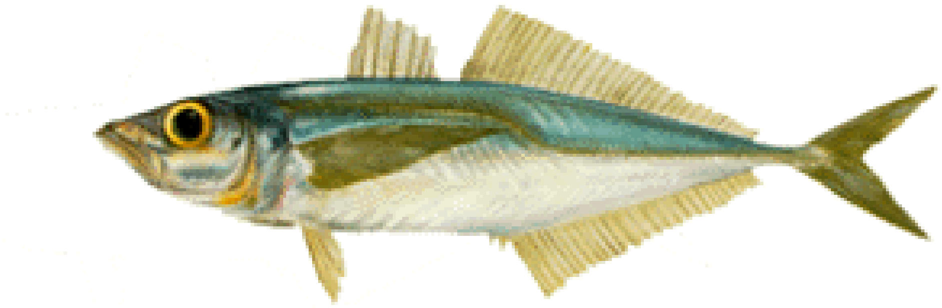
SPRFMO
South Pacific Regional Fisheries Management Organisation

Code: CJM
Scientific name: *Trachurus murphyi*



Taxonomy

Phylum	Chordata
Class	Osteichthyes/Actinopterygii
Order	Perciformes
Family	Carangidae
Genus and species	*Trachurus murphyi* (Nichols, 1920)
Scientific synonyms	Historically *Trachurus symmetricus murphyi*
Common names	Chilean Jack mackerel (FAO, Chile, Russia), Murphy's mackerel (New Zealand), Pacific Jack mackerel (Russia), Peruvian Jack mackerel (Australia, Russia), Jack mackerel, horse mackerel, jurel (Chile, Peru, Ecuador).
Molecular (DNA or biochemical) bar coding	Available in the Barcode of Life Data System (BOLD), at: http://www.boldsystems.org (Ref.:https://www.boldsystems.org/index.php/Public_SearchTerms?query=%22Trachurus%20murphyi%22[tax], see in Public Data to access DNA sequences).See also Poulin et al. 2004.

Species characteristics

Global distribution and depth range

The Chilean jack mackerel is distributed in the sub-tropical waters, of the south eastern Pacific Ocean, both inside areas under national jurisdiction and on the high sea, ranging from the Galapagos Islands and south of Ecuador in the north to southern Chile; ranging from South America in the east to Australia and New Zealand in the west (Evseenko 1987, Jones 1990, Serra 1991a, and Elizarov et al. 1993; Kotenev et al., 2006; Gerlotto et al., 2012) (see Fig. 1).

Aggregations of *T. murphyi* can be found at depths between 0 and 300 meters (Serra 1991a, Guzman et al. 1983, Bahamonde 1978, Anon 1984, Anon 1985, Dioses 2013a). The species exhibits a diurnal migratory behaviour, with fish being found deeper during the day (50-180 m) than at night (10-40 m) (Cordova et al. 1998).

