

Coastal Line Fishery

Harvest Strategy

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Acronyms	Full form
BRUVs	Baited Remote Underwater Videos
CLF	Coastal Line Fishery
CPUE	Catch Per Unit of Effort
ERA	Ecological Risk Assessment
ESD	Ecological Sustainable Development
FRDC	Fisheries Research and Development Corporation
FTO	Fishing Tour Operator
NT	Northern Territory
SRA	Stock Reduction Analysis
SS	Stock Synthesis
TEPS	Threatened Endangered and Protected Species

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1. Introduction

This Harvest Strategy has been developed in line with the *NT Harvest Strategy Policy*, and provides a structured framework for decision making to ensure that the goals and objectives of the Coastal Line Fishery (CLF) are achieved. The intention of this strategy is to provide certainty to users, and improve the operational and long-term sustainable use of resources associated with the CLF.

Application of this Harvest Strategy involves two key steps to be undertaken each year:

1. Use performance indicators (and reference points) to measure and assess fishery performance with respect to an operational objective (or multiple objectives where appropriate); and
2. Utilise pre-determined decision rules to initiate the appropriate management actions that will ensure operational objectives are achieved.

The operational objectives, reference points and decision rules in this Harvest Strategy aim to mitigate ecosystem impacts and are in line with the long-term fishery goals for the CLF.

This Harvest Strategy has been implemented in advance of the Coastal Line Fishery Framework and will be incorporated into the framework upon its implementation.

2. Description of the fishery

The CLF is the name of the multi-sector fishery that spans the entire NT coastline, from the high water mark to 15 nm from the low water mark (Figure 1), which fishes for coastal reef fish using predominately hook and line methods. The fishery includes commercial, recreational, fishing tourism and Aboriginal traditional sectors. The fishery catches a wide range of coastal reef fish such as Black Jewfish, Golden Snapper, Grass Emperor, Coral Trout, cods and red snappers.

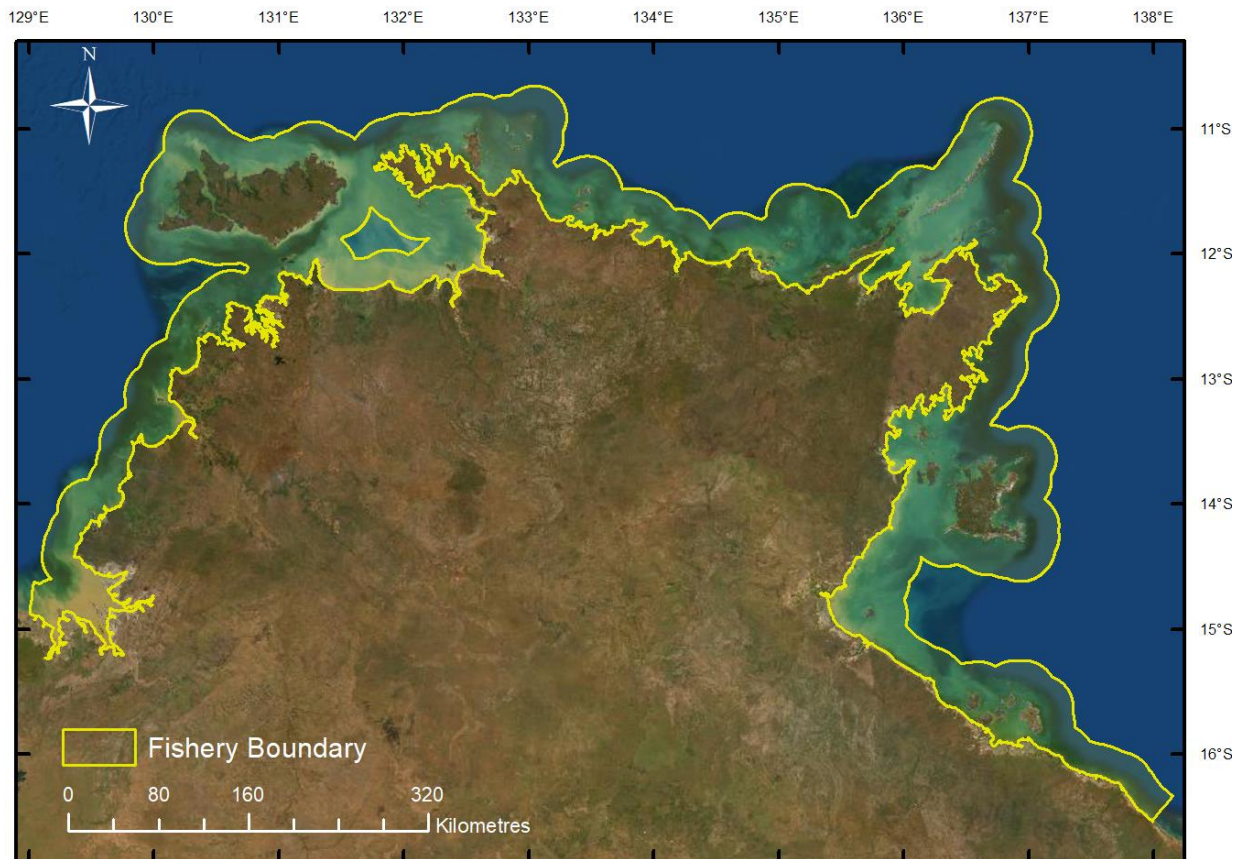


Figure 1. Indicative spatial extent of the Coastal Line Fishery.

2.1. Fishing method

The principal fishing method used by all fishing sectors in the CLF is hook and line. This involves the use of weighted hand or reel lines (generally with baits or jigs). Hand lines are the simplest form of fishing; they consist of one or more baited hooks attached to a line, which is retrieved by hand. Hand lines are also the most common traditional fishing method used by Aboriginal fishers. Hand reels can be attached to a rod (rod and line) or mounted on the side of a vessel. Recreational fishers and tourism clients mainly use rods and lines, while hand reels mounted to vessels (commonly known as deck winches) are used by commercial fishers. Reels are used to deploy and retrieve the line and are usually fitted with a drag system (a 'brake' system, which is designed to create resistance in the reel as the fish takes out line). Commercial fishers can also use drop lines that may contain up to 40 hooks. The hook and line methods employed in the CLF do not include fishing from a vessel that is under way and making way (e.g. fishing methods that involve trolling). Other fishing methods are available to each sector and listed in other sections of this document but are not as frequently used.

2.2. Catch

More than 40 different species of fish are caught by the recreational, commercial, fishing tourism and Aboriginal traditional sectors of the CLF. These species are predominately caught while fishing in coastal waters using hook and line. While most species are reef species there is capture of pelagic species associated with hook and line fishing. The approximate weight of reef fish caught by the CLF in 2018-19 is listed below (Figure 2). Note this indicative figure does not include catch by the Aboriginal traditional sector.

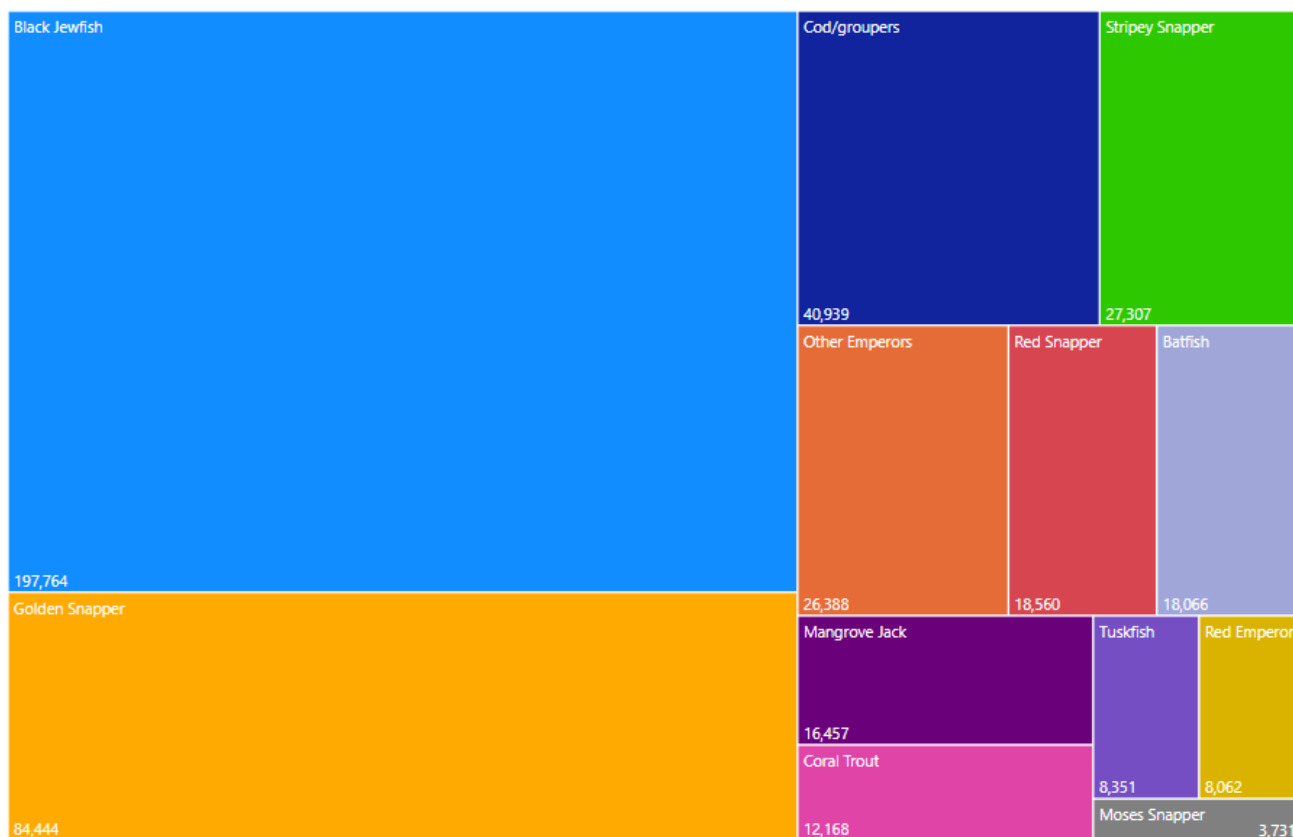


Figure 2. Treemap of the indicative catch (in kilograms) of common retained species in the CLF in 2018-19.

