SIMULATION ANALYSIS OF A SPATIALLY EXPLICIT TAG-INTEGRATED CATCH-AT-AGE MODEL THAT ESTIMATES NATURAL MORTALITY AND REPORTING RATE AND APPLICATION TO LAKE ERIE WALLEYE

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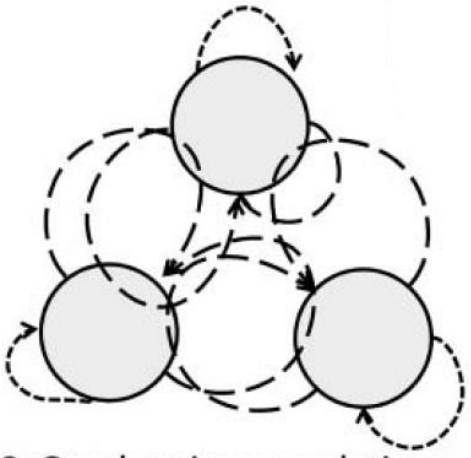
INTEGRATED TAGGING AND CATCH AT AGE ANALYSIS (ITCAAN) MODELS

- Spatially explicit assessment model
- Estimates parameters for natural mortality (M) and Reporting Rate (RR) which are difficult to estimate with catch alone
  - Most analyses assume one or both known
  - Estimability of both parameters is unclear
- Assumptions regarding the movement of the fish
  - Population intermixing vs. natal homing

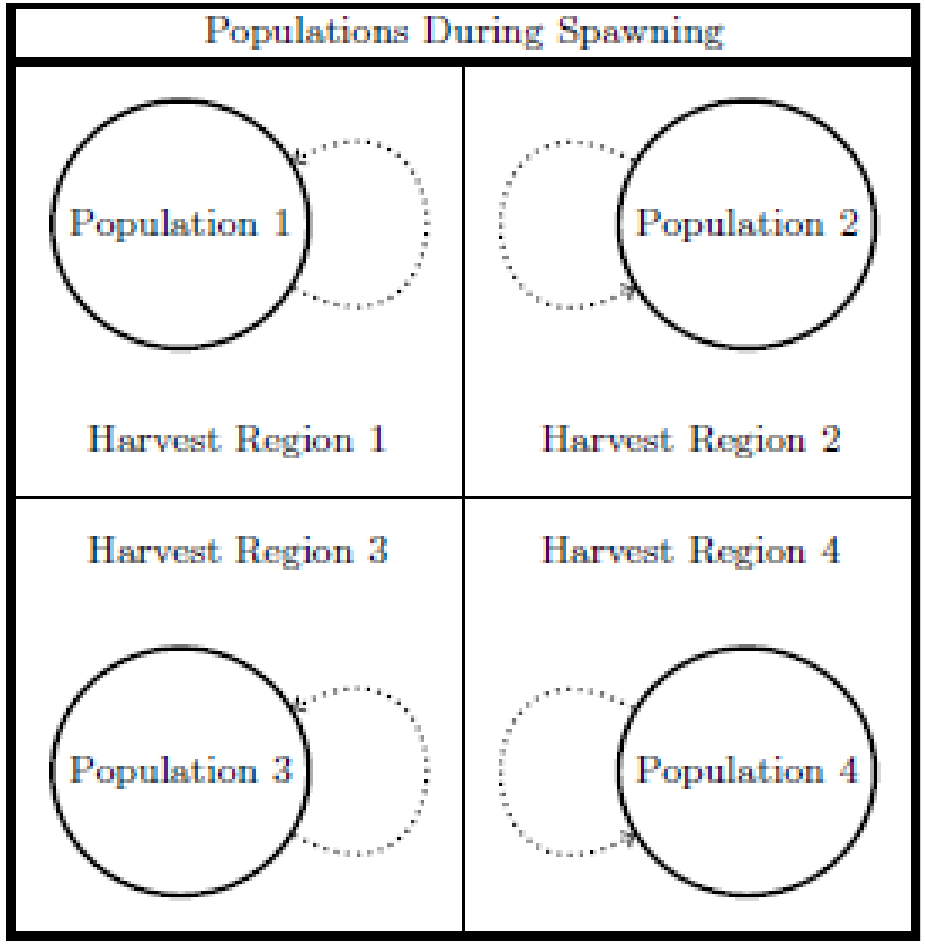


2. Overlapping populations with natal homing

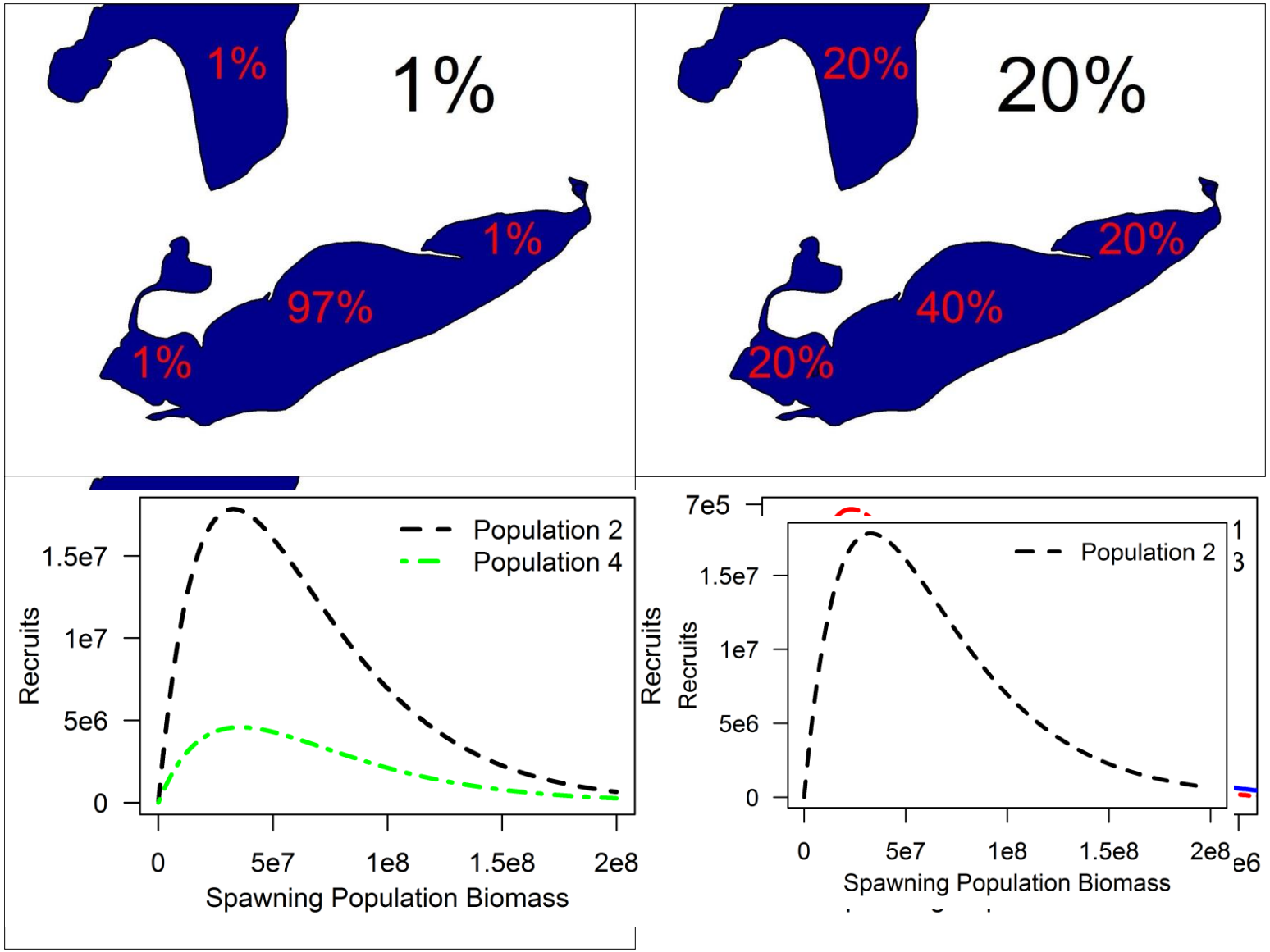
OBJECTIVES

1. Test influence that different movement rates and productivities have on abundance estimates for populations with natal homing
2. Evaluate the accuracy and precision of natural mortality and reporting rate estimates from an ITCAAN model
3. Apply an ITCAAN model to Lake Erie walleye

