

Broad-scale research on jellyfish

Jennifer E. Purcell

Shannon Point Marine Center
Western Washington University
USA

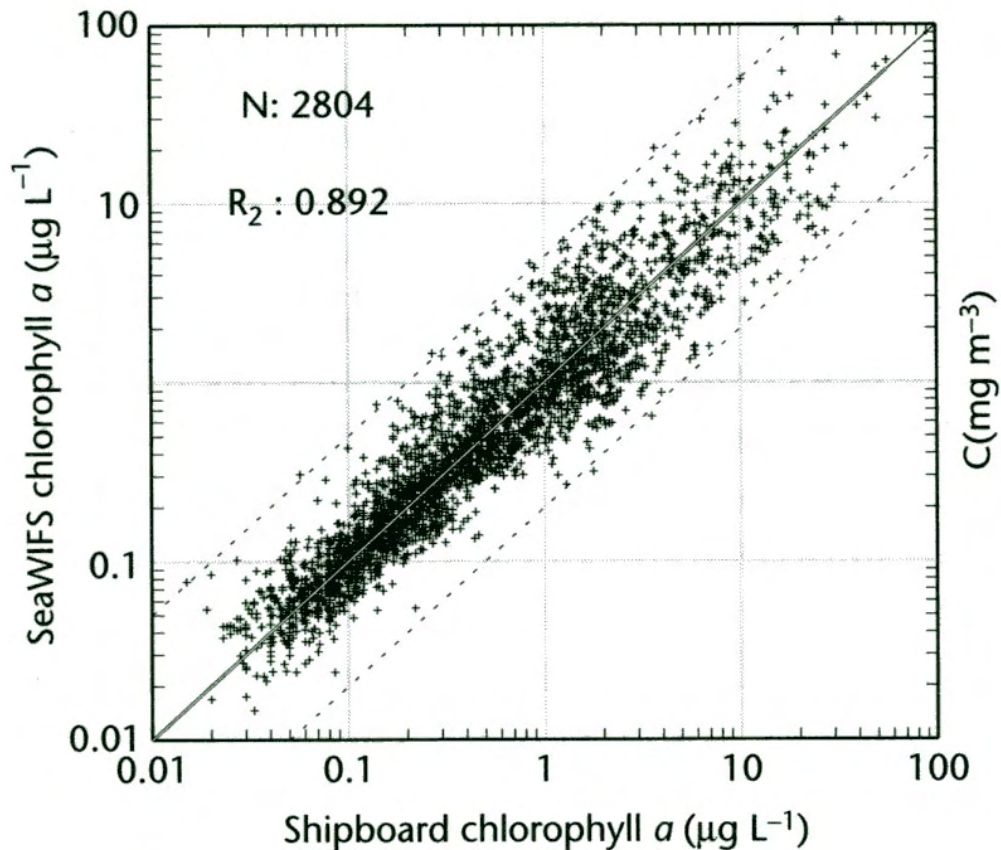


**Jellyfish usually are
sampled at small scales**



**Large-scale problems with jellyfish
require large-scale methods, which
require approximation**

SeaWIFS Chl a



**My objective here
is to recommend
sampling methods
for jellyfish
research on large-
scales**

Fisheries & Aquaculture

- Brodeur et al. (2008) Prog Oceanogr 77: 103-111
- Uye (2008) Plankton & Benthos Res 3 (Suppl): 125-131
- Doyle et al. (2008) J Plankton Res 30: 963-968

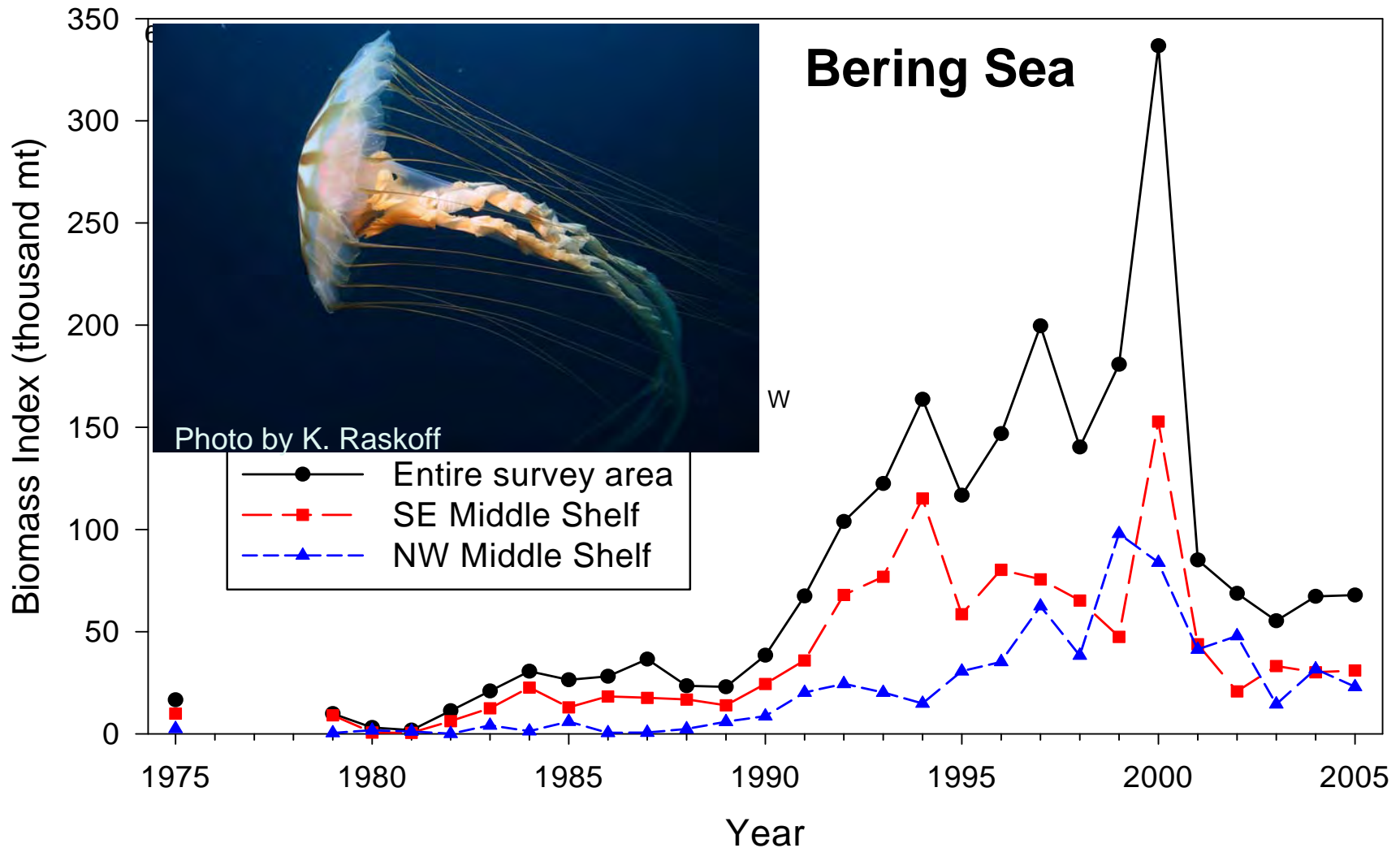
This session

- 15:50 Brodeur et al.

Fisheries surveys

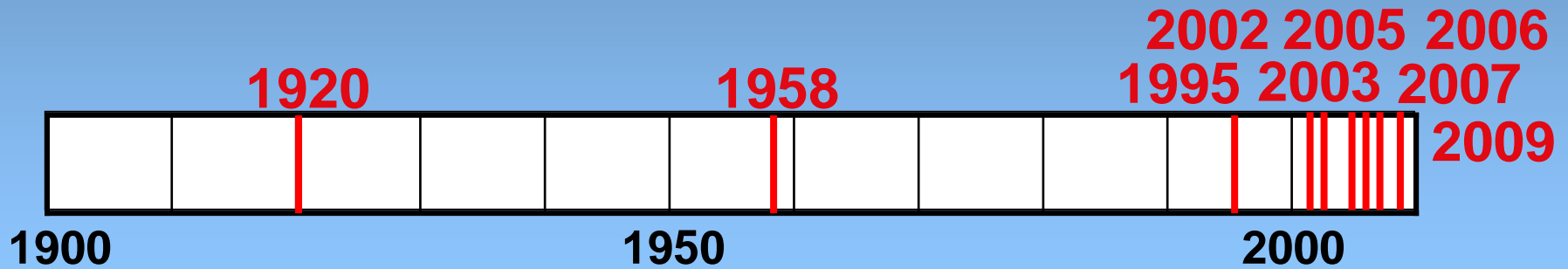
- 356 stations
- 1975-present

Brodeur et al. (2008) Prog
Oceanogr 77: 103-111



Bloom years of the giant jellyfish, *Nemopilema nomurai*

(maximum bell diameter 2 m and wet weight >200 kg)



(<http://www.ananova.com/>)

Nemopilema nomurai medusae entrapped in set-nets along Japanese coast

Uye (2008) Plankton & Benthos Res 3 (Suppl): 125-131

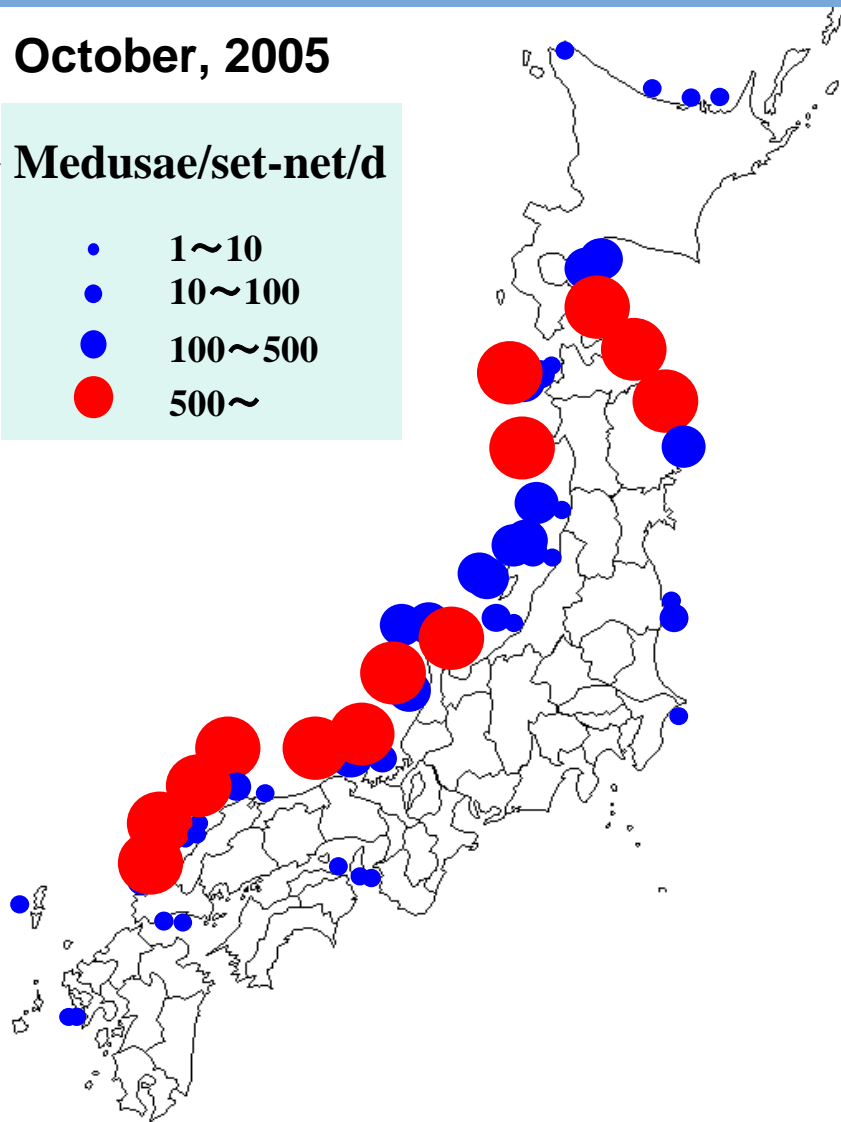
Data archived by Japan
Fisheries Information
Service Center (JAFIC)



