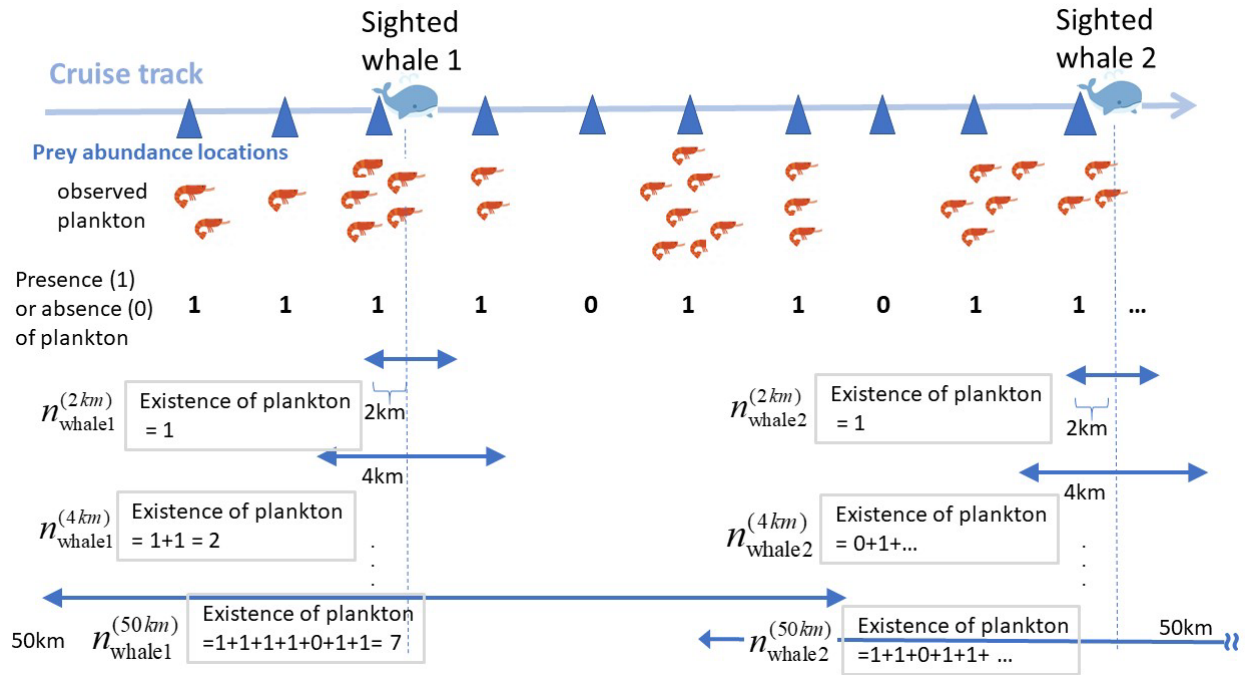


Text1:

Derivation of proportion of spatial overlap between whale and prey and test of whether any spatial overlap of whales and prey occurred



One-dimensional directional distances spanning 2, 4, 6, ..., 50 km are taken from the whale-sighting position, e.g. sighted whales 1 and 2 as seen in the above figure. Within the distances spanned, we count the number of occurrences of prey presence (1 if present, 0 if absent). Assuming that the total number of sighted whale positions is N over the four years (e.g. $N = 40$ for minke whales), the counted number for a prey's presence is given by

$$n_{\text{whale1}}^{(j\text{km})}, n_{\text{whale2}}^{(j\text{km})}, \dots, n_{\text{whaleN}}^{(j\text{km})},$$

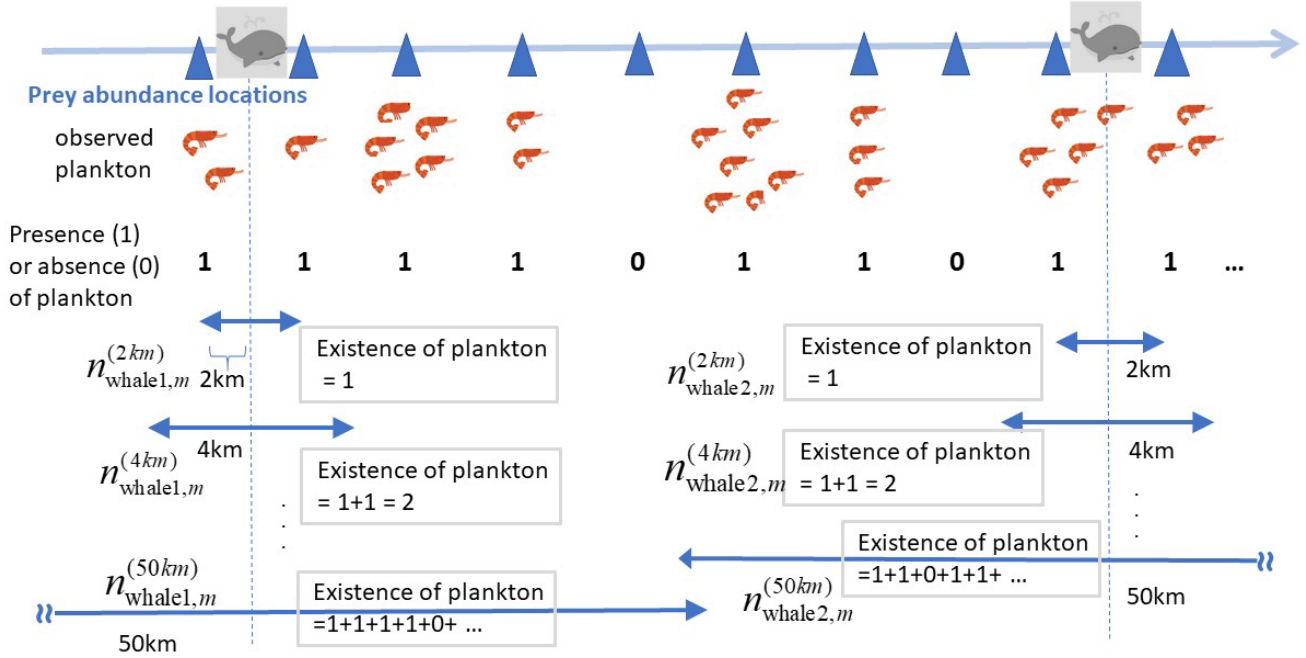
where j indicates span and $j = 2, 4, \dots, 50$ km. The proportion of distribution overlap with a prey species for a j -km span is given by

