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WACK of the Flying Carp

From Louisiana and Missouri through the American heartland and all the way north to Minnesota, Asian carp are invading freshwater lakes and rivers, threatening fisheries and ecosystems as they go.

by JEFF WHEELWRIGHT

WENDING THROUGH CORN AND soybean fields southwest of Chicago, the Illinois River eventually comes to the sleepy little town of Havana, Illinois. On the east bank of the river, the populated side, there is a field station run by the Illinois Natural History Survey. For decades now, INHS biologists in aluminum skiffs have scooted up and down the thinly wooded banks, monitoring local fish—these days, catching, recording and releasing approximately 150,000 of them a year. The local species are small and nondescript for the most part; their behavior is unremarkable. Probably the most colorful thing about these fish is their names: gizzard shad, bigmouth buffalo, largemouth bass, bluntnose minnow—hand-hewn names from America's heartland.

In the mid-'90s, though, the lazy stretch of river

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around Havana was roiled by the invasion of two species of Asian carp, the bighead carp and its flamboyant cousin, the silver carp. Imported from China during the 1970s, the carp escaped their ponds in the South, migrated up the Mississippi River, and spread into tributaries like the Illinois. "They pattered along for a few generations," says Duane C. Chapman, the top Asian carp expert for the U.S. Geological Service, "and then they reached an exponential growth phase." A quirk of silver carp behavior—an exaggerated startle response, causing them to leap from the water when boats approached—revealed their enormous, unexpected populations in the rivers of the Midwest. Along La Grange Reach, as this section of the Illinois is called, routine monitoring tasks took a dangerous turn. Today, the biologists there have to measure the local species amid a glut of flying aliens.

YOU'RE SITTING IN THE KILL ZONE," THAD COOK REMARKED TO ME, AS the skiff pulled away from the launch site. Cook, director of the INHS station, was driving. He sat behind a low shield in the stern, but the visitor's chair beside him was exposed. I stood up nervously, holding onto a strut. I recalled reading about a woman who nearly died while riding a jet-ski near Peoria, upstream from Havana, in 2004. She was knocked unconscious by a silver carp and tumbled into the river. "We're at ground zero," Cook warned, smiling. "The carp don't wax and wane here." In a video I'd watched on the Internet, a water skier wearing a football helmet laughs hysterically as he is towed through a fusillade of carp.

In Louisiana, Arkansas, Tennessee, and Missouri, Asian carp are now a familiar if irritating phenomenon. But as the fish have advanced—presently they're as far north as Minnesota and as far east as Indiana—wildlife agencies and fishermen's lobbies in the Great Lakes region have become alarmed. Commercial and sport fishing in the lakes is a \$7.5 billion industry, and officials fear it will be ruined if the carp invade and take over. The flashpoint of the concern has been the Chicago Sanitary and Ship Canal, which connects the Illinois River to Lake Michigan. The U.S. Army Corps of Engineers installed heavy-duty electrical fish barriers on the canal, and the Illinois Department of Natural Resource poisoned the canal on two occasions, killing thousands of fish while turning up a single bighead carp. Downstream, fishermen hired by the government have pulled hundreds of tons of bigheads and silvers from the upper reaches of the Illinois.

The Army Corps maintains that the invasion of the Asian carp has been halted short of the Great Lakes. But are the electrical barriers a Maginot Line? In June 2010, a 19-lb. bighead was caught in Calumet Lake, upstream of the barriers and only six miles from Lake Michigan. DNA traces of silver and bighead carp have also been detected in the waterways above the barriers. As a result, politicians outside of Illinois have demanded that the canal be shut. A lawsuit was filed by the neighboring states, but an appeals court sided with Illinois last year, keeping the canal open for now.

The news media in Michigan, Wisconsin, and Ohio have responded with investigative reports. La Grange Reach is where reporters go when they need to show what the Asian carp might do in the Great Lakes. "We are media central for carp tours," Cook said, looking in my direction. The July morning was steamy and placid. Motoring slowly upriver, we listened to the cry of a pileated woodpecker in the trees. The Illinois, about 300 feet wide, was ripe with the smell of dead fish and bare mud, for the spring flood had gone down only recently. Around each bend, the carcasses of silver carp speckled the steep shoreline.

Floodplain rivers such as the Illinois are naturally full of nutrients. Before the river was "leveed off" and the landscape behind it given over to agriculture, La Grange Reach tapped into shallow lakes, thick pockets of woods, and myriad sandbars and sloughs, all of which moderated the flow of nutrients into it. Today most of that buffering is gone. Agricultural runoff enriches the water further, as do the organic contributions from urban effluent, including that from Chicago's sewage system.

