



Seafood and the Sea of Cortez: An Ecological Bouillabaisse

Nutritionists have known for decades that seafood is a premier source of top-quality protein, minerals, and vitamins (especially the important B-complex vitamins). Also, seafoods are low in fat and contain all nine essential amino acids—those that our bodies cannot manufacture on their own. And, ocean fishes contain 17 to 25 percent protein by weight. While that percentage is less than most meats, the protein in seafood is more readily broken down and absorbed than the protein in red meats and poultry. Furthermore, seafood contains substantial amounts of omega-3 fatty acids, a crucially important fatty acid that we can only obtain from the foods we eat. Omega-3 fatty acids help keep our bodies from developing arthritis, asthma, heart disease, stroke, and related disorders. Recent studies indicate that eating seafood can decrease your risk of heart attack, stroke, obesity, and hypertension. So, for *Homo sapiens* there is no question seafood contributes significantly to a healthful diet. But, what about the health of the marine environment and the impact that seafood harvesting has on marine ecosystems? Here in the Southwest, much (perhaps most) of our seafood originates south of the border, from the rich waters of the Sea of Cortez, or Gulf of California.

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In this narrow gulf—as in all the world’s oceans—
up to 90 percent of the population
of most predatory fish species has disappeared
due to overfishing.



previous page: Lobster dinner; The Sea of Cortez (Gulf of California) from space. Photo courtesy of NASA.

left cut-out: The giant sea bass (*Stereolepis gigas*), like most large predators, was once abundant but is now greatly diminished in number and average body size in the Sea of Cortez. Photo by Jennifer Rupnow.

middle cut-out: The Panamic fig shell (*Ficus ventricosa*) lives at the same depths dragged by shrimp nets in the Sea of Cortez; it has been decimated by years of bottom trawling and is becoming rare.

right top: Industrial shrimp boat bycatch. For every pound of shrimp dragged from the seabed, 10 to 40 pounds of bycatch are killed.

right middle: Shrimp for sale in a Mexican market. Most shrimp from Mexico is now farm raised, although rarely in ways that are environmentally friendly.

right: The popular seafood market on the Ensenada waterfront (Baja California) sells locally harvested fish and shellfish to both residents and tourists.

For thousands of years this saltwater heart of the Sonoran Desert harbored what seemed to be an inexhaustible supply of seafood. The legendary productivity (and fishing) of the Gulf inspired the likes of John Steinbeck, Ed Ricketts, Thor Heyerdahl, Jacques Cousteau, Edward Abbey, Ofelia Zepeda, David Quammen, John Janovy, Jr., and Ann Zwinger to explore and celebrate its natural wealth. With a watery surface of some 100,000 square miles, the Sea of Cortez reaches within 50 miles of California and Arizona. Many North Americans eat from this wild but increasingly imperiled ecosystem, whether they realize it or not.

Since prehistoric times, seafood and shells from this great sea have been harvested and traded throughout the Southwest. In historic times, traditionally captured large predatory fishes near the top of the food chain—sea basses, groupers, corvinas, snappers, sharks, and the like—were harvested with no concerns for sustainability, as if their abundance could never be depleted. Thirty years ago, when I first started working in the Sea of Cortez, this was still the assumption. But no longer; given the dramatic fish depletions here and in the rest of the world’s seascape, we can no longer delude ourselves with the myth of unending abundance.





above: Pre-Hispanic shell middens (dining refuse sites) can be found near virtually every coastal wetland in Sonora.

Filled venus clams (*Chione undatella*) and Panamic cockles (*Trachicardium panamense*) for sale today on the malecón at Kino Bay. Archeological excavations indicate these species were also popular with Native American inhabitants along the Sea of Cortez.

As a result of over-fishing, populations of large predators are now a mere shadow of what they were 40 years ago.

In this narrow gulf—as in all the world’s oceans—up to 90 percent of the population of most predatory fish species has disappeared due to overfishing. Today, *all* of the traditionally fished species from the Sea of Cortez have been overharvested to the point of collapse, or near-collapse, of their commercial fisheries. Traditionally preferred finfish have been so reduced in numbers that many Mexican fishers now take virtually any fish they can catch, of any edible size. Decades of shrimp extraction have not only decimated shrimp populations, but also severely disrupted the seafloor ecosystem in much of the Gulf.

