

Zoogeography

Lesson 8

Let's begin with a paradox!

Predatory starfish

Many studies of natural communities have confirmed the hypothesis that predators may increase the number of different species that can live in a habitat. The American ecologist Robert T. Paine made an especially fine study on the animal community of a rocky shore on the Pacific coast of North America [55]. The community included 15 species, comprising acorn barnacles, limpets, chitons, mussels, dog whelks and one major predator, the starfish *Pisaster ochraceus*, a generalist which fed on all the other species. Paine carried out an experiment on a small area of the shore in which he removed all the starfish and prevented any others from entering. Within a few months, 60–80% of the available space in the

experimental area was occupied by newly settled barnacles, which began to grow over other species and eliminate them. After a year or so, however, the barnacles themselves began to be crowded out by large numbers of small but rapidly growing mussels, and when the study ended these completely dominated the community, which now consisted of only eight species. The removal of predators thus resulted in the halving of the number of species, and there was additional evidence that the number of plant species of the community (mainly rock-encrusting algae) was also reduced, because of competition from the barnacles and mussels for the available space.



What is a migration?

Migration is the regular movement of animals from one location to another

- Animal migration is the relatively long-distance movement of individuals, usually on a seasonal basis.
- It is observed in nearly all major animal groups.
- It can be also defined as:
 - A movement leading to the redistribution of individuals within a population



Resident vs Migrant



<https://doi.org/10.1007/s10646-015-1450-8>

Pattern of migration

1. Diurnal and tidal movements
2. Seasonal movements between habitats
3. Long distance migration

Diurnal and tidal movements

- Many species repeatedly shift between habitats throughout their lives,
- the timing of these movements varying from hours and days to months or even years.
- e.g. shoreline crabs migrate in sync with tidal changes
- Diurnal migration refers to the daily movement between two habitats, each providing limited resources;
- e.g. planktonic algae in both ocean and freshwater lakes descend at night but rise to the surface during the day.

Seasonal movement between habitat

- The availability of resources in an environment often shifts with the seasons, prompting populations to move from one area to another

e.g. mule deer and American elk exhibit altitudinal migration, traveling to higher mountain regions during summer and descending to valleys in winter

Long distance migration

- Some species travel vast distances to access seasonal food supplies. e.g. terrestrial birds in the Northern Hemisphere migrate northward in spring to take advantage of abundant summer food resources.
- In autumn, they move south to savannahs, where food becomes plentiful following the rainy season.
- Thus, long-distance migration often enables species, such as swallows, to alternate between regions that provide abundant resources, but only for limited periods.

Migration



Latitudinal movements of animals in order to take advantage of long summer days and high productivity in the high latitudes, and then to retreat to lower latitudes to avoid the stresses of the winter season.

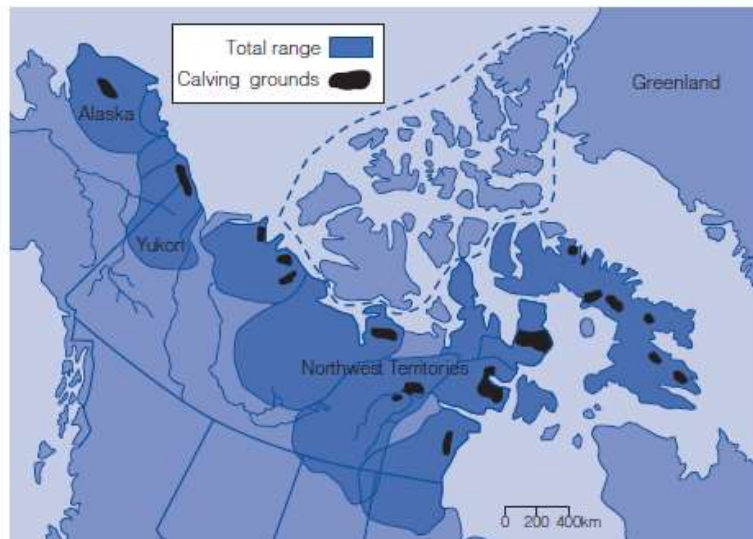


Figure 2.39 Ranges of caribou herds in North America, also showing their calving grounds to which they migrate each spring. Caribou are also located on the islands enclosed within the dashed line. From Sage [59].



Who migrates?

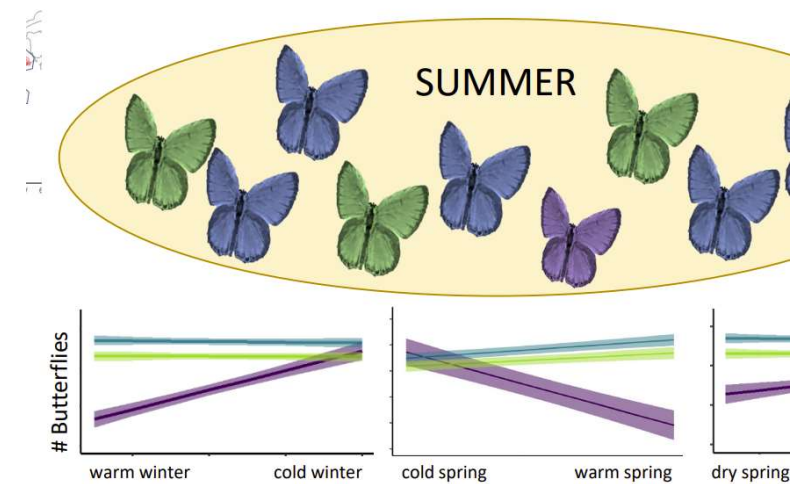
- Mammals
- Birds
- Amphibians
- Reptiles
- Fish
- Insects



Prerequisites for migration

- Sustained movement
 - Physical endurance
 - Mechanisms for storing energy
 - Designated food sources on the migration route
- ❖ Migration ensures animals will have adequate food supplies and will be able to reproduce

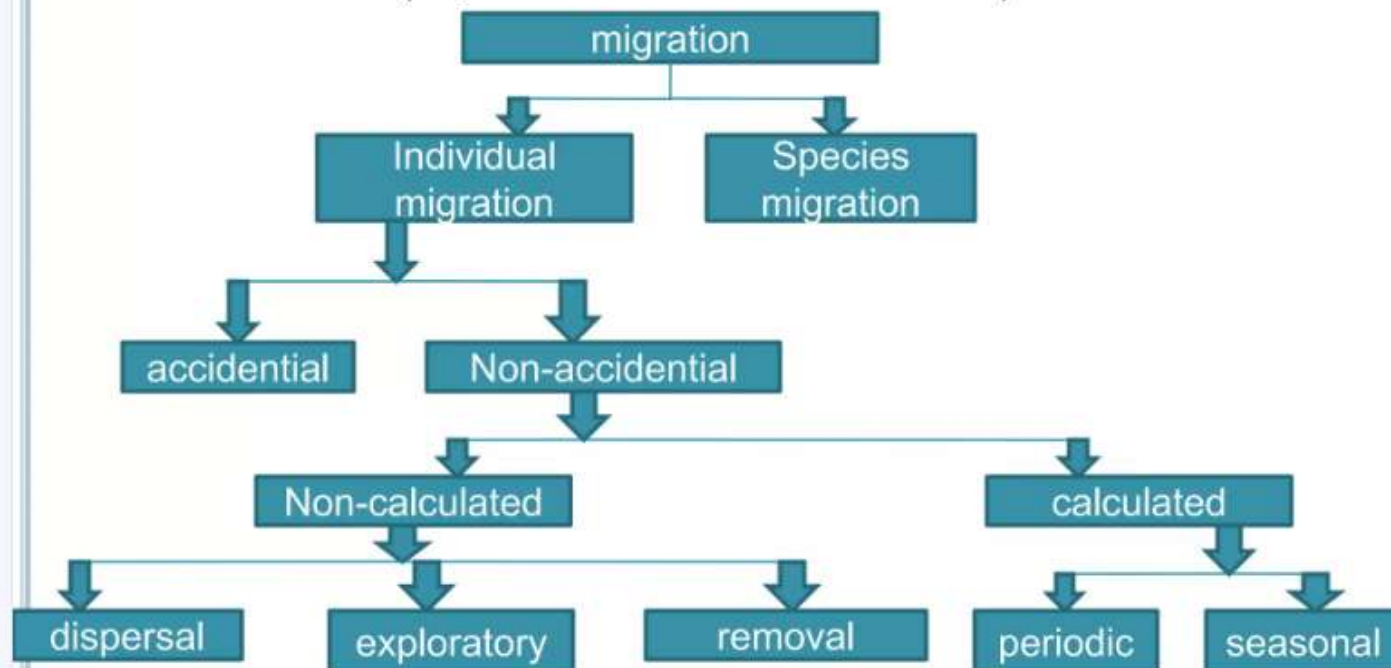
The study of periodic phenomena (such as migration) in animals in relation to changes, climatic and other ecological factors are called **phenology**



