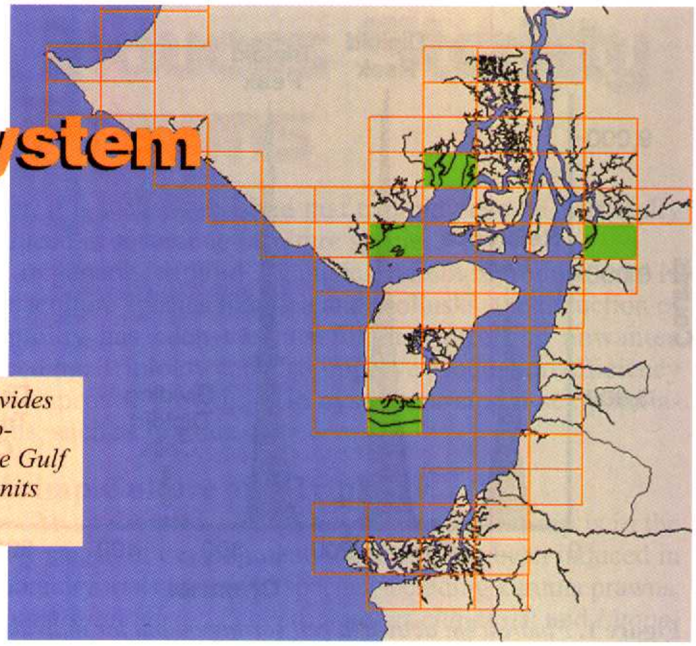
Ecuador Develops GIS-Assisted Alert System For Shrimp Farming

Stanislaus Sonnenholzner, Ph.D.
ssonnen@cenaim.espol.edu.ec

Bonny Bayot, M.Sc.
Ivan Apolo
Teresa Vera
Xavier Ochoa
Zobeida Cisneros, Ph.D.
Leo Van Biesen, Ph.D.
M. Pilar Cornejo, Ph.D.
Jorge Calderón, Ph.D.

Centro Nacional de Acuicultura e Investigaciones Marinas
Campus Politécnico
Casilla 09-01-4519
Guayaquil, Ecuador



The digitized system divides Ecuador's main shrimp-producing region on the Gulf of Guayauil into grid units of 12,860 ha each.

During 1999, the shrimp-farming industry in Ecuador began experiencing heavy crop mortalities and severe economic losses due to the appearance of white spot syndrome virus (WSSV). Resource managers, academics, and shrimp farmers quickly began to realize the need for monitoring programs to foresee future environmental and disease problems.

Monitoring campaigns were carried out to determine the spread and prevalence of WSSV and other shrimp diseases, but they were time-consuming and expensive. Concurrently, the Litoral Superior Polytechnic School (Escuela Superior Politécnica del Litoral, ESPOL), in collaboration with the Flemish University Council (VLIR), began developing an environmental management tool for aquaculture based on a geographic information system (GIS).

Geographic information systems are well suited to environmental and disease-monitoring programs because they provide a comprehensive analysis of spatial and temporal datasets in a cartographic form and allow database query and modeling at the same time. The ESPOL-VLIR GIS was devised to both determine the prevalence of WSSV and provide a scenario for the development of an epidemiological model that could alert shrimp farmers of future disease events.

GIS System

The system developed by ESPOL-VLIR consists of an electronic charting and display system that was initially driven by independent epidemiological criteria obtained from data analysis. However, the success of the epidemiological alert system would require continuous field campaigns to feed the GIS.

Farmers could regularly feed the geographic database on line by introducing their production variables after harvest through a Web site interface. A normalized production parameter was then developed to trigger alert levels in the 65, 13,000-ha cell grids built within the cartographic geographic system covering 107,000 ha of production area in the Gulf of Guayaquil.

Shrimp Production Index And Anomalies

The shrimp production index (SPI) is a reference that combines production variables in the following equation:

$$\mathrm{SPI} = \frac{\left(\dfrac{\text{Yield}}{\text{Pond Area}}\right)\left(\dfrac{\text{Harvest Weight}}{\text{Time}}\right)}{\text{Stocking Density}}$$

