UNIVERSIDADE FEDERAL DE PERNAMBUCO
Departamento de Oceanografia
TROPICAL OCEANOGRAPHY ONLINE

ISSN: 1679-3013
D.O.I.: 10.5914/1679-3013.2011.0056

COPEPODA AS FOOD OF YOUNG TROPICAL ESTUARINE FISHES

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Recebido em: 25/10/2011
Aceito em: 03/04/2012

RESUMO

Muitos peixes de importância econômica e ecológica são comuns nas pescarias artesanais no Canal de Santa Cruz (Itamaracá – Brasil). Muitos estudos sobre hábitos alimentares de peixes enfatizam os Copepoda, pois os mesmos são importantes para obter informações sobre interações tróficas. Amostras de peixes foram coletadas mensalmente com uma rede de espera no período de 1995 a 1998, além de dados publicados desde 1979. As espécies de peixes onde os Copepoda foram registrados foram: *Opisthonema oglinum* (*Oithona* spp. – 40%), *Citharichthys spilopterus* (*Parvocalanus crassisrostris* - 18%; *Oithona* spp. -5%; *Calanopia americana* - 8%), *Symphurus plagusia* (*Parvocalanus crassisrostris* - 20%, *Euterpina acutifrons* - 5% e *Acartia lilljeborgi* - 5%, *Oithona* spp. - 5%); *Eugerres brasilianus* e *Diapterus auratus* (*Macrosetella gracilis* - 6%, *Farranula gracilis* - 3%, *Acartia lilljeborgi* - 10%, *Euterpina acutifrons* - 3% e *Oncaea* sp.- 3%). Náuplios de Copepoda, além de ovos e carapaças de espécies não identificadas foram também comumente registrados. Foi observado que Copepoda planctônico foi um item alimentar frequente em muitas espécies de peixes do Canal de Santa Cruz.

Palavras chave: Copepoda, alimentação, peixes, teia trófica, estuário

ABSTRACT

Many economical and ecological important estuarine fishes are common in the artisan fisheries at the Santa Cruz Channel (Itamaracá – Brazil). Studies about fishes feeding emphasized the Copepoda as they are important to assess the throphic web interactions. Samples were monthly collected along Santa Cruz Channel with a seine net, from 1995 to 1998, besides data published since 1979. Fishes stomach content were analysed under a compound microscope and stereomicroscope. The fishes species that Copepoda were registered in the stomach content were: *Opisthonema oglinum* (*Oithona* spp. – 40%), *Citharichthys spilopterus* (*Parvocalanus crassisrostris* - 18%; *Oithona* spp. -5%; *Calanopia americana* - 8%), *Symphurus plagusia* (*Parvocalanus crassisrostris* - 20%, *Euterpina acutifrons* - 5% and *Acartia lilljeborgi* - 5%, *Oithona* spp. - 5%); *Eugerres brasilianus* and *Diapterus auratus* (*Macrosetella gracilis* - 6%, *Farranula gracilis* - 3%, *Acartia lilljeborgi* - 10%, *Euterpina acutifrons* - 3% and *Oncaea* sp.- 3%). Copepoda nauplii, eggs and carapace from non identified copepod species were also commonly registered. It was observed that planktonic Copepoda was a frequent food item to many fish species in the Santa Cruz Channel.

Key words: Copepoda, feed, fishes, throphic web, estuary

INTRODUÇÃO

Estuarine planktivorous fishes and their prey have received a great deal of attention in recent years in Northeastern Brazil due their important role in trophic ecology (Neumann-Leitão and Schwamborn, 2000). Prey selection at different levels of density and under different environmental conditions is an important determinant of predator and prey dynamics (Murdock, 1969) and thus may play a major role in structuring water column

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communities (Brooks and Dodson, 1965; Lynch, 1979). Most research has been repeatedly demonstrated that both fish and invertebrate planktivores can have a marked impact on zooplankton prey communities (O'Brien, 1979; Lazzaro, 1987). Copepods are the second largest source of protein in the oceans, second only to krill. They are the natural food of many fish in the oceans, especially the early life stages (Dürbaum and Künnemann, 2000). Some fish will not eat non-living foods, and require live feeds such as copepods. In tropical estuaries, relatively small fishes represent an important link between primary consumers and what is often the highest level of the food chain. Among these fishes there are five species feeding mainly on planktonic copepods (*Opisthonema oglinum* (Le Sueur, 1818), *Citharichthys spilopterus* (Valenciennes, 1830), *Symphurus plagusia* Ranzani, 1840, *Eugerres brasilianus* Günther,1862 and *Diapterus auratus* Bloch & Schneider,1801).