Evolutionary model of migration (baker 1978)

- Animal tend to assess the utility of their present habitat (h1) relative to that of another potential habitat (h2).
- They migrate only when the utility of h1 drops below that of h2 multiplied by a migration factor (m)

(ie., h_1 is less than that of h_2m)



Types of migration

- Latitudinal
- Altitudinal
- Reproductive
- Seasonal
- Irruptive



- ❖ Migration may occur:
 - As a round trip
 - As a return migration
- ❖ Some require a lifetime to complete:
 - ex. Pacific salmon
Born in freshwater streams,
Travel to the ocean,
Return to the stream where
they were born,
Spawn and then die.

Migration



Figure 2.40 Breeding grounds, migration routes and wintering grounds of the white-fronted goose (*Anser albifrons*). From Mead [60].

- circumpolar distribution pattern, in summer breeding season.

- winter in southern parts of North America and Central America, in Europe and the Persian Gulf, and in Japan and eastern China, depending upon their breeding season.

Knowing when to Migrate

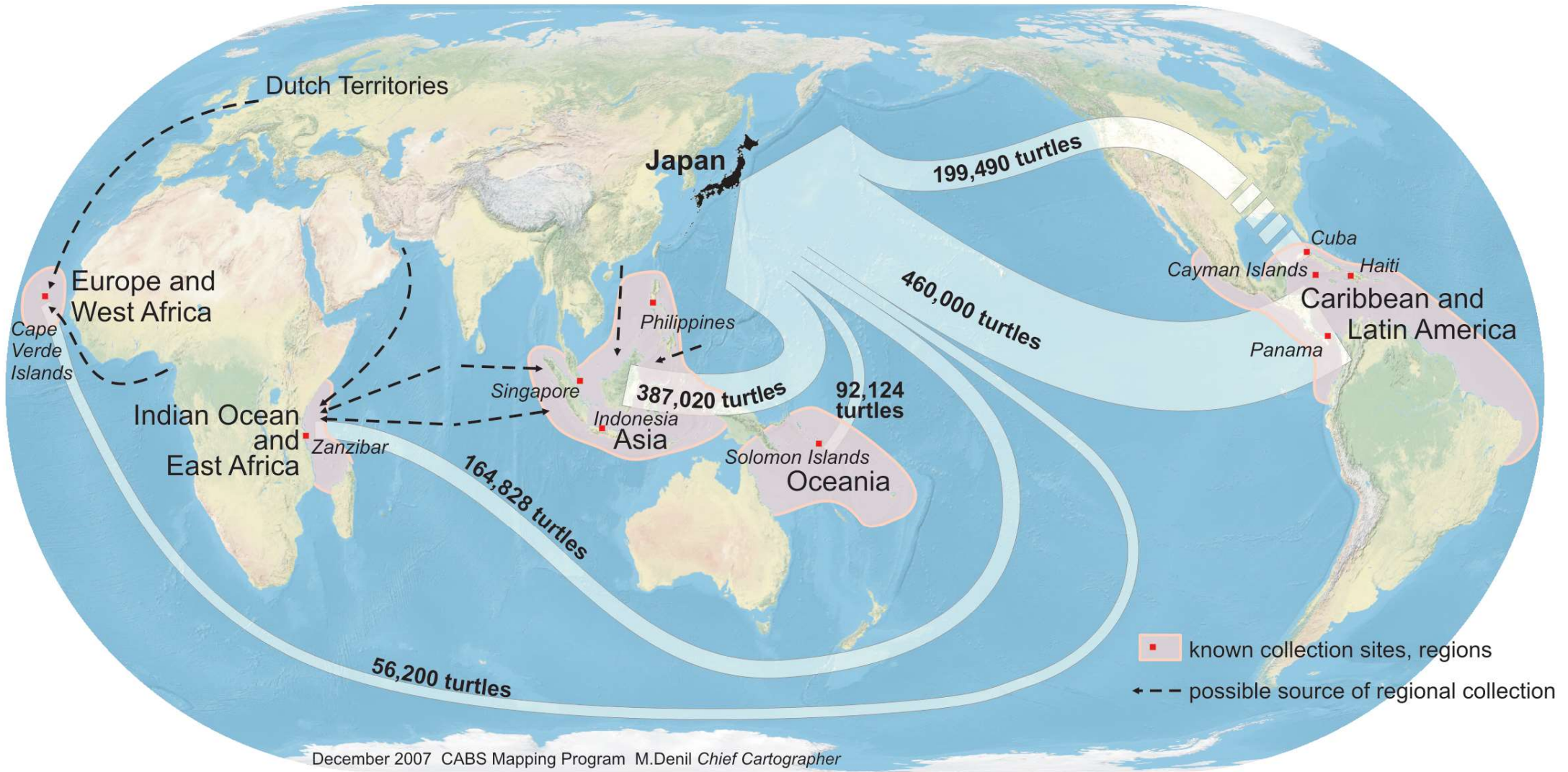
❖ How do animals know when it is time to migrate?

- Internal signals, such as hormonal changes, trigger a powerful urge to eat, mate, and reproduce.

- External signal, such as
Temperature change, Daylight hours,
Scarce food supply



<https://www.seaturtlestatus.org/printed-maps>



Japanese Bekko Imports by Region, 1950–1992 | From “Trade Routes for Tortoiseshell” in [SWOT Report, vol. III \(2008\)](#).

Migration Destinations

❖ How do animals know where to go?

- Specialised abilities to navigate
- External forces (e.g. wind and currents)
- Landmarks (e.g. coastlines, mountain ranges, odours, etc.)
- Sun > Track the passage of days and months
 - > Track their position in relationship to the sun

Migration

- nests in the Arctic
- then it travels toward the Antarctic during the northern hemisphere winter.
- This bird enjoys more daylight in the course of its life than any other organism.
- Arctic tern covers the longest distance (about 17,600 km) ever recorded on earth
- During its whole lifetime, it makes a journey equivalent to 3 return travels to the Moon!

