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Rebuilding Depleted Small Pelagic Stocks in Ghana.Closed Fishing Season Proposal to the Ministry of Fisheries and Aquaculture Development

February, 2016

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CCM	Centre for Coastal Management
CEWEFIA	Central and Western Region Fishmongers Improvement Association
CRC	Coastal Resource Center
CSLP	Coastal Sustainable Landscape Project
DAA	Development Action Association
DFAS	Department of Fisheries and Aquatic Science
DMFS	Department of Marine Fisheries Sciences
DQF	Daasgift Quality Foundation
FtF	Feed the Future
GIFA	Ghana Inshore Fishermen's Association
GIS	Geographic Information System
GNCFC	Ghana National Canoe Fishermen's Council
HM	Hen Mpoano
ICFG	Integrated Coastal and Fisheries Governance
IUU	Illegal, Unregulated and Unreported fishing
MESTI	Ministry of Environment Science and Technology
MOFAD	Ministry of Fisheries and Aquaculture Development
NDPC	National Development Planning Commission
NGOs	Non-Governmental Organizations
SFMP	Sustainable Fisheries Management Project
SMEs	Small and Medium Enterprises
SNV	Netherlands Development Organization
SPR	Spawning Potential Ratio
SSG	SSG Advisors
SST	Sea Surface Temperature
STWG	Scientific and Technical Working Group
UCC	University of Cape Coast
UI	Upwelling Index
URI	University of Rhode Island
USAID	United States Agency for International Development
WARFP	West Africa Regional Fisheries Development Program
YPR	Yield-Per-Recruits

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INTRODUCTION

During Technical Coordinating meetings between the Fisheries Commission (FC) and the USAID Sustainable Fisheries Management Project (SFMP) held on 1/29/2016 and 2/10/2016, the FC made a request to the Scientific and Technical Working Group (STWG) to review and prepare a scientific recommendation regarding the timing of a closed fishing season for marine fisheries resources. A closed fishing season is part of a suite of fisheries management options approved by the National Fisheries Management Plan (2015-2019) and recognized as an effective management tool in the Fisheries Act of 2002.

The STWG convened a meeting on February 11, 2016 at the University of Cape Coast to prepare a science-based recommendation regarding the timing and duration of a closed fishing season for all species, with special focus on small pelagic resources as the dominant and most important species for food security in Ghana.

This paper outlines a proposal for a closed fishing season developed by the STWG with considerations of input from stakeholders through an intensive series of consultative meetings held by Friends of the Nation (FoN) for SFMP. The proposal was conceived to highlight the alarming declining status of the fisheries resources in Ghana, and to request immediate and urgent action to stop overfishing with a plan to reverse the downward trends in order to rebuild fish stocks which are already near collapse.

The STWG discussed the following questions:

- Is the one-month closure proposed by the National Fisheries Management Plan (2015-2019) for all fisheries sufficient to rebuild small pelagic stocks?
- Is the month of June the optimal time to produce the most benefits for these stocks?
- What is the biological benefit of a one-month closure?
- What are the socio-economic impacts on the fishing industry of a one-month closure?

BACKGROUND

Scientific evidence has repeatedly pointed to the undisputed fact that Ghana's marine fisheries are in crisis, with fish landings declining over the last decade. Ghana received a yellow card from the European Union in 2013 for lack of legislative effort to fight Illegal, Unregulated and Unreported (IUU) fishing. Landings of fish continue to decline, while the current population growth combined with increased fishing capacity and efficiency continue to increase. This will have significant implications for the country's economy and food security in Ghana.

In 2015, the Government of Ghana undertook a restructuring of the fisheries sub-sector in order to lift the yellow card issued by the European Union. The objectives of the restructuring were to provide a mechanism to end overfishing, to increase production for local consumption and export, to integrate fishing activities in the farming system through the promotion of aquaculture, to strengthen the Fisheries Department to carry out its mandate, and to develop a fisheries management plan for the entire fisheries sector.

The National Fisheries Management Plan (2015-2019) was developed through stakeholders' consultations, approved by the Cabinet, and gazetted in October, 2015. It was developed to halt further decline and rebuild the fish stocks through a series of measures, including closed fishing seasons for small pelagic and demersal stocks.

CLOSED FISHING SEASON

Seasonal closures are widely used as an effective conservation measure in fisheries. The principle is based on biological returns of the spawning potential, allowing fish to reproduce

during the breeding season before they are harvested. This strategy is often implemented to contribute to effort control and reduction. In many fisheries, seasonal closures are the first management strategy employed, and may be subsequently supplemented or replaced with additional measures if the closures alone do not prove effective.

The short life span of small pelagic species and their sensitivity to climactic variations imply that more rapid changes in stock size from year to year may occur. If these species are allowed enough time to spawn, the stock size could increase in a short period of time due to their high fecundity and growth rate. In addition, small pelagic fish adapt their spawning strategy to the specificities of their environment in order to optimize larval survival. During upwelling periods, the dynamic of ocean circulation is driven by bands of coastal eddies, providing a suitable spawning conditions for the adults and retain their eggs and larvae.

However, for long-lived species, particularly for demersal species, the seasonal closures can only be beneficial if implemented for longer period of time consistent with the life span of the species. For example, for groupers (i.e. *Epinephelus aeneus*) that live 15-20 years, a closed season during spawning season can be beneficial if implemented for at least one half of their life span (7.5-10 years). In this case an area closure, such as Marine Protected Areas (MPA), is much more beneficial and has less socio-economic impacts than a closed season.

