



Greener Earth; Bluer Ocean

A Novel Satellite-based Approach to Mapping Spatio-temporal Spawning Patterns of Sardines in Northern Mindanao, Philippines

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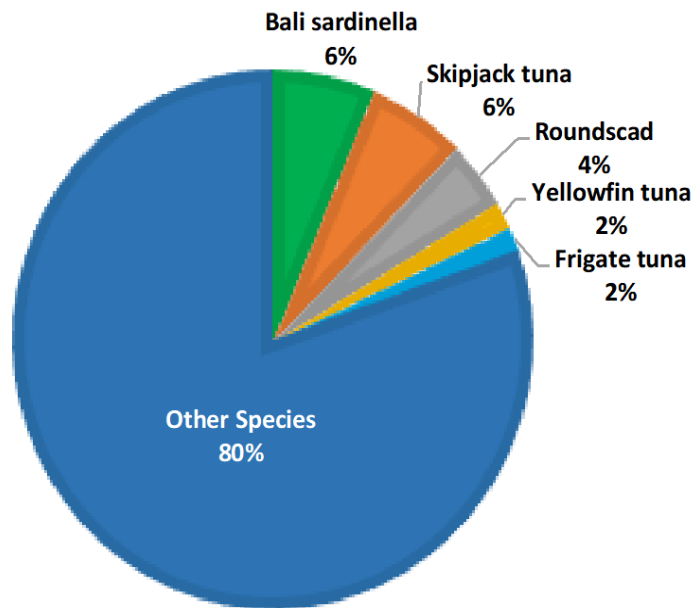


Capture fishery production

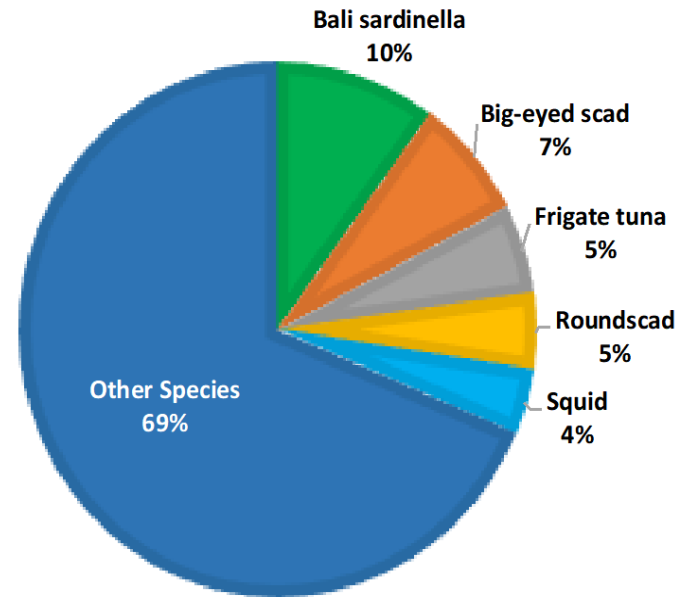
Capture (wild) fishery production does not include seafood produced from fish farming (aquaculture).



Commercial Catch Composition, 2020

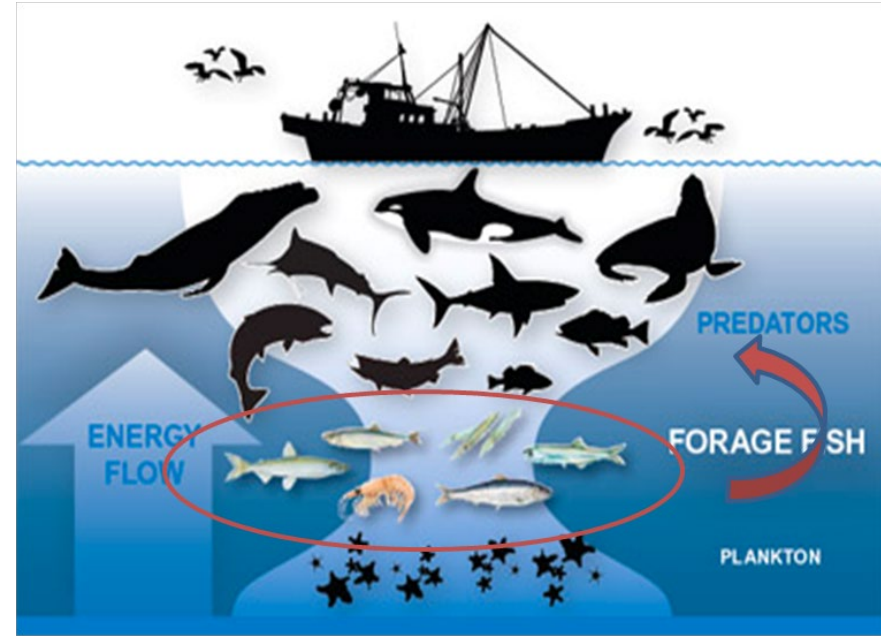


Artisanal Catch Composition, 2020



The PERFECT PROTEIN*

- Abundant, fast growing, high recruitment rates
- Affordable seafood
- Cheapest source of omega-3 polyunsaturated FA
- New “poor man’s fish”



(in the PH, sardines had replaced our iconic “galunggong” or roundscad

- **Sardines – top fish in Philippine capture F (since 2008)**
 - High annual production in Zamboanga peninsula
 - Multi-million post-harvest industry