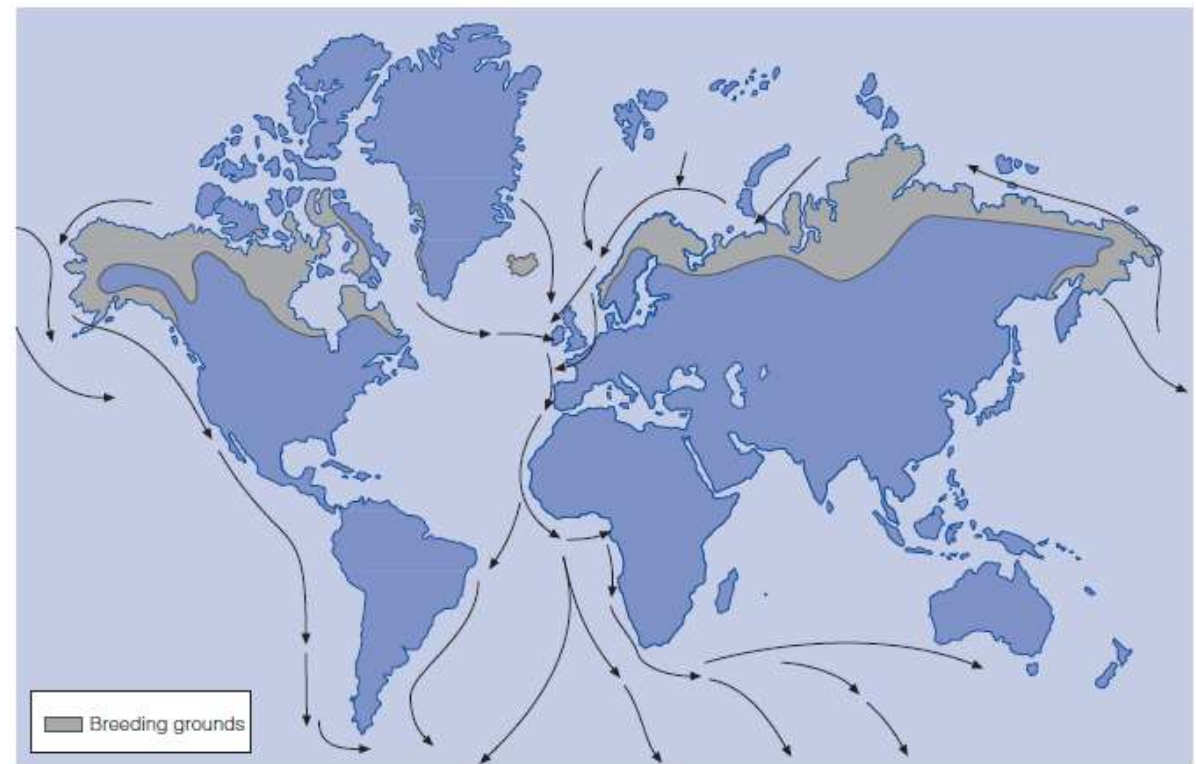
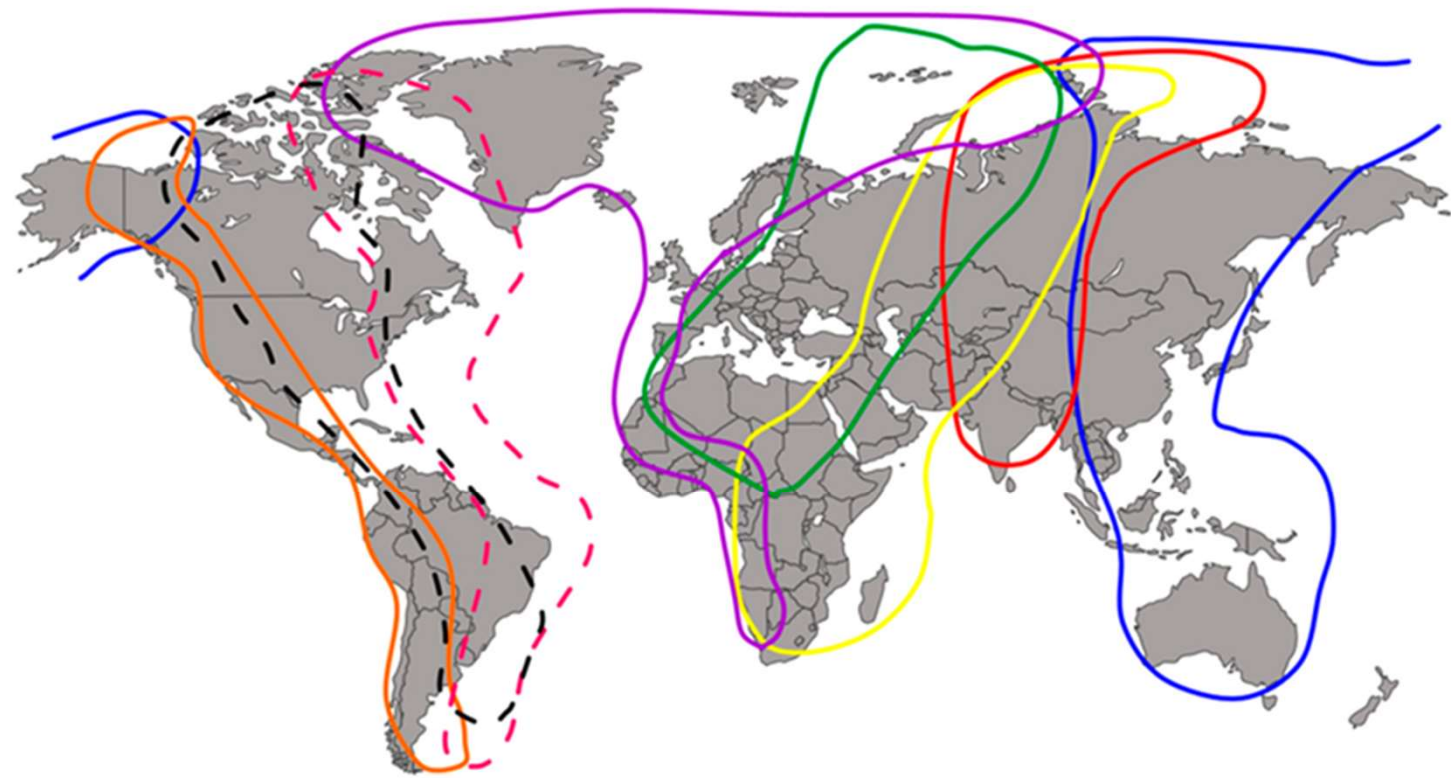


Figure 2.41 Breeding grounds, migration routes and wintering area of the Arctic tern (*Sterna paradisaea*). From Mead [60].

Birds migration

- Over 5 billion land birds of 187 species migrate across Europe, Asia, and Africa.
- Over 5 billion land birds of over 200 species travel between North America and the tropical regions of the Americas.
- In North America, around 75% of the 650 bird species nest locally.



