ASSESSMENT OF NORWAY LOBSTER - *NEPHROPS NORVEGICUS* (LINNAEUS, 1758) POPULATIONS IN THE ADRIATIC SEA USING ALTERNATIVE METHODS

IGOR ISAJLOVIĆ*, NEDO VRGOČ*, SVJETLANA KRSTULOVIĆ ŠIFNER**, OLIVERA MARKOVIĆ***, ANA PEŠIĆ***

** Institute of Oceanography and Fisheries, Šet. Ivana Meštrovića 63, 21000 Split, Croatia*

*** University Department of Marine Studies, University of Split, Livanjska 5/III, 21000 Split, Croatia*

**** Institute of Marine Biology, Dobrota b.b., P.O. Box 69, 85330 Kotor, Montenegro*

PROCJENA POPULACIJE ŠKAMPA - *NEPHROPS NORVEGICUS* (LINNAEUS, 1758) U JADRANSKOM MORU ALTERNATIVNIM METODAMA

Apstrakt

Škamp (*Nephrops norvegicus*) spada u gospodarski najvažnije vrste rakova na području Mediterana i severnoistočnog Atlantika kojeg se godišnje izlovi preko 60000 t. Rasprostranjen je u istočnom Atlantiku i diljem Mediterana od 20 do 800 m dubine. Obitava na muljevitim sedimentima u kojem iskopava karakteristične tunele. Najveća gustoća populacije u Jadranskom moru zabeležena je na području Jabučke kotline, Velebitskom kanalu, Kvarneru i Kvarneriću. U južnom delu Jadrana gustoća populacije je osetno manja. Škamp se u Jadranskom moru intenzivno izlovljava uglavnom povlačnom pridnenom mrežom koćom od strane mnogobrojne ribarske flote svih jadranskih zemalja. Usled toga došlo je do negatvinih promena ukupne biomase, te demografske strukture populacije škampa. Da bi se uspostavilo odgovorno i održivo ribarstvo, te zaštitila populacija škampa provode se brojna istraživanja i monitorinzi, te procene stanja populacije. Ova istraživanja uglavnom se temelje na ribarstveno biološkim metodama kao što su praćenje totalnog ulova, kretanje CPUE ili analitčkih metoda (VPA, LCA and yield-per-recruit analysis). Glavni nedostatak ovih metoda je što se temelje na pretpostavci reprezentativnog uzorkovanja populacija što kod škampa, zbog njegovih bioloških karakteristika, nije slučaj. Obzirom da škamp obitava u tunelima, koje iskopava u sedimentu, on može biti uzorkovan samo kada se nalazi izvan njih, a izlazak varira ovisno o sezoni, dobu dana, veličini, spolu te stadiju zrelosti.

Da bi se postiglo reprezentativno uzorkovanje u svrhu dobivanja tačne procene stanja populacije u poslednje vreme sve više se koristi alternativna metoda istraživanja upotrebom povlačne podvodne kamere (UWTV). Ova metoda se zasniva na promatranju morfoloških karakteristika morskog dna da bi se identifikovale vrste koje obitavaju u tunelima na osnovu karkterističnog izgleda otvora tunela. Da bi se tačno idenetifikovala vrsta koja obitava u tunelima treba promatrati oblik, dijametar, razdaljinu, orijentaciju, grupiranje otvora, prisustvo vrste ili tragova te drugih značajnih parametra. Dobivene vrednosti se zajedno sa rezultatima ribarstveno bioloških istraživanja analitičkim metodama preračunavaju se u indeks biomase po površini. Metodologija istraživanja provodi se upotrebom specijalnih podvodnih kamera montiranih na sanje koje se istraživačkim brodom povlače po morskom dnu određenim vremenom i brzinom. Video snimka, zajedno s ostalim zabeleženim oceanografskim podacima, se putem optičkog kabla u realnom vremenu prenosi u kontrolnu jedinicu na brodu. Snimljeni materijal se analizira prema međunarodnom protokolu (ICES) da bi se omogućila ispravna usporedba podataka. UWTV metoda zajedno s drugim ribarstveno biološkim metodama značajno doprinosi sistematskom praćenju stanja i procjene populacije škampa, te uvođenju odgovornog i održivog iskorištavanja bioloških obnovljivih resursa zasnovanog na znanstvenim saznanjima.

