1. INTRODUCTION AND GENERAL REMARKS

Interest in wildlife in general, and marine mammals in particular, has increased significantly in recent years, both in the general public and in the scientific and management communities. More people than ever are including wildlife watching in their activities, and this includes educational and adventure expeditions to see wild marine mammals up close. At the same time, there is increasing awareness of the integral importance of marine mammals to healthy aquatic ecosystems, and of the growing threats that a variety of human activities pose to these animals and their environments. Research and education programs are seeking to better understand and more clearly communicate the nature of these threats and to recommend appropriate steps to reduce or eliminate their impacts.

Good field guides are integral to all these activities. Although there are guides to limited geographical areas and some subsets of the world's marine mammal fauna, there is as yet no single comprehensive guide that covers all the world's whales, dolphins, porpoises, seals, sea lions, walruses, manatees, dugongs, marine and sea otters, and polar bears. Additionally, few of the existing guides provide aids to identifying live animals, in-hand specimens, and skulls. This field guide, commissioned by the Food and Agricultura1 Organization of the United Nations and the United Nations Environment Programme, is intended as the first attempt to fill that need.

We have attempted to make this volume as complete and comprehensive as possible. However, we are aware that it is limited by the differences in the amount and quality of information available on the various groups, as well as by the inadequacies of our approach towards representing what is available. Therefore, we prefer to think of this as a starting point, to be improved by input from those who use it in the field. Future editions will be modified to correct errors and deficiencies revealed by extensive use. In the mean time, we hope this book helps both amateurs and professionals with the sometimes difficult task of confidently identifying species of marine mammals they see alive or encounter dead.

Most writers use the term 'marine mammal' to include members of 5 different mammalian groups: cetaceans (whales, dolphins, and porpoises), sirenians (manatees and the dugong), pinnipeds (sea lions, the walrus, and seals), marine and sea otters, and the polar bear (Fig. 1). These diverse groups are currently thought to represent 5 or 6 different recolonizations of the water by land-dwelling ancestors. The term marine mammal, therefore, implies no systematic or taxonomic relationship. In fact, the cetaceans are more closely related to horses, pigs, and zebras than they are to other marine mammals, the pinnipeds have more in common with bears and weasels, and the sirenians are more closely allied to elephants and hyraxes. These differences not withstanding, however, all marine mammals have one thing in common - they derive all (or most) of their food from marine (or sometimes fresh) water.

All marine mammals have undergone major adaptations, which permit them to live in the water. The cetaceans and sirenians spend their entire lives in the water, while other marine mammals come ashore for various reasons, at particular times in their life cycle (most commonly to reproduce, moult, or rest). Major structural modifications to the bodies of cetaceans, sirenians, and pinnipeds involve the loss of hind limbs (cetaceans and sirenians), the adaptation of limbs for propulsion through water (pinnipeds), and the general streamlining of the body for hydrodynamic efficiency (all 3 groups). Structural modifications to the marine and sea otters and the polar bear by a marine existence are less apparent in body form; these animals still closely resemble their terrestrial counterparts.

Since this is an identification guide, we include information mainly useful for identifying marine mammal species. For more extensive introductions to the biology of mammals in general, see Gould and McKay (1990) and Macdonald (1984). Additional specific details on the biology of marine mammals can be found for cetaceans in Ridgeway and Harrison (1981a and b, 1985, 1989), Leatherwood and Reeves (1983), Evans (1987) Harrison and Bryden (1988), and Martin (1990); for pinnipeds in King (1983), Bonner (1990), Riedman (1990a), and Reeves et al. (1992); for sirenians in Reynolds and Odell (1991) and Reeves et al. (1992); for marine and sea otters in Riedman (1990b) and Reeves et al. (1992); and for polar bears in Stirling (1988) and Reeves et al. (1992). In addition to the above references, several recent works contain excellent summaries of some of the threats to marine mammal populations. These are Bonner (1982), Northridge (1984, 1991), Perrin (1989), Klinowska (1991), and Woodley and Lavigne (1991).

