

Length-Based Assessment of Data-Poor Multi-Species Deep Grouper Fisheries in Fisheries Management Areas (WPP) 573, 712, 713, 714, 715 & 718 in Indonesia

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1 Introduction

This report presents a length-based assessment of the status of the most abundant species of grouper caught in the multi-species deep demersal fisheries for snappers, groupers, and emperors in Eastern Indonesia. The gear types in these fisheries include vertical drop lines and bottom set long lines at various scales, ranging from small scale village based fisheries with boats less than 5 GT to medium scale drop line and long line vessels measuring up to well over 100 GT for the largest long line vessels. The drop line fishery is an active vertical hook and line fishery operating at depths from 50 to 500 meters, whereas long lines are set horizontally along the bottom at depths ranging from 50 to 150 meters.

The fisheries included in this report operate in Fisheries Management Areas (WPPs) 573, 712, 713, 714, 715 and 718 including the Northern Indian Ocean, Timor Sea, Java Sea, Makassar Strait, Bali Sea, Flores Sea, Banda Sea, Moluccas Sea, Timor Sea and Arafura Sea. Vessels operating in this region are originating from various ports throughout the country and may also operate in other WPPs at times. Data from 2015 to the present date were accumulated for this assessment.

For a complete overview of the species composition of these drop line and long line fisheries please refer to the ID guide prepared for these fisheries:

CLICK: [Link to on-line E-Book Species ID Guide](#)

For further background on species life history characteristics, and data-poor length based assessment methods, as applied in this report, please refer to the assessment guide that was separately prepared for these fisheries:

CLICK: [Link to on-line E-Book Assessment Guide with Biological Information](#)

Since 2015, all fish in the catch of cooperating vessels were photographed as they were caught. Fish were placed on top of measuring boards to enable sizing as well as identification from images. Photographs were taken by crew participating in our Crew Operated Data Recording System or CODRS. Images were analyzed by staff at our fisheries stations to generate species specific length frequency distributions that served as the input for length based assessments presented in this report.

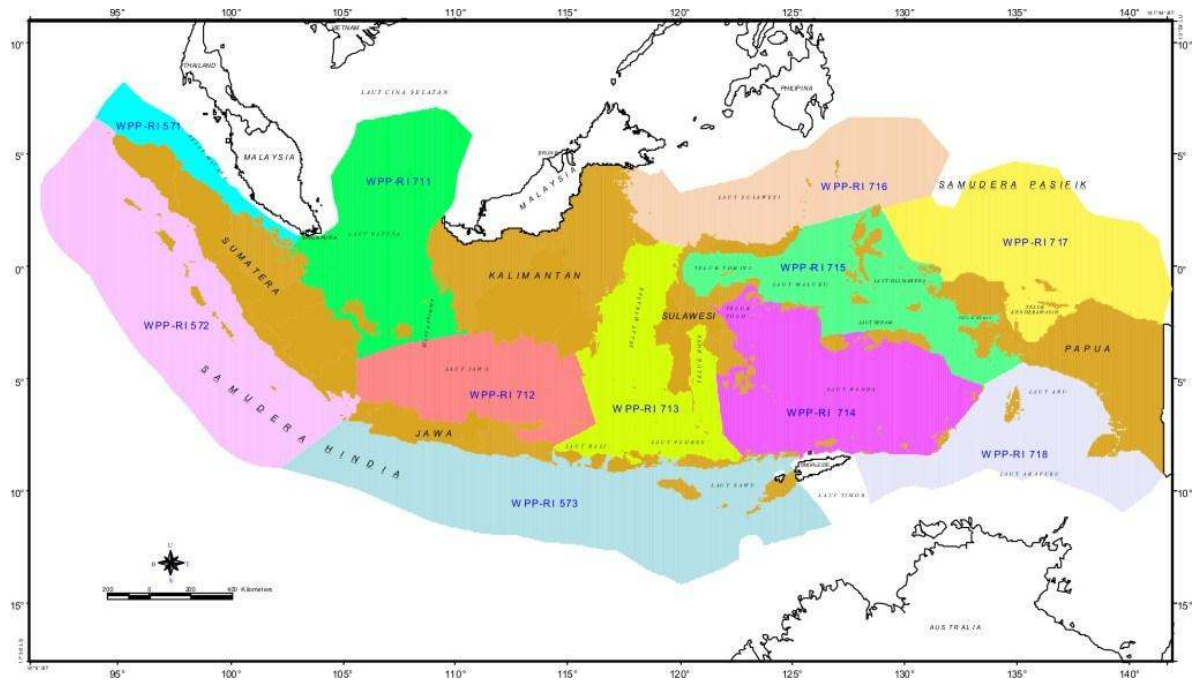


Figure 1. Fisheries Management Areas (WPP) in Indonesian marine waters.

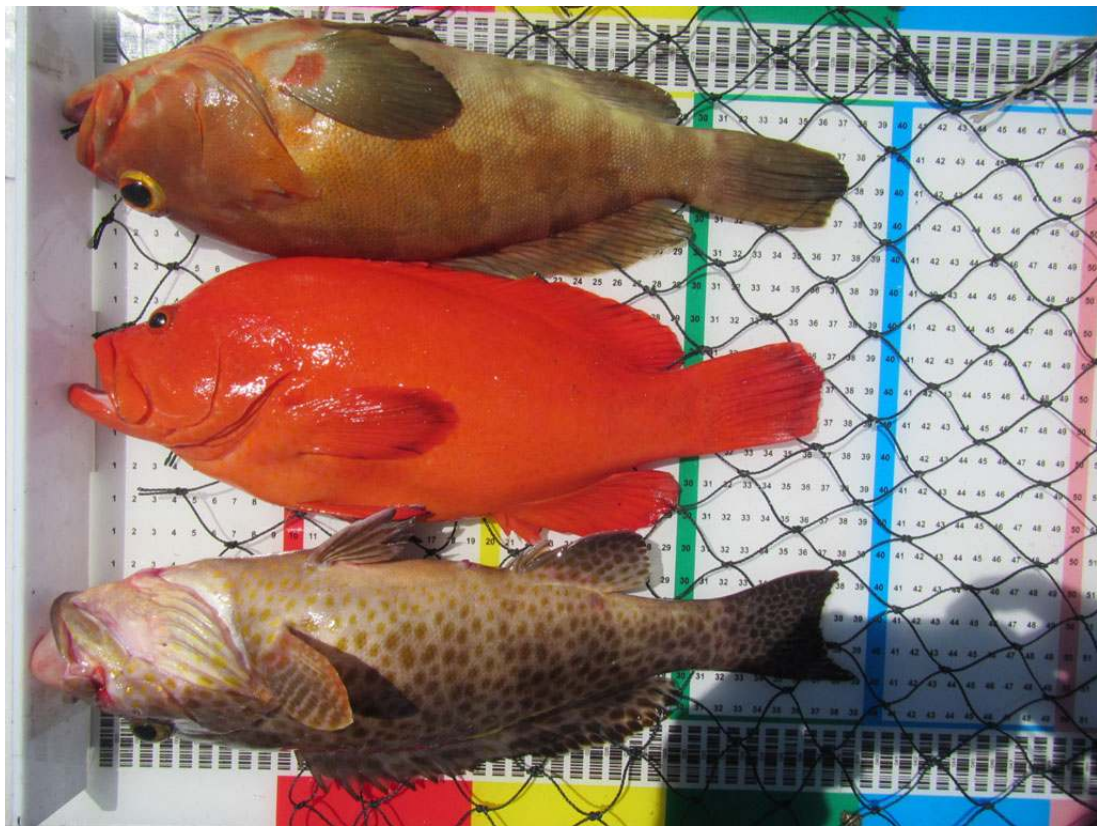


Figure 2. Groupers photographed by fishing crew on board as part of the Crew Operated Data Recording System (CODRS).

Table 1.1: Length-Weight Relationships, Trading Limits and Sample Sizes in Current Year for Grouper Species in Deep Water Hook-and-Line Fisheries in East Indonesia

#ID	Species	Reported	W = a L ^b		Length	Converted	Plotted	Sample Sizes
		Trade Limit Weight (g)	a	b	Type for a & b TL-FL-SL	Trade Limit L(cm)	Trade Limit TL(cm)	
36	<i>Saloptia powelli</i>	300	0.008	3.175	FL	27.28	27.28	14
37	<i>Cephalopholis miniata</i>	300	0.026	2.864	TL	26.35	26.35	23
38	<i>Cephalopholis sexmaculata</i>	300	0.027	3.000	SL	22.37	28.24	65
39	<i>Cephalopholis sonnerati</i>	300	0.015	3.058	TL	25.78	25.78	687
40	<i>Cephalopholis igarashiensis</i>	300	0.049	2.748	FL	23.86	23.86	61
41	<i>Epinephelus latifasciatus</i>	1500	0.010	3.088	TL	48.00	48.00	315
42	<i>Epinephelus radiatus</i>	300	0.061	2.624	FL	25.59	25.59	183
43	<i>Epinephelus morrhua</i>	300	0.061	2.624	FL	25.59	25.59	655
44	<i>Epinephelus poecilonotus</i>	500	0.061	2.624	FL	31.09	31.09	115
45	<i>Epinephelus areolatus</i>	300	0.011	3.048	FL	28.18	28.77	7842
46	<i>Epinephelus bleekeri</i>	300	0.009	3.126	TL	28.09	28.09	500
47	<i>Epinephelus miliaris</i>	300	0.025	3.000	SL	22.74	29.23	45
48	<i>Epinephelus bilobatus</i>	300	0.014	2.990	TL	27.82	27.82	45
49	<i>Epinephelus malabaricus</i>	1500	0.013	3.034	TL	46.85	46.85	71
50	<i>Epinephelus coioides</i>	1500	0.011	3.084	TL	46.94	46.94	499
51	<i>Epinephelus chlorostigma</i>	500	0.015	2.940	FL	34.62	34.62	258
52	<i>Epinephelus retouti</i>	300	0.027	3.000	SL	22.37	28.24	32
53	<i>Epinephelus heniochus</i>	300	0.061	2.624	FL	25.59	25.59	370
54	<i>Epinephelus stictus</i>	300	0.027	3.000	SL	22.37	28.24	70
55	<i>Epinephelus epistictus</i>	1500	0.009	3.126	TL	47.01	47.01	92
56	<i>Epinephelus multinotatus</i>	1500	0.017	2.964	TL	46.90	46.90	90
57	<i>Epinephelus undulosus</i>	1500	0.015	2.940	FL	50.31	50.31	47
58	<i>Epinephelus amblycephalus</i>	1500	0.012	3.057	TL	45.99	45.99	638
59	<i>Hyporthodus octofasciatus</i>	1500	0.106	2.560	TL	41.82	41.82	62
60	<i>Plectropomus maculatus</i>	500	0.016	3.000	FL	31.76	31.76	50
61	<i>Plectropomus leopardus</i>	500	0.012	3.060	FL	32.56	33.38	216
62	<i>Variola albimarginata</i>	300	0.012	3.079	FL	26.68	30.44	131

Table 1.2: Sample Sizes over the period 2015 to 2026 for Grouper Species in Assessment of Deep Water Hook-and-Line Fisheries in East Indonesia

#ID	Species	'15-'16	'17-'18	'19-'20	'21-'22	'23-'24	'25-'26	Total	%
36	Saloptia powelli	86	14	0	0	0	0	100	0.20
37	Cephalopholis miniata	104	23	0	0	0	0	127	0.25
38	Cephalopholis sexmaculata	178	65	0	0	0	0	243	0.48
39	Cephalopholis sonnerati	1874	687	0	0	0	0	2561	5.01
40	Cephalopholis igarashiensis	122	61	0	0	0	0	183	0.36
41	Epinephelus latifasciatus	459	315	0	0	0	0	774	1.52
42	Epinephelus radiatus	411	183	0	0	0	0	594	1.16
43	Epinephelus morrhua	1970	655	0	0	0	0	2625	5.14
44	Epinephelus poecilonotus	232	115	0	0	0	0	347	0.68
45	Epinephelus areolatus	25731	7842	0	0	0	0	33573	65.74
46	Epinephelus bleekeri	461	500	0	0	0	0	961	1.88
47	Epinephelus miliaris	110	45	0	0	0	0	155	0.30
48	Epinephelus bilobatus	258	45	0	0	0	0	303	0.59
49	Epinephelus malabaricus	95	71	0	0	0	0	166	0.33
50	Epinephelus coioides	800	499	0	0	0	0	1299	2.54
51	Epinephelus chlorostigma	1260	258	0	0	0	0	1518	2.97
52	Epinephelus retouti	68	32	0	0	0	0	100	0.20
53	Epinephelus heniochus	644	370	0	0	0	0	1014	1.99
54	Epinephelus stictus	404	70	0	0	0	0	474	0.93
55	Epinephelus epistictus	135	92	0	0	0	0	227	0.44
56	Epinephelus multinotatus	245	90	0	0	0	0	335	0.66
57	Epinephelus undulosus	253	47	0	0	0	0	300	0.59
58	Epinephelus amblycephalus	827	638	0	0	0	0	1465	2.87
59	Hyporthodus octofasciatus	175	62	0	0	0	0	237	0.46
60	Plectropomus maculatus	76	50	0	0	0	0	126	0.25
61	Plectropomus leopardus	503	216	0	0	0	0	719	1.41
62	Variola albimarginata	416	131	0	0	0	0	547	1.07

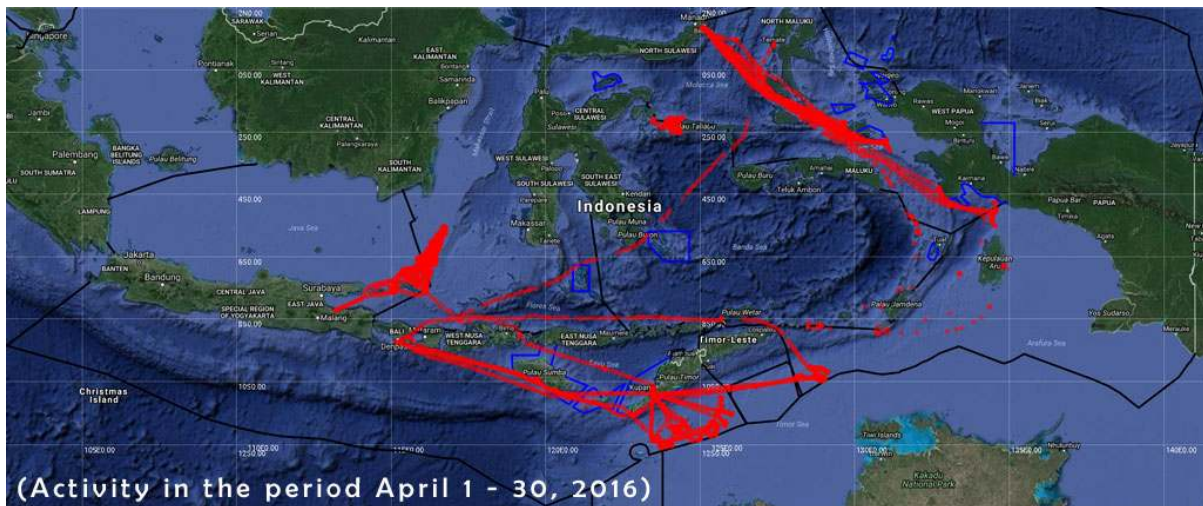


Figure 3. Map with fishing ground bathymetry and tracks (in red) of drop line and bottom long line fishing trips in our area of interest. Black lines are WPP boundaries, blue lines are MPA boundaries.

