The Costs of Ignoring Stock Structure

How VMS and logbook data might be used to compliment surveys

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$$\textbf{Catch} = q \times \textbf{Abundance}$$

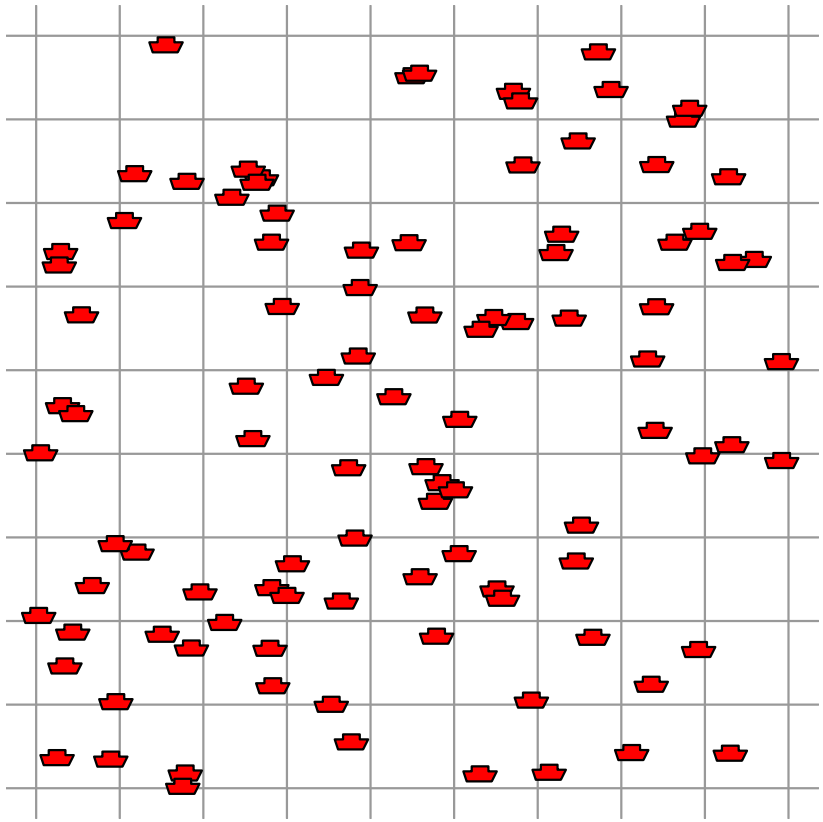
Catch $= q \times$ Abundance

The problem with fishers is that they do not 'sample' **uniformly**

A uniform distribution

$$\text{Index} = \frac{N}{n} \sum_{i=1}^{n} catch_i$$

$n =$ no. of samples
$N =$ no. of sampling units