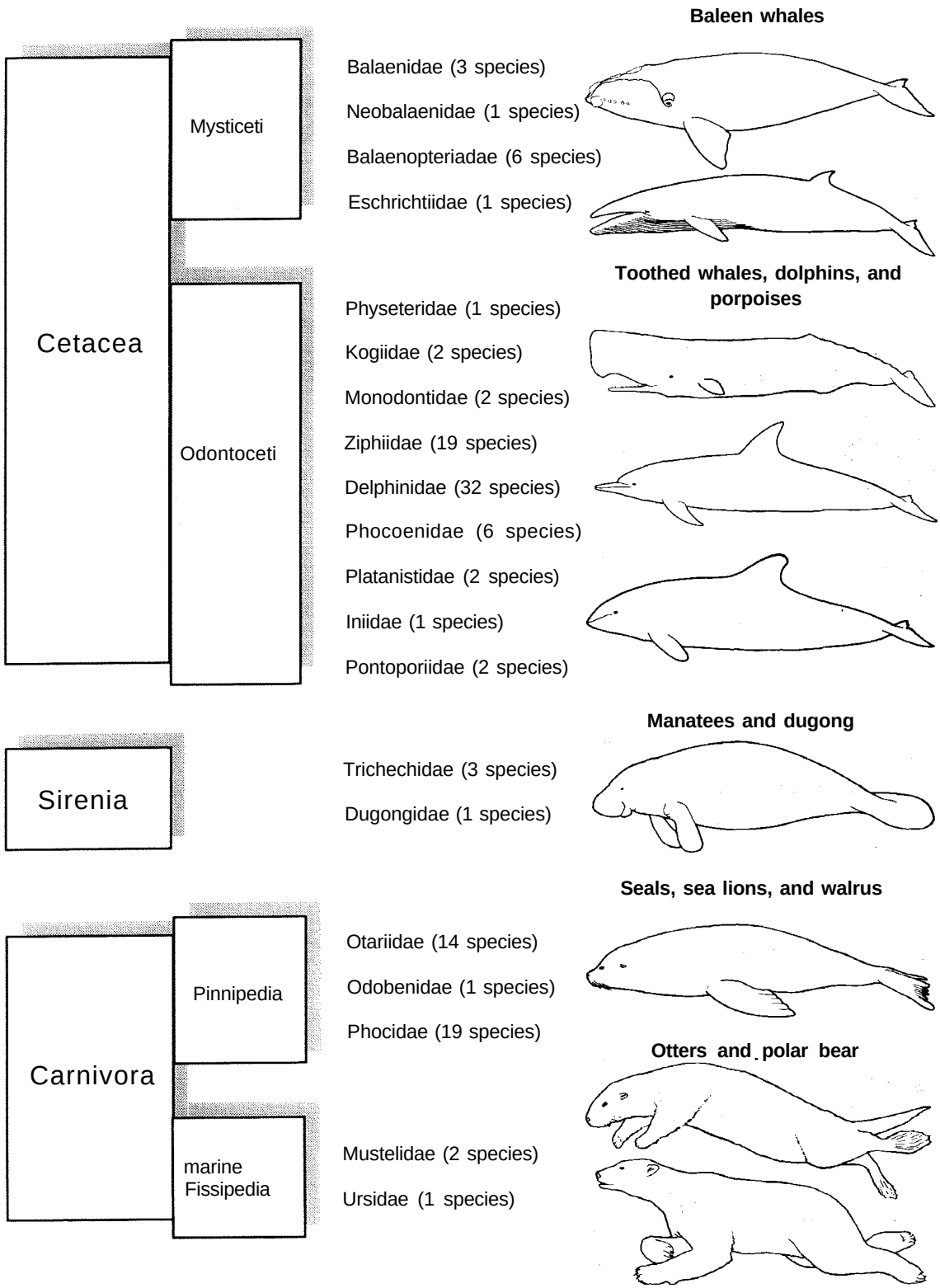


Fig. 1 Classification of the Marine Mammals

1.1 Oceanography and Marine Mammal Distribution

Marine mammals are not randomly distributed in the world's oceans. It has long been known, for example, that certain species are found exclusively or primarily in waters of a particular depth, temperature range, or oceanographic regime, and not in areas lacking one or all of these characteristics. For most species, however, little is known of the particular factors that cause them to be found in one area and not in another that appears, qualitatively at least, the same.

One major factor affecting productivity, and thus indirectly influencing the distribution of marine mammals, is the pattern of major ocean currents (Fig. 2). These currents are driven largely by prevailing winds, modified in their effects by the "Coriolis Forte." Simply stated, the rotation of the earth causes major surface currents to move clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere. This has different implications for animals on east and west sides of ocean basins. In the Northern Hemisphere, warm tropical waters move further north along the east coasts of continental land masses, and warm-water species are often found unexpectedly far north. In the Southern Hemisphere, by contrast, cold polar waters move northward along the west coasts of continents, allowing cold-water marine mammals to range closer to the equator.

The interplay of these surface currents and subsurface movements of major water masses moves nutrients around by upwelling (the vertical turning over of deep and surface waters) and indrift (the bringing in of nutrients by horizontal currents). As these nutrients and sunlight are the basic ingredients of productivity, areas of high mixing often are more productive than still areas of little or no mixing. Wherever oceanic conditions promote high nutrient content, it is likely that some species of marine mammal will be present to exploit that richness. Thus, the presence of marine mammals and other high order predators and consumers in an area is related primarily to prey, and secondarily to the water conditions supporting that productivity. Pagophylic (ice-loving) marine mammals are a special case in that their movements are closely tied to the formation and movement of sea ice.

1.2 Marine Mammal Identification and How to Use This Guide

Marine mammals can be difficult to identify at sea. Even under ideal conditions, an observer often gets little more than a brief view of a splash, blow, dorsal fin, head, flipper, or back, and this is often at a great distance. Rough weather, glare, fog, or other bad sighting conditions compound the problem. Many species appear similar to another, especially in the brief glimpses typical at sea. Animals of some poorly known groups (most notably beaked whales and Southern Hemisphere fur seals) are especially difficult to identify to species, even with a good look ata live animal or an "in hand" specimen. For all these reasons, even experts often must log a sighting as "unidentified" or on an easily confused pair or group of species. In all cases, this designation, accompanied by a detailed description is preferable to recording an incorrect identification.

The species identification sheets in this guide are designed to be the primary tool used in identifying marine mammals observed at sea. A dichotomous key to marine mammals observed at sea would be virtually worthless, because of the lack of useful