In the northern Gulf, the commercial finfish and wild-shrimp fisheries have essentially collapsed, and tourists in beach towns like Puerto Peñasco (Rocky Point) are now just as likely to be served cod or pollock, shipped frozen from Alaska or Europe, as a fresh local fish. Species once regarded as “trash fish” or “bycatch”—such as triggerfish, parrotfish, and skate—are now routinely sold in and restaurants. How did we get here and what can we do about it?

Ancient harvests from the **Sea of Cortez**

What were early inhabitants of the Gulf’s desert coastlines consuming, and are those edible species still abundant? Archeological excavations of prehistoric kitchen middens (dining-site trash dumps) indicate they were feeding on shellfish, finfish, crabs, and sea turtles from coastal lagoons and the open coast, although they also captured some terrestrial reptiles, mammals, and birds that lived along the coast. They relied most heavily on clams and blue crabs, and a few fish species taken from coastal lagoons and estuaries. Thus, many of the seafood traditions that began in the Sea of Cortez in prehistoric time continue to this day in western Mexico, while others, such as the ritual harvest of sea turtles, have all but disappeared as the animals themselves have dramatically declined over the last century.



above: Artisanal (panga) fishers on the coast of Sonora.

cut-out: The Eastern Pacific pearl oyster (*Pteria sterna*) is the first species to be over-exploited in the Sea of Cortez, by Spanish colonists in search of pearls.



Most wild shrimp are captured by bottom trawling, “dragging” with heavy equipment that levels the seafloor—the undersea equivalent of clear-cutting forests.

The Ecological Depletion of the **Sea of Cortez**

Primary producers, algae and seaweeds that capture the sun’s energy at the base of marine food webs, are especially abundant in this semi-enclosed sea. This high primary productivity is driven by year-round strong solar input, upwelling of nutrient-rich bottom waters continuously drawn into the Gulf from the open Pacific, and good circulation. And, this productivity has supported one of the world’s most important concentrations of small oceanic fishes (such as anchovies, sardines, and mackerels), which in turn has provided critically important food sources for larger predatory fishes, jumbo squid, sea birds, marine mammals, and, eventually, humans. Beginning in the 1930s, however, a strong commercial fishery developed in this rich marine ecosystem, with some regrettable ecological impacts.

Remember John Steinbeck’s little gem of a novel, *The Pearl*? The first fishery in the Sea of Cortez to be over-fished was the pearl oyster fishery of the La Paz-Cape Region, which drew Spanish colonists to the area in the 1600s and 1700s. Today, every commercial species in the Gulf is probably overfished, except perhaps jumbo squid, which only recently arrived in the Gulf of California in numbers large enough to harvest. Artisanal fishers today take about 80 species of finfish and shellfish, using long-lines, gillnets, cast nets, hook-and-line, pots, and traps. An estimated 50,000 artisanal fishers operate 25,000 pangas in the Gulf today. And, another 10,000 fishers work on some 1,280 indus-



above: The jumbo squid (*Dosidicus gigas*) is thought to have become abundant in the Sea of Cortez as top-predator finfish have been decimated by over-fishing—the squids are presumably moving in to fill the “empty niche.” Photo by A. Kerstitch

right: Long-lines are one of the most destructive and indiscriminant fishing devices ever developed. They kill sea birds, marine mammals, and marine turtles, as well as having a high fish bycatch.

trial boats. Gulf waters are also subjected to fishing pressure from sportfishing by American tourists.

Today, the most important species for artisanal fishers are shrimp, jumbo squid, and clams. For the industrial fishery, the Pacific (or Monterey) sardine is the most important species, followed by shrimp, tuna, and squid. As traditionally sought large predatory fish and shrimp have dwindled, industrial fishers have shifted increasingly to sardines and jumbo squid.

The shift in primary target species has had significant socioeconomic impacts, but it could have even more profound ecological repercussions. Sardines and anchovy, and jumbo squid, are key elements of the Gulf’s oceanic ecosystem. They represent species very near the bottom and top of the oceanic food chain, respectively. Their population sizes have direct effects on the rest of the food web, including the reproductive success of seabirds. There is a real danger that their over-exploitation could result in fundamental changes in the oceanic ecosystem.

