

The Case of the Green Turtle
*An Uncensored History of
a Conservation Icon*

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If the world goes on the way it is going it will one day be a world without reptiles. Some people will accept this calmly, but I mistrust the prospect. Reptiles are part of the old wilderness of earth, the environment in which man got the nerves and hormones that make him human. If we let the reptile go it is a sign we are ready to let all wilderness go. When that happens we shall no longer be exactly human.

Bore through to the core of what is required and you see that it is an aggressive stewardship of relics, of samples of the original order, of objects and organizations of cosmic craft. This work will take stanch people, and the reptile can be the shibboleth by which they pass.

Archie Carr, *The Reptiles* (1963)

Science does have a major role to play in the future of conservation. . . . Nevertheless, science will need careful guidance and supervision from other disciplines; and even given the best of circumstances, the outcome of its efforts will remain for some time beyond the reach of scientific prediction.

David Ehrenfeld, *Biological Conservation* (1970)

From Seafood to Icon

In the field of marine conservation, one group of species garners disproportionate attention from researchers and government agencies. This group is the sea turtles. To be sure, sea turtles are fascinating creatures to study and observe in the wild. But their power to fascinate is not the only reason they get so much attention. As one observer predicted, by 1980 they had displaced the whales in the "Save the whales" rallying cry of the environmental movement. Sea turtles are now iconic species, emblems for the campaign to save the oceans.¹

The sea turtles' iconic status, and the public stewardship that follows from it, are both premised on the idea that sea turtles are endangered, that some or all the remaining species are at some measurable risk of extinction. Yet a number of scientists active in sea turtle research today question whether most sea turtles are endangered. Most agree that some regional populations require human intervention to prevent their extirpation. And some have argued that we should restore other populations to their former role as keystone species in tropical and subtropical marine ecosystems. One particularly active group of turtle scientists argues that sea turtles are not facing even a medium-term risk of extinction. Nevertheless, all sea turtle species remain listed under the US Endangered Species Act of 1973, and all are classified as threatened under CITES, the international treaty controlling trade in wild species of plants and animals.²

The green turtle, *Chelonia mydas*, is the most heavily exploited of all of the marine turtle species and the first to achieve a degree of recovery because of conservation policies adopted more than thirty years ago. Currently, several conservation scientists are marshaling evidence that the green turtle is no longer endangered. Aware that this classification is both a scientifically derived status and a social construction, these scientists have a variety of motives and tactics. Some seek to demonstrate that

conservation interventions can work and that species can be returned to a nonimperiled state. Others believe that the total preservation strategy adopted in the late 1970s worked an injustice in some human societies; they seek to restore the green turtle to the status of an exploitable resource. Still others may be inspired by a desire to reprise and prevail in a philosophical debate begun by the first generation of sea turtle conservationists.

Under US law, only two populations of green turtles are considered "endangered"—the population that nests on the Pacific coast of Mexico and the one that nests on the east coast of Florida. The remaining populations, including the green turtle population of the Hawaiian archipelago, are considered "threatened." The International Union for Conservation of Nature (IUCN) Red List is the international classification scheme for species, and it has classified the green turtle as globally endangered since 1968. The specialists responsible for this classification argue within their ranks (and in their publications) whether the green turtle is really endangered globally.³ But under the cover of this debate, they are actually reprising another debate that raged among turtle scientists during the 1970s: should the green turtle be commercially exploited or protected from all human consumptive uses until its role in tropical marine ecosystems is restored?

This book is a history of how this one globally distributed species of sea turtle—the green turtle, *Chelonia mydas*—came to be classified legally as an endangered species and why it remains so today. It is a history of the first generation of scientists who, fearing the green turtle would become extinct in their lifetimes, used the laws and treaties they helped devise in the 1970s to prevent that from happening.

A Surprising Conclusion

Steven L. Yaffee's 1982 book *Prohibitive Policy: Implementing the Federal Endangered Species Act* got me thinking about green turtles and the law. A student of natural resource policymaking, Yaffee was interested in learning how bureaucracies adopt one of the most extreme forms of government intervention—the absolute prohibition—a policy that bans certain human behavior in order to achieve a particular social goal. Prohibitory policy was increasingly the norm in the 1970s, but economists

had begun to criticize its inefficiency, arguing that market-based incentives and taxes would be more effective strategies. In the face of this criticism, Yaffee was curious why, when, and how administrative bureaucracies adopt prohibitory mandates and use their scientific and technical expertise to legitimize them.

Yaffee's book focused on the prohibitory regulations that resulted when six species of plants and animals were classified as either endangered or threatened with extinction. These rules had been adopted in the first decade after the US Congress enacted the Endangered Species Act in 1973. The six species included two sea turtles; the other four were the sandhill crane, the Furbish lousewort, the Houston toad, and the now infamous snail darter. Of the six, only the green turtle had commercial value. How had government agencies handled the difficult job Congress gave them of prohibiting human activities in order to protect a wild species?

Not well, Yaffee concluded. And the turtle listing decisions were particularly revealing. The agencies had clearly considered economic interests even though the Endangered Species Act directs them to base their decisions solely on science. To avoid the more prohibitory policy that comes with the label of "endangered," the agencies had classified the heavily exploited and highly depleted green turtle as "threatened with extinction" rather than endangered. This classification gave them the flexibility to postpone adopting prohibitive policies for the politically potent commercial fishing industry.

This finding was not surprising. In my years of teaching environmental law, I'd seen dozens of court cases challenging agencies for going too far in seeking an elusive middle ground between protecting the environment and allowing industries to put useless things into it or take valuable things out of it. What struck me instead was Yaffee's concluding observation on the sea turtle listings. To Yaffee they were examples of a more unexpected decisional problem—one where "personal philosophy heavily influences scientific judgment, leading to conflicting positions on technical decisions."⁴

Could this be true? Why would decision makers need to fall back on personal philosophy to resolve technical issues about a species in peril? Was there any doubt that the green and other species of sea turtle were in danger of extinction? The Endangered Species Act requires listing

decisions to be based on the "best available scientific data."⁵ Surely the listing petition contained sufficient historical evidence to demonstrate that overexploitation and habitat destruction had caused the loss of one green turtle nesting population after another. Or was it that personal philosophies had somehow influenced the view of agency scientists and their advisors on whether a prohibitory policy was necessary to prevent the sea turtles' extinction?

The answers lie in a 1978 decision by the two US fish and wildlife agencies to list the green turtle as threatened (nearly endangered) and to prohibit import into the United States of farm-raised turtle products for use in soup and cosmetics manufacturing. This decision committed the United States to a species conservation policy based on preservation of individual species and their recovery to levels at which they would no longer be at risk of extinction. It closed off domestication as a conservation strategy, ending any further consideration of legal commercial use. With respect to the green turtle, there would be no further debate on the issue that is frequently aired today: whether a "sustainable-use" strategy might be fairer to human communities located near the habitat of the endangered species and, by increasing the value of the species to those communities, promote a broader ecological approach.⁶

In the 1970s, the idea of domestication appealed to a thoughtful minority of those scientists who at the time were studying sea turtle biology and ecology. To this group, turtle mariculture had promise to supply farm-raised turtle meat and shell to both local and distant markets and take pressure off wild green turtle populations, many of which were being exploited at unsustainable rates.⁷ But the majority of sea turtle specialists opposed turtle farming; among them was Archie Carr, the acknowledged founder of sea turtle science and conservation.⁸ Carr, however, grew tired of the domestication issue and became increasingly reluctant to engage directly in policy debates with colleagues or testify in person in legislative proceedings. Others in his circle of former students and close associates took on the task, often in a much more combative manner than Carr would have used. The argument took on a personal tone when the research at Cayman Turtle Farm, the only commercial farm in operation, was criticized, and agency proceedings found the farm's research contributed little to turtle conservation in the wild. The issue was never resolved on the merits because the farm was never granted an

exemption from the Endangered Species Act. The effects of the dispute have lingered on among turtle specialists.⁹

Becoming Endangered

The green turtle is a globally distributed megaherbivore with rookery beaches scattered throughout the tropics and subtropics. The largest rookery beaches are along the Caribbean coast in Central America and on tiny islands on Australia's Great Barrier Reef. Significant rookeries also occur on the South Atlantic's isolated Ascension Island and on the tiny Indian Ocean islands of Europa and Tromelin, near the French territory of Réunion. The green turtle population that nests on the southeast coast of Florida is beginning to recover and now constitutes the second largest nesting population in the Atlantic Ocean.¹⁰

Known for their extensive migrations between their nesting locations and the seagrass pastures where they forage off Nicaragua, Brazil, Kenya, and Queensland, green turtles are long-lived, reaching reproductive maturity only after several decades. After mating, female green turtles go ashore at their natal beaches and lay several clutches of eggs over a period of weeks. They then migrate back to foraging areas for two or more years before returning for another nesting season. After incubating in nests buried deep in the sand, green turtle hatchlings emerge in frenzies and cross the beach and intertidal zone, running a gauntlet of predators and physical hazards. Once they reach the open ocean, they spend a few years drifting passively in ocean currents, foraging on tiny marine life inhabiting the sargassum weed that collects at the oceanic convergence zones. Juvenile green turtles then take up residence in coastal lagoons far away from their beaches of origin and later somehow find their way back to these beaches when they are ready to breed.

The green turtle is classified as endangered on IUCN's Red List of endangered and threatened wild species of plants and animals, and has been since the late 1960s. The current classification is based on a finding by sea turtle specialists that the global population has declined over the last three generations by more than 60 percent and therefore faces a measurable risk of extinction. The causes of the decline are many and vary by region, but the principal reasons are the international demand for green turtle meat and cartilage used for soup, which peaked in the 1960s, and

the local consumption of turtle eggs. International trade in green turtles has existed since the European discovery of abundant Caribbean populations in the sixteenth century. The green turtle is exceptionally easy to capture when on its nesting beaches, and for centuries a highly efficient fishery was prosecuted by the skillful turtle fishermen of the Cayman Islands. From the 1830s until the 1960s, the Cayman Islanders captured turtles on the Miskito Bank, off the coast of eastern Nicaragua, and delivered the giant green turtles live to busy canneries and markets in the United States and Europe.¹¹

Scientists began research and management activities on turtle beaches in the 1940s, first on three tiny islands off the coast of northwestern Borneo and then, in the 1950s, at Tortuguero, on Costa Rica's Caribbean coast. By the 1970s, tagging studies and restoration projects were in place at every significant nesting beach around the world. Scientists compared notes and devised conservation strategies when they met under the auspices of IUCN's Marine Turtle Specialist Group, which Archie Carr had been invited to chair by the founder of the World Wildlife Fund, Peter Scott. Scott, son of the famous Antarctic explorer Sir Robert F. Scott, was a painter and noted waterfowl conservationist, who popularized natural history by hosting a series of television programs for the British Broadcasting Corporation. Scott was an advocate of captive breeding of endangered species and had an early success with the Hawaiian goose, known as the *nēnē*, through captive breeding at his estate in Gloucestershire, England.

Going beyond their traditional role as taxonomic classifiers, the sea turtle specialists began to classify marine turtle species on the basis of survival probabilities, using a scheme devised by Peter Scott. They found that by the middle of the twentieth century the green turtle was again subject to a high level of exploitation, occasioned by the development in the 1960s of worldwide trade in calipee, the cartilage that joins the lower shell, or plastron, to the skeleton and was the principal ingredient of the hugely popular green turtle soup. The Nicaraguan government had abrogated its treaty with Britain and ejected the Caymanian schooners from their turtling grounds on the Miskito Bank. But the turtles were now being taken in large numbers from these same grounds by the coastal Miskito villagers. They were paid cash to deliver their traditional subsis-

tence fishery to three new slaughterhouses that processed hundreds of turtles every day for export to the turtle soup manufacturers and leather goods companies of the world.¹²

When the US Fish and Wildlife Service published a list of the species of marine turtles it considered endangered in 1970, the agency did not consider the green turtle to be in enough peril to warrant listing alongside the leatherback, the Atlantic ridley (now known as Kemp's ridley), and the hawksbill turtles. This was despite the fact the Marine Turtle Specialist Group classified the green turtle as at risk of extinction. Three Central American countries harboring the largest green turtle populations were in a race to profit from the growing demand for green turtle products, constructing their own slaughterhouses and allowing their fishermen to ship turtles live to soup manufacturers in the United States. Many turtle dealers saved shipping costs by buying from fishermen who would slice open and remove the five pounds of calipee from the female turtles when they came ashore to nest. Carr's nongovernmental organization, the Caribbean Conservation Corporation, organized to support his research and conservation activities, had tried but failed to broker a tripartite treaty for a moratorium on turtle harvesting that would give the neighboring countries time to develop a regional management plan.

