Quantifying the value of nursery habitats by measuring survival using natural tags

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Nursery habitats are considered crucial for ecosystem function and population persistence, yet the productivity of nursery areas is rarely quantified. Most evaluations of habitat value rely on simple measures of abundance of young. However, a key measure of nursery value is the habitat-specific contribution of recruits to the adult population. For marine species, recruitment to adulthood depends on biotic and abiotic factors that operate during the larval and juvenile stages. Therefore, habitats that confer a greater survival advantage to settled juveniles will have disproportionately more fish surviving to adulthood. Tracking habitat specific survival is a central measure of habitat value that is often overlooked.

Among estuarine habitats, seagrasses are considered to be among the most productive (Heck et al. 2003). The structural complexity and food supply afforded by seagrass meadows can affect growth and subsequent survival of a resident species. Currently, seagrasses are under heavy anthropogenic stress and grass beds are disappearing (Short and Wyllie-Echeverria 1996). Restoration efforts are often aimed at conserving all seagrass beds; yet recruitment may not be the equal for all beds. For species characterized by life histories requiring individuals to select among nursery areas, a specific habitat choice can affect the adult demography, as factors affecting recruitment may vary among beds.

In the Chesapeake Bay, the spotted seatrout (*Cynoscion nebulosus*) is one of the many obligate habitat users that depend on seagrass beds for nursery area. Seatrout in the Bay maintain a unique relationship with their natal grass beds. Once settled, juveniles remain on the seagrass beds obtaining a unique otolith chemical signature (Dorval et al. 2005b). These juveniles only leave the grass beds as temperatures decline in the winter to return the following spring as adults. The unique chemical signature incorporated in the otolith during the juvenile stage remains with the fish throughout its lifespan. Therefore, this chemical fingerprint acts as a natural tag that can be used to determine the natal origins of adult fish (Thorrold et al. 2001). With such a tightly coupled system the spotted seatrout is a sentinel species for identifying valuable habitat.

We sampled juvenile seatrout in five seagrass habitats across the Chesapeake Bay. These seagrass beds spanned the three main zones, the western shore, eastern shore, and the islands. Fish were collected from each site using an otter trawl every two weeks during the summer from 1997-1999, 2002, and 2006-2008. Distance of the trawl were marked using a GPS navigation system and juvenile abundances were measured using the area swept method. Otoliths were extracted in a class 100 clean room using acid washed glassware. One otolith was selected for trace element analysis using solution based inductively couple plasma mass spectroscopy (ICPMS) while the other otolith was used for both ageing, and stable isotope analysis ($\delta^{13}C$, $\delta^{18}O$). One year old adults were sampled the subsequent spring through recreational anglers and commercial circuit collections. Adult otolith cores were carefully removed using a Micromill ensuring that only the juvenile portion was milled. We analyzed the juvenile portion of the adult

otolith for both trace element (ICPMS) and stable isotope chemistry. We generated natal bed fingerprints from juvenile chemistry using quadratic discriminant function analysis (QDFA) and subsequently matched the adult chemistry to natal beds using logistic regression.