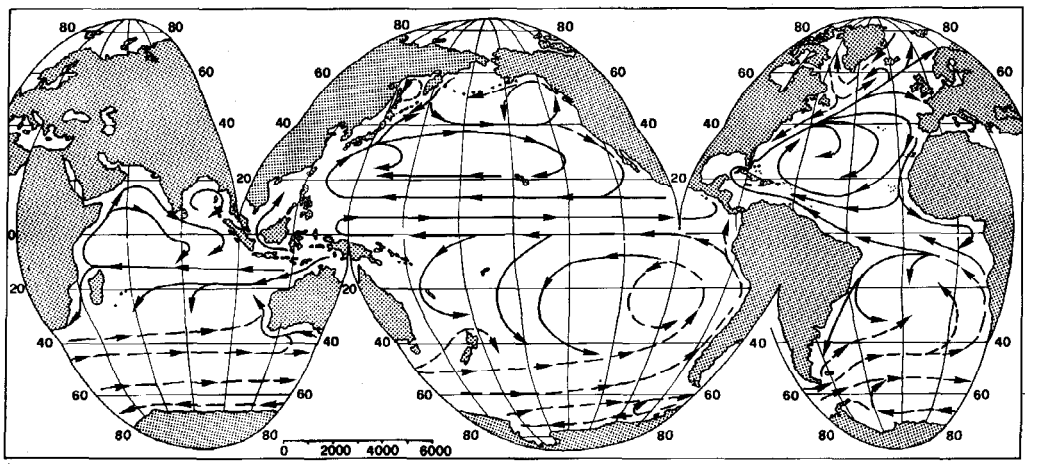


Fig. 2 Major Ocean Currents

cues for most sightings and the variability of marine mammal behaviour. Marine mammal identification at sea is something that must be learned through doing. Experienced marine mammal observers, like birders, often will be able to make an identification based on a composite of characteristic features including behaviour, and personal knowledge of the local marine mammal fauna. This ability will come with experience, guided by working with seasoned observers and the use of a proper field guide.

We must emphasize that the distribution maps presented for each species are approximate. The range limits shown, especially in offshore areas, are often little more than educated guesses, based on limited data and considered in light of available information on the species' distribution and habitat preferences elsewhere. In some cases, the range limits indicated are more a reflection of search effort than of real distribution limits. Therefore, an absence of shading in a certain area does not necessarily mean that the species is not found there.

Available population estimates are also of variable accuracy, and should thus be used cautiously. Techniques for estimating sizes of mammal populations at sea are still evolving and are far from standardized, and available tools have been used unevenly, often with violations of underlying assumptions. For these reasons, the shading on the maps is intended to show only known or postulated range, and not population density.

The status of each species is given in the identification sheets."Endangered Species Lists" are maintained by both the United States Fish and Wildlife Service (USFWS) (U.S. List of Threatened and Endangered Species) and the International Union for the Conservation of Nature and' Natural Resources, now the World Conservation Union (IUCN Red List). In this world guide, we present the IUCN designations. "Endangered" status is assigned to those species considered to be in immediate danger of extinction. Species at risk of soon becoming endangered are listed as "vulnerable." Because of incomplete information and the time lag in completing requirements for listing, these status designations do not always accurately reflect the true status of a species (some species listed as endangered are at no immediate risk; others not listed may be on the verge of extinction). Nevertheless, they are helpful as a warning that plans to exploit a given species must proceed only with great caution.

Marine mammals specimens "in hand" can best be identified by using the dichotomous keys to external features. With such specimens, it may be possible to view the entire body and to measure relative proportions of features. Various features of coloration and morphology are often useful in such considerations. We have used geographical information as little as possible to separate the species. This will help to avoid biasing observers toward making an identification based on what they think is "supposed" to be there.

Marine mammal skulls can be keyed out using the keys provided at the beginning of each major section. We have assumed that no geographical information is available, so the key can be used to identify an untagged skull of unknown origin in a museum.It is clear from our own work and discussions with colleagues that is is not yet possible to prepare a reliable skull key for the non-specialist. Published keys and related literature are marred with errors and inconsistencies. Skulls of many species are sufficiently similar that it will be necessary to examine a full series of each to define reliable diagnostic features. Until that exercise is completed for each species, it would be a disservice to prepare a key to the species level. Instead, we provide a key only to family level.

It can sometimes be very difficult, or impossible, to identify marine mammals to species, whether based on sightings at sea, specimens "in hand", or an unlabeled skull. Great variability in behaviour, coloration, body morphology, and bone structure can occur. Sometimes it may only be possible to label an animal or group as "unidentified long-snouted dolphin", "unidentified beaked whale," or "unidentified fur seal." If this guide helps lead to an identification in some cases and to narrow down the choices in others, then it will have served an important function.

1.3 The FAO Species Codes Included in the Guide

The species codes listed in the species accounts are intended for use by those who need to record catch or sighting data for reporting or database purposes. The 3-letter code is required when reporting statistics to the FAO and are in use by many countries throughout the world. An advantage of these codes is that they are very short but the disadvantage is that they do not contain taxonomic information. The longer code is a taxonomic abbreviation for those who need a short, unique, systematic referente code. It contains in order, abbreviations of the family and genus names and a unique number for each species. The advantage of this is that with practice, taxonomic groups can be recognized from the code. This code is used in a FAO database called SPECIESDAB that contains general biological and fisheries information and will soon be available to interested fisheries workers and conservationists.

