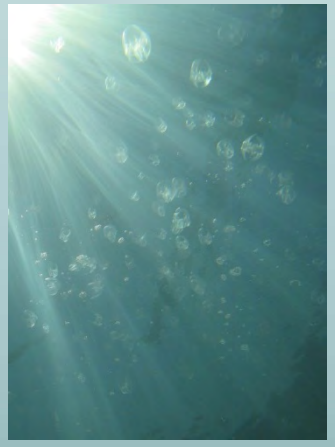
Direct and indirect evidence for massive differences in jellyfish biomass between the Pacific and Atlantic: implications for fisheries bycatch?



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NATURAL ENVIRONMENT RESEARCH COUNCIL

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SMART Swansea Moving Animal Research Team

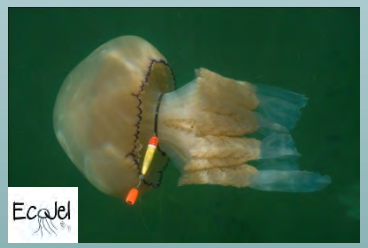
Swansea University Prifysgol Abertawe

Introduction

Historical jellyfish data:
- Incidental observations and bycatch
- Few specific long-term datasets

Jellyfish blooms are attracting widespread attention

Public interaction – many sightings
- *But are blooms actually anything new?*



Few reviews of long-term quantitative data

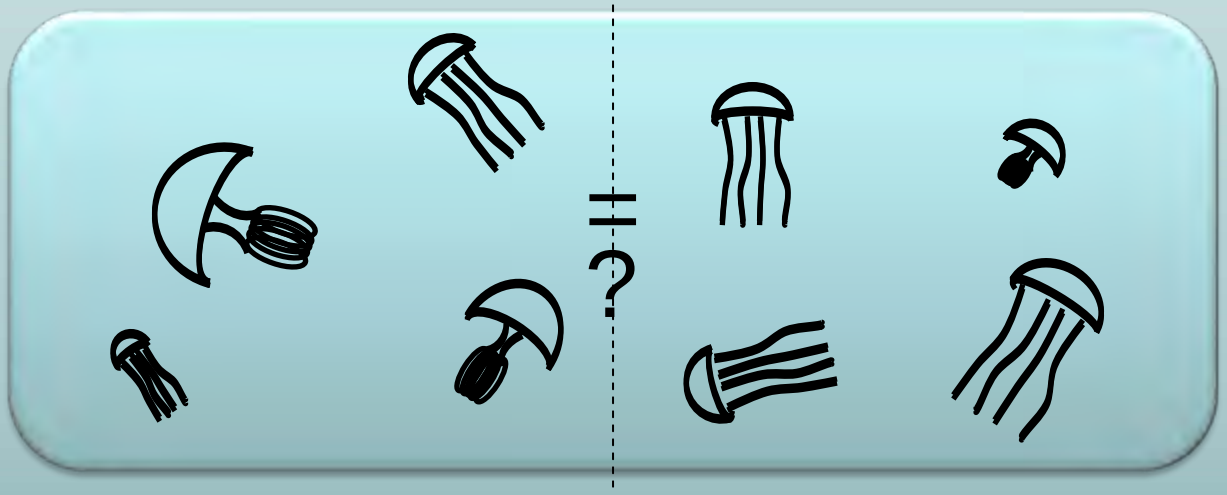
Current projects collating data and assessing qualitative data

Part 1 – Gelatinous biomass assessment

Sampling method?

Numerical data more widely available

but assessment of size absent

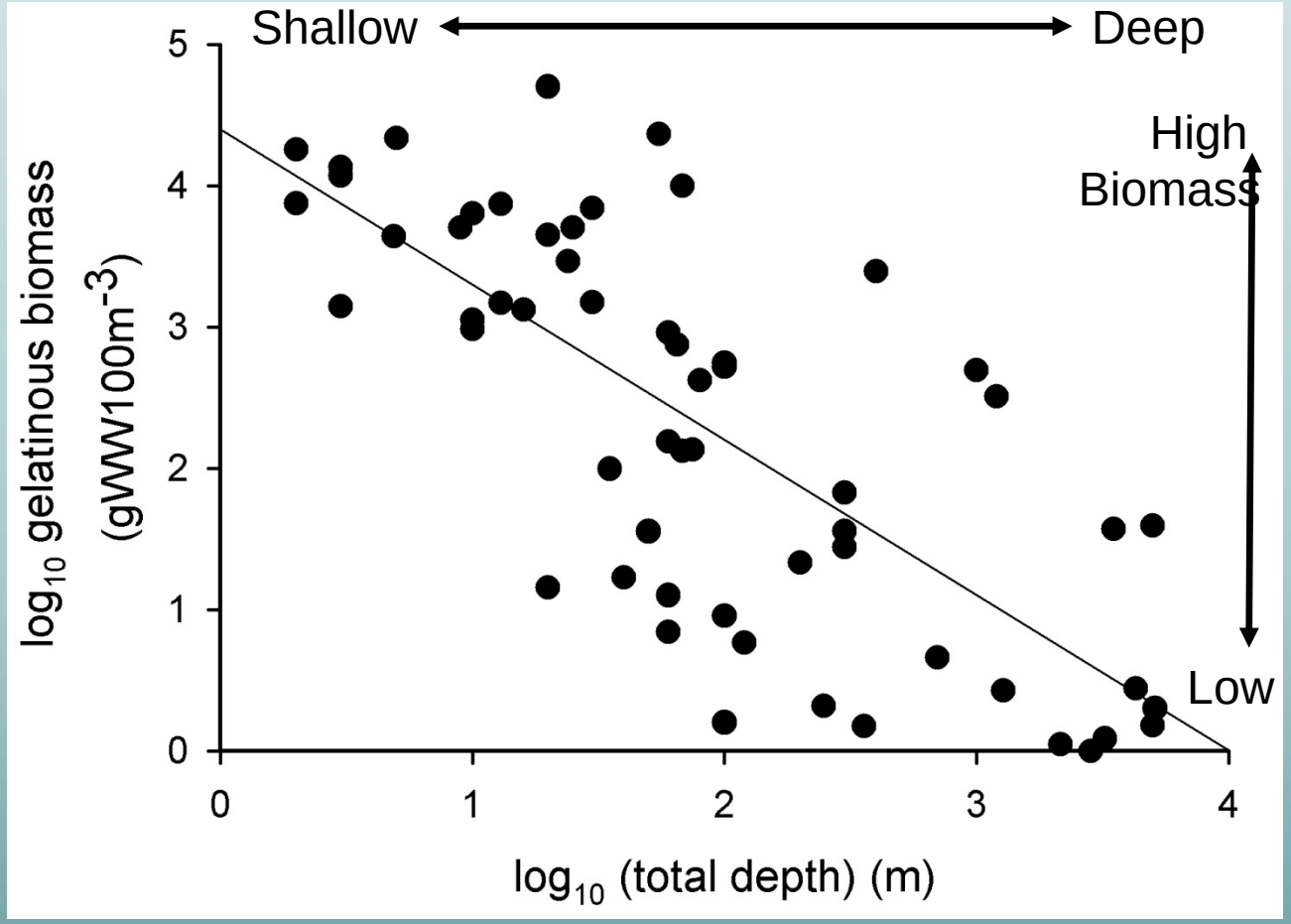


Biomass allows assessment of predation potential and prey availability

but one individual or many?

