Ecological and socio-economic impacts of by-catch mortality associated with shrimp trawling in Bahía de Kino, Sonora, México

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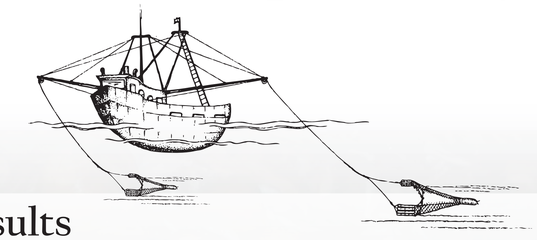


Introduction

The shrimp fishery is the most economically important fishery in Mexico (Gillett 2008). Sonora is the largest producer of shrimp from aquaculture and the second largest producer of shrimp from trawling in Mexico. Kino Bay is an important fishing ground for many of the approximately 925 trawlers operating from ports in the Gulf of California (SAGARPA 2011). The trawl portion of this fishery results in high rates of by-catch, habitat disruption and economic loss to local small-scale fisheries (Gillett 2008).

A shrimp trawler in the Gulf of California.

This study; 1) quantifies and describes **bio-diversity of the by-catch** associated with trawling in Kino Bay; 2) describes by-catch of **species of special concern**; 3) records by-catch species that are **commercially viable** for local small-scale fisheries; and 4) presents a preliminary methodology for **quantifying economic loss** over time in selected species using current price information.

The ratio of retained shrimp to by-catch in one sample (3.23 cubic feet).

Results

- Data were collected from 95 trawl sets on 11 boats over 23 nights between 2003 and 2013.
- **196 species have been identified in the by-catch**, including:
  *123 species of fish from 57 families
  *72 species of invertebrates from 14 phyla.
  *8 species protected under the IUCN Red List, CITES or the Mexican NOM 059.
  *54 species of commercially importantance to small-scale fishermen in the region.
- **By-catch rates averaged 86.08%** in samples from 89 trawl sets between 2003 and 2013. By-catch from 18 trawls in 2013 averaged 88.84% (fig. 2).
- **Elasmobranchs and flatfish frequently found as juveniles** in the by-catch are both highly valued by commercial small-scale fishermen, and also particularly sensitive to over exploitation because of their life histories.
- By-catch from 23 trawls in 2013 included **401 individual commercially important flat fish** from three species (*Paralichthys californicus*, *P. woolmani* and *P. aestuarius*). 154 of those were too small to be sold on today's market and the remaining 247 had a **present-day market value totaling 5,550 pesos (434 dollars).**
- Of the 373 California Halibut (*Paralichthys californicus*) captured as by-catch in 23 trawls in 2013, **26% (if male) or 99.7% (if female) were sexually immature** (fig. 3).
- Of the 59 Shovelnose Guitarfish (*Rhinobatos productus*) captured as by-catch in 23 trawls in 2013, **20 of the 30 females (66.66%) were sexually immature and 10 of the 28 males (35.7%) were sexually immature** (1 unknown) (fig. 3).

Pacific Sharpnose Sharks (*Rhizoprionodon longurio*) caught as by-catch.

Study Area

Kino Bay lies adjacent to Estero Santa Cruz, which provides important habitat for many juvenile fish and elasmobranch species.

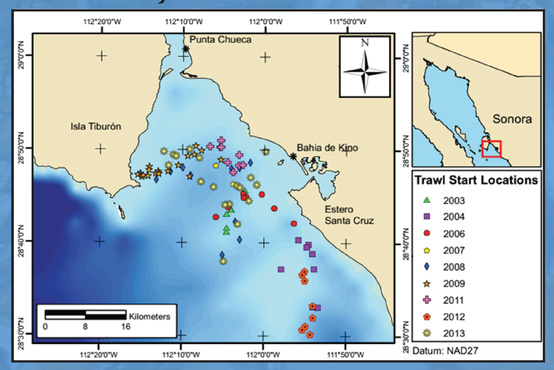
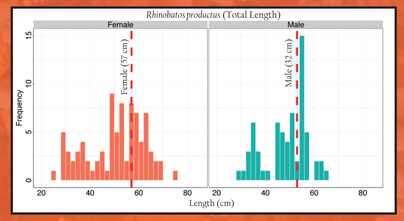


Figure 1: Starting locations for 90 trawls from 2003 to 2013 in the Kino Bay Region.

