Aquatic bird species and water quality at Tenderfoot, Crampton and Morris Lake.

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Introduction

The waterfowl that inhabit many of the lakes of Northern Wisconsin and Michigan are adapted to exploiting some of the lake resources. This includes feeding on living organisms that inhabit lakes and surrounding watershed. Some of these organisms include aquatic plants, insects, amphibians and other small mammals. During the summer months, migratory bird species breed and raise their young before flying south again (Lemler, 1998). The migratory patterns of many aquatic birds make determining waterfowl population effect on lake resources difficult to judge.

North American fossils (Bickart, 1990), northern European rock etchings (Maringer and Bandi, 1953), and other evidence indicate that waterfowl have been feeding from northern hemisphere lakes for about a million years (Lodge et al, 1997). According to Lodge et al (1997), since the 19^{th} century, abundance of aquatic birds has been very low relative to prehistorical levels. Recently, however, the quality and quantity of habitat has been declining; and the population trends for most herbivorous waterfowl have increased (Lodge et al, 1997). With a higher density of waterfowl, the lakes resources may be greatly impacted.

Waterfowl are very mobile and therefore are adapted to the seasonal variation and availability of food in wetlands (Owen and Black, 1972). How a species exploits the wetland habitat depends on its physiological adaptation (Owen and Black, 1972). The type of feeding habit exhibited by a bird is in relation to the morphology of the beak. The Mallard, Black duck, Wood duck and Canada goose feed on or above the surface of water or by partial immersion. The beak morphology of these three birds is similar. The Common loon, Common merganser and Great Blue Heron have somewhat different beak morphology for spearing and catching fish.

A sieve-bill or Lamellate is where the mandibles have a series of transverse tooth-like ridges (Pettingill, 1985). The sieve-bill allows waterfowl like the mallard to sift through the muddy bottoms for macrophytes seeds and aquatic insects. Similarly, the wood duck obtains most of its food on or above the surface of the water (Bent, 1963). The wood duck occasionally will tip up to feed on shallow bottoms, as well as, feeding on land. Most of its food consists of insects that it finds on the surface of the water or on leaves and stems of aquatic plants (Bent, 1963).

The black duck also feeds in shallow waters of lakes and streams. They reach the shallow bottom by tipping up their tails and probing in the mud with their bills (Bent, 1963). According to Bent (1963), black ducks feed on aquatic insects and their larvae, salamanders, tadpoles, small frogs, leeches, worms and small mollusks. They also feed on the variety of snails found on the stems of sedges and grasses. The seeds of aquatic and land plants are also substituted. Black ducks will also pull up and devour the roots of aquatic plants (Bent, 1963). According to Bent (1963), the following genera of water plants are part of the black duck's diet: *Limnobium, Zizania, Elymus, Danthonia, Piper, Myriophyllum, Callitriche*, and *Utricularia.*

The greater scaup and ring-necked duck have the similar beak morphologies as the shallow water dabbling ducks. These birds, however, are not always found in the shallow waters of a lake. The scaup duck and ring-necked duck will dive for their food (Bent, 1963). According to Bent (1964), the scaup duck can remain under water for 50 to 60 seconds. Both ducks feed on fish fry, tadpoles, small fishes, small snails, flies and water insects (Bent, 1964). The ring-necked duck also feeds on minnows, small frogs and crawfish (Bent, 1964). The vegetation they eat consists of buds, stems, roots and seeds of floating and submerged plants (Bent, 1964). According to Bent (1964), the following genera of water plants are part of the scaup duck's diet: *Vallisneria, Lymnobium, Zizania, Piper, Elymus, Iris, Nuphor, Nymphea, Myriophyllum, Callitriche,* and *Utricularia.*

The Common Loon and the Great Blue Heron have a straight bill. This type of bill ends in a sharp point that can be used for spearing fish. The Common Loon remains in deep water where it dives for fish. The stomach content of some common loons contained food material other than fish (McIntrye, 1988). Common loons also eat aquatic plants, insects and crayfish. Parker (1985a) found that the adult loon fed insects and aquatic insect larvae to their chicks.

The Great Blue Heron wades through the shallow water hunting for fish. According to Bent (1963), a heron hunts by using two methods called still hunting and stalking. A great blue heron will stand still when fish are moving about in shallow water. With a quick movement of its head, it will stab its beak into the water to catch a fish. Usually a fish is seized crosswise between the mandibles (Bent 1963). Audubon (1840) states that the principal food of the great blue heron is fish of all kinds; but it also devours frogs, lizards, snakes, and birds, as well as small quadrupeds, such as shrews, meadow mice and young rats.

The Common Merganser beak morphology is quite different from the strait beak of the common loon or great blue heron. Like the loon and heron, it uses its beak to feed on fish. The beak morphology is serrate which is described as saw-like (Pettingill, 1985). The merganser pursues under water and catches successfully the swiftest fish (Bent, 1963). According to Bent (1963), the stomach contents of some mergansers contain perch, chub and pickerel. Mergansers also eat frogs, small eels, aquatic salamanders, crawfish, snails, leeches, worms, water insects and larvae, and the stems and roots of aquatic plants (Bent, 1963).

At some point, all waterfowl species are ecologically dependent on wetlands. The maximum population number that the food supply of a wetland can sustain without being depleted is called the carrying capacity (Newton, 1998). Once the carrying capacity has been reached, a decline in population will occur. Once the wetlands have recovered from depletion due to over population, the population will again increase. Increases and decreases in populations can be a continuous cycle if the wetlands resources are not depleted to a point where recovery is impossible. The objective of this study is to document the number of waterfowl species that reside in the Land O' Lakes area between the months of May and July, and to determine their effects on the lake environment.

Materials and Methods

An initial survey of all lakes on the UNDERC property was taken. Small lakes were looked at, but it was determined through observation that waterfowl species did not frequent these lakes. The first round of observations lasted for two weeks. The second round of observations lasted for one week. The final round of observations lasted for five days. Observations were made using binoculars, photographs and extensive notes on the habitat and waterfowl species. Rowboats and canoes were used to survey all sides of the lakes. Waders were used to explore the shoreline and islands for nests The National Audubon Society Interactive CD, Peterson Multimedia Guides- North American Birds and Sibley's Guide to North American Birds aided in identification of species.

In addition to a waterfowl survey, water chemistry was taken for three of the lakes. The lakes sampled were Morris Lake, Crampton Lake and Tenderfoot Lake. Air and water temperature was taken at the surface, as well as, pH and conductivity readings. Secchi depth was also determined. The YSI Model 55 was used to take dissolved oxygen readings. Readings were taken on the surface of each lake. Both percent oxygen and temperature were taken for the surface and at every meter. Readings were taken at depths of one to four meters for Morris, one to eight meters for Tenderfoot and one to nine meters for Crampton.

Shallow and deep-water samples were taken using the LaMotte Water Sampler. For all three lakes, the shallow water sample was at a depth of one meter. The deep-water sample was at four meters for Morris Lake, eight meters for Tenderfoot Lake and nine meters for Crampton Lake. From the samples, the alkalinity was determined. The amount of Phosphorus, Sulfide, Nitrate, Nitrogen (Ammonia), Iron (Ferrous) was tested for using the Portable Datalogging Spectrophotometer- HACH DR/2010. The codes for these tests were PORT, SIDE, NTAT, NTAM and IRFE. Graphs comparing the size of the lake and the water chemistry data were used to determine if these factors influence the number of waterfowl species found at each lake.

Results

Aquatic Bird Observations

Ten aquatic bird species were observed. In Table 1, the common and scientific names are given for each species, as well as, the number of each bird observed at each lake. Of the three lakes, Tenderfoot had the most diverse collection of aquatic bird species. Tenderfoot had nine out of the ten aquatic bird species listed.

The flock of 25 Canada geese was only found at Tenderfoot. They were observed several times feeding in the shallow waters along the shoreline of Tenderfoot. The common merganser, ring-necked duck and black duck were also only found at Tenderfoot. Many of the waterfowl species appeared to be reproducing successfully. The waterfowl species that were not reproducing at Tenderfoot were the Wood Duck and the ring-necked duck. Only male individuals were found. No offspring were observed among the Blue Heron or the Canada geese. Young adult Canada geese may have been present among the flock observed at Tenderfoot, but no offspring were observed.

Figure 1 shows a map of the University of Notre Dame Environmental Research Center. The birds observed occupied a certain area of the lake from which they raised their young. The merganser and black duck chicks were found swimming with the females along the shallow shoreline of Tenderfoot. The merganser family was only observed along the southeastern bank of Tenderfoot. The black duck family was observed along the northeastern bank and part way up Tenderfoot Creek. The merganser and black duck males were never seen at Tenderfoot. However, both the male and female adult mallards were observed swimming along the western bank of Tenderfoot.

