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Biological Synopsis of the Manatee

K. Ronald, L. J. Selley, and E. C. Amoroso

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Postal Address: Box 8500, Ottawa, Canada K1G 3H9
Head Office: 60 Queen Street, Ottawa

Ronald, K.
Selley, L.J.
Amoroso, E.C.
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/IDRC publication/. Monograph on the manatee, an aquatic mammal (/animal species/) of the /tropical zone/s of /Africa south of Sahara/ and /Latin America/, with an extensive /bibliography/ — discusses the /classification/ of the species and subspecies of the genus *Trichechus*; /morphology/, /physiology/, /behaviour/, /reproduction/, /animal ecology/ (role in /aquatic plant/ /weed control/), and measures for /animal protection/ of the manatee.

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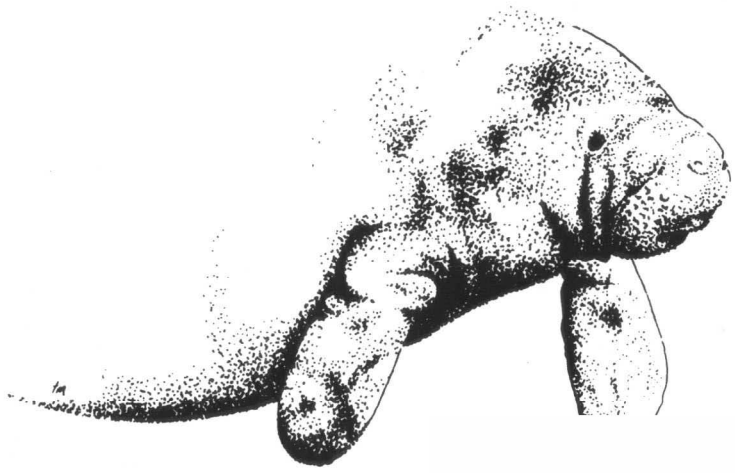
Biological Synopsis of the Manatee

K. Ronald, L.J. Selley, and E.C. Amoroso[1]

College of Biological Science, University of Guelph, Guelph, Ontario



[1] Present address: Agricultural Research Council, Institute of Animal Physiology, Babraham, Cambridge, England.

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Contents

Preface

The *Biological Synopsis of the Manatee* has been written in response to increasing interest in the species, which (as an herbivore) has potential for aquatic weed control and as a source of protein for human consumption. The synopsis is based on a bibliographical summary begun in 1960 and requested, then, by the Food and Agriculture Organization as a part of the FAO series on aquatic animals. The objective of this work has been to gather together all that has been written about the manatee and to summarize the information on its anatomy, structure, function, environment, distribution, etc. Research such as this is critical to the survival and effective use of the manatee, and much more investigation is needed into the animal's physiology, ecology, behaviour, and conservation.

A small international centre for manatee research was recommended at a workshop of scientists from 23 interested research institutions in eight countries held in Guyana in 1974. An interim steering committee, acting under the auspices of the National Research Council of Guyana, was appointed to consider the institutional structure and actions necessary to establish and operate such a centre. Meanwhile, research is continuing in various institutions in Manaus (Brazil), Florida, western Africa, and Guyana. This synopsis is offered as a contribution to this research in hopes that it will advance the current interest in the potential uses of the manatee.

W.H. Allsopp
International Development
Research Centre

Introduction

Manatees are aquatic mammals of the order Sirenia whose two living genera — *Trichechus* and *Dugong* — have maintained a biphyletic history since the middle Eocene epoch. They are herbivores living in subtemperate and tropical coastal waters, rivers, and estuaries of the Atlantic Basin between the tropics of Cancer and Capricorn.

At present, the manatee is threatened with extinction, and its future, ironically, lies in the hands of its major predator — man. For years, it has been hunted relentlessly in all its habitats, for hide, oil, and meat. Although there is legal protection for manatees in many areas, the laws in most are poorly enforced and ineffective.

Protecting the manatee is a political task; it is also an economically beneficial one. The overgrowth of tropical vegetation in waterways and irrigation canals imposes many adverse health and economic conditions on man. Because the manatee will eat almost any form of aquatic vegetation, it represents a natural biological control agent. In Guyana, for example, it has been keeping canals vegetation-free for many years.