2 Materials and methods for data collection, analysis and reporting

2.1 SPOT Trace vessel tracking

Fishing grounds are determined by deploying Spot Trace units on various fishing boats. When in motion, Spot Trace units automatically report an hourly location, and when at rest for more than 24 hours, they relay daily status reports. Location and status report messages are automatically recorded in I-Fish Community, an online database running PostgreSQL with a user interface programmed in Java and analysis and reporting procedures in R and Latex.

Fishing vessels with Spot Trace units on board generate accurate data on fishing grounds and specific fishing locations within fishing grounds. Traditionally, fishing ground data were often collected from logbook data or captain interviews. However, logbook and interview data are sometimes unclear, inaccurate and can easily be tampered with. Spot Trace enables us to match catch data with exact fishing locations, while providing additional safety for the fishing vessels. To mitigate IUU fishing accusations, having the Spot Trace onboard can also be used as proof of legal fishing within Indonesian waters.

2.2 Crew Operated Data Recording System

Data on species and size distributions of complete catches are needed for accurate length based stock assessments. Such data on individual fishing trips are collected via Crew Operated Data Recording Systems or CODRS. This catch data is geo-referenced as the CODRS works in tandem with the Spot Trace vessel tracking system. Crews of fishing vessels are contracted to take images on project-supplied digital cameras of all fish in the catch, positioned over measuring boards. This procedure takes place when batches of fish are taken from chiller boxes on deck, before they are packed on ice in the hold. The crew photographs all the fish in this manner and at the end of the trip hands in the storage chip from the camera to a project stage who analysis the images back at the fisheries station. Double checking with owner and trader data on total catches, and comparison with weights as calculated from fish lengths, showed that we were indeed capturing length frequencies of most if not all fish in the catch in this manner. No species or size classes were missing before analysis.

Analysis of the CODRS images includes ID of the species and reading of the length of the fish as displayed on the measuring board. The image analysis is done by highly trained and experienced project stage and interns, based at our fisheries stations. Data processing, analysis and reporting are done through I-Fish Community, which also receives data on fishing grounds via the Spot Trace units deployed on fishing vessels. All data are stored in real time in the I-Fish Community database, where it is aggregated and analyzed with length-based methods.



Figure 4. Fishing crew preparing fish on a measuring board.

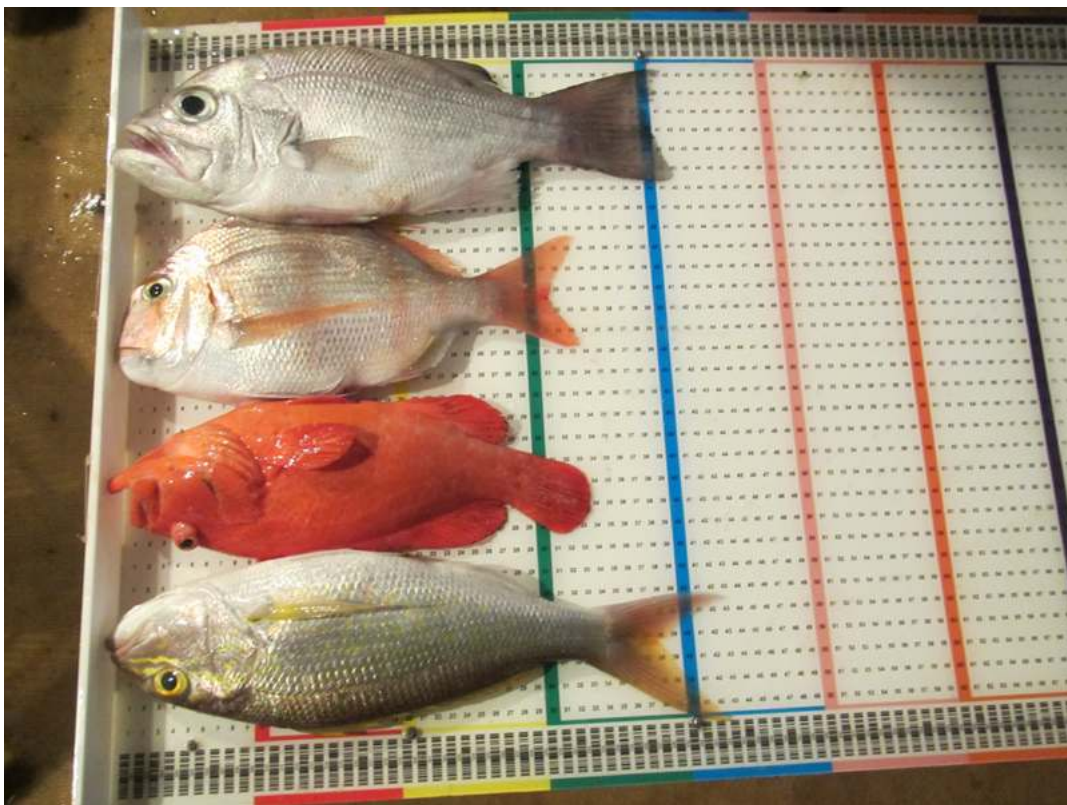


Figure 5. Fish photographed by fishing crew on board as part of CODRS.

2.3 I-Fish Community

I-Fish Community only stores data that are relevant to fisheries management, whereas data on processed volume and sales, from the Smart Weighing and Measuring System, remain on servers at processing companies. Access to the I-Fish Community database is controlled by user name and password. I-Fish Community has different layers of privacy, which is contingent on the user's role in the supply chain. For instance, boat owners may view exact location of their boats, but not of the boats of other owners.

I-Fish Community has an automatic length-frequency distribution reporting system for length-based assessment of the fishery by species. The database generates length frequency distribution graphs for each species, together with life history parameters including length at maturity (L_{mat}), optimum harvest size (L_{opt}), asymptotic length- (L_{inf}), and maximum total length (L_{max}), as well as size limits used in the trade. These "trade limit" lengths are derived from general buying behavior (minimal weight) of processing companies. The weights are converted into lengths by using species-specific length- weight relationships.

Each length frequency distribution is accompanied by an automated length-based assessment on current status of the fishery by species. Any I-Fish Community user can access these graphs and the conclusions from the assessments. The report produces an assessment for the 50 most abundant species in the fishery, based on complete catches from the most recent complete calendar year (to ensure full year data sets). The graphs show the position of the catch length frequency distributions relative to various life history parameter values and trading limits for each species. Relative abundance of specific size groups is plotted for all years for which data are available, to indicate trends in status by species.

Immature fish, small mature fish, large mature fish, and a subset of large mature fish, namely "mega-spawners", which are fish larger than 1.1 times the optimum harvest size (Froese 2004), make up the specific size groups used in our length based assessment. For all fish of each species in the catch, the percentage in each category is calculated for further use in the length based assessment. These percentages are calculated and presented as the first step in the length based assessment as follows: $W\%$ is immature (smaller than the length at maturity), $X\%$ is small matures (at or above size at maturity but smaller than the optimum harvest size), and $Y\%$ is large mature fish (at or above optimum harvest size). The percentage of mega-spawners is $Z\%$.

The automated assessment comprises of six elements from the catch length frequencies. These elements all work with length based indicators of various kinds to draw conclusions from species specific length frequencies in the catch.

1. *Proportion of immature fish in the catch.*

With 0% immature fish in the catch as an ideal target (Froese, 2004), a target of 10% or less is considered a reasonable indicator for sustainable (or safe) harvesting (Fujita et al., 2012; Vasilakopoulos et al., 2011). Zhang et al. (2009) consider 20% immature fish in the catch as an indicator for a fishery at risk, in their approach to an ecosystem based fisheries assessment. Results from meta-analysis over multiple fisheries showed stock status over a range of stocks to fall below precautionary limits at 30% or more immature fish in the catch (Vasilakopoulos et al., 2011). The fishery is considered highly at risk when more than 50% of the fish in the catch are immature (Froese et al, 2016).

IF "% immature" is lower than or equal to 10% THEN:

"At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low."

ELSE, IF "% immature" is greater than 10% AND "% immature" is lower than or equal to 20% THEN:

"Between 10% and 20% of the fish in the catch are juveniles that have not yet reproduced. There is no immediate concern in terms of overfishing through over harvesting of juveniles, but the fishery needs to be monitored closely for any further increase in this indicator and incentives need to be geared towards targeting larger fish. Risk level is medium."

ELSE, IF "% immature" is greater than 20% AND "% immature" is lower than or equal to 30% THEN:

"Between 20% and 30% of the fish in the catch are specimens that have not yet reproduced. This is reason for concern in terms of potential overfishing through overharvesting of juveniles, if fishing pressure is high and percentages immature fish would further rise. Targeting larger fish and avoiding small fish in the catch will promote a sustainable fishery. Risk level is medium."

ELSE, IF "% immature" is greater than 30% AND "% immature" is lower than or equal to 50% THEN:

"Between 30% and 50% of the fish in the catch are immature and have not had a chance to reproduce before capture. The fishery is in immediate danger of overfishing through overharvesting of juveniles, if fishing pressure is high. Catching small and immature fish needs to be actively avoided and a limit on overall fishing pressure is warranted. Risk level is high."

ELSE, IF "% immature" is greater than 50% THEN:

"The majority of the fish in the catch have not had a chance to reproduce before capture. This fishery is most likely overfished already if fishing mortality is high for all size classes in the population. An immediate shift away from targeting juvenile fish and a reduction in overall fishing pressure is essential to prevent collapse of the stock. Risk level is high."

2. Minimum size as traded compared to length and maturity.

We use a comparison between the trade limit (minimum size accepted by the trade) and the size at maturity as an indicator for incentives from the trade for either unsustainable targeting of juveniles or for more sustainable targeting of mature fish that have spawned at least once. We consider a trade limit at 10% below or above the length at maturity to be significantly different from the length at maturity and we consider trade limits to provide incentives for targeting of specific sizes of fish through price differentiation.

IF "TradeLimit" is lower than $0.9 * L\text{-mat}$ THEN:

"The trade limit is significantly lower than the length at first maturity. This means that the trade encourages capture of immature fish, which impairs sustainability. Risk level is high."

ELSE, IF "TradeLimit" is greater than or equal to $0.9 * L\text{-mat}$ AND "TradeLimit" is lower than or equal to $1.1 * L\text{-mat}$ THEN:

"The trade limit is about the same as the length at first maturity. This means that the trade puts a premium on fish that have spawned at least once, which improves sustainability of the fishery. Risk level is medium."

ELSE, IF "TradeLimit" is greater than $1.1 * L\text{-mat}$ THEN:

"The trade limit is significantly higher than length at first maturity. This means that the trade puts a premium on fish that have spawned at least once. The trade does not cause any concern of recruitment overfishing for this species. Risk level is low."

3. Current exploitation level.

We use the current exploitation level expressed as the percentage of fish in the catch below the optimum harvest size as an indicator for fisheries status. We consider a proportion of 65% of the fish (i.e. the vast majority in numbers) in the catch below the optimum harvest size as an indicator for growth overfishing. We also consider a majority in the catch around or above the optimum harvest size as an indicator for minimizing the impact of fishing (Froese et al., 2016). This indicator will be achieved when less than 50% of the fish in the catch are below the optimum harvest size.

IF "% immature + % small mature" is greater than or equal to 65% THEN:

"The vast majority of the fish in the catch have not yet achieved their growth potential. The harvest of small fish promotes growth overfishing and the size distribution for this species indicates that over exploitation through growth overfishing may already be happening. Risk level is high."

ELSE, IF "% immature + % small mature" is lower than or equal to 50% THEN:

"The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low."

ELSE, IF "% immature + % small mature" is greater than 50% AND "% immature + % small mature" is lower than 65% THEN:

"The bulk of the catch includes age groups that have just matured and are about to achieve their full growth potential. This indicates that the fishery is probably at least being fully exploited. Risk level is medium."

4. Proportion of mega spawners in the catch.

Mega spawners are fish larger than 1.1 times the optimum harvest size. We consider a proportion of 30% or more mega spawners in the catch to be a sign of a healthy population (Froese, 2004), whereas lower proportions are increasingly leading to concerns, with proportions below 20% indicating great risk to the fishery.

IF "% mega spawners" is greater than 30% THEN:

"More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low."

ELSE, IF "% mega spawners" is greater than 20% AND "% mega spawners" is lower than or equal to 30% THEN:

"The percentage of mega spawners is between 20 and 30%. There is no immediate reason for concern, though fishing pressure may be significantly reducing the percentage of mega-spawners, which may negatively affect the reproductive output of this population. Risk level is medium."

ELSE, IF "% mega spawners" is lower than or equal to 20%, THEN:

"Less than 20% of the catch comprises of mega spawners. This indicates that the population may be severely affected by the fishery, and that there is a substantial risk of recruitment overfishing through over harvesting of the mega spawners, unless large numbers of mega spawners would be surviving at other habitats. There is no reason to assume that this is the case and therefore a reduction of fishing effort may be necessary in this fishery. Risk level is high."

5. Take less than nature.

Rule number one to minimize the impact of fishing (Froese et al., 2016) teaches us to "take less than nature" by ensuring that mortality caused by fishing is less than the natural rate of mortality. We consider a fishing mortality of less than half the natural mortality to be necessary to minimize the impact of fishing. We estimated the instantaneous total mortality (Z) from the equilibrium Beverton-Holt estimator from length data using Ehrhardt and Ault (1992) bias-correction, implemented through the function `bheq2` of the R Fishmethods package. We estimated the natural rate of mortality (M) using Froese and Pauly (2000) empirical formula with asymptotic length as estimated by species and an ambient water temperature at fishing depth estimated at about 20 degrees Celcius. With an asymptotic length for a snapper of about 80cm this results in an M of about 0.4, which aligns well with the mean of reported values from the literature (Martinez-Andrade, 2003). The fishing mortality F follows as the difference between total and natural mortality.

