Carp in Vietnam

Genetic identity a key to

Research to understand the genetic diversity of distinct fish populations is playing an important role in rebuilding depleted populations and helping to manage stocks for the future

BY REBECCA THYER

A common concern among fisheries undergoing restocking is the need for information about the genetic identity of the existing fish populations. Without this knowledge, introduced stock can lead to 'genetic competition', a situation that can result in the loss, rather than preservation, of genetic diversity.

ACIAR is supporting efforts to safely restock both marine and freshwater species. Of particular interest are fisheries that are the economic lifeline for coastal communities in the Asian and Asia–Pacific regions.

Included in the ACIAR-sponsored efforts are sandfish. Although little bigger than a thumb, small hatchery-bred juveniles are heralding the start of an important industry for coastal communities in the Philippines and Australia.

Sandfish, or sea cucumbers (*Holothuria scabra*), are being bred in hatcheries as part of an ACIAR-funded project to improve local economies and the environment by releasing juveniles in two ways: into 'sea ranches' for harvesting and into marine protected areas to provide spawning populations that will also promote population expansion in non-protected areas.

Released into unenclosed, well-defined coastal environments, sea-ranched sandfish are allowed to grow to commercial size before being harvested by individuals or groups in 'put-and-take' operations, providing new livelihood options for coastal communities.

As a high-value, yet easily harvested resource, sandfish have been chronically over-exploited throughout the Asia–Pacific region. With many of the region's communities relying on fishing and exporting them for sale as bêche-de-mer (boiled, dried and smoked flesh of sea cucumbers), successful sea-ranching enterprises could have important economic impacts.

Coordinating the ACIAR project is WorldFish Center research fellow Len Garces. He says replenishing stock in two ways—through sea-ranching and restocking in marine protected areas—is important because it informs local communities of the value of managing sea cucumbers and also generates income.

"We know that sandfish have been fished out in most localities in the Asia–Pacific region and that the way to repopulate stocks would be through restocking in protected areas," Mr Garces says. "But that would mean leaving the organisms there, hoping that they would repopulate. Instead, I think restocking should be done together with giving livelihood opportunities to communities. It helps engage them in conservation."

Mr Garces says a prerequisite of the project, which began in May 2007, was the engagement of organised, local communities, educated about coastal resource management principles. Local governments have also supported efforts to conserve and manage coastal resources.

Indeed, the project complements ongoing local initiatives, funded by the Philippines Government, to manage sea cucumber stocks, says Dr Annette Menez, the Luzon coordinator and the ACIAR project's primary investigator.

"We established the first sea-ranching site in partnership with a local fishers' organisation and the local government of Bolinao (on the

A fisherman working the Mekong River

PHOTOS: BRAD COLLIS

securing fish populations

Philippines' northern island Luzon)," she says.

The five-hectare site is managed by the fishers' organisation. Since December 2007, almost 5,000 juvenile sandfish have been released. "Monitoring results indicate good growth in the site with estimated survivorship of around 25%."

Dr Menez says that through exclusive harvest rights to the sea-ranched sandfish, granted by the local government, the project should enhance income for the fishers' organisation.

"The partners will harvest and process the sandfish to produce premium grade bêche de mer. Only sandfish greater than 500 g will be harvested and our partners will be provided with training on quality processing."

Sea-ranching sites also serve as reproductive reserves, she says. "They help replenish sandfish populations in the areas outside the sites. With improved management of the wild population—for example implementing minimum size limits—economic benefits due to the sea-ranching efforts will also accrue to other fishers in the area."

Two other sites are being established in other municipalities in north-western Luzon, while sea ranches are planned for Mindanao, the country's southern island. Sea ranches are also to be trialled with Indigenous Australians at the Warruwi community in the Northern Territory.

Although the second part of the project, which will see juveniles released into wild reserves to restore severely depleted spawning biomass, has been delayed because of the difficulty in finding sites with the right management systems and optimal habitat requirements, the team will persist.

"Most reserves protect coral habitats, but we need seagrass beds with a bit of muddy, sandy soil. We can find them, but they are not protected … mortality rates could be recorded that were due to fishing, not other causes."

Underlying all the restocking work is an understanding of the animal's genetic diversity, Mr Garces says. "Our thinking is to take a precautionary approach. We are adopting a policy whereby if we produce juveniles from a particular locality, we restock in that locality. We are mindful of the stock's genetic makeup."

James Cook University's Cathy Hair, who is leading the Australian component of the project, says it is generally accepted that ranching and restocking programs should release juveniles that are genetically similar to wild members of the same species.

