Preliminary Assessment of Nearshore Fishable Resources of Jamaica's Largest Bay, Portland Bight

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ABSTRACT

Sampling of mangrove, seagrass (*Thalassia, Syringodium* and *Halodule*) and nearshore sandy habitats over 13 months in Jamaica's largest bay, adjoining the country's largest landing site, yielded 98 species, comprising 92 finfish species from 41 families, including three elasmobranchs families, plus eight crustacean species from six families, and two molluscan species. Adult, sub-adult and juvenile fishes were captured with two types of seines nets deployed in shallow waters of not more than 2m depth. A total of 18.16 kg of fishable species were taken comprising 2,389 individuals, confirming the small sizes taken. Most (69%) of the 92 finfish species came from mangrove-seagrass habitats, and were represented entirely by juveniles. The five most abundant fish species numerically were *Anchoa lyolepis* (dusky anchovy), *Eucinostomus gula* (silver jenny), *Sardinella anchovia* (Spanish sardine), *Diapterus rhombeus* (caipita mojarra), and *Haemulon sciurus* (bluestriped grunt). Crustaceans comprised 7.1% with *Callinectes* spp. (blue swimming crab) the most abundant species, with molluscs contributing 2% of all species taken.

Species richness for the total area is high (SR = 98), and not unlike that (SR = 87) found in the Florida Everglades by Thayer et al. (1987). Similarity in diversity between sample stations and areas were measured using Jaccard's coefficient of similarity, and preliminary results suggest diversity in adjoining bays was sometimes different from each other. Mangrove-seagrass complexes in eastern Portland Bight had higher species diversity than western, despite nearly identical ecology and physico-chemical characteristics. Portland Bight and the area just west of it was shown to possess important juvenile fishable resources which occupied shallow nearshore zones as well as deeper areas that are fished commercially. Two commercially important marine shrimp species (*Penaeus schmitti* and *P. notialis*, southern white and southern pink shrimps) were caught.

Despite limited sampling, it was apparent that some areas functioned as critical nursery areas for many species and that the entire area as a whole, appeared to function as a giant nursery for many useful species. These fishable resources are inextricably linked with the larger body of resources landed at Old Harbour Bay beach, Jamaica's largest fish landing site, through movement from the Portland Bight area into deeper, exploited reef areas and through directly supporting the commercially fished reef species by providing forage species. The economic value of the fishable resources is thought to be so great that loss of these nursery areas through poorly planned development or other means, would affect the livelihoods of several thousand fishers, as well as equal numbers of directly dependent vendors and their respective families in adjoining parishes. This study was limited to very shallow waters, and thus, sampling of waters deeper than 2 m would be necessary for a more complete assessment.

KEYWORDS: Community structure, biodiversity, ecology, fishable resources, protected areas.

INTRODUCTION

The Jamaica Wetlands Resources Management Project determined that an assessment of the relationship between the wetlands and fishable resources of the large bay called Portland Bight or Old Harbour Bay, would be a very important project output (SCCF 1996). Because of study area size and various limitations, selected areas in the bay were studied.

It is generally taken as "an article of faith" (Boesch and Turner 1984) among estuarine scientists that coastal wetlands, such as mangrove and adjacent seagrass beds function as important nursery areas for juvenile fish and crustaceans. But, despite a great volume of literature on the subject (Austin 1971, Lindall et al. 193, Odum and Heald 1975, Blaber 1980, Staples 1980,Yanez-Arencibia et al. 1980, Robertson and Duke 1987) it has been suggested that the nursery ground value of mangroves up to recentl, was unclear (Robertson and Duke 1987). However, one very recent study, (Nagelkerken 2000) appears to prove conclusively that this assumption may be correct after all. The present study (conducted before Nagelkerken 2000) was thus intended to describe the nearshore fishable species in this largely unstudied area and to determine the extent and values of such resources. The areas investigated by limited sampling over 13 months April 1997 to April, 1998 were mainly mangrove-seagrass habitats, but also included a few alluvial beach sand sites west of Portland Bight.

Our objectives were to determine fishable species compositions and their spatial and temporal distributions, the importance of selected areas as nurseries and/or spawning areas, and seasonal variation in species composition and abundance, as well as the relative, actual, and potential economic importance of the species found. Further, our objective was to identify how existing and potential threats to wetlands and associated ecosystems could affect the actual and potential economic importance. Another goal was to develop area-specific management recommendations, and overall management recommendations for Portland Bight wetlands (Aiken 1996).

The areas sampled are indicated on Figure 1. These areas were, a). East Portland Bight (i.e. Manatee Bay, Coquar Bay, Walker Bay, Galleon Harbour), b). Central Portland Bight (Goat Island, Big Pelican Cay, Pigeon Island), c). Western Portland Bight (Port Esquivel, Salt river, Rocky Point, West Harbour, Miller Bay, Little Miller Bay), and lastly, d). West of Portland Point (Carlisle Bay and Macarry Bay).

Sample sites were all in very shallow nearshore areas with substrate conditions ranging from fine biogenic calcareous sand, soft grey mud, seagrasses, to coarse alluvial sand. Basic sample site characteristics are summarised in Table 1. In summary, sea surface temperature varies from 30 - 45°C. (the high 45°C. reading was caused by a power plant).

