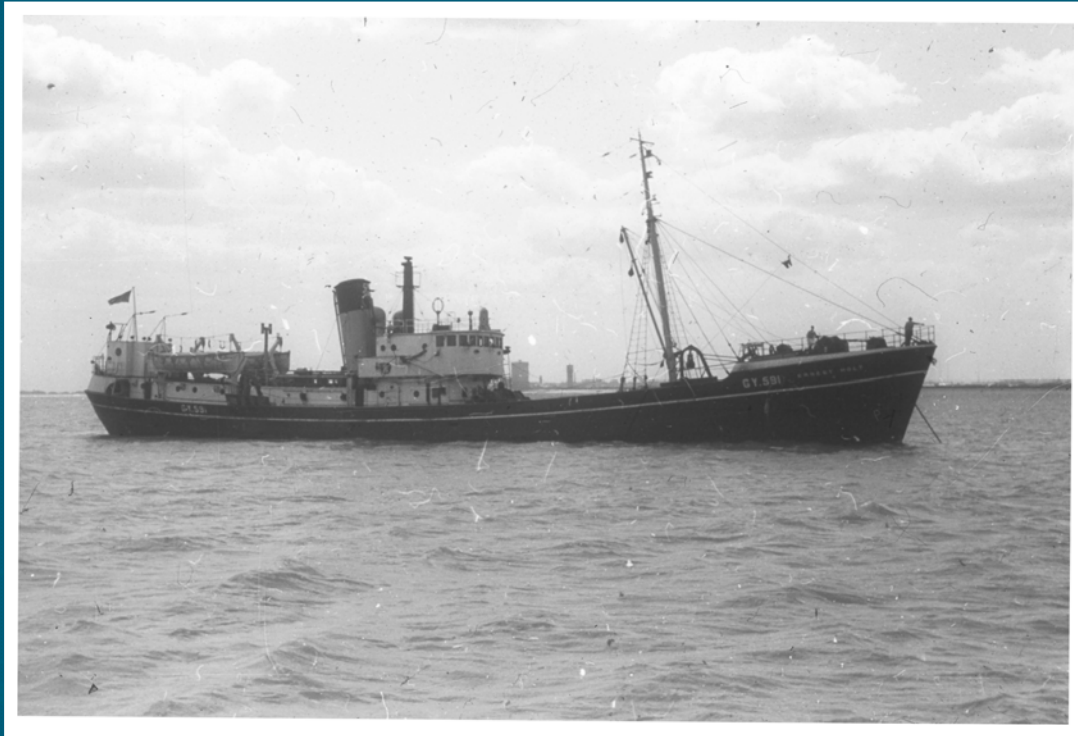


Modelling historical distribution of trawling effort



British steam trawlers in the North Sea

Motivation

Why study fleet dynamics?

- North Sea: dramatic changes fish abundance
- For understanding, *not enough* to focus only on fish biology
- Adults of many fish stocks: $F \gg M$
- More understanding needed of fish' main predator – *fishing fleets*

Motivation

Why study historical fleet dynamics?

- We have extensive historical data, under-utilised
- Historical commercial data more reliable than current
 - quota restrictions, mis-reporting, discarding, compliance
- Strong ‘political’ effect may now drive effort distribution; historically, more purely market-driven
- Tackle old questions using new methods
- Past is key to present