Down on the Farm

Perception of the green turtle's survival prospects changed dramatically in 1970. A small group of entrepreneurs seemed poised to satisfy the demand for green turtle products through mariculture—raising turtles as aquatic livestock. Having made independent fortunes in the manufacture of cigar boxes and the industrial-scale rearing of broiler chickens, the principal investors joined forces with a Florida marine biologist, Robert Schroeder, who had worked with Archie Carr and was inspired by his musings that farming might be necessary to save the green turtle. Robert Schroeder believed the green turtle was the buffalo of the sea.¹³ If it were allowed to graze the seagrass meadows of the Caribbean coastline, people could tap the tremendous nutritional value of seagrass by eating green turtle meat. The turtles would be domesticated and raised for market so efficiently that they would undercut the market for wild

turtles, especially if that market were made illegal under the new treaty, CITES, which would soon control international trade in endangered plants and animals.

Archie Carr had mentioned the idea of turtle farming in his 1963 general readership book, *The Reptiles*. He told the story of how a group of publishers and philanthropists had formed the Brotherhood of the Green Turtle after reading of its plight in an earlier book of Carr's, *The Windward Road*.¹⁴ The Brotherhood funded Carr's Operation Green Turtle, an effort to restore extirpated rookeries throughout the Caribbean basin and establish a pilot turtle farm in the Bahamas, where green turtles could be pastured on seagrass beds like "aquatic cattle." Carr wrote, "If they are successful, the green turtle may become one of the first marine vertebrates to be successfully cultured for food." But he expressed ambivalence about farming as an indirect conservation strategy. He much preferred that humanity acknowledge the intrinsic value of reptiles and save them for that reason: "The only way is to name the real obligation clearly, to say without hedging that no price can be set for things that have to be preserved."¹⁵ Species like the New Zealand lizard-like tuatara must be saved "so that people can sing them out of their holes. Only then are you ready for the harder jobs, like justifying a future for snakes, which have no legs, hear no music and badly clutter subdivisions. Bore through to the core of what is required and you see that it is an aggressive stewardship of relics, of samples of the original order, of objects and organizations of cosmic craft. This work will take stanch people, and the reptile can be the shibboleth by which they pass."¹⁶

Pursuing the vision of an aquatic buffalo range, Schroeder and the entrepreneurs built their green turtle farm on Grand Cayman Island, the former home of the world's most effective turtle fishing fleet and former site of the vast turtle populations that Columbus had remarked upon in the journals of his voyages. Building their breeding stock from wild-caught turtles from Costa Rica and eggs from Suriname, Costa Rica, and Ascension Island, the businessmen planned to restore wild green turtles by supplying the market with a superior product. To stop the farming idea from catching on, species survival activists who admired Archie Carr and shared his preservationist values petitioned the government to list the green turtle as endangered and prohibit trade in all green turtle products. Mariculture, Ltd., the company that built upon Robert Schroeder's

idea, mounted a vigorous defense, insisting that captive-raised turtles were not endangered and that a commerce-based conservation strategy deserved to be tried. Mariculture went bankrupt, however, before it had a chance to prove Schroeder's "buffalo of the sea" theory.

While the listing was pending, a former research assistant of Carr's, Wayne King, who had filed the listing petition while serving as director of conservation for the New York Zoological Society, lobbied state legislatures in New York and California to ban the importation of turtle skins and oil, preventing Mariculture from selling its products to cosmetics and shoe manufacturers. Meanwhile, another turtle drama took place in the cabinet room of Florida's governor. A college student named Frank Lund, whom Archie Carr had encouraged to document green turtle nesting on Florida's east coast, convinced the governor to enact a forty-two-inch minimum size rule for green turtles. The governor did so over the objection of Florida's director of marine research and fisheries, effectively shutting down what remained of the Cayman Islands–Key West trade in turtles from the Miskito Bank.

Court of Last Resort

The centerpiece of the green turtle's history as an endangered species is the case of *Cayman Turtle Farm, Ltd., v. the Secretaries of Interior and Commerce*, decided by John H. Pratt, a judge on the federal district court in Washington, DC, on May 29, 1979. The plaintiffs were the new owners of the turtle mariculture operation on Grand Cayman Island. A physician from Germany and her industrialist husband (who had made a fortune selling her patented personal care product, the OB tampon, to the Johnson & Johnson health products giant), Judith and Heinz Mittag, had purchased the bankrupt farm because they believed the green turtle was at risk of extinction and they wanted to do something about it.

The Mittags did not contest the listing of the green turtle as threatened. They disputed only the Interior and Commerce secretaries' decision to prohibit importation and trade in farmed green turtles in the United States. Without transshipment through US ports, their plan of selling farmed turtle meat and shell to stanch the drain on wild green turtle populations and use the proceeds to fund research would be null and void. They had faith that the agencies administering the Endangered Species

Act would recognize the merit in their business plan and its consistency with the policies underlying that law. They asked the agencies to exempt farmed turtle products from a prohibitive mandate designed to protect wild species from extinction. After all, the sole objective of Cayman Turtle Farm was to use commerce to protect wild turtles from the unremitting exploitation they had suffered for centuries.

The secretaries had not had an easy time deciding to exclude farmed turtle products from the United States. Nor had they made the decision in a vacuum; some of the most eminent biologists in the world had offered their opinions, and had stated them in no uncertain terms. No scientific uncertainty led them to hedge or to qualify their recommendations. But these eminent views were on both sides of the issue. And the issue was fundamentally not one of biological science. The question was this: how would markets and people behave once the turtle farm made green turtle products widely available but charged luxury prices for them to recoup the costs of production? Would demand for green turtle soup again skyrocket, as it had in the 1960s? Would the price of tortoiseshell jewelry tempt people into poaching nesting turtles in newly established nature reserves? There was no "best available scientific information" on these questions, so people had to speculate and surmise rather than draw conclusions from empirical analysis or theoretical principles. And as Steven Yaffee concluded in *Prohibitive Policy*, they fell back on philosophical biases when there was no evidence to rely on one way or the other.

The judge who heard the case of Cayman Turtle Farm against the secretaries of interior and commerce upheld the agencies' decision to deny an exemption from the import ban for maricultured products. Judge Pratt of the federal district court of the District of Columbia relied largely on a principle of judicial review that requires judges to defer to the technical and scientific judgments of government agencies as long as those judgments are reasonable and based on the available scientific information and not on considerations that are outside the scope of the law they are charged with implementing. The judge deferred to the agencies' judgments that turtle mariculture would ultimately harm wild turtle populations. He did so because he could not see in the records of the jointly made decision what had really happened in the agencies' negotiations: the Interior Department staff had followed Archie Carr's lead in opposing commercial turtle farming on philosophical grounds, and the Com-

merce Department staff had struck a compromise that minimized restrictions on commercial shrimp fishermen who also catch sea turtles.

When Cayman Turtle Farm appealed Judge Pratt's decision to the court of appeals, the farm lost by a very slim margin. As it happened, the farm's lawyer had decided to appeal only a narrow issue of statutory interpretation. He did not challenge the agencies' technical conclusion that turtle farming would in fact lead to more killing of turtles in the wild and that the research on the farm did not benefit conservation. He probably should have. In a private note to the chief justice of the court of appeals, the appellate judge wrote: "The logic of this case is appalling. The agency contends that breeding large numbers of endangered species in captivity and thus greatly increasing the number of such species tends to further endanger the species."¹⁷

Conservation's First Social Scientists

Archie Carr opposed commercialization of green turtles in part because of what he had learned from the other scientists and writers whom he inspired with his books. These included the novelist and naturalist Peter Matthiessen, who wrote the haunting and dreamlike novel *Far Tortuga*, about the end of the Caymanian green turtle fishery and the loss of men and ships to storms on the Miskito Bank. Carr was also influenced immeasurably by two cultural geographers from the University of California at Berkeley. The first geographer was James J. Parsons, who wrote an influential book, *The Green Turtle and Man*, at the beginning of the 1960s detailing the exploitation and the global demand. The second geographer was Barney Nietschmann, who met Carr as a graduate student and got the idea for his dissertation from him. Nietschmann's study of the Miskito Indians, the turtle people of coastal Nicaragua, showed Carr that commercialization of the green turtle had tremendous social as well as biological costs.

Another person who influenced Carr was a self-trained polymath named Tom Harrisson who, as curator of the Sarawak Museum, administered an unusual turtle egg ordinance in the British colony on the island of Borneo. With the help of a young American zoologist, John R. Hendrickson, Harrisson pioneered the now-common techniques of tagging breeding adults, relocating eggs to artificial hatcheries, and protecting

hatchlings from predation as they make their way beyond the surf zone. Before World War II, Harrisson co-founded the method of "mass observation" in sociology, documenting the everyday lives of Britons. But Harrisson cared little for the theoretical foundations of his survey methods. He was more interested in species conservation and archaeological discoveries in Southeast Asia than in making a name for himself in any particular subdiscipline of the social sciences.¹⁸

Tom Harrisson was co-chairman with Carr of IUCN's Marine Turtle Specialist Group. Because Harrisson held the same cultural values as the British members of IUCN such as Peter Scott, he was very effective in that role. Despite his many distractions, he marshaled the force of the new conservation institutions to the cause of sea turtle survival.¹⁹ Harrisson drew also on his English upbringing and understanding of human behavior to campaign to depopularize green turtle soup in Britain and Germany. He then helped to devise guidelines for the commercial use of sea turtles but died suddenly before the Marine Turtle Specialist Group could reach consensus on the divisive debate over turtle farming.

A Shared History

The history of an endangered species has the potential to teach us several things. It can help us understand the social institutions and processes by which wild species are determined to be at risk of extinction. It can also show how science informs the concept of species extinction and how research scientists interact with political institutions that govern human-environmental interactions. In particular, such a history can identify the specific scientific facts that helped change the social construction of a species, from an animal that symbolized wealth and abundance to one that represented the plight of all imperiled life on earth. It allows us to consider how scientific facts and philosophical values interact in these social and political institutions. In this sense, an endangered species history is an environmental history, showing us how human society both alters its environment and seeks to rectify the alterations brought about by its own and previous generations.

The history of the green turtle as an endangered species turns out to be a history of a generation of scientists who sought divergent ways to prevent the green turtle from becoming rare or even extinct, using laws and

treaties they helped to write and their abilities to appeal to the public's growing curiosity and admiration for the animal kingdom. In a sense it is a group biography of the people whose lives intersected through concern for the survival of the green turtle. It is the story of how their different philosophical values threatened to tear apart the scientific brotherhood of the green turtle and yet transformed the green turtle's social value for decades and perhaps for all time.

Turtle Kraals and Canneries

Silas Stearns was the first federal fisheries agent to venture into the state of Texas to study the fishing industry. Stearns worked for the US Commission of Fish and Fisheries, a body created by the US Congress in 1871 to determine the causes of the scarcity of food fishes along the Atlantic seaboard. As the scarcity of fish spread to other coasts, the fish commission's mission grew to include investigations of the Pacific, Great Lakes, and Gulf of Mexico fisheries. The fish agent's job was to accompany the US census takers, canvas the fishery resources of the state, and make a report to the US fish commissioner. The commissioner would then decide "what protective, prohibitory or precautionary measures were required" to restore them.¹ The measures might include hatcheries and stocking and introduction of wild fish from other waters.

Stearns's report told of finding great potential but little activity. "Nowhere do the rich Southern fauna find a more genial habitat," he wrote in 1880 to commissioner Spencer F. Baird, "and in few localities could man levy upon the sea a heavier tribute of delicious fish and mollusks to supply his table." Why, he wondered, were residents of the Gulf Coast catching so little? Fewer than 300 fishermen worked full-time in waters teeming with sea trout, mullet, croakers, crabs, and oysters. Up north, the fishermen of only one state, Massachusetts, had landings that were five times more valuable than those of all the Gulf states combined.² And Texas fishermen lagged far behind their counterparts in the other Gulf states, especially Florida.