Ključne reči: UWTV, Jadransko more, procena populacija, ribarstvena biologija
Keywords: UWTV, Adriatic sea, population estimation, fishery biology

INTRODUCTION

Norway lobster (*Nephrops norvegicus*) is one of the most important commercial crustacean species throughout Mediterranean and the NE Atlantic with the annual catch of more than 60000 t according to the FAO fisheries statistics (FAO, 2012) This species is distributed in the eastern Atlantic, from Morocco to Norway and Iceland, and in the Mediterranean from 20 to 800 m of depth (Fisher et al., 1987). Norway lobster mostly inhabits muddy sediments in which it digs its characteristic burrows. It is widely distributed in the Adriatic Sea at depths from about 30 m in the northern Adriatic Sea to 400 m in the southern part of the Adriatic (Karlovac, 1953; Marano et al., 1998; Piccinetti et al., 2012). The most important fishing grounds, with high population density, are in the Jabuka Pit region and in the Velebit Channel, Kvarner and Kvarnerić region along the Croatian coast (Karlovac, 1953; Crnković, 1965). In the southern Adriatic, along the western (Italian) and eastern (Albanian and Montenegrin) coasts, the settlements are not so dense (Karlovac, 1953; Marano et al., 1998) (Fig 1).

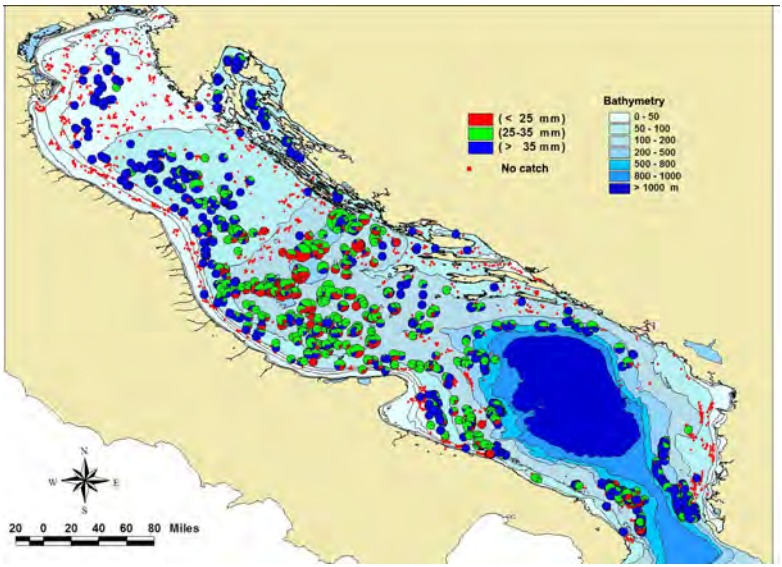

Figure 1. Distribution of Norway lobster (*Nephrops norvegicus*) in the Adriatic Sea (source: Isajlović)

Population of Norway lobster, together with other commercially important species, in the Adriatic is mostly exploited by bottom trawlers of all Adriatic countries in which larger Italian fleet achieved the majority of total catch. Due to that, Adriatic Sea trawling grounds have been classified as fully exploited to overexploited (Sardà, 1998) with respect to Norway lobster which shows decreasing trends both in the total catch and also in the demographic structure since 1993 (Piccinetti et al., 2012).

Since Norway lobster represents one of the most commercially important demersal species in Mediterranean, therefore also in the Adriatic Sea, monitoring of the fisheries pressure and assessment of the population is key factor in applying fisheries management based on responsible and sustainable exploitation. Assessment of Norway lobster population in Mediterranean usually relies almost uniquely on fishery-dependent techniques based on the use of catch and CPUE trends or on analytical methods such as VPA, LCA and yield-per-recruit analysis (Morello et al., 2007). These methods are highly dependent on selectivity of fishing gear which is used as a sampling tool (Fiorentini et al., 1998.) and the main downfalls are that they rely on assumptions such as equal capture availability and stock redistribution following capture. These assumptions do not hold for this species because of its specific biological characteristics. Norway lobster can be caught only when it emerges from its burrow and emergence may vary with time of day, season, animal size, sex, and reproductive status (Morello et al., 2009). Therefore sampling natural population in a certain area or time can result that sample is not qualitatively or quantitatively representative and in this case data obtained by fishery or scientific trawl surveys may represent only part of the population. For these reasons, fishery-independent methods are of particular importance for this species and the most practical of these uses under water video system "UWTV" for burrow counts as an index of stock abundance. If appropriately integrated with trawl hauls, burrow counts can be converted into biomass estimates.

