Monitoring of Queensland's shark catch for the net fisheries

Summary report

2021

Queensland Government

This publication has been compiled by Fishery Monitoring staff of Fisheries Queensland, DAF.

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List of acronyms/definitions

Acronym	*Description*
AIVR	Automated Integrated Voice Response
Catch locations	Fishery Monitoring Program sampling locations, Fisheries Queensland (2009). These are standardised spatial regions that split the east coast and Gulf of Carpentaria into subsections for the spatial stratification of sampling
DAF	Queensland Department of Agriculture and Fisheries
Discards	Sharks that are returned overboard, either alive or dead, i.e. the non-retained portion of the shark catch
EC	East Coast of Queensland
ECIFFF	East Coast Inshore Fin Fish Fishery
FOP	Fisheries Queensland’s Fisheries Observer Program
GBR	Great Barrier Reef shark quota region
GOC	Gulf of Carpentaria shark quota region
GOCIFFF	Gulf of Carpentaria Inshore Fin Fish Fishery
PCS	Percentage of the catch sampled—indicates the sub-sample of the catch where data was recorded
QBFP	Queensland Boating and Fishing Patrol
SEC	South East Coast shark quota region
TACC	Total allowable commercial catch
WTO	Wildlife trade operation approval

Summary

Fisheries Queensland is investing significantly in additional biological monitoring under the *Queensland Sustainable Fisheries Strategy 2017-2027*. A detailed understanding of the retained and discarded shark catch was identified as a 'high benefit, medium feasibility' research priority in the Monitoring and research plan 2017-18 - Sustainable fisheries (Department of Agriculture and Fisheries 2018). Information about the species composition, quantity, fate characteristics and biological characteristics of sharks that are retained or discarded by net fishers was highlighted within the research priorities. This information would enhance managers and stakeholders understanding of the performance of Queensland's net fisheries, facilitate management for the sustainable harvest of sharks and assist with wildlife trade operation (WTO) approvals.

Fisheries Queensland's Fishery Monitoring team established a monitoring program to collect information on the retained and non-retained (discarded) catch of shark by net fishers operating in the East Coast Inshore Finfish Fishery (ECIFFF) and Gulf of Carpentaria Inshore Finfish Fishery (GOCIFFF). Sampling commenced in 2018 and continued through 2020. These are complex fisheries and due to the challenges associated with representative data collection the retained and non-retained catch components were sampled separately to maximise the overall data integrity from each catch component. The ECIFFF retained harvest was sampled across the financial years of 2018-2019 and 2019-2020. The GOCIFFF retained harvest was sampled across the calendar years of 2019 and 2020. Both the ECIFFF and GOCIFFF discarded catch was sampled across the calendar years of 2019 and 2020. Travel and work restrictions caused by Health Directives in response to the Novel Coronavirus (COVID-19) pandemic, severely restricted sampling through much of 2020 (March to December).

The monitoring program collected information on the retained shark catch through fishery-dependent sampling at ports, seafood processors and at sea. The sampling unit used for monitoring the retained catch in this study is a catch, which refers to all landed shark from a fishing event (i.e. a day or trip). Sampling was stratified by location and time to representatively sample the retained catch of sharks in the ECIFFF and GOCIFFF.

The monitoring program collected information on the non-retained (discarded) component of the shark catch through two avenues. A phone survey of commercial net fishers operating in the ECIFFF and GOCIFFF was completed to profile discard behaviour and document the drivers behind shark discarding by fishers. In addition, periodic at-sea surveys were conducted to observe fishery operators checking their nets and recording characteristics of the non-retained shark catch. The sampling unit used for monitoring the non-retained catch in this study is an individual rob event, which refers to a net haul, net lift, or net check. Sampling of rob events (i.e. a net lift, net check, net haul) was stratified by location and time in the ECIFFF and GOCIFFF.

A novel methodology was adopted to achieve highly accurate species identification. The program developed comprehensive staff training tools to enable monitoring staff to accurately identify shark species in the field. In addition, photographic samples and genetic samples were collected to identify cryptic species or incomplete samples (e.g. barrels, trunks, heads) and validate field identification by monitoring staff. A high priority was placed on data verification and data quality assurance.

This report provides an overview of the monitoring program, a summary of key results and recommends additional data investigations. Supplementary documents to this report, that cover procedural details of sampling and data handling as well as further technical data summaries, are available on request. Data and samples generated through the monitoring program are also available through a data request. Detailed results of the phone survey on fisher discard behaviour have been reported in Behavioural and economic drivers influencing shark fishing practices in Queensland's commercial net fisheries (Teixeira et al. 2018).

This shark monitoring program provided a detailed investigation of the catch of shark in the ECIFFF and GOCIFFF. The program addressed its core objectives of collecting data on species composition of the retained shark catch and developing a profile of discarded shark within the ECIFFF and

GOCIFFF. Fishery monitoring staff collected data from 202 retained shark catches. Fishery monitoring staff also observed the discarded catch from 601 individual rob events (i.e. net checks, net lifts, net hauls) equivalent to 3132 soak hours and >150 km of net. For 12% of the observed rob events, all sharks that were caught by the fisher were retained. For 28% of the observed rob events some or all the sharks caught were discarded by the fisher. However, the majority of observed rob events (60%) recorded no sharks caught by the fisher. Regional differences were identified in these patterns of shark discards.

The most frequently encountered species in the retained catch (across all regions) was the *Carcharhinus tilstoni/limbatus* complex, representing 44% of the sampled catch. The next most frequently encountered species in the retained catch were the spot-tail shark (18%) and the Australian sharpnose shark (9%). The scalloped hammerhead was the most frequently encountered hammerhead species identified in the retained catch and overall comprised 7% of the sampled catch. Regional variation in species composition was evident. The size structure of the retained catch was dominated by animals between 50 and 110 cm stretched total length.

The most frequently encountered species in the non-retained catch (across all regions) was the *Carcharhinus tilstoni/limbatus* complex, representing 23% of the sampled discards. The next most frequently encountered species in the non-retained catch was the creek whaler (13%) followed by the pigeye shark (8%) and the scalloped hammerhead (8%). Regional variation in species composition was evident. Species variation in fate characteristics was also evident. Among those commonly discarded species, 45% of *C. tilstoni/limbatus* complex, 65% of creek whalers and 57% of pigeye sharks were released alive. For the scalloped hammerhead, 46% were released alive. This reduced to 18% for great hammerheads and 12% for winghead sharks.

Quality assured data is available for investigating spatial prevalence, size composition, and seasonal patterns in the retained shark catch within the ECIFFF and GOCIFFF. Likewise, quality-assured data is available for investigating the species composition, fate characteristics and gear selectivity for the non-retained (discarded) catch in the GOCIFFF and ECIFFF. This information will feed into species briefs for use in future shark stock assessments. While the retained catch data are considered representative of the fishery, due to the inherent nature of observer work, the non-retained catch data represents the vessels observed and not necessarily the fleet. It is recommended that the non-retained catch data is reconstructed to determine fleet-level metrics before direct comparison with the retained catch metrics.

Across the program, 28 species of shark were recorded in the data. Species identification could be verified through genetic screening for 73% of shark records. A further 12% of shark records had a photographic sample to verify the field identification. The remaining 15% of shark records relied solely on species identification in the field. Genetic species identification was compared with visual species identification to quantify the level of misidentification for visual species identification in the field (i.e. using records that had both data fields). Overall, 7% of records were not correctly assigned to their genetically identified species. However, for those species that were frequently encountered, misidentifications were quite low (2-3%) (e.g. 98% of *C. tilstoni/limbatus* complex and 97% of spot-tail sharks were correctly identified). These results indicate that species misidentification would represent a very minor quantity of the records for those records where only a field identification was available.

In addition to achieving the core project objectives, outputs of the program extend to include a range of tools to assist in shark species identification, an extensive library of genetic samples and sequence data (approaching 6000 samples), and a shark species image library, based on genetically verified records. The monitoring team collaborates with other research agencies to utilise these resources to improve the overall knowledge of shark stocks within Queensland. The program has also developed comprehensive sampling protocols that integrate with other fishery dependant sampling undertaken by the monitoring team. This allows the monitoring team to be well-positioned for any future requirements for monitoring the species composition and biological characteristics of the shark catch.

Introduction

Many shark species show biological characteristics of slow growth, older maturity age, and produce relatively few young. These qualities mean that some shark species will have low resilience to fishing pressure. Accordingly, it is important to monitor fishery activities that interact with shark stocks to ensure catches remain within sustainable levels, enabling shark species to fulfil their ecosystem functions (Heupel et al*.* 2014).

Shark species show large variability in their use of Queensland's coastal habitats. River, estuarine, foreshore, reef and offshore areas can be used at different times throughout a species lifecycle (e.g. some species utilise estuaries or rivers as nursery habitats). Additionally, some shark species may undertake long migrations or have large home ranges while others occupy relatively small home ranges. Consequently, each shark species may experience different impacts from fishing activities. Knowledge of what species are interacting with fishing operations and when is important for adequately assessing the impacts of a fishery on local shark stocks.

In Queensland, most sharks are caught by net operators working in the Gulf of Carpentaria Inshore Finfish Fishery (GOCIFFF) and the East Coast Inshore Finfish Fishery (ECIFFF). The ECIFFF and GOCIFFF cover a vast geographic area and a remarkable array of fishing operations. Variation occurs in terms of vessel and crew size, target species, peak fishing seasons and the type and method of fishing gear used (Teixeira et al. 2018, Jacobson et al. 2019a,b). The harvest of shark is managed through various input and output controls such as limited entry, vessel restrictions, gear restrictions, maximum size limits, possession limits, and catch limits (TACC), including a hammerhead specific TACC. A detailed review of these fisheries can be obtained by referring to the ECIFFF and GOCIFFF scoping studies (Jacobson et al. 2019a,b).

Fisheries Queensland monitors the commercial catch of shark to collect essential catch information. Historically this has taken the form of logbook reporting and, since 1988, there have been a series of logbook iterations which have recorded catch data at different species resolution through time (Leigh, 2015). In January 2018, to address identified knowledge-gaps, Fisheries Queensland instigated new logbook and reporting requirements for all fishers catching sharks. Since January 2018, all retained shark catch is reported in the logbooks (as weight or number) to the level of species or species complex, where specified. Species discrimination amongst carcharhinids, the family group most encountered by ECIFFF and GOCIFFF net fishers, is inherently difficult. Because of this, the current logbook species groupings take into consideration those species where fishers are unlikely to accurately distinguish between species (e.g. *Carcharhinus tilstoni* and *C. limbatus* or *C. leucas* and *C. ambionensis*).

Since 2018, all discarded shark catch is also reported in the logbooks. Discards by number are reporting for each species of hammerhead shark with all other shark combined in the category 'other shark'. Further to these logbook reporting requirements, since 2018 all shark catch is reported on a 'prior notice' through the Automated Integrated Voice Response (AIVR) phone reporting system and lodged on an unload notice. If sharks are caught, the number is reported using the AIVR prior to the fisher landing. Further to this, fishers holding a shark endorsement (i.e. an S symbol) are required to wait for one hour before leaving their landing place to allow for possible inspection by compliance officers from Queensland Boating and Fishing Patrol (QBFP). If an S symbol is not written on the authority, the fisher does not need to wait at the landing place after the 'prior notice' has been given.

While these changes improve the reporting of both the retained and non-retained catch of sharks and improve the species resolution of the catch data, they still rely on individual fishers accurately identifying and recording the correct species in the logbooks. Shark species identification is renowned as a challenging task even for trained and highly experienced observers (Tillett et al., 2012). Accordingly, confidence in the logbook species data remains low.

Fisheries Queensland carried out an observer program (FOP) between 2000 and 2012 (e.g. 2000-2006 – N9 FOP). This program provided a snapshot of net fishers' interactions with shark species. While the FOP provided species composition data that was higher quality than the logbook data, the program encountered its own suite of challenges relating to representative sampling of the fishery and accurate species identification (Leigh, 2015).

As part of the *Queensland Sustainable Fisheries Strategy 2017-2027*, Fisheries Queensland committed to collecting additional biological information for sharks. Information about the species composition, quantity, fate, maturity and size of sharks retained or discarded by net fishers operating in the ECIFFF and GOCIFFF, was highlighted within the research priorities in the Monitoring and research plan 2017-18 - Sustainable fisheries (Department of Agriculture and Fisheries 2018). Likewise, knowledge of fisher behaviour surrounding the practice of discarding sharks was recognised as important. Together this information could enhance managers and stakeholders' understanding of the performance of Queensland's net fisheries, facilitate management for the sustainable harvest of sharks, assist with WTO approvals for the ECIFFF and improve marketing of shark product. A shark monitoring program was established to tackle these data requirements and obtain high-resolution species-level data. This report provides an overview of the monitoring program, a summary of key results and additional data investigation recommendations.

Objectives

Fisheries Queensland's Fishery Monitoring team implemented a fisheries-dependent monitoring program for sharks in the ECIFFF and the GOCIFFF to address two broad objectives.

Objective 1: Provide information on the species composition and biological attributes (size, sex) of the retained catch via representative fishery-dependent sampling.
Objective 2: Develop a profile of the non-retained (or discarded) shark catch using cross-disciplinary techniques:

a. via a structured questionnaire to document commercial fishers' discarding behaviour and
b. via periodic at-sea surveys to observe fishery operators checking their nets to record characteristics of gear use (such as net length, mesh size, soak time and position) together with characteristics of the associated non-retained catch (such as species composition and fate).

Methods

Study area

Fisheries Queensland's fishery monitoring team monitored the retained and non-retained catch of shark by net fishers operating in the ECIFFF and GOCIFFF. The study area extends from the Queensland – New South Wales border to the Queensland – Northern Territory border. The study area is broken into distinct monitoring regions to stratify sample collection and for use in post-survey weighting and analysis (Figure 1). Catches were not targeted in the Central Gulf, Mapoon, Torres Strait, Lockhart, Cooktown, Swains or Coral Sea regions primarily due the frequency of ECIFFF and GOCIFFF net fishers operating in these regions.

Sampling the retained shark catch

Fisheries Queensland's fishery monitoring team use a suite of sampling strategies to collect fishery-dependent data and samples for many species. Those that apply to sampling shark include:

- Commercial catch sampling (Fisheries Queensland 2009)
    - measuring fish/ sharks before they are sold by fishers to seafood wholesalers
    - measuring fish/shark at seafood wholesalers
    - asking fishers to measure their fish/shark or keep samples if required
- Biological Sampling Protocol: Shark, 2018-2020 (Fisheries Queensland 2019)

Where possible, sampling trips for the retained catch of shark are incorporated into existing commercial sampling activities to maximise the program's efficiency (Figure 3). Shark specific sampling events are also scheduled to capture the shark fishery's peak seasonality in key regions to complement this non-specific sampling.

