Climate link may yield fishy secrets

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THE COMMERCIAL fishing industry is as susceptible to the vagaries of climate variability as any farmer. Harvests, and economic returns, vary for different species from year to year, and the lack of research in most instances makes it difficult to predict what climatic conditions may lead to a good year.

Of all the fish species harvested in Australia and New Zealand, the deep-sea orange roughy would seem the furthest removed from climate variability.

The roughy – found at depths up to 1500 metres in the perpetually cold, dark waters off the edge of the continental slope – is very long-lived. Most larger specimens are between 100 and 150 years old by the time they reach Australian and New Zealand restaurants. But an ominous statistic hints that the species is not immune to the effects of variability.

In the 15 years since the New Zealand fishing fleet began harvesting the species, the average size of the catch has remained constant. The paucity of smaller, younger fish suggests that orange roughy populations are replenished by rare periods of good recruitment that occur at very long intervals of at least 15 years, perhaps in response to some change in the pattern of deep ocean currents off the continental shelf.

Dr Nick Bax of CSIRO's Division of Fisheries at Hobart says that while this explanation is speculative, it does seem that the orange roughy is strongly influenced by intermediate-depth currents originating in the sub-Antarctic region (see 'Ocean patterns link life in the deep', *Ecos* 80). These currents are nutrient-rich rivers in an otherwise unproductive oceanic desert. Any change in their pattern could have profound effects on the orange roughy's breeding cycle.

Bax says the uncertain status of the orange roughy illustrates the dilemma of fisheries management in Australasia. If the catch of a particular species suddenly declines, it can be impossible to determine whether it is due to over-fishing or the species' natural response to some climatic variable. The problem is magnified for longer-lived species such as the orange roughy, whose present-day populations could reflect a climatic regime that prevailed decades ago.

Australian fishery authorities recognised long ago the influence of nutrient flushes from flooded coastal rivers on the productivity of marine fisheries, especially for species that spawn and spend the early phase of their life cycle in estuarine environments. In El Niño years, drought and low river flows can reduce spawning and recruitment. The impact of this reduction on particular fisheries, however, may not manifest itself until four or five years later.

Bax says if improved climate prediction can help to disentangle climatic influences from human impacts on fisheries, the advice given by scientists to Australasian fisheries managers could change dramatically.

'For example, in 1994 Commonwealth fisheries authorities decided that an increase in redfish (*Centrobery* x *Affinis*) along the east coast was due to climatic factors, so catch quotas were increased,' Bax says.

Climatic influences can also affect the availability of a species. This is well shown in tuna, which tend to congregate on the edges of warm-core eddies swirling down the east coast. 'If we could predict the formation and behaviour of such eddies, we might enhance our ability to advise the tuna fleet of where and when to fish, with predictions of when to catch the best-quality fish as well,' Bax says. 'That would help the Australian tuna industry to get top prices on the Tokyo market.'

Bax says Australia's banana prawn fishery best shows the influence of climate variability on productivity. 'CSIRO researchers found in the 1970s that the banana prawn fishery of the southern Gulf of Carpentaria is sensitive to rainfall in the wet season,' he says.

'In 1990 there was poor recruitment, but in the following year it was one of the best catches on record. This suggests that climate is a more important influence on the banana prawn catch than parental productivity.'

Bax says the prawn fishery could benefit in future from higher-resolution climate and soil-hydrology models capable of predicting rainfall and run-off in individual catchments, instead of making a generalised prediction for the tropical region as a whole.

Six months' notice of likely rainfall patterns and prawn yields would give the fishing industry more planning time, and allow the harvest to be managed for maximum returns.

At present, CSIRO makes pre-season forecasts based on actual wet season rainfall, but this only allows banana prawn fishery managers a month or two to develop optimum strategies for the fishing season. Fishing strategies that account for market trends during the season, and optimise interactions with related fisheries in northern Australia, cannot be developed.

Recruitment of another highly lucrative species, abalone, also appears to be linked with climate. Bax says that in NSW waters, abalone recruitment appears to correlate with the number of days of strong westerly winds. The same correlation seems to apply to gemfish (*Rexia soldandri*) and Bass Strait scallops.

'At present these are only correlations,' Bax says. 'We hope the multi-divisional program on climate variability will throw light on the causal mechanism.

'For example, these westerly winds may change the pattern of currents on the continental shelf so that the larvae are retained longer in areas more conducive to their survival and growth. The wind strength in general may also influence turbulence in the water column, which would affect the ability of larvae to feed.

'At a low level, turbulence increases nutrient availability, increasing the encounter rate between larvae and prey, but at a higher level, turbulence prevents capture of prey organisms. Increased turbulence would also tend to disperse prey aggregations and spread the larvae through the water column. This could increase their own exposure to predators.

'In the past, too many people have cried wolf over these sorts of correlations; what we now need is causal mechanisms. It's exciting that the climate-driven ocean models of climate variability are approaching a level of resolution that is potentially useful to fisheries biologists.'

Bax says another important outcome of the new climate variability models could be to help fisheries authorities understand the range of variability in marine ecosystems, and how this affects resource management.

'Often there's just not enough information to decide what should be done,' he says. 'But if we know what is likely to happen during the next 10 to 100 years, we can develop management strategies that maximise the use of the resource and minimise over-fishing.'

Long-term climate variability may also influence the siting of aquaculture farms. The coastal environment is susceptible to changes in currents, and to pollution from sources including sewage and high-nutrient run-off.

'There are indications that seagrasses are already being lost through eutrophication, siltation, and shoreline construction projects,' Bax says. 'Seagrass is very important in marine food chains: larvae of the blue grenadier, which spawns at depths up to 600 metres on Tasmania's west coast, feed on seagrass detritus washed out of eastern Bass Strait.

'We're looking at the NSW continental shelf to find out what limits production in that system. Our preliminary results indicate that a lot of food energy in the system comes from seagrass. We need to know how rainfall and catchment dynamics affect the seagrass meadows, which may also be nurseries for other commercial species and sportfish.'

More about fisheries

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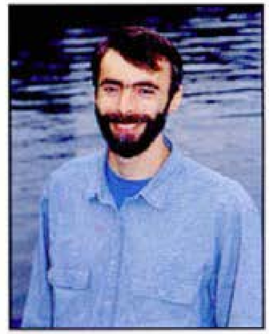

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Dr Nick Bax: models of climate variability are approaching a level of resolution that is potentially useful to fisheries biologists.