October, 2005

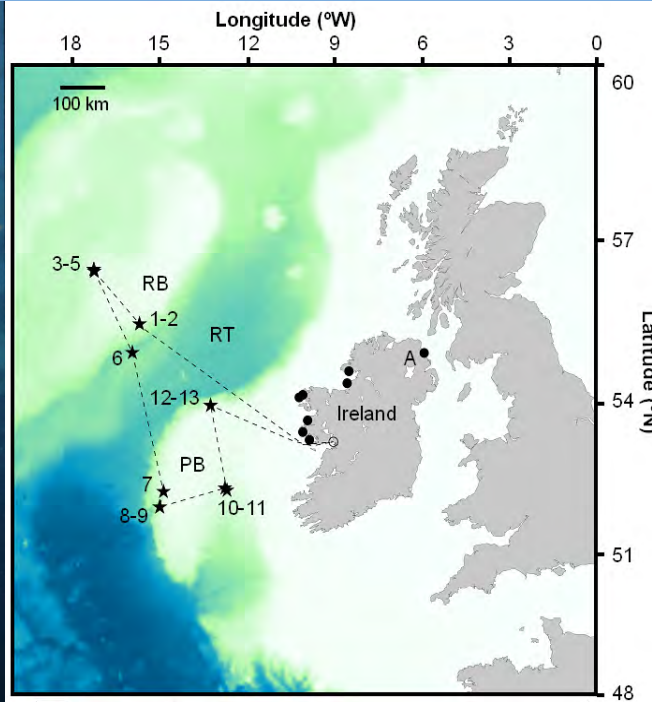
Medusae/set-net/d

- 1~10
- 10~100
- 100~500
- 500~



Pelagia noctiluca kills salmon in aquaculture pens in Ireland and Scotland

Doyle et al. (2008) J Plankton Res 30: 963-968



2007 *Pelagia* killed salmon in pens

- >500,000 stranded on 1 beach
- Recorded ~25 of 100 years

Fisheries survey summary

Problems

- **Sampling is not designed for jellyfish**
- **Requires cooperation (extra cost and effort)**

Advantages

- **Logistics provided**
- **Semi-quantitative**
- **Large temporal and spatial scales**

Aerial surveys

- Purcell et al. (2000) Mar Ecol Prog Ser 195: 145-158
- Houghton et al. (2006) Mar Ecol Prog Ser 314: 159-170
- Crawford et al. (in press) Mar Biol

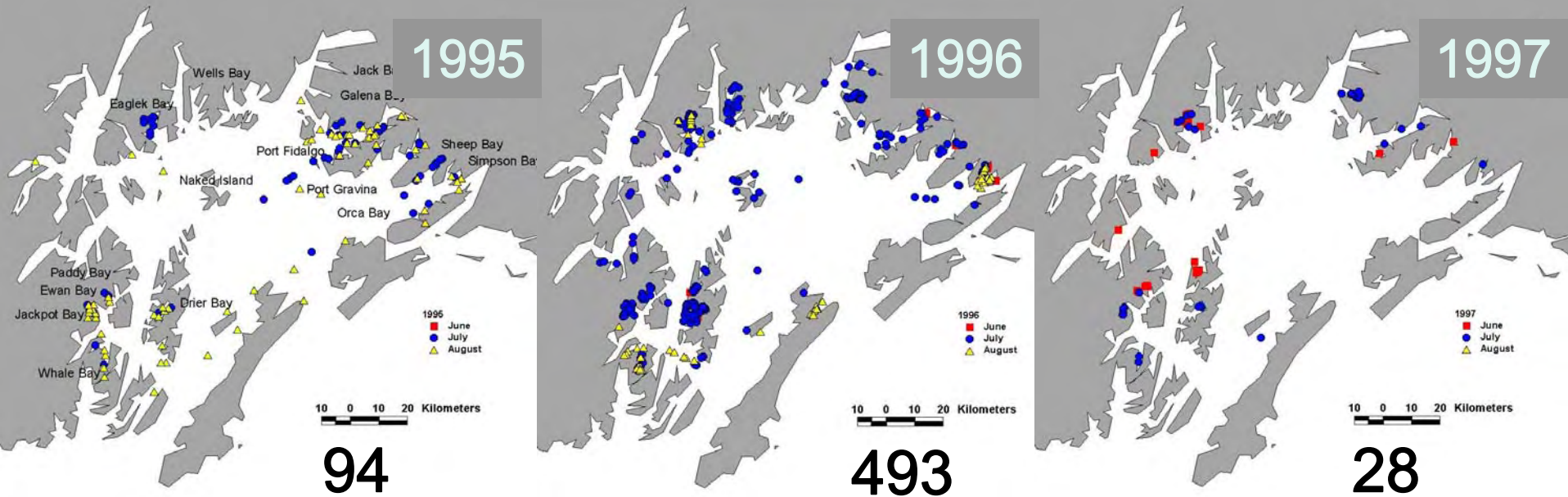
This session

- 16:05 Fujii et al.

Aerial surveys

Purcell et al. (2000) Mar Ecol Prog Ser 195: 145-158

Aggregations of *Aurelia labiata* in Alaska

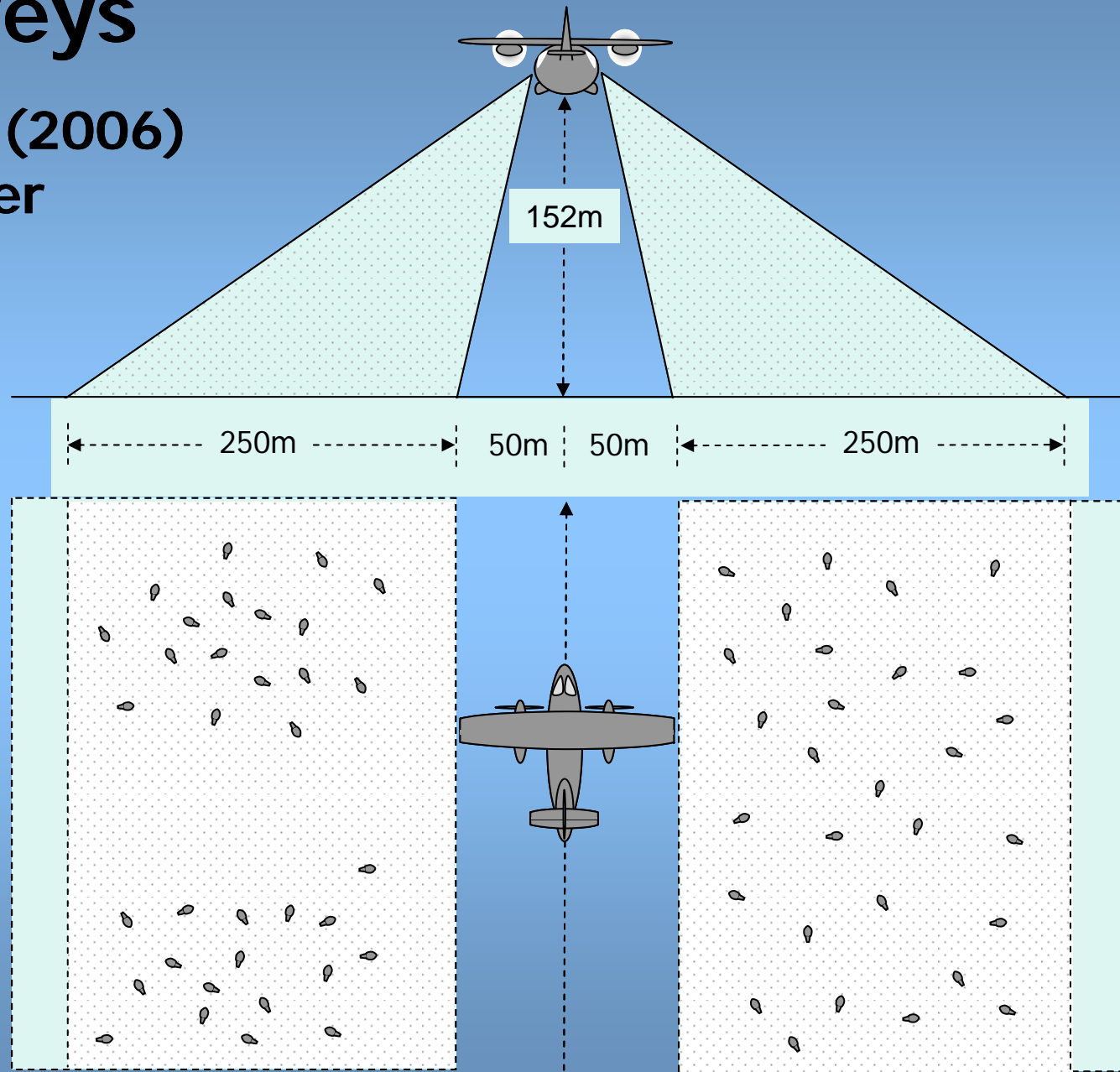


1998 = 770

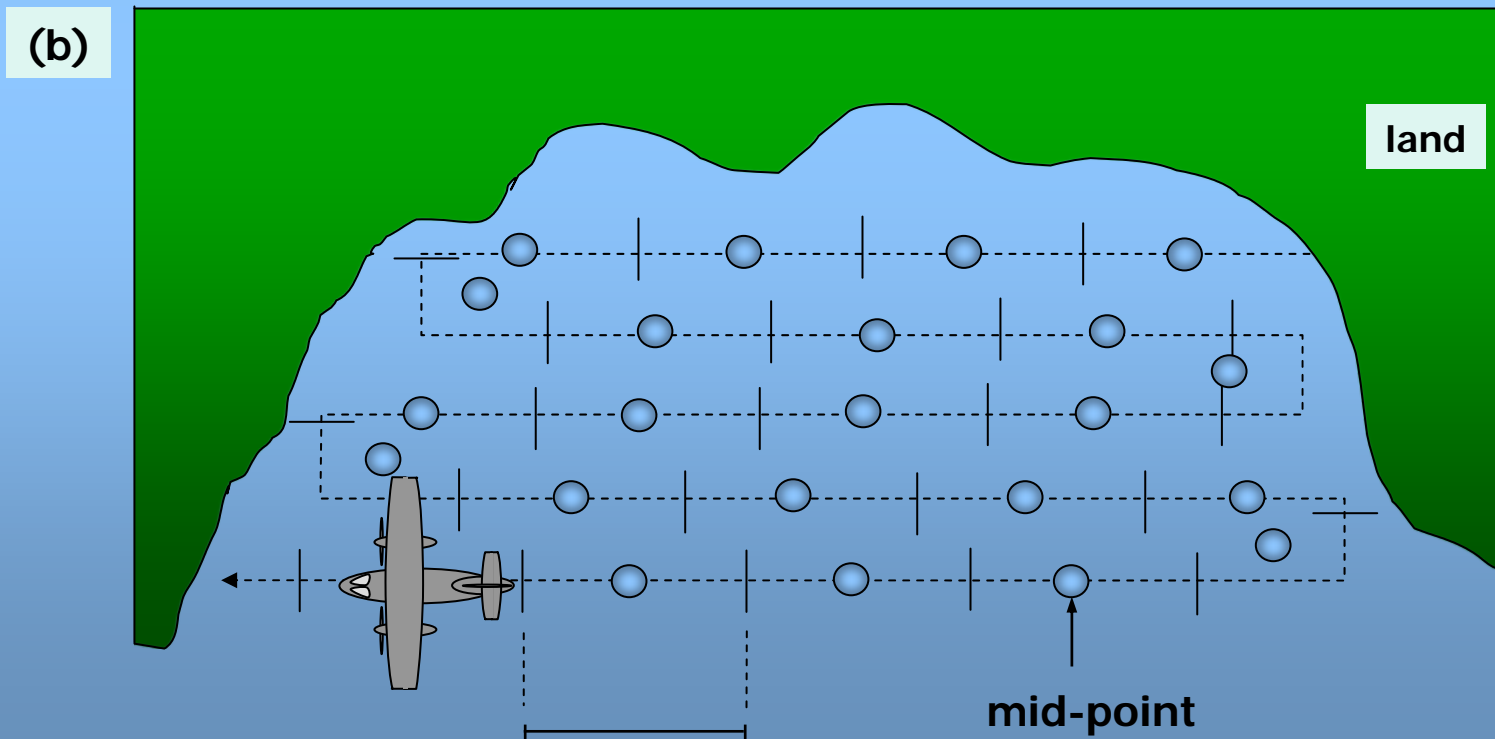
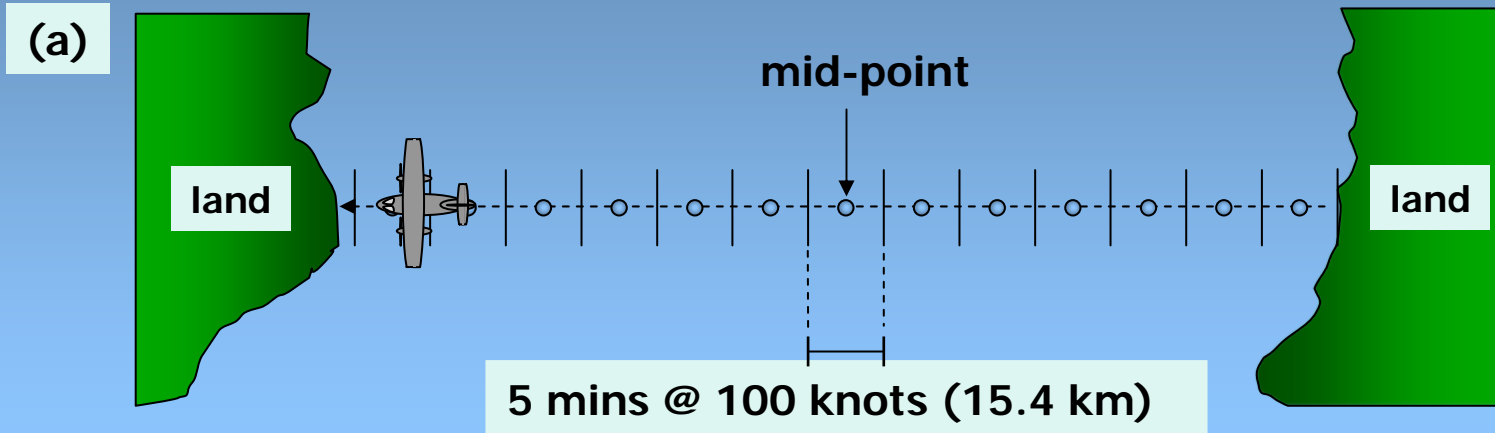