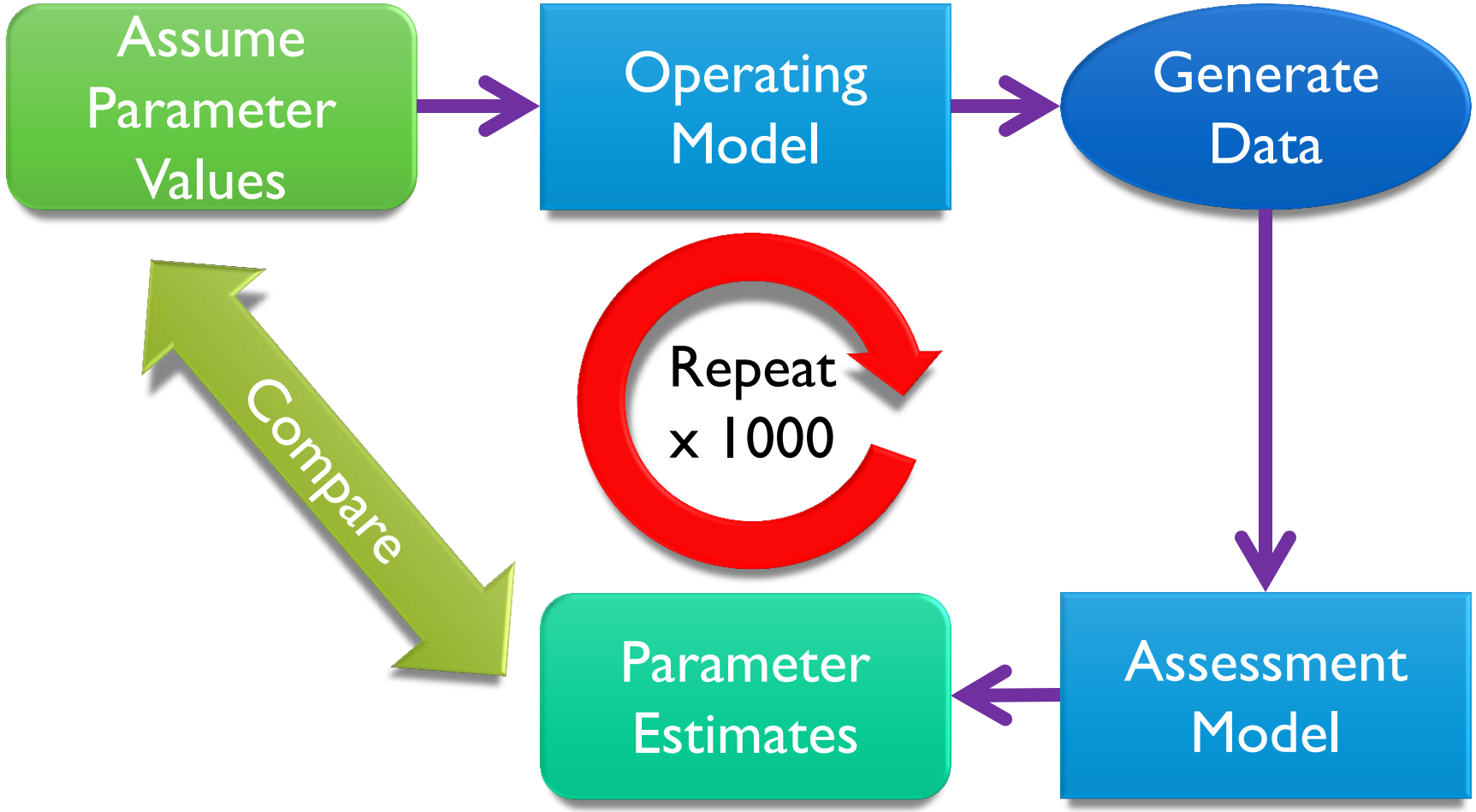
OPERATING MODEL



SCENARIOS PRESENTED



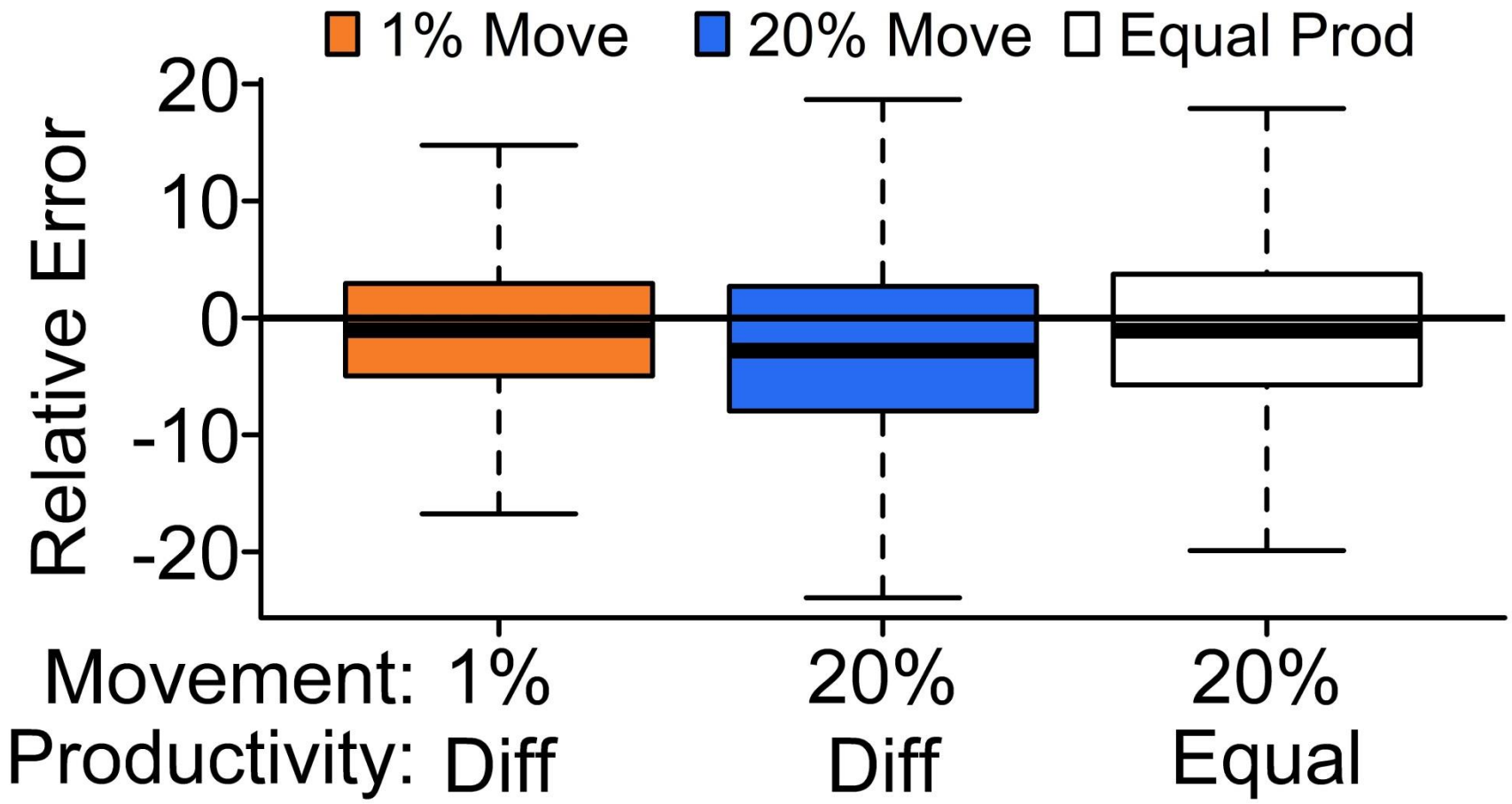
SIMULATION STUDY DESIGN



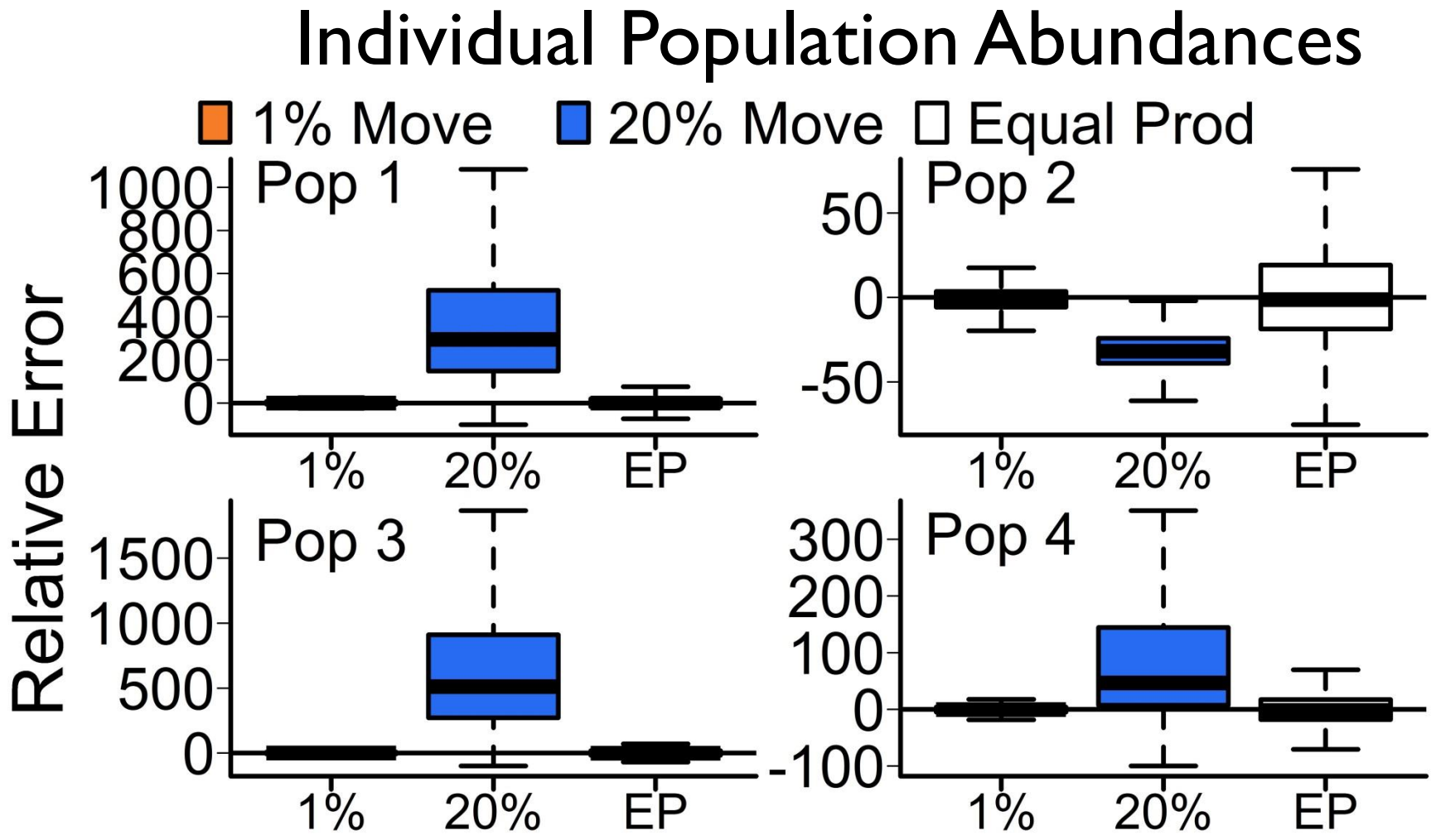