IF "fishing mortality" is greater than or equal to "natural mortality" THEN:
Mortality caused by fishing is greater than or equal to the natural rate of mortality. This means that impact of fishing is severe and that fishing is unlikely to be sustainable at the current level of effort. Risk level is high.

IF "fishing mortality" is lower than "natural mortality" AND "fishing mortality" is greater than 0.5 times "natural mortality" THEN:
Mortality caused by fishing is lower than the natural rate of mortality but more than half of natural mortality. This means that impact of fishing is considerable and trends in various indicators need to be watched carefully while any increase in fishing effort needs to be prevented. Risk level is medium.

IF "fishing mortality" is lower than or equal to 0.5 times "natural mortality" THEN:
Mortality caused by fishing is at or below a level equal to half the natural rate of mortality. This means that impact of fishing is minimized and this fishery is currently probably operating at a sustainable level of effort. Risk level is low.

6. *Spawning Potential Ratio.*

As an indicator for Spawning Potential Ratio (SPR, Quinn and Deriso, 1999), we used the estimated spawning stock biomass divided by the spawning stock biomass of that population if it would have been pristine (see, for example, Meester et al 2001). We calculated SPR on a per-recruit basis from life-history parameters Z , F , K (von Bertalanffy), and L_{inf} . We estimated Z and F as explained above and K from L_{opt} , using the method presented in Froese and Binohlan 2000.

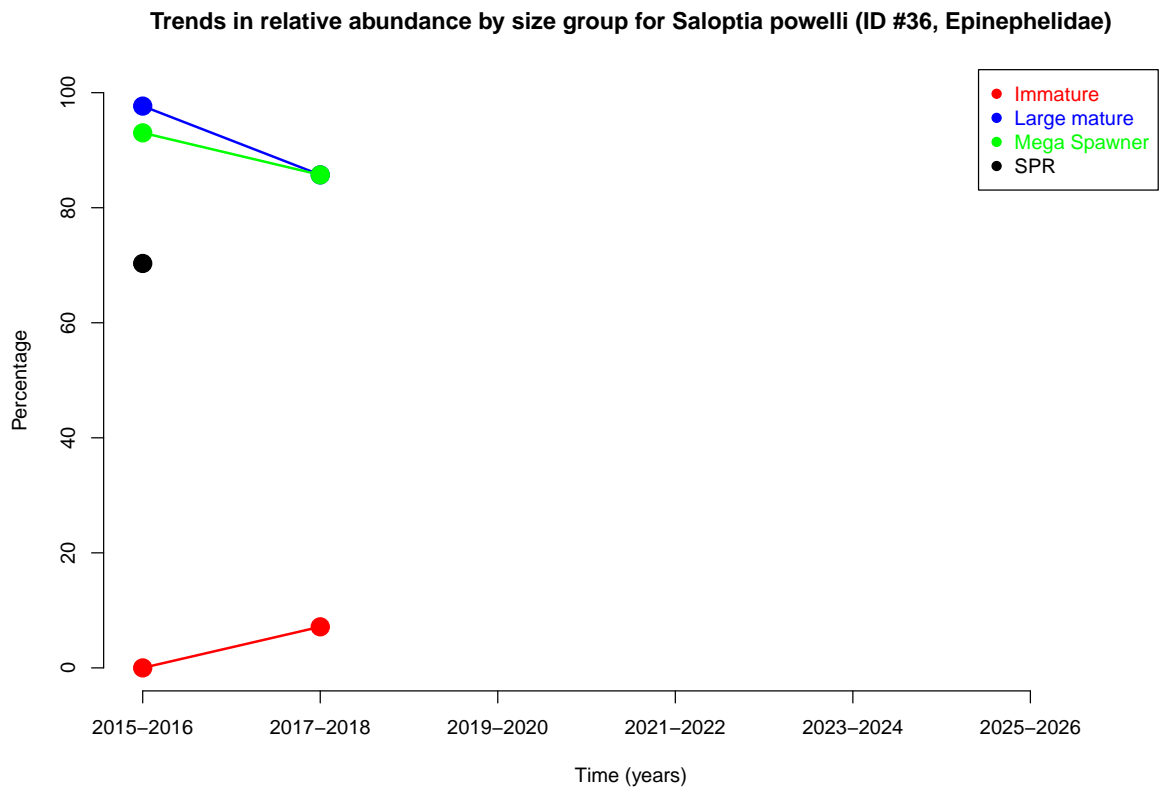
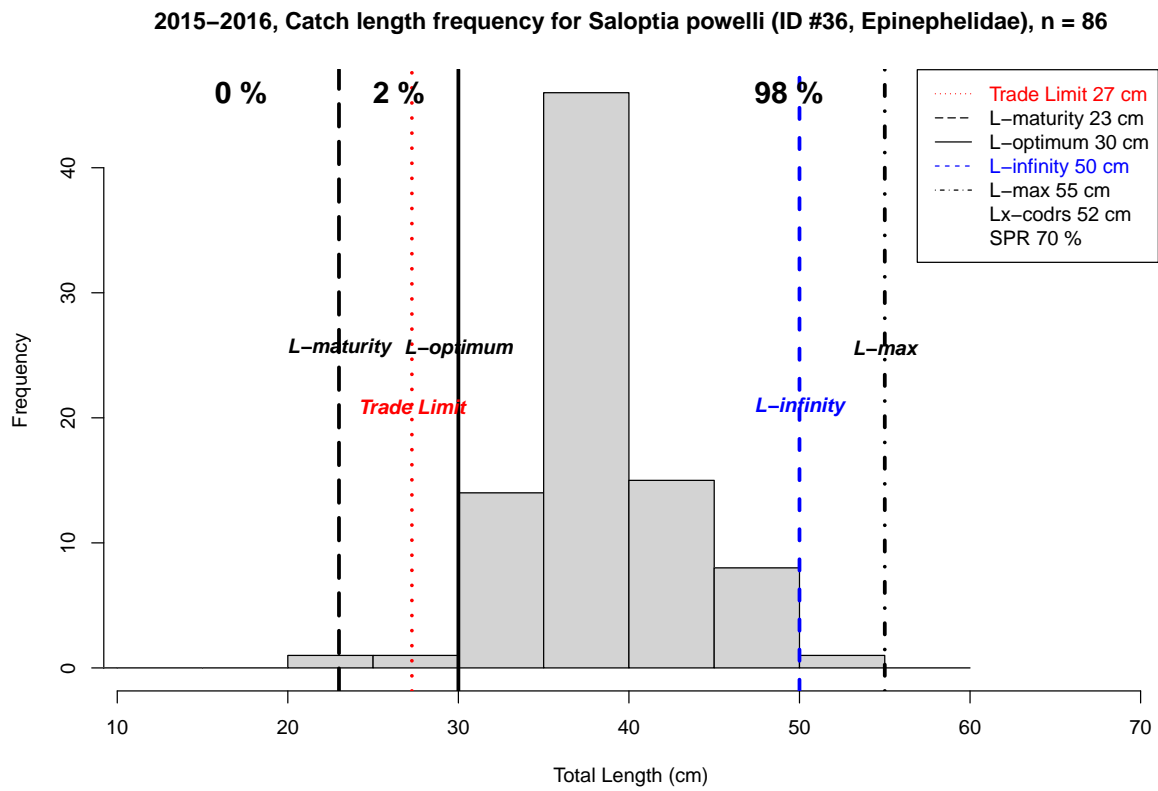
In a perfect world, fishery biologists would know what the appropriate SPR should be for every harvested stock based on the biology of that stock. Generally, however, not enough is known about managed stocks to be so precise. However, studies show that some stocks (depending on the species of fish) can maintain themselves if the spawning stock biomass per recruit can be kept at 20 to 35% (or more) of what it was in the un-fished stock. Lower values of SPR may lead to severe stock declines (Wallace and Fletcher, 2001). Froese et al. (2016) considered a total population biomass B of half the pristine population biomass B_0 to be the lower limit reference point for stock size, minimizing the impact of fishing. Using SPR and B/B_0 estimates from our own data set, this Froese et al. (2016) lower limit reference point correlates with an SPR of about 40%, not far from but slightly more conservative than the Wallace and Fletcher (2001) reference point. We chose an SPR of 40% as our reference point for low risk and after similar comparisons we consider and SPR between 25% and 40% to represent a medium risk situation.

IF "SPR" is lower than 25% THEN:
"SPR is less than 25%. The fishery probably over-exploits the stock, and there is a substantial risk that the fishery will cause severe decline of the stock if fishing effort is not reduced. Risk level is high."

ELSE, IF "SPR" is greater than or equal to 25% AND "SPR" is lower than 40% THEN:
"SPR is between 25% and 40%. The stock is heavily exploited, and there is some risk that the fishery will cause further decline of the stock. Risk level is medium."

ELSE, IF "SPR" is greater than or equal to 40% THEN:
"SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low."

3 Species-specific length-based assessments



The percentages of *Saloptia powelli* (ID #36, Epinephelidae) in 2015-2016, n = 86
Immature (< 23cm): 0%
Small mature (>= 23cm, < 30cm): 2%
Large mature (>= 30cm): 98%
Mega spawner (>= 33cm): 93% (subset of large mature fish)
Spawning Potential Ratio: 70%

At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low.

The trade limit is significantly higher than length at first maturity. This means that the trade puts a premium on fish that have spawned at least once. The trade does not cause any concern of recruitment overfishing for this species. Risk level is low.

The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

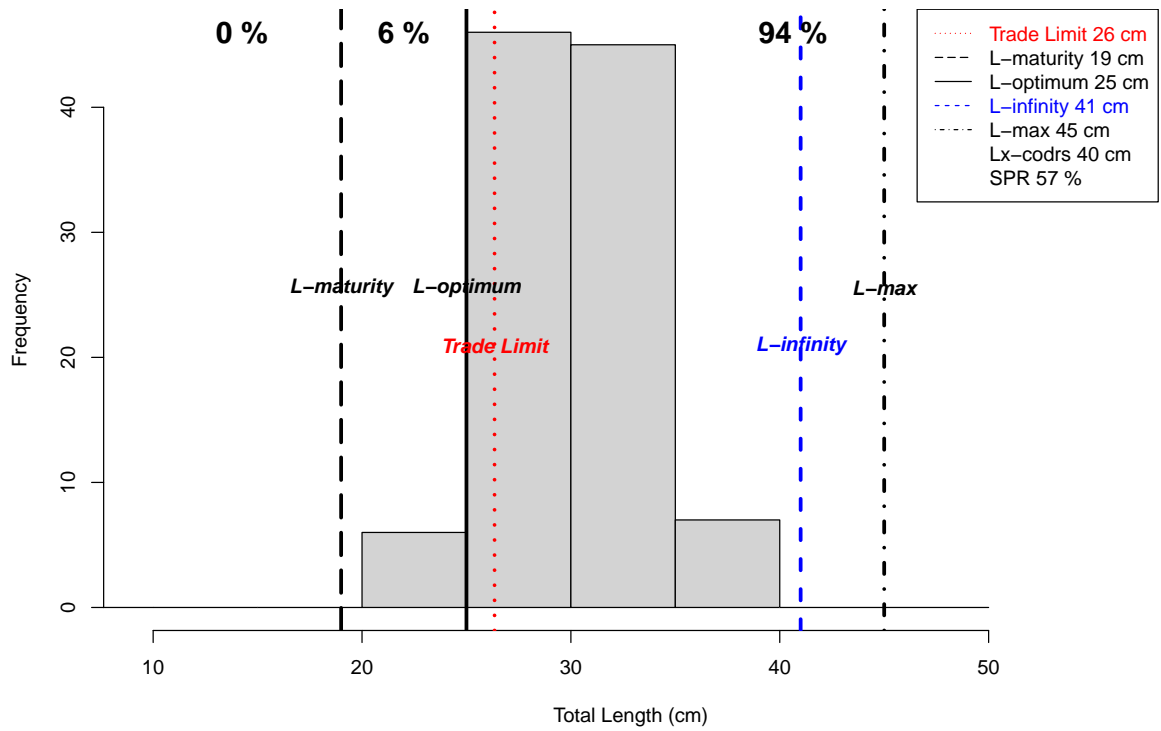
More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is at or below a level equal to half the natural rate of mortality. This means that impact of fishing is minimized and this fishery is currently probably operating at a sustainable level of effort. Risk level is low.

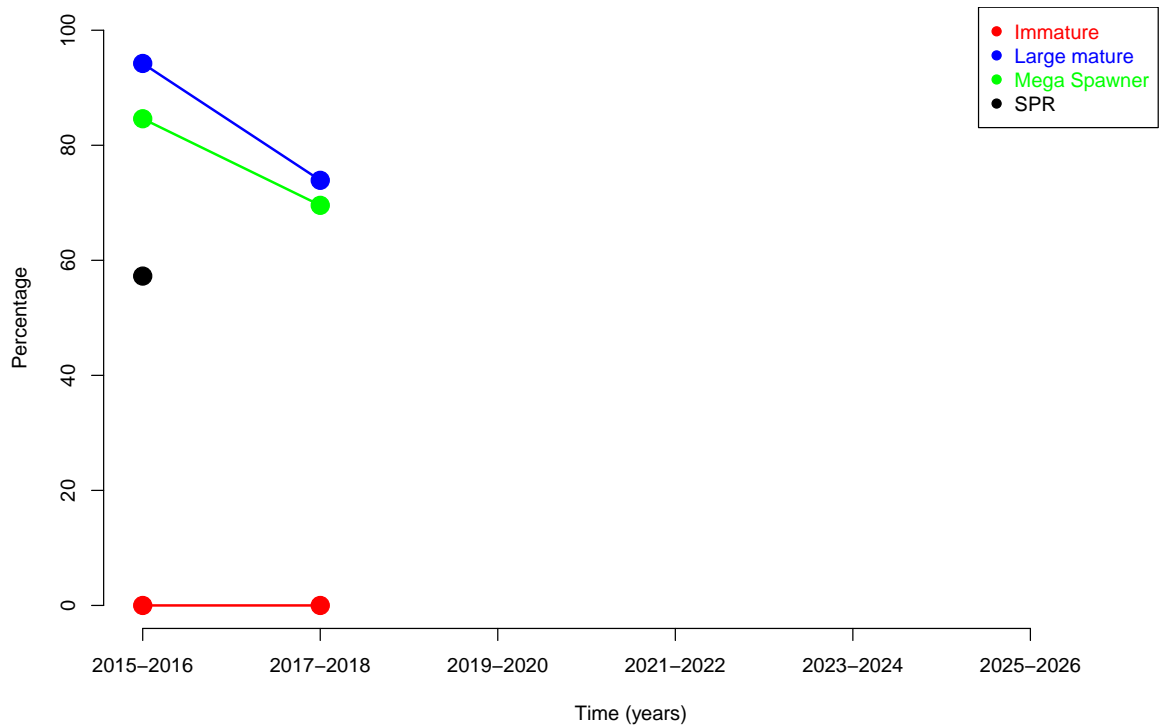
SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low.

