DIET OF VERTEBRATE PREDATORS ON TROUT WATERS IN NORTH CENTRAL LOWER MICHIGAN

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By Gaylord R. Alexander

ABSTRACT

A predator's diet varies considerably, depending on the type of aquatic environment it frequents. To evaluate the impact of predators on trout populations, food data must be obtained either by water type, climatological region, or preferably the lake or stream being studied.

The American Merganser, Common Loon, Great Blue Heron, Belted Kingfisher, American Bittern, mink, otter, and water snake collected from good trout waters in northern lower Michigan contained high proportions of trout in their diet. These trout were generally larger than other species of fish eaten. Size of trout eaten also varied with species of predator. Estimates of daily ration indicated that Common Loons ate about 2.4 pounds of trout per day when feeding in good trout waters. Estimates for the Great Blue Heron were 1.5 pounds and 1.0 pound per day depending on whether the birds were frequenting streams or lakes. Winter-feeding American Mergansers ate about 0.9 pound per day. The otter consumed about 0.7 pound per day. Other predators ate lesser but substantial amounts.

On the North Branch of the Au Sable River (and probably most trout waters) the predators take more trout annually than fishermen. Predators are in direct competition with anglers, particularly for the larger trout. It is believed that benefits would accrue to anglers through predator reduction on waters containing primarily trout.

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[1] A contribution from Dingell-Johnson Project F-35-R-2, Michigan.

Introduction

It is apparent from the literature that much variability exists in the diet of various trout predators. This is very evident even in a relatively small geographical area such as the British Isles. For example, Brown (1974) summarized studies on mink diets in England, Wales, and Scotland. She reported that mink in southern England and Wales fed mainly on waterbirds and some fish--mostly cyprinids, although the waters sampled contained salmonids. Also, most of the fish were eaten in summer. By contrast, studies in Scotland showed the major food of mink to be fish with salmonids comprising 80% of the fish in the diet. Mink in Scotland also ate a higher proportion of fish in winter. Brown also stated that studies in Sweden showed fish to be predominant in the diet of mink, especially in the winter. She hypothesized that mink in the warm climates of southern Britain and Wales spent more time hunting on land in winter where mammals and birds provided a bountiful food resource.

Because of this high variability in predator diet composition, studies to assess the impact of not only mink but also probably most predators on trout populations must include diet data by climatological region and water type, i.e., ponds, streams etc. A still better approach is to obtain diet information from the particular stream or lake being studied. Most predator diet studies in Michigan are of a general nature with specimens being taken state-wide and from all types of waters. This information, however, is of little use for judging predator impact on any specific water.

This paper summarizes the diet of predators collected from good trout waters in northern lower Michigan and considers their possible impact on trout populations.

Methods

Shotguns were used to collect 84 American Mergansers (Mergus merganser), 22 Hooded Mergansers (Lophodytes cucullatus), 12 Green Herons (Butorides virescens), 72 Great Blue Herons (Ardea herodias), 98 Belted Kingfishers (Megaceryle alcyon), 12 Common Loons (Gavia immer), 6 American Bitterns (Botaurus lentiginosus), 5 Coots (Fulica americana), 22 American Golden-eyes (Glaucionetta clangula), and 4 Pied-billed Grebes (Podilymbus podiceps). Four otter (Lutra canadensis), 30 raccoon (Procyon lotor), and 41 mink (Mustela vison) were collected either by shotgun or drowning trap sets. Thirty-seven common water snakes (Natrix sipedon) were dispatched with a club.

Organized hunts were made to collect most mergansers, herons, and kingfishers. Other predators and some of the former were collected whenever the opportunity arose throughout the year.

Predators were weighed and dissected in the laboratory to remove the contents of the gullet and stomach. Food items were then separated by taxonomic group, counted, weighed and the information recorded on individual 3 × 5 cards.

