

CHAPTER 15

AQUACULTURE

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15.1 INTRODUCTION

One of the most common areas of interest in geothermal direct use is that of aquaculture. For those involved with the initial planning of such a project, one of the first questions to be addressed relates to project size. In most geothermal applications, the maximum pond area that can be developed is restricted by the maximum heat available from the resource. It is the purpose of this chapter to present a brief introduction to the subject of heat loss from ponds (or pools) so that developers can make an informed evaluation of geothermal resources for this purpose.

15.2 TEMPERATURE REQUIREMENTS FOR SELECTED SPECIES

In order to determine the heat loss of the ponds, it is necessary to first select the temperature at which the water must be maintained. Table 15.1 provides a summary of appropriate temperatures for selected species. In addition, growth periods for cultures at optimum temperatures are shown in the last column.

15.3 HEAT EXCHANGE PROCESSES

A non-covered body of water, exposed to the elements, exchanges heat with the atmosphere by way of four mechanisms: (a) evaporation, (b) convection, (c) radiation, and (d) conduction. Each of these is influenced by different parameters that are discussed separately in the following paragraphs.

15.3.1 Evaporative Loss

Evaporation is generally the largest component of the total heat loss from the pond. Considering evaporation, the loss of volume generally comes to mind rather than the loss of heat. However, in order to boil water (and hence cause evaporation) heat must be added. The quantity of heat required to evaporate one pound of water varies with temperature and pressure, but under normal atmospheric conditions the value is approximately 1,000 British thermal units (Btu). When water is evaporated from the surface of the pond, the heat is taken from the remaining water. As a result, as each pound of water evaporates from the surface, approximately 1,000 Btu are lost with escaping vapor.

Table 15.1 Temperature Requirements and Growth Periods for Selected Aquaculture Species^a

<u>Species</u>	<u>Tolerable Extremes (°F)</u>	<u>Optimum Growth (°F)</u>	<u>Growth Period to Market Size (mos)</u>
Oysters	32 to 97 typ	76 to 78 typ	24
Lobsters	32 to 88	72 to 75	24
Penaeid Shrimp			
Kuruma	40 to ?	77 to 87	6 to 8 typ
Pink	52 to 104	75 to 85	6 to 8
Salmon (Pacific)	40 to 77	59	6 to 12
Freshwater Prawns	75 to 90	83 to 87	6 to 12
Catfish	35 to 95	82 to 87	6
Eels	32 to 97	73 to 86	12 to 24
Tilapia	47 to 106	72 to 86	--
Carp	40 to 100	68 to 90	--
Trout	32 to 89	63	6 to 8
Yellow Perch	32 to 86	72 to 82	10
Striped Bass	? to 86	61 to 66	6 to 8

a. Behrends, 1978