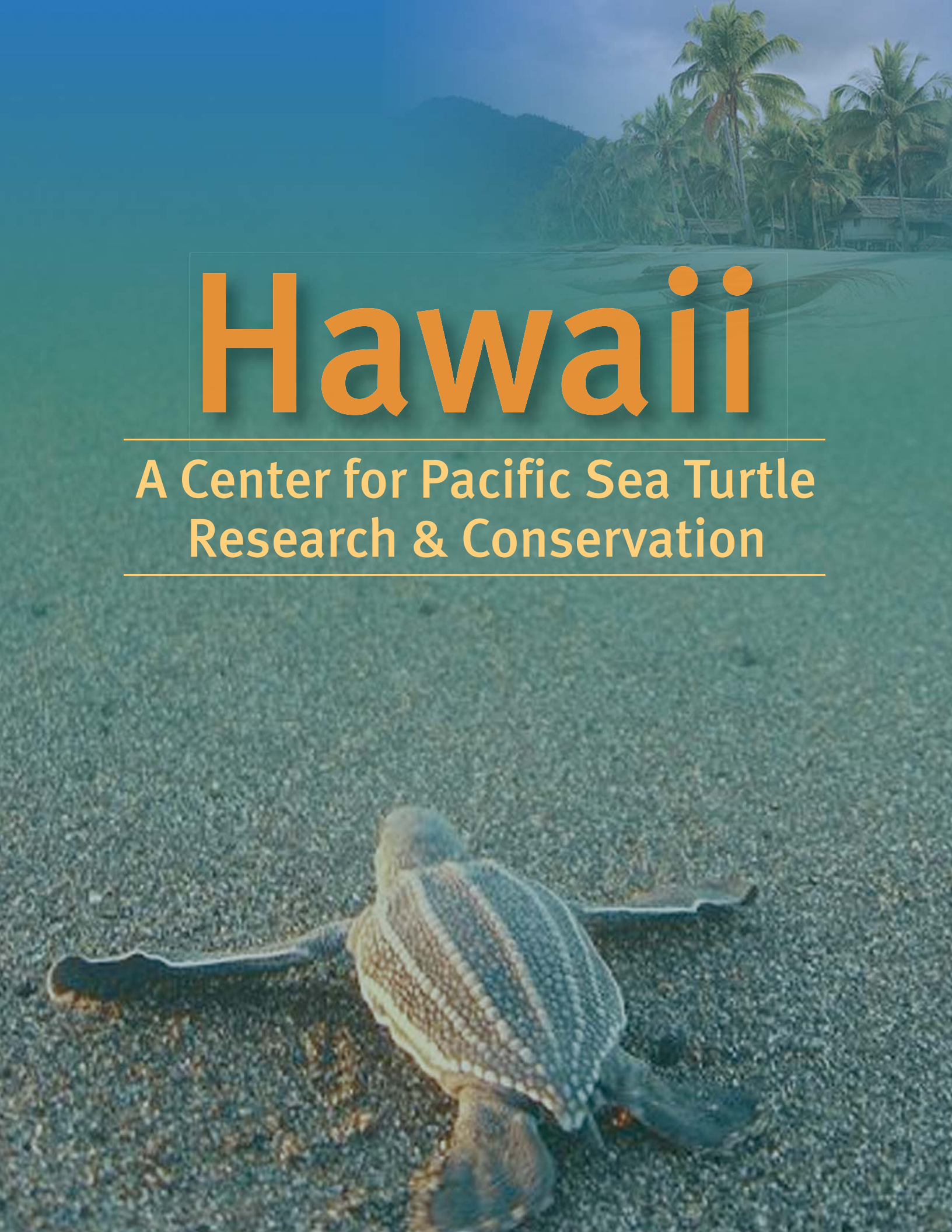

Hawaii

A Center for Pacific Sea Turtle Research & Conservation

The Legend of Kauila

The ancient Hawaiians tell the story of a magical turtle named Kauila, the daughter of Honupookea, who was born on the black sand beach of Punaluu on the island of Hawaii. Kauila made her home at the bottom of a freshwater spring that the Hawaiians named after her, called *Ka wai hu o Kauila* – the rising waters of Kauila.

Children would come to play in the spring and Kauila would transform herself into a girl to watch over them. Kauila became the guardian of the children and the life-giving spring that produced fresh water for the people of Punaluu.

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Cover: Photo mosaic of a leatherback hatchling in Papua New Guinea.

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INTRODUCTION:

Sea Turtle Conservation

Nationally and globally, sea turtle conservation and recovery remain critical issues as virtually all sea turtle populations are designated as either threatened or endangered by the U.S. Endangered Species Act. The people and their activities you will encounter in the following pages reflect the efforts of four federal organizations working together on numerous initiatives that have firmly established Hawaii as a center for sea turtle research and conservation in the Pacific.

Over the past five years, the Western Pacific Regional Fishery Management Council (WPRFMC) in collaboration with three agencies of NOAA Fisheries Service – the Pacific Islands Fisheries Science Center, the Pacific Islands Regional Office, and the Southwest Fisheries Science Center – have increased research, management, and outreach efforts aimed to recover sea turtle populations and reduce sea turtle interactions in commercial fisheries. To date, over 50 projects or conservation initiatives have commenced as a result of these partnerships spanning not only the Pacific Ocean basin but also extending to the Indian and Atlantic Oceans through extensive collaborations with national and international colleagues.

IN THE PACIFIC

For every person mentioned in this report, numerous others stand beside him or her working in collaboration with and cross-pollinating between projects. In this way, scientists and resource managers network their expertise among programs and within the international arena of research, conservation and management. Sharing our sea turtle knowledge and resources makes sense as it reflects how sea turtles live – migrating vast distances across oceans and residing in varying life stages from nesting beaches to the high seas and coastal habitats of numerous nations. An integrated international strategy is critical for the success of our conservation initiatives, and we attribute many of the achievements outlined in this report to the involvement and vision of our global partners.

Actions to understand and control sea turtle interactions with commercial fisheries began in the early 1990s, with the management and operations of the Hawaii-based longline fishery receiving intense scrutiny in 1999. The closure of the Hawaii-based swordfish fishery in 2001 – the result of a lawsuit brought by a coalition of environmental organizations – was a galvanizing event for the industry, NOAA Fisheries Service, and the WPRFMC. However, it was also the catalyst that brought increased federal funding and renewed attention to the plight of Pacific sea turtles.

This document is intended to inform the public and lawmakers of the efforts, progress and challenges of sea turtle conservation in the Pacific. From new research and improved technologies, to international collaborations and increased capacity for international fishery management, an unprecedented Pacific-wide effort is underway to recover sea turtle populations to sustainable levels. As human populations and their resulting impacts increase and fishing continues to expand throughout the Pacific region, the discoveries gained today provide insights to the next critical steps to effectively conserve sea turtles throughout their life cycle.

Every day counts for endangered and threatened sea turtles. As one of the oldest living creatures on Earth, their survival depends on what we do today.

PHOTO: SCUBAZOO

An Introduction to
Pacific Sea Turtles

STATUS
Endangered

STATUS
Threatened

STATUS
Unknown

Seven species of sea turtles grace our oceans, six occur in the Pacific. They evolved 110 million years ago, distinct from all other turtles at that time. During this evolution, the sea turtles we know today split into two main subgroups: the unique family Dermochelyidae, which consists of a single leathery species, and hard-shelled sea turtles in the family Cheloniidae. In the United States, sea turtles are protected by the Endangered Species Act and the Convention on International Trade in Endangered Species. For more information, visit the NOAA Fisheries Office of Protected Resources website at www.nmfs.noaa.gov/pr/species or the WPRFMC website at www.wpcouncil.org/protected.

FAMILY CHELONIIDAE (hard-shelled turtles)

PHOTO: TURTLETRAX

Green Sea Turtle
Chelonia mydas

The green is the most widespread and commonly known sea turtle species. It prefers tropical and sub-tropical waters, is highly migratory and, like all species, is faithful to natal beaches for reproduction. The green turtle is the only herbivorous (or vegetarian) turtle. It earns its name from the color of its body fat, which is green in color similar to the algae and sea grass it digests. Although now illegal to trade in many areas of the world, the green sea turtle and its eggs continue to be consumed by many coastal peoples. In the Eastern Pacific, a morphologically distinct subpopulation of this species, called the black turtle, is considered by some to be a separate species.

PHOTO: C. ROGERS

Hawksbill Turtle
Eretmochelys imbricata

The hawksbill is named for its sharp, pointed beak. Its Latin name refers to the overlapping arrangement of scutes on its shell. Found worldwide in tropical waters, the hawksbill is omnivorous. It helps keep coral reefs healthy by foraging on algae and invertebrates, especially sponges. The hawksbill has a beautiful, translucent shell that has been used in tortoiseshell jewelry for centuries – a form of consumption that has contributed to its sharp population decline in the past century.

PHOTO: C. LIMPUS

Loggerhead Turtle
Caretta caretta

The loggerhead is named for its large head, with powerful jaws to crush mollusks. There are two distinct nesting populations in the Pacific, the north Pacific stock that nests in Japan and a southern hemisphere population that nests in Australia and New Caledonia. Preferring temperate waters, the loggerhead is famed for its vast migrations; for instance, some loggerheads that nest in Japan cross the Pacific to feed in Mexican waters, a distance of over 6,000 miles. This species' highly pelagic and omnivorous nature places it in great risk of interaction with both pelagic and coastal fisheries.

PHOTO: R. ARUAZ

Olive Ridley Turtle
Lepidochelys olivacea

The olive ridley is the most abundant of the sea turtles and is found worldwide in tropical and warm temperate oceans. These turtles nest synchronously en masse in a phenomenon known as the *arribada*, Spanish for "arrival." During these spectacles of nature, thousands of turtles can come ashore to nest simultaneously, using a "safety in numbers" strategy for reproduction. The largest nesting rookery in the eastern Pacific is at Escobillia, Mexico, where between 730,000 and 1,120,000 nests are laid each year.

PHOTO: C. SCHAUBLS

Flatback Turtle
Natator depressus

The flatback is the least studied of the sea turtles and has one of the smallest geographic ranges. Flatbacks stay within a relatively small area around northern Australia, southern Indonesia and southern Papua New Guinea. Unlike other marine turtles, it does not undertake lengthy migrations. This narrow distribution places the species at risk from habitat change and over-exploitation.

FAMILY DERMOCHELYIDAE (leathery turtle)

PHOTO: M. GODFREY

Leatherback Turtle
Dermochelys coriacea

The leatherback is the sole species in its scientific family and the most physically distinct of all sea turtles. It is the largest living reptile on Earth, growing up to a ton (2,000 pounds). The most pelagic and widely distributed of all sea turtle species, it swims the greatest distances and regularly dives to depths greater than 1,000 meters (3,281 feet). It feeds primarily on jellyfish and other ocean drifters. The leatherback's carapace is a single piece in appearance with seven ridges and a rubbery feel.

Their Greatest Challenge in 110 Million Years:

Facing the Hazards of Humankind

SEA TURTLES evolved during the Cretaceous period (110 million years ago) and survived the extinction of the dinosaurs by 65 million years. Today, six species of sea turtles in the Pacific are in danger of extinction as a direct result of human actions. According to the IUCN's Marine Turtle Specialist group, some of the greatest hazards to sea turtles include:

Green sea turtle found entangled in Hawaii and subsequently released by staff of the Marine Turtle Program.

DIRECT HARVEST.

Throughout the world, people consume sea turtle eggs and harvest turtles for their meat, oil, leather and shell.

COASTAL DEVELOPMENT.

Sea turtle habitats are degraded and destroyed by coastal development. This includes both shoreline and seafloor alterations such as nesting beach degradation, seafloor dredging, vessel traffic, construction and alteration of vegetation at critical habitats. Light pollution disrupts nesting behavior and hatchling orientation, leading to hatchling mortality.

FISHERIES IMPACTS.

Sea turtles virtually everywhere are impacted by pelagic and coastal fisheries – especially longlines, gill nets and trawls. Bycatch mortality, habitat destruction and food web changes are the most severe of these impacts.

POLLUTION AND PATHOGENS.

Marine pollution – plastics, discarded fishing gear, petroleum by products and other debris – directly impact sea turtles through ingestion and entanglement. Chemical pollutants can weaken sea turtles' immune systems, making them susceptible to pathogens.

GLOBAL WARMING.

Global warming may impact natural sex ratios of hatchlings; escalate the frequency of extreme weather events resulting in loss of nesting beaches; increase the likelihood of disease outbreaks among sea turtles; and destroy coral reefs or cause other alterations critical to sea turtle habitats and basic oceanographic processes.

THE HAZARDS ARE NUMEROUS, yet the mitigation of each one is possible and depends on human behavior – often simple changes to the actions we take. Ultimately, the fate of the world's sea turtles depends on us.

Sea Turtles of the Pacific:
A Shared History

Throughout the world, the histories of sea turtles and humans have intertwined for thousands of years. Ancient palace walls in Mesopotamia are decorated with depictions of turtles. The early pictograph writings of the Han Chinese were inscribed on turtle shells. Bangles made of turtle shell have been unearthed at prehistoric grave sites in Egypt. Coins, ceramics and statues from ancient Greece captured the likenesses of turtles.

In the Pacific, sea turtles have long been an intrinsic part of the culture, subsistence, traditions and folklore of the region. They have been protected by certain social rules, rituals and legends of traditional native societies through perpetuation of ethics, values and attitudes.

In Vanuatu and Samoa, for example, *kapu* (traditional laws) were placed on the taking of turtle eggs. In Palau, the people of Tobi and Sonsorol instituted *kapu* on eating turtle eggs and even placed fences around turtle nests for their protection. In Kiribati, it was *kapu* to harvest turtles on the beach, and the Enewetak Islanders in the Marshall Islands made several uninhabited islands into turtle reserves by forbidding the taking of turtles or their eggs from these locations.