1.4 Illustrated Glossary of Technical Terms

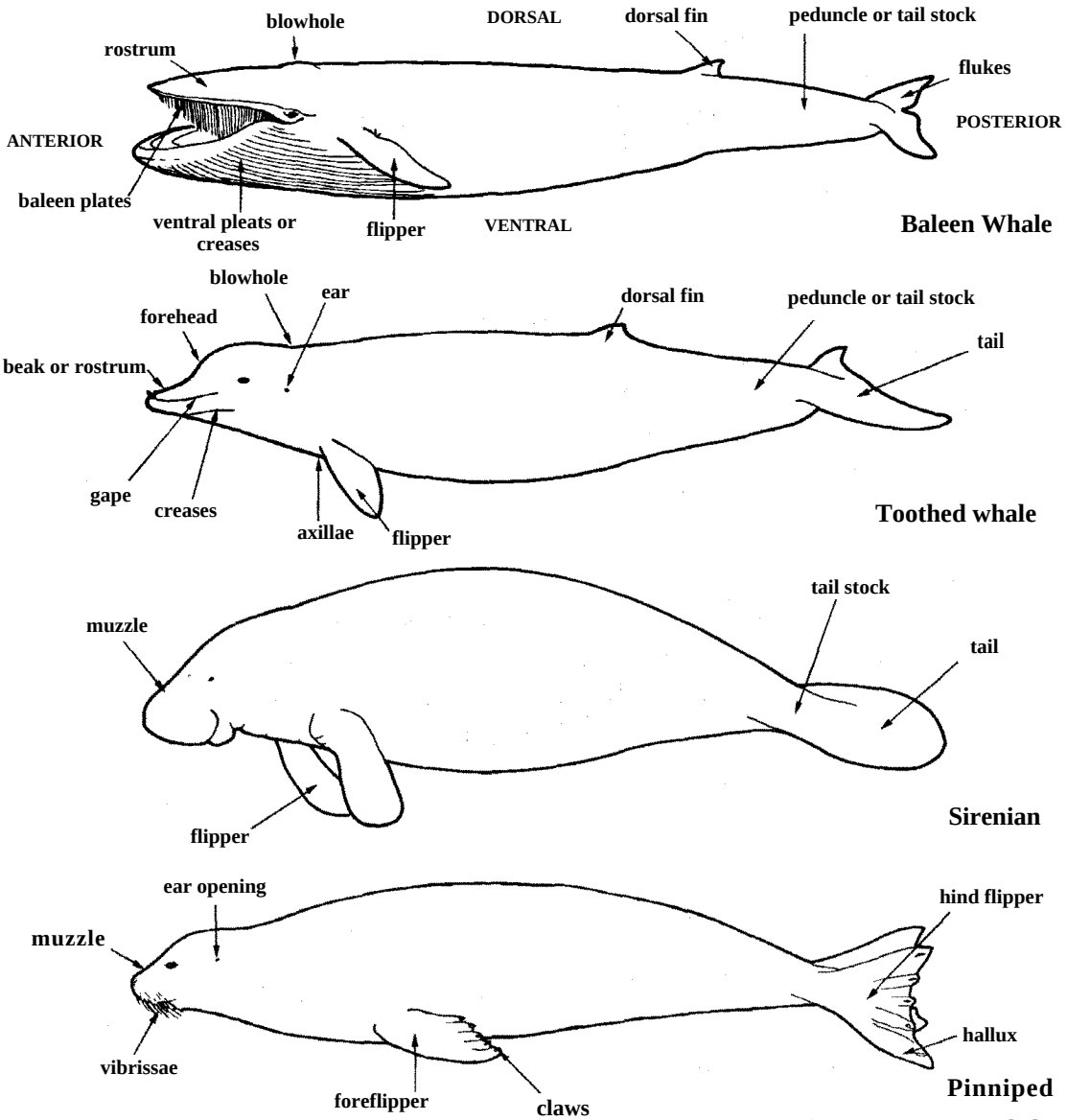


Fig. 3 Externa1 Morphology

Amphipod - A type of invertebrate that is a food source for some whales.

Anterior - Referring to the front (head area) of an animal (Fig. 3).

Axillae (singular: axilla) - Armpit, or in the case of marine mammals, "flipperpit" (Fig. 3).

Baleen - Plates of keratin hanging from the inside of the upper jaw of mysticetes, used instead of teeth to capture prey (Fig. 3).

Barnacle - A type of sessile (mooring) crustacean that is found living on the surface of some marine mammals (Fig. 4).

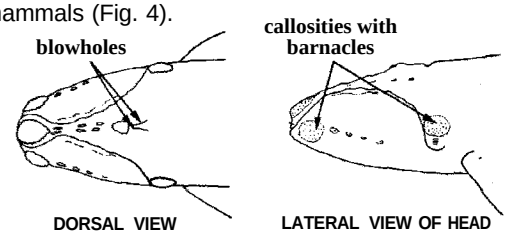
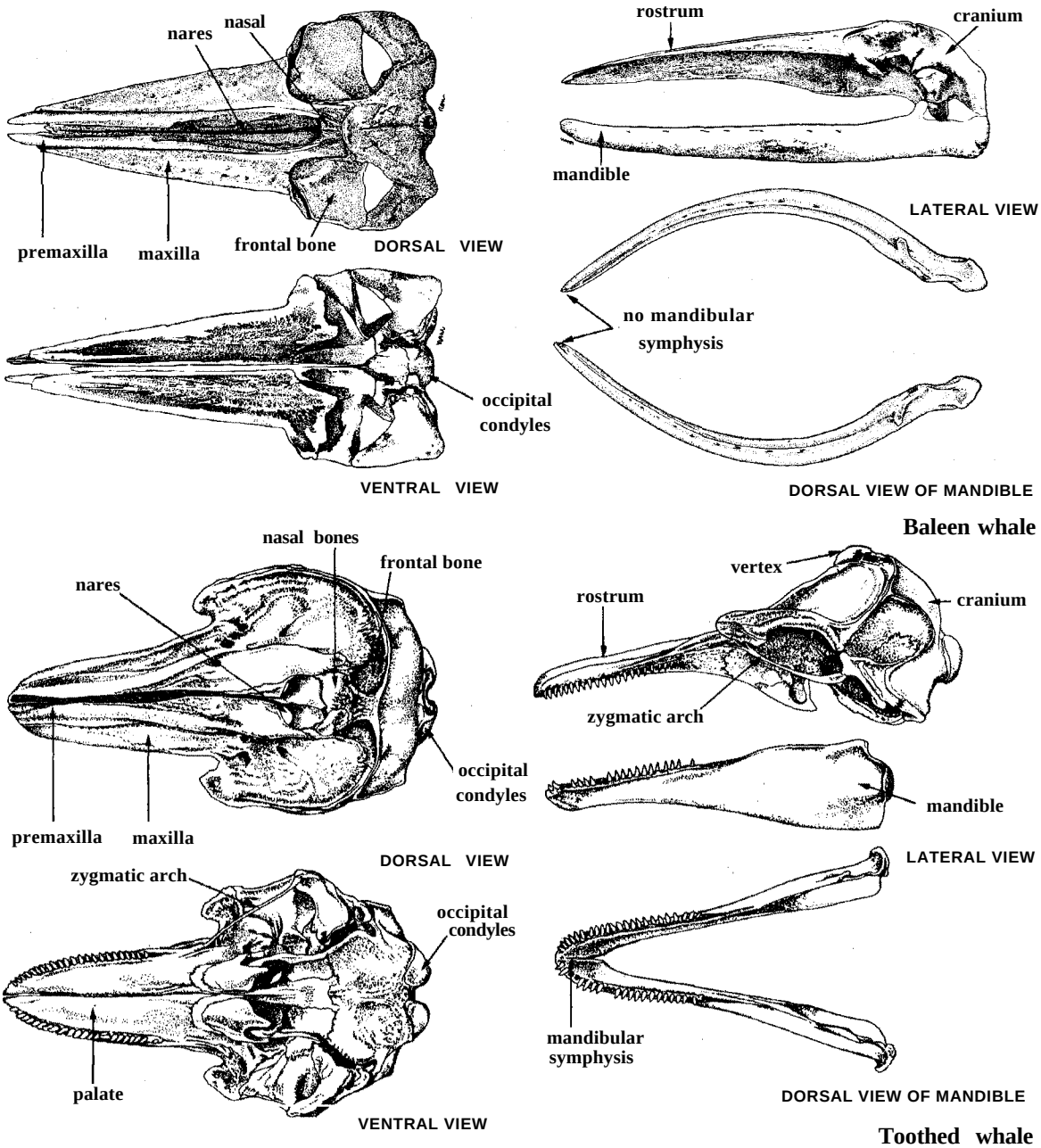


