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Lunar phase and catch success of the striped marlin (*Tetrapturus audax*) in sport fishing at Los Cabos, Baja California Sur, Mexico

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Abstract: The influence of the lunar phases on the catch-per-unit effort (CPUE) of the striped marlin (*Tetrapturus audax*) captured by the Cabo San Lucas, Baja California Sur, Mexico sport-fishing fleet from October 1987 to June 1989 was analyzed. The information is from 3 377 fishing trips by 13 vessels that represent about 10 % of the fleet. The analysis of the CPUE showed a maximum in January 1988 and a minimum in February 1989. Taking into account the knowledge of the factors that had influence on the fishing success is important in the resource management. No significant difference during the full moon compared with results during other lunar phases was found.

Key Words: Billfish, striped marlin, CPUE success and lunar phase.

The billfish are a group of highly migratory fish that inhabit tropical and temperate waters (Sosa-Nishisaki 1998). These organisms are prized by sport fishermen because these they are in general a species of great size and strength. Because of the great abundance of billfish species (striped, blue, and black marlin, sailfish, and swordfish) in waters of the Mexican Pacific, in many areas of the coast centers of recreational fishing have been established causing an increase in all aspects of the tourist industry. In the area of Los Cabos, Baja California Sur, sport fishing represents the area of greatest importance of this activity at the moment because it generates an important source of revenues, valued at $54 million dollars annually (Ditton *et al*. 1996). In this activity, there are about 200 rental vessels plus other private vessels making between 13 000 and 15 000 annual fishing trips (Klett-Traulsen *et al*. 1996).

Activities of sport fishing are done during the day, beginning at about 0700 and finishing between 1500 and 1700, with the vessels returning to the Port of Cabo San Lucas, B. C. S. There is the belief among many that there is a smaller probability of catching billfish if the fishing is done during a full moon. People believe that during a full moon there is enough light for the fish to feed at night so that during the day these big fish do not feed as much and in consequence are more likely to ignore the bait fish offered them. Many tourists plan their fishing trips in consideration of this to avoid the phase of the full moon.

Bibliographical references specifically about the topic of the success of catch of billfish related to the lunar phase only exist for other latitudes, for example the sport-recreational fishing around Florida, USA (Nakamura and Rivas 1974) and for the commercial fishing

of tuna, bait for tuna fishing, and billfish in the Caribbean and the Atlantic Ocean (Kearney 1977, Pallares and Garcia-Mamolar 1985, Mohan and Kunhkoya 1987, Moreno *et al*. 1991, Di Natale and Mangano 1995), where it has been concluded that only in some cases a relationship exists between lunar phases and catch success.

We approached our study with the hypothesis of a relationship of the fishing success of the striped marlin (*Tetrapturus audax* Philippi, 1887) with different lunar phases.

MATERIAL AND METHODS

The information used is from 3377 fishing trips from October 1987 to June 1989 for 13 vessels of the sport-fishing fleet that operates in Cabo San Lucas, B.C.S. The area of operation of the fleet is shown in Fig. 1. For each fishing trip, the number of captured and landed organisms, and those "hooked up" and later released, were recorded, so the catch per unit of effort (CPUE) is represented by the number of organisms captured per trip.

The information was organized by lunar phase using five days for each phase (full moon, waning moon, waxing moon, and new moon). To determine the use of a parametric or nonparametric test in the analysis of the information, Kolmogorov-Smirnov goodness of fit of a normal distribution and Bartlett's test for homogeneity of variances were used. For the comparison of the fishing success for each lunar phase, an analysis of variance was used.

RESULTS

The values of the CPUE during the period analyzed had a maximum during January 1988 with 4 organisms per trip and a minimum in February 1989 with about 1 organism per trip (Fig. 2). The information on the resource during August to October was not recorded, however it is known that the presence of the striped marlin (*T. audax*) in those months is lower and behaves according to the tendency observed in Fig. 2 (Klett-Traulsen *et al*. 1996).

For the analysis of the fishing success by lunar phase (Fig. 3), during the waxing moon the number of organisms was a maximum of 1341, and the minimum during the full moon was 963 organisms.

Because with the Komolgorov-Smirnov test the hypothesis that the sample comes from a normal distributed population (d = 0.1206,

Fig. 1. Study area.

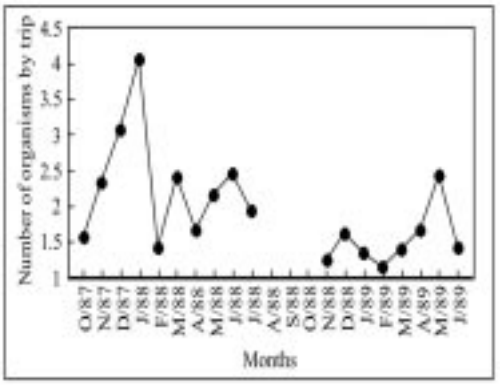

Fig. 2. Number of organisms per trip monthly average of marlin caught in the area of Los Cabos, B.C.S. during the period October 1987 to June 1988.

