

## Current Status of the Small-scale Seine Fishery in Barbados

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### ABSTRACT

The seine fishery in Barbados is considered a minor fishery, operating largely as an alternative fishery during the pelagic fishery 'off-season' (June-September). As such, it remains poorly documented and the importance and contribution of this fishery to the island's fishing industry is largely unknown. This study addresses this lack of information. Data were gathered between June and September 2010 through structured interviews with seine net captains, informal conversation with crew members, personal observation and participation in numerous fishing trips. There are an estimated 100 seine fishers (96% males) currently active in Barbados, operating six large seine nets based along the west (4), south (1) and east (1) coasts. Most fishers are 40 - 50 years old and are well educated. Nets range in length from 183 - 640 m (200 - 700 yd) and have panels ranging from 2.5 - 6.4 cm (1 - 2 ½") mesh. Unlike the typical beach seine operations of neighbouring islands, Barbadian seine nets are set and hauled offshore. Furthermore, although all nets target schooling jacks when available, most also engage in 'chubbing', targeting reef fishes, particularly parrotfishes, grunts, and surgeonfishes. Stated mean catch per trip ranges among nets from 363 - 1,588 kg when targeting jacks, and from 79 - 204 kg when targeting reef fishes. A crude estimate of seasonal harvest indicates that between 78 - 257 mt of jacks (ex-vessel value of US\$257,000 - 848,000) and 9 - 22 mt of reef fishes (ex-vessel value of US\$48,500 - 123,500) are landed by this fishery between June and October. The contribution of the seine fishery to the island's food security and economy is considerably greater than previously recognised. Management challenges include the poor coverage of this fishery by the catch monitoring system, lack of regulations and enforcement, and the potential impacts of removing large numbers of reef fishes, on the health of nearshore coral reefs.

KEY WORDS: Seine fishery, schooling jacks, *Selar crumenophthalmus*, reef fishes, Barbados

### Estado Actual de la Pesquería de Red de Cerco de Pequeña Escala en Barbados

En Barbados, se considera que la pesca con red de cerco es una actividad menor que se desarrolla como alternativa a la pesca pelágica durante la temporada baja de esta última (Junio a Setiembre). Por ello, la pesquería con red de cerco ha recibido poca atención y se desconoce su contribución dentro de la industria pesquera de Barbados. El objetivo de este estudio es el de documentar este arte de pesca en Barbados. Para ello, entre Junio y Setiembre del 2010, se obtuvieron datos sobre esta actividad pesquera mediante entrevistas a capitanes de barcos de red de cerco, conversaciones informales con los miembros del equipaje y mediante observaciones personales durante viajes de pesca a bordo de estas embarcaciones. Se estima que hay aproximadamente unos 100 pescadores de red de cerco (96% varones) actualmente activos en Barbados, los cuales utilizan 6 grandes redes de cerco en la costa oeste (4), en la costa sur (1) y en la costa este (1) de la isla. La mayoría de los pescadores tiene entre 40-50 años y tiene un buen nivel educativo. Las redes tienen entre 183-640 m de largo con talla de malla variando entre 2.5-6.4 cm. A diferencia de las operaciones de red de cerco usadas desde la playa que se observan en las islas vecinas, en Barbados las redes se usan mar adentro. Además, aunque las redes se utilizan generalmente con el objetivo de capturar bancos de caranjidos, la mayoría se usan también para capturar peces de arrecife, particularmente scaridos, haemulidos y acanturidos. Según las entrevistas, la captura media por viaje de pesca varía entre 363 - 1,588 kg para caranjidos y entre 79 - 204 kg para peces de arrecife, dependiendo de las redes. Se estima que entre 78 - 257 toneladas de caranjidos (valor fuera de la embarcación de US\$ 257,000 - 848,000) y entre 9 - 22 toneladas de peces de arrecife (valor fuera de la embarcación de US\$ 48,500 - 123,500) son capturadas anualmente entre Junio y Octubre. Estos resultados indican que la contribución de la pesquería de red de cerco a la seguridad alimenticia y a la economía de Barbados es mucho mayor de lo reconocido. Los desafíos que hay que superar para la gestión de esta pesca incluyen el escaso seguimiento de esta actividad por el sistema actual de monitoreo, la falta de regulación y de implementación, y la falta de datos sobre el impacto potencialmente negativo que la extracción de grandes cantidades de peces de arrecife puede tener sobre los arrecifes.

PALABRAS CLAVE: Pesquería de red de cerco, *Selar crumenophthalmus*, Barbados

### Statut Actuel de la Pêche par Seine à Petite Échelle à la Barbade

MOTS CLÉS: Pêche par seine, *Selar crumenophthalmus*, Barbade.

