



# Fishy futures

George Sugihara has gone from an academic career in biological oceanography to the world of high finance, and back again. Now he is applying the lessons he learned in business to the conservation of fish stocks. **Rex Dalton** reports.

**W**hen George Sugihara was seduced by German bankers, he was wooed with style. He was whisked from his San Diego lab to a swanky London hotel, where his room came with a personal butler. Then it was on to a country estate stocked with the finest food and wines. His suitor was a senior executive with Deutsche Bank, one of the world's leading financial firms. One night, with a Cuban cigar in hand, the banker wrote ever-increasing monetary offers on a napkin. "It was remarkable," Sugihara recalls.

By the mid-1990s, banks and investment houses had realized that academics skilled in mathematical modelling could help them to devise winning strategies with which to play the world's financial markets. Sugihara, who had built a formidable reputation among ecologists by analysing the population dynamics of fish and plankton, was a prize catch. Deutsche Bank wanted him to apply those talents to its 'black-box project', a secret endeavour designed to predict the prices of various financial instruments.

Sugihara struck a hard bargain. In addition to providing an ample salary, Deutsche Bank agreed to let him stay in San Diego — where the Frankfurt-based firm provided a posh

office complex overlooking the harbour. There, it gave him all the resources he needed to devise models to decipher price trends from masses of financial data.

In 1995, when Sugihara took leave of absence from the University of California, San Diego (UCSD), his colleagues thought it unlikely that he would ever return — few scientists who have been seduced by the world of finance have later resumed their academic careers. But Sugihara has bucked that trend, and is now applying his experience in finance to marine conservation. He wants to harness market forces to prevent over-fishing — which governments and the scientists who advise them have mostly so far failed to achieve.

In reality, Sugihara never turned his back on biological oceanography. During his four years with Deutsche Bank, he taught part-time at UCSD, and published more than a dozen scientific articles on complex biological systems. When his leave period was up, he says, hard science was always going to win over high

finance. "No, it wasn't hard to leave that world," he says. "I really wanted to do science."

But Sugihara's experience of the markets has changed the way he thinks about managing the ocean's natural resources. For decades, investors have traded on markets for the future prices of virtually every commodity, from grain crops, through orange juice, to oil. Yet despite worldwide sales of at least US\$80 billion a year, there is no futures market for fish. Sugihara hopes to change that. By providing people with the means to make money, and offering a structured financial environment for the worldwide catch and sale of fish, he argues, it should be possible to prevent stock depletion.

## Trading places

To this end, Sugihara and a number of scientific colleagues are now seeking start-up finance for a company called the Ocean Resource Exchange. This would trade and lease financial instruments or derivatives associated with fish catches, on an electronic commodities exchange.

Perhaps trading is in Sugihara's genes. His Japanese father was a trader in wood products, who settled in California in 1951 with his Indonesian wife and young son, seeking new opportunities away from the turmoil of

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post-war Asia. But the young Sugihara didn't follow his father into business. After graduating from the University of Michigan in 1973, he embarked on an academic career, initially studying lake cores in Africa. First he worked in Zambia, where he identified pollens and diatoms for palaeoclimate studies. Later, he moved to Tunisia to study algal productivity and the origins of hydrogen sulphide emissions from Lake Tunis.

Sugihara's analytical mind found this fieldwork unsatisfying, so he returned to Michigan to bone up on mathematics. "I took 26 courses in two years," he says. And with his growing mathematical sophistication, he developed a theory to explain an observed regularity in the distribution of species abundance<sup>1</sup>. When he approached Robert May, then conducting pioneering analyses of biodiversity at the Institute for Advanced Study in Princeton, New Jersey, with the theory, May immediately recognized Sugihara's potential — and signed him up as a doctoral student.

By the time Sugihara completed his PhD in 1982, he already had his eyes on UCSD's Scripps Institution of Oceanography, which hosted a largely untapped repository of oceanographic and fisheries data. "This was a gold mine," says Sugihara. "And no one was looking at it intensively."

At Scripps, Sugihara used these data to develop and test mathematical models designed to probe the dynamics of complex biological systems. Among the results was an influential article published with May, which showed how to use nonlinear equations — formulas where output isn't proportional to input — to make short-term predictions about the behaviour of chaotic systems such as the population dynamics of marine plankton<sup>2</sup>.

