

Electronic monitoring of protected species interactions with commercial fisheries



<https://www.st.nmfs.noaa.gov/advanced-technology/electronic-monitoring/index>

CSP Project MIT2017-02

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A red fishing vessel is shown at sea, with a large net being deployed. The vessel is positioned in the upper right quadrant of the frame, and the net extends across the water towards the left. The sea is a deep blue, and the sky is a pale, overcast grey. The word "Introduction" is overlaid in large white text across the center of the image.

Introduction

- Fisheries monitoring provides essential information for management
- Human observers the mainstay of monitoring in NZ since the 1990s
 - E-tools: e.g. VMS
- Observer monitoring has challenges:
 - representativeness, the “observer effect”, safety at sea
 - inshore monitoring especially difficult: space onboard, dynamic fishing schedules, etc.
 - cost: people get more expensive
- Electronic monitoring (EM):
 - is a proven monitoring solution, including for protected species
 - not a silver bullet
 - around > 15 years
 - cost: technology gets cheaper



Objectives

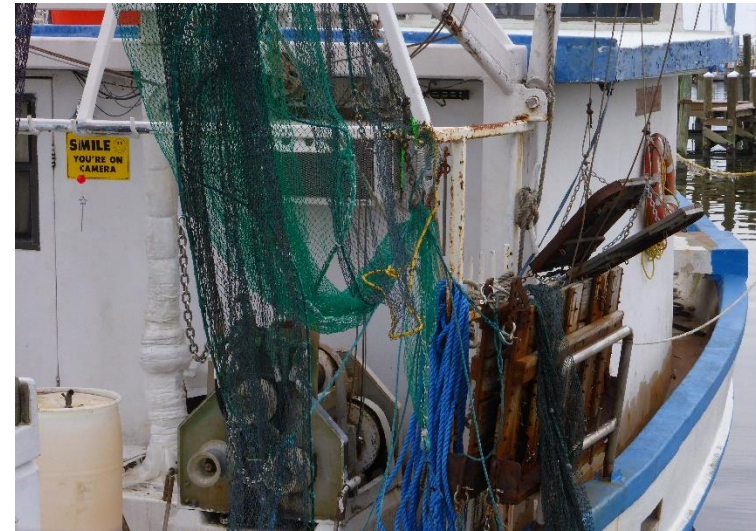
This project reviewed:

- types of interactions between commercial fishing and threatened, endangered and protected species that are detectable using EM
- reviewer training given to detect and characterise those interactions using EM imagery
- progress towards automation of EM imagery review