In Hawaii, chiefs carefully monitored the harvest of turtles and turtle feasts were reserved for special occasions and community celebrations. Many native Hawaiians honor sea turtles as family guardians, or aumākua. To these families, the *honu* (Hawaiian green sea turtle) is not only a protector but also the embodiment of their ancestors. In old Hawaii, members of the *honu* clan did not eat the sea turtle nor were any women allowed to partake of them.

In Hawaiian lore, mention of the *honu* dates back to the *Kumulipo* (ancient creation chant). Countless stories of *honu* with supernatural powers have been passed down through generations, including the story of Kauila, a magical *honu* that lived along the black sand beach of Punaluu on the Big Island of Hawaii. Kauila transformed herself into a young girl and back to a turtle at will to play with and watch over the children. Today, the turtles of Punaluu are still famous for being tame and friendly, and many say the presence of Kauila can still be felt there.

PHOTO: TURTLETRAX

The hawksbill sea turtle, or ea*, is the second of two species that nests in the Hawaii Archipelago. Primary nesting occurs on the east coast of the Big Island of Hawaii. Between 1991 and 2005, researchers have tagged 67 adult female hawksbills and documented 583 nests.*

In the last few decades, however, increasing human pressures from population growth, the erosion of traditional taboos, the preference for modern boats over canoes, and the influence of Western culture and market-based economies have led to the erosion of the "protective buffer" traditional customs once provided.

The modern story of the Hawaiian green sea turtle illuminates many of the contemporary challenges facing sea turtles and humans today. Although no population data exist from the time of the early Hawaiians, it is generally believed that the *honu* lived in relative harmony with traditional Hawaiian practices. However, mass harvesting spurred by expansion of tourism (i.e., market demand for turtle steak in restaurants) in the 1960s and 1970s reduced the sea turtle population in Hawaii.

Over the past 35 years, significant research and conservation efforts have centered on recovering the *honu*. Indeed, the transformation of the Hawaiian green from Pacific cuisine delicacy in the 1960s to contemporary Hawaiian icon may have far reaching impacts. From *honu* tattoos, to *honu* decals and bumper stickers, to a booming ecotourism market, the Hawaiian green can be seen everywhere in the Islands, and are a beloved part of contemporary culture today. In this section, we look at how scientists, the local community and policymakers helped turn the tide for the *honu* and set the stage for current conservation efforts for sea turtles in the Pacific.

Unique picture of an adult male sea turtle – note the long tail.

PHOTO: TURTLETRAX

PHOTO: TURTLETRAX

Green sea turtle.

Green Sea Turtles of the Pacific:

Saving the Hawaiian Green Turtle

Pioneering work on the honu set the stage for current science-based sea turtle conservation efforts throughout the Pacific

The story of the *honu* (or Hawaiian green turtle) is also the story of man. And prominent among the many involved with the conservation of this species is George Balazs, biologist and leader of the "core" Marine Turtle Research Program at NOAA Fisheries Pacific Islands Fisheries Science Center (PIFSC). His nearly 35-year career has been devoted to the study and survival of the Hawaiian green sea turtle.

In 1973, when Balazs set out to count the Hawaiian green sea turtles in the Northwestern Hawaiian Islands, he found just 67 nesting females at the uninhabited East Island of French Frigate Shoals. Subsequent research confirmed that the fate of the endemic *honu*, throughout the entire Hawaiian Island chain depended on fewer than 150 females nesting each year.

Thirty years later in 2002, on the same island, Balazs' research team counted 467 females – a nearly 300 percent increase!

"If someone had told me thirty years ago that the *honu* would become so visible and so enjoyed as part of our greater Hawaiian community today, I would not have believed it," Balazs says.

George "Keoki" Balazs, universally recognized honu expert, was honored with the National Conservation Achievement Award in March 2005 by the National Wildlife Federation for his work on the recovery of the Hawaiian green sea turtle.

Green sea turtle and diver. Ecotourism, is a major industry in Hawaii, and the honu are an important component of this market.

George Balazs with assistant Bridget McBride fitting a green sea turtle with a satellite transmitter.

Balazs first became aware of the plight of the *honu* in 1969 in Lahaina Harbor, where he and wife Linda observed fishermen unloading live sea turtles bound for restaurants along the west coast of Maui. Balazs began to question whether the harvesting of *honu* was going on at a faster rate than the animals could replace themselves. He wondered, "How many turtles can there be out there?"

As he delved into this question, Balazs was astonished to find that biologists knew surprisingly little – even the basics of reproduction, population and ecology – about sea turtles in general. This work, eventually spanning over three decades, became the basis of the first in-depth, scientifically rigorous population study of the Hawaiian green sea turtle.

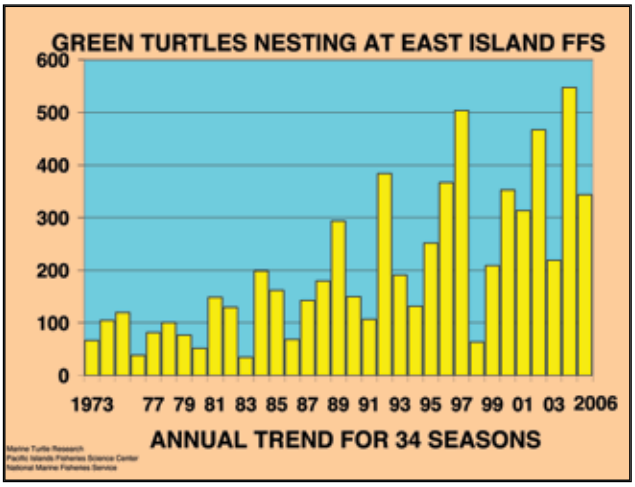
Over time, PIFSC's Marine Turtle Research Program expanded to include a stranding program and investigations on fibropapillomatosis, a tumor-forming disease that reached epidemic levels in the 1980s and 1990s. The project also helps build capacity throughout the Pacific region by training researchers on data collection and research methods in the Pacific Islands of American Samoa, Guam, Saipan and Palau among others.

The *honu* is a genetically distinct Hawaiian stock, an "original native Hawaiian," that nest almost exclusively in the French Frigate Shoals and forage around the main Hawaiian Islands. As part of his work, Balazs leads teams of researchers and volunteers to monitor the *honu* at nearly 25 study sites in the main Hawaiian Islands, with the Big Island of Hawaii and Molokai currently providing the most important foraging areas for the *honu*.

Balazs' precedent-setting work confirmed his suspicion that the rate of harvest, if remained unchecked, would result in a devastating, possibly irreversible, decline. In 1963, records showed that 380 pounds of sea turtle meat were sold, but by 1972 that number had jumped to 25,583 pounds. Unregulated harvest was threatening the species survival, and by 1978 the green sea turtle was listed as threatened under the federal Endangered Species Act.

Conservation efforts over the last three decades are the result of many concerned people, including local legislators, resource managers, environmentalists, the local community and fishermen. Among the latter were many seasoned fishermen who early on recognized the *honu*'s decline and whose vast knowledge about the *honu* has enriched and inspired research.

A paper Balazs co-authored with Milani Chaloupka in 2004 provides encouraging evidence on how this species is recovering. The study documents the speed of population recovery and that such a large population could have quickly resulted from so few individuals.



DATA SOURCE: NOAA FISHERIES PIFSC

Estimated number of Hawaiian green sea turtles nesting at East Island, French Frigate Shoals, NWHI, 1973-2006.

Today, the recovering trend of the once nearly depleted Hawaiian green sea turtle is proof positive that a population can recover, given time and appropriate protection. These results have challenged long-held conventional wisdom that a seriously depleted population might take 100 years or more to recover after the cessation of harvesting, in part because of low reproduction rate, late maturity and long life span.

This pioneering work further provides evidence of the importance of a holistic approach to sea turtle recovery efforts. The long-term research on the *honu* concludes that the increase in nesting females could not be attributed solely to protection under the U.S. Endangered Species Act.

The increased abundance of nesting females was helped by both the reduction of nesting beach disturbance at French Frigate Shoals in conjunction with conservation efforts of both adult and juvenile greens in coastal waters around the main Hawaiian Islands.

While special circumstances can be attributed to the current population trends of the *honu*, due to nesting beach isolation in the Northwestern Hawaiian Islands (NWHI) and its relatively small ecosystem confined to the Hawaii Archipelago, Balazs' work has helped set the stage for scientists researching loggerheads, leatherbacks and hawksbills whose migrations across international borders complicates conservation efforts.

"As a scientist, I know that turtles are harvested worldwide for a variety of reasons, including out of necessity for survival," Balazs says. "Here in Hawaii, I want to see the turtle returned to levels of abundance to fulfill their ecological role as part of our Hawaiian community."

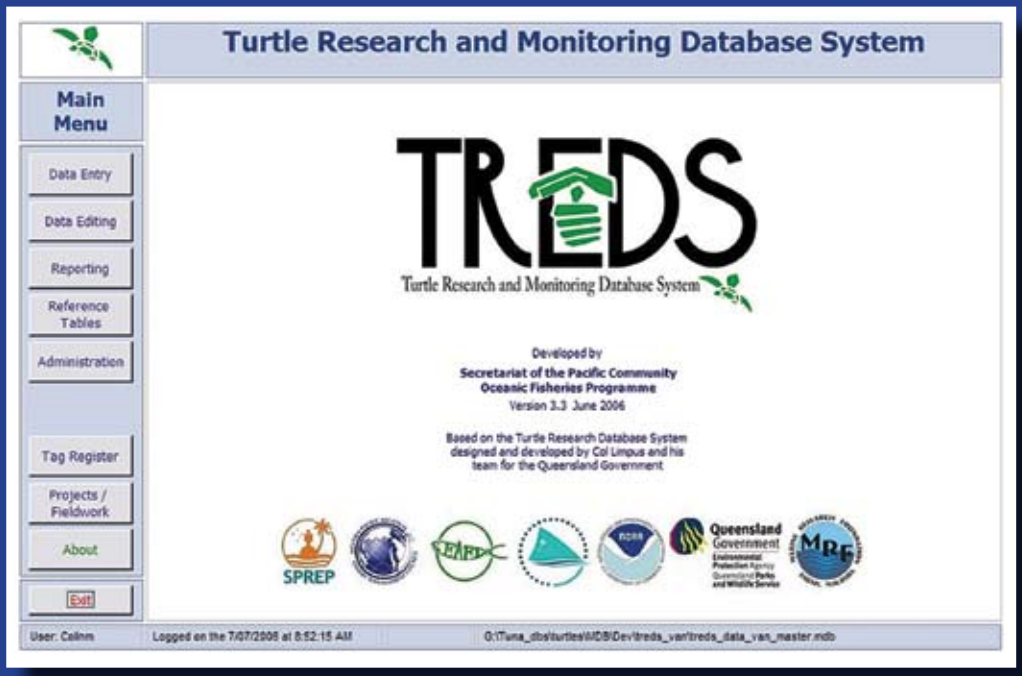
PHOTO: K. FRUTCHEY

American Samoa DMWR staff, Siaifoi Fa'aumu (left), Kate Saili (center), along with the Mayor of Malota, Lisona Leiataua (right), prepare to release a hawksbill turtle with a satellite transmitter in February 2006.

Since 2003, the NOAA Fisheries Service Pacific Islands Regional Office (PIRO) has undertaken sea turtle conservation and management activities geared towards institutional capacity building for sea turtle conservation, management and research in the U.S. flag areas of American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands (CNMI).

The PIRO is working to build capacity to support assessments of local sea turtle populations. In American Samoa, sea turtle research activities are conducted by the Department of Marine and Wildlife Resources (DMWR). They are trained with skills to deploy satellite transmitters, beach mapping, identification of sea turtle foraging areas and underwater surveys for turtles. The CNMI Division of Fish and Wildlife is conducting nesting beach monitoring and surface and underwater surveys to ascertain turtle distributions and numbers throughout the Marianas archipelago. In Guam, the Division of Agriculture and Wildlife Resources (DAWR) undertakes nesting beach monitoring, aerial surveys and collection of nest inventory data. The Guam DAWR has also initiated a volunteer program, *Haggan Watch*, that now has over 40 members to assist with sea turtle conservation on Guam.

The Regional Sea Turtle Research Database System



A critical step in understanding population trends of Pacific sea turtles is implementing a region-wide database. Various institutions throughout the Asia-Pacific region have been tagging turtles and collecting a range of data, and although large volumes of information are being generated, there has been little overall coordination of this work. In response, the Turtle Research Database System (TREDS) has been developed through international cooperation by sea turtle and database experts.

TREDS can store information on tag deployment, nesting and in-water monitoring data, clutch and hatchling information, and biological samples (such as genetic data). It can systematically inventory tags used per project, generate project-specific and site-specific summary reports, and help standardize data collection protocols.

TREDS is a joint initiative between the South Pacific Regional Environment Programme (SPREP), Secretariat of the Pacific Community (SPC), Queensland Parks and Wildlife Service, Southeast Asian Fisheries Development Center (SEAFDEC), NOAA Fisheries Pacific Islands Fisheries Science Center, the Marine Research Foundation in Malaysia, and the Western Pacific Regional Fishery Management Council.

Once completed, programs throughout the Pacific will be invited to use TREDS. The overarching, or central, database for the Pacific Island region will be housed at SPREP, and a second central database will likely be managed by SEAFDEC in Malaysia. Together these agencies will manage and consolidate turtle research data for their 31 member countries in the Pacific Ocean. Neither SPREP nor SEAFDEC become owners of the data, however, projects retain ownership and use of their data (within reasonable time periods) for publishing and recognition. TREDS is expected to reach completion in 2007.

