Validity of the Subspecies Designation for the Dwarf White Sucker (*Catostomus commersoni utawana*)

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A reexamination of white sucker populations originally used to document the subspecies validity and biology of a dwarf white sucker, *Catostomus commersoni utawana*, provided no evidence of two separate populations of different-sized individuals. Small mature white suckers and larger or normal-sized white suckers still were present, but there was a continuous range of sizes after maturity. After maturity males grew slower than females and had a higher rate of annual mortality. If the size separation originally used to separate the two forms was applied to this study, then all normal-sized white suckers in this study were females and would have had to reproduce with smaller males. Also, no meristic or morphological evidence for justification of a subspecies designation for the dwarf form of white sucker in this lake was found. Because it was also known that considerable variation in the size of white suckers at maturity occurs throughout the range of this species, it was concluded that the existence of a distinct dwarf subspecies has not yet been demonstrated.

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Un réexamen des populations de meuniers noirs utilisées au début pour démontrer la validité d'une sous-espèce et la biologie d'un meunier noir nain. *Catostomus commersoni utawana*, n'indique pas qu'il s'agisse de deux populations séparées d'individus de tailles différentes. De petits meuniers noirs mûrs et des meuniers noirs plus grands ou de taille normale sont encore présents, mais il y a cependant une gamme continue de tailles après la maturité. Après la maturité les mâles croissent à un rythme plus lent que les femelles et ont un taux plus élevé de mortalité annuelle. Si l'on applique à cette étude la longueur originellement utilisée pour séparer les deux formes, tous les meuniers noirs de taille normale dans la présente étude sont des femelles, et il aurait fallu qu'elles se reproduisent avec des mâles plus petits. En outre, nous n'avons pas trouvé de caractères numériques ou morphologiques pour justifier le statut de sous-espèce à la forme naine du meunier noir dans ce lac. Etant donné de plus qu'il y a variation considérable dans la taille des meuniers noirs à la maturité dans toute l'aire de répartition de l'espèce, nous concluons que l'existence d'une sous-espèce naine distincte n'a pas encore été démontrée.

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IN 1890 Mather described a new species of white sucker from the Blue Mountain Lake region in northern New York state as "the June sucker" *Catostomus utawana*. Mather considered that this species was distinct from the white sucker, *Catostomus commersoni*, because of its small size at maturity and its later spawning season. In 1937 Dence, working in the same area as Mather, observed that "there are two kinds of common suckers in Wolf Pond [Wolf Lake]. During early June many dwarf suckers (*Catostomus commersonii utawana*) ranging [in standard length] from about 5 to 8 inches in length were spawning in the two principal inlet streams only a short distance from the pond. Larger suckers (*Catostomus commersonii commersonii*) ranging from 12 to 18 inches in length, were taken during this same period at various places in the pond itself". A comprehensive account of the

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biology of the dwarf sucker was published by Dence (1948) based on a study of white suckers from Wolf Lake, situated less than 40 km from the location of Mather's original samples. Dence believed two forms existed sympatrically in Wolf Lake, but he considered there was insufficient taxonomic separation to merit a species distinction and adopted the subspecies designation *Catostomus commersoni utawana* Mather, that had previously been suggested by Greeley and Green (1931). The existence of a small form of white sucker has since been recognized by other workers (Kendall and Dence 1929; Hubbs and Lagler 1964; McPhail and Lindsey 1970) and the occurrence of small-sized mature white suckers is not an uncommon observation throughout the range of the white sucker.

The recognition of subspecies within a small lake poses some interesting questions concerning the mechanism of isolation of the forms because subspecies are normally allopatric and interbreed where they come in contact. Before consideration could be given to the origin of dwarf forms of white suckers it was necessary to attempt to answer some of the questions not considered in Dence's study. This was necessary to confirm whether two distinct forms did exist and if not whether another explanation of the "dwarfs" was possible. Specifically, there were no age-size or morphological comparisons of the two forms and there was very little information concerning the biology of the normal-sized form.

