

ESTIMATE OF ANCHOVY (*ENGRAULIS ENCRASICOLUS*, L.) BIOMASS IN THE SOUTHERN ADRIATIC SEA BY DEP (DAILY EGG PRODUCTION) METHOD (2005-2010)

MILICA MANDIĆ*, ANA PEŠIĆ*, SLOBODAN REGNER**

**Institute for Marine Biology – Kotor, P. Box 69, Montenegro*

***Institute for Multidisciplinary Research, Belgrade, R. Serbia*

e-mail: mamilica@ac.me

PROCJENA BIOMASE INĆUNA (*ENGRAULIS ENCRASICOLUS*, L.) PRIMJENOM DEP (DAILY EGG PRODUCTION) METODE NA PODRUČJU JUŽNOG JADRANA (2005-2010.)

Abstrakt

DEP metoda (daily egg production method, DEPM) je zasnovana na istraživanju ihtiplanktona (jaja i larve riba) i koristi se širom svijeta za procjenu biomase male plave ribe (Hunter and Lo, 1993; Lasker, 1985; Somarakis et al, 2004). Ova metoda se uspješno primjenjuje već 25 godina u čitavom svijetu i prvenstveno je dizajnirana za ribe koje imaju neodređen fekunditet, kakva je većina vrsta iz reda Clupeiformes. Zbog toga se najčešće upotrebljava za procjenu biomase male plave ribe, u prvom redu inćuna (Engraulidae) i srdela (Cupeidae). Pored procjene biomase ova metoda daje značajne podatke o karakteristikama i načinu mrijesta, kao i bitne reproduktivne parametre ribljih populacija. Podaci dobijeni DEP metodom mogu pomoći u razumijevanju mehanizama kojim prirodne promjene utiču na reproduktivnu biologiju i stepen preživljavanja ranih razvojnih stadijuma male plave ribe (Regner, 1985; Somarakis et al, 2004).

Inćun (*Engraulis encrasicolus*, L.) je jedini predstavnik roda *Engraulis* u Mediteranu. Inćun je, uz srdelu, ekonomski najznačajnija vrsta riba u Jadranu i Mediteranu. Dostiže dužinu do 20 cm, migratorna je i planktofag.

Mrijesti se od početka proljeća, obično od aprila do oktobra, a nekada od marta do novembra (Zavodnik, 1970; Merker and Vujošević, 1972; Regner, 1972, 1985, Piccinetti et al., 1979). Mrijesti se više puta tokom sezone mriješćenja („multiple spawner“ Blaxter and Hunter, 1982).

U okviru FAO AdriaMed Projekta (koji se realizuje već sedam godina između Crne Gore, Italije, Albanije, Hrvatske i Slovenije) u vodama crnogorskog primorja DEP me-

toda je prvi put primjenjena 2005 godine za procjenu biomase inćuna. Nakon toga, istraživanje je prošireno na albanske teritorijalne i susjedne međunarodne vode u julu 2008 godine.

U julu 2010 godine procjena biomase inćuna primjenom DEP metode u okviru istog projekta proširena je na područje cijelog južnog Jadrana (GFCM geografska subregija 18). Procjenjena biomasa inćuna u avgustu 2005 godine iznosila je 3842 t., u julu 2008 godine 52 273.2 t dok je u julu 2010 godine iznosila 100 352.07 t.

Ključne reči: DEP metoda, *Engraulis encrasicolus*, biomasa, južni Jadran

INTRODUCTION

Anchovy (*Engraulis encrasicolus*, L.) is one of the economically most important Mediterranean small pelagic species with very wide distribution all over the Adriatic Sea. It is found all over the Mediterranean and the Black sea. Anchovy approaches the coast in spring when the temperature rises, and reaches sexual maturity at the end of the first year of life. Reproductive period of anchovy in the Adriatic Sea lasts from spring to autumn, usually from April to October, and sometimes from March to November (Zavodnik, 1970; Merker and Vujošević, 1972; Regner, 1972, 1985, Piccinetti *et al.*, 1979).

Main spawning area of anchovy is in the eutrophic waters of the western part of the shallow northern Adriatic and along the Italian coast to the peninsula of Gargano (Regner, 1996).