Table 1 Overview of management controls current for 2018-2020

	GOCIFFF	ECIFFF
Input controls (effort management)	Limited entry, 84 fishing symbols	Limited entry, 692 fishing symbols • 231 line • 132 net 120 with an S symbol • Remaining 329 are bait or ocean beach with limited shark interaction
	Spatial and temporal closures (marine parks*/finfish closure)	Spatial and temporal closures (marine parks*/finfish closure)
	Vessel restrictions	Vessel restrictions A 14 m (N1, N2, N10, K1–K8) and 16 m (N4) maximum boat length restriction
	Gear restrictions	Gear restrictions
Output controls (catch management)	Logbook reporting • Species categories for retained shark catch • Hammerhead and other shark categories for discarded catch	Logbook reporting • Species categories for retained shark catch • Hammerhead and other shark categories for discarded catch
	AIVR and Prior reporting	AIVR and Prior reporting • S symbol holders must prior report any catch at least 1 hr prior to landing
	Quota • Hammerhead specific quota of 50 t	Quota • 600 t divided between GBR (480 t) and SEC (120 t) quota regions • Hammerhead specific TACC (GBR 78 t and SEC 22 t)
		Product form limits • S symbol holders may remove the head, tail and or fins except for listed species. The body corresponding to each removed fin must be retained • Fishers operating without the S symbol must keep any fins or tails removed together with the body until the product is unloaded from the boat
		Size limits • 1.5 m Maximum legal size limit and a 60 cm maximum interdorsal length limit for all commercial line operators
		Restricted access to shark resources • Non-S symbol holders have a possession limit of 10 sharks for net and 4 sharks for line • S symbol holders (120 licence holders) can retain a larger number of sharks, for additional licence fee

**Note marine parks are a habitat management tool overseen by government departments other than Fisheries Queensland, DAF*

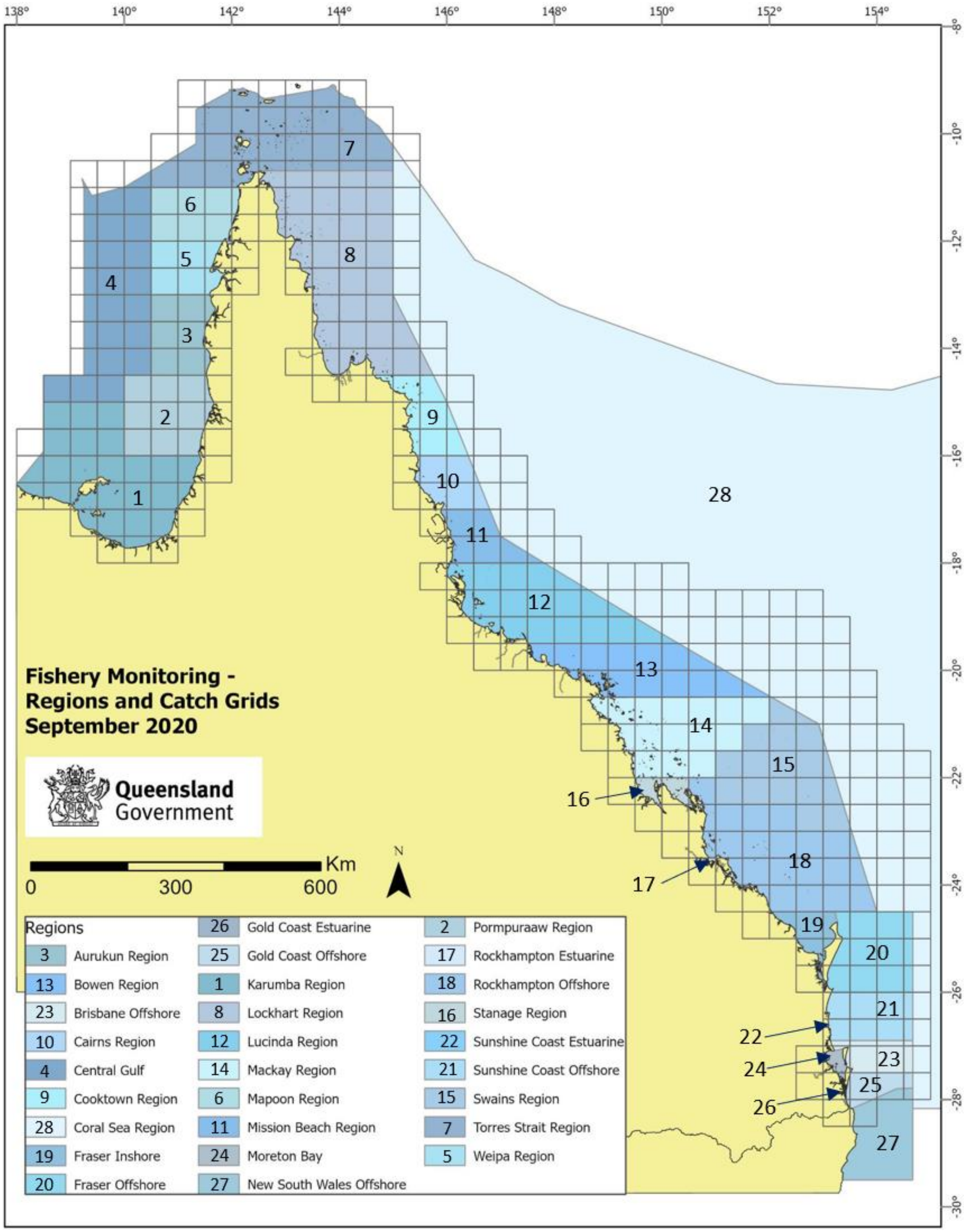

Figure 1 Map of Queensland showing sampling regions for GOCIFFF and ECIFFF shark monitoring. Gridlines indicate the CFISH grids. In the GOCIFFF, catches were not targeted in the Torres Strait, Central Gulf, or Mapoon Regions. In the ECIFFF, catches were not targeted in the Torres Strait, Lockhart, Cooktown, Swains or Coral Sea regions

ECIFFF

Sampling is designed to be representative of the ECIFFF net harvest of shark. Routine fishery-dependent catch sampling spans the breadth of ECIFFF net fishery which operates in coastal waters from the QLD-NSW border to the Lockhart Region (Figure 1). Sampling is stratified to capture variations in region, season, and fishing methods and is focused on S Symbol (shark endorsement) licence holders.

Data collection occurs at-sea, in-port and at Queensland seafood processors. Data collected from each fisher's retained catch includes the date, catch location, fishing method, and species retained, with size, sex, and maturity recorded where possible. Fin clip and photographic samples are collected to aid accurate species identification. See Appendix A for the SHK01 datasheet and the Biological Sampling Protocol: Shark, 2018-2020 (Fisheries Queensland 2019) for further data collection methods.

For the ECIFFF, a new sampling season starts each July (commencing July 2018) and continues through to June (finishing June 2020). Sampling quarters are by financial year:

- 1st quarter: July to September
- 2nd quarter: October to December
- 3rd quarter: January to March
- 4th quarter: April to June.

GOCIFFF

Sampling is designed to be representative of the GOCIFFF net harvest of shark. Routine fishery-dependent catch sampling spans the fishery's inshore and offshore components across its spatial extent (Figure 1). Sampling is stratified to capture variations in region, season, and fishing method. Data collection occurs predominantly at-sea as it is rarely possible to representatively sample GOC fishers' catch in-port or at Queensland seafood processors. Accordingly, sampling fatigue had to be managed where there are only a few operators in the fishery (e.g. offshore GOC). After consultation with the offshore (N12) fishery operator, monitoring staff planned four extended trips per year between February and October to sample the retained shark catch.

Data collected from each fisher's retained catch includes the date, catch location, fishing method, and species retained, with size, sex, and maturity recorded where possible. Fin clip and photographic samples are collected to aid accurate species identification. See Appendix A for the SHK01 datasheet and the Biological Sampling Protocol: Shark, 2018-2020 (Fisheries Queensland 2019) for further data collection methods.

A new sampling season for GOCIFFF starts each February (commencing February 2019) and finishes in October (finishing October 2020). The fishery does not operate over the summer months due to spawning closures. Sampling quarters are by calendar year:

- 1st quarter: January to March
- 2nd quarter: April to June
- 3rd quarter: July to September
- 4th quarter: October to December.

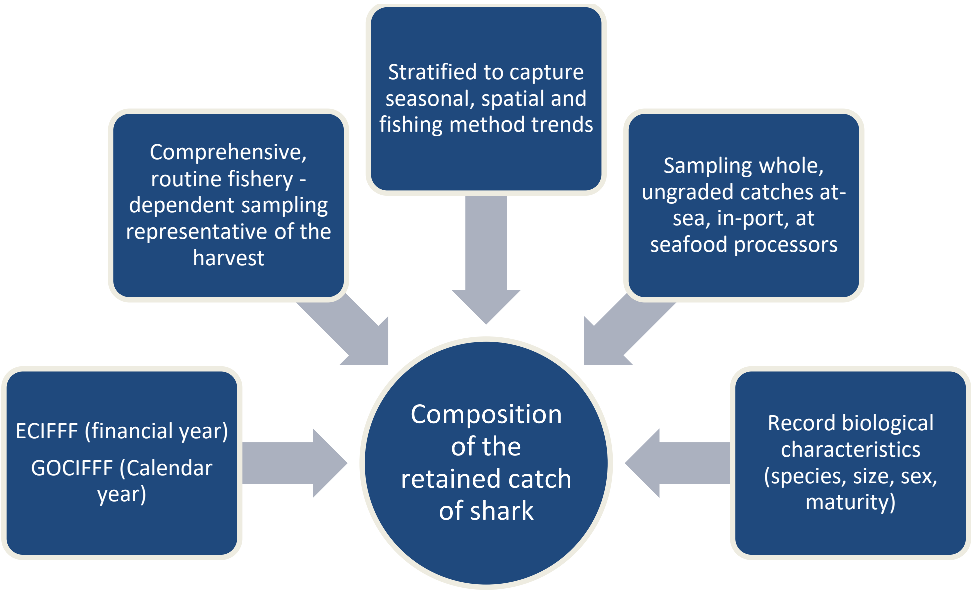

Figure 2 Summary of retained catch sampling

Survey of fisher discarding behaviour

Queensland net fishery operators participated in a structured questionnaire that documented the relative importance of behavioural and economic factors which influence whether sharks are retained or not. Survey participants were active commercial net fishers of the ECIFFF and the GOCIFFF (i.e. reported catch in the two years before the survey commenced).

Data collection was undertaken by Fisheries Queensland's fishery monitoring staff. Fishers were recruited into the survey by telephone with up to five attempts made to contact a fisher. Interviews were conducted via telephone, taking between 10 and 45 minutes to complete.

The survey was structured in three sections:

- 1st section: a series of open-ended questions to discern the reasons why fishers decide to discard or retain their shark catch.
- 2nd section: multiple-choice questions about:
    - the fisher's fishing activities (categorised by years fished, fishing region, fishing symbols, and vessel, fleet, and crew size)
    - the discarded catch (all species and sharks specifically)
    - the frequency of sharks caught
    - whether they target sharks
    - the importance of sharks to their business
    - the primary method of shark interaction
    - the species they are usually targeting when they interact with sharks.
- 3rd section: Likert-scale questions to examine discarding behaviour according to the Theory of Planned Behaviour (TPB) principles.

A pilot was conducted to trial the questionnaire and refine the questions for the final survey. Fourteen fishers partook in the pilot study. These fishers had a history of working closely with Fisheries Queensland's monitoring staff. The pilot survey included extra open-ended questions for the purpose of gathering as much detail as possible to inform the final questionnaire. Several amendments were made to the survey questions following the pilot survey.

A comprehensive summary of the methods is presented in Teixeira et al. (2018).

Figure 3 A series of photographs illustrating retained catch sampling and the variety of product forms encountered (whole animals, barrels, trunks, and heads), highlighting the need for a novel approach to obtain accurate species identification

Sampling the non-retained shark catch

Fishery dependant sampling of the non-retained (or discarded) catch of shark is by direct observation of net fishery operations. Specific at-sea sampling events are scheduled with wide array of fishers to capture variation across gear-types, area, and season (Figure 5).

ECIFFF

Periodic, fishery-dependent, surveys are undertaken at-sea to observe fishery operators checking and hauling their nets (referred to in this report as rob events). Sampling spans the breadth of ECIFFF net fishery which operates in coastal waters from QLD-NSW border to Lockhart Region (Figure 1). Sampling aims to capture variation in region, season, and fishing method. However, sampling is limited by vessel access permissions (i.e. participation in the monitoring program is voluntary), staff safety considerations, and fishery operation size (e.g. small operators may have limited space for an additional person and monitoring staff cannot replace a deckhand). Sampling can be considered opportunistic and, while representative of a diversity of operators who will and can take monitoring staff on board, it may not represent the overall fishery's activity.

Data from each observed rob event (i.e. a net check or net haul) included catch location, fishing method, date; net set details (e.g. net length, mesh size, soak time, fishing position), species discarded and fate. Size, sex, and maturity are also recorded where possible. Fin clip and photographic samples are collected to aid accurate species identification. See Appendix A for the SHK01 datasheet and the Biological Sampling Protocol: Shark, 2018-2020 (Fisheries Queensland 2019) for further data collection methods.

For the ECIFFF, a new sampling season starts each January (commencing January 2019) and continues through to December (finishing December 2020).
Sampling quarters are by calendar year:

- 1st quarter: January to March
- 2nd quarter: April to June
- 3rd quarter: July to September
- 4th quarter: October to December.

GOCIFFF

Periodic, fishery-dependent, surveys are undertaken at-sea to observe fishery operators checking and hauling their nets (referred to in this report as rob events). Sampling spans inshore and offshore components of the fishery across its spatial extent (Figure 1). Sampling aims to capture variation in region, season, and fishing method. However, sampling is limited by vessel access permissions (i.e. participation in the monitoring program is voluntary), staff safety considerations, and fishery operation size (e.g. small operators may have limited space for an additional person on board and monitoring staff cannot replace a deckhand). Furthermore, sampling fatigue needs to be avoided where there are only a few operators in the fishery (e.g. offshore GOC). Sampling is therefore opportunistic and, while representative of a diversity of operators who will and can take monitoring staff onboard it may not be representative of the overall fishery activity.

Data from each observed rob event (i.e. a net check or net haul) included the catch location, fishing method, date, net set details (e.g. net length, mesh size, soak time, fishing position), species discarded and fate. Size, sex, and maturity are also recorded where possible. Fin clip and photographic samples are collected to aid accurate species identification. See Appendix A for the SHK01 datasheet and the Biological Sampling Protocol: Shark, 2018-2020 (Fisheries Queensland 2019) for further data collection methods.

For the GOCIFFF, a new sampling season starts each February (commencing February 2019) and continues through to October (finishing October 2020). This fishery does not operate over the summer months due to spawning closures. Sampling quarters are by calendar year:

- 1st quarter - January to March,
- 2nd quarter - April to June,
- 3rd quarter - July to September,
- 4th quarter - October to December.

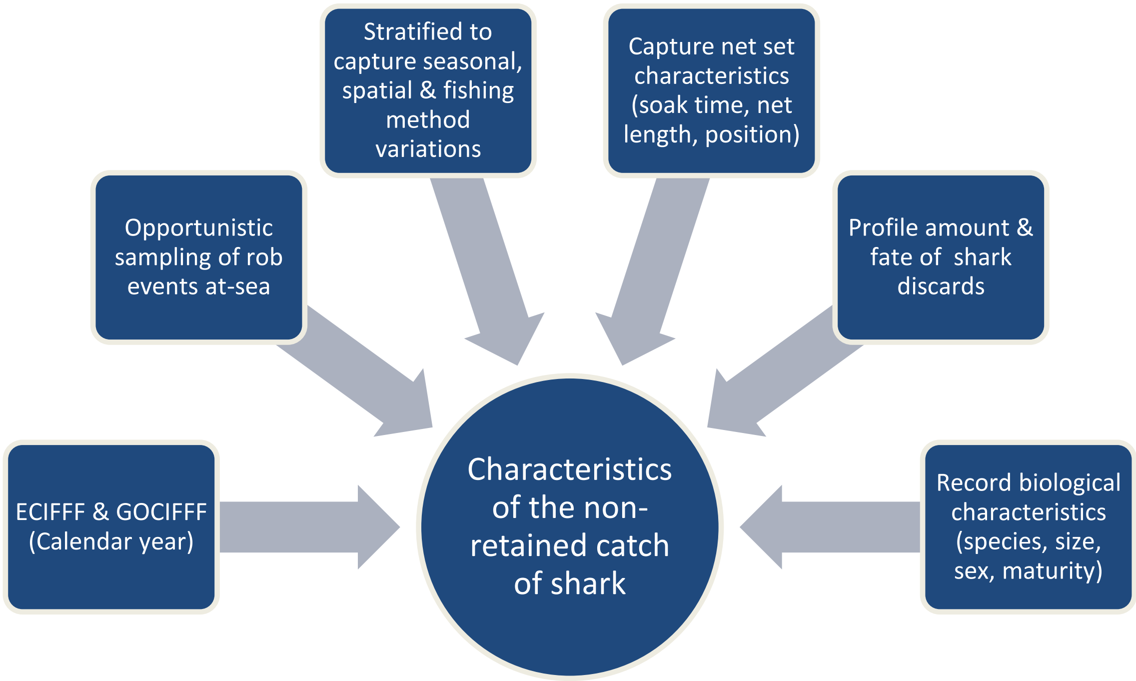

Figure 4 Summary of non-retained catch sampling

Project ethics

Animal ethics approval was sought to cover any interaction staff had with live sharks during the sampling process, such as taking fin clip samples or photographing the animal (AEC reference: CA 2019/08/1309).