Materials and Methods

Wolf Lake, approximately 74°12'W and 44°01'N was selected for this study because of Dence's previous studies in the lake and because this lake, located on the Huntington Wildlife Forest Experiment Station property, has been maintained as a forest preserve and is relatively undeveloped. The bathymetric map (Heady 1942) indicates that it is an elongate, rectangular lake with a basin at the south end of 12 m maximum depth, a central basin of 14 m maximum depth, and a shallower north end with an approximate average depth of 6 m. The lake has a surface area of 59.8 ha and a maximum depth of 14 m.

Fish were sampled May 29–30 and October 9–12, 1971, and June 2–5, 1972. Fish were collected from spawning streams using seines and from the lake using gillnets and small-mesh trapnets (Beamish 1973a). Trapnets were set in many locations in an attempt to sample a variety of habitats. Gillnets of stretched-mesh size ranging from 1.9 to 10 cm were set in the deeper and shallower areas of the lake. Because immature fish and individuals representing the larger "subspecies" were difficult to find, all fish smaller than 100 mm and all those larger than 239 mm were weighed; fork length, sex, and maturity were recorded; and a scale sample and the first 4–6 anterior pectoral rays were collected for the determination of age as described by Beamish (1973b). Subsamples were selected by dividing total catch into smaller lots and sampling all fish in any one lot. Lots of fish of sizes 100–239 mm were subsampled from the catch to provide age-growth and age-maturity estimates of lake-dwelling and stream-spawning fish. Samples of all the large fish, subsamples of dwarf forms captured in the lake and all of the dwarf forms captured in the spawning streams at the south end of the lake were preserved in 10% Formalin for subsequent morphometric comparisons. A total of 93 specimens ranging from 88 to 518 mm total length were examined for meristics and proportions. Fish were selected to include representatives of each sex from the complete total length range as follows: 20 unsexed < 100 mm; 10 male and 10 female 101–200 mm; 10 male and 10 female 201–300 mm; 15 female > 301 mm; and 10 male and 8 female from fish found spawning in one of the creeks.

The following morphometric characteristics, except where noted, were determined according to the methods outlined in Hubbs and Lagler (1964); principal dorsal rays, principal anal rays, pectoral rays, pelvic rays, lateral line scale count (all scales from operculum to end of scales), scales above lateral line, scales below lateral line, branchiostegal rays (left side only), gill rakers on outer surface of first arch (number on upper and lower limb separated), gill rakers on inner surface of first arch (total only), fork length, total length, least depth of caudal peduncle, length of caudal peduncle, height of anal fin (origin to tip of longest ray), length of pectoral fin, length of pelvic fin, head length, snout length, and length of orbit.

The following proportions were calculated arithmetically: height of anal fin into total length, length of pectoral fin into total length, length of pelvic fin into total length, head length into total length, snout length into head length, length of orbit (eye diameter) into head length, caudal peduncle length into total length, and caudal peduncle depth into caudal peduncle length.

Factors for converting total length and fork length were calculated using the 93 specimens between 88 and 518 mm total length (Table 2). All lengths measured in the field were fork lengths and all lengths for meristic and morphometric series were total lengths.

Results

Throughout the study 4250 white suckers were captured from the lake and 70 from a group of spawning individuals in the south inlet stream. All of the 70 inlet spawners and 1130 individuals from the lake were sampled completely for length, weight, sex, maturity, and age. An additional 400 fish captured in the lake were sampled for length, weight, sex, and maturity. Fish larger than 199 mm were sorted and sampled from

TABLE 1. Relative size and sex ratios of white suckers (*Catostomus commersoni*) from Wolf Lake. Numbers in parentheses are numbers of individuals in the samples.