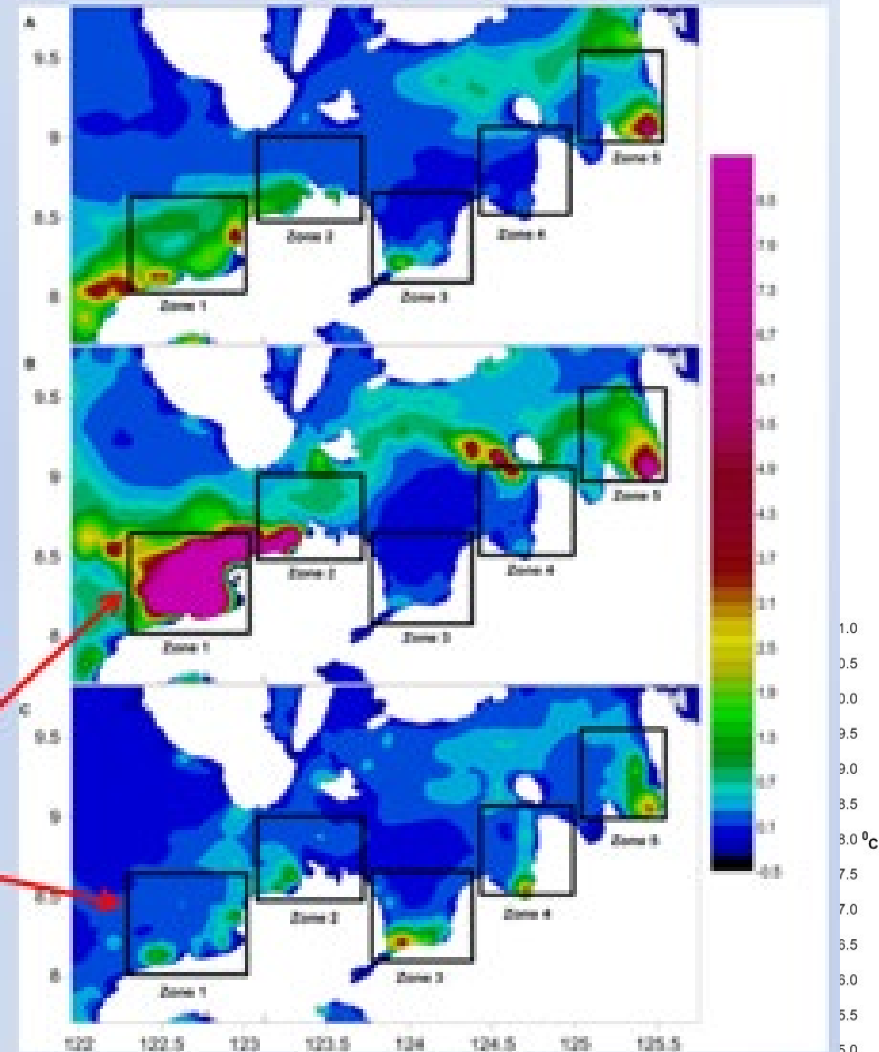
ICE CREAM/ReSiLiENT SEAS Program (2009-2011): Sardine fishery collapse in NZP linked to ENSO

Virtual disappearance of sardine stocks in 2008 & early 2009.

Heavy rains during La Niña in 2008-09 + weak NEM shut down upwelling

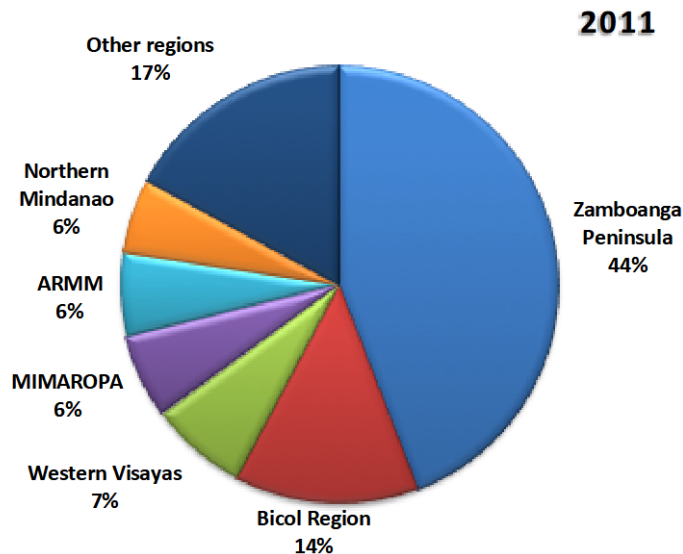
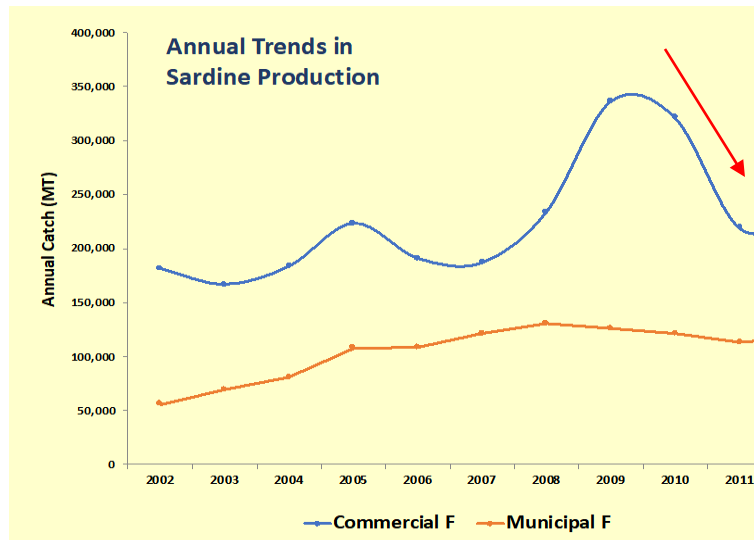
Spatial distribution of chlorophyll in the different zones during **A) January 2005**, **B) January 2007**, and **C) January 2008**.

Extremely high chlorophyll a in 2007 upwelling season collapsed in 2008 (↓ in sardine prod'n)



Source: Villanoy et al. (2011)

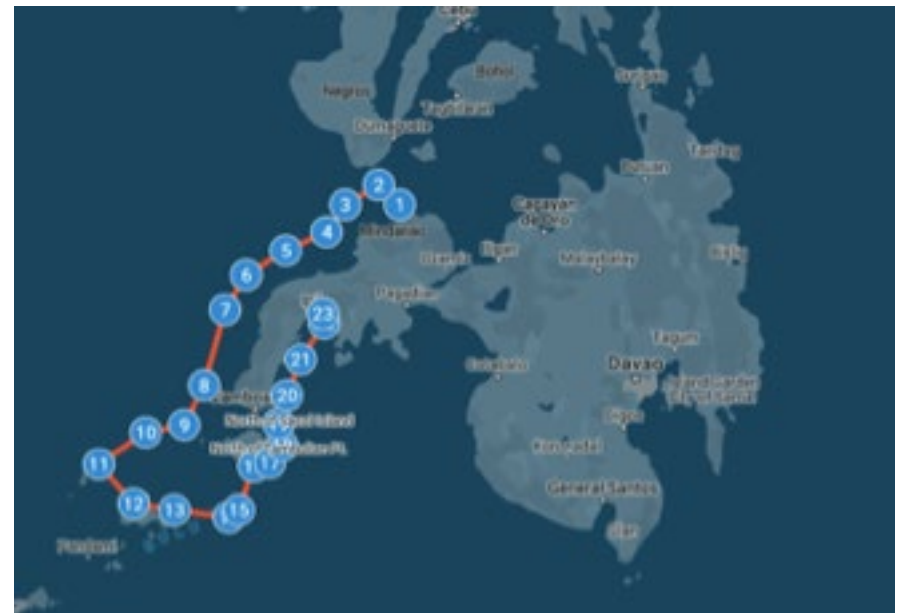
Declining annual sardine catch trends between 2002-2010



Government Intervention

Seasonal Closure of Sardine Fisheries in Zamboanga Peninsula

(JAO No. 1, s. 2011; BAC 255, s. 2014)



Closed Fishing on sardine by Commercial (Industrial) Fishing fleet between Dec 1-March 1; Artisanal fishers allowed to fish.