A human ethics self-assessment was completed for the phone survey, following the National Statement on Ethical Conduct in Human Research 2007 and the Australian Code for the Responsible Conduct of Research.

Species identification and verification

The monitoring program sought to collect high-quality data on species composition. Fisheries Queensland monitoring staff were trained in shark species identification and provided with a range of learning tools to minimise species identification errors in the field. Further, species identification in the field was validated post sampling using photographic samples and genetic samples.

Visual species identification training and competency checks

Morphological based species identification is a practised skill. A suite of training materials was developed to assist monitoring staff competently identify shark species using morphological features and taxonomic keys. Fishery Monitoring staff initially participated in practical workshops hosted by both researchers with high levels of experience in shark identification, and the Ichthyology curator at the Queensland Museum. During the workshops, staff encountered a large variety of species of both fresh and preserved samples. Monitoring staff then completed two further practice tasks, identifying sharks from sets of 40 and 20 photos respectively, using taxonomic keys.

Figure 5 A series of photographs illustrating at-sea data collection capturing the variation of fishery operations that interact with shark

Fisheries Queensland's monitoring staff also completed a series of desktop-based training and competency testing modules specifically developed for the program. Species commonly encountered in inshore net fishing operations were split into five groups with a training module and an accompanying competency quiz available for each (Figure 6). The five groups cover:

- blacktip whaler species (6 species)
- hammerhead species (4 species)
- medium to large bodied whaler species (8 species)
- weasel sharks and small bodied whaler species (8 species)
- whitetip and iconic shark species (9 species)

The training modules help staff commit to memory species-specific anatomical features for 35 species. The testing modules employ a variety of question formats including both visual and text-based questions to identify gaps in staff knowledge. Fishery monitoring staff complete a competency check at least once annually and were encouraged to retrain after any break from fieldwork. If a result lower than 80% is achieved on any quiz, staff are encouraged to spend more time training on the related species group before retesting.

It is helpful to reference various published identification guides for shark and ray identification as each guide can highlight different features and images. Reference materials, including Last and Stevens (2009), Compagno et al. (2005) and Ebert et al. (2013), were used to aid both field identification and identification of the photographic samples. In addition, a desktop-based non-linear key 'Shark and Ray ID Assist' (Queensland Shark and Ray ID tool - Lucid Web Player (lucidcentral.org) was developed and used to assist with species identification of the photographic samples. The tool is based on knowledge compiled from existing taxonomic reference materials and is built in Lucid (Figure 7). The mobile app version of 'Shark and Ray ID Assist', is in test phase and is capable of working on the IOS and Android systems.

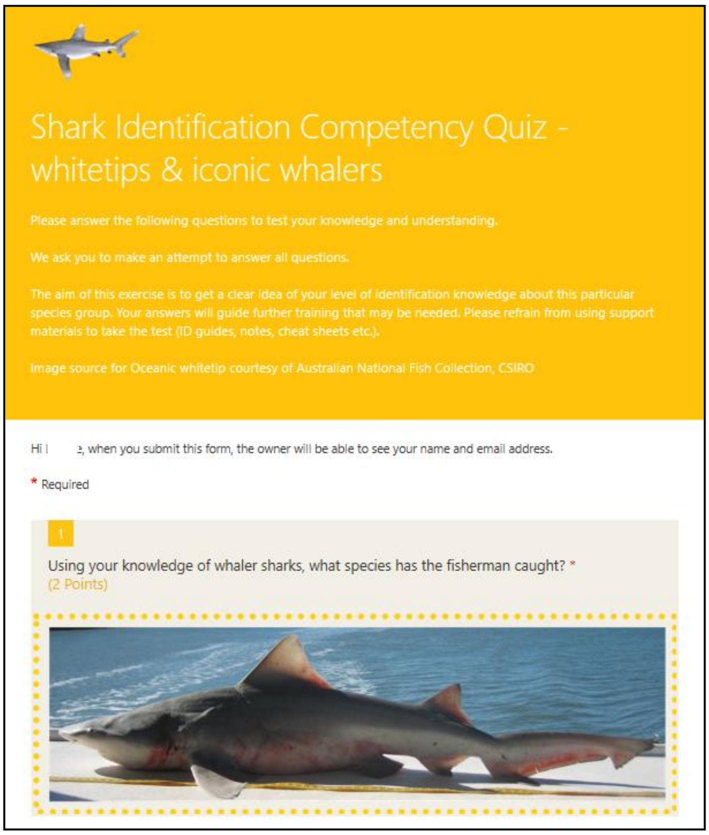

Figure 6 An example competency test hosted in Microsoft Forms, allowing for online distribution and automated feedback. A variety of question formats were used, incorporating both visual and text-based questions

Photographic samples

Photographic samples are collected to address a few purposes, including:

- verifying field species identification
- identifying species on return from the field when monitoring staff require assistance with positive identification of particularly challenging samples
- cross-referencing with the genetic species identification results.

In addition, photographic samples that have an accompanying genetic sample can be used in a genetically verified image reference library.

Genetic species identification

Genetic samples are collected to verify the monitoring staff's visual identification of sharks in the field. Genetic samples are also collected to enable species identification where a visual identification was not possible. For example, where the animal is incomplete (i.e. a trunk or barrel, Figure 3) or visual identification is inconclusive to a species level.

The genetic sample is taken from the animal's fin or body. Mitochondrial DNA is extracted from the tissue, and the NADH dehydrogenase subunit 4 gene (NDH_4) is amplified using polymerase chain reaction (PCR). Purified PCR product is sent to a third party for Sanger Sequencing. For each sample, sequence data is checked by eye, converted into consensus sequences using Geneious R11 (Geneious, 2018 https://www.geneious.com) and compared to reference sequence data using GenBank (Figure 8). The genetic laboratory methods are described in detail in the Biological Sampling Protocol: Shark, 2018-2020 (Fisheries Queensland 2019).

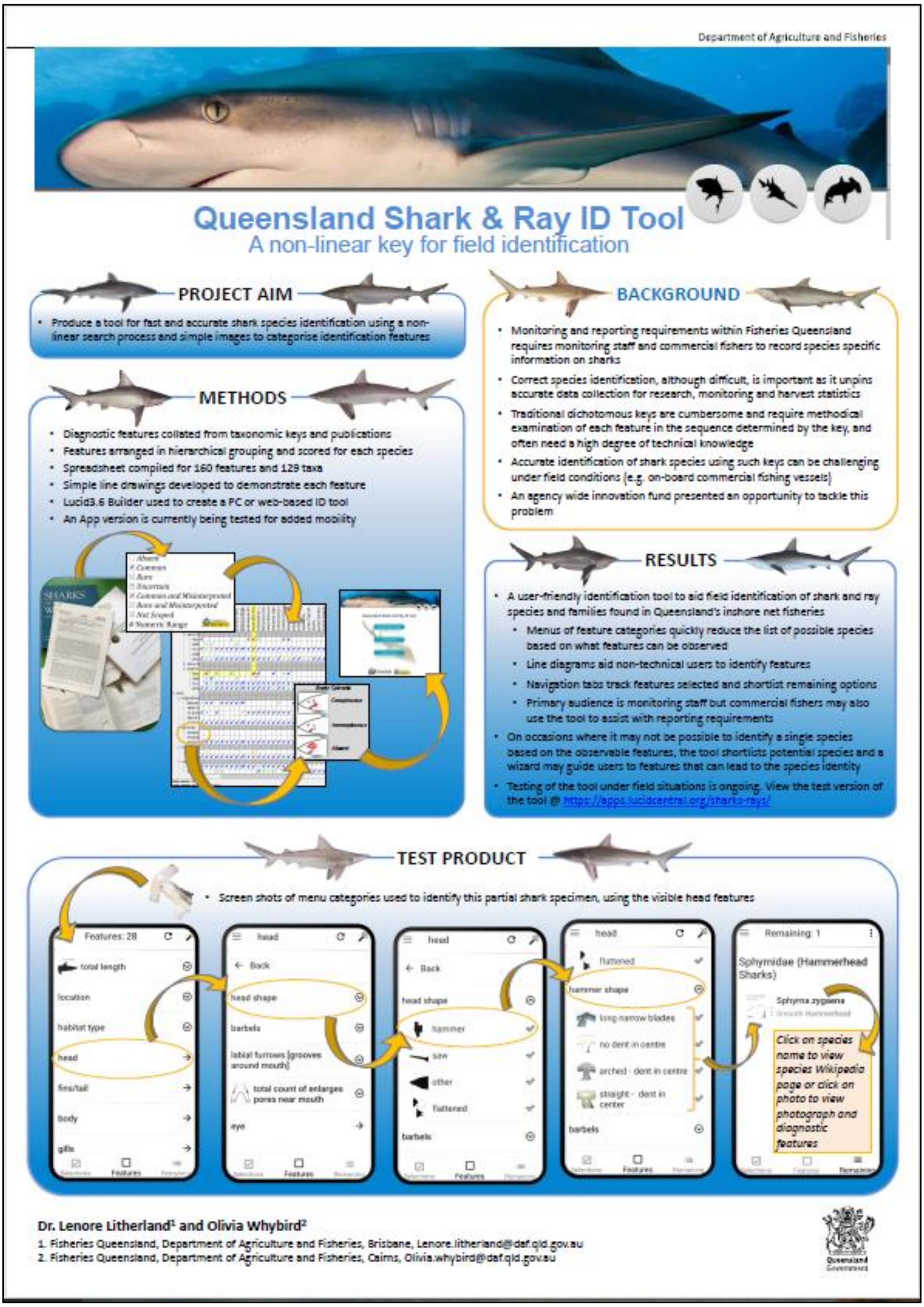

Figure 7 Development of the Shark and Ray ID Assist tool

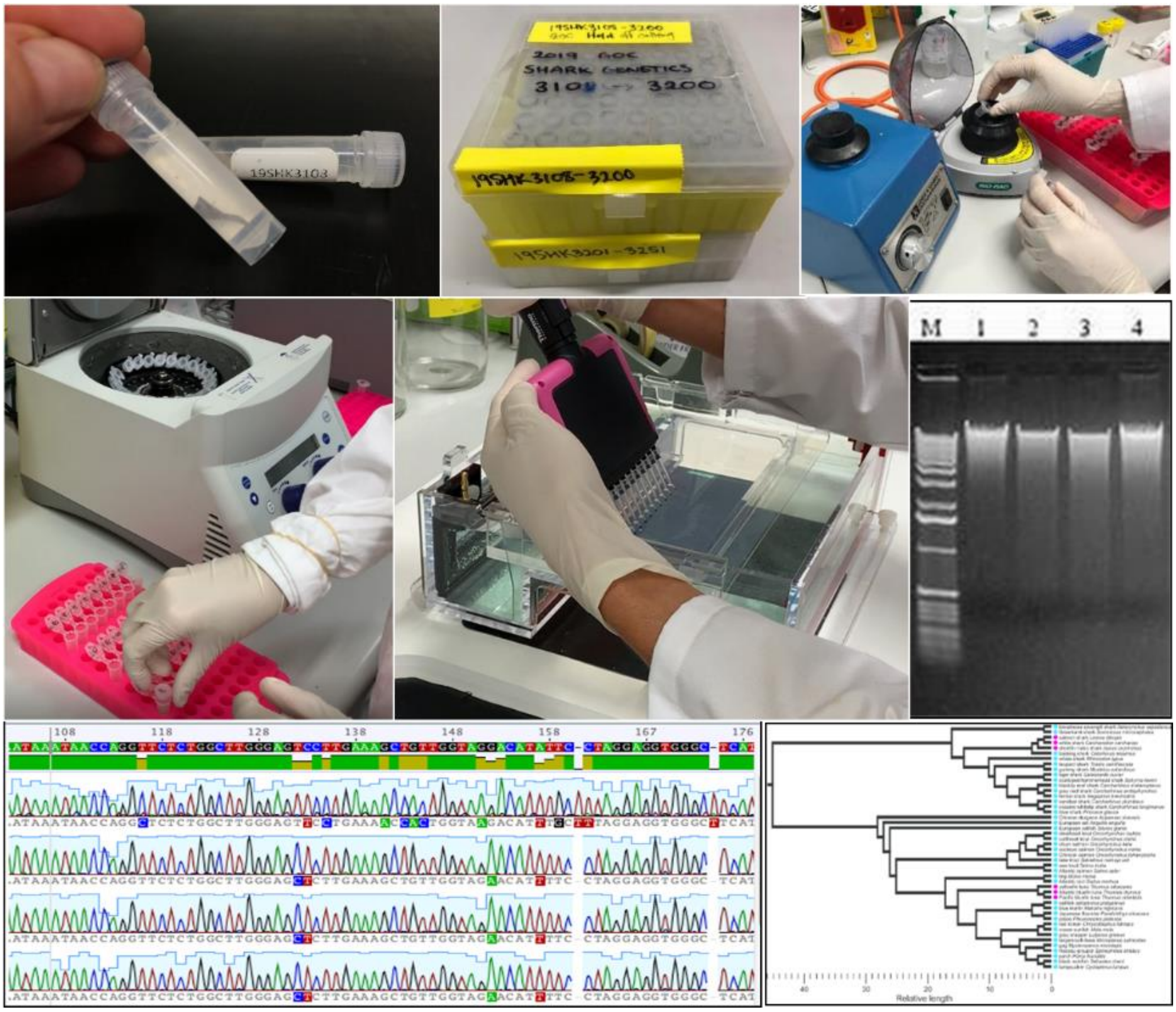

Figure 8 Processing of genetic samples for species identification L-R (Top to Bottom): fin clip samples. Extraction of mitochondrial DNA for polymerase chain reactions (PCR). Preparing gel electrophoresis prior to enzymatic purification and sequencing. Analysis of sequencing results (in Geneious) and plotting sequence divergence for species identification

Verification and quality assurance of the data

After each sampling event, monitoring staff undertake detailed data verification and checking. Care is taken to ensure photographic samples and genetic samples are stored correctly and to remove field data recording errors before data entry. For retained catch sampling at a seafood processor, the fisher is contacted directly to verify the catch data and to check the data collected is a representative sample of the fishers catch and not from a partial or graded catch. This is an important step as some fishers will split their catch into ‘A’ grade and ‘B’ grade or send different product to different markets. These splits can be based on species or size, which would bias the data if only one part of the catch was sampled.