Little is known about the biology of the manatee. At one time because of its voracious appetite, pachyostotic bones, cyclic tooth formation, and hind gut digestion, the animal was thought to have evolved from a line similar to elephants. The dearth of information available is underlined by the fact that the anatomical works of the 19th century remain the definitive papers on this animal. (The plates of Dr James Murie, 1872, Zool. Soc. Lond., Trans., 8: pl. 17-26 — bound in 1874 — appear as an appendix in this monograph.)

There is an especial need for investigations about the African manatee, *T. senegalensis*, and the South American species, *T. inunguis*. Almost no information is recorded about the former and the status of the latter is virtually unknown except that its numbers have rapidly diminished in the last few years.

What is written here is a summary of what little we do know and, therefore by implication, demonstrates what we need to know. As authors, we hope the information presented will provide incentive and directions for future research and would welcome corrections to our interpretations as well as expansion of the material recorded.

Chapter 1.
Nomenclature and Classification

Oldest available name for classification of the species, genus *Trichechi,* is documented in 1802 by Ozertskovsky, N.: *De Specibus Systematicum Genus Trichechi* (Nova Acta Petropolitana, 13: 371–375). The existing classification (Hatt 1934; Scholander 1941; IUCN 1966; Bertram and Bertram 1973) is:

Order: Sirenia (Illiger 1811)
Suborder: Trichechiformes
Family: Trichechidae (Gill 1872[2]), replacing Manatidae (Gray 1821)
Family: Dugongidae
Genus: *Trichechus* Linnaeus 1758, replacing *Manatus* (Horr 1780)
Species: *Trichechus manatus*
Subspecies: *Trichechus manatus manatus* Linnaeus 1758
Subspecies: *Trichechus manatus latirostris* (Harlan 1824)
Species: *Trichechus senegalensis* Link 1795
Species: *Trichechus inunguis* (Natterer 1883)

Common Names

An early record of manatees in the New World was by Columbus, who noted three off the coast of Hispaniola. Later, Spanish and Portuguese explorers reported seeing them in the West Indies. The name was believed to be a derivative of "manatui" or "manatoui" (Simpson 1930). Pereira (1945) referred to the manatee as the Amazon *peixe-boi*, or steer-fish.

Type Locality

T. m. manatus is found in the West Indies, central American coasts, northern South America (Guyana, Surinam, Venezuela, and Trinidad); *T. m. latirostris* is found mainly off the Florida peninsula; *T. senegalensis* frequents West African rivers and coastal regions from Senegal to Angola; and *T. inunguis* is found in the Amazon and Orinoco rivers (Bertram and Bertram 1973).

Objective synonyms[3]

Order: Sirenia (Illiger 1811)
Family: Dugongidae
Trichechidae (Gill 1872)
Genus: *Trichechus* Linnaeus 1758
Synonyms:
Manatus Brunnich 1772
Oxystomus G. Fischer 1803
Halipaedisea Gistel 1848
Monatus D'orbigny, date unknown
Species: *Trichechus manatus* Linnaeus 1758
Synonyms:
Manati Trichechus Boddaert 1784
Trichechus manatus australis Gmelin 1788
Trichechus antillarum Link 1795
Trichechus americanus Link 1795
Manatus Orinocensis Bechstein 1800
Manatus Guyannensis Bechstein 1800
Manatus stroggylonurus Bechstein 1800
Trichechus clusii Shaw 1800
Trichechus Amazonius Shaw 1800
Manatus minor Daudin 1802
Manatus latirostris Harlan 1824
Manatus atlanticus Oken 1838
Subspecies: *Trichechus manatus manatus* (Linnaeus 1758)
Subspecies: *Trichechus manatus latirostris* (Harlan 1823)
Species: *Trichechus senegalensis* Link 1795
Synonyms:
Phoca manatus Brisson 1762
Manati Trichechus Boddaert 1784

[2] Although the Library of Congress does not list a paper by Gill in 1872, it does list: Gill, T. 1873. On the affinities of the sirenians. Acad. Nat. Sci., Philadelphia, Proc., 262–273.

[3] The objective synonyms have been taken from Hatt (1934).