Case study

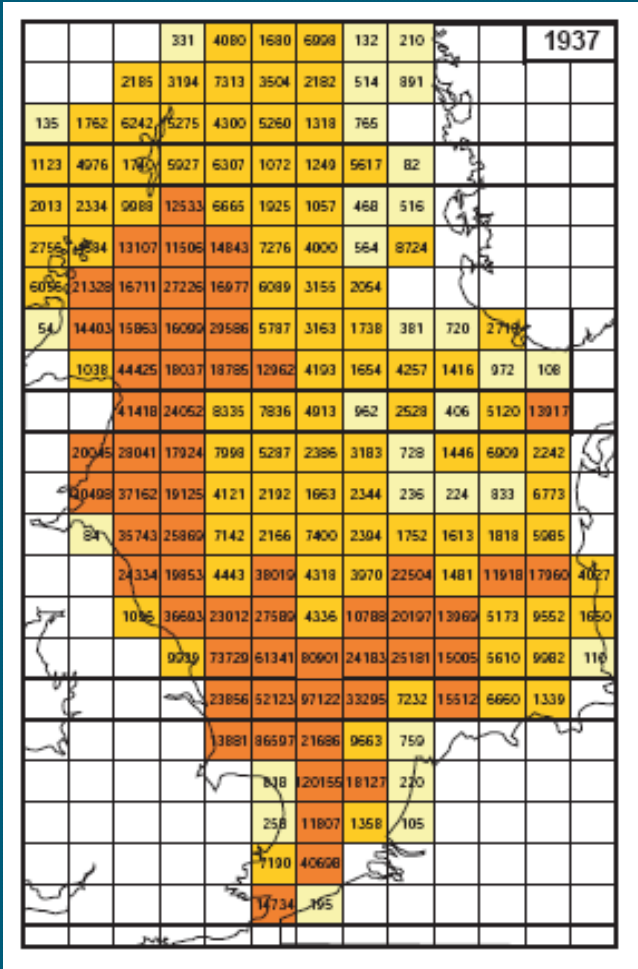
North Sea steam trawlers pre- and post-war



- Before WWII:
 - large fleet
 - low stock levels
- After WWII:
 - reduced fleet
 - high stock levels

