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Seaweed-associated Fishes of Lagonoy Gulf in Bicol, the Philippines -with Emphasis on Siganids *(Teleoptei: Siganidae)*-

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Abstract

Lagonoy Gulf is a major fishing ground in the Philippines. It is large (3071 km^2) and deep (80% of its area is 800-1200 m) where channels opening to the Pacific Ocean are entrenched. Its annual fishery production of 26,000 MT in 1994 slightly decreased to 20,000 MT in 2004. During the same 10-year period, catches of higher order, predatory fishes decreased and were replaced by herbivores and planktivores. Scombrids such as tunas and mackerels composed 51-54% of total harvest. Of the 480 fish species identified in the gulf, 131 or 27% are seaweed-associated or these fishes have utilized the seaweed habitat for juvenile settlement, refuge, breeding and feeding sites. The seaweeds occupy solely distinct beds (e.g., *Sargassum*) or overlap with seagrass and coral reef areas. About half of all fishes (49.6% or 238 species) are coral reef fishes. The most speciose fish genera are *Chaetodon* (19 spp.), *Lutjanus* (18 spp.), *Pomacentrus* (17 spp.) and *Siganus* (14 spp.). Among them, *Siganus* (Siganids or rabbitfishes) is the most speciose, commercially-important genus contributing 560 mt-yr^{-1} to the total fishery production, including about 60 mt siganid juvenile catch. In recent years, there has been a continuing decline of siganid juvenile production. The major reasons are unregulated catching of juveniles and ovefishing of pre-adults and adults. The paper provides a general discussion about the diversity, fishery status and seasonality of occurrence of siganid juveniles, particularly along San Miguel Island, where most (90%) of the juvenile harvest originates. It concludes with recommendations (including on marine protected areas) and research needs toward sustaining the resource.

Introduction

Lagonoy Gulf (123º31'37"E, 13º44'30"N) is the largest fishing ground (3701 km^2) along the northeastern side of the Philippines (Fig. 1). The gulf is bordered by 15 coastal municipalities from the provinces of Albay, Camarines Sur and Catanduanes in the Bicol Region. It is deep (800-1200 m in 80% of its area) where channels opening to the Pacific Ocean are entrenched. Coral reefs (17000 has), seaweed-seagrass beds (8300 has) and mangroves (600 has) are its key critical habitats. Enclosed within the gulf are seven islands where most of the coastal habitats are most extensive. Its ecology and fishery are influenced by northeast monsoon (November-February), southwest monsoon (June-October) and trade wind in summer (March, April and May). During the trade wind, the north equatorial current is the prevalent ocean current affecting the gulf. This major ocean current could play a significant role on its ecosystem, hence,

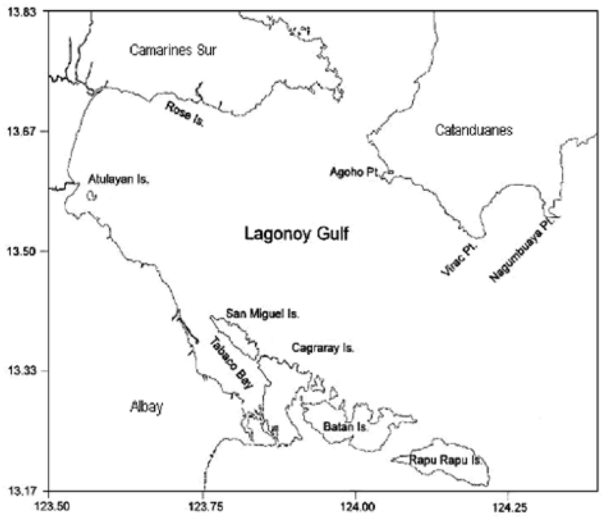

Fig. 1 Lagonoy Gulf showing the three bordering provinces and the four islands in the Albay East Coast where siganid juveniles are abundantly harvested.

