

Severity of winter and sex of deer	Number*		Sex ratio		Age ratio	
	Fawn	Adult	Fawn	Adult	Fawn	Adult
Mild						
Male	362	149	86	50	243	100
Female	420	298	100	100	141	100
Severe						
Male	148	86	80	50	172	100
Female	187	173	100	100	106	100

*Total = 1822.

die under such conditions. The significance of differences in these ratios between mild and severe winters was determined by chi-square, and the results are given in Table 3.

The sex ratio among winter-killed fawns during both mild and severe winters averaged 84 males per 100 females, compared with an average fall ratio of 106.2 males per 100 females as reported by Clarke and Severinghaus (1979). Such differential mortality affects the number of fawns surviving to the following spring. The effect may be illustrated by assuming a fall population of fawns comprising 1,062 males and 1,000 females (equivalent to the sex ratio at the time) or a total of 2,062. If these fawns suffered an average winter mortality of 50 per cent, the loss would amount to 1,031 which, at the ratio derived from the present data, would consist of 471 males and 560 females. The surviving fawns would number 591 males and 440 females, representing a sex ratio as yearlings of 134 males per 100 females. Thus, in actuality, the male fawns would have had a 44 per cent loss and the female fawns a 56 per cent loss. Compared with an equal rate of mortality for both sexes, the lower loss of males would result in a

TABLE 3. SIGNIFICANCE OF DIFFERENCES IN SEX AND AGE RATIOS FOR WINTER-KILLED DEER FROM THE CENTRAL ADIRONDACKS FROM 1930-31 TO 1950-51*

Comparison	Value of chi-square	Significance
Sex ratio among fawns§		
Mild winter	8.33	0.005
Severe winter	7.13	0.01
Combined	14.84	0.005
Age ratio		
Male vs. female		
Mild winter	7.37	0.01
Severe winter	19.66	0.005
Mild winter vs. severe winter		
Male	4.29	0.05
Female	4.18	0.05

*Based on data in Table 2.
§Compared with ratio of 106.2 males per 100 females during the fall as reported by Clarke and Severinghaus (1979).

somewhat higher population of yearling bucks, whereas the greater loss of female fawns would lower the increment of female yearlings and result in reduced fawn production the second year following.

In the central Adirondacks, losses from winter starvation occur almost every year. During the years covered by the present study, such losses were heavier among females than males for adult deer as well as fawns and yearlings. In the 21 years from 1930-31 and 1950-51, there were five severe winters and 16 mild winters, three of the latter being so mild that mortality was negligible. During this period bucks (i.e., males with antlers at least 3 inches long) could be legally hunted every year, but there was only one open season (in 1943) when antlerless deer could be taken. At this time there was little differential in the fall sex ratio among adults, probably being about 80 to 90 males per 100 females, while the ratio among winter-killed adults averaged only 50 males per 100 females. That an almost even sex ratio among the adults in the fall was maintained in spite of the annual removal of antlered bucks by legal hunting seems largely attributable to the proportionately greater loss of adult females from starvation together with some illegal kill. In areas where deer populations are subject to substantial overwinter losses, the differential mortality between the sexes among fawns as well as that among adults must be taken into account in formulating management programs.

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GENERAL NOTES

RELIABILITY OF FALL AERIAL CENSUSES FOR LOCATING ACTIVE BEAVER COLONIES IN NORTHERN NEW YORK[1]

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Aerial censuses of active beaver colonies have been used in New York to obtain information on beaver population levels and trends in abundance. However, comparative data have been lacking on the degree to which such counts represent the actual number of colonies present. During the fall in 1973, 1974 and 1975 complete aerial censuses were made on selected study areas, totalling some 1,500 square miles, in Fulton, Hamilton and Washington Counties. This afforded an opportunity to obtain data, by follow-up ground surveys, concerning the reliability of the aerial method.

Aerial observations were made from either a fixed-wing two-seat float plane or a two-seat Bell helicopter. The float plane was flown at about 80 to 100 miles per hour, while the speed of the helicopter was less than 90 miles per hour. Both types of aircraft were flown at heights of 300 to 1,000 feet above the ground depending on topography and weather. The fixed-wing aircraft was most effective over the inaccessible mountainous terrain of Hamilton County because of its longer flying time (more fuel capacity) and faster flying speed. This was enhanced by the use of a local bush pilot who was familiar with the topography and the census method. The helicopter was effectively used in the more accessible open areas in Fulton and Washington Counties. Its main advantages were that it could be flown at lower elevations and slower speeds than the fixed-wing aircraft and that it was more maneuverable and had better visibility. Disadvantages of the helicopter included higher operating costs and a shorter flying range because of less fuel capacity.

The aerial censuses were made in mid- to late October or early November after the leaves had fallen and before snow and ice were present. In order for a beaver colony to be considered active, a fresh food cache (food bed) had to be observed. No other criteria were used to signify an active colony. If numerous apparently active colonies in an area were observed without food caches, flights were often delayed until a later date. All active, as well as possibly active (questionable), colonies were recorded on U.S. Geological Survey topographic maps.

