Cetaceans

- Kingdom – Animalia
- Phylum – Vertebrata
- Class – Mammalia
- Order – Cetacea
Mysteceti
*Baleen Whales*

Odontoceti
*Toothed Whales*

**Evolution of Cetaceans**

*Adapted from:* Graham J. Slater, Samantha A. Price, Francesco Santini, and Michael E. Alfaro

Evolution of Cetaceans

Right Whales
Pygmy Right Whales
Other Baleen Whales

Odontoceti
Toothed Whales

Adapted from: Graham J. Slater, Samantha A. Price, Francesco Santini, and Michael E. Alfaro
Evolution of Cetaceans

Cetaceans are Mammals

- Mammals...
  - Are warm-blooded
  - Breathe air
  - Lactate
  - Have Hair
Threats in an Aquatic World

- Anthropogenic Threats
  - Competition for Prey
  - Contaminants
  - Vessel/Fishery Interactions
  - Underwater Noise
Cetaceans of the World

- at least 83 extant species
- 46 genera in 14 families
Cetaceans of the World

Link to poster: http://acsonline.org/shop-acs/whales-of-the-world-poster/
Mysticetes
•12 species
Cetaceans of the World

**Odontocetes**
- 71-71 species
- delphinidae: most diverse family (36 species)
Cetaceans of the World

Diverse

• range in size from <5 ft to >90 ft
Global distribution

• occupy water ranging from -2°C to 30°C+

• live in fresh and saltwater

• some species (ie. killer whales) are found in all the worlds oceans
Cetaceans of B.C.

- home to **28%** of world’s cetacean species
- **23** species/populations
- **12** are listed as “at-risk” under SARA
Cetaceans of B.C.

Common species:
- Humpback whale
- Grey whale
- Minke whale
- Blue whale
- Fin whale
- Sperm whale
- Killer whale
- Pacific white-sided dolphin
- Dall’s porpoise
- Harbour porpoise

Less frequently sighted:
- Northern right whale dolphin
- Risso’s dolphin
- False killer whale
- Sei whale
- Cuvier’s beaked whale
- Baird’s beaked whale
- Stejneger’s beaked whale
- Hubb’s beaked whale

Uncommon:
- Right whale
- Common dolphin
- Short-finned pilot whale
- Dwarf sperm whale
- Striped dolphin
Minke whale
*Balaenoptera acutorostrata*

- **Size:** 9 m
- **Group size:** solitary
- **Habitat:** Coastal waters
- **Behaviour:** Shy, inconspicuous
- **Status:** Not at risk
Minke whale
*Balaenoptera acutorostrata*

- highly vocal: grunts, thumps, downsweeps
- gulp or skim feed on krill and small schooling fish
- fast swimmers, often change direction
- mating behavior has not been observed
- believed that births occur in winter
- often seen with sea birds
Grey whale
*Eschrichtius robustus*

**Size:** 14 m  
**Group size:** 1-2 animals  
**Habitat:** Shallow coastal waters + bays  
**Behaviour:** Forages in shallows  
**Status:** Special concern
Grey whale
*Eschrichtius robustus*

- ~25,000 in North Pacific
- Longest mammalian migration: 15-20,000km
  - Mexico to Bering, Chuckchi, Beaufort seas
- A few hundred animals remain in B.C. in summer
- Lifespan is unknown, may be >80 years
- Preyed on by killer whales
- Covered in barnacles and whale lice
Grey whale – feeding behavior

Feed on small invertebrates: amphipods, ghost shrimp, crab larvae
Humpback whale  
*Megaptera novaeangeliiae*

Size: 15 m  
Group size: 1-2 animals  
Habitat: Coastal and oceanic  
Behaviour: May breach, lunge-feed  
Status: Species of special concern
Humpback whale
Megaptera novaeangeliiae