The broth of nutrients supports phytoplankton, which in turn sustain the Asian carp. Both the silver and bighead carp are filter-feeders. Water enters through their mouths and is pumped by a muscular contraction out through the gills. Comblike structures called gill-rakers trap the plankton and funnel them into tiny gullets. Having no stomachs to speak of, the carp must eat almost constantly in order to derive energy from this greenish gruel. Bighead carp are able to ram-feed, meaning they can strain plankton from the water simply by opening their mouths and swimming powerfully ahead. Spawning heavily and putting on weight rapidly, Asian carp soon grow too big for native predatory fish to handle. The biggest individuals can top 50 pounds.

In 2007, seven years after the carp were established in La Grange Reach, INHS biologists studied their impact on two indigenous filter-feeders, gizzard shad and bigmouth buffalo. The carp had caused their native competitors to become skinnier, and perhaps fewer. The density of silver carp themselves, meanwhile, was the greatest ever measured, an estimated 2,500 adults per kilometer of river, or about 4,000 per mile. By another calculation, the Illinois had increased its biomass along this stretch by 8 tons per mile. The food in the river was so rich it could sustain a huge new mess of fish on top of the old.

A fast technique for sampling the river is electrofishing—moving from spot to spot along the banks and stunning the hiding inhabitants with an electric current. The front of our snub-nosed craft was fitted with twin "hoppers," sets of cables dangling from two rings. A pair of young INHS biologists stood above them in the bow holding dip nets on poles; their job was to snag the shocked specimens that would float to the surface. Cook said that when he turned on the juice, not just the surrounding water but the entire skin of the boat would be electrified. The two techs stood on pressure plates, which would release and break the circuit if a man happened to fall in.

We eased into a tributary on the far side of the river. A fish leaped here and there. Cook pushed a lever and lowered the hop-

pers into the water. He nosed the skiff toward a promising snag under which fish might be lurking. “Fire in the hole,” he barked, the signal to start the current. Within a fraction of a second, hundreds of bright fish were in the air. The silver carp reacted to the electricity as if jerked upward by a puppet-master. Their glinting, writhing bodies could be seen for 50 yards in either direction. The eruption made no sound initially—the splashing and thumping started as they fell. Fish landed near the boat and also in the boat, their tails slapping wildly against my ankles, but I couldn’t look down for fear of being struck by others sailing in. I ducked and weaved. I saw two carp arc upwards and comically collide in mid-air, but I wasn’t laughing. A 5-lb. fish banged my left shoulder, another my chest.

The two biologists in front, shrugging off the blows, kept their eyes peeled for native fish. They stabbed the water with their nets. They pulled in a gizzard shad, and a minute later a flathead catfish. A small bluegill was netted. When the exercise was over and the pelting by the carp ceased, the team examined a rare and beautiful catch: a long-nosed gar, a slender fish about 18 inches long, with olive and yellow patterning and a file of small, translucent teeth.

The crew did three more rounds of electrofishing at other sites, and then called it quits. In total, a dozen indigenous fish had been collected and put back, while 60 or 70 silver carp had dropped unwanted into the boat. Cook didn’t even look at them. All the same age, about two years old, and about the same size, roughly two feet long, the carp were bone-white in color, with attractive yellow trim. They gasped through bloodied gills, and their eyes were glazed. Following each round of shocking, the fourth member of the INHS team, the most junior guy in the boat, slung the dying fish over the side. Most of them were too far gone to revive.

WET ALIEN INVASION

In addition to the Asian carp, a slew of other aquatic invaders are causing ecological and economic havoc in freshwater settings across the United States. The following are five of the most destructive.

QUAGGA AND ZEBRA MUSSELS are quickly becoming America’s most troublesome freshwater invasive species. First noticed near the Great Lakes around 1988, these mollusks presumably arrived in the ballast water of ships coming over from Europe. Since then, their populations have exploded, clogging water intakes at municipal water supplies and power-generation stations. When these species invade, they reduce the amount of plankton available to feed native fish. Reduced fish populations allow aquatic plants to grow unchecked, further clogging waterways. Cleanup has cost hundreds of millions of dollars.

COMMON CARP are the most widespread invasive fish in the United States; they also cause more economic and environmental damage than any other fish. Carp feed by uprooting native vegetation, which muddies water and disturbs the habitats of a wide variety of native fish, including a number of commercially valuable ones.