Ideally both would be recorded simultaneously

Biomass trends



Global database estimated from the epipelagic.

Low sample sizes excluded

Exponential decrease with depth. $r^2 = 0.543$, $p < 0.001$

Highest biomass: enclosed lakes

Lowest biomass: mid ocean

Lilley *et al.* (2011) *Marine Biology* **158**: 2429-2436.

Species composition

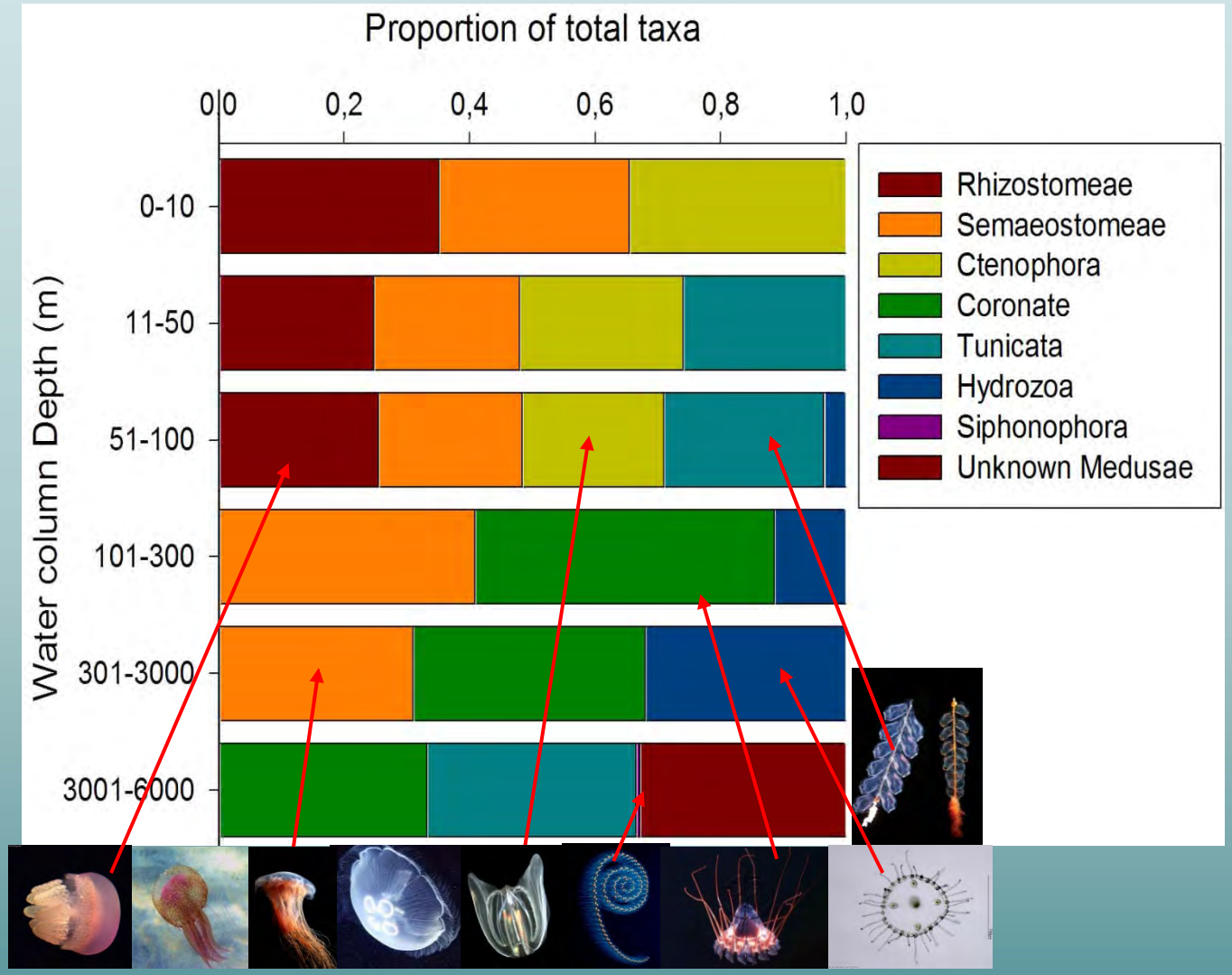
Proportional composition of taxa biomass

Species composition of groupings not consistent with depth. e.g. Semaeostomes

Life-history dictates depth of observations

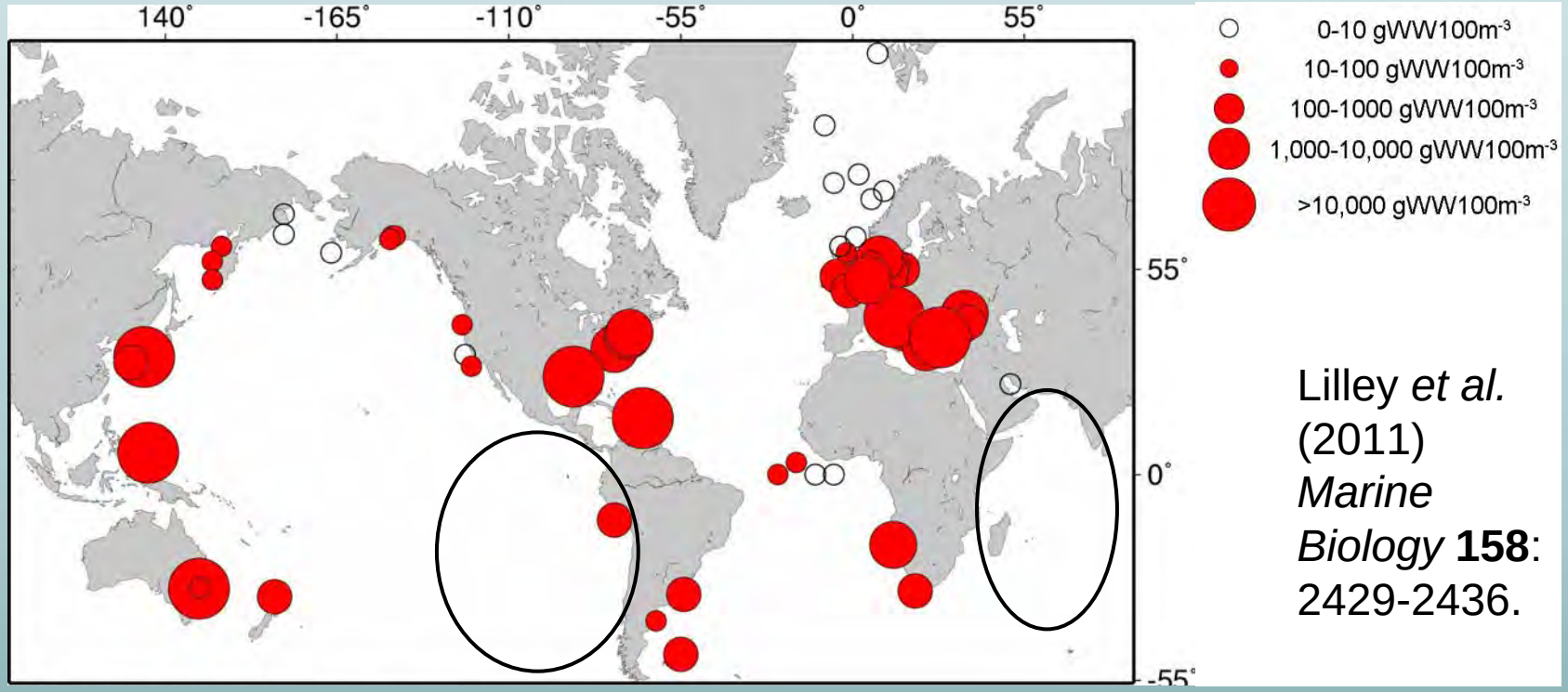
Ctenophores predominantly *Mnemiopsis*.