• ~18,000 in the North Pacific

• migrate from Hawaii and Mexico to B.C. and Alaskan waters

• males will group in breeding grounds, aggressively pursue females

• highly vocal: grunts, whistles, wines
  • Males sing, how/why are mysteries

• gulp or lunge feeds on krill or small fish
  • Bubble-netting: whales work together to create spiral bubble pattern to scare fish into ball

• underside of flukes are like fingerprints

• unique bumps on head called tubercles
<table>
<thead>
<tr>
<th></th>
<th>Fin whale</th>
<th></th>
<th>Sei whale</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Species</strong></td>
<td><em>Balaenoptera physalus</em></td>
<td></td>
<td><em>Balaenoptera borealis</em></td>
<td></td>
</tr>
<tr>
<td><strong>Size</strong></td>
<td>24 m</td>
<td></td>
<td>18 m</td>
<td></td>
</tr>
<tr>
<td><strong>Group size</strong></td>
<td>1-3 animals</td>
<td></td>
<td>1-3 animals</td>
<td></td>
</tr>
<tr>
<td><strong>Habitat</strong></td>
<td>Oceanic</td>
<td></td>
<td>Oceanic</td>
<td></td>
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<tr>
<td><strong>Behaviour</strong></td>
<td>Long dives</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Status</strong></td>
<td>Threatened</td>
<td></td>
<td>Endangered</td>
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**Fin whale**
- rarely fluke
- bi-colored lower jaw
- eat 1 ton of prey in the summer
- preyed upon by killer whales

**Sei whale**
- ~50,000 in the North Pacific, but rarely seen
- historically heavily hunted
- prey: copepods, fish, squid
Blue whale
*Balaenoptera musculus*

**Size:** 33 m
**Group size:** 1-3 animals
**Habitat:** Oceanic
**Behaviour:** Long dives, fluking
**Status:** Endangered

- mottled, bluish skin
- largest animal ever to exist
- can reach 35km/hr
- vocalizations louder than jumbo jet, travel for 1000s km
North Pacific right whale
*Eubalaena japonica*

- **Group size:** Solitary or in small groups
- **Habitat:** Oceanic
- **Behaviour:** Usually inconspicuous, v-shaped blow
- **Status:** Endangered
North Pacific right whale
*Eubalaena japonica*

- slow moving, rich in oil
- ~100 in North Pacific
- callosities: crusty lumps on head
  - largest is called bonnet
- no dorsal fin
- skim feed on copepods and larval invertebrates
- breaching, lobtailing, pectoral slapping observed
- two sightings in 2013
Harbour porpoise
*Phocoena phocoena*

Size: 1.75 m
Group size: 1-5 animals
Habitat: Shallow coastal waters
Behaviour: Shy, avoids boats
Status: Special concern
Harbour porpoise
*Phocoena phocoena*

- largely inconspicuous, often overlooked
- common year round
- social groups of ~20 may gather
- prey: squid, variety of small fish
- spade shaped teeth
- sensitive to entanglement
Dall’s porpoise
*Phocoenoides dalli*

Size: 2 m
Group size: 4-20 animals
Habitat: Coastal and oceanic
Behaviour: Fast-moving, may bow-ride
Status: Not at risk
Dall’s porpoise
*Phocoenoides dalli*

- fastest small cetacean: 55km/hr
- rooster tail: v-shaped splash
- photo identification difficult
- most common small cetacean in North Pacific
  - ~1.4-2.8 million
- prey: squid, small schooling fish
Pacific white-sided dolphin
*Lagenorhynchus obliquidens*

Size: 2.5 m
Group size: 10-200+ animals
Habitat: Coastal and oceanic
Behaviour: Acrobatic, highly social
Status: Not at risk
Pacific white-sided dolphin
*Lagenorhynchus obliquidens*

