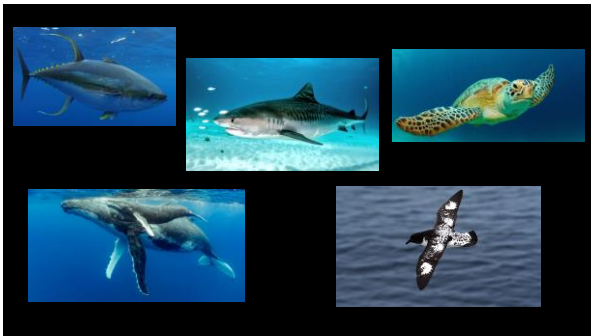




Biology and Conservation of Large Marine Vertebrates

Navigational mechanisms of large marine vertebrates



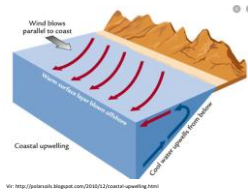
Migrations

- Yearly or seasonal movements,
- Convergent evolution (similar solutions)
- Sense of time (when, how long),
- Physiological adaptations (saving energy),
- Behavioural patterns (response to changes in environment),
- Ability to sense, use navigational cues.



Types of navigational cues

- Magnetic field (strength & incline),
- Celestial bodies (sun, moon & stars),
- Chemical/olfactory cues,
- Sounds,
- Salinity,
- Depth,
- Temperature...



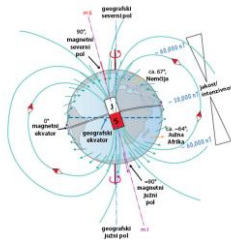
Types of navigation

- Primary/secondary navigation
- Active/passive navigation
- Real/vector navigation
- Navigational cues differ between different groups (availability, physiological adaptations)



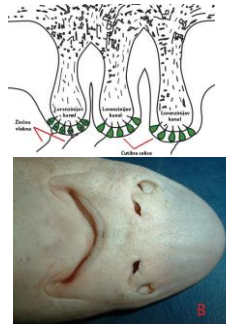
Magnetic Field

- Electric currents (liquid outer core)
- Magnetic field lines (inclination)
- Intensity/strength
- Max and min. (+ oscillations)
- Induction hypothesis (Lorenzini ampullae)
- Iron-mineral hypothesis (magnetite)
- Radical pair hypothesis (cryptochrome)



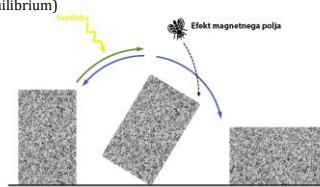
Induction hypothesis

- Electric tension across the electrical conductor in a changing magnetic field/moving of conductor through stationary magnetic field.
- If conductor in shape of circle/coil -> sense of direction



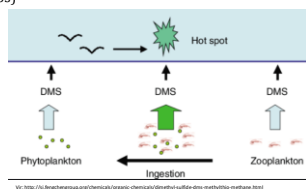
Radical pair hypothesis

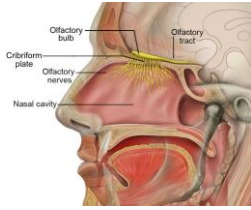
- Cryptochromes (photosensitive).
- Donor and acceptor -> radical pair (ms).
- Singlet and triplet state (not in equilibrium)



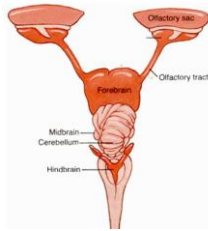
Chemical cues

- Biotic/abiotic
- Seasonal (guidelines, time stamps)
- Dimethyl sulfide (DMS)
- Phytoplankton grazing
- Olfactory system





Vi: https://upload.wikimedia.org/wikipedia/commons/2/24/Head_Olfactory_nerve_labelled.png



