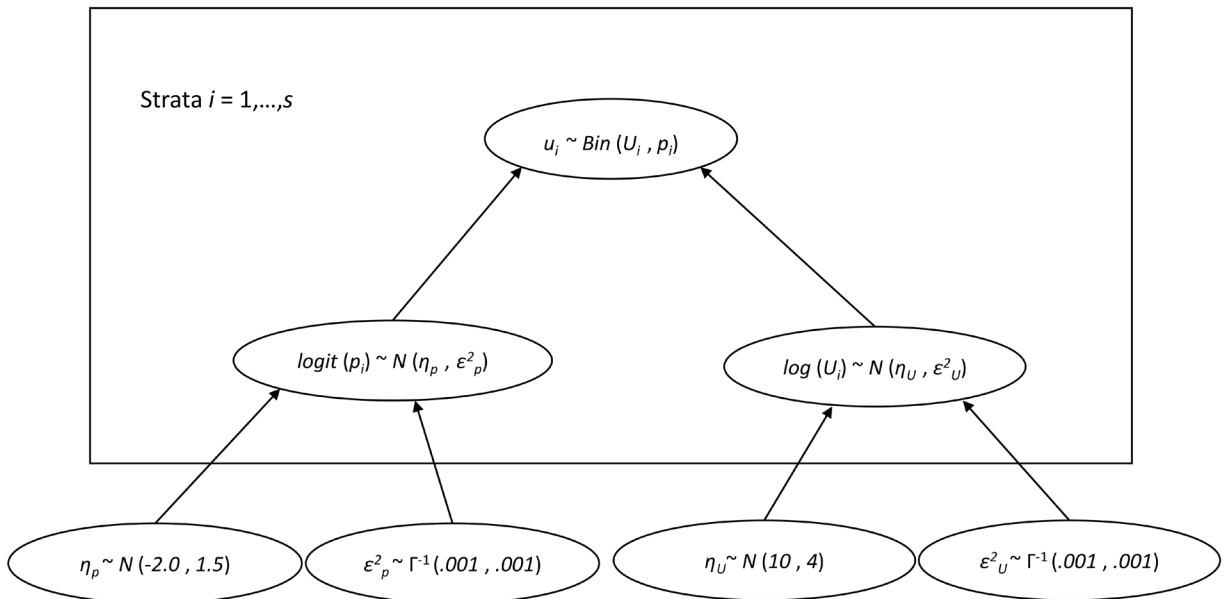


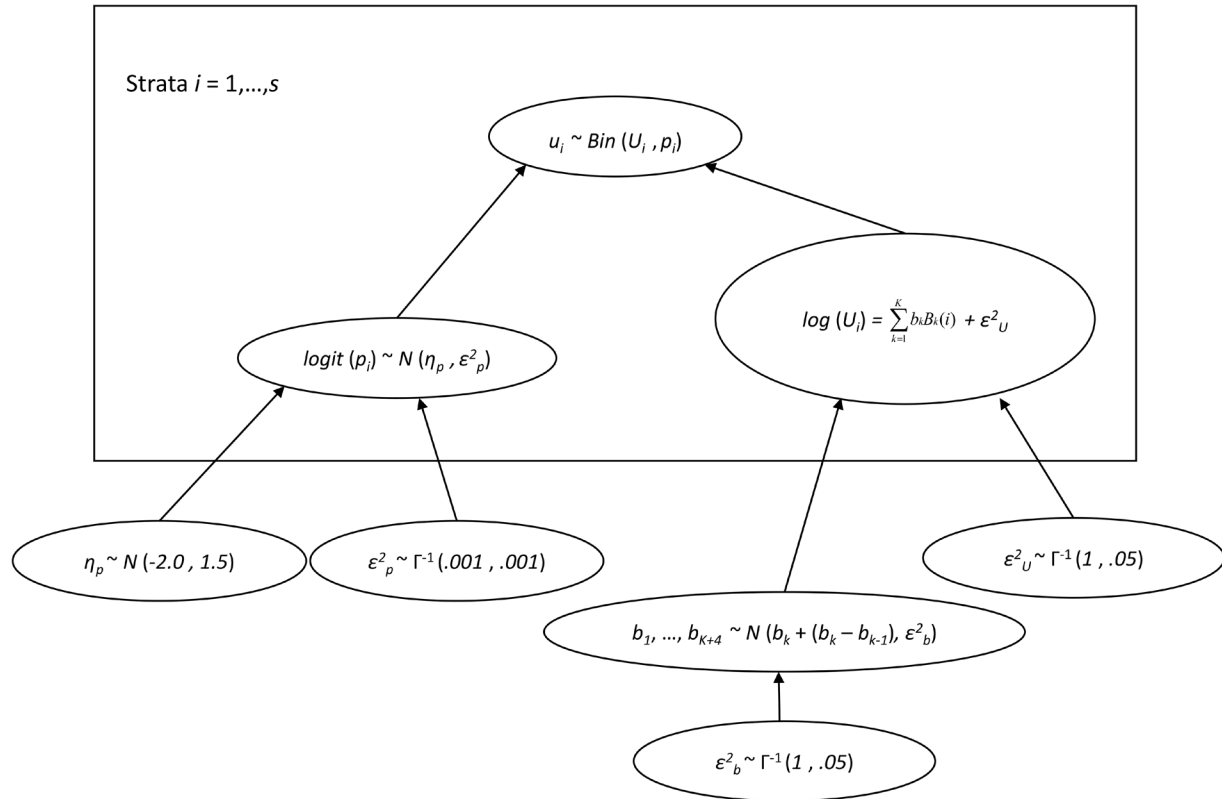
**Supplementary Figure 1**

Standard directed acyclic graph illustrating the structure of the  $M_{PS}$  model that uses pooled capture probability ( $p$ ) and simple marked abundance ( $U$ ) parameters to estimate abundance. Rectangular frames represent structures that are repeated over temporal strata or years. Ellipses are nodes that are stochastic, and diamonds represent nodes that are conditional on their parents.



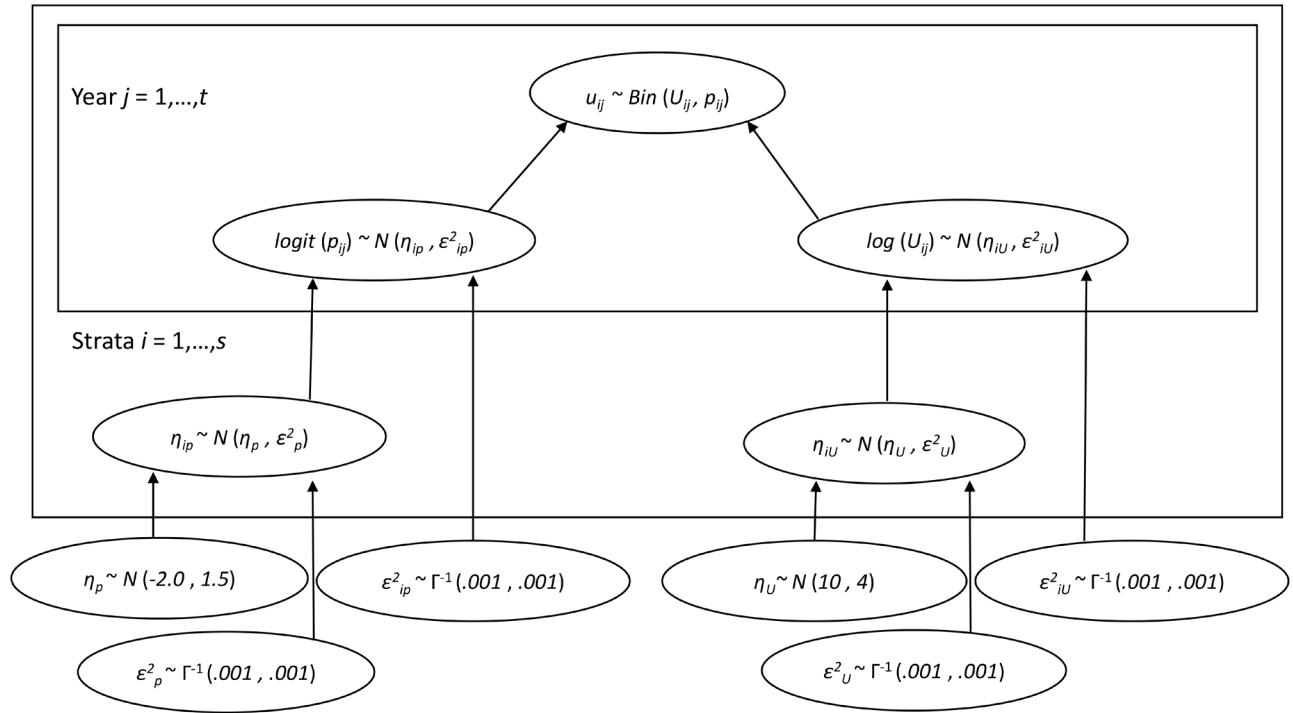
**Supplementary Figure 2**

Directed acyclic graph illustrating the hierarchical within-year parameter structure of the  $M_{HW}$  model. Rectangular frames represent structures that are repeated over temporal strata or years. Ellipses are nodes that are stochastic, and diamonds represent nodes that are conditional on their parents. Parameters include capture probability ( $p$ ) and abundance ( $U$ ).



**Supplementary Figure 3**

Directed acyclic graph illustrating the structure of the  $M_{\text{SPLINE}}$  model, which uses the P-spline hierarchical prior for unmarked abundance. Knot points are spaced evenly across temporal strata at 4-strata intervals, and  $b_1$  and  $b_2$  were assigned improper flat priors. Rectangular frames represent structures that are repeated over temporal strata or years. Ellipses are nodes that are stochastic, and diamonds represent nodes that are conditional on their parents. Parameters include capture probability ( $\rho$ ) and abundance ( $U$ ).



**Supplementary Figure 4**

Directed acyclic graph illustrating the hierarchical within-year parameter structure of the  $M_{HB}$  model. Rectangular frames represent structures that are repeated over temporal strata or years. Ellipses are nodes that are stochastic, and diamonds represent nodes that are conditional on their parents. Parameters include capture probability ( $p$ ) and abundance ( $U$ ).