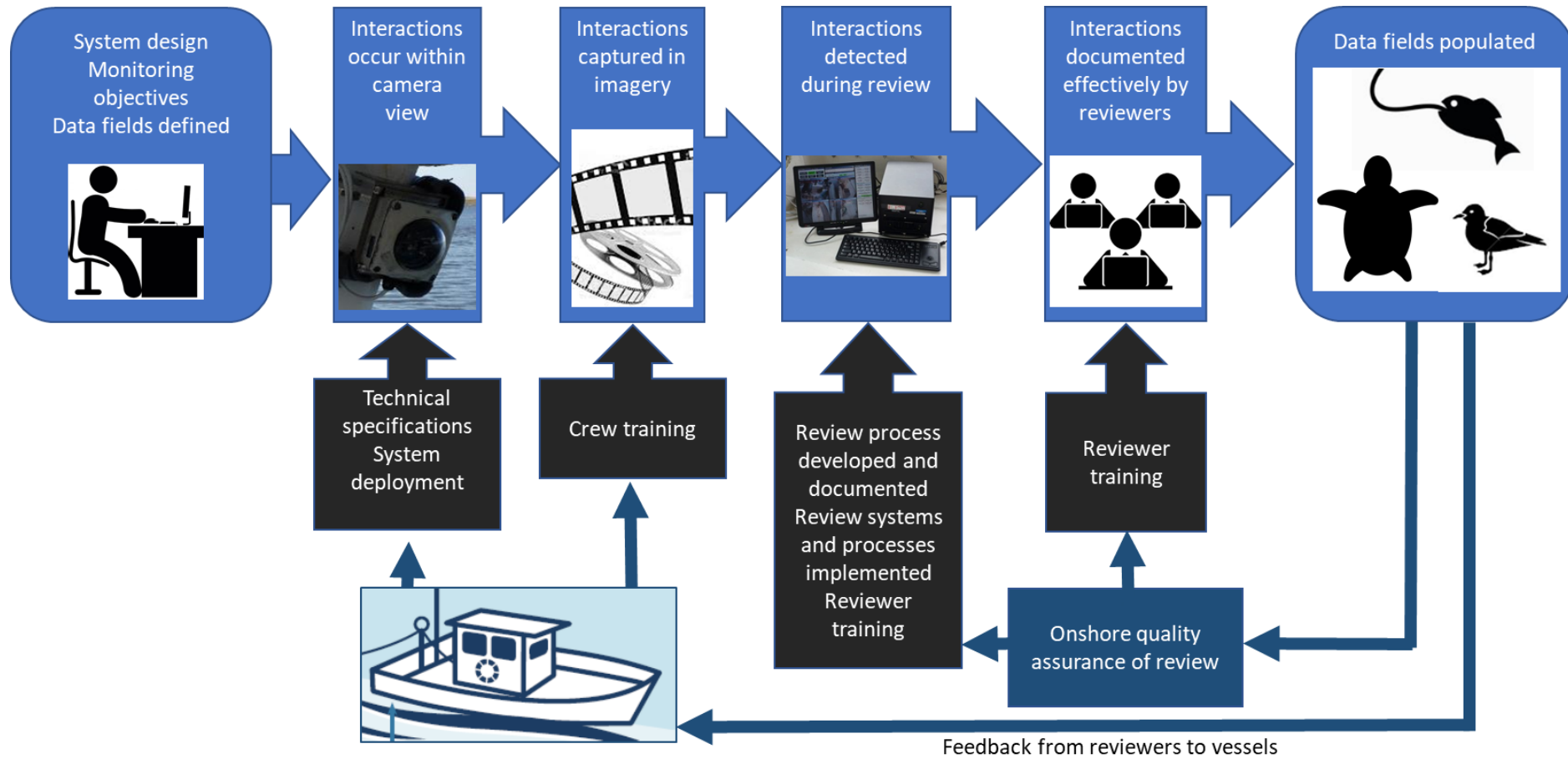
Methods

- Online keyword-based searches for publications, reports, conference literature, working group documents, websites
- Targeted searches where resources known to exist
 - Websites, conference proceedings
 - ACAP, RFMO, fisheries management sites
 - Social media hashtags (e.g. #EM4Fish)
 - Scientific Forum for Fish and Fisheries
- Direct expert consultation