More than one-third of the seafood consumed in the world is now farm raised.



cut-out: The increasingly rare regal murex (*Chicoreus regius*) is a large, beautiful snail consumed locally in the Gulf. This species is often brought up in shrimp trawls and other bottom nets; the shells end up in curio shops.

right: Gill net from a panga fisher, with bycatch of snails and crabs.



Unsustainable fishing, bottom trawling, and environmentally unfriendly shrimp farming are perhaps the most serious threats to the ecological integrity of the Sea of Cortez today. As a result of over-fishing, populations of large predators are now a mere shadow of what they were 40 years ago. The devastated populations include sea basses and groupers, sharks, some snappers, and even some jacks. Due to overfishing, some spawning aggregations of these and others large species—especially the goliath grouper and giant sea bass—may have entirely disappeared from the Gulf.

Many less visible invertebrate species, also once-abundant, are also now rare here. Most wild shrimp are captured by bottom trawling, “dragging” with heavy equipment that levels the seafloor—the undersea equivalent of clear-cutting forests. The heavy chains on traditional trawl nets dig 15 to 30 centimeters into the seabed. For every kilogram of wild shrimp trawled, 10 to 40 kilos of additional bycatch is killed! Shrimp trawlers produce an inordinate percentage of the global bycatch—capturing less than two percent of the world’s seafood by weight, but one-third of the world’s bycatch. Worldwide, every year an estimated 150,000 endangered sea turtles are caught and dragged in shrimp nets until they drown. Shrimp trawlers kill more sea turtles than all other causes combined. ▶



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a challenge for Shrimp Lovers

Almost everyone loves shrimp, and almost every restaurant has at least one shrimp dish on their menu. But, the large shrimps typically marketed as “jumbo shrimp,” “Gulf shrimp,” or “Guaymas shrimp” are some of the most unsustainably harvested seafoods in the world. So, what is a shrimp-loving consumer to do? Well, here’s the deal.

First of all, shrimp come in two varieties. The big boys (“jumbo shrimp”) belong to a group known as the penaeid shrimps—technically, the *Dendrobranchiata*. The smaller shrimps, an inch or less in length and usually marketed as “bay shrimp,” “rock shrimp,” “northern shrimp,” or “salad shrimp,” belong to a group known as the caridean shrimps (technically, the *Caridea*). They are all crustaceans, but the two groups are only distantly related.

No need to worry about the small shrimp; they are by and large sustainably harvested. But jumbo shrimp is another story altogether. Traditionally, they are trawled from the seabed with gigantic nets—a process that literally destroys the seabed and all the life that lives there. Bottom trawling for shrimp is the most destructive fishing practice on Earth. In the United States there are regulations that require shrimp fishers to use better designs of bottom trawls, so the damage from U.S. trawlers is somewhat less than seen in most of the rest of the world. Even so, they still cause an unacceptable level of seafloor damage. One fishing operation in the Sea of Cortez (*Pesquera Delly*), has been trying to lead the way in Mexico by using these less-destructive net designs; however, the future of this effort is



left previous page: Gulf cleaner shrimp (*Lysmata californica*); above: Shrimp in fish market; Industrial shrimp boat bycatch; Coastal mangrove lagoons are critical nursery habitats for commercial shrimps.

unclear. So, right now, the only good choice for wild-caught jumbo shrimp is the artisanal shrimp fishery of Mexico’s Sea of Cortez, which uses small boats (pangas) powered with outboard motors, and floating nets rather than bottom trawls. However, since there is not yet a certification process that tells consumers the origin of the Mexican shrimp sold in our markets, it is best to avoid all Mexican shrimp, and also all U.S. wild-caught shrimp.

For now the consumer’s best choice for sustainably produced jumbo shrimp is U.S. farm-raised.

The alternative to wild-caught shrimp is farmed shrimp. Almost all shrimp farming takes place in earthen lagoons dredged along coastlines in the world’s tropics, where environmental regulations are typically weak or unenforced. Coastal environmental impacts are especially high in Southeast Asia, e.g., Thailand, Vietnam, and Bangladesh. (These are the only three countries of origin I saw on a recent frozen-shrimp search at my local Trader Joe’s market!). Endangered habitats such as mangrove forests are being destroyed or degraded in all of the tropical countries where shrimp farming is taking place. And, once the shrimp ponds are in place, the operations flush directly into the sea, polluting it with wastewater, a variety of chemicals (pesticides, antibiotics, powerful disinfectants), escaped exotic shrimp, and exotic strains of shrimp diseases that infest local wild populations.