Results

Food items and size of fish eaten by predators are summarized in Tables 1 and 2. When samples were sufficiently large, the predator diet was tabulated separately either by lake or stream habitat. Stomach analyses indicate that the Great Blue Heron, Common Loon, American Merganser, Belted Kingfisher, American Bittern, mink, otter, and water snake had relatively high percentages of trout in their diet. The diet of Great Blue Herons contained a very high proportion of trout--about 89% for streams and 60% for lakes. Most of the other Great Blue Heron food was composed of a variety of fish species, particularly in lakes. Minor quantities of frogs, toads, crayfish, insects and small mammals were found. The size of the trout eaten varied considerably with locality.

Birds from the North Branch of the Au Sable River ate trout from 3 to 13 inches in length, whereas herons on Hunt Creek streams ate 3- to 9-inch fish. Birds shot on lakes contained 8- to 11-inch fish. However, few small trout were present in the lakes and few large trout reside in Hunt Creek area streams. Great Blue Herons appear to eat whatever size trout are available, however, greater numbers of 7- to 9-inch fish than smaller fish were consumed in proportion to their abundance in the population. Trout of this size are either preferred or more vulnerable. They readily ate small fish of other species (Table 2). Herons are generally resident on northern Michigan trout waters in the spring, summer, and fall. However, one Great Blue Heron was killed on the North Branch Au Sable River in February and two were shot on Hunt Creek in December and January.

The diet of Common Loons was found to be predominantly fish with 80% being trout. Fish, other than trout, and crayfish comprised the remainder of the diet. Common Loons ate trout from 6 to 12 inches long but few small trout were present in the lakes. Moreover, relatively small populations of coarse fish were present in the lakes because they were managed for trout and were treated periodically with chemicals to remove coarse fish populations. Common Loons visited the waters of the region in all seasons except winter when the lakes were frozen.

The American Merganser diet was composed almost exclusively of fish, with trout making up 84% of the total and the remainder consisting of a variety of other species. American Mergansers contained trout from 2 to 11 inches long. However, we found a 15-inch brown trout partially digested on the shelf ice along the North Branch Au Sable River after flushing a group of American Mergansers. American Mergansers seem to prefer trout about 6 to 9 inches long, or else fish of this size are more vulnerable. Like Great Blue Herons, American Mergansers took many small fish of other species. Mergansers also preyed somewhat heavier on brown trout than brook trout--at least in the Au Sable River. American Mergansers frequent the trout streams of the area from mid-November through late April. On lakes in this region they arrive somewhat earlier in the fall and leave later in the spring than on streams.

Belted Kingfishers utilize the streams all year but in greater numbers during the summer and fall. The stomach contents of Belted Kingfishers were found to be highly variable by water type. Eighty-six percent of their diet on streams in the Hunt Creek Area was fish, 80% of which was trout. Birds on the North Branch of the Au Sable River ate 63% fish with trout comprising 29% of them. For Belted Kingfishers on lakes, the diet was 46% fish of which only 17% was trout (Table 1). Belted Kingfishers eat only small trout (from fry to 5-inch fish) but, like Great Blue Herons and American Mergansers, they kill larger trout than they can ingest. These fish die of puncture or scissor-like wounds. Amphibians were commonly eaten on all waters too. Some crayfish and insects were consumed by kingfishers from all waters also, with as much as 17% of the diet being crayfish in the North Branch of the Au Sable River. Insects constituted about 19% of the fare from lakes and most of the insects were belostomatids.

American Bittern stomachs contained 38% fish of which 27% was trout. Bitterns also ate relatively large quantities of insects, amphibians, and crayfish. Trout found in bitterns were 4 to 5 inches long. Bitterns were observed on trout waters during the spring, summer, and fall.

Mink were found to eat high proportions of fish, comprised mostly of trout in both the North Branch of the Au Sable River and Hunt Creek Area streams. Fifty-six percent of the diet of mink from the river was trout; 52% in the Hunt Creek streams. Other fish species comprised 29% of the diet in the Au Sable River but only 9% in Hunt Creek Area streams. Birds, mammals, crayfish and amphibians made up the balance of the diet. Mink consumed trout ranging in size from 3 to 7 inches long. Mink frequent trout waters all year.

Only four otters were collected for stomach analyses. Other otters were encountered during predator sampling activities but these were spared. About 83% of their diet was fish. If we assume about half of the volume of unidentified fish were trout then about 47% of the otter's diet was trout. Otter stomachs also contained 2% crayfish and 15% unidentifiable material. Trout 3 to 11 inches long were taken from otter stomachs. Both mink and

otter are capable of catching and eating trout much larger than those observed in our samples. Otter frequent trout waters throughout the year.