Motivation for our research

3-yr DOST-SarDyn Program (2011-2014)

Development of robust tools for managing sardine fisheries in the Philippines: Zamboanga Upwelling-Bohol Sea System (SarDyn program)

Program Goal: Provide basis for improving policy (e.g. SFC in ZP) toward sustainable sardine management

- Conventional methods of assessing fisheries production, e.g. **dockside or fish landing surveys** constrained by the absence of ***spatially explicit*** catch/effort data
- Need to identify spawning areas for major sardine stocks to inform adaptive & ecosystem-based FM



➤ **Research in Sardine Volunteer Program (RSVP)**

- ✓ novel strategy - first time implemented in the Philippines at the time
- ✓ obtains area-specific and accurate fisheries production data on sardines using vessel tracking by GPS
- ✓ Participatory-collaboration with commercial and municipal fishers along the NZP and Bohol Sea corridor

“Can accurately identify the specific fishing area for a target fishery” , and insights into where sardines spawn and juveniles are found



Methods

81 RSVP volunteers (since June 2012):

- **18 Commercial Bag Net (BN)**
- **27 Commercial Ring Net (RN)**
- **7 Municipal Encircling Gill Net (EGN)**
- **29 Municipal Drift Gill Net (DGN)**



EGN "Likos"



DGN "Patuloy, Palaran"



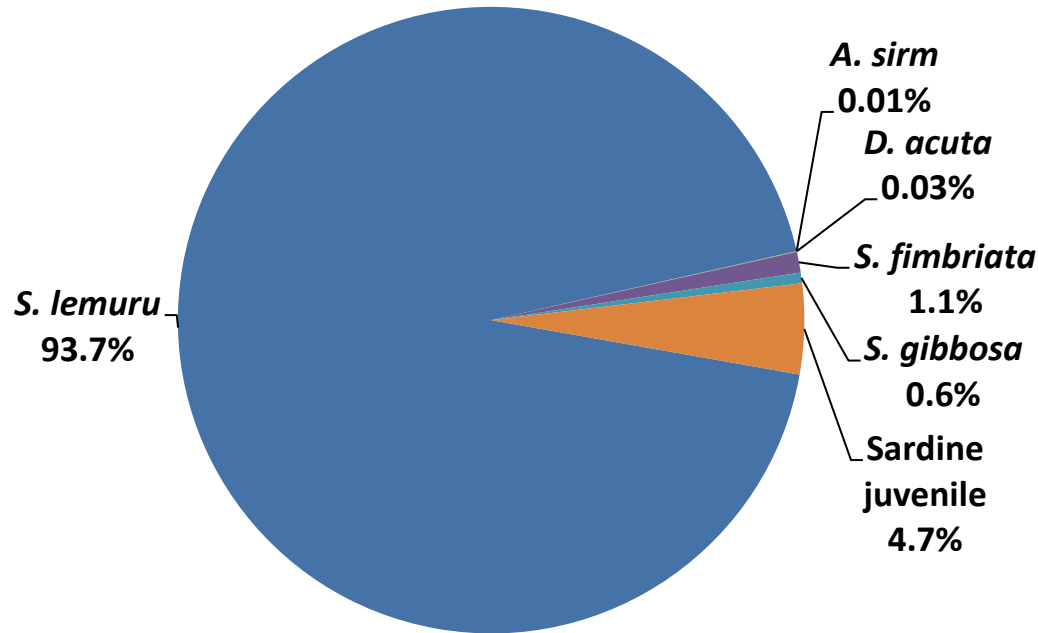
Bag Net "Pakpakan"



Ring Net "Kubkuban"

Project Results: Catch composition

Sardine Catch Composition in NZP-Bohol Sea



Sardinella lemuru (Bali sardine)



Sardinella pacifica
(f. *fimbriata*)



Sardinella gibbosa (gold-line sardinella)