Fig. 4



Benthic - Living on or in the sea floor.

Blow - The spout of water vapor exhaled by whales.

Blowhole(s) - Nasal opening(s) on the top of the head of cetaceans (Fig. 4).

Blubber - The specialized layer of fat just under the skin of most marine mammals.

Boss - A raised protruberance on the skull.

Bowriding - The act of riding on the pressure wave in front of the bow of a ship.

Breach - A complete or nearly-complete leap from the water, resulting in a splash.

Calf - A young cetacean or sirenian.

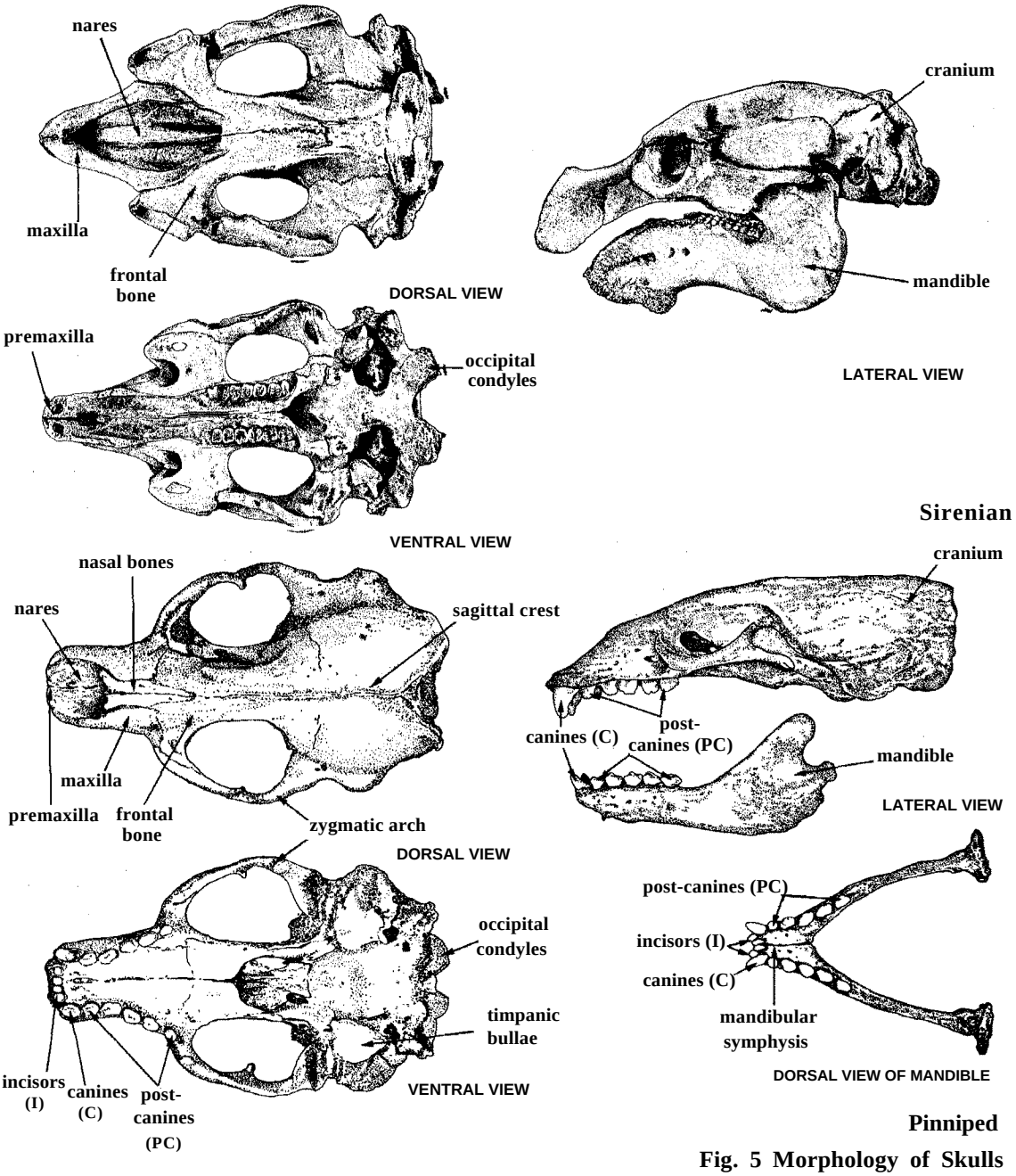


Fig. 5 Morphology of Skulls

Callosities - Areas of roughened skin on the heads of right whales, to which whale lice and barnacles attach (Fig. 4).