- wide ranging
- very social, travel in large groups
- opportunistic feeders on fish and cephalopods
- preyed on by killer whales and large sharks
- acrobatic behavior
- interesting history in B.C.
<table>
<thead>
<tr>
<th></th>
<th>Risso’s dolphin</th>
<th>Northern right whale dolphin</th>
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</thead>
<tbody>
<tr>
<td><strong>Grampus Griseus</strong></td>
<td></td>
<td><strong>Lissodelphis borealis</strong></td>
</tr>
<tr>
<td><strong>Size:</strong></td>
<td>4 m</td>
<td>3 m</td>
</tr>
<tr>
<td><strong>Group size:</strong></td>
<td>10-50</td>
<td>Several hundred</td>
</tr>
<tr>
<td><strong>Habitat:</strong></td>
<td>Mostly oceanic</td>
<td>Oceanic</td>
</tr>
<tr>
<td><strong>Behaviour:</strong></td>
<td>Social, acrobatic</td>
<td>Social, acrobatic</td>
</tr>
</tbody>
</table>

- typically found in warmer waters
- covered in scratches of unknown origin
- prey: squid
- most have no teeth in upper jaw

- groups of up to 3000 observed
- prey: squid, lanternfish
- often seen with other cetaceans
False killer whale
*Pseudorca crassidens*

**Size:** 6 m  
**Group size:** 20-100  
**Habitat:** Mostlly oceanic  
**Behaviour:** Social

- prey: squid, fish
- propensity to strand en masse
- extremely vocal
- many records of human interaction
Beaked whales

• named for long snouts

• oceanic

• adult males (sometimes females) have tusk-like teeth

• teeth in upper jaw are vestigial

• prey: squid

• 3-13m in length

• rarely seen above surface

• groups: 5-20

• most heavily scarred due to competition

Baird's, Cuvier's, Hubb's, Stejneger's beaked whales
Sperm whale
*Physeter macrocephalus*

Size: Males 18 m, females 14 m
Group size: 15-30
Habitat: Oceanic
Behaviour: Deep, long dives, rest at surface
Status: Not at Risk
Sperm whale  
*Physeter macrocephalus*

- exceptionally long divers
- prey: giant squid
- cone shaped teeth on lower jaw
  - can weigh 1kg
- offset blowhole, to left side
- spermaceti: oil-like wax in head
- very social
- ambergris: digestive byproduct, prized by perfumers
- depredation an issue
Killer whale
*Orcinus orca*

**Size:** Males 9 m, females 7 m

**Group size:** 5-30+ animals

**Habitat:** Coastal and oceanic

**Behaviour:** Highly social, acrobatic

**Status:** Endangered, Threatened
Residents, Bigg’s and Offshores

Three distinct ecotypes

- residents: two populations
  - southern: ~80
  - northern: ~260

- Bigg’s (transients): ~300

- offshores: 211 catalogued
  (not representative of population)
Resident killer whales

- two populations in B.C.
- fish eaters; mostly Chinook salmon
- movement patterns predictable in summer
- travel in matrilines
- large groups can be observed
- highly vocal
Bigg’s (transient) killer whales

• prey on marine mammals
• movement patterns unpredictable
• large range
• travel in loose groups
• mostly silent
• increasing in B.C., 2-3% annually
Offshore killer whales

• largely mysterious

• travel in large groups (30-70)

• some catalogued

• distinct vocalizations

• prey on deep sea fish (halibut), sharks
  • teeth worn down
Killer Whales: 40 Years of Research Findings

Lance Barrett-Lennard

Vancouver Aquarium
University of British Columbia
The lead-up to formal research

• 1960: The Canadian Department of Fisheries installs a machine gun at Seymour Narrows to cull killer whales
• Frank Bocato and “Boots” Calandrino attempt to lasso and capture a killer whale in Washington
• 1964: Sculptor Sam Burich harpoons “Moby Doll” for the Vancouver Aquarium. Moby Doll lives for 3 months....
• 1965: Seattle Aquarium acquires the accidentally-caught killer whale Namu---large scale captures begin two years later.
• 1971: The Canadian Department of Fisheries and Oceans tasks Dr Michael Bigg with estimating killer whale abundance.
Killer whale research: the early years