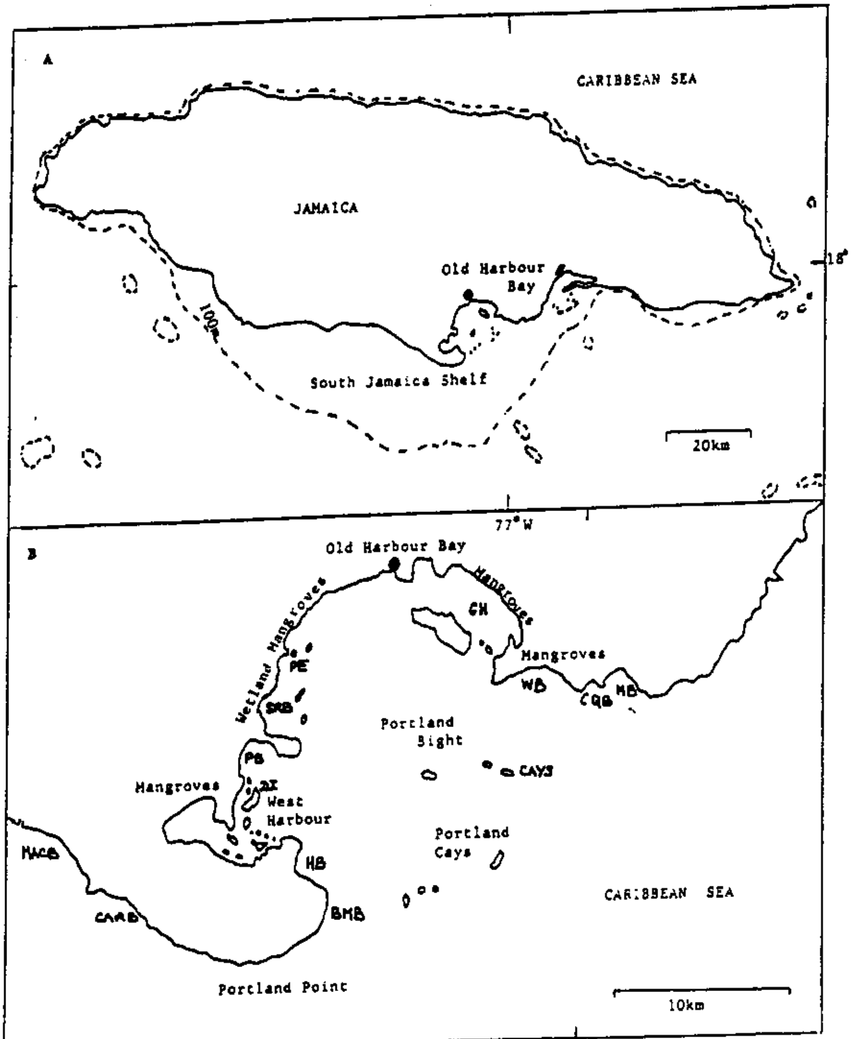

Figure 1. A. Map of Jamaica showing 100m depth contour and proximal oceanic bands; B. Portland Bight and Old Harbour Bay Sampling sites.

Table 1. Characteristics of sample sites

Site and Code Number	Main Characteristics (depth m)
Manatee Bay MB 1-8	Red mangrove prop roots, *Thalassia* beds, MB 1 - 8 scattered *Syringodium*, soft ooze and mud (0.2 -1.5 m)
MB 9-11	*Thalassia* beds, some *Syringodium* over firm white sand, surf. B11 at mangrove-seagrass junction (mean depth 1.5 m).
Coquar Bay CB 12-13	Red mangrove-*Thalassia* junction, *Syringodium*, fine white carbonate sand. Surf zone at west, many dead. *Thalassia* blades (1.0 - 1.5 m)
Walker Bay WB 14-16	Mangrove-dense *Thalassia* junction, with some *Halodule* (manatee grass), soft H_2S- rich mud and ooze (1.5 -1.75 m)
Galleon Harbour GH17-19	`Red mangrove-seagrass junction, soft, deep H2S-rich mud. Salt Island Creek mouth, (GH18) very rich detritus, and red mangrove with *Isognomon alatus* (false oyster) on roots (1.5 - 1.75 m)
Holmes Bay HB20/22	Red mangrove-*Thalassia* junction, deep organic ooze, with nearby *Halimeda* beds (1.0 -1.75 m)
(Big) Miller's Bay BMB 21	*Thalassia* and white carbonate sand, Millipore (fire) coral, encrusting algae accumulated *Thalassia* blades (0.5 - 1.5 m)
Dolphin Island DI 23	Mangrove-*Thalassia* junction, soft, deep organic ooze, with *Casseopeia xamachan* (upsidedown jellyfish) on mud (1.0 -1.8 m)
Peake Bay PB 24-25	*Thalassia* & *Halimeda*, strong surf in centre, hard white sand (0.5 -1.5m). Salt River Bay
Salt River Bay SRB26-29	Mangrove-seagrass interface, soft ooze, (1.5 - 2.0 m)
Rolling Bay RB30	At mouth of wetland creek, *Thalassia*, much dead seagrass, very soft ooze, and quicksand (0.5 - 1.8 m)
Port Esquivel PE31-32	Pebbles, shingle, scattered *Thalassia, Syringodium, Padina*, near creek mouth green urchins (*Lytechinus*) (0.5 - 1.5 m)
Big Pelican Cay/ Pigeon Island BPC33-34	*Thalassia*, fine white sand and red Pigeon Island alga (*Neogoniolithon spectabile*) (1.0 - 1.75 m)
Rocky Point Lagoons RP35 -36	Soft white sand, ooze, lagoon nearby, reduced salinity water, mangroves, murky (1.00 - 2.0 m)
Macarry Bay MB37-38	Alluvial sand, murky water, surf, open ground, lagoons, *Gracilaria* spp. (1.5 - 2.0 m), black mangroves.

METHODS

All sampling was done with seine nets. For areas near mangrove roots, a small meshed seine net with dimensions 5 m long, 2 m deep with 3 mm diameter mesh, fitted with two 2 m wooden poles, deployed by two persons. The distance sampled each time was 10 paces. Over seagrass beds, a larger seine net with dimensions 20 m long, 2 m deep with 15 mm diameter mesh, fitted with two wooden poles, was deployed for 20 paces each time. All catches were placed in labelled plastic bags and immediately fixed in 10-20% formalin. Samplings were executed once per month and this minimum frequency was generally met throughout the 13 month study. In some months, it was possible to do up to three trips. Generally, it was not possible to repeat sampling at each sampling site, except for three sites and therefore the data are for one set of samples per site. All sampling was done in daytime (between 1000 and 1600 hrs.).

All sample sites were sampled with both nets, with not less than three replicate settings of each net (small and large mesh). All catches were labelled and kept separately. Thus three samples were obtained for each net/habitat combination. Two-way analyses of variance with habitats (sort sites by habitats) and daytime as fixed factors were used to compare the equality of mean numbers of fish or crustaceans per netting. For small meshed nettings, catches were always standardized to numbers of fish per 10-pace netting. Not every site had mangrove-seagrass, although most did. Therefore, similar sites were grouped and analyzed together. One-way Analysis of Variance (ANOVA), with site (mangrove-seagrass) as a factor, were used to compare mean catch rates after appropriate transformation of the raw catch data. Similarity between sample areas was measured using the Jaccard (1902) *Coefficient of Similarity (C)*: $C = a/(a+b+c)$ where:

a = the number of species common to both areas or stations sampled

b = the number of species found at area/station b only, and

c = the number of species found at C only.