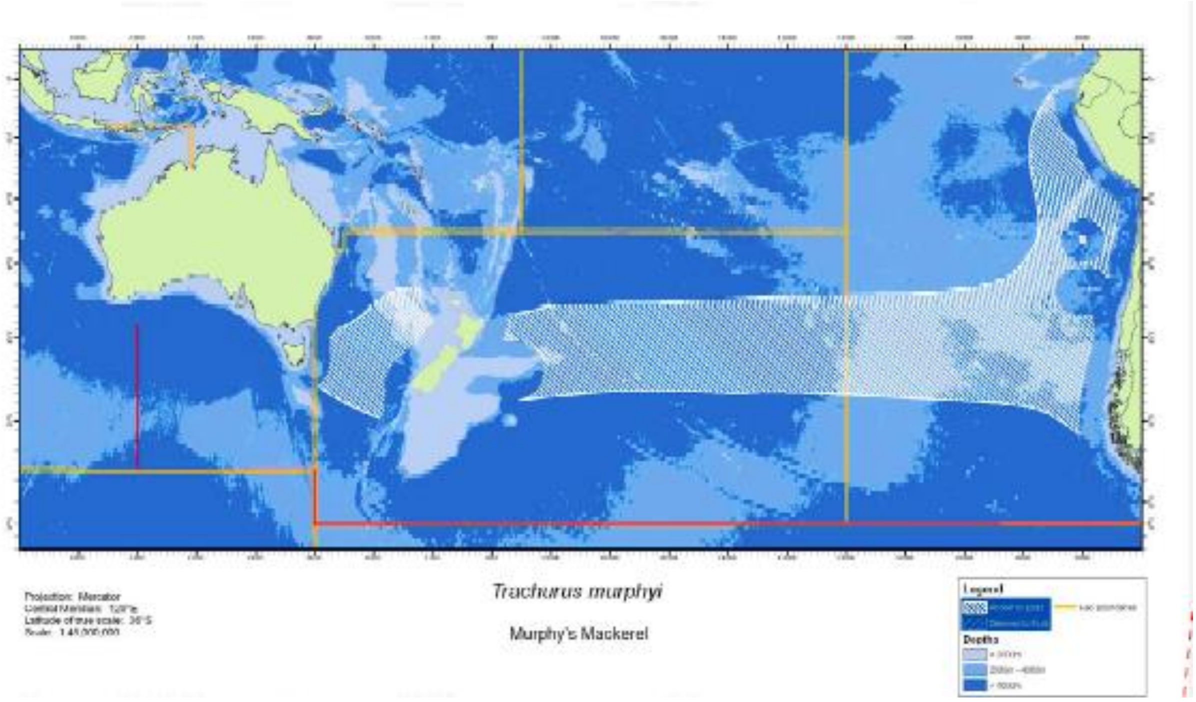


Figure 1. Distribution of Jack mackerel in the high seas in the South Pacific

Distribution within South Pacific area

Elizarov et al. (1993) coined the phrase “Jack mackerel belt” to describe the distribution of *T. murphyi* across the South Pacific (Fig. 1). The Jack mackerel belt is described as having a north-south breadth of “10 to 15 degrees” across “the southern sub region of the southeast Pacific Ocean (SEPO) and southwest Pacific Ocean (SWPO)”, which varies with season as “spawning groups concentrate mainly in the north of 40ºS in spring and summer and south of 40ºS in autumn and winter to feed”.

The stock assessment of Jack mackerel that are carried out on behalf of SPRFMO Commission are based on two hypotheses of population structure. One hypothesis establishes the existence of a single stock caught in the South-central and northern zone of Chile, the national jurisdictional waters of Peru and in the SPRFMO convention area. The other hypothesis establishes the existence of a stock caught in the south-central and northern zone of Chile and in SPRFMO convention area and a stock caught only in the Peruvian jurisdictional waters. Other hypotheses on the jack mackerel population structure have been suggested and discussed in different studies (SPRFMO 2008, Hintzen et al 2014, Gerlotto 2012, 2021).

General habitat and behaviour

T. murphyi is a schooling pelagic species adapted to both neritic and oceanic environments. According to the average catch pattern by fishing areas of jack mackerel *T. murphyi*, the highest concentrations registered in Peruvian and Chilean coastal ocean waters are associated with the high dynamics of coastal upwellings (Ñiquen & Peña 2008, Chernyshkov *et al*. 2008, Vásquez et al. 2020). At the interdecadal scale, variability patterns (warm and cold periods) seem to define favourable and unfavourable scenarios for *T. murph*yi. Likewise, studies by Dioses (1995) and Grechina et al. (1998) indicate that the oceanic fronts formed by the convergence of cold coastal waters and surface subtropical waters, would be the preferred habitat of *T. murphyi*, which is evidenced by the catches of this resource. On the other hand, Bertrand et al. (2004) report that *T. murphyi* is mainly located in oxygenated waters (above oxycline). It is noted that, the optimal oxygen content value for the presence of jack mackerel *T. murp*hyi would be between 1 and 3 ml/L, above oxycline (Dioses 2013a).

Biological characteristics

Morphology

Body elongate and slightly compressed. Enlarged, scute-like scales on primary lateral line. Termination of dorsal accessory lateral line below 2nd to 5th soft ray of dorsal fin. Pectoral fin tip extending to be above the two detached spines anterior to the anal fin. Eye moderate size with well-developed adipose eyelid. Posterior margin of upper jaw below anterior margin of eye. Jaws vomer, palatine, and tongue bearing minute teeth (Kawahara et al. 1988).

Colour when fresh: dark blue dorsal body, silver-white ventrally; upper posterior margin of opercula bears a black spot; pale pelvic fins; caudal, pectoral, and dorsal fins dusky; anal fin pale in the front, dusky in the rear.

