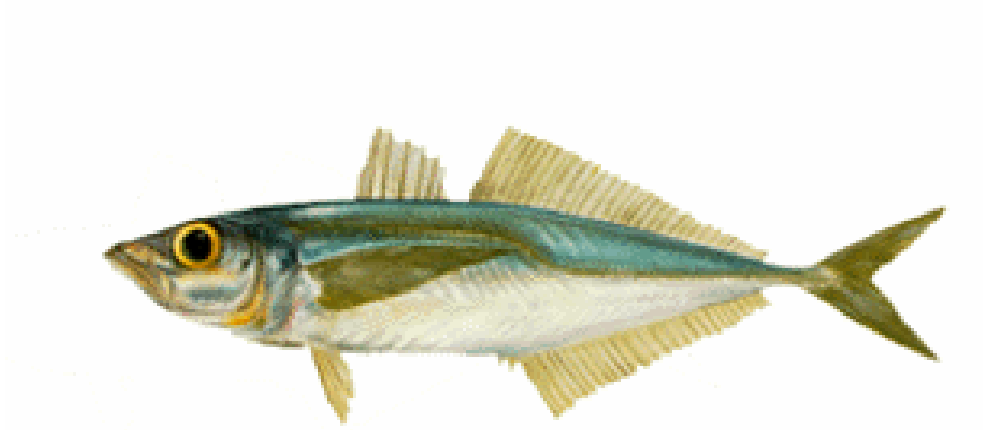


**Information describing Chilean jack mackerel (*Trachurus murphyi*) fisheries relating to the South Pacific Regional Fishery Management Organisation**



**REVISED  
23 April 2007**

|       |  |    |
|-------|--|----|
| 1.    | Overview .....   | 2  |
| 2.    | Taxonomy .....   | 4  |
| 2.1   | Phylum.....  | 4  |
| 2.2   | Class .....  | 4  |
| 2.2   | Order.....   | 4  |
| 2.3   | Family.....  | 4  |
| 2.5   | Genus and species .....  | 4  |
| 2.6   | Scientific synonyms.....                                       | 4  |
| 2.7   | Common names.....  | 4  |
| 2.8   | Molecular (DNA or biochemical) bar coding .....                | 4  |
| 3.    | Species characteristics.....                                   | 5  |
| 3.1   | Global distribution and depth range .....                      | 5  |
| 3.2   | Distribution within South Pacific area.....                    | 5  |
| 3.2.1 | Inter-annual and/or seasonal variations in distribution.....   | 6  |
| 3.2.2 | Other potential areas where the species may be found.....      | 6  |
| 3.3   | General habitat .....  | 6  |
| 3.4   | Biological characteristics .....                               | 6  |
| 3.5   | Population structure.....                                      | 8  |
| 3.6   | Stock productivity .....                                       | 8  |
| 3.7   | Role of species in the ecosystem.....                          | 8  |
| 4.    | Fisheries characterisation.....                                | 9  |
| 4.1   | Distribution of fishing activity .....                         | 9  |
| 4.2   | Fishing technology .....                                       | 9  |
| 4.3   | Catch history .....  | 9  |
| 4.4   | Stock status .....   | 10 |
| 4.5   | Threats .....  | 11 |
| 4.6   | Fishery value.....   | 15 |
| 5.    | Current Fishery Status and Trends.....                         | 15 |
| 5.1   | Stock size .....   | 15 |
| 5.2   | Estimates of relevant biological reference points.....         | 16 |
| 5.2.1 | Fishing mortality .....  | 16 |
| 5.2.2 | Biomass .....  | 16 |
| 5.2.3 | Other relevant biological reference points.....                | 17 |
| 6.    | Impacts of Fishing .....                                       | 17 |
| 6.1   | Catch of associated and dependent species .....                | 17 |
| 6.2   | Unobserved mortality of associated and dependent species ..... | 17 |
| 6.3   | Bycatch of commercial species .....                            | 17 |
| 6.4   | Habitat damage.....  | 18 |
| 7.    | Management .....   | 18 |
| 7.1   | Existing management measures .....                             | 18 |
| 7.2   | Fishery management.....  | 19 |
| 7.3   | Ecosystem Considerations .....                                 | 19 |
| 8.    | Research.....  | 20 |
| 8.1   | Current and ongoing research .....                             | 20 |
| 8.2   | Research needs .....   | 21 |
| 9.    | Additional remarks .....                                       | 22 |
| 10.   | References .....   | 22 |

## 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 south-eastern waters of the Australian EEZ.

From mitochondrial DNA sequencing *Trachurus murphyi* has been identified as a distinct species (Poulin et al. 2004). Some earlier biological summaries have assumed synonymy with *T. symmetricus* and incorporated information from Californian studies of that species, which may therefore be misleading.

*T. murphyi* has become an important commercial species following a substantial increase in its abundance, confirmed by assessments, in the early seventies in the east; a large-scale westward colonisation process into oceanic waters; and a subsequent invasion of New Zealand and Australian waters. Research has been extensive in some of these fisheries.

