# Rainbow Runner: A Latent Oceanic Resource?

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## Introduction

Rainbow runner, *Elagatis bipinnulata* (Quoy and Gaimard), is one of six species in the family Carangidae which is circumtropical in distribution (Briggs, 1960), occurring throughout the warm temperate and tropical oceans. It is a pelagic fish with fusiform body, small mouth, and deeply forked tail (Fig. 1). This species resembles, very superficially, Salmonidae of north temperate waters and is referred to as "salmon" in Jamaica (Kawaguchi, 1974) and the Philippines (Simpson and Chikuni, 1976) and "Hawaiian salmon" in Hawaii.

There are no large-scale fisheries for rainbow runner and this fish is generally only captured incidentally by artisanal or recreational fishermen while fishing for other species. As might be expected for a commercially insignificant species, very little is known about the rainbow runner. However, there is evidence to suggest that this species may be a latent resource of some magnitude.

Okiyama (1970) speculated from a study of fish larvae collected by research vessels enroute to and from, as well as on, tuna fishing grounds that this fish may be a potential commercial species. There are numerous documented and undocumented visual sightings of large schools and high incidental captures of rainbow runner from various localities around the world. This information is published, for the most part, in obscure documents not generally available to the fisheries researcher or has been obtained through personal communications from numerous colleagues. This paper summarizes current information about the rainbow runner, speculates why it is rarely captured at present, and recommends research needed to exploit it.

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## Life History

Larval development and early life history of the rainbow runner have been described by Okiyama (1970) for the Indo-Pacific region and Aprieto (1974) for the Gulf of Mexico and South Atlantic coast of the United States. Larvae and/or juveniles were captured throughout the year with a peak in March in the Indo-Pacific region, and in every month except May and December in the western Atlantic region. Both authors assumed the

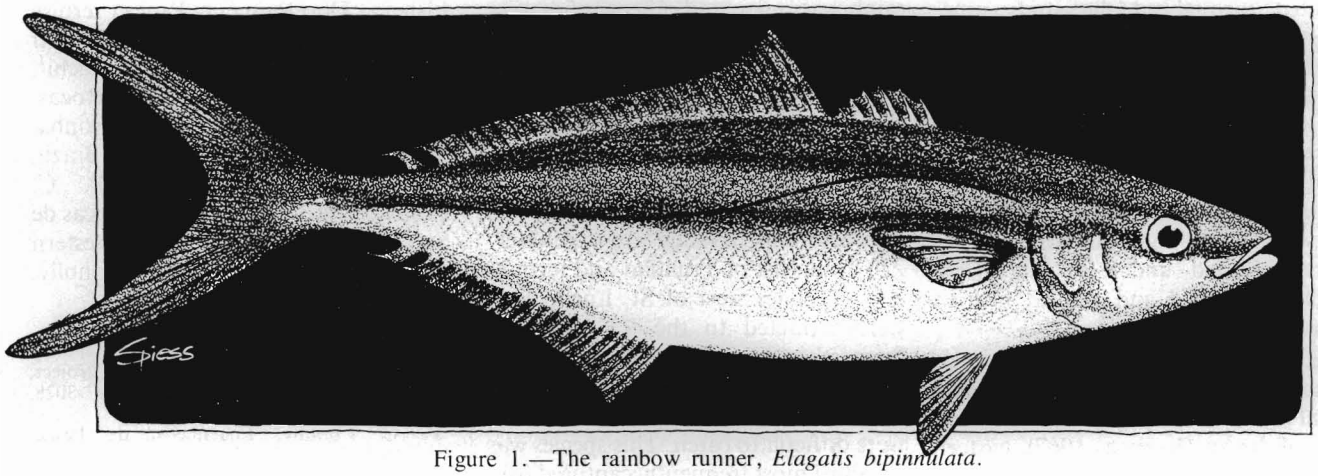


Figure 1.—The rainbow runner, *Elagatis bipinnulata*.

rainbow runner to be a year-round spawner. This species was the most abundant epipelagic larval carangid in tropical and warm temperate Indo-Pacific regions and second most commonly captured carangid of the five jack species (*Decapterus punctatus*, *Seriola zonata*, *Selene vomer*, *Oligoplites saurus*, and *Elagatis bipinnulata*) studied from the western Atlantic region.

Larvae, postlarvae, and juveniles in the Indo-Pacific region were captured at surface water temperatures between 26.5° and 29.9°C with the highest occurrence in 28.0° C. Post larvae and juveniles were found to feed almost exclusively on copepods (Okiyama, 1970).