Trichechus manatus australis Gmelin 1788
Manatus australis Retziuz 1794
Trichechus aequatorialis Lacépède 1799
Trichechus Australis Shaw 1800
Manatus stroggylonurus Bechstein 1800
Trichechus senegalensis Daudin 1802
Manatus sphaerurus Illiger 1815
Trichechus, Manatus, africanus Oken 1816
Manatus senegalensis Desmarest 1817
Manatus atlanticus Oken 1838
Manatus nasutus Wyman 1848
Manatus Vogelii Owen 1856
Manatus Oweni Du Chaillu 1861
Species: *Trichechus inunguis* (Natterer 1883)

Chapter 2.
Criteria for the Classification of Manatees[4]

Gross Anatomy

T. senegalensis and *T. manatus* are indistinguishable in appearance. *T. inunguis* can be identified by absence of nails, a white breast patch, slender proportions, and elongated flippers.

In the vertebral column, the number of vertebrae varies, but there are no other interspecific characteristics of enough definition to separate the species. Thoracic variations are *T. m. latirostris*, 17–19; *T. m. manatus* (Puerto Rico) 17; *T. senegalensis* 17; *T. inunguis* 15, and lumbocaudal differences are *T. m. latirostris*, 27–29; *T. m. manutus* (Puerto Rico) 25; *T. senegalensis* (Congo) 25; *T. inunguis* 25 (older), 22 (younger).

The sternum of *T. manatus* has a deep median notch and no incision in the margin of the caudal prolongation, whereas the sternum in *T. senegalensis* has no single deep median notch in the anterior border of the bone. It may have two light notches flanking a median prominence, and the margin of the caudal prolongation is incised. In *T. inunguis*, the sternum is smaller in relation to the size of the animal than in the others and may be recognized by its slender proportions and backwardly directed lateral processes.

The scapula in *T. senegalensis* resembles more closely that of *T. inunguis* than that of *T. manatus*, but it differs from both, being comparatively long and narrow. Its coracoid border is gently curved, without a pronounced angle at either the coraco-vertebral juncture or above the incisura. The spine in *T. senegalensis* is a little higher than in the others, the tuberosity less pronounced, and the acromion thinner. *T. inunguis'* scapula is intermediate in width but otherwise can hardly be distinguished from *T. manatus*. *T. m. manatus* and *T. m. latirostris* show no constant peculiarities of the scapulae.

The humerus of *T. senegalensis* is thinner than that found in comparably sized *T. m. latirostris* and is half the weight, resembling very closely the size of the humerus in *T. inunguis*.

The relative proportions of the humerus in the three species are also reflected in the radius and ulna. In *T. senegalensis* and *T. inunguis* the diameters of the radius and ulna are half those found in *T. manatus*.

The lengths of the metacarpals differ markedly in the three species.The fourth metacarpal in *T. manatus* is 45% of radial length, in *T. inunguis*, 65%, and in *T. senegalensis*, 62%. Because the fourth digit, the longest, grows more rapidly, or for a longer period, than does the radius, it is proportionately longer in older animals.

In length, the first carpal in *T. senegalensis* is not intermediate between *T. manatus* and *T. inunguis* but is within the limits of variation of its counterpart in *T. manatus*.

The first phalanx of the fourth digit in both *T. manatus* and *T. senegalensis* is 25% of the humerus length or 40% of the metacarpal length; in *T. m. latirostris*, it is longer than in *T. m. manatus*. In *T. inunguis* the corresponding percentages are 40 and 60. *T. inunguis* may be dubbed "long-fingered," and *T. manatus* and *T. senegalensis*, "short-fingered."

Innominate bones are present in the pelvic girdle but are rudimentary in *T. manatus* and *T. senegalensis* and absent in *T. inunguis*.

In general, the skull in *T. inunguis* is elongated with a long snout and is readily distinguished from the broad and compact skull of *T. senegalensis* and *T. manatus*. Ventrally, the posterior nares are shaped differently in all three species (see Table 1).

Twelve skulls of *T. m. latirostris*, from youth to full maturity, measured from 255 to 375 mm in length (Quiring and Harlan 1953), whereas skulls of *T. inunguis* ranged from 200 to 360 mm (Hatt 1934).

The charateristics of individual bones that constitute the skull are shown in Table 1 and are based on extensive verification of morphological data in the literature.

[4] This section is a summary based on Hatt (1934).

Table 1. Bones of skull and jaw.