n = 11, 13, 14, 6, 8, 6 study sites



Lilley *et al.* (2011) *Marine Biology* **158**: 2429-2436.

Location of Biomass estimates



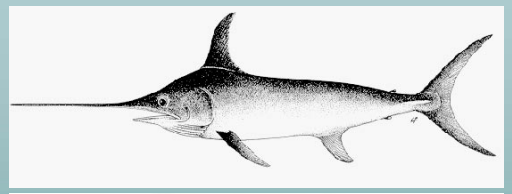
Lilley *et al.* (2011) *Marine Biology* **158**: 2429-2436.

58 data sets/sites

Notable gaps
e.g. central oceanic

Additional data may be available if mined from the sources of overview databases.

Part 2 – Applying biomass estimates at an ocean basin scale and their effects on predators.



Up to 200kg / day

Known predators of gelatinous zooplankton

Kraeer & Van Essen-Fishman (ian.umces.edu/imagelibrary/)

Leatherback turtles:

An indicator of gelatinous blooms?

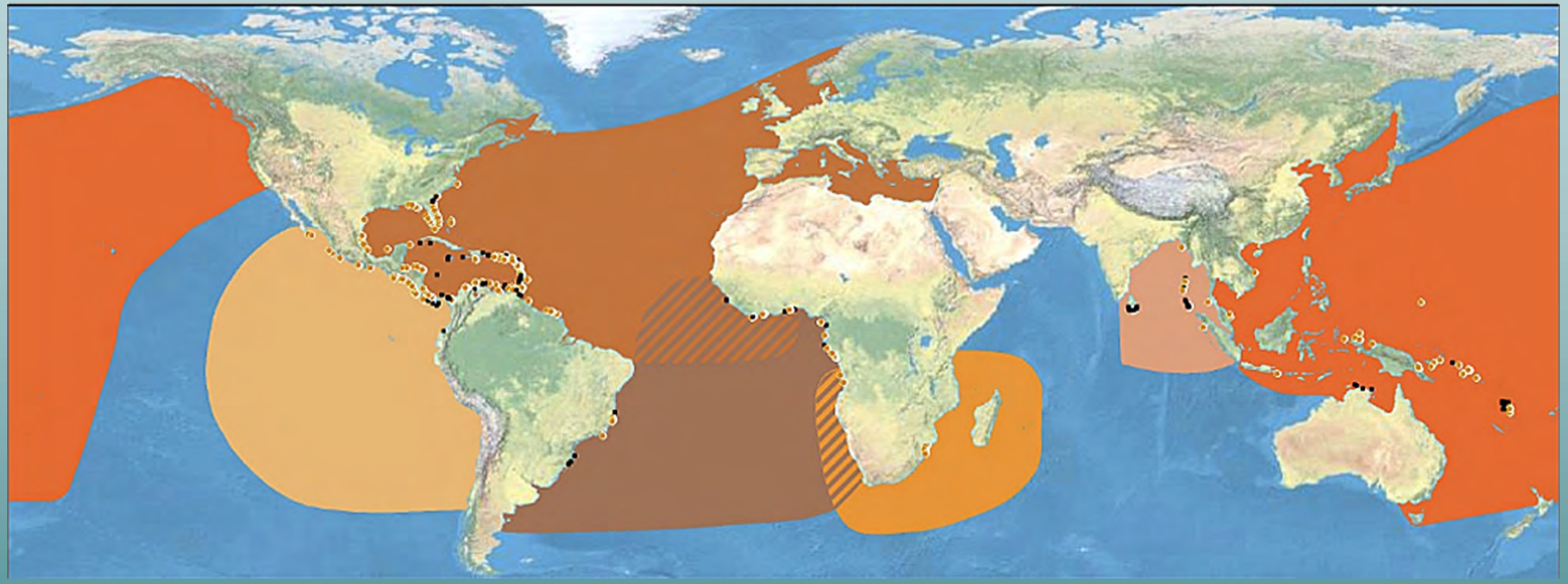
Endangered species

Wide distribution,
independent populations

Deep diver

Feeding migrations

Bi-/Tri-annual nesting



Migrations studied through satellite tracking

Kraeer & Van Essen-Fishman (ian.umces.edu/imagelibrary/)