A closure may be further refined to reflect distinct fishing behaviors by fishermen, such as closures to certain sectors of the fishery or to a particular gear type, such as trawling or bottom-tending gear. Sometimes fishery managers will try to minimize the social and economic impacts of a closure by relaxing rules in other fisheries to give fishermen "something to fish for," or will limit the length of a closure. If, for example, a fish stock spawns twice per year, regulators will close the fishery for just one of the two seasons so as to minimize impacts on fishermen and their related communities and markets.

Furthermore, fishery managers may try to enhance for fishermen the market value of their product by timing closures to maintain or reduce production, as applicable. There are many approaches to using seasonal closures as a management tool for the benefits they produce in rebuilding depleted fish stocks.

There are many examples around the world where the implementation of a closed season resulted in an increase of yield and higher economic returns to the fishing sector. We list a few examples that are familiar to members of the STWG:

- In the U.S., almost all current fisheries management plans include a form of closed fishing season for commercial or recreational fisheries or both. For example, a closed season for tautog (*Tautoga onitis*), a slow growing demersal species, was implemented in 2001 in Narragansett Bay in Rhode Island, USA for two months during spawning season. By 2012, the stock had recovered, with the full rebuilding of the stock projected to be realized by 2016 (RIDFW, 2015).
- In the Philippines, a closure during spawning season led to an increase in sardine catch for three consecutive years. The highest increase was recorded in 2013 by as much as 90,000 mt or close to 30% in just one year of implementing the closed season. Fishers bought into the process and gained the trust of the government to implement this conservation measure. In 2015, fishers even demanded adding more time and more engagement of volunteers to monitor compliance with the process (BFAR, 2015).
- In Senegal, a two-month seasonal closure during spawning season implemented since 2010 for octopus, has provided an approximately 35% increase in yield, and allowed the rebuilding of the stock to sustainable levels in just three years.

- In 2015, the Ministry of Fisheries of Guinea Conakry implemented a seasonal closure for all fisheries, with the exception of subsistence fisheries, for two months (July-August). This initiative was supported by stakeholders and seems to have been positive, according to newspaper reports.
- Similarly, in Mauritania and Morocco, the closed season has been used as a key management measure to reduce fishing effort and fishing mortality and to rebuild small pelagic and octopus stocks. These measures helped reverse the downward trends of small pelagic and octopus stocks. An increase in landings by as much as 40,000 mt in octopus valued at $8 million (Infofish.org, 2013) was realized in Morocco, and as much as 125% increase in landings for small pelagics in 2015 (CECAF, 2015).

In all cases, closed seasons during spawning season are easy to control if implemented across sectors during a period of time to protect spawning potential or juveniles, and are often readily accepted by stakeholders. It is an adaptive management strategy, which involves a collective sacrifice by stakeholders. It can result in immediate returns by increasing biological and economic benefits.

REGULATORY FRAMEWORK AND PROCESS FOR DECLARING CLOSED SEASON

The National Fisheries Management Plan (2015-2019), approved and gazetted last October 2015, is a policy guidance document addressing a range of overfishing issues in all marine fisheries of Ghana. Under section 4.2, it specifies that:

> "*Implementation of closed seasons shall be made according to oceanographic data (mainly from May and June between two upwelling periods when fish adults come close to shore to spawn). The action strategy specifies one month for all species and two (2) months demersal species*".

The regulatory framework for the implementation of closed seasons is described in sub-part VII-84 of the 2002 Fisheries Act- 625 as follows:

> *The Commission may by notice in the Gazette declare closed seasons, including their duration for fishing in specified areas of the coastal waters or the riverine system.*
>
> 1. *A declaration made under the sub-section (1) shall be given all reasonable publicity and, where possible, shall be given advance of the closed season.*
> 2. *A closed season declared by any international body of which Ghana is a member shall be regarded as closed season declared under this Act.*
> 3. *A person who engages in fishing during a closed season declared in accordance with this section commits an offence and is liable on summary conviction of fine of not less than:*
>   a. *$500,000 and not more than $2 million in respect of local industrial or semi-industrial fishing vessel or foreign fishing vessel; or*
>   b. *100 penalty units and not more 500 penalty units in any other case.*
>   c. *In addition, any catch, fishing gear or vessel or any combination of them used in the commission of the offence may forfeit to the state.*

STATUS OF THE FISH STOCKS

During the last decade, total marine fish landings declined while fishing effort continues to increase, and thus catch per unit of effort (CPUE) is getting lower, and sizes of landed fish are diminishing – a clear case of growth overfishing. To exacerbate the situation, all fishing fleets except the tuna fleet operate within the inshore exclusive zone (IEZ), which is invariably the spawning ground for most fish species, and gravid fish are also exploited as a result of recruitment overfishing (Figure 1).