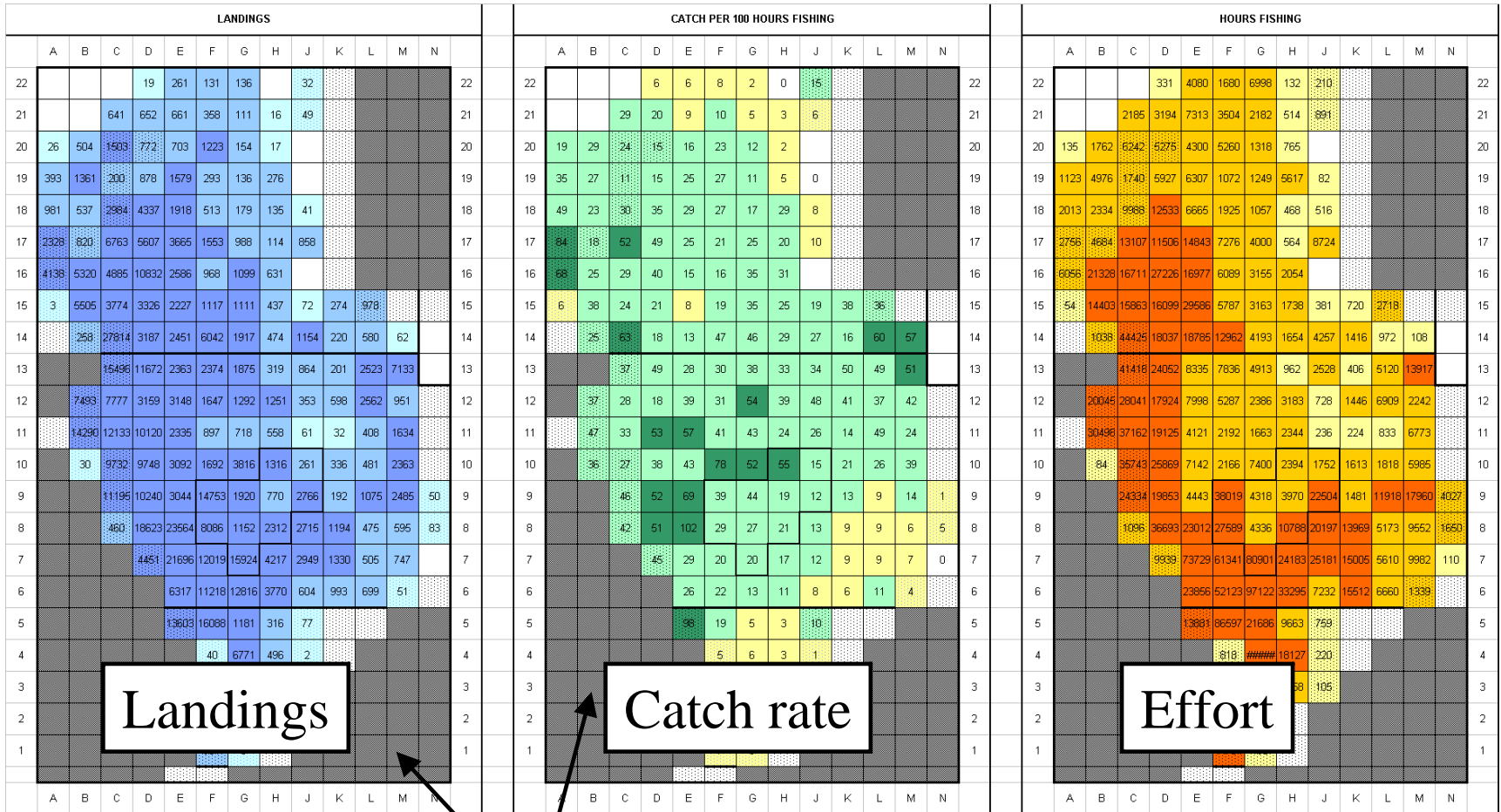
Specific research question

- Why do fishers trawl where, when and how much?
- Can we model distribution of trawling effort?



- Effort (hr fished) by rectangle
 - explained by:
- Fishers' 'habit'
 - previous' year's effort
- Distance to port
 - transport, time costs
- $C_{pue} \times \text{fish price} = \text{'V}_{pue}$ '
 - value per unit effort
- Other variables
 - climate, total stock levels, vessel tonnage

The data



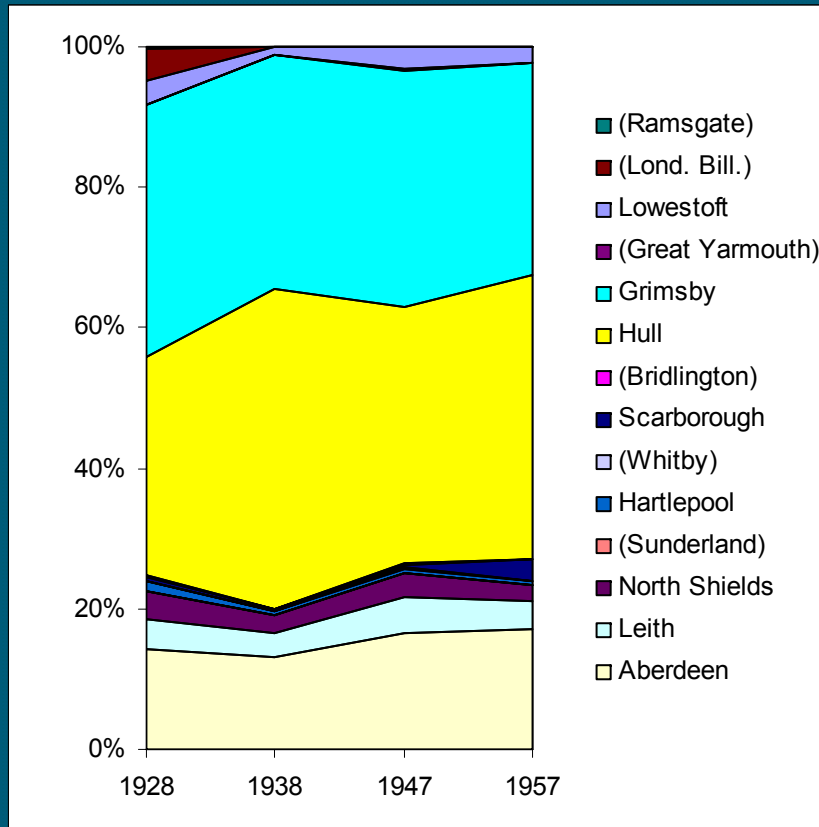
5 main species: cod, haddock, plaice, sole, whiting