The Texan fishermen did not take long to catch up. By 1890, almost 1,400 commercial fishermen fished from shore and plied the shallow bays inside the barrier islands in schooners, sloops, and catboats, catching almost fifty different forms of sea life for the growing market. Farmers and cattle hands were switching to fishing, joined by immigrants from Europe and Mexico, to gather the abundant sea life. One of their quarries

1944. The practice was not outlawed for at least another twenty years, however, the Order in Council of 1950 having outlawed only the commercial taking of green turtles. Turtles confined to the beach for the sport were eventually released and therefore did not fall under this prohibition.³¹

The Turtle Islands of Sarawak

While the epicures of the European capitals were acquiring a taste for green turtle soup and thousands of live turtles were exported from the New World, people in the colonial hinterlands prized the green turtle's eggs as a delicacy. To feed this taste, eggs were systematically harvested from the major turtle rookeries and marketed. To ensure maximum revenue from this resource, colonial governments in places such as Malaya, Ceylon, and Borneo sold exclusive concessions to egg collectors for specific sections of the nesting beaches.

The nesting population that was most affected by these egg harvests was on the Turtle Islands of Sarawak, off the northwestern coast of Borneo. These three tiny coral islands—Talang Talang Besar, Talang Talang Kechil, and Satang Besar—lie off the mouth of the Simitar River and not far from Sarawak's capital city of Kuching. Eggs were systematically collected from these islands from as early as 1839, just before the establishment of the Brookes dynasty, the rulers known as the "White Rajahs."

The Brookes dynasty began in 1841 when the British baronet James Brooke helped quell a rebellion against the sultanate of Brunei and was rewarded by being made rajah of Sarawak. Brooke's nephew, Sir Charles Brooke, became the second rajah. He built a natural history museum in Kuching, on the recommendation of the English naturalist Alfred Russel Wallace, co-discoverer of natural selection independently of Darwin, who had spent two fruitful years of research in Borneo and environs. In 1946, Vyner Brooke, the son of Sir Charles and the last White Rajah, celebrated 100 years of Brooke rule in an enlightened manner. He approved a new constitution for Sarawak, abrogating his absolute powers in favor of a governance structure that would allow the British colony to move toward democratic self-government. Vyner Brooke also adopted a new turtle law.

The Turtle Islands of Sarawak were the nesting grounds for one of the largest populations of *Chelonia mydas* in all of Southeast Asia. The eggs

from the Turtle Islands were the center of a small industry that began after James Brooke's suppression of piracy, with the help of the British Navy. Malay businessmen hired the men who did the actual egg collecting and then sold the eggs to merchants in Kuching and the coastal towns of southwestern Borneo. The nesting turtles had fascinated Rajah James Brooke. He wrote detailed observations in his diary of the scene in 1839 when he revisited the islands: "Morning calm. In the afternoon got under way and anchored again near the islands of Talang Talang. . . . The Bandar of the place came off in his canoe to make us welcome. He is a young man sent by the Rajah Muda Hassim to collect turtles' eggs, which abound in this vicinity, especially on the larger island. The turtles are never molested, for fear of their deserting the spot; and their eggs, to the amount of five or six thousand, are collected every morning, and forwarded at intervals to Sarawak as articles of food."¹

When he visited the islands again three years later while pursuing pirates, James Brooke saw as many as 100 turtles come ashore each night in June and July, perhaps laying as many as 20,000 eggs on a good night. Twenty to forty men lived on the islands. In their watching hut, they waited for nesting females to come ashore. When a turtle had finished covering her nest, the watchers marked the spot with a flag. Brooke noted that the next morning, they "purposely spared some nests" when the eggs were dug up, dried in the sun, crated, and sold to wholesale dealers in Sarawak's market towns. When Brooke became rajah, he sought to preserve this practice. His penal code made it illegal to kill any sea turtle, meeting such destruction with a heavy fine.²

The second rajah, Sir Charles Brooke, also had ideas about what was best for the Turtle Islands. In 1875, Sir Charles broke the monopoly that Rajah Muda Hassim held over egg collecting and awarded the right to the leading Malay *datus*, or chiefs, of Sarawak. The *datus* agreed to rotate control over the egg collecting on an annual basis, each keeping the proceeds from their year of control. Nesting took place all year, but with a definite peak at the end of the northeast monsoon season. This season was met with celebrations, called the *Semah*, after which no one was allowed to land on the islands for three days to ensure that the turtle fertility shrines built during the ceremonies were not disturbed.³

Watchers hired by the Malay *datus* lived on each island. Their job was to mark the location of each freshly laid nest with a flag. Another

crew would dig them up the next morning and send them by boat to Kuching.⁴ The second crew recorded how many eggs were collected, a number that varied between three and four million per year.⁵ The turtles themselves were never eaten; if the European expatriates in Sarawak wanted turtle soup for their dinner parties, it had to be served from a tin. Only in Singapore could one purchase fresh turtle meat and fat.

Edward Banks's Theory about Turtles

Edward Banks, a Welsh anthropologist and naturalist, was the Sarawak Museum's curator from 1925 to 1945. He considered it to be "one of the best jobs in the Far East" and used the position to study many things about Sarawak, including its fascinating green turtles and the industry built up around their mass egg-laying. By Banks's time, the Malay chiefs' exclusive egg concessions had been passed down under Islamic rules of inheritance into many hands, and there was no central control over the egg collecting.⁶ But Banks was able to find records of the number of eggs that had been collected from the islands and sold. From these he tried to piece together a better picture of the turtles, the size of the population, its frequency of nesting, and the conditions that affected nesting productivity.

Banks had a theory to explain why the numbers of eggs laid fluctuated widely from year to year. While the average "bag" was two million eggs, the total could vary by a million each way, with good years making up for bad years. He thought it likely that the two million eggs were the product of 5,000 to 10,000 female turtles. He speculated that their variable production was due to the intensity of the wet monsoon, which disrupted breeding aggregations. The Malay owners of the turtle egg concessions told Banks that the low years' numbers were due to reductions in the number of turtles by fishermen or poachers, or to inadequate prayer meetings, or both. Banks tried to explain to the Malay head turtle-keeper the likely correlation of heavy monsoons and low laying seasons. The keeper rejected Banks's theory. It was contrary to what he had seen with his own eyes since the 1890s. Two years later, however, after another below-average season, the same keeper castigated Banks for taking so long in coming around to the monsoon explanation for low laying numbers.⁷

Banks wondered how the turtle population could survive the very high rate of egg collecting that the Malay chiefs required and whether some sort of intervention was needed. "On the whole it seems as if the natural fluctuations of the turtles are due to weather conditions and not to any decline in population," he wrote, but it is "almost incredible that there should be no such decline, for every year almost all the eggs are taken and few if any left for hatching on the islands. . . . And as it really seems unlikely that allowing the eggs to hatch and the young to escape will assist the population to increase very rapidly, it would appear that some artificial help is needed." But it was not clear what the appropriate means of providing that artificial help would be, given that all previous attempts at fencing in or building enclosures for the young turtles had failed. The one possibility would be to build a sanctuary on Satang Besar on the site of the former leper settlement, where a concrete dam from a reservoir was still in place and which was close enough to the water to be useful. He suggested that sea water could be pumped by a windmill or machine into the enclosure and the young turtles fed coconut products from the adjacent plantation for about six months, "until no longer a prey to the predaceous fishes when returning to the open sea."³

Despite the high mortality of hatchlings that he saw and the near-total take of the eggs, Banks took comfort in the fact that the Malays were "almost fanatical" about protecting the adult turtles. The green turtle eggs were one of the few commodities Malay communities had for trade. Thus, they never thought about killing these turtles or selling them in Singapore. The adult turtles weighed 200 to 400 pounds, so Banks estimated they took about ten years to mature. "With a breeding stock of five to ten thousand females, valued at about £4 in pre-war days, it might have been thought the Malays would have disposed of some of them; but [they] would have none of it, a decision which I rather share on finding that after the shell, fat and cartilage have been removed, only about one-third of this vast quantity is edible meat."⁹

Not long after Banks published his observations in the *Sarawak Museum Journal* in 1937, Rajah Vyner Brooke bought the egg rights back from the Malay chiefs' families. He directed his legislative council to proclaim a new law that would put the museum curator in charge of the Turtle Islands.

Chapter 40 of the Laws of Sarawak declared that it was the exclusive right of the government to take the turtles and eggs from within the territorial waters of Sarawak. A Turtle Board of Management would oversee the industry as a government business. The ordinance, and its counterparts in the states on the Malay Peninsula, reflected the political influence of the British, displacing the notion that rights to the turtles' eggs were a royal prerogative of the sultans. The laws put turtle exploitation under strict control to ensure a source of government revenue, along with Western-style taxation systems. The special Sarawak twist was the Turtle Board. The board would consist of several high-ranking people whose job was to ensure that proceeds from the sale of the one million eggs each year would be distributed appropriately. The museum curator would oversee day-to-day operations on the Turtle Islands. Although the islands were privately owned, under Chapter 40 the turtles were, in essence, held in trust for the people, with the profits from the sale of their eggs accruing to Malay charities and mosques.¹⁰

A New Curator for Sarawak

By the time the Japanese invaded Sarawak on December 25, 1941, Sir Vyner Brooke had already evacuated, and the Japanese interred Edward Banks along with the rest of the expatriate community. The new turtle ordinance sat on the shelf while Japanese bomber pilots used rocks near the Turtle Islands for target practice, and the occupying troops raided the islands for turtle meat frequently. After the war, the curator would have to restore the islands and the egg collecting industry if the Turtle Trust was to operate. Although the collections of Sarawak Museum were preserved, the Japanese had left the Turtle Islands in a shambles.¹¹

With the end of the war, Banks decided not to resume his post as museum curator, and the British polymath Tom Harrisson was chosen to replace him. Harrisson had been to Borneo twice before and knew quite a bit about its diverse flora and fauna as well as its many peoples. In the 1930s, Edward Banks had suggested to Rajah Vyner Brooke that he invite the British zoologist Charles Elton to bring an expedition to explore the biological riches of the Sarawak highlands. Elton turned to Tom Harrisson, who had organized successful Oxford-Cambridge expedi-

tions to Lapland and St. Kilda, in the Outer Hebrides, and had distinguished himself as a talented ornithologist.¹² Harrisson raised the money for the expedition to Borneo and picked its members, among whom was his friend Eddie Shackleton, son of the heroic Antarctic explorer Sir Ernest Shackleton.

Harrisson had arrived in Sarawak in 1932, and it was immediately apparent that the difference in his style and that of Banks, who was in charge of the expedition, was like the proverbial "chalk and cheese." Banks was a quiet and dedicated naturalist with a deep respect for colonial administrative protocol. Harrisson was a brilliant, heavy-drinking know-it-all with boundless energy, who adopted the local living style whenever he was on expedition in remote places, especially if it involved stimulating beverages and intimate relations with women.¹³ When Banks reached the end of his patience, he complained to Charles Elton about the young men's behavior, especially the brash and undisciplined Harrisson. But it was Harrisson who published an account of the Oxford expedition to Sarawak in 1938.¹⁴

Despite his reputation as an *enfant terrible*, Harrisson's knowledge of Borneo and its peoples was by 1945 well regarded in the British government. When he joined the air force during World War II, the military tapped Harrisson to train an Australian special operations team and parachute into the Japanese-occupied highlands of Borneo. Their job was to gather intelligence, but they ended up leading the tribal people in guerilla warfare against the Japanese forces that were fighting the Allied landings.¹⁵

Harrisson distinguished himself in this service as a fearless and inventive organizer, and he had been reluctant to leave the people he had worked so hard to protect. He was especially fond of the Kelabit, an indigenous people of the Borneo highlands whom he had gotten to know during the 1932 expedition. The Kelabit had aided Harrisson's team immeasurably by telling them of Japanese troop movements and by killing and capturing soldiers with blowguns and poison darts. Along the way, they revived the infamous practice of head-hunting that the second rajah had taken pains to suppress. After the special operation, Harrisson had stayed on as a civil officer in the Kelabit district for a time. So when the war was over, and he heard that Banks would not be returning to his job in Kuching, Harrisson applied for the job and got it.

Harrisson had great hopes as he took up his post as the first postwar curator of the Sarawak Museum. He liked the fact that he would be government ethnologist as well as curator. He hoped to study Sarawak's diverse peoples and cultures and build upon the notoriety he gained before the war from his best-selling book, *Savage Civilization*, about living with the people of the New Hebrides after an earlier Oxford expedition. He had no idea that the rajah's turtle ordinance of 1941 required him to administer the turtle egg industry. He hoped to achieve many things for himself and for Sarawak, but had little thought that one of these things would be to pioneer research on green turtles and become a staunch advocate for their conservation.