ABUNDANCE SUMMED ACROSS POPULATIONS WAS ACCURATE AND PRECISE FOR ALL SCENARIOS

Relative Error

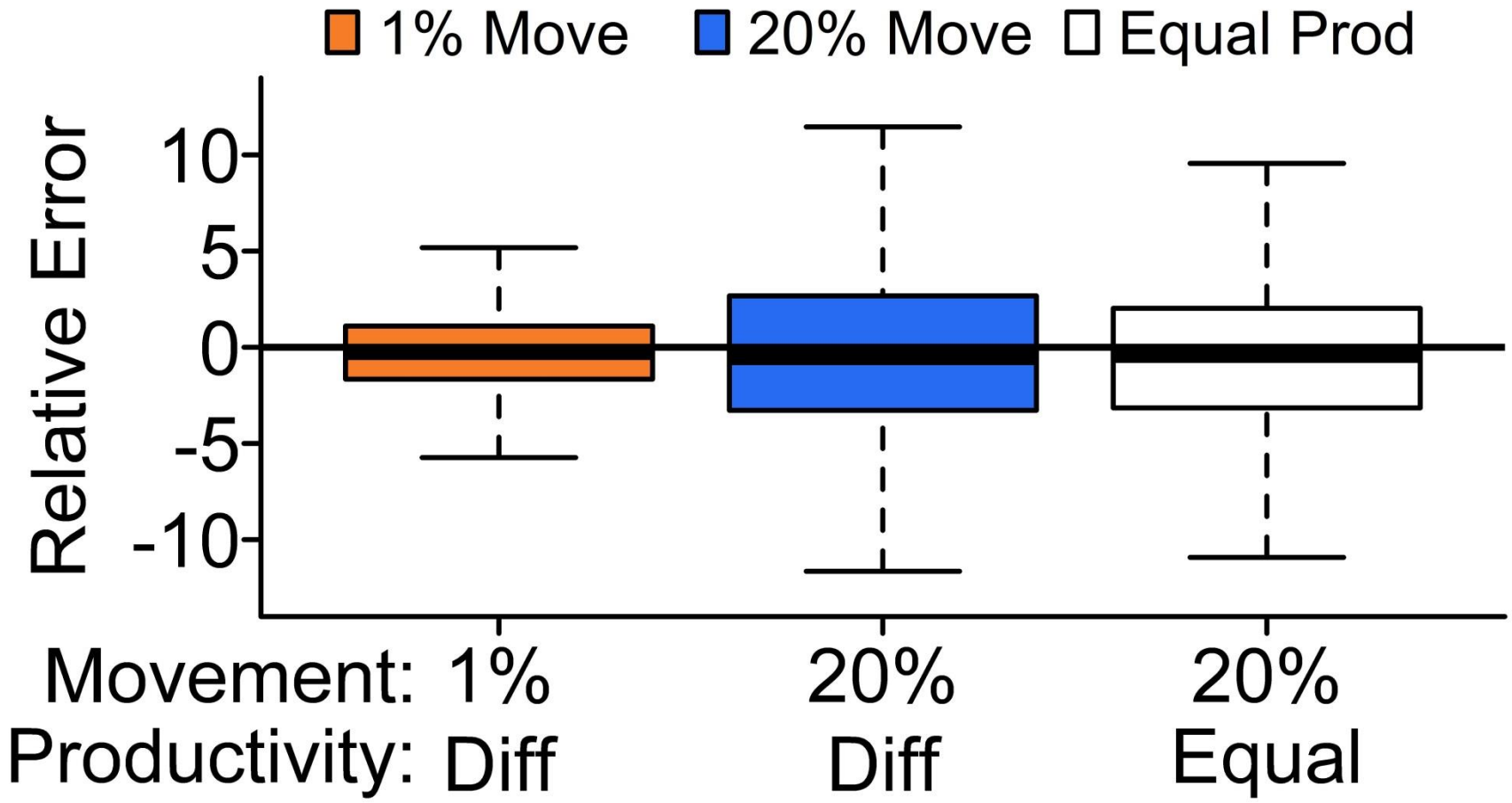
$$\text{Relative Error} = \frac{\text{Estimate - True}}{\text{System-Wide Abundance}} \times 100$$



