Data Analysis and Synthesis

DAST researchers at the University of California, Davis (UCD) continued refining models reported in previous annual reports. An aquaculture pond model useful for the analysis of integrated aquaculture-agriculture systems was modified, and changes were made to a model designed to simulate water temperature, dissolved oxygen (DO), and fish growth in stratified fish culture ponds.

The accuracy of model simulations of organic matter, nitrogen, and fish production in ponds is important for the analysis of integrated aquaculture-agricultural systems. Fishpond ecosystem models have not specifically included organic matter dynamics—processes occurring in the water column and sediments of fish ponds—as primary components of the system. In order to refine organic matter dynamics in fish ponds, DAST researchers began modification of two submodels, a bioenergetic and a multi-G model, which are part of an integrated aquaculture-agriculture model.

The bioenergetic model, which simulates fish growth, was modified to include the effect of feed quality and different digestibility coefficients for various feed types. Preliminary results pertaining to fish growth, nitrogen, and organic matter accumulation are described in this year's report. Fish growth rate simulated by the modified equation was similar to observed data from a PD/A CRSP site in Butare, Rwanda. This result is promising, and after further development and testing, researchers anticipate that the model will be a useful tool for the study of aquaculture systems models where agricultural wastes are the primary feed input sources.

The multi-G model was used to simulate water column and sediment organic matter. Sediment and water column organic matter concentration values were similar to values reported for agriculture waste-fed ponds. Water column nitrate also followed a trend similar to data collected from the PD/A CRSP site in Butare, Rwanda; however, other nitrogen parameters (i.e., sediment nitrogen) require further refinement.

To better predict the variability of water quality and fish growth associated with weather conditions at a given location, further modifications were made to a model of water temperature, dissolved oxygen (DO), and fish growth for stratified fish culture ponds by adjusting the procedure for generating daily and hourly solar radiation estimates. Simulation of hourly results were verified using PD/A CRSP data collected in Thailand. Cumulative probability distributions of daily solar radiation values generated by the model compared well with data measured in Thailand. Temperatures simulated at three depths—the surface, middle, and bottom layers—did not always correspond to the measured data; differences between measured and simulated values were more pronounced for the surface water layer than for the middle and bottom layers. Comparisons of DO values for the three water layers were in agreement—most of the measured values fell within the range of simulated values. Although limited fish growth data are available, measured values of growth fell within the range of simulated values. The difference between maximum and minimum simulated values increased with time, indicating that the width of the probability distribution of the size of the harvested fish increased with time.

The modified solar radiation sub-model proved effective for the estimation of solar radiation values with limited data sets. Further, the temperature, DO, and fish growth simulation results corresponded with measured values, even for long-term simulations.

Through the practical application of POND© decision support software, PD/A CRSP researchers at Oregon State University continued to generate information for pond aquaculture planning and management. A water budget model that considers various sources and sinks was used to predict water requirements for CRSP sites in Thailand and Honduras. Feed requirements for aquaculture ponds were also assessed through the use of the POND© bioenergetics (BE) model. Simulations of plankton biomass changes in Nile tilapia ponds were also undertaken using more complex POND© models. POND© heat balance and fish growth models also were used to conduct sensitivity analyses. Accurate estimations are achievable via a combination of field experimentation and appropriate use of the POND© parameter estimation package.

In a separate effort, OSU DAST team members—in collaboration with the FAO Inland Water Resources and Aquaculture Service—estimated fish yield in Latin America as part of FAO's effort to assess aquaculture potential through the use of a geographical information system (GIS). The POND© heat balance model was used to generate water temperature profiles for continental Latin America. Water temperature profiles were then used in the POND© fish growth model together with pre-set satiation feeding levels and harvest sizes to assess the number of crops per year possible under commercial scale aquaculture for four fish species: Nile tilapia (*Oreochromis niloticus*), tambaquí (*Colossoma macropomum*), pacu (*Piaractus mesopotamicus*), and common carp (*Cyprinus carpio*). The potential for small-scale and subsistence aquaculture was also evaluated.

Application of POND© as a Tool for Analysis and Planning and *Applications of Heat Balance and Fish Growth Models for Continental-Scale Assessment of Aquaculture Potential in Latin America* are contained in the Global Studies and Activities section of this publication.