22ND BIENNIAL CONFERENCE ON THE BIOLOGY OF MARINE MAMMALS

HALIFAX, NOVA SCOTIA

OCTOBER 2017

MARINE MAMMAL BYCATCH IN GLOBAL FISHERIES:

A WORKSHOP SUMMARY OF MITIGATION MEASURES, TOOLS, & SOLUTIONS

TABLE OF CONTENTS

INTRODUCTION

Bycatch is the greatest direct source of mortality for marine mammals world-wide, accounting for an estimated 600,000 dead animals each year (Read et al., 2006). In some cases, bycatch is the primary reason for the decline, lack of recovery, or even extinction of a species as in the case of the baiji or Yangtze River dolphin (*Lipotes vexiler*) (Turvey et al., 2007) and the now critically endangered vaquita porpoise (Thomas et al., 2017). Despite the magnitude of the threat posed by accidental fishery interactions, bycatch mitigation and monitoring still do not attract the level of research, practical implementation efforts, or necessary political will to make measurable and effective progress. Indeed, it was estimated that at the Society for Marine Mammalogy (SMM) meeting in Halifax in October 2017, a scant five percent of the presentations addressed assessment or mitigation of bycatch.

A series of three workshops on approaches and solutions for bycatch mitigation were held immediately following the SMM meeting. A consensus view from these workshops is that immediate actions are needed to reduce marine mammal bycatch globally to prevent additional species extinctions.

This document summarizes each of the three workshops and offers several recommendations for future action and research. In addition, a timeline of upcoming events highlights opportunities to continue to make progress in monitoring and reducing marine mammal bycatch.

1. OVERVIEW OF MARINE MAMMAL BYCATCH: WORKSHOP #1

The first workshop was a one-day event, with a particular focus on multidisciplinary approaches to addressing marine mammal bycatch. Each session addressed a number of challenges and offered potential solutions to each.

1.1 Small-scale coastal fisheries

These are often gillnet-based fishing operations characterized by weak or ineffective governance and with little to no data. In addition, these fisheries are "beyond the reach" of market incentives or regional fishery governance, which might otherwise offer some options. At the same

time, low-cost options such as empty soda bottles as "acoustic deterrents", can be designed in collaboration with the fishery operators. Engaging local community stakeholders is critical, as demonstrated by the successful "River Guard" programs in Cambodia (see cover page image). Spatial models can also help provide the type of data useful for assessing the risk and approximate level of marine mammal interactions in the fishery. Marine mammal bycatch can be a source of great economic loss to some fisheries as marine mammals cause damage and/or loss of fishing gear. One estimate of small scale fishery gear loss in Peru due to large whale entanglement was $300 US per entanglement event, an astounding figure given the average annual income of fishermen there ($6000-7500).

1.2 The use of multilateral and global organizations

Several Regional Fishery Management Organizations (RFMOs) have adopted binding or voluntary measures to allow for some level of monitoring and mitigation of marine mammal bycatch. Progress is very slow, however, with few RFMOs having binding measures such as a prohibition on setting on marine mammals. The September 2017 Ecosystem and Bycatch Workshop of the Indian Ocean Tuna Commission (IOTC) included significant progress on addressing marine mammal bycatch in tuna gillnets. At the more global scale, the Food and Agriculture Organization (FAO) Committee on Fisheries (COFI) is organizing a workshop in March 2018 with funding from the U.S. NOAA's National Marine Fisheries Service. With the ultimate goal of developing marine mammal bycatch guidelines (similar to those developed by FAO for sea turtle and sea bird bycatch), this workshop can help reach developing country fisheries and also stimulate change through regional and national fishery management. The International Whaling Commission (IWC) is increasingly engaged in bycatch, including a new Working Group on marine mammal bycatch, and the hire of a bycatch coordinator. The important work by IWC on disentanglement training also continues.

1.3 Incentivizing approaches

Various government, private eco-label programs, and one-on-one arrangements are underway to reward fishery operators for reductions in marine mammal bycatch. This alternative to top-down regulatory approaches has proven effective in addressing both terrestrial and marine environmental

issues. A big focus at this workshop was the recent rulemaking by NOAA Fisheries calling for countries exporting seafood to the U.S. market to ensure that their marine mammal bycatch measures are comparable in effectiveness to standards in the United States. This is an interesting "unilateral" approach to addressing marine mammal bycatch through the incentive of ensuring market access. A draft "list of fisheries" has been published and highlights nearly 2,600 fisheries world-wide that are proposed as needing action in order to continue to have access to the U.S. market. The Marine Stewardship Council (MSC) recently certified the Mexican dolphin-set tuna fishery; the MSC is in the process or revising their standards for marine mammal interaction, which could be an important opportunity to raise the bar on monitoring and mitigating marine mammal bycatch. Studies on retail prices for seafood in the Southern California market demonstrate the "revealed preference" for sustainably harvested seafood given price differentials for labels such as "wild", "Baja", or otherwise eco-labelled fishery products. Fishery sector examples (such as U.S. Atlantic pelagic longline Bluefin tuna bycatch) demonstrate the potential utility of establishing some form of transferable "rights" or "credits" to marine mammal bycatch.

1.4 Getting the message out and mobilizing action

Given the alarming numbers of marine mammals killed or injured in some fisheries, and the link between bycatch and decline, it is critical to raise the profile of this major challenge to marine mammals. This should include engaging governments and organizations at the highest possible levels, often outside of the traditional players in the marine and conservation realms, much as has been done for terrestrial charismatic mega-fauna such as tigers and elephants. These efforts should stress the need for funding for science and engineering, as well as in-the-field testing with the direct engagement of fishery operators. Sharing technical and practical information will be critical, and the Global Bycatch Exchange offers an extraordinary opportunity for such sharing (www.bycatch.org). Another effective approach is to exchange knowledge and experience on marine mammal bycatch mitigation amongst small-scale fishery operators. Finally, consumer awareness is critical as the ultimate seafood buyer needs to be informed of any marine mammal bycatch issues associated with the products they purchase, along with other ecosystem and sustainability considerations.

2. DEVELOPMENT AND IMPLEMENTATION OF LOW-COST METHODS TO REDUCE CETACEAN BYCATCH IN SMALL SCALE GILLNET FISHERIES: WORKSHOP #2

Bycatch in gillnet fisheries is considered the most significant threat to cetaceans globally. In most cases cetacean bycatch rates are relatively low from a fishery perspective but high, and often unsustainable, from a cetacean population perspective. These are significant challenges to overcome when developing, testing and implementing potential bycatch mitigation measures. This Workshop focused on low-cost cetacean bycatch solutions for small scale gillnet fisheries and followed-up a similar Workshop organized at the SMM 2015 in San Francisco. The Workshop reviewed newly available bycatch reduction methodologies/gear modifications and results from recent and ongoing bycatch mitigation trials. The Workshop also identified areas and fisheries with relative high bycatch rates where bycatch mitigation trials may be conducted with high statistical power. It is recommended that collaborative international research proposals are developed with participation of researchers from areas where trials are logistically difficult but where the results would be applicable. The Workshop further reviewed how to move from successful trial to implementation, particularly in locations and fisheries where legislation and enforcement may be absent. The Workshop primarily addressed drift-and set gillnet fisheries and identified the most promising low-cost mitigation methods for both echo- and non-echolocating species.

3. CATCHING THE RIGHT FISH - A TOOLBOX FOR PLACE-BASED RISK ASSESSMENT OF MARINE MAMMAL BYCATCH: WORKSHOP #3

Marine mammal bycatch, a major threat, poses particular challenges in developing countries. Data to document bycatch and the effects of bycatch are often lacking as research takes limited time, money, and training. We have designed a suite of spatial tools that enable scientists to conduct place-based bycatch risk assessments that can be used in sites with varying gaps in data. The tools are hosted on a website and have open-source processing. Delegates were trained in the use of the toolbox with existing data from our field sites in Southeast Asia. We also asked delegates to come with a summary of their current abundance, distribution and fisheries data. Then, in mixed groups, we determined data gaps, needs, and commonalities, such as needs for training, outside consultants, regional workshops, funding or technology. We also evaluated each site using interdisciplinary methods as found in Teh et al (2015) to determine how socio-cultural and

economic dynamics contribute to bycatch. Our output may be a joint article that will summarize our discussions as a first global view of how these methods will support practitioners to estimate marine mammal population abundance, bycatch, fisheries and find effective measures to reduce bycatch to sustainable levels.

