Supporting Information. Sex-biased survival contributes to population decline in a long-lived seabird, the Magellanic penguin. N. J. Gownaris and P. D. Boersma. *Ecological Applications.* 2018.

Appendix S3: Supplementary Figures

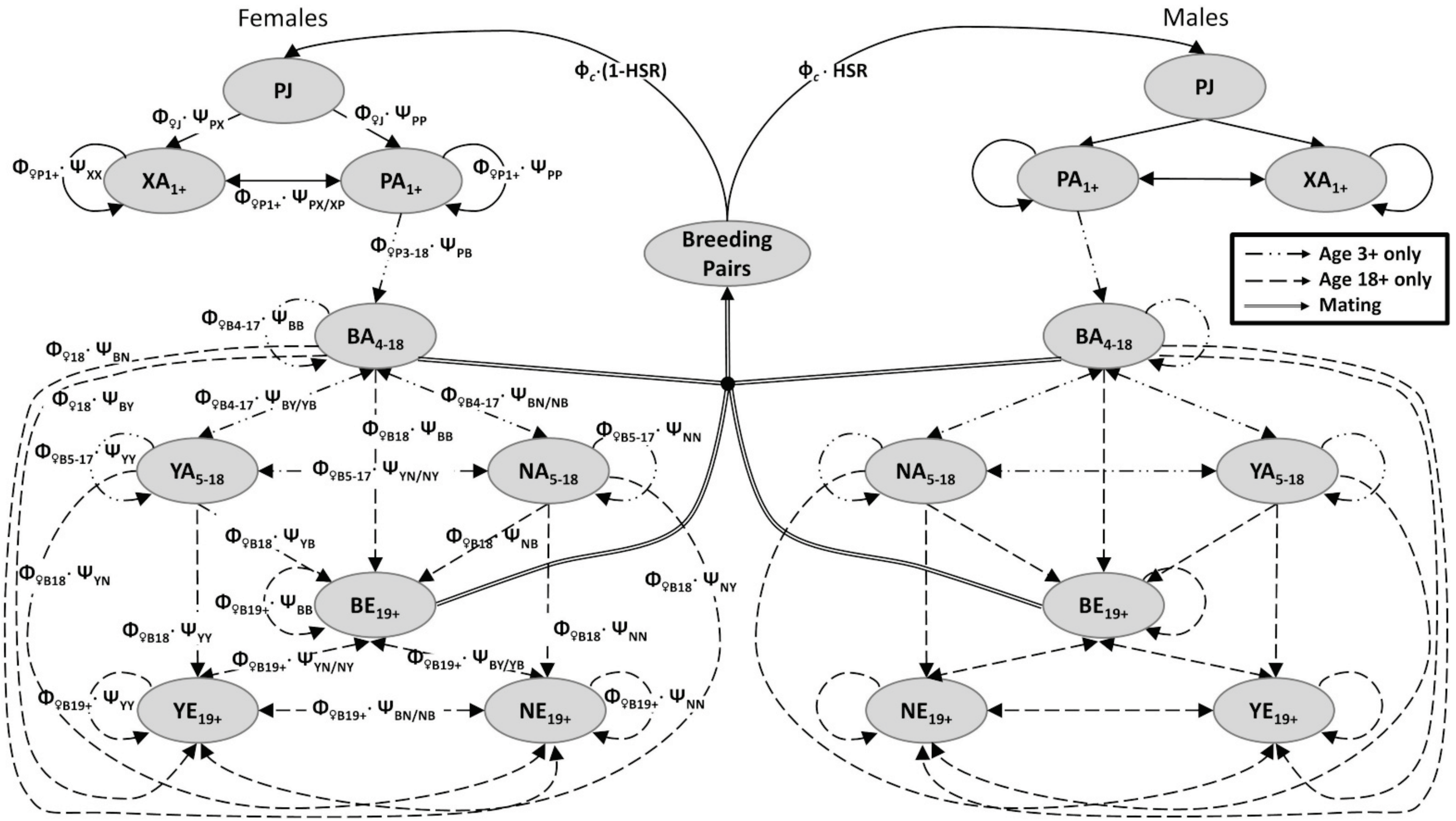

Figure S1: Life cycle diagram showing possible state transitions for female and male Magellanic penguins at Punta Tombo, Argentina. For clarity, transition and survival parameters are not shown for males. Letters represent the breeding state and age class of each population subset and subscript numbers refer to age. Survival rates marked as "B" ($\Phi_{♀B}$) are relevant to breeders, observable non-breeders, and unobservable non-breeders and survival rates marked as "P" ($\Phi_{♀P}$) are relevant to observable pre-breeders and unobservable pre-breeders. Survival rates are age-, year-, and sex-specific. Transition rates are state-specific but not age-, year-, or sex-specific. All fledglings are pre-breeders (P) and survive at the juvenile (J; fledging to age one) survival rate ($\Phi_{♀J}$) then can transition (Ψ) to the observable adult pre-breeding age class (PA) or the unobservable adult pre-breeding age class (XA). Surviving pre-breeders ($\Phi_{♀P}$) can transition (Ψ_{PB}) to the adult breeding state (BA) starting at age three and must be observable the year before they breed. Adults may remain pre-breeders if they do not acquire a mate. Once individuals begin breeding, they may transition among breeder (BA), observable non-breeder (NA), and unobservable non-breeder (YA) states. Individuals aged 18 transition to elder breeder (BE), observable elder non-breeder (NE), or unobservable elder non-breeder (YE) states. The mating process is based on the female dominance mating function, where the number of breeding pairs is constrained by the number of breeding-aged females. Breeding pairs add to the pool of male and female fledglings based on reproductive success and the hatching sex ratio (HSR), assumed to be 0.50.