New Frontiers:
The Challenge Ahead

"New frontiers" of sea turtle conservation in the Pacific focus on the challenges of recovering loggerhead and leatherback populations

St. Croix, in the Caribbean, harbors an intensively monitored leatherback nesting population. Unbeknownst to most tourists attracted to St. Croix's beautiful beaches, almost every turtle that nests there is a result of conservation actions. Nests relocated from erosion prone areas to safer locations have resulted in thousands of leatherback hatchlings over the past 15 years, as opposed to just a handful that survived before management interventions.

"For years, we would only get a handful of turtles coming back. We often wondered: why do we do this?" recalls Peter Dutton, leader of the Sea Turtle Research Program at NOAA's Southwest Fisheries Science Center in La Jolla, California, and co-primary investigator of the St. Croix project.

The answer would come for Dutton and colleagues after 14 years, when, all of a sudden, the leatherback population started increasing exponentially. Today, the St. Croix population is part of a success story in the Atlantic – where, in general, leatherback populations are increasing or have been stable over the last five to eight years. Drawing on these experiences in the Atlantic, Dutton and other concerned scientists, fishermen and conservationists are now turning their attention to the declining populations of leatherbacks in the Pacific.

In the mid-1990s, marine conservation biologist Wallace J. Nichols with ProPeninsula and the California Academy of Sciences came up with the novel idea of surveying dump sites as a way to estimate the number of sea turtles illegally killed and eaten along the

Loggerhead turtle swimming.

PHOTO: M. JOHNSON

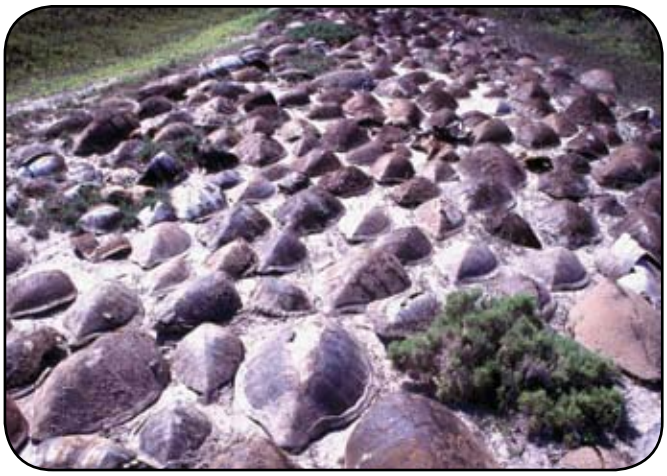


PHOTO: W.J. NICHOLS

Tens of thousands sea turtles are still hunted (illegally) along the Pacifci coast of Latin America. This photo is from the Magdalena Bay area, taken summer 2000.

1,000-mile coastline of Baja California, Mexico. It was hard work for the volunteer crew in the blistering desert heat, but the results became a wakeup call for turtle conservation in the eastern Pacific. Based on years of such surveys, Nichols has estimated that as many as 35,000 turtles are harvested in the area annually. Among them is the threatened loggerhead sea turtle.

"We needed to do this to prove that there's a problem here," says Nichols of the declining loggerhead population. Then, what to do about it?

Today, leatherback and loggerhead sea turtles represent the leading edge of the new frontier of Pacific sea turtle conservation. The work ahead builds on the breakthroughs in research and social changes over the last five years. New scientific data, improved technologies and expanded international cooperation have resulted in major discoveries in understanding the life cycles and ecosystems of these two species, including genetic origins, nesting dynamics, migrations, feeding ecology and pelagic behaviors.

The work proceeds on many fronts, guided by holistic recovery strategies that attempt to address threats to the entire life cycle and ecosystems of these ancient and long-lived creatures. These strategies are strengthened by cooperative efforts among nations and by an expanding, multi-disciplined conservation framework.

In this section, we look at developments in sea turtle conservation activities that range from aerial surveys, genetic mapping, and satellite telemetry to local community-based, grass-roots conservation programs to protect nests and turtles from predation and human harvest. Every sea turtle expert will tell you that there is much more to be discovered, there is much more to be done, and time is of the essence.

The race is now on to prevent population level collapse of what may be the last remaining stronghold for leatherbacks in the Indo-Malay archipelago of Indonesia, Papua New Guinea, Solomon Islands and Vanuatu in the western Pacific.

"In St. Croix, genetics has shown us that some of the new turtles [nesting] are the daughters of the old-timers," says Dutton. "It is a waiting game that requires commitment, but there is hope."

PHOTO: Y. MATSUZAWA

PHOTO: N. PILCHER

Scientist in Japan measuring a loggerhead (above) and local rangers measuring a nesting leatherback in Papua New Guinea (right).

New Frontiers:

Pacific Ocean Ambassador

Adelita's 1997 track from Baja California, Mexico to Japan.

SOURCE: W.J. NICHOLS

The globe-trotting loggerhead sea turtle connects scientists, fishermen and communities across the Pacific

Adelita was the name scientists and fishermen gave a loggerhead turtle they had released on August 10, 1996, off the town of Santa Rosalita in Baja California, Mexico. Named after the daughter of a Mexican fisherman who helped researchers secure a satellite transmitter on her back, the 223 pound mature female splashed into balmy Mexican coastal waters, made a beeline across the Pacific toward Japan and crossed into turtle history.

PHOTO: W.J. NICHOLS

Tracked by satellite, Adelita's 11-month trans-Pacific journey across more than 6,000 miles of ocean provided the first physical proof that these turtles migrated to opposite sides of the Pacific – and supported previous research showing a genetic connection between loggerheads in Japan and Baja. Her journey came at a critical time for the threatened loggerhead sea turtles in the north Pacific.

Once abundant along the nesting beaches of Yakushima Island, near the southern tip of Kyushu, Japan's southernmost island, loggerhead turtles have been in rapid decline in recent decades. The number of nesting females has fallen from an estimated 5,000 per year to only 1,000 annually by 2002. Recent data since 2004 are encouraging

Rodrigo Rangel and Wallace J. Nichols releasing a loggerhead turtle with a satellite transmitter to gather valuable habitat use information to assist in making effective, science-based management decisions.

PHOTO: W.J. NICHOLS

Members of ProCaguama with loggerhead sea turtle. In April 2004, the ProCaguama project was launched through an international conservation partnership among the WPRFMC, NOAA Fisheries, ProPeninsula, and Grupo Tortuguero with collaboration with colleagues from the Sea Turtle Association of Japan (STAJ). The project's aim is to raise community awareness and actively involve local fishers to develop mortality reduction solutions for the Baja California halibut coastal gillnet fishery in Mexico, a leading source of turtle mortality.

PHOTO: Y.MATSUZAWA

Loggerhead turtle nesting in Japan.

and provide evidence of increasing nesting numbers – but it's not time to celebrate just yet.

On the opposite side of the Pacific, in the nutrient-rich waters that surround the Baja California peninsula, a similar tale could be heard. As early as the 1970s, Mexican fishermen reported seeing fewer and fewer turtles, long considered a delicacy at traditional feasts. Even after the Mexican government outlawed the eating of turtles in 1990, as many as 35,000 turtles were still consumed per year, particularly during holidays such as Easter and Christmas.

As late as the early 1990s, however, it was still unknown where Baja California's loggerhead turtles came from, as there are no nesting beaches along the Pacific coast of Mexico. The first confirmed report of their existence in the area was made in 1947, and confirmation that the species did live in the area came in the 1960s.

More knowledge of this species, based on scientifically accurate information, was critically needed to turn the tide for the declining loggerhead population in the north Pacific. Adelita's historic trek proved one leg of the trans-Pacific turtle migration hypothesis – the return journey to nesting beaches in Japan.

Researchers figured, in turn, that juvenile loggerheads, born in Japan, must be crossing the Pacific to feed and mature off the coast of Baja. It would explain why the loggerheads caught by Baja fishermen were large juveniles and sub-adults, and why international longline swordfish fishing fleets in the north Pacific were inadvertently interacting with young juvenile loggerheads.

Then in 1999, a Mexican fisherman came forth with a flipper tag he had removed from a loggerhead he had caught off the Baja coast and stuck on his keychain for five years. The fisherman revealed his find after working with and trusting turtle researchers.

The tag was from a turtle hatched on Yakushima Island, where a third of Japan's loggerheads nest, and tagged with #572 and released in 1988 by Drs. Teruya and Uchida of the Okinawa Aquarium. In 1994 (two years before Adelita began her journey), it was captured in San Carlos, Baja California, Mexico.

This was a great find – the first evidence to complete the circle of the loggerhead's trans-Pacific migration. A small loggerhead, which began its journey in Japan as a 6-inch juvenile, made the 6,000 mile six-year journey to Baja! This discovery would open new international working opportunities among scientists, fishermen and conservationists in Japan, Hawaii, California and Mexico.

"Loggerhead turtles have become a cultural ambassador for countries all working to protect this species, an icon for the connectedness of the ocean," says Irene Kinan, biologist and turtle program coordinator for the Western Pacific Regional Fishery Management Council in Honolulu.

"We became involved in turtle conservation as a result of the Hawaii-based longline fishery's interactions with loggerhead turtles in the central north Pacific. In turn, we came across this fantastic story, remarkable life history, and equally amazing people, on both sides of the Pacific, dedicated to conserving this species."

These international research collaborations over the last decade have yielded new data about the loggerhead, as well as the Pacific Ocean itself. The importance of the waters off the Baja California peninsula as a feeding and development area for loggerheads in the north Pacific was established only recently by scientists. We now know that five out of the six sea turtles species in the Pacific – all listed as endangered or threatened by the ESA – inhabit the waters around the Baja California peninsula.

Recent research has focused scientific investigation to the open ocean and coastal habitats, where turtles are vulnerable to pelagic longline and coastal gillnet fisheries.

"Most, perhaps 99 percent of all sea turtle research has occurred at nesting beaches where turtles are easily accessible to researchers, but turtles spend 99 percent of their lives at sea; where our ability to study and protect them is extremely limited," explains Kinan. Long distance migrations through international and high seas waters, combined with the loggerhead's slow growth rate and extended developmental phase in pelagic and coastal habitats, make these animals extremely vulnerable to both natural and human pressures.

Kinan cautions that reducing incidental catch of loggerheads in commercial pelagic fisheries represents only one aspect of conservation efforts.

"To save loggerheads, we must improve our understanding of their far-ranging ecosystems, reduce direct hunting and illegal trade, protect nesting beaches and conserve turtles in their foraging grounds from accidental catch by artisanal coastal fisheries," she adds, emphasizing a holistic approach to turtle conservation and management.

Turtle conservation efforts have to be wide ranging and international in scope involving scientists, conservationists, fishermen and communities in collaborative, multi-cultural and multi-lingual projects.

Loggerhead sea turtle hatchling. In partnership with the STAJ, the WPRFMC supports beach management efforts to relocate nests laid in erosion prone areas thereby bolstering hatchling production at five loggerhead nesting beaches in Japan.

PHOTO: N. PILCHER

Loggerhead sea turtles, "Pacific Ocean ambassador," connecting people and cultures of the North Pacific.

"People need to see that daily human activities can impact the lives of sea turtles," she adds. The ProCaguama Project, begun in 2004 by ProPeninsula to conserve loggerheads at their critical foraging habitats in the northeast Pacific is a local community-based, grass-roots conservation project that involves building local capacity for conservation by elevating community awareness and working with fishermen to help them make environmentally responsible choices.

"What happens to loggerheads in Japan or Baja or the central north Pacific will affect turtles in all of these places, and in turn they affect us," says Kinan. "Sea turtles literally connect the whole Pacific Ocean."

Creative communication strategies raise community awareness in Baja and help build local capacity for conservation, such as comic books and festivals.

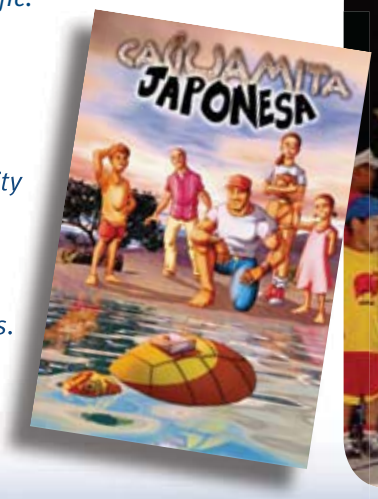


PHOTO: H. PECKHAM

Halibut gillnet fishermen of Baja California, Mexico participating in the ProCaguama project. Fishers are experimenting with different gillnet designs to investigate options and strategies to reduce loggerhead sea turtle interactions.

New Frontiers:

Turning the Tide for the Leatherback

PHOTO: PROJECTO TAMAR

New scientific tools join forces with traditional Pacific Island communities to save the world's largest sea turtle

They are the "muscle men" of the sea turtle world – barrel-chested swimmers, deepest divers and daring adventurers of the ocean. Distinguished by a leather-like rubbery carapace (hence the name), leatherbacks are the largest and the oldest of the seven existing species of sea turtles in the world.

The leatherback is the only surviving descendant of a species that evolved some 110 million years ago. It is also the most endangered sea turtle in the Pacific today. The first signs of trouble came from Mexico, where scientists observed a dramatic decline in nesting leatherback females from 6,500 in 1984 to barely 500 in 1995. Farther

Dr. Peter Dutton (left) leads numerous international research teams working with communities and scientists throughout the Pacific on conservation efforts to protect and recover leatherback turtles. Pictured (on right) is fellow researcher and field compatriot Scott Benson, and adult leatherback turtle ready to be released after capture from feeding grounds off Monterey, California and harnessed with a satellite transmitter to track migratory movements.

south in Costa Rica, a similar population collapse was observed from 1,367 leatherback nesters in 1989 to 69 in 2002.

These mirrored the catastrophic decline in the western Pacific. In Terenganu, Malaysia, once one of the largest leatherback rookeries in the Pacific, prized leatherback eggs were regularly harvested by locals for 50+ years. By the late 1970s, the annual number of nesters had plunged from over 3,000 to just one or two nesting annually by the 1990s. Despite protective measures, such as harvest quotas and beach hatcheries at Terenganu, interventions to reverse the decline now appear to have been too little, too late.