This index compares species on the basis of their presence or absence. Sites were compared in groups of three (triplets).

RESULTS

Species Composition

Some 2,389 fishable organisms comprising 98 species of finfish, crustaceans and molluscs, were taken during sampling from all the study sites. Fin fish comprised 92% of the species. Eight species of crustaceans from 6 families were captured, along with two molluscan species. Table 2 lists species as first encountered from roughly east to west. These fishable species all comprised 18.16 kg weight of total catch. From this total weight it can be deduced that all fishable resources were relatively very small in size and of low weight. Table 3 lists the 10 most numerically abundant species (both finfish and crustaceans) with information on their respective feeding guilds.

Table 2. Fishable species

Species (family)	Common Name	Total Number	Total Weight (gm)
Haemulon aurolineatum (Haemulidae)	Tomtate grunt	61	66
Sparisoma chrysopteum (Scaridae)	Redtil parrotfish	39	873
Stegastes dorsopunicans (Pomacentridae)	Dusky damselfish	36	176
Larisoma guppi (Blennidae)	Mimic blenny	1	-
Lutjanus apodus (Lutjanidae)	Schoolmaster snapper	63	1384
Caranx bartholamaei (Carangidae)	Yellow jack	3	100
Selene vomer (Carangidae)	Lookdown jack	27	41
Eucinostomus gula (Gerreidae)	Silver jenny	452	2692
Umbrina coroides (Scaenidae)	Sand drum	31	247
Callinectes spp. (Portunidae) C	Swimming crab	113	647
Stellifer rastrifer (Scaenidae)	Red Star drum	-	53
Polydactylus spp. (Polynemidae)	Threadfins	13	177
Hemirhamphus balao (Hemirhamphidae)	Balao	9	228
Harengula humeralis (Clupeidae)	Red ear sarine	13	88
Trachinotus goodei (Carangidae)	Palometa	1	41
Chloroscomberus chrysurus (Carangidae)	Leatherjacket	5	4
Chaetodipterus faber (Ephippidae)	Spadefish	1	28
Penaeidae spp. C	Roughneck shrimp	-	1
Sygnathus rousseau (Sygnathidae)	Pipefish	1	-
Lutjanus synagris (Lutjanidae)	Lane snapper	27	332
Unid Blenny (blennidae)	Blenny	2	19
Panulirus argus (Palinuridae) C	Spiny lobster	4	139
Penaeus spp. (Penaeidae) D	Marine shrimp	44	62
Abudefduf saxatalis (Pomacentridae)	Sergeant major	1	1
Unident. Species (Gerridae)	Mojarra	1	1
Gerres cinereus (Gerridae)	Yellowfin mojarra	4	127
Caranx latus (Carangidae)	Horse-eye jack	40	112
Syacium micrurum (Pleuronectidae)	Channel flounder	1	2
Sphyraena barracuda (Sphyraenidae)	Great barracuda	12	756
Scarus croisensis (Sparidae)	Striped parrot	43	56
Synodus foetens *(Synodontidae)*	*Inshore lizardfish*	*5*	*154*
Blennidae	Unidentified blenny		
Mithrax spinossissimus (Mithracidae) C	Spider crab	1	1
Archosargus rhomboidalis (Sparidae)	Sea bream	36	1581
Acanthurus bahianus (Acanthuridae)	Ocean surgeonfish	4	5
Haemulon sciurus (Haemulidae)	Bluestriped grunt	100	654
Odontoscion dentex (Sciaenidae)	Reef croaker	43	32
Jenkinsia lamprotaenia (Clupeidae)	Dwarf herring	95	45
Sparisoma rubripinne (Scaridae)	Yellowtail parrotfish	35	1091
Haemulon flavolineatum (Haemulidae)	French grunt	10	110
Haemulon plumieri (Haemulidae)	White grunt	22	125
Calamus spp. (Sparidae)	Porgy	7	26
Eucinostomus lefroyi (Gerridae)	Mottle mojarra	1	6
Scorpaena brasiliensis (Scorpaenidae)	Plumed scorpionfish	2	62
Sphoeroides spengleri (Tetraodontidae)	Bandtail pufferfish	36	609
Bothus lunatus (Bothidae)	Peacock flounder	7	18

Table 2 continued:

