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# PSP in the Philippines: three decades of monitoring a disaster

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**Abstract**—Paralytic Shellfish Poisoning (PSP) caused by *Pyrodinium bahamense* var. *compressum* is of significant public health concern in the Philippines. Blooms of *Pyrodinium* occurred 135 times in 27 different coastal waters of the country between 1983 and 2005 with a total of 2,161 reported PSP cases and 123 fatalities.

To address the growing problem on PSP a strategy to mitigate the impact has been implemented. PSP monitoring program has been in placed for more than two decades now. This paper summarizes the current status of occurrence and historical perspective of PSP in the Philippines and collaborative efforts done to improve the monitoring system.

**Key words:** PSP, *Pyrodinium bahamense*, *Pyrodinium*, Philippine

## Introduction

The Philippines, being an archipelagic country, is rich in coastal resources. It is comprised of more than 7,000 islands with a total coastline of over 18,000 km. Seventy per cent (70%) of its 1,500 municipalities are located in coastal areas. Coastal fishing activities account for 40–60% of total fish catch with the fisheries sector accounting for about 4% of GNP and employing more than a million Filipinos. Blooms of *Pyrodinium bahamense* var. *compressum*, a toxic dinoflagellate, however, affected the shellfish and other fishery industries and have raised public health concerns mainly because of paralytic shellfish poisoning (PSP) resulting from the ingestion of infected shellfish.

This paper presents records of PSP incidents in the Philippines, occurrence of harmful algal blooms and the monitoring efforts being implemented to mitigate its disastrous impact.

## Paralytic Shellfish Poisoning Incidents

### PSP in 1980's

As reported in a number of papers, the Philippines experienced the first outbreak of the toxic red tides or harmful algal bloom (HAB) in Samar, Central Philippines in June 1983 (Gonzales 1989a). *P. bahamense* var. *compressum* (Pbc), a saxitoxin-producing dinoflagellate known to cause paralytic shellfish poisoning (PSP) was identified as the causative organism. Four years after the first outbreak, bloom was observed in the coastal waters of Zambales and simultaneously recurred in Samar. The following years 1988–1989, *P. bahamense* var. *compressum* was again sighted in different coastal waters of Manila Bay and Visayas region (Fig. 1). Since 1983 to 1989, the PSP recorded incidents totaled to 843 and 52 fatalities (BFAR unpublished report). In terms of its effect in the country's economy, an estimated loss in 1983 alone amounted to PhP 2.2 million while the 1988 outbreak in Manila Bay caused losses of approximately PhP 17 million in a four-day period in commercial fisheries. It was also reported that during those years of outbreaks, the demand in fishery products dramatically decline and prices of seafood commodities dropped to 40% of normal price. This is because most people became scared and avoided eating marine fishery products including those caught in unaffected fishing grounds. Shrimp import from the Philippines by Japan and Singapore was also banned (Relox and Bajarias 2003). From then on, an annual recurrence of this harmful algal bloom was observed in the country.

### PSP in 1990's

Occurrences of the bloom events continue to invade many other coastal waters of Luzon, Visayas and Mindanao, the three major islands of the Philippines (Fig. 1). During this decade, the paralytic shellfish poisoning cases rose to 1264 with 65 fatalities. This increase in the recorded incidents and deaths maybe attributed to increase in the number of coastal waters affected. Although most people took PSP seriously, there were those whose economic situation unavoidably continued to take a risk by either consuming or selling the banned infected shellfish, usually green mussel *Perna viridis*. As experienced in 1988, outbreak in 1992 to 1993 resulted to banning of shrimp export to Japan and Sin-