• 1971 (July 26):—Bigg conducts world’s first “animal census” —on killer whales. Repeated in ’72 and ’73
• 1972: Bigg pioneers the application of photo-identification to killer whales, establishes the first killer whale sighting network
• 1973: tally is complete—only 200-350 killer whales inhabit the BC/Washington coasts
• 1976: Last capture in Washington. Canadian Fisheries Department also decides not to authorize additional captures. Bigg recognizes two type of killer whales but is re-tasked to work on seals.
• 1976-1990: Bigg leads unsanctioned (albeit high-profile) research on killer whale distribution and abundance.
Killer whale research: the eighties

- 1980: Existence of at least two ecotypes, residents and transients (later called Bigg’s) confirmed. The stability of resident kw pods and sub-pods are recognized. Two communities (populations) of residents are identified.

- 1984: Dr John Ford completes ground-breaking study of the dialects of resident killer whales, identifies a new unit of social organization, the clan.

- 1984: Craig Matkin starts a parallel study of Prince William Sound killer whales.


- 1990: Bigg dies of cancer after publishing seminal paper on resident killer whale social organization; his colleague Peter Olesiuk publishes seminal paper on killer whale longevity and demography.
Killer whale research: the last twenty five years

• 1992: Matkin and colleagues confirm population structure of killer whales in Prince William Sound parallels BC; both types were impacted by Exxon Valdez Oil Spill.

• 1993: Lance Barrett-Lennard discover distinctly different echolocation behaviour by residents and Bigg’s.

• 2000 Barrett-Lennard conducts DNA study, confirms genetic independence of residents and Bigg’s & determines mating systems in residents.

• 2005 Ford identifies link between Chinook salmon abundance and resident killer whale mortality.

• Bob Pitman and colleagues identify four (plus) kw populations in the Antarctic

• 2012 John Durban develops photogrammetry methods to assess kw body condition in the field
Population distribution of killer whales, coastal NE Pacific

Residents

Bigg’s

Offshores
Field Research

acoustic and behavioural monitoring

biopsy sampling
MtDNA (D-loop)

West Coast Bigg’s (26)

Gulf of Alaska Bigg’s-A (5)

AT1 Bigg’s (8)

Gulf of Alaska Bigg’s-B (2)

Southern Res (6) & Alaska Res., AD clan (15)

Northern Res. (32) & Alaska Res., AB clan (25)

Offshores (7)

Atlantics-A (1)

Atlantics-B (3)

61

65

98

49

(1 substitution)
Behavioural and ecological differences between residents and Bigg’s are culturally, not genetically maintained and transmitted.

- vocal repertoires
- dietary preferences
- foraging behaviour
- social organization
- mating preferences
- dispersal patterns
- feeding areas and seasonal movements
- echolocation use
Cultural displacement of food preferences reduces competition

residents and Bigg’s co-exist BECAUSE they don’t compete!
What would happen if killer whales lost their culture?

- compromised ability to find food, especially in lean years
- loss of specialized hunting skills
- reduced ability to perceive and reduce risk
- reduced social cohesion
- increased competition and conflict with neighbouring groups
Who are the stewards (and storers) of culture?
What factors determine killer whale abundance?

Abundance of wild populations usually determined by:

- Food availability
- Predation
- Behaviour (territoriality)

From the early 1970’s, killer whale numbers in BC have increased
Northern and southern resident killer whale survival varies with Chinook salmon abundance

In years of lower-than-average Chinook abundance, resident killer whale mortality increases (1 yr time lag)

Ford, Ellis, Olesiuk & Balcomb 2009
Linking killer whale survival and prey abundance: food limitation in the ocean’s apex predator: Biology Letters 6: 139-142.
Resident KW mortality declines and birth rate increases with increasing salmon abundance.
The Effects of Salmon Fisheries on Southern Resident Killer Whales