Flexibility in feeding habits is an important adaptation in ecosystems where fluctuations in the types and amounts of food available are common (Johnson *et al*., 1990).

The Itamaraca estuarine ecosystem is used as nursery grounds by many commercially important species and this has generally been attributed to the abundant food supply in comparison to adjacent marine areas (Schwamborn, 1997). It is also a diverse area containing many different types of habitat suitable for fish. This variety of habitats, along with the complexity of fish community interactions and the migratory nature of many species makes it extremely difficult to assess the overall condition of the fish community in a estuary. Because of this problem, this paper focuses on specific, commercially and ecologically important zooplanktivorous species rather than the fish community as whole through fish stomachs content.

MATERIAL AND METHODS

Study area

The Itamaracá mangrove estuarine system is located at 7°34'00"- 7°55'16" S and 34°48'48" - 34°52'24" W in Pernambuco State. It consists of the U-shaped Santa Cruz Channel with 20 km length; and there are two connections to the South Atlantic Ocean and five tributaries draining into the channel (Figure 1).

The climate is warm-humid, pseudo-tropical with mean annual temperature 24°C and rainfall 1500-2000 $mm.yr^{-1}$, concentrated from March to August. Humidity is higher than 80%. Predominant winds are from the southeast.

The system sustains 36 km^2 of mangrove forests, dominated by *Rhizophora mangle*, *Laguncularia racemosa* and *Avicennia* spp (Medeiros and Kjerfve, 1993; Medeiros *et al*., 2001).

Mangrove forests are usually separated from terrestrial vegetation by a disrupted belt of saltflats. Towards the shelf, the estuarine system is delimited by arenite reefs. Between the reefs and Itamaracá Island, a shallow (0.5 to 2 m depth) coastal basin is formed. In these areas, patches of seagrass (*Halodule wrightii*) create a distinct environment (Schwamborn, 1997). The macrofauna associated to those meadows is dominated by the gastropod *Tricolia affinis* (Alves, 1991). Beyond the reefs, calcareous green algae (*Halimeda* sp) are abundant, originating a calcareous gravel bottom (Kempf, 1970).