### INTRODUCTION

Seine net fishing for nearshore schooling pelagic species (e.g. Carangidae, Scombridae and Sciaenidae) is widespread throughout the Lesser Antilles and makes an important contribution to total fish landings (Mahon 1993). It is a prominent fishing method in the eastern Caribbean, in islands such as St. Vincent (Ryan 1999), St. Lucia, Grenada (Finlay 1984, 1995) and Trinidad and Tobago (MALMR 2006), although the fishery remains fairly poorly documented throughout most of the Caribbean (McConney 2003). Barbados is no exception, and although the gear and fishing method have been briefly

described in a public information document (Willoughby and Leslie 2000), there is very little known about the number of nets and fishers involved, the current fishing practices, the catch rates, annual catch or species composition.

The seine fishery in Barbados is a traditional one (Brown 1942) which operates on a small scale, but is none-the-less believed to be important in contributing to the island's food security (Mahon et al. 2007), and in helping to support the livelihoods of fishers, particularly in the oceanic pelagic fishery 'off-season' (Mahon et al. 1982, GOB 2004). The targeted species of the Barbados seine fishery are reported to include the coastal schooling pelagics known locally as 'jacks' and 'cavalli' (Carangidae), as well as coral reef fish species such as 'barbers' (Acanthuridae), 'chubs' (Scaridae) and 'grunts' (Haemulidae) (Willoughby and Leslie 2000, GOB 2004). However, the majority of the catch is believed to by-pass the Government's system for recording fish landings (GOB 2004 in press), and therefore the estimated annual contribution of this fishery to the island's food security and economy (annual recorded landings 11.7 mt; estimated landed value of US\$29,626; estimated overall value-added at US\$50,749; Mahon et al. 2007) is likely to be grossly under-estimated. A further concern is the fact that at least some net units are targeting reef fishes and may, in addition, be damaging reef habitat during the fishing operation (GOB In press). The Fisheries Regulations under the Barbados Fisheries Act include a minimum mesh size for seine nets but no other restrictions, and both the most recent fishery management plans covering the periods 2004 - 2006 (GOB 2004) and 2008 - 2012 (GOB In press) outline the need for more information pertaining to this fishery.

The vision of the Barbados Fisheries Division for the island's coastal pelagic fishery (seine fishery) is that 'the coastal fish resources are sustainably utilized and managed, and the coastal conflicts that impair fisheries management are reduced or absent' (GOB 2004). The need for a methodical documentation of the current seine fishery in Barbados, including possible coastal use conflicts and habitat damage is obvious as a first step, if this vision is to be achieved. This study aims to address this significant knowledge gap by providing a detailed description of current fishing capacity, including number and description of boats and nets, number of fishers and their demographics, fishing practises and approximate yield.

## METHODS

Information about the seine fishery in Barbados was collected primarily by formal interviews with all seine net captains. This included details about: the crew size, crew experience, net and vessel specifications, location and description of seine fishing grounds, landing sites, fishing techniques, frequency and length of seine trips, species of fish targeted, catch rates, and share system. Formal

interviews were conducted at a time and place convenient to the fisher, and took approximately 30 minutes to complete. Catch data for specific trips were also confirmed over the telephone with the net captains as needed. Information on alternative occupations, home address, age, education level, and kinship amongst crew were obtained from informal conversation with many of the seine fisher crew members.

Additional information on the seine fishing practices (trip frequency, locations of fishing grounds, harvesting strategy duration of trips, net deployment and hauling, catch rate, catch sorting and marketing, on-water conflicts) were recorded whilst accompanying and/or observing five of the six nets on 42 harvesting trips during June through September 2010 (the sixth net did not make any trips during this time due to problems with their engine).

Quantitative biological data on the catch (species composition, size frequency, by-catch) were obtained from a small subsample of seven net hauls, selected haphazardly (west coast nets fishing west and south coasts, south coast net fishing southwest and south coasts). For each haul examined, approximately 100 - 200 individuals were randomly sub-sampled, identified to species and measured for fork length (FL) to the nearest 0.5 cm using a fish measuring board.

Government records of the number of registered seine fishers and recorded seine catches over the last five years were obtained from the Fisheries Information System (FIS) and the CARICOM Fisheries Information System (CARIFIS) databases held by the Barbados Fisheries Division.

## RESULTS

### Fisher Demographics

The FIS database held at the Barbados Fisheries Division indicates that a total of 152 registered fishers are involved in seine fishing. From observation and interviews conducted with seine net captains, we estimate that there are currently 100 active seine fishers in Barbados, who frequently make up the crew of the six seine nets operating from five sites around the island (Figure 1, Table 1). All seine net captains and the vast majority (96%) of the crew are male. One female fisher is part of the regular Paynes Bay-2 crew on the west coast, and there are three female crew members with the Consett Bay net on the east coast. Seine fishers range in age from 13 - 74 years, although the majority are in their forties (Figure 2). Net captains tend to be older than most of the crew (40 - 70 years) and have 15 - 50 years seine fishing experience and 8 - 40 years experience as net captain. The crew of several nets are closely related, with some nets being entirely family owned and operated. Seine fishers are generally well educated with most (57%) having completed secondary school and some (4%) having attained tertiary level qualifications. The remainder (39%) have all received at least a primary

Table 1. Summary of seine net characteristics in Barbados as given by interviewed net captains.