Flirting with Turtle Science

When confronted with the mass of statistics on the numbers of eggs collected and sold each season, Harrisson realized how little evidence lay behind Banks's estimate that the Turtle Islands' nesting population was between 5,000 and 10,000. Without a more certain number, Harrisson would not know how many eggs should be taken for sale and how many eggs allowed to hatch to ensure a continued supply. He also couldn't know the amount of revenue that would be generated from the egg sales. He needed a better idea of the number of mature females that made up the nesting population, the number of nests they laid in a given season, and most importantly, the number of years they spent at sea before returning to nest again. He could count the eggs they laid in each nest and derive the total number of eggs in a season. But the rest required data that he did not yet have.¹⁶

Harrisson considered himself something of an expert in nature conservation. When Britain faced similar questions in 1930 about its bird populations, he had organized several large-scale censuses, often collaborating with Britain's most eminent zoologists and rising academic stars. It was the height of the bird conservation movement; and Harrisson, using rings, had marked and counted the great-crested grebe, the birds of Lundy Island, and the birds and mammals of St. Kilda.¹⁷ While planning the grebe census in 1930, Harrisson became friends with pioneers of ecology and ornithology, including Charles Elton, Julian Huxley, and Max Nicholson, and many younger men who would go on to

found leading conservation organizations.¹⁸ When he looked at the eggs statistics Banks and the Malay chiefs had compiled, he thought they too showed a serious decline in the number of nesting females. He could not be sure, however, unless he had a better idea than Banks's of the total population size. Could sea turtles be marked with rings like grebes?

While back in London on his first home leave in May 1949, Harrison visited the British Museum of Natural History where Hampton W. Parker, the keeper of zoology, helped him find the literature on *Che- lonia mydas*. Harrison soon realized that only a small number of marking studies had been done on sea turtles—one in the Danish West Indies and another on the Great Barrier Reef. He wrote right away to the Great Barrier Reef Committee for a copy of Frank Moorhouse's report on his Heron Island investigations of 1929–30 and for as much of the literature as he could find.

When he read Moorhouse's report, Harrison realized that the green turtle populations of the Great Barrier Reef also were heavily exploited, but with a difference. The canneries on Australia's coral islands were killing adult females, while the Sarawak turtle industry only collected eggs. Moorhouse reported that on Heron Island, females were often killed before having a chance to lay their eggs. Upon his recommendation, the Queensland government required the canneries on the reef to plant the eggs of the female turtles that were killed. Harrison could see, however, that the numbers of eggs that hatched from these artificial nests were not encouraging. He thought perhaps more careful handling and natural egg-laying could ensure a greater hatch rate. Moorhouse had used a tag attached by wire looped through holes drilled into the rear edge of the carapace to mark the adult females. This allowed him to count the number of times they returned to nest and the number of eggs each one laid during the season.

Moorhouse's study inspired Harrison to do similar but more extensive work on his turtle population. Harrison was confident he could improve on both Moorhouse's artificial nesting and marking methods. Moorhouse had studied only one nesting season; he retired soon after compiling the Great Barrier Reef expedition reports. No one else appeared to be studying the green turtles of the Great Barrier Reef or anywhere else in the South Pacific. The field was wide open to someone with access to the kind of nesting population Harrison had in his care under

the rajah's turtle ordinance. He could control all activities affecting turtles on the Turtle Islands, rebuild the population, and make the industry profitable again, generating revenues and reputation for the museum. He resolved to "go at this strongly at Sarawak."¹⁹ He would begin by redoing the study of Edward Banks, his predecessor and former nemesis.

Harrisson corresponded with Paul Deraniyagala, the director of the National Museum of Ceylon, another former British outpost with an important nesting colony of sea turtles. Deraniyagala had published a number of sea turtle taxonomic studies in the *Ceylon Journal of Science*, a publication of the Ceylon national museum, as well in the prestigious *Proceedings of the Zoological Society of London* and the British science journal *Nature*.²⁰ The Sarawak Museum also had a journal, which Harrisson planned to revive and thereby build the museum's reputation for excellent work on the cultural and natural resources of Sarawak.

Once he was back in Sarawak and on the Turtle Islands, Harrisson revived his passion for wildlife biology and ethology, experimenting with different hatching conditions, watching for evidence of light orientation, making observations on growth rates, and even looking for evidence of learning in the young turtles. He increased the number of nests that were allowed to hatch. In Banks's time, only a few nests were allowed to hatch out, and the hatchlings were allowed to run into the sea. Since the turtle watchers were already digging up the nests, he followed Moorhouse's example and devised a hatchery system.²¹ From 1947 onward, he had the workers transplant a certain number of eggs to artificial nests and then hand-raise the hatchlings until they were large enough to fend for themselves. To give them a fighting chance at life, Harrisson used the museum's launch to take the young turtles out beyond the reef and its hungry denizens to where they could swim to open waters.²²

Every time Harrisson, who was a compulsive writer, had interesting observations, he wrote them up under the heading "Notes on the Edible Turtle, *Chelonia mydas*," for the *Sarawak Museum Journal*. But his first note on the Turtle Islands appeared in 1950 in the *Royal Asiatic Society Journal, Malayan Branch*.²³ It was a history of the Turtle Islands' egg industry. Harrisson gave an account of the *Semah*, the festival that took place at the end of the monsoon season, demonstrating his ethnographic skills by recording a multicultural celebration of the turtles' anticipated productivity. Harrisson's writing style was conversational rather than



FIGURE 5 Sarawak Turtle Board's green turtle hatchery at Talang Talang Besar, British Borneo, July 1953, where John Hendrickson applied cow-ear tags to the foreflippers of nesting green turtles for the first time and where, three years later, Barbara and Tom Harrisson first witnessed a flipper-tagged female come ashore to nest.

Collection of the Sarawak Museum, courtesy of Christine Horn.

scientific, using wit and common words like “babies” and “ladies” to make the information accessible to those in his readership who might be inspired to send money to the museum to support further studies. Along the way, he made important observations despite his somewhat unorthodox methods, like raising green turtles in the bathtub of his guest bedroom. He initiated the use of the term “frenzy” to describe the behavior of newly hatched turtles and hypothesized that this behavior allowed them to get rapidly out to the open ocean, away from predators to where food might be available.²⁴

One of the first articles Harrisson published in the Sarawak Museum's journal, after reviewing the egg collection records for 1950, was an



FIGURE 6 Tom Harrison onboard the Sarawak Museum's launch studying green turtle hatchlings before releasing them seaward of the turtle islands, October 1961.

Collection of the Sarawak Museum, courtesy of Christine Horn.

update of Banks's 1937 study of the green turtle's breeding habits on the Turtle Islands. It was a response of sorts to Frank Moorhouse's 1933 study of nesting behavior at Heron Island on the Great Barrier Reef. Harrison sent a shorter version as a letter to the British journal *Nature*, announcing to the world that research on this important species was under way in Sarawak. Convinced that Banks's study had been overlooked because of contradictions in the data, Harrison reported nesting figures obtained from the staff he had stationed on the Turtle Islands as soon as he returned from London. He knew the figures were accurate because, since 1947, the Malay datus—chiefs—no longer controlled the three islands; he did.

He could report that in 1950 over 2,350,000 eggs were recorded (precisely 2,357,664), including eggs replanted for hatching. While peak nesting occurred in the summer, there was no question that eggs were laid every month of the year, even in the height of the monsoon season, perhaps owing to the islands' location so close to the equator, at two

degrees north latitude. The monthly totals ranged from as few as 24,000 in January to as many as 500,000 in August. Contrary to Moorhouse's findings in 1933, which to that time was the most extensive green turtle study, nests in Sarawak had an average incubation period of fifty-two days, with a slower rate during the monsoon, but still much shorter than the sixty-five to seventy-two days Moorhouse had observed.²⁵

Harrisson concluded the *Nature* letter as he often did the *Museum Journal* notes, by inviting correspondence and collaborations with other investigators: "There are interesting possibilities for comparative work over the enormous range of this common (though decreasing) species, the habits of which lend themselves to exact observation and statistical checking. We here would welcome any research co-operation or co-ordination."²⁶

A Clever Solution from a Farm Magazine

John R. Hendrickson was a young American zoologist in 1951 when he accepted his first faculty job at the University of Malaya in Singapore. Unlike Tom Harrisson, Hendrickson had completed his undergraduate studies in biology and after the war had gone on to complete a doctorate, studying under the noted herpetologist Robert C. Stebbins at the University of California at Berkeley. His dissertation was on the slender salamander genus *Batrachoseps*, but Hendrickson soon realized that the Malay peninsula and the island of Borneo offered many other, very interesting animals to study.

A regular reader of the journal *Nature*, Hendrickson had found his teaching position in Singapore through one of its job advertisements.²⁷ When he saw Tom Harrisson's letter on breeding habits of the green turtle in the February 1952 issue of *Nature*, he began to think there might be nesting beaches in peninsular Malaya where he could study these intriguing reptiles. Soon after, he received an invitation from Harrisson, on behalf of the Sarawak Turtle Board, to visit the Turtle Islands. He quickly accepted. Hendrickson was especially pleased that Harrisson had written to his department chair, Professor Richard D. Purchon, seeking his young colleague's help. Hendrickson was anxious to get back into the field and work on challenging biological questions.

When Hendrickson made his first visit to the Turtle Islands in 1952, there was almost too much to do. The most pressing need was for a method to mark the turtles when they came ashore to nest. It was the only way researchers would be able to determine how often a green turtle breeds and whether the females return to the same beach from which they had hatched. Hendrickson doubted any of the marking methods the egg workers were using would produce useful information on the size of the population. Harrison, the boisterous and bossy curator, as executive officer of the Turtle Board kept a research bungalow on the main turtle island of Telang Telang Besar but made only infrequent appearances. He encouraged Hendrickson to experiment with different marking methods until he found one that would serve the purpose.²⁸

There were two problems with the tagging method Moorhouse had used on the Great Barrier Reef. It required the turtles to be turned over onto their backs so that the workers could drill holes in the carapace and attach the tag with wire. Once the tags were attached to the turtles, they were not particularly durable, often coming back corroded and illegible.²⁹ One day while he was back at the university in Singapore, Hendrickson was perusing an agriculture journal when he noticed an advertisement for a self-piercing, self-clinching tag that dairy farmers could apply to the ears of their cattle with patented applicator pliers. At the same time he heard that the Institute for Medical Research in Kuala Lumpur was having a set of sinks made from Monel metal, a nickel-copper alloy that does not rust. He had an idea.³⁰ He would order a custom-made set of Monel cow-ear tags to apply to the turtles of Sarawak. If applied to a tough section of turtle hide somewhere on the foreflipper close to the body, the tag would not act as a fishing lure or otherwise hurt the turtle's chances of returning successfully to the nesting beach.³¹ The tag makers back in Kentucky were only too happy to oblige. When the bulk order of specially fabricated tags arrived in Sarawak that summer, Hendrickson set about doing some serious tagging.³²

The new Monel tags worked well and could be applied quite easily. To ensure that the research team got the most information possible, each tag was embossed on one side with a code letter indicating on which island the turtle was tagged, followed by a number. On the other side each tag bore the words "Sarawak Museum" and "Reward."³³ From March to October 1953, Hendrickson and his student research assistant



FIGURE 7 Sarawak Museum turtle flipper tag used by John Hendrickson and Tom Harrisson at Sarawak Turtle Islands, British Borneo. Courtesy of Carla Kishinami.

tagged as many turtles as they could on all three of the Turtle Islands. He made plans to return and tag more turtles during the next years' peak nesting seasons. If the turtles had a two- to three-year interval between breeding, he could tag the entire population of adult females and help Harrisson get the numbers he needed.

Field Notes and Firsts

The curious curator was not there when Hendrickson returned to the Turtle Islands in early 1953 to apply the new tags. Harrisson had left the previous December for six weeks in the Borneo interior doing other museum-related research. When Harrisson had not returned by February 1953, as scheduled, no one seemed too concerned. He had a tendency to change plans and wander off to other places without notifying his staff.³⁴

Hendrickson kept up the tagging program, managing to tag 1,514 females on Talang Talang Besar by April 1953. He also set about making numerous other observations of the turtles. He measured and weighed them on the beach, devising ingenious methods for hoisting them on



FIGURE 8 John Hendrickson examining turtle tracks at a beach on Sarawak Turtle Islands, British Borneo.