Where a species identity was not assigned visually in the field, the photographic samples are consulted by trained staff to determine a species identity. Spot checks were also made to corroborate the morphological species identity assigned in the field. Focusing on commonly misidentified species, photographic samples are randomly cross-checked for species identification and compared to that assigned in the field.

Entered data is checked using a range of tools developed specifically by Fisheries Queensland's fishery monitoring team and includes a visual comparison of the raw dataset against the database as well as a suite of checking queries.

Results

Supplementary documents to this report that cover procedural details of sampling and data handling, as well as further technical data summaries, are available on request.

Program overview

The shark monitoring program provided a detailed investigation of the catches of shark in the ECIFFF and GOCIFFF (Figure 9). The program addressed its core objectives of collecting data on the species composition of the retained shark catch and developing a profile of the discarded shark catch within the ECIFFF and GOCIFFF. Monitoring staff collected data from 202 retained catches and observed 601 individual rob events between 2018 and 2020. Across the program, 28 species of shark were recorded in the monitoring data with the most frequently encountered species being the Australian blacktip (*Carcharhinus tilstoni*, 21% of the program records by number), the spot-tail shark (*C. sorrah, 17%*), the common blacktip (*C. limbatus, 12 %*) and the Australian sharpnose shark (*Rhizoprionodon taylori*) (9%). Together these species constituted 59% of the total program records by number. The scalloped hammerhead (*Sphryna lewini)* was the most frequently encountered hammerhead species in the data and contributed 7% of the total program records by number. The great hammerhead (*S. mokarran*) and the winghead shark (*Eusphyra blochii*) each made up 1% of total records. Only one smooth hammerhead (*S. zygaena*) was recorded in the monitoring program.

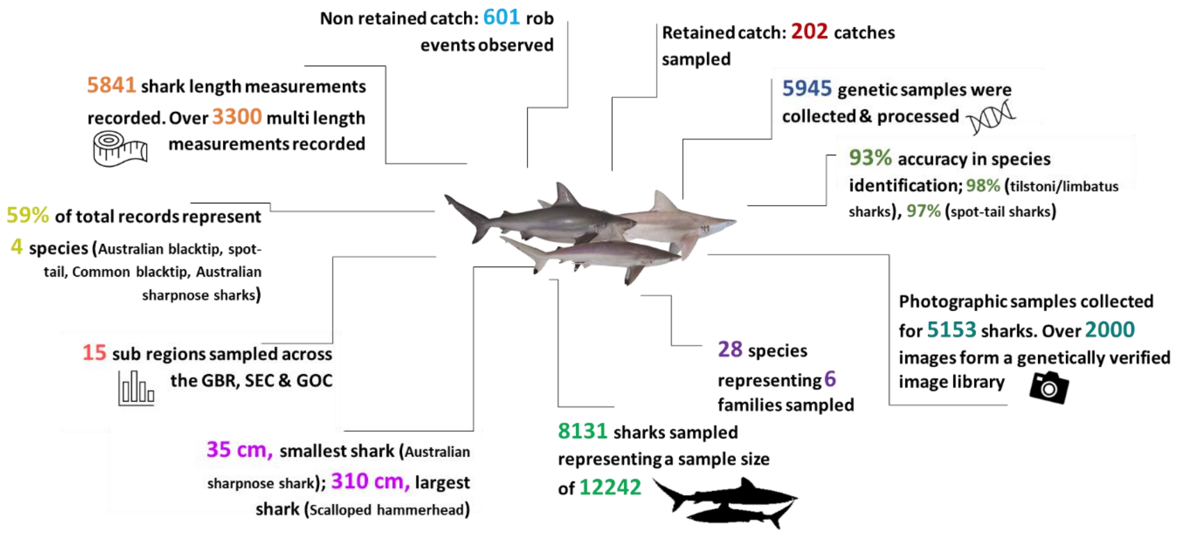

Figure 9 Monitoring program sampling overview

Across the program 8200 individual records were documented, when scaled for the percentage of the catch representatively sampled, this represents a sample of 12 269 individuals. Of the 8200 animals recorded, 8131 were shark species in Queensland catches, representing a scaled sample of 12 242 individual sharks. Of these records, 6878 (85%) had either genetic samples (5908) or images (970) recorded to enable verification of species identity. Records, where the species identity remained unknown, constituted 0.4%. Further to this, three samples could only be identified to the family level (two = Orectolobidae, one = Sphyrnidae). In addition, C. *tilstoni, C. limbatus* and their hybrids are recorded as a species complex in the data. An accurate split of *C. tilstoni, C. limbatus* and their hybrids using CO1 was not attempted in the current study and these are grouped in the data as *C. tilstoni/limbatus* complex for reporting purposes (*see section on Genetic Species Identification for further details)*.

The monitoring program did not separately record data on species of conservation interest (SOCI). If a SOCI interaction did occur, staff reminded fishers of their SOCI reporting obligations. SOCI shark species (white shark, shortfin mako, grey nurse shark or speartooth shark) were not observed in the sampled retained or non-retained catch.

The smallest shark recorded in the program was a 35 cm (TL) Australian sharpnose shark. The largest shark was a 310 cm (TL) scalloped hammerhead, followed by a 295 cm (TL) great hammerhead. Multiple length measures (e.g. fork length, pre caudal length, total length and interdorsal length) were taken for over 3300 individuals to establish length conversions. These length conversions are useful for those records where a total length could not be recorded (e.g. where the product form was a trunk or barrel). Length data is sufficient to provide a species length frequency for at least ten species (e.g. spot-tail shark, scalloped hammerhead, blacktip sharks – *C. tilstoni/limbatus* complex, bull shark, milk shark, Australian sharpnose shark, spinner shark, creek whaler, great hammerhead and pigeye shark).

The monitoring data can be used:

- to identify the species composition of the retained catch including seasonal patterns and regional trends
- to identify size composition, sex ratio and maturity profiles for the retained catch overall and for more than eight species (spot-tail shark, scalloped hammerhead, blacktip shark *C. tilstoni/limbatus* complex, milk shark, Australian sharpnose shark, spinner shark, bull shark, pigeye shark)
- to profile the species composition of the accessible non-retained (discarded) catch including seasonal patterns and regional trends
- to profile the size composition, sex ratio, maturity, and fate characteristics for the accessible non-retained (discarded) catch
- as a library of shark genetic tissue samples, extraction samples and sequence samples for use in future research projects, including shark population characteristics for 13 species
- as a library of genetically validated species images for use in future species identification tools or machine learning identification projects.

A variety of regional, temporal and fishery strata are available for examining the monitoring data. For this report, data will be primarily presented at the regional strata of shark quota regions (GOC, GBR, SEC) and temporal strata of sampling year.

Genetic samples

The sequencing of genetic material collected from fin clips proved useful for determining the identity of 28 species of chondrichthyans (26 sharks, two rays). Genetic sampling was especially critical when monitoring staff sampled a catch that included animals missing key morphometric features (i.e. the product form is not whole). Without this technique, sample sizes (number of catches sampled) for the retained catch would have been greatly reduced across the entire monitoring program and confidence in species identification data for the retained and non-retained catch would have been reduced. A total of 5945 genetic samples were collected, of these 5913 were successfully processed through the program (Table 2), 5908 were from sharks. Across the program only 14 samples returned a failed sequence, and 18 samples were unprocessed as of December 2020.

Table 2 Number of genetic samples collected

Species	*CAAB Code*	*Genetic samples (number)*
Australian blacktip	37018014	1193
Common blacktip	37018039	1036
Australian sharpnose shark	37018024	768
Spinner shark	37018023	710
Scalloped hammerhead	37019001	460
Spot-tail shark	37018013	418
Pigeye shark	37018026	334
Bull shark	37018021	248
Milk shark	37018006	200
Creek whaler	37018035	111
Hardnose shark	37018025	70
Graceful shark	37018033	63
Weasel shark	37018020	52
Great hammerhead	37019002	49
Whitecheek shark	37018009	47
Winghead shark	37019003	41
Nervous shark	37018034	34
Fossil shark	37018011	24
Lemon shark	37018029	13
Dusky whaler	37018003	12
Slit eye shark	37018005	11
Blacktip reef shark	37018036	8
Narrow Sawfish	37025002	3
Grey reef shark	37018030	2
Smooth hammerhead	37019004	2
Giant Shovelnose Ray	37027010	2
Grey Carpetshark	37013008	1
Tiger shark	37018022	1
Total		**5913**

Photographic samples

Photographic samples were valuable for corroborating the species identity post sampling. Photographic samples were collected for 5153 individuals. Of these, 2328 are from whole animals; the remainder are from partial animals (i.e. where the head or some or all fins may have been removed). A total of 4030 shark records with a photographic sample had a corresponding genetic sample. These records form the basis of a shark species image library where individuals have been genetically verified (Table 3). This image library has ongoing value for use in species identification training materials and future electronic monitoring.

Species identification

Species identification could be confirmed through genetic screening for 73% of sharks recorded in the monitoring data (5908 out of 8131 sharks). A further 12% (970 individuals) had a suitable photographic sample (i.e. of a whole animal) to verify the field identification, and the remaining 15% of records relied solely on species identification in the field.

To quantify the level of misidentification for visual species identification in the field, a comparison of genetic species identification with visual species identification was made. This included records where both data fields (visual species and genetic species) recorded a species identity (1888 records). The comparison found that 7% of individuals were not correctly assigned to their genetically identified species. However, the level of misidentification varied between species.

Monitoring staff achieved 100% accuracy for 10 species (Fossil shark, whitecheek shark, nervous shark, grey carpet shark, weasel shark, scalloped hammerhead, dusky whaler, tiger shark, winghead shark, lemon shark). Misidentifications were quite low (2-3%) for species frequently encountered in the harvest. Staff achieved greater than 95% accuracy for two species that dominated catch records – *C. tilstoni/limbatus* complex (98%) and spot-tail sharks (97%). These results indicate that for those records where only a field identification was available, species misidentification would represent a minor quantity of the records.

Overall, monitoring staff achieved 86% accuracy for the bull shark and the pigeye shark. These two species are renown by field biologists to be commonly misidentified. In the monitoring data, these two species were mostly misidentified as each other: 13 records (23%) were incorrectly identified as a bull shark and 18 records (11%) were incorrectly identified as a pigeye shark. Monitoring staff achieved 83% accuracy for the milk shark and the Australian sharpnose shark. These two species were most frequently misidentified as each other: 14 records (15%) were incorrectly identified as a milk shark and 15 records (14%) were incorrectly identified as an Australian sharpnose shark. Monitoring staff achieved 82% accuracy for the spinner shark. This species was most frequently misidentified as a blacktip shark *C. tilstoni/limbatus* complex: 12 records (13%). The most misidentified species were infrequently encountered in the survey. The slit eye shark (*Loxodon macrorhinus*) was recorded in only a single catch. The sliteye shark was misidentified as a milk shark for six records within this catch, which accounted for 55% of records for that species.

Table 3 Number of genetically verified photographic samples

Species	***Photographic samples (Number)***
Common blacktip	829
Australian sharpnose shark	723
Australian blacktip	635
Spinner shark	334
Spot-tail shark	325
Scalloped hammerhead	266
Pigeye shark	213
Bull shark	158
Milk shark	144
Graceful shark	56
Creek whaler	53
Hardnose shark	45
Weasel shark	40
Great hammerhead	36
Winghead shark	34
Nervous shark	33
Whitecheek shark	33
Fossil shark	21
Lemon shark	12
Dusky whaler	12
Blacktip reef shark	7
unknown	7
Slit eye shark	5
Grey reef shark	2
Smooth hammerhead	2
Giant Shovelnose Ray	2
Grey Carpetshark	1
Smoothnose Wedgefish	1
Tiger shark	1
Total	**4030**

Biological data

The monitoring data includes biological data for length, sex, and maturity, where it was possible to record for an individual. Multiple length measures (fork length, pre caudal length, stretched total length and interdorsal length) were taken for over 3300 individuals to help establish length conversions. These conversions are useful for those records where a total length could not be recorded (e.g. where the product form was a trunk or barrel). An interdorsal length was recorded for 1690 barrels where no other length measurement was able to be measured. These samples covered 22 species, although five species made up 71% of records where only an interdorsal length could be recorded (Australian sharpnose shark 323 records; Australian blacktip 282 records; common blacktip 275 records; scalloped hammerhead 218 records; spot-tail shark 107 records).

Overall, the size structure of the sampled harvest was dominated by animals between 50 and 110 cm total length (Figure 10). Multiple sub peaks in the size frequency data may relate to species, fishery or regional trends. Length data is sufficient to provide a species length frequency for at least ten species (spot-tail shark, scalloped hammerhead, blacktip shark *C. tilstoni/limbatus* complex, bull shark, milk shark, Australian sharpnose shark, spinner shark, creek whaler, great hammerhead and pigeye shark. Due to the small sample size of the discarded catch, species specific size frequencies for discards will not be as robust as for the retained catch.

The 2015 Fisheries Queensland shark stock assessment (Leigh, 2015) assumed equal numbers of males and females in the catch. Overall, the sex ratio of sharks recorded in the retained catch and the discarded catch was approximately equal. However, the monitoring data shows the sex ratio does vary between species (Figure 11). The graceful shark, winghead shark, milk shark, hardnose shark, and scalloped hammerhead show a sex ratio >60% male. The great hammerhead and nervous shark show a sex ratio >60% female.

The monitoring data also indicates, for some species (e.g. the blacktip *C. tilstoni/limbatus* complex, spot tail, and Australian sharpnose shark), larger individuals are predominantly female, while for other species (e.g. the scalloped hammerhead), larger individuals are male (Figure 12). Many shark populations aggregate by sex, so it's possible that the sex ratio observed in the harvest may be different to a population's sex ratio.