UWTV METHODOLOGY

The first experimental UWTV surveys were carried out by Scottish scientist in the early 1990s and up to day it has become the standard method of assessment for NE Atlantic stocks (ICES, 2007). UWTV has received detailed attention in a series of ICES workshops aimed at standardizing methodologies and quantifying the uncertainties associated with the method (Campbell et al., 2009). This techniques is based on examination of a surface features to identify the occupant of a given burrow observed by UWTV and in most cases it could be determined to species level. Recognition of burrows and identification of their occupants is based on observing the main morphological features such as shape of burrow openings, presence of tracks and trails, presence of characteristic clusters, diameter of burrow openings, distance between openings of a given burrow, orientation of the burrow, presence of the occupant and any other additional helpful information. Norway lobster dig burrows in a muddy sediment which are consisted of a tunnel with a front entrance opening within a crater-like depression and smaller rear aperture opening on flat surface (Fig. 2). Often Y-shaped burrows are found with 3 openings as well as complex burrows with more openings, which are generally associated with the presence of juveniles, known to attach their burrows to the ones of adults.

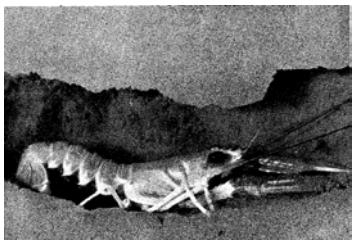

Figure 2. Morphological characteristics of Norway lobster (*Nephrops norvegicus*) burrows system (from CEFAS training material provided by Jim Atkinson)

The surveys are conducted using under water TV camera which is mounted on a sledge and towed by research vessel on the sea bed at a speed of 1 knot. The position of the sledge at each minute, depth, current, turbidity and other oceanographic data are monitored by data-logger systems which are synchronized with the camera deck unit (Fig 3.). The UWTV tows should be carried out during day time at least for 20 minutes at each UWTV station (Martinelli et al., 2013).

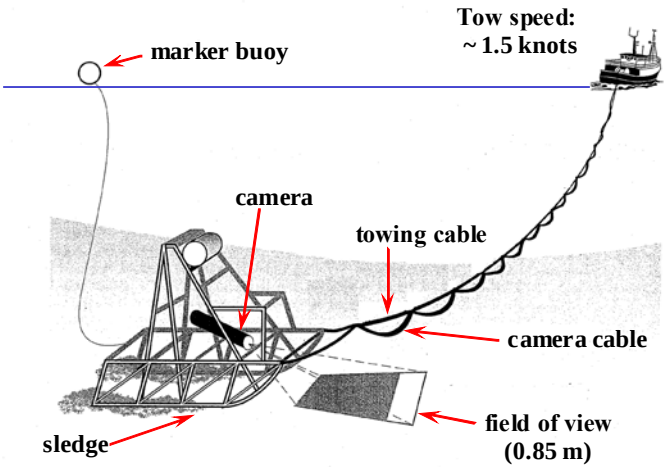

Figure 3. Description of UWTV system and investigation methodology

Analysis of video footage and Norway lobster burrow identification and quantification should be carried out following ICES protocols (ICES, 2008) by several independent trained readers with a minimum of 8 'good' (easy to read) minutes per station as a threshold fixed to accept the validity of each station.

The first experimental UWTV investigations of Norway lobster settlements in the Adriatic Sea were held in the western part of Jabuka pit during the end of 1990s (Froglia et al., 1997). Following their achievement from 2009 systematic UWTV investigations are conducted in wider area of central Adriatic in order to carry out an evaluation of the Norway lobster stock under the framework of the FAO – ADRIAMED project.