The data — a limitation

- only global effort data for the entire steam trawler fleet
- no individual trip data for vessels separately

Initial results—graphic exploration

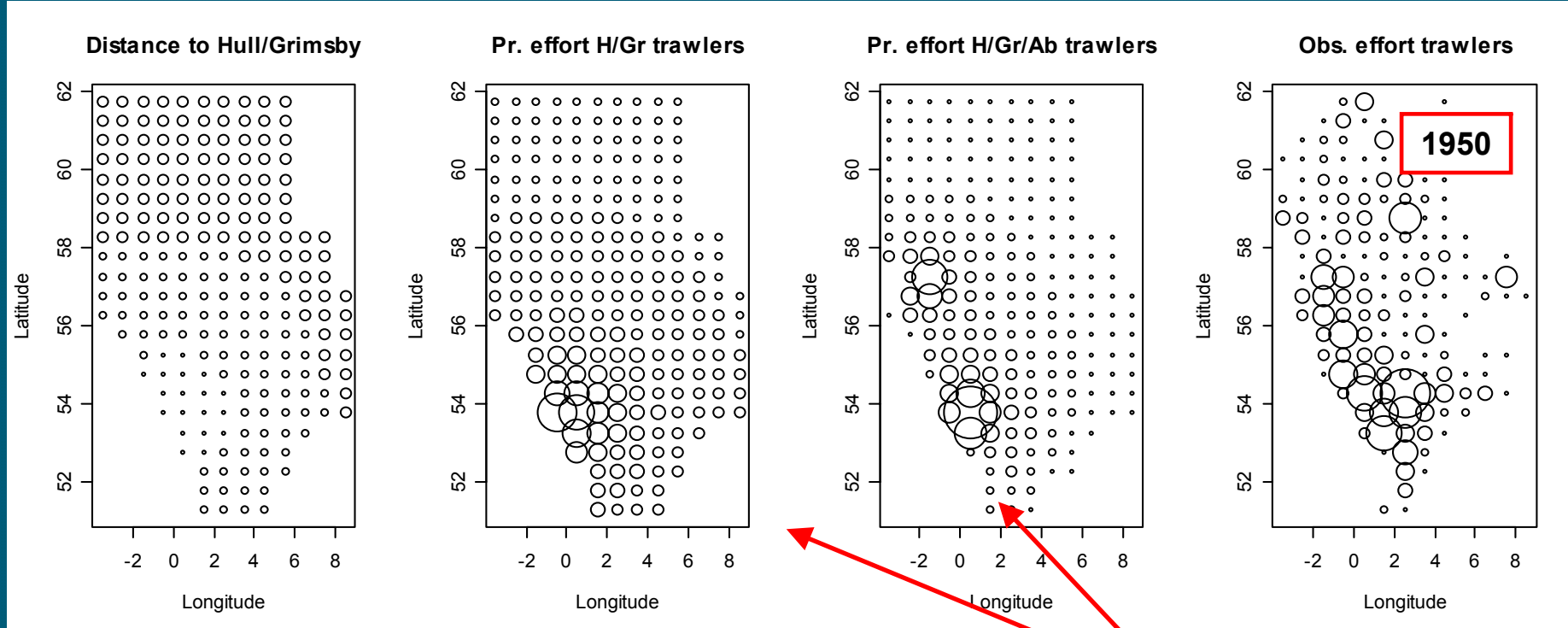
Distance to port



- Landings in main ports by steam trawlers
- By far most important:
 - Hull & Grimsby
 - Aberdeen
- 2 distance variables in model

