ECOLOGICAL STUDIES OF SEMI-INTENSIVE PRAWN AQUACULTURE PONDS

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ABSTRACT

Two of the most pervasive problems in modern aquaculture development are the high costs of supplemental feeds and the control of drastic water quality fluctuations in conventional monoculture operations. Prawn aquaculture in Hawaii is no exception with feed costs comprising some 25 percent of annual operating costs for a 40.5 ha operation and critically low early morning D.O. concentrations occurring due to phytoplankton fluctuations. This latter problem requires flushing large quantities of freshwater (1500 $\ell \cdot min^{-1} \cdot ha^{-1}$ for 24 hr.) to restore oxygen concentrations to acceptable levels. In this study the microbial ecology of the commercial monoculture prawn system and an alternative system, a fish/prawn polyculture system at conventional feeding rates (40 $kg \cdot ha^{-1} \cdot d^{-1}$) and reduced rates (20 and 0.4 $kg \cdot ha^{-1} \cdot d^{-1}$) was examined relative to the conventional system over a 3 year period in Hawaii.

Studies of the commercial monoculture system revealed two distinct environmental conditions--a brown water and a green water condition. Brown water conditions were characterized by uniformly vertical mixing profiles of protein concentrations and RNA and DNA synthesis rates with productivity estimates based on POC increases 6-51 times greater than estimates based on ^{14}C uptake, and by anomalously low surface water C:N ratios (mean 3.8 by weight). Green water conditions were characterized by stratified profiles of protein concentrations, RNA and DNA synthesis rates, "Redfield" C:N ratios (mean 8.2 by weight) and by productivity estimates based on POC

increases and ^{14}C uptake that did not differ significantly. Phytoplankton composition ratios indicated that most of the seston in commercial systems was living nad experiencing nutrient-saturated and light-limited growth rates some 75-80 percent of maximum phytoplankton growth rates. The mean water column oxygen consumption rate comprised some 78 percent of the total oxygen consumption rate in the system and exceeded the mean sedimentary oxygen consumption rate by 7 times.

The addition of high densities of Chinese carps (silver, grass) to semi-intensive prawn ponds stimulated phytoplankton productivity and turnover rates and reduced total phosphorus concentrations while maintaining high AM D.O. levels. Grazing and excretion by these fish appear to keep the phytoplankton healthy and at a stable biomass level. Addition of large amounts of dried chicken manure to fish/prawn polycultures (680 $kg \cdot ha^{-1} \cdot wk^{-1}$) stimulated phytoplankton productivity and DNA synthesis rates by factors of 3.0 and 4.6, respectively, compared to fish/prawn polyculture ponds fed conventional chicken broiler feed at 40 $kg \cdot ha^{-1} \cdot d^{-1}$.

Fish/prawn polycultures fed 50 percent and 1 percent of commercial rates (40 $kg \cdot ha^{-1} \cdot d^{-1}$) had increased rates of primary productivity, total microbial productivity, dissolved organic carbon concentrations and of sedimentary oxygen consumption versus control, monoculture prawn ponds fed conventionally. Fish/prawn polycultures at the reduced feeding rates had significantly decreased rates of percent sedimentary organic matter and no acid accumulations over the experimental period compared to control ponds. Fish and prawn yield characteristics were not significantly different between control, 100 percent feed ponds and fish/prawn polyculture ponds receiving 50 percent of the feed of

control ponds. Prawn yields, survival, mean size and growth rates were not significantly different in these two treatments. However, prawn yield characteristics (mean size, number of harvest size animals and yields) were significantly lower in the fish/prawn polyculture ponds fed 0.4 kg $\cdot$ ha^{-1} $\cdot$ d^{-1} than polyculture ponds fed 20 kg $\cdot$ ha^{-1} $\cdot$ d^{-1}.

Polyculture of Chinese carps and prawns at high densities has great potential to cut feed costs, stabilize water quality and increase net farm income in regions where both prawns and Chinese carps can be successfully marketed.