The common loon was also seen at Tenderfoot as observed in previous studies. As mentioned by Lemler (1998), two offspring were again observed at Tenderfoot. The loon family occupied the center of the lake and rarely came close to the edge of Tenderfoot. No nest was found on any of the Tenderfoot islands.

A family of loons and a Blue Heron were the only species found at Crampton. A nest found was on the island located at the eastern most end of Crampton. The nest was found in the exact location found by Lemler in 1998. The two offspring would venture from the nest following the adult loons. The loon family would remain in the center of the lake and occasionally would wander to the western most side. The adult loons would cry if danger were near signaling the young loons to take cover. Once or twice the family was to far away from the nest on the island and so they would escape to the safety of the western shoreline.

The great blue heron never venture to the center of the lake. It was always observed wading along coves found on the southwestern part of Crampton. When startled, it would fly to the other major cove found on Crampton. The flight of the great blue heron never crossed over the main body of the lake.

The greater scaup, mallard, and wood duck were the only three species found at Morris. No nests were found along the edge of Morris. There were no islands at Morris. No females or offspring were observed. All individuals were males. The greater scaup was observed flying in from the north. It would sense danger and dive into the water. It was often times not seen again for that entire day. The mallard and wood duck were only seen in the evening hours. Never were they seen before 5:00 pm.

Water Chemistry

In figure 2 and 3, Morris Lake shows a gradual decrease in oxygen concentration and percent oxygen from surface to the depth of the lake at 5 meters. Tenderfoot and Crampton show similar high oxygen concentration readings until about 5 m. After 5 m, Tenderfoot continues a gradual oxygen concentration decrease. At about 8 m, the oxygen concentration readings level off just above 0 mg/l. The oxygen concentration for Crampton increases around 6 m. It continues increasing until 9 m where it gradual decreases.

In figure 4, Morris Lake has a maximum temperature of 24°C. The temperature gradually decreases until about 4m where it levels off at about 12°C. Crampton and Morris Lake have a constant temperature around 22-24°C until about 4m. After that, both gradually decrease in temperature until about 7m. From 8 to 10m, the temperature readings appear to fluctuate slightly. The lowest temperature readings were at 13°C for Tenderfoot Lake, and at about 8°C for Crampton Lake. In Figure 5, the Secchi disk depth showed that Tenderfoot had light penetration that reached a depth around 4.5 m. Crampton Lake's Secchi depth was only around 2.5, and Morris Lake's Secchi depth was only around 1.5 m.

In Fig. 6, the conductivity of Morris and Tenderfoot Lake were both around 80 µS. Crampton Lake was lower at 20µS. In Fig. 7, the pH of Morris, Crampton and Tenderfoot Lake were very similar. They only ranged from a pH of around 7-8.

The alkalinity, in Fig. 8, shows Morris Lake with the highest alkalinity of about 80 mg/l $CaCO_3$ for both shallow and deep-water samples. Crampton has the lowest alkalinity of only about 40 mg/l $CaCO_3$ for both shallow and deep-water samples. Tenderfoot has an alkalinity about 80 mg/l $CaCO_3$ for both shallow and deep-water samples.

Morris Lake appears to have the highest nitrate and nitrogen, ammonia concentrations. Fig. 9 shows the nitrate concentration at 0.6 mg/l for both shallow and deep samples. Fig. 10 shows the nitrogen, ammonia concentrations for Morris Lake at about 1.1 mg/l for the deep sample and around 0.9 mg/l for the shallow sample. The nitrate concentrations only differed by 0.4-0.5 mg/l from Tenderfoot and Crampton. The nitrogen, ammonia concentrations differed from Crampton and Tenderfoot by 1.1-0.9 mg/l.

Crampton Lake appears to have the highest sulfide, phosphorus and iron, ferrous concentrations for the deep-water samples. Fig. 11 shows sulfide concentrations for the deep sample of Crampton at about 0.05 mg/l. The deep-water samples only show a sulfide concentration for Morris and Tenderfoot at about 0.01-0.005mg/l. The shallow-water samples for all three lakes have similar sulfide concentrations of less than 0.01 mg/l.

Fig. 12 shows the deep-water sample phosphorus concentrations for Crampton Lake at about 0.13mg/l. The deep-water sample concentrations for Morris and Tenderfoot were at 0.06-0.07 mg/l. The shallow-water samples showed low phosphorus concentrations of less than 0.02mg/l.

Fig. 13 showed deep-water sample iron, ferrous concentrations for Crampton Lake at about 0.35 mg/l. No iron, ferrous was found at Morris and Tenderfoot for the deep-water samples. No iron, ferrous was found at Morris or Crampton for the shallow-water samples, and only a small amount was found at Tenderfoot.

Discussion

Tenderfoot Lake had much greater species diversity when compared to Morris and Crampton Lake. Mallards, ring-necked ducks, mergansers and Canada geese were all able to inhabit Tenderfoot without causing problems with territorial birds like the loons. Another contribution probably was the size and habitat diversity found at Tenderfoot. The deep-water areas of Tenderfoot would provide habitat for fish, which would be food for the diving birds like the mergansers, loons and ring-necked ducks. The shallow waters would provide ideal habitat for a diversity of aquatic plants that are consumed by wading birds and dabbling ducks. The islands and shoreline would be ideal for aquatic birds to nest and raise young.

Crampton was a much smaller lake that was occupied by loons, which are territorial. Crampton only had one island that was occupied by the loons for nesting and raising young. The only other aquatic bird that frequented Crampton Lake was the great blue heron. The heron never ventured onto the main body of the lake. This may or may not have to do with the loons that occupied Crampton Lake.

Morris Lake was the smallest of the three lakes. It was also the shallowest. This would not provide habitat for a diverse fish population. Probably for this reason, only individual male birds were seen. Morris had no islands for nesting and no nests were found when searching the edge of Morris.

The composition of the water at the three lakes might have had a contribution to the number or birds that populated the lakes. The greater the temperature deeper in the lake would provide warmth for organisms to grow. This would have provided a food source for a diversity of fish. The diversity of fish would attract a number of aquatic birds. The greater conductivity found at Morris and Tenderfoot would indicate that there are more particles in the water than found at Crampton. What is not clear is whether or not the particles are microorganisms or sediment from the lake bottom.

Morris Lake is more alkaline than Crampton or Tenderfoot. Morris has a slightly higher organic water composition. Crampton has a slightly higher inorganic water composition. A slightly higher organic or inorganic water composition found in Morris and Crampton might affect the microorganism diversity. This may contribute to fewer organisms, such as fish, that feed on the microorganisms. The aquatic plants might also be affected by the imbalance between inorganic and organic. Indirectly, organisms that feed on the fish and aquatic plants in a lake are affected. Tenderfoot has balance between the inorganic and organic composition in the water to provide habitat for greater species diversity from microorganism to aquatic birds.

The relation of beak morphologies and food type are similar to the comparison of aquatic bird type and lake environment. However, it is unclear which is affecting the other the most. It appears that the lake environment has an impact on the number and diversity of aquatic birds. Based on low population numbers, aquatic birds may not necessarily have as great of an impact on the lake environment.