Length-class (*mm*)	% of catch in each length-class: Gillnet[a] plus trapnet (4044)	Subsample from trapnets[b] (2820)	South inlet spawning individuals	Sex ratio[c] ♀ : ♂	No. of ♂[c]
0–199	83.2	87.2	97.1	0.94:1	449
200–219	10.8	8.3	2.9	3.25:1	40
220–239	3.3	3.2	0	6.13:1	15
240–279	1.8	1.0	0	22.00:1	3
280–299	0.3	1.0	0	No ♂	0
300–399	0.3	<0.1	0	No ♂	0
≥400	0.3	0.1	0	No ♂	0

[a]Total gillnet catch 775 individuals. Effort expressed as meters of gillnet set for a 24-h period.

Stretched mesh (*cm*)	1.9	3.2	3.8	4.5	5.0	6.5	7.5	10.0	11.5
Meters gillnet	60	60	200	170	75	170	365	90	275

[b]A total of 20 trapnets were fished for a 24-h period during the study and the total catch was 3545 individuals.

[c]Sex could not be determined for all 1600 fish examined.

4050 of all fish captured. Only 680 or 16.8% were larger than 199 mm and only 6% were larger than 219 mm (Table 1). The actual percentage of fish larger than 199 and 219 mm in the population may be slightly lower and closer to the values obtained from the trapnet samples (Table 1) because gillnetting operations tended to capture larger individuals, e.g. one 5-cm stretched mesh gillnet captured white suckers ranging in length from 200 to 290 mm. Less than 3% of the inlet spawners were larger than 199 mm and none was larger than 219 mm (Table 1).

The sample of fish smaller than 200 mm contained approximately equal numbers of male and female individuals (Table 1). Approximately 94% of fish larger than 199 mm were females and all 35 fish in length-classes above 279 mm were females. Only 101 females and 3 males larger than 239 mm were found from all fish sampled. The largest male measured 262 mm.

Fish first started to mature at age 3 (Fig. 1). At age 4, 48% of the fish examined were mature and by age 5 only 13% were still immature. Males dominated the catch of mature fish to age 6 and after age 6, females were more numerous (Fig. 1). Sex could not always be distinguished in immature fish, especially in age 1 and 2 individuals. Of the fish that could be sexed, 54% of 77 age 3 immature fish were females; 61% of 38 age 4 immatures were females; 83% of 18 age 5 immatures were females; and 93% of 14 immature white suckers older than age 5 were females. Growth after maturity often is reduced and fish that mature at older ages might also be larger. However, an examination of immature fish 4 and 5 yr old showed that immature fish were actually smaller (t-test $P \leq 0.05$) than mature fish. There also was no indication from the length-frequency distributions of immature fish that two size-groups existed with age-classes.

The growth curves for fish taken in the sampling periods were similar. Only the curve for the spring 1972 sampling period is presented (Fig. 2). Since very few larger and older fish were captured, the individual ages of all fish captured during the study that were age 10 or older were included in Fig. 2. Some of the larger females reached ages up to 18 yr, whereas the oldest and largest male was 14 yr. The probability that the female growth curve was significantly different from the male growth curve (Fig. 2) was tested by estimating the probability that mean female size was larger than mean male size for each age-class of mature fish (t-test). The probabilities were combined for each sex by means of a chi-square transformation (Fisher 1950, Section 21.1) and it was found that the growth curves in Fig. 2 were significantly different ($P < 0.05$), indicating that female growth was greater than male growth after age 3.

A catch curve is a graph of log frequency against age (Ricker 1958). From the slope of the descending right limb of the curve it is pos-