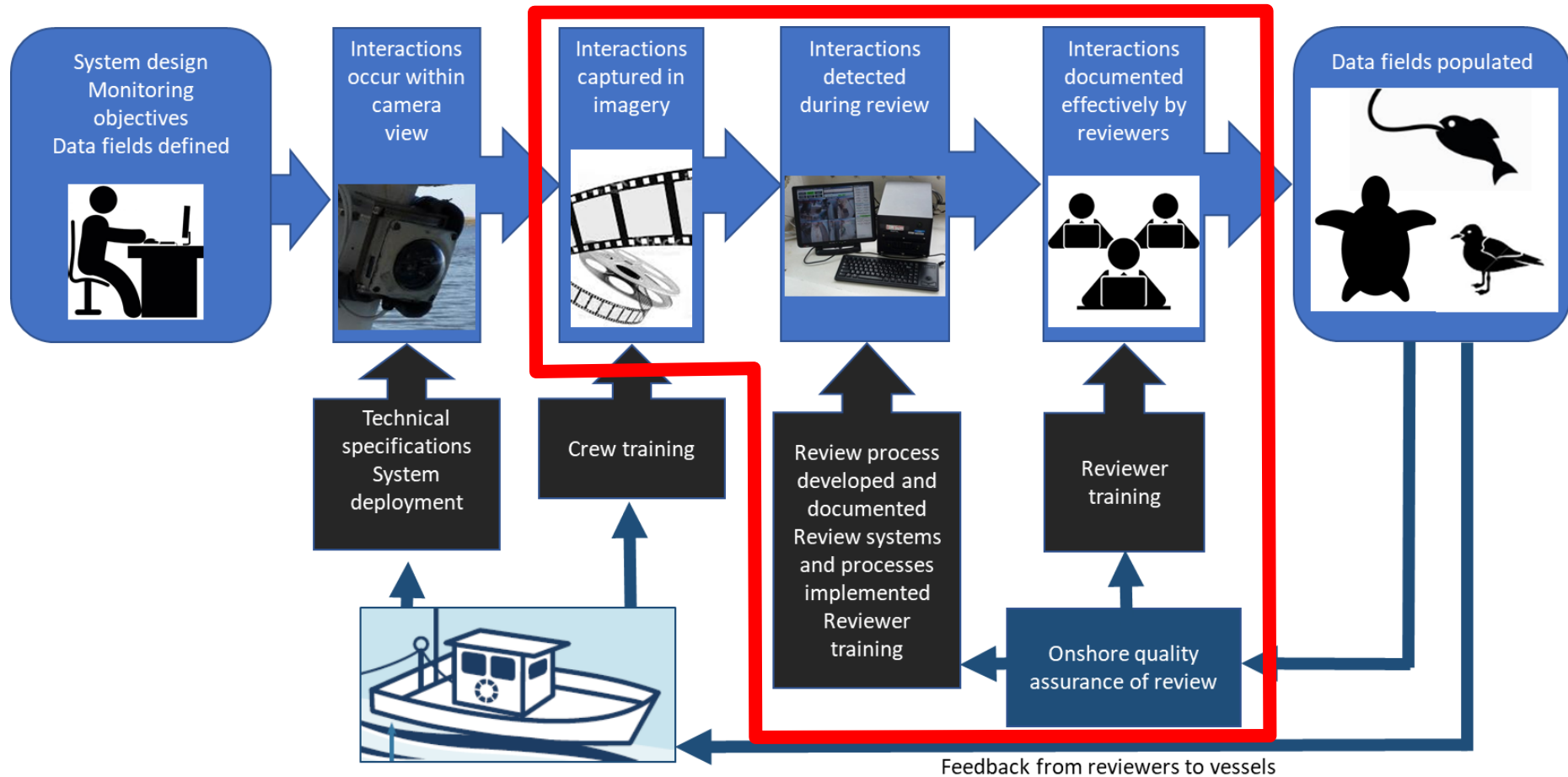


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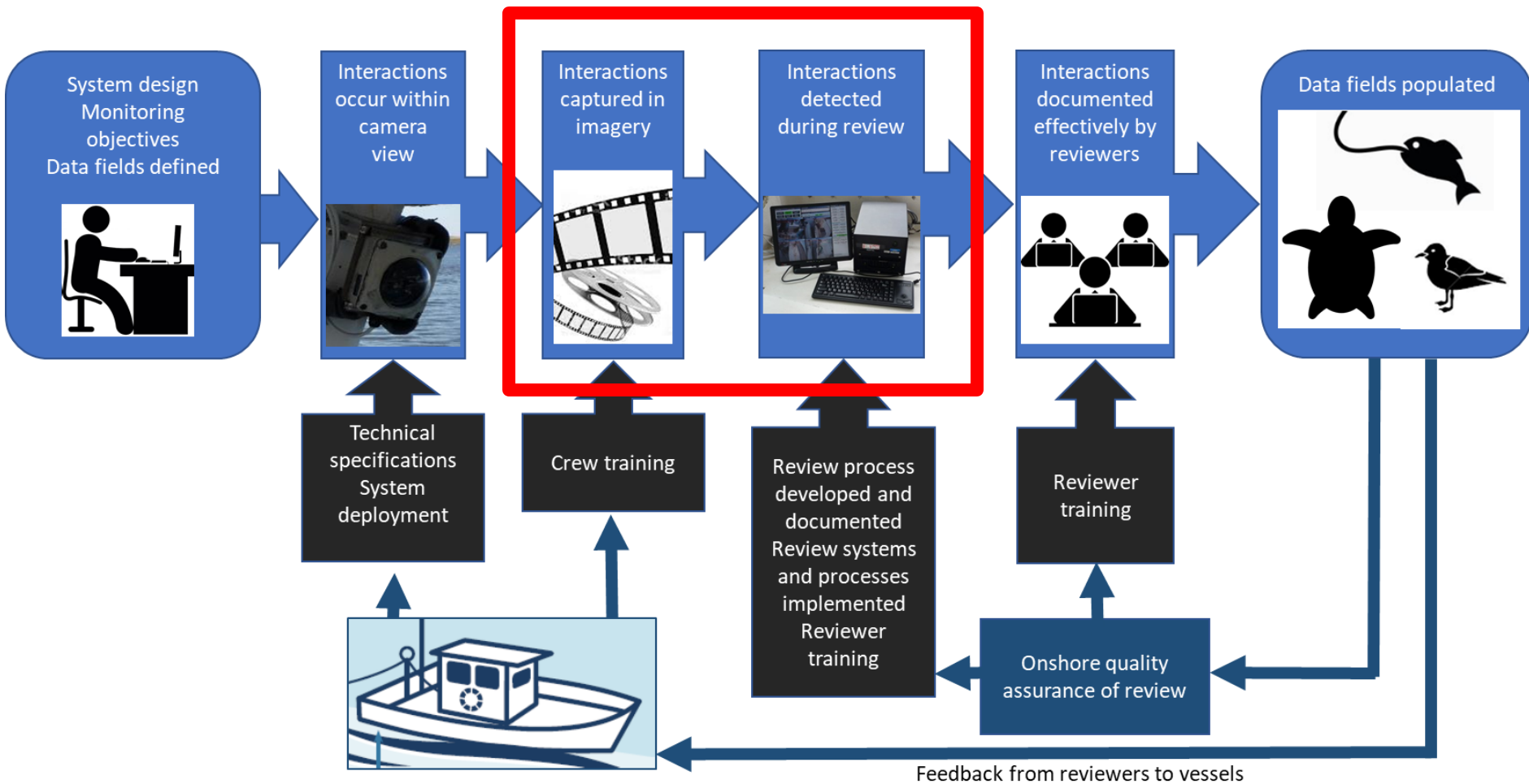
Results: Monitoring context