Initial results—graphic exploration

Distance to port

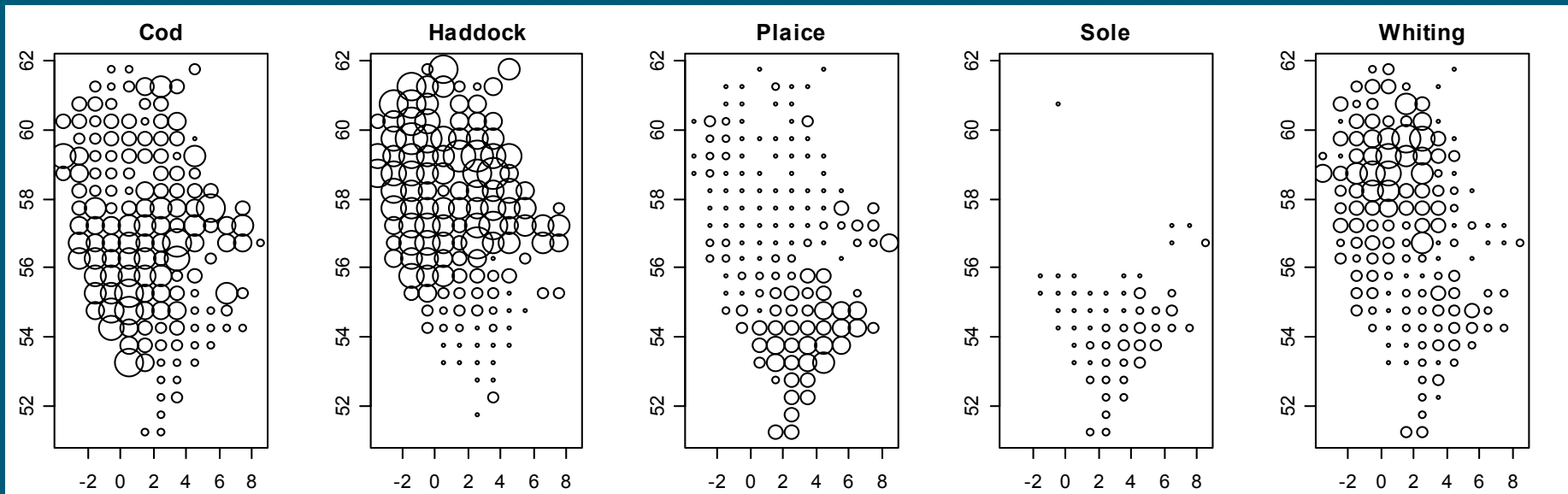


Distance is important, but how can it best be modelled?

