Table 1. Reportable precision (= level of detection in mg/l) of a chemical analysis based on the linear slope of a standard curve.

Slope of standard curve (absorbance units/ mg/l)	Concentration equivalent of 0.001 absorbance units (mg/l)	Reportable precision (mg/l)
0.050	0.020	0.05
0.100	0.010	0.02
0.200	0.005	0.01
0.400	0.0025	0.01
0.600	0.0017	0.01
0.800	0.0012	0.01
1.000	0.0010	0.005
1.200	0.0008	0.005
1.400	0.0007	0.002
1.600	0.0006	0.002
1.800	0.0006	0.001
2.000	0.0005	0.001
3.000	0.0003	0.001
4.000	0.0002	0.001

Overall Advice

1. Maintain a broad perspective when analyzing aquaculture waters. They vary with time, and location and procedures have many sources of error in collection and analysis.
2. Due to potential inconsistencies of reagents, spectrophotometers, standards, laboratory technicians, electrical power supply, etc., it is strongly suggested that a new standard curve be made for and at the time of each analysis.
3. Do not report any concentration with greater precision than 0.01 mg/l. This rarely has any biological meaning in aquaculture.
4. Standardize data sheets to record systematically all important information: units of measurement, flask number, date of collection, date of analysis, laboratory technician's name, project title, etc.
5. Make sensible use of spectrophotometers with automatic concentration readouts. There are many potential dangers and implicit assumptions in allowing the spectrophotometer to calculate concentrations for you. Plot the absorbance measurements yourself, then you will get a curve you can believe.

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References

APHA. 1985. Standard Methods for Examination of Water and Wastewater. - 16th ed., American Public Health Association, American Water Works Association, and Water Pollution Control Federation, Washington, D.C.

Strickland, J.D.H. and T.R. Parsons. 1972. A Practical Handbook of Seawater Analysis. Fisheries Research Board of Canada, Ottawa, Ontario, Canada.

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Pen-Culture-Based Reservoir Fisheries Management: Reservoir Production Improvement by Release of Pen-Nursed Fingerlings of Selected Species in Thailand

HANS MANNI

Introduction

Northeastern Thailand (Isan) is one of the least developed areas in this economically fast growing country. Traditionally, rice farming is the most important source of income and rice is the staple food. Animal protein consumption in the remote areas still largely depends on hunting and collection of products like fish, snails and insects.

Besides fisheries activities on the Mekong River and its tributaries, and fish harvests from ricefields and village fishponds, further potential for fish production has been created with the construction of small- and medium-sized reservoirs.

Reservoirs and Fisheries

In Thailand, large reservoirs contribute to the country's energy requirements and

Stocking pens.

also serve as a source of irrigation water. In recent times, smaller reservoirs have been created in large numbers mainly for irrigation purposes and swamp control. Their dams also serve as roads and improve access to villages.

In northeast Thailand, many poorer villagers rely on the fisheries output of small public reservoirs (25-500 ha). Gillnets, harpoons, hooks and lines, traps and cast nets are frequently used by farmers and catches are mainly for local consumption.

Many of these artificial waterbodies are characterized by unbalanced ecosystems with poor zooplankton development. They are often choked with submerged weeds, and contain large predatory fish populations. Thus, their fisheries production is relatively low, despite regular stocking of reservoirs with fingerlings from government fisheries stations.

Fingerling Nursing in Reservoirs

Under the auspices of the Interim Mekong Committee, technical assistance was provided to the Thai Department of Fisheries (DOF), funded by the Netherlands Ministry of Development Cooperation, for the establishment of a fish seed production center in Yasothon Province in 1990. An ecological survey demonstrated the relative ineffectiveness of stocking programs with small fingerlings.

In cooperation with the DOF, pilot activities on pen culture-based reservoir fisheries management were started in 1990. The objective was to assess the effects of the release of nursed, larger fingerlings of mainly herbivorous species into weed infested reservoirs. In the first year, village committees were established around three reservoirs (25-160 ha), and 4-6 pens (400 m^2 each) per reservoir were constructed and stocked with small (2-5 cm) fingerlings mainly of silver barb (*Puntius gonionotus*), grass carp (*Ctenopharyngodon idella*) and rohu (*Labeo rohita*), at a density of 50/m^2. The committees received a percentage of the nursed fingerlings in return for their inputs in pen management.