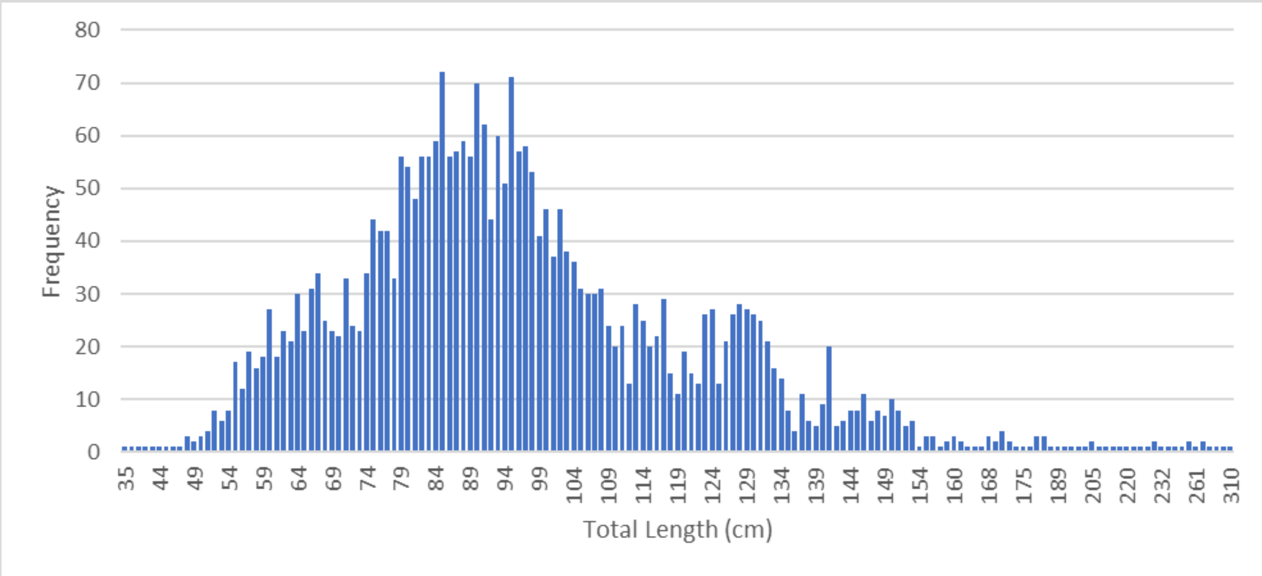

Figure 10 Overall size structure of sharks within the monitoring data

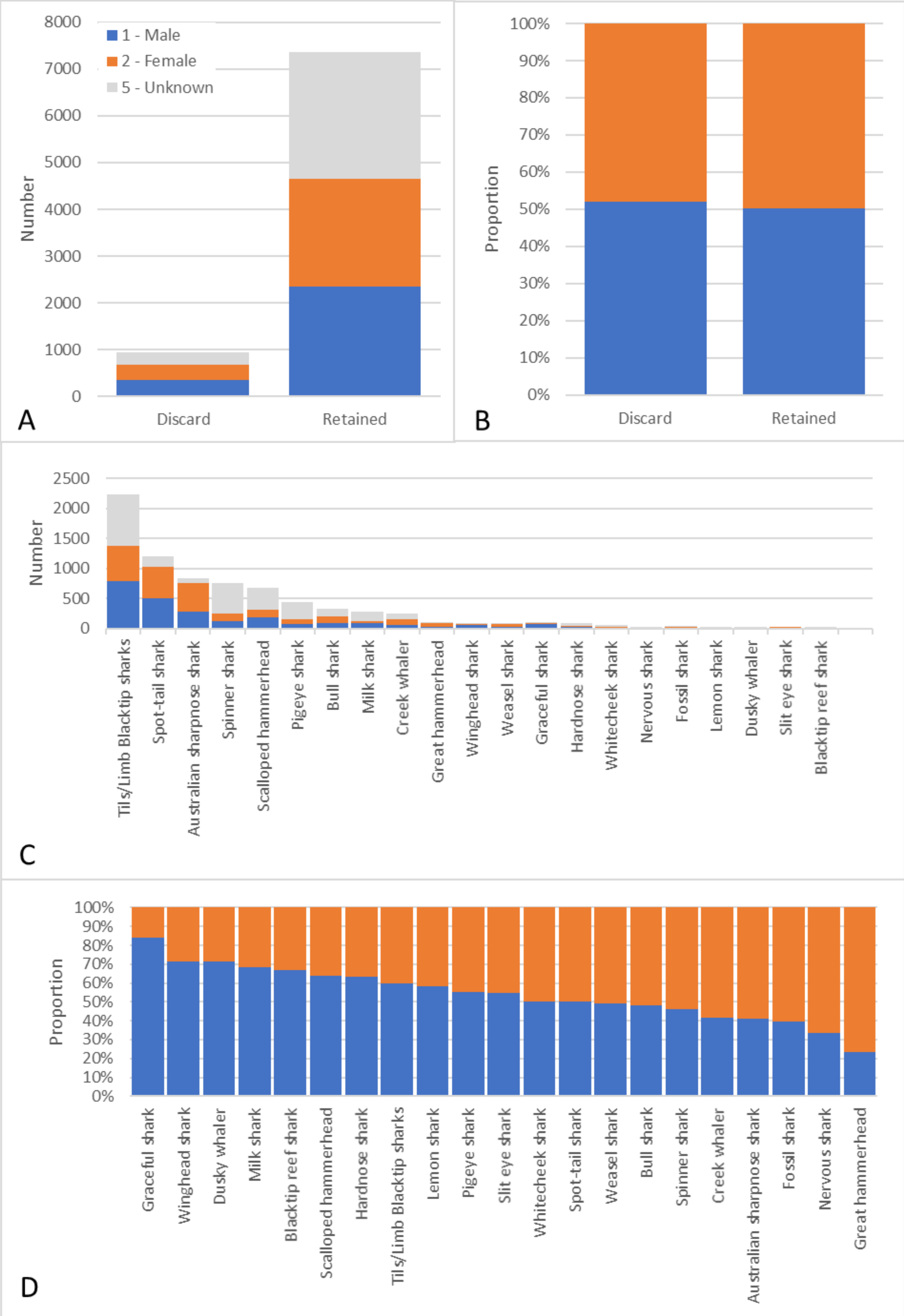

Figure 11 Sex ratio of the retained and discarded catch (A, B) and by species (C, D)

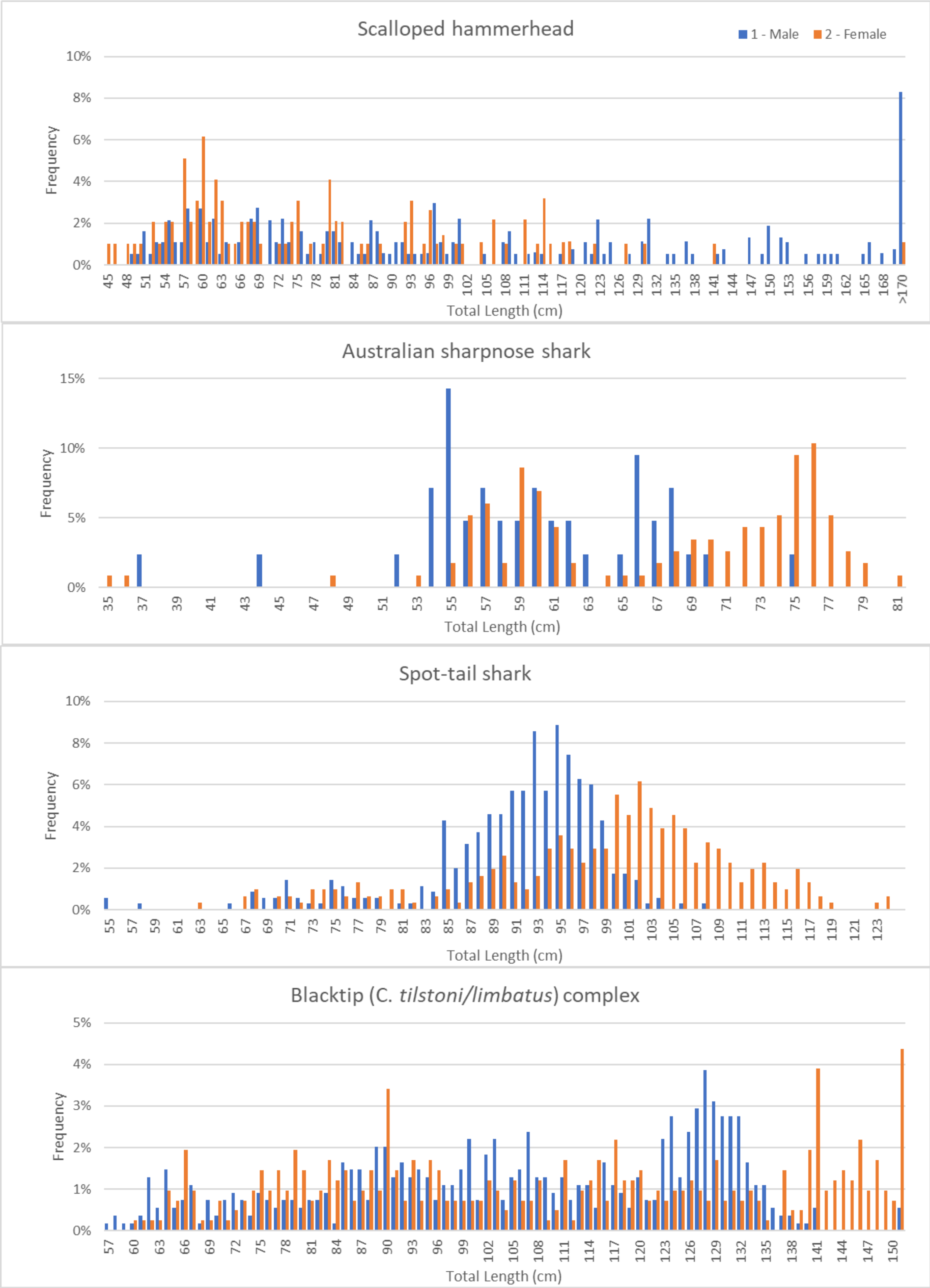

Figure 12 Size structure by sex for four species of shark, highlighting the inter species variability in size characteristics

Retained catch composition

The sampling unit used for monitoring the retained catch in this study is a catch which refers to all landed shark from a fishing event (i.e. a day or trip). A total of 202 catches were sampled during 2018–2019 and 2019–2020 (Table 5). For the GBR and SEC regions, a full year of sampling was completed in 2018–2019, but in 2019–2020 the final quarter was impacted by the health response directives to the COVID-19 global pandemic. For the GOC region, a full year of sampling was completed in 2019; however, 2020 was substantially impacted by the health directive response to the COVID-19 global pandemic (Table 4).

Table 4 Sampling coverage for the retained catch of shark in each fishery

		ECIFFF Financial year sampling				**GOCIFFF Calendar year sampling**				**Program Total**
		2018–2019		2019–2020		2019		2020		
# of catches sampled (by Quarter[1] and total)	**Q1**	17	94	16	77	7	24	7	7	**202**
	Q2	19		19		7		0		
	Q3	32		35		10		0		
	Q4	26		7						
# catches sampled (by region	**GOC**					24		7		**202**
	GBR	35		30						
	SEC	59		47						
# of monitoring regions sampled	**GOC**		10		10	4	4	1	1	**15**
	GBR	6		6						
	SEC	4		4						
# catches sampled with S symbol		86 (91%)		68 (88%)						**90%**
# of species identified by region and total	**GOC**		22		21	13	13	11	11	**22**
	GBR	18		17						
	SEC	16		15						
# of animals sampled[2]	**GOC**		3806		2158	3873	3873	1467	1467	**11304**
	GBR	1304		710						
	SEC	2502		1448						

[1]ECIFFF Quarter 1= July-Sep, 2 = Oct-Dec, 3= Jan-Mar, 4= Apr-Jun
[1]GOCIFFF Quarter 1 = Jan-Mar, 2= Apr-Jun,3= July-Sep, 4 – fishery doesn't operate
[2]sharks sampled from representative catches only, scaled for the percentage of catch representatively sampled
Orange – sampling impacted by health directive response to COVID-19
Grey – NA

In total, 22 species from three families of shark were recorded in the retained catch from the monitoring data. The most species rich family was the Carcharhinidae with 16 species in the catch (Figures 13 and 14, Appendix B). Sphyrnidae had four species in the catch, and Hemigaleidae had two species. The most frequently encountered species overall was the blacktip *C. tilstoni/limbatus* complex, representing 44% of the sampled catch by number. The next most frequently encountered species were the spot-tail shark (18% of the catch by number) and the Australian sharpnose shark (9%). The scalloped hammerhead was the most frequently encountered hammerhead species identified in the catch and overall comprised 7% of the catch by number (Figures 13 and 14, Appendix B). Regional differences were identified in species composition.

In the GBR quota region, 17 species from three families of shark were recorded in the retained catch (Figures 13 and 14). The most species rich family was the Carcharhinidae with 14 species in the catch. The blacktip *C. tilstoni/limbatus* complex was the most frequently encountered species in the GBR catch by number (35% overall; 34% in 2018–2019 and 38% in 2019–2020). This was followed by the scalloped hammerhead (19% overall; 17% in 2018-2019 and 23% in 2019-2020). The Australian sharpnose shark, the spinner shark, the spot-tail shark and the pigeye shark each comprised 5-8% of the catch by number, with contribution varying between years.

In the SEC quota region, 16 species representing three families of shark were recorded in the retained catch (Figures 13 and 14). The most species rich family was the Carcharhinidae with 11 species in the catch. The SEC catch was commonly comprised of three species, the Australian sharpnose shark (23% of the catch by number overall; 27% in 2018–2019 and 18% in 2019–2020), the blacktip *C. tilstoni/limbatus* complex (26% overall; 25% in 2018–2019 and 28% in 2019–2020) and the spinner shark (18% overall; 19% in 2018–2019 and 16% in 2019–2020). The scalloped hammerhead comprised 7% of the catch by number overall (3% in 2018-2019 and 13% in 2019-2020).

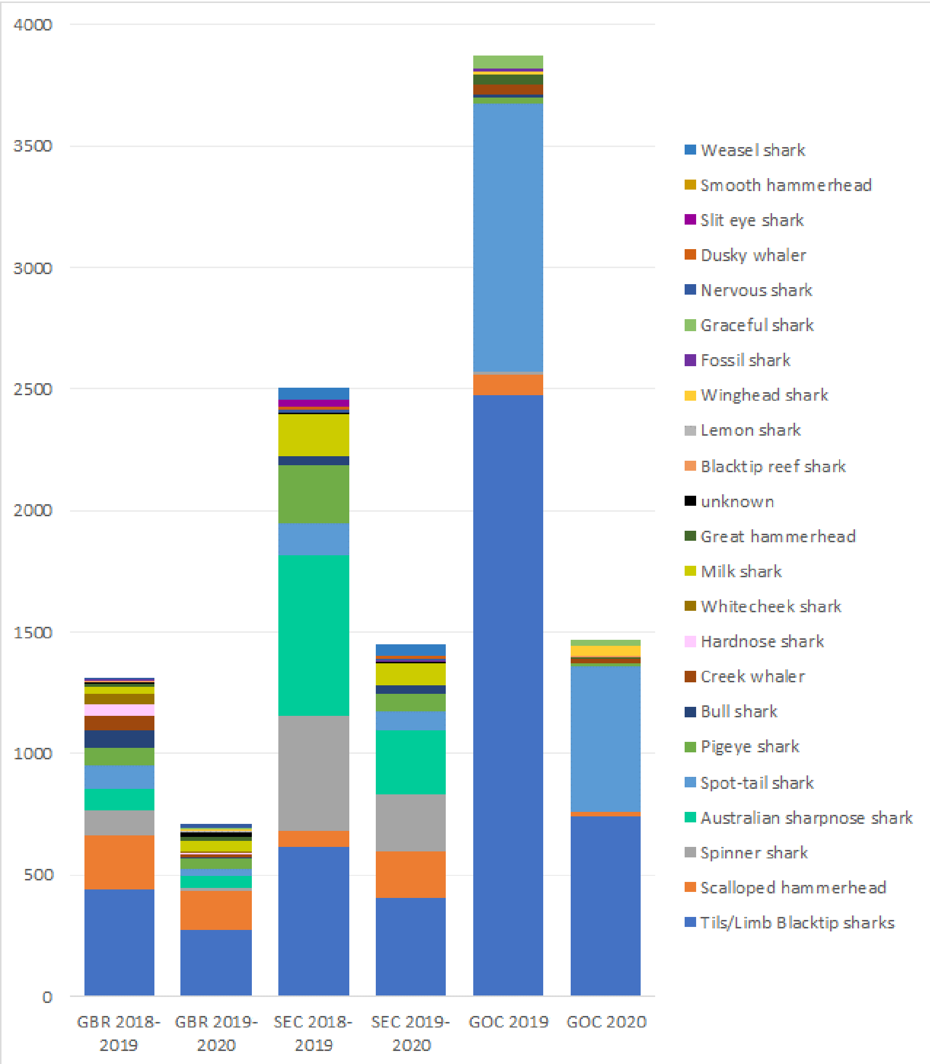

Figure 13 Species composition (number) of the retained catch in each quota region, by sampling year (GBR 2018–19 and 2019–20, SEC 2018–19 and 2019–20, GOC 2019 and 2020). Legend matches order of appearance from bottom to top. See Appendix B for individual species values

In the GOC quota region, 14 species representing three families of shark were recorded in the retained catch (Figures 13 and 14). The most species rich family was the Carcharhinidae with 11 species in the catch. The blacktip *C. tilstoni/limbatus* complex was the most frequently encountered species in the GOC catch (60% of the catch by number overall; 64% in 2019 and 51% in 2020 - noting that 2020 GOC sampling was restricted to a single quarter and region). This was followed by the spot-tail shark (32% overall; 28% in 2019 and 41% in 2020). The scalloped hammerhead comprised 2% of the catch by number overall (2% in 2019 and 1% in 2020).