During the late fall and early winter following the aerial censuses, ground surveys were made to verify the status of those recorded colonies that were readily accessible by car (including 4-wheel-drive vehicles) or snowmobile or on foot. Such censuses and follow-up surveys were made in Fulton County in 1975-76, in Hamilton County in 1973-74, 1974-75 and 1975-76, and in Washington County in 1974-75 and 1975-76.

A total of 621 active beaver colonies were recorded during the aerial censuses (Table 1) although many were the same from year to year. Of these, 251 were visited during the ground surveys and all were confirmed as being active.

The surveys in Hamilton County were made on a 225-square-mile area in the vicinity of the South Branch of the Moose River[2]. Additional information was obtained from beaver trappers on this area because during these years they were required to have a special permit from the Department and to report the location of each colony trapped and whether any beaver were taken at it. The ground surveys by Department personnel were more intensive than elsewhere in order to determine trapping pressure and, for each colony checked, to record whether it was active and being trapped and, if so, the type of trap and set being used. These data were compared with the trappers' reports as well as the observations by aerial census. In addition to the 457 active colonies counted on this area by aerial census, 32 were reported by trappers that either had not been observed or had been recorded as questionable by the aerial observer (Table 2). Of these, 13 (41 per cent) proved to be active.

The data in Table 1 show that, for the beaver colonies recorded by aerial observation as active on the basis of the presence of a fresh food cache, all of those subsequently visited on the

[1]A contribution of Federal Aid in Fish and Wildlife Restoration Project W-135-D.

[2]A description of this area was given by Brown and Parsons (1973).

TABLE 1. NUMBER OF ACTIVE BEAVER COLONIES AS DETERMINED FROM FALL AERIAL CENSUSES AND FOLLOW-UP SURVEYS IN THREE COUNTIES IN NORTHERN NEW YORK

County	Year	Aerial census (number recorded as active)	Ground survey: Number visited	Ground survey: Number inactive
Fulton	1975-76	108	35	0
Hamilton	1973-74	181	71	0
	1974-75	145	54	0
	1975-76	131	45	0
Washington	1974-75	30	25	0
	1975-76	26	21	0
Total		621	251	0

TABLE 2. NUMBER AND STATUS OF BEAVER COLONIES ON THE MOOSE RIVER RECREATION AREA REPORTED BY TRAPPERS BUT NOT INCLUDED IN THOSE RECORDED AS ACTIVE DURING THE AERIAL CENSUSES

Year	Total	Status*: Active	Status*: Inactive
1973-74	11§	4	7
1974-75	11	4	7
1975-76	10	5	5
Total	32	13	19†

*Colonies where beaver were trapped were considered active; those where no beaver were taken were considered inactive.

§One other colony was reported on the study area by trappers, but at the time of the aerial census it had been recorded outside the area and therefore is omitted.

†Of these, seven had been noted during the aerial censuses but were recorded as questionable with respect to activity. Seven others, considered inactive on the basis of trappers' reports, were confirmed as such by ground surveys. The remaining five were considered inactive solely on the basis of trappers' reports.

ground were confirmed to be active. The reports from trappers (Table 2) show that on the study area in Hamilton County 13 active colonies were missed by the aerial surveys. If it is assumed (from Table 1) that the colonies in Hamilton County that were recorded as active but not visited on the ground were in fact active, then less than 3 per cent of the active colonies present (i.e., 470) were missed. On the other hand, even if it is assumed that none of those not visited on the ground was active, this proportion would be less than 8 per cent. In either case it may be concluded that complete aerial censuses on an area during the fall are a reliable and practical method for locating active beaver colonies there.

Winter food caches are easily recognized from the air and appear to provide the best evidence of an active colony. Nevertheless, there were instances where beaver were present but no food cache was constructed. One colony on a bog stream in Hamilton County was marked as questionable (no food cache observed) for two consecutive years, yet beaver were trapped there in both years. However, it is felt that the degree of error from this source is minor.

The most important factor in using these caches as criteria of active colonies is the timing of the aerial census. It is possible to fly too early in the fall before fresh caches have been constructed, or too late when they are concealed by snow and ice. It is essential that census flights be made during or after the time of peak food cache construction. An experienced observer is also essential.

For assessing regional or statewide trends in beaver abundance as a basis for management programs, complete aerial surveys of the range are not always feasible. Surveys on that scale must usually be done by sampling. In northern New York the principal method has been to fly 2-mile-wide strips representing approximately 10 per cent of the total area being considered. The present study indicates that aerial counts are reliable for assessing the active colonies on the area actually surveyed. The wildlife manager must then extrapolate such data to apply to the whole area with which he is concerned.

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GROWTH AND MATURITY OF WHITE PERCH IN LAKE ONTARIO[1]

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The white perch (*Morone americana*) became abundant in Lake Ontario after its invasion from the Hudson River watershed in 1950 (Scott and Christie, 1963), presumably by way of the Erie Barge Canal. In 1973 it was the most common species in the eutrophic Bay of Quinte (Christie, 1973). In the late 1970's it was the fourth most abundant species in the shallower areas of the open lake (N.Y.S. Department of Environmental Conservation, unpublished data). It is now important in both the sport and commercial fisheries. Growth characteristics and maturity information are necessary for evaluating the performance of white perch populations under present levels of exploitation and regulation, and for determining effective minimum size limits, or total allowable harvests within a quota management system.