Aerial surveys

Houghton et al. (2006)
Mar Ecol Prog Ser
314: 159-170

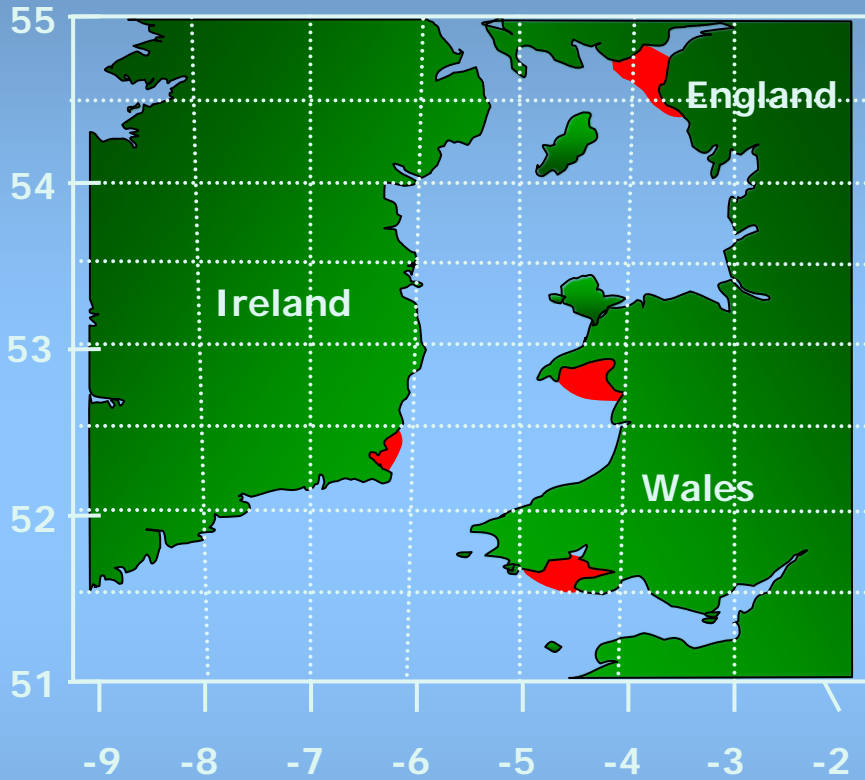


Aerial surveys



Aerial surveys

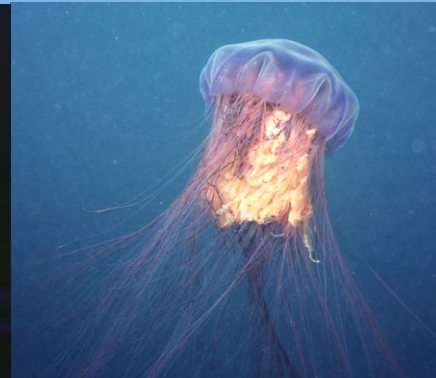
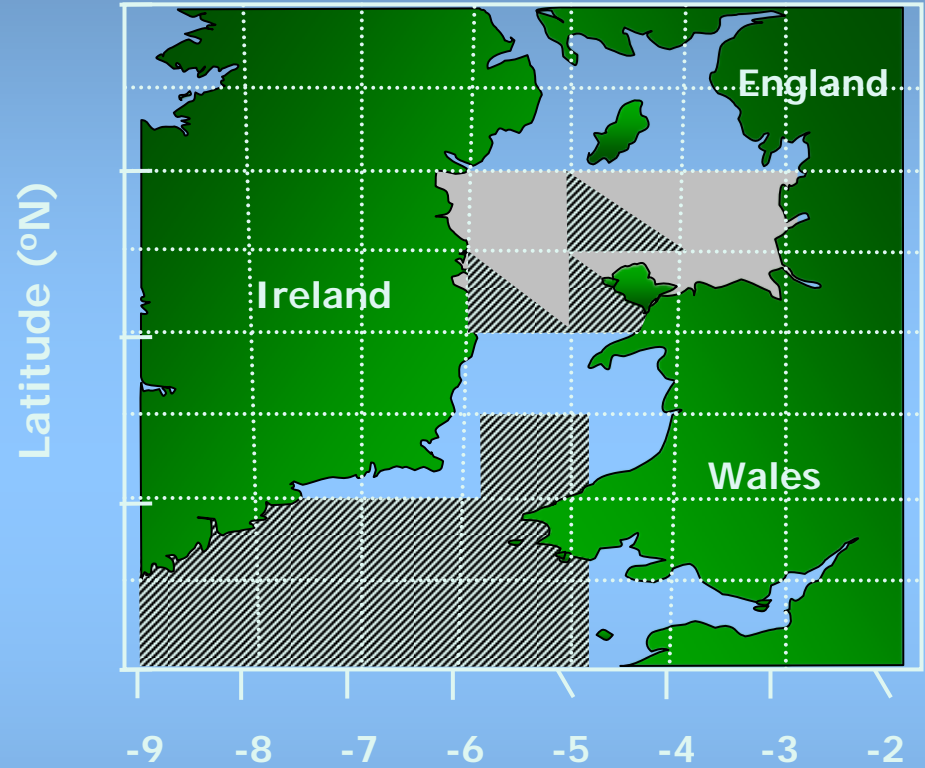
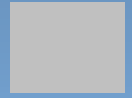
Rhizostoma octopus



Chrysaora hysoscella



Cyanea capillata



Aerial survey summary

Problems

- **Only at surface**
- **Should be calibrated against net tows**

Advantages

- **Inexpensive**
- **Large spatial scale**

Acoustic surveys

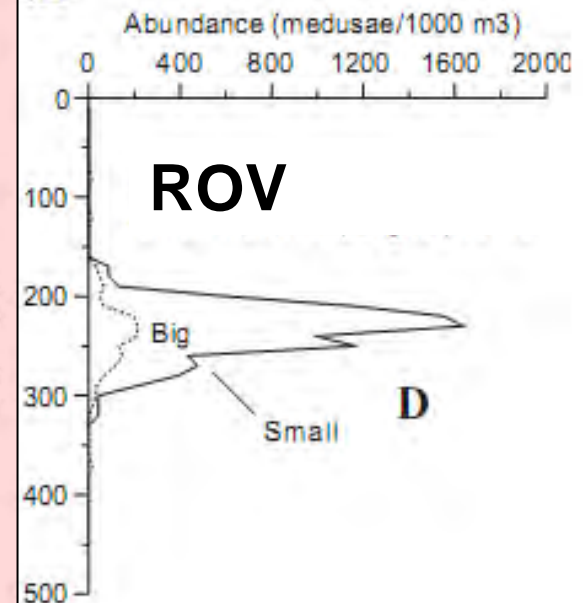
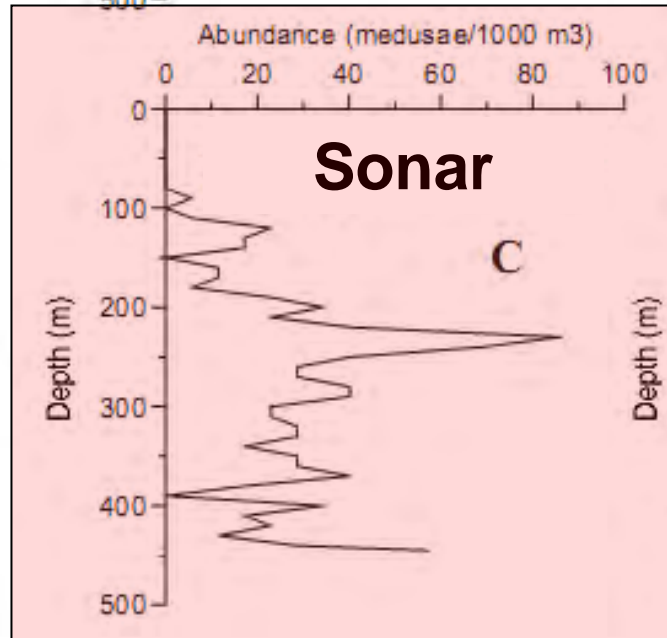
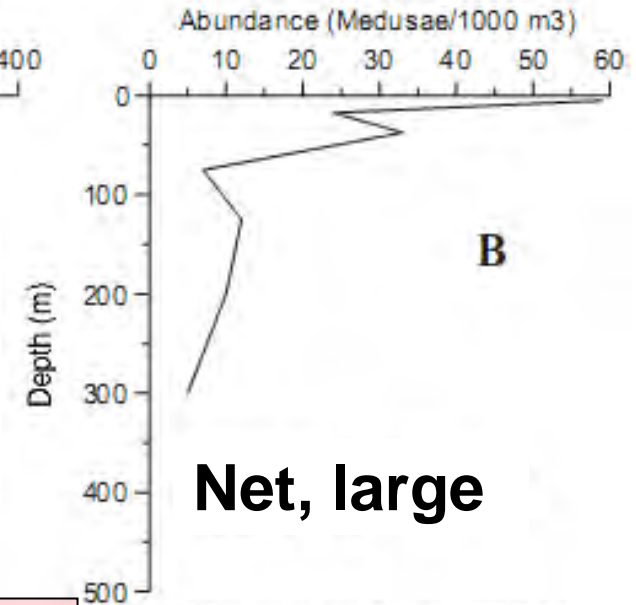
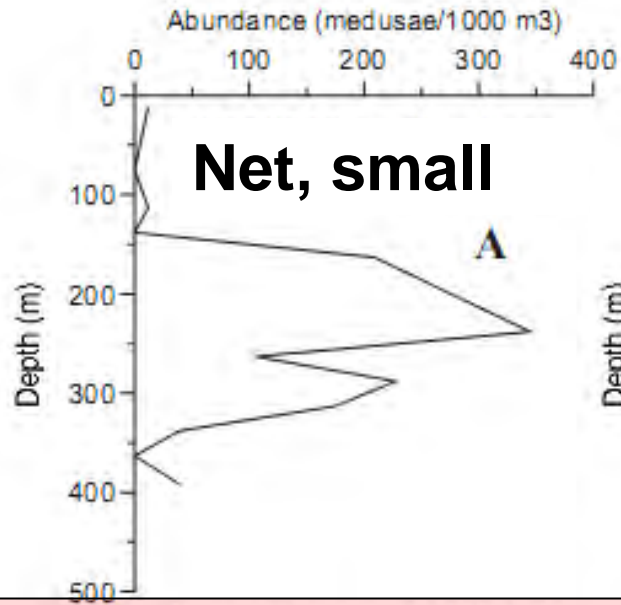
- Toyakawa et al. (1997) Proc. 6th Int Conf Coel Biol
- Brierley et al. (2004) ICES J Mar Sci 61: 383-393
- Båmstedt et al. (2003) J Plankton Res 25: 1307-1318
- Lynam et al. (2006) Current Biol 16: R492-R493

