August 2018

2017-2018 Summary of research undertaken as part of the COLTO project on whale depredation on Patagonian toothfish longline fisheries in the Southern Ocean.

A. Data provided to Paul Tixier

Fishing and whale observation data

- Chile: 2006-2016 received from IFOP (Renzo Taschieri)
- Falklands (Fl): 2003-2016 received from Alex Blake
- Prince Edward and Marion Islands (PEMI): 2002-2018 received from Capfish (Chris Heineken)
- Crozet/Kerguelen: 2003-2016 received from MNHN
- Heard and McDonald Islands (HIMI): 2011-2016 received from AAD
- South Georgia (SG): raw data not received but Paul Tixier travelled to CEFAS (UK) in January 2018 to provide Karin Olsson (working with Marta Soffker) with the codes to process the data.

Photo-identification data

- Chile: 2017 received from Eduardo Infante
- Fl: no data
- PEMI: data from 2011 and 2014 received from Chris Heineken through Nicolas Gasco
- Crozet/Kerguelen: 2003-2017 received from MNHN
- HIMI: 2011-2017 received from Rhys Arangio
- SG: 2007-2016 received from Marta Soffker and Jared Towers

B. Analyses completed

i) Scientific paper submitted to Scientific Reports (August 2018):

"Commercial fishing patterns influence whale-vessel interaction levels in the Southern Ocean"
Paul Tixier, Paul Burch, Gaetan Richard, Karin Olsson, Dirk Welsford, Mary-Anne Lea, Mark A. Hindell, Christophe Guinet, Anais Janc, Nicolas Gasco, Guy Duhamel, Maria Ching Villanueva, Lavinia Suberg, Rhys Arangio, John P.Y. Arnould

Key results

- Large variations of whale interaction levels with fisheries in the Southern Ocean (Chile, Falklands, South Georgia, PEMI, Crozet, Kerguelen and HIMI), with the highest levels recorded at Crozet
- Interaction levels have remained globally stable over the last 15 years. They decreased in Chile for both killer and sperm whales, and increased in the Falklands for sperm whales.
- Fisheries operating in winter less likely to experience sperm whale depredation
- The size of fishing areas, density and mobility of vessels, depth and type of gear influenced interaction levels but other unidentified area-specific factors also contributed to between fisheries differences in interaction levels

ii) Scientific paper published in Marine Mammal Science (January 2018):

"First demographic insights on historically harvested and poorly known male sperm whale populations off the Crozet and Kerguelen islands (Southern Ocean) interacting with longline fisheries."

Guillemette Labadie, Paul Tixier, Christophe Barbraud, Remi Fay, Nicolas Gasco, Guy Duhamel, Christophe Guinet.

Key results

- Total of 295 sperm whales identified as depredating off Crozet and Kerguelen
- Only 1% of these individuals observed in both locations, suggesting segregated populations
- High site fidelity of individuals over years, some being observed interacting with vessels within a 100 km range over periods of 9 years

iii) Scientific paper published in Fisheries Research (April 2018):

"How do fishing practices influence sperm whale (*Physeter macrocephalus*) depredation on demersal longline fisheries?"
Anaïs Janc, Gaëtan Richard, Christophe Guinet , John P.Y. Arnould, Maria Ching Villanueva, Guy Duhamel, Nicolas Gasco and Paul Tixier

Key results

- Sperm whale depredation on the catch increased with the soaking time of longlines, suggesting depredation occurring before hauling
- The probability of vessels to experience sperm whale depredation dropped when vessels travelled over 60 km from a fishing area with depredation.

iv) Scientific paper published in ICES Journal of Marine Science (September 2018):

"Movements and dive behaviour of a toothfish-depredating killer and sperm whale"
Jared Towers, Paul Tixier, Katherine A. Ross, John Bennett, John P.Y. Arnould, Robert L. Pitman, and John W. Durban

Key results

- Tagged killer whale and sperm whale readily travelled >300 km to interact with a vessel on multiple occasions
- The killer whale dove to 1100 m deep when depredating on a longline during hauling
- The deeper the longlines at the bottom, the deeper the sperm whale dove when in the vicinity of longlines during non-hauling phases, suggesting depredation during soaking.

v) Scientific paper submitted to Ambio (July 2018):

"How to assess interactions between odontocetes and demersal longlines at depth? First evidence of sea-floor depredation during soaking time"
Gaëtan Richard, Julien Bonnel, Paul Tixier, John P.Y. Arnould, Anaïs Janc, Christophe Guinet