Coast	Net name	Net dimensions			Vessels					Catch		Fishing practices			Share system			
		Mesh sizes (inches)	Depth (feet)	Length (yards)	Boat type	Length (feet)	Engine type	Hp	Crew size	Average crew size	Target species	Average catch per trip (lb)	Fishing season	Average no. trips per week	Time at sea per trip (hr)	Net boat	Experienced/main crew	Less experienced crew
W	Six Men's	1 1/4	40	200	moses	27	outboard gas	55	7	7	jacks reef fishes	800 175	Jun-Dec	4	3	50	25	25
W	Weston	1 1/4	30	500	moses	27	outboard gas	75	8-15	8	jacks	2,300	All year	-	3	33	33	33
W	Paynes Bay 1	1 1/2 > 1 1/2	50	500	ice-boat day-boat net boat	42 28 22	inboard diesel inboard diesel none	? 135 -	14-24	15	jacks reef fishes	3,500 450	All year	4	-	33	33	33
W	Paynes Bay 2	1 1/4	25	400	moses	22	outboard gas	75	8-12	9	jacks reef fishes	1,500 200	Jun-Sep	4	5	33	33	33
S	Silver Sands	1 1/4 1 1/2	55	700	ice-boat ice-boat net boat	40 32 32	inboard diesel inboard diesel none	330 130 -	15-32	20	jacks reef fishes	3,500 350	Jul-Oct	5	6	33	42	25
E	Consett Bay	1 1/2 2 1/2	30	300	day boat moses	29 20	inboard diesel none	43 -	10-12	11	jacks reef fishes	-	Jul-Oct	-	-	50	25	25

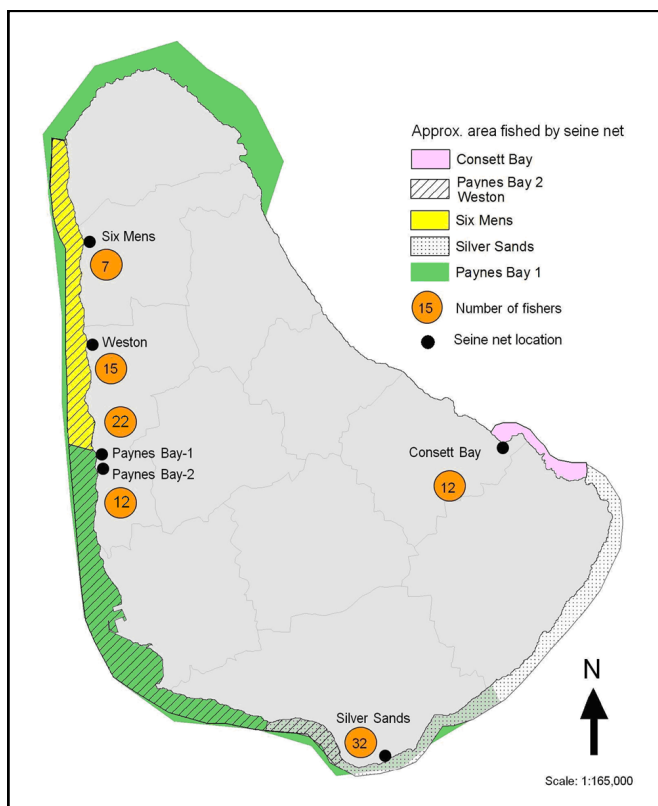


Figure 1. Map of Barbados showing location of the six seine nets, numbers of seine fishers and approximate areas fished by each net around the coastline.

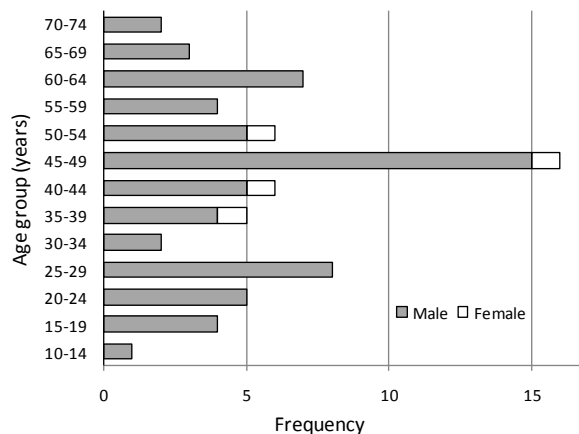


Figure 2. Age-sex ratio of seine fishers in Barbados, obtained by interview.

level education. All of the seine fishers have one or more alternative occupations to seine fishing, with the majority engaging in other forms of fishing, particularly offshore pelagic fishing. Alternative occupations other than fishing, vary widely and include both skilled and unskilled labour and professional occupations (e.g. mason, carpenter, joiner, welder, mechanic, engineer, chef, maid, seamstress, beach vendor, water sports operator, policeman, *inter alia*) as well as full time students.