Measurements for estimating growth characteristics were made from 3,000 white perch collected with bottom trawls, gillnets and trapnets at 11 locations (86 per cent being taken from the eastern outlet basin where the fisheries were most intensive) during May-October 1972 and May 1973. Total length, weight, sex and stage of maturity (immature, ripe or spent) were determined for each fish. Age was determined from scales taken above the lateral line and immediately behind the origin of the spiny dorsal fin. Measurements for back calculations of growth were made along the anterior radius of the anterior-posterior axis of the scale, at a magnification of 42×.

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Body length-scale radius, and length-weight, functional relationships were calculated by using the geometric mean functional regression recommended by Ricker (1973). For comparison with the results of other studies reported in the literature in which fork length was measured, the following regression was derived from the measurements of 325 white perch

$$\text{total length} = 1.05 \text{ fork length} + 3.10 \ (r^2 = 0.98)$$

Where necessary for comparison, this equation was used for converting fork length to total length.

New scale growth appears to begin in white perch earlier in the year among juveniles than among older fish. Scale growth occurred as early as May in 2- and 3-year-old fish, but not until the end of June (or sometimes September) among those 8 years old and older. This seasonal pattern of the beginning of new scale growth for white perch of different ages is consistent

TABLE 1. MEAN TOTAL LENGTH (MILLIMETERS) OF WHITE PERCH FROM LAKE ONTARIO (SEXES COMBINED) AND AS BACK CALCULATED TO THE END OF EACH YEAR OF LIFE

Age group	Number of fish	Mean length at capture	Year of life									
			1	2	3	4	5	6	7	8	9	10
I	198	117	93	. .	. .	. .	. .	. .	. .	. .	. .	. .
II	577	161	86	142	. .	. .	. .	. .	. .	. .	. .	. .
III	565	202	88	152	192	. .	. .	. .	. .	. .	. .	. .
IV	362	219	86	150	194	214	. .	. .	. .	. .	. .	. .
V	436	234	87	147	191	215	229	. .	. .	. .	. .	. .
VI	415	249	87	148	192	216	234	246	. .	. .	. .	. .
VII	227	265	86	147	195	220	238	253	262	. .	. .	. .
VIII	96	282	86	144	192	219	240	256	269	278	. .	. .
IX	56	307	89	151	202	232	254	271	285	297	303	. .
X	24	331	89	153	207	237	259	278	293	306	317	327
Weighted mean			87	148	193	217	235	252	269	288	307	327
Annual growth increment			87	61	45	24	18	17	17	19	19	20

TABLE 2. MEAN TOTAL LENGTH (MILLIMETERS) AT THE END OF EACH YEAR OF LIFE FOR WHITE PERCH FROM VARIOUS LOCALITIES

Locality and authority	Year of life									
	1	2	3	4	5	6	7	8	9	10
Connecticut River Marcy and Richards (1974)*	87	180	226	256	279	309	341	. .	. .	. .
Oneida Lake Alsop and Forney (1962)	89	190	226	244	257	269	307	. .	. .	. .
Quabbin Reservoir Taub (1966)	91	155	208	234	253	269	282	304	320	330
Lake Ontario Present study	87	148	193	217	235	252	269	288	307	327
Bay of Quinte Sheri and Power (1969)§	77	128	165	190	211	227	245	265	281	281
Delaware River estuary Mansueti (1961)*	90	138	164	184	199	220	240	253	268	292
Delaware River Wallace (1971)§	84	134	158	175	187	197	207	211	. .	. .

*Converted from standard length using the equation: total length = 1.20 + 1.58 standard length according to Marcy and Richards (1974).

§Converted from fork length using equation derived in the present study (see text).

with the pattern reported for this species in the Delaware River (Wallace, 1971) and in the Bay of Quinte (Sheri and Power, 1969).

The body length-scale radius relationship was

$$L = 35.87 + 1.46R$$

where

L = total length in millimeters
R = scale radius in millimeters $\times$ 42

The intercept of 35.9 millimeters on the ordinate axis was higher than those of 16.7 millimeters reported by Mansueti (1961) for the Delaware River estuary, 22.8 millimeters reported by Au Clair (1956) for Sebasticook Lake in Maine, and 30.8 millimeters (for males) and 21.9 millimeters (for females) reported by Wallace (1971) for the Delaware River. But it was not as high as the 53.1 millimeters reported by Taub (1966) for Quabbin Reservoir in Massachusetts. Taub suggested that the unusually high intercept he recorded may have been due to an inadequate representation of young white perch in his sample.