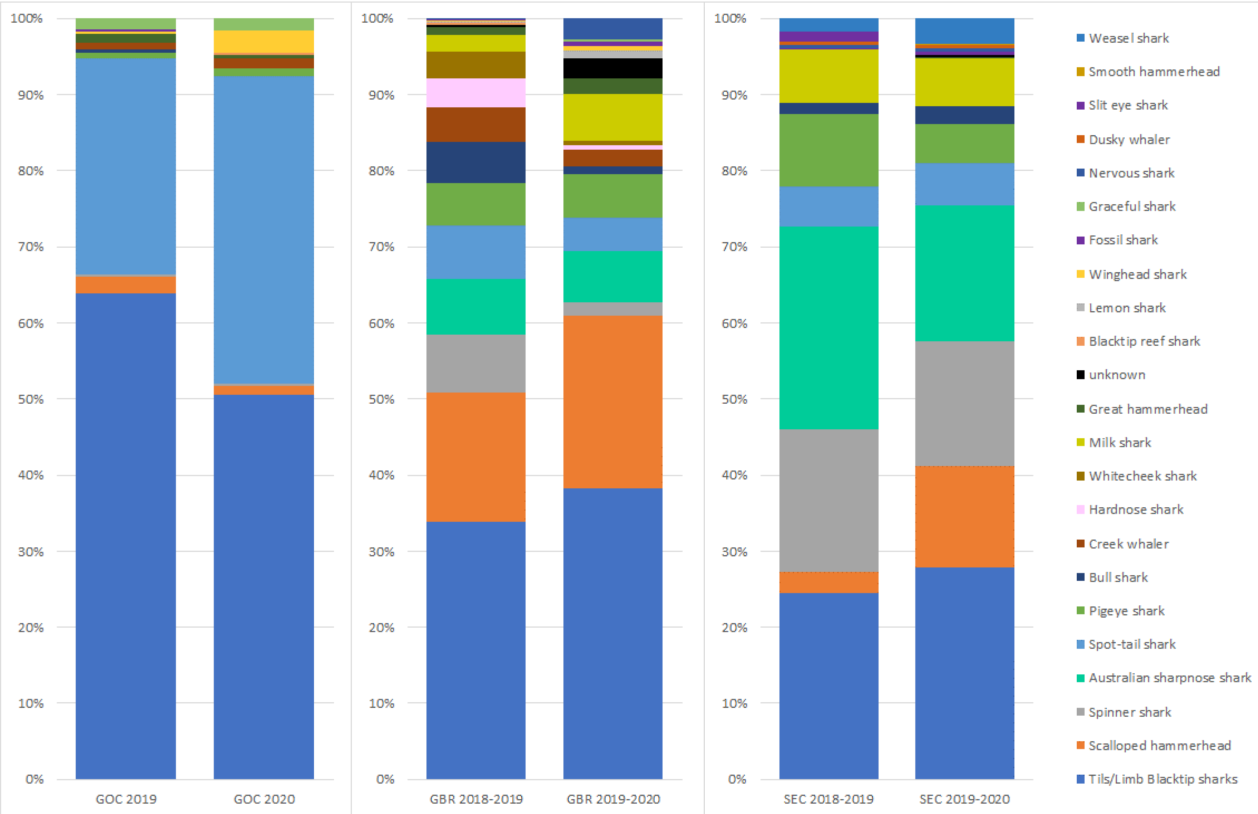

Figure 14 Species composition (percentage) of the retained catch in each quota region, by sampling year (GBR 2018–19 and 2019–20, SEC 2018–19 and 2019–20, GOC 2019 and 2020). Legend matches order of appearance from bottom to top. See Appendix B for individual species values

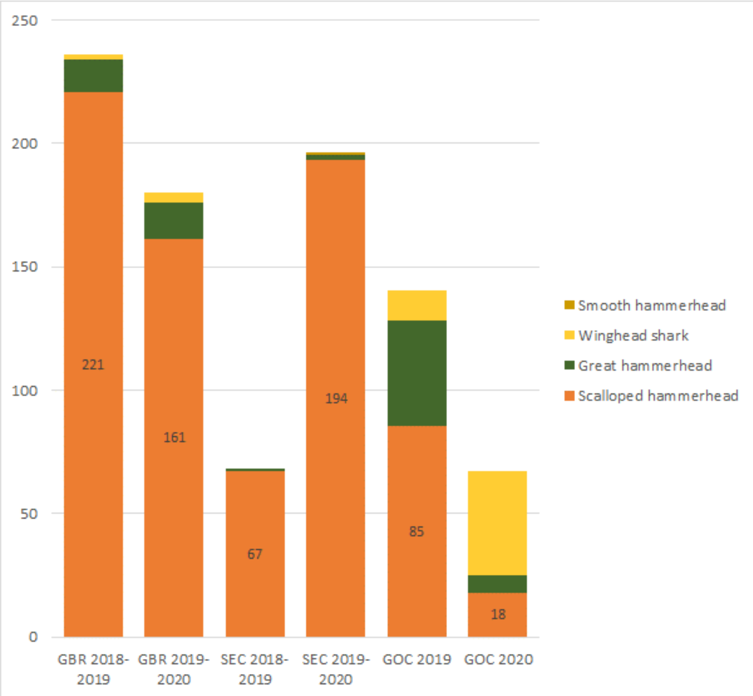

Figure 15 Hammerhead species composition of the retained catch in each quota region, by sampling year (GBR 2018–19 and 2019–20, SEC 2018–19 and 2019–20, GOC 2019 and 2020). Legend matches order of appearance from bottom to top

Non-retained catch composition

The sampling unit used for monitoring the non-retained catch in this study is an individual rob event, which refers to a net haul, net lift, or net check. For each rob event, all the non-retained (discarded) shark product is recorded. A total of 601 rob events were observed during the study (Table 5). A full year of sampling was completed in 2019. Sampling in 2020 was interrupted in March due to the health response directives to the COVID-19 global pandemic (Table 5).

Soak time for rob events describes the time a net was let to soak or ‘fish’ before it was checked, lifted or hauled. The total soak time of all sampled rob events was 3132 hours (equivalent to 130.5 days). A total of 642 soak hours (equivalent to 27 days) were observed in the GBR region, 2374 soak hours (equivalent to 99 days) were observed in the GOC region and 117 soak hours (equivalent to 5 days) were observed in the SEC region.

All sharks that were caught by the fisher were retained in 12% of the observed rob events, while sharks were discarded in 28% of the observed rob events. Of note, the majority of observed rob events (60%) recorded no sharks caught by the fisher. Regional differences were identified in patterns of shark discards. For example, over 60% of rob events in the GBR and GOC regions recorded no sharks being caught, while 39% of rob events in the SEC region recorded no sharks caught. 15% of rob events in the GBR recorded sharks being discarded, while 28% in the SEC and 34% GOC recorded sharks being discarded.

Soak time employed by commercial operators varied substantially between quota regions. Short soak times (i.e. less than one hour in duration) were most frequently observed in the SEC region, with very few operations observed to have a soak time greater than three hours. Soak times between one and three hours in duration were most frequently observed in the GBR region. Soak time between three and five hours in duration were most frequently observed in the GOC. The GOC also had the longest soak times, with the longest observed being 26.75 hours in duration. Short soak times (e.g. less than 4 hours), more frequently resulted in no discards or no sharks caught compared to longer soak times.

Table 5 Sampling coverage for the non-retained catch of shark in each fishery

		ECIFFF Calendar year sampling 2019		ECIFFF Calendar year sampling 2020		GOCIFFF Calendar year sampling 2019		GOCIFFF Calendar year sampling 2020		Program Total
# of robs sampled[1]	GOC		182		50	204	204	165	165	601
	GBR	124		34						
	SEC	58		16						
# of robs sampled - Discards(by Quarter[2] and total)	Q1	13	40	8	8	11	73	51	51	172
	Q2	11		0		14		0		
	Q3	8		0		48		0		
	Q4	8		0						
# of robs sampled - No Discards (by Quarter[2] and total)	Q1	27	142	42	42	6	131	114	114	429
	Q2	70		0		16		0		
	Q3	25		0		109		0		
	Q4	20		0						
# of monitoring regions sampled	GOC		11		7	4	4	2	2	15
	GBR	8		4						
	SEC	3		3						
# of species identified	GOC		18		4	18	18	7	7	24
	GBR	14		2						
	SEC	11		2						
# of sharks sampled	GOC		304		10	534	534	137	137	985
	GBR	258		2						
	SEC	46		8						
Gear type*-mesh size range		1” bin = 1 2” bin = 4 3” bin = 11 4” bin = 44 5” bin = 2 6” bin = 108 7” bin = 3		1” bin = 0 2” bin = 2 3” bin = 0 4” bin = 8 5” bin = 0 6” bin = 36 7” bin = 2		2.75 inch = 1 6.5 inch = 201		2.75 inch = 0 6.5 inch = 165		
Gear type*- net length range		20-92 = 67 100-270 = 42 300-450 = 25 500-600 = 21 700-800 = 20		20-92 = 26 100-270 = 12 300-450 = 6 500-600 = 2 700-800 = 4		20-92 = 101 100-270 = 49 300-450 = 3 500-600 = 16 1500-1800 = 35		20-92 = 149 100-270 = 9 300-450 = 0 500-600 = 2 1500-1800 = 5		

[1]sharks sampled from representative catches only
[2]ECIFFF Quarter 1= Jan–Mar, 2= Apr–Jun,3= July–Sep, 4 Oct–Dec
[2]GOCIFFF Quarter 1 = Jan–Mar, 2= Apr–Jun,3= July–Sep, 4 – fishery doesn’t operate
Orange – sampling impacted by health directive response to COVID-19
Grey – NA

A boat mark was recorded for 21 operators; this equated to 27% of the non-retained catches sampled (i.e. 162 rob events). This was not consistent across the regions. All non-retained catches sampled in the SEC region had a boat mark recorded (100%, 15 boat marks). However, in the GBR region 12% of all non-retained catches had a boat mark recorded (4 boat marks). Likewise, 19% of all non-retained catches had a boat mark recorded (2 boat marks) in the GOC region.

Across the program, rob events were observed in river, foreshore, and offshore gillnet shots. Rob events in rivers were more frequently sampled in the GBR and GOC regions. Rob events in rivers had the longest total observed soak time for each region (60% for GBR, 48% for SEC and 80% for GOC). However, the number of sharks discarded was highest for offshore rob events in the GBR and GOC regions, and foreshore rob events in SEC region (Figure 16).

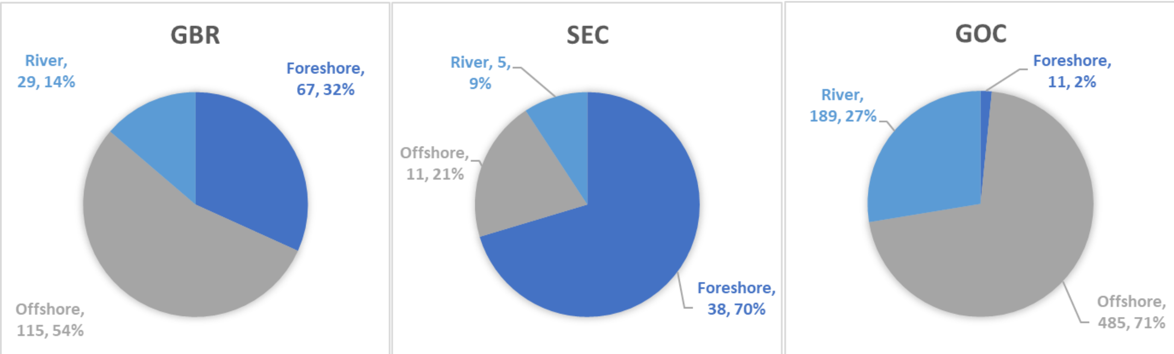

Figure 16 Number and percentage of animals discarded by position for each quota region

Total net length of robs sampled was 154.05 km. 63% of this net length was observed in the GOC region, with 23% observed in the SEC region and 14% observed in the GBR region. Sampled robs covered a variety of net lengths. In the SEC region, the most frequently observed nets were in the 700-800 and 500-600 m categories. This contrasts to the GBR region where the most frequently observed nets were short (e.g in the <100 m category). Similarly, short net lengths were more frequently sampled in the in GOC. Notably, however, the longest net lengths were observed in the GOC region (e.g. 1500-1800 m category).

The largest variety in mesh sized was observed in the SEC region where 12 mesh size categories were observed with the 4-inch mesh category being the most common . In contrast, seven mesh size categories were observed in the GBR region with the 6.5-inch mesh category being the most common. In the GOC region the 6.5-inch mesh category was almost exclusively observed. Most discarded sharks were observed in rob events where a 6.5-inch net mesh was used.

Based on 2019 data only (i.e. a complete sampling year uninterrupted by the COVID 19 pandemic response), 24 species representing six families of shark were recorded in the sampled non-retained catch. The most species-rich family was the Carcharhinidae with 15 species dominating the sampled non-retained catch. The most frequently encountered species overall was the blacktip *C. tilstoni/limbatus* complex, representing 23% of the sampled non-retained catch by number. The next most frequently encountered species was the creek whaler (13%) followed by the pigeye shark (8%) and the scalloped hammerhead (8%). Regional differences were identified in species composition of the non-retained catch (Figure 17, Appendix B).

In the GBR quota region, 14 species representing three families of shark were recorded in the non-retained catch (Figure 17, Appendix B). The most species-rich family was the Carcharhinidae with 10 species documented in the non-retained catch. The blacktip *C. tilstoni/limbatus* complex was most frequently encountered (33% in 2019). This was followed by the creek whaler (23%) and the pigeye shark (23%). The scalloped hammerhead comprised 8% of the non-retained catch.