Courtesy of Carla Kishinami.

scales used for weighing copra, the white meat of the coconut palms that grew on the islands. Hendrickson was a tireless and thorough field biologist. He filled countless notebooks as he observed the turtles' energetic mating behavior in the water, followed hatchlings by swimming and by paddling next to them in a canoe, and excavated every nest after the hatchlings emerged, counting every egg that had failed to hatch to get a sense of the natural hatch rate. He planned to use these notes later when he was back at the university to develop a complete picture of the observable portions of the green turtle's life cycle.³⁵

Hendrickson knew that if the tags applied early in the nesting season stayed on, they would learn how many times a turtle returned in one breeding season and get a more accurate picture of the size of the nesting population. He hoped the tagging would also result in longer-term data that could shed light on whether these turtles made large-scale migrations and used a homing mechanism to find their way back to the

Turtle Islands. Knowing these things would make it possible to conserve and manage the turtle egg industry. At present, the evidence for homing and migration was lacking.³⁶

Managing the industry would also require knowing the green turtle's growth rate and the age at which it reached reproductive maturity. Hendrickson measured the carapace length and width in 200 nesting females. He then compared the ratios of the carapace length to width with ratios measured in turtles raised in captivity in Ceylon, on the Seychelles, on Heron Island, and on the Turtle Islands, whose ages were known. From these data he made "cautious speculations" about the probable growth rate, concluding that the Sarawak turtles matured in less than six years but more than four.³⁷

One day, while Hendrickson was busy taking these measurements, Harrison reappeared out of the blue. The delay in his return had been due to a crash of the plane sent to pick him up from his research site in the Borneo highlands, the plane having crashed as it attempted to take off with him on board. Still ailing from the scrub typhus he had contracted while working in the highlands, Harrison had walked down from the mountains and along the coast. When Harrison found out that the entire egg-collecting staff had been engaged in Hendrickson's research and that Hendrickson had asked the Turtle Board to hire additional local people to help, Harrison was furious.³⁸ Hendrickson was conducting expensive and intrusive experiments that he, as curator, had not authorized, with additional staff he had not hired. The place looked like a laboratory instead of an egg-collecting business. All that hoisting and prodding probably offended the Malay staff and dignitaries who managed the Trust on behalf of the Malay charities.

And where were the tagged turtles? None had returned. Harrison thought they had probably quit the place because of the intrusive and bothersome experiments. But after Hendrickson explained why the work was necessary for managing the egg harvest, Harrison convinced the Malay members of the Turtle Board to allow the tagging to continue, stretching a smaller number of tags in 1954 over nine months. But after only a couple months of tagging in 1955, he bowed to the concerns of the Malays and suspended the tagging indefinitely.³⁹ Because no one knew how long it took before a female returned for another nesting season, there was no way Harrison could reassure the Turtle Board that the wait would

be rewarded. Besides, Harrisson, the experienced bird-bander, doubted whether the tagged turtles would return. He was skeptical of the tagging because Hendrickson, with all of his scientific methods, had made it into such a big production and had probably disturbed the turtles enough to prevent their return.

With the Sarawak tagging program suspended, Hendrickson went instead to San Francisco, to present a paper on the new turtle tag at the annual meeting of the American Society of Ichthyologists and Herpetologists and to visit his PhD advisor, Robert Stebbins, at Berkeley, leaving his detailed field notes on the tagging program with Harrisson.⁴⁰ One of the meeting's attendees listened with particular interest to Hendrickson's paper. David Caldwell was a graduate student in zoology at the University of Florida and in the middle of his field work for a study of the migratory habits of the Atlantic green turtle in Florida. He knew immediately that his professor, the principal investigator of the study, Dr. Archie Carr, would be very excited to learn of the new tag when Caldwell returned to Gainesville.⁴¹

At the Sarawak Museum, Harrisson had all but given up on obtaining any information from the new tag by July 1956, when he and his new wife, Barbara, spent a working honeymoon on Telang Telang Besar. On July 4, they watched in amazement as a flipper-tagged female green turtle came ashore to nest. From the field notes, they determined that Hendrickson had applied the Monel tag to her foreflipper on July 30, 1953. The new tag had been a success after all.

Harrisson took little time in reporting this event to the world—and taking credit for it. He wrote a note for the *Sarawak Museum Journal* and composed another letter to *Nature*.⁴² In his long and rambling museum journal note, "Tagging Turtles (and Why)," he explained how the success had happened. He told of realizing that in order to meet his obligations to the Turtle Board, he needed to know how many females made up the egg-laying population. But he had difficulties in finding a satisfactory method until the fold-over tag "was devised with the *well-helped help* of Dr. John Hendrickson, Department of Zoology, University of Malaya," who was the invited guest of the Turtle Board.⁴³ The letter to *Nature*, which would obviously reach a larger audience, made no mention of Hendrickson.

Some months earlier, Richard Purchon, Hendrickson's department chair, had told his younger colleague that Harrison was publishing notes in the *Sarawak Museum Journal* based on Hendrickson's field notes without acknowledgment. Purchon encouraged Hendrickson to confront Harrison and insist that Harrison give him and the University of Malaya due credit for the work.⁴⁴ When Hendrickson spoke to Harrison, however, Tom insisted he was entitled to use the field notes. He was the one who had instigated the research back in 1947, had gotten the money from the Turtle Board, and had issued the invitation to Hendrickson.⁴⁵

But the young scientist's complaint bothered Harrison enough that while editing the proofs for the museum journal, he added the begrudging acknowledgment of Hendrickson's contribution.⁴⁶ Harrison realized that if he was going to build the museum's reputation for research on and conservation of Borneo's fauna, he would need the enterprise and expertise of zoologists like Hendrickson. He would also need help with the Turtle Islands' nesting turtles if the population size was as low as he now suspected. The tagging returns were showing that the Sarawak turtles nested as many as seven times in a season. Given an average clutch size of 100 eggs, the total number of females in the nesting population was likely to be around 5,000. This was far less than the 10,000 females he thought might be responsible for laying the one to two million eggs per season. If the 4,000 female turtles that had been tagged in 1953 to 1956 never returned because of the experiments, he might have added a significant drop in the nesting population to the gradual decline he detected from the egg statistics.⁴⁷ But before he would invite Hendrickson or anyone else to work with the Sarawak turtles again, he would wait and see if Hendrickson's obsessive concern for statistical rigor paid off in useful results publishable in a good journal. In the meantime, he would enjoy taking credit for the clever new turtle tag.

Harrison always sent reprints of his articles to everyone he thought might help his turtle studies or Sarawak and its museum.⁴⁸ One letter in particular had just such an effect. He sent the second note, on copulation behavior of the "edible turtle," to Archie Carr, the noted zoologist at the University of Florida, who had just completed a taxonomic handbook on the turtles of the United States, Canada, and Baja California. When Carr wrote back thanking Harrison for the "very interesting

paper," he asked him for a copy of the first note, which was on breeding habits.

Carr also asked Harrison for his advice on using the cow-ear tag as a means of marking sea turtles, which he believed Harrison had described in a recent paper at the annual meeting of the American Society of Ichthyologists and Herpetologists, which Carr had missed. Carr wrote: "In my migration study I want something that will stay on for a long time. . . . Will you please tell me, at your earliest convenience, where you have found the most satisfactory place for the fin-tag to be. I expect to tag about a thousand turtles in Costa Rica this July and I hate to think of the tag falling off. I'll be very grateful for any advice you may care to give me."⁴⁹

Harrison read Carr's letter as soon as he returned to the museum from a trip to Europe. By this time it was already the height of the field season in Costa Rica. Harrison apologized to Carr for the delay in replying and gave him the advice he sought. There was just one problem. Harrison had not delivered a paper at the 1955 meeting and had not actually done any tagging. Hendrickson had done both. Harrison nevertheless consulted the field notes that Hendrickson had left with him.⁵⁰ He enclosed a sample tag in his reply to Carr and wrote, "We apply them on the rear side of the forward flipper quite close to the main body. . . . So far we have had one recovery. . . . I am far from satisfied about this method and should be glad to hear about the results of your experiments."⁵¹

When Carr wrote back and told him he had adopted the Monel cow-ear tag for tagging green turtles at Tortuguero and had applied them himself in the last days of the 1955 field season, Harrison knew he was onto something.⁵² He now realized the global significance of what he and Barbara had seen when the first female turtle, which Hendrickson had marked on the flipper with the Monel tag, came ashore to nest after an absence of three years. Like the great-crested grebes he had banded in the 1930s, the green turtle was beginning to look like a candidate for a more vigorous conservation intervention. Harrison suspected that the growing consumption of green turtle soup he had witnessed while in London on home leave was killing off his population of green turtles. Certainly, Carr had sounded the alarm, in his taxonomic handbook on turtles, about the serial extirpation of turtle populations in Bermuda and the Caribbean.⁵³ Harrison thought of mobilizing to the green turtle's

cause his friends and colleagues in England who were active in international wildlife conservation.

Harrison actually had no idea of what was happening to his population when they were not breeding at the Turtle Islands. With few if any tag returns from beyond the coast of Sarawak, he had no proof that his turtles were being captured and shipped abroad to be made into green turtle soup. Maybe the old Malay chiefs who had argued with Edward Banks were right. Perhaps fishermen and poachers were killing the turtles for meat and shipping it to the soup-eating capitals of Europe. Banks was correct in attributing the nesting fluctuations to the monsoon but wrong in not noticing the overall downward trend.

Harrison decided to revisit the social science work he had done in the 1930s when he and others established Mass Observation in England, an organization that conducted the first large-scale public opinion survey. He would use the data and methods he had pioneered to change the public's attitude about green turtles and its taste for green turtle soup.

The Gifted Navigators

When Archie Carr rose to give the keynote address to the meeting of the American Institute of Biological Sciences, he had a different group of turtle islands on his mind. Christopher Columbus called them Las Tortugas. The islands were teeming with sea turtles that looked "like little rocks," Columbus wrote in his journal in May 1503, during his fourth voyage to the New World. The islands he described would later come to be known as the Cayman Islands, and their vast herds, or "fleets," of breeding green turtles would supply European voyagers, vessels, and colonies for the next 300 years.¹

It was September 6, 1954, and Carr had been thinking about the turtles of the Caribbean for more than a decade. On that day in Gainesville, he talked of *Chelonia*, how its size and abundance reflected its straightforward ecology, and how its taste and ease of capture supported the opening up of the Caribbean and probably the entire New World. "All early activity in the New World tropics—exploration, colonization, buccaneering and the maneuvering of naval squadrons—was in some way dependent on the turtle," Carr said. Grazing all day in vast herds on submarine grasses, "they grew fat and numerous and succulent, and in every way a blessing." But it was a blessing that was short-lived. The last fleets of *Chelonia* were passing; he believed fervently that unless the turtle was "effectively protected it may soon be extirpated as a breeding resident of American waters." The green turtle would go the way of the buffalo, but without the notice and drama that accompanied that extermination. The green turtle was simply "too good to last."²

Six Big Questions

Carr had come to believe that the Atlantic green turtle was destined for premature extinction two years earlier while writing his taxonomic

treatise on turtles, *Handbook of Turtles*. In writing the notes on the Atlantic green turtle, he had found historical sources on Bermuda and Jamaica describing the extirpation of one rookery after another as the New World's turtles fed the new colonies and the visiting navies. He cited Samuel Garman, whose 1884 report on the reptiles of Bermuda described how the Bermuda Assembly in 1620 was so concerned about overexploitation that it passed "An Act Agaynst the Killinge of ouer Young Tortoyses," prohibiting the killing of turtle less than eighteen inches in diameter from the waters around Bermuda to a distance of five leagues.³

In the 1950s, green turtles were still being exported in large numbers from the Caribbean to the United States. Carr had seen the impact of this trade with his own eyes as he scouted the Caribbean for sea turtle nesting beaches. Turtle soup canneries still operated in the United States and Europe, and Queensland was still exporting turtles caught by Aboriginal fishing companies.⁴ But the Cayman Islands no longer had the magnificent breeding fleet that Columbus had seen. To stay in the turtle trade once their own herd was gone, the Cayman Islanders had built a fleet of turtle fishing schooners to find seagrass pastures where the green turtle could still be hunted. For the last hundred years or so, the Cayman schooners specialized in catching the green turtles residing on the Miskito Banks, some 350 miles away, off the coast of Nicaragua in the western Caribbean.