2.3. Species of significance

The broad range of species harvested across all sectors and the proportion of individual species caught vary significantly between sectors depending on the economic or social value of each species respectively. Herein species are classified as primary, secondary, or tertiary species for assessment and management purposes:

- **Primary species** are the two species targeted by most fishing sectors (Black Jewfish and Golden Snapper).
- **Secondary species** are reef fish species that comprise more than five percent of both the recreational and fishing tourism reef fish catch by weight (Grass Emperor and Stripey Snapper)
- **Tertiary species** include all remaining reef fish species with vulnerable biological characteristics that place them at a greater risk of becoming overfished (Tuskfish, Coral Trout, Red Emperor, Mangrove Jack, cod/groupers, red snappers).

2.4. Ecosystem impacts

The ecosystem impacts in the fishery were assessed in the NT Coastal Line Fishery Ecological Risk Assessment (NTG 2018). The ecological risk assessment (ERA) was based on the National ESD Framework How To Guide (see www.fisheries-esd.com.au).

The ERA was undertaken to help ensure that management for the CLF is both effective and efficient in the context of achieving Ecological Sustainable Development (ESD) outcomes. The principles of ESD are the basis of fisheries and aquatic resource management in the Northern Territory. In addition to meeting the statutory requirements of the Northern Territory *Fisheries Act 1988* (the Fisheries Act) and national environmental legislation, this approach provides the fishing industry and key stakeholders with an ongoing opportunity to contribute to, and influence, fisheries management outcomes.

In undertaking the ERA subject matter experts and key fishery stakeholders considered the range of potential consequences of an issue, activity, or event, how likely those consequences are to occur, and assigned a risk rating. It is important to note that the ERA was based on the existing management arrangements at the time of assessment. The outcomes of the ERA formed the basis for a comprehensive fishery review and development of contemporary management arrangements contained in this Management Framework.

The ERA can be located at https://dpir.nt.gov.au/_data/assets/pdf_file/0007/619405/NTCLF-ecological-risk-assessment-052018.pdf

3. Management zones

The CLF is managed as two separate zones that establish management of the commercial and fishing tourism sectors. The Western Zone extends from the Western Australia border to Vashon Head on Cobourg Peninsula at the point of latitude $11^{\circ} 07.516'$ south, longitude $131^{\circ} 59.650'$ east. The Eastern Zone extends east from Vashon Head to the Queensland border (Figure 3).

Access to the Western Zone is restricted for CLF and Fishing Tour Operator (FTO) licences. CLF licences must hold individual transferrable quota (ITQ) to fish in the Western Zone. CLF Licences that do not have access must purchase quota in order to gain access to the fishery in the Western Zone. FTO licences that existed prior to the fishery restructure in 2015 (approx. 140 FTO licences) have access to reef fish resources in the Western Zone but all new licences are restricted, and do not have the ability to target reef fish in the Western Zone.



Figure 3. Management zones of the CLF

4. Management regions

The stock structure of the primary species occurs at a finer scale than the management zones currently in place and risk-based management at an appropriate biological scale is necessary. Management regions have been established within the management zones, and future risk assessments conducted at this scale, to ensure the decision rules of the Harvest Strategy are applied at an appropriate spatial scale (Figure 4). The management regions were developed using current knowledge of the primary species stock structures (Saunders et al 2017) and exposure to fishing pressure. The management regions monitored in the Harvest Strategy are listed below:

- Western Region – Western Australia Border to Cape Ford
- Greater Darwin Region – Cape Ford to Vashon Head
- Arnhem Region – Vashon head to the Wessel Islands
- Northern Gulf Region – Wessel Islands to the Roper River
- Southern Gulf Region – Roper River to the Queensland Border

Access to discrete areas within the management regions by sectors may be limited by the decision rules of the Harvest Strategy should performance indicators breach defined trigger or limit reference points (see section 10).

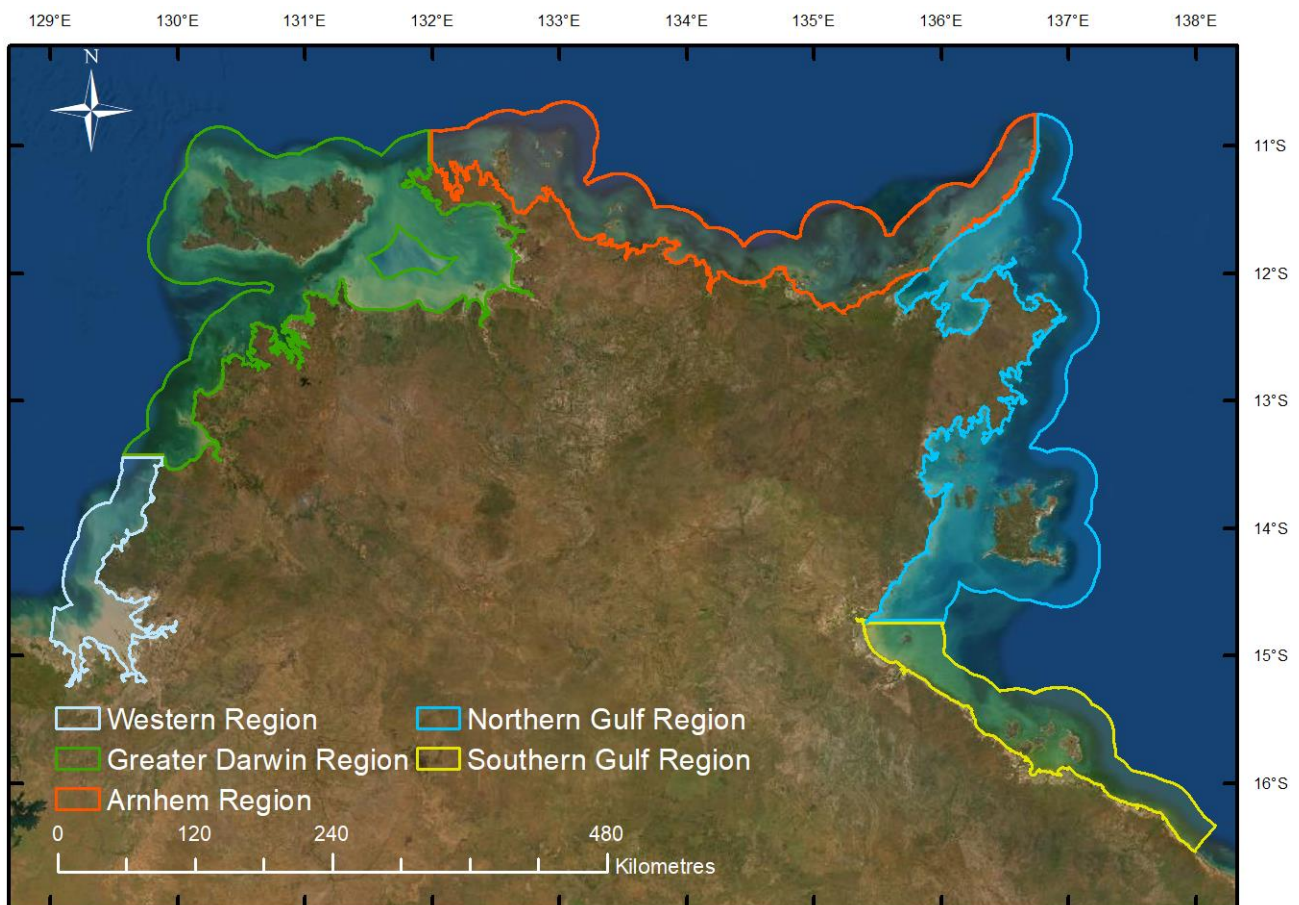


Figure 4. Management regions of the CLF

5. Management areas

Inside the Greater Darwin Region, management areas have been established to improve management of Black Jewfish aggregations (Figure 5). These aggregations are separated by sufficient distance with negligible mixing between aggregations that indicate they are likely to be separate stocks highly reliant of self-recruitment at time scales relevant to fisheries management (Saunders et al., 2017). Independent management of the aggregations is necessary to minimise the risk of overfishing and any associated displaced fishing effort within the broader ITQ management system for the Western Zone.

The management areas for Black Jewfish in the Greater Darwin Region include Channel Point, Mitchell Point and Point Stuart (shown as A, B and C respectively in Figure 5). Access to these areas for recreational, commercial and fishing tourism sectors is dependent on the performance of commercial catch rates inside these areas, in accordance with the decision rules of the harvest strategy (see section 10).