"The leatherback population went from some of the largest in the world to basically collapsing," says Peter Dutton, leader of the Sea Turtle Research Program at the NOAA Fisheries Southwest Fisheries Science Center (SWFSC) in La Jolla, California, and a leading expert on the leatherback turtle. Throughout the Pacific, the species is in serious decline at all known major nesting beaches.

According to Dutton, the good news is the leatherback crisis in the Pacific has literally put the species on the map. Conservation of this unique sea turtle is one of the top priorities of the United Nations Food and Agriculture Organization (FAO) as well as for Regional Fishery Management Organizations such as the Inter-American Tropical Tuna Commission and the Western and Central Pacific Fisheries Commission. High level agencies within Pacific nation governments, such as the Far Seas Fishery Agency of Japan, have also become involved in leatherback conservation efforts.

PHOTO: M. RUF

Leatherback turtle hatchling emerging.

Leatherback turtle nesting in Papua New Guinea.

PHOTO: N. PILCHER

The task is easier said than done, however, as the leatherback is "the most free-roaming reptile in the world," says Dutton. Having the unique ability to maintain a core body temperature several degrees warmer than the surrounding water, adult leatherbacks have been spotted among icebergs in the Gulf of St. Lawrence in Canada and as far south as New Zealand. In tropical waters, leatherbacks have been sighted by fishermen off the north coast of Oahu and the Kona coast of the Big Island of Hawaii.

The species is also the most pelagic of sea turtles. It usually feeds in the open ocean rather than near shore as most other turtles do, and it does not reside within the waters of any single country during its juvenile or adult stages. Not a single Pacific leatherback nesting beach – a logical starting point for conservation efforts – is located in the United States, requiring conservation measures to operate at the more challenging international level.

In the Pacific, high seas longline and coastal driftnet fisheries from many nations, go after highly prized pelagic species, like tuna and swordfish, and inadvertently encounter leatherbacks during fishing operations.

"To address the bycatch concern, we had to start with where they were coming from," says Dutton, who holds a Ph.D. in zoology specializing in sea turtle genetics, a rapidly evolving field in the last decade. As part of NOAA Fisheries and U.S. Fish and Wildlife Service's Pacific sea turtle recovery team formed in the mid-1990s, he helped pioneer the use of genetic tools in research on stock structure and evolution of leatherbacks. The genetics DNA database of about 50,000 sea turtle samples from all over the world, representing two decades of scientific collection, is housed at the SWFSC.

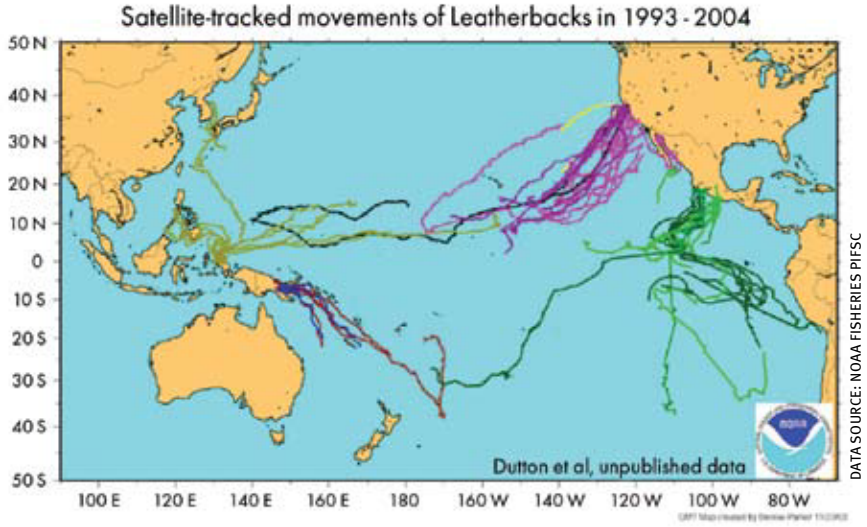
Population genetics used by Dutton and others are an important tool to answer some of the most difficult questions regarding population demographics. They aid conservation efforts by allowing the identification of stocks that make up respective management units.

"We had assumed that leatherbacks encountered in the north Pacific came from Mexico," explains Dutton of the leatherbacks caught as bycatch in the Hawaii-based longline fishery.

PHOTO: P. DUTTON

Villagers in Papua New Guinea (PNG) assist researchers to collect leatherback turtle migratory data using satellite transmitters.

Leatherback sea turtle conservation and research activities in Indonesia and PNG are currently supported by the WPRFMC and NOAA Fisheries in collaboration with WWF-Indonesia, the Far Seas Fishery Research of Japan, the Marine Research Foundation of Malaysia, the PNG Dept. of Environment and Conservation and numerous other locally-based NGOs. Working together with conservation partners, a goal is to develop creative funding for Pacific leatherback turtles to ensure long-term financial support for essential research and community-based conservation actions.



Drawing on the sea turtle DNA database, Dutton was able to look for a genetic match for the north Pacific leatherback DNA samples. He found that they matched the Indonesian leatherback – a western Pacific stock.

Satellite transmitters attached to leatherbacks found at north Pacific foraging grounds in Monterey Bay, California tracked their migration pattern and confirmed the genetic link to the Indonesian stock. Genetic analysis also confirmed that the majority (94 percent) of leatherback turtle interactions with the Hawaii-based longline fishery came from the western Pacific leatherback stock.

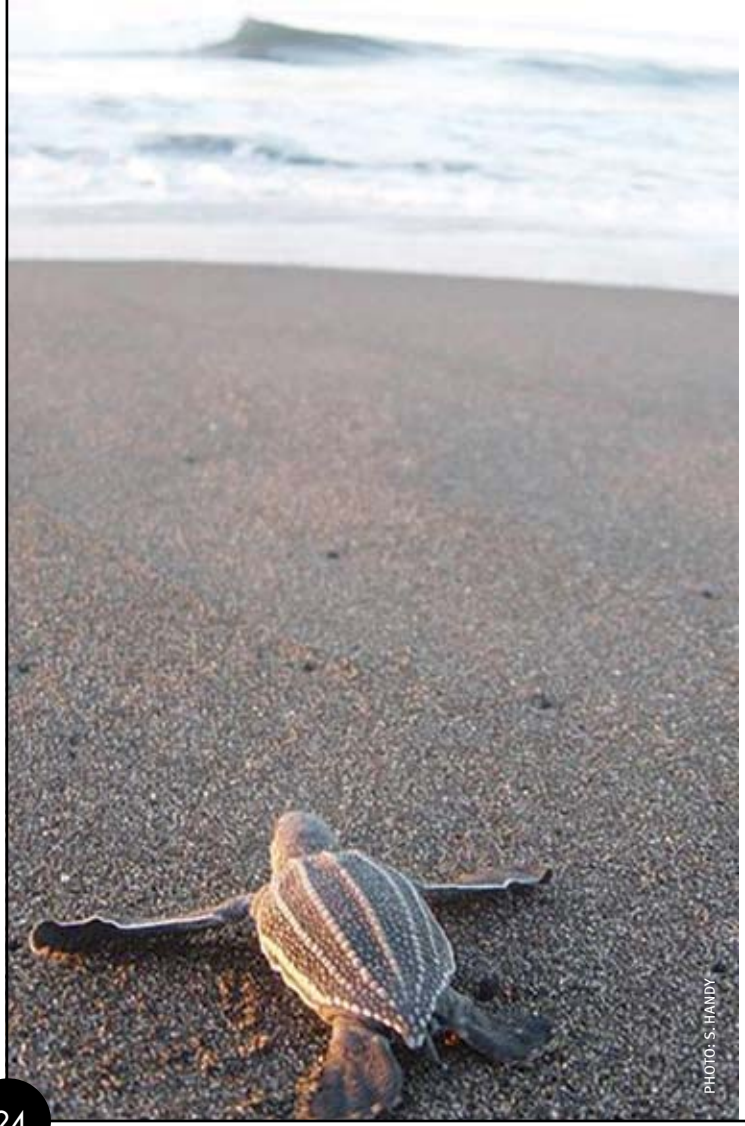


PHOTO: S. HANDY

A leatherback sea turtle hatchling embarking on a long and tenuous journey.

"This completely changed our view and focus. For the first time we realized that to manage leatherbacks in the north Pacific, we need to turn our attention to the western, not eastern Pacific," explains Dutton of this breakthrough find. He and fellow researchers thus found themselves trekking through jungles and forging relationships with chiefs of remote Pacific villages to work on community level projects.

Today, Dutton calls these projects, initiated in the last five years and involved with nesting beaches and foraging grounds in Indonesia, Papua New Guinea (PNG), Solomon Islands, and Vanuatu "at the grassroots level, the front lines of conservation for leatherback turtles in the region."

"It's been a wonderful partnership," says Dutton of the working relationship between U.S., Indonesian and Japanese scientists and native villagers and community groups in these four countries, whose rookeries account for the largest leatherback population remaining in the western Pacific.

Aerial surveys also augment earlier projects using satellite transmitters to help researchers locate unknown leatherback nesting beaches in the remote areas of the region, says marine biologist Scott Benson. Aerial surveys are a quick way to assess

View from the air during an aerial survey of the Huon Coast of Papua New Guinea.

nesting beaches and at the same time gather information regarding the number of nests laid per season. These data helps scientists estimate the size of the nesting population and provide local, community-based organizations with the necessary information to bolster beach protection projects.

While the last five years have witnessed a significant growth in data collection and understanding of the population impacts and pelagic ecology, there is still much we don't know about leatherback sea turtles and their ecosystems.

"There remain large knowledge gaps about their life histories and their role in the larger web of life of the ocean," says Dutton. "They appear to be indicators of when the ocean is in trouble, whether it's from overfishing or beach habitat destruction." Recent scientific data suggest that factors, such as beach health, climatic changes and large-scale ocean conditions may affect the life cycle of leatherbacks and other sea turtles.

"Given this uncertainty, there is a need to integrate a broad suite of approaches into a holistic strategy that, in the short run, will prevent extinction of turtle populations that are clearly in crisis and, in the long run, lead to recovery," he adds.

Dutton is especially encouraged by how motivated people can be – scientists and Pacific Islanders alike – to keep these ancient creatures from disappearing. He has seen firsthand what cooperation across countries and cultures can accomplish and how new scientific tools – including genetics, satellite telemetry, aerial surveying and oceanography – can work in harmony with native know-how, based on familiarity with the ocean.

"We used to think they were our turtles, because they live nearby," recalls Dutton of the words of one village chief in PNG, who was amazed by the maps Dutton showed of leatherbacks crisscrossing the Pacific. "Now we know they belong to the world."

Sustainable Fisheries:
Learning from Turtles

How new sea turtle research and conservation efforts can help keep Pacific fisheries sustainable

Story after story tells us that accidental interactions, or bycatch, with pelagic and coastal fisheries may be one of the greatest threats to sea turtles in the ocean. This section features the work of fishery managers, scientists and industry leaders working to reduce sea turtle interactions with commercial longline fisheries, and also ensure that fisheries are sustainable through the long-term. Hawaii has emerged as the hub of these efforts.

Of the many scientific breakthroughs, satellite telemetry in combination with oceanography and sea turtle foraging ecology has greatly added to our knowledge of sea turtle migration and oceanic habitat usage.

PHOTO: M. JENSEN

Olive ridley "arribada" at Ostional National Wildlife Refuge in Costa Rica.

Physiological research investigates how turtles perceive their environment and has contributed towards a better understanding of environmental factors that influence turtles' behavior. The development of population models has allowed scientists and fishery managers to experimentally gauge the impact of fishery interactions and management measures on a species' long-term survival.

Critical information has been obtained through longline fishery experiments with fishermen regarding gear design, depth, bait, hook type and hook size to minimize sea turtle capture and entanglement. To date, experiments have shown that using large circular hooks effectively reduces sea turtle bycatch rates, compared to using the more commonly used small J-shaped hooks, or Japanese-style tuna hooks. Efforts are now underway to introduce this modification to international longline fleets.

Actions to understand and control sea turtle bycatch began in the early 1990s in Hawaii with a series of workshops to brainstorm options. In 2001, the Hawaii-based swordfish fishery was closed due to interactions with sea turtles, the result of a 1999 law suit brought by a coalition of environmental organizations against NOAA Fisheries. This action ramped up experimental efforts in both the Atlantic and Pacific Oceans. Today, technical innovations and operational modifications, originated in most cases by fishermen themselves, have lead to rigorous scientific testing and the ultimate adoption of new and effective techniques by the Hawaii-based and other U.S. longline fisheries.

Olive ridley turtle accidentally captured during longline fishing operations in Costa Rica. The hooked was safely removed and the turtle returned to the sea.

In April 2004, the swordfish component of the Hawaii-based fishery was re-opened under new regulations that include specific gear requirements (circle hooks and mackerel bait), caps on sea turtle interactions, limits on total fishing effort, 100 percent observer coverage, and stringent turtle handling protocols. These changes have created not only a model longline fishery in Hawaii, but perhaps the most proactive environmentally responsible fleet in the Pacific, setting the standard for reducing sea turtle interaction rates by 85 to 90 percent.

Fruition of the work is also manifested at the international level through the many collaborative partnerships. Through new and improved observer programs to collect accurate information, education and training, fishery experiments, and actions to promote environmentally responsible fisheries, global awareness has been raised. Recent, unprecedented actions by regional fisheries management bodies further demonstrate that sea turtle conservation and bycatch issues have become high international fishery management priorities.

As more is learned about the sea turtle's role in the ocean ecosystem, new ways of sustaining fisheries will develop as we modify the ways we harvest from the ocean.

Olive ridley turtles.

Sustainable Fisheries:

Gearing Up

(Left to right) Circle Hook size 18/0, "J" Hook size 9/0 and Japanese-style Tuna Hook size 3.8 sun.