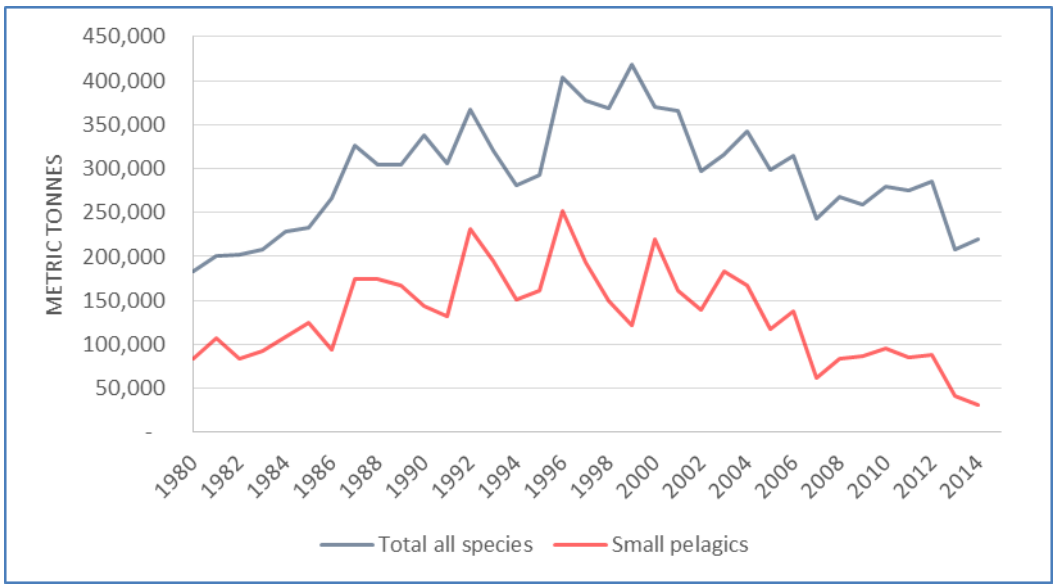

Figure 1 Marine fish landings in Ghana (small pelagics and total all species)

Commercial landings of small pelagic species peaked in 1996 at 250,000 metric tons, then decreased to reach the lowest level recorded since 1980. Commercial landings averaged 135,000 metric tons annually during 1980-2014. The total small pelagic species realized in 2014 represented 24% of the average landings from 1980 to 2014, and only 12% of the maximum landings realized in 1996. The small pelagic landings dominated the total marine production in Ghana for over 2.5 decades since 1980, however, in recent years, their landings reached a low of 20% of the total marine landings. Monthly landings of *Sardinella aurita* also reflect a dramatic decline, with a consistent peak in August which corresponds to the peak spawning season (Figure 2).

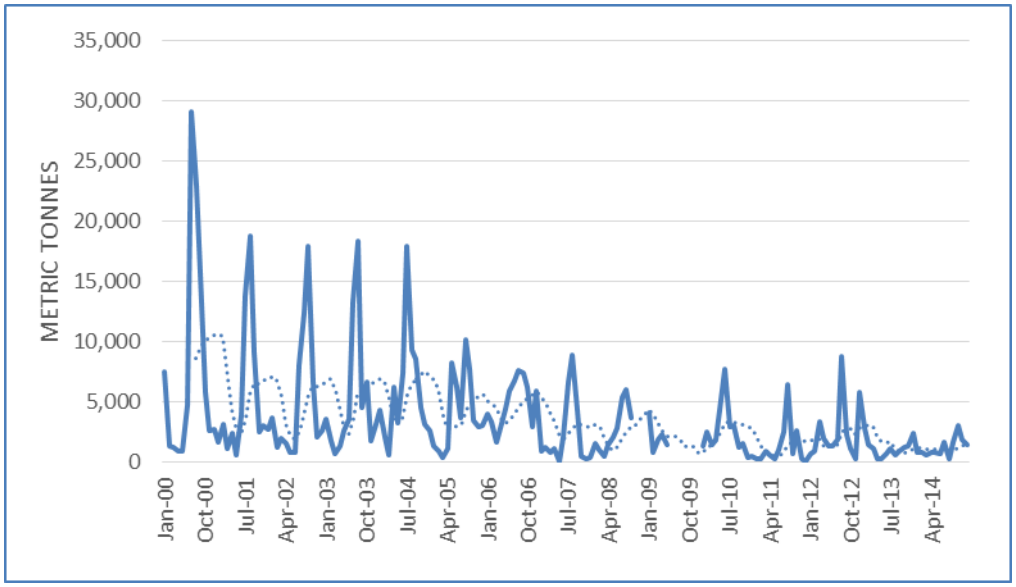

Figure 2 Monthly landings of sardinella aurita (2000-2014)

REPRODUCTIVE CYCLE OF SMALL PELAGICS

Several studies have been conducted to determine the spawning season for small pelagics. Quaatey (1993) observed mature stage fish through the year with the largest peak in June and July and another smaller peak in February, both triggered by the upwelling cycles (Figure 3). Other studies suggested that *Sardinella aurita* spawned over a period of seven months with a minor spawning season in April and May and a major one in August (Osei, 2015) (Figure 4). *Sardinella maderensis* spawned during the same periods and with intensities corresponding to upwellings. It seems to show a lag of one to two months behind *S. aurita* (Osei, 2015). The recruitment pattern estimated based on a length-based assessment (Amponsah et al., 2013) indicates a year-round recruitment of anchovies *Engraulis encrasicolus* with two peaks of recruitment during one year. The minor peak occurred from February to March while the major peak took place in August (Figure 5). The peaks are driven by the effects of the minor and major upwellings.