This session:

- 14:30 Sadayasu et al.
- 14:45 Lee et al.
- 16:45 Han & Uye

Acoustic Båmstedt et al. (2003) J Plank Res 25:1307-1318

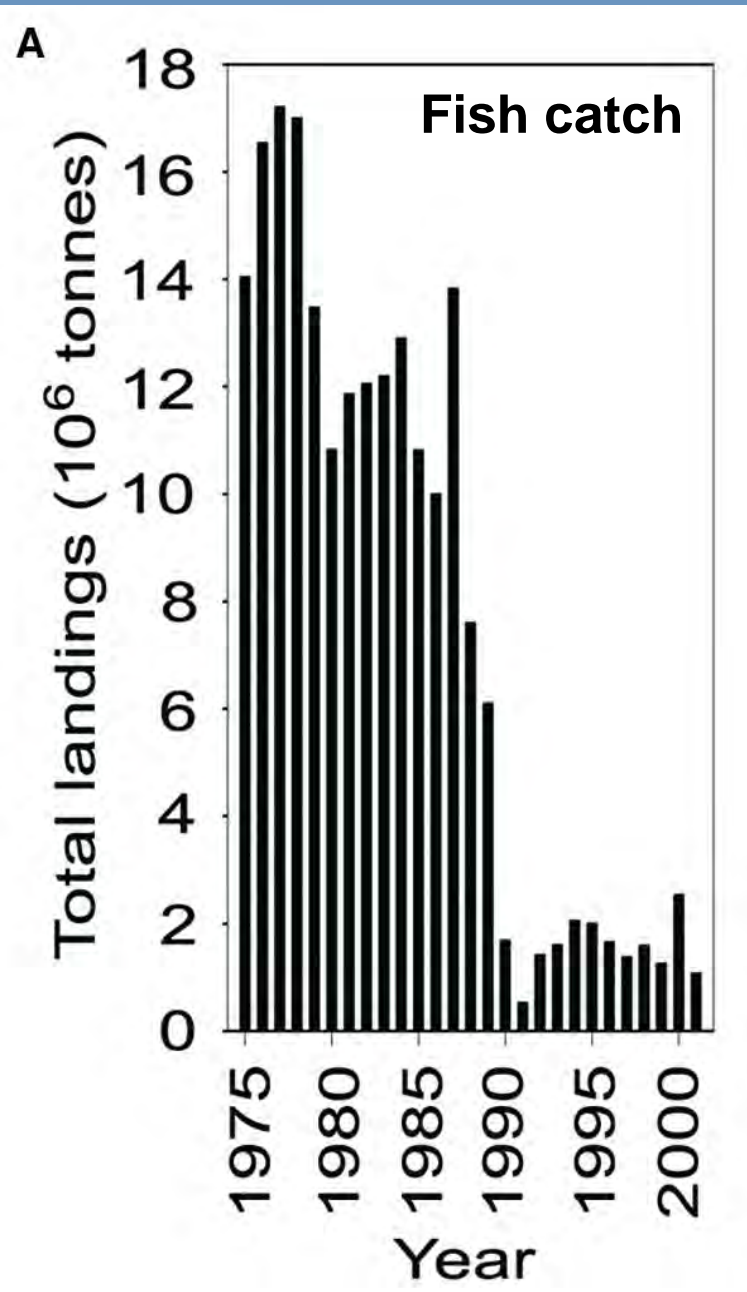
Quantitative with
Individual targets



Jellyfish overtake fish in a heavily fished ecosystem

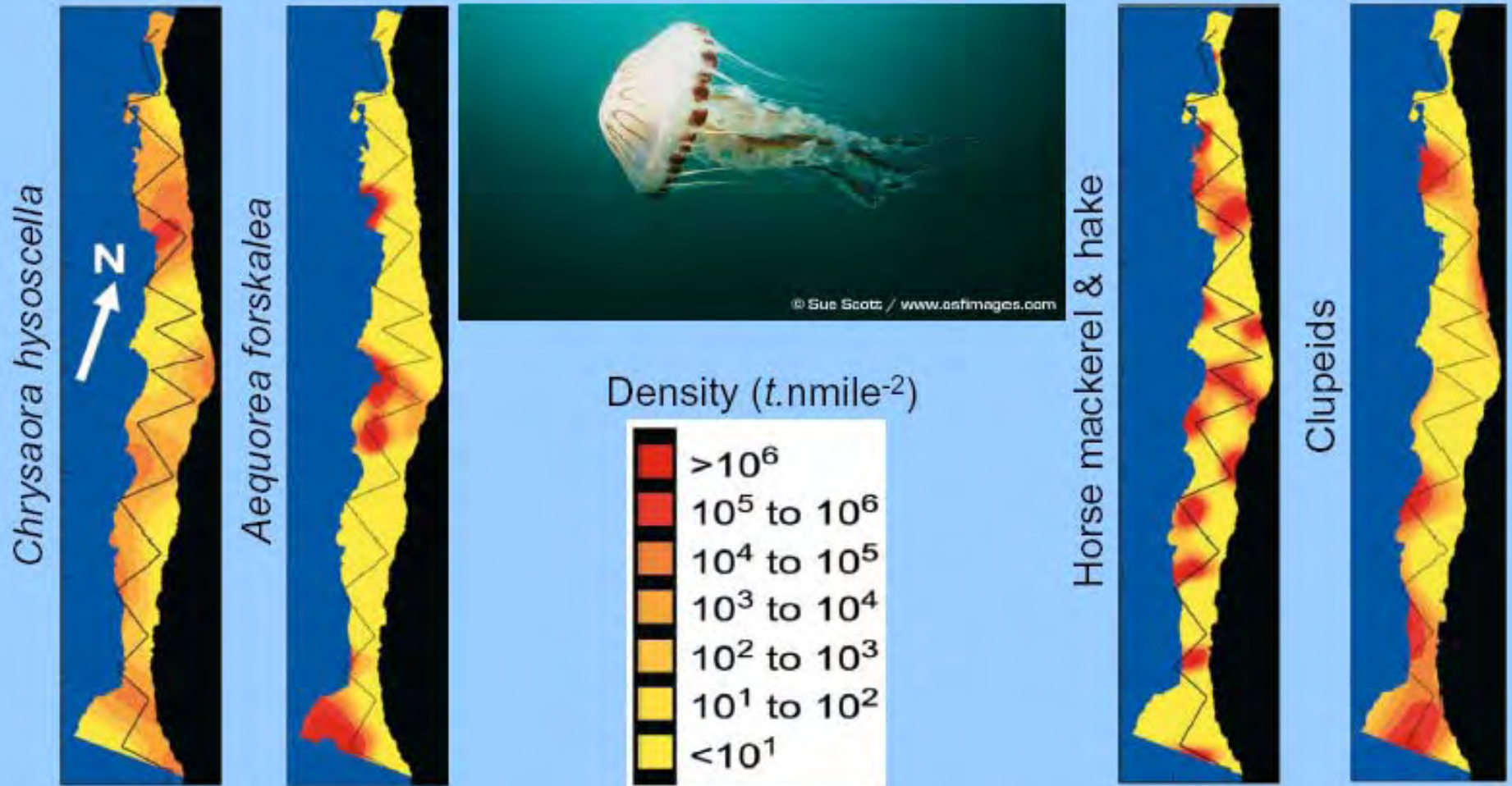
Lynam et al. (2006) *Current Biol* 16: R492-R493

Fishing reduced anchovy and sardines competitors for zooplankton in Namibian Benguela Current



Blooming jellyfish!

Northern Benguela: Jellyfish = 4 x Fish mass in 30,000 sq miles



Acoustic survey summary

Problems

- Requires ships
- Should be calibrated against net tows

Advantages

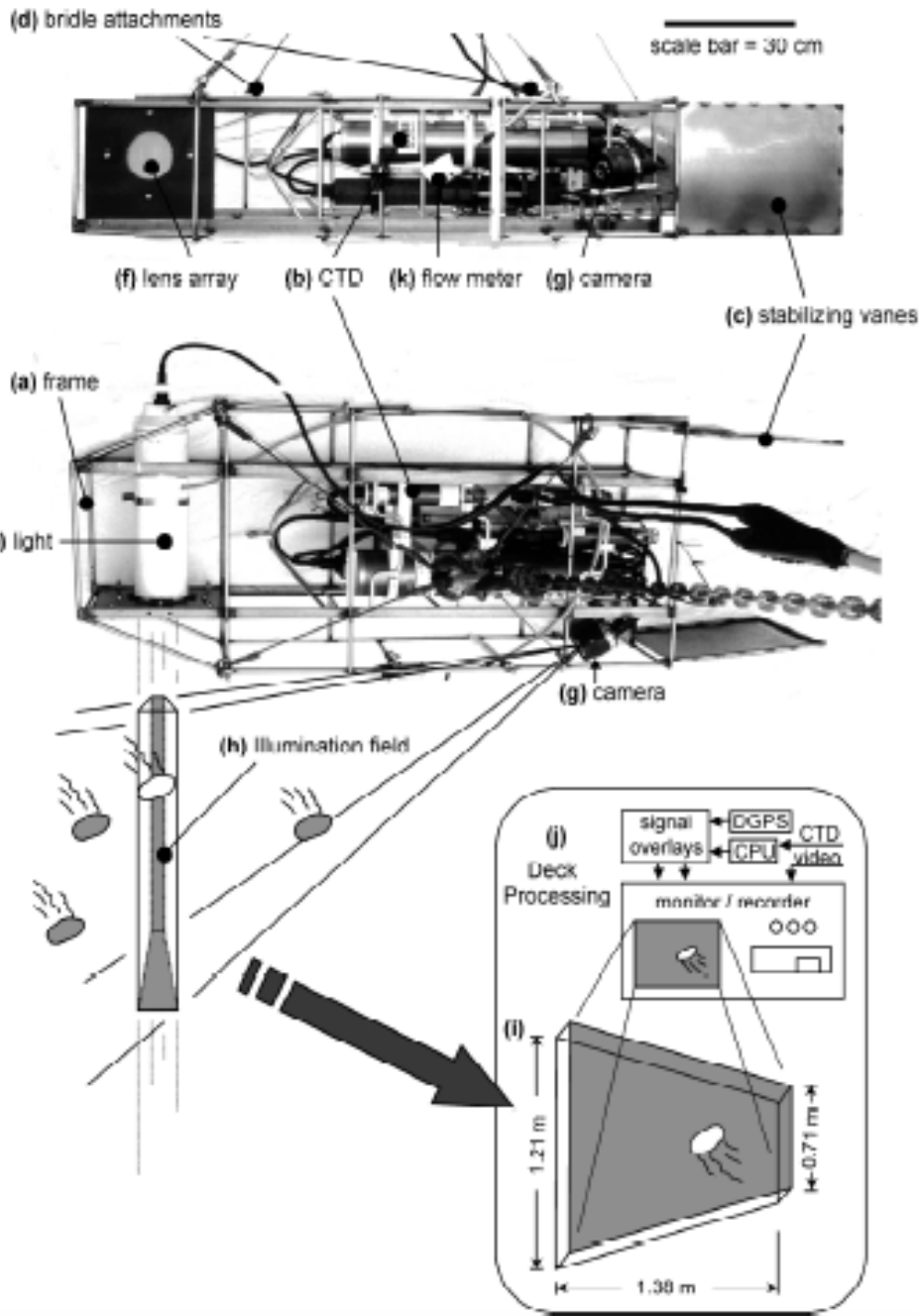
- Quantitative for large jellyfish
- Used for fish

UW camera surveys

- Graham et al. (2003) Mar Ecol Prog Ser 254: 129-140
- Båmstedt et al. (2003) J Plankton Res 25: 1307-1318

This session

- 15:15 Ishii et al.