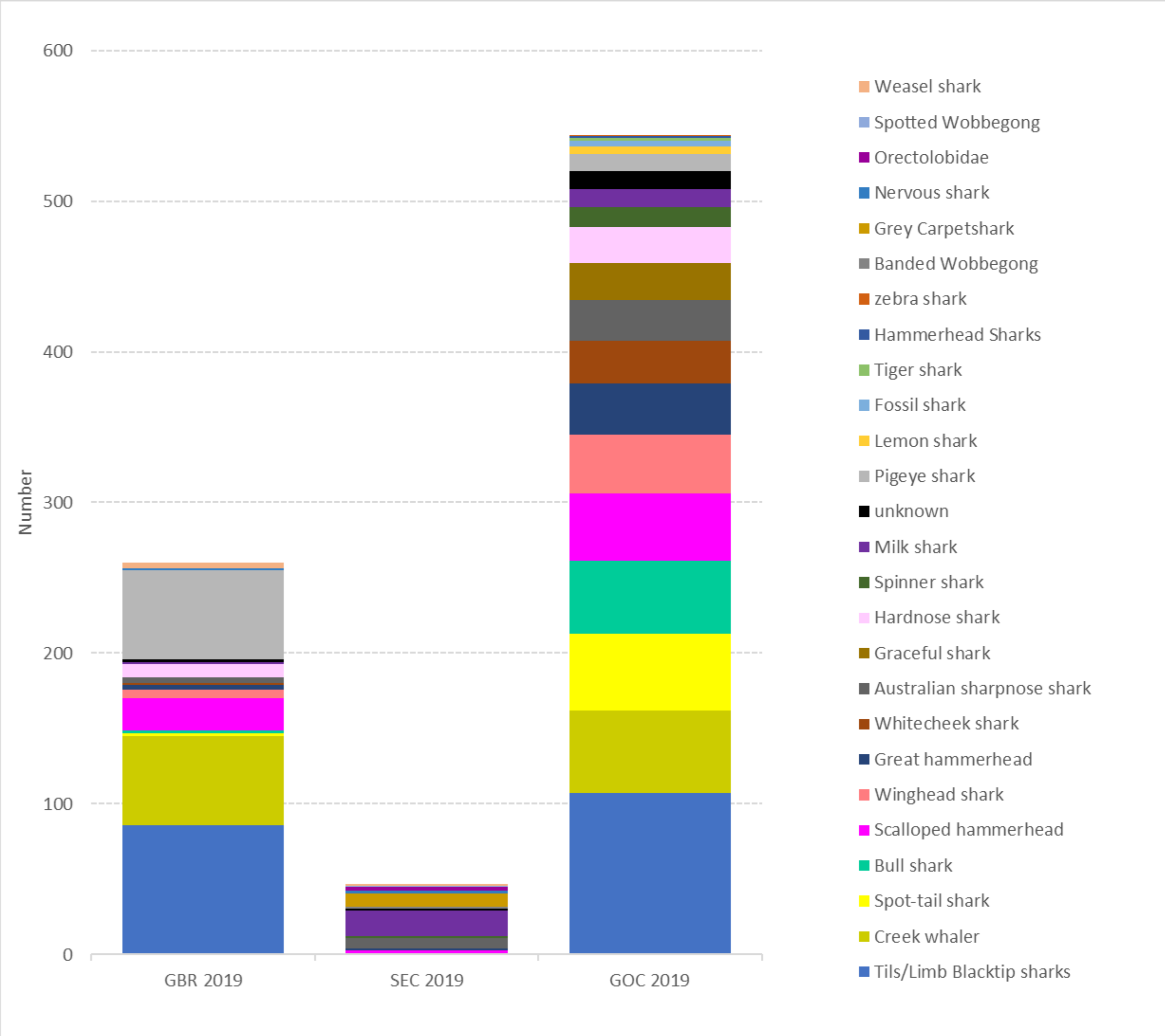

Figure 17 Species composition of the non-retained catch by quota region for 2019. See Appendix B for individual species values. Legend matches order of appearance from bottom to top

In the SEC quota region, 11 species representing five families of shark were recorded in the non-retained catch (Figure 17). The most species-rich family was the Carcharhinidae with five species documented in the catch. The milk shark was most frequently encountered in the SEC non-retained catch (37%, 2019). This was followed by the grey carpetshark (19%) and the Australian sharpnose shark (15%). The scalloped hammerhead comprised 4% on the SEC non-retained catch.

In the GOC quota region, 18 species representing four families of shark were recorded in the non-retained catch (Figure 17). The most species-rich family was the Carcharhinidae with 13 species documented in the catch. The blacktip *C. tilstoni/limbatus* complex was most frequently encountered in the GOC non-retained catch (20%). This was followed by the creek whaler (10%), the spot-tail shark (9%) and the bull shark (9%). The scalloped hammerhead comprised 8% on the GOC non-retained catch.

The fate category applied in this study was binary (alive or dead) to avoid any subjectivity by monitoring staff when determining ‘how alive’ an individual was in varied conditions (e.g. daylight vs night-time sampling events, clear vs turbid water). A fate category was applied to all but two individuals in the non-retained monitoring data.

The percentage of sharks discarded alive varied from 0-100% (Figure 18). All individuals of the fossil shark were dead when discarded. Conversely, all individuals from the Orectolobidae family, the carpet shark and the zebra shark, were alive when discarded. Further to this, 88% of weasel shark were classified as alive when discarded. For the commonly discarded species, 45% of blacktip *C. tilstoni/limbatus* complex, 65% of the creek whaler and 57% of the pigeye shark were released alive. For the hammerhead species, 46% of the scalloped hammerhead, 18% of the great hammerhead and 12% of the winghead shark were released alive (Figure 19).

Overall, river and offshore set nets resulted in lower rates of alive discards (36% and 45% respectively, Figure 18). Monitoring data showed that 85% of sharks discarded in the SEC quota region were released alive; this compares with only 48% and 41% for the GBR and GOC respectively (Figure 18).

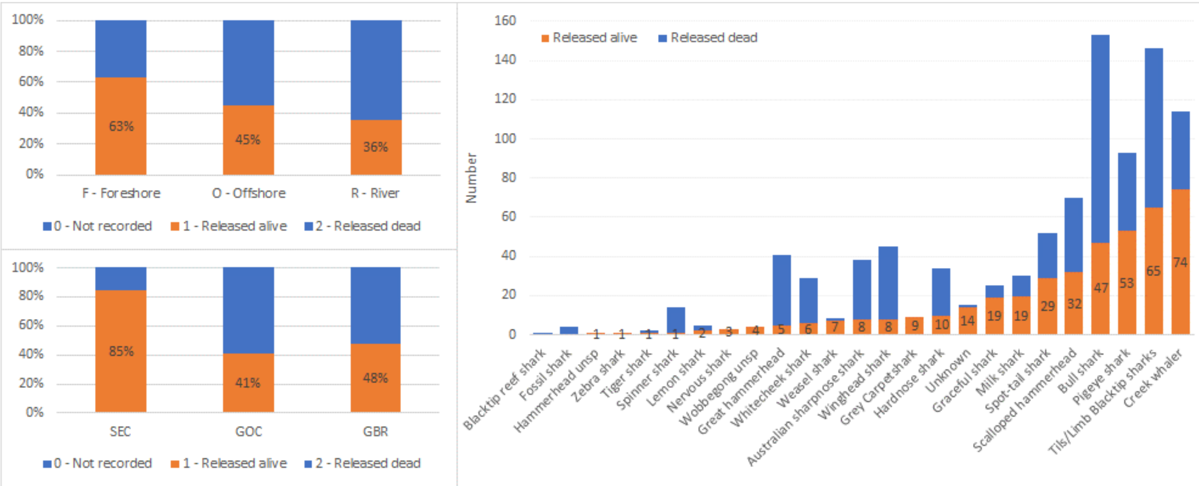

Figure 18 Fate characteristics of the non-retained shark catch. Fate by fishing position (top left), fate by quota region (bottom left), fate by species (right)

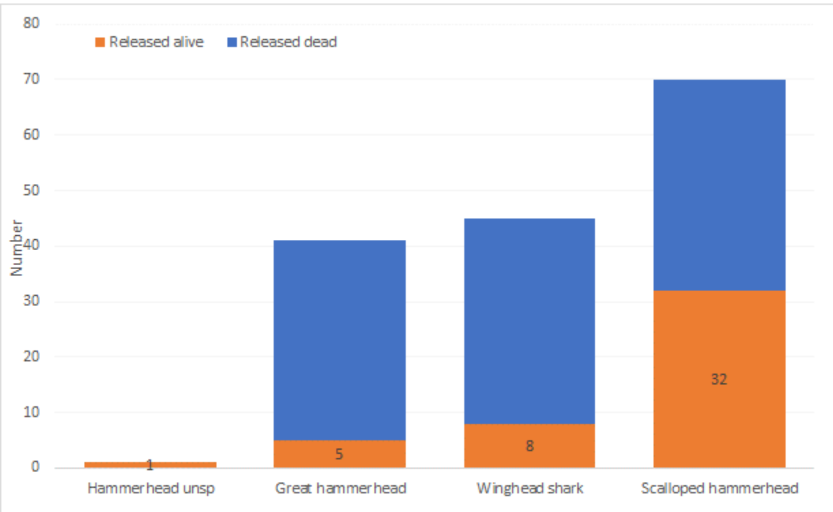

Figure 19 Fate characteristics for hammerhead species

Fishery Discards - Survey

A total of 121 net fishers were interviewed for this study, of which fourteen were part of a pilot survey. Of the fishers in the final survey, 93 were from ECIFFF and fourteen were from GOCIFFF. Most fishers in this survey operated in south-east Queensland (50%), followed by the Great Barrier Reef (29%) and the Gulf of Carpentaria (13%). The survey participants represented various fishing activities, with 40% holding an S symbol.

Results suggest that discarding sharks (live or dead) is common practice in Queensland's net fisheries with 76% of fishers responded that they don't keep a lot or all the sharks they catch. A key finding of the survey was that a combination of regulatory and market forces dictates whether fishers keep sharks. When sharks are retained, 80% of fishers indicated the market is the reason for keeping sharks, with 28% of fishers saying sharks are important to their business. Overall, these survey results suggest that the policy changes enacted in January 2018, requiring additional reporting of shark catch including 1-hour prior reporting, may have encouraged net fishers to discard more sharks. The survey highlighted that many fishers without an S symbol had been mistakenly under the impression that they were required to wait the one hour before landing, a requirement only for fishers with an S endorsement. The requirement to wait an hour before landing for S symbol holders has now been removed as part of the current regulatory reform process.

A comprehensive summary of the fisher interviews is presented in Teixeira et al. 2018 (http://era.daf.qld.gov.au/id/eprint/6437/).

Discussion

The survey methods in this current study ensured monitoring covered broad spatial and temporal interactions with netting operations in the ECIFFF and GOCIFFF. Fisher collaboration in the monitoring program is, however, entirely voluntary. As part of the broader Fisheries Queensland's monitoring programs, monitoring staff endeavour to establish and retain productive, long-term, working relationships with a large diversity of fishers from across Queensland's commercial fishing fleets. Because of this, most fishers were receptive to participating in the retained catch sampling events.

Sampling of the retained shark catch set out to be representative of the harvest. In the ECIFFF, sampling targeted where and when most shark were being landed. Prior reporting through AIVR and contact networks with fishers assisted staff to coordinate this sampling effort. Sampling the retained shark catch in the GOCIFFF was approached differently by necessity. Most of the shark catch is recorded in the offshore fishery (N12), where sharks are processed and packed at-sea. As such, sampling of the retained catch in the N12 occurred primarily at-sea on the commercial vessels. Moreover, this fishery has a small number of operators who typically undertake long fishing trips. It was necessary to manage sampling fatigue (for fishers) along with other sampling logistics to obtain a representative sample of the harvest.

Fisher collaboration in at-sea observation of the non-retained catch in the ECIFFF and GOCIFFF was less forthcoming. This was for various reasons ranging from operators being unwilling to host monitoring staff, to operators who were willing but unable to host staff. Many operators are limited in their capacity to take an additional person (e.g. monitoring staff) on board, especially if monitoring staff were not going to 'replace' a deckhand. Monitoring staff where neither trained as, or experienced, deckhands. A substantial amount of staff time was invested in liaising with fishers and arranging at-sea trips. For each completed trip, several other potential trips would have been arranged and cancelled due to factors such as weather, vessel maintenance or timing.

Many fishers, especially in the GOC, operate in very remote areas. Fishers can use bush camps as a base, making it difficult for staff to access the operator at short notice to undertake sampling events. Others spend extended time at-sea requiring monitoring staff to be selective of when and for how long they join the vessel to sample due to the logistical restrictions on getting the staff member on and off the vessel.

These challenges impact how representative of the fleet non-retained catch sampling can be. The non-retained catch data may not fully represent fleet level characteristics even though the program observed rob events across a broad array of netting operations within the ECIFFF and GOCIFFF (equivalent to 3132 soak hours and >150 km of net). Reconstruction of the non-retained catch data to develop fleet level metrics is recommended before direct comparison with the retained catch sampling data, which is considered representative of the fleet's catch.

Travel and work restrictions were put in place between March 2020 and October 2020 in response to the health directives to the COVID -19 pandemic. These restrictions severely affected sampling effort for the program during 2020. ECIFFF retained catch sampling in the last quarter (April-June) was restricted to the month of June and resulted in a low number of catches sampled during this final quarter of the sampling year. GOCIFFF retained catch sampling was more severely impacted with access blockages to Gulf of Carpentaria communities. In 2020, sampling only took place in the first quarter of the sampling year for one sampling region. Accordingly, monitoring data for the GOCIFFF retained catch may not be representative of the 2020 fishing year.

Sampling was also restricted for non-retained catch sampling due to the health response to the COVID-19 pandemic. For both the ECIFFF and GOCIFFF monitoring data for the non-retained catch may not be representative of the 2020 fishing year. In both fisheries, sampling ceased after the first sampling quarter (January–March) and did not recommence during 2020.

The top 15 species recorded in the Fishery Observer Program (FOP) data (Leigh, 2015) were all encountered in the monitoring data. Some species recorded in the FOP data were not present in the monitoring data and are more likely to be encountered in fisheries other than coastal gillnetting (e.g. whitetip reef shark, sandbar shark, silky shark, silvertip shark, cat shark, gummy shark, dogfish, gulper shark, crested hornshark, tawny shark, angel shark, Galapagos shark). Two species, the grey sharpnose shark (*R. oligolinx*) and the speartooth shark (*G. glyphis*) were present in low numbers in the FOP data and can potentially interact with coastal gillnets but were not recorded in the monitoring data. The speartooth shark is an extremely rare species with a limited distribution (Pillans et al. 2009) and the current study conducted only limited sampling in the few Queensland locations where it has been recorded. Last and Stevens (2009) noted only one validated record exists for the grey sharpnose shark in Australia and it has a similar size and appearance to the Australian sharpnose shark, *R. taylori*. The current study could genetically confirm the presence of only the Australian sharpnose shark, *R. taylori*. The FOP and logbook datasets also record a low occurrence of bronze whalers (*C. brachyurus*). This species was not recorded in the monitoring data and is acknowledged by shark biologists to not occur in Queensland waters. The term Bronze whaler is colloquially used to refer to a number of Carcharhinid whaler species including the dusky shark. One record of an additional species, the zebra shark, was recorded in the monitoring data.

The FOP data records the great hammerhead, the scalloped hammerhead and the winghead shark as dominant species in the discarded catch followed by the bull shark and the milk shark (Leigh 2015). This contrasts with the monitoring data that recorded the blacktip *C. tilstoni/limbatus* complex, the creek whaler, the pigeye shark and then then scalloped hammerhead as the most dominant species in the discarded catch (Figure 17). Regional variation in the species composition of the discarded catch was evident in the monitoring data. The apparent shift in dominant species in the discarded catch between the FOP and the monitoring data may be related to spatial and temporal differences in sampling between the two monitoring programs as well as sampling across a different suite of commercial operators. The current study encompassed a broader temporal and spatial sampling design than the FOP. This result may also indicate a shift in fisher activity or behaviour since the FOP, which ceased in 2012. Anecdotally, fishers have reported to monitoring staff that they now attempt to avoid setting nets where they know they are more likely to intercept hammerhead species.

Fisheries Queensland's fishery monitoring team have developed the capacity for routine processing of fin clip samples for genetic species identification using the NADH dehydrogenase subunit 4 gene (NDH_4). It is noteworthy that NDH_4 is not reliable for distinguishing between *Carcharhinus limbatus*, *C. tilstoni*, or hybrids of these two species (J. Morgan, *pers comm.* 2018). These species, and their associated hybrids also cannot reliably be distinguished from external morphometrics in the field by fishers and researchers and are reported in logbooks as a combined species category. Genetic samples that have been identified as *C. limbatus* or *C. tilstoni* in the monitoring data using the NDH_4 gene can undergo a second sequencing step using the cytochrome oxidase subunit I (COI) gene to provide a more accurate indication of the *C. tilstoni/limbatus*/hybrid mix in the harvest. This process was not completed within the current project and is a recommendation for future project work. The *C. tilstoni/limbtaus* complex comprise a large portion of the retained and discarded catch and the relative proportion of each species from this complex within the harvest would be informative for future stock assessments.