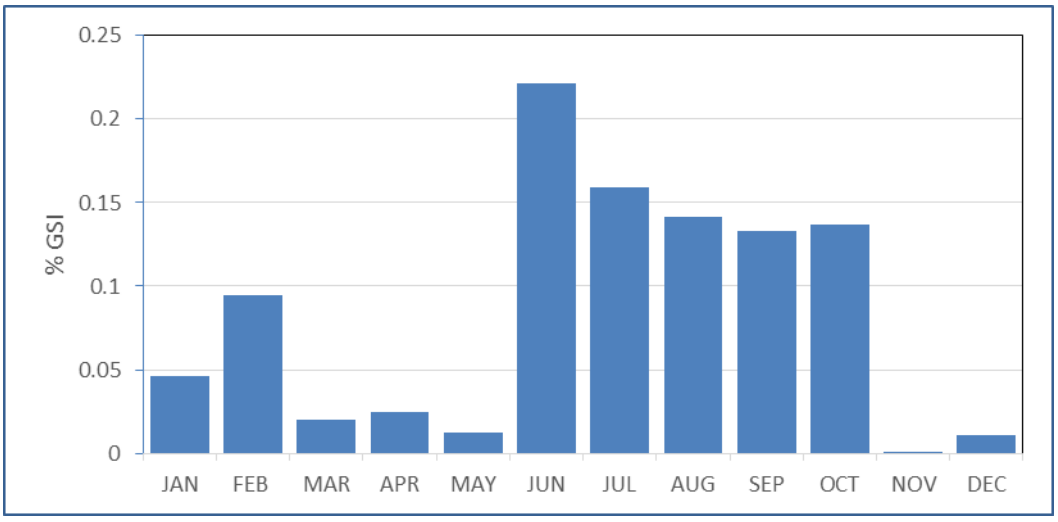

Figure 3 Monthly percent gonadosomatic index of *Sardinella aurita*

(Source: Quaatey, 1993)

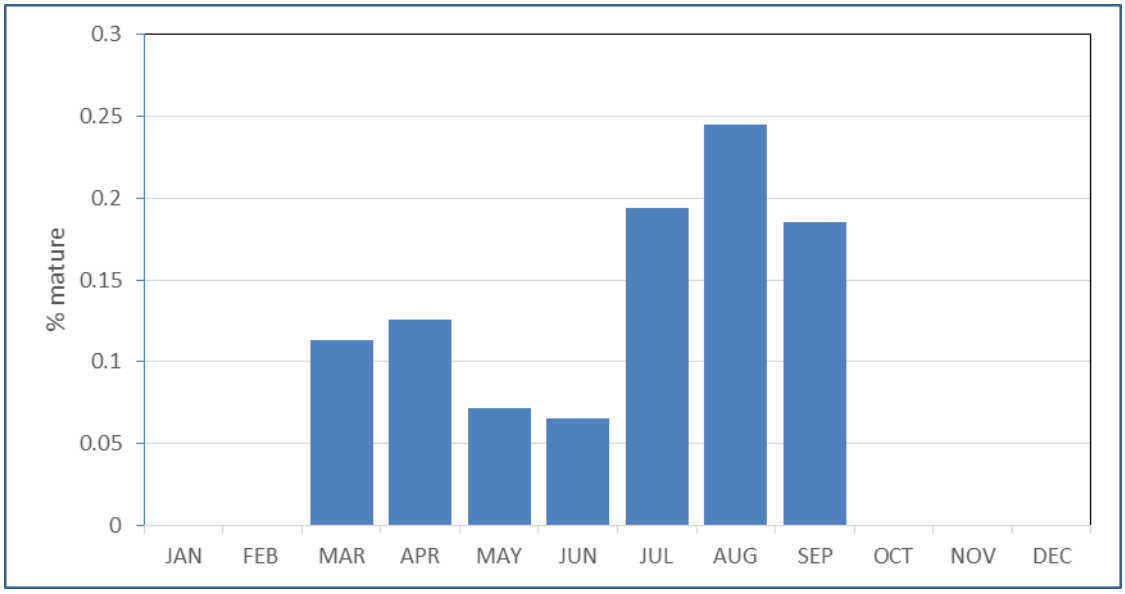

Figure 4 Monthly occurrence of mature males and females of *Sardinella aurita*

(Source: Osei, 2014)