4. TIMELINE MOVING FORWARD: MEETINGS TO CONSIDER FOR PUSHING FORWARD THE BYCATCH CONVERSATION

It was noted that it will be important to address the issue of bycatch outside of traditional forums, including the likes of the UN General Assembly; regional economic forums (Association of Southeast Asian Nations - ASEAN, Southern African Development Community – SADC, etc.), the World Bank, etc. to ensure high level support and sufficient resources to address the conservation and livelihoods impacts of marine mammal bycatch. A few meetings to consider attending are below.

- o March 2018 - FAO Marine Mammal Bycatch workshop
- o Spring 2018 – IWC Meeting in Brazil
- o 2018 – SOLAMAC, Peru
- o Spring 2018 – ECS Conference, Italy
- o Fall 2018 – 3rd World Small Scale Fisheries Congress, Thailand
- o 2018 – IOTC Working Party on Ecosystems and Bycatch
- o December 2019 – SMM Barcelona Meeting
- o 2021 – SMM Ft. Lauderdale Meeting
- o 2018 - IATTC Meetings
- o 2018 – Western and Central Pacific Fisheries Commission

5. APPENDIX I: WORKSHOP NOTES

5.1 Workshop #1

Panel 1: Addressing the Challenges – Case Studies in Assessments and Mitigation of Marine Mammal Bycatch

Getting to the bottom of bycatch – Models and toolkits in data-poor situations

- Context: countries / regions often faced with a lack of data on bycatch interactions, especially in developing countries in the face of the MMPA import rule requiring assessments
- Goal
    - Toolbox to assess interactions in these situations
        - Study site: Southeast Asia (Thailand, Malaysia, Vietnam)
        - Process: dialogue with local stakeholders to develop this spatial tool that can be tailored to each situation with the data available
        - Various factors (e.g. MML sightings / habitat, gear type/gear distribution/etc.): used to assign a risk score for MML bycatch
        - Output: map of risk to a species from a given gear type
        - www.mmbycatchtoolbox.org

Using predictive habitat models to help reduce marine mammal bycatch

- Goal: predict spatial and temporal habitat use
    - Co-occurrence models can be used to separate MMLs and anthropogenic activity
    - Tool: EcoCast
        - In development for CA drift gillnet fishery
        - In near real time, used to predict target / bycatch species
        - Adaptable, maps risk to various species
        - Will include survey data from SWFSC, observer data, regional ocean monitoring data

New tools for confronting marine mammal bycatch in fixed gear fisheries

- Not enough people know about bycatch – we need to build constituency
- Not enough scientific evidence behind bycatch mitigation measures, but doing studies now to assess effectiveness of various rope strengths (both simulated and in the field)
- Global Bycatch Exchange:
    - Place to learn, connect, and contribute to reducing bycatch
    - www.bycatch.org

Q&A:

- How much time and what resource intensity is required for the risk maps?

- o 2-3 months to accomplish (most of time is spent talking with local people)
- o Risk maps for MML bycatch could be really useful for marine seafood certification programs
- What is the minimum amount of data that you need to map MML bycatch risk based on habitat models?
  - o Machine learning approach w boosted regression trees seem to handle these zero inflated datasets quite well.
- State of ropeless technology for fixed gear fisheries?
  - o 1 option: bring ropes to bottom and use acoustic signal to raise them before haul
    - ▪ This tech has been around for a while, has already been in use elsewhere, can offer a 'longer'-term solution
  - o Is this cost-effective?
    - ▪ Depends on the fishery. In Australia, fishers save money because people don't steal their gear as a result.
    - ▪ In MA, study showed that fishers could get lots of money back with this tech instead of losing that gear during normal fishing operations.

Follow up actions:

- o More outreach, sensitizing the world to the problem
- o When researching alternative gear types, assess economic impacts of gear modifications!
- o Remove regulatory impediments to new gear & maybe use regulatory incentives
  - ▪ E.g. not only can the acoustic release tech help fishermen get gear back, but could also help regulators monitor fisheries
- o Work with fishermen to develop solutions
- o Possible recommendation that spatial risk tools are made increasingly available
- o Increase collaboration between broad scale predictive models of bycatch risk and small scale, focused studies that share that goal (i.e. Nick and Ellen's respective approaches)

Zanzibar dolphin bycatch assessment and mitigation
- Working with fishers in E Africa to mitigate marine megafauna bycatch
- Big data gaps in E Africa region
- Artisanal gillnet (bottom set nets and driftnets) fisheries in the region interact with MMLs All catch was used in the past (including marine mammals)
- Pingers reduced gillnet bycatch for bottlenose dolphins, unsure for humpback dolphins
  - o No implemented mitigation to date due to cost
  - o Recycled glass bottles with a bolt inside makes a sound similar to electronic pingers
  - o Air bubble in plastic bottle – perfect sound reflector
  - o Fish catch not affected by glass or plastic bottles
  - o Need more trials to demonstrate that recycled bottles used as pingers and acoustic reflectors reduce dolphin bycatch

- How do we move to implementation if they do work?

Bycatch Assessment & Mitigation in Peruvian Small-Scale Fisheries

- Projects led with fishers, lots of outreach activities
- Fishermen discard dead dolphins – don't want to catch them
- ~15k dolphins bycaught per year
- High rate of entanglement!
    o From observer data & stranding reports
- 40% reduction in bycatch of 4 common species and no change in target catch
- Testing LED lights as well. Some promise, needs more work.
- Is traceability possible in Peru?
- Local communities were onboard especially when local incentives were in play

Resolving Bycatch Challenges in a Riverine Environment: Mekong River Dolphins

- Mekong River – Cambodia – Freshwater dolphins
- Irawaddy dolphins
    o 4 workshops putting all the knowledge together
    o River Guard program developed to reduce threats to this species
    o Nets that are removed each day are burned – over 100k removed
    o Initially thought that disease was the problem, which slowed the ID of bycatch as the primary threat (by 2010)
    o Over 100 river guards in the program now, which seems to have reduced bycatch from gillnets

Q&A

- Gillnets have been removed, so what have fishermen done to cope now?
    o Fishers can still use round nets, but unsure of economic impact
- Is there any export of fishes from these areas?
    o No, not much (Mekong). Some on occasion.
    o Peru: yes, because the target species are sharks – fins to Asia and meat locally / Europe
- Future of River Guard program?
    o Remove gillnets directly but also act as ambassadors to educate community members

Follow-Up Actions

- Test bottles in Peru and other areas with high bycatch rates of MML bycatch reduction
- Share info on success from reducing MML bycatch in Cambodia elsewhere to learn from this example
- ID local leaders / champions
- Governance: ensure fishers awareness of regulations (problem IDed in Peru – fishermen want to reduce bycatch… need tools to do so)

Panel 2: Incentivizing Solutions to the Challenges

Overview of incentivizing tools: transferable bycatch quotas, payments for ecosystem services, market access, labeling schemes

- Necessary to internalize the externality that is bycatch
- Direct v indirect incentives:
    - Direct: Reward fishermen for fishing with a certain gear type vs penalize fishermen for not using a given gear type
    - Indirect: alternative economic opportunities (e.g. community development)
- Need a mix of solutions (economic, social, ecological)
- Top-down approach is maybe most effective if incentives are a part of the plan

Case Studies

Understanding the New MMPA Import Rule, the Implications, & the Opportunities

- Background on slides
- 3270 export fisheries, closer to 700 exempt fisheries in the LOFF
- Difficult to deal with a lack of data on MML bycatch
    - Is there spatial analysis of the co-occurrence of fishing operations and MMLs?
    - Used 'analogous' if not enough data in a given fishery but comparable to US fishery for which there is data
    - gillnet, longline, purse seine, and trawl fisheries = generally export fisheries
    - N/I: not enough information = export
    - None documented: no MML bycatch documented, can be an exempt fishery
- Intermediary nations must comply with these measures as well
- **Better estimates of bycatch are needed
- Emphasis on this being an iterative process

Market incentives for Vaquita Conservation

- Background on vaquita
- Economic incentives for catching totoaba are very high, the penalties have historically been very low. Now a felony for possessing (catching? Unsure of specifics) totoaba, but unsure if it is ever prosecuted
- Legal export fishery – shrimp – using alternative gear types to prevent bycatch interactions
    - RS-INP-MX: includes TED etc.
    - Suripera: other option
- Role of consumers:
    - Surveys in markets in San Diego: large buyers for shrimp from Upper Gulf of Cali are in San Diego. These shrimp are a high-value product and consumers may have the WTP for them if vaquita-safe is an option