Atlantic vs Pacific

An applied case

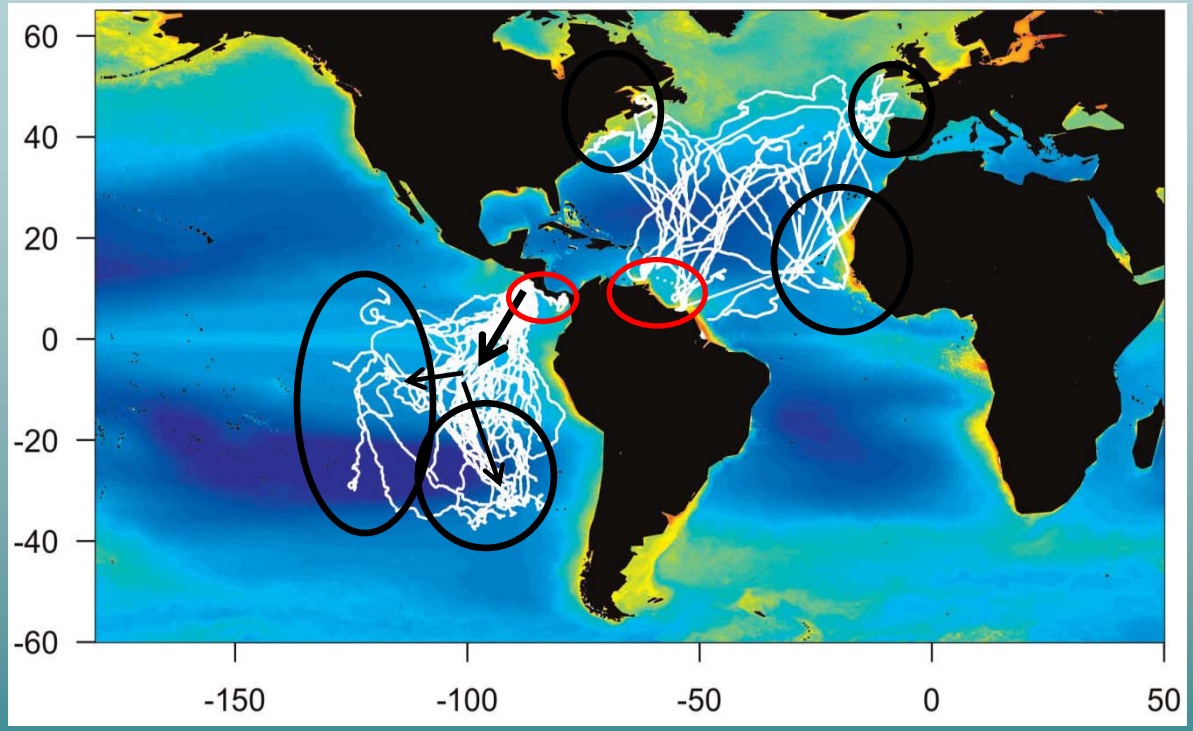
Tracking study
(Bailey *et al.* 2012)

Migration differences

OPEN ACCESS Freely available online PLoS one

Movement Patterns for a Critically Endangered Species, the Leatherback Turtle (*Dermochelys coriacea*), Linked to Foraging Success and Population Status

Helen Bailey[1,2*], Sabrina Fossette[3], Steven J. Bograd[2], George L. Shillinger[4,5], Alan M. Swithenbank[5], Jean-Yves Georges[6,7], Philippe Gaspar[8], K. H. Patrik Strömberg[9], Frank V. Paladino[10], James R. Spotila[11], Barbara A. Block[5], Graeme C. Hays[3]



Behaviours as a proxy for foraging

What is the evidence for a difference between the Atlantic and Pacific?

Kraeer & Van Essen-Fishman (ian.umces.edu/imagelibrary/)

Atlantic vs Pacific

Population differences

Nesting interval – Pacific > Atlantic

Clutch Size - Pacific < Atlantic

Body size - Pacific < Atlantic

Reduced resource availability
for Pacific leatherbacks

Generic issues:

Predation/culling/bycatch

Changes in beach condition/Temp

Poor foraging?

Reduced survival

Result:

Current decline in
Pacific population size

Atlantic vs Pacific

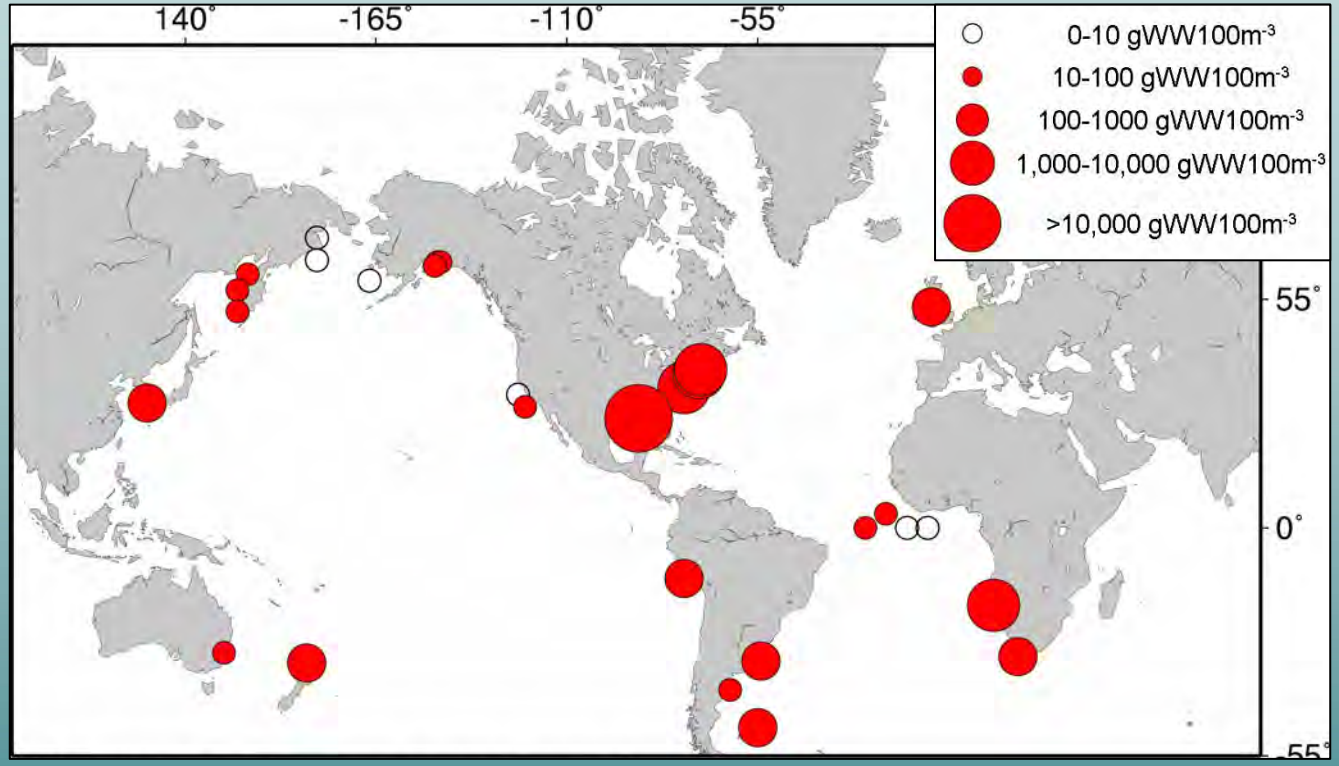
Jellyfish Biomass

Is there a difference between Atlantic & Pacific gelatinous biomass?