**Fishing Grounds**

Seine fishing occurs in nearshore (50 - 400 m from

shoreline), shallow, coral rubble, patch reef, and sand habitats (approx. 1.5 - 15 m deep) around most of the coastline of Barbados with the exception of the very exposed windward central east coast (Figure 1). Some nets may travel considerable distances from their home mooring, and the fishing ranges of several nets, have significant overlap (Figure 1). The Paynes Bay-2 and Weston nets have the exact same stated fishing range and the Paynes Bay-1 net overlaps with 5 of the 6 nets' fishing grounds.

### Landing Sites

There are seven main sites where seine catches are landed. These sites include three primary landing sites where fish landings are monitored by Government (Oistins on the southwest coast, Weston on the west coast, and Consett on the east coast), one unmonitored secondary landing site (Sandpit on the west coast) and three unmonitored tertiary landing sites (Silver Sands on the southeast coast, and Brooklyn and Six Mens on the west coast). The seine boat mooring, landing and operational sites are located near the homes of the captains/boat owners, and most of the crew also live within 2 km of these sites. The seine net units require no special facilities other than a safe mooring and a landing beach, therefore they are not confined to the larger fishing complexes/harbours.

### Fishing Gear and Techniques

Nowadays Barbadian seine nets are set and hauled offshore, rather than from the beach (as was practised prior to the late 1960s), either using a single motorised seine boat (6.7 - 8.2 m in length, powered by an outboard engine) from which the net is deployed and hauled, or using an unmotorized net boat (6.1 - 9.8 m) towed by a motorized pelagic fishing launch (day-boat or ice-boat, Table 1). The nets vary in size from 275 - 914 m (200 - 700 yd) long and 7.6 - 16.8 m (25 - 55 ft) deep, and have panels of different mesh sizes from 2.5 - 6.4 cm (1 - 2 ½") (Table 1). Crew sizes for the different nets vary from 7 - 32 persons for any given trip (Table 1).

The fishing technique requires that the motorized net boat (moses) or fishing launch (day-boat or ice-boat) with its net boat in tow, are positioned up current of the last known location of the fish school. The motorized boat then makes a semi-circular sweep deploying 'swimmers' equipped with mask, snorkel and fins (and usually also carrying a speargun or 'graining' stick) approximately every 10 m. The swimmers search down current for the school, raising a fin in the air and signalling to the net captain when located. Thereafter the net captain oversees the net deployment to encircle the school, and once enclosed the tow is dropped and the seine boat anchors to begin hauling the net with a minimum of three fishers. During hauling, the net is cleared by 'swimmers' each time the lead-line snags on the substrate, until the fish are tightly enclosed. The lead line is then 'stitched' together

using wire ties to make a bag, from which the fish can be scooped out using dipnets, and placed into the launch or net boat (moses) for transport to the landing/marketing site. One of the net boats also carries SCUBA gear to assist swimmers with man-handling the net at depth.

Seine fishing trips are variable in length depending on the travel distance to a chosen fishing ground and the species targeted. Fishers' estimates of the average length of time they spend at sea per trip varied between 3 - 6 hour (Table 1). When fishing for jacks ('jacking'), they tend to target a single school that they have observed, or that has been reported to them by other fishers. In this case they usually make a single haul ('pitch') on the fishing trip. However, when targeting reef fishes ('chubbing') they typically make multiple pitches on a single fishing trip.

### Harvest Season and Fishing Effort

According to the interviewed net captains, the majority of seine nets fish seasonally, typically for about four months during the pelagic fishing 'offseason' (June through October, Table 1), after which the nets are stored ashore. One west coast net fishes for approximately 7 months and two west coast nets stated that they fish year-round, although the frequency of fishing trips declines during the pelagic fishing season and tends to be highly variable depending on availability of schooling jacks. Net captains indicated that during the seine fishing season they would typically make 4 - 5 trips a week (overall average 4.3 trips, Table 1). However, observations of these nets over part of the season in 2010 suggest significant variations in fishing frequency over time and among nets. Some nets fished much less frequently than stated, being hampered by bad weather/sea conditions, other crew commitments or engine problems. As such the mean observed trip frequency across all active nets from June - Sept 2010 was only 2.3 trips per week.

Landings records held by the Barbados Fisheries Division in their CARIFIS database are acknowledged to be incomplete for the seine fishery (Chris Parker, Senior Fisheries Biologist, Barbados Fisheries Division Personal comm.), but do corroborate the reported seasonal and highly variable nature of the landings (Maraj et al. 2011).