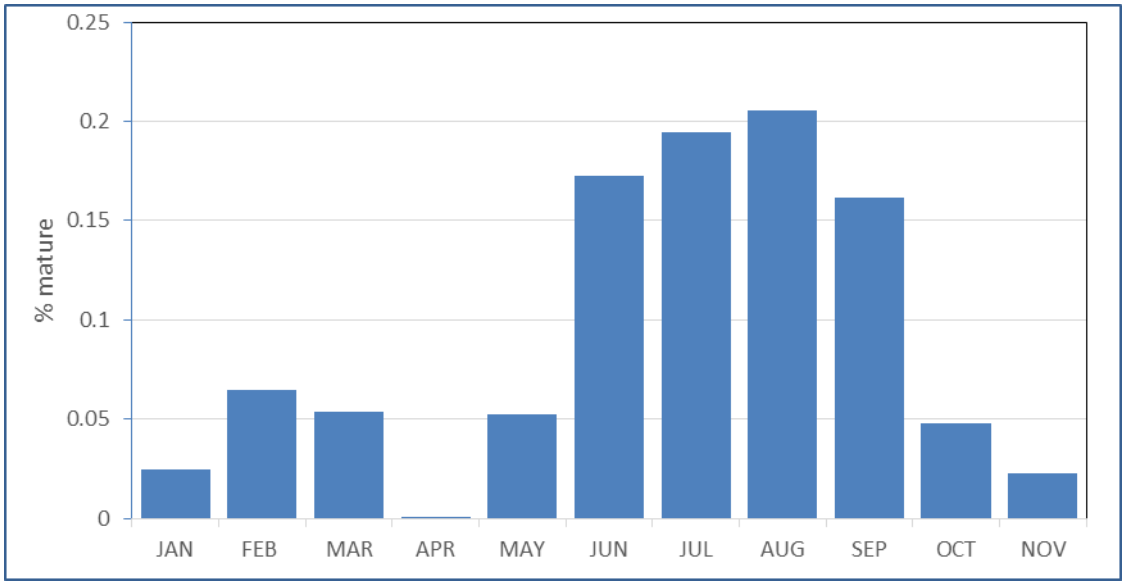

Figure 5 Recruitment pattern of anchovies Engraulis encrasicolus

(Source*:* Amponsah *et al*. 2013)

The biological evaluation of closed spawning season is often realized based on analysis of Yield-Per-Recruits (YPR) or Spawning Potential Ratio (SPR). However, these methods seldom perform to optimize the timing and duration of the closure. The YPR is better used if the minimum size regulation is respected by fishermen and size selection is enforced (Beverton and Holt, 1957). The SPR is more suited in the case of small pelagics by routine sampling (bi-weekly) of the size distribution and their fecundity and spawning stage. This index is simply a ratio of the average lifetime production of mature eggs per recruit in a fished population to what it would have been if the population had never been fished. We identified a critical minimum SPR that could be used as a biological reference point in the management of a highly exploited small pelagic fishery. Simulation modeling can predict the SPR under different scenarios.

For example, we know that a female sardinella can produce between 20,000 and 50,000 eggs and that the survival rate of the eggs is about 5% based on moderate predation and adverse natural conditions. In addition, we know that current mortality rate is about F=0.7 calculated by the STWG in its recent production model assessment (STWG, 2015) and we assume a natural mortality of 0.4 (Amponsah et al., 2013). Based on this information, we can predict an increase in the SPR if we close all fishing on sardinella for the month of August to 2.5 fold increase. This means that we can more than double the number of juvenile sardinella in Ghana's EEZ by the one month closure. The juvenile can grow to become adults in one year if we provide additional protection through selective fishing gear (respecting the minimum size of fish and the mesh size of the nets) (Figure 6).

Seasonal closure during the peak spawning season offers promise in providing a means to begin rebuilding the depleted fish stocks. Similar benefits have been observed and are expected for ecosystem productivity as well as habitat protection. The scale and extent of these benefits is dependent upon the scale and extent of the closure being considered and the commitment of stakeholders.

Area closures can be considered as well but they are most suited for sessile organisms and those that are in well-defined localized regions or in spawning grounds. The benefits are less clear when being considered for the protection of highly mobile organisms such as small pelagic species, since they cover a large distributional range.

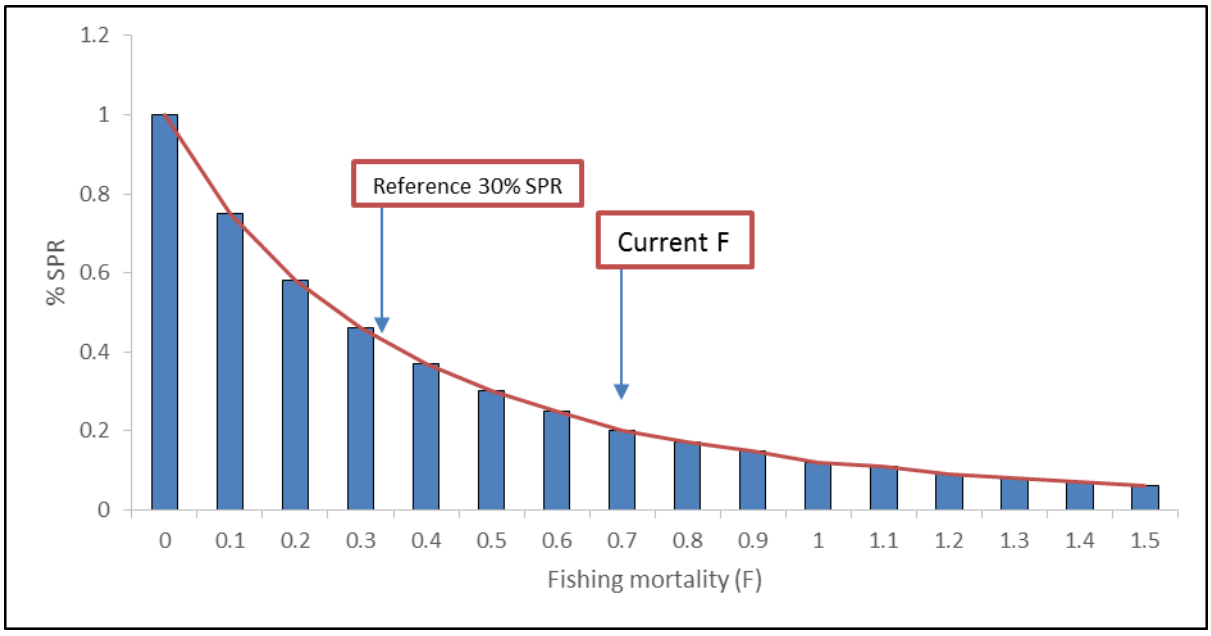

Figure 6 Percent Spawning Ratio of *Sardinella aurita* under various scenarios of F rates.

