Methods text for mapping Washington Dungeness crab vertical lines using logbook data

For the purposes of determining risk of entanglement for whales and turtles, we wish to quantify spatiotemporal variation in Dungeness crab fishing effort. The relevant metric for risk in this context is the density of vertical lines connecting crab traps to surface buoys, or tra density (traps km-2). For their draft Conservation Plan, WDFW desired this information in 15-day intervals at as fine a spatial grain as possible.

The most comprehensive source of information with which to estimate trap density is logbook data, which is required to be collected by all permitted participants in the crab fishery. Raw logbook data include the start and end locations of a ‘string’ of traps on the date they were set and the total number of traps used on each string. We analyzed these data in three steps. First, we assigned traps to specific points along each string by assuming they were evenly spaced along a line defined by the start and end points of each string. Using NGDC composite bathymetry to provide a depth for each point, we excluded any traps on land (depth>0) or in greater than 100m water. Second, we assigned each trap to a cell on a custom-developed 5km x 5km vector grid.

In the third and final step, we calculated the time-averaged density of traps in each cell during each 15-d interval. The simplest approach to estimating trap density would be to sum the total number of traps in each grid cell across all sets, vessels, and days during each interval. However, because fishery participants are not required to report the moving or removal of traps, and traps themselves are not individually-identifiable or labeled in the logbooks, this simple summation could lead to double-counting of traps (e.g., of traps that were set at the beginning of the interval, retrieved to obtain catch, and then replaced in the same or different location). To avoid double-counting, we first averaged the number of traps set in each grid cell by each vessel during each interval, and then summed these mean trap densities across all vessels. We recognize that this approach could either over- or under- estimate trap density. Because it assumes that each set provides an independent estimate of the number of traps in a cell during the entire interval, this approach could overestimate trap density if traps from a set early in the interval were removed for the remainder of the interval. Because there is no requirement to report sets that do not obtain catch, this approach could also underestimate trap density. However, we felt that the time-averaged trap density approach we employed was the best given the limitations inherent to the data.