Key results

- Evidence of sperm whales interacting with longlines at the bottom at depths >1500m from accelerometers deployed on the gear.
- Possible killer whale interactions with longlines at the bottom at depths of around 500m

vi) Scientific paper submitted to ICES Journal of Marine Science (September 2018):

"Assessing the importance of fish depredated from fisheries in the natural diet of a generalist killer whale (*Orcinus orca*) population"

Paul Tixier, Joan Gimenez, Ryan Reisinger, Yves Cherel, Paula Mendez Fernandez, John P.Y. Arnould, Christophe Guinet

- Evidence of Patagonian toothfish being part of the natural diet of killer whales
- Limited differences in diet between depredating and non-depredating killer whales, suggesting that depredation is a facilitated behaviour, not an artificial behaviour.

C. Ongoing analyses

Estimation of the amount of toothfish lost to depredation (to be completed December 2018).
Paul Tixier (for Chile/FI/SG/PEMI), Paul Burch, Simon Witherspoon, Dirk Welsford, Philipp Ziegler, Lavinia Suberg, Ching Villanueva, Rhys Arangio, John Arnould

- Development of generalised spatial models as a tool to accurately estimate the annual amount of toothfish taken by killer and sperm whales when depredating

Fine scale assessment of the efficacy of trotlines equipped with cachaloteras as a mean to reduce depredation (to be completed December 2018)
Paul Tixier (for Chile/FI/SG/PEMI), Paul Burch, Lavinia Suberg, Ching Villanueva, John Arnould

- Use of the PEMI fishery as a case study to estimate the effect of depredation on catch rates across fishing gear types (spanish, trotlines, trotline with cachaloteras) through fine scale models.

Predicting the occurrence of depredation in space and time from environmental conditions in the Southern Ocean (to be completed November 2018)
Paul Tixier, Paul Burch, Gaetan Richard, Karin Olsson, Dirk Welsford, Mary-Anne Lea, Mark A. Hindell, Christophe Guinet, Anais Janc, Nicolas Gasco, Guy Duhamel, Maria Ching Villanueva, Lavinia Suberg, Rhys Arangio, John P.Y. Arnould

- Use of habitat models to identify the environmental conditions increasing or decreasing the likelihood of vessels to experience depredation

Estimating the abundance the number of depredating whales in fisheries of the Southern Ocean (to be completed March 2019)
Paul Tixier, Dirk Welsford, Mary-Anne Lea, Mark A. Hindell, Christophe Guinet, Nicolas Gasco, Guy Duhamel, Maria Ching Villanueva, Lavinia Suberg, Rhys Arangio, John P.Y. Arnould

- Processing the photo-identification datasets and developing capture-mark-recapture models to estimate the number of individuals interacting with vessels in each fishery.

Identification of the factors influencing the detectability of fishing vessels (to be completed January 2019)
Gaetan Richard, Julien Bonnel, Paul Tixier, John P.Y. Arnould, Christophe Guinet

- Determining the acoustic signature of vessels and aspects of this signature more likely to make vessels detectable by the whales
- Investigating the distance at which sounds produced by vessels can be detected by whales depending on the way skippers use the engine.
- Producing insights on how to technologically and behaviourally decrease the probability of vessels to be detected by whales.

Estimation of the distance at which whales detect vessels and redirect their course towards fishing gear (to be completed February 2019)
Ryan Resinger, Gaetan Richard, Paul Tixier, John P.Y. Arnould, Christophe Guinet

- From whale tracking data and VMS data, identification of the decision making points of the whales depending on the distance of the fishing vessels.

Identification of optimal fishing strategies in regards to catch rate/type, whale depredation and management stakes (to be completed March 2019)
Lavinia Suberg, Paul Tixier, Christophe Guinet, Ching Villanueva

- Development of Bayesian Belief Networks to identify the best fishing strategies under different depredation and management scenario.

D. Outputs for the COLTO partner fisheries

Fishery specific reports (to be completed by January 2019)

- Full report for South Georgia and PEMI
- Reports with updated results from catch rate analyses for Chile and The Falklands

Global report (to be completed by February 2019)

The production of this global report will mark the end of the 2 x 6 month periods of the desktop study for the Chilean, SG, FI and PEMI fisheries.

However, from the report, discussions surrounding the results and analyses should remain open with the partners and Paul. In particular, Paul will be happy to address specific requests from the partners, if any, in regard to depredation related questions and needs in the respective fisheries.

In addition, he strongly encourages the data collection programs initiated as part of this project, such as photo-identification, and presence-absence information to be continued.