Prepared for
National Marine Fisheries Service (NOAA Fisheries)
7600 Sand Point Way NE
Seattle, WA, USA
98115-0070

Fisheries and Oceans Canada (DFO)
200 - 401 Burrard Street
Vancouver, BC, Canada
V6C 3S4

Prepared by
Independent Science Panel of the Bilateral Scientific Workshop Process to Evaluate the Effects of Salmon Fisheries on Southern Resident Killer Whales

with
David Marmorek and Alexander Hall
ESSA Technologies Ltd.
2695 Granville Street, Suite 600
Vancouver, BC V6H 3H4

November 30, 2012
Workshop conclusions

‘...increases in Chinook salmon abundance would lead to higher survival rates, and therefore higher population growth rates of SRKW. However, the effect is not linear...’

‘...consistently positive resident kw growth rates can occur by avoiding extremely low Chinook salmon abundance levels observed in the 1970-80s and late-1990s.’

BUT: ‘Elimination of ocean fisheries for Chinook salmon would impact Chinook salmon abundance far less than the variations that have been seen since the 1970s.’
Killer Whale Photogrammetry: What/Why/How

- Body measurements from photos
- Used to assess maturity, pregnancy and body condition
- Horizontal measurements: camera equipped with two parallel laser pointers
- Vertical measurements: camera fitted to unmanned helicopter
Overall Conclusion

The last four decades of killer whale research have been a wild ride!

Killer whales have gone from one of most poorly understood to one of the best understood mammals on the planet.

We’re looking forward to the next four decades!
Cetaceans in BC: Conservation Issues & Research
Conservation concern: Population status

Recovery from whaling
Historic BC Sei whales
4,000 records

In total: 24,427 whales in 59 years
Conservation Research: Necropsies
Conservation Research: Necropsies
Conservation Research: Population surveys (abundance)

- Sightings per km
- Population estimates
Population distribution

- Citizen science program
- Crowd sourcing sightings
Our Network: >3000 observers
Conservation concern: Vessel disturbance

- Interruption of natural behaviors *e.g.*, resting
- Effects of exhaust
- Interference with passive acoustic monitoring
- Ship strike
Conservation concern: Vessel strikes

BCY177- ‘Slash’
On the water- BE WHALE WISE
Stay out of the path of whales
Slow down to less than 7 knots within 400 m of whales.
Always stay at least 100 metres away from marine mammals
Don’t encourage dolphins or porpoises to bow-ride.

If they choose to bow-ride, maintain course and speed.
Conservation concern: Ocean Noise

Commercial shipping

• Increasing shipping in BC (135 million tonnes)
• Container, coal, LNG, pipeline traffic
• Pervasive, potential to block communication
Hydrophone network
• existing & proposed
• ≈ pollution monitoring
• standardized & calibrated
Conservation Research:
Noise & Hearing
Conservation Research: Noise & Hearing

Example cetacean sound reception
Conservation Research: Noise & Hearing

Example hearing curves: porpoises
Conservation concern: Entanglement
Report:

Animals in distress
Strandings
Entanglements
Boat disturbance
Ship strikes

1-800-465-4336
Conservation concern: Entanglement, by-catch
Conservation Research: Entanglement, by-catch
Conservation Research: Entanglement, by-catch
Conservation Research: Entanglement, by-catch

- 1° Pacific white-sided dolphins
- Search, avoidance
- Net discrimination
- Help understand behaviour of wild dolphins

Kathy Heise
Research Associate
Conservation concerns:
Food supply
Conservation Research: Food Supply
Conservation Research: Food Supply
Conservation Research: Food Supply
Conservation Research:
Food Supply
Conservation Research: Energetic needs
Cetaceans in BC: Conservation Issues & Research

- Host of conservation concerns in BC
- Active cetacean field programs (DFO, VA, ENGO’s)
- Acoustic, energetic work (VA)
- BC Sightings Network