CREATING THE PERFECT WAVE

Kerry Black travelled the world in search of the best surf spots. Then he decided to build them himself — on land. **Mark Schrope** meets the maverick oceanographer.

N. BOTHMA/EPA/CORBIS

Lori Wilson Park, near Cape Canaveral on Florida's east coast, is not known as one of the world's best surf spots. On a typical weekday approaching sunset, a handful of surfers might be found catching some good, but not great, waves. Florida's finest surfing doesn't usually occur until a tropical storm or other suitable weather system passes the right distance offshore.

Surfers here may grumble at times, but they accept they are at the mercy of the ocean's fickle moods and the beaches' idiosyncrasies. But surprisingly enough, that may be about to change. Soon, surfers at Lori Wilson Park could become the first ever to have a choice between two new surf options: catching natural waves that have been dramatically improved by an artificial reef, or driving an hour inland to ride great artificial waves at a newly developed surf park.

When that happens, they can thank Kerry Black, a physical oceanographer and lifelong surfer who has spent the past decade trying to override the ocean's whims. He plans to install offshore artificial reefs at places to better control waves and, in the process, improve surfing, create new habitats for marine life and prevent beach erosion. At the same time, Black and his New Zealand-based company, ASR, are working with US partners to construct the first wave pool purpose-built for surfing — which would generate phenomenal waves rivalling those at the world's best natural surf spots.

Breaking technology

Black seems well qualified for both tasks. Born in Melbourne, Australia, he began surfing when he was 14 and eventually trained as an oceanographer. For decades, his research focused on topics such as larval dispersal along reefs and sand transport along beaches. But in 1995 he accepted a professorship at Waikato University in Hamilton, New Zealand — a position that, he says, offers a great deal of autonomy "as long as you don't break any obvious rules".

To the university's surprise, Black decided to shift his research focus. "About two months in," he remembers, "I was literally wandering through the grounds wondering what I wanted to do when I thought: let's see if we can understand surf breaks. And that's when we set up the programme."

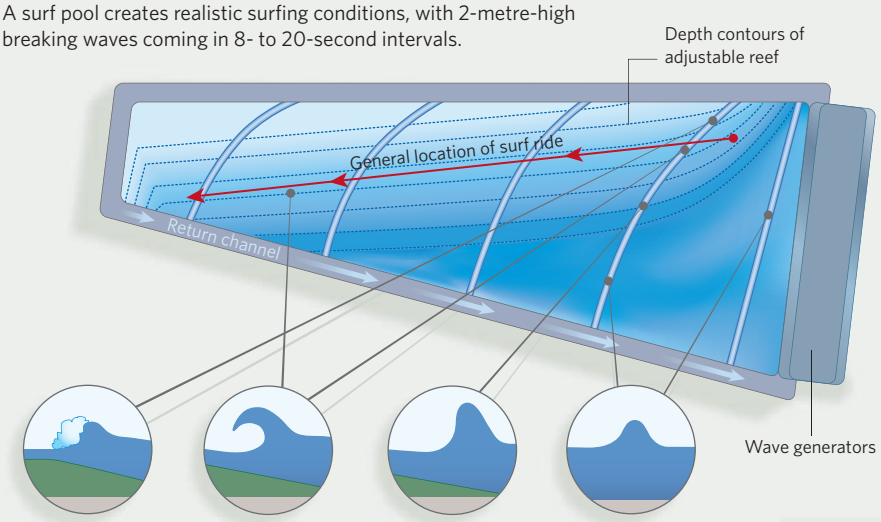
His wave-research programme included travelling to 44 of the world's best surfing spots — from Bingin in Bali, to Malibu in California — to gather sonar data on the topography of the reefs there. Black was flooded with applications from students who wanted to be involved, but faculty response ranged from shocked to cynical to confrontational. In time, the university community came to accept the research, says Black, but the larger academic world was not as malleable. "I took the responsibility to actually explain to every student that if this is your degree course, you could be studying for a profession that does not exist," he says.

Today, that profession has to some degree emerged. After seven years at Waikato, Black left to form his company with some of his graduate students. ASR is based in the surf town of Raglan, made famous in the 1966 documentary *The Endless Summer*. The company's main interests are in designing and building surf pools and artificial reefs; dozens of the latter are in various stages of development in nations such as India, South Africa and the United Kingdom. And in August, the company sponsored the biennial International Surfing Reef Conference, a three-day event that drew some 50 researchers to Black's own surfing resort on Lombok, Indonesia. There, for the first time, many of the presentations were able to go beyond theory and into case studies of reefs that have actually been built.