Reproduction

Several authors have described *T. murphyi* to be an indeterminate batch spawner, based on histological studies and on the oocyte-size-frequency-distribution (OSFD) of reproductively active females, and their "presence over a long temporal extension of seven to nine months per year" (Dioses et al. 1989, George 1995, Oyarzún et al. 1998, Leal et al., 2013, Perea et al., 2013). This conclusion is supported by evidence from Evseenko (1987) and Bailey (1989) who state that *T. murphyi* spawns wherever environmental conditions are suitable. The suitable environmental conditions seem to be water warmer than 15 ºC, with highest densities having been found in waters of 16 - 19 ºC, and low current (less than 15 $cm.s^{-1}$) (Evseenko 1987, Cubillos et al. 2008). During the period of most intensive spawning, 10–15% of females spawn each day, meaning that the average female spawns every 7–10 days at this time (Oyarzún & Gacitúa 2002, Oliva et al. 1995).

Trachurus murphyi spawns, throughout its whole distribution range, in austral spring and summer, with the main spawning season from October to December (Serra 1983, 1991a, Elizarov et al. 1993, Oyarzún et al. 1998, Leal et al. 2013, Perea et al., 2013). Santander & Flores (1983) and Dioses et al. (1989) described Jack mackerel spawning in Peru as mainly occurring between 14º00'S and 18º30'S. However, more recent analyses by Ayon & Correa (2013) show that between 1966 and 2010 Jack mackerel larvae were present (and therefore spawning is inferred) every year along the whole Peruvian coast, with clear year to year north-south shifts in the centres of higher larvae abundance associated with shifts in environmental conditions. They describe important changes with time in the spatial larvae distribution. The centers of gravity of the larvae spatial distribution per year also showed some important differences in the distribution by latitude and distance from the coast, with three clear periods: the first one between 1966 and 1978 with main larvae concentrations between 14°S and 18ºS closer to the coast; the second between 1979 and 1994 more to the north, between 4°S and 14ºS, and more offshore; and, the third one between 1995 and 2010, with the centers of gravity located in an intermediate position between the other two (Ayon & Correa 2013). *T. murphyi* spawns regularly in Peruvian waters but the reproductive activity has a greater variability, lesser abundance and longer spawning period compared to the spawning occurring off Chile (Perea et al. 2013).

The main jack mackerel spawning grounds are located between 30°S and 40°S off central Chile, in coastal and oceanic waters extending beyond 200 miles of the EEZ to about 93º W (Serra 1991b, Núñez et al. 2004, and Arcos et al. 2005). In this region, the spawning activity is associated with the Subtropical front location that reaches its maximum latitudinal extension during austral spring-summer, and on the interannual scale modulates the meridional location of the jack mackerel spawning centroid (Grechina et al. 1998, Cubillos et al., 2008; Núñez et al. 2008). Larval otolith microstructure analysis has revealed a spatial age gradient with the smallest/youngest larvae specimens found primarily in the offshore area and the largest/oldest found in the coastal area, implying offshore-inshore larval drift (Vásquez et al. 2013). Furthermore, an additional area of spawning has been recorded in the area between 105°E and 125°E (Kotenev et al. 2006). In this region, favourable oceanographic conditions can increase larval survival and support the occurrence of juvenile jack mackerel (Parada et al. 2017). Historically, jack mackerel spawning records also have been reported within the EEZ of northern Chile with significant interannual variability and associated with coastal upwelling centres (Braun & Valenzuela, 2008).

Length at maturity

Mean length at first spawning has been reported to vary between 21 and 30 cm fork length in different areas (Basten & Contreras 1978, Cubillos et al. 2008, Leal et al. 2013, Abramov & Kotylar 1980, Dioses et al. 1989, Perea et al. 2013).

Growth

T. murphyi has a moderate growth rate (Cubillos et al. 1998). The maximum recorded age in Chile is 19 years, in New Zealand 35 years and in Peru 11 years.

Growth parameters of the Bertalanffy growth function from several studies indicate that L_∞ is between 70 and 81 cm, W_∞ around 3700 g, K between 0.094 and 0.155 and t_0 between -0.89 and -0.36 (Dioses 2013b, Kochkin 1994, Gili et al. 1996.