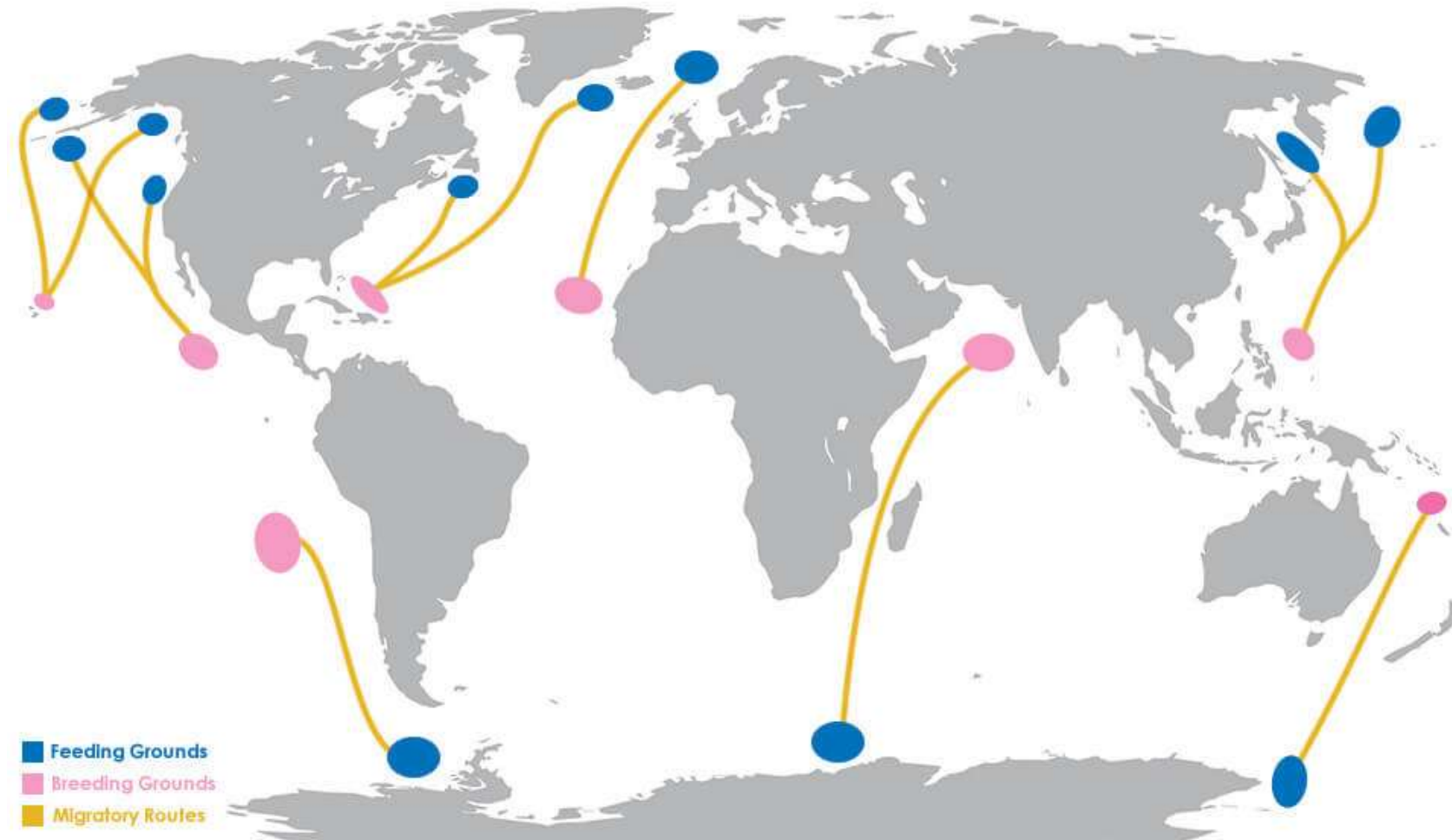
- | | | |
|-------------------------|---------------------------|--------------------------|
| — East Asia/Australasia | — Black Sea/Mediterranean | - - Mississippi Americas |
| — Central Asia | — East Atlantic | — Pacific Americas |
| — West Asia/East Africa | - - Atlantic Americas | |

Migration



- Migrates between Canada and the Pacific Northwest to Central and South America each fall, returning in the spring.
- 42 days to fly from Panama to Canada (the actual travel involved consists of 18 nights of flying).
- The rest of the time is taken up with resting at stopover locations along the route.
- Over the 4800 km journey, 4450 kJ of energy is expended (1 kJ/ each Km).
- only 29% of the energy lost is expended on the actual flight; the remainder is lost during the stopover rests (recuperating and seeking food at these locations)

