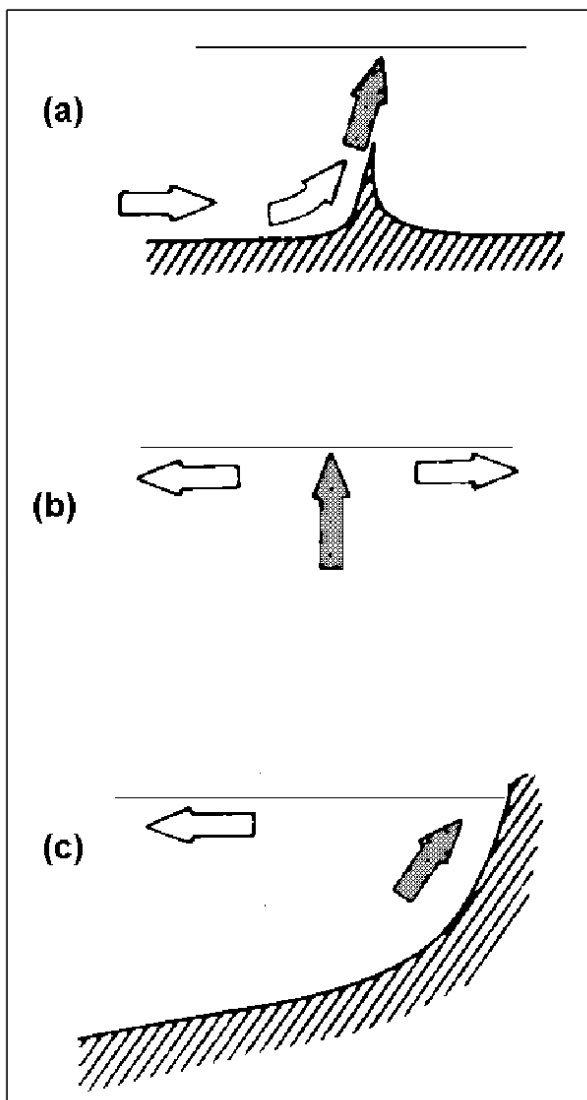


#### 2.7.4 Conservation actions

Eddies are difficult environments on which to focus conservation measures because they are water column features and because of their ephemeral, although sometimes very persistent nature. Because of this, more needs to be known about their method of formation, effects on the local ecology, persistence and areas in which they are consistently generated. General measures to safeguard water quality where these features are known to form will be important, because of their potential to retain and transport pollutants.

#### 2.8 UPWELLING

**Figure 31: Upwelling mechanisms consequent on (a) an underwater ridge (b) divergent surface currents; (c) the movement of water away from a coastline (from Barnes & Hughes, 1982).**



The term upwelling is used to describe the movement of water from relatively deep in the ocean into the photic zone. It can occur as a result of the deflection of deep currents when they meet an obstacle such as a mid-ocean ridge, the movement apart of two water masses, or when water is driven away from a coastline by wind action creating a 'hole' which is filled by water being drawn to the surface (figure 31).

The eastern margins of oceans in the tropics and subtropics are particularly prone to coastal upwelling because of the prevailing winds, although upwelling also occurs beneath currents moving along the continental slope. These are particularly apparent on the western margins of continents and may result in strong localised offshore flows, or 'squirts', typically associated with 'filaments' (elongate bodies of water at the surface with uniform characteristics that differ from their surroundings) (Merrett & Haedrich, 1997). Such filaments have been observed associated with Gulf Stream eddies in the mid-Atlantic Bight as well as other places.

#### 2.8.1 Occurrence in the OSPAR maritime area

The main areas of upwelling are along western coasts where the north-east trade winds in the northern hemisphere and the south-east trades in the southern hemisphere drive water away from the coasts. They also develop along the equator as a result of the divergence of water masses and around Antarctica and the Arctic due to differences in the temperature and salinity of water immediately adjacent to the ice, which creates density-driven current systems. None of these fall into the OSPAR maritime area but smaller upwelling features do occur off the Atlantic coasts of Spain and Portugal where there is a pattern of seasonal upwelling

Upwelling filaments first appear off the Iberian Peninsula in June. They develop as a result of persistent northerly winds and are most obvious in the period from late July to September by which time they may extend 200-250km offshore. There may be five or six in any one year (Merrett & Haedrich, 1997). Most of the upwellings on the north-western Spanish shelf develop close to the coast but they have also been observed in the mid- and outer shelf areas (Bode *et al.*, 1996).