There have been a number of competing stock structure hypotheses, and up to four separate stocks have been suggested: a Chilean stock which is a straddling stock with respect to the high seas; a Peruvian stock which is also a straddling stock with the high seas; a central Pacific stock which exists solely in the high seas; and, a southwest Pacific stock which straddles the high seas and both the New Zealand and Australian EEZs. However, further collaborative research is required to confirm and/or clarify this hypothesised stock structure as a basis for effective management regimes.

Jack mackerel are predominantly caught by purse seine and midwater trawl.

The majority (~75%) of the global catch has been taken by Chilean vessels since the start of the fishery in 1950. In 2004 the Chilean catch was ~363 000 tonnes from the high seas within the South Pacific region, which represents ~25% of the Chilean total catch of this species. In recent years other flags including China, Netherlands, Republic of Korea, and Russia have taken catches on the high seas in the South Pacific region. At the western extent of the species range the high seas catch is much smaller, with New Zealand catches of <1 tonne in 2005. It is not currently possible to accurately quantify high seas catches as reporting is incomplete and those data that are reported do not separate between high seas and within EEZ catches.

The biology of *T. murphyi* is reasonably well known. Stock productivity is believed to be medium, with first spawning at 20 – 25cm, moderate fecundity, fairly rapid growth and a maximum age of ~20-30 years. Annual replacement yields are moderately high.

Currently, with the exception of Chilean vessels, there are no management measures in place for jack mackerel fisheries on the high seas (although all New Zealand and Australian flagged vessels that may take this species as an occasional bycatch are regulated by a high seas permitting regime). Due to the nature of the straddling Chilean stock, the same regulatory controls that apply within the Chilean EEZ also apply on the high seas. These controls include maximum catch limits per vessel owner and minimum size limits.

Although jack mackerel constitute a large resource, there have been concerns at a regional (assumed stock) level. For example, the Chilean straddling stock of *T. murphyi* is currently considered to be fully exploited. There is also an important ecological consideration related to potential over-harvesting of the jack mackerel resource. This relates to potential changes in predator-prey relationships. Jack mackerel constitute both a large predator pool, and a large prey resource, and probably fulfil an important role as a critical node in Pacific Ocean predator-prey networks. Experiences in other ecosystems have shown that substantial changes in the biomass of key species in the food web can lead to substantial and unpredictable responses in both their predators and their prey. Significant changes in predator-prey relationships are likely to cause shifts in food-web structure which are then not necessarily reversed by the reduction of fishing pressure.

For the Chilean (straddling) stock, current stock assessment suggests that the stock is at full exploitation and, given the moderate productivity of this species, caution with respect to any increases in fishing mortality is needed.

For the other stocks given the absence of current information, it is not appropriate to provide detailed comment. However, given the moderate productivity of this species and the lack of information about current stock biomass levels, due caution is appropriate.

There has been a substantial amount of historical research on this species, particularly by Russia. However, substantially less research has been conducted over the past decade, except within the EEZs of a few coastal states.

Research is required to improve the understanding of the stock structure of *T. murphyi* to aid the development of appropriate management units, to obtain biomass estimates for stocks actively fished as inputs to stock assessment modelling, to undertake stock assessment for the fished stocks to provide robust fisheries management advice, and to evaluate bycatch levels, bycatch composition and levels of incidental catch of associated and dependent species in the active high seas fisheries to address issues associated with an ecosystem approach to fisheries management.

## **2. Taxonomy**

Shabonev (1980) summarises *Trachurus* to 12 species; the Integrated Taxonomic Information System (ITIS) at <http://www.itis.usda.gov/index.html> to 15 species. Three species exist in the South Pacific—*T. murphyi*, *T. declivis*, and *T. novaezelandiae*. The latter two species occur in the Western Pacific almost exclusively in coastal waters within EEZs.

### **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**

Historically *Trachurus symmetricus murphyi*

### **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).

### **2.8 Molecular (DNA or biochemical) bar coding**

See Poulin et al. 2004.

### 3. Species characteristics

#### 3.1 Global distribution and depth range

The Chilean jack mackerel is distributed throughout the south eastern Pacific, both inside EEZs and on the high sea, ranging from the Galapagos Islands and south of Ecuador in the north 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 the early to mid-1980s (Evseenko 1987, Jones 1990, Serra 1991a, and Elizarov et al. 1993) (see Fig. 1).

Serra (1991a) 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 as occurring down to 300 m; and, Japanese trawlers have recorded it to depths of 300 m beyond the Chilean EEZ (Anon 1984, Anon 1985).