$$Effort \sim \frac{Area \cdot Fleet}{Distance^2}$$

Initial results—graphic exploration

Catch rates (cpue) 5 principal species

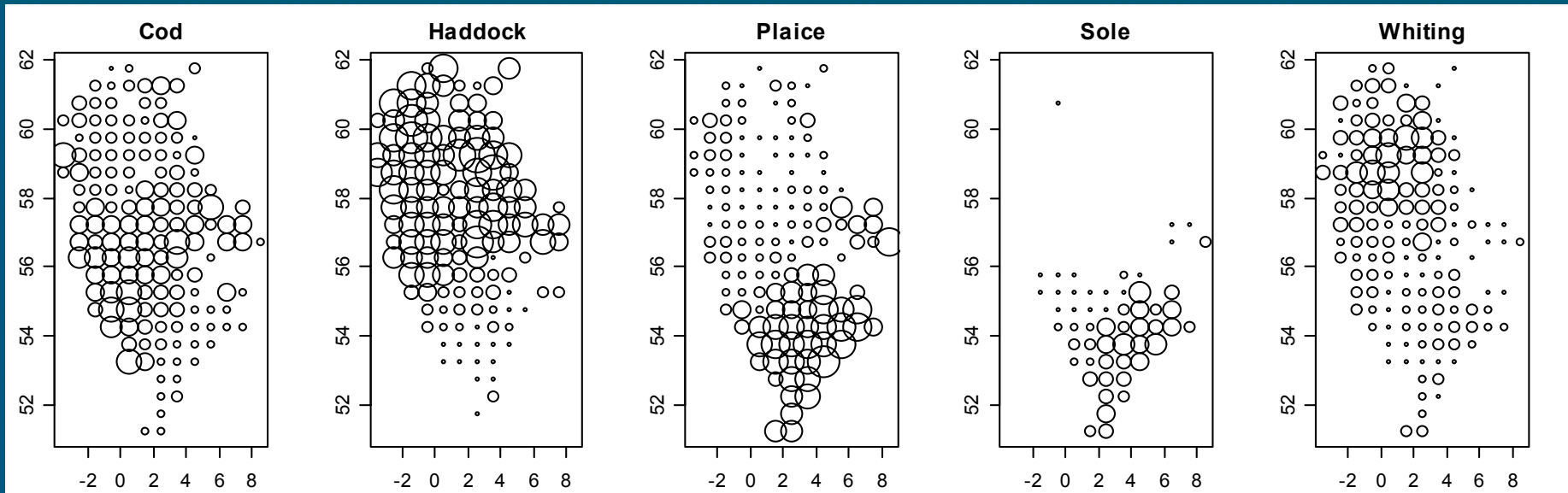


1950

But price differences need to be accounted for

Initial results—graphic exploration

Value per unit effort (vpue) 5 principal species