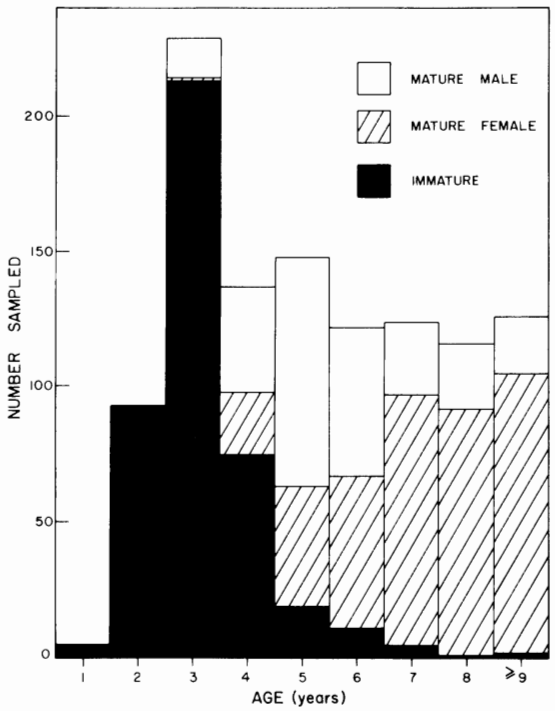

FIG. 1. Relative numbers of mature males, mature females, and immature white suckers (*Catostomus commersoni*) sampled for age in Wolf Lake.

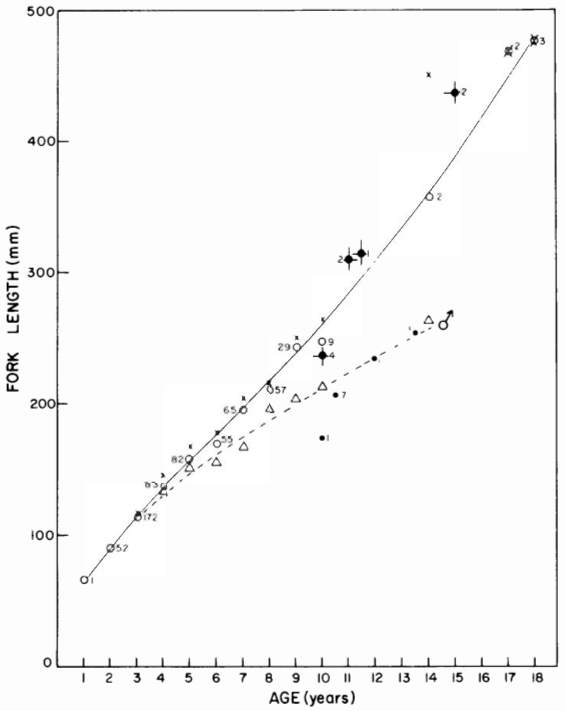

FIG. 2. Growth curve for white suckers in Wolf Lake; curves fitted by eye: ○, mean fork length; ×, mean form length females; sampled in the spring 1972; △, mean fork length males; sampled in the spring 1972; ✦, mean fork length females from all other sampling periods; ●, mean fork length males from all other sampling periods.

sible to estimate the natural mortality in a population. The catch curve of a total trapnet catch of 286 individuals (Fig. 3) showed that age 4 males suffer a higher mortality than females. Not until age 7 do females incur a rate of mortality similar to males. The ratio of females to males captured for this sample was 1.8:1 and was slightly lower than the ratio of 2.2:1 for the total number of fish that were sampled for sex throughout the study (Table 1). This indicates that this trapnet catch could be considered a representative sample of the population.

The meristic and morphometric measurements (Table 2) were similar to the description of those of the common or normal-sized white sucker (Scott and Crossman 1973). The number of anal and branchiostegal rays were seven and three, respectively, in all fish. In none of the characters examined could a definite separation be made between the small and large forms. A discriminant function analysis was applied to the meristic data of Wolf Lake white suckers to determine if a separation of two forms was possible. Fish larger than 220 mm fork length or 239 mm total length were considered to be normal-sized according to the separation used by Dence (1937). No significant difference in the meristic measurements of 23 normal-sized and 48 smaller-sized suckers was found ($P \leqslant 0.05$). In addition to the discriminant function analysis all characters in Table 2 were arranged by total length and the means of the smallest 47 were compared with the means obtained from the largest 46 using a *t*-test. Tests were made for males and females separately and combined. Significant differences ($P \leqslant 0.05$) were found for arc sine transformed proportion values involving snout length to head length, eye diameter to head length, length of pectoral and pelvic rays, pectoral and pelvic fin-ray counts, inner gill raker counts for males and females, outer gill raker counts for females, and the number of scale rows to the origin of the anal fin in females. However, snout length, head length, eye diameter, pectoral and pelvic fin lengths were very strongly correlated to total length (linear regression, $r = 0.94$–0.99) indicating that these measurements were part of a continuous series and not related to any size-group. Thus, only the inner gill raker counts for

TABLE 2. Meristic and morphometric summary. Total length = 1.09 × fork length; ≤195-mm length-class excludes all unsexed fish under 100 mm.