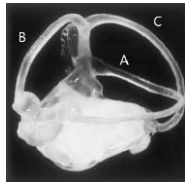
Vi: https://en.wikipedia.org/wiki/File:Brain_2.jpg

Sharks

- Reproducing & feeding
- During migration -> most of the time on the surface + oscillatory dives (navigation?)
- Electroreceptors + vestibular system
- Magnetite (head area)

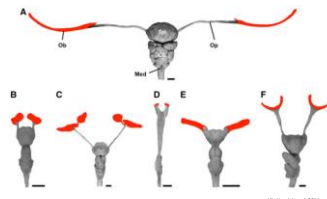


Vi: https://en.wikipedia.org/wiki/File:Shark_head_of_somocid

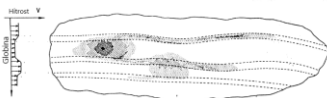


Vi: Montgomery in Walker 2001

- Olfactory bulb,
- Pelagic vs others
- Others: celestial, tem., infrasound...



Vi: Yopak in eol 2014

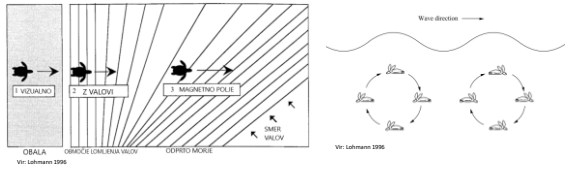


Vi: Huxley in eol 2002

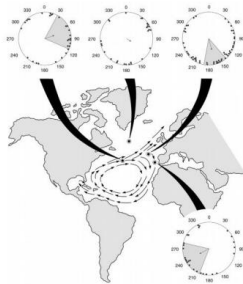
- A: Scalloped hammerhead (*Sphyrna lewini*)
- B: Spadefish (*Alopias superciliosus*)
- C: Tiger shark (*Galeocerdo cuvier*)
- D: Giant chimaera (*Chimaera tigrina*)
- E: Angel shark (*Sphyrna tiburo*)
- F: Cowtail stingray (*Pastinaca medusa*)

Sea turtles

- Reproducing, feeding & ontogenetic development
- Similar as sharks + resting places
- Different cues in different life stages

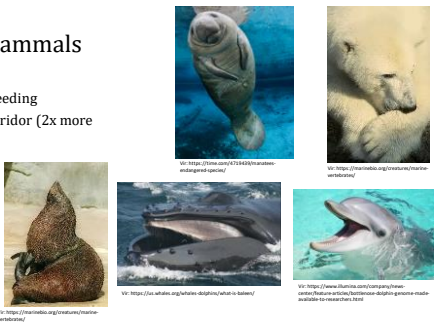


- Magnetite (head area)
- Chemical cues
- Moon & Sun
- Infrasound






Marine mammals

- Reproduction, feeding
- In migration corridor (2x more time on surface)
- Magnetite (brain membrane, spine)



- Olfactory cues (exception are Odontoceti)
- Above water
- memory, topography, visual cues (spy hopping), infrasound (echolocation)

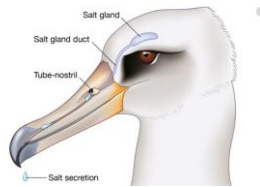
	OR		TAAR2/9	VIR	V2R	TASIR	TAS2R
class I	class II						
 cow	142 ^a	828 ^c	16	40 ^a	0 ^a	3	21
 minke whale	4	56	0	2	0	0	1
 dolphin	2	10	0	1	0	0 ^a	0 ^a

Mr. Kishida et al. 2015



Marine birds

- Adaptations (salt gland)
- Reproduction & feeding
- Most of research on pigeons
- Behaviour similar to sea turtles (resting places)



- Cryptochromes
 - Magnetite
 - Ophthalmic nerve
 - Chemical cues (only in air)
 - Celestial bodies, light polarization
- topography, landscape figures, infrasound, memory