Results: Monitoring context



Results: Monitoring context



Results: Types of interactions

- Seabirds
 - Captures
 - Pelagic and demersal longline, set net/gill net, purse seine, trawl
 - Trawl warp/third wire
 - Locations
 - Australia, Hawaii, NZ, Peru, Solomon Is, NE and NW USA
 - ID to species
 - e.g. black-footed, Laysan and short-tailed albatross, black, giant and Cape petrel, flesh-footed and greater shearwater, gannet, Humboldt penguin, northern fulmar
 - ID to higher taxonomic group
 - e.g. gulls, shearwater, albatross



Results: Types of interactions

- Cetaceans
 - Captures
 - Set net/gill net, trawl
 - Locations
 - Australia, NZ, NE USA, North Sea, Peru
 - ID to species
 - e.g. harbour porpoise, bottlenose, common, dusky and Hector's dolphins
 - ID to higher taxonomic group
 - e.g. dolphin



McElderry et al. 2011

Results: Types of interactions

- Pinnipeds
 - Captures
 - Gill net
 - Locations
 - Australia, NE USA, Peru
 - ID to species
 - e.g. Australian and South American sea lions, gray and harbour seal



<http://59in59.com/the-blog/2016/5/9/glacier-bay-types-of-commercial-fishing>

Results: Types of interactions

- Marine reptiles
 - Captures
 - Pelagic longline, gill net, trawl
 - Locations
 - Australia, NZ, Hawaii, Solomon Is, Peru
 - ID to species
 - e.g. green, hawksbill, leatherback, loggerhead and olive ridley turtles
 - ID to higher taxonomic group
 - e.g. turtle, sea snake



McElderry et al. 2010

Results: Types of interactions

- Fish
 - EM widely used to document fish catch
 - Catch accounting, discarding, verification of fisher reports
 - Shark and ray captures
 - Pelagic longline, set net/gill net, purse seine, trawl, pot/trap
 - Locations
 - Australia, NZ, Hawaii, Solomon Is, Peru
 - ID to species
 - e.g. white pointer, silky, and oceanic whitetip sharks, devil and manta rays
 - ID to higher taxonomic group
 - e.g. *Mobula* spp.



