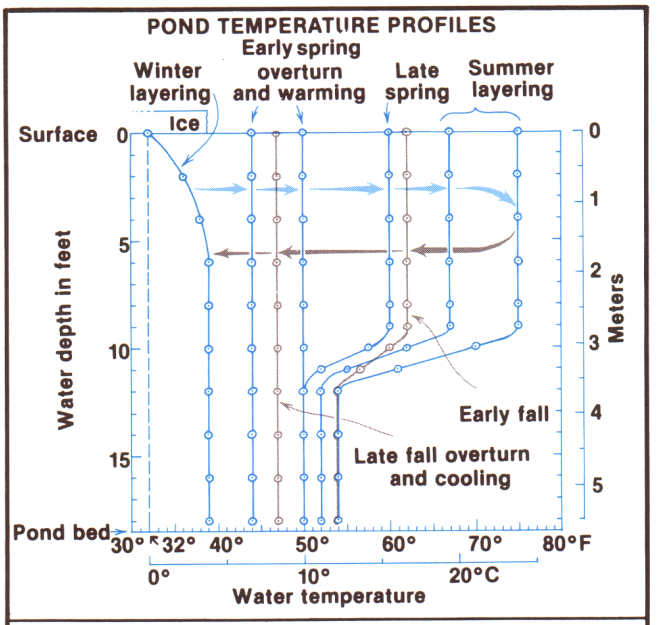
Table 4-2. Water temperature at various depths[1] in an example of a pond, measured on the 15th of each month at the deepest point in the pond which is 18½ feet deep. These are same measurements shown in the figure at right.

Water depth	Temperature (°F) at Mid-Month											
(feet)	Jan[2]	Feb[2]	Mar[3]	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec[2]
surface	32	32	44	50	60	67	71	75	62	51	46	32
2	36	33	44	50	60	67	71	75	62	51	46	39
4	38	36	44	50	60	67	71	75	62	51	46	39
6	39	38	44	50	60	67	71	75	62	51	46	39
8	39	39	44	50	60	67	71	75	62	51	46	39
9					60	67	71	75	62			
10	39	39	44	50	58	62	65	70	60	51	46	39
11					52	55	58	61	57			
12	39	39	44	50	50	52	53	54	54	51	46	39
14	39	39	44	50	50	52	53	54	54	51	46	39
16	39	39	44	50	50	52	53	54	54	51	46	39
18	39	39	44	50	50	52	53	54	54	51	46	39

[1]Measurements made at regular 2-foot intervals, except at one-foot intervals in areas of rapid temperature change.
[2]Pond covered by ice.
[3]About one week after ice has melted.



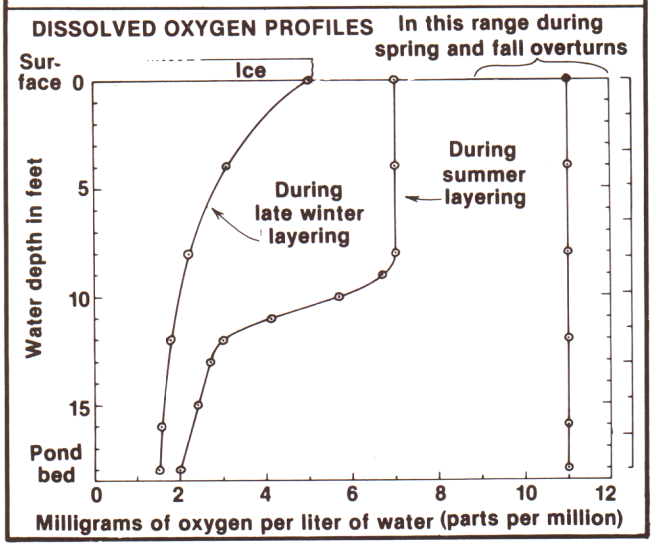


Figure at upper right:
General example of water temperature change during the year in a small, fairly deep "warmwater" pond. These are plots of some of the data in Table 4-2.

Variation can be great between different ponds and from one year to the next in the same pond, depending on water depth, wind strength, air temperature and other factors. Temperature affects water density. Water is heaviest at 39°F (4°C). Thus, water nearest 39°F tends to be at the bottom, with warmer—or, in winter, cooler—water floating on top of it. This vertical density layering, when it occurs, results in a gradation of temperature from top to bottom. Then fish can choose the depth offering preferred temperature—if not prevented by insufficient dissolved oxygen.

***Winter Layering*—Ice covers the surface. Water is 32° just under ice and is progressively warmer at greater depths. Deepest water is near 39°. Warming by groundwater seepage may alter the curve.**

***Springtime Overturn and Even Warming*—After ice melts in March of April, wind mixes water evenly throughout as the pond warms. Temperature stays equal from top to bottom as warming occurs.**

***Late Spring and Summer Layering*—Will not often occur in many ponds, especially not in ones shallower than shown here. Layering happens if upper water becomes, by intense warming, so much lighter than lower water that wind cannot overcome the density difference and can no longer mix all the way to the bottom. Then mixture occurs only in upper water. The well-mixed upper layer has a thinner layer of water with rapidly decreasing temperature between it and the cooler water below.**

The upper layer will usually extend deeper than shown. Wind may become strong enough to destroy layering after it has formed.

Seepage of very cool ground water into the pond may make layering more distinct and stable.

***Autumn Overturn*—Surface water cools, becomes denser, and sinks, mixing with warmer water just beneath. Thus, upper layer is cooled to density near that of lower layer, and wind can mix the whole pond again. Complete fall mixing can occur solely by sinking of upper water as the weather becomes colder; wind is not needed. Fall overturn halts when ice blocks wind action and upper water becomes colder, hence less dense, than water beneath it which is nearer 39°F.**

Dissolved oxygen at different depths in the same pond, as affected by the wind mixing and thermal/density layering shown in the figure on page 20.

***During Spring and Fall Overturn*—Large amounts of oxygen can dissolve into the pond from the air because water that is cooler can hold greater concentration of dissolved gases. Amounts of dissolved oxygen are the same at all depths because water is well circulated throughout. Concentrations of 9-12 ppm commonly occur.**

***During Summer Layering*—Warmer water of upper layer cannot hold as much dissolved oxygen as could the cooler water in spring time. Cool water of the deep layer could hold more dissolved oxygen, but decay of organic matter consumes oxygen, and the lower water cannot obtain more because density layering prevents it from being circulated into contact with the atmosphere. Therefore, dissolved oxygen decreases in the lower layer, and it may become unfit for fish.**

***During Winter Layering*—Ice and snow block entry of light and of oxygen. Plants have too little light for photosynthetic production of oxygen, and none can dissolve into the pond from atmosphere. Respiration and decay consume dissolved oxygen. Concentrations decrease the most near pond bottom where there is more organic matter. Fish are forced upward into layers having sufficient dissolved oxygen.**