In the case of the system off the coast of Spain, the upwelling modifies the vertical structure of the water column during the thermal stratification period (May to September) affecting phytoplankton distributions in relation to the gradients of temperature and nutrients (Bode *et al.*, 1996). In contrast, upwelling events during spring and autumn are influenced by local circulation patterns caused by poleward currents flowing parallel to the shelf-break front. These currents have a major influence on the development of phytoplankton blooms normally occurring in temperature coastal seas as reported for the Cantabrian coast.

#### 2.8.2 Marine communities associated with upwellings

The ecological importance of upwellings lies in the fact that they transport nutrients from depth into surface waters and, as a result, increase primary productivity at the surface. This has a cascading effect up the food chain leading to increased concentrations of fish and seabirds in these areas. This pattern has been detected in the seasonal upwelling system off the north and north-western Spanish shelf. Cold, nutrient-rich deep waters have been detected near the surface throughout March to November, especially in the north-western shelf and are known to be an important source of inorganic nutrients for primary production in that area (Bode *et al.*, 1996).

### 2.8.3 Conservation issues

Coastal upwelling occurs in five major regions of the world and, while these regions together constitute only about one per cent of the total area of the ocean, their importance can be judged by the claim that they supply some 50 per cent of the world's commercial fish catches (Merritt & Haedrich, 1997). The enhancement of primary production makes them 'hotspots' for marine life and hence the targeting of these areas for fisheries.

### 2.8.4 Conservation actions

Upwellings are difficult environments on which to focus conservation measures because they are water column features and because of their ephemeral, although sometimes very persistent, nature. General measures to safeguard water quality where these features form will be important but there is also the possibility that they could be included in marine protected area programmes. The most significant management action must be directed at the exploitation of resources in these areas. Their rich and productive nature makes them a target for fisheries exploitation in particular, the level of which needs careful management.

## 2.9 SEABIRDS

Large numbers and a great variety of seabirds occur in the OSPAR maritime area. They include gannets, gulls and auks as well as fulmars and petrels which are true ocean species, coming ashore only for short periods to raise their young. The adjacent land may be used for roosting, nesting and rearing young but it is the maritime area that provides the food to sustain these populations.

Seabirds use a variety of techniques to feed. They can take food from the surface or just below it while on the wing, exploit the surface layer while swimming and pursuit diving, capture food by deep plunge-diving and swimming at depth as well as scavenging food on the surface. Shearwaters, for example, often combine plunge-diving with surface swimming. Cory's shearwater (*Calonecastris diomedea*) forage day and night often in large concentrations taking prey driven to the surface by predatory fish and sea mammals. Their main food are fish, cephalopods and crustaceans which are taken while flying close to the surface and plunge-diving. Gannets are plunge divers, perhaps penetrating up to 10m but usually remaining submerged for less than 10 seconds during which time they swallow their prey. Because of their weight and strength they can cope with powerful fish such as large mackerel.

Apart from feeding on fish, other components of seabird diet can include surface-living crustaceans, cephalopods, and jellyfish as well as offal and discards from fisheries. Birds are attracted to areas where there are rich natural concentrations of such food such as at fronts and upwellings (see sections 2.6 & 2.8) as well as to areas where food levels are enhanced by human activity such as behind fishing boats.

The isolated islands and archipelagos in the north-east Atlantic as well as coastal cliffs, headlands and sea stacks are an important base for many seabirds. The area as a whole also supports a large proportion of the global population of some seabirds. St Kilda, off the north-west coast of Scotland, is the site of the most important seabird colony in the north-eastern Atlantic. It has the largest gannetry in the world, the largest Leach's petrel and puffin colonies in the eastern Atlantic as well as having populations of fulmar, storm petrel, kittiwake,