Open water sites only (n=16/ocean)

Samples within top 200m

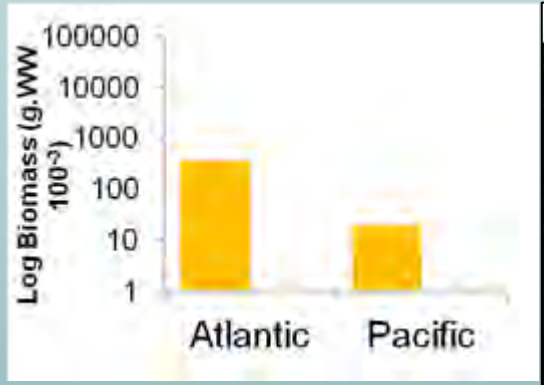
Few truly oceanic samples, typically coastal or continental shelf



Atlantic vs Pacific

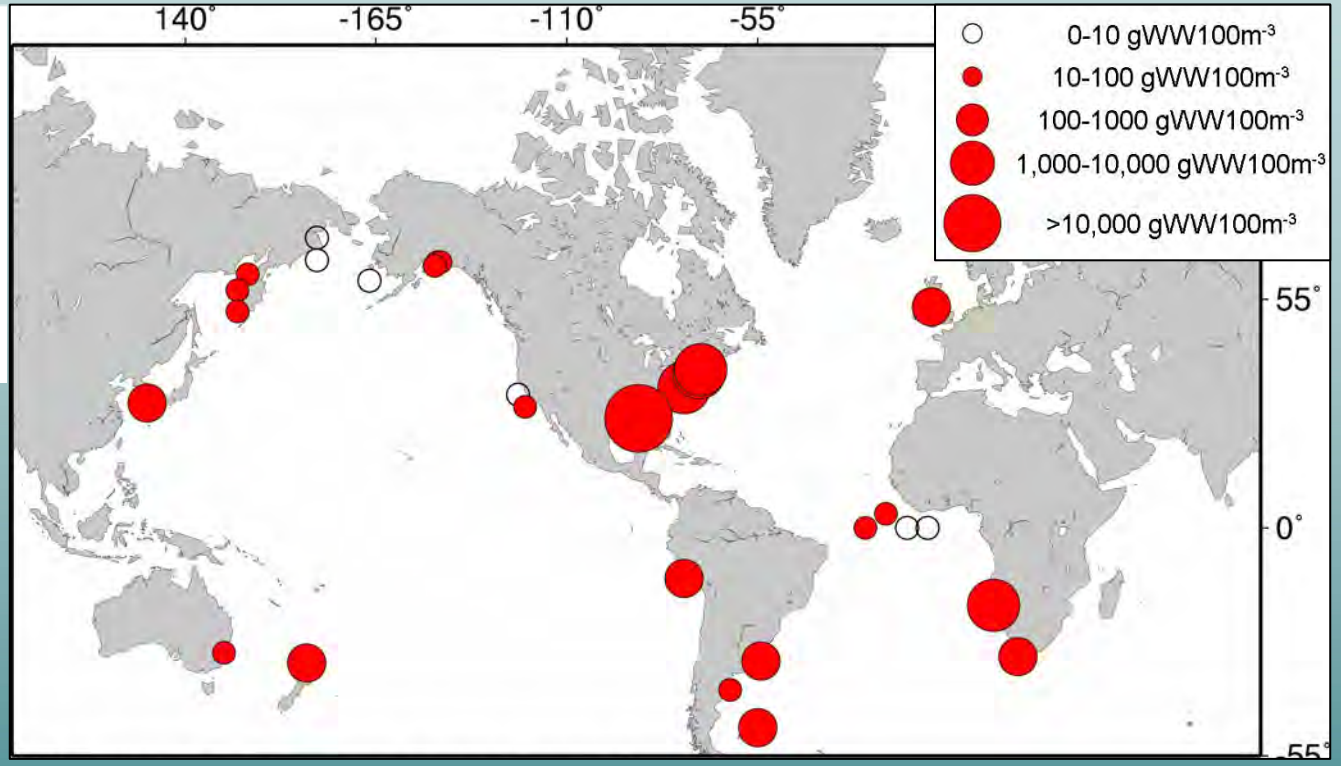
Jellyfish Biomass

Median Biomass – Atlantic > Pacific



<u>Open water sites</u>
Median biomass
Atlantic 20:1g Pacific

N=16 per ocean

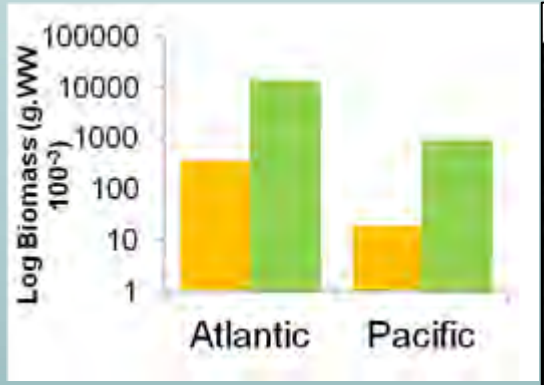


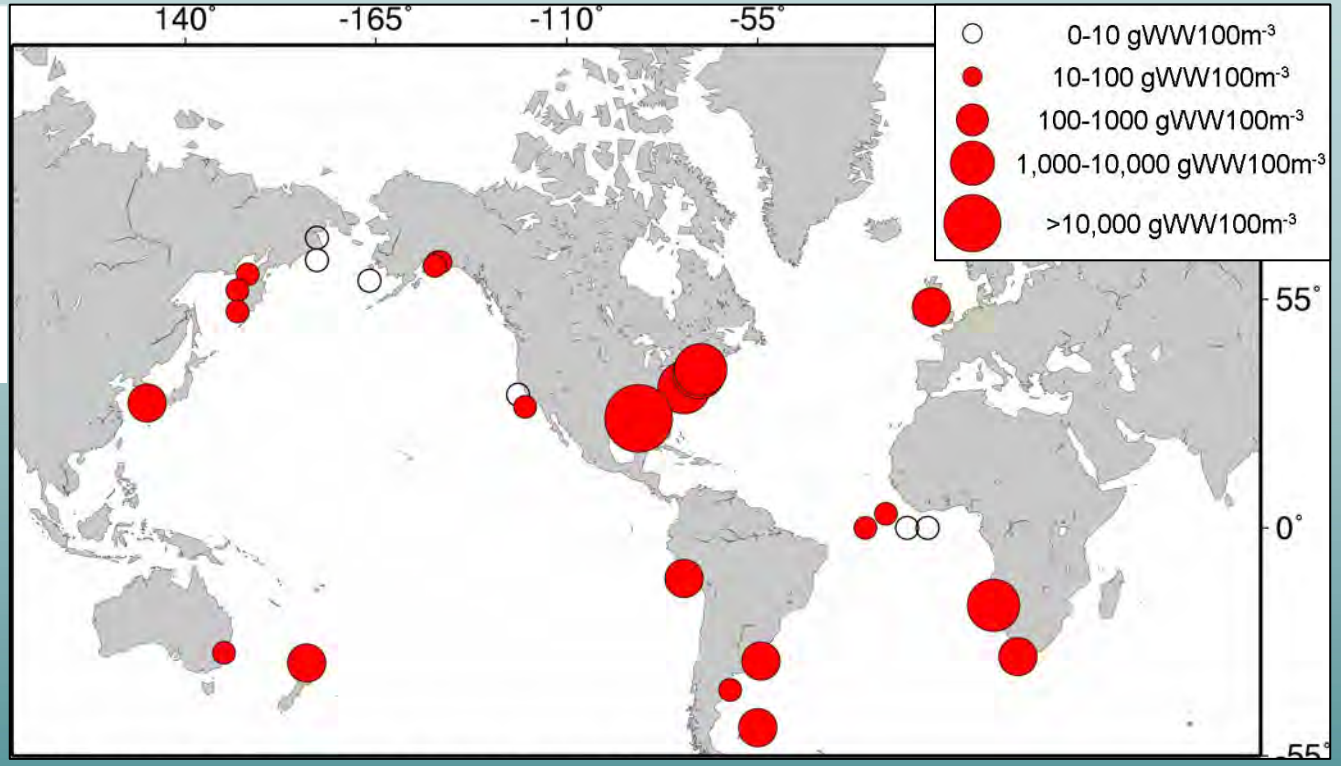
Atlantic vs Pacific

Jellyfish Biomass

Median Biomass – Atlantic > Pacific

Maximum Biomass – Atlantic > Pacific





<u>Open water sites</u>
Most productive site (mean biomass)
Atlantic 15:1g Pacific