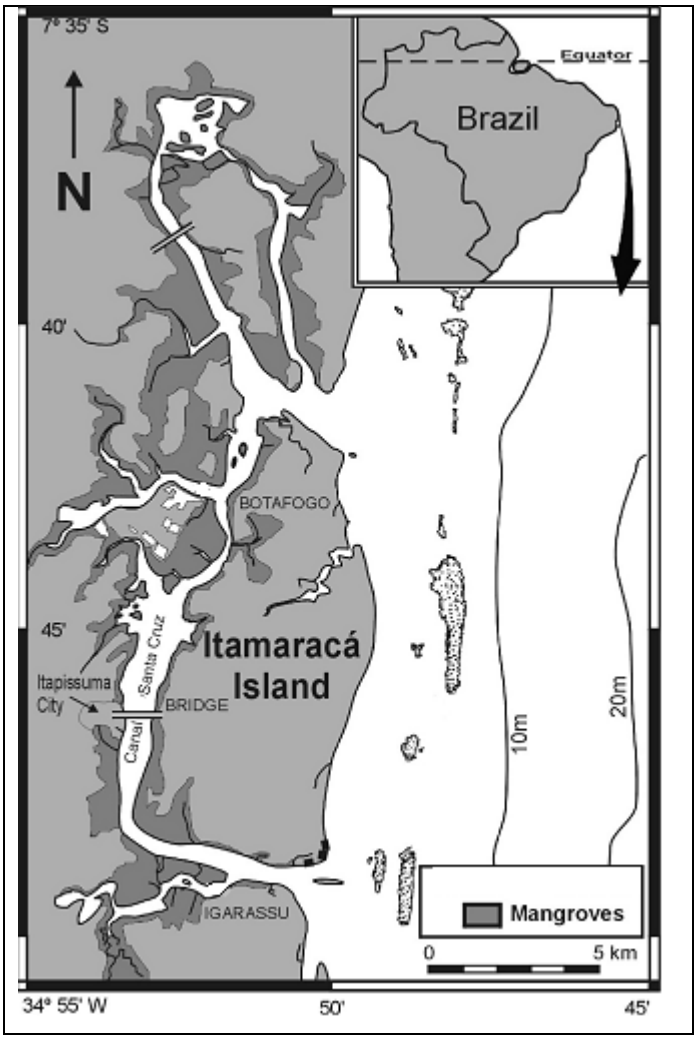

Figure 1 – Studied area at Santa Cruz Channel, Itamaracá ecosystem in North-eastern Brazil.

Methodology

Stomach content diet composition was derived from planktofagous fish species most abundant in the artesian fisheries, besides those ecologically important and those used in the local fish culture ponds. Fish samples were monthly collected along Santa Cruz Channel with a seine net, from 1995 to 1998, besides data obtained since 1979. After field collection, whole fish were immediately transported to the laboratory and total length and weight measurements were recorded. After, the gut from each fish was removed and individually preserved in 10% formaldehyde. Stomachs were dissected vertically and the contents placed in a grid-lined Sedgwick-rafter cell, suspended in 1 ml distilled water (APHA 1995). Stomach content were analysed under a compound microscope and stereomicroscope according to Rounsefell and Everhart (1953) and Hyslop (1980) methodology. Enumeration of food items were recorded at the lowest possible taxonomic level. Copepods were identified according to Björnberg (1981) and Boltovskoy (1999).

RESULTS

A total of 5,150 fishes stomach content were analyzed. Among these 2,685 belonged to five species that presented Copepoda as an important food in their stomach content. Table 1 presents these fishes length and weight data.

Table 1 : Fish families, number of individuals, minimum and maximum total length and weight from Santa Cruz Channel, Itamaracá system, Brazil.

FAMILIES	SPECIES	Number of fishes	Total length (cm)	Weight (g)
Clupeidae	*Opisthonema oglinum* (Le Sueur, 1818)	611	10.0 – 30.0	18.0 – 200.0
Gerreidae	*Eugerres brasilianus* (Valenciennes, 1830)	697	5.1 – 32.0	10.0 – 210.0
Gerreidae	*Diapterus auratus* Ranzani, 1840	997	4.1 – 26.0	9.0 – 190.0
Paralichthydae	*Citharichthys spilopterus* Günther,1862	195	3.0 – 16.0	0.2 – 33.3
Cynoglossidae	*Symphurus plagusia*(Bloch & Schneider,1801)	185	6.0 – 14.4	1.2 – 21.6

Each species presented the following characteristics and stomach content:

- *Citharichthys spilopterus* is marine dependent and 82% of the stomach were with food (Fig. 2) and Copepoda accounted with 34% (Fig. 3). Among the Copepoda outranked *Parvocalanus crassirostris* (18%), *Calanopia americana* (8%) and *Oithona* spp. (5%) (Fig. 4).
- *Symphurus plagusia* is a resident specie and 84% of the stomach were full (Fig. 2) and Copepoda contributed with 38% of abundance (Fig. 3). Copepoda was present with the following species: *Parvocalanus crassirostris* (20%), *Acartia lilljeborgi* (5%), *Oithona* spp. (5%) and *Euterpina acutifrons* (5%) (Fig. 4).
- *Opisthonema oglinum* is a marine visitant species and presented 97% of the stomach content with food (Fig. 2). Nearly 67% of abundance was Crustacea (Fig. 3), of which the Copepoda *Oithona* spp. contributed with 40% (Fig. 4).
- *Eugerres brasilianus* is marine dependent and presented 95% of the stomach with food (Fig. 2) and Crustacea accounted 21% of abundance (Fig. 3). Among Crustacea (21%), Copepoda was present with the species *Acartia lilljeborgi* (10%) and *Farranula gracilis* (3%) (Fig. 4)
- *Diapterus auratus* is marine dependent and 94% of the stomach was with food (Fig. 2) of which 14% was Crustacea. Among Crustacea, it was registered the Copepoda *Euterpina acutifrons* (3%), *Macrosetella gracilis* (3%) and *Oncaea* spp. (3%) (Fig. 4).

