Ratio estimates of density

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Quad sampling: assuming perfect detection

For each transect i ($i = 1, \dots, T$), we observe mussel counts in n_i quadrats. The total number of mussels for each transect is y_i (summed over all quads) and the total area sampled in a transect is $a_i = n_i \times 0.5^2$ square-meters. The total area and number of quads sampled varies across quads, so we will use a ratio estimate of density:

$$\hat{D} = \frac{\sum_{i=1}^{T} y_i}{\sum_{i=1}^{T} a_i}$$

We can use the `survey` package to obtain this ratio estimate and SE for each lake. The design assumes a SRS of transects around the lake with mussel counts and area recorded fro each transect.

Transect sampling (no distance): assuming perfect detection

For each transect i ($i = 1, \dots, T$), let l_i be the length of the transect sampled. The total number of mussels for each transect observed by **both** divers is y_i. The total area sampled in a transect is $a_i = l_i \times w \times 2$ square-meters where w is the (half-width) distance from the transect that divers looked for mussels. The total area and number of quads sampled varies across quads, so we will use a ratio estimate of density:

$$\hat{D} = \frac{\sum_{i=1}^{T} y_i}{\sum_{i=1}^{T} a_i}$$

Results for transects 1-8, assuming $w = 0.5$m:

Try using `unmarked` for double observer removal data

This model uses multinomial distribution for observed removal counts and a Poisson model for transect population mussels counts, denoted N_i. Let y_{ij} be the number of mussels (not clusters) removed at time j at transect i, and $\boldsymbol{y_i} = (y_{i1}, y_{i2}, y_{i0})$ where $y_{i0} = N_i - \sum_j y_{ij}$ is the number of unobserved mussels. Then the model is

$$N_i \sim Pois(\lambda_i) \; \boldsymbol{y_i} \mid N_i \sim Multinom(N_i, \boldsymbol{\pi})$$

Since transects vary in area, we allow mean abundance λ_i to depend on the area of the site using the model

$$\log(\lambda_i) = \beta_0 + \beta_1 a_i$$

This model is fit for Burgan and Little Birch since transect lengths varied. Area is not used in the model for Florida since all transects were 30m in length.

Estimated density is formed from transect level estimates of abundance $\hat{N}_i$:

$$\hat{D} = \frac{\sum_i \hat{N}_i}{A}$$

To look at:

- β_1 estimates are negative?? When excluding intercept it is positive and the $\hat{D}$ estimates are slightly lower for Burgan (LBL is about the same)
- use negative binomial model for N

GOF assessment:

from ddf removal sampling: assumes $w = 0.5$??

Since area is equal to length, assuming that half width is 0.5m. Use the `mrds` package to estimate density as

$$\hat{D} = \frac{n\bar{s}}{\hat{P}_d A}$$

where $\bar{s}$ is the mean mussel count per detection, $\hat{P}_d$ is the estimated probability of detection on a transect (proportion of actual clusters that were detected), and A is the total area surveyed.

Results

Note: detection prob rate for `multiPois` is at the mussel level while it is at the cluster level for `MRDS` models.

```
> kable(arrange(ests.df, Lake), digits = 3)
```

Lake	Dhat	SE	method	detProb
Lake Burgan	0.559	0.210	quads, ratio	1.000
Lake Burgan	0.213	0.070	Double no distance, ratio	1.000
Lake Burgan	0.275	0.054	Double no distance, multiPois	0.952
Lake Burgan	0.221	NA	Double no distance, MRDS	0.963
Lake Florida	0.071	0.047	quads, ratio	1.000
Lake Florida	0.011	0.007	Double no distance, ratio	1.000
Lake Florida	0.012	0.006	Double no distance, multiPois	0.750
Lake Florida	0.012	NA	Double no distance, MRDS	0.960
Little Birch Lake	24.465	9.420	quads, ratio	1.000
Little Birch Lake	10.085	2.899	Double no distance, ratio	1.000
Little Birch Lake	11.721	0.984	Double no distance, multiPois	0.643
Little Birch Lake	10.851	NA	Double no distance, MRDS	0.929