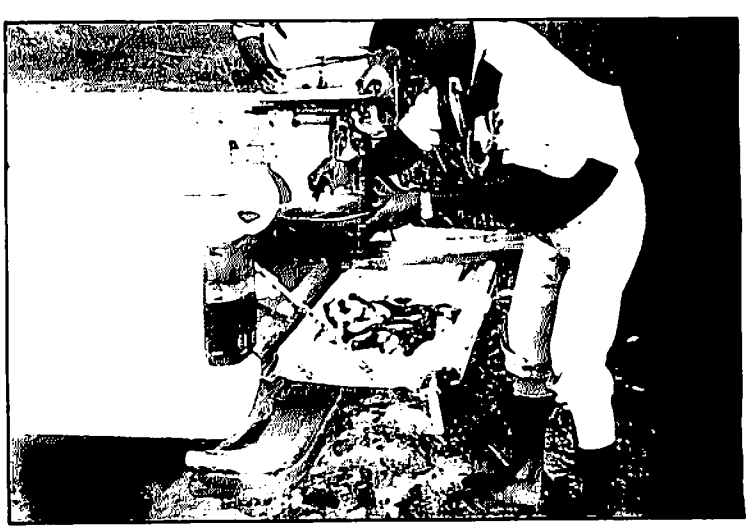
A complete nursing cycle lasted 8-10 weeks, feeding with rice bran and pig feed. Harvesting showed 50-80% survival and fingerling sizes of 7-10 cm. Some problems occurred with poaching, poor feeding and occasional flooding due to unexpected peak water levels. Pen cleaning with rotenone or cyanide to remove natural fish prior to stocking was beneficial.

In 1991, a majority of village committees had taken full responsibility for pen management, including feeding with local rice bran and water plants. Participating villagers were interested because of their benefits in the form of nursed fingerlings and the good effects of the fingerling release on reservoir fish landings.

Improved Fish Landings

Regular surveys on the assessment of fish landings at the reservoirs started several months before the first release of nursed fingerlings. Information was also gathered on the biological characteristics of the reservoirs, in particular, weed biomass and Secchi disc transparency.

Initial findings, mostly based on gillnet fisheries, showed that the species selected for nursing were almost nonexistent in the reservoirs prior to the first release in the rainy season of 1990. The released fingerlings of the 2-3 nursing cycles of 1990 at least doubled total gillnet landings to 75-100 kg/ha/year, with peak abundances of released fish in the average daily catch of over 60%. Data on landings with other fishing gear equipment indicated similar total production levels. No significant competition with native fish was observed. Recapture was satisfactory: for silver barb, 15-20% in one year; grass carp, 2% and rohu, 6-8% (in eight months). The latter



Survey on fish stocks and water quality of reservoirs.

showed excellent growth, with individual weights of 2-4 kg.

Reservoir Fisheries Management

The project on reservoir fisheries clearly showed the effects of releasing advanced fingerlings. The choice of species and numbers of fingerlings to be released depend primarily on biological characteristics of the reservoir. Seasonal fluctuations caused by rainfall, temperature, agricultural run-off and fish breeding interfere as well. In the Yasothon reservoirs, no clear effect of the fingerling releases on weed biomass has been observed as yet.

An example of improved fish landings at reservoirs.

Gear regulations play an important role in fisheries management in public waters. Although the small mesh gillnets were banned in these reservoirs by local authorities, some fish, especially silver barb, were recaptured too soon (100-130 g). Traps, hooks and harpoons were effective for predator removal.

Improved fish stocking with pen culture is expected to lead to sustained higher production levels in these reservoirs. Periodic reviews will remain necessary to observe development of the fish population and of the reservoir habitat conditions. In the case of the important species of grass carp and rohu, repeated stocking cycles are required since they do not spawn naturally in reservoirs.

The project findings have shown that fingerling nursing activities at reservoirs require a motivated group of villagers to be involved. Incentives must be especially clear for the small group of people involved with pen management. Stimulation of fish farming activities (ricefields, ponds, pens and cages) will increase profitability in the form of fingerlings. These community management aspects were therefore studied in 1991.

Project results at the end of 1991 point to additional responsibilities for both government fisheries staff and village reservoir users to make fingerling nursing in pens in reservoirs a success. Activities to be undertaken include: surveys on fish stocks and water quality of reservoirs; surveys on social and economic characteristics of communities surrounding the reservoirs (in particular, fisheries and fish farming activities); extension on fisheries and pen nursing management; site selection; funds for pen construction materials; free fingerling supply; monitoring pen nursing procedures; reservoir fisheries management; and regular evaluation of activities and results on fisheries management improvements by and with local residents.

Epilogue

The project results obtained so far indicate a potential as well as several constraints of a community management approach towards reservoir fisheries management. The technology of pen-culture-based fisheries management to benefit the rural poor reservoirs users may show prospects for wider application in areas with similar conditions, such as southern Laos and parts of Cambodia.

The Interim Mekong Committee and the DOF will continue the project activities in Yasothon, and a new phase on community fisheries management in rural reservoirs is expected to start soon.

Harvesting of nursed fingerlings from a cage.

H. MANNI *has worked in Yasothon from 1990 to 1992 and has coordinated much of the project's fieldwork. This completes a five-year term as Netherlands associate expert in fisheries with assignments in Cameroon and Thailand. The reservoir project was done with the Mekong Secretariat, Interim Mekong Committee, Bangkok, Thailand. The author can now be contacted at Euroconsult, P.O. Box 441, 6800 AK Arnhem, Netherlands.*