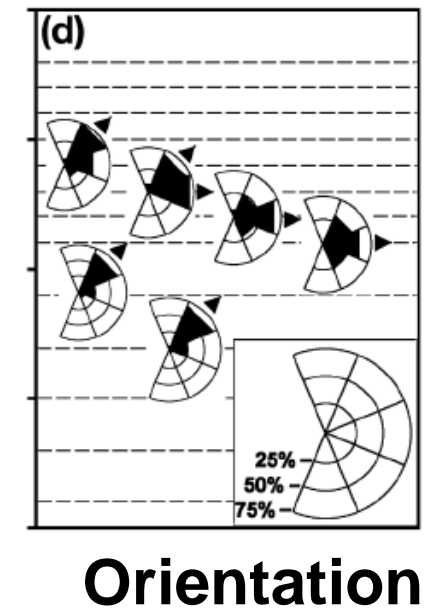
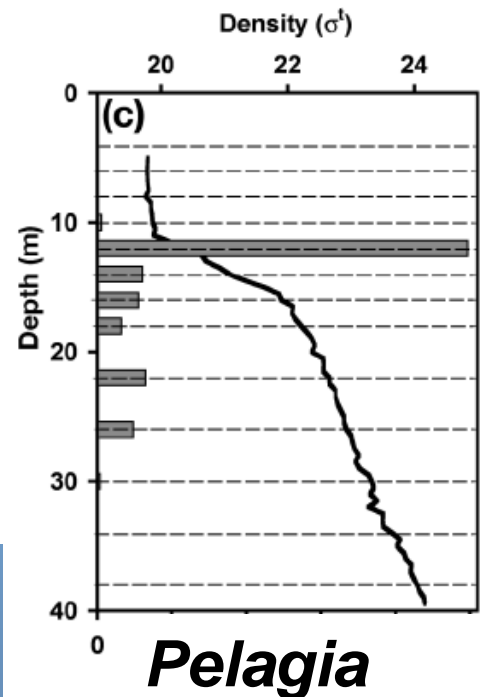
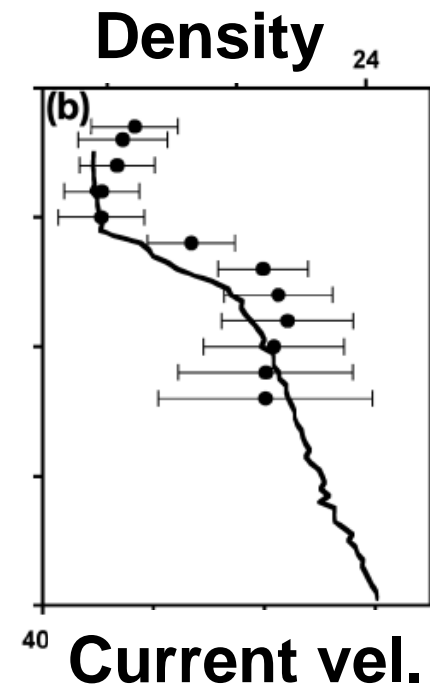
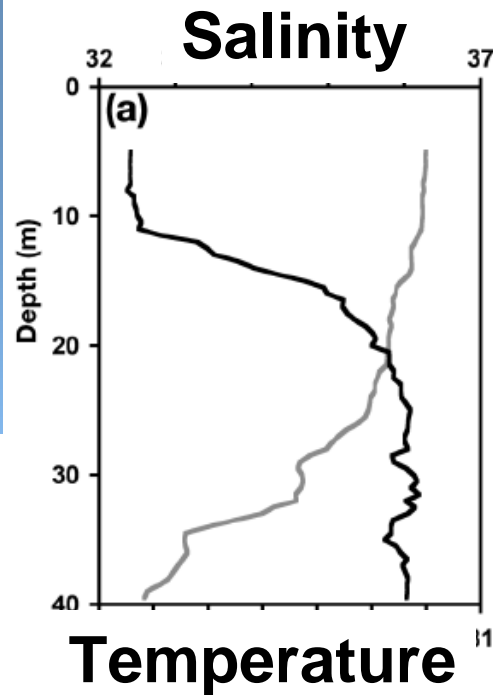
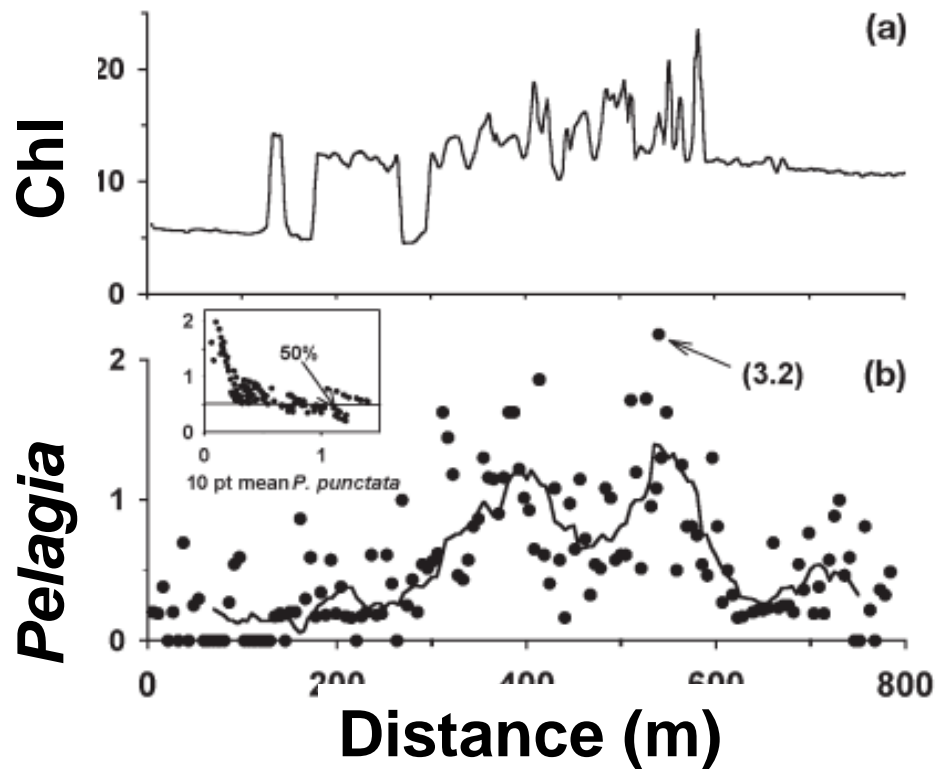
Towed UW Photography

Graham et al. (2003) *Mar Ecol Prog Ser* 254: 129-140

Densities of jellies
Temp, sal, DO, Chl
Depth

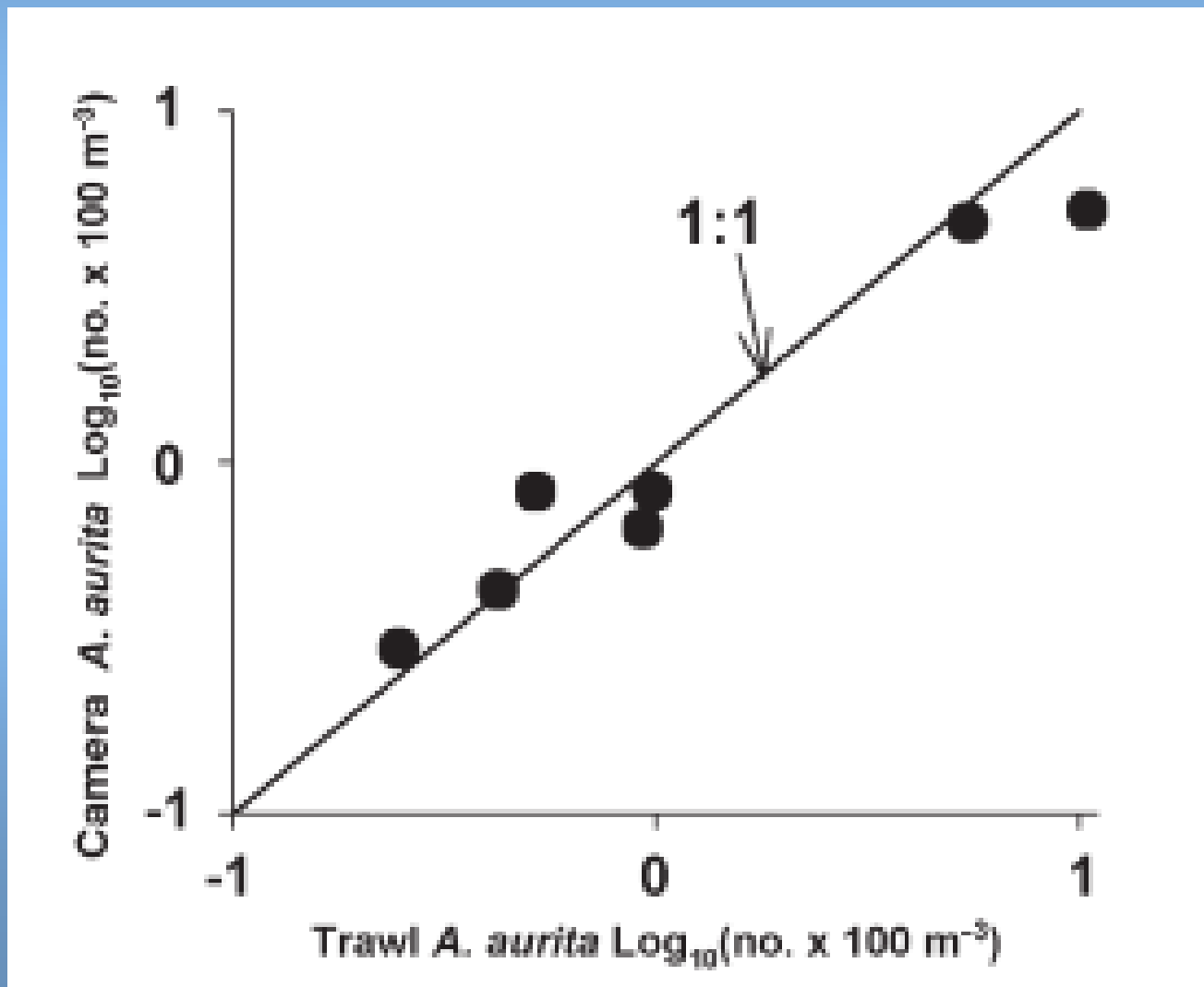
Spatial and depth distributions relative to physical factors

Graham et al. (2003)



Comparison of jellyfish densities by video and trawl

Graham et al. (2003) Mar Ecol Prog Ser 254: 129-140



UW camera survey summary

Problems

- Requires ships
- Should be calibrated against net tows

Advantages

- Quantitative

Ships of opportunity surveys

Ferries

- **Sparks et al. (2001) Hydrobiologia 451: 275-286**
- **Doyle et al. (2007) Hydrobiologia 579: 29-39**

CPR (Continuous Plankton Recorder)