Female white perch in Lake Ontario grew slightly faster than males ($P < 0.05$) as previously reported for this species in other areas by Au Clair (1956), Mansueti (1961) and Taub (1966). Growth was rapid during the first two years of life, reaching 48 per cent of the average length of 10-year-old fish (Table 1). By fitting the von Bertalanffy growth function to the length-at-age data in this table, estimates were derived for the growth coefficient (0.22) and the mean asymptotic length (442 centimeters). Data summarized in Table 2 show that growth of white perch in Lake Ontario was faster than that reported for fish from the Bay of Quinte (Sheri and Power, 1969), the Delaware River (Wallace, 1971) and the Delaware River estuary (Mansueti, 1961), but slower than that reported for fish from Oneida Lake (Alsop and Forney, 1962), the Connecticut River (Marcy and Richards, 1974) and Quabbin Reservoir (Taub, 1966).

The weight-length relationship for white perch in Lake Ontario was

$$\log W = 5.07 + 3.12 \log L$$

where

W = weight in grams
L = total length in millimeters

Among the 3,000 white perch examined, 32 per cent of the males and 8 per cent of the females were mature by age II, and 88 per cent of the males and 56 per cent of the females by age III. All older fish were mature. These ages at maturity were similar to those reported by Mansueti (1961) for white perch in the Delaware River estuary.

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RENESTING BY RING-NECKED PHEASANTS AFTER LOSS OF OR SEPARATION FROM THEIR FIRST BROOD

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In the spring of 1979, 12 wild female ring-necked pheasants were equipped with radio transmitters and followed throughout the nesting season on a study area near Avon in Livingston County (N.Y.). The major objectives were to document the production of young, mortality among hens, and the habitat types used for nesting and brood rearing. The work was part of an intensive effort to better understand the dynamics of New York's wild pheasant population which has declined in recent years. The population density for females on the study area prior to the breeding season was estimated at between 5 and 12 per square mile (Austin, 1979).

All 12 radio-equipped hens attempted to nest and, although some renested after their nests were destroyed or abandoned, 11 were known to have hatched an initial brood. Contact with the other was lost because of radio failure. Of the 11, radio contact with one was lost and three were killed soon after their broods hatched, one lost her brood late in the rearing season and two continued with their broods into the fall. However, four hens either lost their broods or became separated from them early in the rearing season and renested after that.

For these four hens, incubation and hatching dates were determined by radio tracking. Egg-laying dates were calculated by backdating the clutch according to a laying rate of 1.3 days per egg as reported by Buss et al. (1951) and behavioral observations by radio tracking. Chick survival was usually determined by flushing broods at 3 weeks of age and intervals thereafter. Attempts to count chicks without flushing were usually unsuccessful due to the dense herbaceous vegetation used by the broods. Following is the record for each of the four.

Hen 1703 started egg laying on April 26. She began incubating on May 17 and hatched 13 of the 16 eggs on June 9. One chick was seen with the hen on July 5 but none thereafter. She resumed egg laying on July 12 and began incubation on July 25. Nine of 10 eggs hatched on August 15, but no brood was observed with the hen on September 7.

Hen 1709 started egg laying on May 9 but abandoned her nest on May 23. She started laying a second clutch the same day and began incubation on June 3. The clutch of at least nine eggs began hatching on June 25 but was destroyed by a mammalian predator before the brood could leave the nest. She resumed egg laying on July 4 and began incubation on July 17 but was killed 20 days later. Her last clutch contained nine eggs.

Hen 1712 started egg laying on April 25. She began incubating on May 13 and hatched 13 of 14 eggs on June 6, but 3 weeks later she was observed without a brood. She resumed egg laying on July 5 and began incubation on July 19. Ten of 11 eggs hatched on August 10, but no chicks were seen 3 weeks later. The hen died on September 4.

Hen 1435 started egg laying on April 27. She began incubating on May 15 and hatched all 14 eggs on June 6. Thirteen chicks were seen on June 19, but none was observed with the hen on June 29. She resumed egg laying on July 5 and began incubating on July 18. All 10 eggs hatched on August 9, and at least three chicks were with the hen on August 31.

Renesting by pheasants after having hatched an initial clutch has been documented by Dumke and Pils (1979). In that study, in Wisconsin, four of 74 radio-equipped hens renested after losing their first broods, and the authors concluded that the phenomenon was uncommon and of little consequence in terms of total productivity. In the present study, such renesting occurred more frequently. Of the 12 radio-equipped hens, three (25 per cent) brought off second broods. These, together with the 11 initial broods, represented a total of 1.2 successful nests per hen. Also, chick survival at 3 weeks of age (based on minimum counts) for second broods (14 per cent) was comparable to that of initial broods (11 per cent).

Although the radio-tracking techniques employed did not allow absolute confirmation that some chicks in lost or abandoned broods survived to be incremented into the fall population, other data tended to support this. In a summer road survey of broods in general on the study area during the same year, over 36 per cent of the 28 broods observed were without hens (Austin, 1980a). For the 12 radio-equipped hens, the four (33 per cent) that renested had had initial broods which they had lost or from which they had become separated. The authors believe that many chicks in broods encountered without hens when they are 3 weeks old or older do survive to enter the fall population. Also, the age ratio for males taken during the hunting season in Livingston County in 1979 was 3.8 juveniles per adult (Austin, 1980b), and from this a ratio of 4.1 juveniles per adult was calculated for females (Austin, 1980c). In both cases, the proportion of juveniles was significantly greater than that (1.8 per adult) recorded for the radio-tracked broods during the rearing season. It is believed that the difference chiefly reflected the inadequacy of the flushing technique as a means of accurately counting the number of chicks in broods with hens and the failure of radio tracking as a means of assessing chick survival in broods separated from radio-equipped hens.