Trends in relative abundance by size group for *Saloptia powelli* (ID #36, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.
% Immature rising over recent years, situation deteriorating. P: not available
% Large Mature falling over recent years, situation deteriorating. P: not available
% Mega Spawner falling over recent years, situation deteriorating. P: not available
% SPR no trend over recent years, situation stable. P: not available

2015–2016, Catch length frequency for *Cephalopholis miniata* (ID #37, Epinephelidae), n = 104



Trends in relative abundance by size group for *Cephalopholis miniata* (ID #37, Epinephelidae)



The percentages of *Cephalopholis miniata* (ID #37, Epinephelidae) in 2015-2016, n = 104
Immature (< 19cm): 0%
Small mature (>= 19cm, < 25cm): 6%
Large mature (>= 25cm): 94%
Mega spawner (>= 27.5cm): 85% (subset of large mature fish)
Spawning Potential Ratio: 57%

At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low.

The trade limit is significantly higher than length at first maturity. This means that the trade puts a premium on fish that have spawned at least once. The trade does not cause any concern of recruitment overfishing for this species. Risk level is low.

The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is lower than the natural rate of mortality but more than half of natural mortality. This means that impact of fishing is considerable and trends in various indicators need to be watched carefully while any increase in fishing effort needs to be prevented. Risk level is medium.

SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low.

Trends in relative abundance by size group for *Cephalopholis miniata* (ID #37, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.

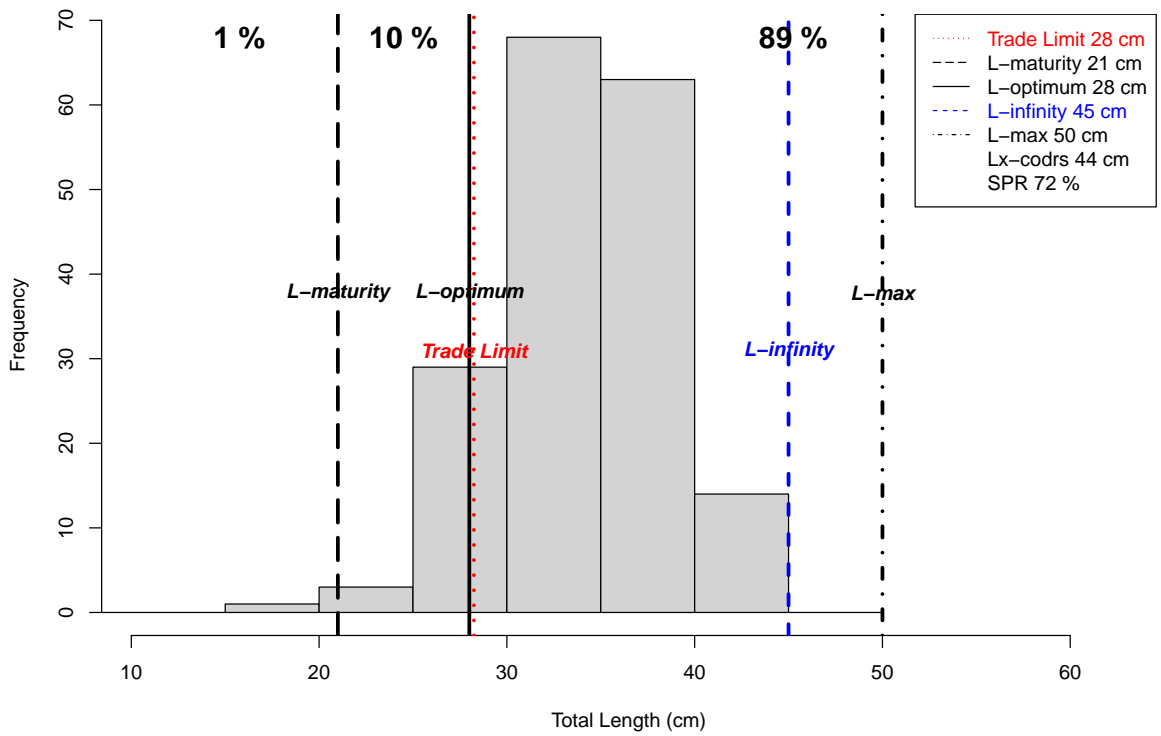
% Immature no trend over recent years, situation stable. P: not available

% Large Mature falling over recent years, situation deteriorating. P: not available

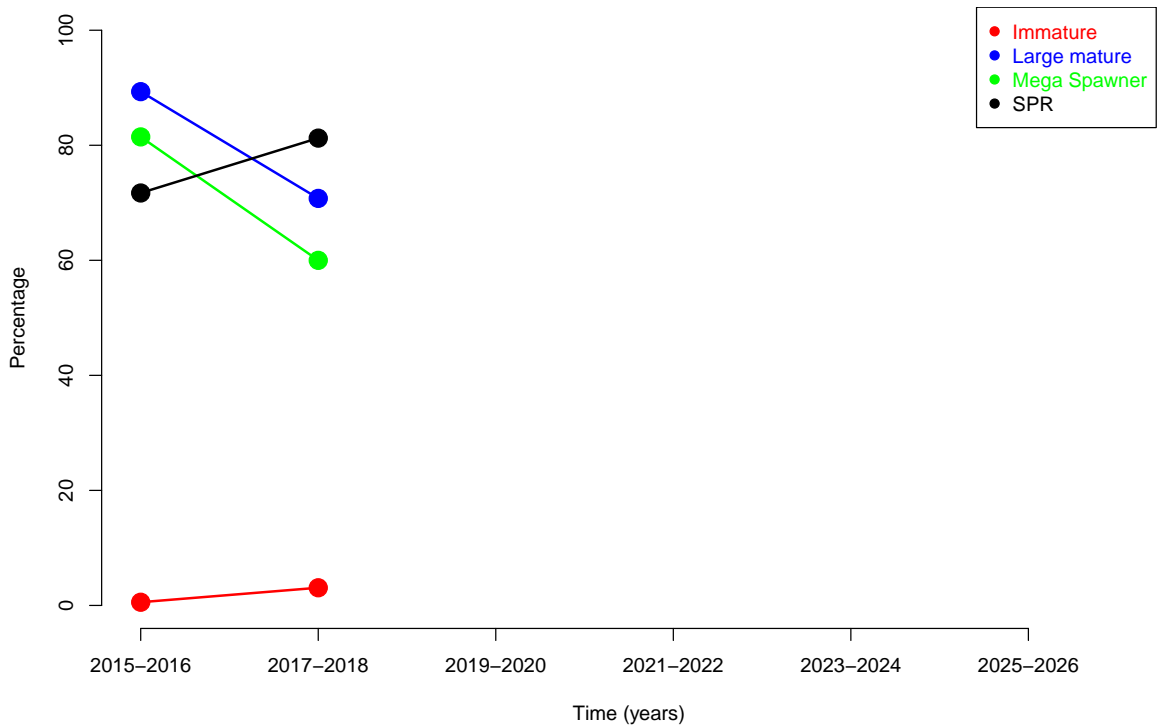
% Mega Spawner falling over recent years, situation deteriorating. P: not available

% SPR no trend over recent years, situation stable. P: not available

2015–2016, Catch length frequency for *Cephalopholis sexmaculata* (ID #38, Epinephelidae), n = 178



Trends in relative abundance by size group for *Cephalopholis sexmaculata* (ID #38, Epinephelidae)



The percentages of *Cephalopholis sexmaculata* (ID #38, Epinephelidae) in 2015-2016, n = 178
Immature (< 21cm): 1%
Small mature (>= 21cm, < 28cm): 10%
Large mature (>= 28cm): 89%
Mega spawner (>= 30.8cm): 81% (subset of large mature fish)
Spawning Potential Ratio: 72%

At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low.

The trade limit is significantly higher than length at first maturity. This means that the trade puts a premium on fish that have spawned at least once. The trade does not cause any concern of recruitment overfishing for this species. Risk level is low.

The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is at or below a level equal to half the natural rate of mortality. This means that impact of fishing is minimized and this fishery is currently probably operating at a sustainable level of effort. Risk level is low.

SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low.

Trends in relative abundance by size group for *Cephalopholis sexmaculata* (ID #38, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.

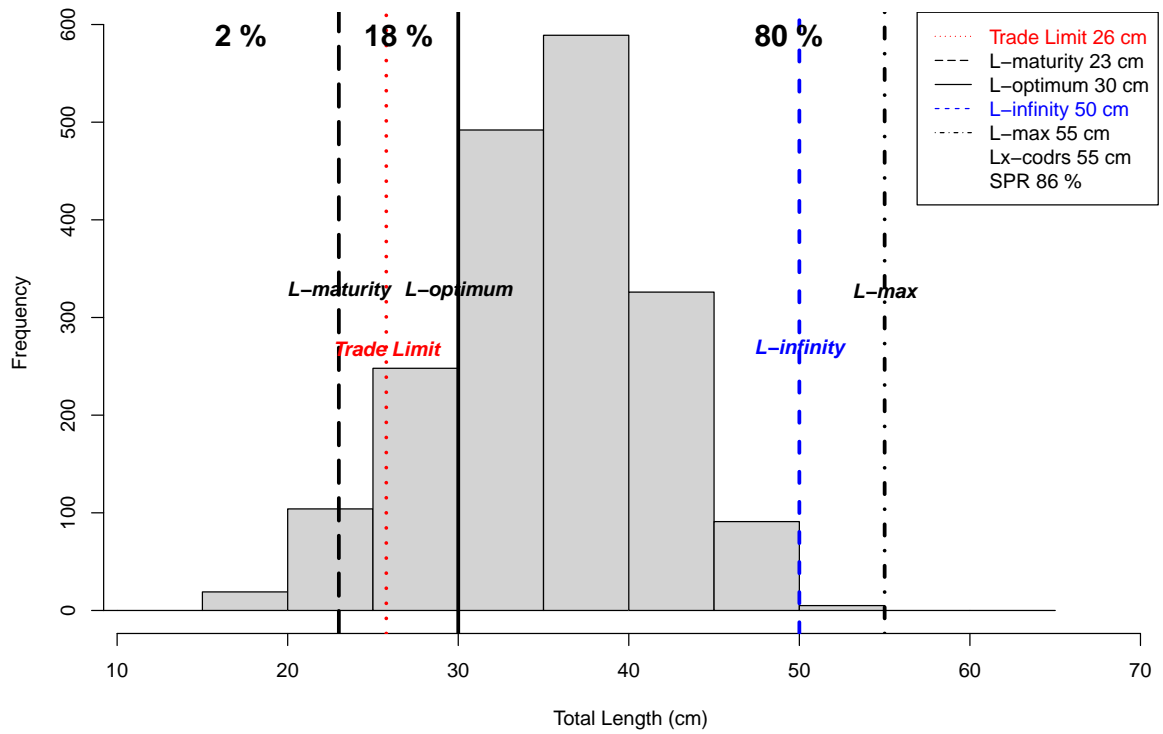
% Immature rising over recent years, situation deteriorating. P: not available

% Large Mature falling over recent years, situation deteriorating. P: not available

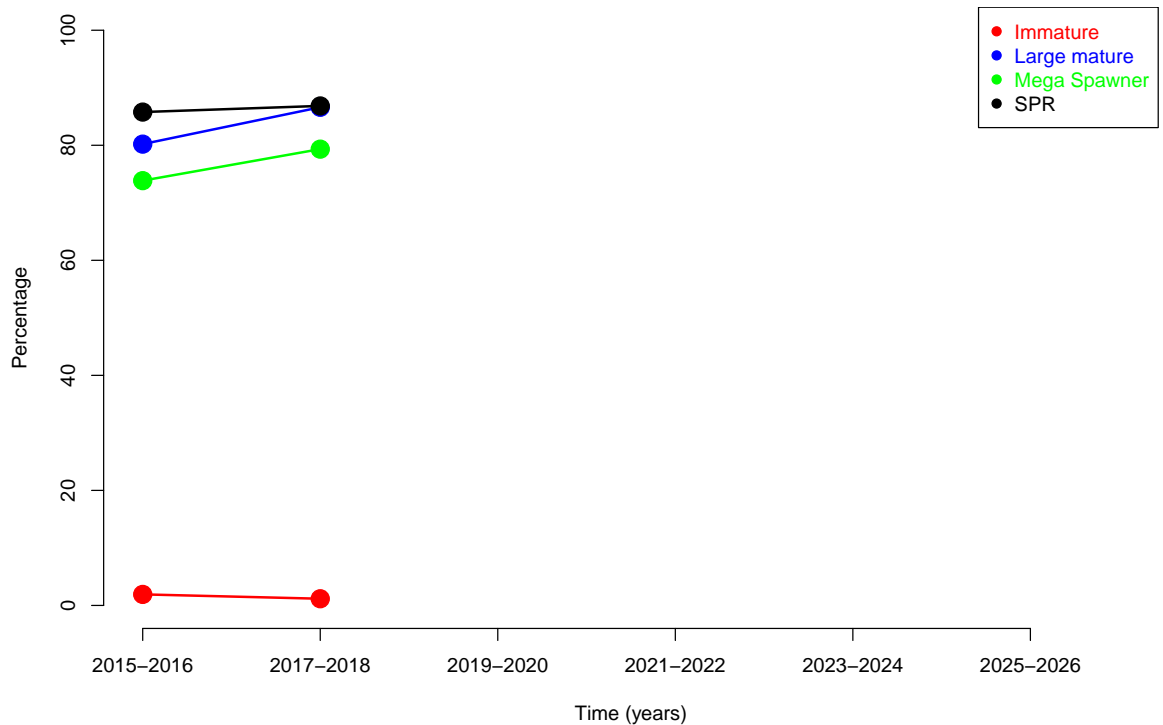
% Mega Spawner falling over recent years, situation deteriorating. P: not available

% SPR rising over recent years, situation improving. P: not available

2015–2016, Catch length frequency for *Cephalopholis sonnerati* (ID #39, Epinephelidae), n = 1,874



Trends in relative abundance by size group for *Cephalopholis sonnerati* (ID #39, Epinephelidae)



The percentages of *Cephalopholis sonnerati* (ID #39, Epinephelidae) in 2015-2016, n = 1,874
Immature (< 23cm): 2%
Small mature (\geq 23cm, < 30cm): 18%
Large mature (\geq 30cm): 80%
Mega spawner (\geq 33cm): 74% (subset of large mature fish)
Spawning Potential Ratio: 86%

At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low.