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its fishery and the livelihood of the people.

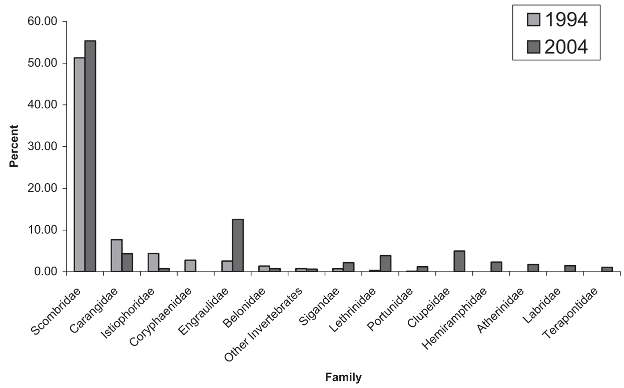
In summer, large amounts of both juvenile and gravid, mature siganids are most abundantly caught in the islands along the gulf's south coast, although siganids are caught throughout the year. The spatial and temporal coherence of such occurrence in the gulf over the last 50 years is an amazing ecological event. Moreover, the catching of siganid juveniles has been an integral aspect of the traditional fishery practices in the gulf particularly in the islands of San Miguel (SMI), Cagraray, Batan and Rapu-rapu on the east coast of Albay. However, there has been a continuing decline of siganid juvenile harvest in the last seven years since 2001. This has been a concern and cause for action among fishers and local government officials.

The paper aims to (i) provide basic information about Lagonoy Gulf, its coastal habitats, fish fauna and fisheries; (ii) elucidate about general aspects of the diversity, seasonality and fishery of siganid juveniles or "Aigo" (in Japanese) or "Kuyog" (in Bicol) in the gulf; and (iii) present resource use and conservation issues concerning its siganid juvenile fishery. Sigands are the most speciose, commercially-important fish family in the gulf, the rationale for the focus of the paper.

1. Lagonoy Gulf: fish species and capture fisheries

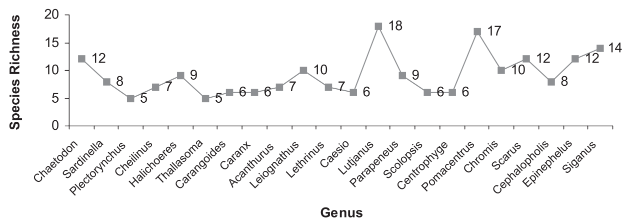
Studies have shown the high species richness of the gulf (Soliman et al. 2005). Four-hundred eighty fish species were identified belonging to 199 genera grouped into 76 families (Fig. 2). The most speciose fish genera are *Chaetodon* (19 spp.), *Lutjanus* (18 spp.), *Pomacentrus* (17 spp.) and *Siganus* (14 spp.) (Fig. 3). Although chaetodontids (butterflyfishes) and pomacentrids are very speciose, they are not common target species in the fishery because they do not command high market price compared to lutjanids (snappers) and siganids. Moreover, siganids annual harvest was higher (600 mt) than snappers (230 mt) in 2004. Siganids are the most speciose, commercially-important among the species group that are exploited.

About 25% (91 species) of all fishes found are subject to exploitation by the capture fisheries. Total fishery production has been 26,000 mt in 1994 and 20,000 mt/yr in 2004 equivalent to 6.5-8.5 mt/km^2/yr. This shows a 7% decline in production in 10 years. While this decrease may not be significant over the decadal period, there had been changes in the species composition whereby higher-order, predatory fishes were replaced by lower order, herbivores most of which are of lesser



Data Sources: ICLARM-BUCF 1994; BSBI-BUTC 2004.

Fig. 2 Changes in the relative composiiton of families of fishes and invertebrate during the REA (1994) and Post-RSA (2004).



Data Source: ICLARM-BUCF 1994.