The raccoon diet was found to be about 23% fish of which 19% were trout. Raccoon generally had a more varied diet than the other predators (Table 1). Birds (mostly ducklings and eggs), mammals, deer carrion, vegetation, crayfish, mollusk, insects, and debris were found in substantial quantities. The relatively few trout found in raccoons were 6 to 8 inches long and were taken mostly during the trout spawning season. It should be remembered that our collections were made solely of animals frequenting water courses at the time of collection and the findings reported here do not necessarily reflect the diet of raccoon feeding in non-trout water areas. Raccoon are mostly spring, summer and fall foragers along trout waters. They are inactive during most of the winter although we did collect three in midwinter.

The water snake's diet appears to be highly variable depending on habitat type. Water snakes contained 72% fish, with trout comprising 64% of the diet on streams. By contrast, only 12% of the snakes' diet from trout lakes was fish with trout representing 4% of the fish. Fair quantities of amphibians and mammals were found in the water snakes frequenting streams. Snakes that foraged in lake habitats ate large quantities of amphibians and moderate amounts of crayfish. Water snakes ate trout from fry size to 8 inches in length. They are believed to feed only during the warmer summer months (May-September).

Hooded Mergansers, Green Herons, Coots, Pied-billed Grebes, and American Golden-eyes were all suspected of being trout predators but no trout were found in their stomachs. Except for American Golden-eye, all stomachs contained 13% to 67% fish. These birds consumed mostly small fish 1 to 3 inches long, and they frequented lakes where small trout were uncommon. I believe that these birds would eat small trout if available. In lakes receiving stockings of small trout, these birds could be significant predators. American Golden-eyes ate mostly insects and crayfish along with moderate amounts of vegetation.

The estimated daily ration of trout is shown in Table 3 for the above predators frequenting good trout waters in north central lower Michigan. Predator weights used were taken from animals collected during this study. I used an average daily ration of 33% of the body weight per day for American Merganser, Hooded Merganser, Great Blue Heron, Common Loon, Coot, Pied-billed Grebe, American Bittern and American golden-eye. A review of the literature indicated that American Mergansers eat about one-third of their weight per day (White 1936; Salyer and Lagler 1940; Elson 1962; and Latta and Sharkey 1964). Hall (1925) and Ball and Cope (1961) reported that White Pelicans ate about one-third of their weight in food per day. A daily ration of 50% of the body weight per day was used for Belted Kingfishers and Green Herons in making calculations of their food consumption. White (1936) found that kingfishers from hatching to flight stage consumed from 1 to 1 3/4 times their weight per day, becoming progressively less as the bird grew older. Alexander (1974) found that Belted Kingfishers during their second week of life, just prior to flying, ate 41% of their weight per day.

The percentage of a mammal's weight eaten per day was estimated to be about 10%. I also judged that the water snake consumed about 6% of its body weight per day. I estimated that trout in East Fish Lake ate about 4% of the body weight per day (Alexander 1969). This estimate was based on known growth increments per unit time. Trout in East Fish Lake showed an annual increment of 681 grams and thus grew about 0.83% of their body weight per day during the 180-day growing season. Using a conversion ratio of 5:1, I calculated that about 4% of the body weight is eaten per day. I judged that the water snake, a terrestrial, poikilothermal animal, would require about 50% more food than the trout which is also a cold-blooded vertebrate. It is on this basis that I derived the 6% daily ration for the water snake. From the foregoing, it is apparent that the daily rations of some of the trout predators are substantial (Table 3). For example, the Common Loon consumes nearly 2.4 pounds of trout per day while the Great Blue Heron on a trout stream and trout lake has a daily ration of about 1.5 and 1.0 pounds, respectively. For the American Merganser it is nearly 0.9 pound.