Young and adult rainbow runner range as widely as the larvae and young juveniles, occurring on the outer continental shelf, around offshore islands/banks, and in mid-ocean. However, the rainbow runner is an inconspicuous species so that nearly all documented reports of occurrences are from around flotsam, artificial structures, or drifting craft.

### Neritic Regime

Occurrence of rainbow runner over various reefs on the continental shelf off Louisiana in the Gulf of Mexico have been reported by Sonnier et al. (1976). Frequency of occurrence on these reefs increased from inshore to offshore, ranging from absent in 37 m, occasional in 59 m, and common in 110-130 m depths. This species was rarely observed around oil platforms located throughout the study area, mostly in water depths of 18-55 m.

Hunter and Mitchell (1967) studied the association of fishes with flotsam in the eastern tropical Pacific off Costa Rica during spring and fall 1963. Flotsam found 1-31 miles off the nearest land were sampled with a miniature purseseine. Young rainbow runner were collected under 29 out of 70 flotsam sampled and ranked fifth in frequency of occurrence.

Rainbow runners have been observed and/or captured around artificial structures moored in the western Sea of Japan (Kojima, 1967), eastern tropical Pacific (Hunter and Mitchell, 1967, 1968), and eastern Gulf of Mexico (Klima and Wickham, 1971). This species was the most numerous of the jack category (*Seriola* sp., *Caranx crysos*) attracted to surface and midwater structures moored in 11-13 m depths off Panama City, Fla., in July 1969. On one occasion, an estimated 500 individuals were associated with a single structure. Rainbow runner and other jack species were most commonly associated with single, surface structures than with complex midwater structures. These jack species generally oriented at the level of or below the structures.

### Oceanic Regime

Attraction of pelagic fishes to a drifting raft in the equatorial Pacific between long. 148° and 160° W was studied by personnel of the Bureau of Commercial Fisheries, Honolulu, Hawaii, during two drifts in February-March 1964 (Gooding and Magnuson, 1967). Twenty-three different species were attracted to the raft during the two drifts. Rainbow runner were observed singly, accompanying the raft during the 9-day drift south of the Equator.

The RV *Discoverer* drifted in the western Atlantic from lat. 13° N, long. 39° W to lat. 10° N, long. 49° W during a 2.5-week period in February 1969 (Potthoff, 1969). Dolphin fish, *Coryphaena hippurus*; blanket octopus, *Tremoctopus violaceus*; flyingfish; and lanternfish were attracted to the vessel in large numbers during this drift cruise. Shark, squid, rainbow runner, and other species were attracted in lesser numbers.

Personnel of the Caribbean Fishery Development Project conducted a cruise in May 1970 to assess the potential of attracting pelagic fish to a drifting vessel in sufficient quantities for commercial fishing (Wolf, 1974). The drift was initiated approximately 220 miles east of Trinidad and terminated 20 miles west of St. Lucia. Fish were attracted to the RV *Calamar* from the first day of the cruise. Considerable numbers of rainbow runner were seen under the vessel, but were difficult to catch. This species was the third most frequently captured fish, after yellowfin tuna, *Thunnus albacares*, and dolphin fish.

Another cruise was conducted by the RV *Calamar* during May-June 1971 to test the effectiveness of drifting structures in concentrating commercial quantities of pelagic fish. Three structures were set adrift about 160 miles east-southeast of Barbados during the first leg and six structures were released approximately 30 miles east of Barbados during the second leg of the cruise (Wolf, 1974). Difficulty was encountered in keeping track of the individual structures which tended to drift apart. Rainbow runner was concentrated under these structures and was the fifth most frequently captured fish after yellowfin tuna, dolphin fish, skipjack tuna, *Katsuwonus pelamis*, and wahoo, *Acanthocybium solanderi*.

Thor Heyerdahl (1978) sailed the reed craft *Tigris* across the north Arabian Sea from the mouth of the Indus River to Djibouti in early 1978. The bottom of the craft after 3 months in the sea supported an upside-down meadow of luxuriant life with barnacles, crabs, and a variety of small fish. These in turn attracted schools of dolphin fish, rainbow runner, triggerfish, pilotfish and sharks.