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

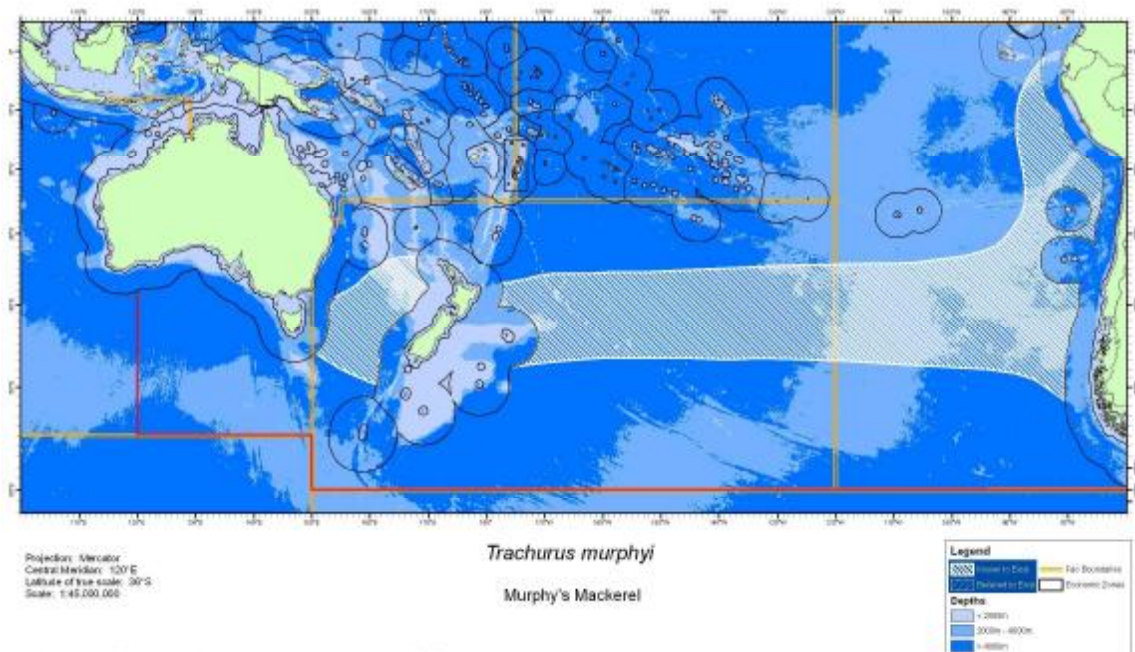


Figure 1. Distribution of Jack mackerel on the high seas in the South Pacific.

**Note: Post SPREMO III this figure will be re-plotted with the distribution more tightly constrained to the 35 to 45°S band.**

#### 3.2 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 40°S in spring and summer and south of 40°S in autumn and winter to feed”.

Following the 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 1991a, Elizarov et al. 1993, and Taylor 2002).

Jack mackerel are also found within the Australian, New Zealand, Chilean, Peruvian and Equadorian EEZs.

### 3.2.1 Inter-annual and/or seasonal variations in distribution

A large increase in abundance over the 20 years to 1991 has been reported (Serra 1991a and b, Elizarov et al. 1993), which is considered to be the cause of its large present distribution. Serra (1991a) 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.).

In oceanic waters, beyond 120°W, Elizarov et al. (1993) described a migratory pattern whereby jack mackerel move from productive, cold southern waters, northward into subtropical waters where they spawn, and then return. Young of the year of the Chilean stock moved eastwards, arriving on the shelf and beginning to recruit into the fishery at age 2.

### 3.2.2 Other potential areas where the species may be found

None likely based on the species biology and the oceanography of the area.

## 3.3 General habitat

*T. murphyi* is a schooling pelagic species adapted to both neritic and oceanic environments.

## 3.4 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, 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.

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, and 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. The suitable environmental conditions seems to be water warmer than 15 °C, with highest densities having been found in waters of 16 – 19 °C, and low current (less than 15 cm.s<sup>-1</sup>) (Evseenko 1987, Nuñez et al. 2004).

*Trachurus murphyi* spawns in spring and summer, with the main spawning season from October to December (Serra 1983 and 1991a, Elizarov et al. 1993, and 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 and extending beyond 200 miles of the EEZ to about 93° W (Serra 1991b, Nuñez et al. 2004, and Arcos et al. 2005).

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

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 fork 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). In Chile the mean length of first spawning is considered to be 25 cm FL.

Several papers have been published describing *T. murphyi* growth functions. Cubillos et al. (1998) summarised 22 studies. *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 otoliths sampled from the central Chile fishery. Their estimates of growth parameters were:  $K=0.094$ ;  $L_{\infty}=70.8$  cm FL; and  $t_0=-0.896$ .

### 3.5 Population structure

Up to four separate stocks have been suggested by analyses of 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), generalised studies using distribution, abundance, size composition, and reproductive distributions (Evseenko 1987, Serra 1991b) and parasite studies (Oliva 1999), which have been referred to as the Peruvian and Chilean stocks. There is also evidence for a stock in the central South Pacific Ocean based on reproductive distributions, morphological and parasite information (Evseenko 1987, Duran & Oliva 1983, Romero & Kuroki 1985, Storozhuk et al. 1987, Kalchugin 1992, and Avdeyev 1992). However, the degree of independence of this stock from the South East Pacific Ocean stocks remains an open question. There is also some evidence for a stock in the Southwest Pacific Ocean based on morphological (Kalchugin 1992) and parasite information (Duran & Oliva 1983, Romero & Kuroki 1985, and Avdeyev 1992).

A large population of *T. murphyi* has existed in New Zealand waters following its initial expansion into the region sometime during the early to mid 1980s. According to Taylor (2002), New Zealand waters appear to be conducive to establishment of a self-sustaining stock. The widespread distribution of prey species in New Zealand waters and the highly adaptable feeding strategy of *T. murphyi* suggest that food is not limiting and the reproductive condition of specimens sampled in New Zealand indicates a wide geographic range of fish in maturing and in spawning condition. However, few juvenile specimens have been taken during the approximately 25 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).