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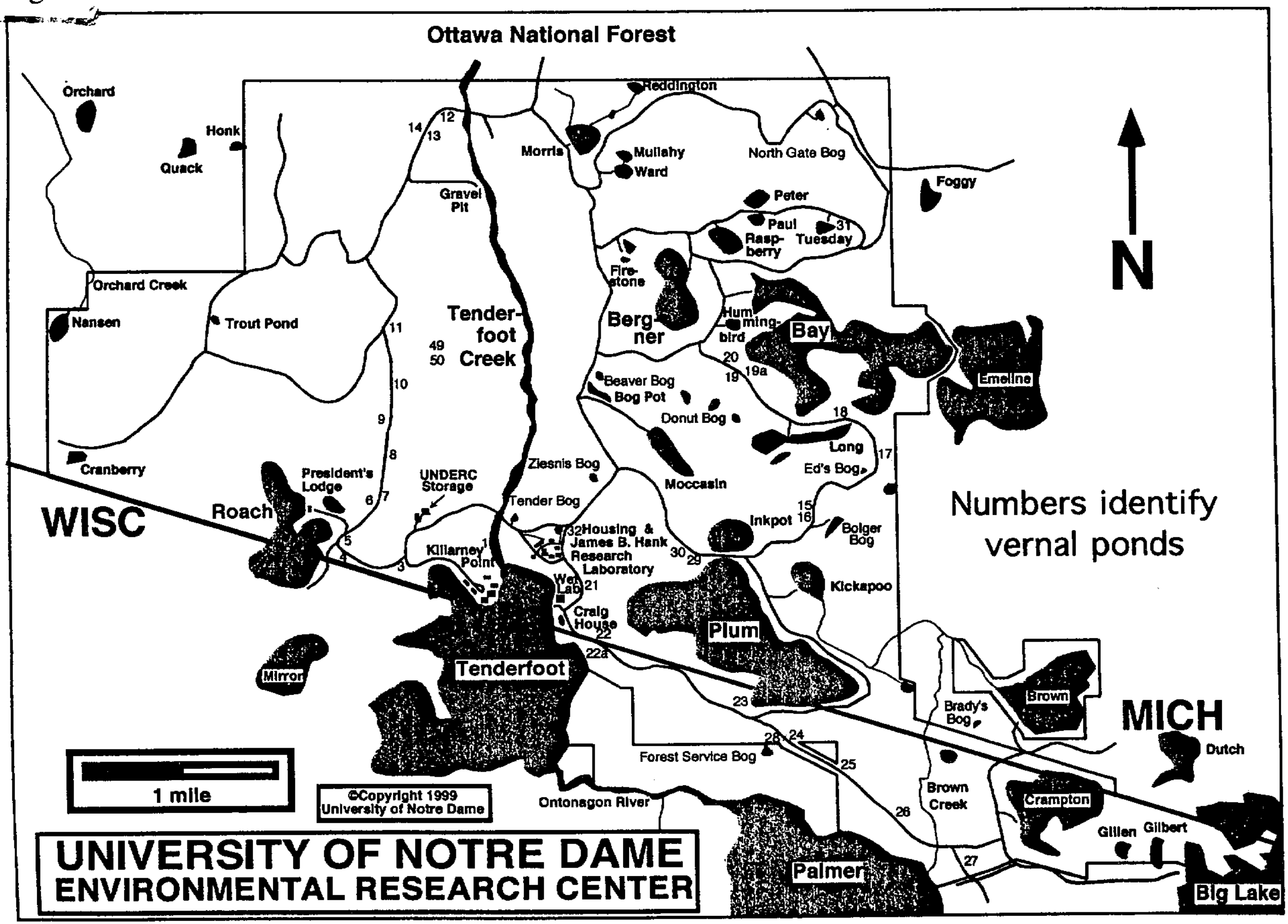
Table 1. Aquatic Birds found at Morris, Crampton and Tenderfoot Lakes

	Morris Lake	**Crampton Lake**	**Tenderfoot Lake**
Canada Goose- *Branta canadensis*	0	0	25
Common Loon- *Gavia immer*	0	4 (male, female, 2 offspring)	4 (male, female, 2 offspring)
Common Merganser- *Mergus merganser*	0	0	6 (female, 5 offspring)
Blue Heron- *Ardea herodias*	0	1	2
Mallard- *Anus platyrhychos*	1	0	7 (male, female and 5 offspring)
Greater scaup- *Aythya marila*	1	0	0
Wood Duck- *Aix sponsa*	1	0	2 (males)
Ring-necked duck- *Aythya collaris*	0	0	3
Black Duck- *Anus rubripes*	0	0	5 (female, 4 offspring)
Total	3	5	54

Fig 1.



Ottawa National Forest
Orchard
Honk
Quack
Reddington
Morris
Mullahy
Ward
North Gate Bog
Foggy
Peter
Paul
Rasp-
berry
Tuesday
31
14
12
13
Gravel
Pit
Orchard Creek
Nansen
Trout Pond
11
Tender-
foot
Creek
49
50
Fire-
stone
Berg-
ner
Hum-
ming-
bird
Bay
Emeline
20
19
19a
Beaver Bog
Bog Pot
Donut Bog
18
Long
Ed's Bog
17
10
9
8
Cranberry
President's
Lodge
UNDERC
Storage
Ziesnis Bog
Moccasin
7
6
WISC
Roach
5
4
3
Killarney
Point
1
Tender Bog
32Housing &
James B. Hank
Research
Laboratory
30
29
Inkpot
15
16
Bolger
Bog
Numbers identify
vernal ponds
Wet
Lab
21
Craig
House
22
22a
Kickapoo
Plum
Mirror
Tenderfoot
23
Brady's
Bog
Brown
MICH
Dutch
28
24
25
Forest Service Bog
1 mile
©Copyright 1999
University of Notre Dame
Ontonagon River
26
Brown
Creek
Crampton
Gillen
Gilbert
27
UNIVERSITY OF NOTRE DAME
ENVIRONMENTAL RESEARCH CENTER
Palmer
Big Lake
N

Fig 2.

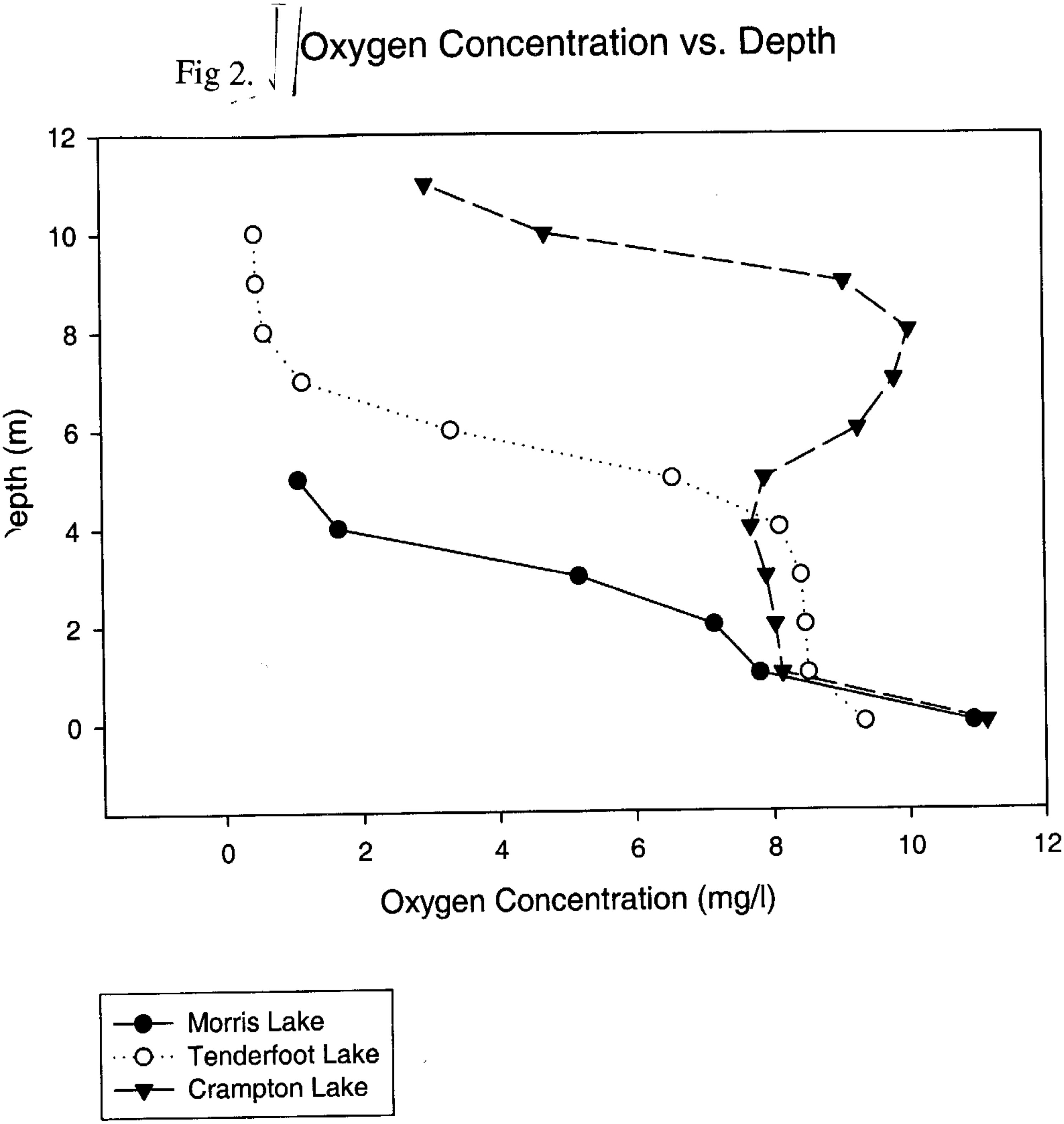

Oxygen Concentration vs. Depth
Depth (m)
Oxygen Concentration (mg/l)
0
2
4
6
8
10
12
Morris Lake
Tenderfoot Lake
Crampton Lake