"If you add up all the surfing breaks in the

MAKING WAVES

A surf pool creates realistic surfing conditions, with 2-metre-high breaking waves coming in 8- to 20-second intervals.



world and count how many you would call classic surf breaks, you realize it's a very small fraction," says Black. This suggests that a nearly magical combination of conditions must align to create great natural waves. Black hopes to capitalize on his knowledge of the world's classic surf spots to build artificial reefs that create the same sort of surfing experience.

Wave theory

The exact details are proprietary, but in the simplest terms, the important factors are the slope of the reef on its ocean side — which helps determine when and how a wave will break on the landward side — and the angle of the reef in relation to incoming swells, known as the 'peel angle'. For good surfing, it is essential that waves do not break all at once but peel — or break in such a way that surfers can ride in front of the crest on an open wave face, or even inside the breaking portion, known as the barrel.

Other critical wave characteristics are size and power; not surprisingly, the bigger and more powerful the wave, the better the surfing. Artificial reefs can control these factors, to some extent, by concentrating the waves' energy. The surfer's ideal wave usually requires a light wind blowing out from shore, to groom the wave face and make it smoother — but reef designers can't do much about that.

Artificial reefs are not as scenic as natural ones; at ASR, they are made of huge sand-filled bags, up to 50 metres long, made from synthetic fibre sheets. Every location has different wind and ocean swell conditions, so each reef must be designed individually for that spot. Reef designers must also meet specific wave goals: for instance, whether to maximize the number of surfable days per year or the quality of waves when the very best swells come through. Reefs can also be tailored for intermediate or advanced surfers. "There is a gigantic juggling exercise that goes on in trying to balance all these different effects," says Black.

Another factor to juggle is whether the artificial reefs can help protect the beach from erosion. Florida's Lori Wilson Park, like many beaches worldwide, has to be repeatedly replenished by sand dredged from offshore, a process called 'nourishment'. "It is basically buying you time, because you're putting the beach back to where it used to be," says Robert Dalrymple, a coastal engineer at the Johns Hopkins University in Baltimore, Maryland. "One thing it doesn't do is cure the original cause of the beach erosion. If it eroded before, it's going to erode again."

Such nourishment projects can protect beachfront properties and restore vanishing beaches, but also have high financial and ecological costs. Black and his colleagues think artificial reefs could hold a solution.

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> — Kerry Black

Artificial reefs could work in some instances, says Dalrymple, as anything placed offshore that reduces the wave energy hitting a beach could potentially reduce erosion. But he warns that the solution isn't necessarily simple. "You have to be really careful because you can also put a structure offshore that makes the erosion problem worse," he says. For instance, an artificial reef could capture sand that would have otherwise been transported to — and deposited on — another section of beach.

The first test of one of Black's designs came at the Narrowneck Reef on Australia's Gold Coast, a massive 60,000-cubic-metre structure completed in 2000. The project, funded mainly to protect the beach from erosion, also included dumping nourishment sand in areas up and down the beach, either side of the reef, to balance erosion that might occur as sand shifted and the beach adjusted to the new structure.

"So far things are going great," says John McGrath, an engineer with the Gold Coast City Council who oversees the monitoring work. The beach inside the reef has widened and nearby erosion has proceeded gradually at expected rates, although McGrath says problems could conceivably still arise given that the period since construction has seen fewer than normal severe storms.

Against the current

Very little is really known about how artificial reefs can affect erosion, says Muthukumar Narayanaswamy, a graduate student at Johns Hopkins who works with Dalrymple. He recently completed a white paper on the potential of artificial reefs to prevent erosion. For instance, a small artificial reef off El Segundo, California — not built by ASR — settled into the sea bed so deeply that it neither improved surf nor reduced erosion. "A lot more work needs to be done before saying that these structures are the cure-all for coastal erosion," he says.

Narayanaswamy's study was commissioned by the Surfrider Foundation, based in San Clemente, California. Chad Nelsen, the group's environmental director, is also cautious; he worries that artificial reefs could create a false sense of security that might promote even more coastal development than has already occurred in the United States. Nelsen thinks proposals for artificial reefs should be carefully scrutinized. Black, he says, "is a salesman and also a talented scientist, but he's motivated to build reefs".