The trade limit is significantly higher than length at first maturity. This means that the trade puts a premium on fish that have spawned at least once. The trade does not cause any concern of recruitment overfishing for this species. Risk level is low.

The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

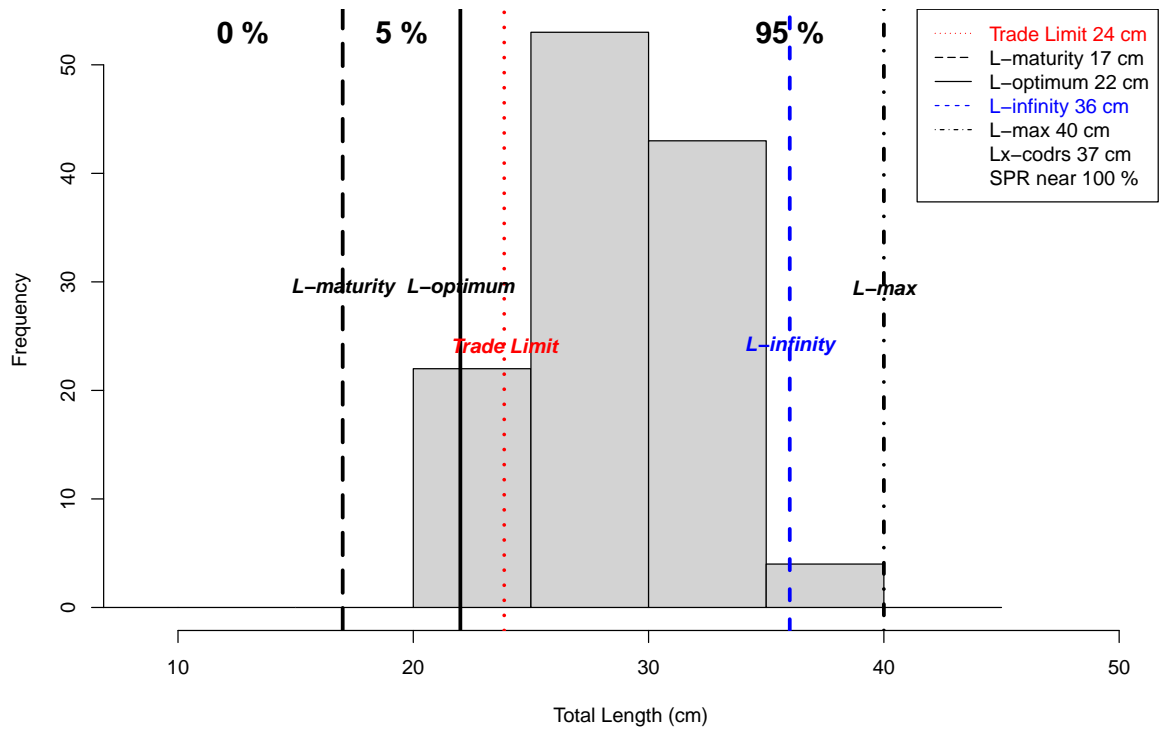
More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is at or below a level equal to half the natural rate of mortality. This means that impact of fishing is minimized and this fishery is currently probably operating at a sustainable level of effort. Risk level is low.

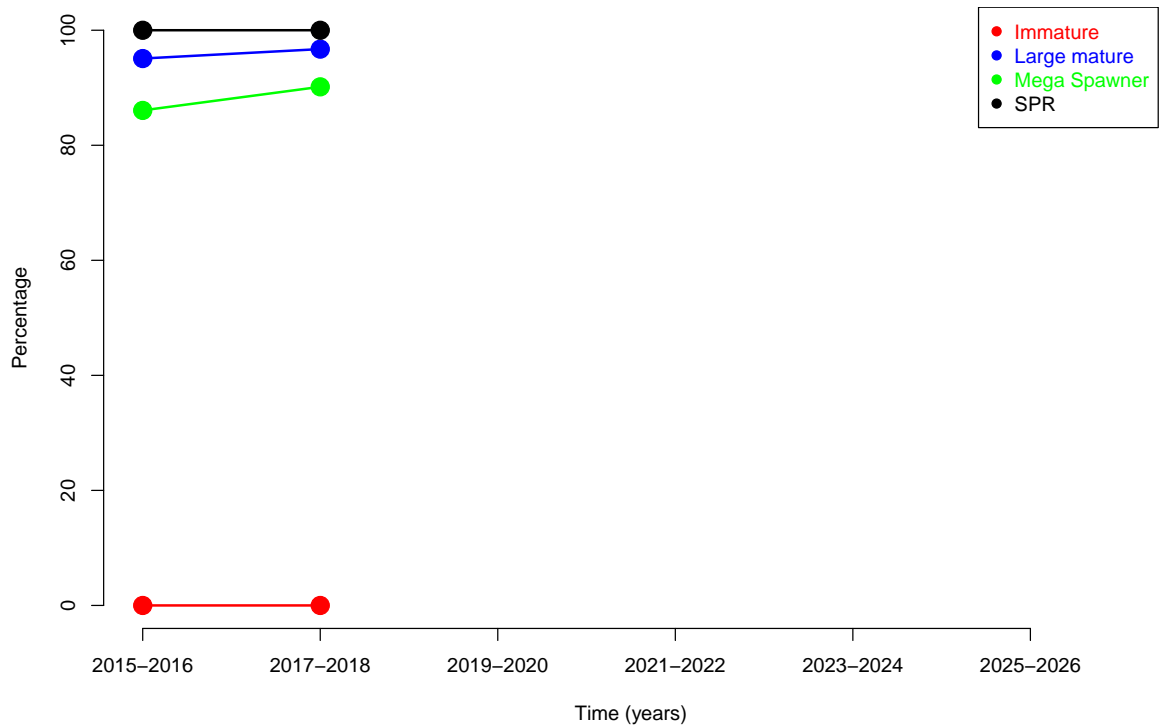
SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low.

Trends in relative abundance by size group for *Cephalopholis sonnerati* (ID #39, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.
% Immature falling over recent years, situation improving. P: not available
% Large Mature rising over recent years, situation improving. P: not available
% Mega Spawner rising over recent years, situation improving. P: not available
% SPR rising over recent years, situation improving. P: not available

2015–2016, Catch length frequency for *Cephalopholis igarashiensis* (ID #40, Epinephelidae), n = 122



Trends in relative abundance by size group for *Cephalopholis igarashiensis* (ID #40, Epinephelidae)



The percentages of *Cephalopholis igarashiensis* (ID #40, Epinephelidae) in 2015-2016, n = 122
Immature (< 17cm): 0%
Small mature (>= 17cm, < 22cm): 5%
Large mature (>= 22cm): 95%
Mega spawner (>= 24.2cm): 86% (subset of large mature fish)
Spawning Potential Ratio: near 100%

At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low.

The trade limit is significantly higher than length at first maturity. This means that the trade puts a premium on fish that have spawned at least once. The trade does not cause any concern of recruitment overfishing for this species. Risk level is low.

The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

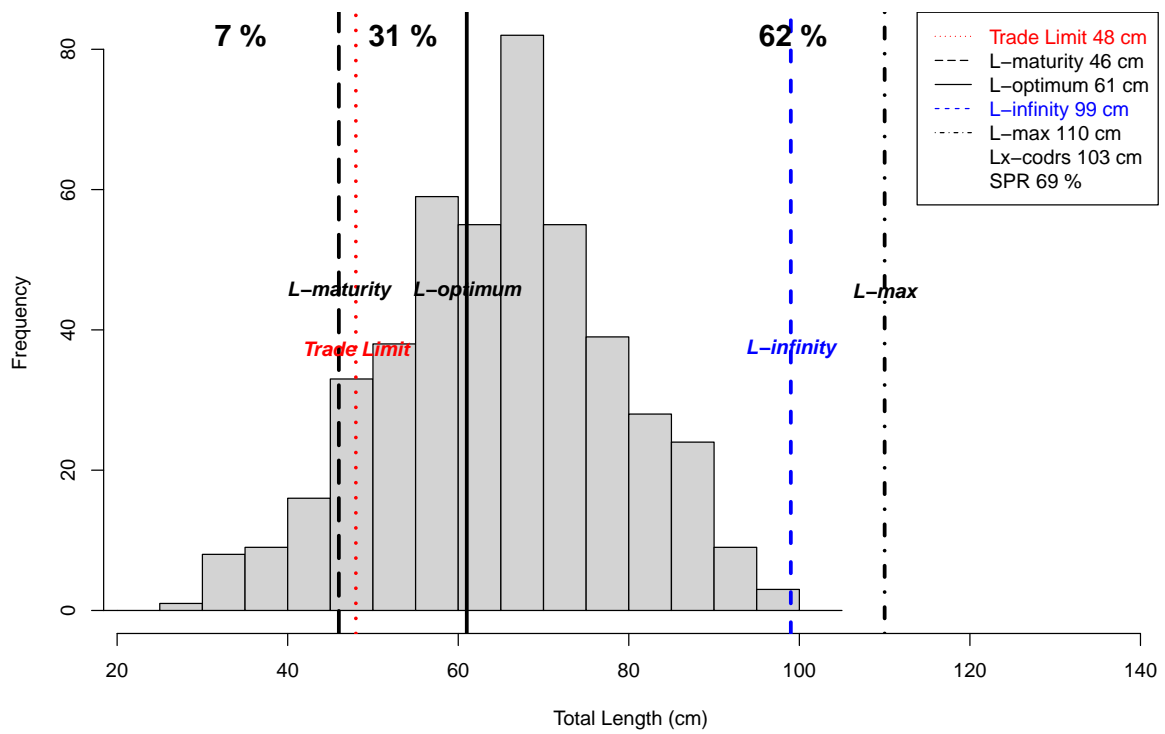
More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is at or below a level equal to half the natural rate of mortality. This means that impact of fishing is minimized and this fishery is currently probably operating at a sustainable level of effort. Risk level is low.

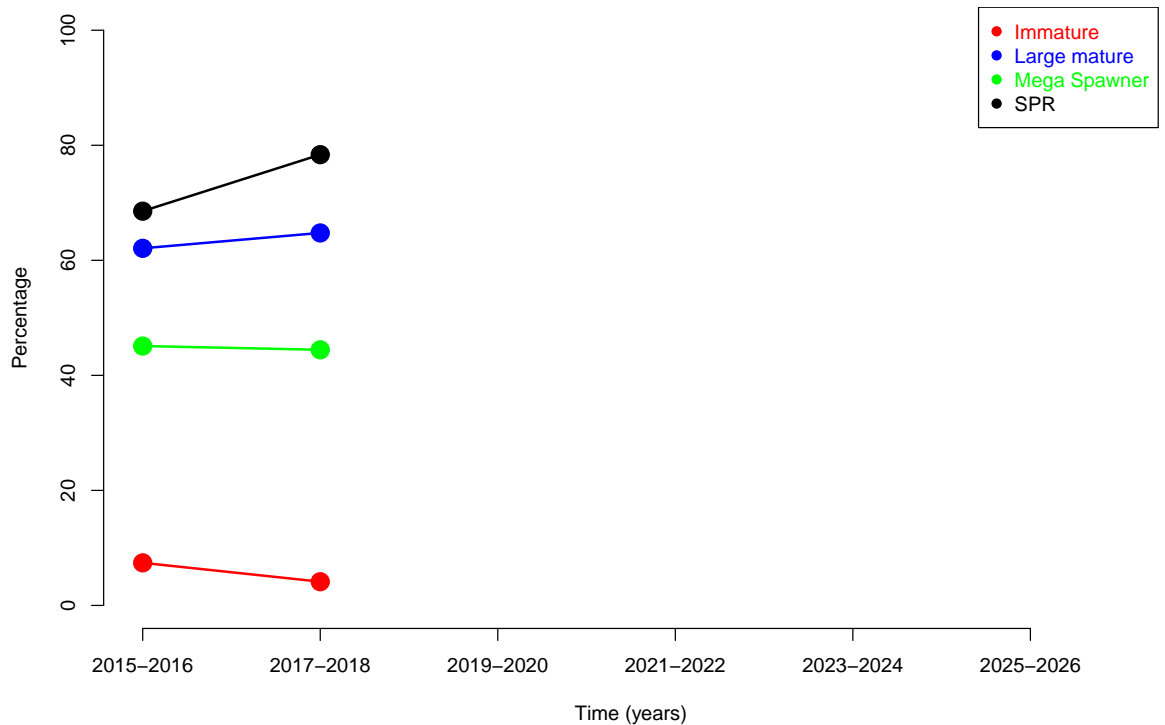
SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low.

Trends in relative abundance by size group for *Cephalopholis igarashiensis* (ID #40, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.
% Immature no trend over recent years, situation stable. P: not available
% Large Mature rising over recent years, situation improving. P: not available
% Mega Spawner rising over recent years, situation improving. P: not available
% SPR no trend over recent years, situation stable. P: not available

2015–2016, Catch length frequency for *Epinephelus latifasciatus* (ID #41, Epinephelidae), n = 459



Trends in relative abundance by size group for *Epinephelus latifasciatus* (ID #41, Epinephelidae)



The percentages of *Epinephelus latifasciatus* (ID #41, Epinephelidae) in 2015-2016, n = 459
Immature (< 46cm): 7%
Small mature (\geq 46cm, < 61cm): 31%
Large mature (\geq 61cm): 62%
Mega spawner (\geq 67.1cm): 45% (subset of large mature fish)
Spawning Potential Ratio: 69%

At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low.

The trade limit is about the same as the length at first maturity. This means that the trade puts a premium on fish that have spawned at least once, which improves sustainability of the fishery. Risk level is medium.

The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is at or below a level equal to half the natural rate of mortality. This means that impact of fishing is minimized and this fishery is currently probably operating at a sustainable level of effort. Risk level is low.

SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low.

Trends in relative abundance by size group for *Epinephelus latifasciatus* (ID #41, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.