- o Numerous shrimp fisheries get higher price for products that are certified (MSC / Mont. Bay / Mazatlán Sustainable Label)
- Alternative livelihoods:
  - o Renewable energy, ecotourism, agriculture, etc. Nothing seems to have the push necessary to move away from fishing at this point

Lessons from the Alaska pollock and Atlantic pelagic longline bluefin tuna fisheries

- Example focused on chinook bycatch in Alaskan groundfish fisheries
  - o Council instated bycatch caps and let fishery coops come up with solutions on their own
  - o Tons of fishery coverage for time-area closures set by a third party (not the gov)
- Example focused on bluefin tuna bycatch during swordfish longline sets
  - o Often upgrading to better tuna (high grading) due to the limit on bluefin bycatch retention
  - o Solution: individually transferrable quota (can sell it without fishing / can lease your quota / up to you!), captains who are good at avoiding bluefin bycatch can fish in a place where others cannot
- Possible to come up with bycatch quotas for marine mammals?
  - o Can engage outside partners effectively
  - o Could incentivize bycatch reduction with less top-down regulation

Q&A

- Even though aquaculture might not have a marine mammal bycatch problem, the fisheries catching the food for those aquaculture species do. How do you classify?
  - o Unsure of how far back into the supply chain we go.
- Surprising about freshwater fisheries being MML exempt fisheries…
  - o For now, yes. Can change when data comes in.
- Aquaculture industry is looking for alternatives to MML bycatch feed issue. There are labeling programs for aquaculture programs related to bycatch in feed and so on. Will NMFS look deeper into this supply chain issue?
  - o Get back
- Small scale fisheries – oyster / crab in SE Asia for instance – is Sirenian bycatch considered?
  - o Yes, if possible… NMFS needs more information, particularly regarding aquaculture (e.g. on ropes in coastal waters).
- MMPA Import requires intentional killing of marine mammals to result in export classification, but some countries allow intentional killing of targeted problem sea lions… what then?
  - o Can't export to USA. No flexibility currently.
- Concept of 'equivalent in effectiveness' is interesting. That being said, US process has failed in some cases… so if another country mimics US policy but fails to reduce bycatch, would similar leniency be applied?

- o Get back on answer, but complicated issue. Other countries seem to interpret 'equivalence' based on the real-world effectiveness of USA TRTs.
- o US would be hard pressed to force another country to meet a US standard that US isn't meeting. In terms of world trade court, US would likely lose if so. Within US, it is possible that NGOs may force US government to meet its own standards through MMPA and ESA.
  - ▪ Yes- lawsuit pending regarding ESA / MMPA for NARW takes in lobster fishery without proper take permits.
- o Difficult with meeting 'US standards' related to stock delineation and abundance as well. In the US it is really hard… how do we do it elsewhere?
- o Has NMFS considered the ripple effects of the rule in case countries decide to just not send the US their product?
  - ▪ Yes, working and thinking about it.
  - ▪ There is a lot of room to work on bycatch through FAO and other multinational organizations.
  - ▪ Rule is species and gear type specific- won't ban a product entirely from a country for bycatch in one fishery.
- Some eco-labeling can result in some of the higher profits going back to the fishermen (e.g. Mazatlán).
  - o Would be fantastic to have some profits from these products end up with the communities where the fishing takes place (reminds me of various MPA efforts e.g. Shark Reef Marine Reserve, Fiji)
- How hard will it be to keep gillnet removal efforts going in Northern Gulf of California after vaquita go extinct?
  - o The problem will continue but for other species. Enforcement has been an issue.
- Re ITQs, some fisheries use risk pools in cases where low probability / bad outcome fishing situations arise (e.g. in cases where bycatch quotas are so low)
- Animal welfare issue regarding the quota option. Would need to be prepared for 'allowing' a take of a marine mammal.
- Re vaquita: issue with paying fishermen to not fish -> what about the people who earn a living doing things related to fishing industry, but not actually fishing?
-

Recommendations

- Can we get NGOs / governments to pay for the testing of ropeless fishing/ other mitigation options?
  - o Happening already to some degree (Bycatch Reduction Engineering Program (BREP) / Atlantic Fishery Fund / etc.)
- Need for compiling success stories
  - o **requires caution as 'success stories' change constantly. Call it 'encouraging story'.
- Consider welfare implications of quota option

- Empower women in local communities to broaden economic portfolio -> reduce need for dangerous / illegal fishing
- Re MMPA import rule – need to work with FAO to build capacity

Panel 3: Supporting Solutions to the Challenges through International Agreements and Regional Fisheries Management Organizations (RFMO's)

What is being and should be done by intergovernmental organizations to reduce marine mammal bycatch?

- Drift gillnet tuna fisheries likely the most significant threat to cetaceans in Indian Ocean Tuna Commission (IOTC) area of competence
- Artisanal fishery effort has increased since 2000, whereas industrial fishing (purse seine and pelagic longline) effort has slightly declined.
- Highlights lack of data for artisanal fisheries compared to the industrial effort
- Few mortalities from tuna purse seine and pelagic longline fisheries in the region. However, better bycatch assessment in pelagic longline fisheries is still needed.
- Still many data gaps in the IOTC area, particularly on bycatch in drift gillnets (marine mammals, sea turtles and elasmobranchs)
- IOTC now has cetaceans on the agenda re to bycatch interactions
- Executive Summary for cetaceans available on the website, hoping for forward movement in this area in the near future

Convention on Migratory Species (CMS) ACCOBAMS

- Background of CMS
- New resolution on bycatch from COP 12
- ASCOBANS- binding UN agreement on small cetaceans in NE Atlantic
- ACCOBAMS- binding UN agreement on larger cetaceans in Med / Black Sea
  o Generally speaking, lack of data on cetacean bycatch in Med Sea
- Joint ACCOBAMS/GFCM project- goal to enhance cetacean conservation by promoting alternative livelihoods, etc. (results on ACCOBAMS webpage)

International Whaling Commission

- Background on conservation of whales through IWC
- Recognition that bycatch is for most populations and species, the single greatest human impact on these animals
- Bycatch / Human-Induced Mortality Committee working on reducing bycatch
  o Summary of six years of large whale bycatch data from National Progress Reports to IWC Scientific Committee

- o Global Entanglement Database resource
- o Multiple workshops developing principles and guidelines for entanglement response
- o Have established a Bycatch Mitigation Initiative to tackle the problem more directly
  - Welfare issues have prompted movement on this issue (entanglement) given the time until death after entanglement (~6 months)
- o Big problem: severely underestimating entanglement / mortality for large whales because they take the gear with them. Maybe up to 1 reported to 10 not reported in developed countries with reporting infrastructure and in developing countries more like 1 in 100 (? Ballpark).

Q&A

- Does IOTC cetacean stuff get approved past the bycatch committee?
  - o Yes, needs to go to the Scientific Committee, then Commission itself.
- Important for IWC Bycatch Committee is for bridging political management level at Commission with scientific community / findings. Need to link the research to the management practices.
- What trials are taking place in the Pakistan gillnet fisheries?
  - o Changing the depth of the net:
    - Seems to reduce bycatch
- What kind of discussion is going on regarding replacement of gear that causes bycatch with alternative gear types?
  - o Cost prohibitive to switch to other gears like longlines
  - o IWC: not at that stage, but stories of fishermen switching to longlines or other gears to avoid whales because they lose gear and it costs them money.
    - Brazil especially – fishermen losing tons of gear and forcing them to switch to alternative gear types
  - o Mediterranean: bycatch is localized (big problem in Morocco) and so the answer is really place-to-place, but no movement towards a specific alternative gear per se
- Should we be thinking about bycatch in terms of multi-species assemblages instead of species-specifically?
  - o Yes, can't focus only on one species. Still collecting data on all kinds of species in IOTC and Med.
- IOTC & IWC collaboration is good, filling data gaps is good, etc. But the cost for species specific conservation is very high (e.g. vaquita). In the face of significant bycatch interactions on a large scale for RFMOs, will this discussion shift the trends in places where declines are happening but data are lacking?
  - o Public pressure (which worked in ETP) is maybe not a good option in IOTC. But WWFPak has done a great job of working with fishermen to ID bycatch species, collaboratively solve bycatch problems. More on the ground collaboration is

critical. Small, country wide projects working in parallel with RFMO regulatory measures may be effective.
- o Sensitive to the time constraints of getting things done. The US MMPA Import Rule will help from the industrial side, but maybe not so much for the artisanal side of things. May need to approach the issue by offering assistance to fishermen who don't want to catch whales as opposed to trying to do conservation for the sake of the species.
- o Toolkits: lots of work going into rapid assessments of bycatch at Duke and elsewhere. A team is looking at doing this in Asia (Ellen Hines) and E Africa (combining fisher surveys and abundance estimates, etc.).
  - ▪ Lots of initiatives looking at bycatch using survey data, but can you trust the results? Combining with other techniques (e.g. landing data) is helpful. But landings data can be misleading as well because people don't want to get in trouble. In this case, survey data may be more helpful.
- Is there any new perspective on agreements for other regions than covered by CMS?
  - o There is cetacean MOU for South Pacific but not aware of any new agreements really.