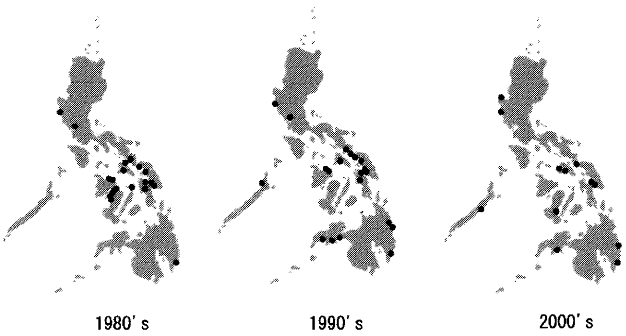


**Fig. 1.** Coastal areas affected with PSP episode in 1980s, 1990s and 2000s (dark circles).

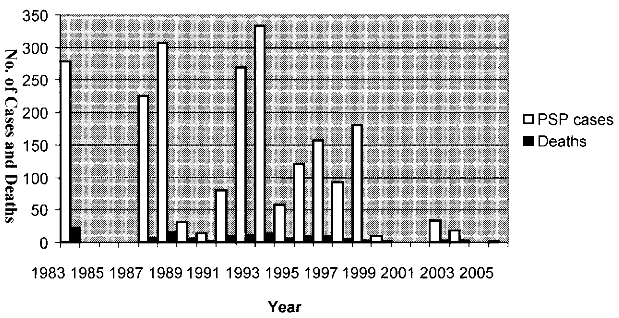


**Fig. 2.** Recorded PSP incidents in the Philippines from 1983–2005.

gapore. Closures of shellfish areas resulted to unemployment, displacement from livelihood of fishermen and loss of income of shellfish farm workers, fish vendors and secondary processing industries.

### PSP in 2000 and beyond

In the last five years, episodes of *Pyrodinium* blooms persisted in the country, it was, however, notable that during 2000, 2001 and 2004, there was no reported incident of paralytic shellfish poisoning though blooms were apparent in many Philippines' coastal areas. From 2002, 2003 and April 2005, a total of 54 PSP incidents and 6 deaths were reported.

For over two decades now, a total of 2161 paralytic shellfish poisoning cases with 123 fatalities are reported. Figure 2 shows the recorded PSP incidents in the Philippines from 1983–2005.

## Monitoring and Management of PSP

The Philippine government initiated the monitoring program for all red tide affected areas in 1984 to detect a bloom at its early stage. Plankton and shellfish samples are collected from areas where *Pyrodinium* blooms were experienced. Aerial surveillance on board helicopters and light aircraft of the Philippine Air Force and the Department of Agriculture are carried out to determine the extent of the bloom and movement of the visible red tides. From the observations gathered, the residents in the affected area are alerted. Red tide alert are disseminated to the public through print and broadcast media whenever toxicity in shellfish collected from the affected areas exceeds the regulatory limit. Public are being advised not to consume shellfish from the infected areas to avoid paralytic shellfish poisoning. Public meetings and seminars are also being conducted to educate or inform the fishermen and the public about the red tide situation. Primers are also being distributed and audiovisual presentation of information on red tide is shown to the public through local television (Gonzales 1989b).

In 1987, the Department of Agriculture (DA) through the Bureau of Fisheries and Aquatic Resources (BFAR) conducted a national training course on red tide detection, identification and monitoring for regional offices of DA who would form the core groups that would monitor the red tide in their respective areas so as to be able to give timely alert and response to the public which should have a threat of *Pyrodinium* bloom become imminent. A year after, the National Red Tide Task Force (NRTTF) through Executive Order #489 was created as one of the task force of Inter-Agency Committee on Environmental Health (IACEH). Members of the committee are from the Departments of Agriculture, Health, Environment and Natural resources, Science and Technology, Interior and Local Government, BFAR, Philippine Information Agency, Philippine Coast Guard and non-government organizations. The main tasked of the committee is to evaluate the data on red tide occurrences to avoid inaccurate reporting and to publish a weekly Red Tide Updates to protect the citizens from poisoning.

At present, the Marine Biotoxin Monitoring Unit of Bureau of Fisheries and Aquatic Resources is the one responsible in monitoring occurrence of harmful algal blooms. The two key parameters being employed in detecting PSP occurrence are toxicity level in shellfish meat and presence of PSP causing organisms.

Sample (shellfish and water) collections were done on a regular basis. Frequency of sampling for Manila Bay that covers Cavite, Navotas, Bulacan and Bataan is twice per week. In the provinces, sampling is conducted on a monthly basis and during red tide occurrence sample collection is done on a weekly basis. For the regular monitoring program of BFAR, primary sampling stations were already established. These fixed stations are representative of the whole area and specifically chosen based on logistic reports of red tide occurrence and availability of shellfish resources.

Plankton sample is collected by vertical haul using 20 $\mu$m mesh size plankton net. Shellfish samples are collected in shellfish growing areas. If shellfish farms are not present, wild shellfish are collected. PSP causing dinoflagellates are identified from plankton samples and subsequently quantified. Values are reported in cells/liter. Toxin level in shellfish is determined by mouse assay and reported as

