

AQUACULTURE INFORMATION SERIES: NO. 2

CARRYING CAPACITIES OF REARING PONDS

I. INTRODUCTION

When the marketing analysis data have been evaluated and the Product Definition identified, the production potential of the fish farm must be determined. In essence, the marketing potential and the production potential must be comparable. If they are not, the time to make the appropriate adjustments is in this stage - not later, when the fish are in the ponds and/or the delivery contracts are negotiated.

This production potential process establishes the carrying capacities of each rearing pond. Depending upon the preferences of the user, the process requires the collection of specific physical, chemical, and biological data with as much precision as possible.

II. PHYSICAL-CHEMICAL PARAMETERS

The following data should be collected:

A. Physical parameters

- 1) Pond dimensions: Total and fish-rearing length, width, and depth
- 2) Water inflow(s)
- 3) Annual daily average water temperature (°C) profile on a biweekly or monthly basis.
- 4) Elevation of the facility above sea level

B. Chemical parameters:

- 1) Water chemistry analysis: Alkalinity, total hardness, specific conductance, dissolved oxygen, pH, inorganic nitrogen, dissolved nitrogen gas, heavy metals (copper and zinc), biological oxygen demand, chemical oxygen demand.
- 2) Discharge permit limitations

The foregoing rearing pond and water inflow data would be better in metric units; i.e., meters and liters, rather than English units; i.e., feet and gallons. The primary reason for this is the obvious simplicity in converting units within the system and the sensitivity. For example, 1000 liters = 1.0 cubic meter (m³). Also, measuring and weighing fish in mm and grams is much more sensitive than using inches and pounds. For example, 1 mm = 0.039 in. (1/25.4 of an inch) and 1.0 gram = 0.0022 pound (1/454 pound). Thus, the degree of sensitivity afforded by the metric unit system is far more than that of the English unit system. Finally, in converting units between the metric and English systems there is an inherent rounding error which can lead to large discrepancies over an extended period of time.

C. Calculations to be made using the physical parameter data:

- 1) Water Volume (raceway)

$$\text{length} \times \text{width} \times \text{depth} = \text{volume}$$

2) Water Volume (circular)

radius squared x 3.1416 x depth = volume

3) Water Volume (D-end rectangular circulating)

(radius squared x 3.1416 x depth) + (length minus width *
width x depth) - (length x thickness x depth of the center
wall) = volume

4) Fish Rearing Volume

length x width x depth of space occupied by the fish = rearing
volume

5) Water Replacement Time (raceway)

60 divided by (water inflow in units/hour divided by water volume)
= minutes required for 100% replacement

6) Water Replacement Time (circulating water pattern)

(water volume divided by the water inflow in units per minute) x
3.0 = minutes for 95% replacement of water volume.

7) Water Velocity (raceway)

(inflow in units per second divided by the cross-sectional area in
units squared) x 100 = units per second of velocity.

III. BIOLOGICAL PARAMETERS

The production potential of a fish farm is based upon establishing the carrying capacities (oxygen, density, and ammonia) of each pond and the Allowable Growth Rate (AGR) of the fish in the system.

Ponds, particularly raceway ponds, arranged for serial passage of water have been one of the more serious constraints to successful fish health management. In systems utilizing 3-5 serial water uses, the status of health in succeeding populations often gets progressively worse. This condition is influenced by at least three major factors within the system: (1) the pond loadings; (2) the successive accumulation of waste products (fecal material and ammonia) and uneaten feed; (3) the successive depletion of dissolved oxygen. Thus, any successful production in situations such as this must take these three constraints into account.

Each of the three carrying capacities of rearing units must be defined for each unit; i.e., oxygen or life support; density, and ammonia must be considered as an individual criterion, with the lowest carrying capacity value being determinant for the rearing unit. The details for calculating each of the three carrying capacities are presented in A Manual For Rainbow trout Production On The Family-Owned Farm, published by Nelson and Sons, Inc.

The Allowable Growth Rate (AGR) of the fish is influenced by many factors in the system, the main of which are (1) water temperature; (2) metabolizable energy; and (3) water chemistry parameters; e.g., alkalinity

and calcium. The individual influences of specific water chemistry parameters are difficult to predict because their effects are dose-dependent; i.e., the relative amount dictates the degree of response.

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