Age determination

The ageing analysis of *T. murphyi* in Chile have been validated using three methods: 1) daily microincrement readings in sagittal otoliths of young-of-the year (YOY) fish to validate the first annulus; 2) modal progression of strong year-classes (PSYC) to validate the second and third annuli, and 3) bomb radiocarbon analysis of otolith cores to validate the absolute age in older fish over 40 cm fork length (FL). The result showed a fast growth in the firsts two years, identifying two false rings compared with currently ageing estimation (Cerna et al. 2016; Araya et al. 2019). These finding were consistent with bomb radiocarbon method results that validated the age of older fish (Cerna et al. 2016; Ojeda et al. 2008).

In Peru, the age and growth of Jack mackerel has been determined by the direct reading and measuring of annual growth rings in whole otoliths (Dioses 2013b) and have been confirmed by independent observations through the reading of micro-increments or daily rings in otoliths (Goicochea et al. 2013) and length frequency analysis of commercial and research survey catches (Díaz 2013). The same author tested the validity of the methodology being used by checking the growing similarity between rings (whose growth decreases with the formation of a new ring) and the monthly variation of otolith marginal increment, while Goicochea et al. (2013) and Díaz (2013) obtained very similar results using independent methods and different sources of data.

Natural mortality

Natural mortality has been estimated to be in the range of 0.22 to 0.31 y^{-1} based on size composition data, growth functions and other traits (Cubillos et al. 2008, Canales & Serra, 2008).

Role of species in the ecosystem

This species is a generalist feeder capable of utilising a wide range of prey species (Konchina 1979) and may be acting as an energy flow channeler from primary producers to top predators. In the Peruvian upwelling system, the Euphausiidae is the dominant prey for Jack Mackerel and contribute with 49% (Alegre et al., 2015). However, its wide range of prey species shows that it is not restricted to this role. Population size of *T. murphyi* can be extremely high, as indicated by the “bloom” event in the early to mid-1990s when 4.4 Mt were taken in the Chilean fishery in 1995 and which coincided with a peak in aerial sightings records in New Zealand waters (P.R. Taylor, NIWA, New Zealand, unpublished data) and with the relatively high catches and abundance indices off Peru (Segura and Aliaga 2013, Ñiquen et al. 2013).

Little is known about its predators, although Bailey (1987) tentatively identified juvenile jack mackerel from the stomachs of albacore tuna (*Thunnus alalunga*) taken in the central South Pacific (36ºS to 42ºS and 148ºW to 165ºW) as *T. murphyi*. It has also been found in the stomach contents of swordfish off the Chilean coast (M. Donoso, IFOP, Chile, pers. comm.). Generally, it can be expected that its predators will be similar to those of other carangid mackerels and will include tunas, billfish, and sharks. As a consequence of the large size of the Jack mackerel and its important role as both predator and prey, this species is likely to be an important node in Pacific Ocean predator-prey networks.

Impacts of Fishing

Habitat damage

No direct habitat damage known in the mid-water trawl and purse seine fisheries and such damage is unlikely due to the gear types used.

References

Abramov, A.A., Kotlyar, A.N. (1980). Some biological features of the Peruvian jack mackerel, *Trachurus symmetricus murphyi*. *Journal of Ichthyology 80*: 25–31.

Alegre, A., Bertrand, A., Espino, M., Espinoza, P., Dioses, T., Ñiquen, M., Navarro, I., Simier, M. Ménard, F. (2015). Diet diversity of jack and chub mackerels and ecosystem changes in the northern Humboldt Current system: A long-term study. *Progress in Oceanography*, *137*, 299-313.

Araya, M., Marianela, M., Segovia, E., Peñailillo, J., Avilés, M., Chisen, K., Arcos, A., Charlin, J., Pacheco, C., Plaza, G., Rodríguez-valentino, C., Galeano, A.M. (2019). Validación de la formación de los anillos de crecimiento diario de jurel. Proyecto FIPA Nº 2017-61. Informe Pre-final. 172 p. https://www.subpesca.cl/fipa/613/articles-97310_informe_final.pdf.

Anon (1984). Report of survey for the development of new distant water trawling grounds in 1983. Kaihatsu News No 40.

Anon (1985). Report of survey for the development of new distant water trawling grounds in 1984. Kaihatsu News No 45.

Arcos, D., Gatica, C., Ruiz, P., Sepulveda, A., Barbieri, M.A., Alarcon, R., Nuñez, S., Chong, J., Cordova, J., Rebolledo, A., Gonzales, C., Contreras, F., Aguayo, M., Vejar, F., Torres P., Toro. C. (2005). Condición biologica de jurel en Alta Mar, año 2004. Informe Final Proyecto FIP 2004-33. Fondo de Investigación Pesquera.