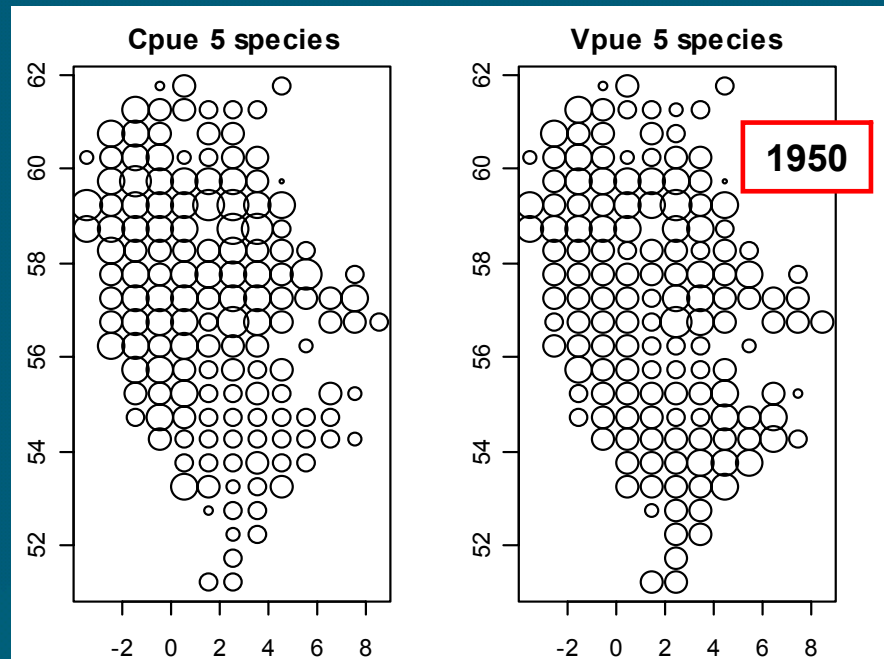


1950

Species-specific vpue's can be summed
index of profitability of rectangles

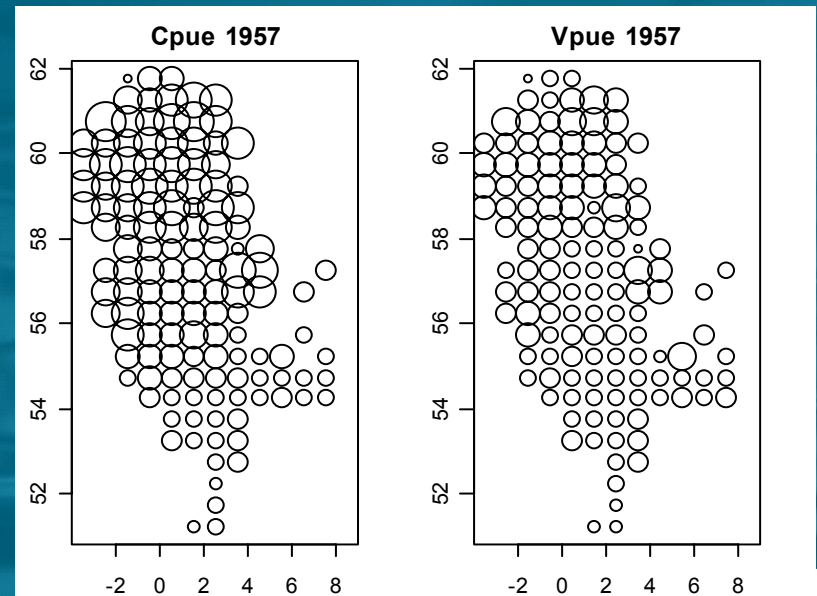
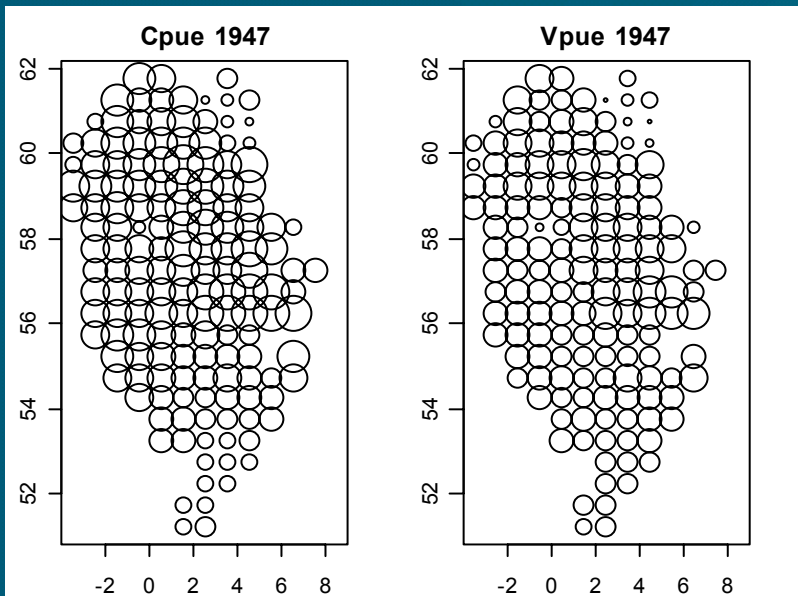
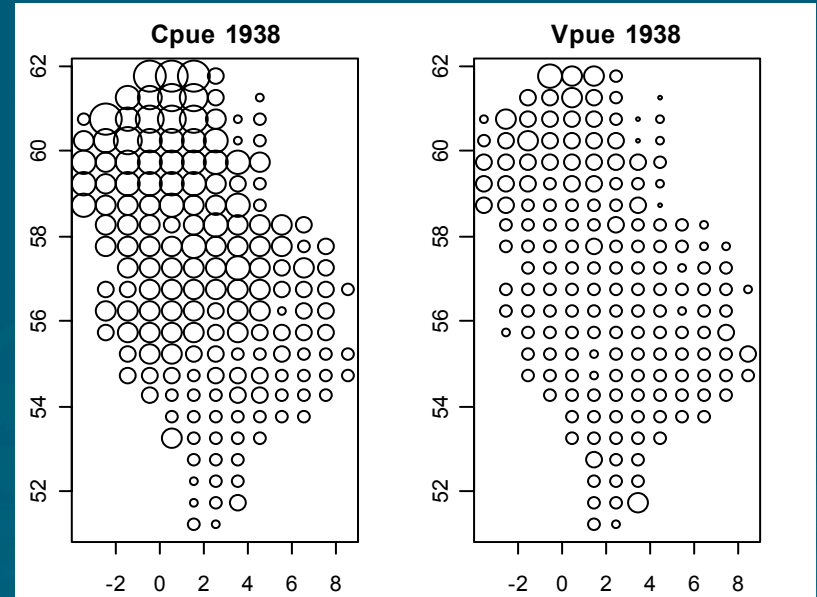
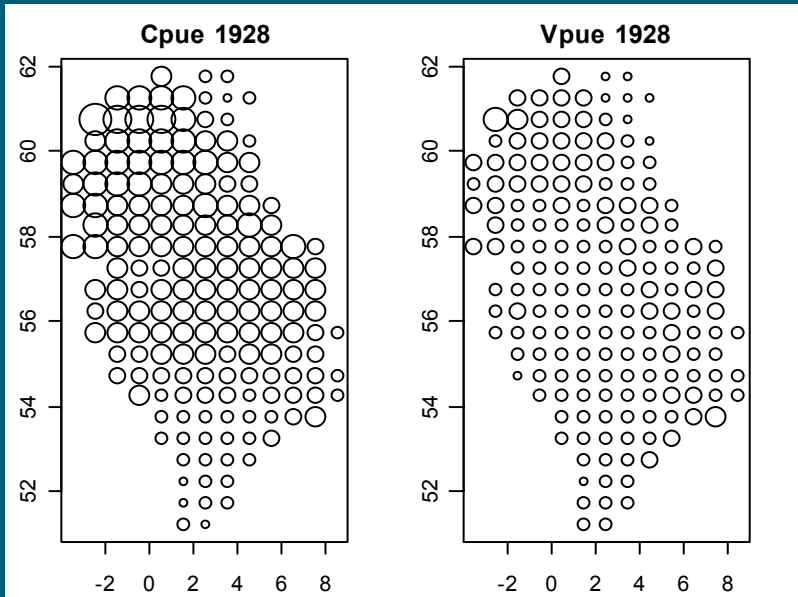
Initial results—graphic exploration