	T. inunguis	*T. senegalensis*	*T. manatus*
Skull			
Bones	Soft consistency, chalky and elaborately roughened; lighter than *T. senegalensis* and *T. manatus*	Dense and smooth	Dense and smooth
Shape	Elongated with a long snout	Broad, compact, short snout (shorter than *T. manatus*)	Broad, compact, short snout
Nasal basin	Long and narrow; very distinct from *T. senegalensis* and *T. manatus* even in immature skulls	In adults, much broader than in *T. inunguis* but narrower than in *T. manatus* (Kaiser 1974); cannot distinguish *T. manatus* from *T. senegalensis* in immature animals.	Broader than in other two species; *T. m. manatus* longer snouted than *T. m. latirostris* but not conclusively
Posterior nares (basal view)	Ventrally, presents the form of a double, symmetrically notched circle	Almost circular	Deltoid
Nasal process of premaxilla	Upper border of premaxilla lies below lower border of frontal	Overlies the orbital process of frontal to some extent; the suture between the bones is shorter than in other species	As in *T. inunguis*, upper border of premaxilla lies below border of frontal
Anterior frontal margin		Between roots of orbital process, typically smooth, unserrated[a]	Slightly jagged; breadth is greater than in *T. senegalensis*[a]
Nasalia	Not always present as separate bones; when present, surface of frontals slightly concave to accommodate the modified lozenge-shaped bones (triangular or quadrangular — greatest diameters: 25–13 mm, smallest: 15–11 mm, thickness 6–3 mm)	Extremely varied in their development; right more frequently absent than left; left when present usually small, spongy, and fixed in the small pit of the frontal	Typically thick, almond-shaped bodies but range from apparent absence to well-developed peglike bones, lying in deep sockets of the frontal and uniting in a loose suture with the ascending rami of maxillae and/or premaxillae
Lacrimal bone	Often missing in prepared specimens		
	Scalelike, unlike *T. manatus*.	Intermediate in size and shape between *T. inunguis* and *T. manatus*; broadest point 3 mm in thickness, tapers to groove between 2 laminae of maxillae; upper border nearly in contact with orbital process of frontal; lower edge touches edge of jugal; triangular surface freely exposed laterally and forms part of the anterior-medial wall of orbital ring	Large, thick; closely resembles *T. senegalensis*

(con't.)

(Table 1 con't.)

	T. inunguis	*T. senegalensis*	*T. manatus*
Vomer	Intermediate in length between *T. senegalensis* and *T. manatus*; in newborn nearly as short as in *T. senegalensis*; in old, occasionally reach to within 25 mm of incisive foramen	Short; extending approximately to level of the middle of orbit	Long (except in newborn); reach to foramen incisivum or beyond
Floor of nasal chamber	Ledges present but lightly developed; farther to rear than in *T. senegalensis*	Ledges on sides of floor; consistently present	No ledges
Circumorbital region	Orbital process of frontal diverges most strongly in lateral direction; upper orbital borders, strongly convergent; when line of outer border of orbital process is extended forward, will cross median line within limits of skull; feature is well marked in newborn	Similar to *T. inunguis*	Unlike *T. inunguis* and *T. senegalensis* if line of outer border of orbital process is extended forward, will cross median line anterior to end of skull
Infra-orbital foramen	Usually simple	Usually simple	May be divided
Temporal bone	Muscular ridges; laterally directed and not rising above general level of skull roof		
Zygomatic arch		Thicker at its base than in *T. inunguis*	Similar to *T. senegalensis*
Malar process	Narrow, sharply tipped, and backwardly directed	Broad and sharply truncated	Same basic shape as *T. senegalensis*, but backwardly directed as in *T. inunguis*
Supraoccipital bone	Differs markedly from other species, surface roughened; lambdoidal ridge, seen from above, is yoke-shaped	Surface smooth and very nearly flat in transverse plane	Shares common pattern with *T. senegalensis*
Exoccipitals	Similar to *T. senegalensis*	Outer borders are knotty, pitted, and rough	Not as roughened as in other species
Foramen magnum	Narrowest, with vertical diameter 75% of the horizontal diameter	Intermediate between *T. inunguis* and *T. manatus* in transverse diameter	Ratio of the greatest vertical diameter to the greatest horizontal diameter is the least in this species *T. m. latirostris*: Flat dorsal rims; this may be one of constant features to justify subspecies; notching of basioccipital fairly constant and distinctive mark of this subspecies

(con't.)

(Table 1 con't.)