DEPM survey is part of the AdriaMed project since 2005, when it was conducted for the first time in southeast Adriatic Sea (Montenegrin continental shelf) for estimation of spawning stock biomass of anchovy (*Engraulis encrasicolus*). In July 2008 the survey was extended to Albanian territorial and adjacent international waters – from Boka Kotorska to Valona. Latest survey was performed in July of 2010 and it was extended to entire southern Adriatic Sea (GSA 18).

MATERIAL AND METHODS

DEPM (Daily Egg production Method) is the method developed by Coastal research division of the Southwest Fisheries Center, La Jolla (SWFC, California). Method is based on ichthyoplankton investigation for estimating spawning stock biomass (SSB) of batch spawners with indeterminate annual fecundity, in particular Clupeids and Engraulids. It was developed in the late 1970s and since then, it has been applied to a variety of small pelagic stocks. Application of this method requires knowledge of the boundaries of the spawning area of target species.

The spawning stock biomass estimation is based on the model described by Parker (1980):

$$B = \frac{E}{k * Frb * f * R}$$

Where: B = spawning biomass in metric tons; E = number of eggs produced per day over the surveyed area; k = conversion factor from grams to metric tons; Frb = relative

batch fecundity; f = spawning frequency; R = sex ratio (fraction of mature females by weight).

Spawning frequency (fraction of mature females spawning per night) was estimated using postovulatory follicles (POF's) method (Hunter and Macewicz 1985) and by hydrated oocyte method (this method is based on the number of hydrated females compared to the total number of treated females).

Relative batch fecundity was calculated as a number of eggs produced per unit of female weight (ovary-free weight).

RESULTS AND DISSCUSSION

Results of biomass assessment applying DEPM in southern Adriatic Sea are presented in Table 1. The DEPM assumes that the estimated parameters are constant over the area and duration of the survey (Somarakis *et al.*, 2002). The distribution and abundance of anchovy eggs are presented in Figure 1. The data were processed in Surfer Golden Software 8 applying the kriging method. Anchovy spawning areas and number of anchovy eggs per square meter per day are presented too.

Table 1. Summarized biomass estimates of anchovy stocks in southern Adriatic Sea (in metric tons).

Year	Region	Surveyed area (km ²)	DEPM (Spawning biomass)
2005	Montenegrin continental shelf	5401	3842
2008	Montenegrin and Albanian continental shelf	14446.16	52 273.2
2010	Southern Adriatic sea (GSA 18)	17516	110 352.07

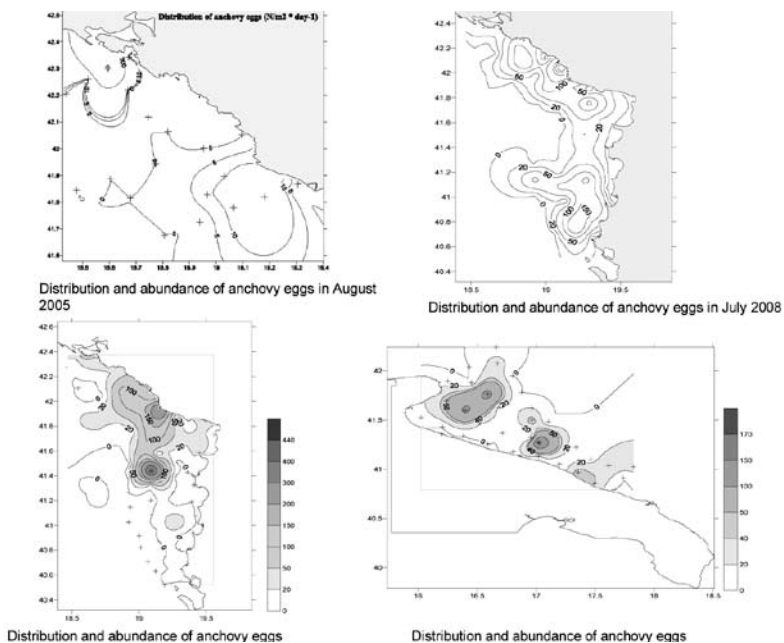


Figure 1. Distribution and abundance of anchovy eggs in southern Adriatic Sea. Numbers of eggs were adjusted as a number of individuals per m^2 of the surface.