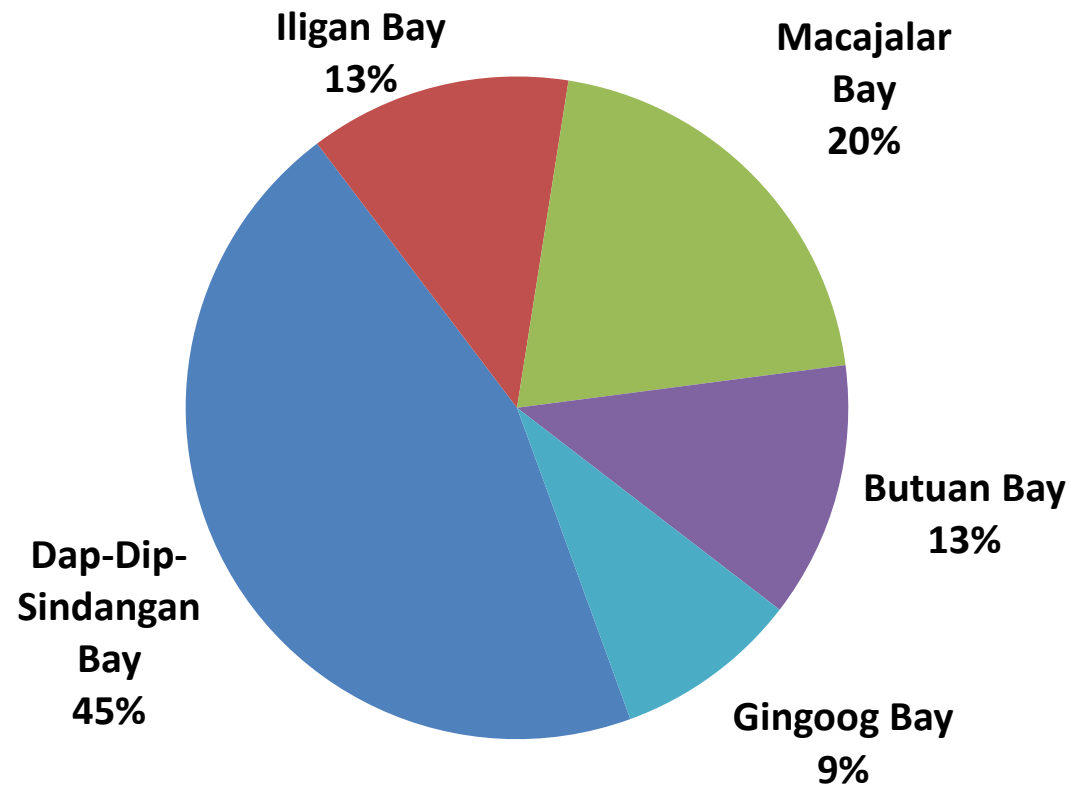
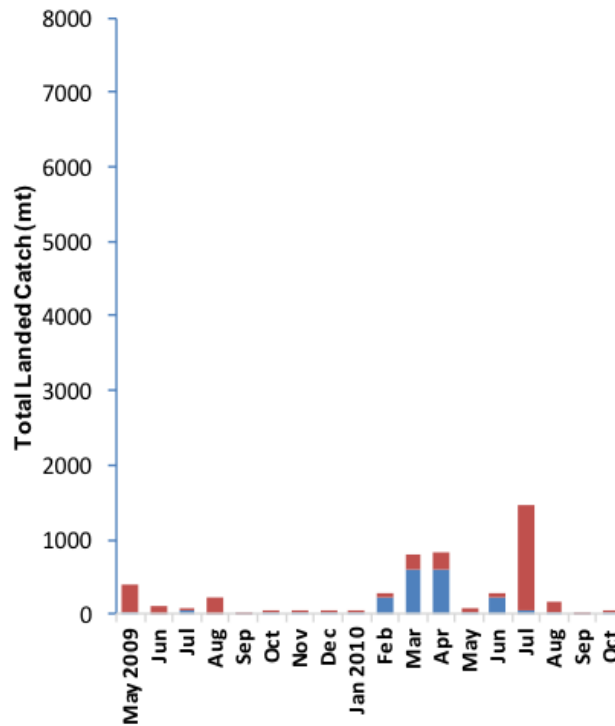


Amblygaster sirm
(Spotted sardine)

Sardinella lemuru is the dominant sardine in Northern Mindanao

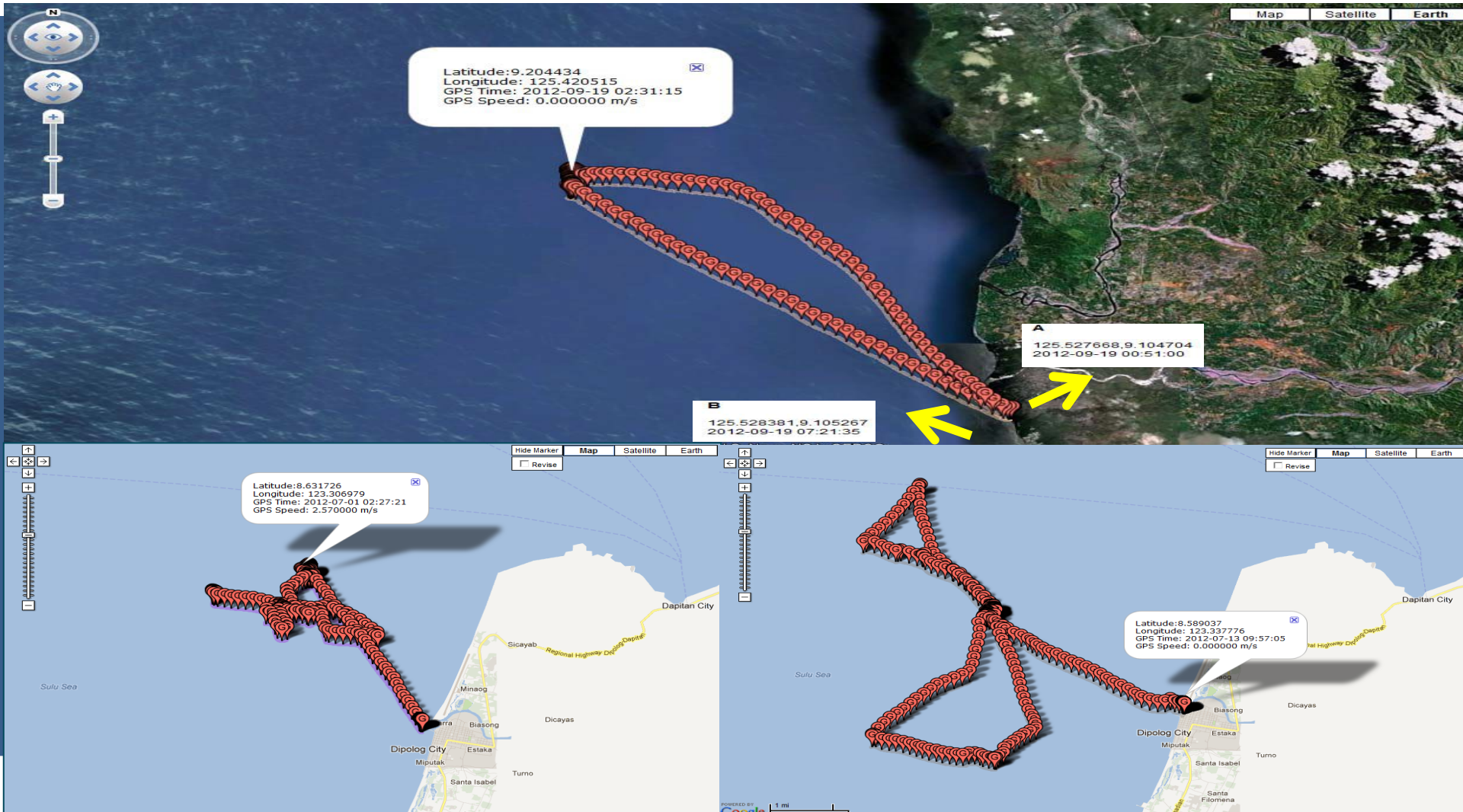
Spawning peak: November-January (a second, minor peak between May-Aug (observed in NZP))

Project Results: Catch trends



Total sardine production in all monitored bays in NZP and Bohol Sea System (mean annual prod'n = 39,496 mt) bet. 2011-2014