	T. inunguis	*T. senegalensis*	*T. manatus*
Postero-Ventral View of Skull			
Pterygoid process	Formed by wing of alisphenoid, palatine, and pterygoid bone; long and narrow, palatal point highest of 3 species	Long and narrow, palatine and pterygoid points coequal and longer than alisphenoid	No general rule for all subspecies. *T. m. latirostris'* pterygoid similar to *T. senegalensis* except thicker. *T. m. manatus'* pterygoid, short and very broad and either pterygoid or palatine point, is highest
Foramen incisivum	Completely or incompletely divided	Always simple	Partial division into anterior and posterior incisive foramina
Palate	Anterior end broadest at junction of maxilla and premaxilla and constricted just anterior to the level of the premolars		
	Constriction pronounced, width being about half that at the maxillary-premaxillary suture	Same as in *T. manatus*	Constriction variable, but never pronounced
Molars	Differ markedly from other species; smaller diameter, with anterior and posterior transverse ridges present and strongly furrowed even in unerupted teeth; the primary cones of these ridges broken into a series of smaller cones	Transverse ridges present and divided into 3 primary cones or sectors; ridges smooth in unerupted teeth	Indistinguishable from *T. senegalensis*
Mandible			
Interramal interval	Rami lie more nearly in parallel planes than in other two species; likewise, angular process wider and more in line with ramus	Less constriction in diameter of ventral border between the body and angular process than in *T. manatus*	As broad as in *T. senegalensis*
Symphysial suture	Furrowed but less conspicuous than in *T. manatus*	Closes early, no deep furrow along anterior margin	Furrow most conspicuous in this species but best developed at maturity and not well marked in newborn
Anterior end of mandible	Truncated as with other species and spine on anterior part of symphysis sometimes present	Truncated and spine invariably absent	Truncated; sharp median cone of compact bone (spine) extends forward from anterior part of the symphysis as a constant postnatal feature in this species
Mandibular ramus — ventral border	Slightly curved in longitudinal plane		More greatly curved in the horizontal plane than in other species; results from deepening of mandibular symphysis and is one of the most pronounced features of this species

(con't.)

(Table 1 concluded)

	T. inunguis	*T. senegalensis*	*T. manatus*
Coronoid process	Highly variable in shape and cannot be relied on as taxonomic feature		
Mandibular foramen	No septum; rarely, converging processes occur that nearly touch to form a partial septum	Septum well developed	Similar to *T. inunguis*
Mental foramina	11–15	3–4	4–7
Tooth rows	Never closely approach mandibular symphysis in old age as in other 2 species		

[a] According to Kaiser's (1974) plates, the anterior frontal margin is smooth and narrow in *T. inunguis*; jagged and broad in *T. manatus*; and *T. senegalensis* is intermediate in both respects.

Chapter 3.
Evolution and Distribution

Sirenia is a mammalian order comprising only two living genera, the manatee (*Trichechus*) and the dugong (*Dugong*) and, until recent times, the Steller's sea cow (*Hydrodamalis*) (Savage 1977). The earliest known sirenians appeared in the Eocene epoch (Savage 1977), with Trichechids forming a separate phyletic line from the dugongs (Reinhardt 1959). After the Eocene, Oligocene, Miocene, and Pliocene ages, eight sirenian genera (*Prorastomus, Trichechus, Protosiren, Eotheroides, Halitherium, Anomotherium, Metaxytherium, Dugong*) appeared and all but two (*Eotheroides* and *Halitherium*) were monospecific. Fossil remains have been found in America, Europe, and North Africa, and recently major discoveries have been made in Middle-Upper Eocene marine deposits of southeast France (Savage 1977).

The sirenians evolved from a four-footed terrestrial mammal into an aquatic animal. Their hind limbs degenerated, the tail became flattened, and the hairy body covering disappeared except for a few scattered bristles. In some, the teeth were reduced in number or lost completely; in others they were replaced in a cyclic pattern (Hopwood 1927; Prater 1928), and the jaw became deflected downward to varying degrees (Prater 1928; Simpson 1930; Savage 1977).

According to Savage (1977), the structures common to early sirenians included pachyostosis especially in the ribs, zygoma, postorbital processes, and premaxilla, and a distinctive periotic system. All of these features are maintained in the known manatees. Others have evolved and are discussed in the relevant sections of this text.

Distribution

Historically, *T. manatus* ranged from North Carolina to southern Texas in the U.S., from the Bahamas and Greater Antilles to southern Mexico, along the Caribbean and Atlantic coasts of Central and South America to central Brazil (Bertram and Bertram 1973; Heinsohn 1976; Campbell 1976). At present, the species is extremely rare, and population estimates should be regarded as tenuous (Heinsohn 1976).