CONCLUSION

Following the negative changes both in population stock biomass and demographic structure of Norway lobster population in the Adriatic Sea special consideration should be given to the exploitation of this species. Since it is one of the most important commercial species exploited by large fisheries fleet of all Adriatic countries, primary goal of fisheries scientist is to provide recommendations for sustainable exploitation of Norway lobster based on scientific conclusions. Use of the UWTV methodology together with trawl surveys in the future would allow systematic assessment of the Norway lobster stocks and contribute to identification and monitoring of year-to-year variation in biomass and size composition.

ACKNOWLEDGMENTS

This study was made within the framework of bilateral scientific cooperation between Croatia and Montenegro (project "ADRIJA"), and in the framework of FAO AdriaMed project.

REFERENCES

Campbell, N., Dobby H., Bailey, N. (2009): Investigating and mitigating uncertainties in the assessment of Scottish *Nephrops norvegicus* populations using simulated underwater television data. ICES Journal of Marine Science 66, 646-655.

Crnković, D. (1965): Ispitivanje ekologije i mogućnosti racionalnog unaprijeđenja eksploatacije raka *Nephrops norvegicus* (L) u kanalskom području sjeveroistočnog Jadrana. Doctoral thesis. University of Zagreb. 112 pp

FAO (2012) The State of World Fisheries and Aquaculture 2012. Food and Agriculture Organization of UN. Rome, www.fao.org

Fiorentini, L, Dremiere, PY, Sala, A, Leonori. I. (1998) Efficacy of the trawl used for the MEDITS project. Biologia Marina Mediterranea 3, 12-34.

Fisher, W., Schneider, M., Bauchot, M.L. (eds.) (1987): FAO d'identification des espèces pour les besoins de la pêche. Mediterranée et mer Noire. Vol. I – II. FAO. Rome. 760 pp.

Froglia, C., Atkinson, R.J.A., Tuck I., Arneri, E. (1997): Underwater television survey, a tool to estimate *Nephrops* stock biomass on the Adriatic trawling grounds. In: Tisucu Godina Prvoga Spomena Ribarstva u Hrvata (ed. B. Finka). Croatian Academy of Science and Art. Zagreb. 657-667

ICES (2007): Workshop on the use of UWTV surveys for determining abundance in nephrops stocks throughout European waters. Heraklion. ICES CM 2007/ACFM, 14, 198 pp.

ICES (2008): Report of the Workshop and training course on *Nephrops* burrow identification (WKNEPHBID). Belfast. ICES CM 2008/LRC, 03, 44 pp.

Karlovac, O. (1953): An ecolocical study of *Nephrops norvegicus* (L) of the high Adriatic. Report of fisheries biological Expedition "Hvar" 1948-49, 5 (2C), 1-50

Marano, G., Marsan, R., Pastorelli, A.M., Vaccarella, R. (1998): Areale di distribuzione e pesca dello scampo, *Nephrops norvegicus* (L.), nelle acque del basso Adriatico. Biologia Marina Mediterranea 5 (2), 284-292.

Martinelli, M, Morello, E.B, Isajlović, I, Belardinelli, A, Lucchetti, A, Santojanni, A, Atkinson, R.J.A, Vrgoč N, Arneri, A. (2013) Towed underwater television towards the quantification of Norway lobster, squat lobsters and sea pens in the Adriatic Sea. Acta Adriatica. In press

Morello, E.B., Froglia, C., Atkinson, R.J.A. (2007). Underwater television as a fishery-independent method for stock assessment of Norway lobster (*Nephrops norvegicus*) in the central Adriatic Sea (Italy). ICES Journal of Marine Science 64, 1116-1123.

Morello, E.B., Antolini, B., Gramitto, M.E., Atkinson, R.J.A., Froglia, C. (2009): The fishery for *Nephrops norvegicus* (Linnaeus, 1758) in the central Adriatic Sea (Italy): preliminary observations comparing bottom trawl and baited creels. Fisheries Research 95, 325–331.

Piccinetti C, Vrgoč N, Marčeta B, Manfredi C (2012) The Recent State of Demersal Resources of the Adriatic Sea. Acta Adriatica 5, 1-220 pp.

Sardà, F., Lleonart J., Cartes J. E. (1998): An analysis of population dynamics of *Nephrops norvegicus* (L.) in the Mediterranean Sea. Scientia Marina 62, 135–143.