### Trend setter

Among those who recognized the equations' power was former behavioural ecologist Steven Schulman, who knew Sugihara from Princeton. By 1990, Schulman was in the New York office of the financial firm Merrill Lynch, conducting quantitative analyses to reduce investment risk. In Sugihara's equations, Schulman saw the possibility of predicting prices in market derivatives. So he brokered a consulting deal: Merrill Lynch provided Sugihara with financial data, which he mined for price trends.

For Sugihara, it was a dream. First, the arrangement allowed him to put his own finances on a sounder footing. "I couldn't afford to send my children to college, back then," he says. Analysing the markets also presented him with fresh intellectual challenges. "I'm driven by access to data," he says.

Then, in 1995, came the extravagant courtship by Robert Stein, then the head of Deutsche Bank's Japanese office. Confidentiality agree-



Nice work: the Deutsche Bank installed George Sugihara in plush offices on the 20th floor of the Emerald Plaza in San Diego.

ments prevent Sugihara from discussing details of his work for the bank. "Basically, I modelled the fear and greed of mobs that trade," he says. And at the time, Sugihara was even more discreet, telling acquaintances who asked about his work: "I'm a teacher." Former colleagues who visited didn't know what to make of his new life as a financial sleuth. Sugihara recalls the first time that May dropped by at his harbour-side office and assumed he was the victim of an elaborate practical joke. "He opened a desk drawer to look for something with my name on it," Sugihara says.

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Sugihara's earnings in the world of finance have provided a home with an enviable sea view, plus a vintage Porsche parked in the garage. But by the standards of banking high-fliers, these are limited extravagances. For Sugihara, acquiring wealth was never the main goal, so he had few qualms about getting back on the treadmill of winning grants for his research. That's not always easy for someone who cuts across disciplines, and whose ideas are often ahead of their time. "It's too far out of the box" is a common comment from reviewers, Sugihara observes.

But unlike his colleagues, whose grant

applications get tossed aside, Sugihara has the luxury of being able to support some of his own research, using a trust fund set up during his Deutsche Bank days. In part, that was how he funded his latest work, an analysis of environmental fluctuations and ecological catastrophes in the North Pacific<sup>3</sup>. This suggests that fishing quotas may need to be set more conservatively, and adjusted more frequently to compensate for environmental conditions, than is typically the case. "The way fish quotas are set is wrong," says Sugihara. "It doesn't fit nature or reality."

### Net gains

The National Marine Fisheries Service (NMFS), which sets quotas in US waters, is at least prepared to listen to this message. When Sugihara gave a lecture in June to a NMFS scientific panel on quota methodology in the North Pacific, his talk went on for two hours — three times as long as scheduled — as agency staff quizzed him on the details. "It was really interesting," says Jeffrey Polovina, a NMFS biological oceanographer who organized the meeting, held in Seattle. "But it was pretty complicated stuff. Most of us don't have the background in chaos theory."

Sugihara hopes that the Ocean Resource Exchange will provide an incentive to preserve fish stocks that doesn't rely on a detailed understanding of complex biological systems, and instead taps into people's baser instincts. "Show them how to make more money," he says. The first derivative is likely to be a futures contract for a certain percentage of a fisherman's catch at an agreed price at a specified time. Another planned derivative is an instrument for trading fish quota allotments, called an 'individual transfer quota'.

"Essentially, these are tradable poker chips or options for fishing rights," Sugihara says. Fishermen and investors could hedge their bets, which should reduce the tendency for catches to swing between boom and bust, and give all stakeholders a tangible financial incentive not to cheat and plunder the ecosystem for the maximum short-term return.

As a test of the idea, Sugihara is modelling the concept using data from a Californian squid fishery — where about 200 vessels bring in a haul worth up to US\$36 million per year. But both catches and prices can fluctuate widely, making it a prime candidate for a market in derivatives. "The motive here is public service," he says. "I think we can use market forces for conservation." ■

**Rex Dalton is Nature's US West Coast correspondent.**

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2. Sugihara, G. & May, R. M. *Nature* **344**, 734-741 (1990).
3. Hsieh, C.-H., Glaser, S. M., Lucas, A. J. & Sugihara, G. *Nature* **435**, 336-340 (2005).