Species (family)	Common Name	Total Number	Total Weight (gm)
Siconyia spp. (Siconyidae) C	Grass shrimp	3	3
Diapterus rhombeus (Gerridae)	Caipita mojarra	157	970
Lutjanus griseus (Lutjanidae)	Grey snapper	9	115
Ripticus maculatus (Serranidae)	Whitespotted soapfish	2	18
Anchoa lyolepis (Engraulidae)	Dusky anchovy	371	193
Strongylura notata (Belonidae)	Redfin needlefish	2	5
Ocyurus chrysurus (Lutanidae0	Yellowtail snapper	48	354
Chilomycterus antillarum (Diodontidae)	Web burrfish	4	100
Lactophrys triqueter (Ostraciidae)	Smooth trunkfish	1	16
Uroluphus jamaicensis (Dasyatidae)	Yellowspotted stingray	2	452
Acanthurus chirurgus (Acanthuridae)	Doctorfish	5	9.5
Acanthurus coeruleus (Acanthuridae)	Blue tang	1	7
Stegastes variabilis (Pomacentridae)	Cocoa damsel	1	7
Monacanthus ciliatus (Monacanthidae)	Fringed filefish	5	13
Monacanthus hispidus (Monacanthidae)	Planehead filefish	1	1
Diodon holacanthus (Diodontidae)	Balloonfish	11	1995
Hemiramphus brasiliensis (Hemiraphidae)	Ballyhoo	23	211
Synodus intermedius (Synodontidae)	Sand diver	2	10
Symphurus arawak (Cynoglossidae)	Tonguefish	2	9
Haemulon bonairiense (Haemulidae)	Black grunt	4	44
Lachnolaimus maximus (Labridae)	Hogfish	1	4
Monacanthus tuckeri (Monacanthidae)	Slender filefish	1	1
Stegastes leucostictus (Pomacanthidae)	Beaugregory damsel 3	7	
Squilla spp. (Squillidae) C	Mantis shrimp	1	5
Gobionella saepepallens (Gobiidae)	Dash goby	1	0.25
Abudefduf saxitalis (Pomacentridae)	Sergeant major	3	2
Mulloidichthys martinicus (Mullidae)	Yellow goatfish	1	16
Hyporamphus unifasciatus (Belonidae)	Needlefish	1	18
Sphoeriodes testudineus (Tetraodontidae)	Checkered puffer	5	60
Dasyatus amaricana (Dasyatidae)	Southern stingray	3	1248
Balistes vetula (Balistidae)	Queen triggerfish	1	9
Leptocephalus larvae (Elopidae)	Tarpon or ladyfish	2	<1
Harengula jaguana (Clupeidae)	False pilchard	2	16
Lactophrys polygonius (Ostraciidae)	Honeycomb cowfish	1	10
Labrisoma nuchipinnis (Blennidae)	Hairy blenny	2	24
Bothus ocellatus (Bothidae)	Eyed flounder	1	13
Scorpaena plumieri (Scorpaenidae)	Spotted scorpionfish	3	101
Sparisoma aurofrenatum (Scaridae)	Redband parrotfish	1	5
Sardinella anchovia (Clupeidae)	Spanish sardinge	263	146
Hippocampus reidii (Syngathidae)	Reid's seahorse	1	2
Bairdiella sanctaluciae (Sciaenidae)	Striped croaker	2	18
Trachinotus falcatus (Carangidae)	Permit	12	298
Strombus gigas (Strombidae)	Queen conch	1	20

Table 2 continued:

Species (family)	Common Name	Total Number	Total Weight (gm)
Acanthostracion quadricornis (Ostraciidae)		Cowfish	120
Centropomus spp. (Centropomidae)	Snook	2	50
Rhinobatus lentiginosus (Rhinobatidae)	Atlantic guitarfish	1	128
Achirus lineatus (Soleidae)	Lined sole	6	52
Penaeus schmittii (Penaeidae)	Southern white shrimp	3	13
Trichiurus lepturus (Trichiuridae)	Largehead hairtail	2	77
Anchoa spp. (Engraulidae)	Unidentified anchovy	2	6
Penaeus notialis (Penaeidae)	Southern pink shrimp	3	10
Alectis crinitus (Carangidae)	African pompano	1	0.5
Isognomon alatus (Bivalvia) M	False or flat oyster	Unknown	
Total		**2439**	**18057**

Table 3. Ranked numerical abundance of top ten species indicating feeding guilds.

Species	Common Name	Food Guild	Number
Anchoa lyolepis	Diusky anchovy	Zooplanktivore	367
Eucinostomus gula	Silver jenny	Zoobenthivore	349
Sardinella anchovia	Spanish sardine	Zooplanktivore	264
Diapterus rhombeus	Caipita mojarra	Zoobenthivore	155
Callinectes spp.	Swimming crab	Zoobenthivore	116
Haemulon sciurus	Bluestripved grunt	Zoobenthivore	102
Jenkinsia lamprotaenia	Dwarf herring	Zooplanktivore	99
Umbrina coroides	Sand drum	Zoobenthivore	75
Lutjanus apodus	Schoolmaster snapper	Piscivore	71
H. aurolineatum	Tomtate grunt	Zoobenthivore	70

Spatial Distribution of Species Between Habitats, Species Diversity and Species Richness

It shows that the number of species found was greater per site in the eastern portion of the Bight than the west. Manatee Bay westward through to Galleon Harbour (four bays) had a mean species number of 32 (± 2.4) species, while in contrast the Cays (2 sites) had only 8 species in the same shallow depth (0.5 - 2 m) sampled at all sites. Carlisle and Macarry Bays on the extreme west had a mean of 15 (± 3.1) species present or were roughly 50% less diverse than eastern sites. The Diversity Index estimate for the whole of Portland Bight and immediately adjacent areas is Species Richness = 98, which is relatively high for an estuarine/coastal lagoon environment (Colinvaux 1986).

Table 4 provides a comparison of relative Species Richness by site, and suggests that eastern sites were more diverse than western ones.

Table 4. Species found at Manatee, Coquar, and Galleon Harbour 12 months apart, indicating nursery role

Species	Common Name
Anchoa lyolepis	Dusky anchovy
Archosargus rhomboidalis	Sea bream
Sparisoma chrysopterum	Redtail parrot
Eucinostomus gula	Silver jenny
Selene vomer	Lookdown jack
Gerres cinereus	Yellowfin mojarra
Caranx latus	Horse-eye jack
Ocyurus chrysurus	Yellowtail snapper
Haemulon sciurus	Bluestriped grunt
Sphyraena barracuda	Great barracuda
Lutjanus apodus	Schoolmaster snapper
Odontoscion dentex	Reef croaker
Bothus lunatus	Peacock flounder
Lutjanus synagris	Lane snapper
Acanthurus chirurgus	Doctorfish
Sphoeroides spengleri	Bandtail puffer
Penaeus spp	Marine shrimp

Comparisons of Guilds Between Biotopes (Habitats)

Densities of zooplanktivorous fishes (herrings and sardines) were higher in the red mangrove prop-root biotopes than the seagrass beds, and these densities and abundances were probably higher there due to structural complexity of the red mangrove prop roots. This complexity was lowest over open muddy ground.

Over seagrass beds the abundance and densities of diurnally active zoobenthivores and herbivores was greater than for mangroves. However, it must be noted that depths greater than 2 m were not sampled and also that other biotopes, such as patch reefs, open sandy areas, and coral rubble were not sampled. Such sampling needs to be executed in future for complete guild structure assessment. Table 3 compares the various major feeding guilds found.

Comparisons of Guilds Within Biotopes

The shallow nearshore area sampled was dominated by zoobenthivores (mainly *Eucinostomus gula* and *Diapterus rhombeus*), and zooplanktivores, principally *Anchoa lyolepis* and *Sardinella anchovia*), (See Figure 5 finfish families by occurence). Zoobenthivores comprised 36.7% (Gerreidae, Haemulidae and Sciaenidae) and zooplanktivores 32.1%. Diurnal herbivores (Scaridae and Pomacentridae) comprised 6.7% of fishes taken (Figure 2).