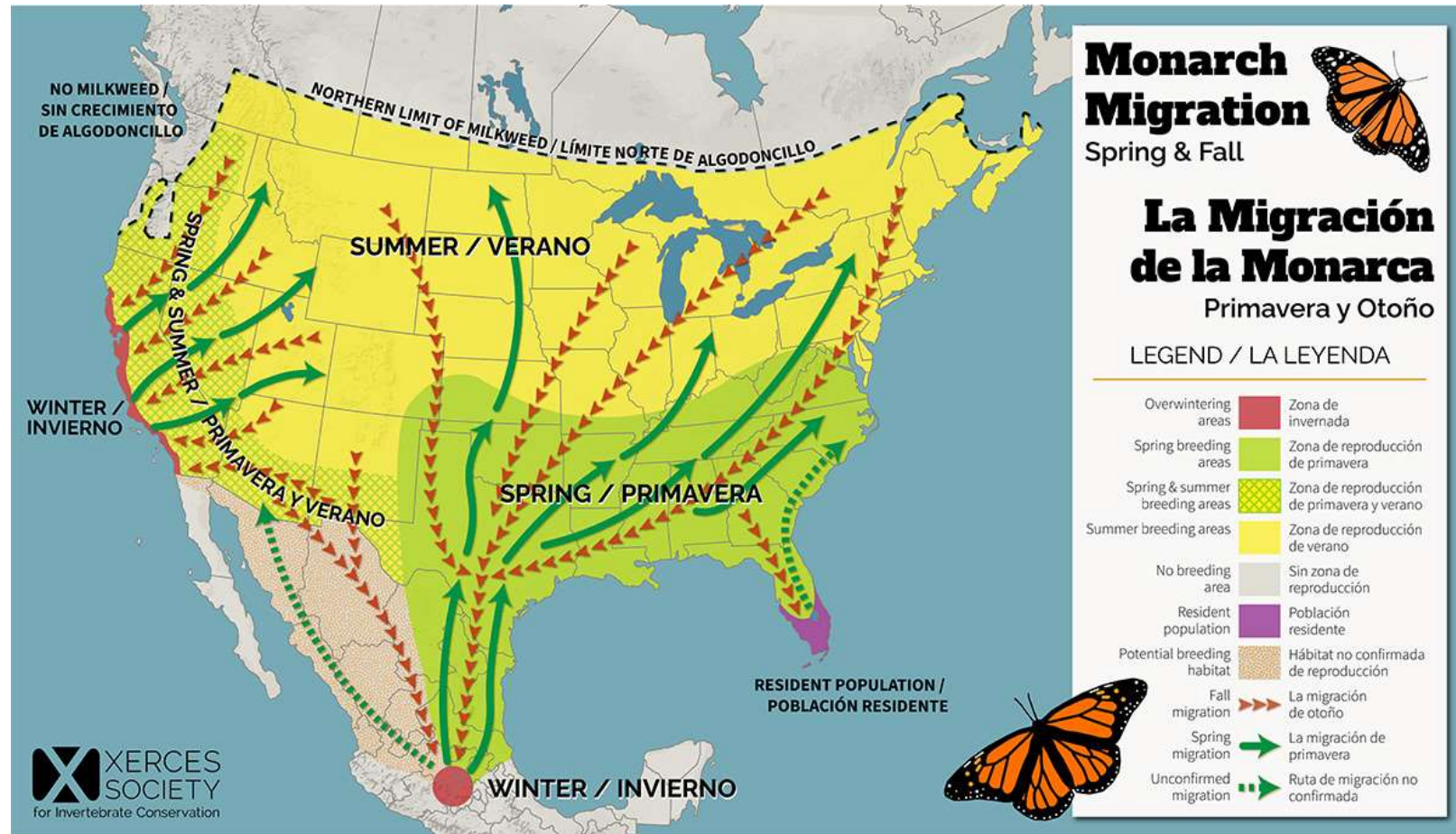
Migratory Routes of the Humpback Whale



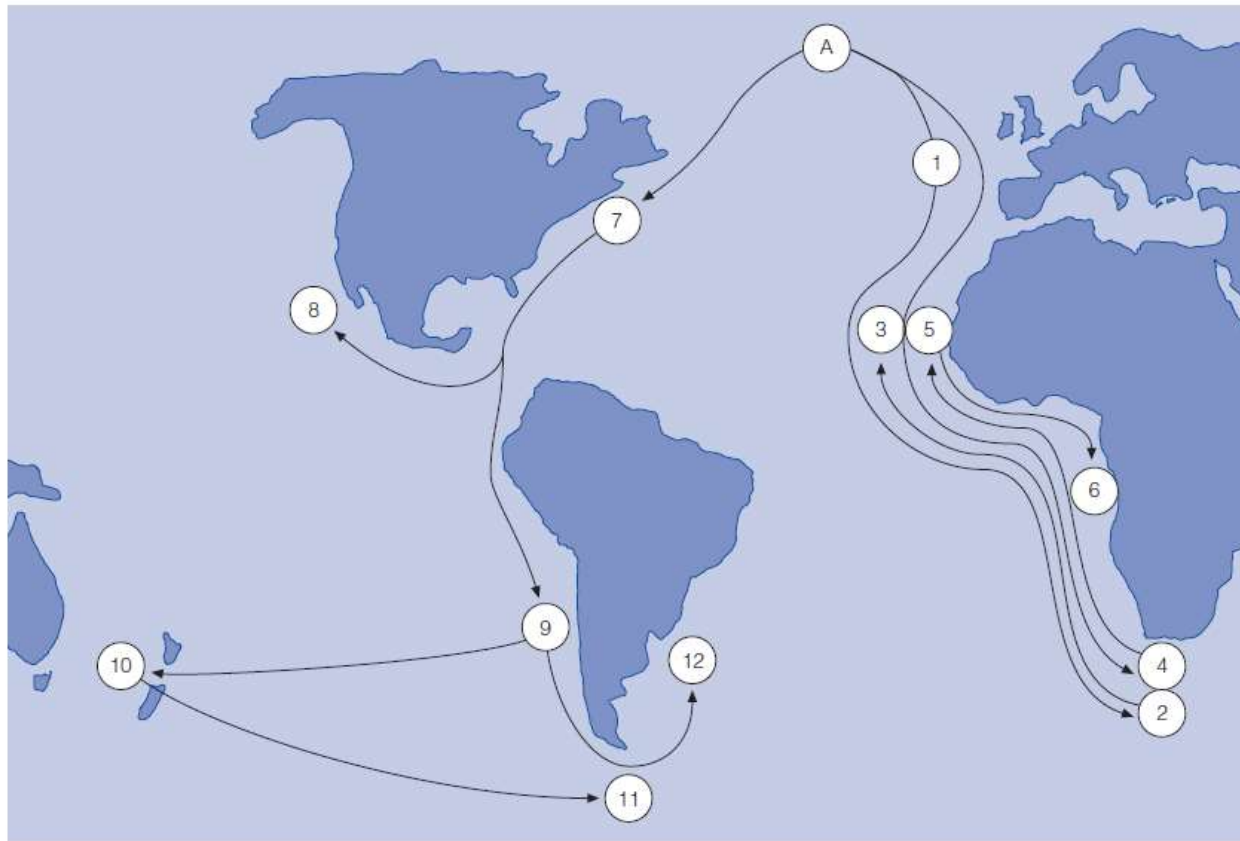
More than 90% of the marine environment's habitat is pelagic, encompassing the vast, three-dimensional space from the ocean's surface down to its deepest trenches, known as bathypelagic zones.

Butterfly migration

- East of the Rocky Mountains, monarchs travel up to an astonishing 3,000 miles to central Mexico, whereas the shorter migration west of the Rockies is to the California coast



The case of the hake *Merluccius*



(a)