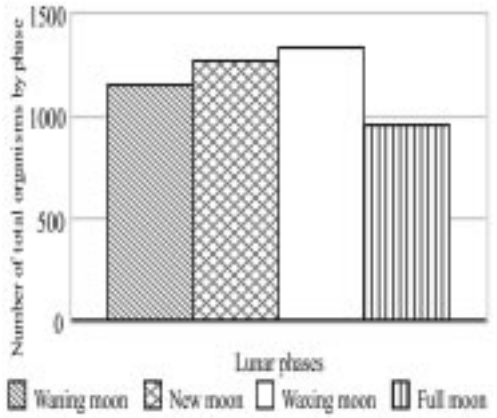

Fig. 3. Number of total organisms captured in each lunar phase.

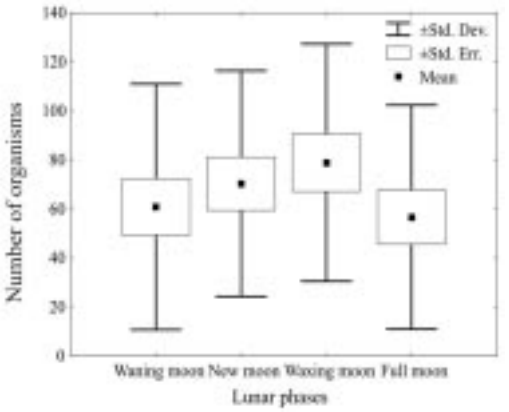

Fig. 4. Number organisms per trip captured in each lunar phase.

$p = 0.22$) was not rejected nor was the assumption for homogeneity of variances ($B_t = 0.0328$, $p = 0.99$), we proceeded to use an analysis of parametric variance. Although the behavior in the capture per trip had a maximum during the waxing moon and a minimum during the full moon, the difference was not significant ($F_{(3,67)} = 0.9769$, $p = 0.41$) (Fig. 4).

The average capture per trip (CPUE) and the number of periods analyzed in each phase is in Table 1.

DISCUSSION

Pallares and Garcia-Marmolar (1985) found the yield of the Atlantic yellowfin tuna caught by the Spanish tropical tuna fleets was related to the phases of the moon. The maximum yield was recorded in the second half of a waxing moon and the minimum in the first half of a waning moon.

The same authors mention that significant changes are found in yields during the different phases of the moon, especially in the Atlantic yellowfin tuna. Changes of abundance, catchability, and catch can be explained by relation to the phases of the moon. To interpret them as changes in the abundance of the stock, we would have to assume the CPUE is an index of abundance, assuming also a constant catchability. However, this hypothesis seems doubtful because there is no basis to justify it. Pallares and Garcia-Marmolar (1985) assume that a second explanatory hypothesis is that because of the influence or the effect of lunar phases on catchability, these phases can impact vertical migrations of the schools, modifying accessibility of the fish to the fishing gear.

TABLE 1
Average number of organisms per trip captured in each lunar phase and number of periods analyzed.

Lunar phase	CPUE average for lunar phase	No. of periods
Waning moon	2.0	19
New moon	2.1	18
Waxing moon	2.5	17
Full moon	1.8	17

For the swordfish, Di Natale and Mangano (1995) suggest that a first annual analysis of the CPUE data of the catch in the mesh of a drift net of the Italian fleet confirms the relationship between the phases of the moon and the CPUE, as much for the specific species as for the total capture, and they discuss that this can be related to five possible causes: a) that during the full moon the mesh of a drift net is more visible and detectable by the swordfish; b) that the behavior of the swordfish is influenced by the lunar phase (as consequence of the different ambient light); c) that the behavior of the swordfish could be influenced by changes in the vertical distribution of cephalopods caused by the full moon; d) the combination of these three factors seems to cause a decrease in catchability of the specific species; and e) the CPUE could be affected in some way by a reduction of the fishing effort during the full moon.

Evidence reported about the nonexistence of the relationship between the lunar phases and the fishing success in the fishery exists; *Xiphias gladius* Linnaeus, 1758; yellowfin tuna, black marlin, white marlin, and sailfish (*Makaira nigricans* Lacepede, 1802, *Tetrapturus albidus* Poey, 1860 and *Istiophorus platypterus* Shaw and Nodder, 1792), according to Nakamura and Rivas (1974), Anonymous (1989) and Moreno *et al.* (1991).

Because of all of the references quoted above, it is not possible to conclude whether there is, or is not, some relationship among the lunar phases and the success of capture of the different species mentioned. These studies deal with different resources in different areas possibly causing a different pattern of behavior related to other abiotic and biotic characteristics of the ecosystem being studied.

What we can conclude at present is that according to the analyzed information and to the results, statistically no significant difference exists between the different lunar phases and the success of capture of the striped marlin *T. audax* in the sport-recreational fishing of Los Cabos, B.C.S. Mexico.

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RESUMEN

Se analizó la influencia de las fases lunares sobre la captura por unidad de esfuerzo en el marlín rayado (*Tetraptus audax*) capturado por la flota deportiva en Cabo San Lucas, Baja California Sur, desde octubre de 1987 a junio de 1989. La información de 3377 viajes de pesca por 13 embarcaciones que representan cerca de un 10% de la flota. El análisis mostró un máximo en enero de 1988 y un mínimo en febrero de 1989. Tomar en consideración el conocimiento de los factores que tuvieron influencia en el éxito en la pesca es importante en el manejo de los recursos. No se encontró diferencias significativas durante la luna llena comparado con los resultados obtenidos durante las otras fases de la luna.

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