To determine the total consumption of trout by a predator or a population of predators, additional data are needed on the numbers of predators present and the number of days of predator residency on the particular water. With this information the estimated weight of trout consumed by a predator population may be calculated from the formula:

$$x = abcd$$

where x = weight of trout consumed
a = number of predators
b = number of days feeding
c = daily ration (weight) of all food
d = proportion (weight) of trout in diet

In addition, estimates of the number of brook or brown trout consumed can be made by converting the weight of trout eaten to number by species, using the observed frequency of trout by size classes found in the stomachs of predators, coupled with the known length-weight relationship data of prey trout.

Such estimates of trout consumption by American Mergansers, Great Blue Herons and Belted Kingfishers have been made for the North Branch of the Au Sable River (Alexander 1974). Here the American Merganser consumed 514 trout, Great Blue Herons about 506 trout, and Belted Kingfishers an estimated 1,062 trout for a total of 2,082 trout per stream mile per year. In addition, unknown numbers of trout were injured and escaped capture by these predators, only to succumb later from their wounds. By comparison, the anglers' catch averaged 837 trout per mile of stream per year for the North Branch Au Sable River. The Great Blue Heron and American Merganser are competing with the angler for many of the same size trout. Moreover, the Great Blue Heron, American Merganser, and Belted Kingfisher on the North Branch of the Au Sable River accounted for up to 62% of the brown trout annual mortality and up to 53% of the annual brook trout losses, depending on age class of trout. Trout 1 to 3 years old suffer the greatest losses to these predators.

These mortalities occurred when densities of birds per mile of stream varied from only 0.23 for American Mergansers during November-April and 0.31 for Great Blue Herons during May-October to 1.36 for Belted Kingfishers in summer and 0.36 in winter.

The impact of other predators on the North Branch Au Sable or other waters has not been computed because the size of the predator populations on these waters is not known. Predator populations are very difficult to measure, particularly for animals like mink, otter, raccoon and water snakes. Difficulties also arise in determining the proportion of time that the predator feeds on the water under study. Otter for example, are extensive travelers, covering many miles of stream per day and even traversing considerable distances over land between streams and lakes. The mobility of bird predators is obvious.

We should remember that daily rations calculated in this paper are primarily for adult animals. When ascertaining the total impact of a predator, the food taken by the adult predator for the sustenance of its young must also be accounted for.

There is little doubt that predators kill a substantial number of trout in our better trout waters. Predators are in direct competition with anglers for this resource. If we take the position that man has priority to these trout, reduction of predators has the potential for increasing the catch of trout by anglers. Of course, if predators are reduced, anglers must function as the predator by killing trout presently taken by the predators. We cannot expect to stockpile trout significantly except for a short time by reducing the predator population because some other agent of natural mortality will step in.

I believe that direct benefits will accrue to anglers through predator reductions on waters containing predominantly salmonids. A five-fold increase in the production of Atlantic salmon smolts was achieved in New Brunswick, Canada, by control of American Mergansers (Elson 1962). However, reduction of predators on waters having populations of trout and competing coarse fish may not result in significant benefits to anglers because predators also may exert some control on the coarse fish. Much would depend on the species of coarse fish present.

Before controlling predator populations the natural resource manager must carefully weigh the relative values of the trout and trout fishing against the values of the predators for such things as furs, coarse fish control, pest control and esthetics.

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Table 1.--Percentage, by weight, of various food types found in stomachs of potential trout predators collected from the North Branch of the Au Sable River and Hunt Creek Area lakes and streams