The effect on the fall population of the production of second broods by hens that have lost or become separated from their initial broods depends on the number of chicks that survive and the relative level of the pheasant population. In the present instance, the population density was low and the authors believe that the contribution was significant.

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CONTENTS OF BLACK BEAR SCATS FROM THE CENTRAL ADIRONDACKS IN LATE SUMMER[1]

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Little has been published on the foods eaten by black bears in the Adirondack region. This note summarizes the contents of 35 scats collected during July and August of 1978 in the central Adirondacks. Most of them were collected on the Archer and Anna Huntington Wildlife Forest, a 15,000-acre property of the State College of Environmental Science and Forestry near Newcomb in Essex County. The area is transitional between a spruce-fir forest to the north and a northern temperate deciduous forest to the south. Four major forest types were present: northern hardwoods (beech, yellow birch, sugar maple and hemlock); mixed hardwoods (transition between northern hardwoods and spruce flat); spruce flat (red spruce, balsam fir and hemlock); and swamp (black spruce, red spruce, white cedar and red maple). Predominant understory vegetation included raspberries, blueberries, witchhobble and (in summer) wood sorrel and trillium. Raspberry patches were common and extensive along roadsides and in clearings created by logging.

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TABLE 1. CONTENTS OF 35 BLACK BEAR SCATS COLLECTED IN THE CENTRAL ADIRONDACKS DURING JULY AND AUGUST IN 1978

Food and other material	Frequency* (per cent)	Trace§	Aggregate volume (per cent)
Fruit			
Raspberry (*Rubus* spp.)	63	2	38.1
Cherry (*Prunus* spp.)	23	0	6.1
Blueberry (*Vaccinium* spp.)	20	0	2.2
Bunchberry (*Cornus canadensis*)	6	1	0.2
Highbush cranberry (*Viburnum opulus*)	3	1	tr
Unidentified	11	3	tr
Sub-total	xxx	xxx	46.6
Green vegetation			
Grasses (Gramineae) and sedges (Cyperaceae)	40	1	26.5
Unidentified (other than leaves)	43	3	8.8
Spruce needles (*Picea* spp.)	34	6	0.2
Leaves (unidentified)	14	3	0.2
Tamarack cones (*Larix laricina*)	3	1	tr
Sub-total	xxx	xxx	35.7
Animal			
Ants (Formicidae)	38	0	2.9
Wasps (Vespidae)	20	0	1.7
Unidentified larvae	6	1	0.3
White-tailed deer (*Odocoileus virginianus*)	20	1	0.2
Beetles (Coleoptera)	9	2	0.1
Grasshopper (Acrididae)	3	1	tr
Unidentified hair	6	2	tr
Sub-total	xxx	xxx	5.2
Garbage	29	1	10.0
Other			
Bark	38	0	1.8
Moss	4	0	0.5
Inert	19	2	0.2
Sub-total	xxx	xxx	2.5
Total	xxx	xxx	100.0

*Scats in which found.
§Number of scats in which item appeared as less than 0.1 per cent.

Scats were collected for a 7-week period during July and August from five areas, i.e., the four forest types and at least one of two local dumps at the nearby villages of Newcomb and Long Lake. One scat was collected in each area each week, making a total sample of 35. They were placed in paper bags and air dried for storage. Upon examination, they were rinsed under running tap water to facilitate separating the contents. Various references (e.g., Martin and Barkley, 1961; Borrer and White, 1964; Moore et al., 1974) were used for identifying the food items. Visual estimation was used to approximate the percentage volume of the different items.

The analyses are summarized in Table 1. Fruits occurred most frequently and constituted nearly half of the total volume, the great majority being raspberries, especially red raspberry (*Rubus ideaus*) and blackberry (*R. allegheniensis*). Considerable quantities of cherries, probably black cherry (*Prunus serotina*) and chokecherry (*P. virginiana*), and blueberries had also been eaten. Green vegetation, chiefly grasses, sedges and unidentified plant material, composed about a third of the contents. Scats that contained primarily (more than 50 per cent) grasses and sedges were collected before raspberries began to ripen (about July 20). Other vegetation present, mainly hardwood leaves and spruce needles, were usually found in only trace amounts and were considered to have been ingested incidentally to feeding, as were also miscellaneous items such as bark, moss and pebbles.

Colonial insects (Hymenoptera), especially ants and wasps, made up the majority of the animal food found in the scats, but they constituted only a small part of the total volume.

