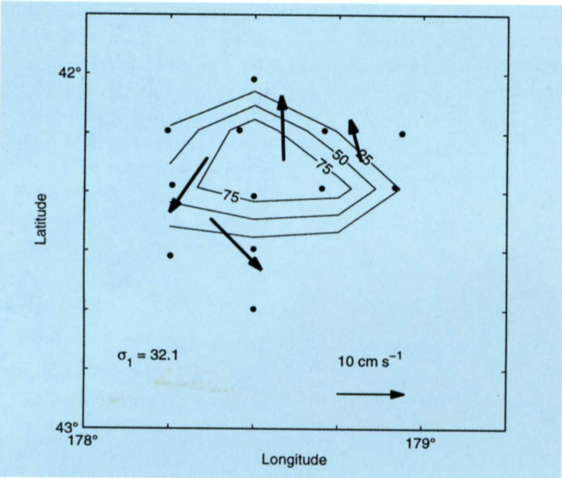

Horizontal section through deep eddy. Contours show percentage of southern deep AAIW on density surface σ_1 = 32.1. Circles show locations of CTD casts (see inset on map, page 17). Arrows are geostrophic velocity at this isopycnal, with mean (i.e., translational) velocity removed.

marked on the diagram (left). Thus, the intrusion appeared to be an eddy rather than just a parcel of water caught in the flow.

Chatham Rise circulation: revision?

In summary, then, in mid-1996 we located a cool-core anticyclonic eddy, having a radius of about 15 km, lying deep in the AAIW north of the Chatham Rise. Such deep eddies in the ocean are not uncommon, but the importance of this result is that the eddy was found where it was.

Our eddy was located too deep to have flowed over the top of the Chatham Rise – this would have required vertical excursions of at least 1000 m, and water in the ocean just does not make such large vertical movements. Thus, the eddy must have been formed at the eastern end of the Chatham Rise, and moved to its observed location. We think it was formed by a strong jet on the southern side of the Chatham Rise which breaks into eddies where the rise ends. We have some evidence that such a jet exists, but have no detailed data for the region where the eddies may be formed.

Present conceptual ideas of the flow along the Chatham Rise show continuous eastward flow along both north and south sides of the rise. If these ideas are correct then the eddy was found about 500 km upstream from its likely source. This suggests that the our ideas have to be modified. The presence of this deep eddy suggests that the circulation off the Chatham Rise is more complicated than previously thought, and any conceptual or numerical models of this circulation have to accommodate the possibility of such deep eddies. ■

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LAKE ECOLOGY

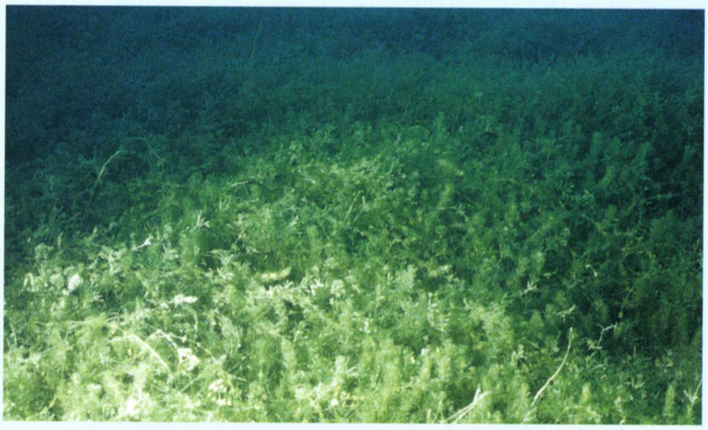
Where does all the carbon go?

Mark James

Ian Hawes

Max Gibbs

Sophisticated techniques using stable isotope ratios to examine lake food webs have produced some unexpected results concerning the role of underwater vegetation.



above right:

Deep growing characean meadow in Lake Coleridge South Island.

ANYONE WHO HAS TRIED to launch a boat in a New Zealand lake such as Taupo, Rotorua or Wanaka will be well aware of the underwater vegetation around the edges which can form thick beds, particularly around boat ramps. Beneath the surface, this underwater vegetation can extend as meadows of macrophytes (rooted plants) to depths of more than 30 m in some of the clearer South Island lakes. Trout and small native fish can often be seen cruising around the edge of this vegetation looking for aquatic invertebrates, particularly their favoured foods of dragonfly and mayfly nymphs or larval midges and caddis flies.

It is tempting, then, to suggest that primary production by these plants indirectly supports lake fish populations through links with herbivorous aquatic invertebrates.

Traditionally, lake biologists have considered that carbon and energy fixed by macrophytes is passed to higher trophic levels either directly by grazing, or indirectly via detritivores feeding on dead and decaying plant material. Recent NIWA work in the littoral zone (the region inhabited by macrophytes) of New Zealand lakes has attempted to unravel the dynamics of littoral zone food webs using an array of techniques. The study has come up with some surprising twists on this tale.

Old and new techniques

Our recent experiments have been designed to determine not only *what* foods are eaten by various groups, but also *how much* and *how useful* a given food is to the grazer or predator.

In the past we have undertaken studies using radioactively labelled food and experiments to determine the rate of depletion of plant material when various grazers are present. We have also examined the gut contents of insect larvae, snails and fish. A major drawback of these techniques is that they tell us only what the animals have recently ingested rather than their most common foods. What is more, they mostly