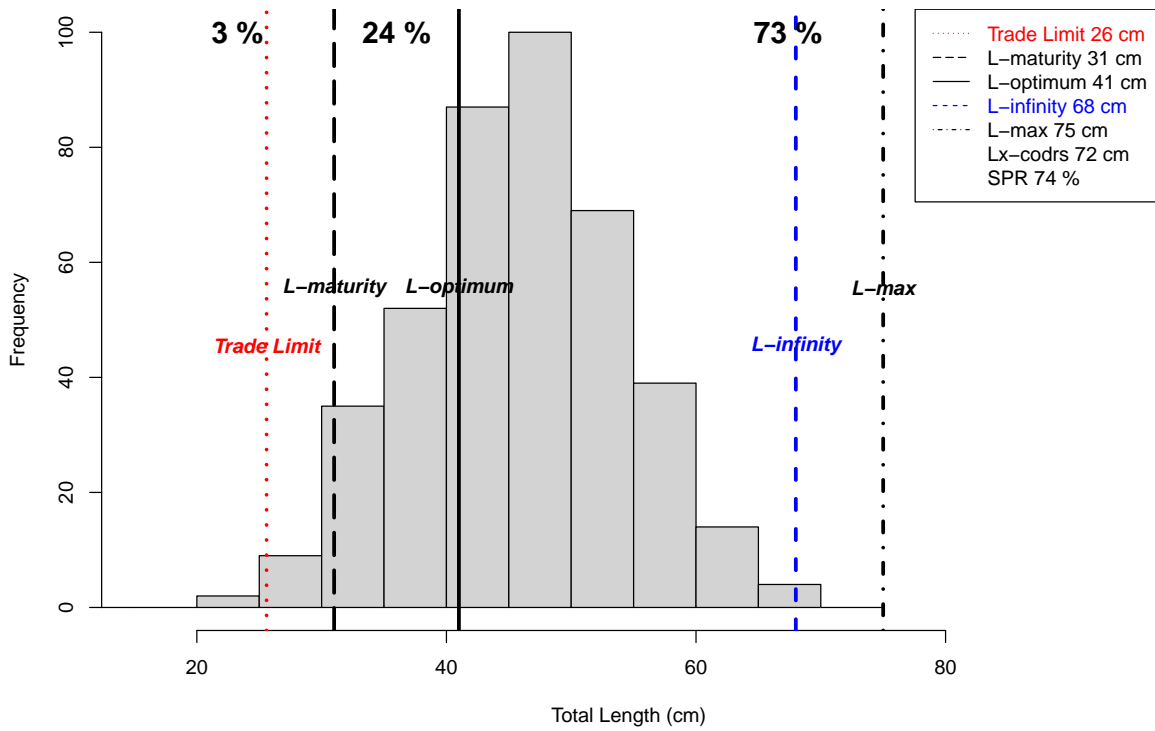
% Immature falling over recent years, situation improving. P: not available

% Large Mature rising over recent years, situation improving. P: not available

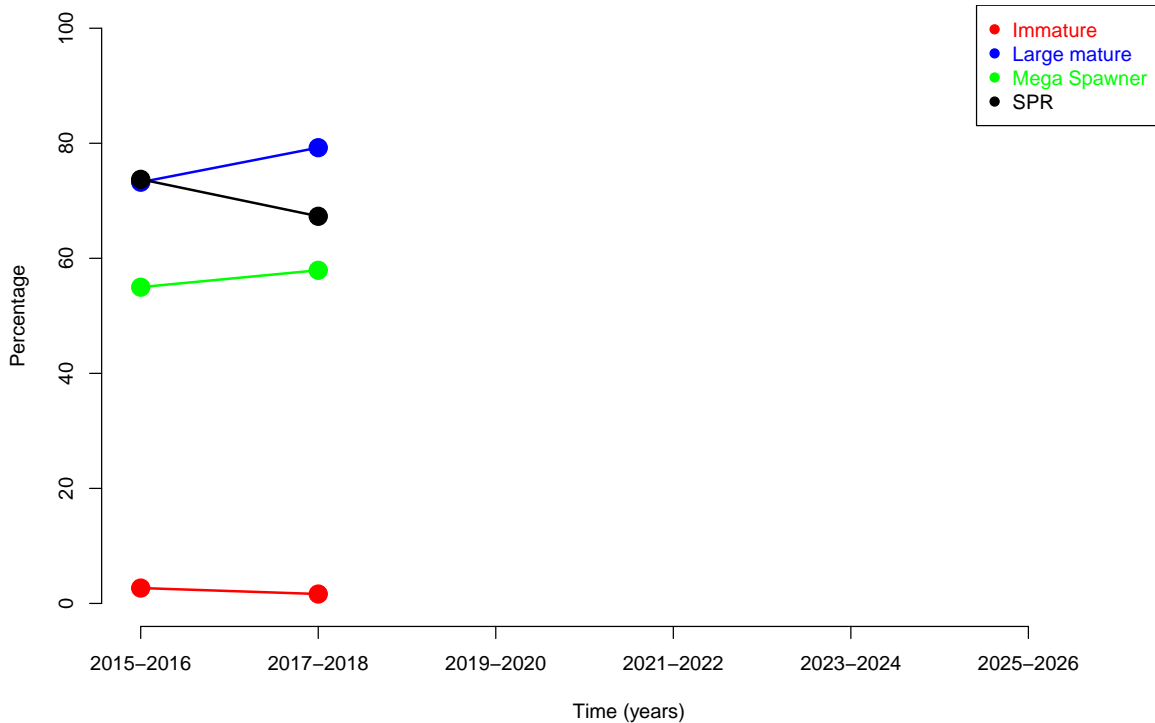
% Mega Spawner falling over recent years, situation deteriorating. P: not available

% SPR rising over recent years, situation improving. P: not available

2015–2016, Catch length frequency for *Epinephelus radiatus* (ID #42, Epinephelidae), n = 411



Trends in relative abundance by size group for *Epinephelus radiatus* (ID #42, Epinephelidae)



The percentages of *Epinephelus radiatus* (ID #42, Epinephelidae) in 2015-2016, n = 411
Immature (< 31cm): 3%
Small mature (>= 31cm, < 41cm): 24%
Large mature (>= 41cm): 73%
Mega spawner (>= 45.1cm): 55% (subset of large mature fish)
Spawning Potential Ratio: 74%

At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low.

The trade limit is significantly lower than the length at first maturity. This means that the trade encourages capture of immature fish, which impairs sustainability. Risk level is high.

The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

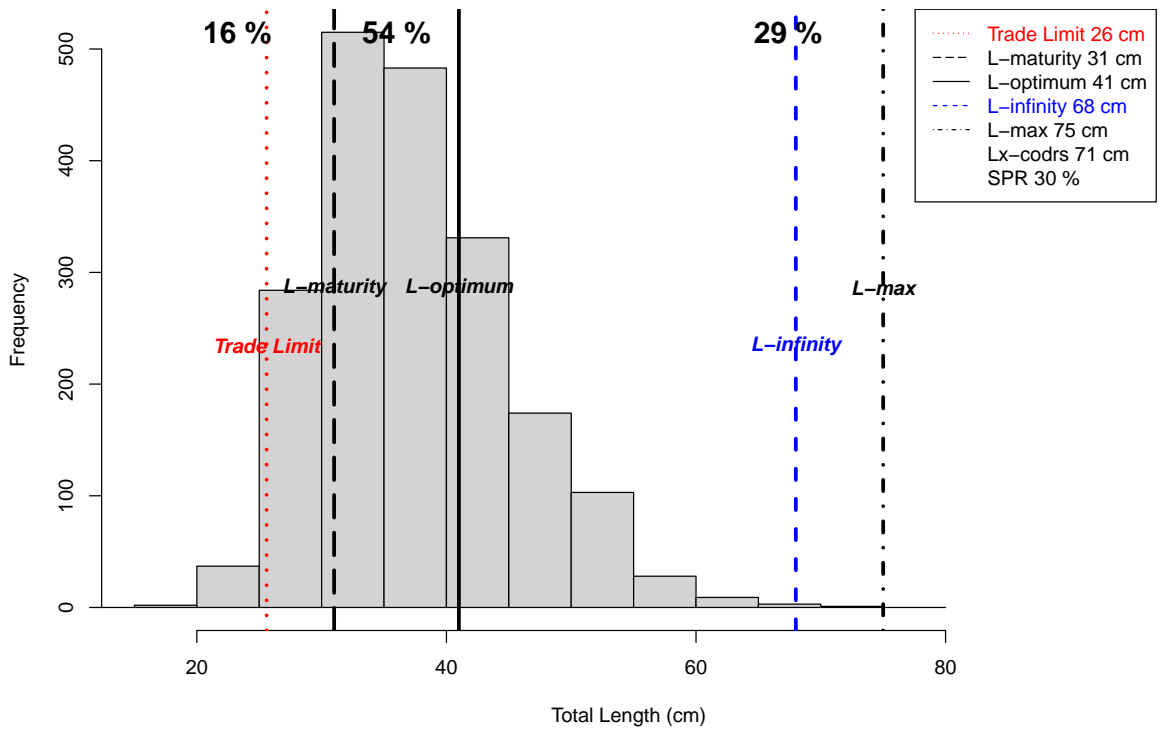
More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is at or below a level equal to half the natural rate of mortality. This means that impact of fishing is minimized and this fishery is currently probably operating at a sustainable level of effort. Risk level is low.

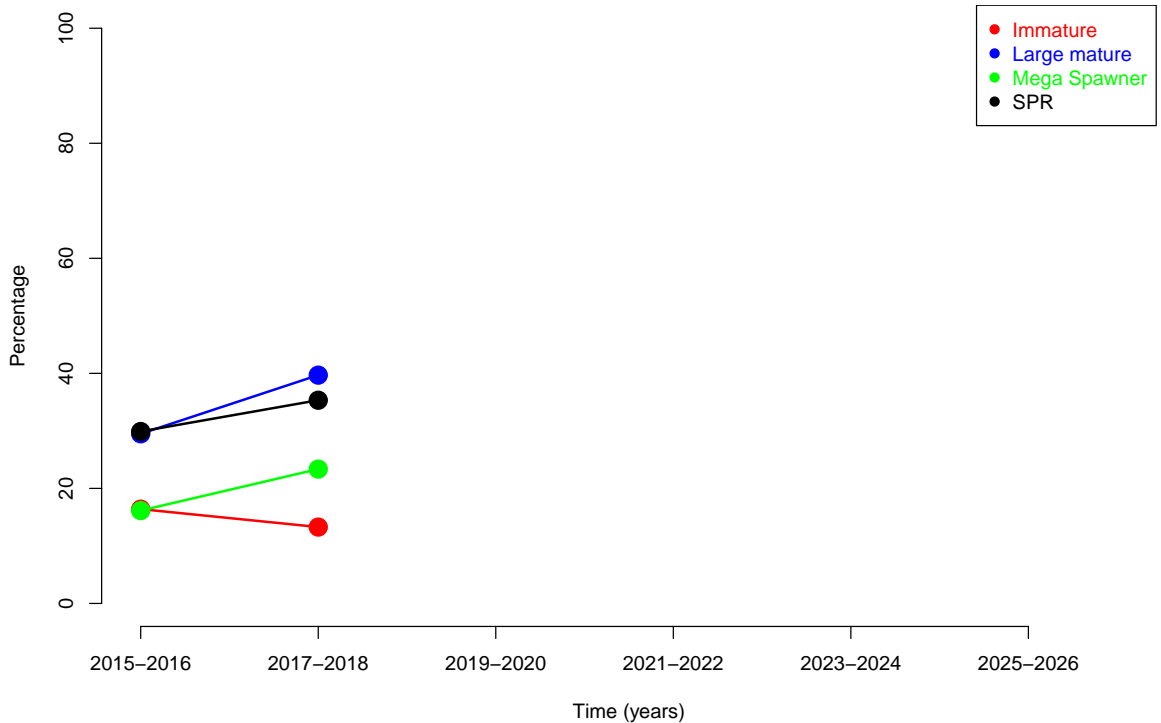
SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low.

Trends in relative abundance by size group for *Epinephelus radiatus* (ID #42, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.
% Immature falling over recent years, situation improving. P: not available
% Large Mature rising over recent years, situation improving. P: not available
% Mega Spawner rising over recent years, situation improving. P: not available
% SPR falling over recent years, situation deteriorating. P: not available

2015–2016, Catch length frequency for *Epinephelus morrhua* (ID #43, Epinephelidae), n = 1,970



Trends in relative abundance by size group for *Epinephelus morrhua* (ID #43, Epinephelidae)



The percentages of *Epinephelus morrhua* (ID #43, Epinephelidae) in 2015-2016, n = 1,970
Immature (< 31cm): 16%
Small mature (>= 31cm, < 41cm): 54%
Large mature (>= 41cm): 29%
Mega spawner (>= 45.1cm): 16% (subset of large mature fish)
Spawning Potential Ratio: 30%

Between 10% and 20% of the fish in the catch are juveniles that have not yet reproduced. There is no immediate concern in terms of overfishing through over harvesting of juveniles, but the fishery needs to be monitored closely for any further increase in this indicator and incentives need to be geared towards targeting larger fish. Risk level is medium.

The trade limit is significantly lower than the length at first maturity. This means that the trade encourages capture of immature fish, which impairs sustainability. Risk level is high.

The vast majority of the fish in the catch have not yet achieved their growth potential. The harvest of small fish promotes growth overfishing and the size distribution for this species indicates that over exploitation through growth overfishing may already be happening. Risk level is high.

Less than 20% of the catch comprises of mega spawners. This indicates that the population may be severely affected by the fishery, and that there is a substantial risk of recruitment overfishing through over harvesting of the mega spawners, unless large numbers of mega spawners would be surviving at other habitats. There is no reason to assume that this is the case and therefore a reduction of fishing effort may be necessary in this fishery. Risk level is high.

Mortality caused by fishing is lower than the natural rate of mortality but more than half of natural mortality. This means that impact of fishing is considerable and trends in various indicators need to be watched carefully while any increase in fishing effort needs to be prevented. Risk level is medium.

SPR is between 25% and 40%. The stock is heavily exploited, and there is some risk that the fishery will cause further decline of the stock. Risk level is medium.

Trends in relative abundance by size group for *Epinephelus morrhua* (ID #43, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.