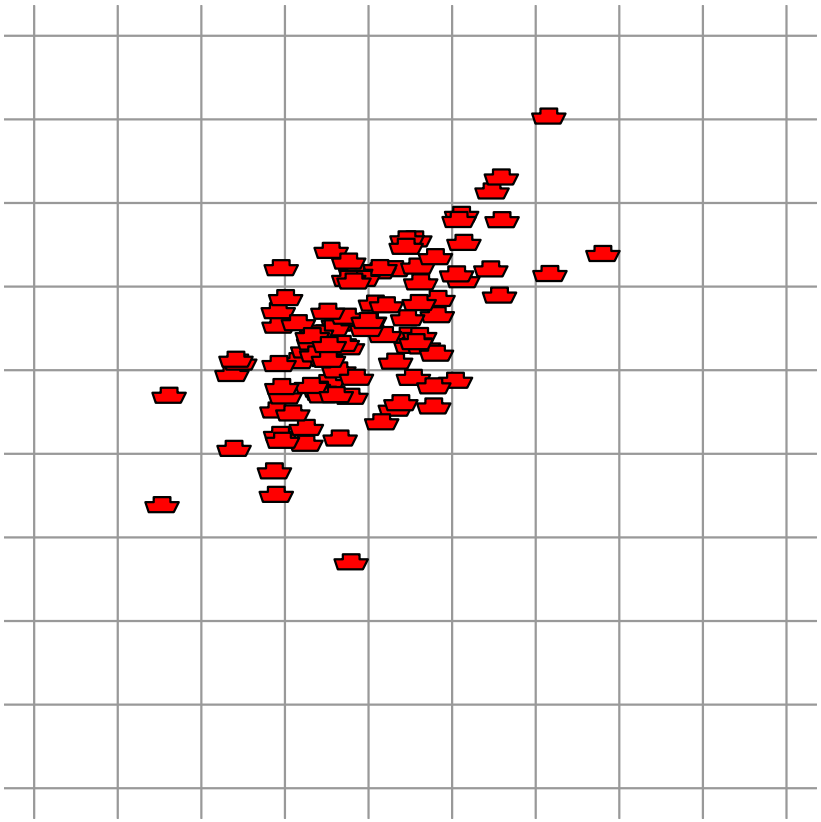


Catch $= q \times$ Abundance

Fishing tends to be a focused activity

$$\text{Index} \neq \frac{N}{n} \sum_{i=1}^{n} catch_i$$

$n =$ no. of samples
$N =$ no. of sampling units



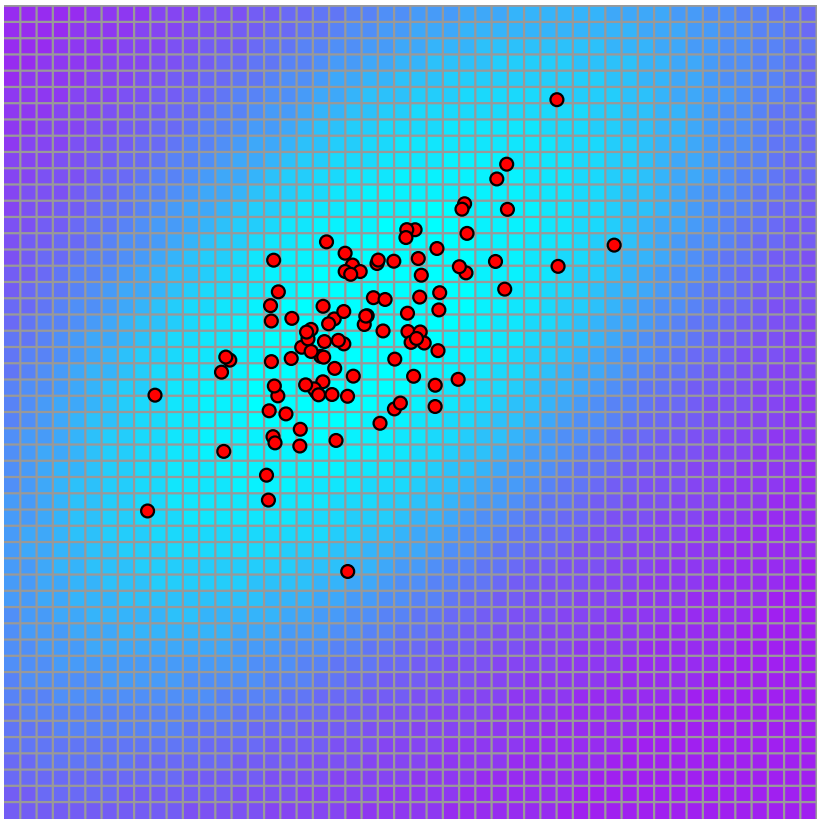
Catch $= q \times$ Abundance

So there is an unequal probability of sampling

Unequal probability sampling
Hansen-Hurwitz estimator

$$\text{Index} = \frac{1}{n} \sum_{i=1}^{n} \frac{catch_i}{p_i}$$