Habitat Dominance

Table 1 summarizes the major features of the habitats which were sampled in the study. The dominant habitat sampled was the red mangrove prop root-seagrass interface. The Cays that were sampled (Big Pelican Cay and Pigeon Island only) were characterised by sandy shore-seagrass habitats. Many cays in the bay were not sampled due to limitations of this programme. The westernmost sites outside of

Portland Bight were characterised by black mangrove-lined lagoons and seagrass or muddy/alluvial sand substrates. Generally, as mentioned, eastern sites had more fishable species than western ones.

Single-species Comparisons

The 10 most abundant species consisted of three small pelagic (surface-dwelling planktivorous) coastal pelagic fishes (anchovies, sardines and herrings; see Table 3) and seven benthic (bottom-dwelling) species (including the swimming crabs). All of the 10 species are of commercial importance.

The dusky anchovy (*Anchoa lyolepis*) was the most numerous species (N = 367) taken. Size composition of this species is shown in Figure 3, and the mean size was 41.25 (± 3.3) mm TL and a mean weight of 0.53 g (± 0.09). Despite their small size they are vital in the food chain as a forage species for many larger commercial fishes. The largest dusky anchovy were found at Carlisle and Macarry Bays and one large specimen weighed 7.0 g and measured 87 mm FL. However, the mean size at Carlisle Bay was only 21.9 (± 3.1) mm TL, while on the eastern side of the Bight this species had a mean size of 34.8 (± 4.1) mm TL.

The silver jenny mojarra (*Eucinostomus gula*) was the second most abundant (N = 349) species (see Figure 4), the largest numbers found in Galleon harbour, Manatee Bay, and Port Esquivel, and it appears to be strongly associated with those areas near mangrove prop-roots and mud.

Spanish sardine (*Sardinella anchovia*) was the third most abundant (N = 264) species and was present only around the Cays sampled and the western side of the Bight, continuing into Carlisle Bay. The mean size for the species in the entire area was 33.2 mm TL (± 3.0) Mean size for this species in Carlisle Bay was 48.4 mm TL (± 3.9). At Big Pelican Cay, Spanish sardine had a mean size of 32.3 mm TL (± 4.1).

The most abundant invertebrate species was the swimming crab, *Callinectes* spp. (N = 89) and was found at most sites. Figure 4 indicates from their size distribution that they were generally small with a mean carapace width (MCW) of 41.3 mm (± 5.1).

Critical Habitats

There are at least four types of critical habitats for fishable species that were encountered in the area studied:

i) Coastal mangrove lagoons - (Manatee & Walker (Long) Bays, Rocky Point (Carlisle Bay), Macarry Bay)
ii) Red mangrove prop root-seagrass complexes - (Galleon Harbour & Goat Island, West Harbour)
iii) Coastal seagrass beds - (Portland Cays, Manatee & Walker Bays, Galleon Harbour)
iv) Wetland drainage-seagrass interfaces - Cockpit & Browers River areas.

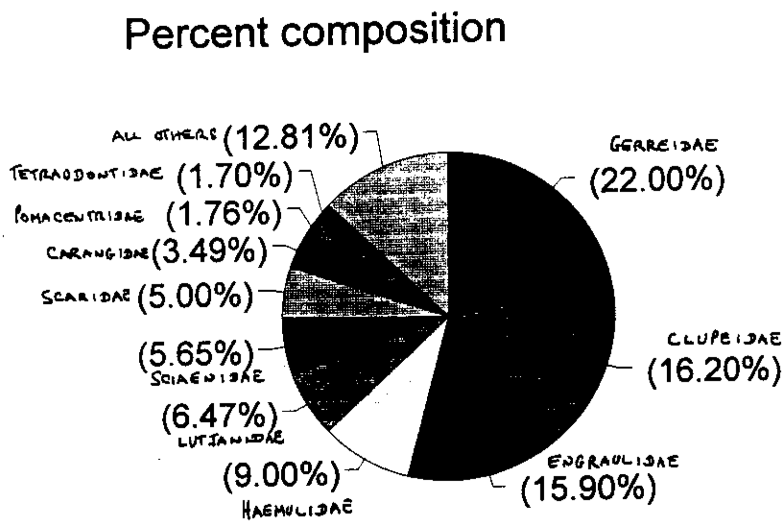

Figure 2. Percent composition of finfish families

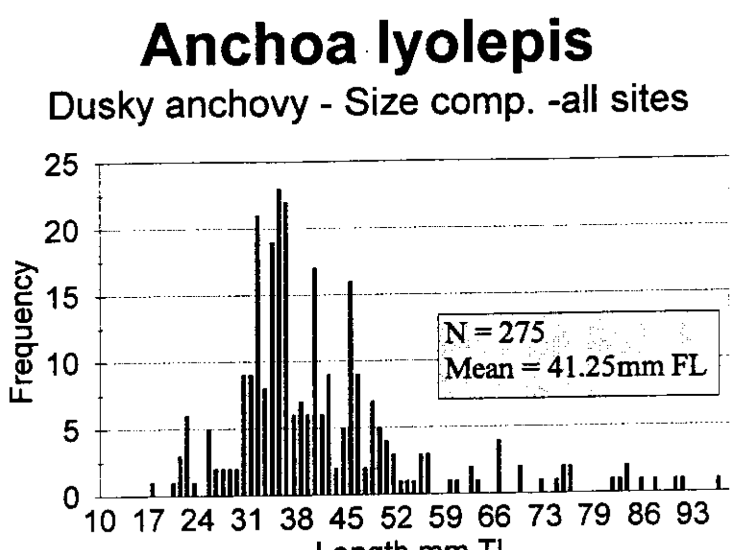

Figure 3. Size-frequency distribution for the dusky anchovy, *Anchoa lyolepis*, from all sites.

Similarity of Diversity Between Sites

Figure 6 shows the Jaccard's coefficient of Similarity for the sample sites. In summary, it appears that the most similar areas were Manatee bay and Galleon Harbour (eastern sites), while most of the western sites were very similar in diversity, with Carlisle Bay being most dissimilar to these westen sites.

