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NURSERY HABITATS FOR MEDITERRANEAN COASTAL FISHES: THE NEED FOR A QUANTITATIVE APPROACH

HABITAT NURSERY PER SPECIE ITTICHE COSTIERE MEDITERRANEE: LA NECESSITÀ DI UN APPROCCIO QUANTITATIVO

Abstract *– Two quantitative criteria aimed at assessing the nursery role of costal habitats for fishes were tested in the context of the Torre Guaceto MPA (where habitat extent and juvenile fish settlement were assessed): 1) the per-area-unit contribute and 2) the overall number of juveniles provided. This study allowed evaluating advantages and caveats of the two criteria when used for prioritizing habitat types in relation to specific conservation/management goals.*

Key-words*: fish fauna, nursery habitats, marine parks, management, Mediterranean Sea.*

Introduction – The role of coastal habitats as nurseries for juvenile fish is extremely important in management considerations for identifying critical habitats for conservation and restoration and for maintenance and/or recovery of local fish populations (Lipcius *et al*., 2008). Management of nursery habitats, from these perspectives, is critical for biodiversity conservation and fishery management (Beck *et al*., 2001; Sala *et al*., 2002). The nursery role of coastal habitats, however, has been often addressed to single species and poorly investigated from a quantitative viewpoint. We tested here the multispecies nursery role of Mediterranean coastal habitats using two quantitative criteria taken from the literature (Beck *et al*., 2001; Dahlgren *et al*., 2006). Such aspects could be important to improve management of coastal areas and to prioritize inclusion of specific habitats into marine protected areas (hereafter MPAs).

Materials and methods - This study was carried out in the MPA of Torre Guaceto (Brindisi, SE Italy; Southern Adriatic Sea). Data on juvenile fish were collected on a fortnightly basis, from June 2005 to July 2006, by snorkeling or scuba diving in relation to habitat and depth. Juvenile density (settlers of ~1.5 cm total length) was evaluated by means of visual census along strip transects of 25×2 m. Five replicate censuses were performed for each habitat type (see below) at each sampling time, for a total of 1200 replicates. To assess the nursery role of habitats for fish settlers (i.e. early benthic stages following the larval pelagic phase), we took into account only density data collected in correspondence of the settlement peaks of each species. We selected 10 habitat types at Torre Guaceto on the basis of a preliminary survey and the literature information about the habitat requirements for juvenile fish (Harmelin-Vivien *et al*., 1985): 1) sandy bays (0-1.5 m depth) with freshwater inputs (habitat code: SBFI); 2) sandy bays (0-1.5 m) without freshwater inputs (SB); 3) shallow rocks with macroalgae (0-1.5 m) (SR); 4) exposed indented shallow rocks (0-1.5 m) (EISR); 5) exposed linear shallow rocks (0-1.5 m) (ELSR); 6) shallow sheltered coves (0-1.5 m) (SSC); 7) small-sized seagrasses (e.g. *Cymodocea nodosa*) (3-6 m) (SSS); 8) *Posidonia oceanica* beds (3-6 m) (POC); 9) sublittoral rocks with macroalgae and zoobenthos (3-6 m) (SRMZ); 10) sand (3-6 m) (SAND). The nursery role has been quantitatively

assessed following two criteria taken from the literature: 1) "a habitat is a nursery for a certain fish species if its contribution per-unit-area to the production of individuals that recruit to adult populations is greater, on average, than production from other habitats in which juveniles occur" (criterion code: NH, nursery habitat; Beck *et al.*, 2001); 2) "a habitat is a nursery for a certain fish species if it is most important for maintaining adult populations in terms of its overall contribution of juvenile individuals (EJH, essential juvenile habitat; Dahlgren *et al.*, 2006). As we selected 10 habitat types, this 2nd criterion indicates that a habitat is a "nursery" when it contributes to more than 10% of the total number of juveniles produced, on the whole, within the reference area (in our case the Torre Guaceto MPA). In this study the "number of settlers" is used as a proxy of juvenile fish provided to local adult populations.

Data on the overall cover of subtidal habitats within the Torre Guaceto MPA were obtained from the available literature (Fraschetti *et al.*, 2005), while the extent of very shallow habitats along the coastline (i.e. within 1.5 m depth) was obtained by direct field sampling and calculations with GIS softwares.

Results - We recorded fish settlers of 14 species, 7 of which belong to the Sparidae family and 4 to Labridae (Tab. 1). POC and SRMZ hosted fish settlers belonging to the highest number of species and both met the NH and EJH criteria. Strictly considering the number of species, shallow (i.e. within 1.5 m depth) and deeper habitats (3-6 m) were more effective as NH and EJH, respectively (Fig. 1).

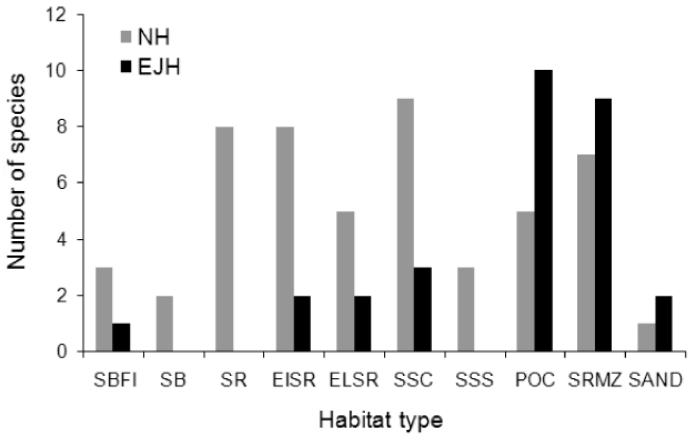

Fig. 1 - Number of species (as settlers) for which the 10 habitat types at Torre Guaceto were identified as 'nurseries" according to NH and EJH criteria (see details and habitat codes in the Materials and Methods section).