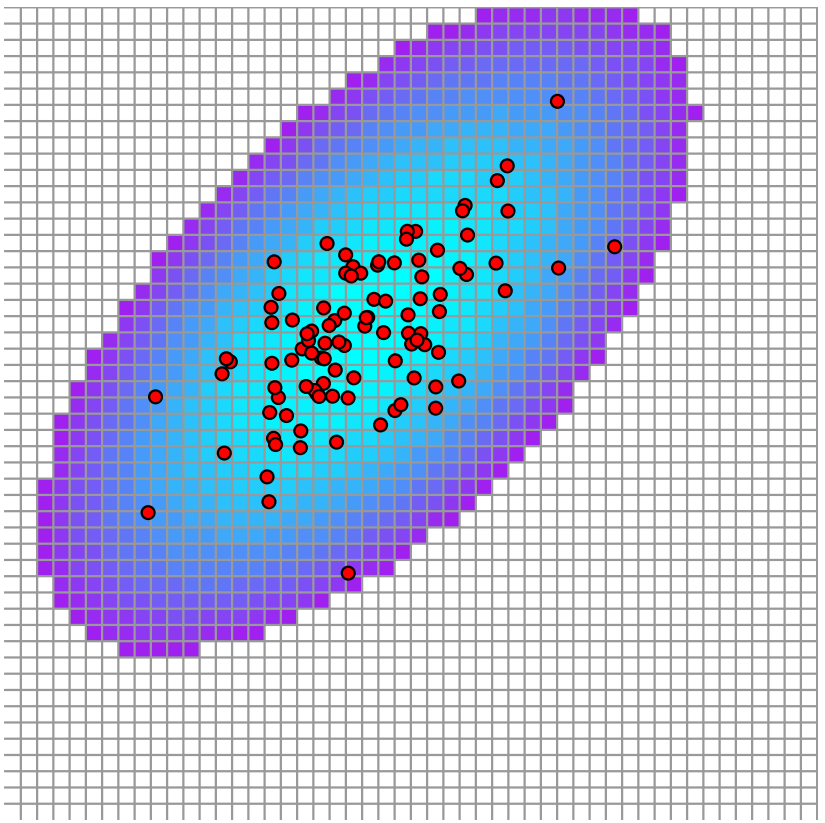
$n =$ no. of samples
$p_i =$ probability of sampling



Catch $= q \times$ Abundance (in fished area)

There are also regions that are never sampled

A non uniform distribution with regions of **zero** sampling probability

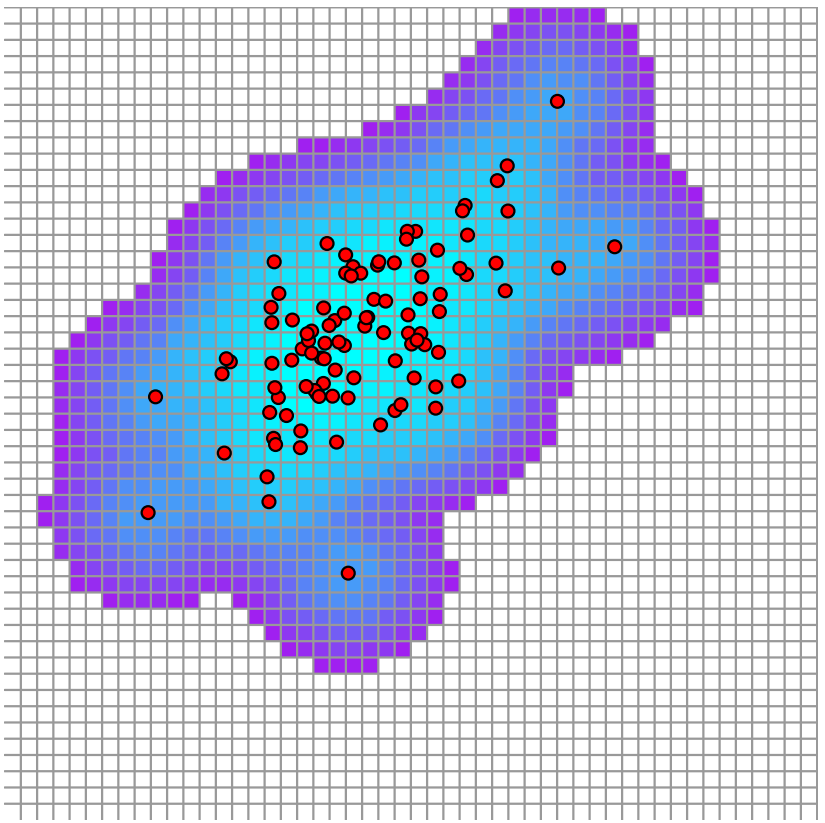


$$\text{Index}_{\text{fished population}} = \frac{1}{n} \sum_{i=1}^{n} \frac{catch_i}{p_i}$$

Catch $= q \times$ Abundance (in fished area)

What is the probability of sampling?

