

**DRAFT REPORT to the First International Meeting on the  
Establishment of the South Pacific Regional Fisheries Management  
Organisation – For First International Meeting on the Establishment of  
the South Pacific Regional Fisheries Management Organisation  
Discussions Only**

**SPECIES PROFILE FOR:**

**Chilean jack mackerel (*Trachurus murphyi*)**



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unless specifically authorised in writing by the Chair of the First  
International Meeting on the Establishment of the South Pacific  
Regional Fisheries Management Organisation**

## 1. Overview

This carangid mackerel is widespread throughout the South Pacific, from the shelf adjacent to Ecuador, Peru, and Chile; throughout the oceanic waters along the Subtropical Convergence Zone; in the New Zealand EEZ south of about 34 °S; and in southeastern waters of the Australian EEZ. From mitochondrial DNA sequencing, it has been concluded that *Trachurus murphyi* is a distinct species (Poulin et al., 2004). Some biological summaries have assumed synonymy with *T. symmetricus* and incorporated information from Californian studies, which may be misleading. Its biology is reasonably well known. *T. murphyi* has become an important commercial species following an increase in its abundance in the early seventies in the east and a subsequent large-scale westward migration into oceanic waters and a subsequent invasion of New Zealand and Australian fisheries waters.

## 2. Taxonomy

2.1 Phylum: Chordata

2.2 Class: Osteichthyes/Actinopterygii

2.3 Order: Perciformes

2.4 Family: Carangidae

2.5 Genus and species: *Trachurus murphyi* Nichols, 1920

2.6 Scientific synonyms: none

2.7 Common names: Chilean jack mackerel (FAO, Chile, Russia), Murphy's mackerel (New Zealand), Peruvian jack mackerel (Russia), jack mackerel, horse mackerel, jurel (Chile, Peru, Ecuador).

## 3. Species characteristics

### 3.1 Distribution and depth

The Chilean jack mackerel is distributed throughout the southeastern Pacific, ranging from the Galapagos Islands and south of Ecuador to southern Chile. From south-central Chile it crosses the Pacific Ocean along the West Wind Drift having reached New Zealand and Tasmanian waters in early to mid 1980s (Evseenko, 1987; Jones, 1990; Serra, 1991; Elizarov et al., 1993).

Elizarov et al. (1993) coined the phrase “jack mackerel belt” to describe the distribution of *T. murphyi* across the South Pacific. It 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 40°S in spring and summer and south of 40°S in autumn and winter to feed”.

A large increase in abundance over the 20 years to 1991 is reported (Serra, 1991; Elizarov et al., 1993) which is believed to explain its large present distribution. Serra (op. cit.) also described a seasonal migration between coastal and oceanic waters for the Chilean subpopulation, and related

this to “reproductive and trophic processes”, stating, “this migration forms a pattern which determines the seasonal availability of the resource in the coastal and oceanic fisheries and establishes an important factor for stock assessment.” In Chilean fisheries waters, large jack mackerel tend to be distributed toward the south. A similar tendency for larger fish in southern waters is also seen in New Zealand fisheries waters (Taylor, in prep.).

Serra (1991) summarised depths for aggregations of *T. murphyi*: Guzman et al. (1983) used hydroacoustic equipment to record the species down to 250 m off the coast of northern Chile; in central and southern Chilean waters, Bahamonde (1978) described it to 300 m; and, Japanese trawlers have recorded it to depths of 300 m beyond the Chilean EEZ (Anon 1984, 1985).

Cordova et al. (1998) described a diurnal migratory behavior with fish deeper during the day (50-180 m) than at night (10-40 m).

### 3.2 Habitat

*T. murphyi* is a schooling pelagic species adapted to both neritic and oceanic environments. Larvae are adapted to oceanic conditions. Serra (1991) described a cyclic migration in which adults from the Chilean stock left the coastal waters to spawn in oceanic waters, returning to coastal waters to feed. In oceanic waters, beyond 120°W, Elizarov et al. (1993) described a migratory pattern moving the jack mackerel from southern cold waters and rich in production toward the north to subtropical waters where it spawns and vice versa. Young of the year of the Chilean stock moved eastwards, arriving on the shelf and recruiting at about age 2 years.