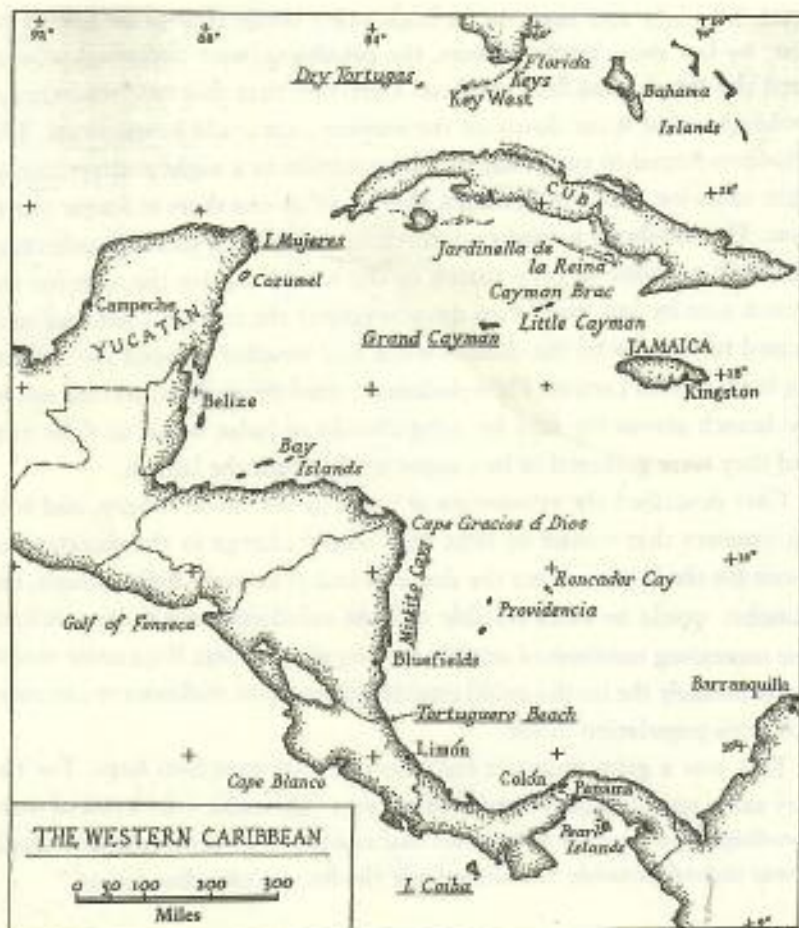
Since long before the war, Carr told his audience of biologists, a green turtle cannery in Key West, Florida, has done a brisk trade with the schooners of Grand Cayman.⁵ Carr hastened to say that the Miskito Bank turtle fishery was not the most serious drain on the greens of the Caribbean. That was happening where the turtles gathered and came ashore for breeding in Costa Rica. The capture for export from a place called the Turtle Bogue was a relatively new fishery. Because it took adult breeding turtles, it was likely to be the last straw for *Chelonia*.⁶

Carr told his audience that the extirpation of the Atlantic green turtle could be prevented, but the knowledge needed to do so was lacking. The will was there, but the science was not. He noted that "at this point our procedure is blocked by an astonishing ignorance of the biology of the animal. Most of the countries and peoples with a stake in the Caribbean littoral would be in sympathy with the idea of saving the green turtle.

But once persuaded of the necessity of doing something they embarrass you by insisting that you tell them exactly what to do."⁷

But turtle fishing people did not lack this knowledge. Carr said that fishermen throughout the Caribbean and Florida believe that the green turtle is migratory, but "nowhere in the canons of zoology is there a shred of what could be called scientific evidence to prove it." Especially knowledgeable were the Cayman schooner captains, who had an unparalleled knowledge of the turtles and a stake in their survival. It was their belief that the turtles left the Miskito Bank in the spring and made their way south to Turtle Bogue. The captains not only believed in these mass migratory feats, they were convinced that the turtles found their way by virtue of a strong homing instinct. Their proof was that individually recognizable turtles could be found sleeping beneath the same rock night after night, returning to the same spot after a day spent grazing in seagrass pastures that were miles away from their favorite sleeping holes. The fishermen were convinced also by the story of the storm of 1924, one of several stories Carr had collected in his wanderings throughout the Caribbean looking for turtle nesting grounds. A large male green turtle with distinctive shark-bite scars on his flippers was captured on the Miskito Bank, branded with the schooner's initials, and sent to the cannery in Key West, which was soon hit by a hurricane that October. The next season, the Caymanian captain who had caught the turtle saw him again sleeping under the same rock where he had been captured the previous season. Carr concluded that the story had to be true, for it lacked any sentimentality added by the teller for effect. The captain had caught the turtle a second time and sold it again to the same dealer in Key West.⁸

Carr asked aloud what could account for the popularity of the Turtle Bogue as the primary nesting beach for the Caribbean green turtle. Predators and hunters abounded there. It was an exposed shore with heavy surf and no obvious landmarks to make it easy to find by the herds of turtles coming from both the south and the north to breed. It was on the beach at Turtle Bogue, known to Costa Ricans as Tortuguero, that Carr intended to find out how *Chelonia* accomplished its long-range feat of migration. But at this twenty-four mile stretch of black beach, a law was in effect that had the exact opposite intent of the 1620 Bermuda ordinance. The Costa Rica law created an orderly and highly efficient



Geographer James Parsons' map of the western Caribbean, 1961.
 From James J. Parsons, *The Green Turtle and Man*, courtesy of David J. Parsons.

process for taking all the turtles, and Carr knew it had to be changed before he could start the tagging program that would establish the scientific fact that green turtles were mass migrators.

Costa Rica's law gave the government ownership of the first mile of shore land extending inland from the surf zone. Every year it sold leases to mile-long sections of the beach at public auction. The highest bidders, the *contratistas*, were given the right to take all the turtles that came ashore on that section of the beach. They hired local people to patrol the

beach all night and turn on its back every turtle that came ashore to nest. By law these turtle-turners, the *veladores*, were supposed to wait until the female had laid her nest. Carr saw that this rule was always broken because it cut down on the number that could be captured. The *veladores* hoped to turn thirty to forty turtles in a night and get thirty-eight cents for each. And besides, there was no one there to know otherwise. The *veladores* turned each turtle onto her back to await collection and built a shelter of coco thatch so she would survive the wait for the launch sent by law every two days to collect the turtles. Carr had seen turned turtles die by the dozens when bad weather delayed the collecting launch from Limón. The *veladores* floated those that survived out to the launch across the surf by tying chunks of balsa wood to their fins, and they were gathered in by canoes working for the launch.

Carr described the economics at work in the turtle fishery, and told his listeners that sooner or later they would change in the direction of doom for the turtles. Once the demand and price were high enough, the launches would be more reliable and the *veladores* even more efficient. The increasing numbers of settlers moving to the Costa Rica coast meant it was unlikely the turtles could establish alternative rookeries to get away from this population drain.

This was a grim prospect but also one that gave him hope. For the very same reason that the green turtle was vulnerable—its habit of mass breeding—the number of beaches that needed to be protected was small. It was indeed possible “to bring back the fleets Columbus found.”

It is not often that we are offered a set of circumstances so promising; a one-item feeder with its pastures undamaged, vast in extent and used by no other animal; a species attuned to building and thriving in dense populations and yet flexible enough to proliferate and scatter in dilute colonies; above all, a depleted species, the cause of whose depletion is clear and surely possible to remedy. There is still a skeleton breeding stock and the best of the remaining nesting shores are the least cluttered by man. Group action by the governments concerned would surely save *Chelonia* and build unity and strength in the Caribbean by raising the yield of the sea to the people around it. In the field of live-resource management, it is not often you can hope for so much.⁹

It was a remarkable speech. Carr displayed the gifts he would soon become known for: an ability to combine natural history observations, scientific curiosity, and a lively, uncluttered prose to convey the mystery and magnificence of the green turtle.¹⁰ Also evident were his abiding concern for survival of this species and recognition that both science and law were necessary to achieve it. Efforts to negotiate an agreement among the countries of the Caribbean for the protection and restoration of green turtles had little hope as long as key aspects of their biology are not known.¹¹

Carr was still optimistic that science would overcome political and economic considerations. Two years earlier he had written that if we could answer just six questions, "the specific information which in this connection seems most necessary would be available." Those questions were

1. Where are the principal remaining breeding areas located?
2. What is the breeding season at each of the nesting localities?
3. How many times does a female lay during one year and how many eggs constitute her annual total? Is laying an annual occurrence, or do the turtles lay on alternate years as has been suggested?
4. Where do the hatchling and post-hatchling stages go and what do they do prior to attaining "chicken turtle" size—five pounds or so in weight?
5. What diurnal, seasonal, and developmental migrations, if any, take place, and to what extent might an increase in the population in one area be expected to replenish that in another? Are the Caribbean and South Atlantic stocks genetically isolated from each other? These points could readily be clarified by marking experiments.
6. What is the volume of the annual turtle and egg takes throughout the range of the animal?

The good news was that these questions could be answered: "If adequate solutions to these problems could be obtained—and they await only a proper investigation—it seems probable that the green turtle could not only be saved from virtual extermination but might even be encouraged to regain something approaching its primitive range and abundance."¹²

This was in 1954, eight years before Rachel Carson's *Silent Spring* sounded the alarm over the impending extinction of songbirds due to

humankind's profligate use of the pesticide DDT. The green turtle had found a champion who was as determined to understand its biology as he was to save it from extinction. Carr was not, however, falling victim to scientism—the optimistic belief that science could solve all societal problems including biological conservation. He could see clearly the economic forces at work that would require a countervailing political and legal pressure. He believed that these pressures could only arise when there was more biological and ecological knowledge about the green turtle.¹³

The Research Station at Tortuguero

The biggest of Carr's six big questions was whether the green turtle is a long-range migrator. To answer it, Carr needed reliable tags, a team of people to attach them to lots of turtles, and a stretch of beach where the turtles would be unmolested by the veladores. Any study of the Caribbean green turtle would have to focus on the rookery at Tortuguero, Costa Rica, and it was there that he would set up his field station. While he sought grant money from the National Science Foundation, Carr asked the Costa Rican Ministry of Agriculture to allot a two-mile section of beach adjacent to the station where the veladores could not turn the turtles. Carr then hired the veladores displaced from their own industry to work on his, turning the turtles for tag and release rather than capture and export.

After three summers of reconnaissance, it was finally time to start the work. In July 1955, the research station was established at facilities in Tortuguero that a banana company put at Carr's disposal. Once Carr got the tagging program started, his friend and former professor Leonard Giovannoli, with help from the veladores, would tag as many turtles as possible.¹⁴ If the tags remained on the turtles during their suspected migration, the reward offered on the tag would motivate the turtle's catcher to return the tag to Carr with information on where and when it was caught. With the data thus received, he could test the hypotheses about the mass, long-range migration he had gleaned from conversations with the turtle captains of Cayman Islands.¹⁵

Giovannoli was a master tagger. He managed to tag fifty overturned turtles in one night, using Monel metal wire to attach inscribed oval plates to the overhanging back edge of their carapaces.¹⁶ But the shell tags

eventually came off; they could not withstand the scuffle and abrasion of the males' mating behavior. Carr had been testing different tag types in a pilot study with his graduate student David Caldwell, using green turtles caught off the Cedar Keys of Florida in the Gulf of Mexico.¹⁷ While Carr went to Tortuguero to open the field station, Caldwell attended the annual meeting of the American Ichthyologists and Herpetologists in San Francisco.

When Carr got back to Gainesville, Caldwell told him he had heard a paper about researchers in Borneo using a narrow strip of Monel metal to tag green turtles, bending it over the flesh of the front flipper. Carr immediately ordered a supply of tags from the company in Kentucky. The supply of flipper tags arrived just before the end of the first field season. Carr rushed it down to Tortuguero, and he and Giovannoli applied forty of the new tags in four days before closing the station for the season. It was the Monel cow-ear tag that John Hendrickson had designed for the Turtle Islands to replace the copper plates that were like the ones used by Frank Moorhouse on the Great Barrier Reef.¹⁸

Carr did not have to wait two or three years to conclude that the flipper tag was a great success. The tags stayed on and demonstrated that females returning to nest within the season could reemerge at almost the exact spot where they had previously emerged, showing "some sort of orientation accomplishment." Carr saw these as "feats of great stature" because it was unlikely the turtles had loitered off the exposed shoreline for the three to four weeks they were absent.¹⁹

All of Carr's tags offered a five dollar reward for their return, and this seemed to get immediate results. Fishermen returned tags from ten of the turtles he and Giovannoli had tagged during the first field season. Seven of the ten came from the Miskito Bank, the area some 300 miles northwest of Tortuguero, off the coast of Nicaragua, where the Cayman Islands turtle schooners operated. This was the first positive evidence of long-range migration, at least of individual turtles if not en masse. Carr was very pleased with the new tagging method and decided to report the initial results in *American Museum Novitates*, a publication of the American Museum of Natural History, in New York City.²⁰ Between 1956 and 1966, Carr would publish a total of six notes in *Novitates*, including papers with his student Harold Hirth and his research assistant Larry Ogren. James A. Oliver, the director of the American



FIGURE 9 Applying cow-ear tag on turtle flipper at Tortuguero. Special Collections, George A. Smathers Libraries, University of Florida, Gainesville, courtesy of Carr Family Trust.