### Catch

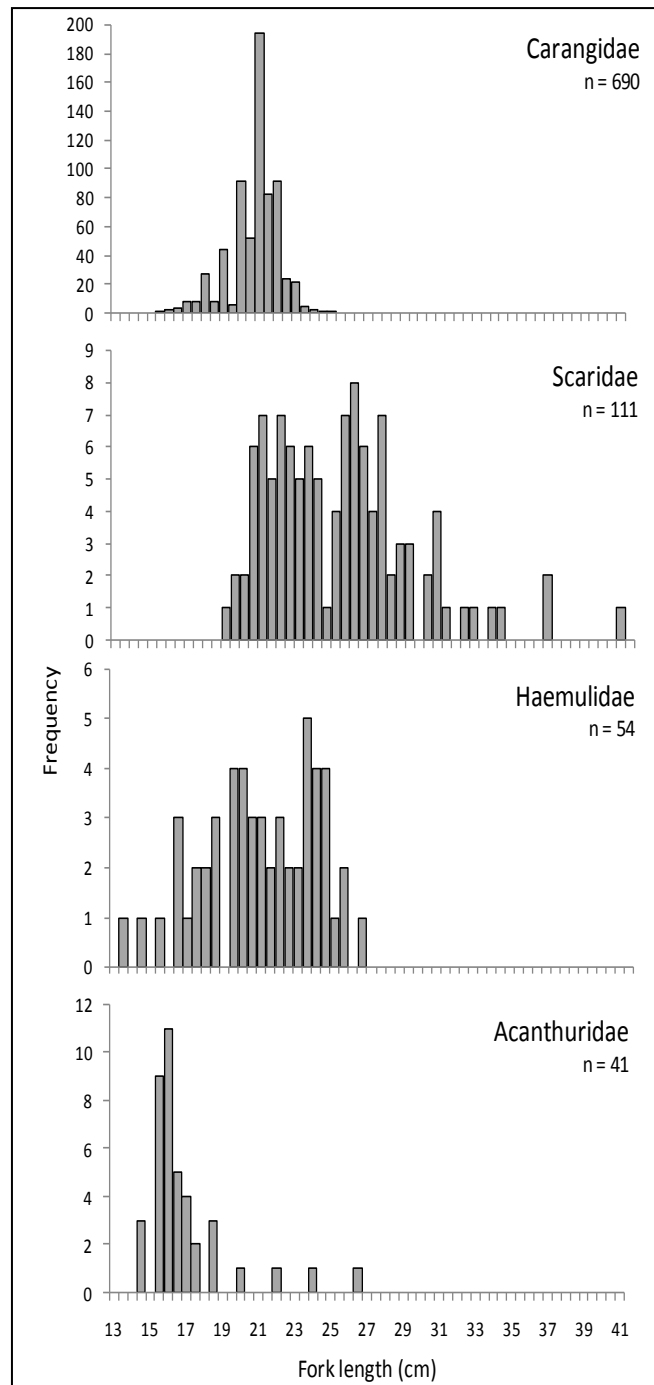
*Species composition* — All seine nets target schooling jacks whenever available, and this practise is known as 'jacking'. The catch on these occasions is essentially single-species, usually bigeye scad, *Selar crumenophthalmus*, (known locally as 'jacks' or 'johns') and much less often the blue runner, *Caranx crysos*, (known locally as 'cavalli'). By-catch species taken in the net when 'jacking' (e.g. great barracuda, needlefish, yellow goatfish, trunkfishes, ocean surgeons) are all retained, but account for less than 2% of the total catch by number (Table 2). Other species were also observed to be taken by swimmers

whilst attending the net and include the white sea urchin, queen conch and other coastal pelagics which are picked up by hand or speared.

Five of the six nets also engage in ‘chubbing’ when they purposefully target reef fishes by ‘pitching’ and hauling the net in patch reef and coral rubble habitats (Table 1). A variety of reef fishes are taken when ‘chubbing’ although the dominant families in the catch appear to be parrotfishes (Scaridae), locally referred to as ‘chubs’ (an estimated 46.8% of total number of fish caught), grunts (Haemulidae) (22.8%) and surgeonfishes (Acanthuridae), locally known as ‘barbers’ (17.7%, Table 2). The most common parrotfish species observed in the catch were redbtail (*Sparisoma chrysopterum*) and redband (*Sparisoma aurofrenatum*), the most common grunts, french grunts (*Haemulon flavolineatum*) and the most common surgeonfishes, ocean surgeon (*Acanthurus bahianus*). Coral rubble and the occasional piece of live coral are also picked up by the net, especially when ‘chubbing’, but are thrown back as the net is ‘sieved’.

**Table 2.** Catch composition (shown as percentage of the total number of fish caught) of Barbadian seine nets when targeting jacks (‘jacking’) and reef fishes (‘chubbing’). Data obtained from examining a small sub-sample (n = 4 ‘jacking’, n = 3 ‘chubbing’ trips) of net hauls.