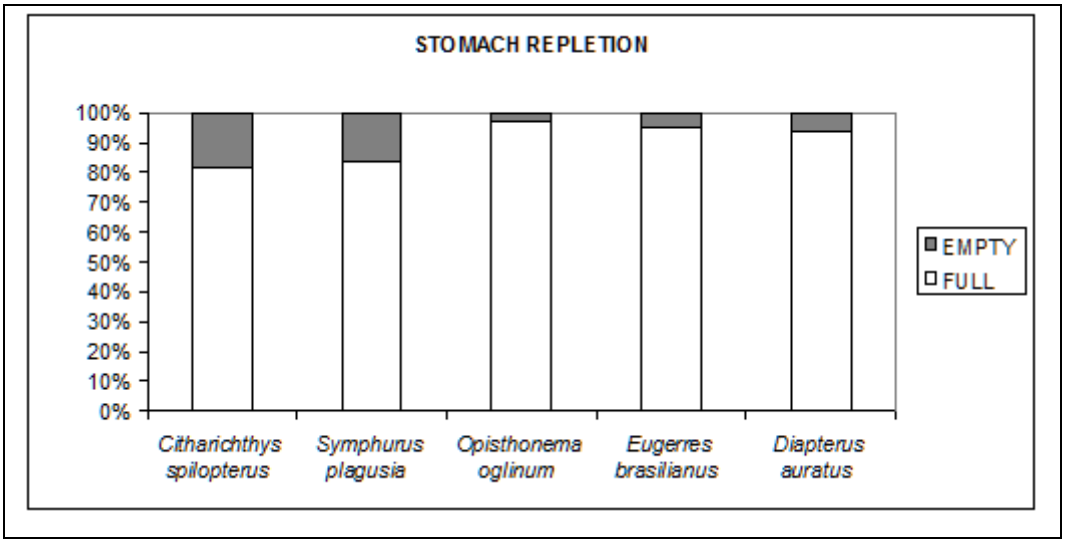

Figure 2 – Stomach repletion of fish species from Santa Cruz Channel, Itamaracá, Brazil