Juveniles Versus Adults

A total of 68% of the 98 fishable species were found as juveniles, with only 7% as adults and 25% were a mix of juveniles with adults.

Spawning Areas

From the size of the juveniles caught, spawning probably occurs in deeper waters away from the areas sampled and that the habitats, such as the mangrove-seagrass complexes, are associated with spawning adult fishes. Note especially, that the muddy areas near Galleon Harbour and off Carlisle Bay and Macarry Bay had adult and juvenile marine commercial shrimp in numbers larger than elsewhere in this study. The previous section also shows that 93% of all the fishable species were found as juveniles or these mixed with adults.

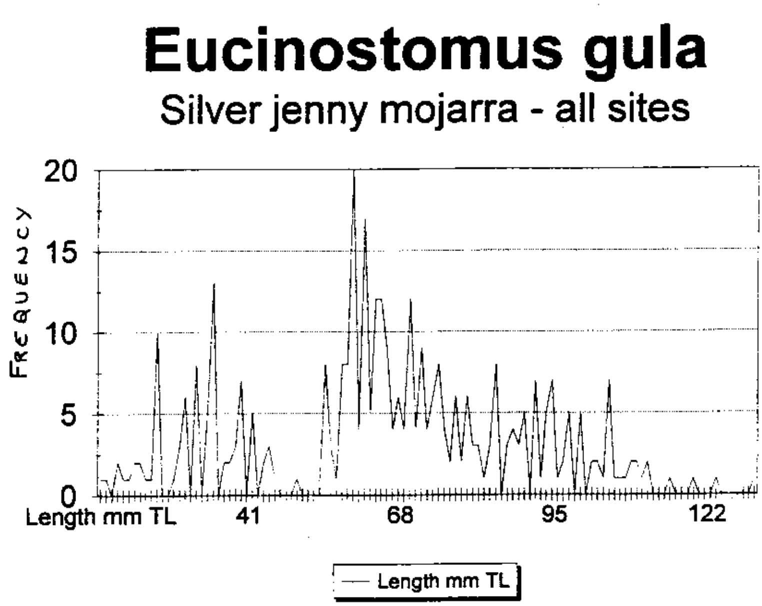

Figure 4. Size-frequency distribution for the silver jenny mojarra, *Eucinostomus gula*, at all sites.

Economic Importance of Fishable Resources

The economic importance was deduced from the following categories into which they may be placed:

i) Juveniles of commercial reef (pot fishery) finfish species,
ii) Juveniles of commercial crustacean (lobster) species (to be later caught in traps and by divers),
iii) Juveniles of marine shrimp species.
iv) Many abundant small pelagic fishes form the forage or prey species on which the commercial fishes thrive and without which they would have to move away and/or die.
v) There are socio-economic considerations. For instance, the large fisher communities, including the largest fish landing site in Jamaica at Old Harbour Bay with over 150 boats and 400 fishers and at least four other landing sites, all directly depend on the availability of fishable resources in and around Portland Bight.
vi) A large fish vending community directly depends on the success of fishers and the availablity of fishes.
vii) A large body of fresh fish product distributors and mobile retailers, directly depend on the fishers and vendors for their supply.

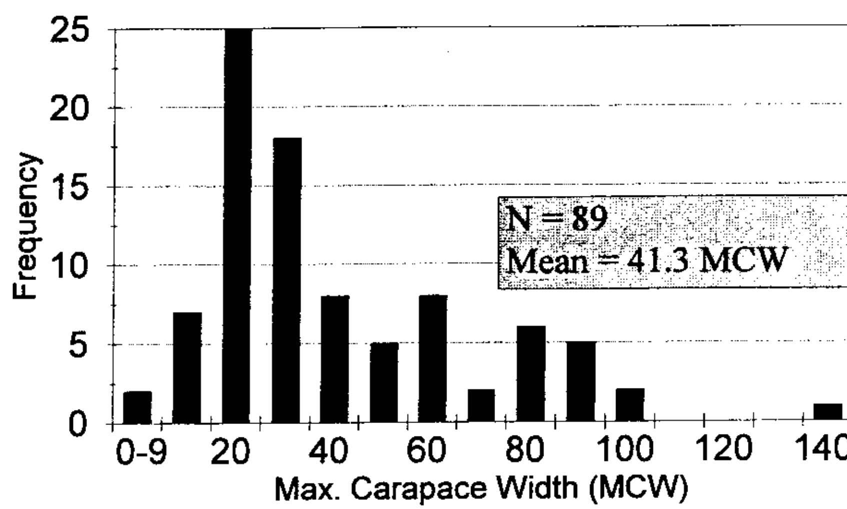

Figure 5. Size-frequency distribution of *Callinectes* spp. crabs from all sites.

Regarding fishes, of the ten most abundant families, eight are of prime commercial importance in their own right, with no less than 33 commercial species (or 29.6% of fish species). The major fish families in Portland Bight are represented in Figure 2. Four of the 10 families are of value to the trap pot) fishery, two to the seine and tangle net fisheries, and two to the hook-and-line fishery as bait. The two baitfish families (the anchovies and herrings) made up nearly 32% or about one third of all finfish species caught numerically.

We suggest that the demise of the fishable resources in Portland Bight will have serious consequences for persons residing in the geographic area, both of and surrounding, Portland Bight.

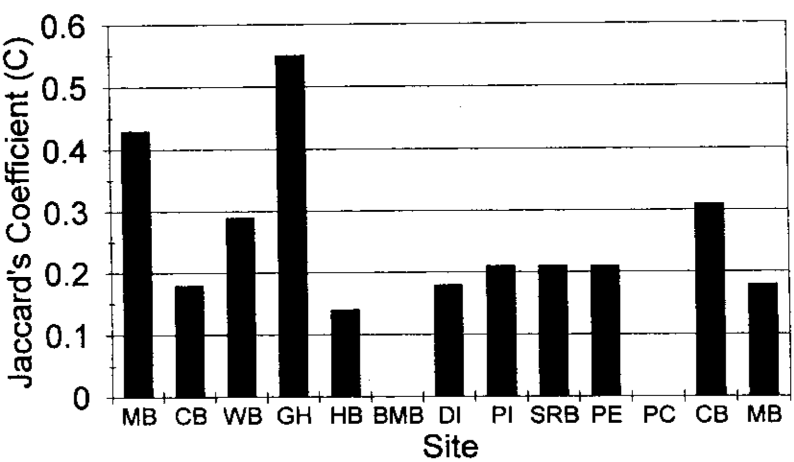

Figure 6. Jaccard's Coefficient of Similarity. Comparisons of fish species, divided by sampling site.