	< 100 m	101–200 m		201–300 m		300 + m	Creek spawners		≤ 195 mm		> 195 mm		
	♂ + ♀	♂	♀	♂	♀	♀	♂	♀	♂	♀	♂	♀	Total
Pectoral rays	17.1	16.6	16.9	16.9	17.0	14.9	18.1	16.9	17.1	17.0	17.3	15.9	16.7
Pelvic rays	9.4	9.9	9.9	10.0	9.6	9.1	10.1	9.8	9.9	9.8	10.0	9.8	9.6
Dorsal rays	11.2	11.3	11.4	11.0	11.5	11.0	11.3	11.6	11.4	11.3	11.3	11.3	11.2
Scale rows lateral line to dorsal	10.0	11.1	11.3	11.0	10.4	11.5	10.3	10.4	10.8	11.1	10.8	10.9	10.7
Scale rows lateral line to origin of anal fin	7.3	8.1	7.4	8.2	8.6	8.3	8.1	7.8	8.0	7.6	8.2	8.1	7.9
Gill rakers inner	24.7	25.7	24.5	26.5	25.4	25.8	26.0	22.3	23.6	25.1	26.6	25.8	25.5
Gill rakers outer	21.8	21.6	21.3	23.4	22.4	22.7	22.4	26.6	22.1	21.5	22.8	22.6	22.2
Lateral line scales	62.6	60.3	63.8	63.6	65.3	65.7	64.2	66.4	62.0	64.3	63.5	65.7	63.9
Height anal fin: total length	0.147	0.205	0.165	0.210	0.169	0.158	0.208	0.165	0.203	0.165	0.210	0.163	0.174
Length pectoral fin: total length	0.160	0.173	0.167	0.175	0.166	0.160	0.173	0.165	0.172	0.167	0.174	0.162	0.166
Length pelvic fin: total length	0.116	0.141	0.120	0.152	0.113	0.110	0.142	0.111	0.141	0.109	0.157	0.112	0.125
Head length: total length	0.213	0.203	0.217	0.203	0.207	0.214	0.202	0.212	0.203	0.210	0.203	0.211	0.210
Snout length: head length	0.430	0.454	0.448	0.484	0.502	0.500	0.488	0.513	0.463	0.464	0.481	0.519	0.471
Eye diameter: head length	0.210	0.188	0.180	0.170	0.164	0.136	0.175	0.166	0.182	0.177	0.172	0.150	0.174
Caudal peduncle length: total length	0.144	0.155	0.160	0.152	0.148	0.154	0.149	0.154	0.153	0.156	0.151	0.153	0.151
Caudal peduncle depth: caudal peduncle length	0.500	0.477	0.474	0.504	0.493	0.484	0.475	0.478	0.475	0.490	0.494	0.486	0.488

