



Fishing and conservation

A rising tide

Scientists find proof that privatising fishing stocks can avert a disaster

FOR three years, from an office overlooking the Atlantic in Nova Scotia, Boris Worm, a marine scientist, studied what could prevent a fishery from collapsing. By 2006 Dr Worm and his team had worked out that although biodiversity might slow down an erosion of fish stocks, it could not prevent it. Their gloomy prediction was that by 2048 all the world's commercial fisheries would have collapsed.

Now two economists and a marine biologist have looked at an idea that might prevent such a catastrophe. This is the privatisation of commercial fisheries through what are known as catch shares or Individual Transferable Quotas (ITQs).

Christopher Costello and Steven Gaines (the biologist) of the University of California and John Lynham of the University of Hawaii assembled a database of the world's commercial fisheries, their catches and whether or not they were managed with ITQs. As these fisheries were not chosen at random and without having any experimental control, they borrowed techniques from medical literature—known as propensity-score matching and fixed-effects estimation—to support their analysis. The first method compared fisheries that are similar in all respects other than the use of ITQs; the second averaged the impact of ITQs over many fisheries and examined what happened after the quotas were introduced. Whichever way they analysed the data,

they found that ITQs halted the collapse of fisheries (and according to one analysis even reversed the trend). The overall finding was that fisheries that were managed with ITQs were half as likely to collapse as those that were not.

For years economists and green groups such as Environmental Defense, in Washington, DC, have argued in favour of ITQs. Until now, individual fisheries have provided only anecdotal evidence of the system's worth. But by lumping all of them together the new study, published this week in *Science*, is a powerful demonstration that it really works. It also helps to undermine the argument that ITQ fisheries do better only because they are more valuable in terms of their fish stocks to begin with, says Dr Worm. The new data show that before their conversion, fisheries with ITQs were on exactly the same path to oblivion as those without.

Racing to fish

Encouraging as the results are, ITQ fisheries are in the minority. Most fisheries have an annual quota of what can be caught and other restrictions, such as the length of the season or the type of nets. But this can result in a "race to fish" the quota. Fishermen have an incentive to work harder and travel farther, which can lead to overfishing: a classic tragedy of the commons.

The use of ITQs changes this by dividing the quota up and giving shares to fish-

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ermen as a long-term right. Fishermen therefore have an interest in good management and conservation because both increase the value of their fishery and of their share in it. And because shares can be traded, fishermen who want to catch more can buy additional rights rather than resorting to brutal fishing tactics.

The Alaskan halibut and king crab fisheries illustrate how ITQs can change behaviour. Fishing in these waters had turned into a race so intense that the season had shrunk to just two to three frantic days. Overfishing was common. And when the catch was landed, prices plummeted because the market was flooded. Serious injury and death became so frequent in the king crab fishery that it turned into one of America's most dangerous professions (and spawned its own television series, "The Deadliest Catch").

After a decade of using ITQs in the halibut fishery, the average fishing season now lasts for eight months. The number of search-and-rescue missions that are launched is down by more than 70% and deaths by 15%. And fish can be sold at the most lucrative time of year—and fresh, so that they fetch a better price.

In a report on this fishery, Dan Flavey, a fisherman himself, says some of his colleagues have even pushed for the quota to be reduced by 40%. "Most fishermen will now support cuts in quota because they feel guaranteed that in the future, when the stocks recover, they would be the ones to benefit," he says.

Although governing authorities are important in setting up ITQs, so is policing of the system by the fishermen themselves. In the Atlantic lobster fishery a property-based system has arisen spontaneously, says Dr Worm. Families claim ownership over parcels of sea and keep others out. Anyone trying to muscle in on the action ▶▶

risks being threatened; their gear may be cut loose or their boat could vanish.

Jeremy Prince, a fisheries scientist at Murdoch University in Australia, has been involved in ITQs since they were pioneered in the early 1980s by Australia, New Zealand and Iceland. In Australia they are only one way of managing with property rights, he says. Depending on the nature of a fishery, other methods may work better. These might divide up and sell lobster pots, numbers of fish, numbers of boats, bits of the ocean or even individual reefs. The best choice will depend on the value and underlying biology of each fishery, and in some places they may not work at all. In a fishery with a large, unproductive stock that grows slowly, fishermen may prefer

short-term profit to the promise of low long-term income and catch all the fish straight away. Nevertheless, Dr Prince believes that, overall, market-based mechanisms are the way forward.