### 3.6 Stock productivity

The biology of *T. murphyi* is reasonably well known. Stock productivity is believed to be medium, with first spawning at 20 – 25cm, moderate fecundity, fairly rapid growth and a maximum age of ~20-30 years. Annual replacement yields are moderately high.

### 3.7 Role of 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 role. As the “bloom” event in the early to mid 1990s indicated (4.4 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, NIWA, New Zealand, unpublished data), population size 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 swordfish off the Chilean coast (M. Donoso, pers. com). 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 resource and its important role as both predator and prey, the species is likely to be an important node in Pacific Ocean predator-prey networks.

Substantial changes in jack mackerel abundance are therefore likely to lead to unpredictable, substantial and enduring changes in the abundances of its predators and prey, which may not be easily reversible by reduction of fishing mortality.

#### **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 within and outside the EEZ. 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 mile EEZ off central Chile. The main fleet was from the former USSR, but vessels from Cuba and the German Democratic Republic also fished. Since 2002 some Chinese vessels have fished in this area and more recently also one Dutch vessel.

**Note: This section needs to be updated during the upcoming meeting.**

##### **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 historically 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 metre of hold capacity, while the size of the fishing fleet in the central Chilean fishery was 56 vessels with an average hold capacity of 1105 cubic metre and an average length of 55 metres.

**Note: This section needs to be updated during the upcoming meeting.**

##### **4.3 Catch history**

The majority of the total global catch comes from FAO area 87, the Southeast Pacific (Table 2).

The high seas in the South Pacific were fished by vessels of the former USSR from 1978 to 1992. This activity remained high in the 1980s with a maximum catch of 900,000 tonnes beyond the EEZ off central Chile, and 1.1 M tonnes off the South American coast. Fishing activity stopped suddenly in 1992. In total over 13 million tonnes of jack mackerel were taken by the former USSR in the South Pacific during 1978-1991.

Chile's jack mackerel catches far exceeds other countries catch taking 75% of the world's reported catch. From 1950 to 1994 over 54 million tonnes of jack mackerel were taken by Chile. The Chilean fishery for *T. murphyi* peaked at around 4.5 M t. in 1995. Present total catch is around 1.5 M tonnes including 130,000 tonnes taken by a Chinese fleet on the high seas off central Chile. Between 1994 and 2002, almost 100% of the Chilean catch of

*T. murphyi* was taken within the EEZ (Table 1), but in 2003 and 2004 the proportion dropped considerably, with 32% and 28% taken outside the EEZ.

The Peruvian fishery is an order of magnitude smaller than the Chilean fishery, peaking at almost 800,000 tonnes in 2001, but declining to a variable fishery averaging about 100,000 tonnes between 2002 and 2004.

In New Zealand, *T. murphyi* forms part of the jack mackerel catch, which also includes *T. declivis* and *T. novaezelandiae*, and totals about 25,000 t per annum. The majority of New Zealand's jack mackerel is caught within the EEZ.

A Dutch vessel fishing on the high seas in 2006 had reported provisional landings up to the end of August in FAO area 87 of approximately 21 000 t of *T. murphyi*.

**Note: A table describing high seas catch in Area 87 would be useful here also.**

**Table 1: Percentage of Chilean jack mackerel catch in FAO Area 87 taken outside its EEZ and inside the proposed SPRFMO area by year, 1994-2004.**

| Year | Chile |
|------|-------|
| 1994 | 0.05  |
| 1995 | 1.45  |
| 1996 | 2.30  |
| 1997 | 0.88  |
| 1998 | 0.52  |
| 1999 | 0.24  |
| 2000 | 5.27  |
| 2001 | 0.01  |
| 2002 | 3.81  |
| 2003 | 32.33 |
| 2004 | 27.95 |

Source: IFOP, Chile.

#### 4.4 Stock status

##### *Chilean stock*

The Chilean straddling stock is at present considered to be fully exploited (FAO, 2005).

##### *Peruvian stock*

The status of the Peruvian stock is unknown.

##### *Central South Pacific stock*

The status of the Central Pacific stock is unknown.

##### *Southwest Pacific stock*

The status of the Southwest Pacific stock is unknown.

#### **4.5 Threats**

Not listed on IUCN.