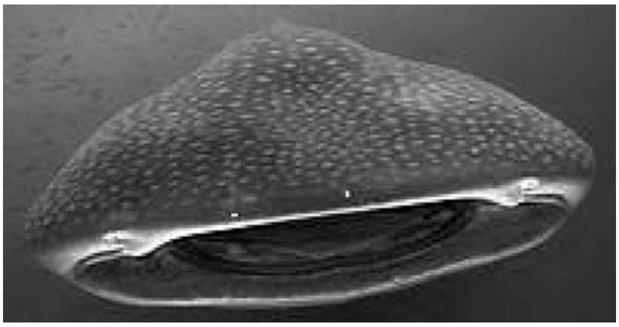
Fig. 3 Species number by genus of the fishes in Lagonoy Gulf.

market value (e.g., small pelagic species and some reef fishes). The fishes of the families Istiophoridae, Coryphaenidae, Carangidae and Belonidae significantly declined over the 10-year period. But the families Engraulidae, Clupeidae, Hemiramphidae, Atherinidae, Labridae, Terapontidae, Lethrinidae, Siganidae and Portunidae increased several fold. In short, there had been a significant change in the quality of species composition but the quantity of production did not decrease significantly.

The change in quality of species composition manifests an impact by the fishery to the ecosystem. Such impact also influences the economics of fishing in the gulf. Because while the market price of currently less valuable species may appreciate in time, the lower income generated from less valuable species will exacerbate present poverty conditions in the gulf. Only the scombrids such as tunas and mackerels have relatively maintained production of 51-54% of total production over the same period. But most of the scombrids are highly migratory while the small pelagics and reef fishes are residents of the gulf. The status of scombrids is thus to be viewed in a larger context, not within the gulf itself.

Twenty-seven percent (27% or 131 species) of all fishes are seaweed-associated or these fishes have utilized the seaweed habitat for juvenile settlement, refuge, breeding and feeding sites. The fish-seaweed association occurs because the structural complexity of seaweeds offers important refuge from predation, and invertebrates associated with seaweed beds provide rich food resources for juveniles (Hay and Fenical 1996; Duffy and Hay 2001). Such association could influence the initial pattern of recruitment and it is vital to understanding reef fish population dynamics. Thirty percent of the seaweed-associated fish species in the gulf are labrids, which is represented by 80% of all the labrid species.

Of the fish species found in the gulf, two species could stand out as peculiarly interesting. They are whalesharks (*Rhincodon typus*) and opahs (*Lampris guttatus*) (Fig. 4). Whaleshark, locally called "Butanding" in Bicol Region, are the largest fish in the world. The town of Donsol, Sorsogon, also in Bicol Region, is dubbed as the "whaleshark capital of the world" because of the very high frequency of occurrence of the largest fish in its coastal waters. There have been several sightings of the whaleshark in the gulf this year. Opahs are occasionally caught by fishers and are sold in the public markets surrounding the gulf. Opahs can reach a total weight of close to 300 kg and total length of 1.8 m.



Rhincodon typus

Lampris guttatus

Fig. 4 Two large fishes in Lagonoy Gulf – whaleshark (*Rhincodon typus*) and Ophas (*Lampris guttatus*).

2. San Miguel Island: coastal habitats and siganid juvenile fishery

The coastal habitats in San Miguel Island (SMI; coral reefs – 8 km^2, seagrass-seaweed beds – 3.6 km^2) are home to siganid juveniles. In one particular area called "Dinagsaan" in SMI where siganid juveniles are always observed, the dominant seaweeds are characterized by calcareous, tougher, coarsely-branched bodies or thalli (e.g., *Sargassum, Halimeda, Padina, Dictyota*) which have chemicals (secondary metabolites) and serve as structural defenses to herbivory. This suggests that the area is regularly subjected to herbivory because the seaweed community reflects it.

Siganus is the most speciose and economically valuable genus comprising 14 species (Table 1). Fifteen

Table 1. Species of the genus Siganus that have been observed in Lagonoy Gulf.