Recommendations

- In considering MML bycatch reduction, must consider the effects on other species.
- Start with regional /pilot gear and work with fishermen prior to scaling up / work in parallel with large governmental bodies.
- Focus on helping small-scale fisheries where the most threatened species / populations are often found.
- Share non-lethal deterrent guidelines with other nations (from US).
- Setting up entanglement response teams in countries with bycatch issues at small scale can be helpful -> tool kits for assessing MML bycatch would be helpful.

Panel 4: How Have We Successfully Put All the Pieces Together to Drive Meaningful Conservation Progress?

Tuna / Dolphin Issues: Lessons Learned

- Background on tuna / dolphin issue and push for dolphin-safe tuna
- Has been a switch in thinking about tuna fisheries – gradual, long term process with lots of small steps / agreements / treaties / etc. Has been a 30 yr. + process.
- Lots of court battles between US and Mexico regarding 'dolphin safe'
  - o Possibility of serious cryptic mortality in this fishery / sub-lethal effects could be significant

Largescale Driftnet Ban

- Historical perspective on this issue (this gear type is mostly not in use anymore)
- How did we solve the bycatch situation associated with this gear type?
    o It was collectively agreed upon internationally due to the magnitude of the problem. With current issues, it seems to be much more complex and expecting this kind of action in modern times is maybe unrealistic.
        ▪ More than marine mammals were considered – this was across taxa and very costly to fisheries and coastal fishers as well given salmon being anadromous.

Driving Political Will: Wildlife Crime Model
- Parallels between bycatch and illegal wildlife trade
- Connecting wildlife trade with illegal / militant networks made solving this issue related to a security issue, elevating its importance; we must consider how can we make connections to other government priorities for bycatch
- Raising the importance of the issue led to high level meetings and workshops to increase political will to solve the problem
- Key to WWF success on illegal wildlife trade:
    o Redefine the problem – a marketing problem really; connected it to national security issues.
    o Broaden scope outside of CITES / CMS / etc. at local, regional, and international level; think beyond the environmental sector to other government agencies, international bodies with greater resources.
- Is there a way to link bycatch to some of these issues?
    o We know the problems, we have lots of the solutions. We need to take this to the higher level to tackle the problem.
- Lesson learned: Be prepared for success. Need solutions available and ready in case governments get behind a given idea / policy.

Q & A
- How can we best apply this model to collective action on cetaceans?
    o Look for hooks that appeal to the governments. Can we go through the fishing lobby (e.g. in the case of losing livelihoods because of gear loss)? What will appeal to governments to get the resources we need to address this issue?
- In some oceans, it is still allowed to set nets on dolphins – with a limit- but still allowed on mixed schools of tuna and dolphins. Will these be allowed with deliberate killings of marine mammals?
    o No
- Is the US a good model for other countries? How are these problems tackled in other countries?
    o I.e. Does influencing the 'sec of state' in other countries do anything?
- In developing countries, how to you even begin to solve this problem?

- o Deliberate take of dolphins in nets for crab fishery in Chile – got public involved, got a lot of press, pressure from US government related to trade agreements, but generally bottom up engagement
- o These kinds of changes take a long time and government's change hands too fast to result in something like bycatch being a high priority.
  - Similar thoughts from Brazil. Governments have higher priorities.
  - Sometimes the short time frame of the issue can be beneficial if the administration is trying to solve a problem – moves quickly in those cases.
  - Focusing on the economic value to a country can help raise the profile of conservation of a given species.
- o In the case of ivory trade in Thailand – WWF tackled from within the country while simultaneously visiting their embassies in other countries and at the international level as well. Important to get lots of these issues on the radar and attack them from every direction.
- o In Columbia, lack of information prevented movement forward do even assess the problem prior to actually raising the issue at higher levels.
- o In Peru, success has come from the chef community – using them as vectors for reaching people and communicating the bycatch issue.
- o In Brazil, complex history of environmental and fisheries management. Fisheries management takes place within Dep of Commerce now. As such, fisheries = money and environmental protection takes back seat. Bycatch is a known issue there, but economic development takes priority.

Recommendations

- Quantify economic benefits of MML conservation.
- Use celebrity champions to raise profile of the issue.
- Take advantage of international meetings in your country to make a commitment on the world stage – e.g. IWC meeting in Brazil – what could Brazil commit?
- UN Sustainable Development Goals (SDG) provide a platform for commitments.

Wrap Up Discussion and Brainstorm

- Lots of effort to get noise and ship strikes recognized as threats.
- Bycatch has been around for so long, people are kind of numb to it.
- Maybe some kind of threat competition going on? Acoustics / ship strikes / bycatch….
- Should we be pushing for proclamations from management bodies?
  - o There are tons of resolutions and recommendations. What is key is the organizations that take those and run with it as a platform for doing the work.
  - o In an abstract kind of world, they are important. WTO legal challenges make working unilaterally difficult now (compared to how the US pushed forward on ETP dolphin issue, driftnets, etc.).

- - - From this perspective, it is important to have these kinds of things because it gives international consensus and buy-in.
    - Important to cultivate champions in government and having these pieces of paper are an important start.
- Should try to increase local mitigation efforts in places of concern – focused on bycatch solutions.
- Going to be running into new problems with climate change. Arctic fisheries, for instance, are on the way.
- Two main strategies to tackle this issue – external pressure & internal ground up action simultaneously.
  - MPA goals by 2020 may be one tool in this effort to reduce bycatch.
- World Bank involvement is occurring – specifically on ecosystem management approaches in Africa.
- Need to rebrand 'bycatch' as a continuation of the whaling issue…
- Public – private partnerships can be used to encourage bycatch reduction and provide funding for research and mitigation.
- Need to think outside the box.

5.2 Workshop #2

Development and implementation of low-cost methods to reduce cetacean bycatch in small scale gillnet fisheries

Introduction
- MML Bycatch:
    - Most significant threat to marine mammals, but little research done on the topic
    - Bycatch rates are low, making trend detection difficult
    - In developing countries, particularly difficult given lack of resources
- Goal of workshop:
    - Review low cost bycatch mitigation techniques for small scale gillnet fisheries
        - *Q1: What are available options?*
        - *Q2: What are the ongoing initiatives?*
        - *Q3: What are the 'bycatch hotspots' in developing countries where mitigation trials can be initiated?*
        - *Q4: What are the conditions under which trials should be conducted?*
- Review of outcomes from 2015 SMM Workshop & ID of areas with high cetacean bycatch suitable for trials
    - Looked into low cost methods to reduce bycatch in artisanal gillnets
        - Drafted a decision tree to choose mitigation methods as well as address stakeholder involvement
            - For echolocators and non-echolocators
        - Workshop agreed that SMM needs to increase research in this area and recommended that a paper ID the lack of engagement in this area
        - For this year's workshop, we need to ID locations to conduct trials where bycatch is common and zero-inflated datasets can be avoided if possible. In these places, coordination with fishing communities is paramount.

Q&A
- Which gear modifications were discussed at the last workshop?
    - Mechanical alarms, reflectors, coke bottles, line / link tension
    - The last workshop was less of a thorough review than a sort of catalyst for work on the issue
- How much of bycatch w / MMLs is due to depredation?
    - Only estimate is for pelagic LL fisheries. For small scale fisheries we don't have information.