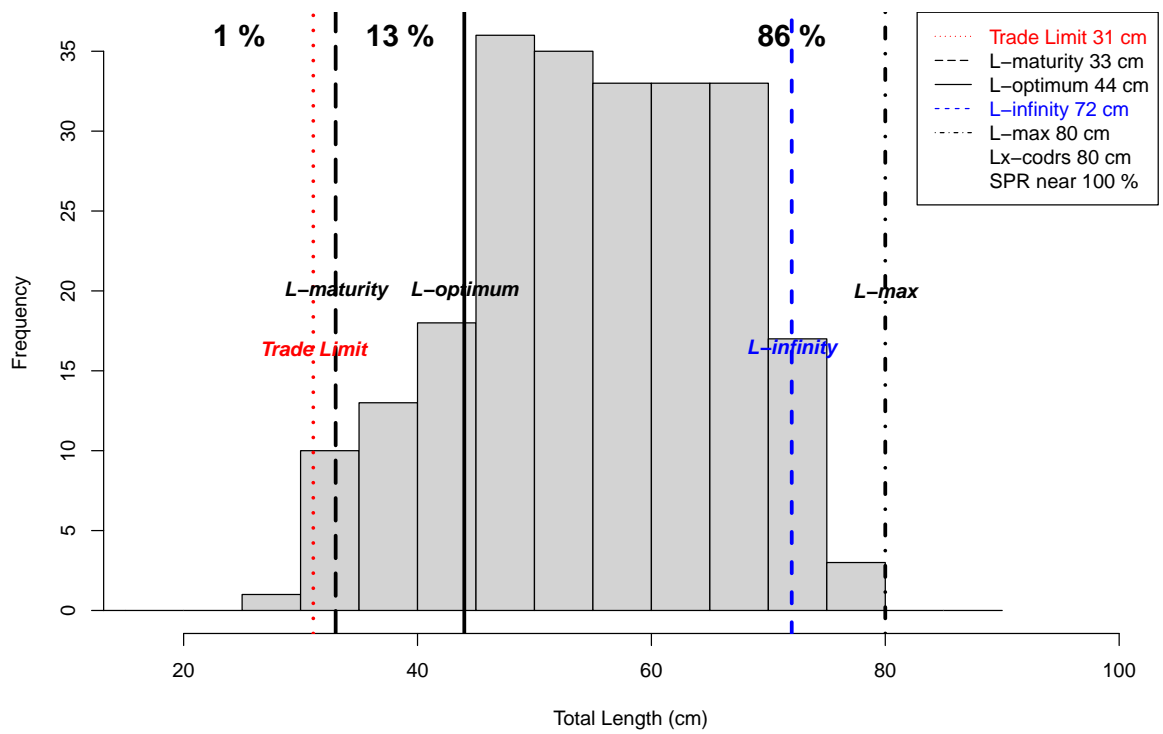
% Immature falling over recent years, situation improving. P: not available

% Large Mature rising over recent years, situation improving. P: not available

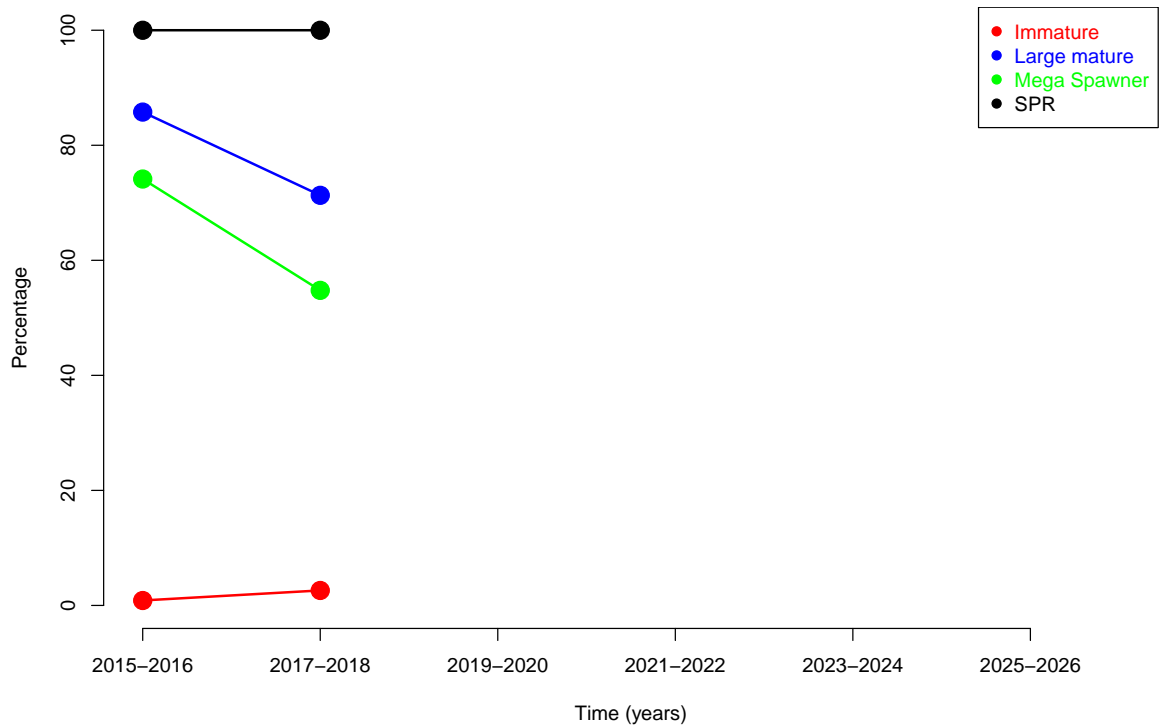
% Mega Spawner rising over recent years, situation improving. P: not available

% SPR rising over recent years, situation improving. P: not available

2015–2016, Catch length frequency for *Epinephelus poecilonotus* (ID #44, Epinephelidae), n = 232



Trends in relative abundance by size group for *Epinephelus poecilonotus* (ID #44, Epinephelidae)



The percentages of *Epinephelus poecilonotus* (ID #44, Epinephelidae) in 2015-2016, n = 232
Immature (< 33cm): 1%
Small mature (\geq 33cm, < 44cm): 13%
Large mature (\geq 44cm): 86%
Mega spawner (\geq 48.4cm): 74% (subset of large mature fish)
Spawning Potential Ratio: near 100%

At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low.

The trade limit is about the same as the length at first maturity. This means that the trade puts a premium on fish that have spawned at least once, which improves sustainability of the fishery. Risk level is medium.

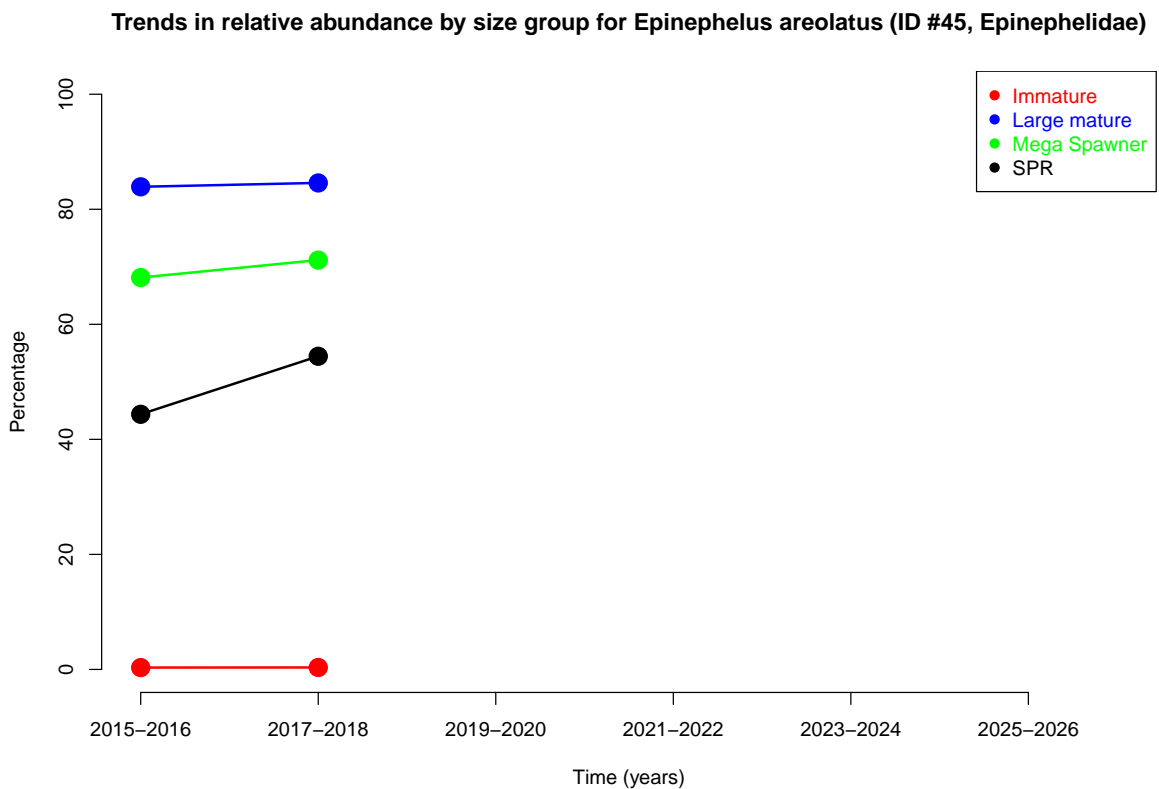
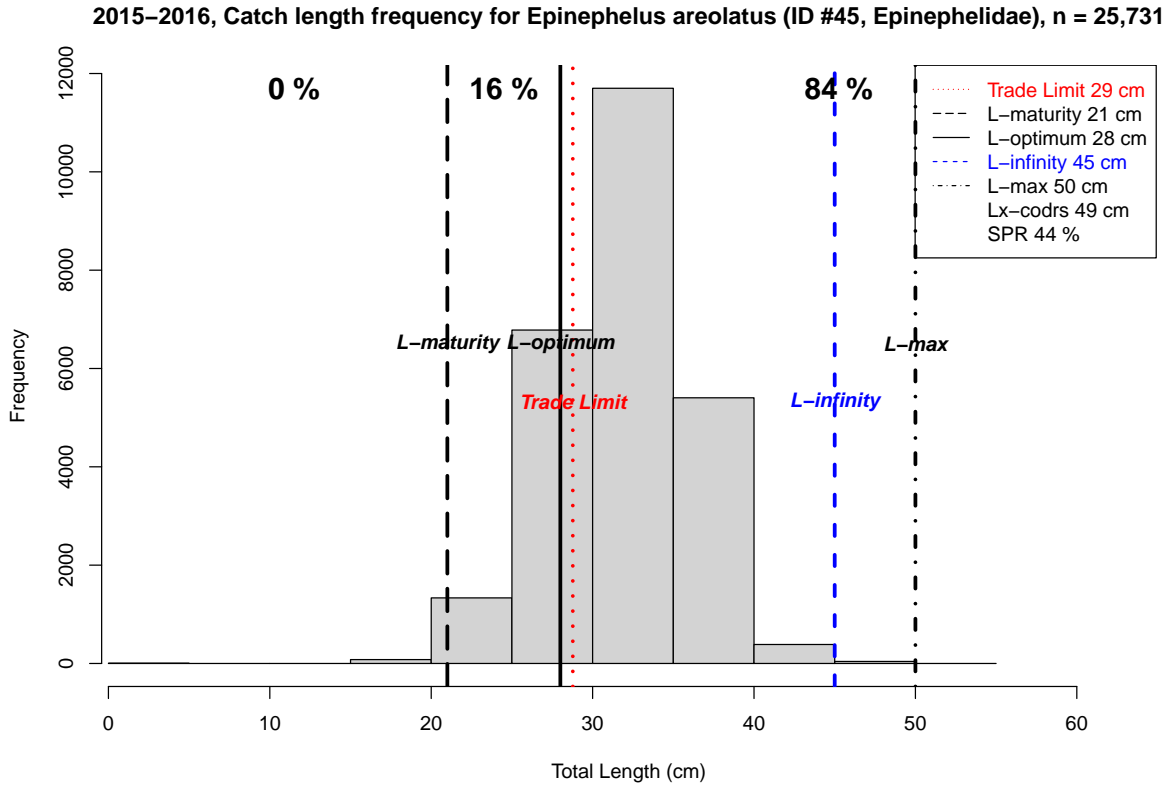
The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is at or below a level equal to half the natural rate of mortality. This means that impact of fishing is minimized and this fishery is currently probably operating at a sustainable level of effort. Risk level is low.

SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low.

Trends in relative abundance by size group for *Epinephelus poecilonotus* (ID #44, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.
% Immature rising over recent years, situation deteriorating. P: not available
% Large Mature falling over recent years, situation deteriorating. P: not available
% Mega Spawner falling over recent years, situation deteriorating. P: not available
% SPR no trend over recent years, situation stable. P: not available



The percentages of *Epinephelus areolatus* (ID #45, Epinephelidae) in 2015-2016, n = 25,731
Immature (< 21cm): 0%
Small mature (>= 21cm, < 28cm): 16%
Large mature (>= 28cm): 84%
Mega spawner (>= 30.8cm): 68% (subset of large mature fish)
Spawning Potential Ratio: 44%

At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low.

The trade limit is significantly higher than length at first maturity. This means that the trade puts a premium on fish that have spawned at least once. The trade does not cause any concern of recruitment overfishing for this species. Risk level is low.

The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

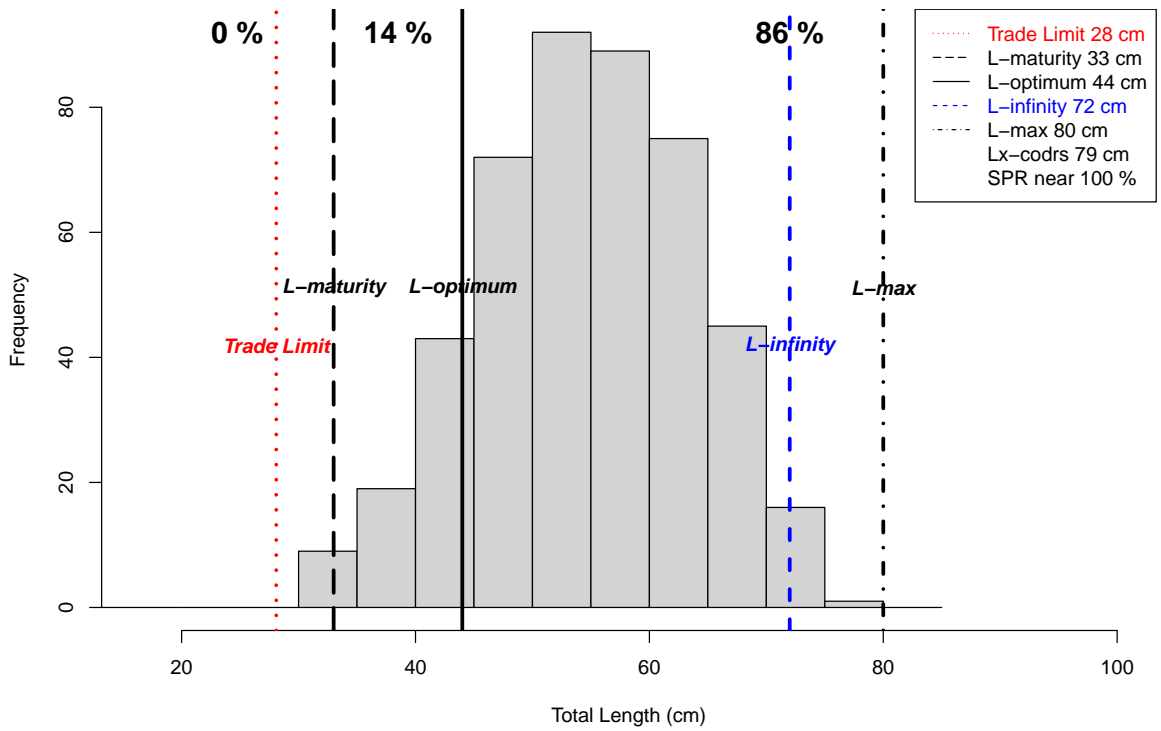
More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is greater than or equal to the natural rate of mortality. This means that impact of fishing is severe and that fishing is unlikely to be sustainable at the current level of effort. Risk level is high.