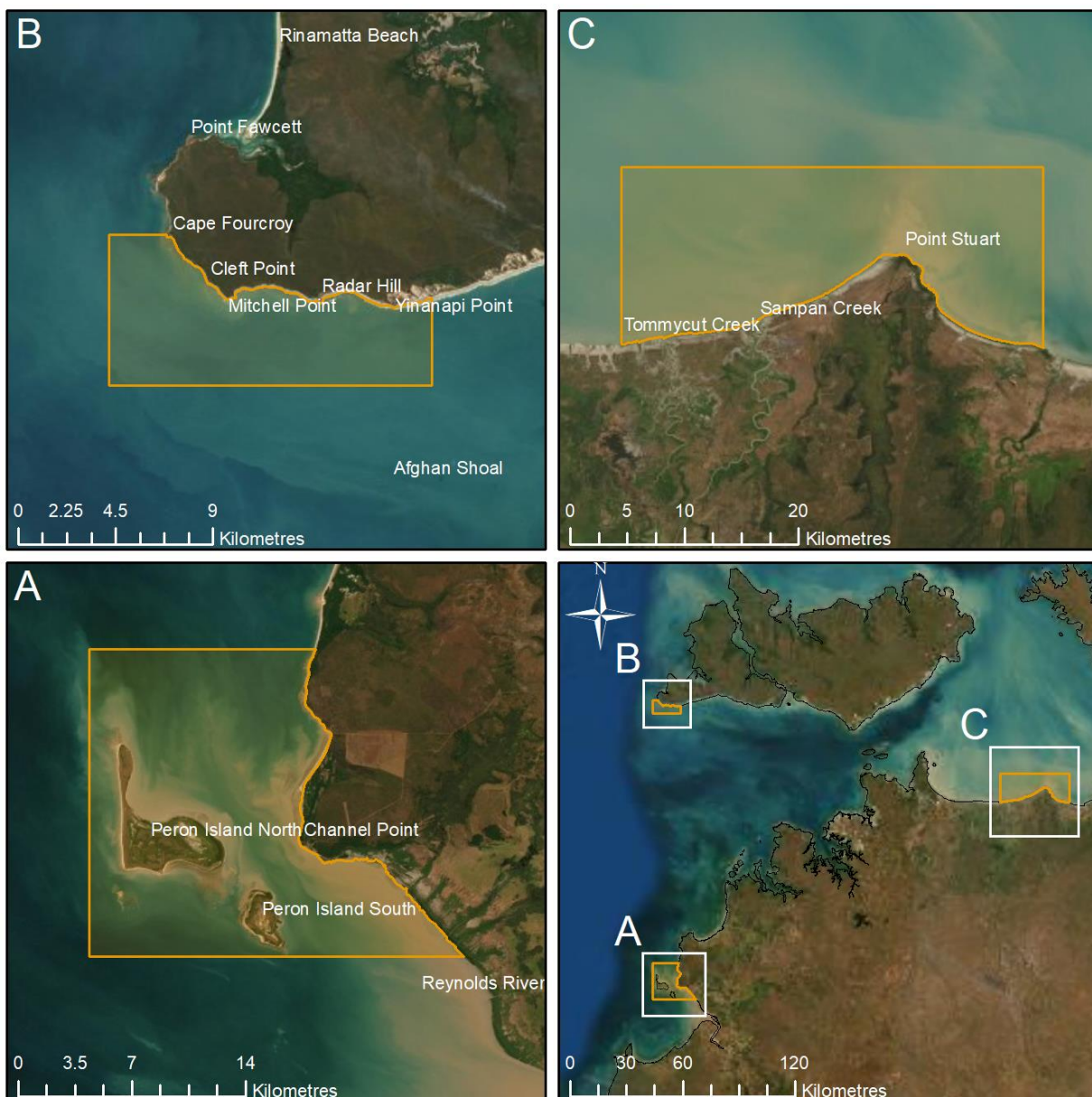


Figure 5. Map of the aggregation areas identified as priorities for management of Black Jewfish

5.1. Commercial catch limits for management areas

The catch limits specify the total amount (in weight) of Black Jewfish that can be sustainably taken each year by CLF licences inside the management areas within the Greater Darwin Region. The catch limits distribute the allowable catch for CLF licences in the Western Zone among known Black Jewfish aggregations and reduces the fishing pressure that could previously be exerted on individual aggregations.

The catch limits were modelled using a Schaeffer surplus production model adapted from Martell and Froese (2013) by Haddon et al (2019). This conservative model utilises a time-series of catch and randomly selected pairs of parameters for growth (r) and carrying capacity or unfished biomass (K) to predict plausible stock reduction trajectories consistent with known catches. Model outputs include a range of values for r and K in addition to a corresponding range of maximum sustainable yields (MSY) from which quantiles are drawn and the median MSY is estimated. The quantiles represent an upper and lower bound of plausible MSY values (e.g. the 5% quantile is the lower bound and 95% quantile the upper bound for which 90% of the model MSY values estimated are contained within. Henceforth, the 50% quantile is the median (middle value or most frequent result). Note the model outputs are based on commercial catch and are not to be used as an indicative MSY incorporating all fishing sectors.

The catch limits for Black Jewfish in each management area are equivalent to their respective MSY 95% quantile (Table 1). The MSY quantiles for each of the aggregation management areas will be reviewed every five years and coincide with the review of the Framework. Five years is considered an appropriate timeframe to allow for additional data to influence the model outputs.

Table 1. CLF licence catch limits for Black Jewfish inside each management area.

Management area	Black Jewfish catch limit
Channel Point	86t
Mitchell Point	32t
Point Stuart	25t
TOTAL	143t

6. Long-term fishery goals

Long-term fishery goals define how the fishery is carried out to the benefit of the community. The goals are needed to translate the high level objectives into fishery-specific objectives. The long-term fishery goals create a clear vision for where the fishery intends to be in 5-10 years and were informed by key stakeholders. The long-term fishery goals relevant to the operational use of resources are contained in the Harvest Strategy Framework (see section 10).

7. Operational objectives

Operational objectives have been established to ensure the operation of the fishery is working towards achieving the long-term fishery goals. The operational objectives directly relate to retained and non-retained species, ecosystem impacts and social aspirations of the fishery. The operational objectives are more precise than the long-term fishery goals and are formulated in a way that can be easily assessed. They are linked to performance indicators and reference points and are contained in the Harvest Strategy Framework (see section 10 Table 5).

8. Performance Indicators and Reference Points

Performance indicators have been established for each operational objective and are used to measure fishery performance with respect to achieving the objectives (by comparing where the indicator sits in relation to a linked reference point). The performance indicators vary according to which fishery region, species and ecosystem effect is being monitored.

The following reference points are used to assess fishery performance in this Harvest Strategy in accordance with the *NT Fisheries Harvest Strategy Policy*:

1. **Target Reference Points (Target)** define the values of a performance indicator for a fish stock or management unit that are desirable or ideal and at which management should aim.
2. **Trigger Reference Points (Trigger)** define the value of a performance indicator for a fish stock or fisheries management unit at which a change in the management is considered or adopted. Trigger reference points may be used to determine staged management responses to different stock levels or to define when a stock or management unit is transitional-depleting or transitional-recovering.
3. **Limit Reference Points (Limit)** define the value of a performance indicator for a stock or management unit that are considered unacceptable from a sustainability perspective. For example, when a stock or management unit has become recruitment overfished or environmentally limited.

The performance indicators and their target, trigger, and limit reference points used in this Harvest Strategy are described in greater detail in the tables below (Table 2, Table 3, and Table 4) and set out in the Harvest Strategy Framework (see section 10).

8.1. Greater Darwin Region Performance Indicators and Reference Points

Table 2. Performance Indicators and Reference Points specific to the Greater Darwin Region

Performance Indicator	Reference Points
Biomass estimates relative to unfished levels derived from a stock reduction analysis (SRA) is used as a biological performance indicator for the primary species.	Target = 50% Biomass estimates
	Trigger = 40% Biomass estimates
	Limit = 30% Biomass estimates
	The biomass figures chosen for the target, trigger and limit reference points are above the internationally accepted benchmarks for moderate to long-lived fish species (target = 40%, trigger = 30%, limit = 20%). This reflects the vulnerability of the primary species to overfishing due to their biological characteristics. The target biomass of 50% represents a level that maximises fish availability for all sectors. The SRA model outputs are calculated at 95% confidence intervals (i.e. the 95% confidence bounds encompass the value of the reference point).
Commercial CPUE (nominal) will be used as a biological performance indicator for Black Jewfish inside the management areas. As new data becomes available under the Monitoring and Research Plan (Section 12.3.2) the CPUE performance indicator will be refined, which may include adjustments for fish availability and standardised of catch rates.	Target = mean CPUE
	Trigger = 50% of mean CPUE
	Limit = 25% of mean CPUE
	The reference points were calculated using the mean standardised quarterly CPUE inside each management area between 2015/16 and 2019/20. This timeframe provides a baseline period for fishing operations under the ITQ management system. The reference points for each aggregation management area are contained in Appendix A .
Maximum Sustainable Yield (MSY) estimated from Catch MSY models is used as the primary biological performance indicator for secondary species.	Target = Grass Emperor - Lower bound of the 90th Percentile of the Mean MSY value. Stripsey Snapper - Mean MSY value
	Trigger = Median value between the Target and Limit points.
	Limit = Grass Emperor - Mean MSY value. Stripsey Snapper - Upper bound of the 90th Percentile of the mean MSY value.
	The reference points are derived from the mean CPUE for the 60 x 60 nautical mile grid area (grid code 1230) that encompasses Darwin and Bynoe Harbour. This area represents the highest fishing pressure inside the Greater Darwin Region. The reference points for secondary species monitored in this harvest strategy are contained in Appendix D - Designated spatial closures for recreational and tourism fishers (yellow boxes)

8.2. Western, Arnhem, and Gulf Regions Performance Indicators and Reference Points

Table 3. Performance Indicators and Reference Points specific to the Western, Arnhem, Gulf and Vanderlin Regions.

Performance Indicator	Reference Points
Commercial and FTO catch is used as the biological performance indicator for all primary, secondary and tertiary species.	Target = NA
	Trigger = 10000 kilograms
	Limit = 20000 kilograms
	The reference points are based on the level of cumulative catch for each 10 x 10 nm sub-grid area (currently utilised for reporting purposes for FTO logbooks) that is considered sufficient to control and prevent localised depletion from occurring. The sub-grids are contained in Appendix C .

8.3. All Regions Performance Indicators and Reference Points

Table 4. Performance Indicators and Reference Points applicable to all regions of the fishery.

Performance Indicator	Reference Points
The risk of overfishing derived from a quantitative sustainability assessment for fishing effects (SAFE) is used as the biological performance indicator for tertiary species.	Target = Low risk ($F < F_{MSM}$)
	Trigger = Medium risk ($F_{MSM} \leq F < F_{CRASH}$)
	Limit = High risk ($F \geq F_{CRASH}$)
	F_{MSM} is the instantaneous fishing mortality rate that corresponds to the maximum number of fish in the population that can be killed by fishing, yet the population remains sustainable in the long term. F_{CRASH} is the minimum unsustainable instantaneous fishing mortality rate that, in theory, will lead to the population extinction in the long term. F_{MSM} is equivalent to F_{MSY} and the relationship with natural mortality differs between Chondrichthyans and teleosts (Chondrichthyans, 0.41M and Teleosts, 0.87M).
The risk ratings derived from an Ecological Risk Assessment are used as the primary biological performance indicator for bycatch, TEPS, habitat and ecological processes.	Target: Low risk
	Trigger: Medium risk
	Limit: High risk
	The risk ratings are based on the definitions used in accordance with the <i>NT Fisheries Ecological Risk Assessment Guidelines 2020</i> .

9. Decision rules

The decision rules used in this Harvest Strategy provide direction for pre-determined management actions to achieve the operational objectives. For each performance indicator and reference point, an accompanying decision rule directs the management needed to achieve the operational objectives (Table 5). These decision rules are designed to maintain the performance of the indicator above the trigger point (i.e. within the target range), or rebuild it where it has fallen below the trigger (undesirable) or the limit (unacceptable) points.