**Table 1: Reported catches (t) of Chilean jack mackerel by country for FAO area 87 from 1950 to 2006.**

| <b>Country</b>              | <b>1950</b> | <b>1951</b> | <b>1952</b> | <b>1953</b> | <b>1954</b> | <b>1955</b> | <b>1956</b> | <b>1957</b> | <b>1958</b> | <b>1959</b> |
|-----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Chile                       | 1 000       | 700         | 1 300       | 1 900       | 2 000       | 1 200       | 1 400       | 4 700       | 5 600       | 11 200      |
| Peru                        | 0           | 100         | 100         | 100         | 100         | 100         | 700         | 400         | 200         | 400         |
| South Pacific Region Total  | 1 000       | 800         | 1 400       | 2 100       | 5 100       | 5 800       | 11 600      | 6 500       | 5 800       | 11 600      |
| Outside South Pacific Total |             |             |             |             |             |             |             |             |             |             |
| Grand Total                 | 1 000       | 800         | 1 400       | 2 000       | 2 100       | 1 300       | 2 100       | 5 100       | 5 800       | 11 600      |
| <b>Country</b>              | <b>1960</b> | <b>1961</b> | <b>1962</b> | <b>1963</b> | <b>1964</b> | <b>1965</b> | <b>1966</b> | <b>1967</b> | <b>1968</b> | <b>1969</b> |
| Chile                       | 6 200       | 5 400       | 9 000       | 8 700       | 10 300      | 12 700      | 17 600      | 26 400      | 23 800      | 16 600      |
| Peru                        | 300         | 200         | 700         | 200         | 1 700       | 2 600       | 4 300       | 3 100       | 2 800       | 4 200       |
| South Pacific Region Total  | 6 500       | 5 600       | 9 700       | 8 900       | 12 000      | 15 300      | 21 900      | 29 500      | 26 600      | 20 800      |
| Outside South Pacific Total |             |             |             |             |             |             |             |             |             |             |
| Grand Total                 | 6 500       | 5 600       | 9 700       | 8 900       | 12 000      | 15 300      | 21 900      | 29 500      | 26 600      | 20 800      |
| <b>Country</b>              | <b>1970</b> | <b>1971</b> | <b>1972</b> | <b>1973</b> | <b>1974</b> | <b>1975</b> | <b>1976</b> | <b>1977</b> | <b>1978</b> | <b>1979</b> |
| Bulgaria                    | -           | -           | -           | -           | -           | -           | -           | -           | -           | 4 726       |
| Chile                       | 104 000     | 149 900     | 86 000      | 121 600     | 193 512     | 261 205     | 342 269     | 340 806     | 586 681     | 597 511     |
| Cuba                        | -           | -           | -           | 100         | -           | 800         | 900         | -           | 1 000       | 19 000      |
| Japan                       | -           | -           | -           | -           | -           | -           | 35          | 2 273       | 1 667       | 120         |
| Korea, Republic of          | -           | -           | -           | -           | -           | -           | -           | -           | 819         | -           |
| Peru                        | 4 700       | 9 200       | 18 800      | 42 800      | 129 211     | 37 899      | 54 154      | 504 992     | 386 793     | 151 591     |
| Poland                      | -           | -           | -           | -           | -           | -           | -           | -           | -           | 1 180       |
| Un. Soc. Sov. Rep.          | -           | -           | 5 500       | -           | -           | -           | -           | -           | 49 220      | 532 209     |
| South Pacific Region Total  | 108 700     | 159 100     | 110 300     | 164 500     | 322 723     | 299 904     | 397 358     | 848 071     | 1 026 180   | 1 306 337   |
| Outside South Pacific Total |             |             |             |             |             |             |             |             |             |             |
| Grand Total                 |             | 159 100     | 110 300     | 164 500     | 322 723     | 299 904     | 397 358     | 848 071     | 1 026 180   | 1 306 337   |

**Table 1 (cont.):**

| Country                           | 1980      | 1981      | 1982      | 1983      | 1984      | 1985      | 1986      | 1987      | 1988      | 1989      |
|-----------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Bulgaria                          | 15 065    | 12 629    | 13 561    | 24 324    | 14 694    | 2 290     | -         | -         | -         | -         |
| Chile                             | 562 262   | 1 060 909 | 1 494 683 | 865 272   | 1 426 301 | 1 456 989 | 1 184 317 | 1 770 037 | 2 138 255 | 2 390 117 |
| Cuba                              | 83 971    | 74 227    | 83 881    | 54 875    | 34 008    | 32 258    | 46 833    | 35 980    | 44 209    | 24 486    |
| Ecuador                           | -         | -         | -         | 24 937    | 10 000    | -         | -         | -         | -         | 2 312     |
| Estonia                           | -         | -         | -         | -         | -         | -         | -         | -         | 82 590    | 77 351    |
| Georgia                           | -         | -         | -         | -         | -         | -         | -         | -         | 23 134    | 26 358    |
| Germany                           | 1 031     | -         | -         | -         | -         | -         | -         | -         | -         | -         |
| Japan                             | -         | 29        | -         | 1 694     | 3 871     | 5 229     | 6 835     | 8 815     | 6 871     | 701       |
| Korea, Rep.<br>of                 | -         | -         | -         | -         | 62        | 641       | -         | 2 018     | -         | -         |
| Latvia                            | -         | -         | -         | -         | -         | -         | -         | -         | 128 966   | 128 692   |
| Lithuania                         | -         | -         | -         | -         | -         | -         | -         | -         | 75 122    | 102 980   |
| Peru                              | 123 380   | 37 875    | 50 013    | 76 825    | 184 333   | 87 466    | 49 863    | 46 304    | 118 076   | 140 720   |
| Poland                            | 528       | -         | 7 136     | 39 943    | 80 129    | -         | -         | -         | -         | -         |
| Russian Fed.                      | -         | -         | -         | -         | -         | -         | -         | -         | 498 214   | 662 626   |
| Ukraine                           | -         | -         | -         | -         | -         | -         | -         | -         | 130 262   | 98 285    |
| Un. Sov.<br>Soc. Rep.             | 494 402   | 554 646   | 555 367   | 591 005   | 570 612   | 563 968   | 673 049   | 818 628   | -         | -         |
| South Pacific<br>Region Total     | 1 280 639 | 1 740 315 | 2 204 641 | 1 678 875 | 2 324 010 | 2 148 841 | 1 960 897 | 2 681 782 | 3 245 699 | 3 654 628 |
| Outside<br>South Pacific<br>Total |           |           |           |           |           |           |           |           |           |           |
| Grand Total                       | 1 280 639 | 1 740 315 | 2 204 641 | 1 678 875 | 2 324 010 | 2 148 841 | 1 960 897 | 2 681 782 | 3 245 699 | 3 654 628 |