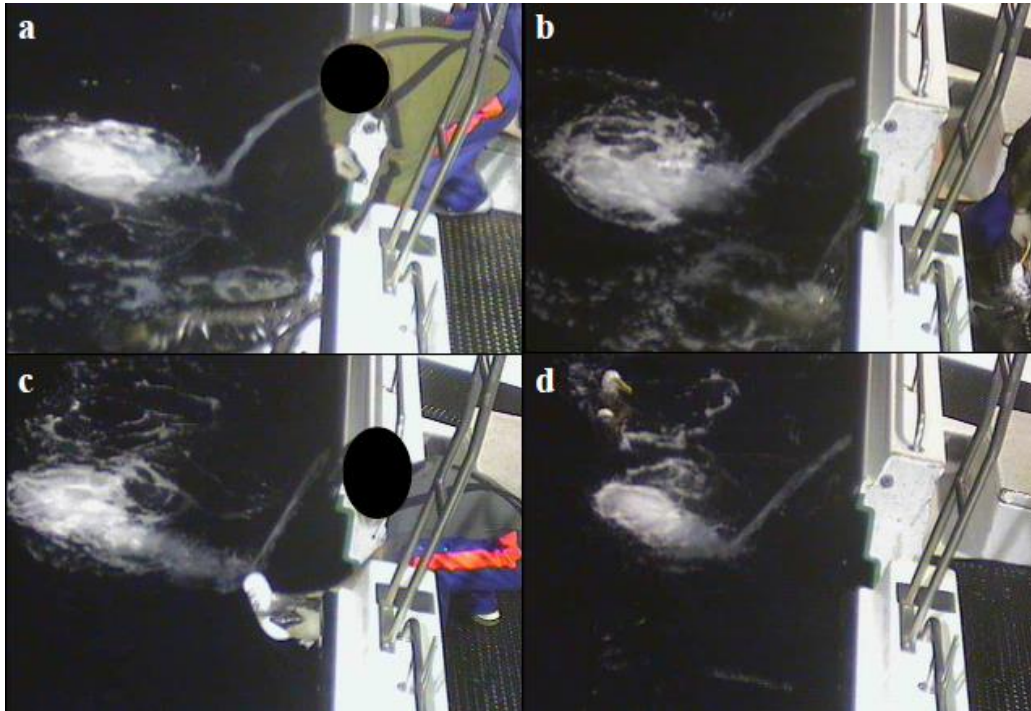
Piasante et al. 2012

Results: Types of interactions

- Corals
 - Black, Gorgonian and hydrocorals from a longline fishery, South Georgia
 - “Benthos” detection, trawl fishery in Australia
 - Sponges and snails, trawl fishery northeastern USA



Results: Life status



Piasante et al. 2012



McElderry et al. 2010



Results: Bycatch risk factors

- Mitigation
 - Tori lines
 - Warp scarers
 - Turtle excluder devices
 - Bycatch reduction devices
 - Pingers