Canines - The set of long, sharp teeth on either side of the front of the upper and lower jaws (abbreviated C in dental formulas) (Fig. 5).

Cape - Adarker region on the back of many species of dolphins and small whales, generally with a distinct margin.

Cephalopod - A group of invertebrates, including squids and octopuses, fed on by many marine mammals.

Circumpolar - Ranging completely around either polar area (i.e., the Antarctic or Arctic).

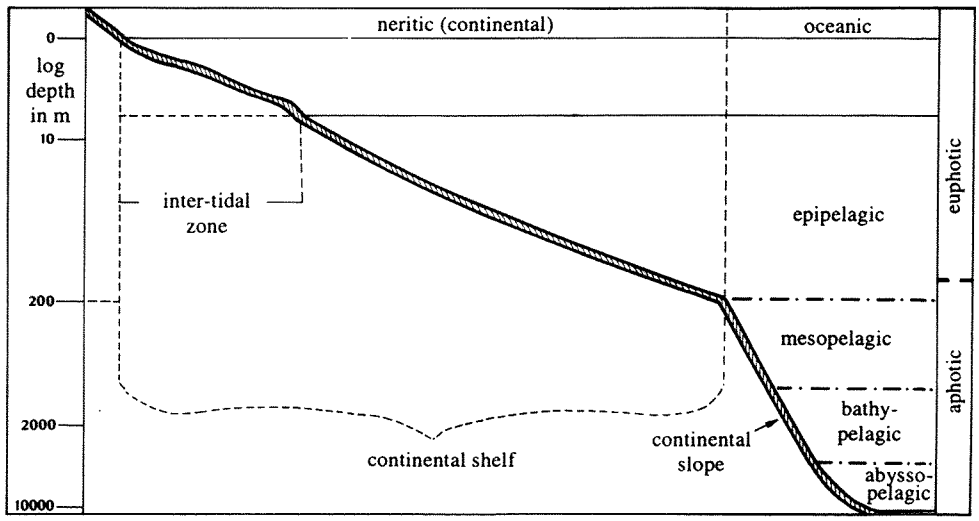


Fig. 6 Profile of the Seabed

Continental shelf - The oceanic margin of the continents, characterized by a relatively flat bottom. Generally defined as the benthic area out to 200 m depth (Fig. 6).

Continental slope - The oceanic region of steep drop-off just beyond the continental shelf. Generally defined as the benthic area of depths of 200 to 2 000 m (Fig. 6).

Copepod - A type of small crustacean fed on by some whales.

Countershading - Cryptic coloration with the upper surface dark and the lower surface light.

Cranium - The main par-t of the skull, exclusive of the lower jaw bones (mandibles) (Figs 5 and 7).

Crustacean - Member of a class of mostly aquatic invertebrates that are food for many marine mammals.

Curvilinear length - Secondary body-length measurement for pinnipeds, taken from the tip of snout to tip of tail along the back, belly, or side (note: not comparable with standard length).

Deep scattering layer (DSL) - Adense aggregation of largely light-sensitive aquatic organisms (mostly fish and various invertebrate species) that migrates vertically in the water column each day (towards the surface in darkness and deeper in brightness).

Dental formula - Pinnipeds, sirenians, otters, and bears have differentiated teeth represented in a formula in which numbers indicate the quantity of each type of tooth in the upper and lower jaw. The formulas presented in this guide take the following form: Incisors (I) upper/lower, canines (C) upper/lower, post-canines (PC) upper/lower. In otters, bears, and some sirenians, the post-canines are differentiated into premolars (PM) and molars (M).

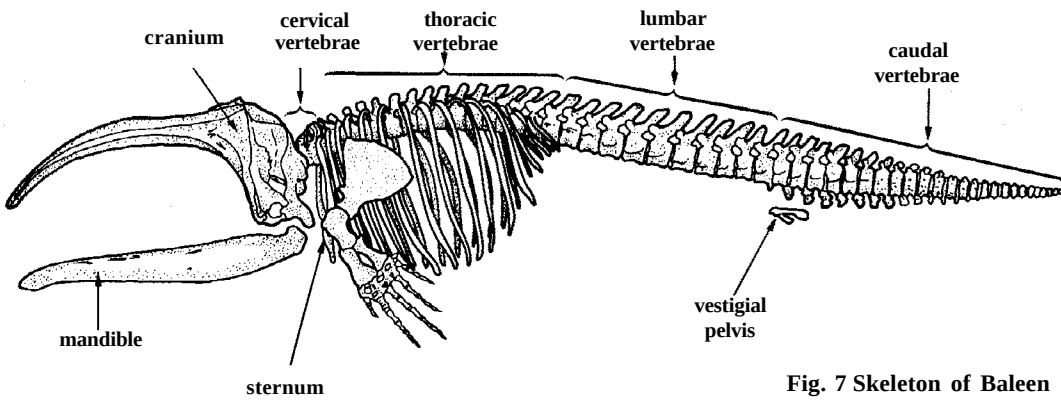


Fig. 7 Skeleton of Baleen

The numbers refer to the number of teeth on each side of the jaw (Fig. 5).

Demersal - Found on or near the bottom of the sea.

Dorsal - Relating to the upper sur-face of an animal (Fig. 3).

Dorsal fin - The structure on the back of most cetaceans (not supported by bone). Some species only have a dorsal hump or ridge, others have no hint of a dorsal structure (Figs 3 and 8).