GIANT SALVINIA is native to southeastern Brazil. It was most likely brought here by the aquarium trade; this free-floating aquatic fern is now particularly problematic in many southern states. It forms giant mats of vegetation on the water’s surface, obstructing waterways and impeding the function of power plants, navigation equipment, and irrigation systems. At its densest, salvinia blocks light, depleting oxygen needed by the aquatic life in the water below.

WATER HYACINTH is another Brazilian native. This floating plant was imported for its lovely lavender flowers, but it is now overtaking many freshwater sources in the southern United States. Like salvinia, it depletes oxygen and prevents light from penetrating the water’s surface, rendering freshwater habitats uninhabitable for most native aquatic species.

MOXOBOLUS CEREBRALIS is a myxozoan (a parasite of aquatic animals) that infected European trout shipped to the United States in the 1950s. The organism then made the leap to both wild and farmed trout across the American west, causing what’s known as whirling disease. Once infected, a juvenile fish experiences potentially lethal neurological damage and skeletal deformation. The disease can kill off 90 percent of infected populations.

JENNIFER BERGLUND

We raced back to the launch site. High speed made the trip exciting because the silvers, spooked by the roar of the motor, flew into our space all the quicker. One whizzed by my head so fast I never saw it—just a flash and a trail of water on my sunglasses. Cook had been hit several times too. Ashore, he made light of the sticky imprint of a carp’s tail on his ballcap. He had flecks of slime and blood on his shorts and bare legs. “What’s really bad is when they destroy a thousand-dollar GPS system,” Cook quipped, but there was an undercurrent of anger on his face, which the biologist could not disguise. Things were badly out of whack on his beloved Illinois River.

Fifty years ago, when wildlife managers and aquatic biologists were eager to tinker with nature, Asian carp looked like a great fit for American waters. Four species of carp were imported: first the grass and black carp, and later, the silver and bighead. Their general assignment was to keep ponds and lakes clean. The first introduction was the grass carp, or white amur, in the early 1960s. Biologists in Arkansas thought the carp would crop reeds and other weedy vegetation. They did the job well, and were adopted by agencies in other states. In many places they ended up overdoing the job. “Grass carp can turn vegetated zones in lake margins to essentially a bathtub in a few years,” says the USGS’s Chapman. “Overstocking of grass carp in ponds and lakes and reservoirs causes problems all the time.”

The grass carp became the most widespread of the four invaders, but, lacking large numbers in rivers, it doesn’t get much publicity. Nor does the most recent import, the black carp. In the 1980s this species, which feeds on molluscs, was used to control snails that host parasites in catfish ponds, and though it too escaped to rivers, it is generally confined to the deep South. The bighead and the silver species, the two notorious carp, were brought into Arkansas in the early 1970s by an enterpreneurial fish farmer. Taking an interest in them, state and federal labs and local universities bred the carp and distributed their eggs. Officials were looking for alternatives to the chemical treatment of sewage lagoons and aquaculture ponds. The Asian carp made the water “clean enough to drink,” enthused one researcher, and



could be raised for human consumption as well. Louisiana and Alabama fish-farmers welcomed the bighead carp. A few lakes were stocked for the benefit of fishermen. Nobody lost sleep when some silvers and bigheads escaped into rivers during flood events.

The commercial catch of bighead carp increased ten-fold in the Mississippi River Basin between 1994 and 1997, a figure that reflects a surge in supply rather than growing demand to eat them. But by then the bighead were out of control. They had migrated 1,000 miles from their introduction points in North America. It seemed inevitable that they would threaten the Great Lakes.

The threat posed by Asian carp to the lakes is more economic than ecologic, driven by the value of the Great Lakes fishery. The native walleye is thought to be directly vulnerable, because its larvae are small and might be ingested along with the carp's regular diet of phytoplankton. More generally, the food chain of the walleye, salmon, and whitefish—all prized by fishermen—might be at risk. The fear is that the greedy carp would claim first dibs on the microscopic food supply, and that trophic effects would cascade. "The first rule of competition is, whoever can eat the smallest stuff wins," explains Chapman. "If silver carp eat all the plankton that the prey of adult walleye would eat, then you get less prey for the walleye and less walleye." Competition between fish at the base of the food pyramid could be

much stiffer in the lakes because of limits on the nutrients there.

Since the discovery of carp DNA in the waterways near Chicago in 2009, the Asian Carp Regional Coordinating Committee, which consists of federal, state, and local agencies, has spent \$100 million on carp research and control. The official line is that if any fish are living north of the electrical barriers on the canal, they are sparse and scattered, too few to reproduce in the Great Lakes. Though he doesn't disagree, Chapman adds a note of doubt. "They're very cryptic. They're wanderers—an open-water fish. They *could* be out there."