Fig 3. Percent Oxygen vs. Depth

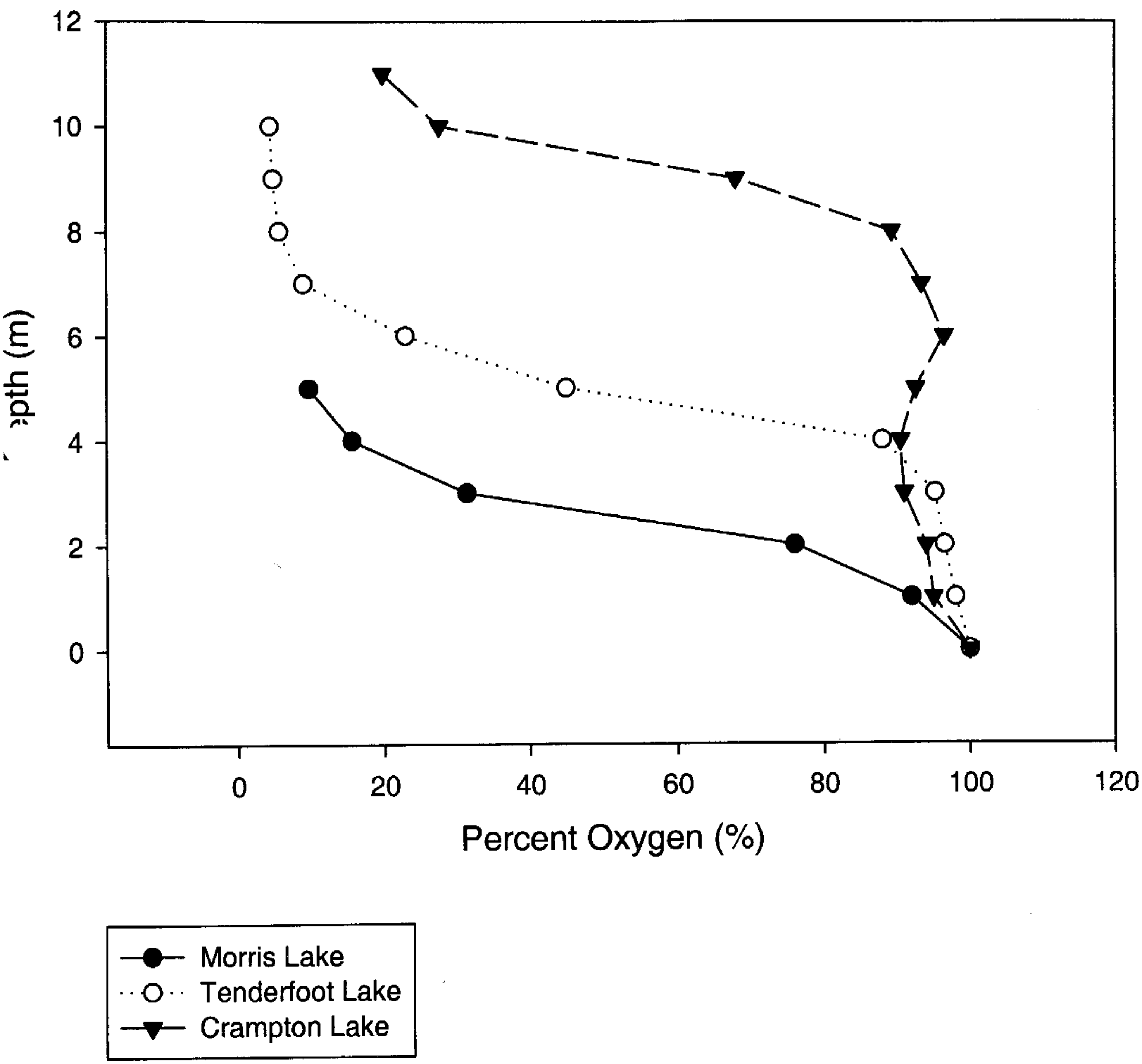


Fig 4. Temperature vs. Depth

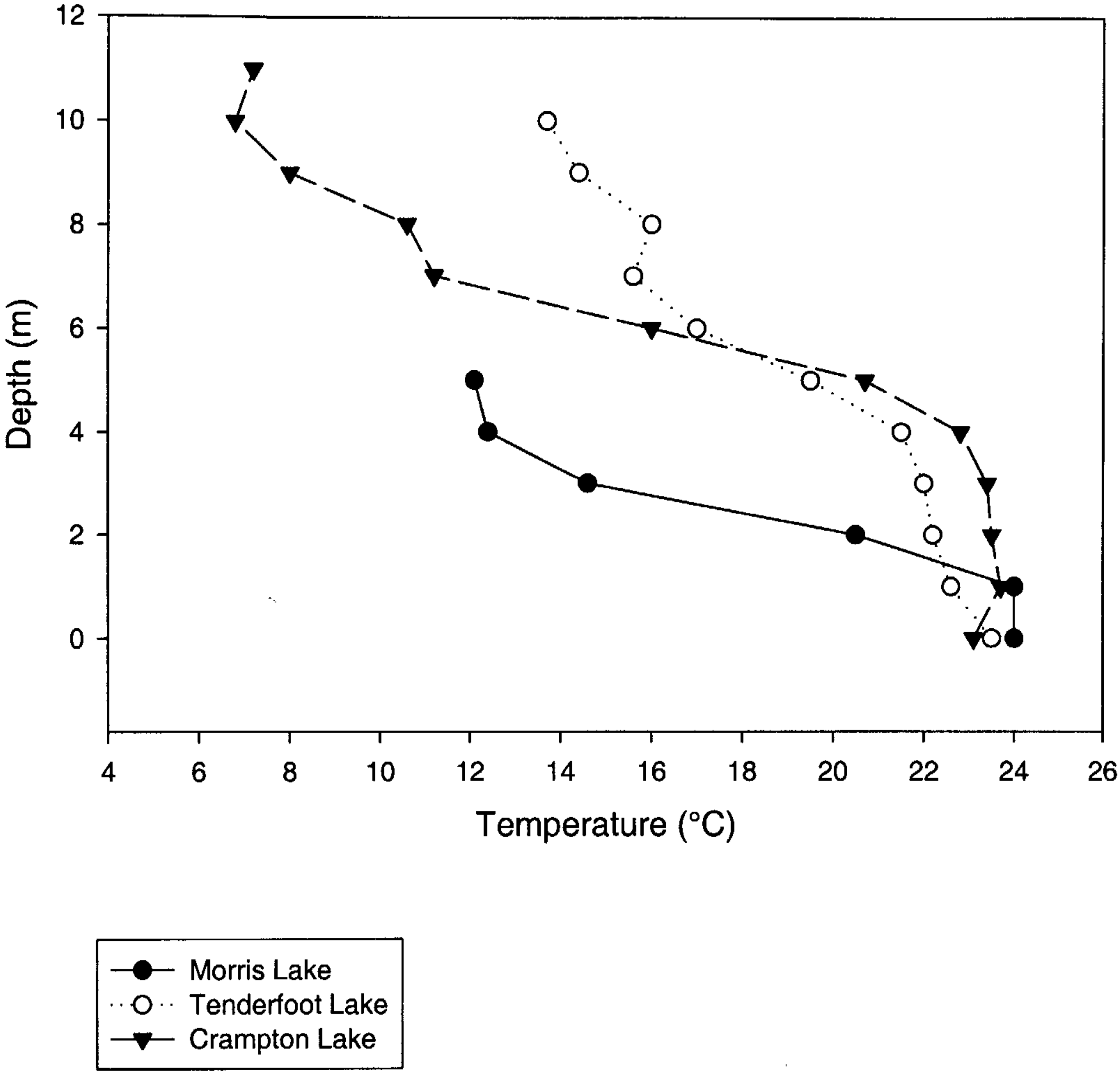


Fig 5.