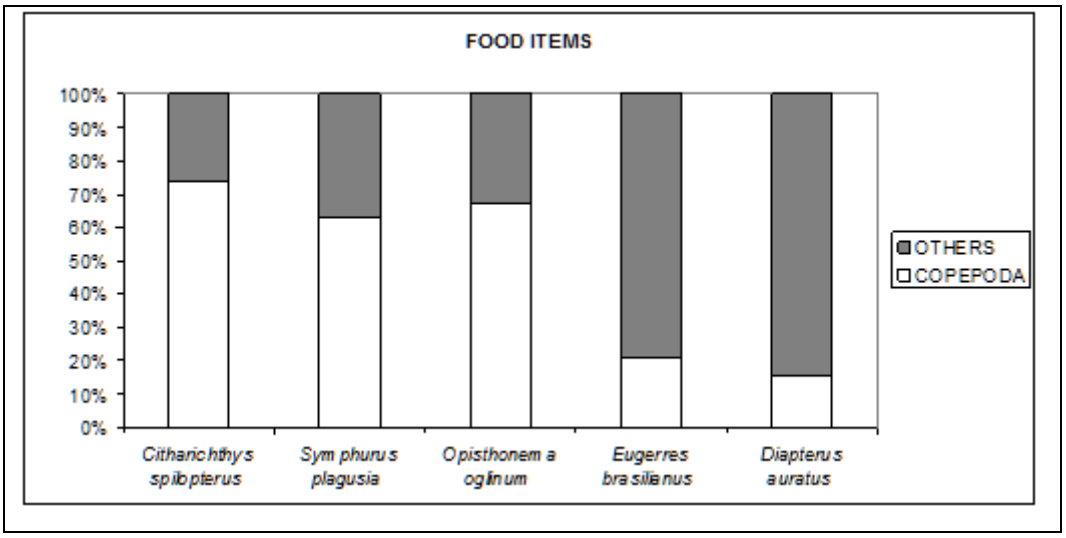

Figure 3 – Food items of fish species from Santa Cruz Channel, Itamaracá, Brazil

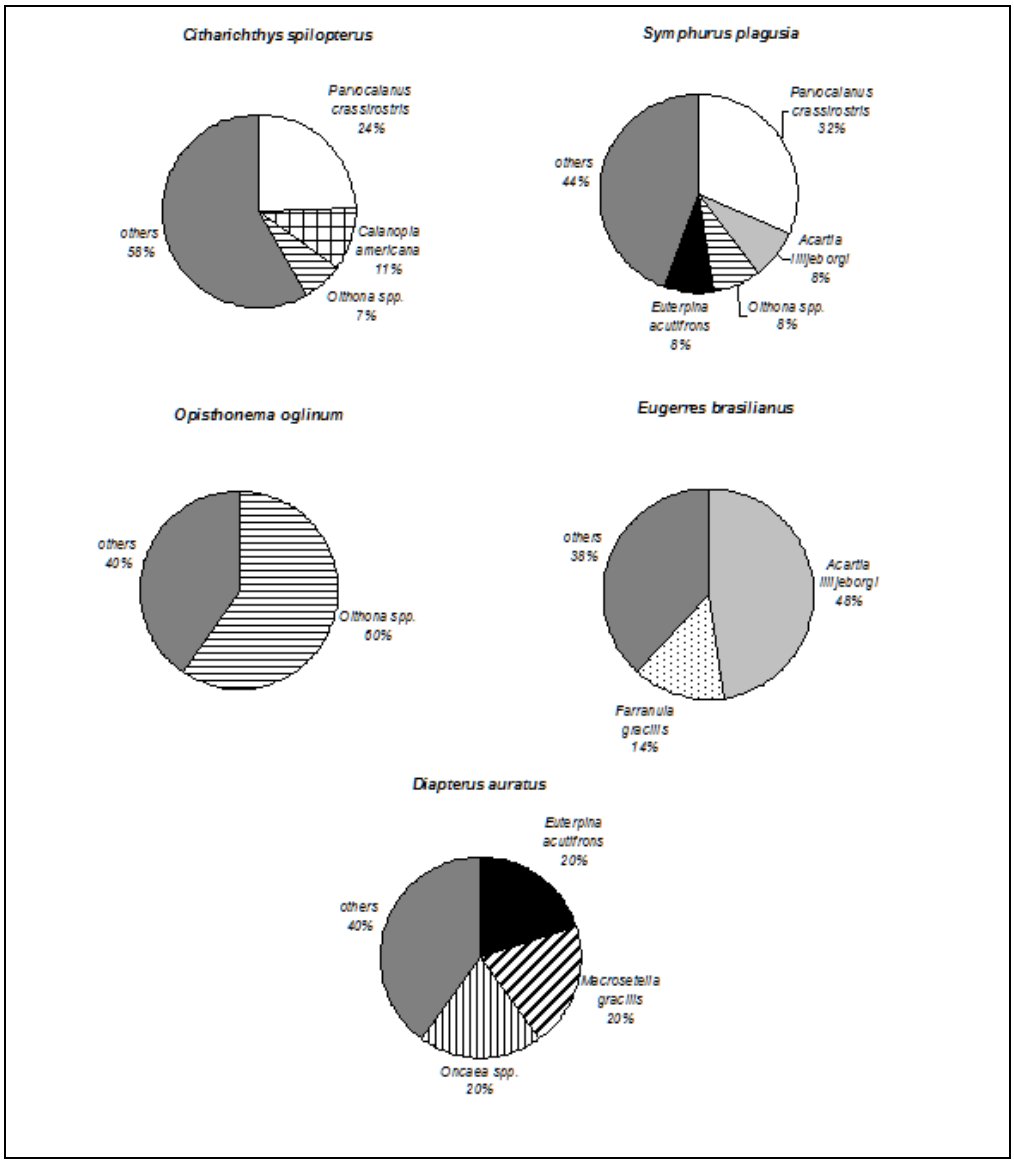

Figure 4 – Copepoda species in the stomach content of fishes from Santa Cruz Channel, Itamaracá, Brazil.