**Table 1 (cont.):**

| Country                    | 1990      | 1991      | 1992      | 1993      | 1994      | 1995      | 1996      | 1997      | 1998      | 1999      |
|----------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Bulgaria                   | 1 649     | -         | -         | -         | -         | -         | -         | -         | -         | -         |
| Chile                      | 2 471 875 | 3 020 512 | 3 212 060 | 3 236 244 | 4 041 447 | 4 404 193 | 3 883 326 | 2 917 064 | 1 612 912 | 1 219 689 |
| Cuba                       | 41 197    | 30 828    | 3 196     | -         | -         | -         | -         | -         | -         | -         |
| Ecuador                    | 138       | 23 123    | 22 818    | 9 946     | 23 723    | 174 393   | 56 781    | 30 302    | 25 900    | 19 072    |
| Estonia                    | 78 627    | 60 318    | 376       | -         | -         | -         | -         | -         | -         | -         |
| Georgia                    | 36 130    | 12 181    | -         | -         | -         | -         | -         | -         | -         | -         |
| Japan                      | 157       | -         | -         | -         | -         | -         | -         | -         | -         | 7         |
| Latvia                     | 113 221   | 83 719    | 2 298     | -         | -         | -         | -         | -         | -         | -         |
| Lithuania                  | 80 874    | 109 292   | 7 842     | -         | -         | -         | -         | -         | -         | -         |
| Peru                       | 191 139   | 136 337   | 96 660    | 130 681   | 196 771   | 376 600   | 438 736   | 649 751   | 386 946   | 184 679   |
| Russian Fed.               | 688 551   | 419 650   | 31 357    | -         | -         | -         | -         | -         | -         | -         |
| Ukraine                    | 124 894   | 57 788    | -         | -         | -         | -         | -         | -         | -         | -         |
|                            |           |           |           |           |           |           |           |           |           |           |
| South Pacific Region Total | 3 828 452 | 3 953 748 | 3 376 607 | 3 376 871 | 4 261 941 | 4 955 186 | 4 378 843 | 3 597 117 | 2 025 758 | 1 423 447 |
| Grand Total                | 3 828 452 | 3 953 748 | 3 376 607 | 3 376 871 | 4 261 941 | 4 955 186 | 4 378 843 | 3 597 117 | 2 025 758 | 1 423 447 |

| Country                    | 2000      | 2001      | 2002      | 2003      | 2004      |
|----------------------------|-----------|-----------|-----------|-----------|-----------|
| Chile                      | 1 234 299 | 1 649 933 | 1 518 994 | 1 421 296 | 1 451 599 |
| China                      | -         | -         | 76 261    | 94 690    | 131 020   |
| Ecuador                    | 7 144     | 134 011   | 604       | -         | -         |
| Ghana                      | 2 472     | 1 157     | -         | -         | -         |
| Korea, Rep. of             | -         | -         | -         | 2 196     | 9 227     |
| Peru                       | 296 579   | 723 733   | 154 219   | 217 734   | 186 931   |
| Russian Fed.               | -         | -         | -         | 132       | -         |
|                            |           |           |           |           |           |
| South Pacific Region Total | 1 540 494 | 2 508 834 | 1 750 078 | 1 736 048 | 1 778 777 |
| Grand Total                | 1 540 494 | 2 508 834 | 1 750 078 | 1 736 048 | 1 778 777 |

Source: FAO Database 2006

## 4.6 Fishery value

In determining fishery value, three key types of jack mackerel product are considered: products for human consumption; fishmeal production from reduction fishing; and, fishmeal production from the processing waste stream.

In Chile, the industry, that uses jack mackerel as raw material, generated revenues of US\$164.9 million from export for human consumption and US\$264.4 million from fish meal during 2005. Overall prices average US\$655.9 per tonne for fishmeal and US\$733.6 per tonne for the human consumption products.

The majority of New Zealand's small high seas catch is landed as fishmeal. The average FOB<sup>1</sup> return for fishmeal not suitable for human consumption for the last 12 months was NZ\$1.25/kg. Total revenue from New Zealand jack mackerel exports in 2005 was NZ\$30 694 218 (5.8% of total exports), however, this mainly comprised of catch from within the EEZ (New Zealand Seafood Exports Report 5A, 2005).

## 5. Current Fishery Status and Trends

### 5.1 Stock size

#### *Historic estimates of biomass for various parts of the South Pacific*

Using virtual population analysis estimates for mixed stocks, it was determined that in the 5–7 years before 1993, the biomass of *T. murphyi* remained stable, varying from 12–22 M t in total: 1.3–2.4 M t in the northern SEPO (north of 30°S of the South East Pacific Ocean), 10–14 M t in the southern SEPO (south of 30°S) and eastern part of the SWPO, and 6–8 M t in the central and western SWPO (Elizarov et al., 1993). An acoustic / trawl survey in the SWPO (105 – 165°W) in 1987 was used to estimate total biomass in this region as 8 M t (Nazarov & Nesterov 1990). Depending on the proportion of acoustic signal assumed to be plankton (about 50 M t), biomass of *T. murphyi* was estimated to be about 5–7 M t (Vinogradov et al. 1991).