But, there’s good news. U.S. shrimp farmers must adhere to strict regulations that circumvent most of the above problems. For example, U.S. shrimp farms are not allowed to drain directly into the sea. And, more and more U.S. farms are using largely vegetable-based feeds

that produce shrimp at close to a 1:1 ratio of fish-food to shrimp production, as opposed to fish pellets made from wild-caught fish, requiring a 3:1 ratio (an actual net loss from the sea). A fine example of good shrimp farming practices is the Desert Sweet Shrimp Farm in Gila Bend, Arizona (www.desertsweetshrimp.com). In Mexico, in just the past few years, new federal and state regulations on shrimp farming have also been improving the situation. Some farms are

moving inland, away from the fragile coastal environment, and in Sonora these new shrimp farms often use land that was long-ago ruined by too many years of intensive agriculture—barren land is thus being recycled and put to good use. These inland shrimp ponds still drain to the sea, but the long canals (up to several kilometers) quickly develop a natural flora and fauna of their own that helps to “filter” the discharge water before it reaches the coast. A good example of these improved practices in Mexico is the La Borbolla shrimp farm, south of Kino Bay. La Borbolla has roughly a 1:1 ratio of fish-food to shrimp production, and can produce 25 to 35 shrimp per square meter of pond. In 2008, the operation produced over two million pounds of Pacific white shrimp. But, these kinds of shrimp farms are still rare in Mexico.

So, for now the consumer’s best choice for sustainably produced jumbo shrimp is U.S. farm-raised. Hopefully, in the near future Mexican farmed shrimp will be equally sustainably produced. Sticking to conscientious choices will be a challenge for shrimp-lovers, but it is one we must confront.



Seafood

Is Aquaculture the Answer?

More than one-third of the seafood consumed in the world is now farm raised. Aquaculture has the potential to relieve pressures on declining wild seafood populations and create waste-free sustainable production—if it is **done right**. Unfortunately, this rarely happens, especially in the developing world (where most of our farmed seafoods originate). Most of the world's saltwater farming (mariculture) actually threatens wild fish stocks and disrupts or destroys natural habitats.

The cultivation of carnivorous fish and shellfish (e.g., salmon, shrimp) has traditionally depended on catching wild fish to feed them, and these farms rely on huge quantities of wild-caught seafood. It can take over three kilos of wild-caught fish to raise one kilo of farmed salmon or shrimp, resulting in a *net* loss of fish from the sea. Today, about a quarter of all seafood caught in the wild is converted into fishmeal to feed farmed fish and shrimp.

In addition, farmed fish and shrimp, whose place of origin is typically not local, frequently escape into the sea, polluting the gene pools of native species and introducing exotic diseases. For all these reasons, marine species that are low in the food chain and subsist on a plant diet (herbivores) and will breed in captivity (e.g., catfish, trout, tilapia), are the best options for aquaculture.

The first commercial shrimp farms in the Sea of Cortez were constructed in coastal Sonora in the 1980s. As of 2007, more than 150 shrimp farms had been built on the Sonora shoreline alone, covering an area of 100,000 hectares. Today, Mexico is the second largest producer of farm-raised shrimp in the Western Hemisphere, but by the Mexican government's own reckoning a few years ago, few of the shrimp farms gain high marks for sustainable practices.

In Mexico, shrimp are typically raised in dirt ponds bulldozed out of coastal habitat. Until very recently, these sites were typically placed in or next to critically important coastal wetlands, threatening habitat and rare or endemic marsh plants. Many of the Gulf's mangrove forests and tidal

Avoid these seafoods, at least for now. They come from sources that are overfished or are caught or farmed in ways that harm other marine life or the environment.

Chilean sea bass/toothfish*, corvina, groupers*, king crab (imported), mahi mahi/dolphinfish (imported), marlin, monkfish, orange roughy*, red snapper, salmon (farmed, Atlantic), sharks*, shrimp (all wild-caught, all imported), spiny lobster (Caribbean), swordfish (imported), totoaba, tuna (all tuna species caught by longline)*, tuna (bluefin, caught by any method)*

* Limited consumption also advised due to concerns about mercury or other contaminants.