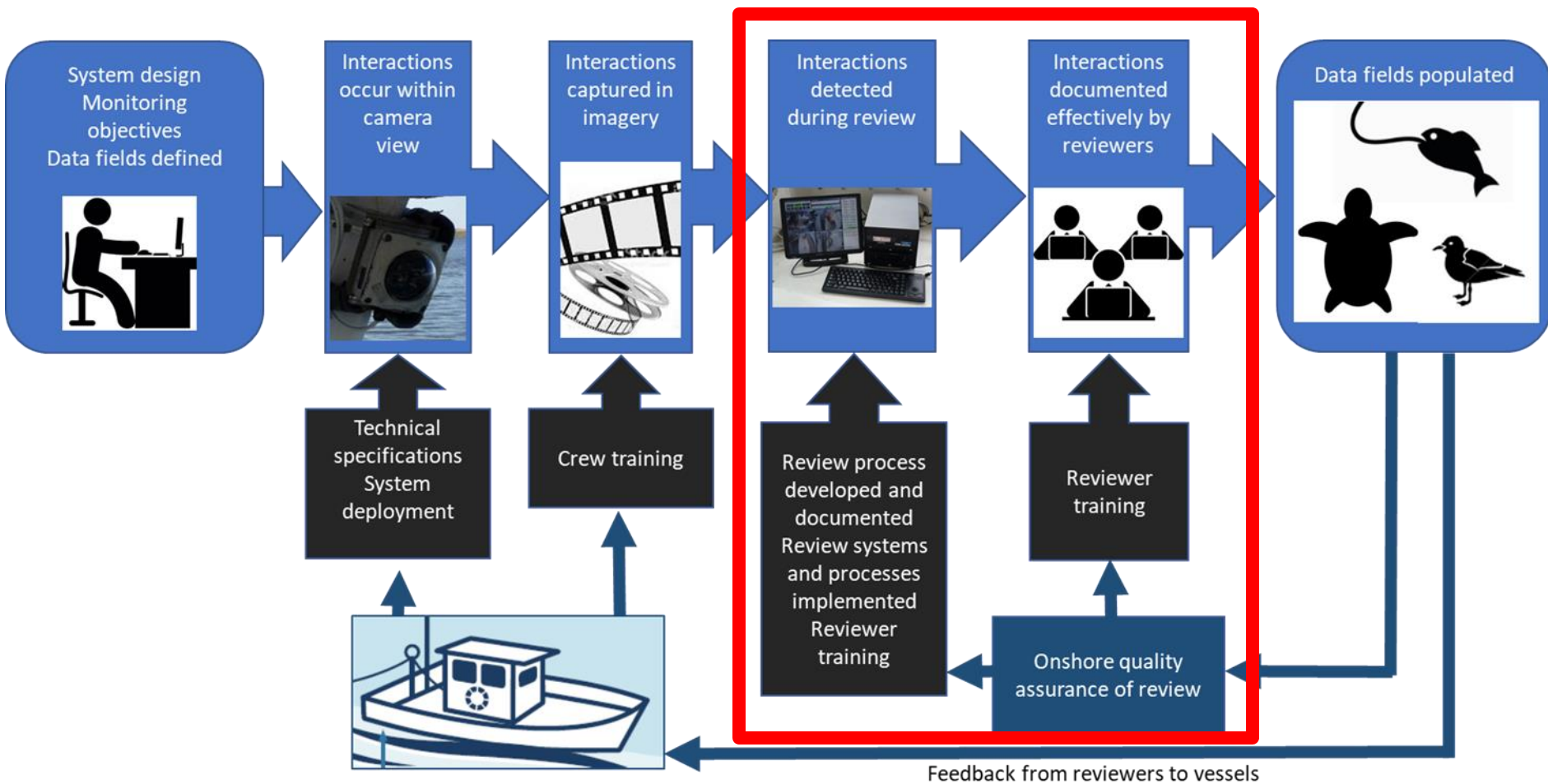


Results: Bycatch risk factors

- Fish waste discharge
- Abundance counts
- Protected species handling

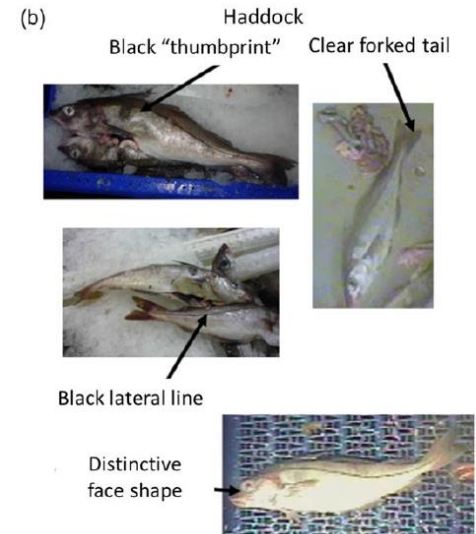


Results: Monitoring context



Results: Training

- No standard approach, training details seldom reported
- Where training is reported, components included:
 - Species identification from imagery
 - Self-testing
 - Tutorial-style feedback on self-assessment
 - Practice runs with imagery
 - Formal testing to assess capability
- EM reviewers may be naïve or experienced in identifying catch
 - Both can be trained to perform similarly well
 - If reviewers are/were observers, training needs to focus on working from imagery



Needle et al. 2015

Results: Species ID

EM reviewers:

- may be trained current or ex-observers
- do not observe at sea, but can receive observer training
- work from a species list or image library
- are provided with field guides
- are given bespoke ID tools for EM work

(a)

Cod



Whiteish lateral line



Green mottled colour



Distinctive head shape

(b)

Haddock

Black "thumbprint"

Clear forked tail



Needle et al. 2015



Black lateral line

Distinctive face shape



Results: Rationale for ID

- Body size
- Morphology
- Distinctive markings
- Colouration

- No standard for documenting ID
- 2 identifying characteristics



<https://www.stuff.co.nz/environment/100625479/fishing-for-the-truth-about-penguins-and-dolphins-snared-in-nets>



McElderry et al. 2011



Massachusetts Energy and Environmental Affairs,



AFMA 2018.



<https://mote.org/research/program/fisheries-ecology-and-enhancement/electronic-monitoring-project>