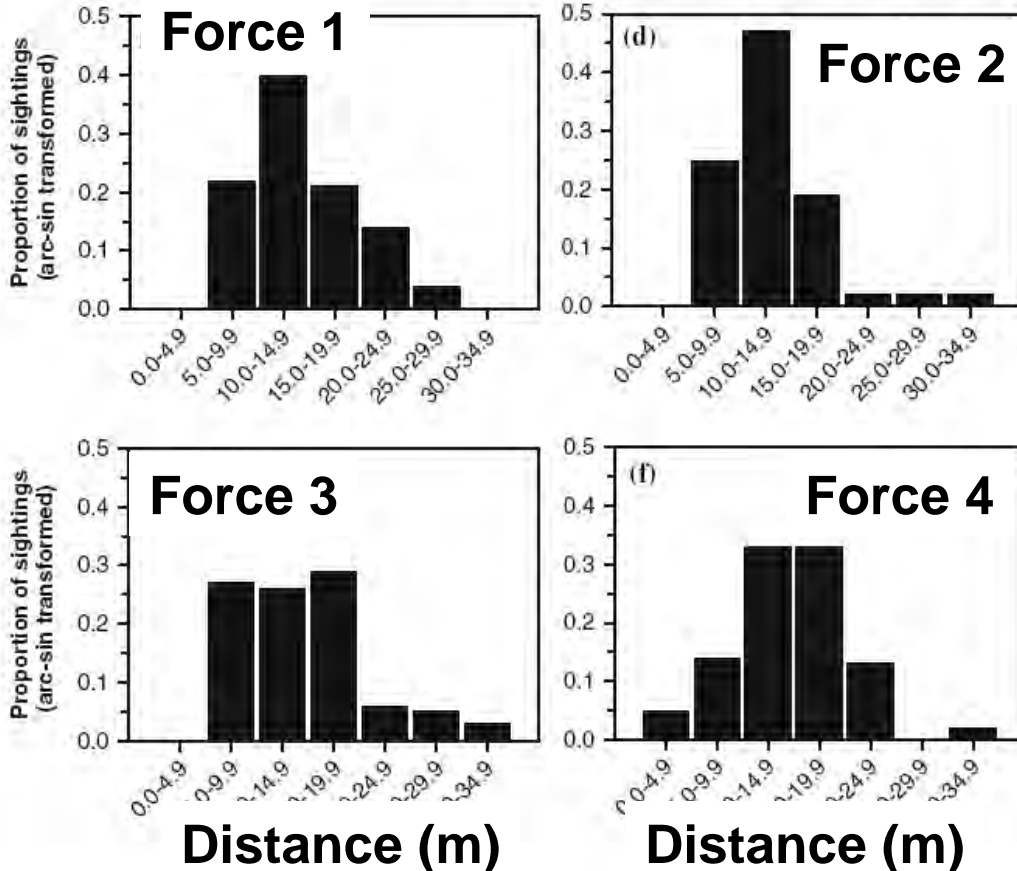
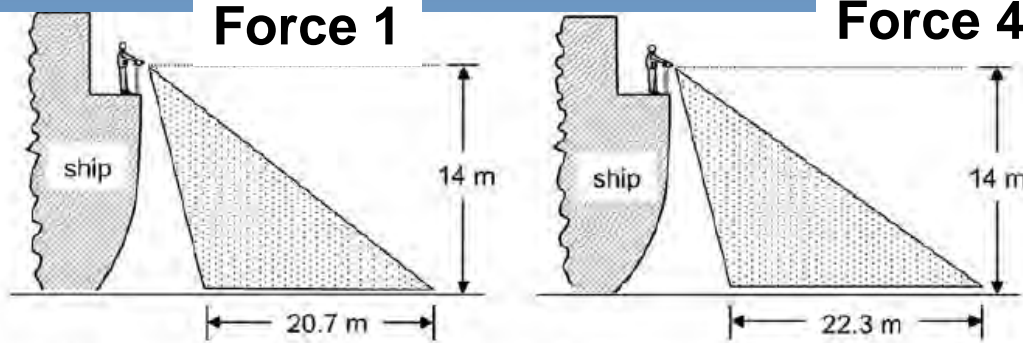
- **Attrill et al. (2007) Limnol Oceanogr 52: 480-485**
- **Gibbons & Richardson (2009) Hydrobiologia 616: 51-65**
- **Baxter et al. (submitted)**

This session:

15:15 Ikeda et al.

Ships of Opportunity Doyle et al. (2007) Hydrobiologia

579: 29-39



- Categories of abundance in 5-min intervals
- Accounted for wind and glare

Results of ferry surveys

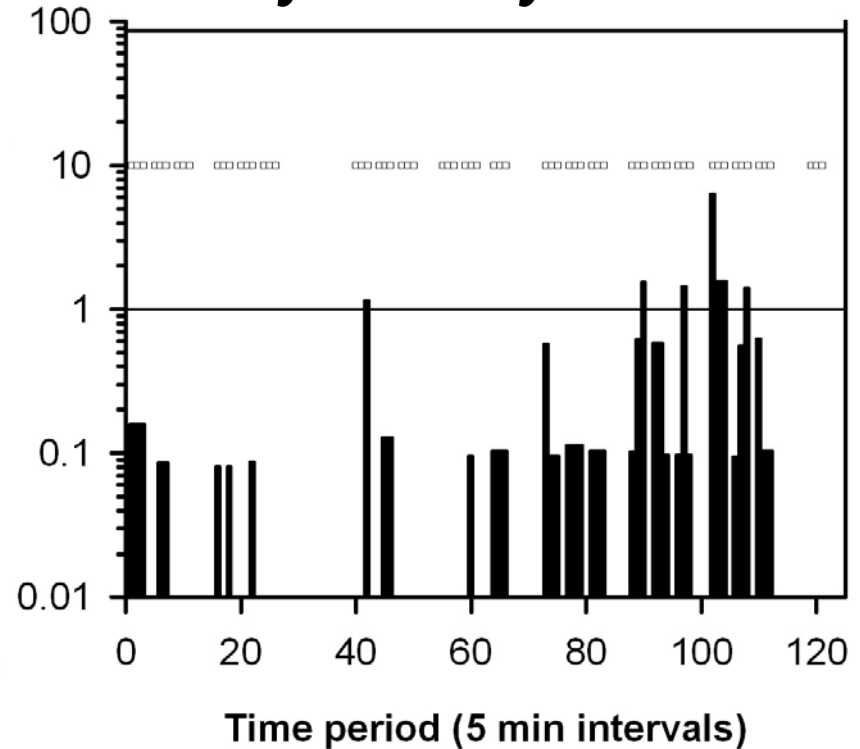
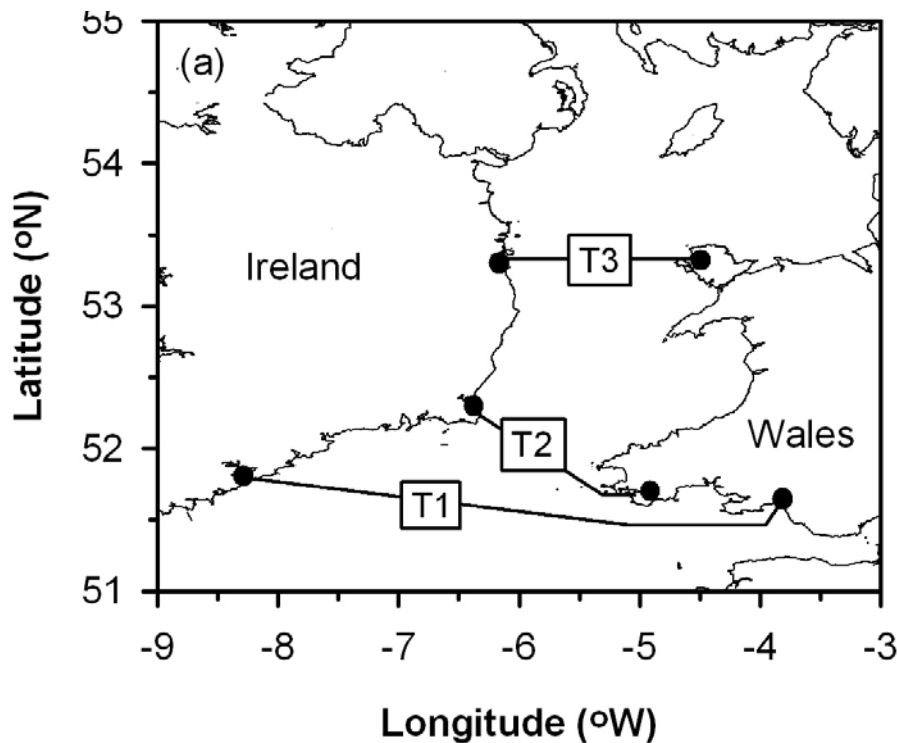
Doyle et al. (2007) *Hydrobiologia* 579: 29-39