Best sample biomass
Atlantic 219:1g Pacific
N=16 per ocean

Atlantic vs Pacific

Jellyfish Biomass

Median Biomass – Atlantic > Pacific

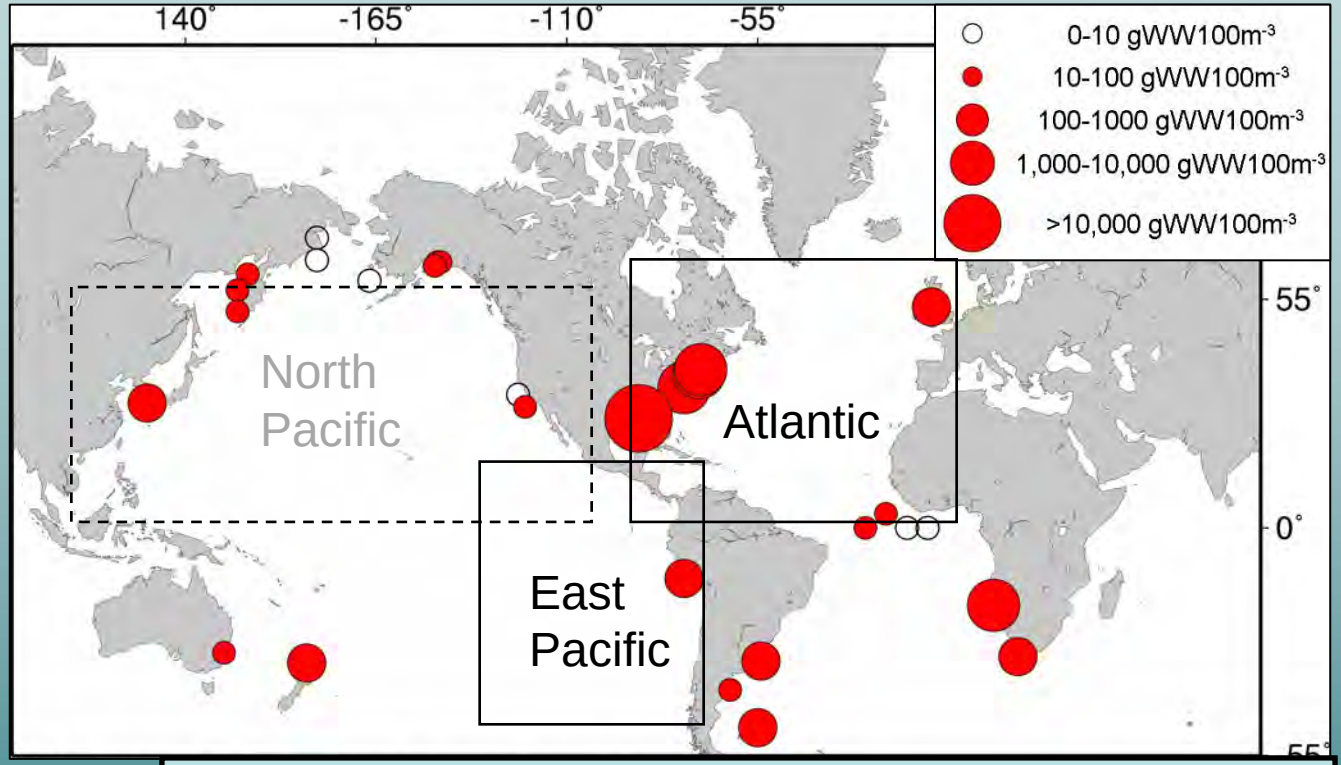
Maximum Biomass – Atlantic > Pacific

Biomass caveats:

Spatial variability

Energy density

Coastal research emphasis

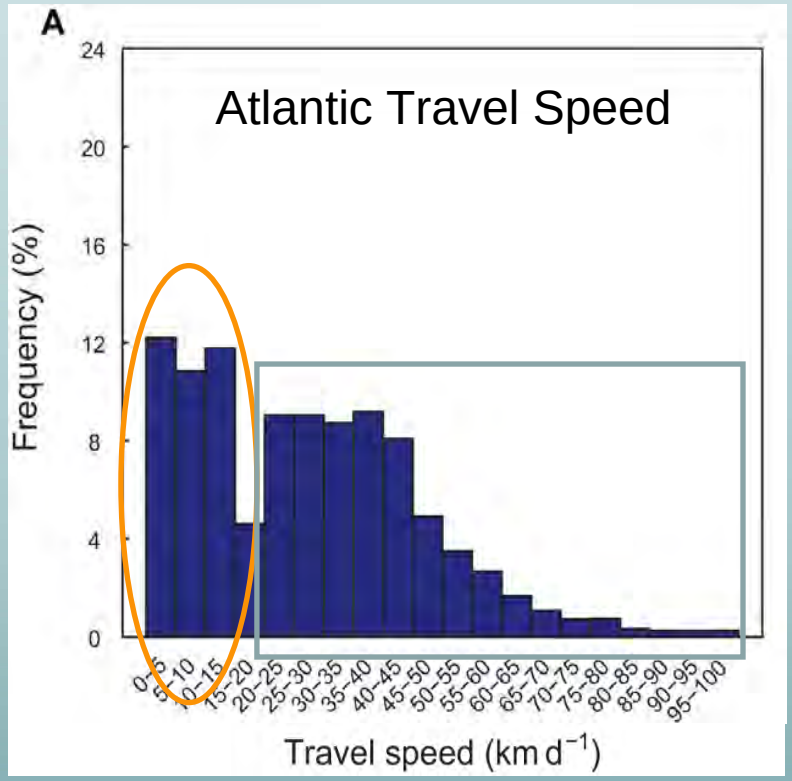


Does turtle behaviour overlap with prey availability?