Fishing type	Family	% Catch
Jacking	Carangidae	98.4
	Mullidae	0.7
	Acanthuridae	0.3
	Ostraciidae	0.3
	Belonidae	0.1
	Sphyraenidae	0.1
	<b>Total</b>	<b>100.0</b>
Chubbing	Scaridae	46.8
	Haemulidae	22.8
	Acanthuridae	17.7
	Carangidae	3.0
	Pomacentridae	2.1
	Mullidae	1.7
	Lutjanidae	1.3
	Kyphosidae	0.8
	Monacanthidae	0.8
	Ostraciidae	0.8
	Pomacanthidae	0.8
	Belonidae	0.4
	Chaetodontidae	0.4
	Labridae	0.4
	<b>Total</b>	<b>100.0</b>



**Figure 3.** Size frequency distributions of main families caught in Barbadian seine nets. Carangidae is comprised entirely of bigeye scad (*Selar crumenophthalmus*). Scaridae is dominated by two species, redbtail (*Sparisoma chrysopterum*) and redband (*Sparisoma aurofrenatum*) parrotfish. Haemulidae is predominately french grunt (*Haemulon flavolineatum*) and Acanthuridae is mostly ocean surgeon (*Acanthurus bahianus*). Sample sizes of fish measured (n) given in each panel.

Based on net captain interview data (5 respondents, Table 1) the stated average catch per trip when ‘jacking’ ranges from 363 - 1,588 kg of jacks (overall mean 1,052 kg) and from 79 - 204 kg of reef fishes when ‘chubbing’ (overall mean 133 kg). Observed catch rates across 21 ‘jacking’ trips revealed catch rates from 0 - 1,588 kg per trip, with an overall mean across nets of 614 kg. For 20 ‘chubbing’ trips a range of 45 - 159 kg per trip was observed, giving an overall mean across the active ‘chubbing’ nets of 101 kg.

### Harvest Estimates

A very crude upper and lower estimate of the seasonal harvest of jacks and reef fishes by the seine fishery was obtained using the stated mean catch rates and fishing frequency per week extrapolated over 16 weeks, and the observed overall mean catch rates and fishing frequency for June - September 2010, respectively (Table 3). As such we estimate that between 78 - 257 mt of jacks and 9 - 22 mt of reef fishes are likely to be landed by the seine fishery

(6 nets) over the main 4-month seine fishing season (Table 3). It is further acknowledged that the annual yield of the seine fishery would likely be larger, given that one of the nets has a 7-month season and two of the six seine nets fish year-round.

The Barbados Fishery Division CARIFIS database indicates high inter-annual variation in recorded landings of jacks (*Selar crumenophthalmus*) by the seine fishery, with annual records fluctuating between 3.5 – 10.1 mt and an overall average annual recorded catch over the last five years (2005 - 2009) of just 5.4 mt of jacks. Other species landed by the seine vessels whilst ‘jacking’ (e.g. blue runners) or ‘chubbing’ (e.g. reef fishes) cannot be reliably separated from recorded landings by the reef fishery.

### Sale of Catch

From observation, the vast majority of the seine net catches are sold directly to customers from temporary road-side stalls near the home mooring site of the vessels. Very little of the catch passes through the official markets

**Table 3.** Two alternate crude estimates of the total seasonal (4-month) yield of the seine fishery in Barbados

Parameter used for estimate	Net type (target species)		
	Jacks only	Jacks & reef fishes	
		Jacks	Reef fishes
Overall mean of <b>stated</b> fishing frequency (trips per net per week)	4.3	4.3	4.3
Observed proportion of trips for target species (% total trips)	100	51	49
Estimated seasonal (16 weeks) total trips per net for target species	68.8	35.1	33.7
Overall mean of <b>stated</b> catch rate for target species (kg per trip)	1,052	1,052	133
Estimated seasonal total catch per net of target species (kg)	72,398	36,923	4,490
Number of nets	1	5	5
Estimated total seasonal harvest of target species (kg) by boat type	72,398	184,616	22,452
Estimated total seasonal harvest of target species (kg) by entire seine fleet	257,014		22,452
Overall mean of <b>observed</b> fishing frequency (trips per week)	2.2	2.2	2.2
Observed proportion of trips for target species (% total trips)	100	51	49
Estimated seasonal (16 weeks) total trips for target species	35.7	18.2	17.5
Overall mean of <b>observed</b> catch rate for target species (kg per trip)	614	614	101
Estimated seasonal total catch per net of target species (kg)	21,908	11,173	1,766
Number of nets	1	5	5
Estimated total seasonal harvest of target species (kg) by boat type	21,908	55,864	8,829
Estimated total seasonal harvest of target species (kg) by entire seine fleet	77,772		8,829

and is therefore weighed and recorded by Government. Very large catches may be transported by boat to several landing sites/markets and may also be distributed inland by vehicle. The typical landed price is US\$3.30/kg for jacks and US\$5.50/kg for reef fishes. Approximately 95% of the landings is sold fresh and whole to consumers and 5%, mostly juvenile jacks (sprinklers), is sold for bait in the longline and snapper fisheries.

### Catch Shares

All the seine nets participate in a relatively simple share system, where the gross revenue (from the sale of the catch) is shared between the crew and the net unit. However, the percentage value of the shares varies among the different nets (Table 1). With some nets, a 50% share goes to the net unit and the other 50% share is split equally amongst the crew. Other nets give one third share (33%) to the net unit and two thirds is divided equally amongst the crew. One net gives one third to the net unit, a quarter share to the less experienced crew and the remainder (approx. 42% share) to the core, experienced crew (Table 1).