Case Study Presentations

Examination of pots as an alternative to gillnet gear in a small-scale fishery in NE Argentina

- Gillnet bycatch prevention techniques:
    - Acoustic deterrents, physical modifications to nets, time-are closures, gear switching
        - In small-scale fisheries, time/area closures aren't very effective given low political will and lack of enforcement.
        - There is also little research on the effectiveness of these time/area closures given the need for large size, etc.
        - So perhaps moving away from gillnets is a better approach – if solving bycatch issue with gillnets is not possible?
    - Alternative fishing gear – tested for Franciscana dolphin
        - High bycatch (500-800 per year) in gillnets
        - Gillnets & pots fishing simultaneously next to each other, catch compared
            - Pots reduced bycatch entirely, increased catch quality, similar size classes for most species
            - Could get the same CPUE with pot fisheries as gillnets if 6 pots are used per boat
    - Acoustic deterrents for Franciscana dolphin
        - For various pinger types, significant reduction in bycatch but issues with habituation and effect over time
        - New trial – does a partially pinger-covered net increase bycatch compared to a fully covered one?
    - **Not using glass bottles because the frequencies may increase sea lion depredation
    - Highlighted the use of Bycatch Consortium website

Responding to cetacean entanglement in artisanal gillnets

- Focusing mostly on large cetaceans
- Entanglement occurs worldwide wherever there is fixed gear and whale co-occurrence
    - **Passive / fixed gears are the main issue
    - Drift and grounded gillnets are implicated
- Outcomes from past IWC workshops:
    - Need more data and capacity building focused on prevention
    - Have conducted workshops at local level to train entanglement responders
        - Provides a great platform for outreach and is often requested by fishermen losing expensive gear to cetaceans that have become entangled
- Locations for entanglement studies:
    - Brazil – 40% of fishermen reported entanglements
    - Peru – perhaps one whale entanglement per fisherman per year (~8000 per year nation-wide?)
    - Greenland – Humpback entanglements seem to be increasing
- Possible that un-safe practices are widespread in freeing whales from entanglements

- Need to find low-cost entanglement tools to reduce cost to small scale disentanglement teams
- Mitigation ideas for artisanal gillnets:
  o Switch to lower-risk gear
  o Avoid high-risk areas
  o Weak float lines in combination with anchors
  o Red ropes

Q&A

- Drift gillnets banned in Norway after taking lots of harbor porpoises
  o Some fishermen reported catch and live release of these animals if the nets were floating. This was never reported for sinking nets.
- Re switching to pot gear- how does this affect entanglement risk?
  o In places where whales don't occur, switching to pots can be really effective
  o But need to consider leatherbacks and other species as well.
  o Also, even with the risk posed from ropes attached to pot gear, the risk posed by gillnets is even higher to large whales.
  o Fishermen like switching to pots from nets because during bad weather you can go home and leave them out.
  o Given government push for gillnet avoidance, pot gear may be a good alternative.
    ▪ Cod pots in Norway are one case of this being done, but avoiding seal predation and bycatch is important. Requires stronger construction of the pots.
- Pinger effectiveness / effects?
  o In many fisheries, pingers could be useful. In deployment and methods, the simpler the better.
  o Trials with acoustic deterrents have reduced bycatch of Franciscana dolphins (Bordino et al., 2002).
  o Pingers reduce cetacean bycatch either by an 'alert' or a 'spook' effect. The effect depends on the cetacean species.
  o Some large whales are curious and could be drawn to fishery gear with pingers.
  o Is there a difference between pinger effectiveness related to depth of deployment?
    ▪ Complex question – really depends on type of pinger and local conditions.
- Explanation of why reduced number of pingers leads to higher catch rates of MMLs?
  o In some studies, increased harbor porpoise bycatch results from bad spacing of pingers or a failed pinger along a net – results in a 'dead' area that seems OK to swim through but is not.
  o Multiple studies on spacing are occurring.
    ▪ 100 m spacing and 400 m spacing are equal in effectiveness in a study in Denmark (Larsen et al., 2013)
    ▪ Another study reducing harbor porpoise bycatch – 200m spacing seems to be effective as well
- Small scale fisheries are often overcapitalized / open access. Reducing the gear in the water from this angle will reduce bycatch as well.

- Is there a motivation in the Franciscana fishery to reduce bycatch?
  - o Fishermen don't want to kill them and they tear holes in nets, but most importantly fishers are catching fewer fish and sea lions are taking more of what they do catch.

Recycled bottles offer potential low-cost solution to marine mammal bycatch

- Bycatch in gillnets identified and agreed as the most significant threat to marine mammals, still little effort is made to mitigate the issue.
- In Zanzibar, population of bottlenose dolphins impacted by tourist activities, fisheries, etc.
- Bycatch mortality of 10% estimated per year in driftnets (0.02 dolphins / haul).
  - o Trials with pingers reduced the bycatch but haven't been implemented (Amir, 2010).
    - ▪ Cost has been barrier to getting this done ($50-80 per 100m net for currently available electronic alarms).
  - o To mitigate, need cheaper options that don't change the catch of target species.
    - ▪ Alternative: glass bottles at $0.2 per 100 m net.
      - • Similar sound produced from the bottle device as a Fumunda 10 kHz pinger, but a bit broader.
    - ▪ Alternative: plastic bottle sound reflector
      - • Perfect sound reflector from the air bubble inside the bottle.
      - • 100-1000 fold increase in target strength compared to gillnet material
- Experiment: do bottle alarm / reflectors reduce dolphin bycatch in driftnets
  - o Trial with onboard observers comparing nets with glass bottles (400 sets), nets with plastic bottles (310 sets) and control nets (400 sets) with no bottles
  - o No dolphin bycatch in any nets during trial (expected dolphin catch in control nets was 8), so impossible to detect effect of bottles
  - o Target species: no difference in catch
    - ▪ Dolphins were present in the area during the trial
    - ▪ Not enough power
    - ▪ Possible that driftnets with glass bottles affected control nets
  - o Fishermen happy to use, gear is cheap, offers a good possible solution but need the data to back it up.
- Low-cost light development:
  - o Can be used in combination with bottle alarms / reflectors to reduce megafauna bycatch
  - o Cheap (<$1)

Q&A

- Possible to mark each set with GPS to get spatial analysis?
  - o Yes, ideally with a smartphone app.
- Is this research continuing?

- o Yes, additional trials underway in Kenya and planning trials in other areas
- Has density of animals in the area changed since surveys?
  - o Not according to available population size estimates
- Are the coke bottles at the surface for any reason?
  - o Have test on bottom as well. The bottles do work at the bottom (depending on depth). And place the bottles vertically with bolt suspended as a pendulum to increase acoustic signal compared to horizontal alignment.
- Any increased bycatch of other species with these bottles?
  - o Not indicated in the data from the trial.
- Suggestion for plastic bottles- crumple bottle to increase acoustic signal.
- Trials conducted in shallow waters (e.g. seagrass habitats)?
  - o No trials in shallow water. These have been done at 50 m. Could be really helpful to go shallow and test for dugongs.
- How long until you need to replace bottles?
  - o Quite durable bottles and very easy and cheap to make.
- Any financial incentives for fishermen participating in trials? What made them participate?
  - o Did offer some money. $5 to observer, $2 to fishermen for working with them.
  - o Could do a lottery for the fishermen as well to increase participation.
- Change in catch rates for elasmobranchs?
  - o Unsure for now- need to analyze, but the sharks are target species so the fishermen would be happy.
- How does the weather change the applicability of the bottles?
  - o Hard to say, need to figure out if they work in general before looking at effect of sea state.
  - o In bad weather, could just put the bottles on the gillnet lead-line.
  - o Study with pingers and harbor porpoises showed that in rough weather, the acoustic signal from the pingers was too weak to change porpoise behavior given the high background noise of wave action, etc.
- Could look at configurations of acoustic devices (bottles / pingers / etc.) on the behavior of porpoises in San Francisco waters.
- Are all species easily deterred by pingers?
  - o For porpoises, yes, for others not sure. Would be useful to know whether narrow band high frequency pingers are the right configurations for various species (e.g. Franciscana dolphins).
  - o Some studies on different dolphin species around the world with variable effectiveness.
    - ▪ Reactions to predators and different sounds are species-specific in large whales.
- Are there effects of season x species? If animals are on their way to feed, then perhaps they ignore the pingers… is the cetacean behavioral response situation dependent?
  - o Can test some of this in Chile. What are seasonal / species-specific / etc. effects?
- Are there detrimental impacts to animals using pingers?

        o   Potential habitat exclusion as a result.