The most difficult place to introduce market-based conservation methods is in international waters. Attempts to do so have ended in failure. One problem is that there is simply too much cheating in the open ocean. Some scientists think a renegotiation of the law of the sea through the United Nations is the only way forward—or a complete ban on fishing in international waters. Although a dramatic course of action, the effects may not be so huge. Dr Worm reckons that 90% of the world's fish are caught in national waters.

So, if Dr Costello and his colleagues are right and the profit motive can drive the sustainability of fisheries, why do the world's 10,000-plus fisheries contain only 121 ITQs? Allocating catch shares is a difficult and often fraught process. In America it can take from five to 15 years, says Joe Sullivan, a partner in Mundt MacGregor, a law firm based in Seattle. The public, he says, sometimes resists the privatisation of a public resource and if government gets too involved in the details of the privatisation (rather than leaving it to the fishermen to work out), it can end up politically messy. But evidence that ITQs work is a powerful new hook to capture the political will and public attention needed to spread an idea that could avert an ecological disaster. ■

Sleep

Restless

A strange case raises the question of what sleep is for

THE function of sleep, according to one school of thought, is to consolidate memory. Yet two Italians have no problems with their memory even though they never sleep. The woman and man, both in their 50s, are in the early stages of a neurodegenerative disease called multiple system atrophy. Their cases raise questions about the purpose of sleep.

Healthy people rotate between three states of vigilance: wakefulness, rapid eye-movement (REM) sleep and non-REM sleep. But all three are mixed together in the Italian patients. The pair were initially diagnosed by Roberto Vetrugno of the University of Bologna and his colleagues as suffering from REM behavioural disorder, in which the paralysis, or cataplexy, that normally prevents sleeping people from acting out their dreams is lost. This can cause people in REM sleep to twitch and groan, sometimes flailing about and injuring their bedmates. These patients, however, soon progressed from this state to an even odder one, according to a report in *Sleep Medicine*.

One of the principal ways to measure sleep is to monitor brainwave activity, which can be done by placing electrodes on the scalp in a technique known as electroencephalography (EEG). Non-REM sleep itself is divided into four stages defined purely by EEG patterns; the first two are collectively described as light sleep and the last two as deep or slow-wave sleep. When the Italian patients appeared to be asleep, their EEGs suggested that their brains were either simultaneously awake, in REM sleep and non-REM sleep, or switching rapidly between the three. Yet when subjected to a battery of neuropsychological tests, they showed

no intellectual decline.

Mark Mahowald of the University of Minnesota Medical School, whose group first described REM behavioural disorder in 1986, thinks memory consolidation is still going on in the brains of the two Italian patients; hence their lack of cognitive impairment or dementia. What needs to be revised in light of their cases, he says, is the definition of sleep.

Dr Mahowald suspects that sleep can occur in the absence of the markers that currently define it, which means those markers are insufficient. What's more, the Italian cases lend support to an idea that has been gathering steam in recent years: that wakefulness and sleep are not mutually exclusive. In other words, the human brain can be awake and asleep at the same time.

That evidence takes the form of a growing list of conditions in which wakefulness, REM and non-REM sleep appear to be mixed. An example is narcolepsy, in which emotionally laden events trigger sudden cataplexy. When the dreaming element of REM intrudes into wakefulness, which can happen with sleep-deprivation, the result is wakeful dreaming or hallucinations. Since such dreams can be highly compelling, Dr Mahowald thinks they might account for some reports of alien abduction.

But there is another possible explanation of the Italian puzzle: that sleep is not necessary for memory after all. Jerry Siegel of the University of California, Los Angeles, has studied the sleep habits of many animals and thinks that could well be the explanation. All of which gives researchers something new to keep them awake at night.



Children's health

Worries in a bottle

Are commonly used plastics and medicines harming human health?

IT IS a family nightmare. New parents try to eliminate potential hazards from their children's lives, but what if hidden dangers lurk in the use of everyday objects and familiar substances, like plastics or medicines? Just imagine if baby-feeding bottles harmed infants' health, or if a painkiller widely administered to children ended up doing more harm than good.

Activists have long raised concerns about the poorly understood links between the environment and health. Some worry about toxins in the air and the overuse of plastics, while others fret that children are overmedicated. Regulators and industry officials have pooh-poohed such talk, but several studies released this week may lead them to reconsider.

A frequent cause for concern has been bisphenol-A (BPA), a commonly used plastic. The Work Group for Safe Markets, a coalition of American charities and lobbying groups, earlier this year issued a report called "Baby's Toxic Bottle" that suggested BPA leaches into milk when bottles are