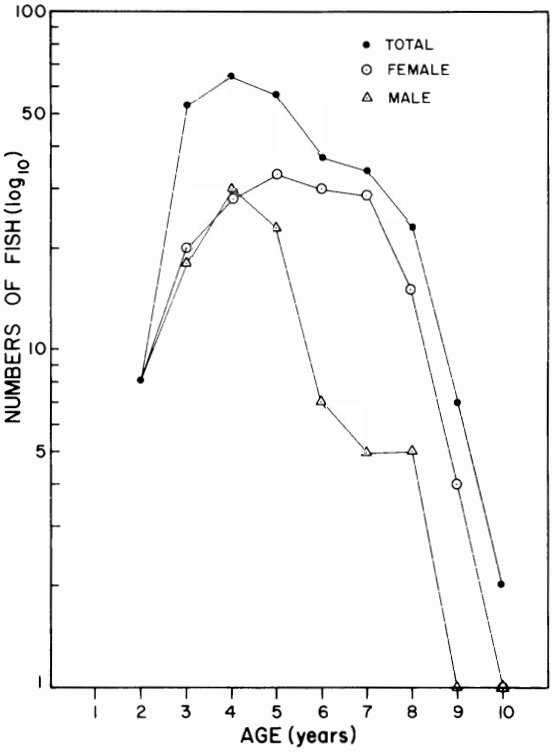

FIG. 3. Catch curve for one total trapnet catch.

males and females, the outer gill raker counts for females, the number of scale rows to the origin of the anal fin, and the female pectoral ray counts could be considered to be significantly different between the two groups. In all but one case the frequency counts (Table 3) were similar and overlapped to the extent that no distinction between size-groups could be made. Only when comparing the number of pectoral rays for females larger than 330 mm total length with fish smaller than 196 mm total length was there any apparent separation between the groups. However, there still was some overlap in counts, especially for the intermediate lengths, and this character was only significant for females. Thus, a separation of the two forms could not be made using the meristic or morphometric characteristics.

Discussion

Small and larger mature white suckers still exist in the lake in which the biology of the so-called dwarf white sucker was originally studied. However, there was one continuous size range and no evidence was found to indicate two separate populations of different-sized individuals. Immature fish of both sexes were equally abundant and similar in size up to age 3. At age 3 a greater percent of males began to mature and after age 4, males incurred a higher mortality rate and slower growth than females. As a result there was a disproportionate number of larger and older females in the population. This culminated in the extreme condition that 100% of the fish larger than 279 mm fork length were females. Also important was the observation that these large individuals constituted <1% of the catch. Thus, the large- or normal-sized white sucker was not numerous; indeed, such large fish must be considered to be rare.

Dence (1937) stated that the size range for mature normal white suckers in Wolf Lake was 12-18 in., standard length, and for mature dwarf

TABLE 3. Frequencies of counts of characters that differed significantly ($P \leq 0.05$) between the large and small size-classes.

Character	Size range total length (*mm*)	Mean of frequency count	Frequency										
			6	7	8	9	10						
No. scale rows	88–195	7.7	0	4	7	0	0						
lateral line to anal fin (♀)	196–518	8.1	0	3	22	4	1						
	< 100, sexes combined	7.3	1	14	4	1	0						
	> 330[a]	8.3	0	0	10	2	1						
			15	16	17	18	19						
No. pectoral rays (♀)	88–195	17.0	0	2	7	2	0						
	196–518	15.9	5	9	12	2	0						
	< 100, sexes combined	17.1	0	1	14	4	0						
	> 330[a]	15.6	5	5	1	0	0						
			19	20	21	22	23	24	25	26	27	28	29
No. outer gill rakers (♀)	88–195	21.5	1	0	5	3	2	0	0	0	0	0	0
	196–518	22.5	0	1	3	10	7	4	0	1	0	0	0
	< 100, sexes combined	21.8	1	2	3	8	4	1	0	0	0	0	0
	> 330[a]	22.3	0	0	2	2	3	1	0	1	0	0	0
No. inner gill rakers (♀)	88–195	24.8	0	0	0	1	1	3	1	4	1	0	0
	196–518	25.9	0	0	0	2	1	4	2	4	9	3	1
	< 100, sexes combined	24.7	1	0	0	1	0	5	6	4	2	0	0
	> 330[a]	25.7	—	—	—	1	1	1	1	1	2	1	1
(♂)	88–195	25.4	0	0	1	0	2	1	5	4	1	2	0
	196–518	26.6	0	0	0	0	0	1	3	3	4	2	2
	< 100, sexes combined	24 7	1	0	0	1	0	5	6	4	2	0	0
	> 330[a,b]	—	—	—	—	—	—	—	—	—	—	—	—