### Large Schools

Rainbow runners aggregate in large schools in specific areas during certain times of the year. Visual sightings of large schools have been reported from the following areas: 1) Navidad and Silver Banks, Caribbean (Caribbean Fishery Development Project cruise data sheets); 2) continental shelf off Nicaragua, Caribbean (K. Kawaquchi[1], pers. commun.); 3) Atol das Rocas, Ilha de Fernando de Noronha, offshore banks of northeastern Brazil, western tropical Atlantic (P. C. Conolly[2], pers. commun.); 4) Rocas de Sao Pedro e Sao Paulo, western tropical Atlantic (P. C. Conolly,

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[2]P. C. Conolly, Engenheiro de Pesca, SUDEPE/PDP, Avenida Duque de Caxias, No. 190, Natal, Rio Grande do Norte, Brazil.

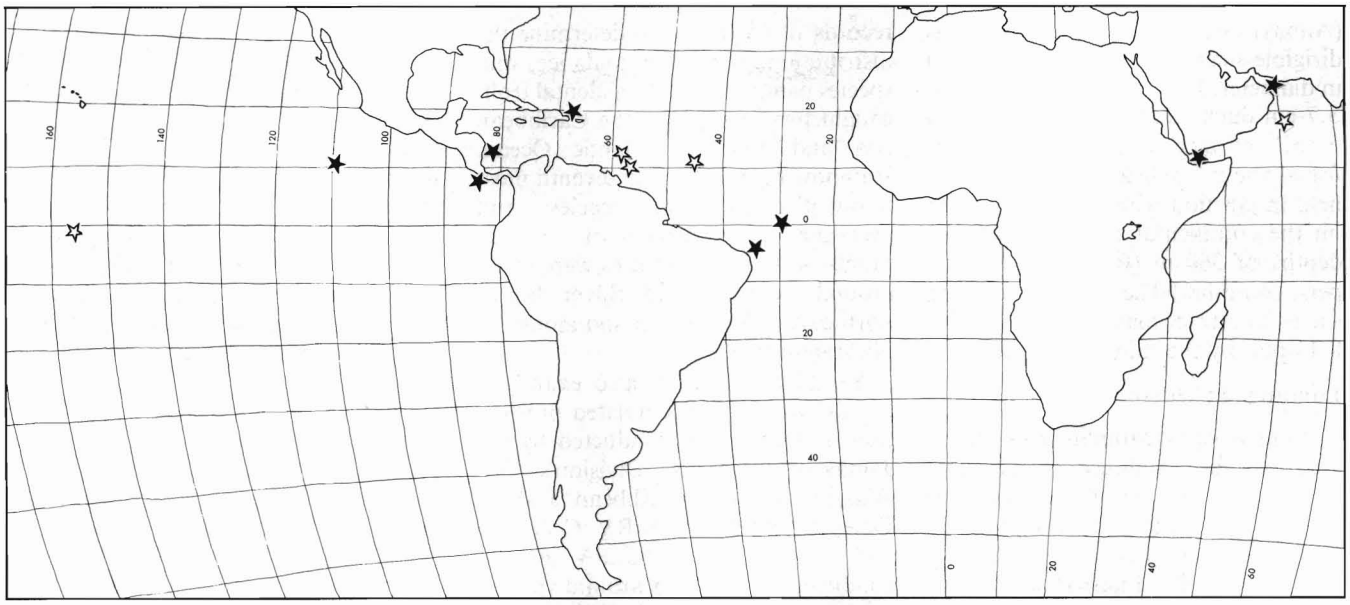

Figure 2.—Locations of rainbow runner sightings. Closed stars indicate sightings of large schools along continental edges off oceanic banks and islands. Open stars indicate sightings under drifting craft in the oceanic regime.

footnote 2); 5) continental shelf off Panama, eastern tropical Pacific (T. Gastsson[3], pers. commun.); 5) Clipperton Island, eastern tropical Pacific (C. Limbaugh, 1963); 7) specific location unknown, Gulf of Aden (J. F. LeGurun[4], pers. commun.); 8) Daimaniyat Islands, off Batina coast of Oman, Gulf of Oman (M. A. Barwani[5], pers. commun.).

Locations where rainbow runners have been seen under drifting craft in the oceanic regime and in large schools along the edge of the continental shelf, offshore banks, and islands are shown in Fig. 2. It seems highly unlikely that rainbow runner occurs in large schools only in the above mentioned locations. It is more likely that high concentrations of this species occur in other areas throughout the Caribbean, western tropical Atlantic, eastern tropical Pacific, and north Arabian Sea, as well as throughout other regions of the warm temperate and tropical oceans.