Secchi Disk Depth of Morris, Crampton, and Tenderfoot Lakes

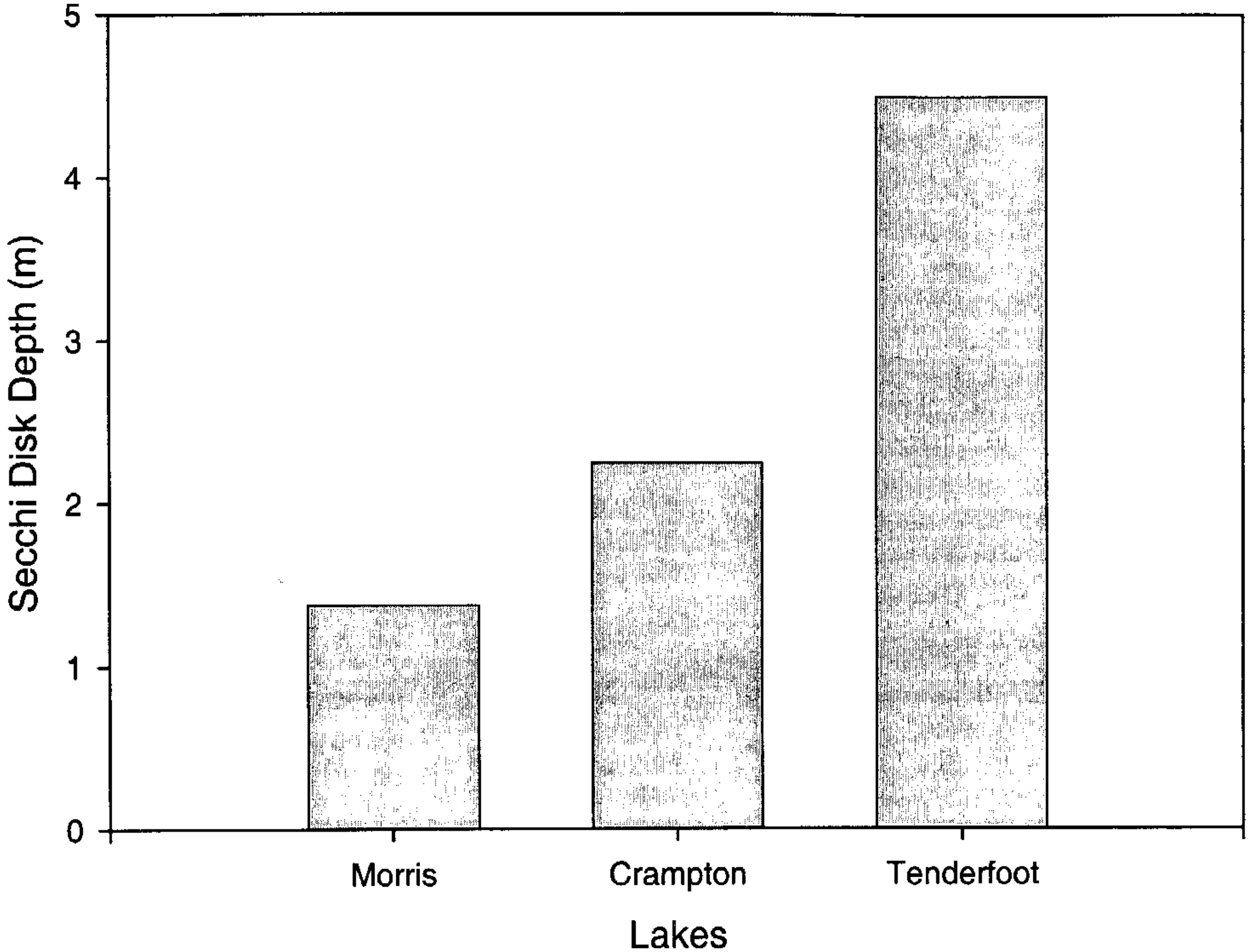


Fig 6.