Maturity of Selected Species of Special Concern



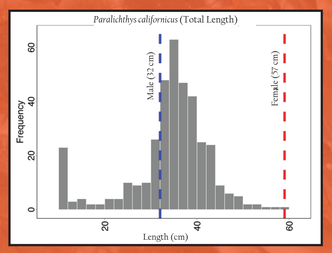


Figure 3: Frequency of total lengths (cm) of California Halibut (*Paralichthys californicus*) and the Shovelnose Guitarfish (*Rhinobatos productus*) in by-catch from 23 trawl sets in 2013. Dashed line indicates size at 100% maturity.

By-catch Rates

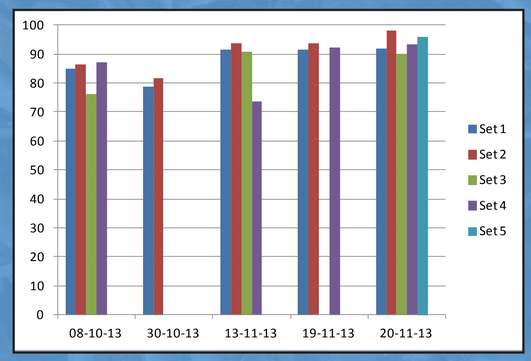


Figure 2. The percentage of by-catch in 18 trawls over 5 nights in 2013 ranged from 73.49% to 97.96% and averaged 88.84%.

Methods

Observer teams take data aboard shrimp trawlers.

- Data were collected aboard working shrimp trawlers in the Kino Bay vicinity (28°50'00"N to 28°30'00"N, and 112°16'00"W and 111°50'00"W between depths of 15.2m and 39m, typically along a sandy substrate.
- The species diversity was recorded for every set and unknown species were photographed and later identified.
- Measurements were recorded for every individual species of special concern, as well as sex and maturity if applicable.
- The by-catch percentage by weight was calculated for a random sample from each set.
- Current economic value of selected flatfish (*Paralichthys* spp.) and elasmobranchs found in the by-catch was calculated using market information provided by small scale fishermen targeting and commercializing those species in Kino Bay.

Literature Cited

[CITES] Convention on the International Trade of Endangered Species of Wild Flora and Fauna. 2013. Checklist of CITES Species. [cited 2014 26 March]. Available from: http://checklist.cites.org/#
Gillett R. 2008. Global study of shrimp fisheries. FAO Fisheries Technical Paper. No. 475. Rome: FAO. 331p.
Haugen, CW. 1990. Fish Bulletin 174. The California Halibut, *Paralichtys californicus*, Resource and Fisheries. UC San Diego: Scripps Institution of Oceanography Library.
[IUCN] International Union for the Conservation of Nature. 2013. 2013 IUCN Red List of Threatened Species. [cited 2014 26 March]. Available from: www.iucnredlist.org
Márquez-Farías JF. 2007. Reproductive biology of shovelnose guitarfish *Rhinobatos productus* from the eastern Gulf of California México. Mar Biol 151:1445-1454.
Meltzer L, Blinick NS, Fleishman AB. 2012. Diversity of by-catch species associated with commercial shrimp trawling efforts, Bahía de Kino, Sonora, Mexico. PLoS ONE 7(6): e35609. doi: 10.1371/journal.pone.0035609
[SAGARPA] Secretaria de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentacion. 2011. Anuario Estadistico de Acuacultura y Pesca 2011. www.sagarpa.gob.mx

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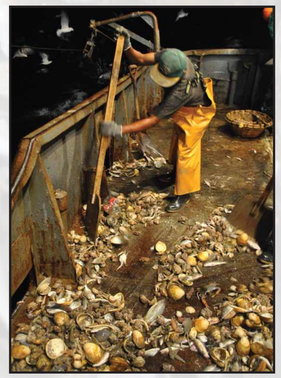
Conclusions

- Applying our by-catch rate of 86.08%, **29,128 MT of by-catch** are estimated to result from the Sonoran trawled shrimp catch of 4,712 MT reported by SAGARPA in 2011 (SAGARPA 2011).
- High juvenile mortality rates among sensitive species such as the Shovelnose Guitarfish (*Rhinobatos productus*) and California Halibut (*Paralichthys californicus*) results in **population impacts and future economic loss to small-scale fishers** in Kino Bay.
- Further study and collaboration is needed in order to calculate the higher **future economic loss associated with juvenile mortality** of valuable elasmobranch and flatfish species in the by-catch.
- The ecological and economic impact associated with biomass removal, disturbance of important nearshore habitat, and juvenile mortality of commercially valuable species of by-catch in Kino Bay **requires management attention.**
- Future studies should quantify the highly **variable and "patchy" distribution** of by-catch species over the geographic study site and throughout the season.



A crewmember sweeps the by-catch off the deck.

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