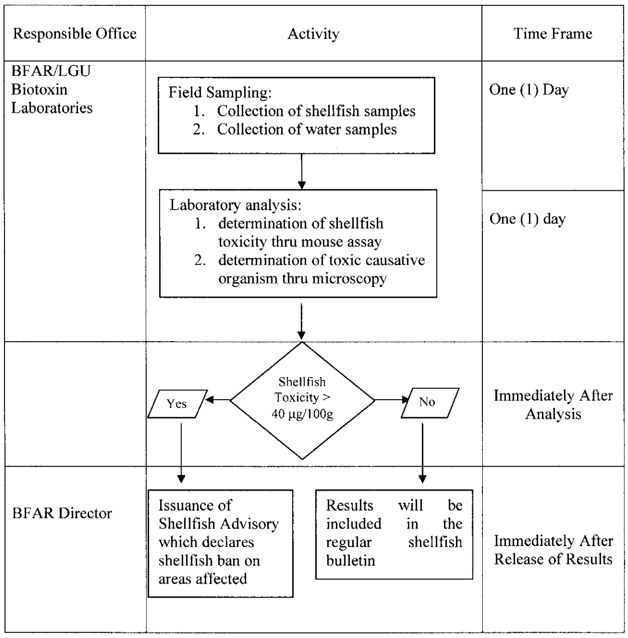


**Fig. 3.** Process flow for imposing shellfish ban.

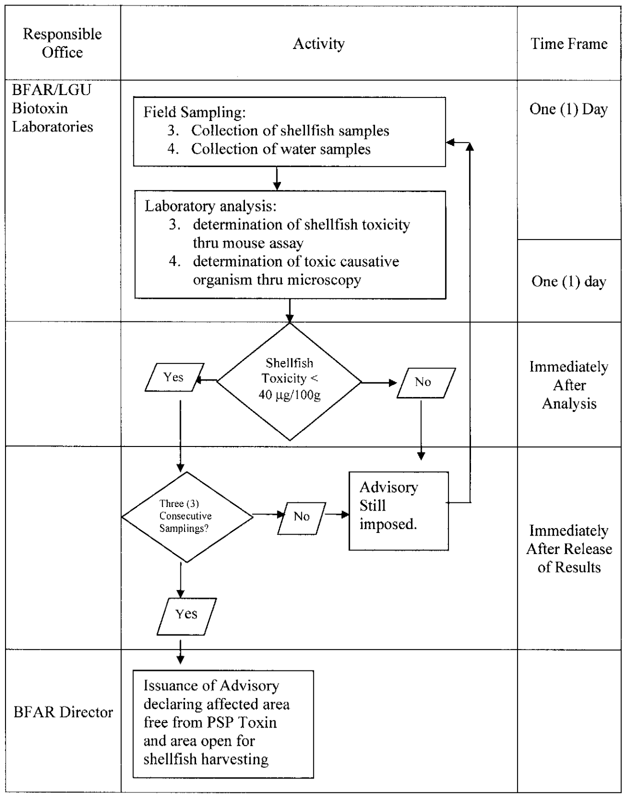


**Fig. 4.** Process flow for lifting shellfish ban.

$\mu$g/STX-equivalent per 100-gram shellfish meat.

Results obtained from the monitoring activities of BFAR are used as a basis of the Shellfish Bulletin issued by the Bureau twice a month. This document specifies areas of the Philippines that are free from toxic red tides and areas that are under shellfish ban. Moreover, if toxicity in shellfish is detected, BFAR issues a Shellfish Advisory declaring the affected area banned from harvesting, selling and consumption of bivalve shellfishes. Regulatory limit set for the Philippines is 40 $\mu$g STX-equivalent per 100 g shellfish meat. If analysis results showed that toxin level shellfish meat is greater than the limit, then ban on affected area is issued. Conversely, areas under shellfish ban are constantly monitored on a weekly basis. If analysis results showed that toxin level in shellfish meat is less than the limit for three consecutive weeks, then advisory is again issued declaring the area free from toxic red tide and opening the area for shellfish harvesting. Procedures followed by BFAR in imposing and lifting bans are summarized in Fig. 3 and Fig. 4.

The toxic red tide incidents that lead to PSP contamination cannot still be predicted with any degree of certainty, as is also the case with the degree and duration of PSP contamination of shellfish. However, a well structured monitoring and surveillance program to accurately detect possible algal blooms and PSP cases, implemented effectively coupled with appropriate and emergent measures, could mitigate the corresponding negative impacts of the harmful algal blooms on economy and public health. The number of areas being monitored and the frequency of monitoring and the ability to respond rapidly to red tide blooms are also of critical importance to prevent the loss of human life.

In addition, collaborative work between BFAR, the University of Tokyo and University of Nagasaki titled "Gene characterization of PSP causing dinoflagellates" that aims to understand better the behavior of HAB species is currently being undertaken. Results of this work will surely aid in the understanding of the bloom's spreading mechanism and eventually enhance the monitoring system.

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