#### *Chilean stock*

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

Serra (1983 and 1991b) and Serra et al. (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, 1991a; Elizarov et al. 1993). The Chilean stock attained a biomass of about 21 M tonnes by the end of the 1980s. It has declined since to about 7 M tonnes in 2004 due to reduced recruitment and fishing.

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<sup>1</sup> Unit value is calculated by dividing the FOB value in NZ\$ by the weight in kg. (FOB= Free on Board. The value of export goods, including raw material, processing, packaging, storage and transportation up to the point where the goods are about to leave the country as exports. FOB does not include storage, export transport or insurance cost to get the goods to the export market.)

A Korean hydroacoustic research survey in August-December 2003 estimated biomass from three strata with a total 5,742 nm sq. area (the three strata were on the high seas in the vicinity of 29°S – 35°S, 83°E – 95°E) to be 1,461,335 tonnes (SD ± 569,920) (Kim, DooNam, pers. comm.).

***Peruvian stock***

No recent information available.

***Central South Pacific stock***

No recent information available.

***Southwest Pacific stock***

No recent information available.

**5.2 Estimates of relevant biological reference points**

5.2.1 Fishing mortality

***Chilean stock***

For the Chilean stock in 2005, using a fishing mortality reference point of  $F_{40\%BDR}$ ,  $F/F_{ref}$  was 1.25.

***Note: BDR needs definition.***

***Peruvian stock***

No current information available.

***Central South Pacific stock***

No current information available.

***Southwest Pacific stock***

No current information available.

5.2.2 Biomass

***Chilean stock***

For the Chilean stock in 2005 the Spawning Potential Ratio (Mace et al., 1996) was 0.3.

***Peruvian stock***

No current information available.

***Central South Pacific stock***

No current information available.

***Southwest Pacific stock***

No current information available.

5.2.3 Other relevant biological reference points

***Chilean stock***

No other relevant reference points.

***Peruvian stock***

No current information available.

***Central South Pacific stock***

No current information available.

***Southwest Pacific stock***

Recent aerial sightings data in New Zealand waters shows that this species is now less abundant at the surface than during the mid 1990's (Taylor, 2002).

**6. Impacts of Fishing**

**6.1 Catch of associated and dependent species**

No estimates available.

**6.2 Unobserved mortality of associated and dependent species**

This is unlikely given the methods used (mid-water trawl and purse seine) and the small mesh sizes of that gear allowing limited escapement.

**6.3 Bycatch of commercial species**

***Chilean stock fisheries***

The main bycatch of the jack mackerel fishery is chub mackerel (*Scomber japonicus*) which can form substantive quantities at times (see the species profile at <http://www.southpacificrfmo.org/working-groups/public/current-work/>). Other species taken are hoki (*Macruronus magellanicus*), snoek (*Thyrsites atun*) and in recent years giant squid (*Dosidicus gigas*).

### *Peruvian stock fisheries*

No current information available.

### *Central Pacific stock fisheries*

No current information available.

### *Southwest Pacific stock*

For high seas fisheries in the Southwest Pacific, the small jack mackerel catches are typically a bycatch of trawl fishing for other species (e.g. alfonsino). In the absence of current targeting of the species in the area, the bycatch information is presented in the relevant species profiles.

## **6.4 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.

## **6.5 Trophic relationships**

There may be some concerns related to any excessive fishing-induced reductions in jack mackerel abundance, and the effects this may have on stability of Pacific Ocean predator-prey networks.

## **7. Management**

### **7.1 Existing management measures**

#### *Chilean stock – Chilean vessels*

In Chile the fishery is managed under a scheme of total allowable catch that is allocated under a scheme of “maximum catch limits per shipowner” according to the shipowner’s historical catch records, and a correction factor established in fisheries law for the hold capacity of the fishing vessels. This includes spatial and sectoral controls (artisanal, industrial). Large reductions in catch occurred from the end of the 1990s due to regulations introduced to halt declining trends. 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 (straddling) stock.

For the 2007 year, the approved total quota is 1,600,000 tonnes.

#### *Peruvian stock*

There is no information available.

#### *Central South Pacific stock*

There is no information available.

### ***Southwest Pacific stock – New Zealand vessels***

In New Zealand fisheries waters, *T. murphyi* is managed as part of the tri-species jack mackerel fishery, with total allowable catches set for the combined species catch in a number of geographical regions (quota management areas) within the EEZ. A high seas permitting regime applies to all New Zealand vessels fishing the high seas, but there are no jack mackerel specific management measures in place beyond the EEZ at this time.

## **7.2 Fishery management**

### ***Chilean stock***

The Chilean (straddling) stock of *T. murphyi* has been declared to be fully exploited under Chilean 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. Introduction of this regulation caused a decrease in the fleet size due to rationalization of investment in the pelagic fishery. The fleet size in the northern fishery decreased by 30%, and by about 80% off central Chile. Current stock assessment suggests that this stock is at full exploitation and, given the moderate productivity of this species, caution with respect to any increases in fishing mortality is needed.