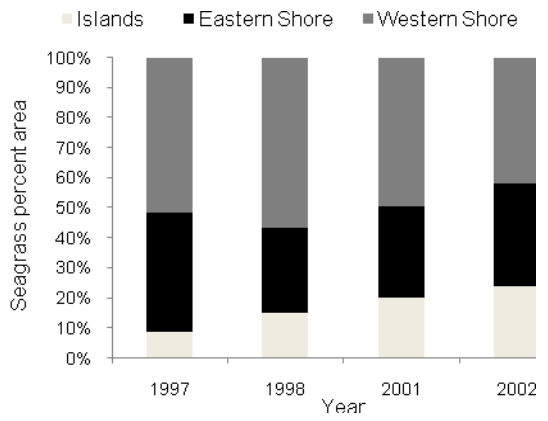

Fig. 1 Percent area coverage of seagrass

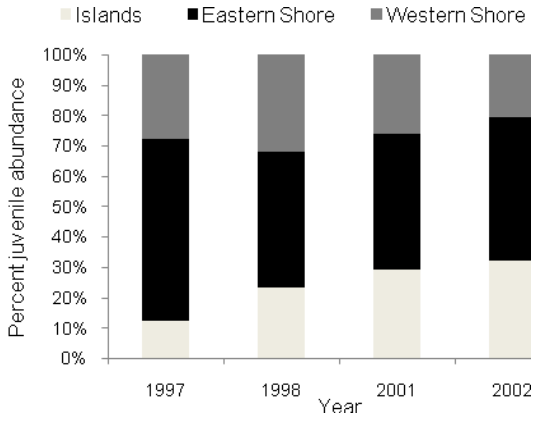

Fig. 2 Percent juvenile abundance per area

Juvenile abundances and seagrass coverage varied across all habitats for all years. Of the total seagrass acreage in the Bay, the western shore consistently had the highest percentage coverage (Fig. 1) consistently making it the largest nursery habitat in the Bay. However, the highest abundances of juveniles were seen on the eastern shore. Of the total seatrout juvenile population, the islands and western shore grass beds contributed small percentage of the juvenile population in any given year (Fig. 2).

Using QDFA resampling and reclassification of individual data points, we were able to classify juveniles to their natal beds with 55-70% accuracy. There was good separation of all three zones using stable isotopes and trace element analysis (Fig 3). The elements used for classification varied annually, however Ba, Mn, Mg and Sr were often the best elements for separation. Classification of juveniles to natal habitat was especially high in years with reduced mixing in the Bay. Years with reduced rainfall increased our ability to classify.

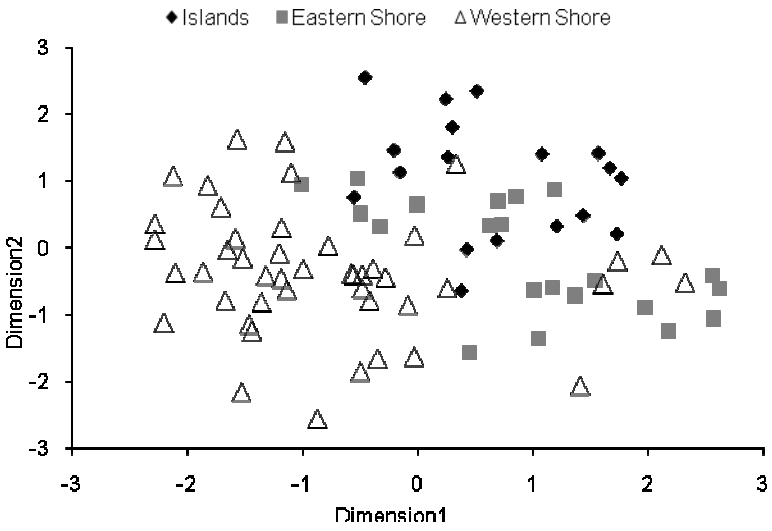

Fig. 3 2002 juvenile non-metric multidimensional scaling plot

Chemical signatures of adults show that almost 80% of the recruits consistently come from nursery habitats on the western shore (Fig. 4). Although the western shore seagrass beds had overall lower percentages of the juvenile abundance, these beds confer a survival advantage to juveniles allowing more recruits to the adult population. These results show that productivity is not necessarily a function of local juvenile abundance.

Our results have far reaching effects for the conservation of nursery habitats. Absolute measures of abundance may not be the best assessment of habitat value, as survival to adulthood is not equal among seagrass habitats. Tracking recruitment using a natural tag gives finer scale resolution on the productivity of nursery habitats. These methods are widely applicable, and can be used to determine which areas contribute most importantly to the persistence and sustainability of a fish population.

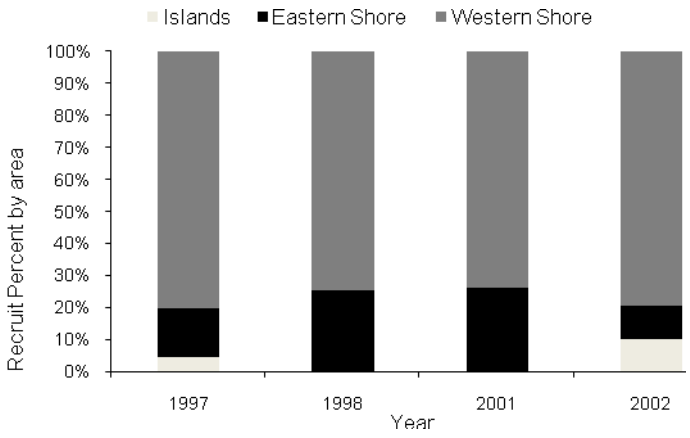

Fig. 4 Percent recruits by area

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Preference: Oral Presentation

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