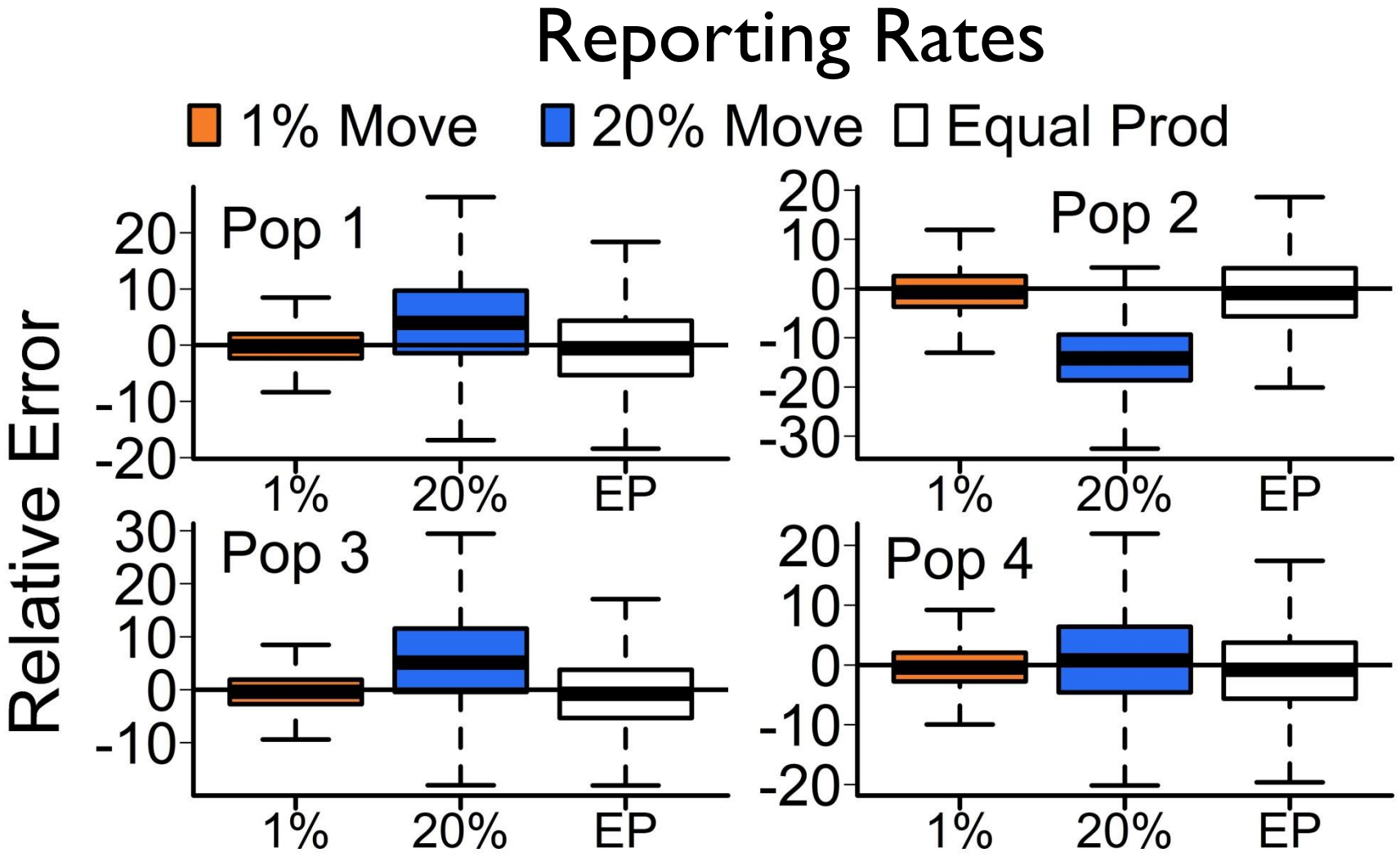
WITH HIGH MOVEMENT AND DIFFERENT PRODUCTIVITIES THE POPULATION ABUNDANCE ESTIMATES WERE BIASED