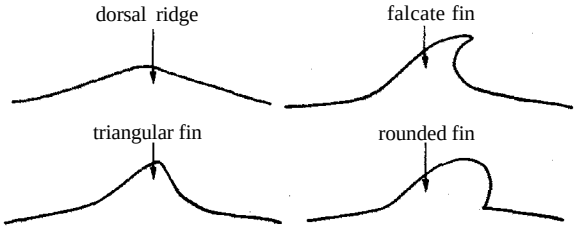


Fig. 8 Dorsal Fins

Echolocation - The process of sending out sounds and using the returning echoes to locate objects

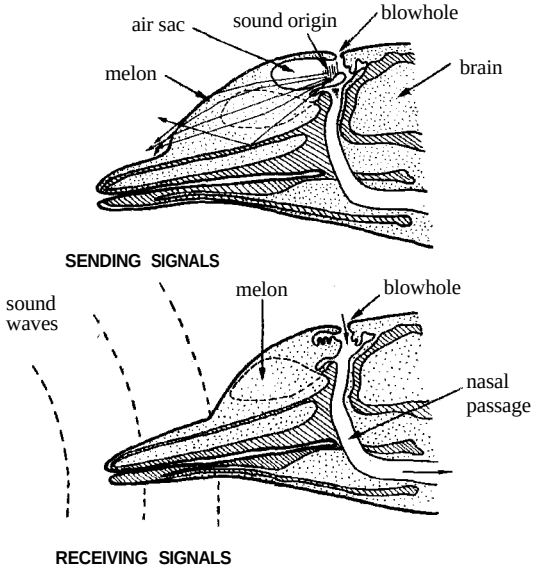


Fig. 9 Organs Associated with Echolocation

Epipelagic - Associated with the surface layer of the oceans (< 200 m depth) (Fig. 6).

Estrus - The period of sexual receptivity of a female mammal.

Estuary - An area partly enclosed by land, where saltwater and freshwater meet.

Extirpate - To exterminate a species only from a specific part of íts range.

Extralimital - Outside the normal limits of an animal's dístributíon.

Falcate - Sickle-shaped and curved toward the tail (Fig. 8).

Flipper - Flattened fore- or hindlimb of a marine mammal (supported by bone) (Fig. **3).**

Flukes - The horizontally flattened and blade-shaped taíl of cetaceans or dugongs (not supported by bone)(Fig. 3).

Fluke-up - To raise the tail flukes into the air upon diving.

Foreflipper - The front flipper of a pinniped (Fig. 3).

Frontal bone - The major bone comprísíng the forehead (Fig. 5).

Gape - The corner of the mouth, or the widest opening of the mouth (Fig. 3).

Guard hairs - The long, thick, sparse outer layer of hairs of a pinníped or otter (Fig. 10).

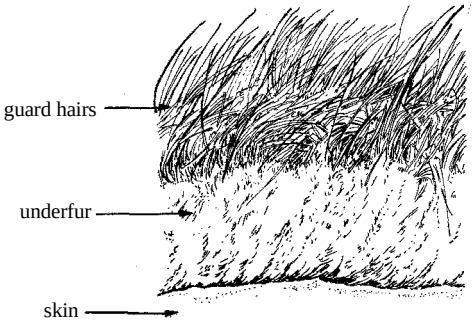


Fig. 10 Structure of Pelt

Hallux- Dígit number 1 on the hindflipper of a pinniped (counting from the outside in) (Fig. 3).

Haul-out - The act of bringing the body on to land, ice, or other substrate by a pinniped, otter, or very rarely, a sirenian.

Herd - A coordínated group of marine mammals (often used synonymously with school for dolphins, and pod for whales).

Híndflipper - The rear flipper of a pinniped (Fig. 3).

Hybrid - The offspring resulting from a cross between 2 species.

Incisors - The front, cutting teeth between the canines (abbreviated I in dental formulas) (Fig. 5).

Jug handling - The posture used by most fur seals of lying at the surface with fore- and hindflippers curled into a loop.

Junk - The modified melon of sperm whales.

Krill - A small shrimp-like crustacean that forms the major food of many baleen whales.

Lair - A shelter under snow and/or ice, with an opening to the water, used by some seals.

Lanugo - The birth coat of fur of a pinniped (sometimes shed in the uterus).

Lateral - Referring to the side of an animal.

Mandible - The lower jaw bone (Figs 5 and 7).

Mane - A region of long fur around the neck of some male pinnipeds.

Mass stranding - A stranding involving 3 or more animals.

Maxilla - One of the 2 major bones of the upper jaw (Fig. 5).

Melon - The fatty organ in the forehead of toothed whales, believed to be used in echolocation (Fig. 9).

Mesopelagic - Associated with the middle layer of the oceans (200 to 1 000 m depth) (Fig. 6).

Molars - The grinding teeth at the back of the jaw, which grow only once in life (abbreviated M in dental formulas) (Fig. 5).

Mollusk - A type of invertebrate, including clams, squids, and octopuses.

Moult -The process of shedding the fur, or the skin and the fur, to be replaced by a new set.

Monogamy - A social system in which individuals have only 1 mate per breeding season.

Monotypic - A taxonomic group that has only 1 member.

Muzzle - The projecting part of the head, including the mouth, nose, and jaws (Fig. 3).

Mysid - A shrimp-like invertebrate that is the food of some marine mammals.

Mystacial area - The area around the vibrissae, or whiskers, in pinnipeds and otters.

Nape - The area of the back of the neck on a pinniped.

Nares (singular: naris) - The bony nasal openings of the skull (Fig. 5).

Nasal bones - The small bones around the nasal openings of the skull (Fig. 5).

Neonate - A newborn

Occipital condyles - The rounded areas on the occipital bone of the skull where the vertebral column attaches (Fig. 5).