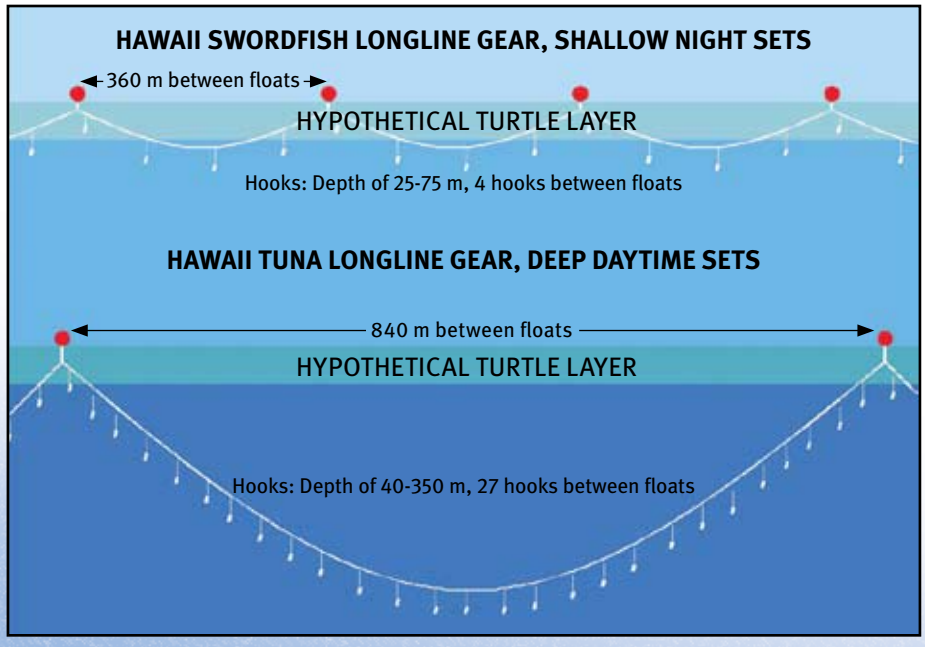
New technologies and changes in fishing gear aim to help fishermen protect sea turtles

Longline fishery interactions are considered a major threat to sea turtles in the pelagic environment. A variety of current research is testing new gear modifications and approaches to fishing to reduce that threat.

Fish-type bait

Chris Boggs and Yonat Swimmer, fishery biologists at the NOAA Fisheries Pacific Islands Fisheries Science Center (PIFSC) in Honolulu, are at the center of these investigations. Working with fishermen, they have discovered some promising changes in longline fishing gear to reduce sea turtle interactions, such as altering the type and size of fishhook.

Their experiments have shown that using large circular hooks effectively reduces sea turtle bycatch rates, compared to using the more commonly used small J-shaped hooks, or Japanese-style tuna hooks. Also, hook size (and not necessarily shape) may be of critical importance to reducing



Longline gear schematic, shallow vs. deep design.

Understanding gear design and depth has lead to significant advancements in reducing sea turtle interactions with longline gear. Measures that have proven effective at reducing interaction rates or the severity of hooking include replacing "J" shaped or traditional Japanese-style tuna hooks with large circle hooks, and using fish-type bait instead of squid. Additionally, since sea turtles tend to occur near the surface, shallow-set longlines have increased interaction rates. Therefore, setting gear deeper results in reduced interactions with sea turtles.

sea turtle interactions. However, the use of circle hooks, independent of size, is likely to reduce the severity of injury to sea turtles (e.g., reduced proportion of swallowed hooks) and thus minimizes negative impact on populations.

Experiments have also shown that, in addition to the positive implications for sea turtles derived from the use of large circle hooks, the catch of target species can be maintained. Sometimes this may require using different bait to offset reduced catch rates caused by circle hooks, but not always. Recent studies in Brazil show that a larger size swordfish and increased number of target species can be caught as a result of using large circle hooks and squid bait. In the U.S. North Atlantic fishery, however, mackerel bait increased catch of swordfish enough to offset a loss caused by circle hooks. The replacement of small J-hooks with large circle hooks can present a win-win scenario for the fishing industry and sea turtles and a viable alternative in some fleets.

Building on earlier research in the Atlantic Ocean, Boggs and Swimmer have been testing additional strategies throughout the Pacific that may also prove effective in reducing sea turtle interactions and mortality from longline fisheries. These other measures include setting gear below depths where turtles are abundant, using fish instead of squid for bait, single-hooking fish bait, reducing gear soak time, and analyzing the potential of closing certain areas to avoid bycatch "hotspots."

Another challenge is developing bycatch solutions for multiple species groups to ensure that solutions for one species does not negatively impact another taxonomic group (such as sharks, seabirds, marine mammals, or non-target fish). As with most things, there are trade-offs that must be understood and evaluated to ensure that sound management decisions are made.

Many longline fisheries are different, based on a wide array of factors including the target species, the depth of the gear, and the time gear is set; hence it is unlikely that one mitigation method would be effective at reducing bycatch across the board. As such, field tests must be undertaken throughout the world and under as many different conditions as possible to determine the best combination of solutions for each scenario to ultimately result in minimizing the incidental capture of unwanted and often endangered or threatened species such as sea turtles.

Ecuadorian fishermen examining a circle hook.

Fishers themselves are at the frontline for developing bycatch solutions. In 2003, with support from the Ecuadorian government, a massive effort was mobilized in Ecuador by the Inter-American Tropical Tuna Commission, NOAA Fisheries, WPRFMC, WWF, The Ocean Conservancy, Ecuadorian fishworker cooperatives, and local environmental groups.

The program focuses on deriving solutions that will allow fishers to continue to earn a living from the ocean while fishing sustainably. The program is based on replacing J-hooks with circle hooks and testing their efficacy in reducing sea turtle mortality; providing tools and training to fishers on safe sea turtle handling and release techniques; implementing an observer program; and initiating education, communication and outreach activities.

Results have shown that circle hooks significantly reduce hooking rates of sea turtles, as well as the types of hooking that lead to higher post-hooking mortality. Attitude changes among fishers, resulting from the outreach program, are expected to generate even further reduction in sea turtle mortality. This successful project has now expanded to other Latin American countries, including Columbia, Costa Rica, El Salvador, Guatemala, Mexico, Panama and Peru with potential for replication in other regions of the world.

Sustainable Fisheries:
Thinking Like a Turtle

Turtle outfitted with popup satellite archival tag.

Dr. Yonat Swimmer stays close to the ocean and turtles as a fishery biologist and ecologist based at NOAA Fisheries Pacific Islands Fisheries Science Center. She is currently an elected member of the IUCN (the World Conservation Union) Marine Turtle Specialist Group, the world's largest conservation network that includes scientists and experts from 181 countries.

Science and technology expand our knowledge of how sea turtles thrive in their ocean home

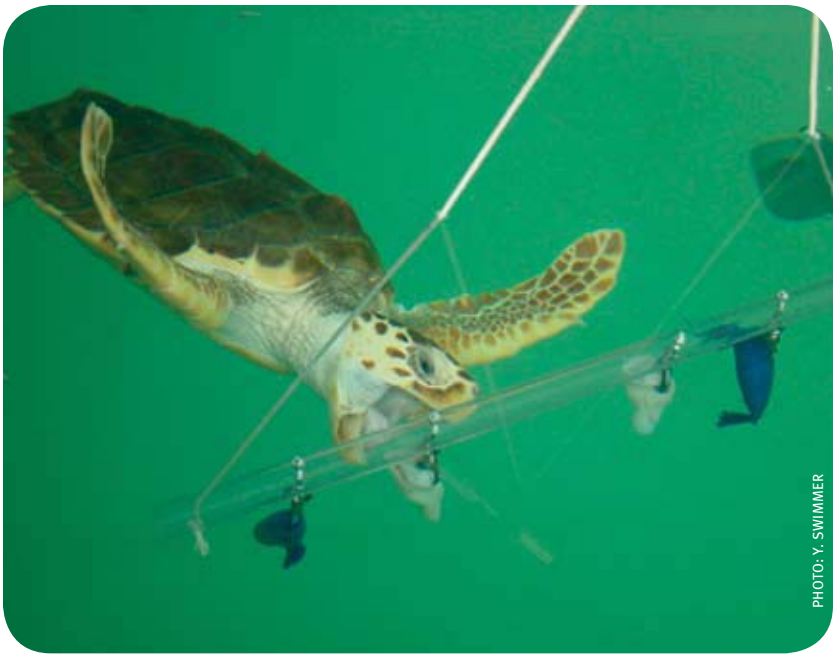
"How well do turtles survive a bycatch encounter?" was one of the first questions posed to research scientists searching for ways to protect sea turtles, particularly those with declining populations. In November 2001, fishery biologist Yonat Swimmer, based at the NOAA Fisheries Pacific Islands Fisheries Science Center (PIFSC), set off for Costa Rica in the Eastern Tropical Pacific, to find out.

Swimmer and her colleagues went high-tech and tracked 15 turtles using popup satellite archival tags (PSATs). Resembling a small flashlight, the PSAT is used to track the movements of wildlife, including some marine animals, such as hard-shelled sea turtles, that can tolerate trailing the device after it has been affixed to its carapace. The primary value for the use of PSATs is the capability to discern a mortality event from tag failure, which sets this tag apart from other tracking devices.

In addition to providing information on the turtles' movements, PSATs record the turtles' geolocation and depth in the water column, as well as oceanographic information about their habitat, such as water temperature and chlorophyll content. In this way, the tagged turtles help to provide biologists and oceanographers with information they can use to predict a turtles' whereabouts in an ever-changing ocean.

"The beauty of this technique is the data we gather are guided from the turtle's point of view, and the information can be archived and transmitted by satellite or obtained from recovered tags," explains Swimmer.

Fourteen olive ridleys and one green were tracked an average of about two months. Some of these were "controls" that had been free-swimming when captured. They were used to compare behaviors of those turtles that had been caught in fishing gear and released. Nearly all of these turtles were hooked in the mouth and had hooks removed prior to their release back to sea.



A blue-died bait experiment to investigate a sea turtle's reaction to colored bait.

What are the cues for sea turtles that food is near? Is it the shine of the hook? The smell of the bait? Or the sound of fishing lines deploying? To answer these questions, scientists at PIFSC are examining the sensory cues that attract sea turtles and fish to pelagic longline gear, with the ultimate goal of developing modified gear to attract fish but not sea turtles.

Current findings indicate that both fish and turtles are primarily attracted to fishing gear by visual cues and that there are differences in the color sensitivities between fish and sea turtles. On the basis of these findings, researchers are now experimenting with flashing light sticks, colored bait, and other modifications to longline gear to attract fish but not turtles.

According to Swimmer, the data showed no significant difference between the control group and longline-caught group in terms of horizontal movements, depth distributions and length of time the PSAT stayed on the turtles, an average of 61 days for the control group and 54 days for the longline-caught group. The turtles' movements appeared much more dictated by ocean temperature than if they had been caught in longline gear.

"Our conclusion was that olive ridley turtles that are lightly hooked and handled properly survive and generally behave normally following interactions with shallow-set longline gear," Swimmer says.

This research is ongoing and numerous other studies are underway tracking loggerhead sea turtles with PSATs in both the Atlantic (off Brazil) and the North Pacific to help answer the question regarding post-hooking mortality and survivorship following a fishery interaction.

While scientists like Yonat Swimmer are studying post-hooking sea turtle survivorship, biological oceanographer Jeff Polovina is researching sea turtle movements in the ocean to help identify important pelagic habitats and thereby help fishermen avoid them.

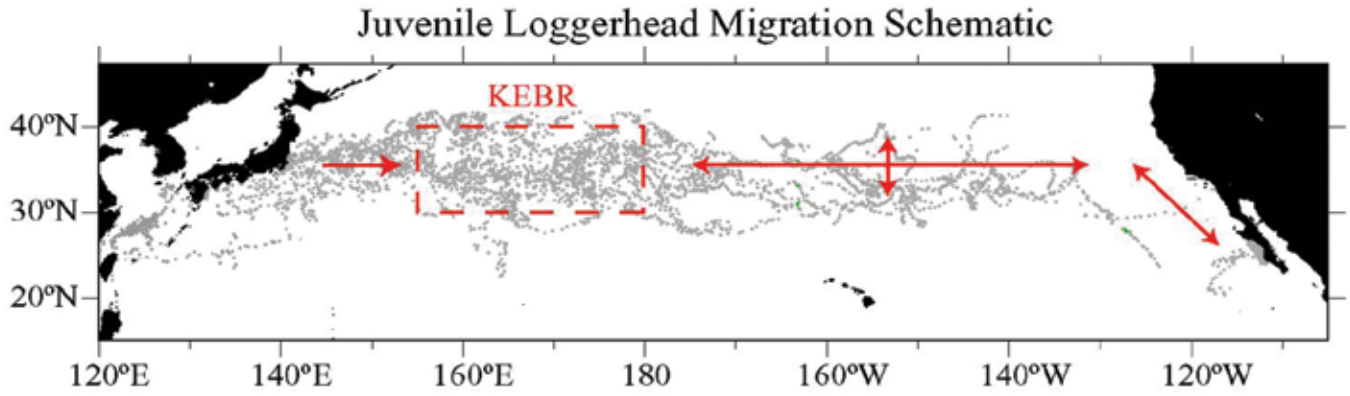
Since his work in ocean ecology became involved with turtle research nearly a decade ago, Polovina has been "seeing the ocean from the turtles' perspective." He now even refers to himself as a "turtle oceanographer."

What amazed Polovina and other scientists was how sea turtles use the ocean and how researching turtles has led to new insights and rethinking about what we know about the Pacific Ocean.

"Turtles are extremely successful ocean creatures. They have a map of the ocean inside them and know where they are," says Polovina, who heads the Ecosystem and Oceanography Division of PIFSC. "We now believe they spend most of their lives migrating back and forth across vast ocean waters and have the remarkable ability to navigate complex features of the ocean."