Conductivity of Morris, Crampton, and Tenderfoot Lakes

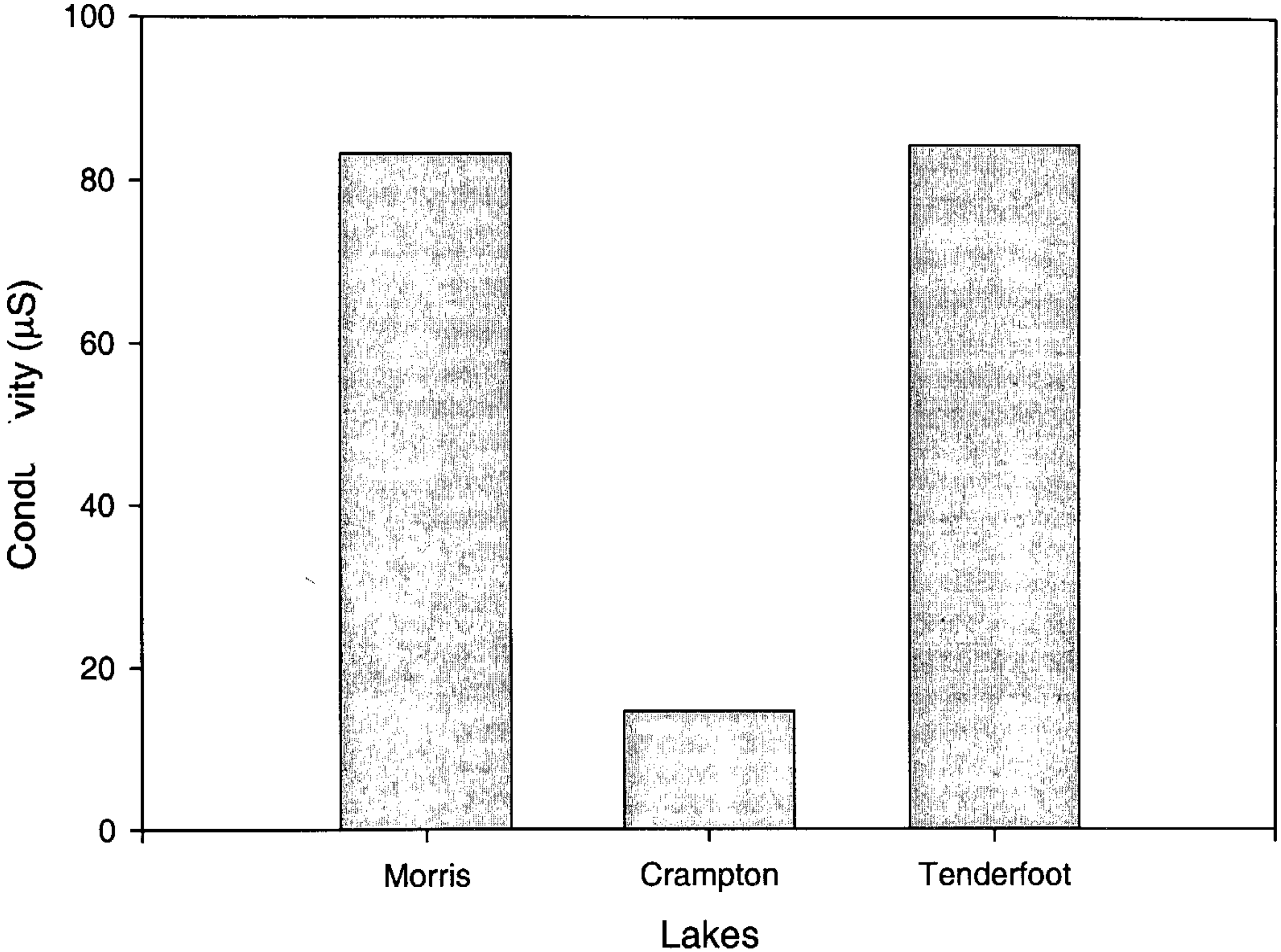


Fig 7. pH of Morris, Crampton, and Tenderfoot Lakes

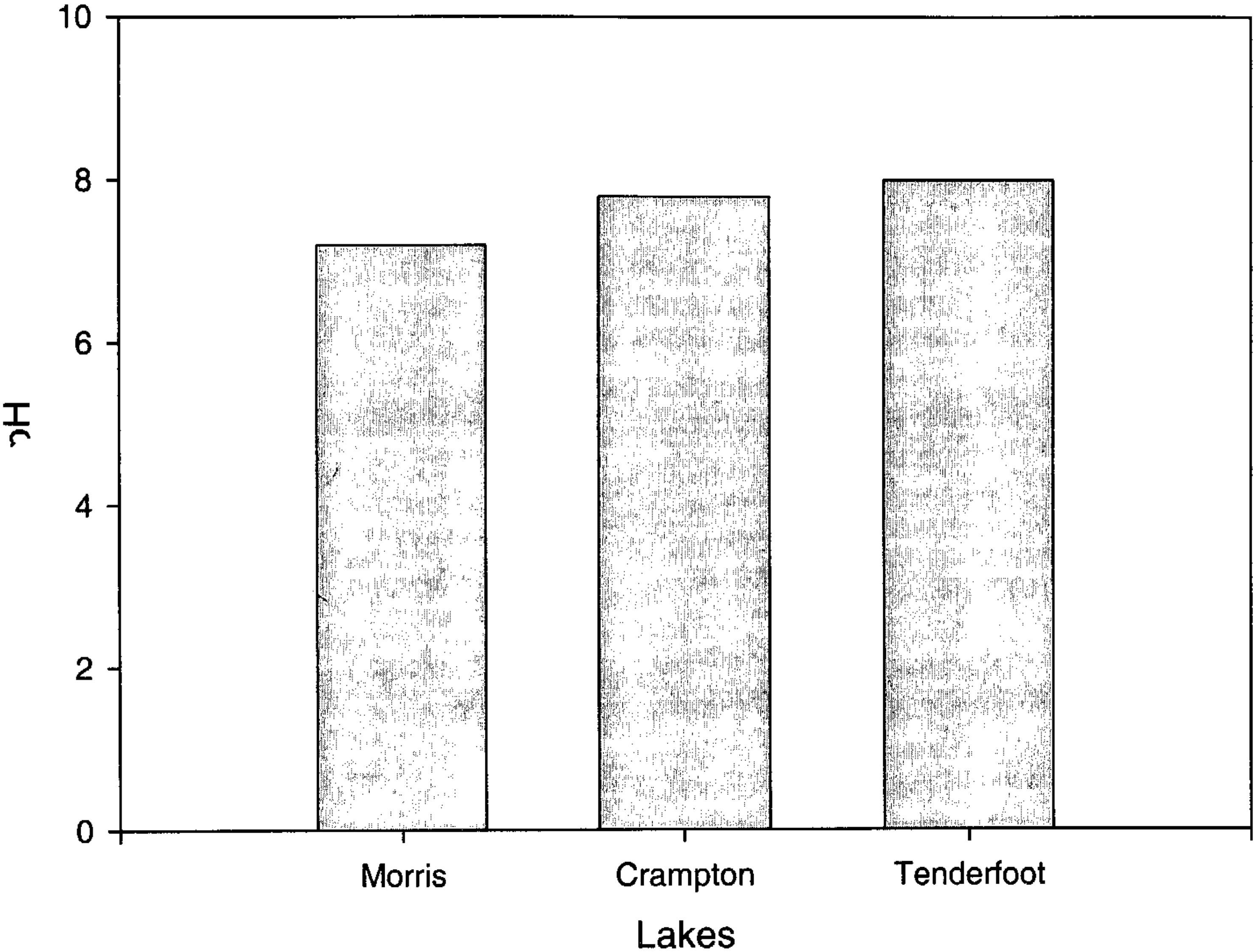


Fig 8. Alkalinity of Morris, Crampton, and Tenderfoot Lakes

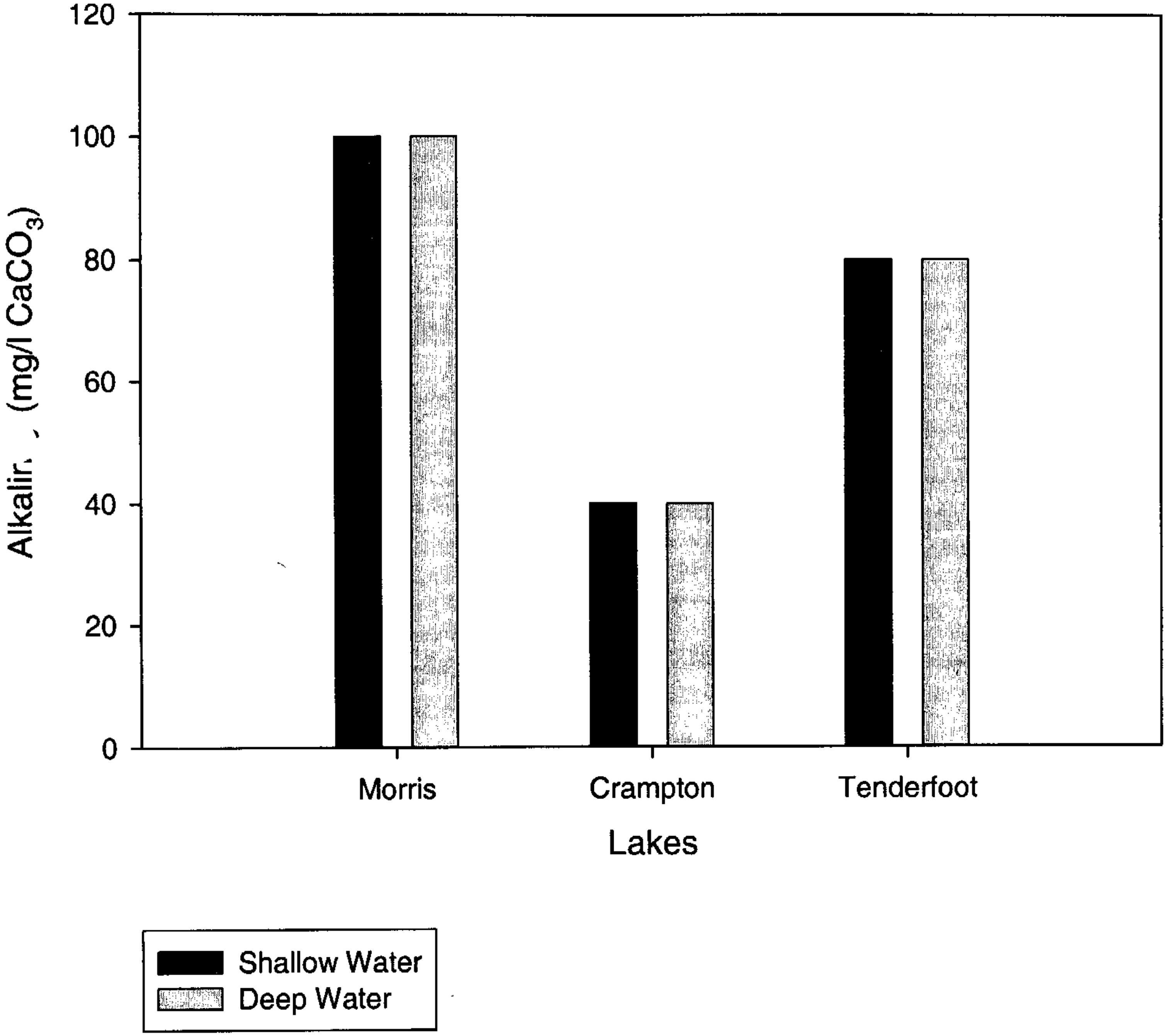


Fig 9. Nitrate in Morris, Crampton, and Tenderfoot Lakes

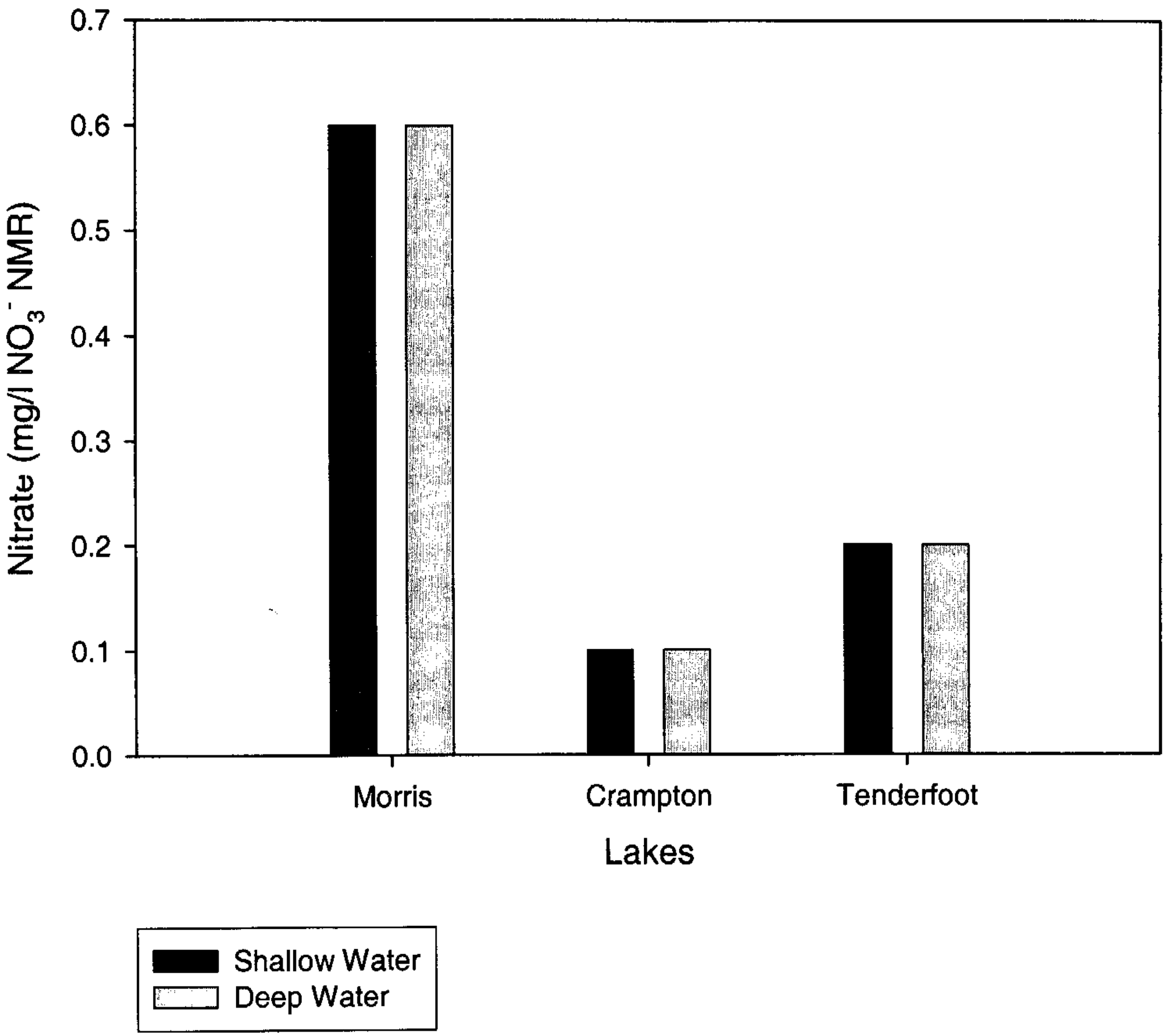


Fig 10.