## Association With Other Fish

Potthoff (1969 reports whitetip shark, *Carcharhinus longimanus*, being accompanied occasionally by rainbow runner during a 2.5-week drift cruise of the RV *Discoverer*. Rainbow runners were concentrated under the drift structures released by the RV *Calamar* during May-June 1971, in association with two species of sharks (*C. longimanus* and *C. falciformis*). Limbaugh (1963) observed rainbow runner around Clipperton Island frequently escorting two species of sharks (*C. platyrhynchus* and *C. galapagensis*) common there. The rainbow runner has an affinity to sharks, and in this habit is similar to two other carangids, *Naucrates ductor* and *Seriola zonata*, which are frequently associated with sharks.

## Feeding Habits

The rainbow runner has a small, terminal mouth without sharp teeth which would limit the size of prey that this species can ingest to tiny organisms. Kojima (1967) classified this species as a predator of fish and squid (Group 1 of his classification) whereas his table lists stomachs of young to contain fish eggs/larvae, plus fish flesh, shrimp, megalops, isopods, amphipods, and seaweeds. Field examinations showed crustaceans to be always present in the stomachs of adults captured by trolling gear off the northeast coast of Brazil (P. C. Conolly, footnote 2). Morphology and limited data from stomach analyses indicate the rainbow runner to be principally a first-stage carnivore.

# Fisheries

## Pot Fishery of Papua New Guinea

There is a pot fishery for rainbow runner centered around Rabaul Harbour in Papua New Guinea

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(Anonymous, 1968). The pot is dirigible-shaped, 1.8 m long and 1.5 m in diameter. It is constructed of 2.5- to 3.7-cm thick bamboo strips and has a funnel entrance at one end. This pot is fished about 1 m below the surface and held in position with rope and anchor on the continental shelf and slope to depths of 360 m (R. E. K. D. Lee[6], pers. commun.). The pot is baited with leaves to attract malambur, which are fed upon by the rainbow runner.

### Landings in Oman

A cursory port sampling program to monitor the landings of artisanal fishermen at six locations along the northeast coast of Oman was conducted during late 1972 and early 1973 (Mardela International Ltd., 1975). Rainbow runner was the seventh most abundant species or species group and constituted 2.9 percent by numbers of the total sample. This sample did not include anchovies, sardines, halfbeaks, lizardfish, or mackerels, which are generally landed in baskets. Rainbow runner was sampled at Mutrah and Qurayat and not at the other four ports. Mutrah and Qurayat are rocky coastal ports, whereas the others are sandy coastal ports. Rainbow runner landings were markedly seasonal and observed only during the months of February (99 fish), June (477), and July (260) at Mutrah and during April (199) at Qurayat. Artisanal fishermen capture this species incidentally with trap nets, gillnets, troll lines, and handlines.

### Incidental Captures

*Trolling*

Caribbean Fishery Development Project vessels generally fished two and occasionally three troll lines from the stern during daylight hours while steaming to and from fishing grounds and from one fishing station to another. Yesaki (1969[7]) examined the records of 65 cruises to determine the distribution, relative abundance, and species composition of incidental troll-caught fish throughout the Caribbean Sea and adjacent Atlantic Ocean. Rainbow runner was the seventh most frequently captured species and accounted for 3 percent of the total numbers. Highest captures were made around Navidad and Silver Banks northeast of Hispaniola and along the Nicaragua shelf.

Yesaki (footnote 7) also examined the fishing logs for simulated production trolling cruises conducted by the Jamaican Fisheries Division's RV *Bluefin* and the Caribbean Fishery Development Project's RV *Calamar* and RV *Fregata*. The RV *Bluefin* conducted nine cruises around various banks east, southeast, and south of Jamaica from August to December 1967. Rainbow runner was the third most commonly captured fish and composed 17 percent of the total numbers. Highest catch rates of this species were obtained on "Salmon Bank" (9.0 kg/hour), Albatross-Little Albatross Banks (5.8 kg/hour), and Morant Bank-Decca Ridge (5.1 kg/hour). These banks are located southeast of Jamaica. The RV *Calamar* expended one cruise and the RV *Fregata* a day and parts of 2 days in simulated production trolling on Anguilla Bank during April-May 1969. Rainbow runner was much less abundant on this bank and composed only 1 percent of the total.

The Federal fisheries service of Brazil (Superintendencia do Densenvolvimento de Pesca/Programa de Pesquisa e Densenvolvimento Pesqueiro do Brasil) initiated exploratory fishing activities off the northeast region in May 1976 with the N/Pq *Riobaldo* and subsequently with the N/Pq *Diodorin*. The area of investigations encompassed principally the continental shelf off the State of Natal, Atol das Rocas and Ilha de Fernando de Noronha, as well as around several offshore banks.