Duane Chapman knows his rivers, but the scientists who study the lakes are less impressed by the carp threat. "It's way overhyped," says Gary Fahnenstiel, an aquatic biologist with the Great Lakes Environmental Research Laboratory, which is run by the National Oceanographic and Atmospheric Administration. One reason is that the nutrients and plankton in the waters of the Great Lakes are not merely limited, they are crashing, due to a different exotic species, the zebra mussel, and its cousin, the quagga mussel, two invaders that stowed on ships from Europe in the 1980s. Having multiplied on the bottom of the lakes, the mussels are straining the lake water of most of its plankton. One result, Fahnenstiel points out, is that the population of a shrimp important to the diet of whitefish and salmon is plummeting. The mussels' threat to the



Front spread: Two species of Asian carp, the bighead and silver, jumping out of the Illinois River near Havana, Ill. Left: Scientists help educate media and the public about Asian carp on the Illinois River.

habitat. Their eggs and larvae need to drift for a period in a mild, steady current or else they will sink and be smothered on the bottom. Chapman calls the spawning requirements of silver and bighead carp their Achilles heel because the rivers feeding the Great Lakes—assuming the fish could discover them—tend to be fast, rocky and short, not ideal for nursing carp.

Most probably, then, Lakes Michigan, Superior, and Huron will not support Asian carp in worrisome numbers. NOAA's Fahnenstiel was not as confident about the unsuitability of Lake Erie. Erie could well host carp. The smallest and warmest of the Great Lakes, Erie has sheltered coves containing algae and a meandering river, the Maumee, for potential spawning. Three bigheads— isolated individuals—have been pulled from its waters by fishermen, though none have been seen lately. “Those were big fat fish,” Chapman cautions. “Lake Erie looks like a pretty good home for [populations of] bighead and silver.”

The USGS's Columbia Environmental Research Center (CERC), where Chapman works, is in Columbia, Missouri, near the eponymous river— some 350 miles from Chicago and the front of the invasion. CERC maintains and studies carp of all sizes: adult bigheads and silvers in a dozen ponds; six-inch juveniles, swirling in tight schools in tanks; eggs and larvae floating in beakers; even carp in an aquarium behind the receptionist's desk. Chapman directs a dozen scientists and staffers on various explorations of carp behavior and physiology.

There is pressure on the scientists to understand the life history of the two species better so that the agencies can attack them more precisely. For instance, when alarmed, juvenile Asian carp emit “aggregation pheromones,” biochemical signals telling the fish to bunch up. If the pheromones can be decoded and synthesized, they might be used to disrupt migration and spawning. The phases of egg hatching and larval development are the subject of another project. Chapman and colleague Amy George published a paper last year that aimed to predict the growth rates and temperature and current requirements of juveniles drifting in rivers. The work might allow wildlife managers to prioritize the tributaries that they ought to check for carp. A new finding that came out of the study was that, very soon after hatching, larval carp are able to swim vertically, fighting off their tendency to sink toward the bottom.

A post-doctoral researcher, Karthik Masagounder, who is in charge of nutritional studies, took me around a lab building at CERC. Masagounder records the calories in the dried algae that he feeds to his captive carp, and then he tracks the weight of the fish, which depends as well on the temperatures maintained in the tanks. He has put together a mathematical model of the calorie exchange. “We want to know,” he explained, “if they colonize the Great Lakes, how will they grow? With a certain amount of plankton available, the model will tell us their weight gain in a year.” Masagounder climbed a ladder onto the side of a large, round tank. It was covered with mesh, lest the subadult silver carp jump out. With a small dip net, the researcher tried to catch

fishery is not hypothetical—it's actually happening.

As the mussels transfer nutrients from the upper levels of the lakes to the bottom, yet another exotic species, the round goby, has exploded. The round goby is a small fish that feeds on the bottom, unlike the silver and bighead carp. In effect, the mussels bring the food supply down to the level where the gobies can get it. Indeed, it was the round goby that prompted the installation of the first electrical barrier in the Chicago Ship and Sanitary Canal 15 years ago. The barrier was meant to keep the goby out of the rivers, rather than the carp from the lakes, and it failed. At any rate, should a wave of carp make it through the canal or penetrate the lakes by another route, they will find little food to sustain them. Chapman counters that they might concentrate their diet on a blue-green algae, *Mycrocystis*, which the mussels don't eat, or turn to a clumpy, shoreline algae known as *Cladophora*. They might get enough to eat that way, he says.