Scientific name	Local name	Remarks
Siganus argenteus	balawis	Least commonly caught
Siganus fuscescens	bataway	Most commonly caught
Siganus canaliculatus	bataway	Most commonly caught
Siganus spinus	burikat/ketong	Least commonly caught
Siganus guttatus	mublad	More commonly caught
Siganus javus	mublad	More commonly caught
Siganus punctatus	sandig	Commonly caught
Siganus punctatissimus	sandig	Commonly caught
Siganus virgatus	taragbago	Most commonly caught
Siganus vulpinus	taragbago	Commonly caught
Siganus puellus	taragbago	Commonly caught
Siganus unimaculatus	taragbago	Commonly caught
Siganus vermiculatus	taragbago	More commonly caught
Siganus corallinus	taragbago	Commonly caught

species are reported in the Philippines (Duray 1998) and 25 in the Indo-Pacific region (Woodland 1973). Siganids are always found in the public market of Tabaco City. Their juveniles are particularly abundant in March, April and May. Siganids are subject to exploitation during their juvenile, pre-adult and adult phases. This condition predisposes the resource to various forms of overfishing. In the last seven years (2001-2006), there has been a continuing steep decline in production of juvenile harvest. This has been a concern among fishers and government agencies alike.

Bagnet and seine-net are the 2 gears that catch siganid juveniles in the gulf (Fig. 5). Bagnets are operated (with light-attraction) at midnight until early morning. They are set 50-100 m from the reef edge. Seine nets are operated from early morning until afternoon in the reefs, seagrass, and seaweed beds. Bagnets catch pre-settling juveniles while seines catch the settled juveniles. It could be said that the seines catch what is left uncaught by the bagnets. The total annual harvest (66-175 mt/yr) of juveniles is almost equally shared by the two gears.

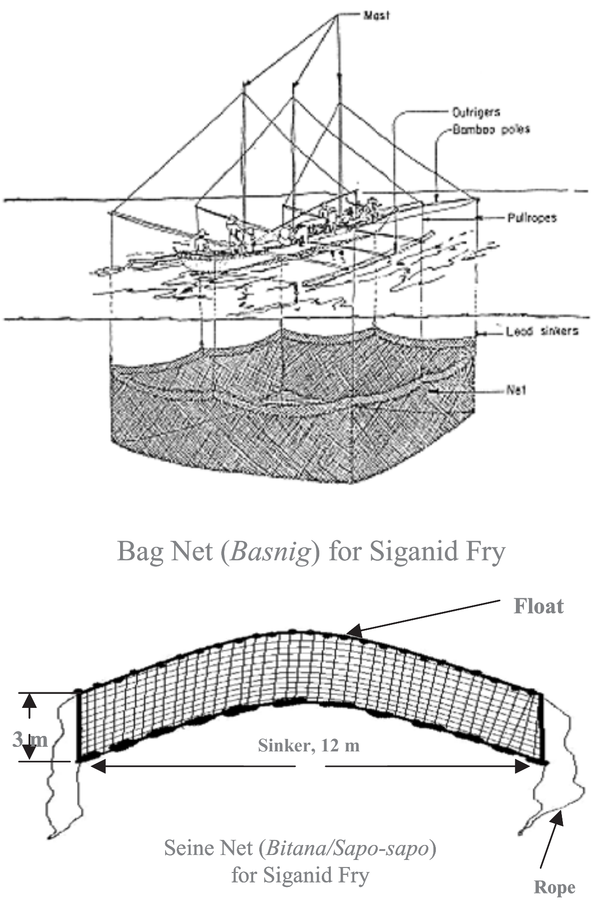


Fig. 5 Bagnet and seine-net, the two fishing gears that catch siganid juveniles in Lagonoy Gulf.

