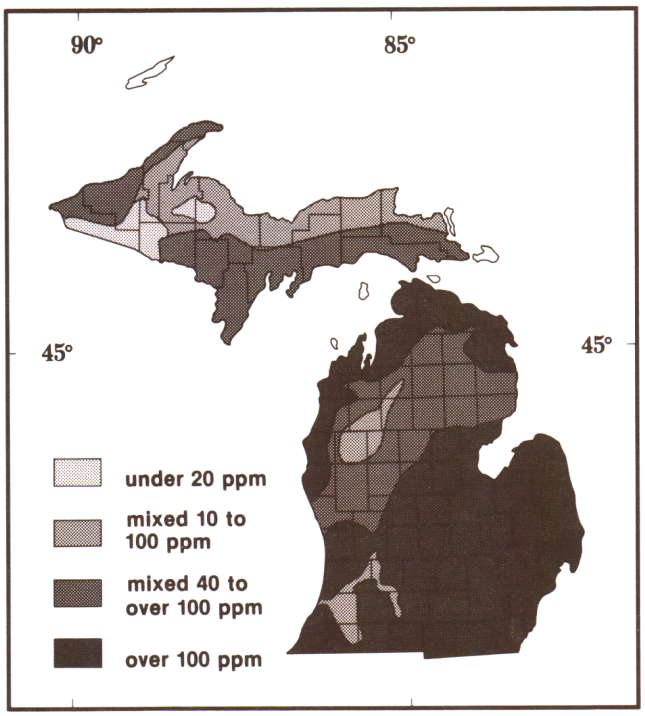

Pond alkalinity regions of Michigan. Most of the regions have a rather broad mixture of water alkalinities.

Table 4-1. Pond carrying capacity related to alkalinity of the water. These are very rough indications of how much fish can be supported by naturally-occurring food in a pond. Particularly for trout, much greater amounts can be sustained in the pond by artificial feeding, but with drawbacks explained in Chapters 7 and 8.

	Approximate carrying capacity (pounds/acre)			
	Warmwater ponds			Coldwater ponds
Alkalinity of water	Bass or catfish	Bluegills or other panfish	Total**	Trout**
More than 100 ppm*	50-100	200-400	250-500	150 or more
40 to 100 ppm	25-50	75-200	100-250	25-150
Less than 40 ppm	under 25	under 75	under 100	under 25

*parts per million

** In warmwater ponds, much of the total poundage will be in the form of young fish that are too small for angling. In coldwater ponds, all or most of the trout will usually be large enough for angling—and the poundage shown may provide about as much fishing as that shown for warmwater fishes on the same line.

The amount of phosphorus dissolved in the water does indeed limit, in most ponds during the growing season, the algal and leafy plant production which is the basis of the food web. Increasing the amount of phosphorus increases total production of pond life—but this does not always result in greater production of fish. Often only a portion of total algal production is from kinds of algae that are useful to fish. The size of that portion depends on the **alkalinity** of the water.

Alkalinity is the amount of certain minerals dissolved in the water. The main constituent in the alkalinity of Michigan water is usually calcium carbonate ($CaCO_3$), the "lime" we see deposited in the bottom of a tea kettle when "hard" water is heated and evaporated.

When water is of **low alkalinity**, presence of a small amount of phosphorus results in small amounts of the kinds of algae that water fleas and other fish food organisms like to eat. As more and more phosphorus is added to low alkalinity water, however, a point is soon reached where these beneficial algae cease to increase. Instead, the added production takes the form of "bluegreen" algae, a class which algae-eating animals don't like. Thus, rather than supporting the food web that leads to more fish, bluegreen algae proliferate without being cropped back by grazers, reach nuisance abundances, die, and directly support decay bacteria—which become so abundant as to draw excessively on the pond's supply of dissolved oxygen. The result of too much phosphorus for the amount of alkalinity is, then, a condition of occasional oxygen stress which may harm fish.

Water that is more alkaline will enable more phosphorus, if present, to grow a greater amount of the kinds of algae that result in more fish. At any level of alkalinity, however, there still can be a phosphorus level above which bluegreen algae will begin to dominate the pond.

Thus, the more alkaline a pond is, the greater its potential for producing fish. But the fulfillment of that potential will be seen only if there is just the right amount of phosphorus and if other conditions, such as temperature, are also just right.

There are other benefits from moderate to high water alkalinity, as well. Alkalinity helps avoid a variety of chemical conditions unfavorable to fish and other aquatic life. The dissolved minerals "buffer" against extreme acidity. Acids can come from various sources. For example, rainwater is becoming increasingly acidic, owing to air pollution of certain kinds, and this is making conditions unsuitable for fish in ponds that aren't well buffered. Alkalinity also maintains conditions in which fish are less subject to poisoning by the presence of certain dissolved metals.

Michigan ponds range in alkalinity from about 4 parts per million (ppm) to over 300 ppm. Most are between 50 and 240 ppm. Alkalinity of 40 ppm seems to be a pivotal value below which fish production declines and above which fish production is moderate to high, but with no steady trend of increase with increasing alkalinity because of variability in other key conditions.

Pond Breathing, Circulation and Stratification

A pond exchanges gases with the air above it. This is a form of breathing. The gases and other dissolved and drifting materials are moved about the pond by water circulations caused by wind and gravity. In winter, ice may greatly reduce