### 3.3 Biological characteristics

#### 3.3.1 Reproduction

Several authors 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). This conclusion is supported by evidence from Evseenko (1987) and Bailey (1989) that *T. murphyi* spawns wherever environmental conditions are suitable. These conditions seem to be water warmer than 15 °C, having been found the highest densities in waters of 16 – 19 °C, and low current (less than 15 cm s<sup>-1</sup>) (Evseenko, 1987; Nuñez et al., 2004).

According to Oyarzún and Gacitua (2002) and Oliva et al. (1995), 10–15% of females spawn each day during the period of most intensive spawning, meaning that the average female spawns every 7–10 days at this time.

First spawning has been described at 25 cm fin length (FL) by Abramov & Kotlyar (1980); 23 cm total length (equal to 21 cm FL) by Dioses et al. (1989), based on histological examination of ovaries; 22 cm (Marcelo Oliva Morena, Instituto de Investigaciones, Universidad de Antofagasta, Chile, pers. comm.); and 23 cm FL (Basten & Contreras 1978).

*T. murphyi* spawns in spring and summer, with the main spawning season from October to December (Serra 1983 and 1991; Elizarov et al. 1993; Oyarzún et al. 1998). It spawns throughout its distribution, but the main spawning ground of the Chilean subpopulation is off central Chile in coastal waters extending beyond 200 miles of the EEZ to about 93° W (Serra, 1991; Nuñez et al., 2004; Arcos et al. 2005).

*T. murphyi* also spawns along the Subtropical convergence, between the southern and northern limits (42 °S and 36 °S). The western center of the spawning occurs within 130 to 155°W and 35 °S to 40 °S (Evseenko, 1987; Elizarov et al. 1993)

### 3.3.2 Growth

Several papers have been published describing *T. murphyi* growth functions. Cubillos et al. (1998) summarized 22 studies. Based on two of these, *T. murphyi* can be described as having a moderate growth rate. In Chile the maximum recorded age is 19 years, which contrasts strongly with the maximum age of 32 years estimated in New Zealand.. Some of the difference in these estimates can be explained by New Zealand specimens being larger, and therefore older, than those taken in Chile, as would be expected for an animal near the extreme of its range. However, some of the difference may be the result of differing ageing methodologies used in the two countries—counts of whole otoliths are used in Chile, whereas counts from embedded, sectioned otoliths are used in New Zealand.

Kochkin (1994) sampled specimens from both the South West Pacific Ocean (SWPO) and the South East Pacific Ocean (SEPO) between 1983 and 1990 and investigated growth using otoliths and length frequencies. His estimated von Bertalanffy relationship was  $L_t = 74.2405[1 - e^{-0.1109(t + 0.8113)}]$ , and he determined  $L_{max}$  to be  $0.943L_{\infty}$ .

Gili et al. (1996) investigated growth using otholiths sampled from the central Chile fishery. Their estimates of growth parameters were:  $K=0.094$ ;  $L_{\infty}=70.8$  cm FL; and  $t_0=-0.896$ .

**Note: need to insert a table describing mean size at age**

### 3.4 Morphological characteristics

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, palantine, and tongue bearing minute teeth (Kawahara et al. 1988).

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

### 3.5 Role of the species in the ecosystem

This species is a generalist feeder capable of utilising a wide range of prey species (Konchina 1979). It undoubtedly plays a role occupying the “specialist” niche in wasp-waist systems (Cury et al. 2000), acting as a conduit of energy flow between the primary producers and the higher generalists and predators. However, its wide range of prey species shows that it is not restricted to this. As the “bloom” event in the early to mid 1990s indicated (4.2 M t were taken in the Chilean fishery in 1995 (Table 1), which coincided with a peak in aerial sightings records in New Zealand waters—P.R. Taylor, unpublished data), productivity of *T. murphyi* can be extremely high. Little is known about its predators, though Bailey (1987) tentatively identified juvenile jack mackerel from the stomachs of albacore tuna (*Thunnus alalunga*) taken in the central South Pacific (36°S to 42°S and 148°W to 165°W) as *T. murphyi*. It has also been found in the stomach contents of

sword fish off the Chilean coast (M. Donoso, pers. com.). Generally it can be expected that predators will be similar to those of other carangid mackerels and will include tunas, billfish, and sharks.