Kraeer & Van Essen-Fishman (ian.umces.edu/imagelibrary/)

Atlantic vs Pacific

Turtle behaviour



Bimodal frequency between travelling and foraging

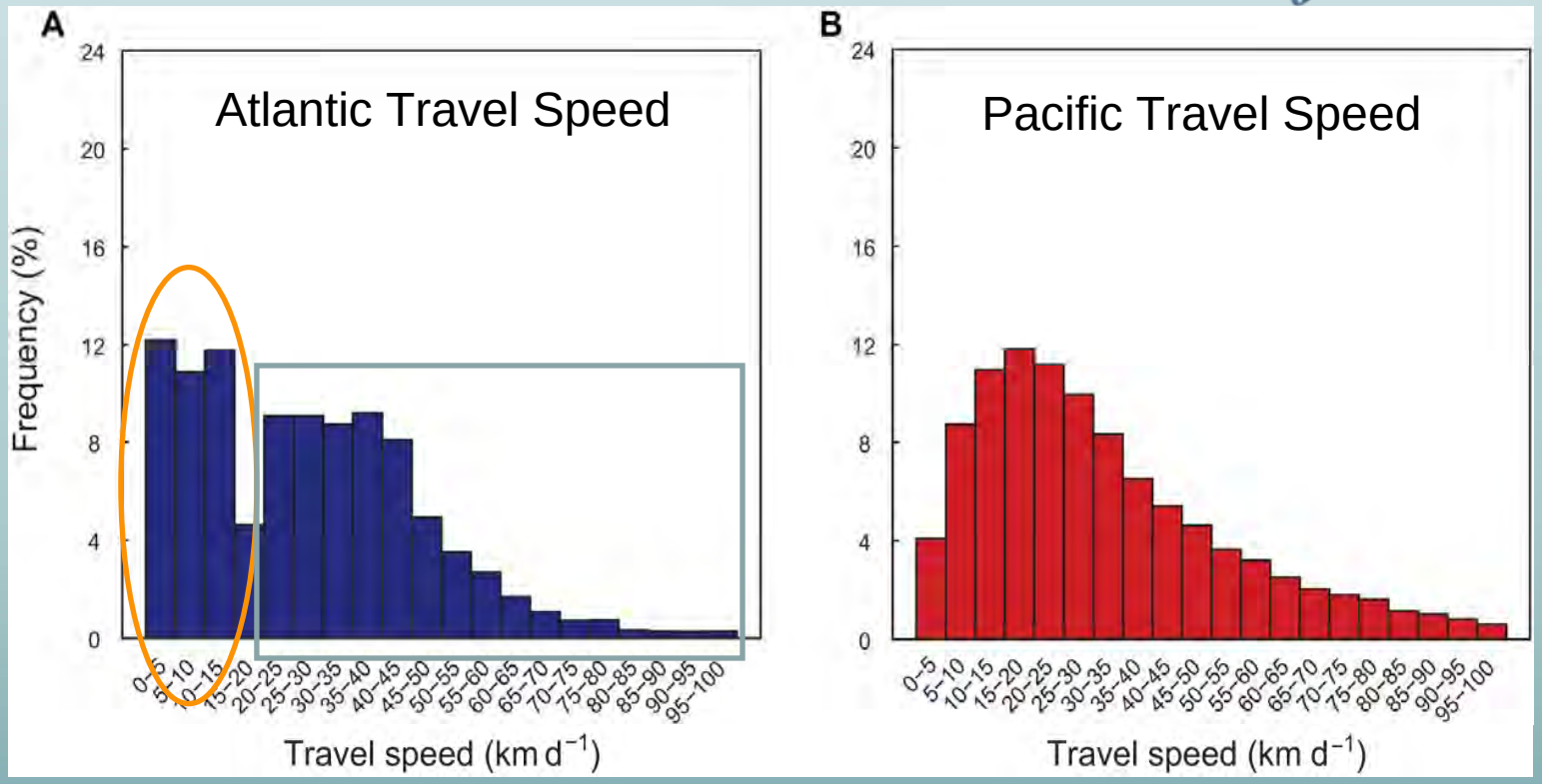
Percentage frequency graph of daily distance travelled

Can identify:
1) Foraging
2) Migration
3) Compare rate of travel between individuals or locations

Kraeer & Van Essen-Fishman (ian.umces.edu/imagelibrary/)

Atlantic vs Pacific

Turtle behaviour



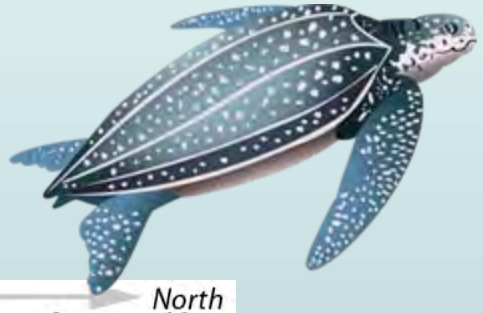
Bimodal frequency between travelling and foraging

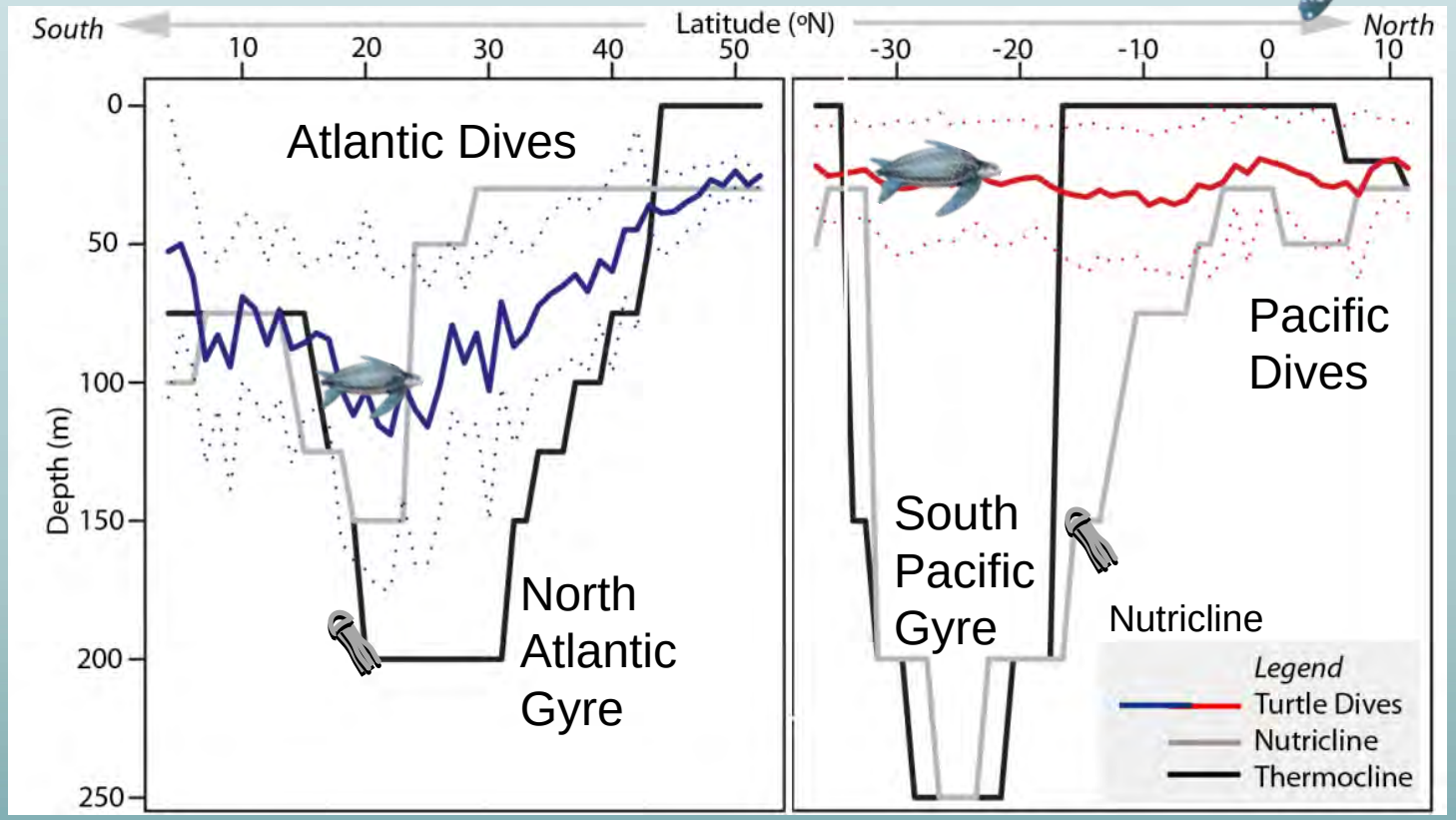
Unimodal frequency in the Pacific – More migration, less foraging