3. Seasonality of catching siganid juveniles

Perhaps, one of the most remarkable ecological events on the SMI coast is the annual settlement or "run" of siganid juveniles. This "run" occurs almost predictably in time and space. The highest volume of "run" occurs at new moon. Siganids are lunar-spawners. April and May are the peak months (Fig. 6). The arrival of juveniles starts from the fringing reefs, to the patch reefs and associated seaweeds, then to the Sargassum beds and/or sandy flats and finally onto the seagrass (mostly *Enhalus acoroides*) beds. For a maximum of eight days, the juveniles move to and from the reefs, sandy areas and seagrass and seaweed beds.

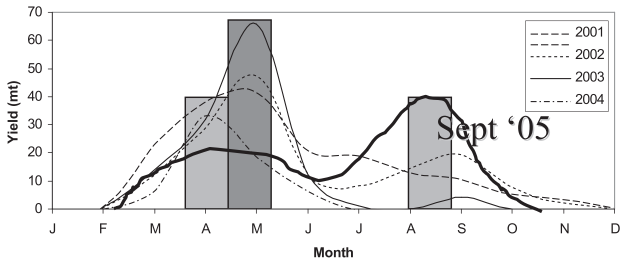


Fig. 6 Total annual catches of siganid juveniles from Lagonoy Gulf.

Monitoring of the siganid juvenile catches for 4 years (2001-2004) showed a consistent seasonality of this occurrence. Peak months of catch were in April and May every year. Exceptionally, the peak was observed in September 2005. The exact mechanism for this deviation is unclear. A possible explanation could be put forward which could be called a "see-saw hypothesis". The 4-year monitoring data indicate some crest of the catches in September 2002 and 2003. There were no observable crests for 2001 and 2004. But note from the data that a low crest in September corresponds to a high crest or peak in May. From 2001 to 2005, the peak in May was lowest in 2005. The data suggests that certain compensation in juvenile settlement occurs between April-May and September or between the major peak juvenile settlement and the minor settlement month. This seems partly tenable because several siganid species have been reported to spawn thoughout the year. However, this poses a lot of questions. Do siganids delay spawning when environmental conditions are not favorable and wait till the right time comes? Do siganids in the tropics have two spawning seasons? To old, experienced siganid fishers in Albay particularly those residing in SMI, this phenomenon is not new and this has been occurring, they claimed, in the past years before our juvenile catch monitoring. But the siganid fishers cannot explain why it happened.

Reproductive biology is a major factor affecting settlement. Gonado-somatic index (GSI) data from the literature on reproductive cycle of siganids are shown in Fig. 7. The GSI (= fish weight/weight of gonad) are for *S. canaliculatus* (Hasse *et al.* 1977), *S. spinus* (Harahap *et al.* 2001), *S. argenteus* (Park *et al.* 2006) and *S. guttatus* (Rahman *et al.* 2000) which are also caught in the gulf. The representation of the curves was simplified by aggregating the values on a monthly basis instead of the weekly basis in the original literatures. This simplification does not diminish the information value of the original data.

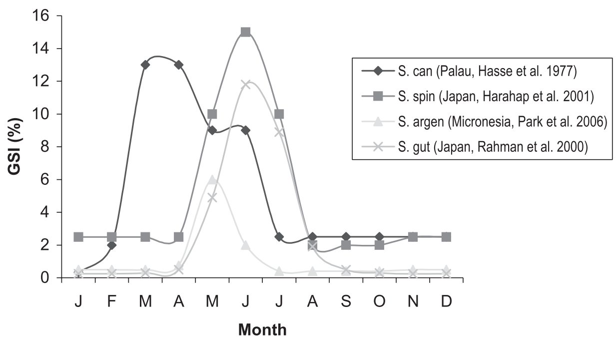


Fig. 7 Comparison of gonadosomatic indices on some siganids

The April-May peak seems to concur only with the GSI data for *S. canaliculatus* from Palau. Juvenile production peaks in April-May are often dominated by *S. canaliculatus*. It would be some confirmation (for the juvenile catch data) from the GSI data if the age of juveniles in May were to be between 30-60 days. This confirmation and related aspects are currently being undertaken by the authors. For the other three species, the link between the catch data and GSI seems improbable.