Discussion: Creative methods for supporting bycatch mitigation

- Species-specific responses make mitigation efforts challenging.
    - o Need to consider the species that you test as well as the mitigation device.
    - o Can't assume that noise will work for dugongs / humpback whales / etc. Some good reviews (Dawson 2013) are a good place to start for thinking about the right tool for the right species.
- In Baltic Sea, mitigation device that synthesized harbor porpoise sounds used in a study that had trouble working with fishermen – they didn't want to participate in a study that may lead to difficulty for fishermen. Need lots of time to build up collaboration.
- For large whales, there is financial incentive to solve these problems in some places (e.g. Brazil).
- In Zanzibar, there is incentive to work with scientists to reduce bycatch given the benefits of dolphins to the community through ecotourism.
- If mitigation is possible in Peru with humpbacks, could take lessons learned there and apply them to Arabian Sea population.
- Area avoidance effects of acoustic alarms are variable by species and location.
    - o Different environmental conditions affect pinger effectiveness maybe even more than species. (probably an effect of the interaction between species and habitat…)
- Harbour porpoise bycatch in lumpfish gillnet fishery – need methods to reduce bycatch and could be opportunities to test effectiveness there.
- GAME project and or Ocean XPrize can encourage finding solutions for a given issue in many places.
- US MMPA Import Rule provides a push for solving these problems quickly.

Discussion: Lessons from elsewhere

- Acoustic cat's eye effects on harbor porpoise bycatch reduction. Looking at the attention of porpoises to these devices and saw minimal effects, but a promising idea. Could redesign floats that still float and also provide acoustic reflection. No promising results so far.
- In Norwegian fisheries, in deep water, can't use things like coke bottles. Instead, pingers are a better option as harbor porpoises do respond to these. Need to increase reliability of pingers as well as lifespan with a focus on the attachment method and housing durability (not the electronics themselves).
- In Europe (Baltic Sea Information Center), bycatch was reduced by working with fishermen to fish less during target seasons but could continue fishing during those seasons if they used bycatch mitigation devices as a part of ongoing research on their effectiveness. This process took years.
- When getting techniques from one place to another, can use fishermen to communicate ideas to other fishermen.

- In the US, when fishing techniques are developed in one area, then you try to transfer it to a new location, the fishermen there are resistant to adopt the measures.
  - Important to test devices in different areas with different species (to ensure fish catch in those areas with different target species is not affected).
    - Are there enough resources to do this?
      - Perhaps using smartphone technology…
      - There is variability even boat-to-boat as well, which requires coaching on the personal level.
  - What have fishermen said when asked about how to convince them to participate?
    - Mixed bag (country / fishery / situation). In US, fear of regulation is a reason to avoid this kind of work. Incentives are more effective than top-down regulation. In some fisheries, fishermen have come up with ways to reduce bycatch on their own.
- Hard to jump to bycatch mitigation when we don't know what species are affected and where… in Cambodia, need a method for rapid assessment of bycatch to provide some foundation for future work and implementation.
  - Social surveys may be the quickest and easiest way to get the data that is needed to have a starting point pre-mitigation.
  - In Vietnam, estimation of uncertainty in distribution models underway based on habitat models used in risk assessments of bycatch interactions. Could be effective to come out of a spatial modeling process that narrows down the types and frequency of surveys needed to collect data on distribution.
- In Pakistan, lowering of gillnets could provide a solution to MML bycatch? Bycatch rates seem to go down when the nets are lowered. Animals often entangled in the very top of the gillnet, so lowering them could be effective.
  - Catch rates of target species hasn't changed.
  - Found exactly the same on Bay of Biscay fisheries where dropping headline of the gillnets may have reduced bycatch and not affected target catch. Could be applied to tuna gillnet fisheries all over.
  - Need this kind of information to be available (maybe through bycatch.org?).
    - Bycatch.org is a collective effort – upload your own studies and reports to the website whether it is peer-reviewed or not.
    - Could send this to MARMAM to request information?
- Have any buyouts of gillnets been effective?
  - In some places, where enforcement works well, it is possible (Mekong River).
- Lotteries are fun for fishers, free of moral content, provide a vehicle for education, and can encourage compliance without regulation. A possible avenue for future work.
- In some places, where depredation is a huge problem, it just isn't worth fishing with gillnets. Alternative gears that increase the catch value of target species could provide incentives to switch gears.
- Community outreach and citizen science can be quite effective at reducing this effort.
- After the introduction of pingers in a drift gillnet fishery, bycatch of beaked whales went to zero while bycatch of sperm whales was reduced but not significantly.

Funding opportunities

- NGO and animal welfare sources
- GEF funding (global environmental facility)
- IWC?
    - There are small pots available and bycatch coordinator may be helpful in developing these activities
    - https://iwc.int/homeMarine
- Marine Mammal Commission
    - https://www.mmc.gov/grants-and-research-survey/current-funding-opportunities/research-program-small-grants/
- Video game apps / outside of the box thinking to raise funds
- National Science Foundation think tank
    - https://www.sesync.org/
    - Can fund workshops and meetings to plan and develop research that is cross-disciplinary
- New England Aquarium opportunities through NOAA funding
    - For supporting marine mammal bycatch mitigation
- Need to think broader to get big pots of money instead of all working independently with small grant funds. Could maybe work on a global scale to find solutions through a large group of collaborators working under umbrella funding. Could tie in assessment as well in data-poor regions.
- MSC certifications:
    - NGOs have been coming together to help address bycatch issues across taxa. Could use MSC contacts to develop large scale collaboration.

Options / Toolbox

- Acoustic alarms
- Gear switching
- Reflectors
- Time area closures
- Disentanglement

Future actions / Recommendations

- Interested in using bycatch.org to help facilitate future actions.
- Need to better understand how to get solutions implemented in the fisheries.
    - Need more economists and social scientists involved in this process / a multidisciplinary effort.
        - Convening a group with folks from all different backgrounds can result in a broader approach to solving the issue of bycatch.
    - Need to know how to convince policy-makers to implement solutions as well.
    - Already have information, but need to know how to use it more effectively.

- - - Market-based approaches are a good option. Leverage public and consumer support to influence government and the market while engaging with fishermen simultaneously – bottom up and top down approach.
    - Bycatch.org could provide a platform for this vital collaboration.
- Need to look at outcomes of our work. Are we effective? Are we doing this correctly?
- Before jumping in to mitigation and going big, we need to know what methods are effective and where.
- Would like to test effectiveness of glass bottles from a behavioral perspective – how does it affect movements of cetaceans?
    - Highlighted for San Francisco Bay. Field trials would be helpful.
- Should IWC create a toolkit for artisanal fishermen disentanglement (removal of live animals entangled in fishing gear) of megafauna like whales?
    - Who would be responsible if it goes wrong (and who is responsible if something goes wrong without any training…)?
    - If we develop a toolkit for small cetacean removal, could get it approved by IWC to get 88 stamps of approval in one go.
- Should IWC include small and large cetaceans in entanglement workshops with fishermen?
    - Yes, because fishermen are attached to the net (driftnet) as it fishes. If you catch a dolphin as bycatch, release it.
    - Would be good to have an easy to follow protocol for releasing small cetaceans available.
    - For dugongs, Japanese government held workshops with life size models to show fishermen how to safely release animals.
- A decision tree for which mitigation devices to use would be helpful, especially for which pingers to use. Develop decision trees further and highlight this in the report from the workshops here.

5.3 Workshop #3

Catching the right fish

Introduction

- Goal:
    o With limited data, what can we accomplish related to bycatch assessment?
- magnitude of bycatch problem is growing
- Difficult to address given shortage of various data series
- Creating risk assessments to understand spatially explicit risk of bycatch interactions with marine mammals
    o BYRA (bycatch risk assessment) toolbox is the output
    o www.mmbycatchtoolbox.org
        ▪ Process:
            1) Gather and compile data
                a. Carefully consider the uncertainty within the data using a stoplight approach (green = confident, red = lots of uncertainty)
                b. On fishing activity (effort & gear), species abundance and distribution (Maxent software), habitat suitability based on previous modelling efforts, bycatch & stranding data
            2) Analyze bycatch risk
                a. Using database tool and geographic information systems (GIS) spatial overlays
            3) Map the risk outputs from the toolbox
                a. Based on exposure to various gear types associated with varying levels of risk
                    i. Gear-type specific overlays for each species
            4) Investigate data uncertainty with maps that highlight areas of data needs
    o Important given MMPA Import Rule. Possibility for collaboration with Monterey Bay Aquarium Seafood Watch

Case Studies: Thailand, Vietnam, Malaysia – What data are available?