Previous estimations of anchovy spawning stock biomass by DEP Method in southern Adriatic Sea indicate to already well known fluctuations in anchovy biomass.

Large annual oscillations in anchovy biomass can be explained by fluctuations in abiotic and biotic factors in the Adriatic Sea (Regner 1985, 1996). In view of the scarce information on the spawning ecology of *Engraulis encrasicolus* in the Southern Adriatic, and the importance of anchovy in fisheries, the aim of DEP method estimations was to investigate distribution of spawning in relation to environmental conditions, and to estimate anchovy biomass applying this method.

On the Montenegrin coast, in contrast to other Adriatic countries, commercial fishery of small pelagic species at the open sea is still undeveloped, and almost exclusively small scale fishery gears are in use. At present, there is only one active vessel (purse seiner) which exploits those resources in Montenegro, but the catches are poor, probably because of unskillful crew and some technical problems.

Based on estimated biomass by DEP method, MSY (Maximum sustainable yield) can be determined, that is, maximum amount of fish that may be caught without compromising the dynamics of natural populations

REFERENCES

- Arneri, E. (1994): Fisheries resources assessment and management in the Adriatic and Ionian Seas: GFCM Document TC/CM/III/94 14 pp.
- Blaxter, J. H. S. and J.R. Hunter (1982): the biology of clupeoid fishes. Adv. Mar. Biol., 20: 1-223

Hunter, J.R. & B. Macewitz (1985). Measurement of spawning frequency in multiple spawning fishes. In: LASKER, R.(edt), An Egg Production Method for Estimating Spawning Biomass of Pelagic Fish: Application to the Northern Anchovy, *Engraulis mordax*. NOAA Tech. Rep. NMFS, 36: 79-93.

Hunter, J.R., Lo, N.C.H. (1993). Ichthyoplankton methods for estimating fish biomass. Introduction and terminology. Bull. Mar. Sci. 53, 723-727.

Lasker, R. (1985). An Egg Production Method for Estimating Spawning Biomass of Pelagic Fish: Application to the Northern Anchovy, *Engraulis mordax*. NOAA Tech. Rep. NMFS, 36.

Merker, K. and M. Vujošević (1972): Density and distribution of the eggs of the anchovy (*Engraulis encrasicolus* L.) in Boka Kotorska Bay. (in Serbian). Poljoprivreda i šumarstvo, 18(2): 15-27

Parker, K. (1980): A direct method for estimating northern anchovy, *Engraulis mordax*, spawning biomass. Fish. Bull. U. S., 78: 541-544.

Piccinetti, C., Regner, S. and M. Specchi (1979): Estimation du stock d'anchois, (*Engraulis encrasicolus* L.) de la haute et moyenne Adriatique. *Inv. Pesq.*, 43: 69-81

Regner, S. (1972): Contribution to the study of the ecology of the planctonic phase in the life history of the anchovy in the Central Adriatic. *Acta Adriat.*, 14 (9): 40p.

Regner, S. (1985): Ecology of planktonic stages of the anchovy, *Engraulis encrasicolus* (Linnaeus, 1758), in the central Adriatic. *Acta Adriat.*, 26(1), Series Monographiae, 1:1-113.

Regner, S. (1996): Effects of environmental changes on early stages and reproduction of anchovy in the Adriatic Sea. *Sci. Mar.*, 60 (Supl.2): 167-177

Somarakis, S, C. Koustikopoulos, A. Machias and N. Tsimenides (2002): Applying the Daily Egg Production method to small stocks in highly heterogeneous seas. *Fish. Res.*, 55: 193-204

Somarakis, S., I. Palomera, A. Garcı 'a, L. Quintanilla, C. Koustikopoulos, A. Uriarte & L. Motos (2004): Dailly egg production of anchovy in European waters. *ICES Journal of Marine Science* 61: 944-958.

Zavodnik, D. (1970): Comparative data on the spawning of sardine (*Sardina pilchardus*, Walb.), sprat (*Sprattus sprattus*, L.) and anchovy (*Engraulis encrasicolus*, L.) in the North Adriatic. *Ichthyologia*, 2: 171-178.