Predator, water, and number of stomachs		Food type										
		Trout	Non-trout	Unidentified fish	Crustacea	Mollusk	Insect	Amphibian	Bird and Mammal	Vegetation	Debris	Unidentified
American Merganser												
N. Br. Au Sable R.	84	84	16	0	0	0	0	0	0	0	0	0
Hooded Merganser												
Hunt Cr. lakes	22	0	13	0	72	0	14	1	0	0	0	0
Belted Kingfisher												
N. Br. AuSable R.	62	29	32	2	17	0	3	13	0	1	0	3
Hunt Cr. lakes	19	17	29	0	5	0	19	27	1	0	0	2
Hunt Cr. streams	17	80	6	0	2	0	3	9	0	0	0	0
Great Blue Heron												
N. Br. AuSable R.	38	89	5	0	1	0	0	4	1	0	0	0
Hunt Cr. lakes	19	59	39	0	1	0	0	1	0	0	0	0
Hunt Cr. streams	15	88	2	0	1	0	1	4	2	1	0	1
Green Heron												
All waters	12	0	67	0	1	0	9	10	0	3	0	10
Common Loon												
Hunt Cr. lakes	12	80	18	0	2	0	0	0	0	0	0	0
Coot												
Hunt Cr. lakes	5	0	44	0	46	0	5	0	0	3	2	0
Pied-billed Grebe												
Hunt Cr. lakes	4	0	27	0	17	0	7	0	0	49	0	0
American Bittern												
All waters	6	27	11	0	14	0	30	18	0	0	0	0
American Golden-eye												
N. Br. AuSable R.	22	0	0	0	35	3	43	0	0	19	0	0
Mink												
N. Br. AuSable R.	10	56	26	3	4	0	0	3	6	1	1	0
Hunt Cr. streams	31	52	6	3	11	0	2	5	17	0	1	3
Otter												
All waters	4	42	32	9	2	0	0	0	0	0	0	15

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Table 1.--concluded.

Predator, water, and number of stomachs		Food type										
		Trout	Non-trout	Unidentified fish	Crustacea	Mollusk	Insect	Bird and Mammal	Vegetation	Debris	Unidentified	
Raccoon												
All waters	30	19	4	0	14	3	3	12	19	17	3	6
Water snake												
Hunt Cr. lakes	9	4	8	0	15	0	0	68	2	0	0	3
Hunt Cr. streams	28	64	7	1	1	0	0	14	12	0	0	1

Table 2.--Number of fish in each size group of fish species eaten by predators, collected from the North Branch of the Au Sable River and Hunt Creek Area lakes and streams

Predator, water, and species eaten[1]	Size group (inches)												
	1	2	3	4	5	6	7	8	9	10	11	12	13
American Merganser													
N. Br. AuSable R.													
Brook trout	..	1	8	18	11	15	14	6	1				
Brown trout	..	..	4	17	6	..	8	13	10	4	1		
Sculpins	25	30	12	2									
Blacknose dace	19	24	16	1									
Creek chub	16	6	4	6	7								
Common shiner	1	2	4										
Suckers	..	..	1	..	3	1	1	..	1	1			
Darters	15	1											
Brook stickleback	1												
Yellow perch	..	1	1										
Rock bass	..	..	..	1									
Hooded Merganser													
Hunt Creek lakes													
Brook stickleback	15	1											
Fathead minnow	..	3											
Belted Kingfisher													
N. Br. AuSable R.													
Brook trout	..	3	8	2									
Sculpins	2	5											
Blacknose dace	8	11											
Creek chub	1	1	2	1	1								
Common shiner	1	2											
Darters	13	8											
Hunt Creek lakes													
Brook trout	..	..	..	1									
Suckers	..	..	..	1									
Brook stickleback	5	4											
Fathead minnow	..	3											
Hunt Creek streams													
Brook trout	1	4	3	2	1								
Sculpins	..	1											
Redbelly dace	..	4											
Brook stickleback	2	3											

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Table 2.--continued

Predator, water, and species eaten [1]	Size group (inches)												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Great Blue Heron													
N. Br. AuSable R.													
Brook trout	..	..	8	3	4	5	9	6	2				
Brown trout	..	..	..	1	..	1	2	3	5	4	5	5	1
Sculpins	3	5											
Blacknose dace	4	9	4										
Creek chub	..	3	5	7	6	1							
Common shiner	..	4	..	1									
Suckers	..	..	1	1	1								
Hunt Creek lakes													
Brook trout	..	..	..	..	..	..	..	1	1	2			
Rainbow trout	..	..	..	..	..	..	..	1	3	1	4		
Creek chub	..	..	..	1									
Suckers	..	..	..	..	1	4	5	1	2	1	1		
Brook stickleback	17	5											
Mudminnow	..	2	1										
Hunt Creek streams													
Brook trout	..	..	3	7	9	5	1	2	1				
Redbelly dace	..	4											
Brook stickleback	..	1											
Fathead minnow	..	9											
Green Heron													
All waters													
Redbelly dace	2	5											
Creek chub	..	1	..	2									
Darters	..	3											
Brook stickleback	51	5											
Fathead minnow	..	12											
Mudminnow	..	6	1										
Largemouth bass	1	1											
Common Loon													
Hunt Creek lakes													
Brook trout	..	..	..	..	..	1	..	..	..	3	..	1	
Rainbow trout	..	..	..	..	..	2	1	1	..	..	1		
Suckers	..	..	..	..	..	1	1	1	1				
Pumpkinseed	..	..	1	1									
Coot													
Hunt Creek lakes													
Brook stickleback	5	3											
Fathead minnow	..	1											