9.1. Reviewing the performance indicators

The process of reviewing the performance of the CLF against the Harvest Strategy will depend on the review period of the chosen performance indicator:

- Indicators with a quarterly review period have decision rules that specify pre-determined management actions that come into effect immediately if a trigger or limit reference point is met during the course of the fishing season.
- Indicators with an annual or longer review period have decision rules that specify pre-determined management actions which require consideration by the Advisory Group before they are recommended to the Director of Fisheries for implementation.

Indicators with an annual or longer review period are assessed based on calendar year. For these indicators the Advisory Group is required to review all available evidence associated with performance of the indicator and help determine the extent of the management action taken, increasing in line with an increasing risk to the resource.

The Advisory Group must develop its advice and provide a recommendation to the Director of Fisheries within a three month period between February and April each year. This is to provide sufficient time for the management actions to be implemented at the start of the next fishing season.

Extraneous circumstances will be taken into consideration when assessing the performance of indicators.

9.2. Recovery Plan

In the event that a performance indicator breaches a trigger or a limit reference point, a recovery plan will be developed in consultation with the Advisory Group to track progress and measure recovery of the performance indicator. This should include structured recovery targets and timeframes, which may be different from generational length, and may be driven by other factors.

9.3. Application of the decision rules

To enable the application of the Harvest Strategy decision rules, legislative provisions will allow the Director of Fisheries to impose the management actions. While all efforts will be made to implement the management actions prior to the start of the next fishing season, the ability and timeframe for implementing some management actions may depend on the legal instrument under which the management action occurs.

10. Harvest Strategy Framework

Table 5. Harvest Strategy performance indicators, reference points and decision rules for the CLF.

GREATER DARWIN REGION					
Long-term fishery goal	Operational objective	Performance Indicator	Method / review period	Reference Points	Decision Rules
Maintain the harvest of coastal reef fish stocks within sustainable levels taking into account natural variation	Maintain the biomass of Golden Snapper in the Greater Darwin Region above 50% B ₀	Biomass estimates	Stock assessment conducted on an annual basis	Target: 50% Biomass	Continue management aimed at achieving long-term fishery goals and if above Target for three consecutive years then consider providing an increase in the Total Allowable Catch as determined by scientific modelling.
				Trigger: 40% Biomass	If below Trigger then reduce the total mortality by 10 to 50% as determined by scientific modelling to enable a return to Target within one generation (14 years) by: <u>Recreational & FTO:</u> Reducing the previous year’s catch by implementing a temporal or spatial closure. <u>All sectors:</u> Implementing an education and awareness program. <i>Note: Management actions will be applied at a scale commensurate with sector specific use/risks</i>
				Limit: 30% Biomass	If below Limit then reduce the total mortality by 50 to 100% as determined by scientific modelling to enable a return to Target within one generation (14 years) by: <u>Recreational & FTO:</u> Reducing the previous year’s catch by implementing a temporal or spatial closure. <u>All sectors:</u> Implementing an education and awareness program. <i>Note: Management actions will be applied at a scale commensurate with sector specific use/risks</i>
	Maintain the biomass of Black Jewfish in the Greater Darwin	Biomass estimates	Stock assessment conducted on an annual basis	Target: 60% Biomass	Continue management aimed at achieving long-term fishery goals and if above Target for three consecutive years then consider providing an increase in the Total Allowable Catch as determined by scientific modelling.

	Region above 60% B ₀ .			Trigger: 50% Biomass	<p>If below Trigger then reduce the total mortality by 10 to 50% as determined by scientific modelling to enable a return to Target within one generation (9.5 years) by:</p> <p><u>Commercial</u>: Reducing the previous year's catch by an appropriate reduction in quota.</p> <p><u>Recreational & FTO</u>: Reducing the previous year's catch by implementing a temporal or spatial closure.</p> <p><u>All sectors</u>: Implementing an education and awareness program.</p> <p><i>Note: Management actions will be applied at a scale commensurate with sector specific use/risks</i></p>
				Limit: 30% Biomass	<p>If below Limit then reduce the total mortality by 50 to 100% as determined by scientific modelling to enable a return to Target within one generation (9.5 years) by:</p> <p><u>Commercial</u>: Reducing the previous year's catch by an appropriate reduction in quota.</p> <p><u>Recreational & FTO</u>: Reducing the previous year's catch by implementing a temporal or spatial closure.</p> <p><u>All sectors</u>: Implementing an education and awareness program.</p> <p><i>Note: Management actions will be applied at a scale commensurate with sector specific use/risks</i></p>
	Maintain the catch rate of Black Jewfish in the management areas within sustainable levels.	Commercial CPUE of Black Jewfish	Analysis of mean CPUE on a quarterly basis.	Target: Target reference points for each management area are defined in Appendix A	Continue management aimed at achieving long-term fishery goals.
				Trigger: Trigger reference points for each management area are defined in Appendix A	<p>If below Trigger and biomass of Black Jewfish is above 40% then:</p> <ul style="list-style-type: none"> conduct observations on commercial vessels to validate CPUE; and if below Trigger for the next quarter then implement a closure of the management area for three months for the commercial sector. <p>If below Trigger and biomass of Black Jewfish is below 40% then implement a closure of the management area for three months to the commercial sector.</p> <p><i>Note: The Trigger will not apply to the management area if a quarter has less than two commercial fishers or less than 72 hours fished.</i></p>

				<p>Limit: Limit reference points for each management area are defined in Appendix A</p>	<p>If below Limit and biomass of Black Jewfish is above 40% then:</p> <ul style="list-style-type: none"> • conduct observations on commercial vessels to validate CPUE; and • if below Limit for the next quarter then implement a six month closure of the management area to the commercial sector and the designated closure area for the recreational and tourism sectors (see Appendix D). <p>If below Limit and biomass of Black Jewfish is below 40% then implement a six month closure of the management area to the commercial sector and the designated closure areas for the recreational and tourism sectors (see Appendix D).</p> <p><i>Note: The Limit will not apply to a management area if a quarter has less than two commercial fishers or less than 72 hours fished.</i></p>
Maintain the catch rate of secondary species in the Greater Darwin Region within sustainable levels.	Maximum Sustainable Yield	Analysis of total mortality on an annual basis.	Target: Target reference points for secondary species are defined in Appendix B	Continue management aimed at achieving long-term fishery goals.	
			Trigger: Trigger reference points for secondary species are defined in Appendix B	If above Trigger then conduct key research projects identified in the research and monitoring plan to inform stock assessment models.	
			Limit: Limit reference points for secondary species are defined in Appendix B	<p>If above limit then conduct key research projects identified in the research and monitoring plan to inform stock assessment models and reduce the total mortality by:</p> <p><u>Commercial</u>: Restricting catch by a condition on licences.</p> <p><u>Recreational & FTO</u>: Reducing the previous year’s catch by amending existing possession and or vessel limits, and or implementing a temporal or spatial closure.</p> <p><u>All sectors</u>: Implementing an education and awareness program.</p> <p><i>Note: Management actions will be applied at a scale commensurate with sector specific use/risks.</i></p> <p><i>Note: If a management arrangement is in place for a primary species that is identified to provide an appropriate level of catch reduction for a secondary species. No additional closures will be implemented.</i></p>	

WESTERN, ARNHEM AND GULF REGIONS					
Long-term fishery goal	Operational objective	Performance Indicator	Method / review period	Reference Points	Decision Rules
Maintain the harvest of coastal reef fish stocks within sustainable levels taking into account natural variation	Maintain catches of reef fish stocks in the Western, Arnhem, Northern and Southern Gulf Regions within sustainable levels.	Commercial and FTO catch.	Monitoring of cumulative catch inside a sub-grid (10x10 nm ² area) on a quarterly basis.	Target: NA	Continue management aimed at achieving long-term fishery goals
				Trigger: 10000 kg	If above Trigger and mean CPUE of the main contributing species is 70% less than the previous quarter, then implement an immediate closure for 3 months, applicable to commercial and FTO sectors. Conduct fishery dependant monitoring in the next fishing season.
				Limit: 20000 kg	If above Limit then immediately implement a temporary closure of the sub-grid for the remainder of the fishing season, applicable to the commercial and FTO sectors. Conduct fishery dependant monitoring in the next fishing season. If monitoring confirms an aggregation then consider implementing a management area to further reduce the risk of overfishing.

ALL FISHERY REGIONS					
Long-term fishery goal	Operational objective	Performance Indicator	Method / review period	Reference Points	Decision Rules
Maintain the harvest of coastal reef fish stocks within sustainable levels taking into account natural variation.	Maintain a low risk of overfishing for tertiary species.	Risk of overfishing	Conduct a SAFE assessment every 2 years	Target: Low risk	Continue management aimed at achieving long-term fishery goals.
				Trigger: Medium risk	Conduct key research projects identified in the Research and Monitoring Plan to inform stock assessment models.
				Limit: High risk	Conduct key research projects identified in the Research and Monitoring Plan to inform stock assessment model and reduce the total mortality to enable a return to Target within one generation by: <u>Commercial</u> : Restricting catch by a condition on licences. <u>Recreational & FTO</u> : Amending existing possession and or vessel limits, and or implementing a temporal or spatial closure. <u>All sectors</u> : Implementing an education and awareness program.