Ayón, P., Correa, J. (2013). Spatial and temporal variability of Jack mackerel *Trachurus murphy* (Nichols 1920) larvae in Peru between 1966-2010. In: J. Csirke, R. Guevara-Carrasco y M. Espino (eds). 2013. Ecology, Fishery and Conservation of Jack mackerel (*Trachurus murphyi*) in Peru. Rev. Peru. Biol. Special Issue 20 (1): 083-086. (Volume published in Spanish with titles, abstracts and captions in English).

Bahamonde, R. (1978). Distribución y abundancia relitiva de los principales recursos demersales entre Corral (40ºS) y el Cabo de Hornos (57ºS). Instituto de Fomento Pesquero IFOP/JAMARC. Informe Interno.

Bailey, K. (1987). Townsend Cromwell surveys South Pacific albacore resource. *Catch, 14(7)*; 20–22.

Bailey, K. (1989). Description and surface distribution of juvenile Peruvian jack mackerel, *Trachurus murphyi*, Nichols from the subtropical convergence zone of the central South Pacific. *Fishery Bulletin 87*: 273–278.

Basten, J.; Contreras, P. (1978). Observaciones preliminares sobre la pesquería del jurel *Trachurus murphyi* (Nichols) en la zona norte de Chile. Períoda julio 1975–julio 1978. Universidad del Norte Departamento Pesquerías Informe Técnico. 62 p.

Bertrand, A., Segura, M., Gutiérrez, M., Vásquez, L. (2004). From small-scale habitat loopholes to decadal cycles: a habitat-based hypothesis explaining fluctuation in pelagic fish populations off Peru. *Fish and Fisheries 5*: 296 – 316

Braun, M., Valenzuela, V. (2008). Seasonal distribution and abundance of jack mackerel (*Trachurus murphyi*) eggs and larvae off northern Chile 1981-2007. Paper 01.CHJMWS presented to the SPRFMO Chilean Jack Mackerel Workshop, Santiago, 30 June – 4 July 2008.

Canales, C., Serra, R. (2008). Chilean jack mackerel stock assessment model. Paper 20.CHJMWS presented to the SPRFMO Chilean Jack Mackerel Workshop, Santiago, 30 June – 4 July 2008.

Cerna F., Valero, C., Moyano, G., Muñoz, L. (2016). Protocolo de lectura de otolitos de jurel. Informe Final FIP N° 2014-32. 147 p + anexos. https://www.subpesca.cl/fipa/613/articles-89390_informe_final.pdf

Chernyshkov, P., Timokhin, E., Glubokov, A. (2008). Inter-annual and seasonal variability of oceanological conditions in the Southern Pacific Ocean in connection with the pelagic ecosystem structure. Paper 06. CHJMWS presented to the SPRFMO Chilean Jack Mackerel Workshop, Santiago, 30 June – 4 July 2008.

Cordova et al. (1998). Evaluación hidroacústica del recurso jurel en la ZEE de Chile. IFOP/FIP 98-11. Informe Final. 200 págs. +figs.

Cubillos, L., Gatica, C., Serra, R. (2008). Short review of natural mortality and size at first maturity on jack mackerel (*Trachurus murphyi*) in the southeastern Pacific. Paper 14.CHJMWS presented to the SPRFMO Chilean Jack Mackerel Workshop, Santiago, 30 June – 4 July 2008.

Cubillos, L., Alarcón, R., Vilugran, L., Sepúlveda, A., George-Nascimento, M., Araya, M., Medina, M., Zambrano, J., Guzman, M., Martinez, L., Peñailillo, J., Gili, R., Young, Z., Alegria, V., Bocic, V., Muñoz, L., Cid, L.(1998). Validación de los métodos aplicados en la determinación de edad y crecimiento y determinación de la mortalidad del jurel en la zona centro.sur. Informe Final Proyecto FIP 95-10, 170 p.

Díaz, E. (2013). Estimation of growth parameters of Jack mackerel *Trachurus murphyi* (Nichols 1920) caught in Peru, from length frequency analysis. In: J. Csirke, R. Guevara-Carrasco y M. Espino (eds). 2013. Ecology, Fishery and Conservation of Jack mackerel (*Trachurus murphyi*) in Peru. Rev. Peru. Biol. Special Issue 20 (1): 061-066. (Volume published in Spanish with titles, abstracts and captions in English).