Best Choices: These fish are abundant, well managed, and caught or farmed in environmentally friendly ways.

Arctic char (farmed), barramundi (U.S. farmed), bay scallops (farmed), catfish (U.S. farmed), clams (farmed), cod (Alaska line caught)*, crab: dungeness, stone, king, blue (U.S.), flounder and sole (Pacific U.S.), halibut: Pacific, herring: Atlantic/sardines, lobster (wild-caught from Pacific Baja* and Maine), mahi mahi/dolphinfish (U.S.), mussels (farmed), octopus, oysters, pollock (Alaska wild-caught), rainbow trout (U.S. farmed), salmon (Alaska wild-caught), shrimp (U.S. farmed), squid, striped bass (farmed), swordfish (U.S.), tilapia (U.S. farmed), tuna (pole-caught albacore, bigeye, yellowfin, skipjack), yellowtail (U.S. farmed)

*certified as sustainable to the Marine Stewardship Council standard (msc.org).

marsh ecosystems have been severely damaged due to a variety of coastal development, including the rapid growth of shrimp farms. In addition to habitat destruction, Mexico's coastal shrimp farms usually flush to the open sea. In doing so, huge nutrient loads from uneaten food, shrimp feces, and dead shrimp wash out to the coast—along with antibiotics, added vitamins and hormones, other chemicals used in the ponds, and, often, introduced (exotic) microorganisms from other regions that are imported with the shrimp that are introduced into the ponds.

Today, U.S.-farmed shrimp is your best choice because it meets strict



Consumer power is enormous! In restaurants, supermarkets, and fish markets, ask about the source of the seafoods you buy; ask if it is farmed or wild-caught (and, if caught, where and how it was caught).

far left: Estero Soldado (San Carlos) is one of the last remaining mangrove wetlands in Sonora that has not felt the impacts of shrimp farming.

left: Oyster farm at Kino Bay. Most oyster farms in the Gulf are small scale, open water, sustainable operations.

government environmental guidelines. Fortunately, the situation in Mexico is now beginning to improve and soon, hopefully, Mexican farm-raised shrimp will be on the recommended list. For now, one of the best places to purchase seafood is your local Wal-Mart. In 2006, the company made a pledge to America that their U.S. stores would sell only sustainably harvested seafoods, relying heavily on recommendations of the Marine Stewardship Council and Aquaculture Certification Council. Because Wal-Mart is the world's largest retail seller of seafood, this decision has had a powerful and positive impact on global seafood markets. In addition, the Walton Family Foundation provides hundreds of millions of dollars annually for marine conservation efforts; they are especially active in protecting the Gulf of California.

What is Being Done?

The rise of the conservation movement in Mexico over the past 20 years has led to significant increased pressure on federal agencies, and meaningful steps are now being taken to protect the Sea of Cortez for the future. Since the landmark declaration of two biosphere reserves

in northwestern Mexico in 1993—the Alto Golfo de California y Delta del Río Colorado, and the El Pinacate y Gran Desierto de Altar Biosphere Reserves—hard work and steady lobbying has resulted in the establishment of 15 more protected areas on the Baja California peninsula and in the Sea of Cortez.

Creating change in fisheries management has been harder. However, because of declining fisheries catches, pressure from environmental organizations, the rise of sustainable seafood initiatives, and new political leadership, things are starting to change. There is reason to believe that the government of President Felipe Calderón recognizes the need for better fisheries management. Some positive first steps are being taken. New federal and state laws in Mexico are establishing environmental controls over coastal aquaculture, including shrimp farming. New coastal wetland protections are forcing shrimp farms inland, away from sensitive coastlines, and regulations on the import of exotic “seed” shrimp and on aquaculture pond discharges are now appearing. One of the best examples of sustainable mariculture are the oyster farms that have sprung up in most of Sonora's coastal lagoons over the past 20 years or so; these farms use no additives and do not pollute or negatively impact the environment.



*We don't need to stop eating seafood;
people lived in a balance
with the sea for thousands of years, until only recently.*

What Can You Do?

Because we are now aware of the depletion of the seas, we have a greater responsibility, not just for the sake of the marine environment but also for our own selfish interests, to pay attention to the sources of our seafood. And we now have a wealth of information about what to buy and what to avoid to help prevent the overharvesting and degradation of the Sea of Cortez and other ocean environments.