Jellyfish per 1000m²

Chrysaora hysoscella

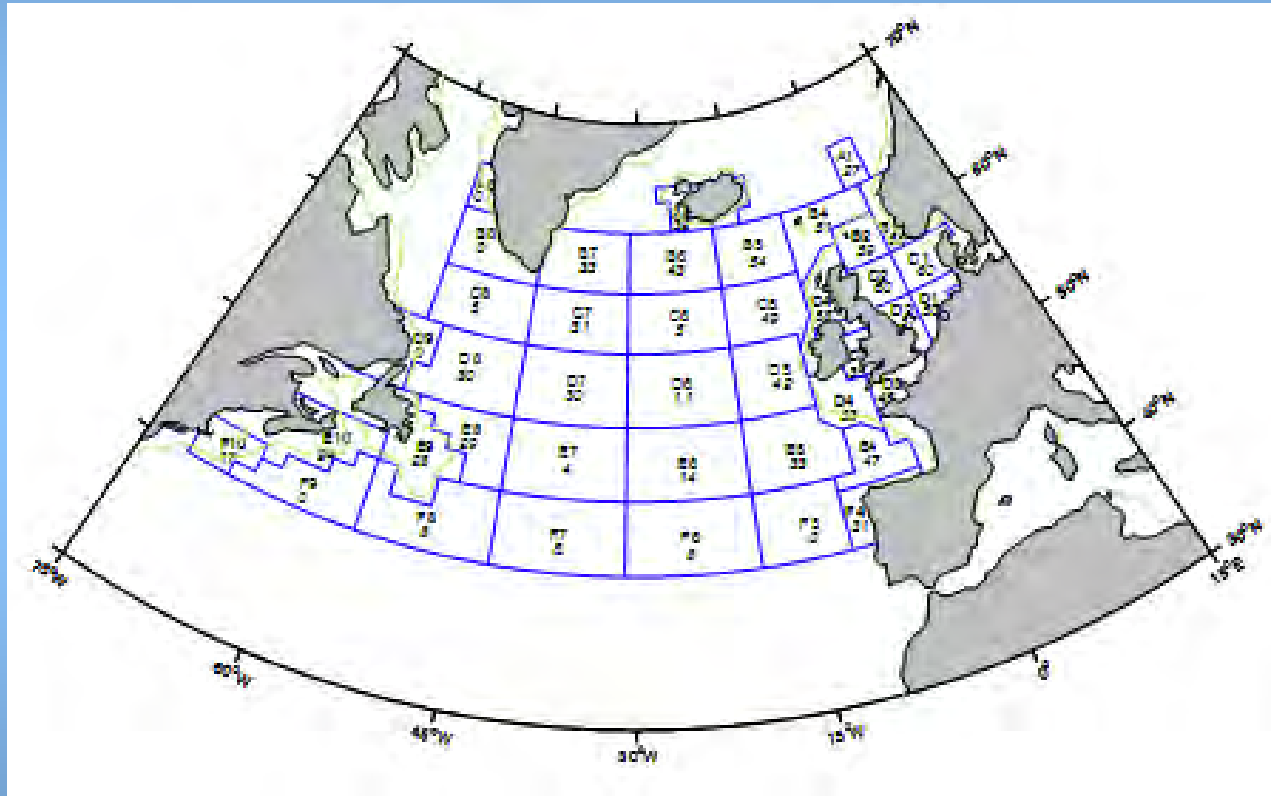
Transect routes



Ships of Opportunity CPR nematocysts

Gibbons & Richardson (2009) Hydrobiologia 616: 51-65

CPR survey area in North Atlantic



**Kinds of
cnidarians
unknown**

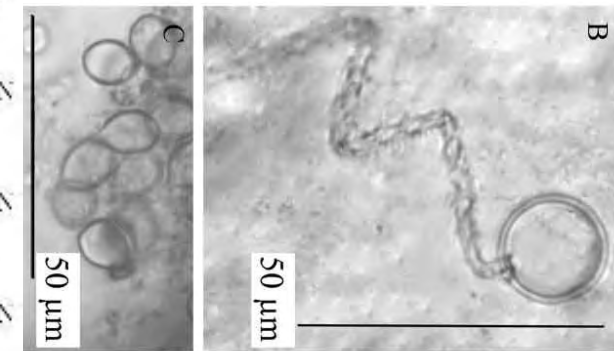
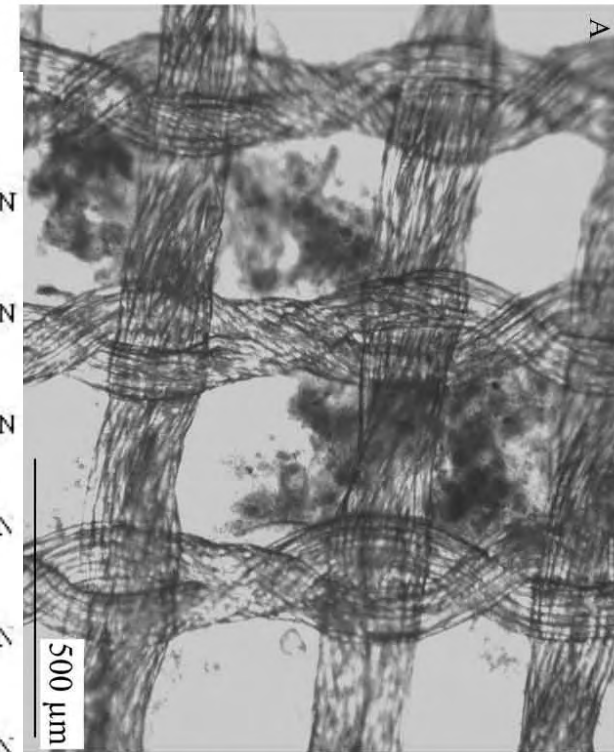
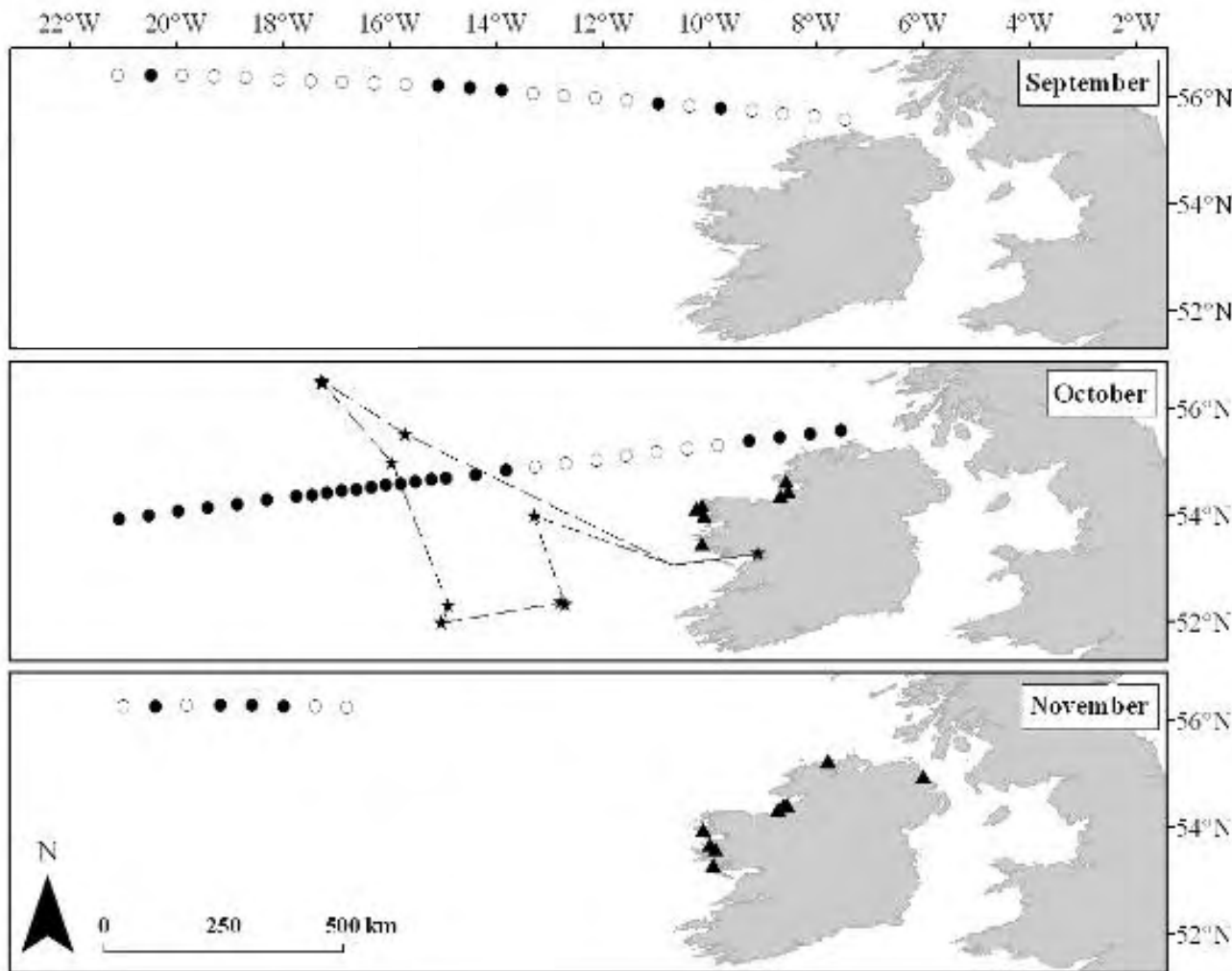
- CPR survey in North Pacific (Batten et al.)
- CPR survey in South Pacific (Richardson)

Cruise and CPR survey coincided in N Atlantic

Pelagia noctiluca nematocysts identified on CPR samples

Baxter et al. (submitted)

Molecular analyses in progress



Ships of Opportunity survey summary

Problems

- **Only at surface**
- **Should be calibrated against net tows**
- **Requires cooperation**
- **CPR not quantitative for jellyfish**

Advantages

- **Logistics provided**
- **Large temporal and spatial scales, frequent**

Shore-based surveys

- **Bernard et al. (1988) Ann Inst Oceangr Paris 64: 115-125**
- **Cargo & King (1990) Estuaries 13: 486-491**
- **Doyle et al. (2007) Hydrobiologia 579: 29-39**
- **Fuentes et al. NW Mediterranean coast of Spain**

- **This session**
- **16:05 Fujii et al.**

Jellyfish blooms on the Spanish Mediterranean Coast

Verónica Fuentes, Dacha Atienza, Josep-Maria Gili, Uxue Tilves, Alejandro Olariaga and William Silvert

Medusa project ICM-ACA

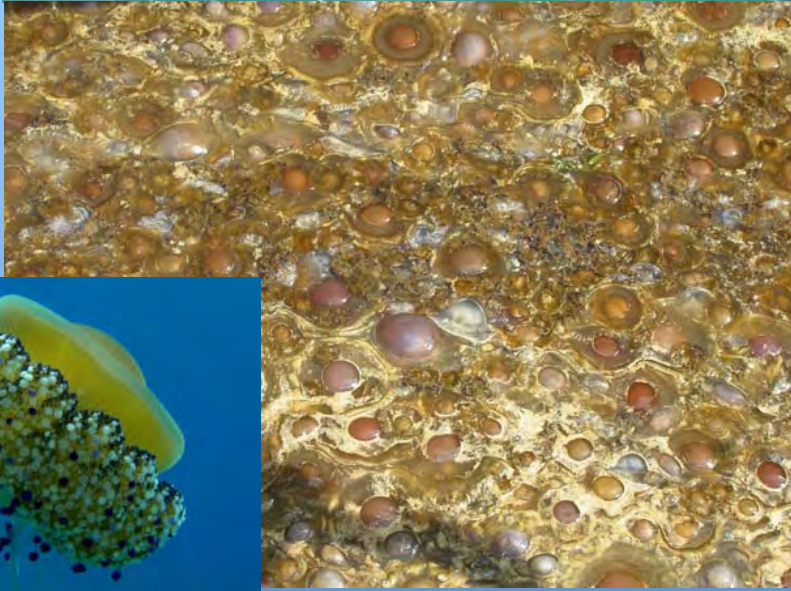
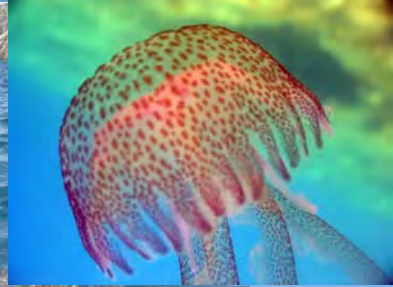


**Agència Catalana
de l'Aigua**

Rhizostoma pulmo



Pelagia noctiluca



Cotylorhiza tuberculata

Aequorea forskalea

Sources of Information

Data collected at 300 beaches daily May-Oct by Catalan Water Agency employees

- On beach
- By boats
- In planes











- By Red Cross from stinging events



IDENTIFICACION GUIDE

PROJECTE MEDUSA 2008

Aquest document és una guia de reconeixement i informació sobre les espècies de meduses que es poden trobar a la costa catalana

<p><i>Pelagia noctiluca</i> Medusa luminiscent</p>		→ molt freqüent	<p><i>Veella veella</i> Barquetes de Sant Pere</p>		→ freqüent
<p><i>Rhizostoma pulmo</i> Born Blau</p>		→ freqüent	<p><i>Aequorea forskalea</i></p>		→ poc freqüent
<p><i>Cotylorhiza tuberculata</i> Ou ferrat</p>		→ freqüent	<p><i>Chrysaora hysoscella</i> Born radiat</p>		→ poc freqüent
<p><i>Aurelia aurita</i> Born</p>		→ freqüent	<p><i>Physalia physalis</i> Caravel·la portuguesa</p>		→ molt rara

Data collection

To be completed
when jellyfish are
observed

None **Few** Abundance categories
Many

By species



Agència Catalana
de l'Aigua



CSIC



Fitxa de Recol·lecció de dades: Presència de meduses en la costa catalana

Municipio:	Data:
Platja:	Hora:
Informador/Servei:	Temp. Aigua:

Meteorologia i factors ambientals

Meteorologia	Sol	Sol/Núvol	Núvol	Pluja	Tempesta
Estat de la Mar	Plana	Arrisada	Marejol	Maror	Mar de fons
Corrent	Si	No	Feble	Moderada	Forta
Color Bandera	Verd	Groc	Groc M	Vermella	Vermella M

Meduses

	Abundància			Grandària				
	1	2	3	0-5 cm	5-10 cm	10-15 cm	15-25 cm	> 25 cm
<i>Pelagia noctiluca</i>								
<i>Rhizostoma pulmo</i>								
<i>Cotylorhiza tuberculata</i>								
<i>Chrysaora hysoscella</i>								
<i>Velella velella</i>								
<i>Aurelia aurita</i>								
<i>Aequorea forskalea</i>								
<i>Physalia Physalia</i>								
Sense identificar								
Altres								