Dioses, T. (2013a). Abundance and distribution patterns of Jack mackerel *Trachurus murphyi* (Nichols 1920) in Peru. In: J. Csirke, R. Guevara-Carrasco y M. Espino (eds). 2013. Ecology, Fishery and Conservation of Jack mackerel (*Trachurus murphyi*) in Peru. Rev. Peru. Biol. Special Issue 20 (1): 067-074. (Volume published in Spanish with titles, abstracts and captions in English).

Dioses, T. (2013b). Age and growth of Jack mackerel *Trachurus murphyi* (Nichols 1920) in Peru. In: J. Csirke, R. Guevara-Carrasco y M. Espino (eds). 2013. Ecology, Fishery and Conservation of Jack mackerel (*Trachurus murphyi*) in Peru. Rev. Peru. Biol. Special Issue 20 (1): 045-052. (Volume published in Spanish with titles, abstracts and captions in English).

Dioses, T. (1995). Análisis de la distribución y abundancia de los recursos jurel y caballa frente a la costa peruana. *Informe Progresivo del Instituto del Mar del Perú 3*, 55 pp.

Dioses, T., Alarcon, V.H., Nakama, M.H., Echevarria, A. (1989). Desarrollo ovocitario, fecundidad parcial y distribucion vertical de los cardumenes en desove del jurel *Trachurus murphyi* (N). (Oocyte development, partial fecundity and vertical distribution of the spawning schools of jack mackerel, *Trachurus murphyi* N.). Revista de la Comision Permanente del Pacifico Sur. 287–294.

Elizarov, A.A.; Grechina, A.S.; Kotenev, B.N.; Kuzetsov, A.N. (1993). Peruvian jack mackerel, *Trachurus symmetricus murphyi*, in the open waters of the South Pacific. *Journal of Ichthyology 33*: 86–104.

Evseenko, S.A. (1987). Reproduction of the Peruvian jack mackerel *Trachurus symmetricus murphyi* in the South Pacific. *Journal of Ichthyology 27*: 151–160.

George, M.R. (1995). Aspects of the reproductive cycle of southern Pacific jack mackerel, *Trachurus murphyi* Nichols, 1920, off northern coast of Chile. *Ices C.M 1995/H30*: 12.

Gerlotto, F., Gutiérrez, M., Bertrand, A. (2012). Insight on population structure of the Chilean jack mackerel (*Trachurus murphyi*). *Aquatic Living Resources, 25*(4), 341-355.

Gerlotto F., Bertrand, A., Hintzen, N., Gutiérrez, M. (2021). Adapting the concept of metapopulations to large scale pelagic habitats. Working paper presented to the 9th meeting of the SPRFMO Scientific Committee, 27 September – 2 October 2021. SPRFMO document SC9-HM01: 37 p

Gili, R., Alegría, V., Bocic, V., Cid, L., Miranda, H. (1996). Estudio biológico pesquero del recurso jurel en la zona centro sur, V a X Regiones. Determinación de la estructura de edad y parámetros de crecimiento del jurel. FIP 018 - 93.

Goicochea, C., Mostacero, J., Moquillaza, P., Dioses, T., Topiño, Y., Guevara-Carrasco, R. (2013). Validation of the formation rate of growth rings in otoliths of Jack mackerel *Trachurus murphyi* (Nichols 1920). In: J. Csirke, R. Guevara-Carrasco y M. Espino (eds). 2013. Ecology, Fishery and Conservation of Jack mackerel (Trachurus murphyi) in Peru. Rev. Peru. Biol. Special Issue 20 (1): 053-060. (Volume published in Spanish with titles, abstracts and captions in English).

Grechina, A., Núñez, S., Arcos, D. (1998). El desove del recurso jurel, *Trachurus symmetricus murphy* (Nichols), en el océano Pacífico Sur. En D. Arcos (Ed.). Biología y ecología del jurel en aguas chilenas. Instituto de Investigación Pesquera, Chile: 117 – 140.

Guzman, O.; Castillo, J.; Lillo, S.; Pineda, P.; Rodriguez; Giakoni, I. (1983). Estudio de recursos pelágicos. Programa monitoreo de los recursos pelágicos. I. Prospección zona Arica–Coquimbo. (18º30'–30º00'S). CORFO. Gerencia de Desarrollo. IFOP (AP 83–32). 48 p.