A small colony of approximately 1000 individuals of the subspecies *T. m. latirostris* resides along the Florida peninsula (Heinsohn 1976), and another 60 on the west coast in the Crystal River (Hartman 1971). The population of *T. manatus* in Mexico is estimated to be 5000 (Heinsohn 1976), and in Guyana, which has the largest numbers, between 1000 and 10 000 (Bertram 1974; FAO 1976; Heinsohn 1976). In Guyana, the species has been sighted along the sea coast, in all the main rivers, but, primarily, in the estuaries (Bertram and Bertram 1973). In Surinam, there is thought to be a moderate number ($\pm$1000) of animals living in the rivers, creeks, and in the swamp areas of the west. The status of this species in Central America is unknown and should be investigated (Bertram and Bertram 1973; FAO 1976; Heinsohn 1976). In 1968 Charnock-Wilson reported moderate numbers in Honduras, where they are relatively safe because their alligator predators are rare and they are not hunted by man. *T. manatus* is rare in Puerto Rico and absent from the Virgin Islands (Evermann 1900; Erdman 1970). In 1975, a single manatee was sighted at the west end of the Grand Bahamas for the first time since 1904 (Odell 1976, personal communication). The Brazilian coast population is estimated to be about 200 (Heinsohn 1976).

T. inunguis was once abundant in the Amazon basin, including Brazil, Peru, Colombia, and Venezuela. The animals frequented the Putumayo, Napo Tigre, Maranon, and Ucayali rivers and possibly the Rio Huallaga in Peru, and the Orinoco River in Venezuela (Bertram and Bertram 1973; Heinsohn 1976). According to Pereira (1945), the numbers at that time were small in the Amapa (Rio Branco), Mearim, and Marapanim river mouths, and the lower Amazon. The species was more frequently seen in the Faro lakes area, which was sparsely inhabited by human beings. Pereira reported thriving colonies in the Lago Grande de Vila France, Lago do Periquito, Parintino, Lago de Macurincana, and the Uruli River. In the lakes surrounding the towns of Itacoatiara, Urucara,

Table 2. Worldwide distribution of manatee.

Trichechus inunguis		*Trichechus manatus*		*Trichechus senegalensis*	
Country	Site	Country	Site	Country	Site
Colombia	Putumayo-Leticia regions	USA	Florida peninsula	Senegal	Marigots from Senegal River south to the Casamance region on coastal areas between Dakar and Banjul
Peru	Putumayo, Napo Tigre, Maranon, and Ucayali Samiria, Pacaya Maniti, Autumayo Amazon rivers	Mexico	Yucatan peninsula	Gambia	Gambia River
		Belize	Rivers, e.g., Belize River	Portuguese Guinea	
		Guatemala	Peten region	Guinea	
		Honduras	Caribbean coast	Sierra Leone	Mangrove swamps
Venezuela	Orinoco headwaters	Nicaragua	Caribbean coast, Bluefield River	Liberia	
Guyana	Rupununi and Essequibo headwaters (not confirmed)	Costa Rica	Limon Province	Ghana	Volta River (above and below the dam), probably lower reaches of other rivers
		Panama			
		Colombia	Caribbean coast	Ivory Coast	Cavally River, probably lower reaches of other rivers
Brazil	Lower reaches of Amazon main tributaries (e.g., Nhamunda, Tapajos rivers) and its lower lake	Venezuela	Lake Maracaibo, lower Orinoco	Togo	
		Guyana	Coastal region, all main rivers	Benin	
		Surinam	Coastal region, rivers, swamps of west	Mali	Segou, Lac Debo, Timbuktu Ansongo, Gao
		French Guiana	Coastal region	Nigeria	Mouth of the Niger River, Calabar; coastal rivers in western and midwestern regions: Benue River, e.g., at Numan
		Brazil	Coastal rivers in the northeast	Chad	Lake Lere, Benue River
		Curacao		Cameroon	Mangrove regions
		Cuba		Rio Muni	
		Jamaica		Gabon	Lower reaches of Gabon and Ogooue rivers
		Haiti			
		Dominican Republic		Congo	Kouilou River
		Puerto Rico		Zaire	Lower Zaire from Banana to Chaudron d'Enfer, especially around Boma
		Other Caribbean			
		Bahamas	West Grand Bahamas	Cabinda	
				Angola	Coastal rivers north of the Cuanza

Source: National Science Research Council, Guyana, 1974.