NATURAL MORTALITY ESTIMATION WAS ACCURATE AND PRECISE



REPORTING RATES WERE BIASED IN SOME REGIONS UNDER HIGH MOVEMENT AND DIFFERENT PRODUCTIVITIES

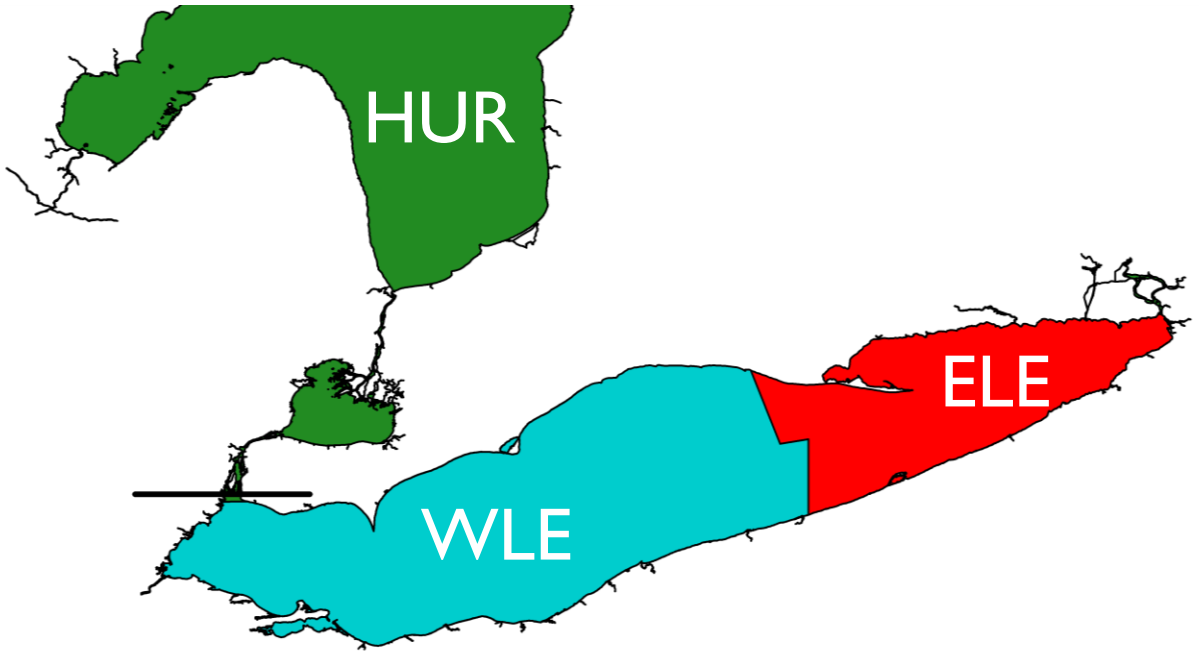


CONCLUSIONS

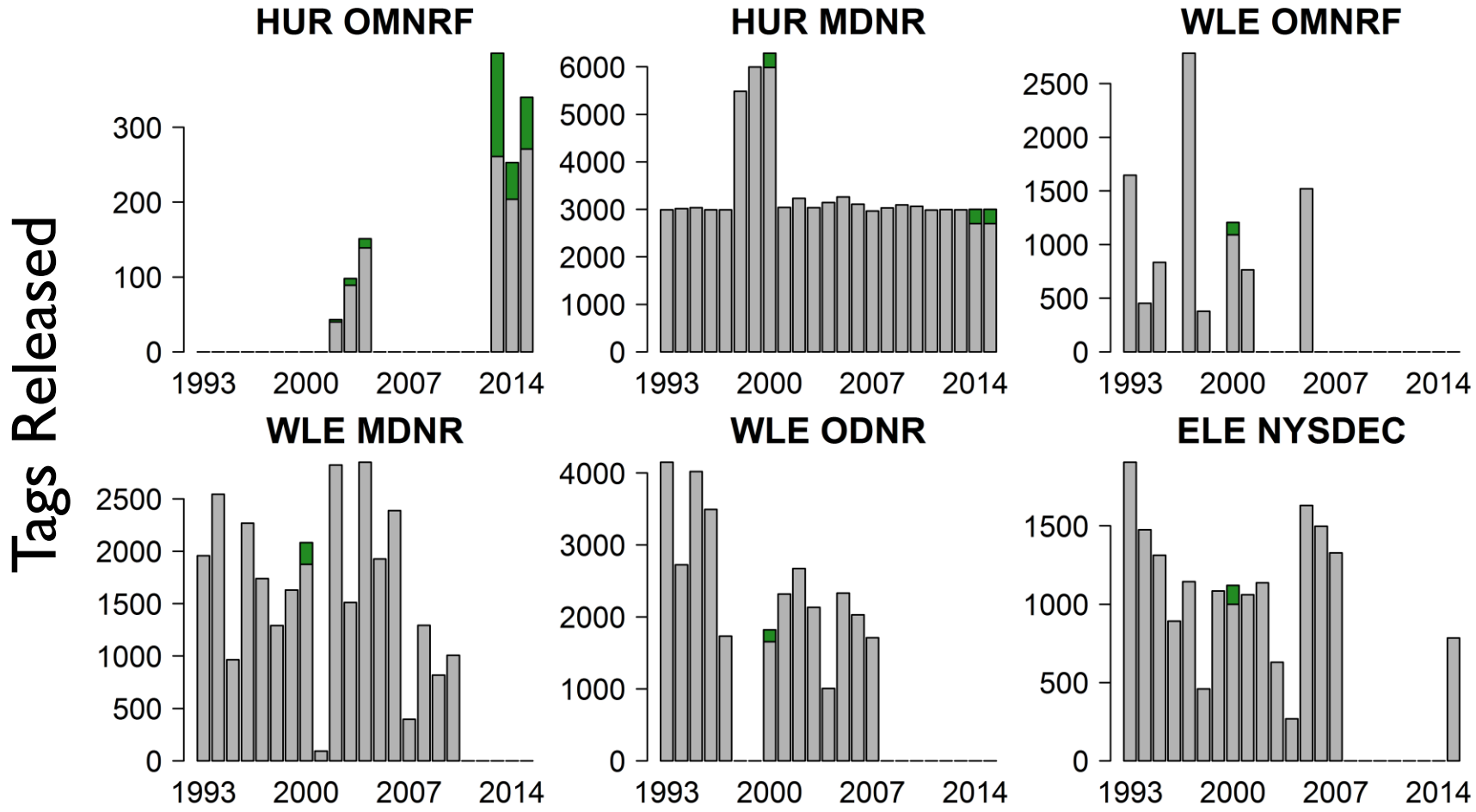
- High rates of movement with large differences in stock sizes are difficult to estimate
- Natural mortality is accurately estimated
- Reporting rates are estimable though maybe slightly biased at high movement rates
  - Additional simulations show high reward tag release can aid estimation, but do not fix bias entirely

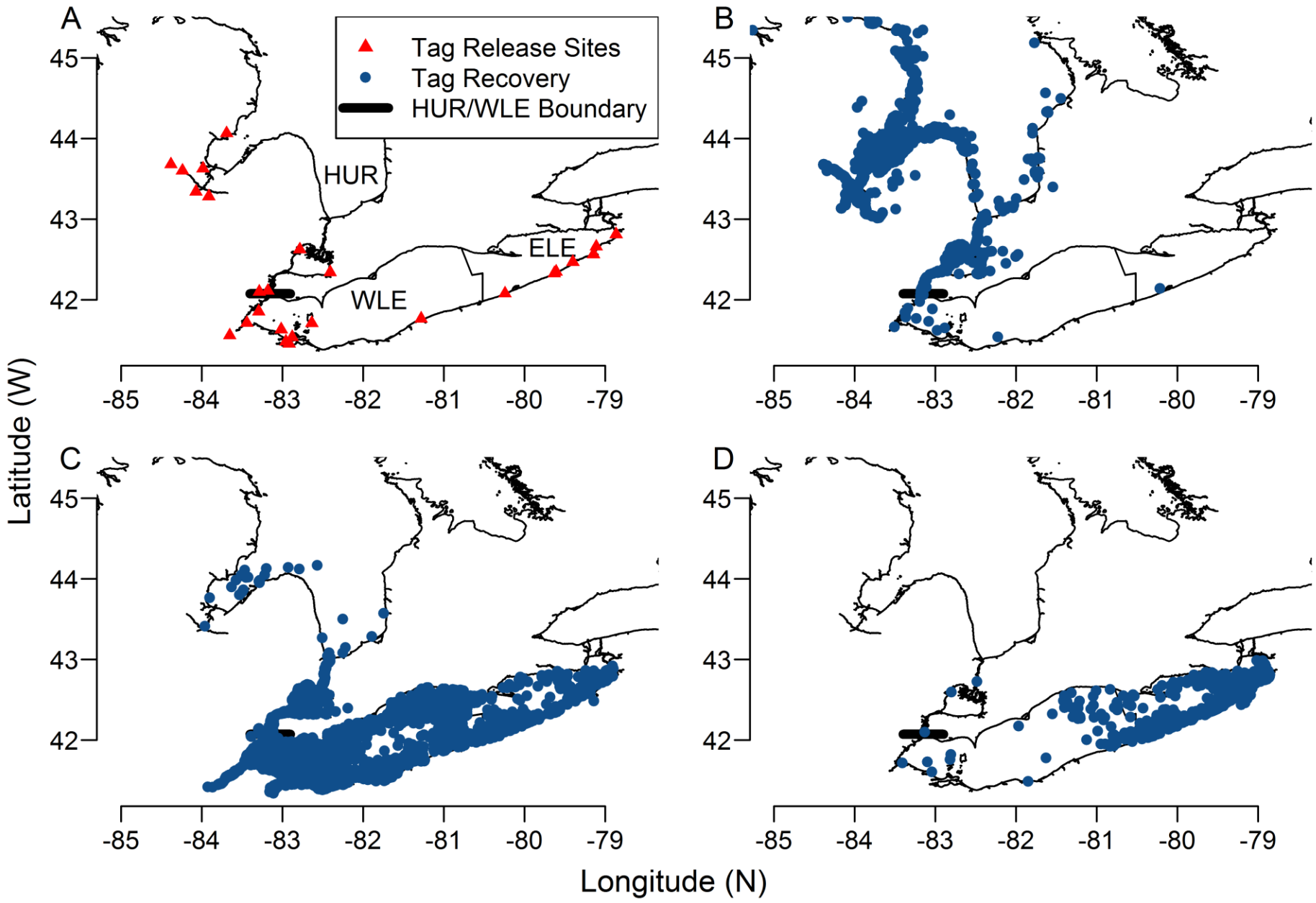
APPLICATION TO LAKE ERIE WALLEYE

- 3 region model
- 6 fishery independent surveys
- 12 fisheries
  - 4 recreational, 4 commercial, 1 bycatch and 3 tag recoveries only
- Display high rate of natal homing during spawning (assumed 100%)
- Regionally different reporting rates and natural mortality