Nitrogen, Ammonia in Morris, Crampton, and Tenderfoot Lakes

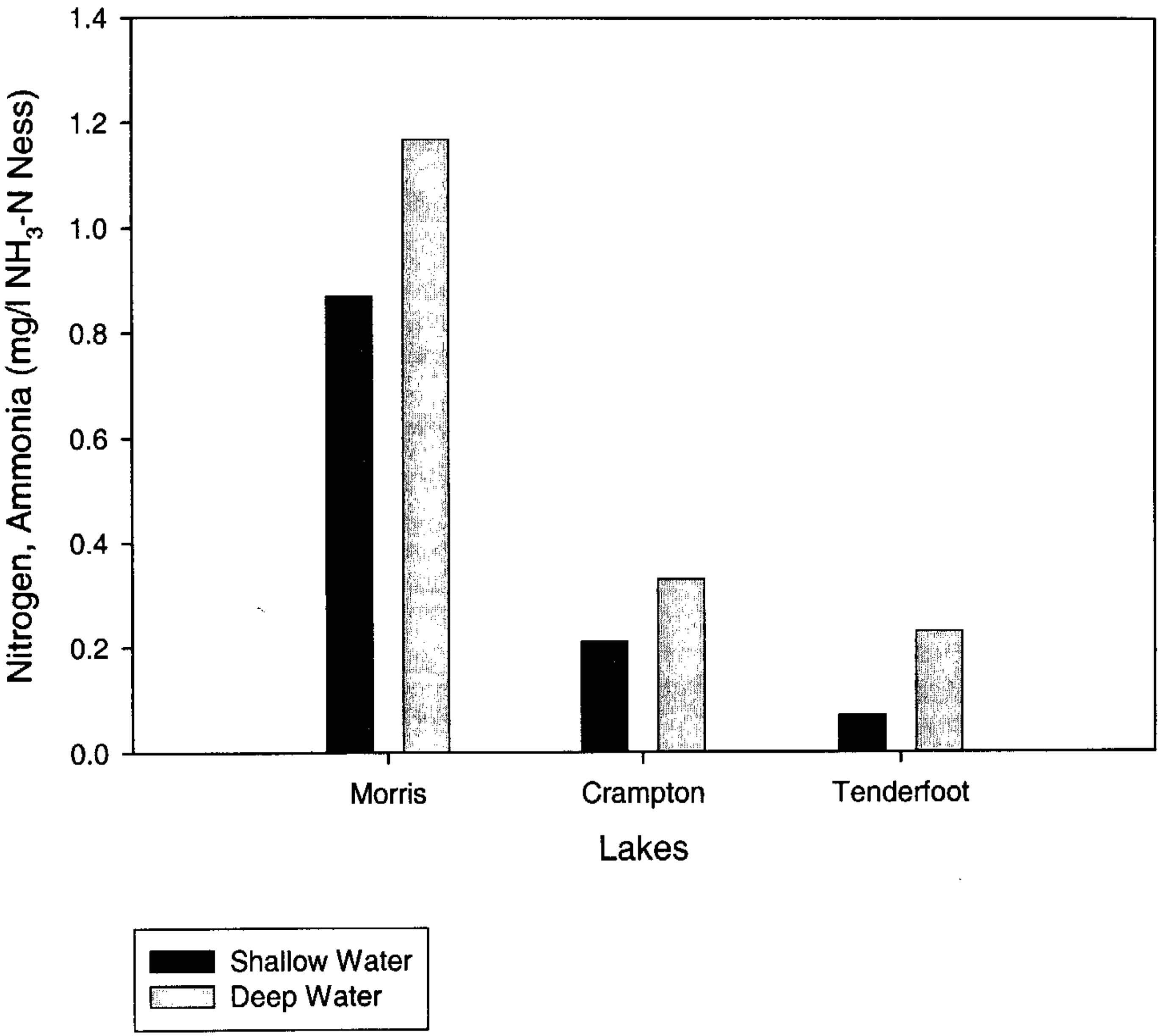


Fig 11. Sulfide of Morris, Crampton, and Tenderfoot Lakes

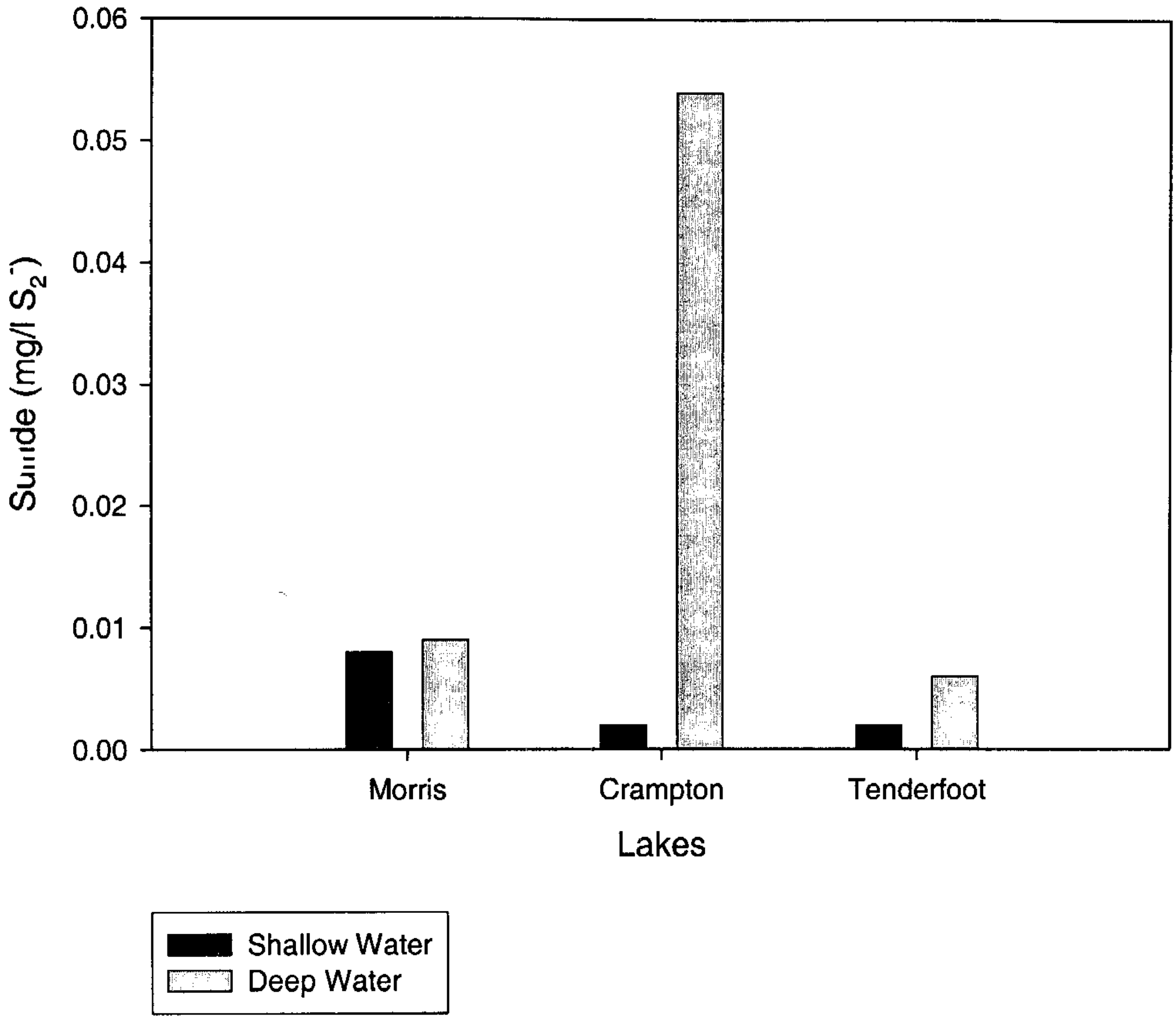


Fig 12. Phosphorus in Morris, Crampton, and Tenderfoot Lakes