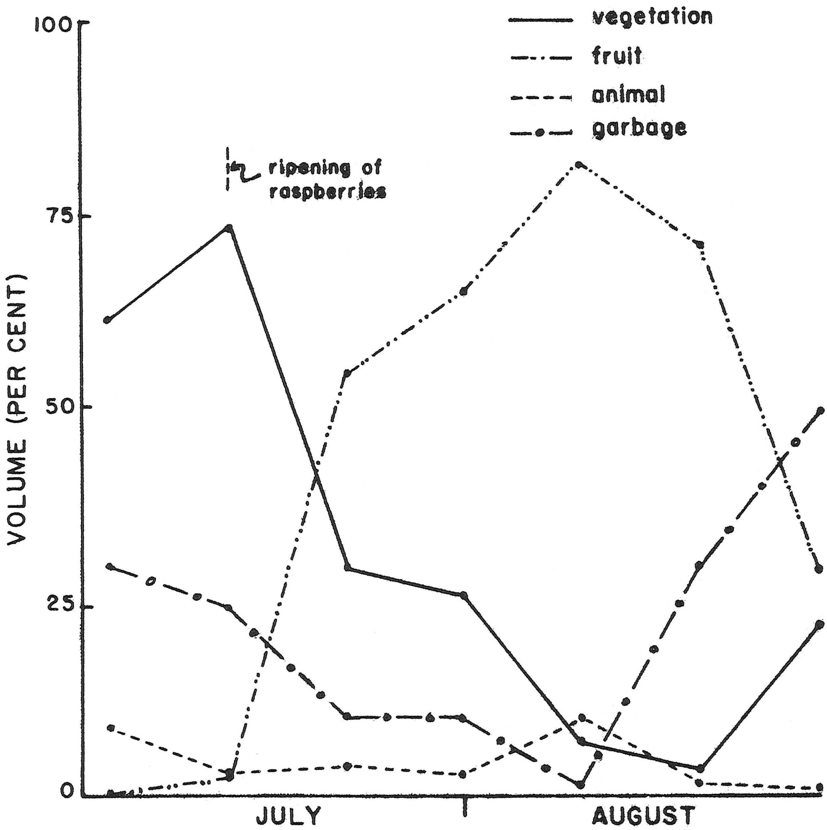

Figure 1. Aggregate volume of four major food categories in 35 black bear scats collected in the central Adirondacks during July and August in 1978. Collections were made at roughly weekly intervals.

However, since insect parts had a high frequency of occurrence, this category may be more important than these records indicate. Also, as noted by Landers et al. (1979), animal foods tend to be under-represented in scats. The only vertebrate identified was the white-tailed deer, but whether this represented predation or feeding on carrion was not known.

The high proportion of garbage reflected the collection of scats from the village dumps at Newcomb and Long Lake. Such scats were often pulpy, apparently due to bears eating foods associated with cardboard boxes. Pieces of plastic garbage bag, glass and bone were also found, and bears were observed eating scraps of all sorts as well as licking the inside of pet-food cans and old syrup or honey containers. Although such material is foreign to their natural diet, Sauer et al. (1969) suggested that dumps in the Adirondacks provide a supplementary food supply for bears and attract them as long as the dumps are available. Also, Rogers et al. (1974) noted that bears that supplemented their diet with garbage maintained higher reproductive rates than those that did not.

The aggregate volume (as percentage) of each of the four major food categories in the scats collected each week is plotted in Figure 1. Considering only the natural foods, the great importance of green vegetation and fruits at this season is apparent. Green vegetation was the principal food during the first two weeks, but with the ripening of raspberries about July 20 these and other fruits predominated for the rest of the study period. Raspberries were abundant since they commonly grow in logged-over areas and can grow well even on infertile sites. It was not unusual to find scats composed entirely of raspberries or blackberries in areas where patches of berries were not present. The occurrence of animal foods, chiefly ants, wasps and deer (probably carrion), was fairly consistent throughout the period, although the volume eaten was low.

Of interest with respect to the use of fruit is its possible relationship to productivity in black bears. Hatler (1972) in Alaska and Rogers (1976) in Minnesota correlated failure in the blueberry crop with declines in the bear population. Jonkel and Cowan (1971) in Montana found that during a period of low huckleberry production all 34 marked adult females they captured or observed were without cubs.

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LONG-DISTANCE MOVEMENTS BY TRANSFERRED WILD TURKEYS IN NEW YORK

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The trapping and transfer of wild turkeys is currently considered the most effective method of establishing populations in suitable unoccupied habitat. In New York such a program was undertaken in 1959, and since then wild turkeys have been released in 38 of the State's 62 counties with the objective of establishing self-sustaining populations in all suitable environments.

In the mid-1960's efforts were begun to establish wild turkeys in southeastern New York by transferring trapped birds from range in the southwestern part of the State where the species had already become established. By 1970 the birds had increased sufficiently in Delaware County so that turkeys could be trapped and released in other parts of the southeastern region. Between the two operations, 227 turkeys were transferred from 1966 to 1978. The records for two of these are noteworthy because of the distance between the points of release and recovery.

One, a juvenile male, was trapped in the Town of Almond in Allegany County on September 12, 1969 and released with 11 other turkeys in the Town of Walton in Delaware County about 209 kilometers to the east. This turkey was recovered 8 years later on November 23, 1977 in the Town of Roxbury in Delaware County about 53 kilometers northwest of the release site. It had been shot illegally during the closed season.