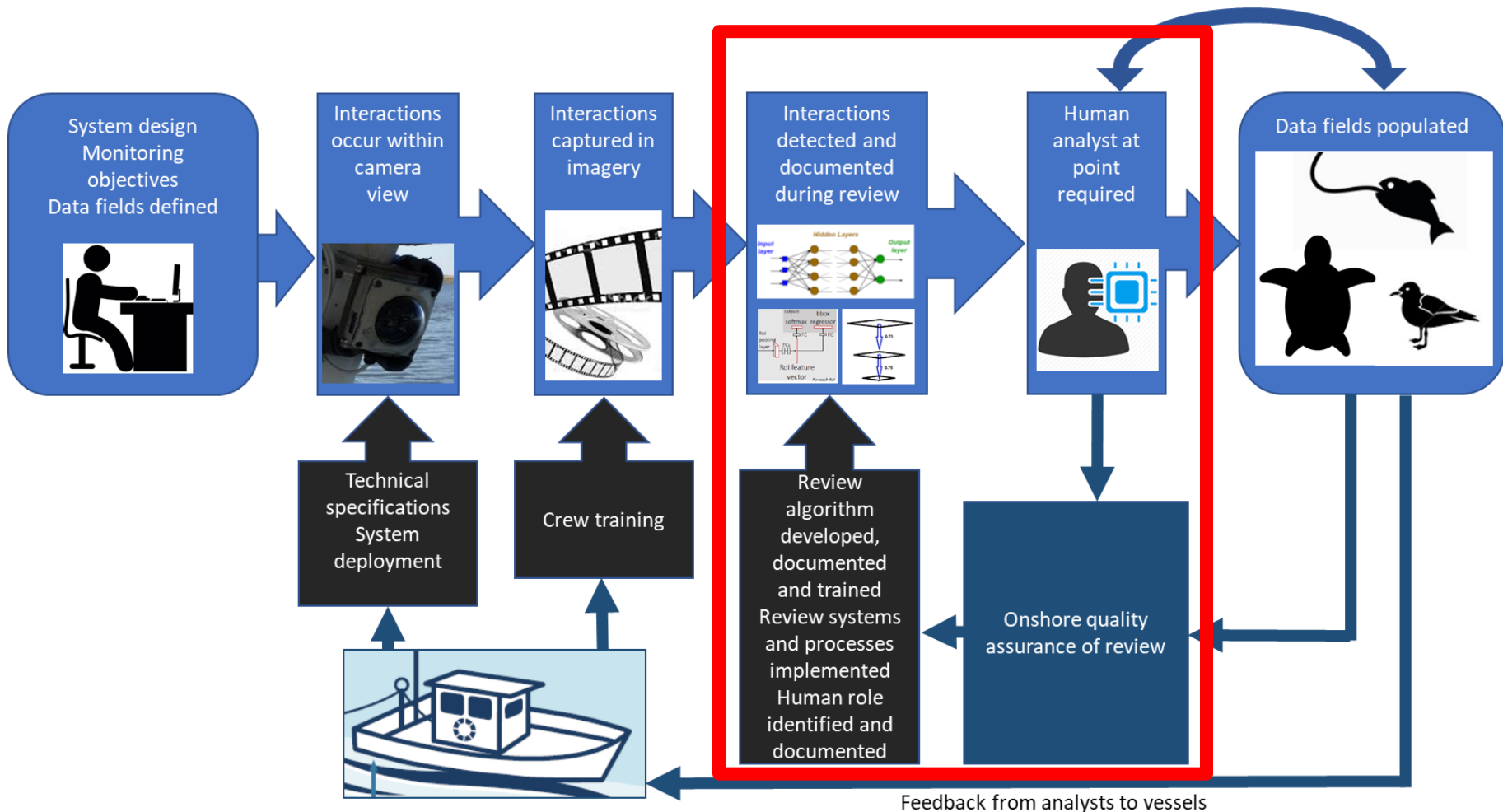
Results: Quality assurance

- Importance widely acknowledged
- No standard approach
- Repeatability of analysis valuable
- Same imagery stream reviewed by multiple reviewers
 - e.g. 10%, then findings compared
- Refresher training vital



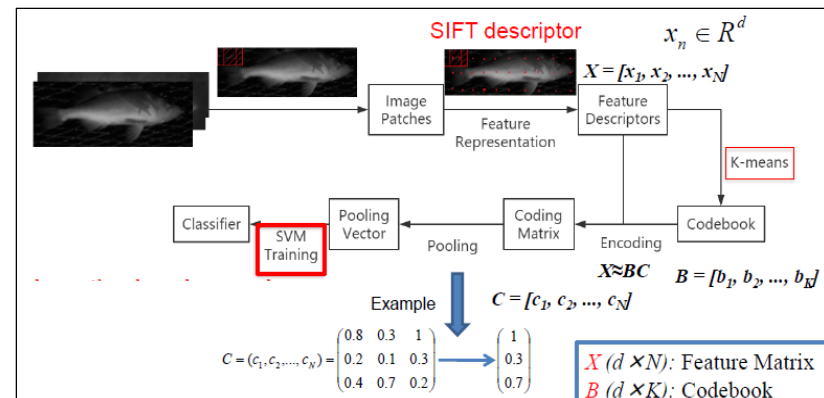
<http://www.seychellesnewsagency.com/articles/5768/Seychelles+takes+the+lead+with+electronic+monitoring+system+on+fishing+vessels>

Results: Automated review



Results: Automated review

- Growing body of work on machine learning
- Not yet operationalised or deployed at scale
- Mostly focused on fish (ID, length)
- Training algorithms a key component
- Work underway on machine learning for seabird bycatch events and identification
- Will change the role of humans in analysing EM imagery
- Near future of EM review is still human-centric