					<p><i>Note: Management actions will be applied at a scale commensurate with sector specific use/risks.</i></p> <p><i>Note: If a management arrangement is in place for a primary or secondary species that is identified to provide an appropriate level of harvest reduction for a tertiary species then no additional closures will be implemented.</i></p>
<p>Ensure that fishing does not cause serious or irreversible harm to populations of bycatch species and interactions are reduced to as low as reasonably practical.</p>	<p>Maintain a negligible or low risk to populations of bycatch species.</p>	<p>Risk of fishing impact to bycatch populations.</p>	<p>Ecological risk assessment conducted every 5 years.</p>	<p>Target: Low risk</p>	<p>Continue management aimed at achieving long-term fishery goals.</p>
				<p>Trigger: Medium risk</p>	<p>Reduce amount of by-catch to enable a return to Target by:</p> <p><u>Commercial and FTO</u>: Implementing move on provisions by a condition on licences.</p> <p><u>All sectors</u>: Reviewing gear types to reduce interactions, and implementing an education and awareness program.</p>
				<p>Limit: High risk</p>	<p>Reduce amount of by-catch to enable a return to Target by:</p> <p><u>Commercial and FTO</u>: Implementing move on provisions by a condition on licences.</p> <p><u>All sectors</u>: Reviewing gear types to reduce interactions, implementing an education and awareness program, and implementing spatial closure for area(s) of concern.</p>
<p>Ensure interaction with threatened endangered and protected species are measured and minimised and do not impact on the potential for those populations to persist in the long term.</p>	<p>Maintain a negligible or low risk to populations of threatened endangered and protected species.</p>	<p>Risk of fishing impact to TEPS species as informed from logbook and observer coverage.</p>	<p>Ecological risk assessment conducted every 5 years, or unless there is a clear shift in interactions as identified by bi-annual fishery reporting.</p>	<p>Target: Low risk</p>	<p>Continue management aimed at achieving long-term fishery goals.</p>
				<p>Trigger: Medium risk</p>	<p>Monitor and reduce interactions with TEPS to enable a return to Target by:</p> <p><u>Commercial and FTO</u>: Increasing the amount of observer coverage to 20% for the responsible sector(s).</p> <p><u>All sectors</u>: Investigating the options to reduce the risk within three months and implement appropriate management action as soon as practicable.</p>
				<p>Limit: High risk</p>	<p>Monitor and reduce interactions with TEPS to enable a return to Target by:</p> <p><u>Commercial and FTO</u>: Increasing the amount of observer coverage to 30% for the responsible sector(s).</p>

					<u>All sectors:</u> Investigating the options to reduce the risk within three months and implement appropriate management action as soon as practicable.
Mitigate the risk of causing serious or irreversible harm to habitat structure and function.	Maintain a negligible or low risk to habitat structure and function.	Risk of fishing impact to habitat structure and function.	Ecological risk assessment conducted every 5 years.	Target: Low risk	Continue management aimed at achieving long-term fishery goals.
				Trigger: Medium risk	Reduce impact to habitat structure and function to enable a return to Target by implementing an education and awareness program and limiting methods of vessel positioning to non-destructive methods for 'at risk' habitat identified by benthic mapping.
				Limit: High risk	Reduce impact to habitat structure and function to enable a return to Target by implementing an education and awareness program and specific area closures on 'at risk' habitat identified by benthic mapping.
Mitigate the risk of causing serious or irreversible harm to ecological processes.	Maintain a negligible or low risk to ecological processes.	Risk of fishing impact to ecological processes.	Ecological risk assessment conducted every 5 years.	Target: Low risk	Continue management aimed at achieving long-term fishery goals.
				Trigger: Medium risk	If the catch and habitat management actions do not provide sufficient protection then implement additional area closures to enable a return to Target.
				Limit: High risk	If the catch and habitat management actions do not provide sufficient protection then implement additional area closures to enable a return to Target.

11. Review of the Harvest Strategy Framework

A review of the Harvest Strategy Framework will be conducted after the first year of its implementation to ensure it is operating as intended. A comprehensive review of the Harvest Strategy Framework will be undertaken every five years.

12. Monitoring and Research Plan

The aim of the Monitoring and Research Plan is to utilise the best available assessment and monitoring tools to underpin the Harvest Strategy and to improve research and monitoring of key species in the CLF Framework.

12.1. Monitoring activities

The monitoring activities evaluate key performance indicators within the Harvest Strategy. These are listed below and summarised in Table 6.

1. Conduct stock assessments aligned with the performance indicators;
2. Analyse Catch Per Unit Effort (CPUE) from the commercial sector in each management area;
3. Analyse catch and CPUE from the commercial and tourism sectors in the Western, Arnhem and Gulf Regions;
4. Complete life history, reproductive biology and investigate stock structure for secondary and tertiary species (if required);
5. Independent monitoring to validate fishery dependant data and collect biological information; and
6. Monitoring of spatial or temporal closures (if required).

12.2. Research activities

The research activities are designed to fill knowledge gaps and investigate potential monitoring tools that may provide better information to inform the Harvest Strategy (e.g. investigation of fish abundance survey methods). These are listed below and summarised in Table 7:

1. Improving stock assessment methods;
2. Use recreational research activities to inform fisheries management;
3. Update knowledge of the stock structure of primary and secondary species;
4. Incorporating recreational social experience and economic contributions into management; and
5. Investigate methods to measure Indigenous catch and effort.

Table 6. Monitoring activities for all species and species groups (including Threatened, Endangered and Protected Species (TEPS)).

Performance Indicator	Frequency	Management region	Data sources	Species					
				Primary		Secondary		Tertiary/bycatch	TEPS
				Black Jewfish	Golden Snapper	Grass Emperor	Stripey Snapper		
Stock assessment	Annually	Greater Darwin	All sectors catch Commercial CPUE Biological data						
CPUE	Quarterly	Greater Darwin (Management Areas)	Commercial CPUE						
CatchMSY	Annually	Greater Darwin	All sectors catch						
Biology	As required	All regions	Reproductive biology Stock connectivity Age structure						
SAFE assessment	Annually	All regions	Biological data Area fished						
Catch	Annually	Western, Arnhem and GOC	All sectors catch						
ERA	Every five years	All regions	Stock assessments All sectors catch Biological data Area fished						

Table 7. Research activities for all species and species groups.

Research and monitoring activity	Management region	Knowledge Improvement	Species					Tertiary/bycatch	TEPS
			Primary		Secondary				
			Black Jewfish	Golden Snapper	Grass Emperor	Stripey Snapper			
Stock assessment	All regions	Improve assessments for primary and secondary species.							
Stock structure	All regions	Periodically update knowledge of key species stock structure.							
Catch and Effort	Greater Darwin	Develop recreational research activities to inform the management of the fishery (e.g. expert angler CPUE time series). Investigate methods to measure Indigenous catch.							
Biology	All regions	Periodically update knowledge of primary and secondary species biology.							
Fishing Experience	All regions	Investigate methods for monitoring recreational and tourism fishing experience.							

12.3. Monitoring activities

12.3.1. Conduct stock assessments aligned with the performance indicators

12.3.1.1. Stock assessment methods and data requirements

Modelling is the primary means for providing quantitative estimates on the status of a stock biomass and rate of fishing mortality in order to determine the sustainability of current harvest levels. The choice of model is determined on the quality and quantity of data available from catch and effort returns, observer monitoring, targeted biological and population research. Therefore, the complexity and options for modelling decrease where gaps in data and knowledge are exposed. Table 8 outlines the models that are available (but not limited to) for each species or species group, the quality of data available and data used to complete modelling assessments.

Table 8. List of models and tools used to assess fish stocks. Models are ordered in decreasing complexity and or data requirements. Colours indicate the capacity to conduct model/assessment and letters represent the primary source for used executing the model.

Model	Primary		Secondary		Tertiary
	Black Jewfish	Golden Snapper	Grass Emperor	Stripey Snapper	
Stock Synthesis (SS)	+	+			
Stock Reduction Analysis (SRA)	A	F,R			
Catch MSY	C	F	F	F	
Sustainability Assessment for Fishing Effects (SAFE)	A	A	A	A	A
Environmental Risk Assessment (ERA)	A	A	A	A	A

C – Completed with Commercial Data; F – Completed with Fishing Tour Operator; R - Completed with Recreational; A – data available from Commercial, Fishing Tour Operator and Recreational sectors; + Additional data required to implement model method.

Accurate and relevant is available

Data collection for future implementation

Unknown or Insufficient Data Available

12.3.1.2. Stock Synthesis

Stock Synthesis (SS) is a flexible well-supported modelling package that is underpinned by population dynamics, i.e. the change in numbers and size and/or age structure over time. SS provides a standardised reporting framework for modelling inputs, diagnostics and results, which will broaden understanding and increase transparency. The synthesis modelling approach is in line with national recommendations and will improve confidence in estimates of relative abundance for key species when paired with representative inputs of length and age data.

12.3.1.3. Stock reduction analysis (SRA)

Stock Reduction Analysis (SRA) models (Walters et al 2006) require species catch data from all sectors; from commercial and FTO logbooks and recreational fishing surveys (Coleman 1998, Henry and Lyle 2003, West et al 2012, Matthews et al. 2019a, Matthews et al. 2019b), an abundance time series, annual estimates of vulnerability to the fishing gear and biological information. This allows the model to develop a 'productivity'

schedule that calculates all removals (mortalities) and all additions (recruitment) for each year to calculate the biomass relative to unfished levels.

12.3.1.4. Catch Maximum Sustainable Yield

Secondary species are primarily harvested by recreational fishers and FTOs. Given fishing for these species is less targeted than the primary species, CPUE from either of these sectors is unsuitable to be incorporated in more data intensive stock assessment models. Consequently, assessments on these species in the Greater Darwin Region will be undertaken using catch data in a Catch Maximum Sustainable Yield (catch MSY) model. Catch of these species will be determined from logbooks (commercial and FTO) and recreational fishing surveys. Biological parameters for these species are also used in the model. While this model is peer reviewed (Haddon et al 2019), there are numerous caveats that need to be considered when analysing the outputs, most importantly is that the catch history is assumed to represent a proxy for abundance and this assumption can often be violated.

12.3.1.5. Sustainability Assessment for Fishing Effects

Tertiary species represent a low proportion of the total harvest by the fishery. Consequently, even catch only models cannot be undertaken for these species. Therefore, a semi quantitative Sustainability Assessment for Fishing Effects (SAFE) (Zhou and Griffiths, 2008; Zhou et al., 2009, 2011) will be used to assess the sustainability of these species across all regions of the fishery. The SAFE assessment estimates the proportion of overlap between an area fished and the distribution of a species as a relative measure of the proportion of a population vulnerable to fishing pressure. Adjustments are made to account for catchability and escapement to give an estimate of fishing mortality rate and the relative risk to measure against reference points. F_{MSM} and F_{CRASH} are the primary statistics calculated by SAFE. F_{MSM} is the instantaneous fishing mortality rate that corresponds to the maximum number of fish in the population that can be killed by fishing (F_{MSY}), yet the population remains sustainable in the long term. F_{CRASH} is the minimum unsustainable instantaneous fishing mortality rate that, in theory, will lead to the population extinction in the long term. Note the SAFE assessment is only valid for species that are not targeted by the fishery.

12.3.1.6. Ecological Risk Assessment

By-catch species, TEPS and ecosystem components are unlikely to be significantly impacted by the CLF given the line fishing gear that is predominately used and the small footprint of the fishery. Because of the low impact on these components, they will be assessed under the *Northern Territory Fisheries Ecological Risk Assessment Guidelines* every five years. The ERA methodology is based on that identified in Fletcher (2015) and is consistent with International Standard ISO 31000 Risk Management processes (Standards Australia 2018). The ERA will incorporate all sources of information including current management arrangements, annual fishing effort and catch, habitat distribution, ecosystem information, observer data and other available research.