The other, also a juvenile male, was trapped in the Town of Stamford in Delaware County on February 1, 1977 and released with two other turkeys 60 kilometers to the northeast in the Town of Charleston in Montgomery County. This turkey was recovered on May 31, 1978 in the Town of Gilboa in Schoharie County about 52 kilometers southeast of the release site. It was taken legally by a hunter during the spring gobbler season.

In each case the habitat at the sites where the transferred birds were released was considered suitable for the establishment of a wild turkey population. Turkeys are now abundant in the Delaware County area, with many birds being taken during both spring and fall hunting seasons. The release site in Montgomery County was in an area of marginal habitat. However, all the turkeys released there were marked with colored streamers, and some two years later observers began to see birds without such streamers, indicating successful reproduction.

Although it is not unusual for turkeys to wander about after liberation, reported movements have averaged less than 16 kilometers (Bailey, 1959; Schorger, 1966; Proud, 1969; Wunz, 1971). For the other 17 recoveries from the transferred birds noted here, movement averaged 9.5 kilometers. There are few records of travels over long distances. However, Russo (in Schorger, 1966), Burget (ibid.) and Oliver and Bennett (ibid.) reported movements of 40 to 60 miles (64 to 97 kilometers) in Arizona, Colorado and Washington, respectively. Wunz (1971) stated that an adult gobbler was shot 100 miles (161 kilometers) southeast of its release site at Pymatuning, Pennsylvania.

A variety of influences are probably involved in transferred birds moving from their release site. Nervousness from capture and strange surroundings were reasons advanced by Schorger (1966). Proud (1969) felt that the urge to locate others of their own kind as well as to find habitat of their own liking are motivations. The turkey that was recovered in Delaware County 53 kilometers from its release site and 8 years later may have begun travelling immediately to locate an existing flock and may have been kept moving by encounters with hunters during the fall. How long it took is unknown, but virtually all the habitat between the two sites was considered very good for turkeys. With respect to the other bird reported here, the release site in Montgomery County was in marginal range and some 24 to 32 kilometers north of established turkey populations. That it moved southward shortly after release may have represented a search for better habitat or other turkeys or both.

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FIRST RECORD OF THE BANDED DARTER IN THE NEW YORK PART OF THE SUSQUEHANNA RIVER DRAINAGE[1]

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The banded darter (*Etheostoma zonale*) is widely distributed in the Mississippi River drainage from Tennessee and Kansas north to Minnesota and New York (Denoncourt and Stauffer, 1976). However, it was not reported from the Susquehanna River drainage until

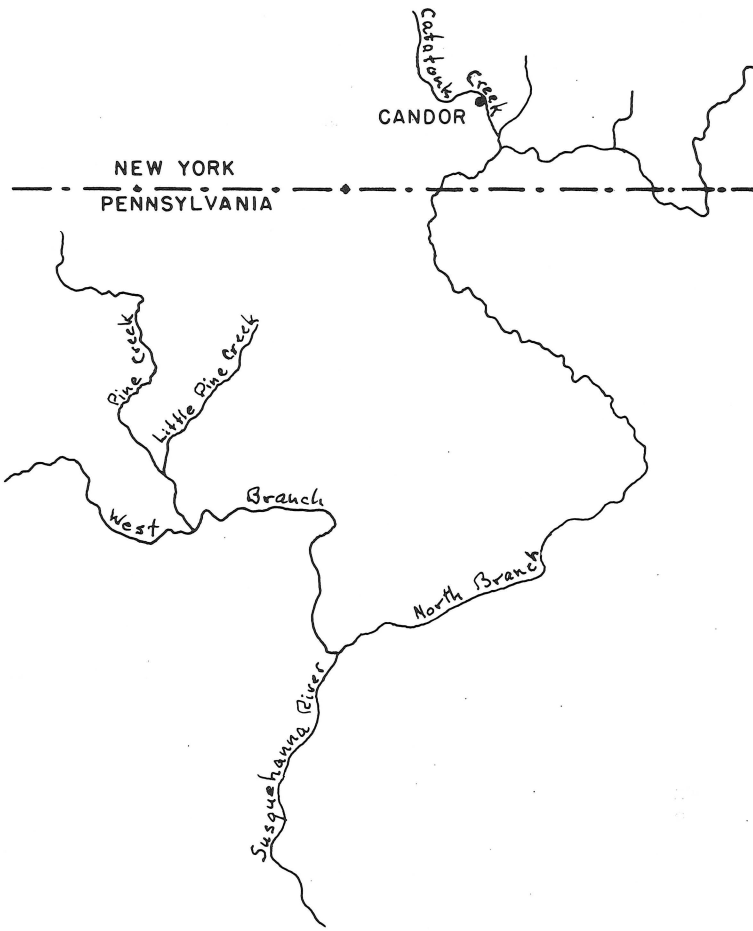

Figure 1. Map of upper Susquehanna River showing Pine Creek and Little Pine Creek on the West Branch in Pennsylvania where the banded darter was first collected, and Catatonk Creek on the North Branch where it was taken in New York.

[1]The specimens reported from New York were collected during an ichthyology class field trip. The author wishes to thank John B. Heiser, Harold Weeks and fellow students for their help in collecting the darters. Thanks are also extended to John B. Heiser, Harold Weeks and Edward B. Brothers for reading the manuscript.