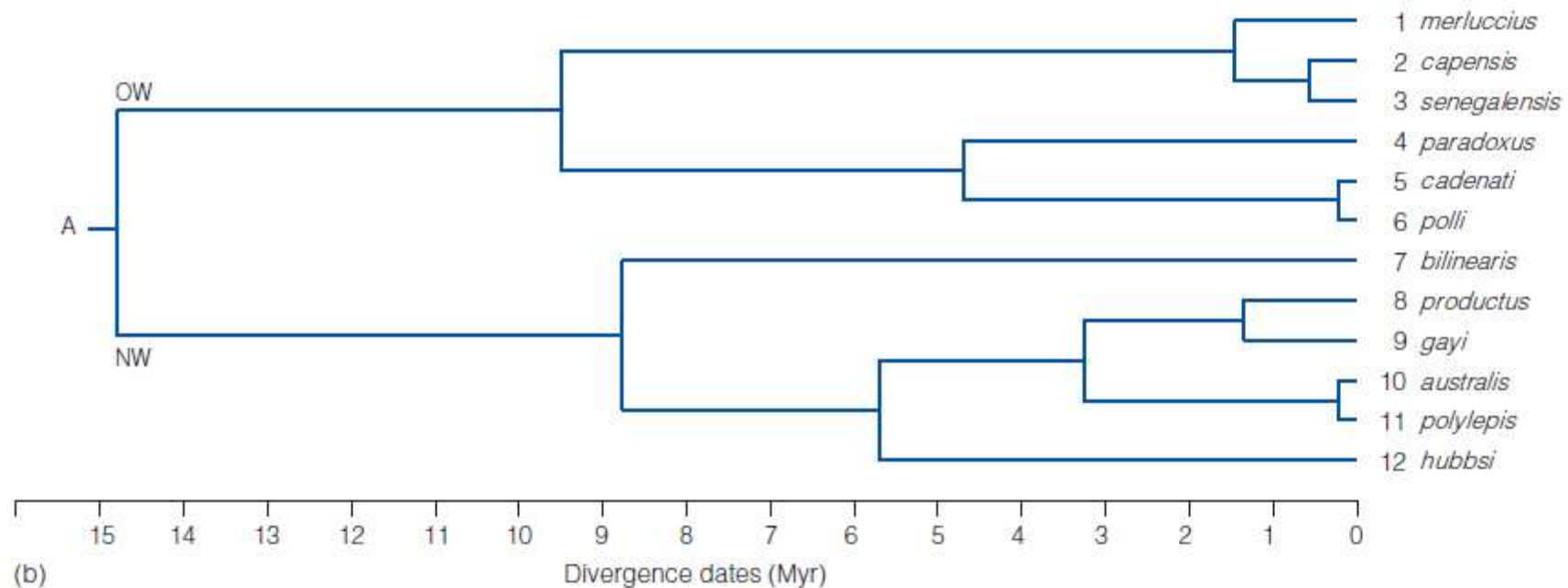
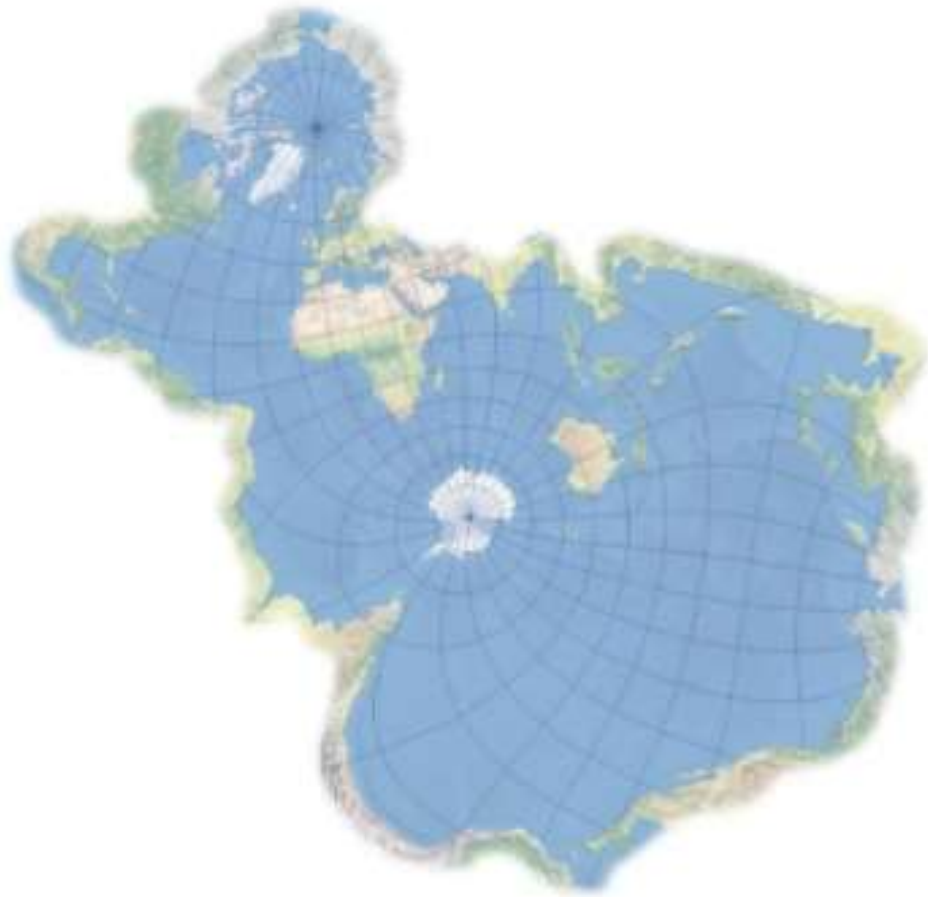


Figure 9.1 The dispersal of 12 species of hake, *Merluccius*, as suggested by fossil and molecular data. (a) Map showing distributions and dispersal. The numbers refer to the individual species shown in the cladogram of phylogenetic relationships (b), which also shows the dates of divergence between the different lineages, in millions of years. The numbers refer to the individual species as shown in the cladogram. A, ancestral *Merluccius*; NW, New World lineage; OW, Old World lineage. Data from Grant and Leslie [3].

World map according to fish



Although pelagic areas may seem like a boundary-less continuum, water chemistry, salinity, depth/pressure, currents and variations in primary productivity create different regions within these systems with distinct biotas and geographies.

- 210 000 species of marine organisms have been described so far



- 1,8 million species from the land



- 250 000 land plant species



- Only 3500-4500 phytoplankton species



Larval dispersal

- The potential efficacy of larval dispersal is shown by the fact that species of benthic invertebrate along the western coasts of the Atlantic are more widely distributed if they have planktonic larvae than if they do not

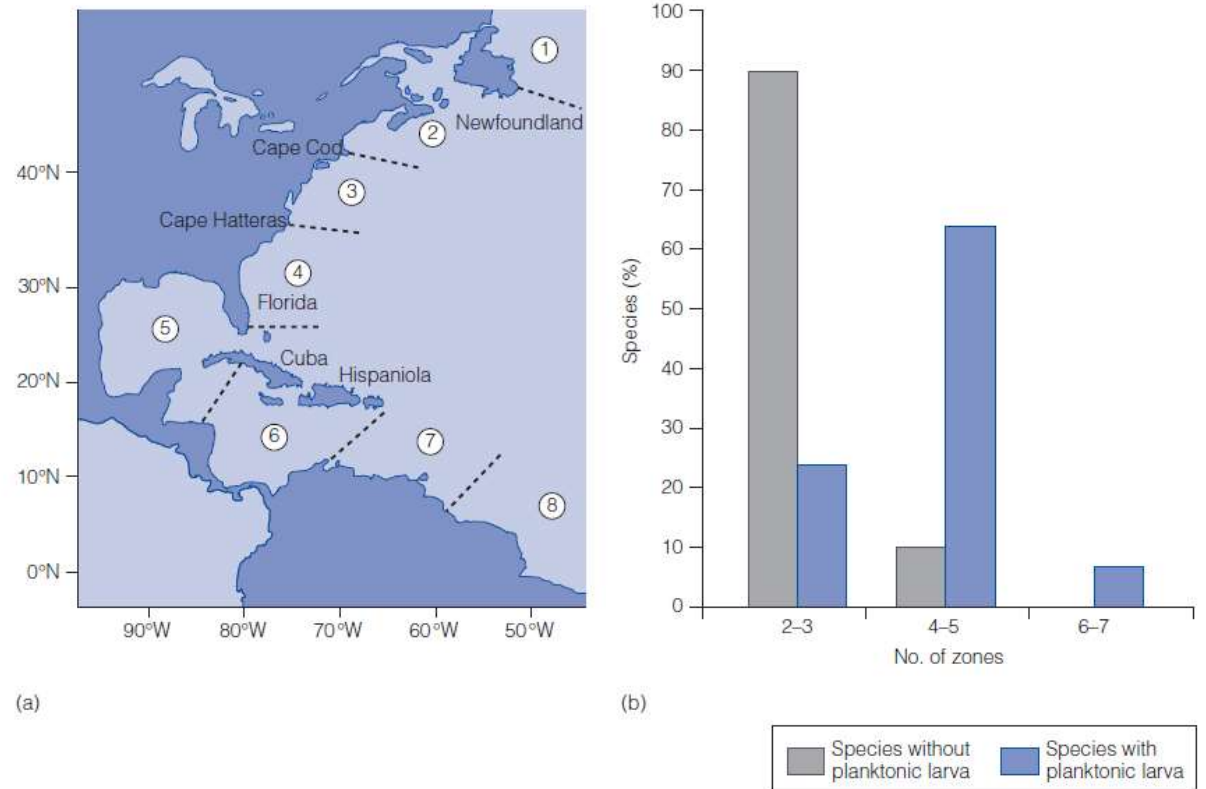


Figure 9.8 (a) Biogeographical zones down the western coasts of the Atlantic. (b) The number of invertebrate benthic species that occupy these zones, with or without planktonic larvae. Adapted from Scheltema [63].