Fishing activities included multiple line trolling, handlining, gillnetting, squid jigging, and purse seining. Greatest effort was expended in trolling with 16 lines along the edge of the continental shelf and offshore banks.

During 1977, 13 combination fishing cruises (trolling/handlining, trolling/gillnetting etc.) were completed by the N/Pq *Diodorin* (Anonymous[8], 1977). Rainbow runners were captured on troll lines during all but one of these cruises and was the sixth most frequently captured species (3 percent of the total). Schools of rainbow runner were sighted during 10 of the 13 cruises, primarily over the 200-m depths along the eastern edge of offshore islands and banks, i.e., the edge fronting the South Equatorial Current. The numbers of rainbow runner captured by trolling were nowhere near commensurate with the numbers observed and prompted personnel of SUDEPE/PDP to initiate fishing trials with gillnets and in late 1977 with purse seine.

*Handlining*

Caribbean Fishery Development Project's RV *Alcyon* conducted extensive exploratory and simulated production handline fishing in the northwestern Caribbean Sea from 1967 to 1970 (Kawaguchi, 1974). Rainbow runner was captured by this fishing method along the edge of the Central American shelf, especially over a high ridge that peaked at 29-33 m below the surface at lat. 14°33'N, long. 81°45°W. This species was attracted to the lights of the vessel while at anchor for the night and captured near the surface with line and baited hook. Highest catches of rainbow runner were made from April to June when this species accounted for 7.7 - 16.5 percent of the total landed weight.

The N/Pq *Diodorin* made a cruise to Rocas de Sao Pedro and Sao Paulo in the equatorial Atlantic in March 1978. Four schools of rainbow runner were sighted around these islands, of which one was attracted to the vessel lights one morning. This school was

[6]R. E. K. D. Lee, Team Leader/Master-fisherman, FAO Pole and Line Tuna Fishing in southern Thailand, c/o P.O. Box 618, Bangkok, Thailand.

[7]Yesaki, M. 1969. Troll fishing catches in the Caribbean Sea and adjacent Atlantic Ocean. UNDP/FAO Caribbean Fishery Development Project. Mimeogr. rep., 25 p.

[8]Anonymous. 1977. Relatorio do cruzerio nos. la 13 de 1977. Programa de Pesquisa e Desenvolvimento Pesqueiro do Brasil. Ministerio da Agricultura-Superintendencia do Desenvolvimento da Pesca.

fished with unweighted lines and small hooks baited with pieces of flyingfish and 300 kg of rainbow runners was captured during 1 hour of handlining (P. C. Conolly, footnote 2).

*Purse Seining*

Rainbow runner is not commonly captured incidentally by tuna purse seiners in the eastern Pacific Ocean (W. L. Klawe[9], pers. commun.), but is often captured in the eastern Atlantic Ocean off Tema, Ghana (F. H. Berry[10], pers. commun.). The largest known purse seine catch of this species was made by the FAO pool vessel RV *Lemuru* while on assignment in Indonesia for a fisheries training project. This was a 6 t school, comprised predominately of rainbow runner, which was detected by sonar and encircled with the purse seine. The entire school was captured as was a submerged tree under which the rainbow runners had been concentrated (B. Bjarnason[11], pers. commun.)

The South China Sea Fisheries Development and Coordinating Program chartered two purse seiners to evaluate the tuna resources, principally in the Moro Gulf and Sulu Sea off the Philippine Islands. Normal daytime purse seining tactics proved ineffective during the intitial stages of the charter period, so nighttime fishing tactics practiced by local purse seiners were tried with encouraging results.

After various modifications, the following fishing tactic was adopted for much of the duration of the charter period. The vessel searched for flotsam and upon locating a suitable log, raft, etc., would tie onto it and drift. At dusk, the night lights were switched on to concentrate small fish which served as an attractant for tuna. The flotsam and skiff with gas light would be set adrift just before dawn and the vessel's night lights were gradually switched off. The small fish concentrated by the night lights remained with the flotsam/lighted skiff, the purse seine was set around the school (Simpson and Chikuni, 1976).