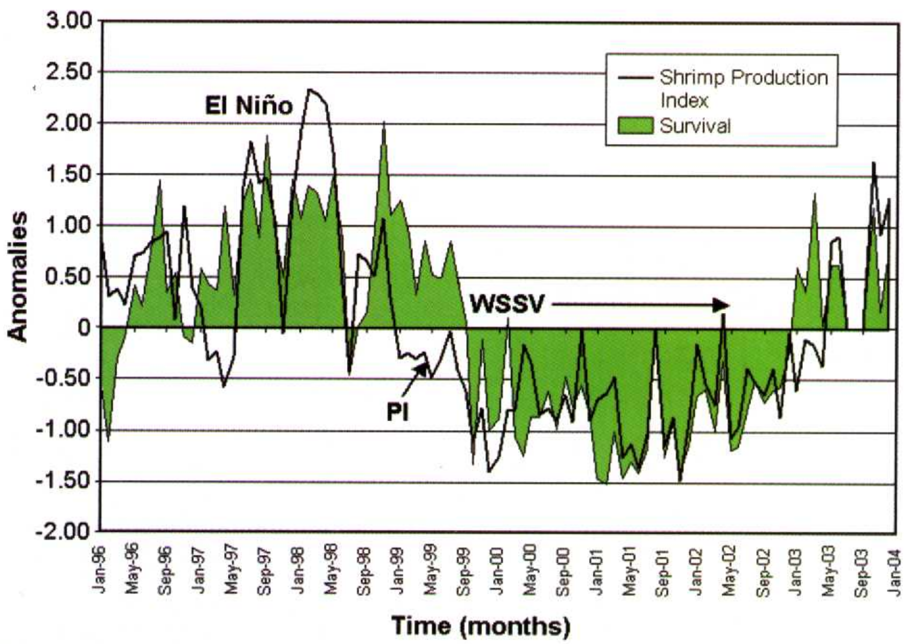


Figure 1. *Shrimp production index and survival anomaly time series for an Ecuadorian shrimp farm.*

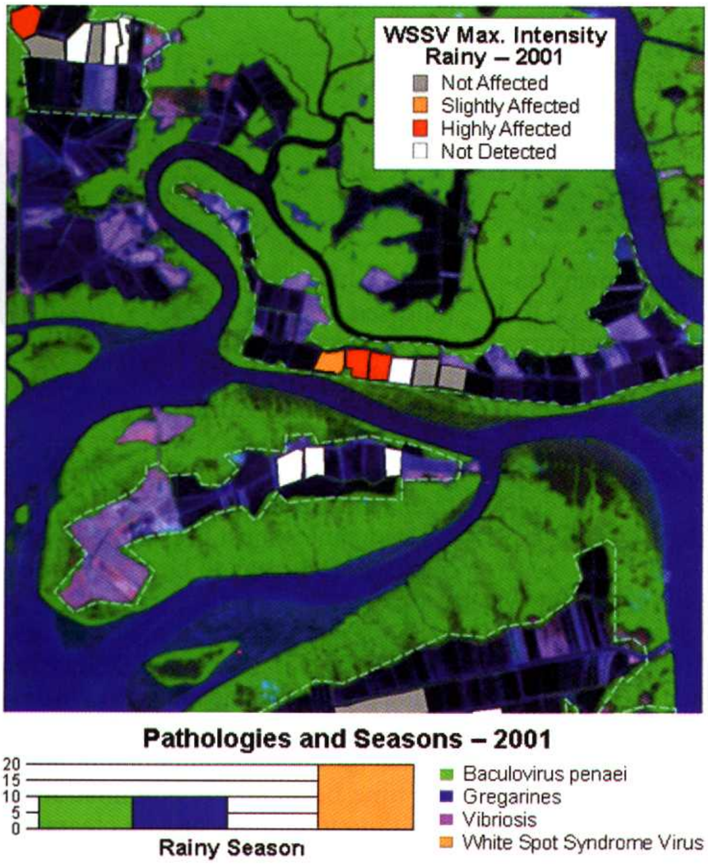


Figure 2. *SPI alert levels for individual ponds within a farm in Ecuador.*

The resulting SPI units are: 10 (g/day) (g/shrimp).

Departures of SPI values from their averages for a particular month and grid are measured in terms of anomalies as standard deviations from mean. This requires the normalization of SPI values by the subtraction of an SPI value from the average and division to standard deviation. One average and one standard deviation are obtained for each month in each grid. Each grid compiles the SPI values from farms contained in the grid.

The alert levels are triggered by changes in magnitude and sign in the monthly anomalies. Color criteria express the four alert levels, from green for anomalies greater than or equal to zero to red, which represents negative anomalies less than or equal to -0.25 the standard deviations.

Time Series Example

The SPI anomaly time series (1996-2003) for a participating shrimp farm is presented in Figure 1. The survival anomaly is included in the same graph for comparison. Negative SPI anomalies were registered in late 1998 and early 1999 prior to the negative survival anomaly observed after May 1999. WSSV was officially recognized in Ecuador in April 1999.

Of interest are the negative SPI anomalies registered in January-May 1997 prior to El Niño, despite positive survival anomalies, and the June-July 1998 period, which coincided with negative survival anomalies. SPI and survival anomalies present the same negative pattern throughout the period of mid-1999 to 2003. Recovery of SPI values for this farm is evident in late 2003.

The project's future success will depend on the active participation of farmers in feeding their data into the database in a consistent and timely manner.

Electronic Charting Display

Land cartography from the Military Geographical Institute of Ecuador and satellite images were combined into a digitized geographic frame containing shrimp pond-positioning information distributed within corresponding grids of 12,860 ha each. Farm and pond density within each of the 65 grids varied depending on production location.

All production information from the different farms and ponds within the grid is used to calculate the SPI and its corresponding anomaly in the grid. Since SPI values are estimated from individual pond information, the alert system can be extended to ponds (Figure 2).

The project's future success will depend on the active participation of farmers in feeding their data into the database in a consistent and timely manner. A Web page to access information has already been created. The effort is now focused on a door-to-door campaign to involve farmers in this alert system.