Oceanic - The ocean region past the edge of the continental shelf (generally deeper than 200 m) (Fig. 6).

Palate - The roof of the mouth (Fig. 5).

Pantropical - Occurring globally around the tropics.

Parasite - An organism that obtains a benefit from another organism while causing it harm.

Peduncle (caudal) - The laterally compressed region between the dorsal fin and tail flukes of cetaceans and dugongs; a narrow tail stock (Fig. 3).

Pelage - Fur (Fig. 10).

Pelagic - Inhabiting the water column of the oceans past the inter-tidal zone (Fig. 6).

Pinnae (ear) (singular: pinna) - The external ear flaps (Fig. 3).

Photo-identification - The method of study of marine mammals using photographs to identify individuals.

Pod - A coordinated group of whales.

Polar - Relating to the regions near the poles.

Polygyny - A social system in which males have more than 1 mate per breeding season.

Polynya - An area of open water in sea ice fields coursed by currents.

Population - A biological population is a group of interbreeding individuals of the same species, isolated from other such groups.

Porpoising - The act of leaping out of the water while moving forward at speed.

Post-anal hump or keel - A protruberance of connective tissue just behind the anus of some cetaceans.

Post-canines - The set of all undifferentiated teeth behind the canines in pinnipeds (abbreviated PC in dental formulas) (Fig. 5).

Posterior - Referring to the rear (tail area) part of an animal (Fig. 3).

Premaxilla - One of the 2 major bones of the upper jaw, bering the incisors in carnivores (Fig. 5).

Premolars - The set of bicuspid teeth in front of the molars, which change from juveniles to adults (abbreviated PM in dental formulas) (Fig. 5).

Proboscis - A hanging enlargement of the nose.

Pup - A young pinniped or otter.

Rafting - The act of several individuals lying together at the surface.

Rookery - A terrestrial breeding area for pinnipeds.

Rostrum - **Beak or** snout. Also refers to the upper jaw of the skull (Figs 3 and 5).

Saddle - A light patch behind the dorsal fin of some cetaceans.

Sagittal crest - A bony crest on the top of the skull in some pinnipeds, often resulting in an external bump on the forehead (Fig. 5).

School - A coordinated group of cetaceans (often used synonymously with herd for dolphins).

Sexual dimorphism - A difference in the appearance of the sexes, generally with males larger than females, often accompanied by differences in body shape.

Spermaceti - The oil found in the spermaceti organ of sperm whales.

Spinal blaze - A light streaking of color invading the cape below the dorsal fin of some dolphins.

Spy-hop - **The** act of a whale bringing its head vertically out of the water.

Standard length - Body length, measured from the tip of the upper jaw to the notch in the fluke (straight line) for cetaceans, and from the snout tip to the end of the tail (straight line, belly up) for pinnipeds.

Sternum - The breastbone (Fig. 7).

Stock- A biological population, generally defined for management purposes.

Stranding - The act of coming on to land, either alive or dead, intentional or accidental, of cetaceans or sirenians.

Supraorbital processes - Small bony protruberances above the orbits on the skull (Fig. 5).

Symphysis (mandibular) - The coming together of the 2 lower jaw bones (Fig. 5).

Tail stock - The region just ahead of the tail, connecting it to the rest of the body (Fig. 3).

Taxonomy - The science of classification of organisms using different groupings. From highest to lowest level of organization the groupings of interest to this guide (with examples for the bottlenose dolphin) are: Class (Mammalia), Order (Cetacea), Suborder (Odontoceti), Family (Delphinidae), Genus ***(Tursiops)*** , and Species ***(Tursiops truncatus).***

Telescoping - The migration, over the course of evolutionary history, of the cetacean skull bones to form their current configurations, resulting in the placement of the nares on the top of the skull.

Temperate - Inhabiting the mid-latitudes characterized by a mild, seasonally changing climate.

Thorax - The front or top region of the body, behind the head.

Throat grooves, creases or furrows - Short grooves on the throat, characteristic of some groups of whales (Fig. 3).

Tropical - Inhabiting the low latitudes characterized by a warm, seasonally stable climate.

Tympanic bullae - One of the 2 major innner ear bones of mammals (Fig. 5).

Underfur - The short, numerous hairs underlying the guard hairs of pinnipeds and otters (Fig. 10).

Urogential area - The region around the anal and genital slits in cetaceans (Fig. ll).

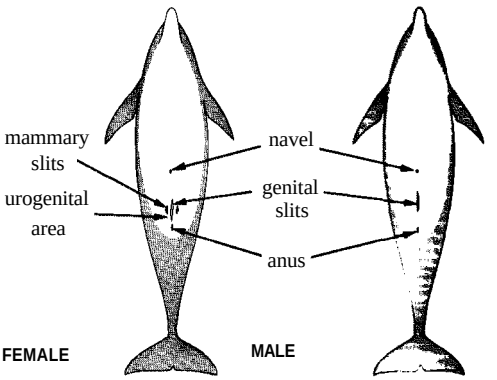


Fig. ll Ventral View of Cetacean

Ventral - Relating to the lower surface of an animal (Fig. 3).

Ventral pleats - The long pleats extending from the tip of the jaw to as far back as the navel in some baleen whales (Fig. 3).

Vertebrae - The bones of the vertebral column, consisting of 5 sections (cervical, thoracic, lumbar, sacral, and caudal). Some marine mammals do not have true sacral vertebrae (Fig. 7).

Vestigial - Existing as a trace of something that is in the process of being evolutionarily lost.

Vertex - The elevated portion of the skull immediatley behind the bony nares (Fig. 5).

Vibrissae - Whiskers (Fig. 3).

Zygomatic arch - The bony arch of the cheekbone in marine mammals (Fig. 5).

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