In this technological age, satellite tagging and detailed satellite ocean mapping are helping scientists unravel the mystery of where, how and why turtles travel the seas.

Working with observers on Hawaii-based longline vessels beginning in 1997, Polovina and other scientists started tracking turtle movements, using satellite transmitters attached to the carapaces of accidentally captured and released turtles.



In a breakthrough U.S.-Japanese study initiated in 2003, researchers released 43 two-to three-year-old captive raised loggerhead sea turtles off the coast of Japan and tracked their movements by satellite telemetry. This work has helped to identify an important migratory, foraging, and developmental "hotspot" in the Central North Pacific.

Dr. Jeffrey Polovina, chief scientist of the Ecosystem and Oceanography Division at the NOAA Fisheries Pacific Islands Fisheries Science Center, has been studying the ocean through "the eyes of sea turtles" for almost a decade. His research has been instrumental in identifying juvenile loggerhead sea turtle pelagic hotspots in the central north Pacific.

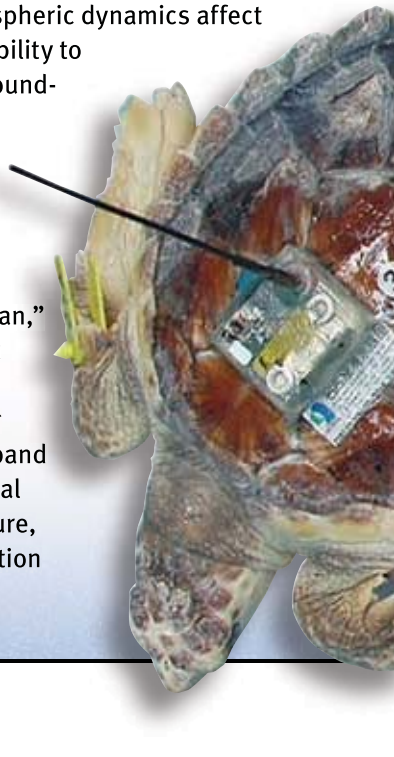
When we began this work, the paradigm was that juvenile loggerheads left Japanese nesting beaches at some time after hatching, transited the North Pacific, and remained in coastal habitat along Baja California, Mexico until they returned to Japan decades later to nest. Our tracking work has shown that many juvenile loggerheads do not simply travel across the Pacific to Mexico but spend much more time in the open ocean moving east and west, back and forth, across the Pacific Ocean. They are very much creatures of the open ocean.

Research has identified an oceanic nursery ground for juvenile loggerhead turtles located at the eastern end of the Kuroshio Extension Current that may be just as important as the coastal nursery ground off Baja California, Mexico. Satellite telemetry coupled with oceanography has identified a 9,000 km-long ocean feature (the Transition Zone Chlorophyll Front) that loggerhead turtles use in their trans-Pacific travels.

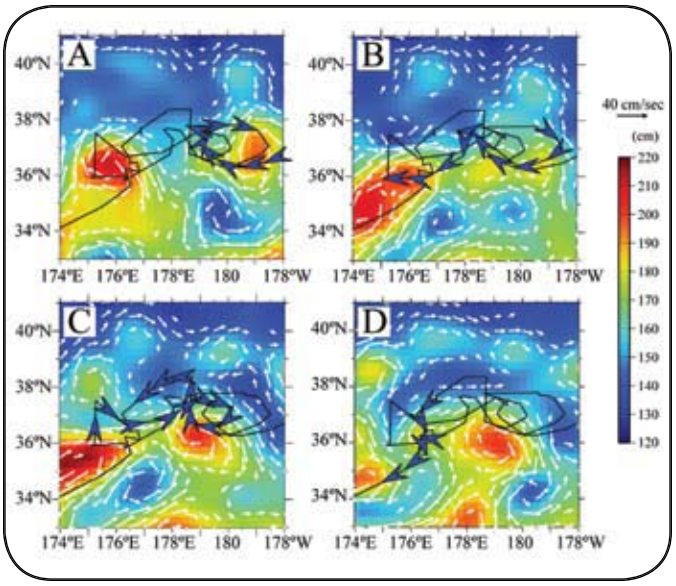
Polovina points out that the ability of sea turtles to orient themselves in open water just to an oceanographic feature is a significant scientific discovery and a much more complex feat than returning to a fixed geographic point, such as salmon returning to streams to spawn or even turtles returning to a nesting beach where they were hatched.

Combining satellite telemetry research of juvenile loggerheads with ocean data recorded from remote satellites, the U.S. and Japanese scientists conclude that oceanic regions in the northern Pacific are important foraging and developmental habitats for juvenile loggerheads and conservation efforts should focus on identifying and reducing threats to loggerhead survival in these hotspots.

Polovina hopes newer technology, such as remote sensors and video cameras to monitor foraging habits, as well as new information on how atmospheric dynamics affect ocean features, will expand our ability to track turtles. He envisions the ground-breaking work with sea turtles being extended to discover the "maps" of other sea animals in order to create an "ocean atlas."



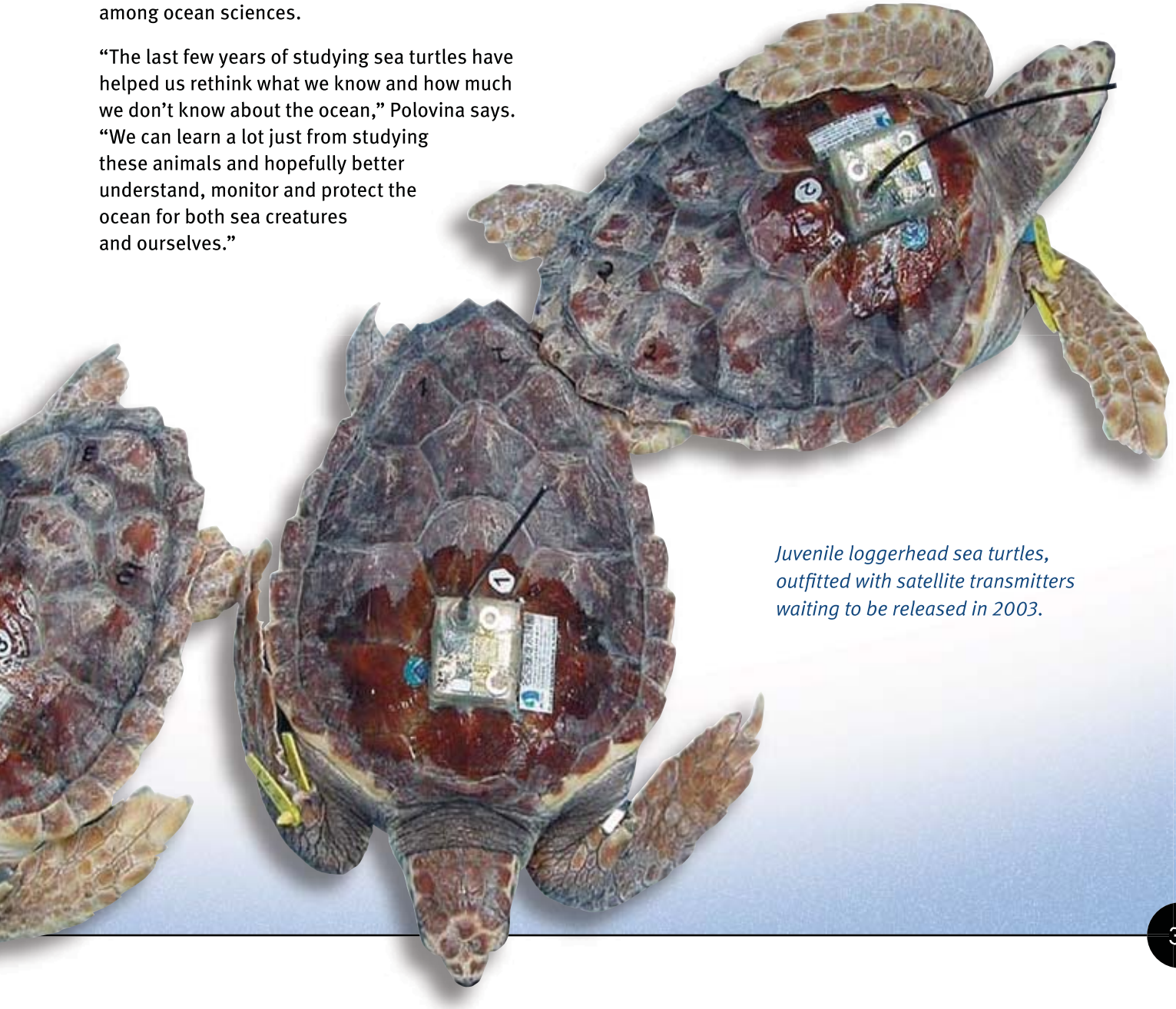
"Sea turtles have provided an ecosystem perspective of the ocean," says Polovina. The intent is to not only refine our scientific ability to avoid sea turtles during fishing operations, but to continue to expand our knowledge of the ocean. Global ocean monitoring, by its very nature, will involve international cooperation



Juvenile loggerheads are not passive drifters in ocean currents, but are capable of navigating 100-mile eddies and geostrophic currents and, if swept off course, able to find their way back. Graph depicts loggerhead turtle daily track (blue arrows) and satellite-derived sea surface height and currents (color and white arrows) that shows a turtle's movement around ocean currents and eddies, January to April, 2001. (A) January the turtle is traveling around the edge of a warm-core eddy with the current; (B) February the turtle travels against and across the current to the edge of another eddy; (C) March the turtle travels with the current eastward back to the previous eddy; and (D) April the turtle travels westward against and across the current.

among nations and cross-disciplinary collaboration among ocean sciences.

"The last few years of studying sea turtles have helped us rethink what we know and how much we don't know about the ocean," Polovina says. "We can learn a lot just from studying these animals and hopefully better understand, monitor and protect the ocean for both sea creatures and ourselves."



Juvenile loggerhead sea turtles, outfitted with satellite transmitters waiting to be released in 2003.

Sustainable Fisheries:
Observing Turtles

Hawaii's on-vessel observer program sets high standards for fishery data collection

To step up the search for workable solutions to reduce sea turtle bycatch, all eyes turned first to data collected at sea. And the single most reliable source of unbiased, scientifically collected ocean-based information comes from the observer program based at the NOAA Fisheries Pacific Islands Regional Office (PIRO) in Honolulu.

Scientists need to know where and what turtles were being caught. Fishing industry leaders need to know what fishermen can do to avoid turtles and, if they caught one by mistake, what to do to increase its chances of survival. And fishery managers need to know the best proven solutions as the basis for sound management policies.

"The cooperative relationship we have forged with scientists, fishing boat operators and our observers has been key for raising awareness of the sea turtle bycatch issue," says Fisheries

Swordfish landed by a Hawaii-based longline vessel.

PHOTO: T. SWENARTON

Fishery observer measuring a bigeye tuna.

Observer and fishermen using safe handling techniques to bring a turtle onboard for dehooking.

Administrator, Charles Karnella. PIRO is responsible for fishery and resource management in the Pacific Islands region through four major divisions: International Fisheries, Sustainable Fisheries, Protected Resources, and Habitat Conservation.

PIRO oversees one of the largest observer programs in the Pacific. It collects information on interactions between sea turtles, seabirds and marine mammals on the Hawaii and American Samoa-based longline vessels operating in the high seas and federal waters of the nation's largest Exclusive Economic Zone.

Over the last five years, federal funding for turtle conservation has enabled the expansion of PIRO's observer program to over 60 observers who cover

PHOTO: WUTMI

In the freely-associated States of the Republic of the Marshall Islands (RMI), the Federated States of Micronesia (FSM) and Palau, NOAA Fisheries Pacific Islands Regional Office (PIRO) focuses on raising awareness of sea turtle conservation and institutional capacity building.

These efforts, together with the data gathered by trained fishery observers placed on domestic and distant water vessels, as well as the results of nesting beach monitoring, underwater surveys and collection of genetic samples, will greatly expand existing regional databases and create a cadre of Pacific Island turtle researchers.

Women United Together in the Marshall Islands (WUTMI) data collector, Hanna Jacob, measuring carapace length of a green turtle in Wotje Atoll, Marshall Islands.

De-hooking and line cutting equipment that can be used to safely release a sea turtle that is accidentally captured during longline fishing operations.

anywhere from 20 to 100 percent of the Hawaiian fleet at any one time. This has resulted in the highest longline observer coverage in the world and time series of observer-based fishery data extending back to 1994.

Observers are typically college graduates (a bachelor's degree in marine biology or related discipline) who go to sea with the fishing crews and are trained to collect catch data and species-specific information if interactions with protected species (sea turtle, seabirds and marine mammals) occur during fishing operations. Observers are knowledgeable of protected species handling procedures and assist fishermen to release animals from gear if accidental interactions occur. If a sea turtle is captured and landed aboard the vessel, the observer will measure and tag it and may deploy satellite transmitters to track its movements.

As the leading longline observer program in the Pacific, the Hawaii-based program has mentored numerous other Pacific Island programs. Since 2001, PIRO has "gone on the road" to train observers in Japan and Korea, countries with large established Pacific fishing fleets but no observer programs, as well as Pacific island nations with developed and emerging fisheries. These Pacific nations include Indonesia, Papua New Guinea, Palau, the Republic of the Marshall Islands (RMI), and the Federated States of Micronesia (FSM).

To encourage community-based marine stewardship among Pacific Island peoples, PIRO works together with Alu Like in Hawaii to provide observer training opportunities to Native Hawaiians, including those without the required college degree. A similar training program aimed at recruiting local observers is expected to begin soon in American Samoa.

The observer program has turned out to be just the starting point to helping Pacific nations better manage their ocean resources for long-term sustainability, Karnella explains. "We have begun to share our experience more broadly to support institutional capacity building among our Pacific nation neighbors."