The genetic samples, together with the DNA extractions and sequences obtained through the monitoring program, form the basis of an extensive library of genetic data for more than 15 species of sharks in Queensland. This is one of the largest collections of shark genetic tissue, and as such, this library has ongoing value for other research projects. The monitoring team is collaborating with research groups to utilise these resources to improve the overall knowledge of shark stocks within Queensland. The library will also be made available to the broader scientific community through elasmobranch tissue sharing websites (e.g. Otlet).

The extensive datasets from the monitoring program will provide detailed species briefs for future stock assessments. These and other recommendations for future work are outlined in Table 6.

Table 6 Areas of work for future consideration

1	**Estimating the overall species assemblage and fate of sharks discarded from the ECIFFF and the GOCIFFF.**	
	Need	Fisheries Queensland requires an estimate of total shark discards partitioned into alive and dead, by species, for Queensland inshore net fisheries (ECIFFF and GOCIFFF).
	Issue	Fleet dynamics and sampling logistics inhibit direct comparisons of the retained and non-retained monitoring data. Retained catch data is considered representative of the fleet, non-retained catch is not considered representative of the fleet and likely biased towards operations that either could or would allow monitoring staff aboard their vessels. A subset of the monitoring data, where both the retained and non-retained catch was concurrently sampled can provide interim proportions of retained : discarded. However, this data is biased towards small catches as it is generally not feasible to representatively sample the retained and discarded catch concurrently when a large number of animals are encountered.
	Potential solution	The monitoring program has collected data on the species composition and fate of discarded and retained sharks in the ECIFFF and GOCIFFF. The integration of this monitoring dataset with the logbook dataset may allow researchers to estimate the species mix and total amount of discards for the commercial fishery. In addition, vessel tracking was introduced in the ECIFFF and GOCIFFF in January 2018. This may provide yet another source of information to integrate with the monitoring dataset.

		A modelling project could use the discards data collected by the monitoring program and the logbook reported effort based on fishery sector. The fishery method (which may or may not include the S symbol), region, season, year and potentially other environmental measures could be used to reconstruct the data to represent discards across the entire fishery. A similar method was used by Tony Courtney to estimate sea snake captures by the East Coast Otter Trawl Fishery. http://frdc.com.au/Archived-Reports/FRDC%20Projects/2005-053-DLD.pdf

2	**Species briefs for stock assessments**	
	Need	The most recent shark stock assessment (Leigh 2015) incorporated all key harvest species. Future stock assessments aim to be more species focused. Species-specific catch characteristics will greatly aid the accuracy of the stock assessment outputs.
	Issue	Species-specific trends and characteristics have been limited for past shark assessments.
	Potential solution	The monitoring data has sufficient samples sizes to investigate the catch demographics for approximately ten species. Species briefs can be developed in conjunction with the stock assessment team to collate all suitable data and highlight species-specific trends and insights. From the monitoring data: • # sampled, # harvested, weight harvested • sex ratio, size composition • length relationships • fate, fate by sex • species prevalence – region and season (proportion by number, proportion by weight) sampled and weighted by harvest • gear selectivity characteristics. From literature: • size at maturity, size at birth, max. size, max. age, age at 50% maturity, age at 95% maturity by se • litter size, pupping interval • seasonality of breeding • Von Bertalanffy growth parameters.

3	**Validation of logbooks**	
	Need	Logbook validation is an ongoing requirement for WTO approvals.
	Issue	Validation mechanisms are still under development by Fisheries Queensland and interim mechanisms are being investigated. In general, fishery monitoring data is collected in a deidentified manner. The current monitoring program diverged slightly from this norm and formally recorded a fishers boat mark when sampling a non-retained catch, but only where a fisher did not object to it being recorded.
	Potential solution	A small percentage of the monitoring data is accompanied by a boat mark and could be cross-validated with the logbook's records.

4	**Ongoing monitoring of the retained shark catch**	
	Need	A time series of accurate species-level information for shark catches in the ECIFFF and GOCIFFF is most informative for stock assessments and will help address WTO approvals.
	Issue	Like most fisheries, the shark catch shows inherent interannual and seasonal variation. One year of monitoring data exists with a second partial year available (due to COVID-19 pandemic health response related sampling restrictions).
	Potential solution	Fisheries Queensland's monitoring team are equipped to carry out representative retained catch sampling for shark with a high level of species accuracy should there be an ongoing or future requirement to obtain additional years of data. This sampling can integrate with other fishery dependent monitoring activities. In addition to ongoing data collection, detailed analysis of the existing monitoring dataset could inform priority areas for data validation efforts.

5	**Ongoing monitoring of the non-retained catch**	
	Need	A time series of species-level information for shark discards in the ECIFFF and GOCIFFF is most informative for stock assessments and will help address WTO approvals.
	Issue	Non-retained catch sampling via at-sea observations is opportunistic and, while representative of operators who will and can take monitoring staff onboard, it may not be representative of the overall fishery activity. Furthermore, on-board sampling it is extremely resource-heavy and can encounter numerous logistical challenges that impact data quality.
	Potential solution	Fisheries Queensland's monitoring team are equipped to carry out non-retained catch sampling for shark should there be an ongoing or future requirement to obtain additional years of data. This sampling can integrate with other fishery dependent monitoring activitiesand may be a suitable gap filler until alternative electronic monitoring options come online. In addition to ongoing data collection, detailed analysis of the existing monitoring dataset could inform electronic monitoring strategies and data validation efforts. For example, identifying priority areas to target for future on-board monitoring trips to observe discards or priority areas for placing electronic monitoring cameras on-board vessels.

6	**Species identification training tools for commercial fishers**	
	Need	Commercial fishers are required to accurately identify sharks to the level of species or species group in their logbooks.
	Issue	Accurate shark species identification in the field using morphometrics is challenging, and there is low confidence in logbook species reporting.
	Potential solution	Fisheries Queensland's fishery monitoring team have developed a range of training materials to assist with shark species identification. These could be re-focused for commercial fishers and made available to facilitate their species identification capacity and improve reporting confidence.

7	**Photographic library of shark species**	
	Need	Electronic monitoring with species ID capacity could be the best chance of obtaining representative data on the non-retained catch.
	Issue	Images of accurately identified species for artificial intelligence machine learning underpin successful electronic monitoring. At the start of the monitoring program, few image resources could be relied on for accurate shark species identification.
	Potential solution	Images that are coupled with a genetic verification of the species have been collated through the monitoring program and are available as an image reference library. Many images of a single species are required for successful machine learning, as such other research projects and partners (fin blue line and NT fisheries) could be potential collaborators for this topic.

8	**Genetic sample and sequence data library**	
	Need	Knowledge of stock boundaries is important for purposeful management and realistic stock assessments
	Issue	Population structure for many shark species that interact with the GOCIFF and ECIFFF are undefined.
	Potential solution	Genetic samples and sequence data obtained thought the monitoring program (for species identification) can also be used to determine stock structure. Collaborations with researchers at UQ are underway to use sequence data to look at population structure for a range of species. In addition, the genetic sample library can be posted on tissue sharing websites (e.g. Otlet) to expand this work through collaborative projects.

9	**Harvest proportions of the blacktip (*C. limbatus/ tilstoni*) complex**	
	Need	The blacktip *C. tilstoni/limbatus* complex dominates the retained and non-retained catch. These two species and their hybrids have different life history attributes, yet they are unable to be visually separated reliably. As such they are classified as a complex in the logbooks. The 2015 shark stock assessment split the blacktip *C. tilstoni/limbatus* complex based on latitude. All *C. tilstoni, C. limbatus* or hybrids in GOC or EC south to shoalwater (approx. 22.7) are arbitrarily assigned *C. tilstoni,* and south of 22.7 they are assigned *C. limbatus*. Shoalwater was considered a natural break between huge bays with abundant mudflats and straighter coastlines with direct access to the ocean. In addition, the FOP observed few blacktips around Shoalwater (Leigh, 2015). A more reliable method for determining the proportions of each of these species in the catch would afford a more robust assessment of each stock.
	Issue	The split assigned for the 2015 stock assessment is a rough approximation (Leigh 2015). The exact latitude is subject to high uncertainty, and complete segregation is an oversimplification of the population structures. A more realistic approach would be to determine the relative proportions of *C. limbatus, C. tilstoni* and hybrids by monitoring region from the current monitoring data using the genetic samples collected through the program. The monitoring program used NDH_4 genetic sequencing due to its reliability for species determination. However, NDH_4 doesn't pick up the *C. tilstoni/limbatus* hybridisation accurately. A second sequence run using the CO1 gene is required for this.
	Potential solution	Using genetic samples identified as blacktip *C. tilstoni/limbatus* complex in the monitoring data, fin clip samples can be sequenced at the CO1

		gene to separate out the *C. tilstoni, C. limbatus* and hybrids. All genetic samples or alternatively a subset of the genetic samples could be used. J. Morgan (DAF, Animal Science) is a potential project partner.

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Appendix A – SHK01 datasheet

SHK01 (Shark Datasheet)
DAF. Fisheries Queensland

Session ____________
Page ________ of ________
Verify ____________
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Session Details

ETR/Tallied? Yes / No | Photo's uploaded? Yes / No | Genetic samples checked? Yes / No   Trip report #: ____________ SurveyID: ____________ SessionID: ____________

Session (Your Initials | DDMMYY)	Sampling Location
_ _ _ | _ _ _ _ _ _	
Comments	

Site Details

Catch Code	Catch Location	Date Caught (dd/mm/yyyy)	Sampling Activity Code	Fishing Method Code	S symbol (Y/N)	Non-retained catch sampling event only: Total Net length (m)	Mesh Size (mm)	Soak time (H:mins)	Position	Boat Mark
		/ /								
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Sample Details

Catch Code	Sample #	% catch sampled	Sub sample	Total catch	Comments

Sector Code	Sampling Activity Code	Fishing Platform Code	Fishing Method Code		Position	Non-retained catch event fields
Default as	75- Commercial processor FM measured	Default as	00 - Unknown	44 - Tunnel Net	F-Foreshore	Total net length
3 - Commercial	76- Commercial fisher FM measured	1- Boat	04 - Gill Net	64 - Haul Net	R-River	Soak time
	77-Commercial fisher targeted otolith survey		34 - Ocean Beach Netting		O-Offshore	Mesh size, Position
	78- Commercial fisher fishing ground survey					Boat mark: OPTIONAL

SHK01 (Shark Datasheet)
DAF. Fisheries Queensland

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Page ________ of ________
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Catch Details

Sample #	Species Name/	CAAB Code	Fish number	Photo number (# eg P0001 or P0001-2; session added after #)	Length 1 (mm)	Length Type 1 Code	Length 2 (mm)	Length Type 2 Code	Length 3 (mm)	Length Type 3 Code	Length 4 (mm)	Length Type 4 Code	Length 5 (mm)	Length type 5 Code	Sex Code	Reproductive Stage	Sample type	Fate Code	Comments (i.e. interdorsal ridge)

Length Type Code		Fish Number	Photo #	Sex Code	Reproductive stage- shark		Sample type	Non-retained catch sampling event: Fate Code
0- Not recorded	21-Clasper length (males)	YRSHK####	Enter : P0001 etc	1 - Male	1 – Neonate (males & females)	5 / Blank=Unknown	1 -whole (not altered)	0- Not recorded
1 - Fork Length	22- DA inter dorsal for barrels	EC-N= 0001-2000	Will auto fill with	2 - Female	2 – Juvenile (males)		11- trunked (no head with fins)	1- Released alive
19 - Pre-caudal length		EC-S= 4001-6000	Session later	5- Unknown	3- Adolescent (males)		12- Barrel (no head, some/ no fins)	2- Released dead
20 - Total length (stretched)	2 - Total Length (natural)	GOC = 2001-4000	LEL180618P0001		4 – Mature (males & females)		13- fins only; 14- partial sample	

Appendix B – Species composition tables

Table B1: Retained catch composition by quota region strata for two survey years

		Species frequency (%) by region and survey year						
		GBR		SEC		GOC		
Species	***CAABCode***	**2018-2019**	**2019-2020**	**2018-2019**	**2019-2020**	**2019**	**2020**	**Whole program**
Australian sharpnose shark	37018024	7	7	27	18	0	0	**9**
Blacktip complex	37018039 & 37018014	34	38	25	28	64	51	**44**
Blacktip reef shark	37018036	<1	0	0	0	0	<1	<1
Bull shark	37018021	5	1	1	2	<1	0	**1**
Creek whaler	37018035	5	2	0	0	1	1	**1**
Dusky whaler	37018003	0	0	<1	<1	0	0	<1
Fossil shark	37018011	<1	1	<1	<1	<1	<1	<1
Graceful shark	37018033	<1	<1	0	0	1	2	**1**
Great hammerhead	37019002	1	2	<1	<1	1	<1	**1**
Hardnose shark	37018025	4	1	0	0	<1	0	<1
Lemon shark	37018029	<1	1	<1	0	0	0	<1
Milk shark	37018006	2	6	7	6	0	0	**3**
Nervous shark	37018034	<1	3	<1	<1	0	0	<1
Pigeye shark	37018026	6	6	10	5	1	1	**4**
Scalloped hammerhead	37019001	17	23	3	13	2	1	**7**
Slit eye shark	37018005	0	0	1	0	0	0	<1
Smooth hammerhead	37019004	0	0	0	<1	0	0	<1
Spinner shark	37018023	8	2	19	16	<1	<1	**7**
Spot-tail shark	37018013	7	5	5	6	28	41	**18**
unknown	99999004	<1	3	<1	<1	0	0	<1
Weasel shark	37018020	0	0	2	3	0	0	**1**
Whitecheek shark	37018009	4	1	0	0	<1	0	<1
Winghead shark	37019003	<1	1	0	0	<1	3	**1**

Table B2 Non-retained catch composition by quota region strata for one sampling year (2019) compiled from 601 rob events.

Species	*CAABCode*	*Species frequency (%) by region*			
		GBR	**SEC**	**GOC**	**Whole Program**
Australian sharpnose shark	37018024	2	15	5	**4**
Banded Wobbegong	37013001	0	2	0	<1
Blacktip complex (C. tilstoni/limbatus)	37018039 & 37018014	33	2	20	**23**
Bull shark	37018021	1	0	9	**6**
Creek whaler	37018035	23	0	10	**13**
Fossil shark	37018011	0	0	1	<1
Graceful shark	37018033	0	0	5	**3**
Great hammerhead	37019002	1	2	6	**4**
Grey Carpetshark	37013008	0	19	0	**1**
Hammerhead unspecified	37019000	0	0	<1	<1
Hardnose shark	37018025	3	0	4	**4**
Lemon shark	37018029	0	0	1	**1**
Milk shark	37018006	<1	37	2	**4**
Nervous shark	37018034	<1	4	0	<1
Orectolobidae unspecified	37013900	0	4	0	<1
Pigeye shark	37018026	23	0	2	**8**
Scalloped hammerhead	37019001	8	4	8	**8**
Spinner shark	37018023	0	2	2	**2**
Spot-tail shark	37018013	1	0	9	**6**
Spotted Wobbegong	37013003	0	2	0	<1
Tiger shark	37018022	0	0	<1	<1
Unknown species	99999004	1	3	2	**2**
Weasel shark	37018020	2	3	0	**1**
Whitecheek shark	37018009	<1	0	5	**3**
Winghead shark	37019003	2	0	7	**5**
Zebra shark	37013006	0	0	<1	<1