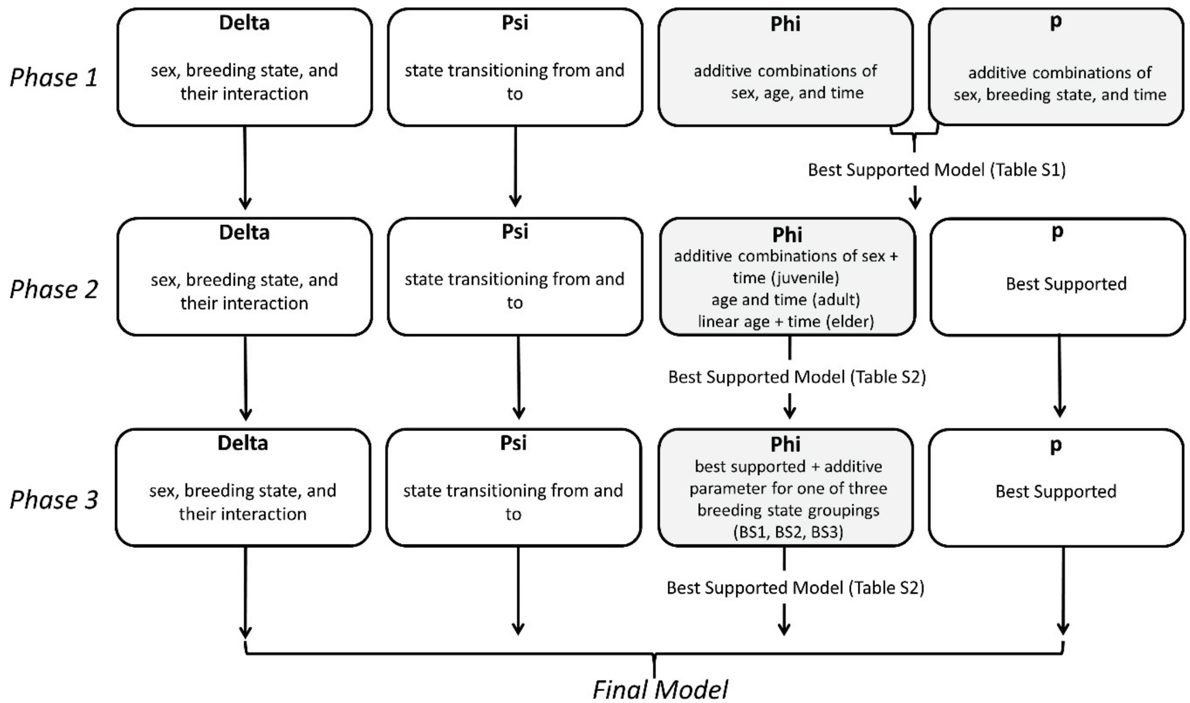

Figure S2: Workflow diagram of the phases of mark-recapture model selection used. Grey boxes indicate the parameters for alternative specification tested during each phase. Formulae for delta, the assignment certainty parameter, and psi, the state transition parameter, were held constant throughout model selection. The best supported model (lowest QAIC) resulting from each phase was used as the input model during the next phase of testing. In the third phase of model selection we tested for variation in survival across breeding states based on the following three groups: 1) BS1 grouped all individuals not breeding (observable and unobservable pre-breeders and non-breeders) separately from all individuals breeding (breeders), 2) BS2 grouped all individuals that had not yet successfully bred (observable and unobservable pre-breeders) separately from those that had begun breeding (breeders and unobservable and observable non-breeders), 3) BS3 had three separate groups: individuals that had not yet bred (unobservable and observable pre-breeders), individuals that were breeders (breeders), and individuals that had begun breeding but were not breeding in a given year (unobservable and observable non-breeders).

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Figure S3: Structure of the population matrix model for the population projection and perturbation analyses. Survival rates were either time-invariant or time-specific, depending on the analysis, and were based on the mark-recapture analysis conducted for Punta Tombo. F refers to fecundity based on the female dominance mating function, ϕ refers to survival, HSR refers to hatching sex ratio (the proportion of hatchlings that are male), and N refers to the number of individuals of each age and sex. Survival rates are sex-specific but, in place of age-specific rates, rates are averaged and used for all age classes within the following groups: juvenile (J; fledging-1), pre-breeder (PA: 1-5 for females, 1-6 for males), breeding adult (BA; 6 or 7-18), and elder breeder (BE; ≥19).

