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IMPACT OF SEMI-OFFSHORE TUNA FARMS ON FITNESS STATUS OF WILD FISH POPULATIONS: GILTHEAD SEABREAM AS A CASE STUDY SPECIES FROM THE EASTERN ADRIATIC SEA

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Introduction

In the last two decades, a significant increase in wild gilthead seabream populations has been observed in some coastal areas of Mediterranean Sea including the Adriatic Sea. Synergic effects of global warming (Coscia et al. 2011), fish escapement through farming and spawning in cages (Somarakis et al. 2013) can partially explain such phenomenon. The recent trend of gilthead seabream expansion in the Adriatic Sea is accompanied with increased damages on mussel farms caused by seabream predation and fish competition for a new food sources and habitats (Šegvić-Bubić et al. 2011). Nowdays, increased abundance of the gilthead seabreams has been seen around tuna farms. Modified environment and altered trophic network with bait-fish (anchovy, sardines) as a main source of food around farms may induce range of fitness consequences for aggregated fish populations. For this, we investigated (1) seabream abundance and its dietary composition, (2) proxy measures of fitness of farm-associated and unassociated fish including fatty acid composition, body and gonad condition indices and (3) fish scale microchemistry.

Materials and methods

Gilthead seabream abundance was investigated at two tuna fish farms and at corresponding nearby control locations using the stationary stereo-video system AQ1 AM100. Temporal replication included sampling two random times during cold season and two during warm season. Depth related differences in species abundance was investigated trough the four 4 depth strata: surface, midwater, cage net depth and bottom. Statistical analysis was performed in PRIMER +PERMANOVA version 6. To determine dietary composition, stomach contents were analysed and identified to the lowest taxa possible. Proxy measures of fitness of farm-associated and unassociated fish was assessed on the sample size of 600 seabreams, analysing the relative body condition index (Kn), the gonadosomatic index (GSI) and fatty acid composition (FA). Lipid analysis was performed as previously described by Petrović et al. 2015. For the purpose of stock discrimination, inductively coupled plasma-mass spectrometry (ICP-MS) was applied for trace elements determination on digested scales from the 20 farm-associated and unassociated seabream specimens.

Results

The result of the univariate PERMANOVA showed large temporal and spatial abundance variation of seabream populations indicating that seasonal abundance changes varied across overall impact and control locations. Namely, the gilthead seabream was 43 times more abundant at the impact location in comparison to the control locations where all censused fish were exclusively observed at the bottom. According to the dietary importance index (IRI), pisces was the most important item found in the farm-associated seabream stomachs with 91% of total prey contribution. In contrast, bivalves with 75% of contribution was the most important item found in unassociated seabreams, following pisces with 16% of contribution. Proxy measures of fitness (Kn and GSI) significantly differed between farm associated and wild seabreams. In summer and winter, fish caught in proximity of tuna fish farms had average Kn 1.06 to 1.14 times higher than their wild counterparts while GSI values were consistently >1.4 times greater in seabream collected around tuna fish farms compared to wild fish. Even though, farm associated and wild fish display relatively similar values of total fat content (1.7 vs. 1.6), significantly higher n-3/n-6 fatty acids ratio and EPA/DHA ratio was noted in farm associated compared to wild fish (3.4 vs 0.4 and 0.5 vs 0.1, respectively). Multivariate analysis demonstrates that the trace element composition of seabreams scales differ significantly between farm associated and wild fish ($p < 0.01$). K, Ba, Cu, Sr and B all contribute significantly to the group classification (p to remove < 0.05).

Discussion

Adriatic tuna farms attract wild seabream populations throughout the year where increased amount of food consumed by farm-associated ones indicates strong trophic connectivity between fish and farms. High-energy food (anchovy and sardines) was observed in stomachs of farm-associated fish in contrast to the low energy food i.e. bivalves observed in stomachs of wild fish. Consequently, high-energy diet greatly contributed to enhanced proxy measures of fitness (Kn and GSI) of associated fish and even had positive impact on the levels of omega-3 and 6 fatty acids. From the nutritional point of view, consumption of fish enriched with n-3 fatty acids (EPA + DHA) may have more protective role against cardiovascular disease in humans.

The recycle role of farm-associated fish through removal of waste feed from the bottom seems beneficial for both, fish itself and farm surrounding environment. Dempster et al. (2011) estimated that saithe aggregated at Norwegian salmon farms remove as much as one third of the waste feed. Similar results were also found at open-cage farms for sea bass and sea bream in the Mediterranean (Sanchez-Jerez et al. 2011).

Scale chemistry which depends on water chemistry, diet and fish physiology, provides a highly successful method to distinguish different seabream origins, with low concentrations of K being the key marker that indicates tuna farm associated origin.

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