NUMBER OF TAG RELEASES BY AGENCY





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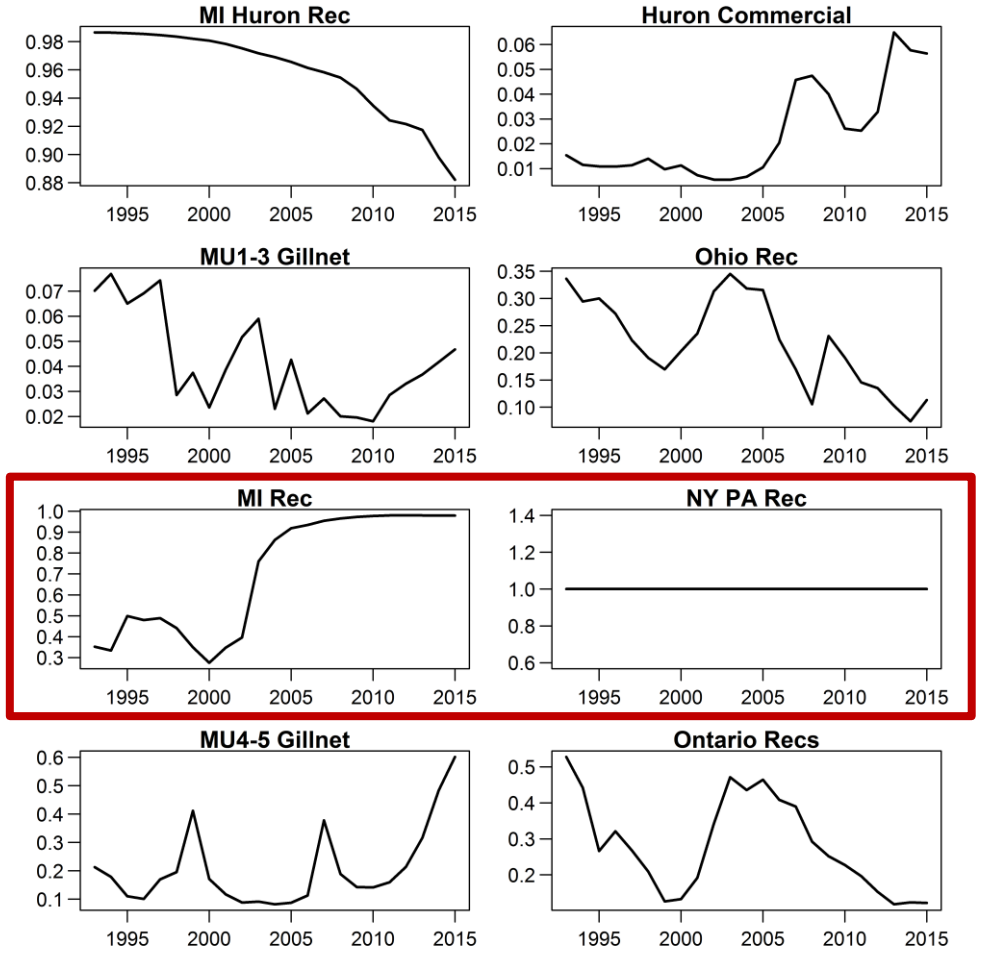
DIFFICULTIES ESTIMATING REPORTING RATES

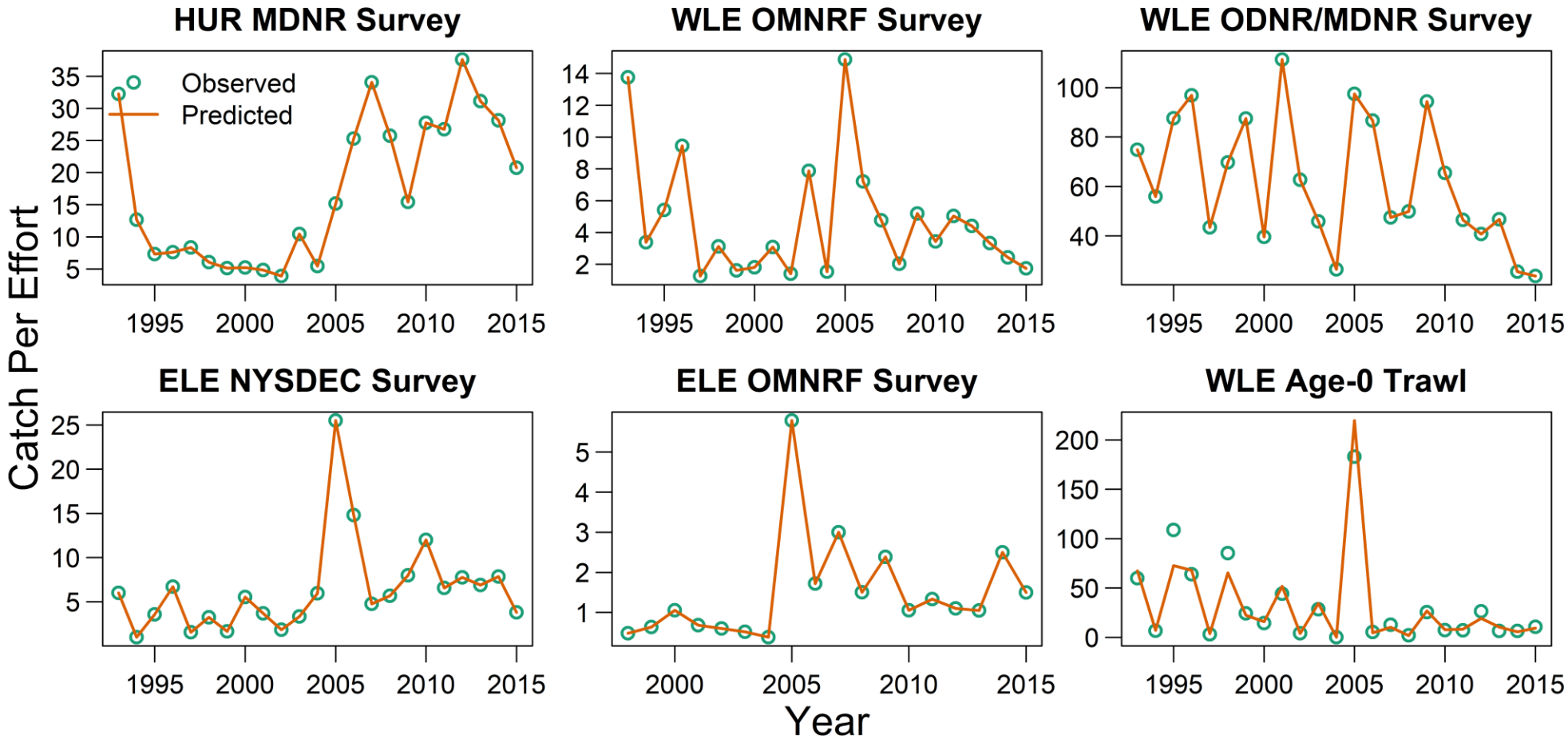
- Estimating annual RR for all fisheries resulted in suspect values
- Angler dynamics might influence reporting rate
- Combined all recreational fisheries into single RR (i.e. assume spatially constant RR)