She says this is important because in areas where sandfish genetic studies have been carried out, researchers have found that stocks of sandfish are generally distinct at relatively small spatial scales—as little as 100 to 200 kilometres in some cases.

"The practical application of this is that

PARTNER COUNTRIES: Cambodia, Laos, Thailand, Vietnam and the Philippines

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DNA-based technology is being made available to support fisheries management and restocking efforts in the Philippines, where sea ranching of sea cucumbers is being established (above), and in the Mekong Basin, where a better understanding of mud carp species (centre) is being sought to help local fishers (left).

we should source hatchery broodstock from an area close to where progeny will be later released," she says.

WorldFish Center scientists have used this knowledge to release cultured juveniles in a way that preserves the genetic diversity of existing stocks, many of which are quite isolated.

Mr Garces says to do otherwise could upset the marine environment's ecological balance. "It could cause some imbalances because an introduced organism has different characteristics, and instead of maintaining the diversity of an area, we could in fact reduce it."

Before restocking or other management programs take place, researchers often use DNA diagnostic tools—similar to those used to solve crimes in forensic science—to garner information about the structure of certain fish stocks.

Queensland University of Technology's (QUT) Dr Peter Mather used similar diagnostic tools in an ACIAR-funded freshwater project with the Mekong River Commission (MRC) to better understand the stock structure of two important carp species—*Henicorynchus siamensis* and *H. lobatus*.

Very common in the Mekong system, the fish were thought to be one migratory species, he says. However, researchers discovered there were multiple distinct stocks of both species with quite different genetic characteristics and distribution patterns across the Mekong River Basin.

Dr Mather says the genetic approach used was to evaluate variation in marker genes in the two species in different parts of the river system. "If the frequency of those genes is the same in widely distributed populations, then you can assume that individuals are dispersing through the whole system or are moving to reproduce collectively with other populations elsewhere.

"However, if the genes are different in frequency, or unique forms are present in different places, you can assume the fish are semi-independent or independent populations."

Although people who handle the fish cannot readily tell them apart using external morphological traits, the project team did find that the two carp species had different genetic characteristics.

Using mitochondrial DNA (mtDNA) tools, Dr Mather and collaborators from government fisheries agencies in Cambodia, Laos PDR, Thailand and Vietnam examined the two species to help inform fisheries bodies about fish stocks.

Unlike nuclear DNA, which is inherited from both parents and in which genes are rearranged in the process of recombination, there is usually no change in mtDNA from mother to offspring.

This means that if there is a difference in how fish populations have evolved, there will be a much bigger effect on mtDNA than on nuclear DNA. "That is why we target it first, because if we are going to see differentiation between populations, it will be more apparent in mtDNA than in nuclear DNA," Dr Mather says. "So we use that as a starting point in demonstrating the utility of taking a genetic approach."

He says the more these tools are used, the more researchers and fisheries management bodies will learn about stock structures. "What was thought to be one large stock could actually be lots of smaller populations behaving either completely independently or semi-independently."

Dr Mather says this builds important information for future management decisions. "If there is overpressure in an area considered to have a single population, and which turns out to be multiple populations, it could lead to local population declines or extinction that may not be naturally recolonised."

That is why fish stocks need to be identified. "Our point was to demonstrate the approach to identifying fish stocks and then fisheries bodies are able make decisions to conserve that biodiversity."

Dr Mather's team, which includes Dr David Hurwood, a postdoctoral researcher at QUT, has run workshops in Thailand to teach MRC fisheries researchers about these techniques. Although a problem in the region was a lack of laboratories, in recent times better facilities have been set up in Vietnam and Thailand and are starting to do similar work routinely on freshwater and marine species.

Although the project has finished, Dr Mather has a number of international postgraduate students from Mekong River Basin institutions who are gaining the technical and theoretical experience to run similar studies on other Mekong River Basin species.

Interestingly for DNA detectives such as Dr Mather, an understanding of an area's geography and how it evolved can often be as important as DNA diagnostic tools in understanding fish-stock structure.

Dr Mather says once gene patterns are clarified, a greater understanding of how those patterns evolved can be made. "That is dependent on two sets of information: what geomorphology can tell us about changes in landform and river-drainage patterns over time, and the animal's life-history characteristics."

It has helped the team understand how the Mekong River carp species evolved to be so different. "Their evolutionary histories are different and this has influenced their patterns of gene frequencies in divergent ways."

What they have found from their work is that one of the species is moving through that area freely and the other isn't. "Each year people have been observing mass migrations assuming that both species have been moving through this area against the current, but that is not the case for one of the species."

Dr Mather says it is this sort of genetic information that ensures restocking and protection work can be done in an environmentally and ecologically acceptable way, so that important genetic diversity is maintained. ■