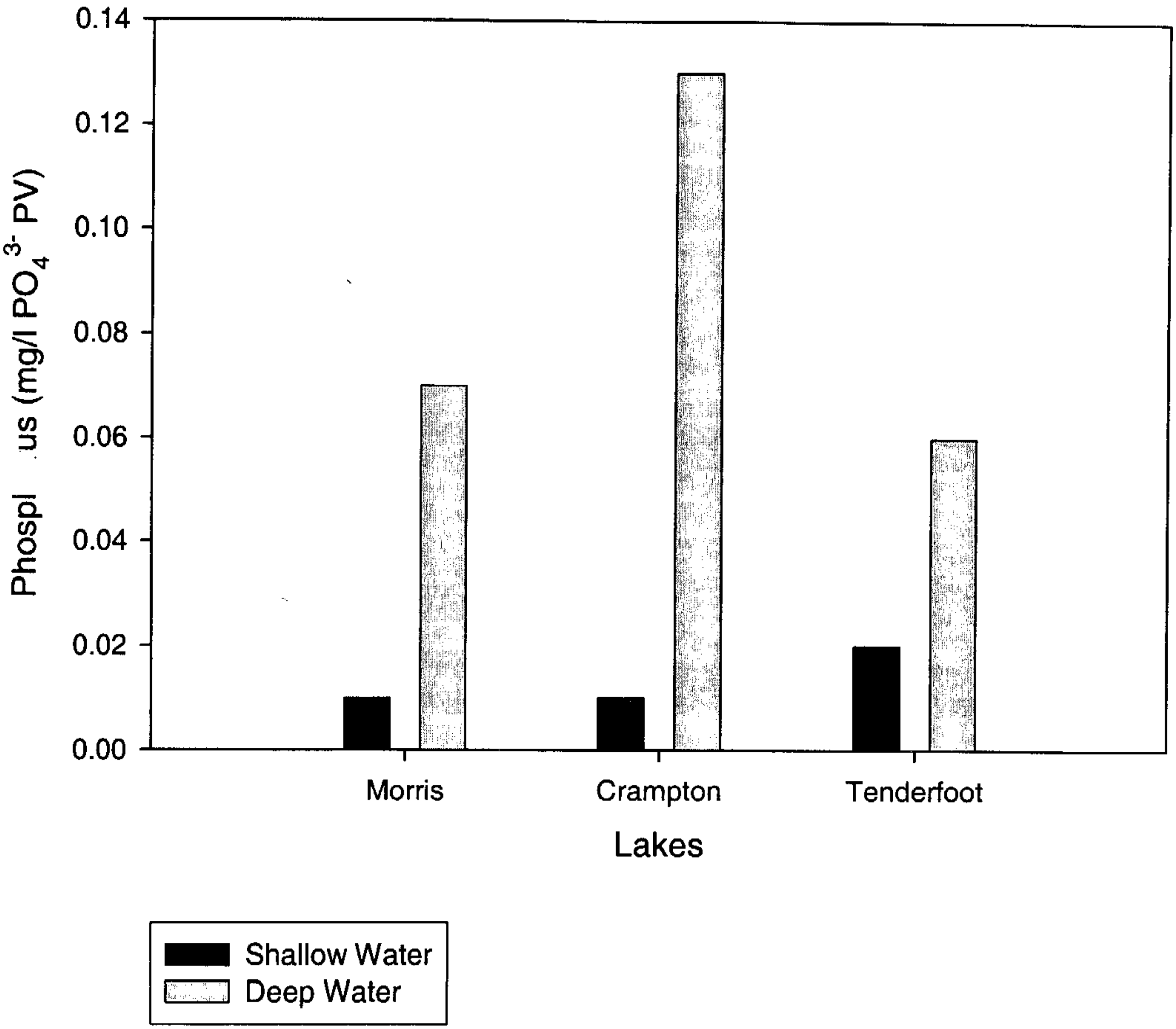
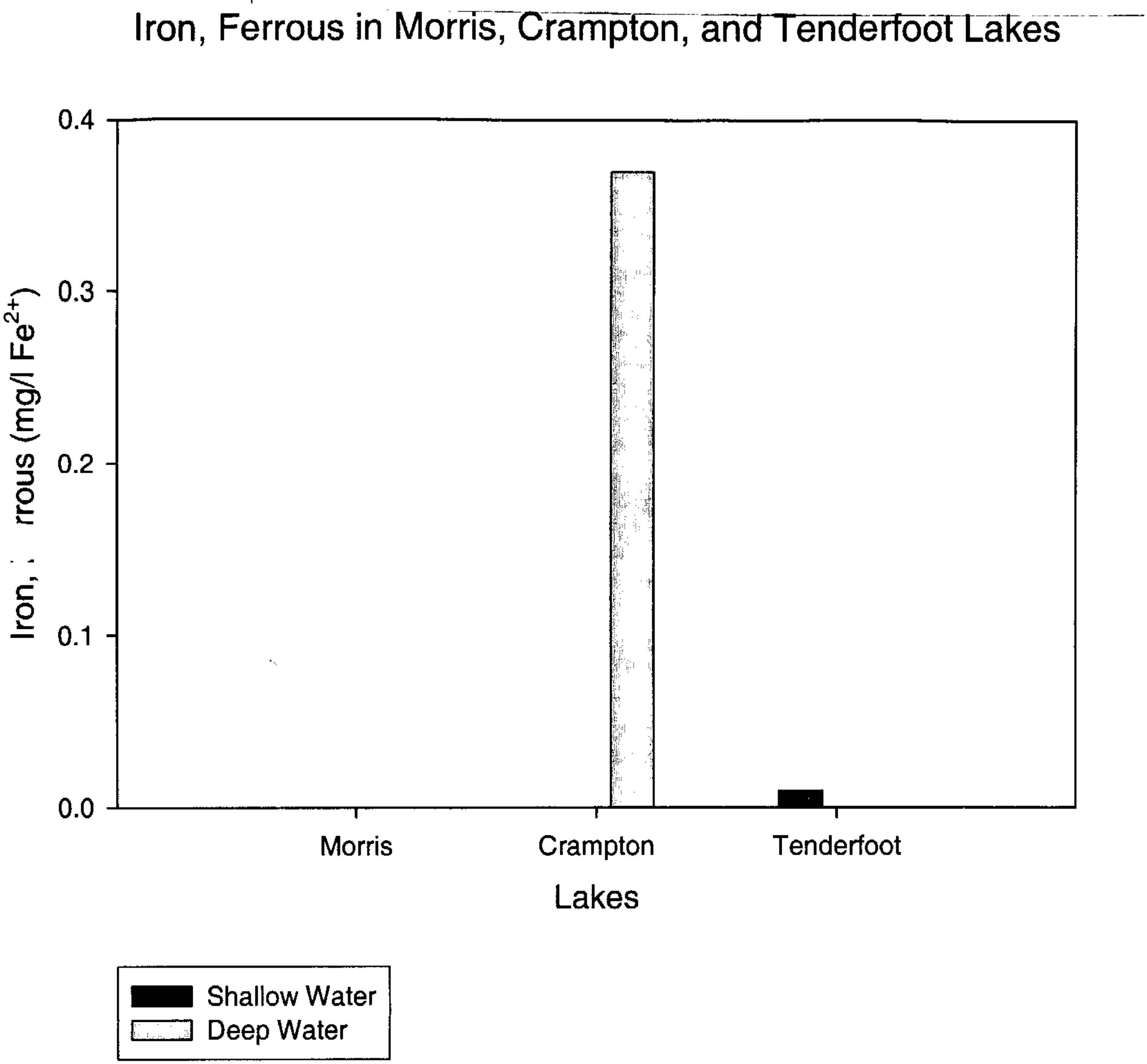


Fig 13.


Iron, Ferrous in Morris, Crampton, and Tenderfoot Lakes
0.4
0.3
0.2
0.1
0.0
Iron, rrous (mg/l Fe2+)
Morris
Crampton
Tenderfoot
Lakes
Shallow Water
Deep Water