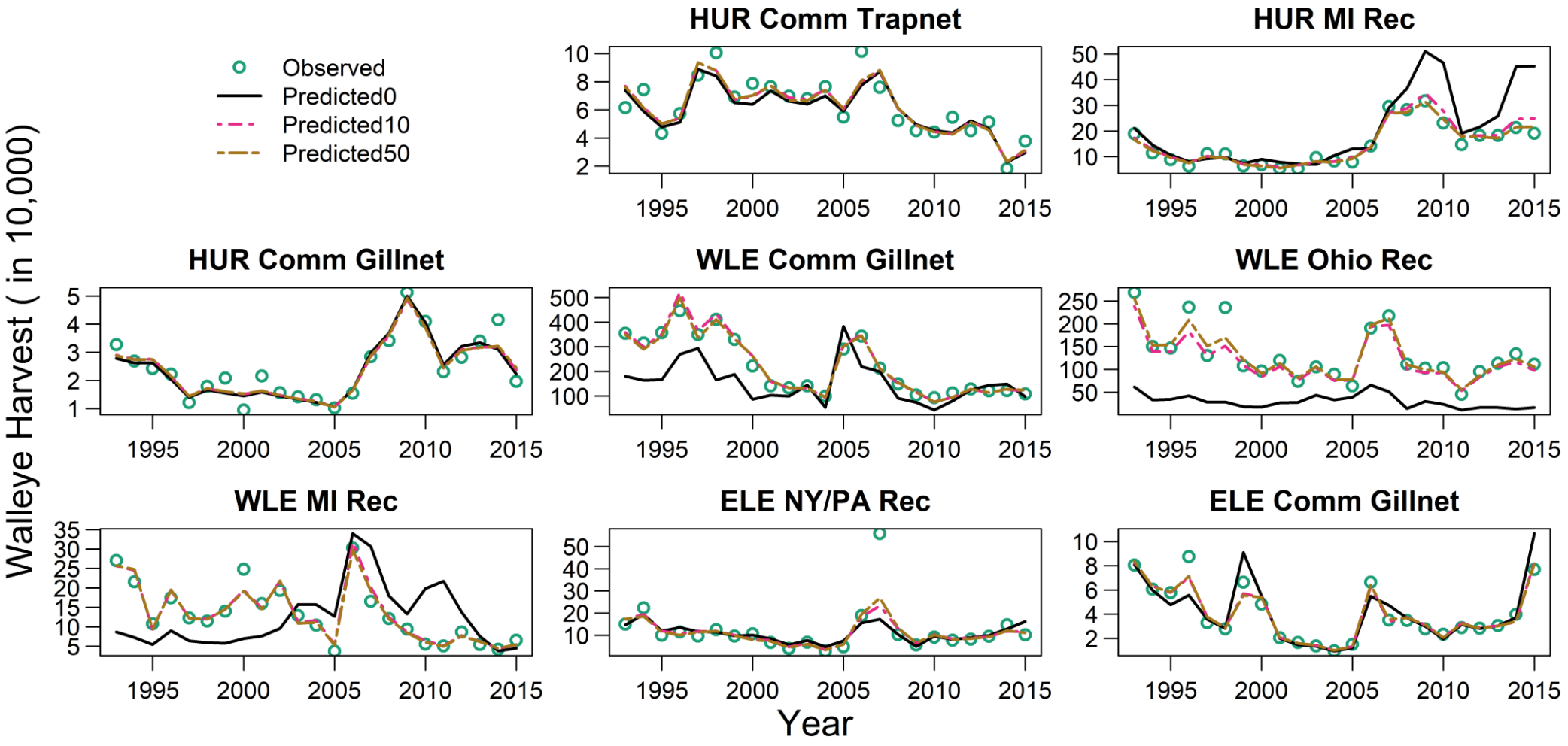
ITCAAN MODEL ASSUMPTIONS

- Estimate reporting rates: commercial fisheries independently and a single parameter for all recreational fisheries
- Estimate temporally constant regional natural mortalities
- Tag dynamics same as entire populations
- Tag shedding rate known (estimated from double tagged fish)
- Assessment and data are in number of walleye