[a]Minimum total length for normal white sucker as defined by Dence (1937).
[b]No males were > 330 mm total length.

suckers, 5–8 in. Allowing an increase in length of approximately 10% to convert to fork length this defines mature common suckers as ranging from 330 to 500 mm in fork length and dwarf white suckers from 140 to 220 mm. According to these limits all common white suckers captured during the present study were females. If all fish larger than 220 mm fork length were considered to be the normal-sized subspecies, then the population of common white suckers examined in the present study would still be composed mostly of females. Only 3 of the 101 fish larger than 239 mm fork length from a sample of 4320 individuals were males. The larger females examined in early June 1972 had spawned and since larger males were extremely rare, these fish probably spawned with the males from within the size range Dence considered to be the dwarf subspecies.

Smaller fish of each sex were also younger fish. There was no indication that the lake contained discrete groups of similar-aged individuals that differed greatly in size. The examination of immature fish did not reveal two size-groups of immature fish. In many populations of normal-sized white suckers growth tends to be curtailed after the fish mature (Beamish 1973b). The Wolf Lake population did not demonstrate this pronounced reduction in growth after maturity. The larger fish result from the rare occurrence of a female surviving and continuing growth up to the maximum age observed for the species. The small fish that characterize the inlet and outlet streams during spawning apparently represent the segment of the population that is able to navigate in the restrictive openings and channels of these streams.

This interpretation differs from Dence's (1948) explanation because this study concentrated on the period of lake residence and because the fish

could be accurately aged using sections of pectoral fins. The ages assigned were consistent with the size of young-of-the-year, age at first maturity, and growth as estimated by Dence (1948). Dence (1948) did not conduct extensive studies in the lake as he was reluctant to catch trout. His 1948 report indicated that he captured only 12 large or common white suckers from a sample of 12,000 fish. Had he conducted such a study we feel he would have realized that the larger form was rare and composed mostly of females.

An alternative explanation that the structure of the population has changed since Dence's study and the present study does not appear probable. The lake and watershed have been preserved in their natural state as part of a forestry research area. The species composition of the lake found in this study (Beamish 1973a) was similar to that recorded by Dence (1937, 1940). His observations (1948) that females started to mature at a fork length of 140 mm, 12–25 mm larger than males, was similar to observations in this study. Similarly, his observation that several male white suckers tagged during their 1st yr of maturity and recaptured after 7 yr had shown increases in length of 75 mm is similar to a mean increment of 90 mm found in this study for a similar period (Fig. 2). Finally in his one netting attempt for the 1948 study he reported (p. 92) that a 1¼-in. bar mesh trammel net resulted in a catch of mostly females. He acknowledged that all fish less than about 200 mm fork length could pass through the net. Thus, the disproportionate number of larger female fish was not unique to this study.

From the large number of fish captured by Dence (1948) during his study and the facility of capture of individuals during this study (Beamish 1973a) Wolf Lake apparently contains a large number of white suckers for such a small lake. It is suggested that a large percentage of the population is composed of small individuals that do not attain older ages or larger sizes as a result of environmental pressures. The subspecies-separating character used by Dence (1948) that the common form spawned before the dwarf form is consistent with our personal observations that larger individuals within a white sucker population are the first to spawn.

Definitions of subspecies do not require a complete morphological separation of forms and the failure of the tests used in this study to isolate the two forms meristically or morphometrically do not by themselves indicate that no separation exists at the subspecies level. There may be other characters that should have been examined; there may also have been measuring problems associated with the temperature during or the timing of the development of characters chosen. However, when the negative results of the meristic and morphological data analysis are considered in association with the age, size, and sex composition of the population, there can be little doubt that distinct dwarf and normal-sized subspecies do not exist in this lake. Considering the results of this study, the observation by Dence (1948) that considerable variation in size of dwarf white suckers may occur within the same watershed, and that variation in size at maturity occurs throughout the range of the species (Beamish 1973b), we conclude that the occurrence of a distinct dwarf subspecies has not yet been demonstrated.

Acknowledgments

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