Criteri para abundancia

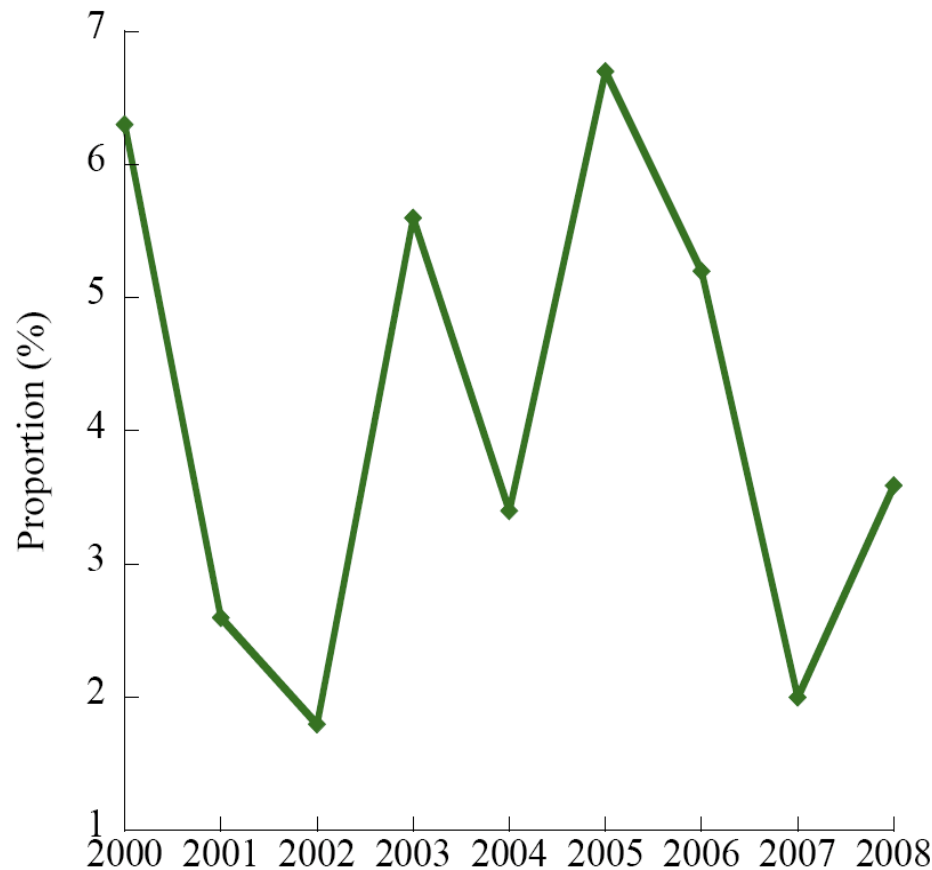
- 1: **Poques:** < 1 medusa per 10 m²
- 2: **Bastants:** > 1 medusa per 10 m²
- 3: **Moltes:** > 1 medusa per m²

Observacions

Interannual variability

Data from 2000 to present

Observations adjusted by the total number of Inspections



From surveys get patterns of relative abundance, distribution, correlated with environmental data

Shore-based survey summary

Problems

- **Not quantitative**
- **Should be calibrated against net tows**
- **Requires cooperation**

Advantages

- **Low cost**
- **Large areas**
- **Frequent, long term**

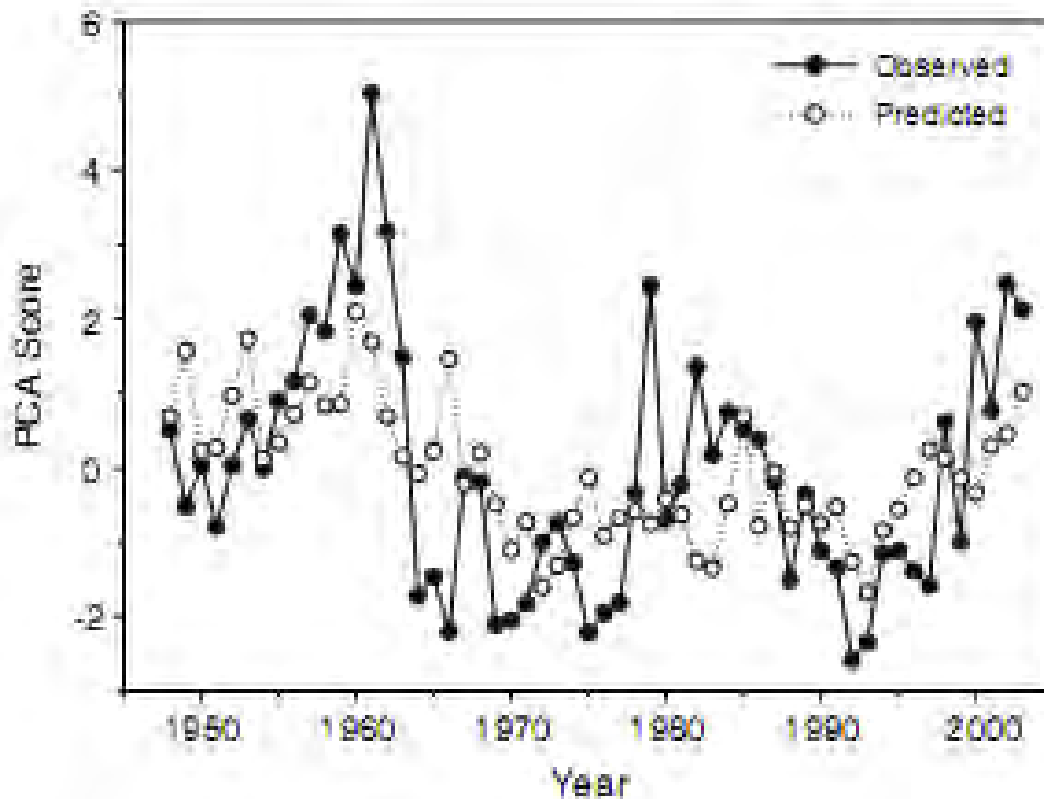
Predictive modeling relies on data from previous methods

- **Goy et al. (1989) Deep-Sea Res 36: 269-279**
- **Cargo & King (1990) Estuaries 13: 486-491**
- **Decker et al. (2007) Mar Ecol Prog Ser 329: 99-113**
- **Brodeur et al. (2008) Prog Oceanogr 77: 103-111**
- **Gibbons & Richardson (2009) Hydrobiologia 616: 51-65**

- **This session**
- **17:00 Okuno et al.**

Ships of Opportunity (CPR) and modeling

Gibbons & Richardson (2009) *Hydrobiologia* 616: 51-65



**Jellyfish in
North Atlantic**

- Observed in CPR
- Predicted by multiple regression with SST and zooplankton as predictors

Large-scale methods summary

- **General problems**
 - May not be quantitative
 - May rely on non-scientific partners
 - **Useful only for large species**
 - But there are now recognized approximately:
 - 190 species of scyphomedusae (Arai 1997)
 - 20 species of cubomedusae (Mianzan & Cornelius 1999)
 - 840 species of hydromedusae (Boullion & Boero 2000)
 - 200 species of siphonophores (Pugh 1999)
 - 150 species of ctenophores (Mianzan 1999)
- **General advantages**
 - Not time-consuming
 - Inexpensive or partners provide logistics
 - Long duration of records

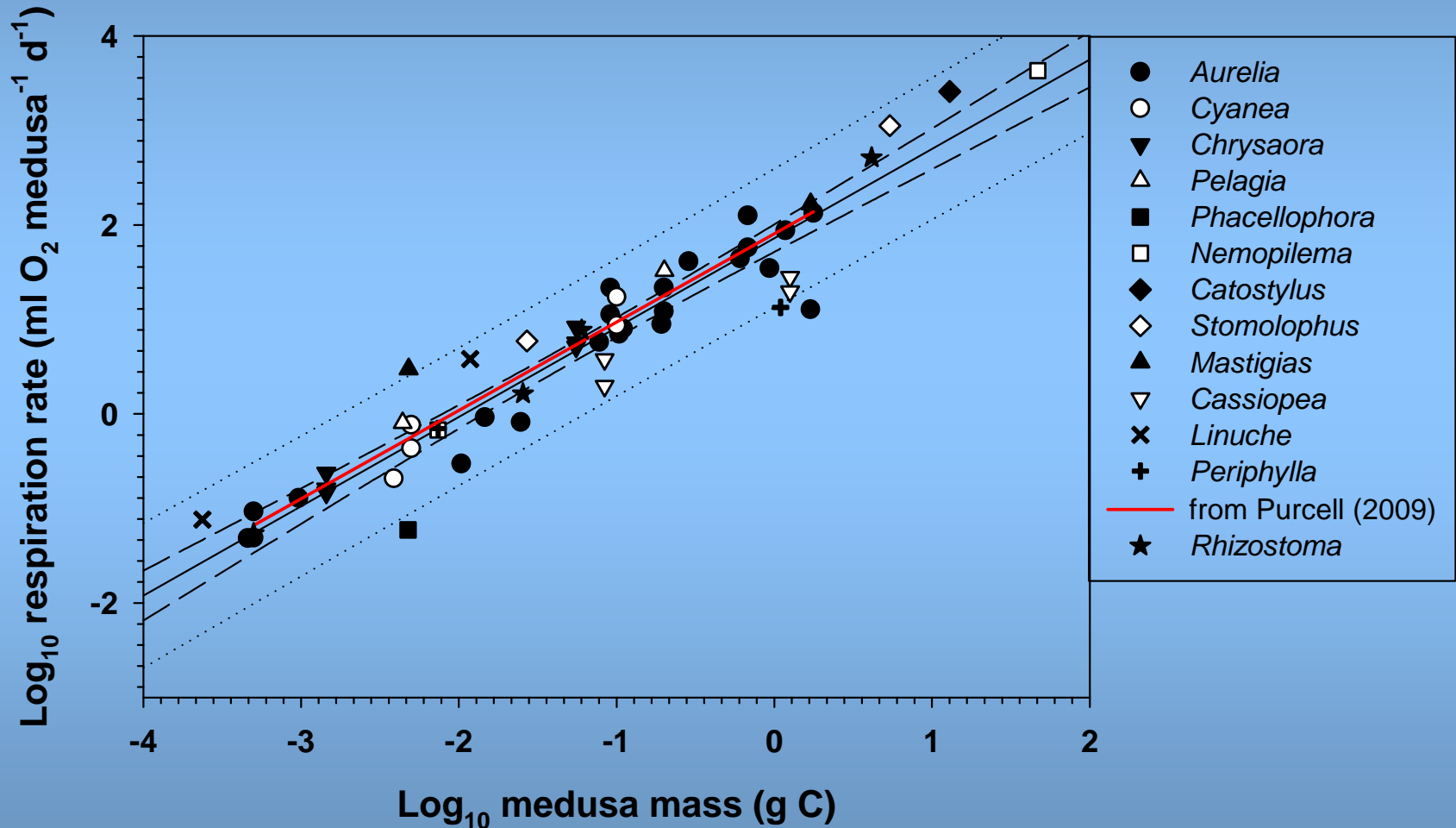
Recommendations

- **For non-quantitative patterns of spatial and temporal abundance, these large-scale methods can be used to monitor jellyfish populations**
- **For ecological effects we also need to:**
 - **Calibrate large-scale methods against quantitative methods**
 - **Determine numbers and biomass**
 - **Estimate trophic importance**

Large-scale methods to estimate trophic effects

- **Respiration rates of scyphomedusae scale 1:1 with mass and can be used to estimate metabolic demands**
 - **Purcell (2009) Hydrobiologia 616: 623-650**
 - **Purcell et al. (in revision)**

Respiration rates of scyphomedusae and trophic needs can be calculated from mean size



Purcell (2009) *Hydrobiologia* 616: 623-650; Purcell et al. (in revision)

Feeding pressure of *Nemopilema nomurai* population on mesozooplankton



Respiration:
1000 mg C d⁻¹

Mean size:
3 kg WW = 18 g C

Abundance:
2.5 medusae 1000 m⁻³

Mesozooplankton biomass:
10 mg C m⁻³

**25% of zooplankton biomass
consumed d⁻¹**

Large-scale method for trophic effects

**Electron-transport system (ETS)
method permits *in situ* estimation of
respiration demand**

Owens & King (1975) Mar Biol 30: 27-36

Båmstedt (2000) J Exp Mar Biol Ecol 251: 239-263

**With combinations of methods
we will get the most
information about jellyfish
populations**

Thank you!