### 3.6 Stock structure

Up to three separate stocks are suggested by the data throughout the range of this species. In South America there is evidence for at least two stocks based on results of genetic studies (Koval 1996) and generalised studies using distribution, abundance, size composition, and reproductive distributions (Evseenko 1987, Serra 1991), which can be identified as the Peruvian and Chilean stocks. There is also evidence for a stock in the South West Pacific Ocean based on reproductive distributions, morphological and parasite information (Evseenko 1987, Duran & Oliva 1983, Romero & Kuroki 1985, Storozhuk et al. 1987, Kalchugin 1992, Avdeyev 1992). The independence of this stock from the South East Pacific Ocean stocks is an open question.

The Chilean stock has supported previous exploitation by the Chilean and Soviet Union fisheries and currently supports exploitation by a Chinese fleet. The Soviet Union fishery vanished in 1992.

Evidence shows that following a strong increase in its abundance from the early 1970s, *T. murphyi* expanded its distribution toward the west and crossed the Pacific Ocean along the West Wind Drift, reaching New Zealand waters in the early to mid 1980s (Bailey, 1989; Serra 1991; Elizarov et al. 1993; Taylor 2002).

Although a large population of *T. murphyi* has existed in New Zealand waters following its initial invasion sometime during the early to mid 1980s, there is little evidence to support the stock being self-sustaining. According to Taylor (2002), New Zealand waters appear to be conducive to establishment of a self-sustaining stock, although analyses are compromised by inclusion of data for *T. declivis* and *T. Novaezelandiae*. The widespread distribution of prey species in New Zealand waters and the highly adaptable feeding strategy of *T. murphyi* largely preclude the possibility of food being limiting and the reproductive condition of specimens sampled in New Zealand indicates a wide geographic range of fish in maturing and spawning condition. However, few juvenile specimens have been taken during the approximately 20 years that *T. murphyi* has been present in New Zealand waters and recent monitoring shows that this species is now less abundant at the surface than during the mid 1990s (Taylor in prep).

## 4. Fisheries characterisation

### 4.1 Distribution of fishing activity

Four fisheries can be identified off the Chilean coast. The first is in northern Chile, from the boundary with Peru to 24° S. A second fishery operates from 24° S to 32° S. The main fishery is located off central Chile, from 32° S to about 43° S. In the two first fisheries the target species are small pelagic fish with jack mackerel a secondary target species. From 1978 to 1992 an international fishery operated beyond the 200 miles EEZ off central Chile. The main fleet was from the Soviet Union, but included vessels from Cuba and the German Democratic Republic. Since 2002 some Chinese vessels have fished in this zone.

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## 4.2 Fishing technology

*T. murphyi* is caught mainly by purse seine and midwater trawl net. In Chile, it is targeted extensively by domestic purse-seine vessels. In the northern Chilean fishery a Marco type of purse seiner is used, while in the fishery off central Chile purse seiners with their fishing gear at the deck level are used, similar to the Scandinavian design. The international fleet was composed mainly of large Russian midwater trawlers.

In 2004, the size of the purse seine fishing fleet in northern Chile was about 84 vessels, with an average size of 370 cubic meter of hold capacity, while the size of the fishing fleet in the central Chilean fishery was 56 vessels with an average hold capacity of 1 105 cubic meter and an average length of 55 meters.

### *Section still in progress*

## 4.3 Catch history

The Chilean fishery for *T. murphyi* peaked at around 4.2 M t. in 1995. Present catch is around 1.6 M tons including 130,000 tons taken by a Chinese fleet in the High Sea off central Chile. In Peru, the average annual catch of *T. murphyi* between 1994 and 2004 was 275,000 tons (Instituto del Mar del Peru — IMARPE). In New Zealand, *T. murphyi* forms part of the jack mackerel catch, which also includes *T. declivis* and *T. novaezelandiae*, is taken by purse-seine and midwater trawl, and totals about 25,000 t per annum.

The high seas were fished by Russian interests from 1978 to 1992. This activity remained high in the 1980s with a maximum catch of 900,000 tons beyond the EEZ off central Chile, and 1.1 M tons off the South American coast, according to FAO statistics. The fishery waned in 1992. Currently, Chinese interests are also utilizing the resource.