Numero di specie (come giovanili) per le quali i 10 habitat a Torre Guaceto sono stati identificati come 'nursery' secondo i criteri NH e EJH (vedi maggiori dettagli ed i codici degli habitat nella sezione Materiali e Metodi).

In Tab. 1 the species whose juveniles were recorded at Torre Guaceto, with related habitats identified as "nurseries", are reported. The NH criterion allowed to identify from 2 to 5 habitats as "nurseries" depending on the species considered. Settlers of *D. sargus* were present in all 10 habitats, but in only 3 habitats (i.e. SR, EISR, SSC) their density per-unit-area was high enough to meet the NH criterion. Settlers of *C. chromis*, instead, were present in the same two habitats (i.e. POC, SRMZ) that were identified as "nurseries" using the NH criterion. The EJH was more restrictive than the NH criterion in terms of number of habitats identified as "nurseries" (except for

O. melanura; Tab. 1). Some habitats that were classified as "nurseries" for *D. sargus* according to NH failed to meet the EJH criterion, e.g. SSC. This is attributable to the high density of settlers per-unit-area in SSC, but the scarce overall extent of this habitat in the area. Conversely, some habitats that were not designated as "nurseries" following NH (e.g. POC) met the EJH criterion thanks to their wide extent. In addition, besides hosting settlers of a high number of species, POC was the exclusive "nursery" (following EJH) for *S. cantharus*, while, on the other hand, on SAND just the settlers of a couple of species were recorded, but for some, like *M. surmuletus*, this habitat was one of the few acting as "nursery" (following both criteria; Tab. 1).

Tab. 1 - Juveniles of fish species and habitats where they have been recorded as 'present' (P) or according to the "Nursery Habitat" (NH) or "Effective Juvenile Habitat" (EJH) criteria. *Giovanili di specie ittiche ed habitat in cui sono stati registrati come 'presenti' (P) o in accordo con i criteri di* Nursery Habitat *(NH) o* Effective Juvenile Habitat *(EJH).*

Species	P	NH	EJH
Coris julis	6	2 EISR, SRMZ	2 POC, SRMZ
Chromis chromis	2	2 POC, SRMZ	2 POC, SRMZ
Dicentrarchus labrax	4	3 SBFI, SR, SSC	2 SBFI, SSC
Diplodus annularis	6	3 SBFI, SSS, POC	2 POC, SRMZ
Diplodus puntazzo	5	4 SB, SR, EISR, SSC	3 EISR, ELSR, SSC
Diplodus sargus	10	3 SR, EISR, SSC	3 POC, SRMZ, SAND
Diplodus vulgaris	10	5 SB, SR, EISR, ELSR, SSC	3 POC, SRMZ, SAND
Mullus surmuletus	10	5 SBFI, SSS, POC, SRMZ, SAND	2 POC, SAND
Oblada melanura	3	2 EISR, SSC	3 EISR, ELSR, SSC
Sarpa salpa	8	5 SR, EISR, ELSR, SSC, SRMZ	2 POC, SRMZ
Symphodus ocellatus	6	4 SR, EISR, SSC, POC	2 POC, SRMZ
Symphodus roissali	5	5 SR, EISR, ELSR, SSC, SRMZ	1 SRMZ
Symphodus tinca	7	4 SR, EISR, ELSR, SSC	2 POC, SRMZ
Spondilyosoma cantharus	2	2 SSS, POC	1 POC

Conclusions - The simple presence of juvenile fish in a habitat is not enough to identify it as a "nursery". Differently from the approach in fishery biology (where "nursery" is often an operative and quantitative term, also related to fishing activities), the literature available on the assessment of coastal habitats as "nurseries" (especially in the Mediterranean Sea) has seldom used quantitative definitions. The two criteria tested here have been debated (Sheaves *et al.*, 2006), but they represent useful attempts to quantify the nursery roles of marine habitats that could help managers to prioritize habitat types e.g. for inclusion into MPAs. They should not be used, however, without considering the specific goal(s) to achieve. If the main aim of a MPA is habitat and species conservation, then rarer habitats should be favored over more common ones, particularly if those contribute disproportionately on a per-area basis to juvenile fish production. Habitats like SSS, for instance, could be potentially effective nurseries deserving major protection, even though, due to their small extent, they not contribute in providing with a significant number of juveniles at Torre Guaceto. Oppositely, if the goal of a MPA is to sustain fishery production then habitats effective as EJH should receive major attention. From this perspective, juveniles of many species showed low densities in POC, but the extent of *P. oceanica* is so wide that its overall contribution in providing juvenile fish is remarkable.

Recent studies showed clear limits of MPAs' zoning to properly protect habitats for adults of relevant fish species (Guidetti *et al.*, 2006), a situation that stressed the need for a better consideration of representativeness (See Roberts *et al.*, 2003) as a criterion to include habitats into MPAs (according to percent cover of habitats at the regional scale, or specific fixed-area standards, e.g. 10% for each habitat type, including the rarer ones). A proper consideration of the functional nursery role of different habitat types could help the managers in designing the MPA and including habitat types in appropriate proportions. For instance, major attention should be paid to rarer habitats if they contribute disproportionately per-area to fish production. On the other hand, the EJH criterion could support overrepresentation of an habitat within MPAs (e.g. in the case of *P. oceanica*) due to the huge contribution effectively provided to produce juvenile fish. Instead of considering and representing habitats proportionately, they should be represented in MPAs also in relation to their ecological roles.

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