12.3.2. Analyse catch per unit effort (CPUE) in each management area

CPUE is being used as a performance indicator in each management area to monitor short-term changes in abundance of Black Jewfish and allow additional management to be applied quickly if there appears to be a decline in abundance. This is particularly important in the management areas as the stock assessment that is used to monitor biomass at a broader geographic scale is heavily influenced by the CPUE in the highest catch area (Channel Point) so declines in abundance in Mitchell Point and Point Stuart could be masked by high catch rates in Channel Point.

Nominal CPUE calculated from logbooks submitted by commercial fishers and based on line hours fished will be used to monitor each management area. The transition to electronic logbook reporting for commercial

licences will significantly reduce the timeframe for the Fisheries Division to receive catch and effort data and allow CPUE to be monitored within a quarterly basis. CPUE monitoring of management areas will be investigated to refined to account for fish availability inside each aggregation (ensuring that CPUE is only analysed on days when fish are present) and standardised as validation improves our understanding of the impacts of factors unrelated to abundance (e.g. weather, fisher skill or economics). These changes to the CPUE performance indicator will be updated when available.

12.3.3. Analyse catch from the commercial and tourism sectors in the Western, Arnhem and Gulf Regions

There is insufficient information on primary, secondary and tertiary species in the Western, Arnhem and Gulf regions of the fishery to identify areas that may require specific monitoring. Instead, a non-specific catch limit is applied across these regions at the scale of a ten by ten nautical mile grid system (see Appendix C) to reduce the potential risk of localised overfishing from occurring if fishing activity were to increase in these regions under the new management arrangements in the Framework. Catch information from both commercial and FTO logbooks will be analysed on a quarterly basis to assess whether breaches of grid catch limits have occurred during a fishing season. Note FTO catch, reported in numbers of fish will be converted to weights based on estimates using the most recent fishery observer data. If a breach has occurred then CPUE of the main contributing species will be analysed. It is expected that the transition to electronic logbook reporting for the commercial and FTO licences will significantly reduce the timeframe for the Fisheries Division to receive catch data and allow grid catch limits to be closely monitored within the required timeframes.

12.3.4. Complete life history, reproductive biology and investigate the stock structure for secondary and tertiary species (if required);

Secondary or tertiary species may have a biological collection program initiated if a trigger or limit reference point is exceeded in the Harvest Strategy. This biological collection program will be used to elevate its current assessment to a more complex model with the aim of better informing the assessment of the species. The data that will be collected could include some or all of the following information: Growth and reproductive biology, stock structure information and ageing studies. The type of data collected and the anticipated resourcing requirements will be identified and considered during the annual Harvest Strategy review by the Advisory Group.

12.3.5. Independent monitoring to validate fishery dependant data and collect biological information

12.3.5.1. Methods

There are variety of independent monitoring methods that can be used in the Coastal Line Fishery:

- **Human observers:** This involves trained personnel being on-board vessels for the duration of the fishing activity. Information from human observers will be used to assess (and validate) logbook data and collect biological information (lengths, sex and age).
- **Port/landing-site monitoring:** This involves trained personnel collecting information when a vessel makes landfall. Information from port/landing-site monitoring will be used to assess (and validate) logbook data and collect biological samples.
- **Electronic monitoring:** Electronic monitoring is a system of video cameras (and may include sensors) capable of monitoring and recording fishing activities which can be reviewed later to verify logbook data and fishing operations.

- Vessel Monitoring System (VMS): VMS is used to validate effort data from logbooks including fishing effort, vessel location, landing site/port, and timing and duration of landings.

12.3.5.2. Coverage

The level of independent monitoring coverage is determined based on the number of trips required to:

1. Validate catch and effort data reported from logbooks; and
2. Collect the required biological information to inform stock assessments.

For the commercial sector it is important to validate CPUE from CLF licences and monitor Black Jewfish biology in the management areas that represent greater than 90% of the commercial catch in the fishery. 12 observer will be conducted inside the management areas to validate logbook data, and gather the required biological information to improve the stock assessments (see section 12.4.2).

For the fishing tourism sector it is important to improve data quality from reported FTO logbooks and monitor Golden Snapper and Black Jewfish biology in the Greater Darwin Region. A combination of 40 observer trips and days of port/landing-site monitoring will be conducted for FTO vessels that engage in reef and bottom fishing to validate logbook data and gather biological information to improve the stock assessments (see section 12.4.2).

Additional coverage will be conducted if the relevant reference points are breached under the application of the Harvest Strategy. This would occur when the CPUE of Black Jewfish declines below the trigger reference points in the management areas, or when the risk of fishing impact to TEPS species is identified as medium or higher. Alternatively in the Western, Arnhem and Gulf management regions, observer coverage may be required as the fishery develops to validate commercial catch and effort information.

12.3.6. Monitoring of spatial or temporal closures (if required)

Any closures that are implemented when biomass reference points are breached under the application of the Harvest Strategy will have an explicit fishery independent monitoring plan that will monitor the recovery of the population. The duration of the closure will be determined by the biology of the species and will be tailored to allow for new female recruits to reach maturity and spawn at least once (e.g. Golden Snapper females take at least 6 years to reach maturity). The duration of the closure may be shortened if the monitoring program indicates that the abundance of the population increases substantially. Baited Remote Underwater Video and controlled line fishing surveys are the most likely independent monitoring activities that will be associated with these closures. The fishery independent monitoring plan will be developed in consultation with the Advisory Group and may be distributed for broader stakeholder consultation.

12.4. Research activities

12.4.1. Improving stock assessment methods

Improving certainty in sustainability assessments requires additional biological data collection to facilitate adoption of more data intensive stock assessment methodologies. The Fisheries Division intends to transition from using the existing SRA model to the SS model as soon as data becomes available for both Golden Snapper and Black Jewfish. Application of the SS model requires inputting annual age structure information for these species such as length and age frequency, sex and reproductive condition. This data will be collected from onboard observers on both CLF and FTO vessels and by port/landing-site monitoring interviewers. Additionally, FTO logbooks will be amended to include the collection of biological data such as lengths and weights of key species.

Additionally, there will be ongoing investigation to improve the abundance time series (currently commercial and FTO CPUE) through ongoing CPUE standardisation (trying to account for factors that influence catch but are not biomass related e.g. weather) and/or investigating the development of fishery independent abundance estimation methods (e.g. BRUVs, controlled line fishing). Improving abundance time series will be very important to increase the accuracy of the model outputs for secondary species as currently these assessments only consider total catches as the CPUE time series by the various sectors are not meaningful due to other species being targeted.

12.4.2. Use recreational research activities to inform fisheries management

Information gathered from the recreational sector is limited to the total catch by species inside a broad area, as well as total effort from periodic surveys. Given this sector harvests the majority of species, aside from Black Jewfish, the Fisheries Division will be undertaking ongoing investigations to try and get better information from this sector. Initially, this work may focus on recruiting 'expert anglers' to electronically complete fishing diaries on an application that is planned to be researched and developed by the Fisheries Division. This information would provide an estimate of abundance based on the fishers catch rates at different spatial scales across the fishery.

12.4.3. Update knowledge of the stock structure of primary and secondary species

Updating the knowledge of primary and secondary species stock structures is often a large and expensive undertaking. Unless there is an identified need for a dedicated research project, this research will be undertaken opportunistically (as part of other formal funded projects) to address known connectivity issues in the fishery. For example, identifying connectivity of Black Jewfish between Mitchell Point and Caution Point, or between Mitchell Point and Point Stuart and between offshore and coastal stocks of Mangrove Jack and Red Emperor.

12.4.4. Incorporating recreational social experience and economic contributions into management

The Coastal Line Advisory Group (CLAG) has identified recreational experience and economic contributions as a priority objective and a potentially important indicator of performance to be incorporated into the management of the fishery. However, current data streams from recreational boat ramp surveys do not currently collect fisher experience data. The lack of data on recreational experience, and economic contribution, is not unique to the NT and has been highlighted at the national level.

To obtain data to inform satisfaction levels an FRDC project will be developed in conjunction with key fishing stakeholders that will seek to engage specialist expertise to design an online survey or appropriate survey questions that can be added into existing boat ramp surveys to measure social performance in the Northern Territory. The FRDC project is expected to take approximately 12-18 months to complete. On completion the survey will be used to begin gathering baseline data for the fishery.

The FRDC project will also seek to understand how the social experience can be incorporated into management of the fishery i.e. how the data can be used to inform the decisions either operationally as part of the Harvest Strategy, or whether it fits in another component of the management framework. The outcomes of which will be considered for inclusion into management either during an annual review (post completion of the project) or at formal review of the Harvest Strategy and Framework in five years' time.

12.4.5. Investigate methods to measure Indigenous catch and effort

The only estimates of indigenous catch and effort across the Northern Territory are reported from the National Recreational and Indigenous Fishing Survey conducted in 2000/01 (Henry and Lyle 2003). These results also had large underlying assumptions that have not been thoroughly examined.

There is support at the national level for a proposal to undertake a national indigenous fishing survey and the Fisheries Division will engage with the commonwealth and other jurisdictions to investigate methods to record this data. Within the NT, the Fisheries Division has recently incorporated an identifier within the recent NT Recreational Fishing Survey 2019 which asks whether surveyed persons identify as Aboriginal or Torres Strait Islander within the onsite (boat ramp) survey component. There is potential for this to be included as a requirement in the onsite surveys undertaken in the Greater Darwin Region.

Initially, NT Fisheries will investigate the potential of using the recreational fishing application to get information on catch and effort by this sector in key Aboriginal communities. It is expected that getting results from this work will take between three to five years. Updated estimates of Indigenous catch and effort data will be used to better inform the stock assessments for primary and secondary species. This data can also be used to revise the Aboriginal traditional sectors allocation of species in the fishery, rather than using the current assumption made for resource use by this sector.