### Changes in Seine Fish Availability

Although not explicitly asked, several fishers offered their opinions on changes in the availability of schooling jacks. All of these indicated that jacks had declined in abundance in nearshore areas over the last few years. Some suggested that an increase in 'green water' events was to blame, whilst others implicated an increase in watersports tourism.

### Management Concerns

Very few seine fishers reported having any conflicts within the seine fishery and none had any problems sharing fishing space with other seine nets. Several spoke of space-use conflict and disturbance of fish schools by other nearshore resource users (e.g. jet skis, coast guard vessels, recreational fishers, sailing charter boats). The large number of parrotfishes removed from rubble habitats adjacent to coral reefs was mentioned as a matter of concern by several seine fishers and was a source of complaint from other fishers, especially those using fish traps. The use of nets in reef areas, and the removal of large quantities of reef fishes were also matters of concern expressed by personnel from the Coastal Zone Management Unit and the Fisheries Division.

## DISCUSSION

### Fishing Capacity

The Barbados seine fishing capacity is estimated at 100 active fishers, six nets, and 11 vessels. Just over half (56%) of the fishers and four of the six nets operate from the leeward west coast which generally has much calmer sea, more suited to this type of fishing, than the windward

south and east coasts. The fishing grounds, however, cover about 75% of the coastline.

The number of fishers recorded in this study is lower than that recorded in the FIS database of the Fisheries Division (152 registered seine fishers). However, this was not unexpected, given that the registration process allows fishers to register themselves for any fishery regardless of how often they participate, or even whether they are currently active in a given fishery (Staskiewicz et al. 2008). It is clear from the current study that the number of persons who take part in the seine fishery on an *ad hoc* basis is certainly higher than the 100 persons considered here to be 'regularly active', since captains only shared information on crew who were regular members of the team, whilst indicating that there are some opportunistic folks who may occasionally accompany the vessels on fishing trips. These folk may not even consider themselves fishers, may have a primary occupation on the land or may be students on school break during the summer, looking for 'extra money'. It is clear that the current seine fishery has the capacity to provide employment opportunity and income for 100+ individuals in Barbados.

The crew sizes of the seine fishing fleet can range from 7 to 32 crew members depending on the type of vessel configuration used. The day-boat/ice-boat with towed seine net boat configuration can accommodate at least 50% more crew than the smaller powered moses boats that operate independently.

The number of nets currently operating in Barbados is substantially less than the number of nets currently operating in other eastern Caribbean Islands of similar size. In Barbados there are just six nets, whereas Grenada has 56 nets; St. Vincent and the Grenadines has 58 nets; St. Lucia has 29 nets and Dominica has 48 nets (Finlay 1995). The low density of nets in Barbados may explain the low levels of conflict reported amongst them, and the lack of any informal rules of access to schools which are recognised in other eastern Caribbean seine fisheries (Finlay 1995, Ryan 1999).

### Fishing Gear and Techniques

The Barbadian seine nets have two or more panels of different mesh size that vary among nets from 1 to 2 ½ inches. Interestingly, the current fishery regulations state a minimum mesh size for seine nets of 1½ inches. This indicates a disregard of the regulations and an obvious lack of enforcement. Small mesh sizes will increase the likelihood of capturing juveniles, and even though fishers were observed to 'sieve' the net, (i.e. remove and throw back juveniles as the net is pulled onboard) a relatively high proportion of immature fish is still being landed. Interestingly, minimum mesh sizes are also regulated in other eastern Caribbean islands but are smaller than in Barbados, with St. Vincent and the Grenadines and Grenada having a minimum mesh size of 1 inch and

Dominica a minimum of  $\frac{3}{4}$  inch in their significant seine fisheries (Ryan 1999).

Barbadian nets and crew sizes fall within the reported size ranges of seines in St Vincent and the Grenadines (Ryan 1999) but are fished somewhat differently. Barbadian nets are 'pitched' and hauled offshore, a practise that was apparently developed in the late 1960s when competition for beach space became an issue with the development of the tourism industry. This practise remains in contrast with other eastern Caribbean islands where nets are almost always pulled from beaches at recognised 'hauls' (Finlay 1995, Ryan 1999). Furthermore, in Barbados, the fishery is strictly seasonal for some nets, with harvesting occurring for about four months a year during the summer pelagic 'off-season' (June – October) as an alternative occupation for these pelagic fishers. This contrasts with the typical practise of other eastern Caribbean seine fisheries which operate year-round (e.g. Mahon 1993, Finlay 1995, Ryan 1999). Another difference is that most Barbadian nets engage in two types of seine fishing, one targeting jacks (jacking) and the other targeting reef fishes (chubbing). The latter practise is not known, or at least not reported to occur in other Caribbean seine fisheries.