Use the spatial location of fishing pings to estimate the probability of sampling



$$\text{Index}_{\text{fished population}} = \frac{1}{n} \sum_{i=1}^{n} \frac{catch_i}{\hat{p}_i}$$

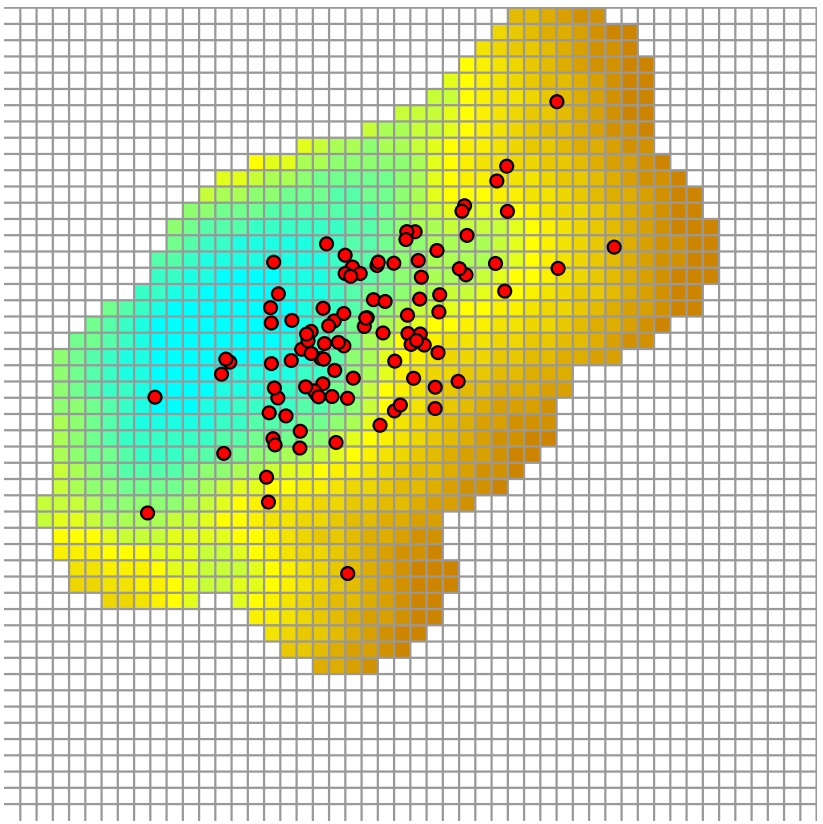
Comparing with Survey Data

We can also estimate the surface of $q \times$ Abundance

Use the spatial location of fishing pings and catch observations to estimate a **smooth** density surface