Marine mammal status in the Eastern Gulf of Thailand

- Records of strandings, aerial survey data, fishing effort data, etc.
    o 10% of strandings due to bycatch interactions, seems to be increasing over time
    o ~30% can't tell cause of death because of decomposition
    o Most carcasses are ~90% decomposed

- Toolkit provides a way to take all of these data and put them together into something useful
- Thailand situation isn't particularly data-poor, has the most data of current field sites.

Q&A

- How has this been developed?
    - Through a network of municipalities, tourism activities, fishermen, workshops, phone apps, etc.
    - Workshops train 'first responders' in MML first aid
- What are the MMLs used for?
    - Not for bait or anything really- reports of strandings almost always go to the stranding network teams
    - Not the same story for the Indian Ocean, where the MML bycatch is used as shark bait
- How do you identify whether a stranding is due 'bycatch' interactions?
    - Using information based on gear type / net marks / hemorrhage
- *There is a change in perception in Eastern Africa. New generations are forgetting about dugongs as they are less frequently seen. So, the new generation doesn't show interest in the meat.*

Vietnam

- General lack of data on cetaceans or bycatch in the area
- Data on species abundance / distribution comes from:
    - Boat-based surveys, interviews, whale temples (presence / absence), social media
- Data on fishery:
    - Surveys and government reports
- Bycatch data:
    - From interviews
    - All interviewers recorded bycatch within last five years, with finless porpoise and Irrawaddy dolphins most common species
- Role of bycatch toolbox at this site:
    - With little information, how to base management decisions?
    - Can help establish conservation priorities, etc.

Q&A

- What are local regulations for use of these bycatch animals?
    - No regulation for what to do with the bycaught animals
    - Local village control what happens with them
    - Some local respect of whales / worship and so may not bring home
    - Other places – may bring home to eat – unlikely to use for bait
    - *Some changes with the new generation forgetting about the tradition of respect/worship, so they seem to be more inclines to use dolphin meat. Long has never heard about the use of dolphin meat as bait.*

Sarawak, Malaysia

- Dolphin watching tours at this site
- Mosaic of habitats across the area, varying levels of protection (national parks / fishing activity / etc.)
- Data available:
    o Mark-recap and line-transect distance techniques both used for abundance estimates
    o Fishing activity data on encountered rates of various gear types
    o Strandings have increased in recent years.
- Stressed importance of local collaboration with fishermen to get data on interactions
- Challenges:
    o Government resistance to acknowledge bycatch problem
    o Current reports of bycatch interactions are lacking for much of the coast. Based on reports in the area of study, they are underreported nationwide.
    o Need support – no marine mammal veterinarians for instance.
- Bycatch toolkit will allow a framework for working on assessing bycatch.

Q&A

- When comparing bycatch rates between fishermen declarations from surveys, can assess bycatch rates that aren't much different from those generated from observer programs. Could this be replicated elsewhere?
    o Can be difficult in some areas.
- What other options are there?
    o Public participation GIS
    o Fishermen surveys
    o This toolkit
    o Ask fishermen to take photos
- *Discussion regarding the consequences of too many surveys: In some places (Africa, Brazil) it seems that fishermen are fed up with surveys as they don't receive feedback. Also in Brazil after numerous years of surveys, the government made drastic changes that effect the fisherman negatively without discussion. Now fishermen think the government made this decision based on the analyses of the survey, so they don't want to do other surveys. It seems that taking the time to present the results/consequences on the survey to the fisherman is highly important so as not to lose their participation in the long run.*

The bycatch toolbox: data inputs & analysis steps

- Four step procedures:
    o Where are the animals likely to be?
        ▪ Sightings data (not mandatory)
        ▪ Environmental data
            • Distance to coast / distance to river mouth / bathymetry / SST / salinity / prey data

- These data can come from various sources and assigned a level of uncertainty
- Data is then processed with GIS / MaxEnt / more complex options
- **If you don't have variables for one place, can choose to use data from elsewhere and assign a given level of uncertainty.
  - Where are the fishing gears likely to be?
    - Often collected during marine mammal surveys – where are traps / where are boats? Take what you can get.
  - BYRA Criteria
    - Exposure
    - Consequence sensitivity (consequence of exposure – based on severity of interaction and life stages affected by gear)
    - Consequence resilience
      - Age at maturity, reproductive strategy, population connectivity, local status of species (if none, enter 0)
      - Weight each of these by gear type for each species

Data Session

Objective:

Initiate the identification of data gaps and data needs to better assess the risk of bycatch in your working area. Within each group share your experiences, what you have, what is missing, what you need. We will try to have mixed groups in term of data availability and regions.

- Groups:
  - **Mexico:** bottlenose dolphin, compared between an MPA and non-MPA
  - **African countries**: various countries / various bycatch species
  - **Brazil:** Franciscana dolphin

Each group had to work on (see Material at the end of the minutes):

- Identifying their data and data gaps
- Think of their exposure/consequence factors for ByRA
- Complete Teh et al. (reference: Teh SLL, Teh CLL, Hines E, Junchumpoo C, Lewison R. Contextualizing the coupled socio-ecological conditions of marine megafauna bycatch. *Ocean and Coastal Management* 116: 449-465) score, examine and compare resulting plot.

Recommendations

- Conference / workshops / interviews with fishermen present related to the issues of importance in a given area.
- E.g. have MML conference invite fishermen in a fishery of concern (vaquita / NARW / boto / etc.)

- Teh et al session:
    - In some places, must consider that these separate factors are limiting in some places and enabling in other places. Would be helpful for the user to decide if a given factor is limiting or enabling.
    - People entering these values should probably define categories together, then enter in their values independently, then average it all out. Or something like that…
    - Could sit down with folks from Fisheries Department / Fishermen / Scientists / NGOs / general public etc. and then combine these data with community based mapping.
    - Good tool to use at the beginning of workshop. Good to compare different perceptions.
    - Could also do scaling of categories…
    - Could add a row in the Teh et al. worksheet regarding:
        - whether industrial and small-scale fisheries overlap as it could be an important factor.
        - Add temporal element – night v day influence.
    - Resulting plot (see material below) very informative and quickly gives a picture of the situation.
    - Please send us data.
- ByRA scoring system:
    - When scoring system contains categories such as high, medium, low, make sure to clearly mention that people will have to describe what they mean when using these criteria as precisely as possible.
- Next step- look more into uncertainty of how reliable these outputs really are. What kind of training / what kind of funding do we need as we move forward?

Bottom Line
- Toolkit can be used to inform decision making based on risk of bycatch and all the inputs to the datasheets.
- Highlights data gaps as a part of the process.
- Next steps: need to gather data from various regions of the world and identify gaps in what we need for bycatch mitigation – goal for a publication with Ellen (increase collaboration among group and outside but be sure to define how each category is broken up).
- Toolkit can be used to increase collaboration with fishermen through better communication, etc.

6. APPENDIX II: AGENDAS & WORKSHOP REGISTRANTS

6.1 Workshop #1

Saturday, Oct 28, 2017
Organizers: Rebecca Lent (Marine Mammal Commission) & Leigh Henry (WWF)

AGENDA

Saturday, October 28th

Halifax World Trade & Convention Center

Room 200 C2

8:30-9:00 Welcome and Overview – **Randy Reeves,** Okapi Wildlife Associates & Chair, IUCN/SSC Cetacean Specialist Group

9:00-10:30 *PANEL 1* **Addressing the Challenges – Case Studies in Assessments and Mitigation of Marine Mammal Bycatch** Presentations and Q&A/Discussion; FACILITATOR: Rebecca Lent

9:00-9:45

- o Models and toolkits in data poor situations - **Ellen Hines**, San Francisco State University
- o Using predictive habitat models to help reduce marine mammal bycatch - **Nicholas B. Sisson**, Old Dominion University
- o New tools for confronting marine mammal bycatch in fixed gear fisheries—**Tim Werner**, New England Aquarium

9:45-10:30

- o Zanzibar dolphin bycatch assessment and mitigation – **Per Berggren**,

- o Bycatch Assessment & Mitigation in Peruvian Small-Scale Fisheries **-**

- o Resolving Bycatch Challenges in a Riverine Environment: Mekong River Dolphins –**Lindsay Porter**, The University of St. Andrews

10:30-11:00 Break

11:00-12:30 *PANEL 2* **Incentivizing Solutions to the Challenges** Presentations and Q&A/Discussion; FACILITATOR: David Mattila