Existing and Potential Threats to Wetlands and Associated Ecosystems

The existing threats to wetlands as they applied to fishable resources, which were identified are as follows:

i) Dynamiting over coralline and seagrass habitats,
ii) Cutting of mangroves, and
iii) Waterborne pollution of rivers draining into Portland Bight and the Caribbean Coastal Area Management Foundation's management area.

Temporal Distribution of Species

Insufficient repeat sampling was done to allow this type of comparison but it showed that the following species could be repeatedly found in the same location up to one year later (see Table 4) At least 17 fishable species apparently repeatedly use the above sites as nurseries. There were another 10 species that were found only once.

DISCUSSION

The entire area can be considered a giant estuarine wetland complex. Such area are indispensable in the life cycles of many marine fishes and crustaceans (Salm and Clark 1987, Clark 1977, Geyer 1970, Nagelkerken 2000).

Community Structure (fishable resources)

Examination of the species list, the total numbers and weights of organisms, and the feeding guilds to which they belong, suggest that small, zooplanktivorous inshore or coastal pelagic fishes numerically dominated (three of 10 most abundant species or 39.7% of 10 numerically most abundant species). It is accepted that fishes may show ontogenetic differences in food utilisation, and of differences in food utilisation according to food availablity (Nagelkerken 2000).

Seagrass habitats yielded less fish and fewer species than expected. This may be due to disturbance of the fish fauna by the sampling boat (noise factor) and by the samplers who operated in relatively clear water and were easily observed by the fish. Normally, one would expect at similar sites and depths, an abundance of small scaridae (parrotfishes) and other young herbivores over seagrass in the shallows. Of note is the observation that normal high water clarity is probably a factor in the relatively low catches over seagrass. Thus, when occasional rough weather produced cloudy water, catches over such habitats were consistently higher.

Catches were numerically dominated by anchovies, sardines and herrings. Juvenile grunts measured from 21-35 mm TL only, though many eventually could attain 300 mm TL or more. This shows that the shallow mangrove-seagrass interface all around the Bight, serves as a nursery. We note that the presence of juveniles at all times during a 12 month period defines that area as a nursery.

The three small pelagic species are valued as baitfish by the hook-and-line fishery, while the others species comprise the fish trap (pot) and the chinese (tangle) seine net fisheries. All these fisheries take place in and around the Portland Bight management area.

Some 81% of finfish came from mangrove-seagrass habitats, and 19% from sandy substrate sites west of Portland Point. Most of the 89 finfish species were represented entirely by juveniles. The top five finfish species numerically were anchovies, mojarras, grunts and swimming crabs. The 10 most abundant fish species comprised 69.8% by number and 39.7% by weight of all catches. Three of these 10 species are important as baitfish and serve as forage fish for large commercial carnivores such as snapper and groupers. The 10 most abundant finfish families comprised 87.1% by number of all finfish. Four of the eight crustacean species found are commercially important and included three types of marine shrimp (*Penaeus* spp.) and the spiny lobster (*Panulirus argus*). The most abundant crustacean captured in the study was the edible swimming crab species (*Callinectes* spp.). The two molluscan species were of commercial importance (conch and flat or false oyster). Densities of small juveniles and sub-adult fishes were significantly higher in mangrove-seagrass than over open sandy ground. Fishable resources were relatively more abundant and in eastern Portland Bight mangrove-seagrass than western habitats. Diversity was also higher in the eastern Bight. West of Portland Bight (past Portland Point) diversity was lowest.

In comparison, Robertson and Duke (1987) investigating mangrove and seagrass habitats in Australia, found 103 fish species in mangroves and another 20 species in seagrasses. The present study found 92 fish species, with 58% being commercial versus 18.6% commercial species of 102 species in Australian mangrove estuaries (Robertson and Duke 1987). The Australian study found distinct mangrove and seagrass fish and crustacean faunas, whereas the present study did not. Similar to the Australian study, we found post-larval, juvenile and small (sub-adult) fish in the mangrove habitat. Small crustaceans were significantly more abundant on the western edge of the management area (i.e. in the muddy parts of Carlisle and Macarry Bays) than in Portland Bight sites.

The mangrove-seagrass complexes in the western portions of Portland Bight had relatively less diversity than those on the eastern boundary (see Table 4). This was despite their outward near identical appearance with the same mangrove and seagrass species, and physico-chemical factors.

Of special note was the observation that nearly all the species collected west of Jackson's Bay were larger and heavier than their relatives in the Bight itself. This may be due to the roles of the large western complex of shallow coastal lagoons and the adjoining black mangrove (*Laguncularia racemosa*) forests immediately behind Carlisle and Macarry Bays, the presence of the Rio Minho river and the different type of substrate (muddy seafloor) there.

Galleon Harbour (eastern edge of Portland Bight), is the most important area both in terms of critical habitat and as a nursery area. We suggest there is a nutrient-supplying role and linkage between the wetlands of the Cockpit River and Browers River and the relatively rich fishable resources near the mouths of these small tidal creeks.

The vital roles, as put by Salm and Clark (1987) of the renewable resources of coastal lagoons and estuaries, such as those that dominate the ecology of Portland Bight, should not be overlooked. The total yield of Portland Bight fisheries was estimated by Cesar et al. (2000) at 1,088 tons in 1997 or a unit yield of 0.8 $t/km^2/yr^1$ This yield is approximately 7.7% of the annual national catch (14,000 tons in 1996). Further, they estimated that fishers could make US$6.8 million for whole Portland Bight Area at a mean price of US$2.8 /kg. Thus, the study area has quite valuable resources which need to be managed in a sustainable manner.