SURVIVAL OF THE ASIAN CARP IN THE DEEP, windblown, and, in winter, ice-covered waters of the Great Lakes is one thing, but development of a breeding population there is quite another. Silver and bighead carp cannot spawn in lakes; instead, they must find their way into river

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one. Cautiously he edged the net under the mesh. But the little fish went bonkers, leaping and splashing as its relatives do on the Illinois, and Masagounder backed off, shaking his head and remarking, “They make my life miserable.”

That is something Duane Chapman would never say about a carp. “They drive my waking moments, and I’m thinking about them at 3 a.m.,” he reflects. The 53-year-old Chapman is a commanding figure. With his resonating bass voice and 6’4” height, he dominates conversations with his peers, whether at formal meetings or standing around the water cooler. Although his focus these days is experimental, he has paid his dues in the field. “I’ve spent thousands of hours getting carp-slimed on the river,” he says, sounding proud. One day when he came home from work, he smelled so bad that his daughter, running across the lawn to greet him, stopped and ran the other way. If you e-mail him a technical question about fish slime, he may send you more than you need to know, such as the fact that

“fish have mucous on the outside of their bodies for the same reason that we have mucous inside our noses. It makes it hard for things we don’t like to get a purchase on our tissues.” And: “I have to admit, silver carp and bighead carp do seem to have a bit fishier smell to them than most, and I think that is something in the slime, plus the fact that their feces are usually runny and tend to run out and go everywhere when the fish jump in your boat. And the green color of the feces does not help.”

I soon realized that, though his mission is to stop them, Duane Chapman is fond of Asian carp. In his office he shows off a rack of teeth that were taken from a monstrous, 106-lb. bighead. Placed at the very back of the throat near the gullet, the small teeth grind the plankton just before the food goes down. When he diagrams how the fish transfers the plankton from the water to its gill-rakers and then to its gullet, Chapman says, “It’s such a cool thing they’ve got, to channel their food.” Likewise, when reporters seek his views on the threat to the Great Lakes, his passion for the subject can encompass all sides of the issue, usually sketching how the carp could adapt to the lakes, but other times arguing why they might not. When I noted that three bigheads had already been caught in Lake Erie, he said sharply, “Do you know how hard it is to stock a big lake with Asian carp? The Europeans really had to struggle to establish a population.”

There are many places in the world where these fish are

wanted. In their native China, which Chapman has visited twice, the silver carp are small and overfished and hardly jump at all. Chapman thinks the leaping behavior seen in the U.S. is probably a function of crowding; a less likely explanation is the emergence of a genetic quirk. In lakes and rivers in Europe, an Asian carp is a welcome catch. Americans turn up their noses because they associate the bighead and silver carp with the common carp, which roots in the mud. To foster a more positive impression, the Illinois Department of Natural Resources sponsors bow-fishing tournaments for carp (“Bow-fishing is a great way to enjoy the outdoors... an exciting and fun way to catch fish—while also highlighting the importance of removing invasive Asian carp from our waterways”). The agency puts on cooking demonstrations and donates carp meat to food pantries for the poor (“Target Hunger Now!”). Silver carp goes by a new name on local menus: silverfin.

Chapman has concerns about the establishment of a carp fishery in the U.S. because traffic in the two species could make it easier for them to spread. But in his enthusiasm for all

things carp he once made a YouTube video showing how to debone the fish (no easy chore) and prepare it for the pan. When I asked if they tasted good

on the grill, it didn’t take much persuasion for Chapman to organize a barbecue at CERC during the lunch hour. In the hot sunshine of a back lot, beside an equipment bay, molecular biologists, fish physiologists, and summer interns munched on carp fajitas. The white meat was firm, smooth, slightly flaky—delicious.

“Ninety per cent of the catch in the Danube River is bighead and silver,” Chapman remarked to his listeners. “They’re not an issue there; they *are* the fishery. If you want more biomass, or to feed more people, then it’s a great choice.” He pointed out that “invasive” was a relative term. “If you like ‘em, they’re not invasive.”

Reaching for some more grilled fish, the pork-rub filet this time, he said, “I don’t like Asian carp not because they’re ‘bad’. It’s what they do to walleyes and salmonids. In Europe, fishes with pelagic [open-water] life history did poorly in the presence of silver carp.” Brightening again, he continued: “These are really cool fish. They can do what so many fish can’t do.” He paused, looking torn. “I just wish they weren’t here.”



Carp, a series of fish species from the family Cyprinus, are native to Europe and Asia. These relatively large, freshwater animals are considered invasive in the United States.

Jeff Wheelwright, a longtime contributor, is the author of *The Wandering Gene and the Indian Princess: Race, Religion, and DNA* (W.W.Norton, 2012).