Hintzen, N.T., Corten, A., Gerlotto, F., Habasque, J., Bertrand, A., Lehodey, P., Brunel, T., Dragon, A.C., Senina, I. (2014). Hydrography and Jack Mackerel stock in the South Pacific – Final report Studies for carrying out the Common Fisheries Policy, Open call for tenders No MARE/2011/16 Lot 1, European Commission.

Jones, J.B. (1990). Jack mackerels (*Trachurus* spp.) in New Zealand waters. *N.Z. Fisheries Technical Report No. 23*: 28 p.

Kawahara, S.; Uozumi, Y.; Yamada, H. (1988). First record of a carangid fish *Trachurus murphyi* from New Zealand. *Japanese Journal of Ichthyology 35*: 2 212–214.

Kochkin, P.N. (1994). Age determination and estimate of growth rate for the Peruvian jack mackerel, *Trachurus symmetricus murphyi*. *Journal of Ichthyology 34*: 39–50.

Konchina, Y.V. (1979). The feeding of the Peruvian jack mackerel, *Trachurus symmetricus murphyi*. *Journal of Ichthyology 19*: 52–61.

Kotenev, B.N., Kukhorenko, K.G., Glubokov, A.I. (2006). Main results of the Russian multidisciplinary ecosystem research, and exploratory fish-finding of concentrations of hydrobionts and their fisheries development in the south Pacific. Moscow: VNIRO. 37 p.

Leal, E., Díaz, E., Saavedra-Nievas, J.C., Claramunt, G. (2013). Ciclo reproductivo, longitud y edad de madurez de jurel Trachurus murphyi, en la costa de Chile. *Revista de Biología Marina y Oceanografía Vol. 48*, No3: 601-611.

Nunez, S., Letelier, J., Donoso, D., Sepulveda, A., Arcos, D. (2004). Relating spatial distribution of the Chilean jack mackerel eggs and environmental factors in the oceanic waters off Chile. Proceedings (Tomo II) of the Pan Ocean Remote Sensing Conference, 2004. Remote Sensing of Oceans, Coasts and Atmosphere: Developments and Applications. *Gayana, Vol. 68 Nº 2*: 444-449.

Núñez, S., Vásquez, S., Ruiz, P., Sepúlveda, A. (2008). Distribution of early developmental stages of jack mackerel in the Southeastern Pacific Ocean. Paper 02.CHJMWS presented to the SPRFMO Chilean Jack Mackerel Workshop, Santiago, 30 June – 4 July 2008.

Ñiquen, M.A., Peña, C.L. (2008). Distribution of jack mackerel (*Trachurus murphyi*) related to oceanographical features between north Perú to north Chile. Paper 02.CHJMWS presented to the SPRFMO Chilean Jack Mackerel Workshop, Santiago, 30 June – 4 July 2008.

Ñiquen, M., Bouchon, M., Ulloa, D., Medina, A. (2013). Análisis de la pesquería del jurel *Trachurus murphyi* en el Perú. In: Csirke J., R. Guevara-Carrasco & M. Espino (Eds.). Ecología, pesquería y conservación del jurel (*Trachurus murphyi*) en el Perú. Rev. peru. biol. número especial 20(1): 097-106.

Ojeda, V., Bocic, V., Muñoz, L. (2008). Methodology employed for age determination in Chilean jack mackerel (*Trachurus murphyi*). Paper 08.CHJMWS presented to the SPRFMO Chilean Jack Mackerel Workshop, Santiago, 30 June – 4 July 2008.

Oliva, J., Claramunt, G., Herrera, G., Padilla, C., Pizarro, P. (1995). Reproducción In: Alegría, V. (Ed.), Estudio Biológico Pesquero sobre el recurso jurel en la zona norte (Regiones I y II). IFOP.

Oyarzún, C., Gacitúa, S. (2002). Aspectos reproductivos, fecundidad parcial y frecuencia de desove del jurel, año 2001. In: Cubillos, L. (Ed.) Condición biológica del jurel en alta mar, año 2001. Preinforme Final Corregido, FIP 2001-12. 168 p. + Anexo.