- Overview of incentivizing tools: transferable bycatch quotas, payments for ecosystem services, market access, labeling schemes – **Rebecca Lent**, U.S. Marine Mammal Commission
- Case studies:
  - Understanding the New MMPA Import Rule, the Implications & the

  - Market incentives for Vaquita Conservation – **Oriana Poindexter**, OAI,

  - Lessons from the Alaska pollock and Atlantic pelagic longline bluefin tuna fisheries **– Rebecca Lent,** U.S. Marine Mammal Commission

12:30-2:00 Lunch

2:00-3:00 *PANEL 3* **Supporting Solutions to the Challenges through International Agreements and RFMOs** Presentations and Q&A/Discussion; FACILITATOR: Leigh Henry

- What is being and should be done by intergovernmental organizations to reduce marine mammal bycatch?
  - Indian Ocean Tuna Commission (IOTC) - **Jeremy Kiszka**, Florida International University
  - Convention on Migratory Species (CMS) ACCOBAMS- **Simone Panigada**, Chair, ACCOBAMS Scientific Committee & President, Tethys Research Institute
  - International Whaling Commission (IWC) – **David Mattila**, International Whaling Commission

3:00-3:30-Break

3:30-4:30 *PANEL 4* **– How Have We Successfully Put All the Pieces Together to Drive Meaningful Conservation Progress?** Presentations and Q&A/Discussion; FACILITATOR: Rebecca Lent

- Tuna Dolphin – **Kate O'Connell**, Animal Welfare Institute
- Driftnet Ban – **Mike Gosliner**, U.S. Marine Mammal Commission
- Driving Political Will: Wildlife Crime Model– **Leigh Henry**, WWF

4:30-5:00 **Wrap Up Discussion and Brainstorm** – Solving the Bycatch Puzzle: How Can We Put All the Pieces Together to Drive Meaningful Conservation Progress on Marine Mammal Bycatch?

REGISTRANTS

Simon Allen

Per Berggren

Arne Jostein Bjoerge

Bill Braulik

Elizabeth Campbell

Daniel Danilewicz

Rob Deaville

Carolyn Doherty

Camila Domit

Ana Maria Garcia-Cegarra

Michael Gosliner

Leigh Henry

Francine KershawJeremy Kiszka

Melissa Landry

Rebecca Lent

Kristy Long

Jay Lugar

Ellie MacLennan

Sarah Mallette

David Mattila

Cathy Merriman

Kristen Monsell

Kate O'Connell

Sylvan Oehen

Paulo Ott

Simone Panigada

Monica Pepe

Randall Reeves

Macarena Santos-Carvallo

Maritza Sepulveda

Prem Sarup Sharma

Kara Shervanick

Nick Sisson

Brendan Talwar

Timothy Werner

6.2 Workshop #2

Sunday, Oct 29, 2017

Organizers: Per Berggren (Newcastle University) and Jeremy Kiszka (Florida International University)

AGENDA

Development and implementation of low-cost methods to reduce cetacean bycatch in small scale gillnet fisheries

Date, time & location: Sunday 29 October 2017. 08:30-12:00. **Room 203.**

Organizers: Per Berggren (Newcastle University, UK) & Jeremy Kiszka (Florida International University)
Contact email: per.berggren@ncl.ac.uk and jkiszka@fiu.edu

8:30-08:50   **Introduction (**Per Berggren & Jeremy Kiszka)
- Welcome, housekeeping & appointment of rapporteurs
- Review Workshop Agenda & Terms of Reference

Case study presentations (12 minutes + 8 minutes questions for clarifications)

08:50-09:10   **1. Review the outcomes of the 2015 SMM Workshop + Identification of areas with high cetacean bycatch suitable for trials**
Per Berggren & Jeremy Kiszka

09:10-09:30   **2. Examination of pots as an alternative to gillnet gear in a small-scale fishery in northeastern Argentina, and up-dates on pinger studies.**
Tim Werner (New England Aquarium, US)

09:30-09:50   **3. Methods to disentangle live small and large cetaceans in gillnets**
David Mattila

09:50-10:10   **4. Development and trials of glass and plastic recycled bottle alarms and acoustic reflectors**
Per Berggren

10:10-10:30   **Coffee break**

Round table

10:30-11:00   5. Creative methods for supporting bycatch mitigation

11:00-11:30   6. Development of collaborative international research proposals and possible funding options

11:30-12:30   7. General discussion and agreement on strategy to move forward

REGISTRANTS

First Name	Last Name	Email	Country
Jeremy	Kiszka	jeremy.kiszka@gmail.com	United States
Maitha	Al Hameli	maitha.alhameli@ead.ae	United Arab Emirates
Per	Berggren	per.berggren@newcastle.ac.uk	United Kingdom
Arne	Bjoerge	arne.bjoerge@imr.no	Norway
Boris	Culik	bculik@fh3.de	Germany
Daniel	Danilewicz	daniel.danilewicz@gmail.com	Brazil
Camila	Domit	cadomit@gmail.com	Brazil
Swapnali	Gole	swapnali@wii.gov.in	India
Dennis	Heinemann	dheinemann@mmc.gov	United States
Ellen	Hines	ehines@sfsu.edu	United States
Elizabeth	Hogan	ehogan@worldanimalprotection.org	United States
Lynn	Kavanagh	lynnkavanagh@worldanimalprotection.ca	Canada
Tina	Kesselring	tinakesselring@aol.de	Germany
Jan	Lakemeyer	Jan.Helge.Carl.Lakemeyer@tiho-hannover.de	Germany
Rebecca	Lent	rlent@mmc.gov	United States
Sarah	Marley	sarah.marley86@gmail.com	Australia
David	Mattila	david.mattila@iwc.int	United States
Kristen	Monsell	kmonsell@biologicaldiversity.org	United States

Kate	OConnell	kate.oconnell@balaena.org	United States
Paulo	Ott	paulo.henrique.ott@gmail.com	Brazil
Macarena	Santos-Carvallo	msantos@eutropia.cl	Chile
Maritza	Sepulveda	maritza.sepulveda@uv.cl	Chile
Brendan	Talwar	btalwar@mmc.gov	United States
Nick	Tregenza	Nick.Tregenza@chelonia.co.uk	United Kingdom
Bianca	Unger	Bianca.Unger@tiho-hannover.de	United States
Tara	Van Belleghem	vanbelleghemtara@gmail.com	Brazil
Long	Vu	long.vu.192@gmail.com	Vietnam
Timothy	Werner	twerner@neaq.org	United States
Linda	Westphal	linda.westphal@meeresmuseum.de	Germany
Noel	Wingers	noel.wingers@gmail.com	United States

6.3 Workshop #3

Sunday, Oct 29, 2017

Organizer: Ellen Hines (San Francisco State University

AGENDA

- 1330-1345 Greetings and background of our project and toolbox

- 1345-1415 Presentations from three of our field sites: the eastern Gulf of Thailand, Kien Giang Biosphere Reserve, Vietnam, and Kuching, Sarawak, Malaysia

- 14:15-14:40 Presentation of inputs and model results for our present field sites

- Break for 20 minutes

- 1500-1600 In mixed groups of workshop delegates, we will determine data gaps, needs, and commonalities, such as needs for training, outside consultants, regional workshops, funding or technology. (Please see the attached Data Session guidelines)
  - including 15 minutes for group presentations

- 1600-1645 In groups, evaluate each site represented using interdisciplinary methods as found in Teh et al (2015) to determine how socio-cultural and economic dynamics contribute to bycatch locally (Please see the Table 1 in Teh et al)
  - including 15 minutes for group presentations

- 1645-1730 Discussion of differences/commonalities, should there be regional groups working together? What is the need for this kind of place-based structure? Discussion on output/journal article.

REGISTRANTS

Presenters: Ellen Hines, Weerapong (Mac) Laovechprasit, Cindy Peter, Long Vu, Marjolaine Caillat

Participants:

Per	Berggren	United Kingdom
Alejandro	Buren	Canada
Camila	Domit	Brazil
Swapnali	Gole	India
Michael	Gosliner	United States
Dennis	Heinemann	United States
Lucy	Keith Diagne	Senegal
Jeremy	Kiszka	United States
Sarah	Marley	Australia
Kristen	Monsell	United States
Eduardo	Morteo	Mexico
Paulo	Ott	Brazil
Daniel	Schiavon	Brazil
Brendan	Talwar	United States
Tara	Van Belleghem	Brazil