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Optimal energy allocation to ovaries after spawning

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ABSTRACT

For iteroparous organisms in which fecundity is positively related to body size, a trade-off exists between allocation of energy to gonads, thus ensuring some reproductive output, and allocation to somatic growth, thus increasing potential fecundity in the future. This trade-off can influence several life-history patterns, including when, for organisms that grow after maturity, allocation to gonads begins following the previous reproductive event. White crappie *Pomoxis annularis*, a spring-spawning freshwater fish, began allocating energy to ovaries in autumn at the expense of continued somatic growth and higher potential fecundity. Within five populations, the amount of early allocation varied between years. We combined dynamic programming with an individual-based model to determine how summer and spring feeding conditions interact to influence when allocation to reproduction should begin. Model results indicated that autumn allocation to ovaries was in response to future spring feeding conditions rather than recent summer feeding conditions. At least a 10% probability of poor spring feeding conditions resulted in ovary investment patterns that matched field observations. The model was unable to explain the inter-annual variation in autumn energy observed in the field. Early allocation of energy to ovaries is probably an evolutionary adaptation to the possibility of poor spring feeding conditions.

Keywords: dynamic programming, optimal energy allocation, *Pomoxis annularis*, reproduction, timing, uncertainty.

INTRODUCTION

When energy resources are limited, how an organism partitions energy between somatic (storage or growth) and reproductive tissues will influence its lifetime fitness (Fisher, 1930). For iteroparous organisms, optimal energy allocation will be a response to the trade-off between current reproductive development and somatic growth towards future reproductive development (Williams, 1966). This trade-off is most pronounced in organisms for which body size is positively related to fecundity because energy allocated to somatic rather than reproductive growth can enhance future potential fecundity. Over the reproductive life of an organism, this trade-off can influence several life-history patterns, including age at first reproduction, whether an organism allocates energy to somatic growth after reproduction and when, in organisms that grow after maturity, allocation to reproduction begins after the

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