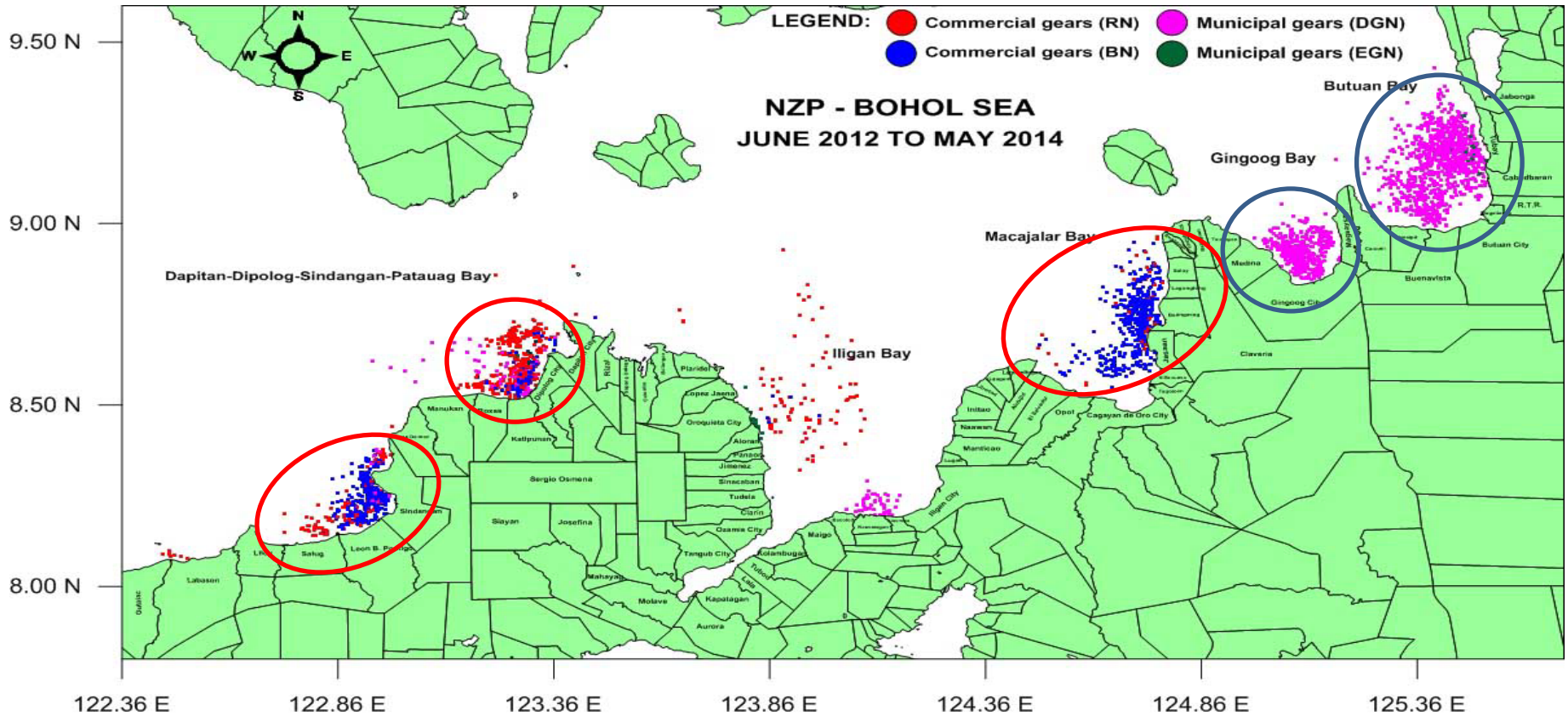
Project Results: Sample of recorded data