$$p_{\text{a prey}} = \sum_{l=1}^N n_{\text{whale } l}^{(j\text{km})} / N.$$

In order to test whether any spatial overlap of whales and prey species occurred, the following procedure is performed:

1. Whale sighting locations are randomly re-assigned on the cruise track (e.g. different locations are assigned to the whales in the next figure);

Simulation: based on randomly re-assigned sighting locations (m times)



2. Presence-absence observations of prey for 2-, 4-, ..., 50-km spans are counted as explained above;

3. By iterating 1 and 2 for 200 times, total counted number for a prey is calculated by

$$\sum_{m=1}^{200} \sum_{l=1}^N n_{\text{whale } l, m}^{(jkm)},$$

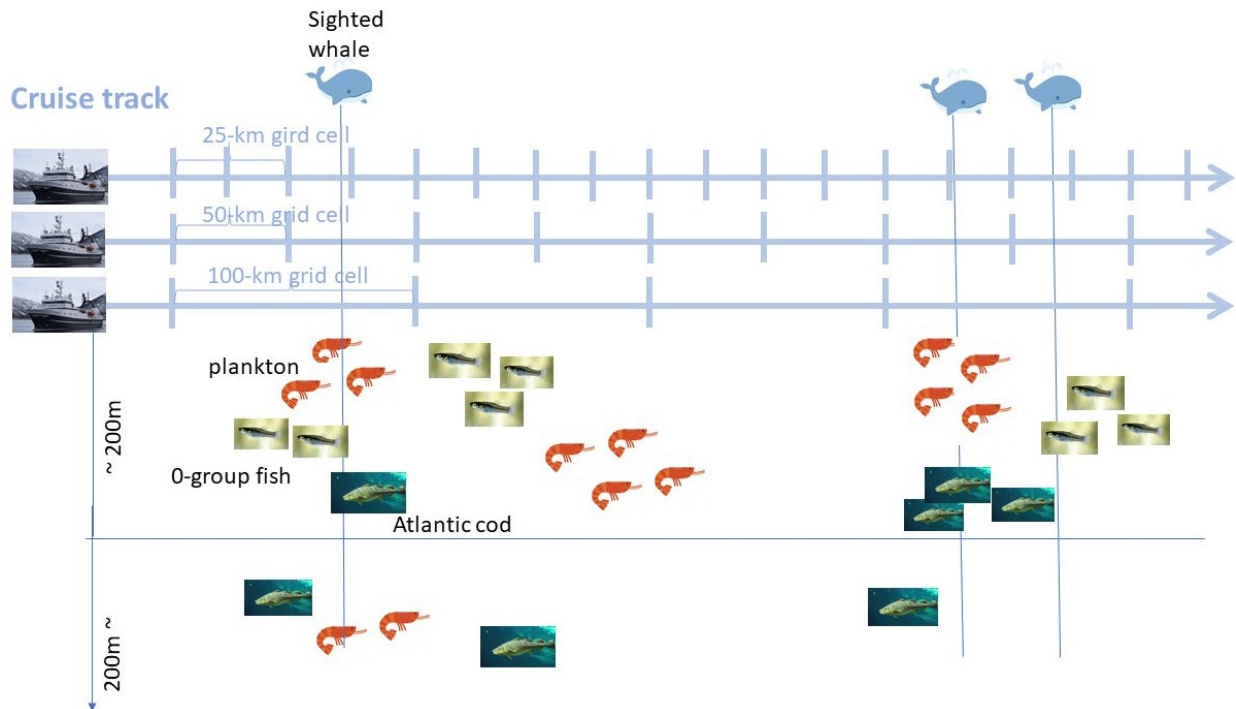
where m is number of iterations;

4. The proportion of distribution overlap between random re-assigned whales and a prey for a j -km span is given by

$$p_{\text{a prey, simulated}} = \sum_{m=1}^{200} \sum_{l=1}^N n_{\text{whale } l, m}^{(jkm)} / 200N; \text{ and}$$

5. Finally, the difference between $p_{\text{a prey}}$ given by the data and $p_{\text{a prey, simulated}}$ given by the simulation is assessed by a *two-sided probability* test of success, using function *prop.test* of R package *stats* (version 3.5.1. 2018).

Text2:



Analyses for test of independence between whales and prey and among preys, as well as logistic regression analysis, are applied to the data aggregated to 25-, 50-, and 100-km grid cells along the cruise track. In the *Chi-square* test for independence, the estimated prey concentrations are replaced by presence (=1) or absence (=0) for two depth categories (below/above 200 m), while real estimates of prey species for these two depth categories are compared to whale presence in the logistic regression analysis. The data for each grid cell are summarized in Supplementary Table.