The Hawaii-based program has partnered with a variety of stakeholders in different countries, ranging from government marine resource agencies and local fishermen to foreign-based fishing companies and environmental groups. In Indonesia, for example, which has one of the largest longline fleets in the Pacific region, PIRO has partnered with WWF to begin developing an observer program as part of a larger effort to monitor that nation's significant fisheries.

In Papua New Guinea, PIRO is working with the National Fisheries Authority and an Australian designer to develop turtle excluder device (TED) for use in that country's prawn trawl fishery to reduce turtle captures and for meeting U.S certification requirements on protected species to export shrimp to the U.S market.

Surprisingly, the work to conserve sea turtles and elevate fishery monitoring capacity has had other positive spin-offs. Important bycatch issues for other species such as sharks, seabirds and marine mammals, as well as for some fish species have been highlighted. Plus the trust and working relationships that have developed over the past few years have been manifested at the international level.

Key fishery organizations of the southwestern Pacific, such as the Secretariat of the Pacific Community and the Forum Fisheries Agency, have modified their observer training programs to support improved data collection and species identification to generate better bycatch estimates, and to provide proper handling training to fishermen to reduce sea turtle mortality.

"Our experience has shown that turtle conservation cannot be done unilaterally in the Pacific," says Karnella. "Building relationships and sharing expertise will unite Pacific Island nations and make sustainable fishery efforts more effective and successful."

PHOTO: M. MCCOY

Observer training in the Marshall Islands. Observers learn how to use a dehooking device to release an accidentally caught turtle.

At the regional level, the PIRO is working with the Pacific Islands Forum Fisheries Agency to train and equip Pacific Islands fishery observers deployed on U.S. purse seine vessels and vessels in certain Asian fishing fleets. This work includes regular communication with the Secretariat of the Pacific Community's Oceanic Fisheries Programme and the recently established secretariat of the Western and Central Pacific Fisheries Commission.

The PIRO conducts post-project evaluations and regional analyses of expected biological and economic effects of these activities to ensure that the program is as effective as possible.

Observer training in marine turtle-fisheries interaction mitigation techniques (including de-hooking and proper release of captured turtles) have been conducted in Palau, FSM, RMI, Indonesia and PNG, and it will soon be conducted in New Caledonia.

Sustainable Fisheries:
Q&A with Kitty Simonds

Executive Director, WPRFMC

Kitty M. Simonds has been the Executive Director of the Western Pacific Regional Fishery Management Council since 1983. She reminds us that protecting marine turtles challenges managers, scientists, fishermen, environmentalists and others to take practical steps in the direction of "ecosystem-based management."

The Western Pacific Regional Fishery Management Council (WPRFMC or Council) is one of eight Councils in the United States established by the Magnuson Fishery Conservation and Management Act of 1976. The WPRFMC is the federal management authority for fisheries operating in the Exclusive Economic Zone of the Pacific Islands Region.

Q: *Hawaii has emerged in the last five years as the hub of turtle conservation efforts in the Pacific. How has that come about?*

A: Hawaii has always been a leader in sea turtle conservation. Just look at the successful comeback of our *honu* [see feature story, "Saving the Hawaiian Green Turtle"]. But the closing of the Hawaii-based swordfish fishery in 2001, due to interactions with sea turtles, was a watershed event for us. The fishery comes under the jurisdiction of NOAA Fisheries and the Council as part of the 1.5 million square miles of federal waters we oversee. The Hawaii-based longline fishery was a $40 million fishery, and the closure of the swordfish component – the tuna fleet still continued – made a serious impact on the fleet and local economy. The fishery's value shrank about 40 percent and nearly 500 jobs were affected.

The complex problem of how to conserve marine turtles in the Pacific Ocean has taught us to think more strategically about ecosystem-based resource management. Turtles have complex lives, including pelagic and coastal phases that makes them especially vulnerable to many types of impacts, both natural and human-related.

The real "saving" of sea turtles through reduction of their accidental catch in fisheries requires that the Council, NOAA Fisheries and our partners search for broad-based, multi-lateral solutions across a diverse array of cultures and economies, remembering what we have already learned about managing pelagic animals – they can only be understood in the context of their ever-changing ocean environment. These lessons must be combined with what we are presently learning from the marine turtle experts who advise that all life phases of these unique creatures must be considered for effective conservation.

Fish auction in Hawaii.

Q: ***We have learned that interactions with commercial fisheries are a serious threat to marine turtle survival. What international actions have occurred to help address impacts by commercial fleets?***

A: To achieve any significant reduction in the accidental catch and mortality of marine turtles, gear mitigation measures must be widely transferred to all longline fishing nations, not just adopted by Hawaii and other U.S. longline fisheries. International codes of conduct, regional memoranda of understanding and voluntary plans of action to reduce marine turtle bycatch on the high seas need to be supported by the active engagement of longline industries at the fishermen's level.

Informational brochures teach fishermen about best practice fishing methods and safe turtle handling techniques.

None of this will be realized, however, without the active participation of international Regional Fishery Management Organizations (RFMO). And there have been some very encouraging developments in Pacific RFMOs where unprecedented sea turtle conservation and bycatch resolutions have been recognized – resolutions that would have received little or no attention a few years ago.

Since 2004, sea turtle conservation measures for fisheries have been adopted by international management organizations of the Western and Central Pacific Fisheries Commission (WCPFC), the Inter-American Tropical Tuna Commission (IATTC), and the United Nations Food and Agriculture Organization (FAO).

In 2004, the FAO guidelines for sea turtle conservation were adopted through a technical consultation that aims to reduce sea turtle mortality in fishing operations through specific gear recommendations and safe handling protocols. The IATTC has adopted two resolutions that address the interactions of sea turtles with the fisheries managed by the IATTC. In December 2005, at the first substantive meeting of the WCPFC held in Pohnpei, Federated States of Micronesia, the United States delegation successfully proposed bycatch resolutions for both sea turtles and seabirds.

Q: What's next?

A: Arguably, there is more work to be accomplished to strengthen these resolutions and to gain acceptance by more countries. However, by endorsing these actions it is evident that fishery management agencies are serious about addressing the global impact of bycatch to ensure sustainable fisheries and healthy oceans.

Our work stems from recommendations by major international institutions, such as the IUCN and FAO, as well as expert advice from our advisory bodies and the U.S. Sea Turtle Recovery Plans. For the Council, our objective is to continue all our sea turtle and fishery projects because the success of our conservation initiatives is dependent upon long-term commitments. We also plan to reach out to the international community to ensure that Pacific fisheries are sustainable and the open oceans safe for sea turtles and other protected species.

Addressing nesting beach impacts, such as dog depredation, by use of nest management techniques, such as bamboo grids, protects nests and increases hatchling production thereby bolstering leatherback turtle population recovery in PNG.

One of the Council's strengths is through liaison and facilitation at the national and international level, and we will continue to convene international workshops, fishers forums, and support worldwide sea turtle conservation conferences to promote collaboration and information exchange.

The re-opening of the Hawaii swordfish longline fishery in April 2004 was a crucial step in the effort to spread mitigation techniques and technologies to all longline fishing fleets in the Pacific to reduce sea turtle interactions. We can demonstrate that the improvements adopted by the Hawaii fishery can ultimately be part of a broader international initiative to protect sea turtles throughout their life cycle. We have the eyes of the world upon us. We hope to make a difference.

PHOTO: I. KINAN

Sustainable Fisheries: ***Marine Turtle Conservation*** THROUGH NATIONAL POLICY IMPLEMENTATION

All actions taken by the WPRFMC, and NOAA Fisheries PIRO, PIFSC and SWFSC to protect and recover marine turtle populations are done in-compliance-with and under-the-authority of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), Federal Endangered Species Act (ESA), and the National Environmental Policy Act (NEPA). The MSA calls for protection of marine turtles and other non-target species in federally- managed fisheries in U.S. waters. The ESA contains provisions to arrest or reverse the decline of endangered or threatened species and neutralize threats to their survival so their long-term survival in nature can be ensured. NEPA requires Federal agencies to integrate environmental values into their decision-making by considering environmental impacts of their major proposed actions. The following sections describe elements of these policies that are principal drivers behind the Regions' ever-expanding marine turtle research, conservation, and management program.

Protection through Fishery Management Legislation

Originally enacted in 1976, the MSA is the primary law governing marine fisheries management in the federal waters of the United States. Congress passed the MSA to claim sovereign rights over the fishery resources of the continental shelf within the U.S. exclusive economic zone. The MSA also established eight regional fishery management councils, including the Western Pacific Regional Fishery Management Council. Councils have advisory jurisdiction to develop fishery management plans (FMPs) and plan amendments that regulate marine fisheries in federal waters. Two aspects of the MSA especially relevant to marine turtle conservation and management in the region are the requirements for bycatch reduction and fishery observer programs. Observer programs in the region are described in the article, "Observing Turtles."

Conservation requirements of the MSA were strengthened in 1996 to require that bycatch of ocean wildlife, such as sea turtles, marine mammals, fish and sea birds incidentally caught during fishing operations, be minimized to the extent practicable. In the event bycatch cannot be avoided, conservation and management measures are required to minimize the mortality of such bycatch. Measures taken to reduce and monitor the frequency and severity of marine turtle bycatch in the Region's fisheries comport with the requirements of the MSA. The MSA provides an important basis for the WPRFMC and NOAA Fisheries to take proactive measures to reduce threats to marine turtles in domestic fisheries in the U.S.

Protection through Endangered Species Legislation

The ESA of 1973 provides for the conservation of species that are endangered or threatened throughout all or a significant portion of their range, and the conservation of the ecosystems on which they depend. Under ESA definitions, a "species" is considered endangered if it is in danger of extinction throughout all or a significant portion of its range. A species is considered threatened if it is likely to become an endangered species within the foreseeable future.

As mentioned previously, all marine turtles occurring in U.S. waters are listed as threatened or endangered under the ESA and all have been extended legislative and regulatory protections for species classified as endangered. Marine turtle conservation and management actions in the Region have the over-arching objective of restoring these populations to a point where they are secure, self-sustaining components of their ecosystem so as to allow a delisting. Particularly relevant to the WPRFMC and NOAA Fisheries' marine turtle research, conservation and management actions are sections 4 and 7 of the ESA.

Section 4(f) of the ESA directs NOAA Fisheries and the U.S. Fish and Wildlife Service to develop and implement recovery plans for threatened and endangered species. These plans incorporate a description of site-specific management actions necessary to achieve recovery of the species; objective, measurable criteria which, when met, would result in a determination that the species be removed from the list; and estimates of the time and costs required to achieve the plan's goal. All marine turtle projects implemented and/or supported by the WPRFMC and NOAA Fisheries in the western-central Pacific Region

address priority elements identified in the recovery plans for U.S. Pacific marine turtle populations. Prioritization of conservation, research and management actions for the Region were further refined at the WPRFMC's Western Pacific Sea Turtle Cooperative Research and Management Workshops in 2002, 2004, and 2005 and by the WPRFMC's Turtle Advisory Committee. The suite of activities ultimately implemented in the region was designed to reduce the greatest threats and address information gaps of the most precarious populations occurring in the Region.

Section 7 of the ESA contains two mandates which are important drivers to regional efforts to protect and recover marine turtle species. Section 7(a)(1) explains that Federal agencies have an affirmative conservation responsibility and instructs them to use their authorities in furthering the purposes of the ESA by carrying out programs for the conservation of threatened and endangered species. Section 7(a)(2) requires that each Federal agency ensure that any action they authorize, fund, or conduct, is not likely to jeopardize the continued existence of the species. Impacts of proposed fishery management actions on listed species are evaluated through consultations under section 7 of the ESA to ensure that activities authorized by NOAA Fisheries will not reduce the likelihood of the listed species survival and recovery.

Federally authorized fisheries with known impacts to marine turtles have gone through many courses of formal review under section 7 of the Act. The conclusions of these consultations are documented in Biological Opinions. Fisheries in the region, especially the Hawaii-based longline fishery, have been substantially modified to meet section 7 requirements. Section 7 has provided the primary motivation for innovative solutions to reduce marine turtle bycatch in federally authorized fisheries. The collaborative efforts of the WPRFMC, NOAA Fisheries, and many other partners including the fishers themselves, have yielded encouraging results about the ability to drastically reduce the impacts of these fisheries by significantly decreasing the number and severity of interactions between marine turtles and fisheries. New technologies and techniques continue to be explored and tested to achieve the dual objectives of minimizing impacts to marine turtles while maximizing the economic benefit of the fisheries.

The observer program, required through the section 7 process, documents fishery/turtle interactions that has yielded valuable information on marine turtle distributions and movements. Interestingly, fisheries monitoring data including documenting the species and location, applying satellite tags to turtles, collecting tissue samples for genetic analysis, and taking measurements from turtles captured in the fishery comprise the bulk of the best data available to determine the structure and origin of marine turtle populations occurring in the Region.

Informed Decision Making through the National Environmental Policy Act

The purposes of the National Environmental Policy Act of 1969 (NEPA) are to encourage a harmonious relationship between humans and their environment; promote efforts that will prevent, mitigate, or eliminate damage to the environment, promote efforts that will stimulate the health and welfare of humans; and to enrich the understanding of the ecological systems and natural resources important to the Nation. NEPA requires Federal agencies to integrate environmental values into their decision-making processes by considering the positive and negative environmental impacts of their major proposed actions and reasonable alternatives to those actions. To comply with NEPA, Federal agencies must prepare a detailed statement of the environmental impacts of any major Federal action significantly affecting the quality of the human environment. These detailed statements are known as an Environmental Impact Statement (EIS). Federal actions not significantly affecting the quality of human environment are evaluated in an Environmental Assessment (EA) and must conclude with a finding of no significant impact.