- long-lived larvae will need to feed during the days of dispersal, so it is not surprising to find that such larvae are more common in low latitudes, where the phytoplankton season is long, than in high latitudes, in which it is shorter

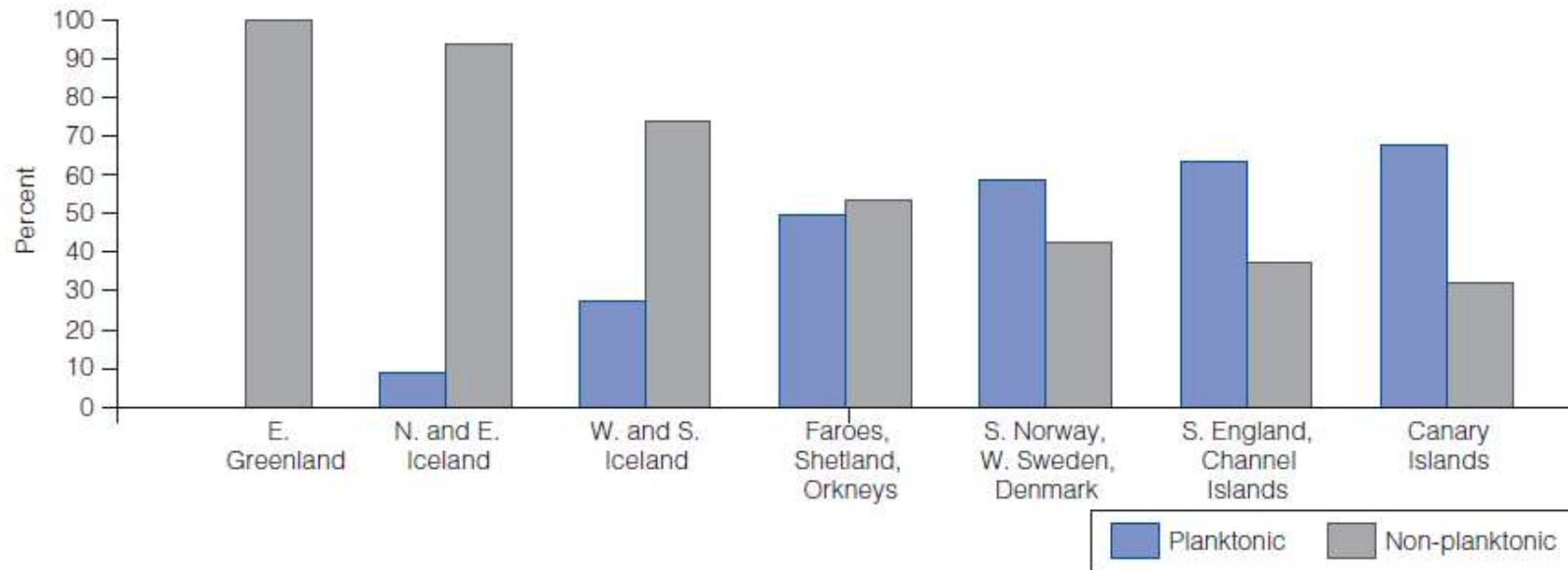


Figure 9.9 The percentage of gastropod species that either have, or do not have, planktonic larvae, at different latitudes. Adapted from Thorson [64].

Coral reefs

- Coral reefs provide a complex, three-dimensional environment that is home for an immense diversity of marine organisms, including 25% of the diversity of life in the oceans, and comprise the greatest diversity of species of vertebrate per square metre known on Earth.
- To date, 35 000–60 000 different species of reef-dwelling organisms have been described, and this is probably only a fraction of the total number.

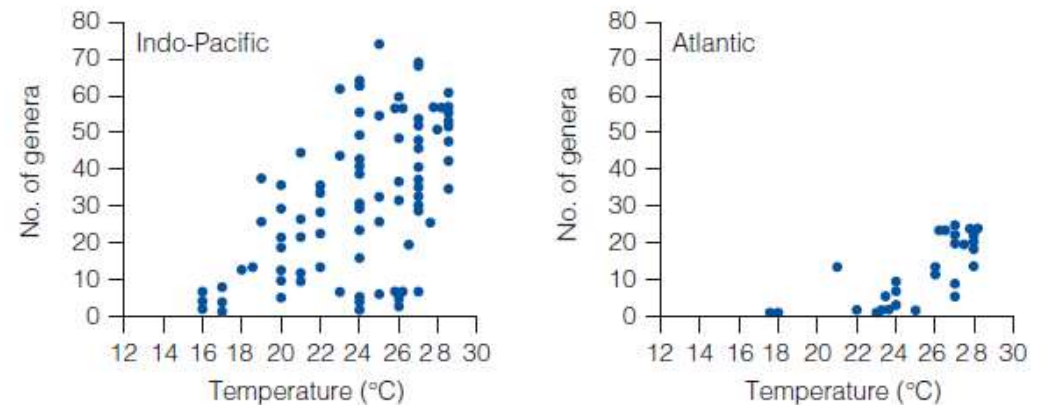


Figure 9.10 The number of genera of coral at different mean annual sea-surface temperatures in the Indo-Pacific and Atlantic oceans. From Rosen [65].