Since the peak of around 4.2 M tons in 1995, the Chilean fishery has declined to about 1.4 M tons between 2001 and 2004. (Table 1). The Peruvian fishery is an order of magnitude smaller, peaking at almost 800,000 tons in 2001, but declining to a variable fishery averaging about 100,000 tons between 2002 and 2004. Catch by the Chinese fleet on the high seas increased from 76,000 tons in 2002 to 130,000 tons in 2004.

**Table 1: Chilean jack mackerel catch in the Southeast Pacific.**

Year	Chile	Peru	China
1994	3,794,318	186,771	
1995	4,195,838	376,600	
1996	3,281,796	346,928	
1997	2,630,257	371,485	
1998	1,565,982	314,123	
1999	1,175,070	82,541	
2000	1,242,851	240,881	
2001	1,460,773	774,603	
2002	1,465,912	93,128	76,261
2003	1,414,318	134,677	96,000
2004	1,447,467	105,203	130,000

Sources: Chile, IFOP; Peru, IMARPE; and China, FAO.

Between 1994 and 2002, almost 100% of the Chilean catch of *T. murphyi* was taken within the EEZ (Table 2), but in 2003 and 2004 the proportion dropped considerably, with 32.5% and 24% respectively taken outside the EEZ.

**Table 2: Chilean catch in percentage taken inside and outside the EEZ.**

Year	inside EEZ	outside EEZ
1994	99.95	0.05
1995	98.55	1.45
1996	97.70	2.30
1997	99.12	0.88
1998	99.48	0.52
1999	99.76	0.24
2000	94.73	5.27
2001	99.99	0.01
2002	96.19	3.81
2003	67.52	32.48
2004	75.85	24.15

Recent data on high seas catches for New Zealand vessels are given below. Catches are mainly by purse seine.

*Section still in progress*

4.4 Non-target fish catch

*Section still in progress*

4.5 Non-fish catch

*Section still in progress*

4.6 Fishery potential

The Chilean subpopulation is at present fully exploited.

4.7 Fishery value

*Section still in progress*

5. Status and trends

5.1 Fishery productivity

*Section still in progress*

5.2 Population size

The biomass of the Chilean stock of *T. murphyi* has been estimated with statistical catch at age models (Serra, Canales and Caballero, 2005), hydroacoustic methods (Cordova et al., 2004) and the daily egg production method (Arcos et al., 2005).

Serra (1983 and 1991b) and Serra, Canales and Caballero (2005) described the increase in abundance of the Chilean jack mackerel subpopulation since the early seventies. Associated with this increase, the population expanded its distribution, crossing the South Pacific Ocean along the West Wind Drift (Serra, 1991; Elizarov et al. 1993). The Chilean stock attained a biomass of about 21 M tons by the end of the 1980s. It has declined since to about 7 M tons in 2004 due to reduced recruitment and fishing (ref?).

Elizarov et al. (1993) refers to work by Bogorov (1967), who classified the transoceanic zone from South America to New Zealand as being among the most highly productive regions of the Pacific. Using virtual population analysis it was determined that in the 5–7 years before 1993, the biomass of *T. murphyi* remained stable, varying within 12–22 M t in total: 1.3–2.4 M t in the northern SEPO, 10–14 M t in the southern SEPO and eastern part of the SWPO, and 6–8 M t in the central and western SWPO. An acoustic trawl survey in the SWPO in 1987 was used to estimate total biomass in this region as 8 M t (Nazarov & Nesterov 1990). Based on the biomass of the plankton (about 50 M t), biomass of *T. murphyi* was estimated to be about 5–7 M t (Vinogradov et al. 1991). “Work performed between 1979 and 1982 [has] shown that the jack mackerel form[s] commercial concentrations from 78 to 160 °W.”

Elizarov et al. (1993) suggested that El Niño events influence the composition of coastal communities. They refer to the “catastrophic event of 1972–73” and its effect on the anchovy population of the SEPO, with the subsequent dramatic increase in abundance of other pelagic planktivores like mackerel (*Scomber japonicus*), sardine (*Sardinops sagax*), and jack mackerel, as described by Zuta et al. (1983). The result was that “these species began to occupy the ecological niche made available by the disappearance of the anchovy,” and “by the end of the 1980s the total catch of the primary pelagic fishes in the region—anchovy (*Engraulis ringens*), sardine, jack mackerel, and mackerel—had almost reached the level of the anchovy catch during the late 1960s and beginning of the 1970s (12–13 M t).”