Museum of Natural History and a close friend of Carr's, assisted Carr's migration studies.²¹

A Marvel of Nature

One Cayman turtle captain in particular provided the bulk of Carr's evidence of the green turtle's migration. Carr had developed his hypothesis that green turtles were long-range migrators with a strong homing instinct after hearing Captain Allie Ebanks's stories of recapturing turtles branded with his schooner's initials in the same place after they had escaped from the pens at Key West. Now, the same Captain Ebanks, on



FIGURE 10 Dragging turtle to scales. From left to right: Harold Hirth, Larry Ogren, Leo Martinez, and Archie Carr.
Special Collections, George A. Smathers Libraries, University of Florida, Gainesville, courtesy of Carr Family Trust.

the *A. M. Adams*, the schooner that he captained for Thompson Enterprises in Key West, would return a tag from a turtle that had been flipper-tagged at Tortuguero at the end of the 1955 season and was caught on March 3, 1956, at Southeast Rock, south of Miskito Cay. The fisherman, who had used his own marking method to assert ownership of a sea turtle, would provide evidence of the superiority of the new flipper tag.²²

Not only was Carr looking for evidence of mass migration; he was also looking for scientific information that would convince the Caribbean nations to cooperate to save the green turtle from certain extinction. The green turtle in American waters could not be saved without "protection from international laws, and the laws will have to be based on an understanding of the life history of the animal." But there was no conclusive evidence of the link between the catching of turtles in the

western Caribbean and the populations in American waters. The Caymanian captains believed turtles had a homing mechanism, but there was no scientific evidence to support these beliefs. Without the science, the green turtle would not get the protective laws it needed.²³

Carr recounted some of the anecdotes upon which the Cayman schooner captains based their belief in a homing ability in his book *The Windward Road*. The best story was the one Carr heard from Allie Ebanks, from 1942. Captain Allie had let one of the men who caught the turtles from the *A. M. Adams's* small catboats select and mark five green turtles and send them home to his family via the *Lydia Wilson*, which had finished its trip and was returning to Grand Cayman the next day. Two weeks later, the same catboat fisherman recaptured one of the marked turtles that he had put on the *Lydia Wilson*, at the very same rock where he had caught it the first time. This convinced Ebanks and the crew of the entire fleet that the *Wilson* had been lost in the storm they had just endured, freeing the turtles to return to their sleeping rock. But several days later Ebanks learned from another passing schooner that the *Wilson* was safe at home in Grand Cayman, 350 miles away, and that the storm had flooded the turtle pens at Georgetown where the turtles were being kept. "So the story changed quickly from tragedy to just a marvel of nature." The animal had not only returned; it had followed the shortest and best route, using either a special sense or its ordinary senses in "some clever way." Carr was convinced that the turtles that made up the breeding fleet at Tortuguero were migrants from Miskito Bank. When he received the tags from Allie Ebanks in 1956, he was sure of it.²⁴

A Misunderstanding in Gainesville

While Carr's manuscript on the 1955 field season at Tortuguero was in press for the *American Museum Novitates*, he received a manuscript from John Hendrickson based on Hendrickson's investigations at the Turtle Islands of Sarawak. Tom Harrison's letter describing the results of the Sarawak tagging project had just appeared in the December 29, 1956 issue of *Nature*. Hendrickson decided it was time he published a paper from his field notes; he was the one who had made the detailed observations that Harrison was relying on. If he could not get back to the Turtle Islands to continue the work, he would at least contribute what

he knew to this important species and discuss what he thought were the best approaches to its utilization and management.²⁵

Hendrickson had seen Carr's 1954 grantee report of his reconnaissance of the turtle beaches in the Caribbean and knew that Carr was also studying the behavioral ecology of the green turtle. In this short note Carr concluded that in American waters, the green turtle seemed to be "in a dangerous state of depletion" but that it was also "most peculiarly amenable to conservation manipulations."²⁶ What Hendrickson had not yet seen was Carr's first paper in the *Novitates*. In it, Carr and his student David Caldwell reported on their pilot studies of migration and homing by the green turtles that Florida fishermen caught in a seasonal fishery off the west coast of Florida. The paper described testing three types of tags inscribed with a reward and return address: two sizes of Monel metal disks attached by wire to the carapace, and one 2-inch cow-ear tag attached by a special pincer to the fore flipper. All three were being tested for durability on captive turtles at the aquarium in Fort Walton Beach, and they were likely to use the flipper tag for the remainder of the study. Carr and Caldwell's paper, however, mistakenly attributed the idea of using the cow-ear flipper tag to a paper presented by Tom Harrisson at the 1955 annual meeting of the American Society of Ichthyologists and Herpetologists.²⁷ It was Hendrickson who had given the paper, and it was Hendrickson who had come up with the idea.

Hendrickson asked Carr for an unsparing review of his Sarawak manuscript, telling him he had decided to stop revising the paper and send it off for review. After eighteen months, it was clear to him that he was not going to be invited back to the Turtle Islands to continue the study. He asked Carr to send it on to Robert Stebbins at Berkeley when he was finished and told him Stebbins would repay him for the postage. His plan was to submit it to *Proceedings of the Royal Society of London*, but he invited Carr to suggest other outlets.

Hendrickson apologized for not seeing Carr's paper with Caldwell on the Florida greens but promised to cite it in the final manuscript. He assured Carr that his falling out with Harrisson was not over who had thought up the cow-ear tag. He wrote: "It doesn't much matter at all about who first had the idea. . . . I am not sure I didn't get the notion from someone. . . . [As] you will see, the turtles Harrisson works on are the same ones [that I did the] major part of my work with. . . . I tagged a lot

while I was working there, and . . . extra tags and pliers were left on the islands."²⁸ Harrison's letter in *Nature* had mentioned that 4,000 turtles had been tagged; Hendrickson himself had tagged 2,404 turtles and had overseen the tagging of another 316. He concluded that Harrison had continued with the tagging after he had left the islands.

He acknowledged that his falling out with Harrison was to the detriment of the turtles and to science but thought it in bad taste to discuss the details in a letter. "I feel that you need some explanation of the background," he said, and asked if Carr would be willing to let Hendrickson acknowledge his assistance in reading the manuscript. "It may be important for you to preserve good relations with Harrison, and any implication that you have helped me might not go down well with Tom." He offered to have a set made of his turtle photographs from Sarawak in gratitude for Carr's help and to deliver them in person in the coming summer.

Carr wrote back two months later. He apologized for the delay, saying he had been busy with the start of the new academic term and had wanted to read Hendrickson's paper closely. He had assumed he would have lots of corrections to make, given the "concurrent evolving of your project and two progress reports of my own [the two papers in *Novitates*], but it turns out I have held you up for nothing." He liked the paper very much and told Hendrickson that he could indeed say that Carr had read it and thought it was "a damn fine job." There was only one bone he wanted to pick: Hendrickson's paper had shed no additional light on the issue of migration. He urged his young colleague to keep an open mind:

Your material was quantitatively so much more imposing than ours has been that I was hoping to get reflections in the movements of your turtles that would reinforce or help interpret my own case histories. You and we are working on widely separated populations, and probably on genetically different creatures, but they are obviously not very different and I suggest that you not rule out migration (not that you have) as a possibly important aspect of the life history of your turtle. It is of course conceivable that, as you seem inclined to believe, your rookeries are all recruited from among local residents. With the lack of any spermatophyte grazing flats in the area and with no big feeding aggregations known from anywhere around I

would remain very receptive to the possibility that your nesting turtles come in there, possibly in schools or waves that overlap too much to show up in your frequency data, from over a wide territory. We have shown a six hundred mile spread in recruitment for our rookery here and I am sure we have only begun. If you stay out there I surely hope you can figure out a way to tackle this aspect of the problem. That is what interests me most about the work here, and once we have established long-range migration as a fact there will be spectacular possibilities for studies in orientation and navigation mechanisms.²⁹

But Carr would soon have more data from his own tagging studies and the strong evidence he sought for the long-range migrations the turtle captains had told him of. The tag returns from the station at Tortuguero were generating results, thanks in no small part to the idea Hendrickson had had while reading an American farming magazine in Singapore.

The Geography of Turtle Soup

Another scholar who was drawn to the green turtle was James J. Parsons. Neither a zoologist nor a curator but a geographer from the University of California at Berkeley, Parsons believed a geographer's place was in the field. He was, in fact, an economic geographer with a regional focus on Latin America. By the mid-1950s, Parsons had studied a range of topics in American agriculture and natural resource-based industries. Plants were his particular passion; his detailed assessment of the introduction of African grasses to the Americas became a classic in the field. While Parsons was studying the geography of the Miskito pine savanna, the southernmost stand of pine on the American continent, he came across Archie Carr's 1953 book, *High Jungles and Low*, and its vivid description of forests along the part of the eastern Nicaraguan coast known as the Miskito Shore.¹ Carr had written the book after returning to Florida from his four-year stint teaching at the Pan-American School of Agriculture in Honduras.²

Parsons visited and wrote about the English-speaking settlements of the Miskito Shore and the offshore islands of San Andrés and Providencia.³ The trade that connected these islands with the Miskito coast introduced Parsons to a different species of the American tropics, whose interesting geography had not yet been told. Switching from flora to fauna, he decided to document the geography of exploitation of the green turtle.

The Green Turtle and Man

When he began to explore what was known about the green turtle, Parsons soon realized that Archie Carr had also begun to focus on the green turtle, finding in the literature accounts of Carr's research in Florida and Costa Rica, alongside the studies reported by Tom Harrisson and John Hendrickson from Borneo and Malaya. Between these three scientists,

Appendix A

The 1966 U.S. Classification of *Chelonia mydas* as Rare and Endangered

From US Department of Interior, Fish and Wildlife Service, *Rare and Endangered Fish and Wildlife of the United States* (the "Red Book"), Resource Publication no. 34 (1966).

Peripheral*

GREEN TURTLE *Chelonia mydas mydas* Linnaeus
Order CHELONIA Family CHELONIDAE

Distinguishing characteristics: Abutting, non-overlapping shields on carapace; four pairs of lateral shields in shell; one pair of prefrontals on head; very large size; paddlelike feet.

Present distribution: Tropical oceans in shore waters. Wanders up United States coast during summer.

Former distribution: Same; but uses Florida beaches as a laying site.

Status: "Practically extirpated as a breeding entity in the fauna of the U.S." (Carr and Ingle). Still common as a breeding entity on Hawaiian Islands (RLW).

Estimated numbers: In U.S., probably very few, but world-wide, still fairly abundant.

Breeding rate in the wild: Probably once a year, although possibly once every two years, 125-200 eggs per female.

Reasons for decline: Widely used for food; young subject to very heavy predator and human pressure.

Protective measures already taken: Molestation of nesting sea turtles and their eggs is prohibited in South Carolina, Georgia, Florida, Texas, Puerto Rico, and Hawaii. Hatchlings are flown from Caribbean beaches to Florida for release. Similar release techniques are employed in Buck Island Reef National Monument, Virgin Islands, and in Virgin Islands National Park. Results in the form of return of released hatchlings not verified as yet.

Measures proposed: Raising hatchlings in impoundments up to shell lengths of 6-8 inches, then releasing them (Carr and Ingle); establishment of protected breeding beaches.

Numbers in captivity: Very many, practically every saltwater aquarium and a few zoos have them often as many as 5-10.

Breeding potentiality in captivity: Practically nil; no opportunity to lay eggs.

References:

A. Carr and R. Ingle; *The Green Turtle in Florida*; Bull. Marine Sci. Gulf and Carib., 1959, pp. 315-20.

Ronald L. Walder (pers. comm.).

* The classification "peripheral" was defined as a species "whose occurrence in the United States is at the edge of its natural range and which is rare or endangered within the United States although not in its range as a whole."

Appendix B

IUCN Principles and Recommendations on Commercial Exploitation of Sea Turtles

As reprinted in the first issue of the IUCN/SSC *Marine Turtle Newsletter*, no. 1, August 1976 (editor: N. Mrosovsky, University of Toronto) from the *IUCN Bulletin* 6, no. 4 (April 1975).