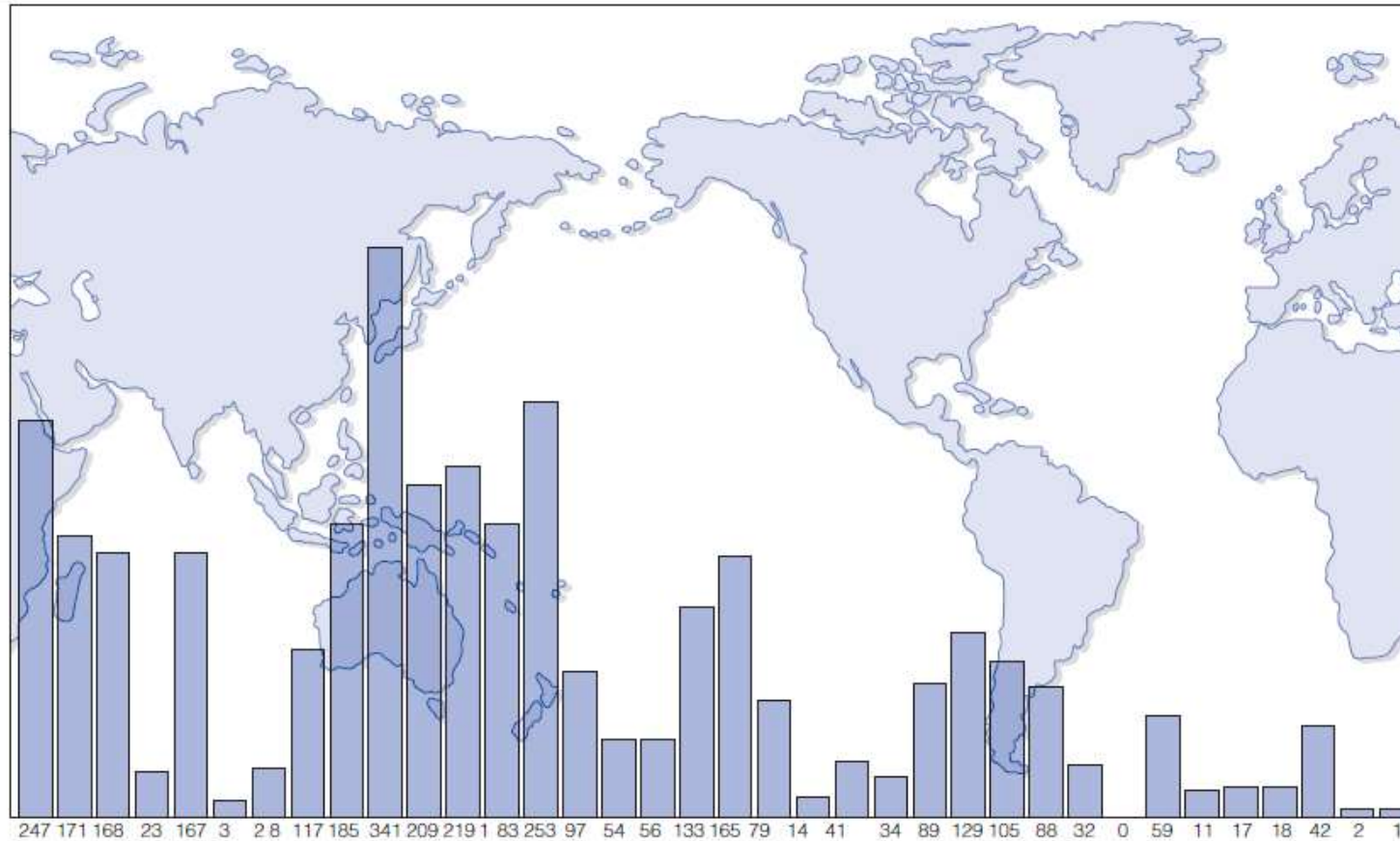


Figure 9.13 Longitudinal gradients in fish species richness. The columns represent the total number of fish species (from a sample of 799 species) that occur in each 10°-wide band of longitude. Note how the diversity increases in the latitudes that include the West Indies and Caribbean, where there are many coral reefs. Adapted from McAllister *et al.*

Migration: Behaviour or Instinct?

- Migration is instinctive (often guided by the Earth's magnetic field for orientation)
- Fly without guidance or previous experience
- Use little or no directional clue
- Learning migration behaviours for most animals is critical to their survival

Migration Behaviours

- Most animals must learn their migratory routes

Older members of the group pass down essential knowledge to younger animals, teaching them the migration route along with valuable strategies and behaviours.

Animals who are not taught these behaviours will not likely survive



Advantages of migration

1. Migration allows birds to secure more favorable living conditions by avoiding extreme climates—such as intense cold, heat, or storms—and by moving to areas with abundant food.
2. By alternating between two different habitats, migratory birds can access varied food sources, enabling larger populations to thrive.
3. Change in habitat provides greater variety in bird diet.
4. long summer days offer extended daylight hours for foraging, which is crucial for feeding their young.
5. Predation pressure is less because it arrives in large numbers in breeding ground, so it help in their survival

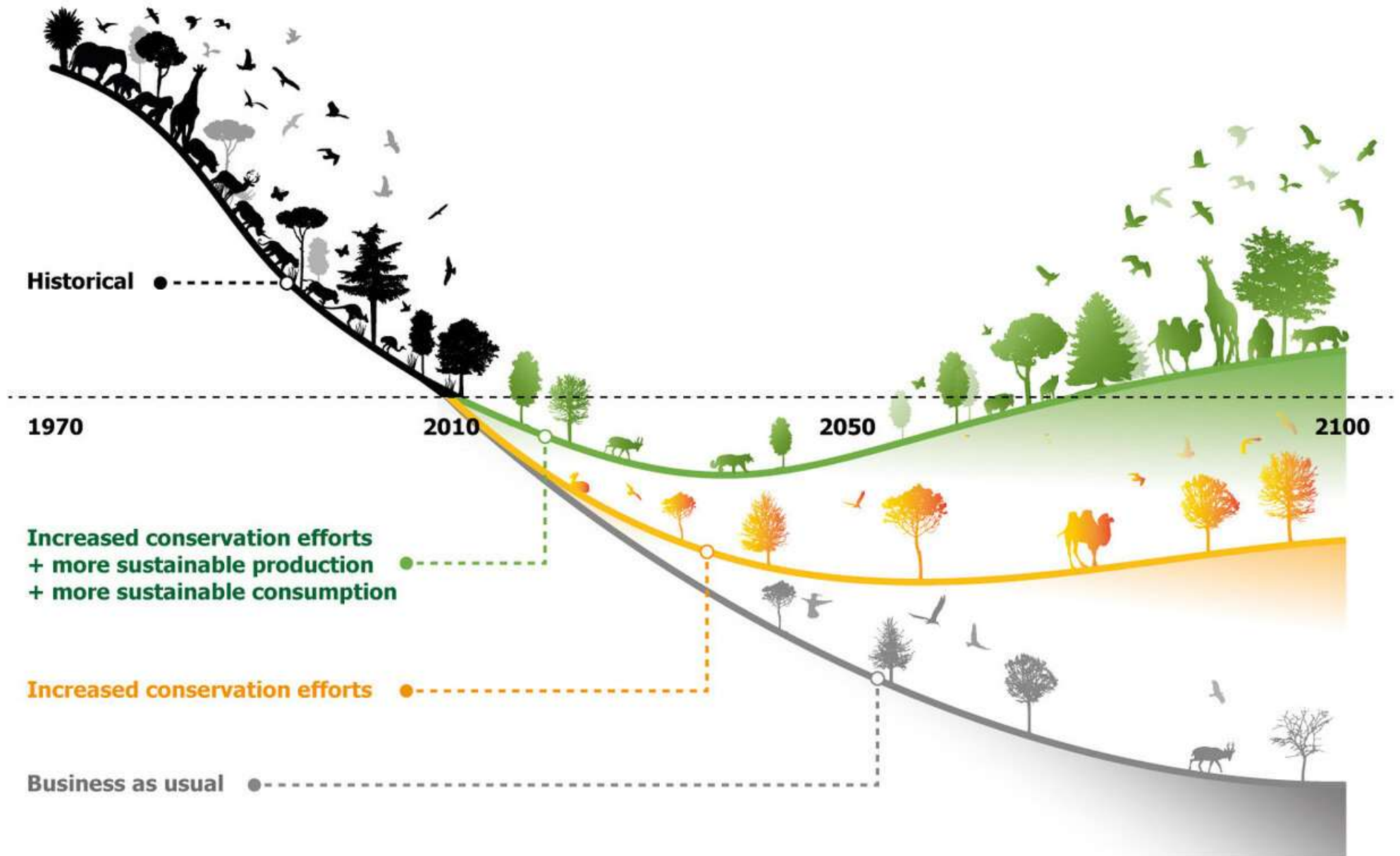
Hazards of Migration

❖ Natural hazards:

- Climate changes
- Drought
- Food supply
- Predators
- Physical demands of migration
- Journey is tiresome, some specimens die during the journey

❖ Man-made hazards:

- Barriers (fences, dams and skyscrapers)
- Water, aircraft, and fishing practices
- Telegraphic wires, towers, light houses



This artwork illustrates the main findings of the article, but does not intend to accurately represent its results (<https://doi.org/10.1038/s41586-020-2705-y>)

Key indicators

- **8 million:** estimated total number of **animal and plant species** on Earth
- **1 million:** estimated total number of **species threatened** with extinction
- **75%:** **Earth's environment 'severely altered'** by human actions
- **66%:** **marine environment 'severely altered'** by human actions
- **1000 x:** current rate of **biodiversity loss** compared to natural rate