At Narrowneck, the artificial reef hasn't been as good at enhancing surf as it has at preventing beach erosion. Waves have improved somewhat, but not as much as intended. Although designed by ASR, the company was not involved in its construction, which was handled by local engineers. The bags that make up the reef were dropped from a barge, and the reef ended up not being as high as planned. This kept the barge from grounding itself on the bags, but also reduced the reef's impact on incoming swells.

But Narrowneck has worked well ecologically. The reef is covered with seaweed that supports marine creatures such as worms, crabs, lobsters and a wealth of baitfish. Corals cannot attach themselves to the geotextile material, but there are few nearshore reefs in the area, making it biologically valuable, says Steve Smith, a marine biologist at the University of New England in Coffs Harbor, Australia. Narrowneck is also popular with snorkellers.

Elsewhere, ASR has had more luck with achieving both good waves and good ecology at its 6,000-cubic-metre Mount Reef in Mount Maunganui, New Zealand. To get around the barge depth problem, Black's team designed a system for connecting the bags using seatbelt material. Workers dragged a web of empty bags into place using anchors in the sea floor, then filled them with sand using dredging equipment. "This is the first reef we've had control

M. SCHROPE

Brain wave: physical oceanographer Kerry Black wants to create an artificial reef and ocean-sized swell in a wave pool for surfers in Florida.

over all the way," says Black. "It is really proof of all parts of the concept."

Mount Reef saw its first significant swell in October. "To see some waves breaking as we knew they would, that's a pretty good feeling," says David Neilson, executive director of the Mount Reef Trust, which raised money for the project. Sand has also built up between the reef and the beach, and crayfish have colonized the reef, along with mussels, crabs and snapper.

Surfers' paradise

But even the world's best artificial reef relies on storms, winds and tides to create great waves. To get around that problem, Black's team set out to design a new kind of wave pool specifically for surfers. The first is under construction in Florida.

There are countless wave pools around the world already, mainly for lazy, family fun in water parks. Although some of the pools produce surfable waves, none are specifically designed for surfing. Black realized that a few relatively simple changes to basic designs could dramatically improve the situation. Wave pools typically get wider as you move away from the wave machine, and they use fresh water. To improve surfing, ASR's design calls for narrowing pools to concentrate energy and salt water to improve buoyancy.

More critically, wave pools don't contain reefs. So ASR designed a patented structure called the Versareef, made of steel triangles overlain with rubber, to sculpt pool waves to satisfy even the most advanced surfer. The shape of the Versareef can be shifted on demand to allow different configurations — thus producing waves that mimic those of the world's best surf breaks.

The first Versareef pool is a beginner's model that will produce waves about 1 metre high, at the Ron Jon Surf Park in Orlando, Florida. If this is successful, a larger pool, for expert waves up to 2 metres high, will be built soon after that. A number of other projects, including in England and California, are on hold until the first pool is successfully completed. "No one will sign until this one works," says Black.

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In August, the pool was filled and the first waves created, but the prototype Versareef was unable to withstand the pressure of the waves. On a recent visit to the test pool, despite the setback, Black spoke confidently of the prospects for success. "We know it's going to work," he says. The reef structure has now been beefed up substantially, and the first successful waves were produced at the beginning of December.

For Florida surfers, the pools clearly can't be completed soon enough; thousands are already on the waiting list for park membership. Black envisages that one day the pools will host unprecedented surf contests where competitors will be able to ride identical waves, which will enable more accurate judging. And he hopes the pools could even be used for wave research, as they will be larger than most wave tanks that are currently available to scientists. Dalrymple says the pools could be a valuable resource if they are not too expensive for scientists' research budgets.

Back in Cocoa Beach, Florida, surfers may also see better surfing options soon. John Hearin, an engineer with NASA, is working with Black and others to push through plans for an artificial reef that Hearin designed for his master's degree. The plan, most likely for Lori Wilson Park, is still in its early stages, but local officials and business have been supportive.

So, with natural waves enhanced by artificial reefs and unbelievable artificial waves available on demand, will surfers be willing to give up their famous global quest for good waves? Absolutely not, says Black. He views the pools and artificial reefs as a great addition to surfing, but not as replacements for the real thing. Surf beaches are his favourite place in the world to go, he says. "I really need these places for my own health to get away and just surf." ■

Mark Schrope is a freelance writer, and regular surfer, in Florida.