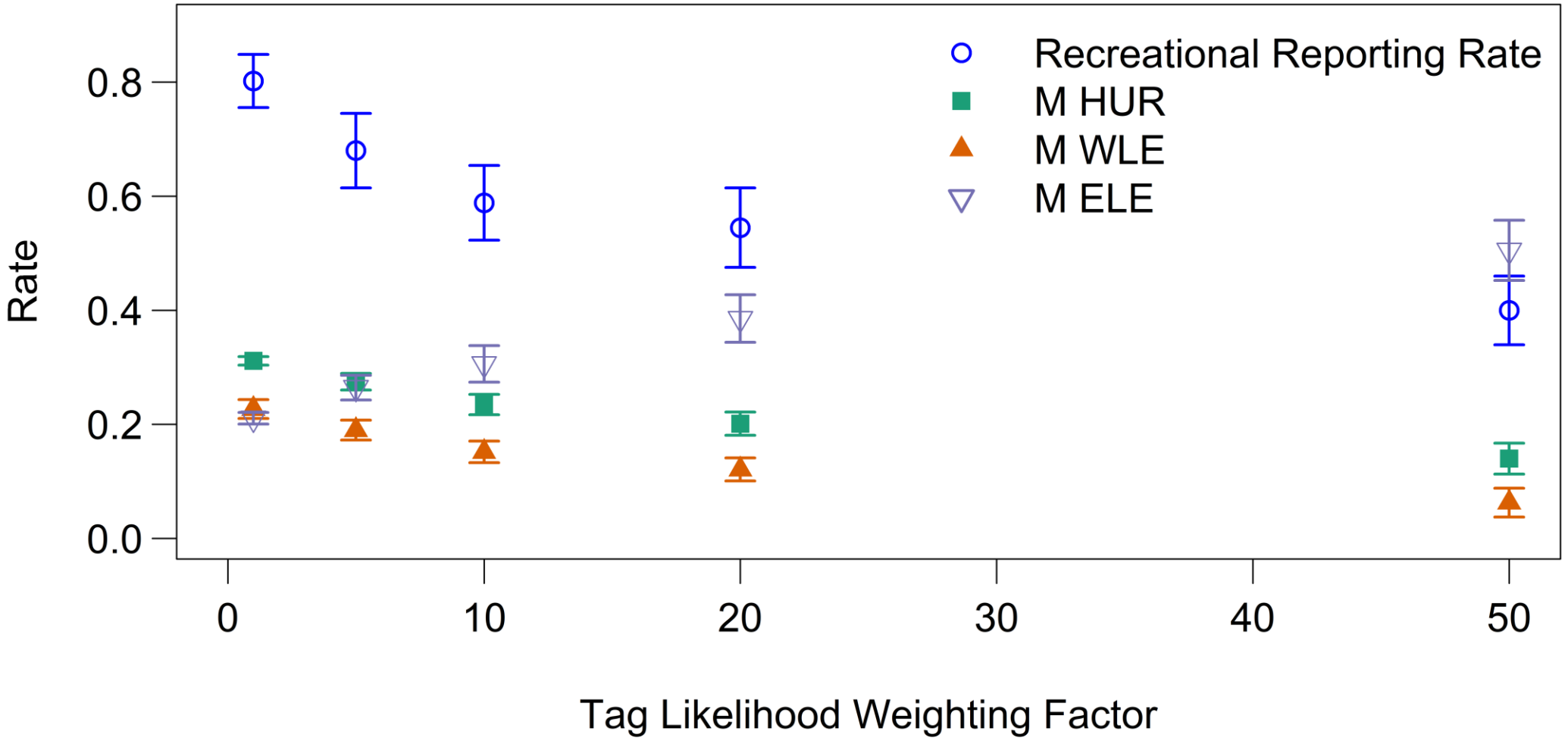
FIT TO SURVEY DATA



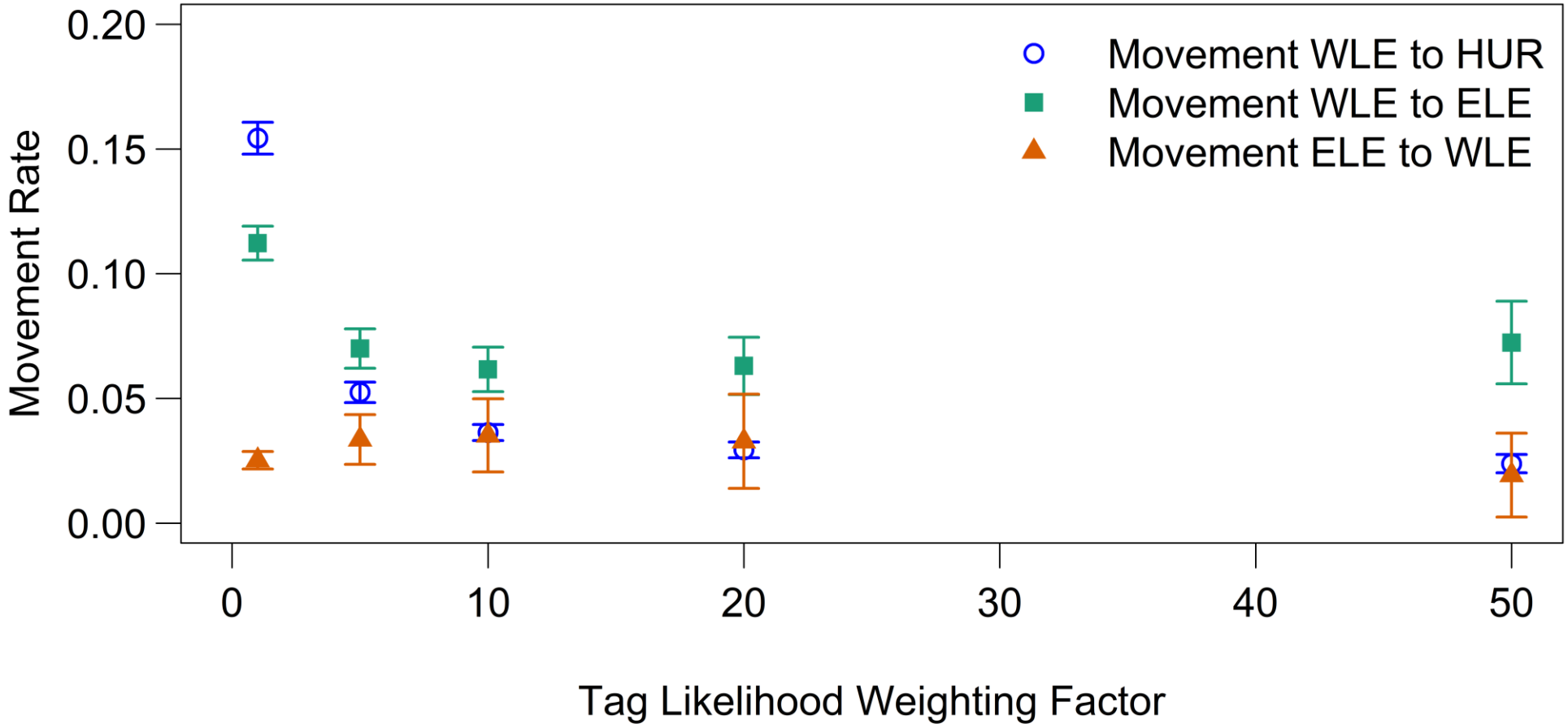
FIT TO CATCH DATA



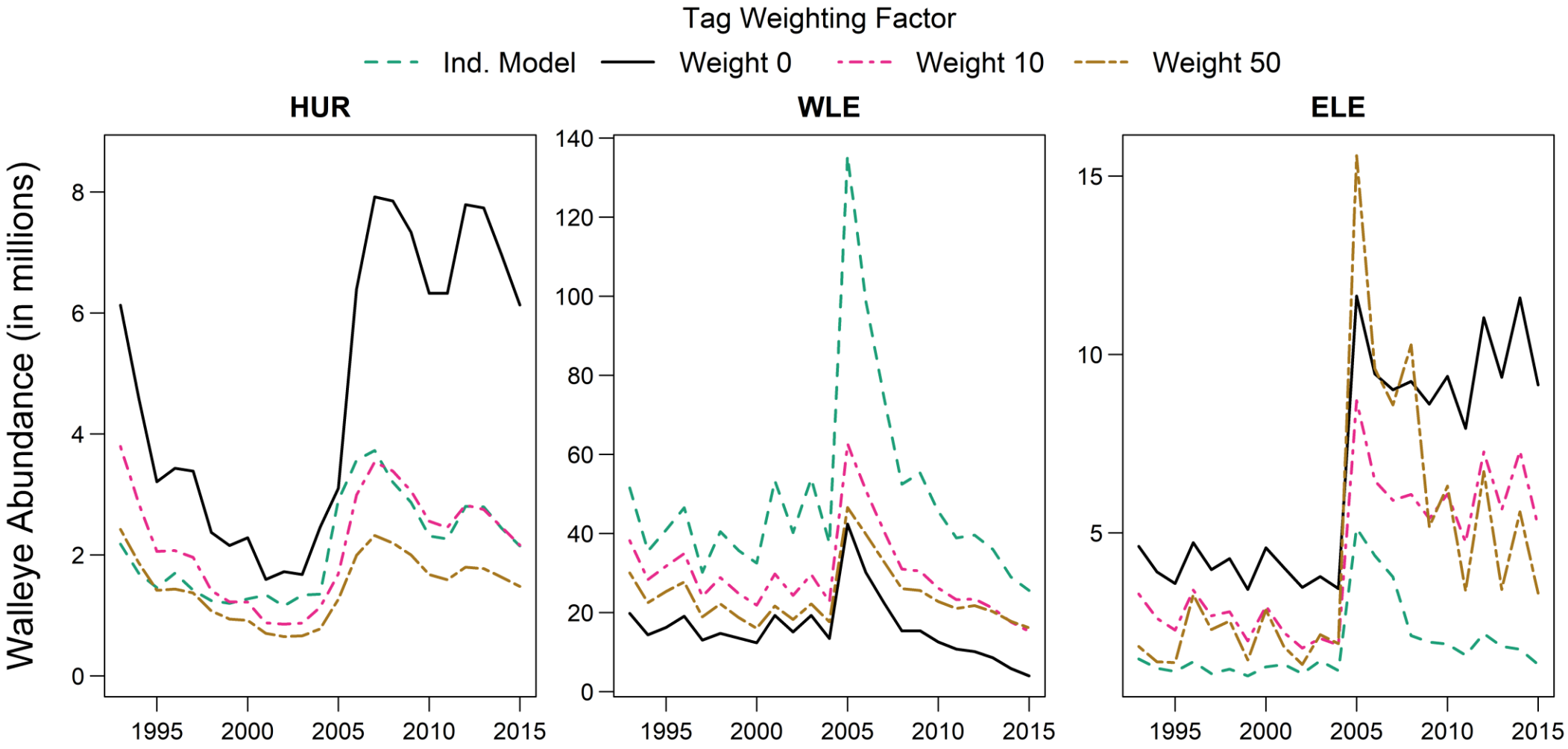
SENSITIVITY TO TAG-RECOVERY WEIGHTING



MOVEMENT RATES



REGIONAL ABUNDANCE ESTIMATES



CONCLUSIONS

- Abundance of ELE may be overestimated by ITCAAN model based on simulation results
  - ITCAAN can have biased estimates under large differences in population abundance and intermixing rates
- Natural mortality used by current assessment model in WLE of 0.32 may be too high
- Estimation of both natural mortality and reporting rate in an assessment is feasible but may require simplifying assumptions
- Tagging may not capture the dynamics of the entire population, especially in the western basin of Lake Erie

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QUESTIONS

- Is it better to have a reporting rate estimate at an upper bound or make an assumption of spatially constant reporting rates?
- What to do if the tagging data are not representative of the entire population?
- Weighting of tagging data, is there an optimum method?

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