Similar fluctuations are suggested for oceanic waters, with the result that during years of El Niño the Peru-Chile Countercurrent, which carries nutrient-enriched equatorial waters to the far south (48–52 °S), becomes highly intensified. This intensification is also observed in the upwelling of the subantarctic divergence zone which “leads to the increase in productivity of the water in the jack mackerel belt”, and “favourable conditions [being] created for pelagic fish.” It is assumed that because of the scale of fluctuations in oceanic and atmospheric conditions in this region, changes occur almost simultaneously in coastal and oceanic waters, providing favourable conditions offshore for the population of jack mackerel that had begun to increase rapidly in size.

Recent monitoring in New Zealand waters shows that this species is now less abundant at the surface than during the mid 1990s.

### 5.3 Fishery exploitation

#### *Section still in progress*

### 5.4 Stock status

The Chilean stock is presently in a cycle of low abundance. Large reductions in the catch had occurred from the end of the 1990s due to regulations introduced to stop its declining trend.

### 5.5 Management implications

The Chilean subpopulation of *T. murphyi* has been declared to be in a regime of full exploitation in agreement with the Fishing Law. The fishery management objective is to avoid further decline in the stock. For this purpose catch quotas are applied to the industrial and artisanal fisheries. In the industrial fisheries the catch is allocated following a scheme called “maximum catch limits per shipowner”. Introduction of this regulation caused a decrease in the fleet size due to a rationalization of investment in the pelagic fish fishery. The fleet size in the northern fishery decreased by 30% and about 80% off central Chile.

A minimum size restriction is also applied in Chilean fisheries to protect the small fish and to avoid growth overfishing.

Similar regulatory controls are applied to the Chilean fishery outside the EEZ as the catch is all taken from the same stock (straddling).

## 6. Species/community management

### 6.1 Fisheries management by area/sub-area/jurisdiction

According to Anon (1997), most of the main fisheries in the SEPO “are under some kind of national fisheries management scheme, although their efficacy and the amount of research and administrative efforts devoted to their implementation vary greatly with the type of fishery and from country to country. Limiting access through fishing licences or fishing permits, the setting of total annual catch quotas, closed seasons, closed areas and limiting the minimum size of fish caught are amongst the most frequent management tools that are used and are frequently combined by national fisheries management authorities to regulate fishing in their areas of influence”.

In New Zealand, *T. murphyi* is managed as part of the tri-species jack mackerel fishery with total allowable catches set for the aggregate in a number of geographical regions or Fishstocks within the EEZ.

In Chile it is managed under a scheme of total allowable catch that is allocated under a concept called “maximum catch limits per shipowner” to the shipowners according to their historical catch records and a correction factor established in the fishing law for the hold capacity of the fishing vessels. This includes spatial and sectorial controls (artisanal, industrial).

### 6. Research underway

#### ***Section still in progress***

## 7. Threats

While it seems unlikely that there could be any threat to such a large resource as the total population of *T. murphyi*, there have been concerns at one regional level at least. The Chilean population of *T. murphyi* has reached low levels in some years, leading to fishery closures.

In New Zealand there has been a decline in the availability of *T. murphyi* to the purse-seine fishery, but it is unknown whether this represents a decline in its abundance.

8. Information on similar species

Shaboneyev (1980) summarises *Trachurus* to 12 species; the Integrated Taxonomic Information System (ITIS) at <http://www.itis.usda.gov/index.html> to 15 species. Large fisheries exist for a number of them. Research has been extensive in these fisheries and published information is readily available. Three species exist in the South Pacific—*T. murphyi*, *T. declivis*, and *T. novaezelandiae*.

9. Additional remarks

This document is still a draft and requires additional information in several sections.

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\* Reference not available for examination during literature searches for the review of Taylor (2002) but were cited in papers summarised there; sometimes relevant information (e.g., report number, page numbers) were omitted from the original citation and so could not be included here.