Oyarzún, C., Chong, J., Malagueño, M. (1998). Fenología reproductiva en el jurel, *Trachurus symmetricus* /Ayres, 1855)(Perciformes, Carangidae) en el área de Talcahuano-Chile: 1982-984. En: D. Arcos (ed). *Biología y Ecología del Jurel en Aguas Chilenas*: 67.75.

Parada, C., Gretchina, A., Vasquez, S., Belmadani, A., Combes, V., Ernst, B., Di Lorenzo, E., Porobic, J., Sepulveda, A. (2017). Expanding the conceptual framework of the spatial population structure and life history of jack mackerel in the eastern South Pacific: an oceanic seamountregion as potential spawning/nursery habitat. – *ICES Journal of Marine Science, 74*: 2398–2414.

Perea, A., Mori, J., Buitron, B., Sánchez, J. (2013). Reproductive aspects of Jack mackerel *Trachurus murphy* (Nichols 1920) in Peru. In: J. Csirke, R. Guevara-Carrasco y M. Espino (eds). 2013. Ecology, Fishery and Conservation of Jack mackerel (*Trachurus murphyi*) in Peru. *Rev. Peru Biol. Special Issue 20* (1): 029-034. (Volume published in Spanish with titles, abstracts and captions in English).

Poulin, E., Cárdenas, L., Hernández, C.E., Kornfield, I., Ojeda, F.P. (2004). The brief history of the Chilean jack mackerel: population genetic inference from the mitochondrial DNA control region. *J. Fish Biol. 65*: 1160-1164.

Santander, H., Flores, R. (1983). Los desoves y distribución larval de ciertas especies pelágicas y sus relaciones con las variaciones del ambiente marino frente al Perú. En Sharp, G.D. y J.Csirke (eds) Actas de la Consulta de Expertos para examinar los cambios en la abundancia y composición por especies de recursos de peces neríticos. San José, Costa Rica, 18-29 abril 1983. Una reunion preparatoria para la Conferencia Mundial de la FAO sobre ordenación y desarrollo pesqueros. FAO Fish.Rep./FAO,Inf,Pesca, (291) vol.2: 553p.

Segura M., Aliaga, A. (2013). Biomasa acústica y distribución del jurel *Trachurus murphyi* en el Perú. En: Csirke J., R. Guevara-Carrasco & M. Espino (Eds.). Ecología, pesquería y conservación del jurel (*Trachurus murphyi*) en el Perú. Rev. Peru. Biol. Número Especial 20(1): 087- 096.

Serra, J.R. (1983). Changes in the abundance of pelagic resources along the Chilean coast. In: G.D. Sharp and J. Csirke (Eds.) Proceedings of the Expert Consultation to examine changes in abundance and species composition of neritic fish resources. San José, Costa Rica, 18 - 29 April 1983. FAO Fish. Rep. 291 (2): 255 - 284.

Serra, R., Glubokov, A. (2008). Population structure of Chilean jack mackerel, *Trachurus murphyi*, in the South Pacific Ocean: Full proposal for an international joint research programme. Paper 23.CHJMWS presented to the SPRFMO Chilean Jack Mackerel Workshop, Santiago, 30 June – 4 July 2008.

Serra, R. (1991a). Important life history aspects of the Chilean jack mackerel, *Trachurus symmetricus murphyi*. *Investigacion Pesquera (Chile) 36*: 67–83.

Serra, R. (1991b). Long - term variability of the Chilean sardine. In: Proceedings of the International Symposium on the Long - Term Variability of Pelagic Fish Populations and their Environment. T. Kawasaki, S. Tanaka, Y. Toba and A. Taniguchi (eds.) New York: Pergamon Press. pp 165 - 172.

SPRFMO. 2008. Report of the South Pacific Regional Fisheries Management Organization Chilean Jack Mackerel Workshop, 30 June-4 July 2008, Santiago, Chile. Document SPRFMO-VI-SWG-02: 70 p.

Vásquez, S., Correa-Ramírez, M., Parada, C., Sepúlveda, A. (2013). The influence of oceanographic processes on jack mackerel (*Trachurus murphyi*) larval distribution and population structure in the southeastern Pacific Ocean. *ICES Journal of Marine Science*, 70: 1097–1107.

Vásquez, S., Salas, C., Sepúlveda, A., Grazia Pennino, M. (2020). Estimation and prediction of the spatial occurrence of jack mackerel (Trachurus murphyi) using Bayesian Hierarchical spatial models. 8th meeting of the scientificcommitee, New Zealand. SC8-HM07.