This short study of the fishable resources of Portland Bight is the first ever conducted there and is only a preliminary assessment. The overall study (wetlands, socioeconomics, etc.) is an attempt to have a first look at this unique area of Jamaica which is part of the last remaining relatively undeveloped part of the central south coast, with the island's largest bay. It may also be the opportunity to protect some of Jamaica's valuable marine nurseries from the impacts of coastal development.

Any conclusions are necessarily preliminary. Manatee Bay and Coquar Bay, are previously known to serve as nursery grounds in the shallows near the centre of the bay, especially for rays (Ann Sutton, pers. comm. and pers. observ.). It appears that red mangroves and shallow nearshore seagrass beds shelter and nurture juvenile fishes and crustaceans. These juveniles and sub-adults dominated the fishable fauna here and at all sites sampled. Therefore, all of these shallow areas could function as fish and crustacean nurseries. Thus, bearing this in mind, Manatee Bay and Coquar Bays should be included in any plan for the sustainable development of the overall area.

MANAGEMENT RECOMMENDATIONS

Based on the foregoing, we suggested the there should be *area-specific and overall management recommendations.*

Based on their roles as nurseries and critical habitats, *protected areas/fish sanctuaries* should include:

- i) Manatee and Coquar Bays and the adjoing mangrove lagoons behind the beach berms and also the seagreass beds offshore for distance of not less than 1.6 km
- ii) Walker (Long) Bay and adjoining lagoon and seagrass beds (as in 1)
- iii) Galleon Harbour and adjoining lagoon and seagrass beds (as in 1 above)
- iv) Salt Island Creek for its entire length be protected
- v) The Goat Islands and its inextricable linkage with the Galleon Harbour habitats also be included (note that Big and Little Goat Islands have now merged due to the sediment-accretion role of the mangroves over approximately 20 years since the printing of the Survey Departments 1:250,000 Jamaica topographic chart for 1977).
- vi) Inner West Harbour mangroves (nursery roles and potential touristic value)

Since the time of this study, the above areas have been made protected areas (CCAM 1998). These area are policed by the fishers groups in the area who are memebers of the Portland Bight Fishers Management Council (PBFMC).

Since this study, the Caribbean Coastal Area Management Foundation has made several of these areas fish sanctuaries (Figure 7) within the Portland Bight Sustainable Devoplment Area (CCAM 1998)

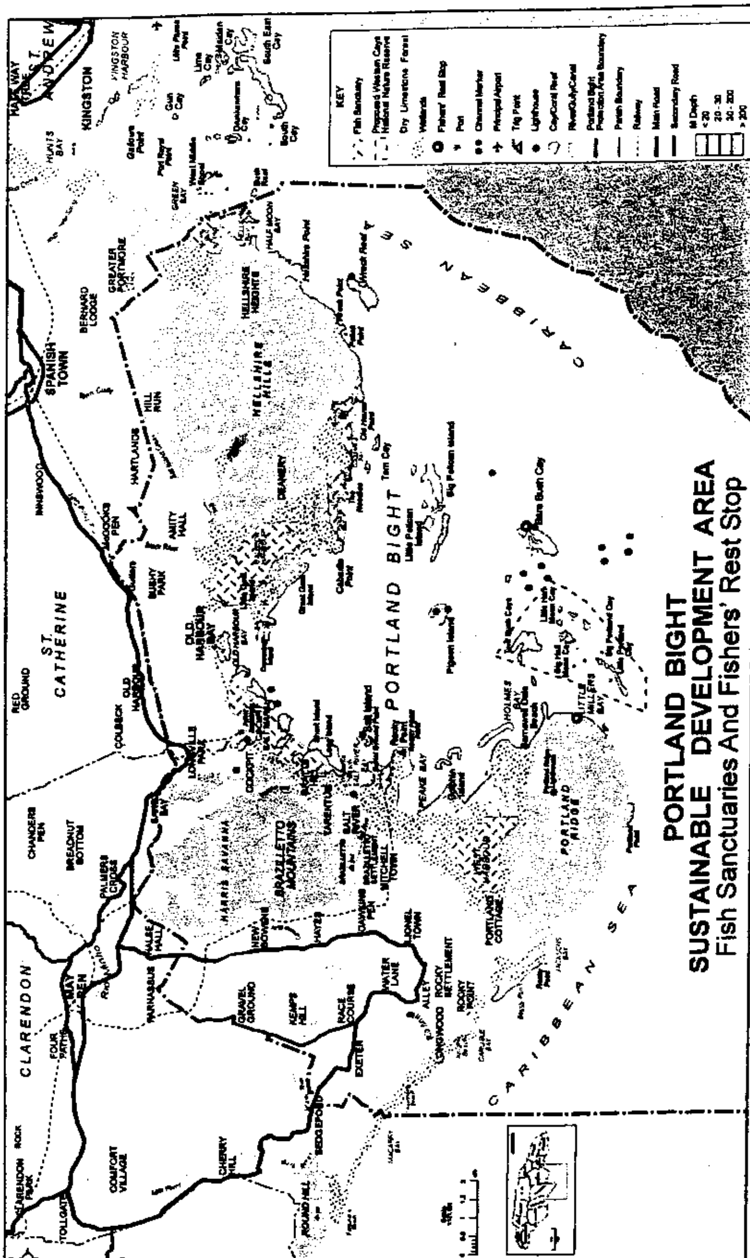

Figure 7. Portland Bight Sustainable Development Area: Fish Sancturaries and Fisher's Rest Stop

FUTURE RESEARCH

The present study examined only the shallow edges of the bay to only 2 m depth. This omitted, for various reasons, the middle and deeper parts of the Bight as well as the coral reef areas near the mouth of the Bay. Also, we recommend that the virtually unknown large coastal lagoons behind Carlisle Bay and Macarry Bay, in partitcular, be closely studied with regard to their role as fish nurseries and/or critical habitats. A first economic valuation of the entire area of Portland Bight is put at over US$52 million dollars (Cesar et al. 2000), and thus, sustainable management of the fisheries resources will contribute to the maintenance and enhancement of this value.

ACKNOWLEDGEMENTS

Fishers from Old Harbour Bay, St. Catherine, and Salt River, Portland Cottage and Rocky Point, Clarendon, gave assistance. Dr. Ann Sutton assisted in preliminary planning tours, provided maps and charts, amd much useful advice. Some of these data were first published by the South Coast Conservation Foundation (Aiken, 1998).

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