ENVIRONMENTAL CONDITIONS AND CHANGES AFFECTING SPAWNING PERIODS OF SMALL PELAGICS

Is well documented that populations of short-lived species, such as small pelagic species, can grow or decline quickly in response to climatic shifts, and that this rapid decline in productivity often requires similarly rapid interventions by fisheries managers. If fisheries management lags behind these environmental changes, a population can be driven to collapse, as may be the case with the small pelagic stocks in Ghana. The STWG is unable to quantify the impact of the environmental conditions on spawning and recruitment of small pelagic stocks in the region. However, it is clear that sea surface temperature along the coast has increased with an inter-annual variability (Figure 7). Monthly mean sea surface temperature measured 100m off Tema showed consistently increasing temperatures during the warm season after the major upwelling (FSSD, 2015), (Figure 8). These measurements show that upwelling intensity of the major and minor upwellings are decreasing, an indication of the weakening of the major production of zooplankton and small pelagic stocks.

The variability in sea surface temperatures as well as changes in the strength and duration of coastal upwelling affects recruitment of pelagic fish stocks. A low or high upwelling index correlates with higher or lower fish landings along the coast of Ghana. (The Upwelling index is UI = SST- 25 oC). The average monthly UI in recent years is below zero, indicating low intensity and therefore low production of small pelagics (Figure 9).

Scientific research shows that coastal precipitation of the July-September period are also correlated by both the coastal and equatorial sea-surface temperature (SST). This correlation results in a decrease or rise of rainfall when SSTs are abnormally cold or warm, respectively. The areas that are more subject to coastal and equatorial SSTs occurred around the Cape Three Points, where the coastal upwelling exhibits the maximum amplitude.

Several ichthyoplankton surveys (eggs and larvae surveys) were conducted over a 24 year-period off the coast of Ghana (Wiafe *et al*. 2008). The results from these surveys show that the peak production of eggs and larvae coincided with the major upwelling during July and August when fish spawn (Figure 10).