12.5. Review of the monitoring and research plan

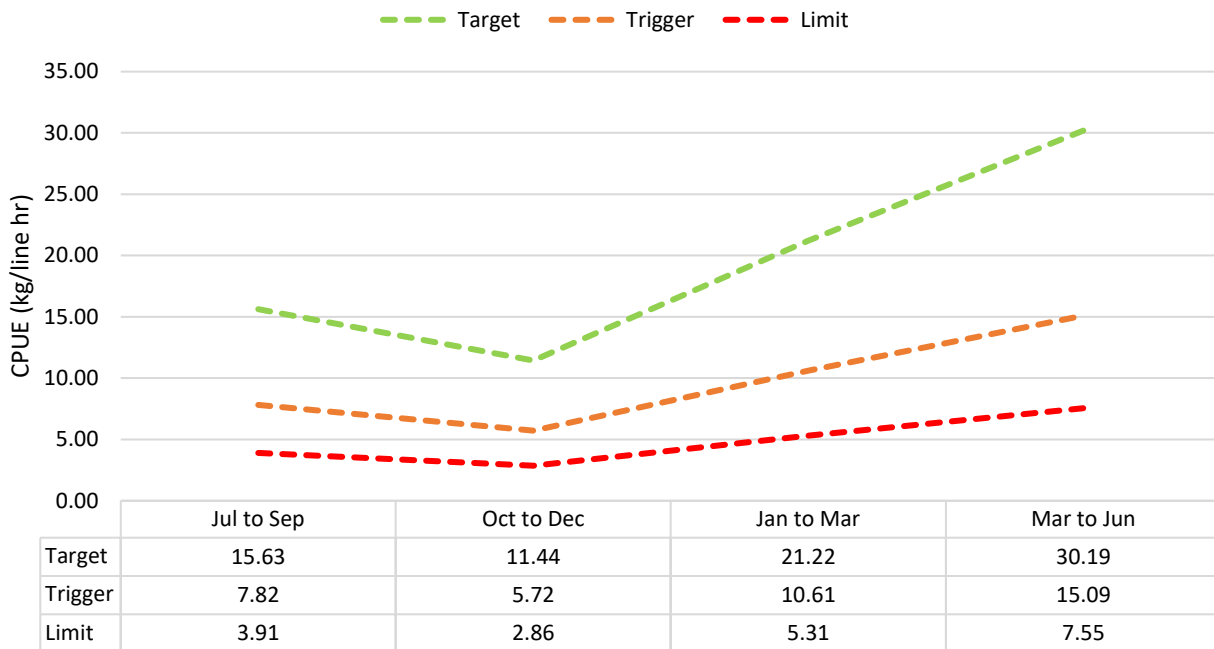
A review of the performance of the monitoring and research plan as well as progress towards achieving the objectives will be conducted on an annual basis and coincide with assessment of the Harvest Strategy.

13. References

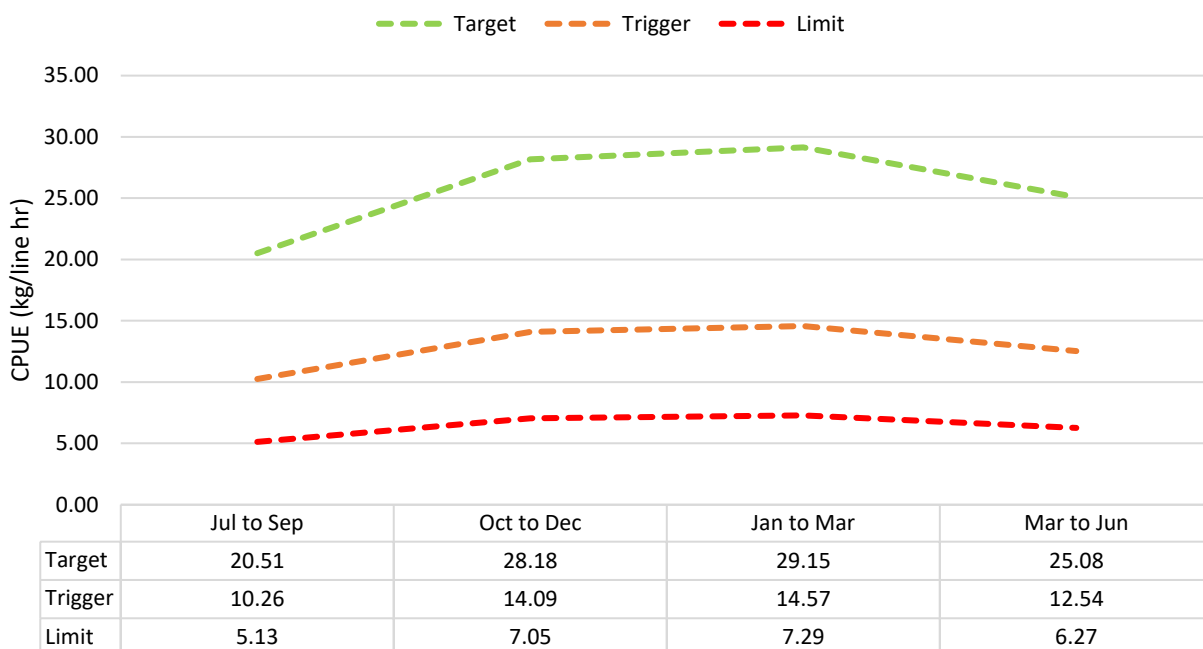
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Appendix A - Reference Points for management areas

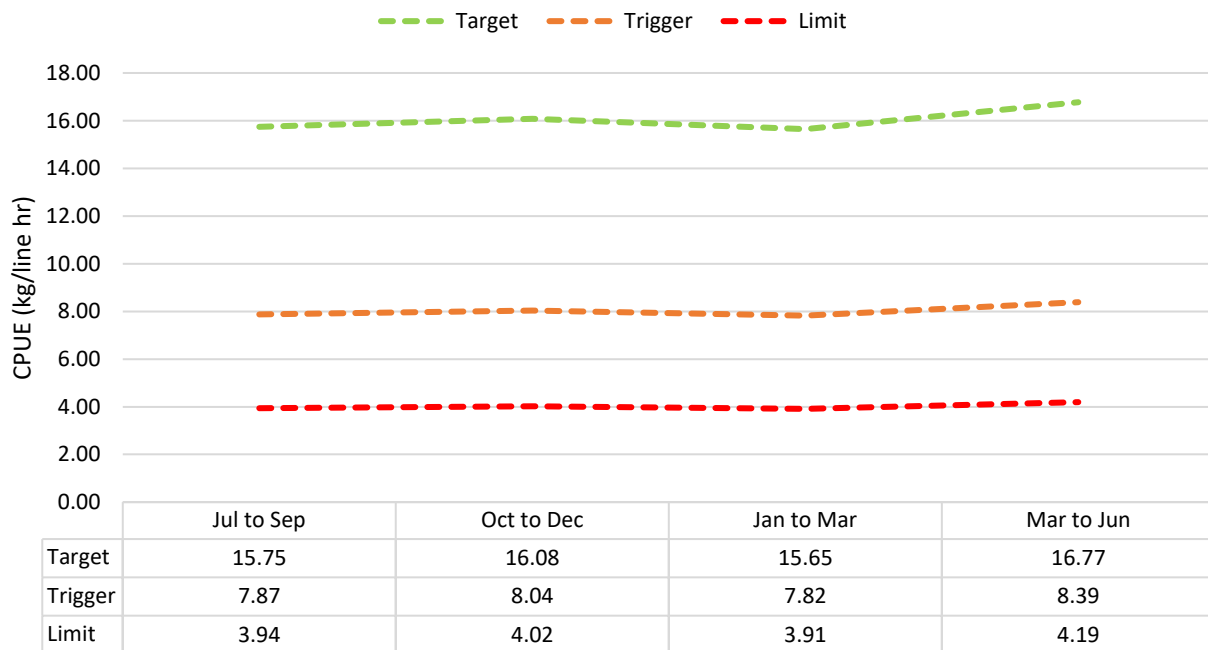
Reference Points for Channel Point Management Area