Kraeer & Van Essen-Fishman (ian.umces.edu/imagelibrary/)

Atlantic vs Pacific

Turtle behaviour





Deeper dives
Dives peak around the productive gyre region

Gyre deeper
Shallow dives
No peak in diving behaviour
= less gelatinous prey?
Or out of reach?

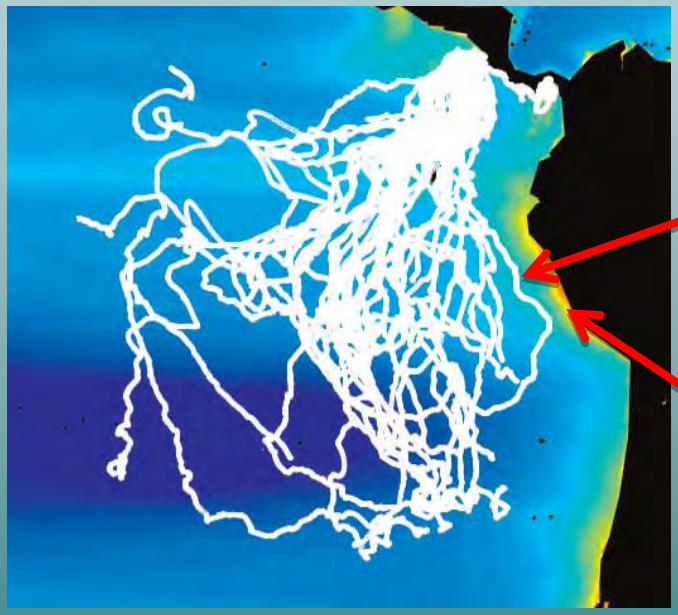
Kraeer & Van Essen-Fishman (ian.umces.edu/imagelibrary/)

Atlantic vs Pacific

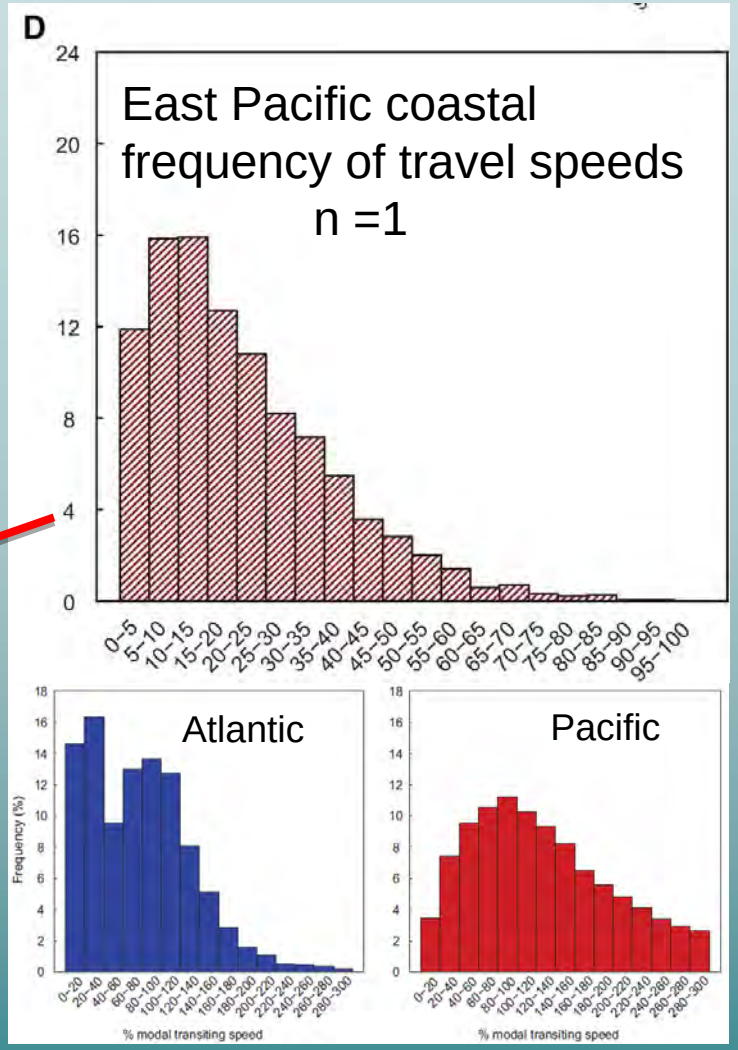
Turtle behaviour

The exception:

- Coastal migration path
- Data similar to Atlantic individuals
- Larger female
- Larger clutch sizes
- Productive upwelling region
- More productive for turtles?



Highest recorded East Pacific jellyfish biomass



Kraeer & Van Essen-Fishman (ian.umces.edu/imagelibrary/)

Atlantic vs Pacific

Conclusions

Biomass estimates would support hypothesis of a reduced food resource in the Pacific

Broadscale evidence for prey trends (Brotz et al 2012)

- SE Pacific – gelatinous decline

- Atlantic – stable/increasing

Foraging response?

Turtles may no longer forage in best jellyfish regions because of bycatch

(Mismatch productivity & foraging locations)

Turtle behaviour may be useful as an indicator of productive regions for gelatinous biomass

One last thought

Questions? – lilley@obs-vlfr.fr
Poster S7-7 / S7-8

What role do smaller gelatinous species, such as these small 4g *Linuche*, play in the diet of turtle species?

*(Fossette et al 2012, Biology Letters **8**:351-4.)*

Thanks to:
PhD supervisor
Graeme Hays
(Swansea University)

Fabien Lombard (UPMC/LOV)
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