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Table 2.--continued

Predator, water, and species eaten [1]	Size group (inches)												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Pied-billed Grebe													
Hunt Creek lakes													
Brook stickleback	8	3											
American Bittern													
All waters													
Brook trout	..	..	..	1	1								
Redbelly dace	..	2											
Creek chub	..	2	1										
Brook stickleback	9	1											
Fathead minnow	..	2											
Mink													
N. Br. AuSable R.													
Brook trout	..	..	1	2	1	1							
Brown trout	..	..	..	..	..	..	1						
Sculpins	..	3											
Blacknose dace	..	2											
Creek chub	..	..	1	..	1								
Suckers	..	..	..	1									
Darters	3												
Hunt Creek streams													
Brook trout	..	..	..	5	3	2							
Sculpins	..	1											
Creek chub	..	..	..	3									
Redbelly dace	..	1											
Otter													
All waters													
Brook trout	..	..	2	..	..	..	1						
Brown trout	..	..	..	..	..	..	..	..	..	1			
Rainbow trout	..	..	..	..	..	..	..	..	..	..	1		
Blacknose dace	1	14	1										
Creek chub	..	2	2	1	1	1							
Common shiner	..	1	..	..	1								
Suckers	2	5											
Darters	5												
Raccoon													
All waters													
Brook trout	..	..	..	..	..	2	..	1					
Sculpins	..	1	1										
Creek chub	..	3	1										
Suckers	..	..	..	..	..	1							
Fathead minnow	..	3	2										

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Table 2.--concluded

Predator, water, and species eaten[1]	Size group (inches)												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Water snake													
Hunt Creek lakes													
Brook trout	..	..	1										
Sculpins	..	1											
Creek chub	..	..	..	1									
Hunt Creek streams													
Brook trout	1	4	2	6	3	3	3	1					
Sculpins	3	10	4										
Creek chub	..	..	..	2									

[1] Common names follow the official list of the American Fisheries Society (A.F.S. Special Publ. No. 6, 3rd ed., 1970).

Table 3.--Average weight and daily ration of potential trout predators feeding on good trout waters in northeastern Lower Peninsula of Michigan

Predator	Type of habitat	Number of predators	Average weight (lb)	% of body weight eaten per day	Estimated daily ration (lb)	% trout in diet	Estimated ration of trout (lb)
American Merganser	Stream	84	3.12	33	1.03	84	0.865
Hooded Merganser	Lake	22	1.42	33	0.43	0	0.000
Belted Kingfisher	Stream	79	0.33	50	0.16	54	0.086
	Lake	19	0.33	50	0.16	17	0.027
Great Blue Heron	Stream	53	5.25	33	1.73	89	1.540
	Lake	19	5.25	33	1.73	59	1.021
Green Heron	All waters	12	0.60	50	0.30	0	0.000
Common Loon	Lake	12	8.97	33	2.96	80	2.368
Coot	Lake	5	1.13	33	0.37	0	0.000
Pied-billed Grebe	Lake	4	1.14	33	0.38	0	0.000
American Bittern	All waters	6	1.65	33	0.54	27	0.146
American Golden-eye	Stream	22	2.06	33	0.68	0	0.000
Mink	Stream	39	1.81	10	0.18	54	0.097
Otter	All waters	4	15.66	10	1.57	42	0.659
Raccoon	All waters	30	13.23	10	1.32	19	0.251
Water snake	Stream	28	0.49	6	0.03	64	0.019
	Lake	9	0.49	6	0.03	4	0.001

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