In restaurants, supermarkets, and fish markets, ask about the source of the seafoods you buy; ask if it is farmed or wild-caught (and, if caught, where and how it was caught). As evidenced by the history of tuna fishing, **consumer power** is enormous. Express your interest in sustainably harvested products, and don't buy finfish and shellfish whose populations are being decimated. The status of these fish may change over time, so keep up-to-date via websites like those at the end of this article. In the meantime, use the lists on these pages to guide your purchases. The Marine Stewardship Council lists supermarkets and restaurants worldwide that carry the council's sustainable certification, as well as sustainable seafood sources for your business.

top: Floating tuna farms off the Pacific coast of Baja California.

middle left: Seafood market, Baja California.

middle right: Gulf giant hermit crab (*Petrochirus californiensis*).

left: the long-beaked common dolphin (*Delphinus capensis*) occurs in pods of up to hundreds of individuals in the Sea of Cortez. They are frequently killed by drowning in gill nets that indiscriminately kill anything that gets trapped in their mesh.

For more comprehensive coverage on sustainable seafood choices, visit:

Arizona-Sonora Desert Museum
(desertmuseum.org/center/seafood.php)

Monterey Bay Aquarium Seafood Watch Program
(mbayaq.org/cr/cr_seafoodwatch)

Marine Stewardship Council: (www.msc.org)

Oceans Alive (oceansalive.org)

Seafood Choices Alliance (seafoodchoices.com)

We don't need to stop eating seafood; people lived in a balance with the sea for thousands of years, until only recently. Fish from the Sea of Cortez, our Sonoran Desert ocean, remains an excellent choice for local healthy food. But we need to better manage our harvests and our consumption to prevent catastrophic collapse of marine ecosystems.

A Special *flea* to Southern Arizona Restaurateurs

Please consider doing what the Ironwood Food Service's restaurants do at the Desert Museum—make a pledge to serve only sustainable seafoods. It's easy. Just dedicate your menu to seafoods in the "best choices" list in this issue of *sonorensis* (or the "best choices" listed by Monterey Bay Aquarium's Seafood Watch program). Delicious preparations are easy—think farmed bay scallops, Alaskan salmon and flounder, Pacific halibut, Maine or Baja lobster, U.S. mahi mahi, U.S. farmed shrimp and tilapia, and farmed mussels, oysters, and trout. In Monterey, California, over two dozen restaurants are now serving 100 percent sustainable seafoods. If they can do it, so can Arizona. Go sustainable, and let the Desert Museum help promote your good work! **S**

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Pineapple & Rum Marinated Shrimp

Shrimp is high in protein and vitamins B12 and D.

with mango-papaya relish

*Courtesy of Nick Ruman, Executive Chef,
Ironwood Food Services,
Arizona-Sonora Desert Museum*



16 jumbo shrimp

marinade

- 4 tablespoons lime juice
- 1 teaspoon pureed chipotle (no seeds)
- 6 ounces pineapple juice
- 2 ounces rum
- 1 teaspoon minced garlic
- 1 ounce prickly pear syrup
- 1/2 teaspoon salt

relish

- 1/2 mango, diced
- 1/2 papaya, diced
- 1/2 green pepper, diced
- 1/2 red pepper, diced
- 1/3 red onion, diced
- 2 ounces pineapple juice
- 2 tablespoons lime juice
- 2 tablespoons red wine vinegar
- 1 teaspoon minced fresh ginger
- 1 teaspoon minced garlic
- 1/2 teaspoon salt
- optional – 1/2 seeded and chopped serrano chili

1. Devein the shrimp by making a shallow slit down the back and picking out the vein.
 2. Marinate shrimp on their skewers for 2 to 4 hours only, not more or the shrimp will get tough.
 3. Mix all relish ingredients and let stand for 2 or more hours.
 4. Grill shrimp over medium, not hot heat, turning once, for 2 to 4 minutes on each side. Remove *as soon as* the outer skin has changed color from gray or bluish to orange or pinkish. **Do not overcook!**
 4. Put relish on plate and top with grilled shrimp.
- Serves 3 to 4 people.
- Fried yam matchsticks make a nice garnish.