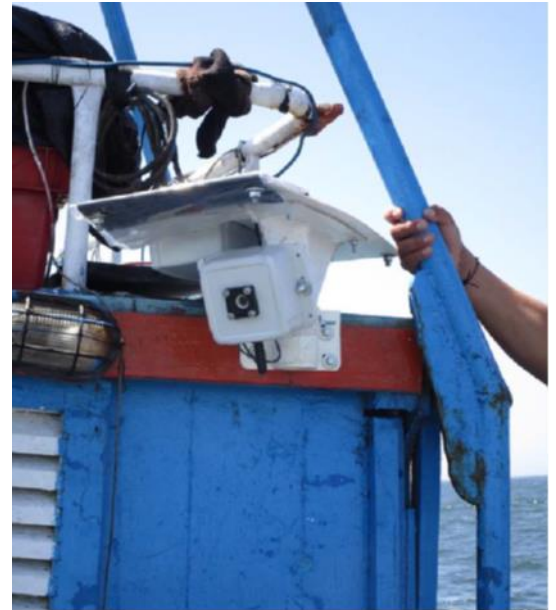


Conclusions

- *types of interactions between commercial fishing and threatened, endangered and protected species that are detectable using EM*
 - Captures of seabirds, marine mammals, reptiles, fish
 - Pelagic and demersal longline
 - Trawl
 - Purse seine
 - Set net
 - Pot/trap (fish)
 - Life status
 - Seabird interactions with trawl warp / third wire
 - Coral bycatch

Conclusions

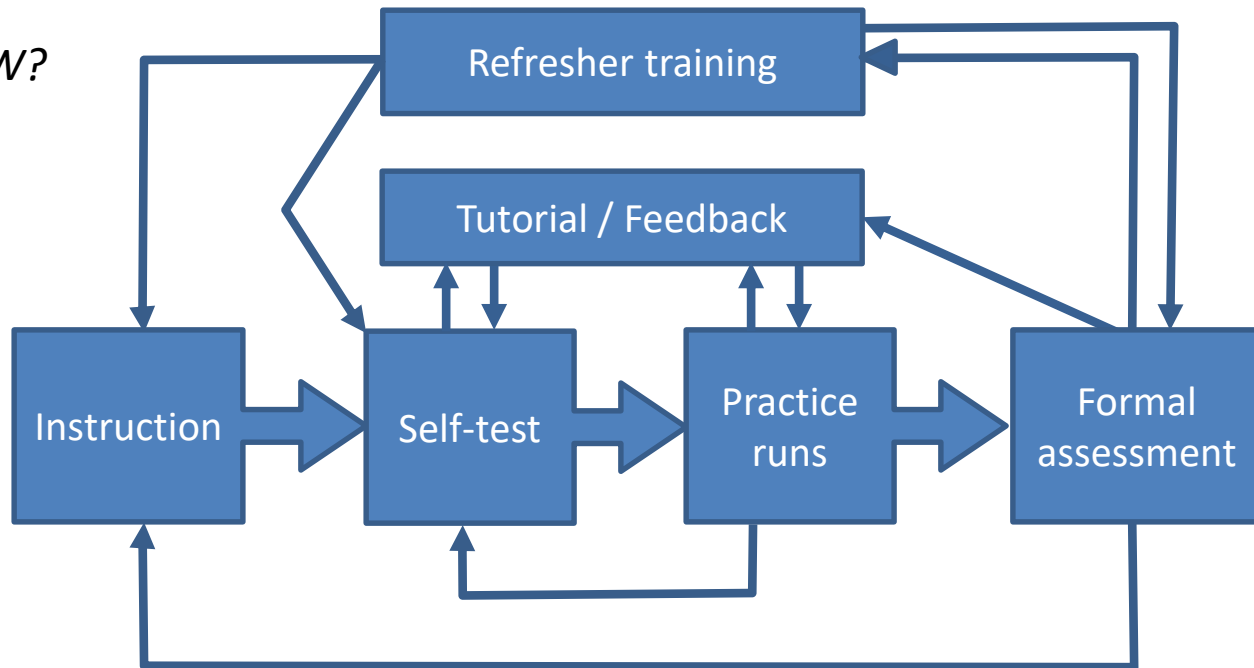
- *risk factors for interactions*
 - Mitigation measures
 - Fish waste discharge
 - **Abundance**
 - Handling
- *progress towards automation of EM imagery review*
 - **Yes but for now it's still human-centric**



Conclusions

- *reviewer training given to detect and characterise those interactions using EM imagery*

HOW?





Conclusions

- *reviewer training given to detect and characterise those interactions using EM imagery*

WHAT?





Conclusions



- Detection of protected species
 - Captures, dropouts, mode of capture
- Identification
 - Characteristics documented
- Life status
- Mitigation
 - Present/absent
- Unusual crew behaviour
 - May indicate captures
- **Training from real imagery as much as possible**



Acknowledgements

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