Total cpue and total vpue



- 1950: cpue and vpue ~equally distributed North Sea
 - more high-price fish in S than N (plaice, sole)
 - little contrast in data, difficult to assess effects on effort
- How are temporal trends?
 - account for retail price index

Trends cpue and vpue (corrected for retail price index)



Initial results—modelling GLM

$$\text{effort}_{r,y+1} = (\text{vessels}_{y+1} / \text{vessels}_y) (\alpha \text{ effort}_{r,y} + \beta \text{vpue}_{r,y} + \gamma \text{distance}_r^2) + \varepsilon$$

log-transformed

$$\ln \text{effort}_{r,y+1} = \ln (\text{vessels}_{y+1} / \text{vessels}_y) + \alpha \ln \text{effort}_{r,y} + \beta \ln \text{vpue}_{r,y} + \gamma \ln \text{distance}_r + \varepsilon$$

Refining of model construction currently in progress

GLM

- Effect of $Effort_y$ on $Effort_{y+1}$
 - very closely related
 - may suggest *conservative* behaviour fishermen
 - multicollinearity
 - maybe model *change* in effort?
- *Distance to port* (if $effort_y$ excluded):
 - generally (quite) strong *negative* effects
 - Hull/Grimsby > Aberdeen (in accordance with fleet size)
 - suggests fuel, time constraints are strong

- Effects of *Vpue* (if previous year's effort excluded from model):
 - 1928, 31 no effect
 - 1937 *positive*
 - 1947, 48 no effect
 - 1950, 56 *positive*
 - 1954 no effect
 - 1955 (positive trend)
 - 1977 no effect
- Note low contrast in *vpue*
 - less likely to find effects
- Should species be accounted for?
 - do fishers target *species* or *total* catch composition?
- Should more species be included?
 - candidate species with high value — hake, turbot, brill
 - may significantly affect *vpue* distribution

Acknowledgements

For information on statistical charts, see:

www.cefas.co.uk/Publications/techrep/tech128.pdf

Feedback by many, including

Laurie Kell

Colin Bannister

Trevor Hutton

Beatriz Roel

John Pinnegar

Cefas library staff



In commemoration of my Father and his tales about life at sea