### Fisher Demographics

The seine fishery harvest sector, in common with the other fisheries of Barbados, is heavily dominated by males and most are between the ages of 35 – 59 years. These fishers generally have many years of experience in the fishery and have the ability to train the younger crew members. Four of the nets have a mixture of mature and young crew, but two (Consett Bay and Six Mens) are currently crewed solely by a small number of older fishers which may result in the loss of these two nets from the active fishery in the next decade.

The main seine fishing communities in Barbados are Silver Sands and Paynes Bay, with 66% of the seine fishers residing in these two areas. The seine crew appear to be tight knit, with a strong bond among them. This is likely because most of the crew of a given net unit are related and/or their families have been members of the same community for generations.

Seine fishers are generally well educated with most having completed secondary school, and all have alternative occupations within the fishing industry or as skilled or unskilled labour in other sectors. As is typical for the 'minor' fisheries of Barbados (e.g. Staskiewicz et al. 2008, Oxenford et al. 2008), none of the fishers appear to depend entirely on the seine fishery for their livelihoods, but it is clearly an important income source for many, especially for pelagic fishers during the summer 'off-season'. Furthermore, the fishery is open access and crew are not required to make any capital investment in the seine net unit, thus providing good employment opportunity, particularly for family members.

### Yields

The catch when the nets are 'jacking' comprises mostly bigeye scad (*Selar crumenophthalmus*). This is also the most important species in seine catches of neighbouring islands (Finlay 1995, Ryan 1999). Interestingly however, the 'robin' (*Decapterus* sp.), the second most important species in neighbouring islands' seine fisheries (Finlay 1995, Ryan 1999), does not appear to be taken in the Barbadian seine fishery.

Annual landings records for the Barbadian seine fishery, kept by the Fisheries Division, are clearly grossly underestimating the contribution of this fishery. The value used by Mahon et al. (2007) when investigating the contribution of fisheries to the Barbadian economy and food security based on Fisheries Division figures was 11.7 mt of jacks per year, with an ex-vessel value of just US\$29,626. The mean of the most recent five years (2005 - 2009) landings data from the Fisheries Division suggests that only around 5.4 mt of jacks are now being landed by the seine fishery annually. This contrasts sharply with our own observations and crude estimates of total seasonal yield. Barbadian seine nets are capable of landing more than 1.5 mt of jacks in a single haul and were observed to land an average of 0.6 mt per haul whilst 'jacking' during the summer months (June – September). Our own crude estimates indicate that somewhere between 77.8 and 257 mt of jacks with an ex-vessel value of US\$257,000 – 848,000 are likely to be landed seasonally (June – October), and that annual catches could be almost double those estimates. Furthermore, the seine fishery is also landing a substantial yield of reef fishes, hitherto unrecorded, which contribute a further US\$48,500 – 123,500 to the seasonal income. If the same 71% added value, as reported by Mahon et al. (2007) for reef fishes and jacks, is added to our own ex-vessel estimates, it would suggest that the seine fishery could have a seasonal output value somewhere between US\$513,000 – 1,659,555. These data indicate that the seine fishery is contributing considerably more to Barbadian food security and the economy than previously realised.

The Fishery Division is well aware that the official catch recording system does not capture the seine fishery landings very effectively, but the amount missed is unknown. A high proportion of the seine catches are landed at unmonitored secondary and tertiary landing sites and are sold directly to the consumer from roadside stalls. This means that the majority of the catch (perhaps as much as 90% of the jack landings and 100% of reef fish landings) is never recorded. This has serious implications for fishery management, and for estimating the true contribution of the seine fishery to the fishing industry.



### Management Challenges

A number of management challenges are clear for the seine fishery, not least of which is the lack of accurate landings records and unacknowledged contribution of the fishery to the island's economy. Without such information, the fishery is unlikely to receive the attention it deserves to ensure that it remains sustainable. Lack of regulations and enforcement mean that there is no control over the harvesting of juveniles, nor the practise of indiscriminate harvesting of large numbers of reef fishes. The latter, particularly the removal of large numbers of grazers (parrotfishes and surgeonfishes), is likely to be having a significant negative impact on the health of today's over-exploited, eutrophic reefs.

The lack of any seine fisher association; the differences in opinion amongst seine fishers regarding the practise of 'chubbing'; and the observed indiscipline amongst the younger crew members, indicate that self-regulation of this fishery is unlikely to happen without outside encouragement and assistance. Although the seine fishery has many of the characteristics required for successful co-management (strong community connections and cooperation among fishers; a clear identity; shared fishing grounds; a localised resource that would respond to local level management; an interest amongst some of the seine fishers in developing better fishing practises) it is recognised that such co-management initiatives have many challenges, as reviewed by McConney (2003) for the seine fishery in Grenada. The lack of organisation within the Barbadian seine fishery will make it harder to resolve future conflicts with other marine space users and coastal stakeholders in a way that is beneficial to, or at least not detrimental to the continual existence of this fishery.

The description of the current seine fishery given by this study provides an important first step towards achieving the Fisheries Division's stated vision for the island's coastal pelagic fishery.

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