### ***Southwest Pacific stock***

Given the absence of current information, it is not appropriate to provide detailed comment for this stock. However, given the moderate productivity of this species and the lack of information about current stock biomass levels, due caution is appropriate.

### ***Peruvian stock***

Given the absence of current information it is not appropriate to provide detailed comment for this stock. However, given the moderate productivity of this species and the lack of information about current biomass levels, due caution is appropriate.

### ***Central South Pacific stock***

Given the absence of current information it is not appropriate to provide detailed comment for this stock. However, given the moderate productivity of this species and the lack of information about current biomass levels due caution is appropriate.

## **7.3 Ecosystem Considerations**

### ***All stocks***

Habitat is unlikely to be of concern in this fishery due to the fishing methods used.

Large extractions of any important species such as jack mackerel may lead to changes in predator-prey relationships, which in turn could lead to shifts in food-web structure. These shifts in community structure are not necessarily reversed by the reduction of

fishing pressure. Neira et al. (2004), using eco-trophic modelling, found that fishing could have a negative eco-trophic impact on important fisheries resources such as the horse mackerel. Ecosystem modelling of pelagic species in upwelling systems has highlighted the alteration of matter fluxes in trophic webs caused by jack mackerel fishery removals. The estimated potential annual consumption of zooplankton by jack mackerel removed by fishing is equivalent to about 2.7 - 5 million tonnes C y<sup>-1</sup> (Cury et al. 2000). The implications for the management of this fishery are unknown.

Bycatch data for jack mackerel fisheries in the proposed South Pacific RFMO area are very limited. Without quantitative information it is not possible to provide other than generic precautionary advice. Detailed data collection in the various fisheries should be undertaken to enable detailed assessment of bycatches.

Catch of associated and dependent species in the jack mackerel fisheries has not been documented on the high seas. Given the experience in other purse seine fisheries in the Pacific (which catch sharks, billfish and cetaceans in the central eastern Pacific) and other mid-water trawl fisheries which discard fish waste at sea (which result in mortality of seabirds in the south western Pacific), some incidental catch will occur in the Southeastern Pacific. Without information it is not possible to provide other than generic precautionary advice. Detailed data collection in the various fisheries should be undertaken to provide an opportunity to enable assessment of associated and dependent species by-catches.

## **8. Research**

### **8.1 Current and ongoing research**

There has been a substantial amount of historical research on this species, particularly by Russia. However, substantially less research has been conducted over the past decade, except within the EEZs of a few coastal states.

#### ***Chile***

The Chilean jack mackerel fishery is monitored by observers and sampling programmes for the main fleets and at all landing locations. Biological sampling of landings for species composition, size, weight, sex and maturity is undertaken. Otoliths for age studies are also collected. Fishery independent monitoring surveys are also undertaken, including acoustic surveys off south-central Chile and annual egg production surveys to estimate the spawning stock using a daily egg production method.

#### ***Korea***

Experimental mid-water trawling and hydroacoustic surveys were conducted in the Southeastern Pacific Ocean by the Korean research vessel, TAMGU No.1 and two commercial mid-water trawl vessels during August-December 2003.

#### ***New Zealand***

The within-EEZ jack mackerel fishery is monitored by observers and sampling programmes for the main fleets, and at all main landing locations. Biological sampling of

the landings for species composition, size, weight, sex and maturity is undertaken and otoliths are collected for age studies.

**Note: It would be useful to refocus this research section on a stock basis, and to provide detail from other participants – this is an expected outcome of the SWG upcoming meeting.**

## 8.2 Research needs

Research is required to:

- Improve the understanding of the stock structure of *T. murphyi* to aid the development of appropriate management units.

*This should be done using multiple techniques such as genetics, otolith microchemistry, morphometrics, meristics, parasites and ecology to discriminate between separate stocks and test the current stock structure hypothesis. A collaborative approach in undertaking and funding this project will be required for a comprehensive and enduring outcome.*

- Obtain biomass estimates for all stocks that are actively fished as inputs to stock assessment modelling.

*This will need careful planning to ensure that biomass estimates are obtained using standard methods that can be utilised for stock assessment purposes.*

- Undertake a stock assessment for the actively fished stocks to support the provision of robust fisheries management advice.

*A preliminary task is the compilation of relevant data for undertaking stock assessment. A review of the available data will determine the types of assessment that might be able to be used. Any assessment should be done using a modern method capable of integrating all relevant available data and that can provide the types of management advice sought by the SPRFMO negotiation participants.*

- Evaluate the bycatch levels and bycatch composition in the active high seas fisheries to allow assessment of interactions between fisheries and consideration of the issues associated with an ecosystem approach to fisheries management.

*This will require collection of detailed bycatch data across fisheries at the species level.*

- Evaluate levels of incidental catch of associated and dependent species to allow determination as to whether the catches are adverse and where appropriate the development of mitigation measures.

*This will require the collection of verifiable data from the fishery across a representative sample of area, seasons and fishing methods*

**Note: This section needs to identify research gaps and also list priorities for future research. This is an expected outcome of the SWG upcoming meeting.**

## 9. Additional remarks

None at this time

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