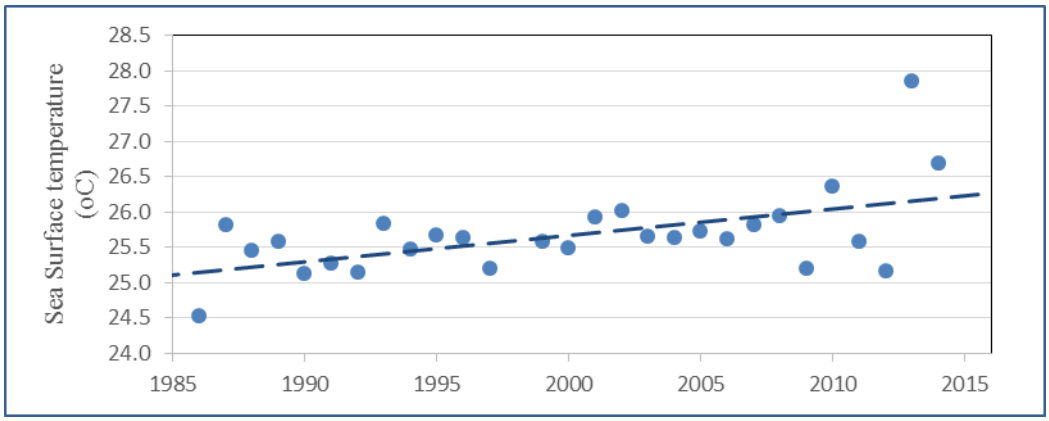

Figure 7 Trends of Average sea surface temperature

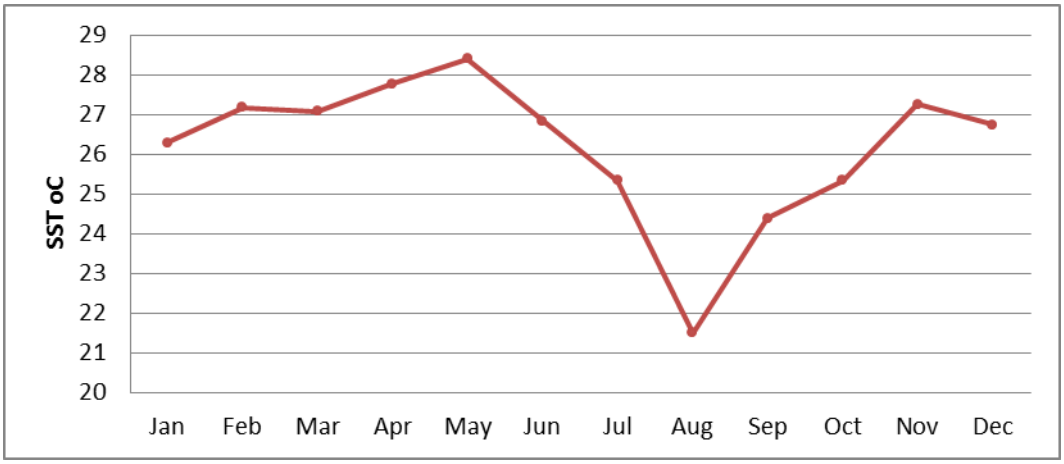

Figure 8 Mean Sea Surface Temperature in coastal Ghana

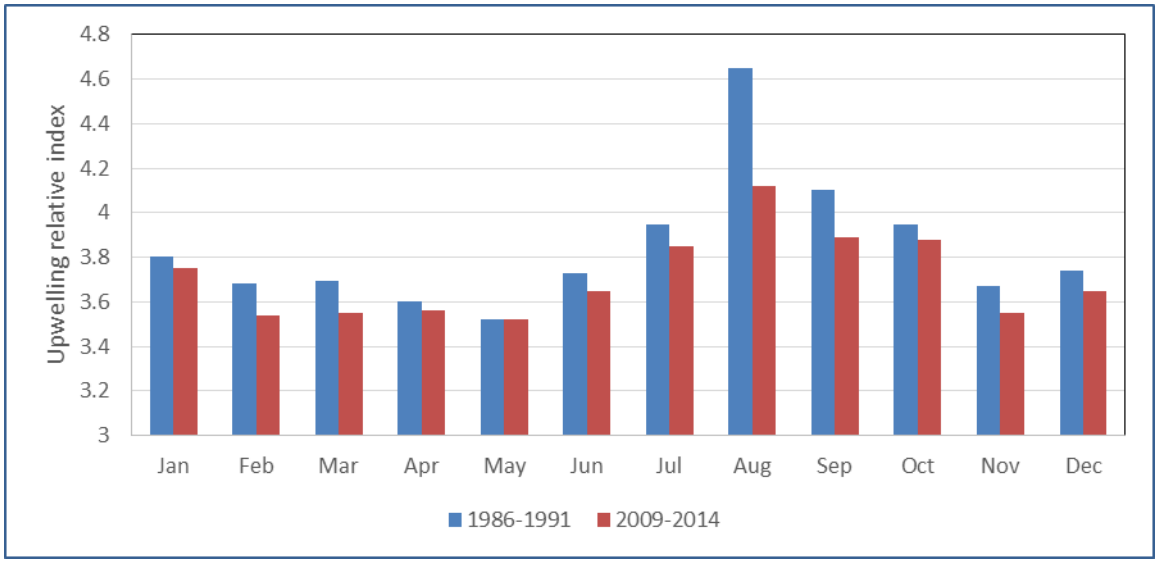

Figure 9 Mean upwelling relative index in coastal Ghana

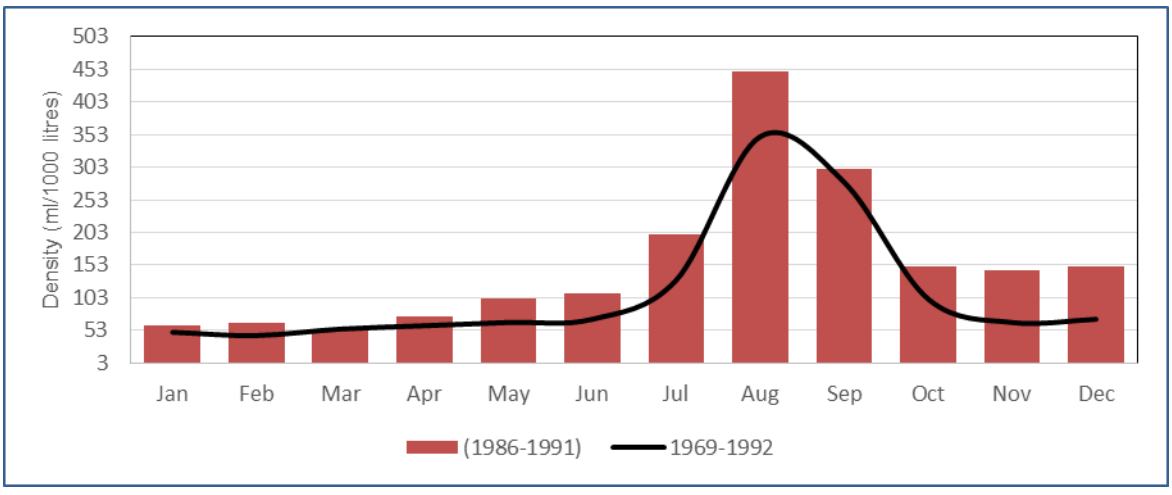

Figure 10 Mean zooplankton abundance (ml/1000 litres)

(Sources: Quaatey (1993); Wiafe et al. (2008))