In general, the factors that could potentially influence siganid juvenile settlement are reproduction, habitat and physical oceanography. There are studies on reproductive biology of some species listed above but studies on the influence of habitat and physical oceanography are almost non-existent.

4. Resource utilization issues on the siganid juvenile fishery

The fishery catches very young (about three weeks and less in age) and very small (1.5-3.0 cm) fishes. This fishery, legally speaking, is illegal by virtue of the Philippine Fisheries Code of 1995 or Republic Act 8550. Under Section 21 of the Act, it is prohibited to catch young and immature fish. The intuitive basis could be "growth overfishing" (Pauly 1988) or the excessive harvesting of young fish that could disrupt ensuing recruitment to the fishery. However, the juvenile fishery has long and deep roots in traditional culture. On the other hand, available data from rapid stock assessment indicated overexploitation of siganid stocks; on the average, the exploitation rate was beyond the level that would be sustainable, and siganids were caught at sizes that are generally less than their size at maturity (Soliman *et al.* 2006).

MPAs could significantly assist to sustain the siganid resource by providing better breeding and nursery habitats and protecting adults from being caught. Moreover, a social dimension to MPA is that managed MPA could serve as a showcase or "living visual aid" of effective coastal management to the community. However, a simple spatial analysis of the area devoted to MPA reveals that the present coverage could be insufficient to effect significant ecological, hence stock, rehabilitation in the gulf. The total area of the six MPAs in the gulf is about 30km^2 which is equivalent to only 3% of the total coral reefs area (Table 2).

The key information in the previous sections showed the high species richness and commercial importance of seaweed-associated fishes in the gulf, vis-à-vis their high exploitation. Indications of overfishing are presented. Management strategy would thus require effort rationalization on the one hand complementary to habitat enhancement on the other hand. Both measures need sustainable livelihood for fisher families to shock-absorb the effects of their displacement from fishing.

In terms of research directed to assist management, the immediate focuses proposed are (i) seaweed inventory and assessment in the gulf and (ii) studies on the ecology and population dynamics of siganids. The latter aspect would include otolith microstructure analysis for siganids, a research discipline which is not well-represented in the scientific literature. A clear understanding of siganid ecology is needed to sustain the resource.

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Table 2. Marine protected areas that have been established in Lagonoy Gulf.

	Sites					
	San Miguel Is.	Atulayan	Agojo	Malinao	Tiwi	Bacacay
1. Status	Operational	Operational	Operational	Operational	Operational	Operational
2. Number of years since establishment	11	14	14	4	6	3
3. Organizations	LGU	LGU	LGU	LGU-	LGU	LGU
involved	Brgy.	Brgy	Bantay	CBRMP	FARMC	Bgry
in management and	Council	Council	Dagat	Bantay	FRMP	Council
monitoring	FARM-C	Bantay	FARMC	Dagay	Bantay	BFAR-PIU
	MPAS-MC	Dagat		FARMC	Dagat	FRMP
4. Key habitats present	Bantay	PSU				Bantay
a. Mangrove	Dagat					Dagat
b. Seagrass/Seaweeds	BU					
c. Corals						
	X		X			X
	X		X			X
	X	X	X	X	X	X
5. Human community						
Presence	Present	Present	Present	Present	Present	Present
Participation	Active	Active	Active	Active	Active	Active
6. Area (has)						
Sanctuary	1.0	72	127	180	586	46.25
Reserve	1.2	386.63	1700	270	1574	453.25
7. Distance of corals from:						
Seagrass	200 - 300 m		200 - 300 m			200 m
Mangrove	> 1 km		> 1 km			> 1 km

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