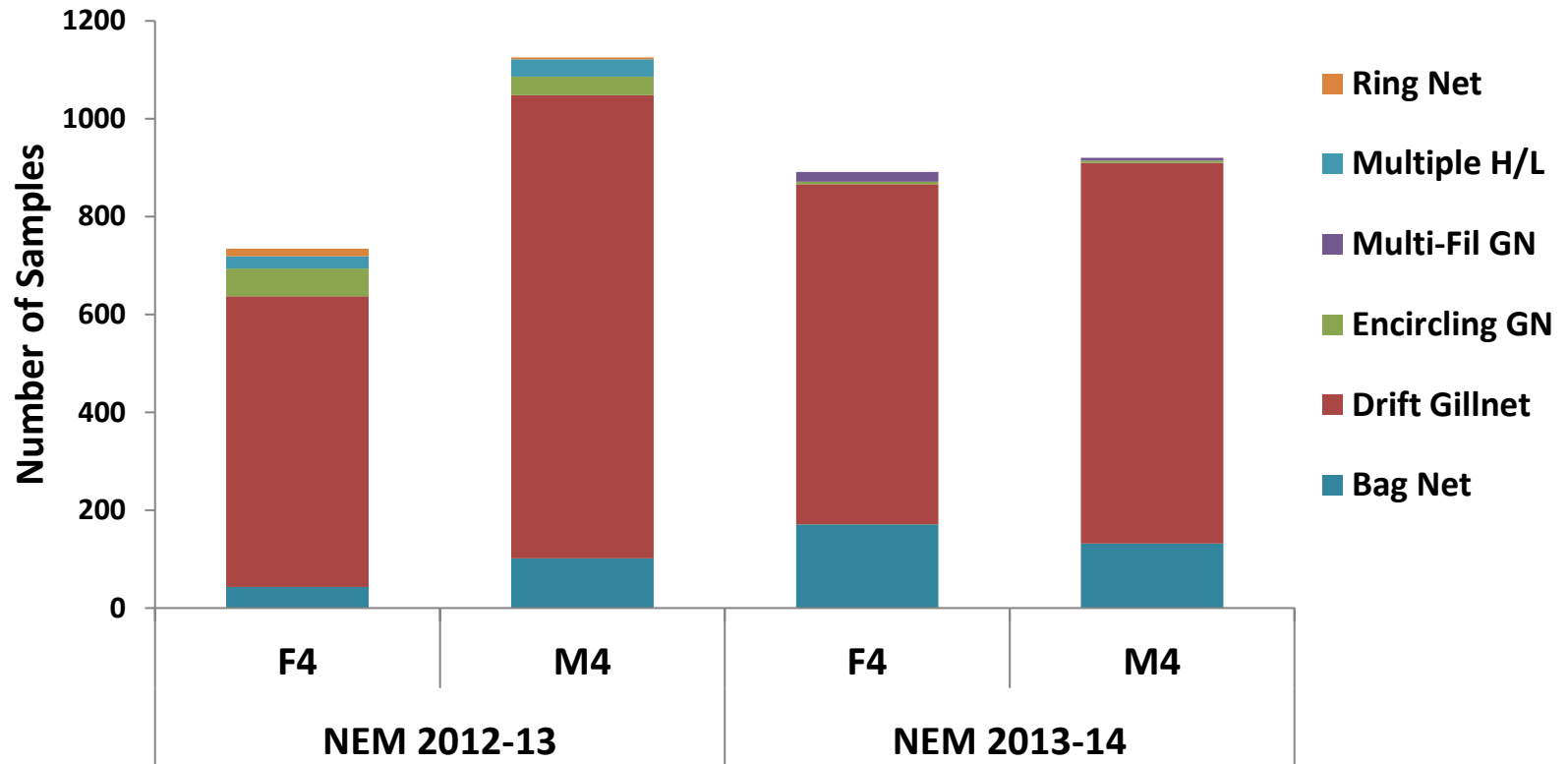
Sample Fishing Boat Tracks

Results

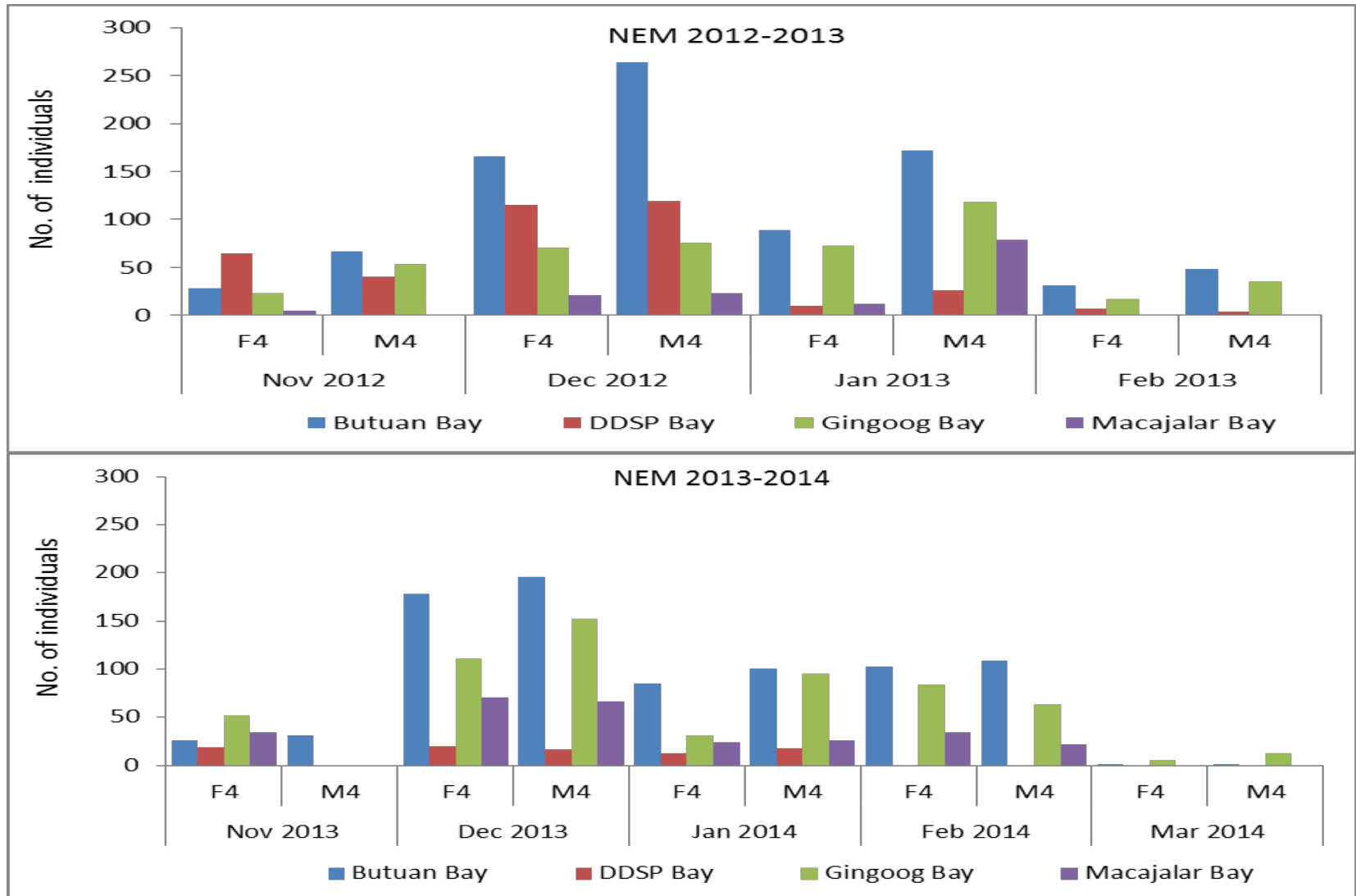
Spatial map of fishing effort tracked under RSVP