1971 (Kneib, 1972) despite extensive studies on the ichthyofauna of the drainage (Fowler, 1949; Bielo, 1963), several taxonomic and distributional studies on the species (Tsai, 1966; Tsai and Raney, 1974) and collections in Pine Creek and Little Pine Creek by E.L. Cooper during the period 1962 to 1965 (Denoncourt et al., 1975). The specimens collected in 1971 were taken in Little Pine Creek in Lycoming County, Pennsylvania, and appear to have resulted from a bait-bucket introduction (Kneib, 1972; Denoncourt and Stauffer, 1976). In June 1972 Hurricane Agnes caused a severe flood in the Susquehanna system, and shortly thereafter the banded darter was collected downstream in southern Pennsylvania and Maryland (Denoncourt et al., 1975).

On October 5, 1980, two male and two female banded darters were seined from Catatonk Creek at Candor in Tioga County, New York (Figure 1). The males measured 55.0 and 53.5 millimeters in standard length, and the females measured 49.0 and 48.0 millimeters.[2] They constitute not only the first published record for this darter in the Susquehanna River drainage in New York, but also the first for the North Branch.[3] It is almost certain that the species had reached the collection site in Catatonk Creek during the previous year since Cornell ichthyology classes had visited this stream annually for the preceding six years (Edward Brother, personal communication).

Assuming that there were no additional introductions of the banded darter to the Susquehanna, this occurrence represents an extraordinary upstream movement for a small, benthic fish. Winn (1958) reported that darters may at the most swim only a few kilometers upstream each year to spawn. Quite probably, banded darters were present at the mouth of the North Branch immediately after Hurricane Agnes in 1972, although some may have entered the stream earlier, just after Cooper's collections in 1965. In either case, the present record suggests that the species extended its range upstream some 235 kilometers in 8 to 15 years.

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[2]One of these specimens has been deposited at Pennsylvania State University and three at Cornell University (CU 65037).

[3]Two additional specimens were collected from Catatonk Creek on September 21, 1981.

OCCURRENCE OF THE NANDAY CONURE IN WESTCHESTER COUNTY, NEW YORK[1]

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In early June 1980, an adult and immature nanday conure or black-hooded parakeet (*Nandayus nenday*) were observed at the northern end of Silver Lake in the Town of Harrison in Westchester County (N.Y.). In November 1980, six nanday conures were reported foraging in a field at Indian Point in the Town of Buchanan, 20 miles from Silver Lake. Local residents had been watching and feeding these birds for four months. One was also seen in Cold Springs, about 10 miles from Indian Point. The only previously documented occurrences of the species in New York were on Long Island in the early 1970's when two birds were taken along the south shore and another was destroyed by a farmer in Bellport when it was seen feeding in his cornfield (Roscoe et al., 1976).

The nanday conure is native to central South America where it forms large flocks that forage in the savannahs and palm groves for seeds, fruits, nuts, berries and vegetable matter. It is particularly abundant in southern Paraguay and causes considerable damage to sunflower and maize crops (Forshaw, 1978). In addition to being a pest on corn, Kolar (1972) reported it to be a pest on wheat and rye.

A feral population consisting of captive-raised birds, that were released or escaped, and their progeny occurs and breeds in San Bernardino County in California. These birds feed mainly on seeds of the chinaberry, a common ornamental tree. They also eat palm fruits, sunflower seeds and nuts and feed on the ground in harvested cornfields (Fisk and Crabtree, 1974), and according to the same authors they use old woodpecker holes and tree cavities for nesting sites.

Another South American member of the parrot family, the monk parakeet (*Myiopsitta monachus*), was able not only to survive New York winters but also to establish a breeding population on Long Island and in metropolitan New York. In the early 1970's, approximately 95 monk parakeets were eradicated and 11 nests were destroyed because the growing population represented a threat to agriculture (Forbes, 1974).

With the potential problems of agricultural depredation and competition with native hole-nesting birds in mind, it was decided to remove the nanday conures from the wild. If they proved as difficult to trap as the monk parakeets, removal while their numbers were still small would save time and money. The six conures at Indian Point were pre-baited during Christmas week and came in to feed regularly. However, during the week, the birds started disappearing one by one. A young boy with a pellet gun was suspected of shooting them, but it is also possible they did not survive the sub-zero temperatures then occurring. For the period December 25, 1980 to January 6, 1981, the average low temperature at the Westchester County Airport was 10.3° F. (National Oceanic and Atmospheric Administration, 1980, 1981). No dead birds were found, so the cause of their disappearance could not be firmly determined. On January 6, 1981, the only remaining nanday conure was trapped in a standard dove trap. Examination revealed serious frostbite, both feet being completely gone and the upper mandible almost gone. The bird is presently (August 1981) being held in captivity, and its bill appears to be regenerating to some extent. Although only one of the conures was ultimately taken by Department personnel, it is felt that the removal of these exotic birds before they became more numerous was the proper course.

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[1]The author acknowledges the assistance of Joseph Steely, senior wildlife biologist, on this project.

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