DISCUSSION

Fish composition, abundance, distribution, and condition are considered indicators of ecosystem health because fish integrate effects of environmental stress over space and time (Campos, 2000). The fish fauna of Itamaracá is extremely diversified, composed of 145 species (Vasconcelos Filho, 2001). These fishes have been categorized as resident, marine dependent, marine and limnetic visitors (Vasconcelos Filho *et al.*, 1984; Vasconcelos Filho and Oliveira, 1999; Vasconcelos Filho, 2001; Paranaguá *et al*., 1999). Among these, 14 were registered as secondary consumers (Vasconcelos Filho *et al.*, 2010) and nine species were primary consumers (Vasconcelos Filho *et al.*, 2009), and five abundant fishes species were found feeding mainly on copepods.

Odum and Heald (1975) mention that the most abundant fishes in an estuary tend to be omnivorous and opportunistic at all sizes. In our study the zooplanktivorous species had an important role in the trophic web of Itamaracá system indicating a health environment. The predominance of mullets and some clupeids in this area confirm that throughout the tropics some genera of these families absolutely depend on estuaries and copepods for juvenile growth (Longhurst and Pauly, 1987), as shown already to Itamaracá area (Vasconcelos Filho, 1990).

It is well known that crustaceans are important in the diets of fishes and that copepods are among the principal foods of several economically valuable fish species (Kleppel *et al*., 2005). In the marine environment copepod life stages typically make up the bulk of the zooplankton biomass in the size range suitable as prey for most larval and planktivorous fish (Turner, 1974). Numerous diet studies in the field show that the nauplius through adult stages of copepods are important prey items of many marine fish larvae, making up greater than 50% or more of their stomach content (Turner, 1974).

Copepods were present in the guts of more than 80% of the fish species studied by Turner (2004) during some part of the life cycle. Calanoids copepods are particularly abundant members of the pelagic realm in estuaries and other coastal habitats and generally represent an important link between the phytoplankton and/or detritus and fish in these inshore nursery systems (Marcus, 2005).

Of the copepods recorded in the fish's stomachs of the Santa Cruz estuarine area dominated the calanoids *Acartia lilljeborgi, Parvocalanus crassirostris* and *Calanopia americana. Acartia lilljeborgi* is an important food item to *Eugerres brasilianus* and this copepod occurs in large quantities in the Santa Cruz Channel (Silva *et al.*, 2003); and this may be related to the high amount of detritus (Silbert *et al*., 1978). Detritus is highly consumed by *A. lilljeborgi*, as has been demonstrated through stable isotope measurements and feeding experiments performed in the laboratory and *in situ* (Schwamborn, 1997; Schwamborn *et al.*, 1999) showing the important role of this species as an important link in the detritivorous food web. The stomach content of the genera *Eugerres* and *Diapterus* in the Santa Cruz Channel (Itamaracá, Pernambuco) were studied and already showed that copepods were an important complementary food item (Vasconcelos Filho, 1979; Vasconcelos Filho *et al.* 1981).

Parvocalanus crassirostris is a common item in the stomach of *C. spilopterus* and *S. plagusia*. It is very common in most Brazilian estuaries (Matsumura-Tundisi, 1972; Björnberg, 1981), even those that are heavily impacted (Schwamborn *et al*., 2004; Silva *et al*., 2004). *Parvocalanus crassirostris* feeds significantly on picoplankton and nanoplankton and behaves as an opportunistic particle feeder, showing higher consumption rates upon the most abundant cells (2-5 μm nanoplankton) (Calbet *et al.*, 2000). Generally, it is an abundant species in eutrophic systems. *C. spilopterus* fed also on *Calanopia americana,* which is benthic during the day and occurs in high density in the surface water during the night (Björnberg, 1981).

Other copepod species did not occur in any considerable number, most of them being typical of coastal waters (Boltovskoy, 1999; Neumann-Leitão *et al*., 1999; Magalhães *et al*., 2006) or euryhaline; this shows that the intense marine influx during high tide influencing the fishes food items, mainly *Diapterus auratus*.

The diet of *Opisthonema oglinum* is chiefly zooplankton and stomach contents of specimens comprised copepods exclusively. The specimens analyzed in Santa Cruz Channel were juveniles because according to Houde (1977) adults are generally oceanic or coastal although primarily a tropical fish, and never abundant in temperate waters. Juveniles are reported in small numbers from nearshore and estuarine areas, but adults apparently prefer offshore waters.

AKNOWLEDGEMENT

The authors would like to thank the fishermen from Itamaracá system (PE-Brazil) that helped in the fisheries.

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