Number of samples by gear type

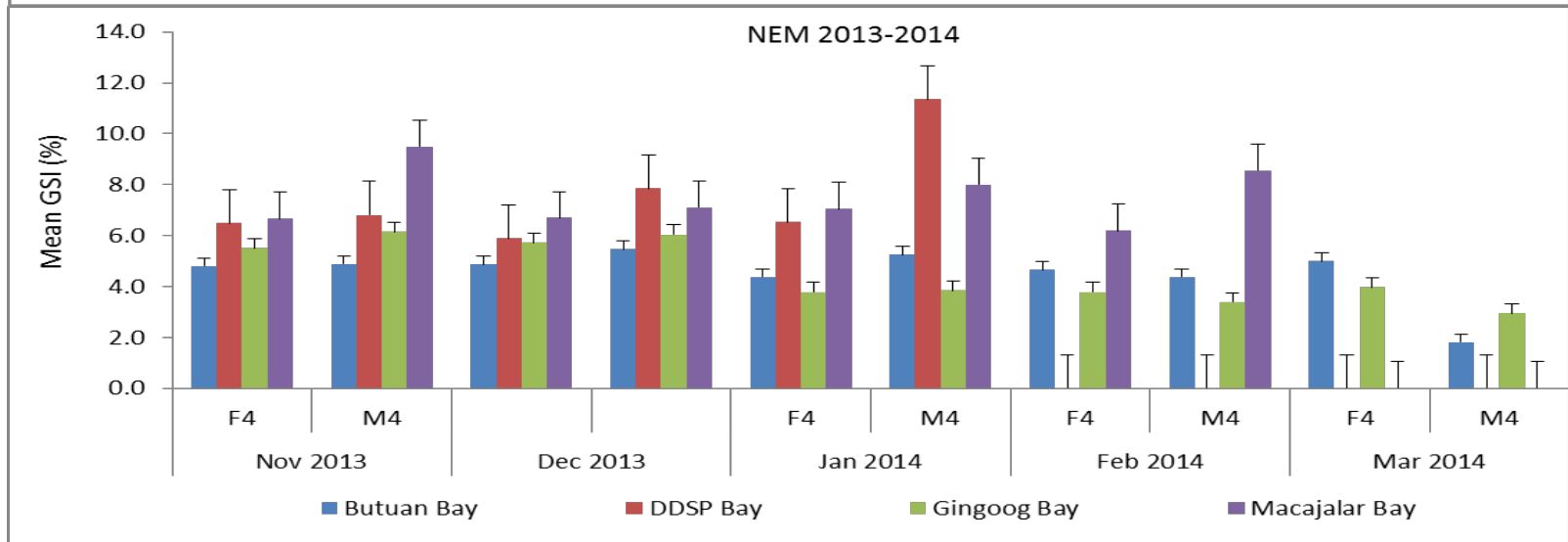
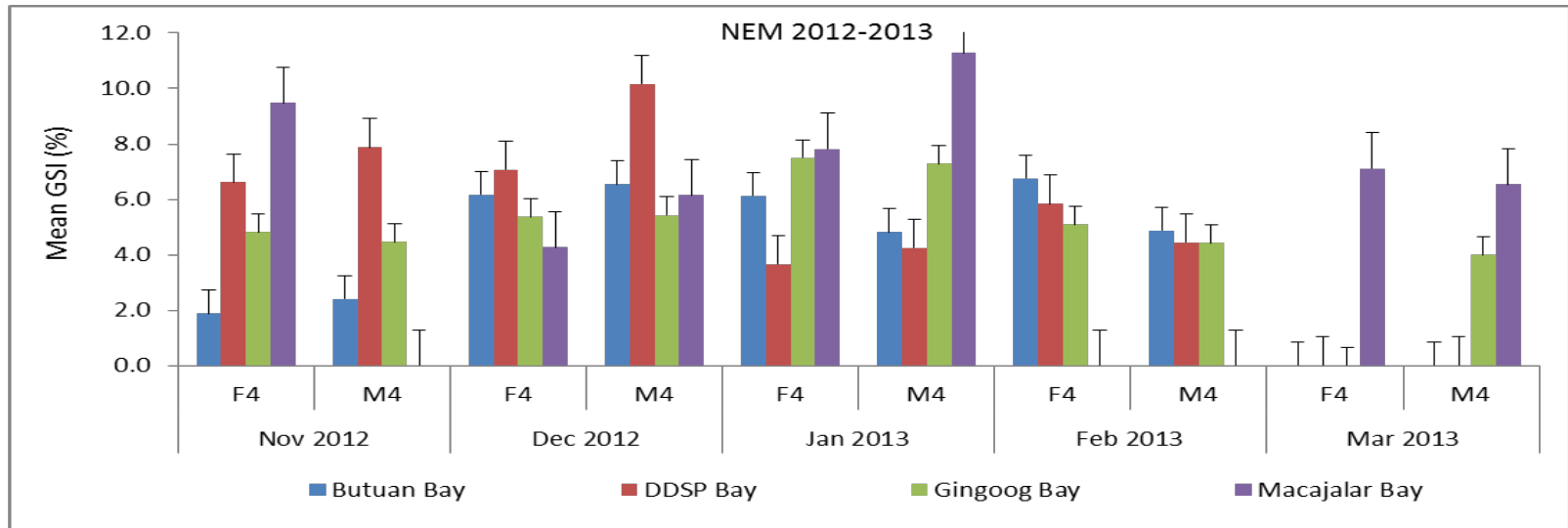


Samples of mature Bali sardine by bay



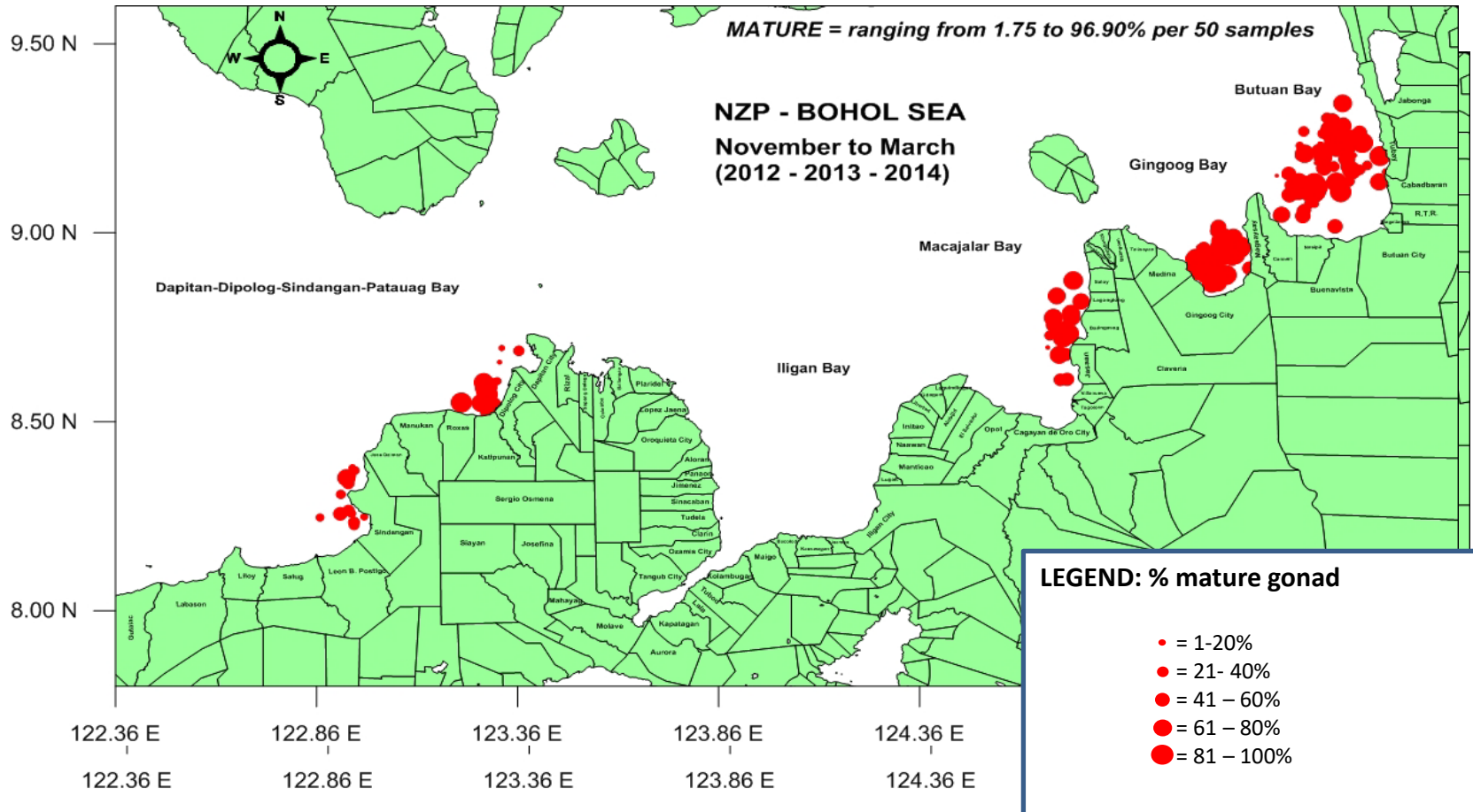
Spawning period of *S. lemuru* peaks bet. Nov & Jan (NEM)