Federal fisheries management actions are typically major Federal actions and the WPRFMC and NOAA Fisheries have prepared many EIS documents for the various Fishery Management Plans in the Region. While NEPA is not a driver in the way that the MSA and ESA are for marine turtle conservation and research; it does compel the agencies to document all of the known impacts from the various management alternatives on marine turtles and consider that information in its decision making processes. Analyses conducted under NEPA summarize the available science and relate the science to the anticipated effects of a particular action to various components of the system and make a determination about the nature of the impacts. These determinations may range from significantly adverse impacts to the resource in relation to a pre-defined baseline to significantly positive. These determinations allow agencies to compare and contrast expected impacts from all aspects of an action, from ecosystem to economic factors, when deciding on a final course of action. While project review under the ESA is limited to impacts on listed resources, review under NEPA must consider all aspects of the human environment, including social and economic impacts.

Generating reports and following procedures to adhere to and comply with the MSA, ESA and NEPA regulations may appear "dry" compared to other hands-on research and conservation activities undertaken in the Region. However, this present document would have been amiss had it not included reference to the foundation upon which projects are built and the legal framework that the WPRFMC and NOAA Fisheries must work within to ensure that marine turtle research, conservation and management actions are undertaken within the parameters of National laws, policies and procedures.

THE COLLECTIVE SEA TURTLE PROGRAM:

Summary of All Sea Turtle Related Projects

PROJECT NAME	REGION	COOPERATING AGENCIES*	PURPOSE
EDUCATION & OUTREACH	Pacific Ocean Region	WPRFMC / PIRO / PIFSC/SWFSC	Brochures, manuals, reports, safe handling guidelines, and workshop proceedings generated to inform and raise public awareness.
MEETINGS AND FORUMS	Pacific Ocean Region	WPRFMC / PIRO / PIFSC / SWFSC	Support for and convening of conferences, workshop and meetings to promote information exchange, and maintain momentum for continued research, conservation and management.
REGULATORY DOCUMENTS	Pacific Ocean Region	WPRFMC / PIRO / PIFSC / SWFSC	To comply with ESA section 7 (Biological Opinions), National Environmental Policy Act (Environmental Assessments), and Fishery Ecosystem Plan management.
SCIENTIFIC AND TECHNICAL PUBLICATION	Hawaii/ Global	WPRFMC / PIRO / PIFSC / SWFSC	Peer review publication of long-term data sets, scientific and/or management results.
MITIGATION OF SEA TURTLE BYCATCH IN LONGLINE FISHERIES	Latin America (Ecuador, Costa Rica, Mexico, Columbia, Peru and Chile), Brazil, Vietnam, Indonesia	WPRFMC / PIRO / PIFSC / SWFSC	To introduce mitigation measures (circle hooks, mackerel bait & dehooking devices) to artisanal longline fishers to reduce sea turtle bycatch.
TURTLE RESEARCH DATABASE SYSTEM (TREDS)	Pacific Ocean Region	WPRFMC / PIFSC	Rehabilitate SPREP's sea turtle research database in collaboration with six international organizations.
WAR-MON BEACH NESTING BEACH PROJECT	Papua Indonesia	WPRFMC / SWFSC	Leatherback nesting beach conservation and management.
KEI ISLANDS CONSERVATION PROJECT	Papua Indonesia	WPRFMC / SWFSC	To study and reduce direct harvest pressure of leatherbacks in coastal foraging grounds.

NOTE: Projects may also operate in partnerships and in collaboration with one or many NGOs, domestic or international agencies.

PROJECT NAME	REGION	COOPERATING AGENCIES*	PURPOSE
HUON COAST NESTING BEACH PROJECT	Papua New Guinea	WPRFMC / SWFSC	Leatherback nesting beach conservation and management.
ANTHROPOLOGIST	Papua New Guinea	WPRFMC	Socio-economic study and education/ outreach for PNG leatherback project.
TECHNICAL SUPPORT OF NESTING BEACH PROJECTS	Papua New Guinea	WPRFMC	Technical (research and scientific) and management support of PNG leatherback project.
STAJ NESTING BEACH MANAGEMENT	Japan	WPRFMC	Loggerhead nesting beach management to save doomed nests at five sites.
***PROCAGUAMA* GILLNET FISHERY MITIGATION**	Baja California, Mexico	WPRFMC / SWFSC	To reduce direct harvest and incidental capture of juvenile loggerheads in the halibut gillnet fishery.
ECONOMICS POST-DOC	Pacific Ocean basin	SWFSC / PIRO	A three-year post-doctoral position in the economics of sea turtle conservation.
POLICY RESEARCH	Indonesia	SWFSC / PIRO	Investigate options for sustainable land based marine turtle conservation activities in the WCPO.
LEATHERBACK AERIAL SURVEYS	• Papua New Guinea, Indonesia, Solomon Islands • Latin America	SWFSC / PIRO	• Four year study to quantify leatherback nesting beaches of the W. Pac. Region. • Annual monitoring to survey leatherback nesting beaches.
LEATHERBACK SATELLITE TAGGING	Papua New Guinea, Indonesia, Solomon Islands, Latin America	SWFSC / PIRO	To gather information regarding migratory movements and pelagic habitat use.
LEATHERBACK IN-WATER SURVEYS	U.S. West Coast	SWFSC	To monitor and survey foraging habitats located off the northern California coast.
LEATHERBACK NESTING BEACH PROJECTS	Mexico, Costa Rica, St. Croix, Indonesia	SWFSC	Leatherback turtle monitoring, investigations, and conservation.
LOGGERHEAD AERIAL SURVEYS	Baja California, Mexico	SWFSC	To quantify population density and habitat use of loggerhead turtles in off-shore waters of Baja.

NOTE: Projects may also operate in partnerships and in collaboration with one or many NGOs, domestic or international agencies.

PROJECT NAME	REGION	COOPERATING AGENCIES*	PURPOSE
SEA TURTLE GENETICS LABORATORY	Global	SWFSC	To archive sea turtle genetic data.
SEA TURTLE POPULATION ASSESSMENTS & CAPACITY BUILDING	Guam, Am. Samoa, CNMI	PIRO / PIFSC / DAWR / DMWR / DFW	To determine local sea turtle population status, including nesting beach surveys and outreach and education.
GREEN & HAWKSBILL TURTLE POPULATION SURVEYS	Palau	PIRO	Population assessment, education and outreach.
NESTING BEACH MONITORING	Yap, Federated States of Micronesia (FSM)	PIRO	Tagging of nesting females on Ulithi Atoll (10 year review of previous effort).
SEA TURTLE IN-WATER SURVEY	CNMI	PIRO / PIFSC	Population assessment, capacity building.
CULTURAL SURVEY	Republic of the Marshall Isl. (RMI)	PIRO	Define parameters for potential research: ID past and ongoing research, literature search, feasibility and logistics study.
OBSERVER TRAINING AND CAPACITY BUILDING	West & Central Pacific Ocean – RMI, FSM, Indonesia, Papua New Guinea, Vietnam, New Caledonia	PIRO / SWFSC / PIFSC	Assistance to national observer programs and institutional capacity building to promote increased observer coverage in longline fisheries. Regional in-country training of observers to improve protected species ID reporting, safe handling measures, and understanding of mitigation technologies.
TED INTRODUCTION - OBSERVER TRAINING AND CAPACITY BUILDING	Papua New Guinea	PIRO	To implement TED's in the shrimp fishery operating in the Gulf of Papua, PNG, and continued assistance to the national observer program.
"CORE" SEA TURTLE BIOLOGY AND ECOLOGY	Hawaii and Pacific Islands Region	PIFSC	Train Pacific Islanders and fishery observers, exchange information, archive fishery interaction data, collect field data on sea turtle biology (e.g. growth rates, survival, movements), and monitor long-term sea turtle population trends.
SEA TURTLE HEALTH AND DISEASE	Hawaii, Pacific Islands Region, Global	PIFSC / USGS	Investigate health and disease with a focus on fibropapilloma to better understand the etio-pathology, impacts, and amelioration of this disease.

NOTE: Projects may also operate in partnerships and in collaboration with one or many NGOs, domestic or international agencies.

PROJECT NAME	REGION	COOPERATING AGENCIES*	PURPOSE
FIBROPAPILLOMA STUDIES	Hawaii	PIFSC	Study of captive green sea turtles to compare antibody production and physiological characteristics among turtles living in different seawater environments, and determine the potential influence of water conditions on the occurrence of fibropapilloma disease.
SEA TURTLE STRANDING NETWORK	Hawaii	PIFSC	Hawaii stranding network to rescues live, stranded, sick and injured sea turtles on-shore to apply veterinary treatment. Rehabilitation of turtles and quantify entanglement of turtles in fishing nets, fishing line, and marine debris.
SEA TURTLE POPULATION ASSESSMENT AND MODELING	Hawaii	PIFSC	Evaluate the impact of the Hawaii-based, deep-set longline fishery on Pacific marine turtle populations.
STOCHASTIC SIMULATION MODELS	Pacific Ocean Region	PIFSC	Create stochastic simulation models of sea turtle populations to identify data gaps, evaluate demographic trends, design and evaluate management strategies.
SEA TURTLE PELAGIC ECOLOGY – LOGGERHEAD TURTLE FOCUS	• Central North Pacific, Japan • New Caledonia	PIFSC	Satellite telemetry and oceanography of juvenile loggerheads to investigate migration and pelagic habitat use.
SEA TURTLE PELAGIC ECOLOGY	Central North Pacific, Hawaii, Costa Rica, Brazil	PIFSC	Satellite telemetry and oceanography research to study foraging, migration and pelagic habitat use, and investigate the influence of oceanographic processes on sea turtle distributions: • of turtles that interact with the Hawaii-based longline fishery; • of turtles captured in situations other than longline fisheries (e.g., from nesting beaches, free-swimming).
SATELLITE TAGGING RESEARCH – BYCATCH MITIGATION STUDIES	Hawaii, Costa Rica, Brazil	PIFSC	To investigate post-hooking survival of by-caught turtles in longline fisheries (pop-up tags).

NOTE: Projects may also operate in partnerships and in collaboration with one or many NGOs, domestic or international agencies.

PROJECT NAME	REGION	COOPERATING AGENCIES*	PURPOSE
TURTLE BEHAVIOR AND PHYSIOLOGY RESEARCH	Hawaii, Galveston lab, University research, Brazil	PIFSC / SEFSC	• Behavioral and physiological studies of captive turtles to understand longline gear and bait interactions. • Olfaction (smell) and taste studies to test potential bait deterrents to reduce turtle interactions with longline gear.
TURTLE BEHAVIOR AND PHYSIOLOGY RESEARCH	University research	PIFSC	Sea turtle and fish vision studies for longline gear mitigation options: • bait less visible to turtles while attractive to fish, • flicker fusion frequency, • daylight vs. night vision.
TURTLE BEHAVIOR AND PHYSIOLOGY RESEARCH – MODELS	University research	PIFSC	Contracted the development of computer and physical models of the biomechanics of turtle biting to study the ingestion of hooks with different shapes, sizes, and resulting injuries without the use of real turtles.
FISHERY MITIGATION EXPERIMENTS	Atlantic and Pacific Ocean	PIFSC / SEFSC	Test "stealth gear" (blue dyed bait, colored gear, shaded light sticks), deep day-time fishing, and circle hooks.
FISHERY MITIGATION EXPERIMENTS	Hawaii	PIFSC	Experimental testing of circle hooks, fish bait and "stealth gear" in the Hawaii-based longline fishery.
FISHERY MITIGATION EXPERIMENTS	Hawaii	PIFSC	Test barbless circle hooks in Hawaii shoreline fisheries with some experimentation in longline operations.
FISHERY MITIGATION EXPERIMENTS	Costa Rica, Brazil, Guatemala, Baja California Mexico	PIFSC	Test effectiveness of blue dyed bait in the mahimahi fishery in Costa Rica and the swordfish fishery in Brazil. Test effectiveness of circle hooks in mahimahi and sharks artisanal longline fishery in Guatemala.
FISHERY MITIGATION EXPERIMENTS	Peru, Ecuador	PIFSC / SWFSC	Test a new circle hook (whisker) design.

NOTE: Projects may also operate in partnerships and in collaboration with one or many NGOs, domestic or international agencies.

PROJECT NAME	REGION	COOPERATING AGENCIES*	PURPOSE
FISHERY MITIGATION EXPERIMENTS	Azores, Atlantic Ocean	PIFSC / University of Florida	Hook experiments in the Azores swordfish longline fishery.
JAPAN-HAWAII SEA TURTLE AND SEABIRD EXPERIMENT (JHSTSE)	Central North Pacific	PIFSC / WPRFMC/ National Research Institute of Far Seas Fisheries, Japan	Workshops and collaborative research plan to test the effectiveness of small and large circle hooks in Pacific longline fisheries.
FOREIGN EXPORT OF TECHNOLOGY – EDUCATION AND OUTREACH	Ecuador, Guatemala, Costa Rica, Brazil, Korea, Thailand, Hawai, Japan	PIFSC	Disseminated sea turtle identification and safe handling guidelines, turtle handling tools, and provide training at international meetings.
FOREIGN EXPORT OF TECHNOLOGY – GEAR TRIALS	Hawaii, Philippines, Mexico, Spain, Peru, Costa Rica, Korea, Brazil	PIFSC	• Promote international export of "turtle friendly" longline technology, and outreach activities regarding use of improved gear, turtle handling methods, and tag and release. • Supply gear (hooks, lines, de-hooking equipment) and expertise for fishery mitigation experimentation in international longline fleets.
FOREIGN EXPORT OF TECHNOLOGY – GEAR TRIALS	Mediterranean Sea	PIFSC	Fishery mitigation experiments to test squid bait vs. fish bait and circle hooks in the Spanish and Italian swordfish fisheries.
ANALYSIS OF MITIGATION MEASURES	Hawaii	PIFSC	To evaluate and monitor the reopened shallow-set Hawaii-based longline swordfish fishery.

NOTE: Projects may also operate in partnerships and in collaboration with one or many NGOs, domestic or international agencies.

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