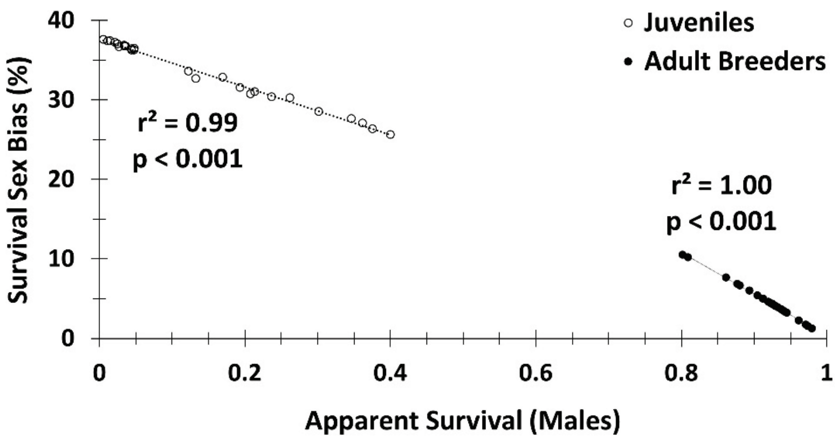

Figure S4: The sex bias in apparent survival of juvenile and breeding adult Magellanic penguins at Punta Tombo, Argentina was greatest when apparent survival was lowest. The survival sex bias was measured as the percent difference between female and male survival and is in reference to male survival, which is higher than female survival.

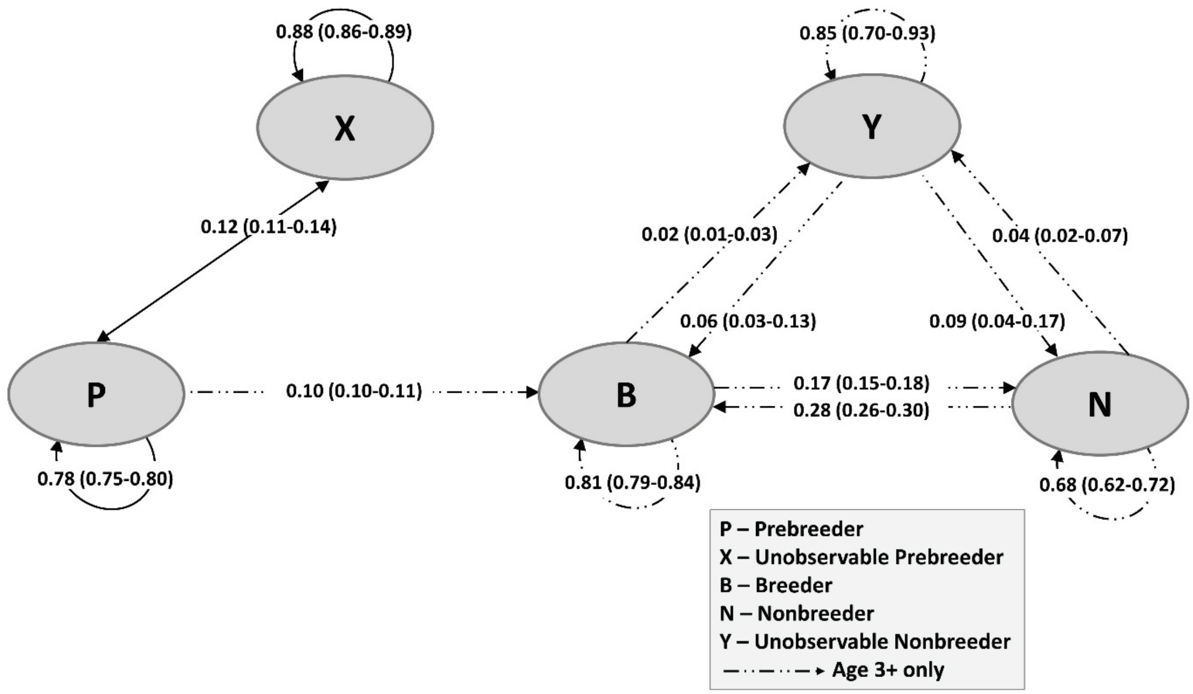

Figure S5: Transition probability estimates resulting from the best-supported mark-recapture model in this study. Pre-breeding and non-breeding Magellanic penguins sometimes undergo temporary emigration, so determining unbiased survival estimates must consider breeding states with a zero probability of recapture (i.e. unobservable states X and Y). The transition rates are invariant of age, sex, or time and the confidence intervals of the rates are in parentheses. Pre-breeders must be observable the year before they breed and, once they reach breeding age, have a 10% annual probability of becoming breeders. Breeders and non-breeders are likely to stay in their current state the following year. Individuals in unobservable states have a low probability of transitioning to an observable state.