The two charter vessels captured 975 t during the November 1975 to April 1976 period, of which 76 percent and 14 percent were skipjack and yellowfin/bigeye tunas, respectively. The remainder of the catch was composed of frigate mackeral, *Auxis* spp.; eastern little tuna, *Euthynnus affinis*, barracuda, *Sphyraena* spp.; rainbow runner; Spanish mackerel, *Scomberomorus* spp.; and sharks. Rainbow runner was frequently captured in very small numbers, ranging from 0 to 20 individuals per set. However, commercial purse seiners in the Philippines land large quantities, virtually tons, of rainbow runner (R. E. K. D. Lee, see footnote 6).

## Discussion

Sufficient, if fragmentary, information has emerged to permit speculation on the probable life history of the rainbow runner. This species spends its larval, postlarval, juvenile, and much of its young and adult life in the epipelagic zone of warm temperate and tropical oceans.

It is my hypothesis that the rainbow runner occupies the ecological niche in the epipelagic zone of a first-stage carnivore and, therefore, is the low-latitude ocean equivalent of the Pacific salmon, *Oncorhynchus* spp., in the cold temperate Pacific Ocean. This hypothesis is based on general similarities in body form, limited information of feeding habits, and sightings from drifting craft in the open ocean.

The rainbow runner is dispersed in small aggregations on the high seas and at certain times of the year and/or particular stage in development, moves to the outer continental shelf, offshore islands, and banks, sometimes in considerable numbers. It is further hypothesized that the rainbow runner is a latent resource of appreciable magnitude in the low-latitude ocean.

The argument that rainbow runner is an abundant species is negated by the paucity of documented accounts of occurrences and insignificant commercial landings. A probable reason why there are few documented accounts of occurrences is that this species appears to aggregate only in specific localities during certain periods of the year. These localities are generally distant from land and infrequently visited by researchers.

Another reason for the few accounts of rainbow runner occurrences is the inconspicuous behavior of this species in contrast to other schooling large pelagic fishes such as surface swimming tunas. Tunas are voracious predators that often disturb the sea in a "feeding frenzy" when after small fish. Also, surface swimming tunas are generally followed by flocks of sea birds which can be easily detected from afar. A rainbow runner school does not break the surface in a "feeding frenzy" and is generally not followed by birds (P. C. Conolly, footnote 2).

Incidental captures of rainbow runner have been made with a variety of gears, but very seldom in consistently commercial quantities. Probable reasons this species is not landed in larger quantities are use of inappropriate gears and/or limited fishing in areas of high concentrations.

Surface trolling is practiced in warm temperate and tropical regions principally to capture surface swimming tunas, Spanish mackerels, dolphin fish, wahoo, etc. Troll lures used for these species are too large for the small mouth of the rainbow runner. Furthermore, surface trolling is generally conducted at speeds of 4-6 knots which may be too fast for this species.

Rainbow runners are frequently captured with gillnets, principally during the northern spring off Muscat, Oman. The continental shelf off Muscat is extremely narrow with no freshwater outflow which results in the intrusion of oceanic water almost to the coast. Gillnets are not used extensively in the Caribbean nor off either the coasts of Central America and northeastern Brazil. When they are used they are restricted to the inner

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neritic regime. Landings of rainbow runner in these regions would likely increase with extension of gillnet fishing to the outer neritic and oceanic regimes.

Purse seining for small schooling fish in warm temperate and tropical oceans is generally restricted to the inner neritic regime, inshore of the normal distributional range of the rainbow runner. American tuna purse seiners range the oceanic regime of the Pacific and Atlantic Oceans in their quest for yellowfin and skipjack tunas. Rainbow runner is not captured in large quantities by these seiners which suggests that this species does not aggregate in large concentrations in the areas fished. On the other hand, large schools of this species may not be detected, or if detected, may not be set upon because of differential behavior patterns.

Available information indicates that the most promising region for further investigations of rainbow runner would be the western tropical Atlantic Ocean. Here, sightings of large schools and high incidental captures have been made from the offshore banks of the Greater Antilles in the north, along the continental shelf off Central America in the west, around the offshore islands and banks off the northeast corner of Brazil in the south, and around the Rocas de Sao Pedro and Sao Paulo in the east.

Fishing trials to date in this region, principally with troll lines and handlines and to a lesser extent with gillnets and purse seines, have not yielded consistently high captures of rainbow runner. Gear research, where and when the rainbow runner is known to concentrate, to develop effective fishing gears to capture this species is of paramount importance. Further fishing trials with appropriate gillnets and purse seines would probably be most rewarding, though experimental fishing with floating pots, traps, and midwater troll lines may be interesting. Also, research is needed to develop means of concentrating rainbow runners in the outer neritic and especially in the oceanic regime.

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