Mean GSI by bay



GSI data on *S. lemuru* also peak bet. Nov & Jan (NEM)

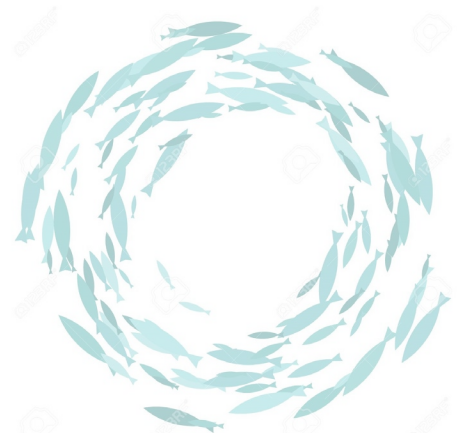
Geo-referenced spatial map of potential sardine spawning grounds



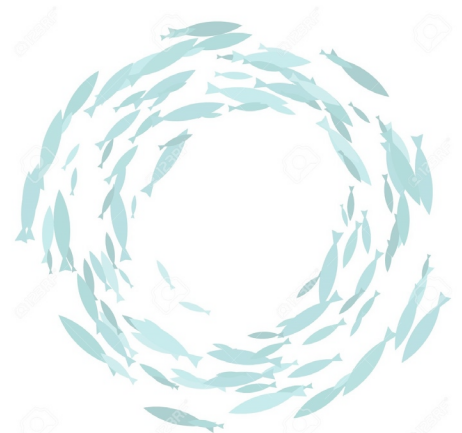
Sardine spawning occurs close to shore

Generalizations

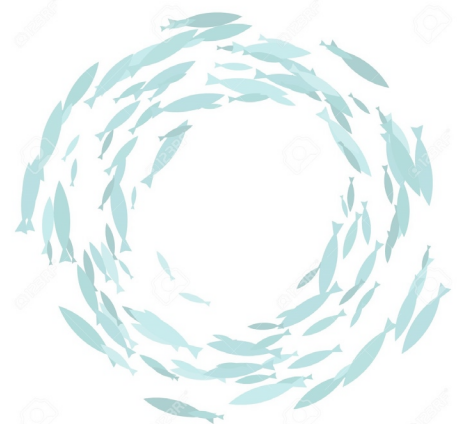
- Limitations of GPS tracking and data logging technique
 - ✓ Data downloading encountered compatibility and internet problems
 - ✓ Satellite-based: No signal, no tracking
 - ✓ Reluctance of some volunteers in constant maintenance (e.g. battery charging) and accountability of equipment



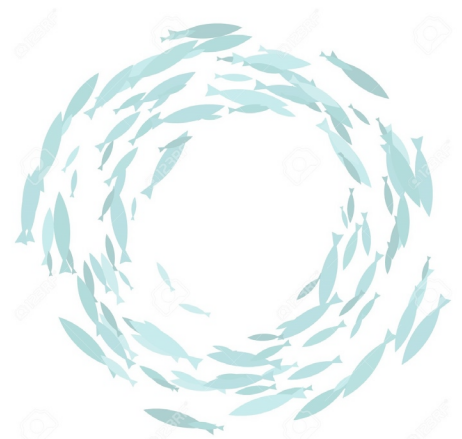
- Limitations of GPS tracking and data logging technique in identifying spawning ground
 - ✓ Preference of volunteer fishers tend to fish near shore, rather than, in deeper waters
 - ✓ Thus, **whether spawning of sardines occur in deeper waters** of the bays or outside them cannot be determined from the available data



- Although limitations are noted, the RSVP approach accomplished its objective:
 - ✓ Produce time-series, area specific catch and effort information
 - ✓ Temporal changes in fish stock abundance in the fishing ground
 - ✓ More importantly, **GPS tracking provides geo-referenced data on potential spawning grounds** based on gonadal analysis of fish samples

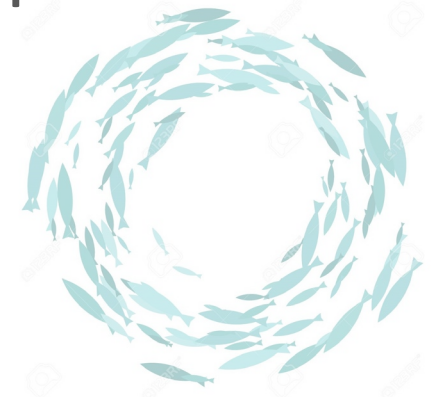


- This novel approach demonstrates
 - ✓ the benefits of combining geo-referenced information on fisheries data and biological surveys into time-series resource maps
 - ✓ invaluable participation of fishers in producing spatially explicit information for fisheries management



Recommendations

- ✓ Need for longer time-series sample collection and mapping of gonadal maturity
- ✓ Use of acoustic surveys (using sonar) to show if sardines do migrate to deeper waters
- ✓ Test fishing in deeper waters using purse seine or bigger deep sea fishing boat to obtain a more complete picture of spawning patterns in sardine



Thank You for Listening

Acknowledgments

- Project funding from DOST-PCAARRD
- RSVP Partners:
 - Fisher Associations (CFAMO, MOFBA)
 - Commercial and municipal sardine fishers in Northern Zamboanga Peninsula and 4 bays in northern Mindanao