1. Because the majority of the distinct populations of *Chelonia* (green turtles) are extinct, threatened or rapidly declining, the entire group should be considered endangered.
2. The reasons for the extinction and decline of populations include particularly exploitation for meat, hides, eggs and other products (including souvenirs), massive killing of turtles in the trawl nets of fishing fleets as well as increasing habitat destruction and disturbance.
3. The situation has become even more critical with the expansion of international commercial trade in sea turtles and their products.
4. As regards trawling, urgent attention should be given to encourage the use of nets designed to minimize undesirable catches of turtles, and research into this question should be given funding priority.
5. As regards souvenirs, the taking and preparing of turtles and turtle products for the primary purpose of souvenirs should be strongly discouraged.
6. As regards primary exploitation (meat, hides, eggs), where it can be demonstrated that local turtle populations can tolerate exploitation, and the desire or necessity is present, this should be done only by peoples traditionally dependent on them, with methods ensuring minimal waste and for local utilization. The diversion of wild sea turtle resources from traditional use by local people, or the expansion of that use, to satisfy or extend the demands of international commerce, is condemned.
7. It is emphasized at this point that there is a distinction between turtle farming and turtle ranching; a turtle farm implies that the unit is completely independent of wild stocks; a turtle ranch is a unit dependent on wild populations for eggs or turtles with the animals kept in varying degrees of captivity (H. Hirth, *FAO Fisheries Synopsis* No. 85, "Synopsis of Biological Data on the Green Turtle," December 1971).
8. Further, in recognition of the deteriorating energy and food resources of the world, it is advocated that wherever possible any turtle culture be maintained at the lowest applicable trophic level.*

* All organisms are classified as producers, primary consumers (herbivores), secondary consumers (carnivores), or decomposers according to the place they occupy in the food chain of an ecosystem. The placement is termed "trophic level." Therefore, herbivorous species should subsist on a diet based on plant protein and carnivorous species on animal protein.

9. Farming objectives which lead to the expansion of existing markets resulting possibly in an increased exploitation of wild turtles are unacceptable. However, it would be consistent with the foregoing principles to accept turtle farming whose products will replace wild turtle products in existing traditional markets. The acceptability of any farm should be demonstrated by suitably designed and independently evaluated tests and data. Moreover, those ranching endeavors satisfying the above conditions and which can be shown not to harm wild turtle populations are also acceptable.
10. Funds should be provided for the preparation of informative pamphlets to promote the application of the foregoing principles and immediate measures should be taken to ensure the early implementation of such action as is necessary to conserve the marine turtle resource in accordance with these principles.
11. Nearly all the considerations stated for *Chelonia* may be applied with equal force to populations of the six other species of marine turtles.

20. As we have seen, Parsons used the map in one endpaper; the other endpaper was his own map of the nesting and feeding grounds around the world.

21. Carr and Ogren, "Green Turtle in the Caribbean Sea," 28. It is not clear from the letters whether Carr saw the "slip of some sort" when he reviewed Hendrickson's manuscript in March 1957, but as noted in chapter 4, Carr had told Hendrickson he was disappointed that Hendrickson's research had shed no light on the issue of long-range migration. When the Carr and Ogren paper came out, Hendrickson took mild exception to Carr's characterization of his conclusion on site fidelity but told Carr these were only "personal comments for your own enlightenment." He presumed Carr could have judged from the sentence following the one that he quoted that Hendrickson was referring to consistency over a lifetime because the evidence Hendrickson had found was strong only for consistency within one breeding season. "I am unable, by the way, to agree with you that my data show by inference that the turtles return to nest on the island where they themselves had hatched. I cannot eliminate the possibility of a general "pool" of turtles in the South China Sea, with each annual increment of newly-matured individuals following a drift or migration of older, experienced adults to breeding beaches, then fixing their location sense and its attendant "homing" instinct on a substrate of individual adult experience rather than racial memory or memory of infant experience. It would indeed be a pleasure to have an opportunity to discuss some of these questions with you in person some time." In a postscript connected by a penciled-in arrow to the above paragraph, Hendrickson added, "I am still stumped by the problem of marking hatchlings so they will be recognizable when adults—have you any ideas? JRH." Hendrickson to Carr, April 12, 1961, Carr Papers, Series 2. Hendrickson made no comment on the plastic disks applied to 20 percent of the hatchlings delivered to distant sites under Operation Green Turtle, as described in Parsons' photo essay in the concluding chapter. Hendrickson wrote again two weeks later and softened his tone, saying, "We obviously are not going to disagree on any of the substantiated aspects of the Sea Turtle problem. My 'pool' of South China Turtles is actually not a real belief on my part either. It is only a concept which I cannot as yet exclude from my thinking." Hendrickson to Carr, May 2, 1961, Carr Papers.

22. Carr and Ogren, "Green Turtle in the Caribbean Sea," 29: "In spite of . . . the lack of statistical support for the belief, we are convinced, as we have said, that the re-nesting returns alone indicate a marked homing urge and ability in the female Caribbean green turtle."

23. Parsons to Carr, April 12, 1961, Carr Papers.

24. Carr, *The Reptiles*.

Chapter 6: A Turtle Flap in London

1. Tom Harrisson, "The Edible Turtle (*Chelonia mydas*) in Borneo, 9: Some New Hatching Observations," *Sarawak Museum Journal* 10, nos. 17-18 (1961): 299. See also Harrisson, "West Borneo Numbers," 614-23.

2. Tom Harrisson, "Present and Future of the Green Turtle," 265-69.

3. *Ibid.* Harrisson's remark about the name *Mydas* might have been a reference to the legend in Greek mythology of King Midas, who turned everything he touched into gold.

4. Heimann, *Most Offending Soul Alive*, 337. See Barbara Harrisson's book *Orang-utan*.

5. Heimann, *Most Offending Soul Alive*, 129, 162, 391-92.

6. Mark V. Barrows, Jr., *Nature's Ghosts*, 315-16.

7. *Ibid.*, 311. At the time of its founding, the IUCN was called the International Union for Nature Preservation.

8. *Ibid.*, 315-17.

9. Davis, *Man Who Saved Sea Turtles*, 181-83. Carr told IUCN officials that he would rather see Costa Rica adopt the park at Tortuguero as an act of national sovereignty over its natural resources than at the behest of an international campaign.

10. *Survival Species Memorandum, No. 14* (London: Fauna Preservation Society, Zoological Society of London, Sept. 24, 1963), in Harrisson Papers, IUCN Series, box 7. See also Barrows, *Nature's Ghosts*, 315-17. In 1964, biologists at the US Bureau of Sport Fisheries and Wildlife created a committee on wildlife which published in August 1964 the first Red Book of threatened species, following the model of IUCN's Survival Service Committee. Yaffee, *Prohibitive Policy*, 34-35.

11. Davis, *Man Who Saved Sea Turtles*, 169-70.

12. Barbara Harrisson, "International Proposals to Regulate Trade in Non-human Primates," *Primates* 13, no. 1 (March 1972): 111-14.

13. Ehrenfeld, *Biological Conservation*, 109.

14. Tom Harrisson, "Present and Future of the Green Turtle," 265-69.

15. Tom Harrisson to David Astor, 1963, Harrisson Papers, Correspondence Series.

16. Tom Harrisson, "Must the Turtle Die?" *Sunday Times (London) Weekly Review*, June 14, 1964, 29.

17. LaCroix to IUCN, June 1964, Harrisson Papers, IUCN Series. Harrisson somewhat retracted his insinuations, however, when he explained his meaning to David Astor. Harrisson to Astor, July 1964, Harrisson Papers, Correspondence Series.

18. Davidson, *Fire in the Turtle House*, 33.
19. John R. Hendrickson and E. Balasingham, "Nesting Beach Preferences of Malayan Sea Turtles," *Bulletin of the National Museum of Singapore* 33, no. 10 (1966): 69-76.
20. Kishinami, "John Roscoe Hendrickson Biography."
21. John L. Culliney, *Islands in a Far Sea* (Honolulu: University of Hawaii Press, 2006), 118-19.
22. Daniel Kaha 'ulelio, *Ka 'Oihana Lawai'a: Hawaiian Fishing Traditions* (Honolulu: Bishop Museum Press, 2006), 239. There is disagreement among historians on whether turtles were eaten by the common people or reserved for the nobility.
23. Hendrickson, "IUCN Report on Hawaiian Marine Turtles," Harrisson Papers, IUCN Series.
24. Ernest S. Reece to Tom Harrisson, Aug., 1965, Harrisson Papers, Correspondence Series.

Chapter 7: The Buffalo of the Sea

1. Carr, *The Reptiles*, 175.
2. Carr, *Handbook of Turtles*, 357.
3. Carr, *Windward Road* (1979 ed.). In this edition (p. 252), Carr included a photograph of young farm-reared green turtles at Torres Strait, Australia. Carr took this photograph in October 1973 when he visited the farms on behalf of the Australian government's inquiry into the turtle farms.
4. David K. Caldwell and Archie Carr, "Status of the Sea Turtle Fishery in Florida," in *Transactions of the Twenty-Second North American Wildlife Conference (March 4-6, 1957)*, (Washington, DC: Wildlife Management Institute, 1957), 460. The first North American Wildlife Conference had been called by Franklin D. Roosevelt in February 1936 and included a session entitled "The Problem of Vanishing Species." The proceedings were published as a US congressional committee print, for the 74th Congress, 2nd session.
5. Caldwell and Carr, "Sea Turtle Fishery in Florida," 461-62.
6. *Ibid.*, 462-63.
7. Harold Coolidge was the vice president of IUCN from 1948 to 1954, then its president, and was the founding chair of IUCN's Survival Service Commission. See James L. Aldrich and Anne M. Blackburn, "A Tribute to Harold J. Coolidge," *Environmentalist* 5, no. 2 (1985): 83-84; and Lee M. Talbot, "Dedication to Dr. Harold J. Coolidge," *Environmentalist* 2, no. 4 (1982): 281-82. Coolidge co-organized the Pacific Science Congress every four years. He may have met John Hendrickson at the 1953 Congress in Manila. At the 1957 congress in

Bangkok, Coolidge recommended that countries of Southeast Asia become involved in IUCN so that they could coordinate their conservation efforts. At that session, Tom Harrison described the status of conservation in Borneo, noting that uncontrolled trade for zoos and pets was threatening many native species. The one exception was the green turtle because he controlled the level of egg collecting. Harrison, "Conservation in the Island of Borneo," 12.

8. Archie Carr, "The Navigation of the Green Turtle," *Scientific American* 212, no. 5 (1965): 84.

9. Carr and Ogren, "Ecology and Migration of Sea Turtles, 4: The Green Turtle in the Caribbean Sea," 23-24. Carr and Ogren described informal tests of the sea-finding ability of hatchlings and female nesters under different conditions of beach gradient, distance from water, light intensity, and so on. *Ibid.*, 29-46.

10. Carr, *So Excellent a Fish*, 87-88. Carr noted that they needed "more searching tests" to determine what turtles see and how they react to light in finding the sea.

11. David Ehrenfeld was a PhD student of Carr's in the mid-1960s working on the behavioral ecology of green turtles and a National Institutes of Health fellow during the 1966 field work. He published the results with Arthur L. Koch. See David W. Ehrenfeld and A. L. Koch. "Visual Accommodation in the Green Turtle," *Science* 155 (Feb. 17, 1967): 827-28. Ehrenfeld went on to write extensively on the scientific and philosophical aspects of biological conservation, including the first textbook on the subject, drawn from his courses at Barnard College. He cautioned against scientism, saying that "science will need careful guidance and supervision from other disciplines" if it is to play a positive role in the future of biological conservation.

12. Carr described this work in *So Excellent a Fish*, 89-90.

13. Several of these students went on to careers that allowed them to continue to contribute to Carr's work in sea turtle conservation. Larry Ogren went to work for the National Marine Fisheries Service; Harold Hirth, to the University of Utah, with stints at the UN's Food and Agriculture Organization and Fulbright fellowships to Qatar. Howard Campbell went to work at the Department of Interior's Office of Endangered Species. David Ehrenfeld taught at Barnard College and then Rutgers University, where he authored the first textbook in biological conservation and founded the first scientific journal in that field, *Conservation Biology*. F. Wayne King was conservation director for the New York Zoological Society, where he actively campaigned to list Florida's endangered reptiles, including the American alligator and the green turtle, and held leadership positions in IUCN's Species Survival Commission.