Reference Points for Mitchell Point Management Area

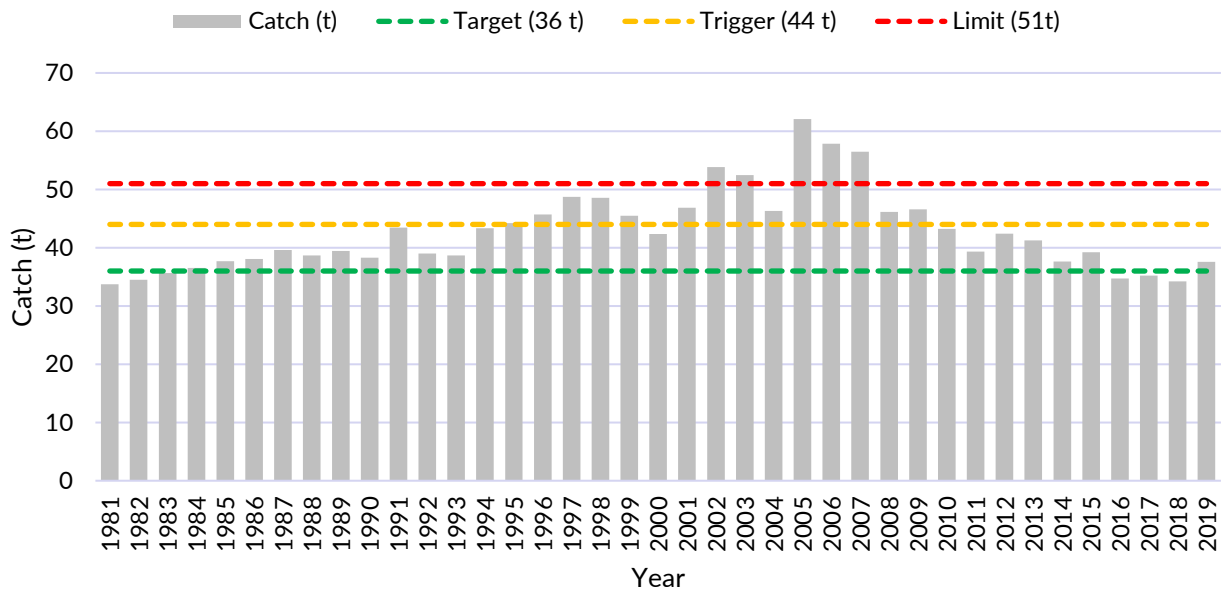


Reference Points for Point Stuart Management Area

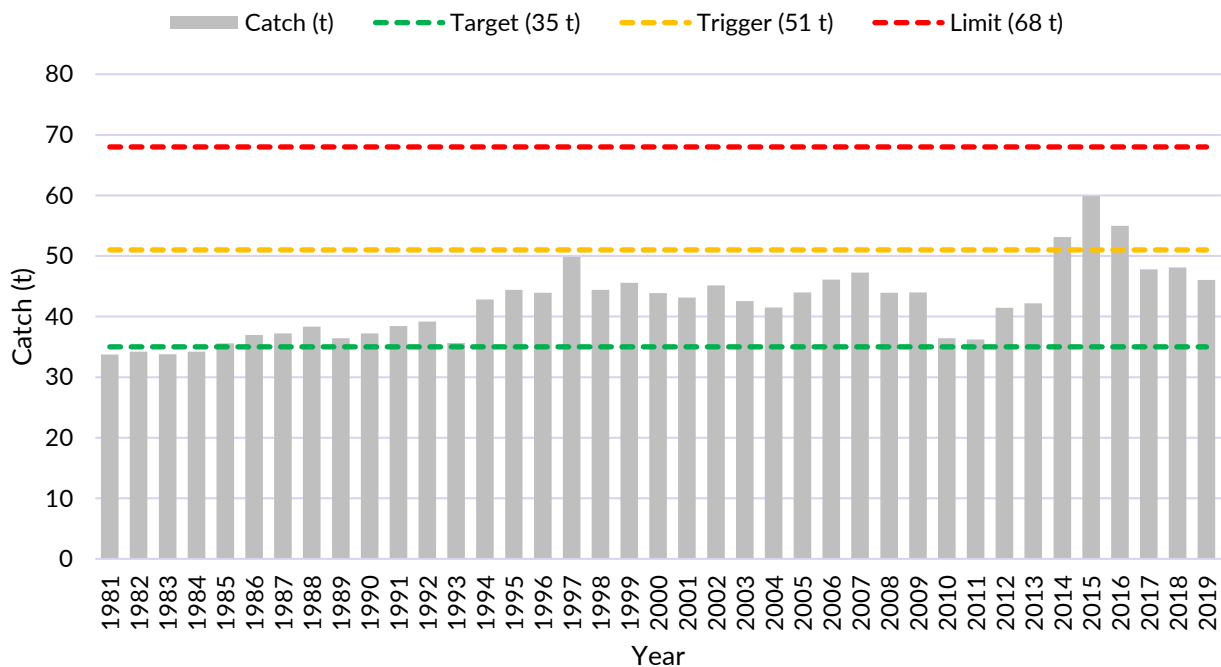


Appendix B - Reference Points for secondary species

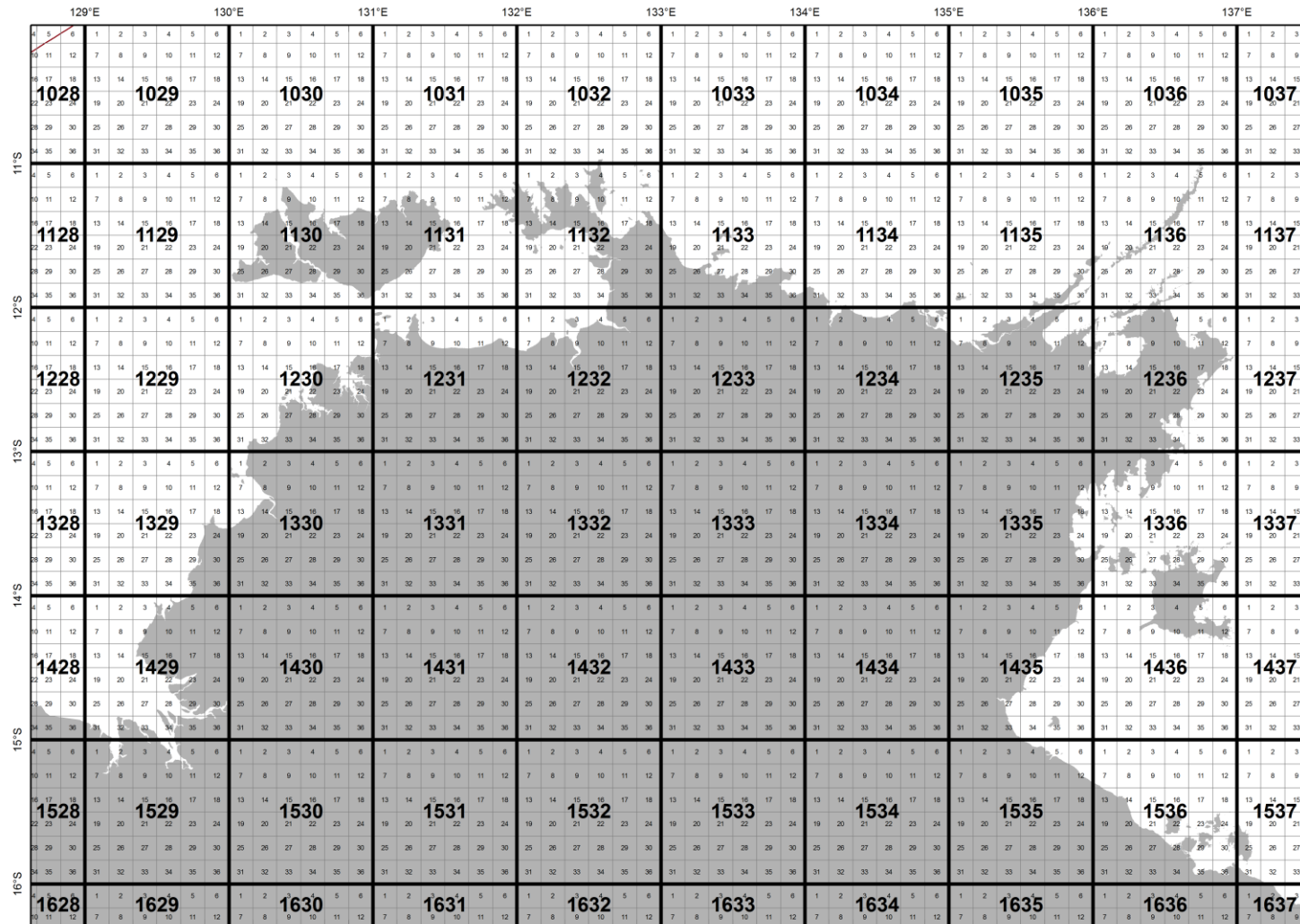
MSY reference points for Grass Emperor for the Greater Darwin Region



MSY reference points for Stripey Snapper for the Greater Darwin Region



Appendix C – NT Fishing grids (60 x 60 nm) and sub-grids (10 x 10nm)



Appendix D - Designated spatial closures for recreational and tourism fishers (yellow boxes)

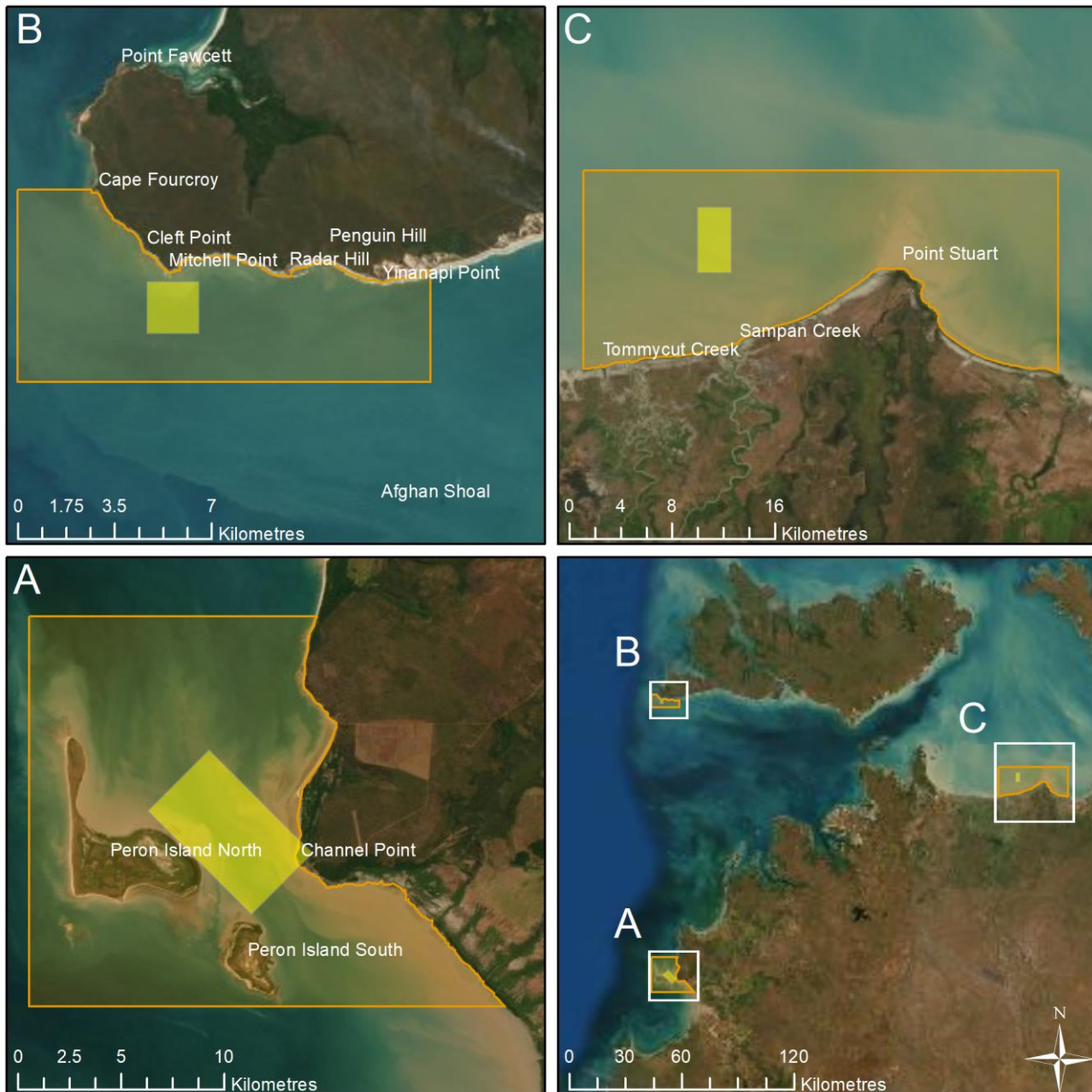


Figure 76. Designated spatial closures within the extent of the management regions