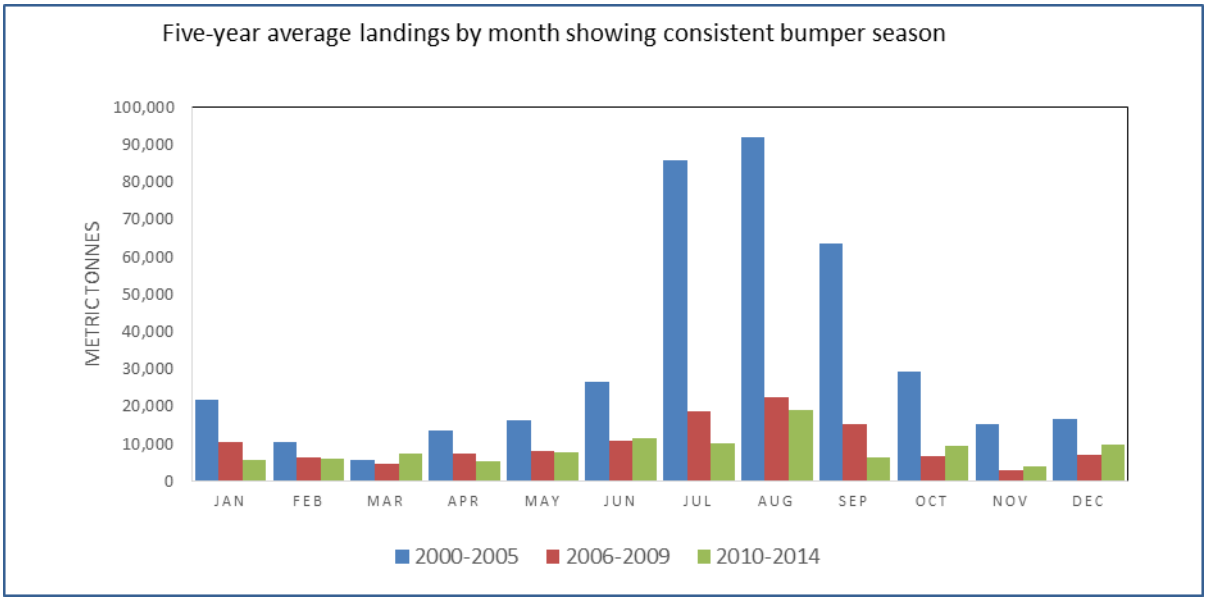

Figure 11 Five-year average landings by month showing consistent bumper season

IMPACT OF SEASONAL CLOSURE

Biological Impacts

The desire to protect a spawning stock at its most vulnerable times during the year is a major guiding principle of the closed season. While some closures are specified only by the species or species complex, there is also the possibility of instituting a seasonal closure only in certain geographical areas (i.e. for demersal species). However, a seasonal closure can be ineffective if the subsequent effort to this closure increases as fishermen rest to prepare and assemble forces to harvest the growth in production. The closure cannot be achieved without strict enforcement and a large educational and communication campaign. Fishermen will respect this closure when there is a commitment by the large majority to observe the closure and celebrate together its benefits.

The biological gain under good environmental conditions should increase egg production and provide room for survival of new recruits. We project a 2.5-fold gain in recruitment if a closed season is observed during peak spawning for small pelagic stocks. These new recruits, if protected, will add to the total biomass and contribute to the rebuilding of the spawning biomass.

Socio-economic Impacts

Removing fishing effort from the system for a period a time will decrease yield that would otherwise be harvested if the access to the resources were allowed. This loss has consequences on fishermen's income and livelihood. Similarly, fish processors and other indirect businesses (net, fuel, boats, street vendors, etc.) will feel adverse effects.

For example, a 47% reduction in landing could be expected if the fishery were closed for three months. A full 3-month closure as a start is therefore inadvisable under current circumstances. The closure of fisheries requires a learning phase by stakeholders to test the closure and witness the positive response. Stakeholders are more likely to observe and voluntarily respect the closure when it is phased in with a few weeks to one month initially, with an increase in the length of the closure if necessary. The closure for the month of August, proposed by the STWG, is expected to reduce annual landings of sardinella by about 18-20%, assuming no increase in effort (Table 1). However, the biological gain if the brood stock is allowed to spawn during the peak month of August, will contribute gradually to the

rebuilding of the stock by increasing the stock spawning potential and its recruitment. Considerations should be given to protecting juveniles after the closure and in subsequent years.

While there are many examples on which to raise expectations for potential benefits from the spawning closure, we should also recognize the existence of limiting factors such as recruitment failures impacted by environmental factors. However, the closure represents a first step by Ghanaian fishermen and women to work together and provide avenues to experiment with an effective closure and measure and feel its impacts. With this experience, it should be possible to base future considerations of seasonal closures not only on the relative expected biological benefits, but also on the implementation and coordination aspects of the closure toward building stakeholders' engagement and participation in fisheries co-management.

Table 1 Average percent monthly landings of small pelagic (Sardinella, Anchovies and Mackerel) from 2000 to 2014 averaged over 5 year-periods.

	2000-2005	2006-2009	2010-2014
January	5.3%	8.8%	6.5%
February	2.7%	4.8%	5.5%
March	3.4%	4.2%	7.7%
April	3.4%	6.0%	4.7%
May	5.4%	7.1%	7.0%
June	6.7%	9.3%	11.2%
July	20.3%	15.2%	9.4%
August	21.1%	16.8%	18.3%
September	15.0%	11.4%	6.1%
October	8.2%	4.9%	8.1%
November	4.1%	3.4%	4.2%
December	4.5%	8.0%	11.3%

Table 1 shows the average percentage of monthly landings per year over five year intervals from 2000 to 2014. It illustrates the importance of the month of August, known as bumper season, when fish aggregate, move close to shores and become easily accessible to fishermen. A closed fishing season in August to all fishing is likely to result in a loss of yield equivalent to its historical percentages (Table 1). For example, we should expect a loss of landings between 15-21% of the total annual landings if we close all fishing during the month of August. Similarly a loss of landings between 9-20% can be expected if we close fishing for the month of July. These expectations assume no major effort increase immediately after the closed fishing season.

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