$$E[catch_i] = D_{loc(i)}$$

where D has spatial structure



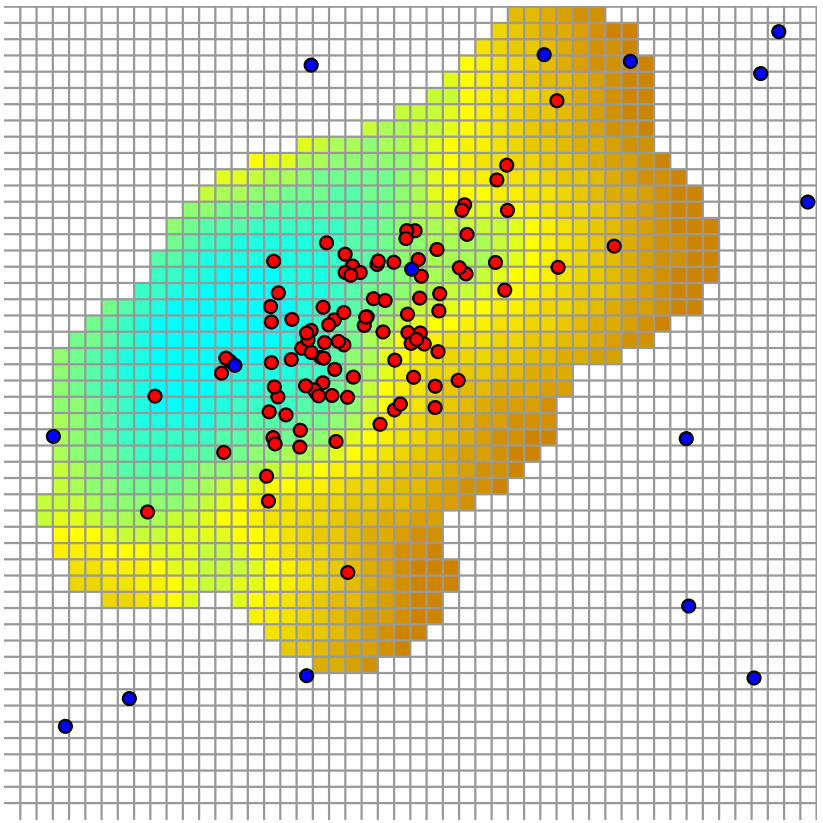
Filling in the gaps

To combine we need the ratio in catchabilities

$$E[catch_i] = D_{loc(i)}$$
$$E[survey_j] = r \times D_{loc(j)}$$

where

$$r = \frac{q_{surv}}{q}$$



Filling in the gaps

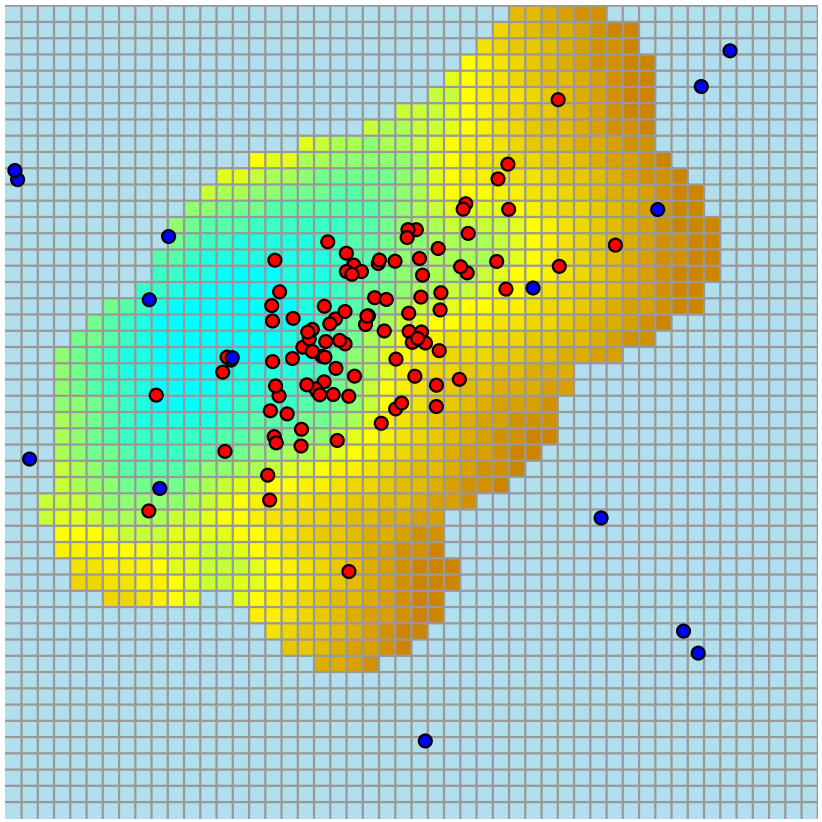
Combining survey and catch data

$$\frac{1}{n}\sum_{i=1}^{n}\frac{catch_i}{\hat{p}_i} + r\frac{N_s}{n_s}\sum_{i=1}^{n_s} survey_i$$

n_s = no. of survey samples

N_s = no. of 'unfished' units

r = the catchability ratio



VMS - Vessel Monitoring System

Reports the position of a vessel every 2 hours
Also reports speed and vessel ID