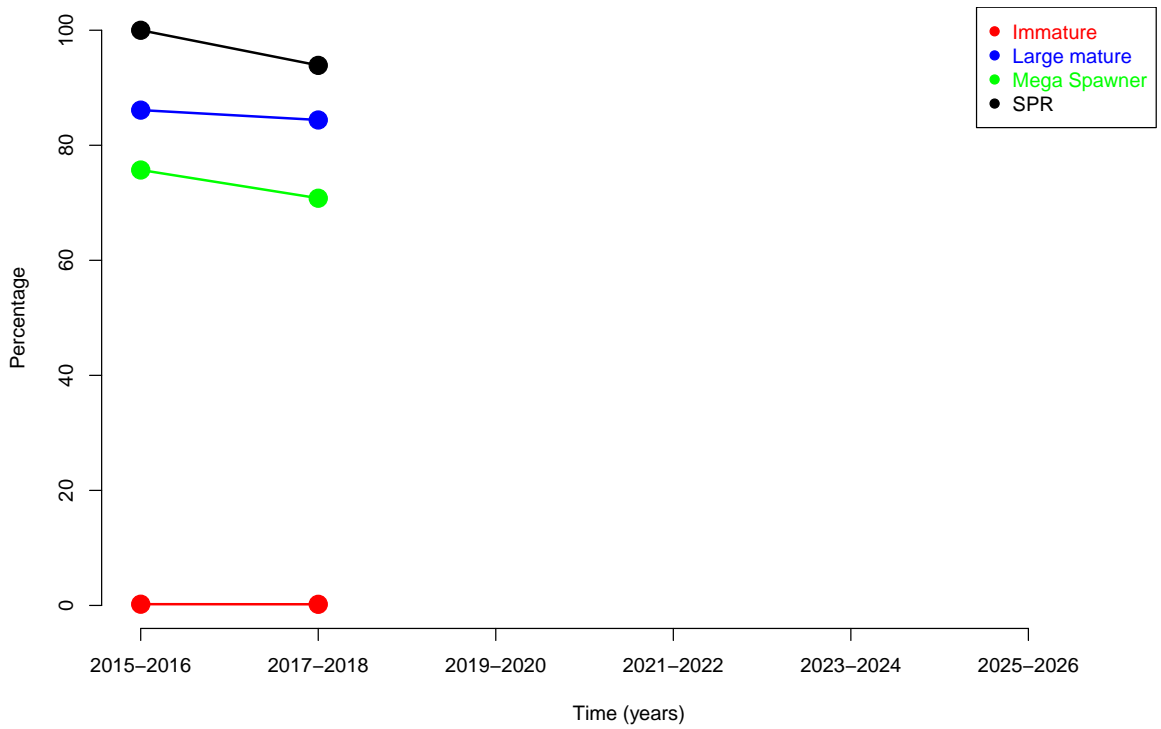
SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low.

Trends in relative abundance by size group for *Epinephelus areolatus* (ID #45, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.
% Immature no trend over recent years, situation stable. P: not available
% Large Mature rising over recent years, situation improving. P: not available
% Mega Spawner rising over recent years, situation improving. P: not available
% SPR rising over recent years, situation improving. P: not available

2015–2016, Catch length frequency for *Epinephelus bleekeri* (ID #46, Epinephelidae), n = 461



Trends in relative abundance by size group for *Epinephelus bleekeri* (ID #46, Epinephelidae)



The percentages of *Epinephelus bleekeri* (ID #46, Epinephelidae) in 2015-2016, n = 461
Immature (< 33cm): 0%
Small mature (\geq 33cm, < 44cm): 14%
Large mature (\geq 44cm): 86%
Mega spawner (\geq 48.4cm): 76% (subset of large mature fish)
Spawning Potential Ratio: near 100%

At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low.

The trade limit is significantly lower than the length at first maturity. This means that the trade encourages capture of immature fish, which impairs sustainability. Risk level is high.

The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

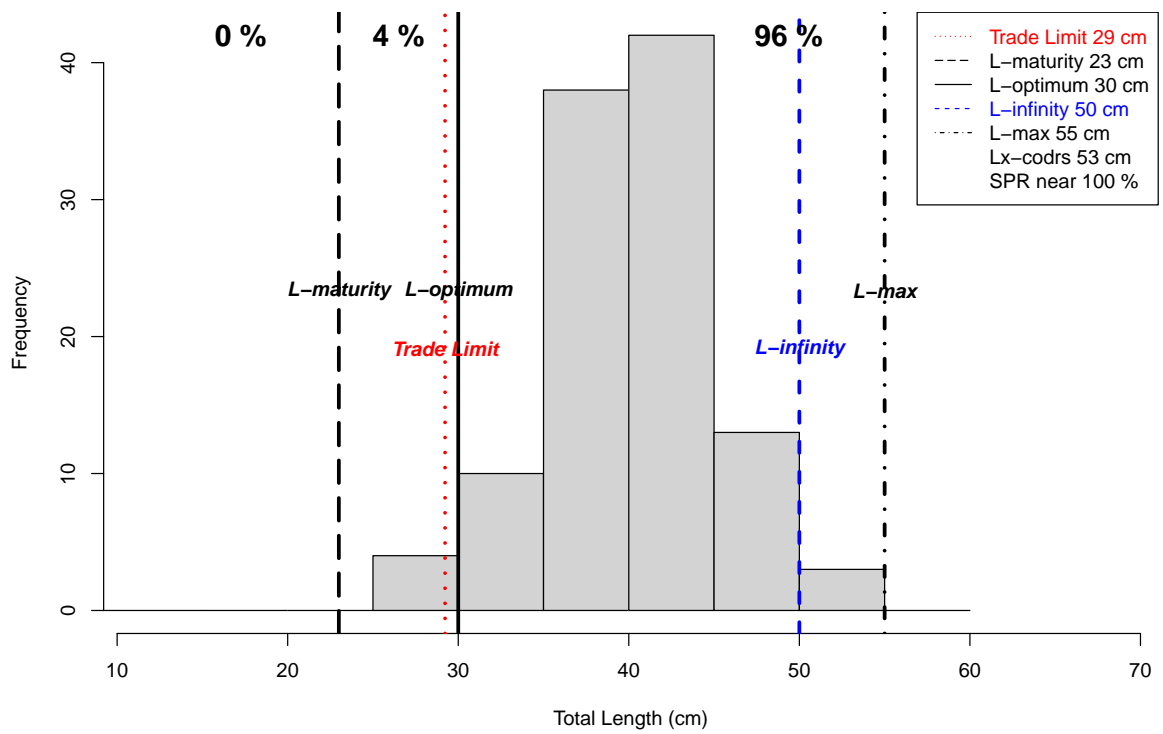
More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is at or below a level equal to half the natural rate of mortality. This means that impact of fishing is minimized and this fishery is currently probably operating at a sustainable level of effort. Risk level is low.

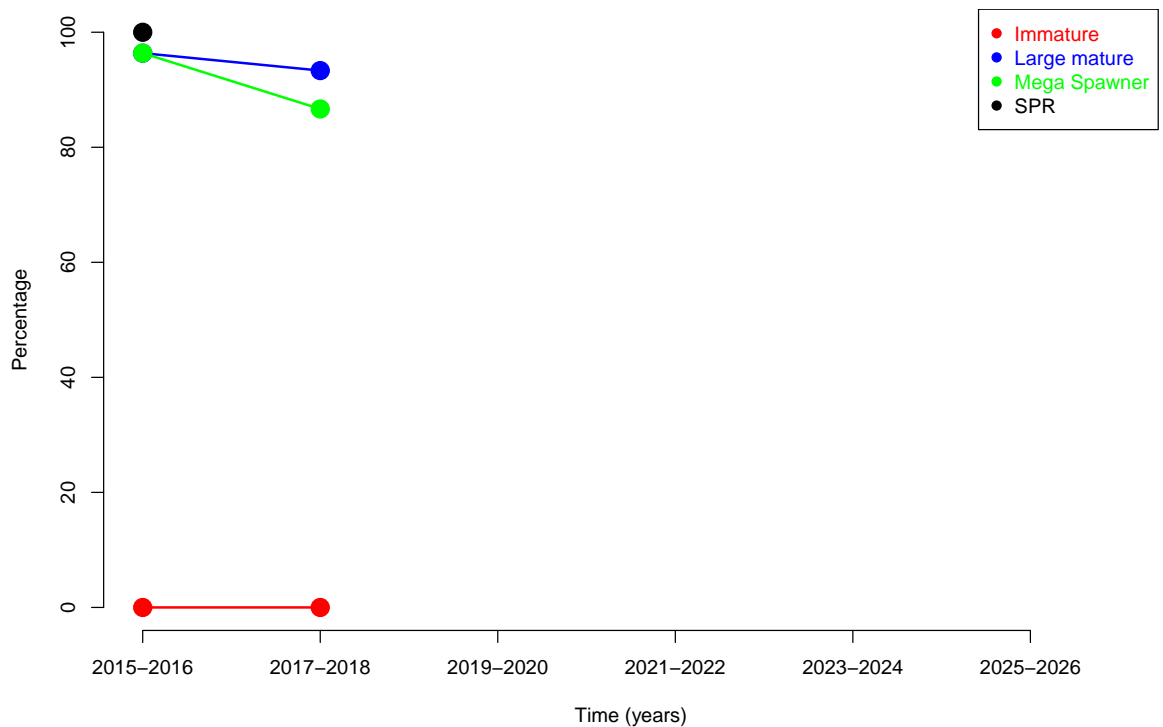
SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low.

Trends in relative abundance by size group for *Epinephelus bleekeri* (ID #46, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.
% Immature no trend over recent years, situation stable. P: not available
% Large Mature falling over recent years, situation deteriorating. P: not available
% Mega Spawner falling over recent years, situation deteriorating. P: not available
% SPR falling over recent years, situation deteriorating. P: not available

2015–2016, Catch length frequency for *Epinephelus miliaris* (ID #47, Epinephelidae), n = 110



Trends in relative abundance by size group for *Epinephelus miliaris* (ID #47, Epinephelidae)



The percentages of *Epinephelus miliaris* (ID #47, Epinephelidae) in 2015-2016, n = 110
Immature (< 23cm): 0%
Small mature (\geq 23cm, < 30cm): 4%
Large mature (\geq 30cm): 96%
Mega spawner (\geq 33cm): 96% (subset of large mature fish)
Spawning Potential Ratio: near 100%

At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low.

The trade limit is significantly higher than length at first maturity. This means that the trade puts a premium on fish that have spawned at least once. The trade does not cause any concern of recruitment overfishing for this species. Risk level is low.

The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

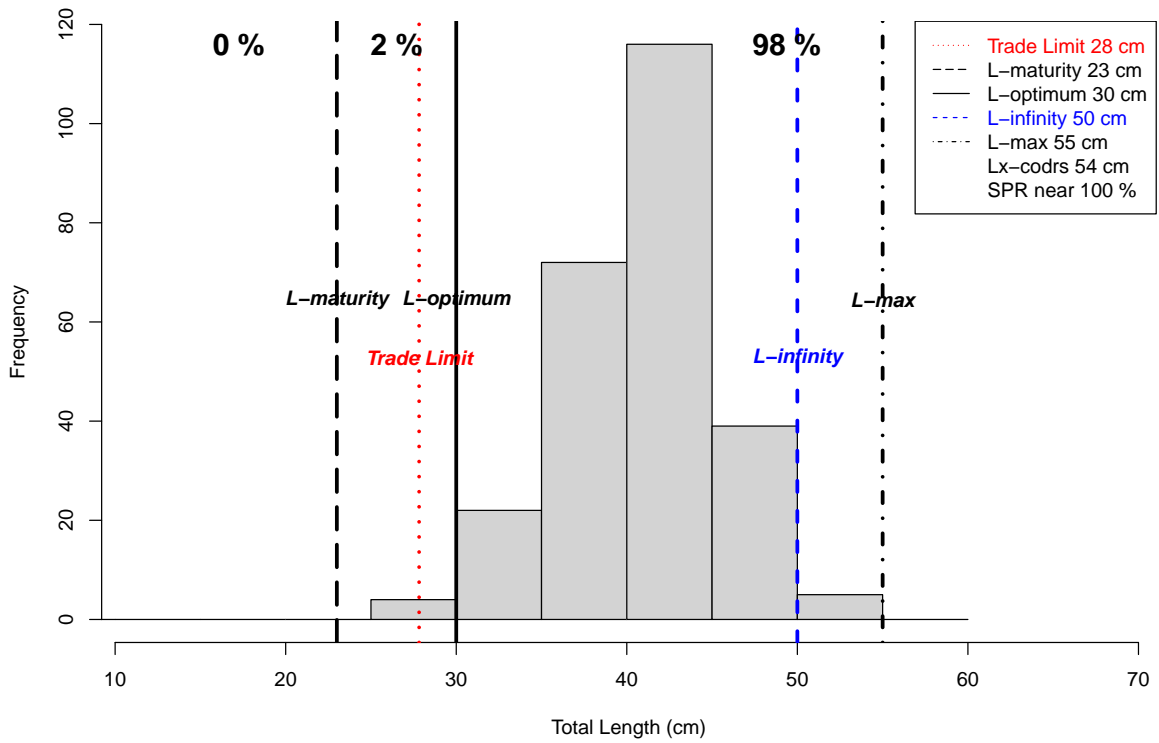
More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is at or below a level equal to half the natural rate of mortality. This means that impact of fishing is minimized and this fishery is currently probably operating at a sustainable level of effort. Risk level is low.

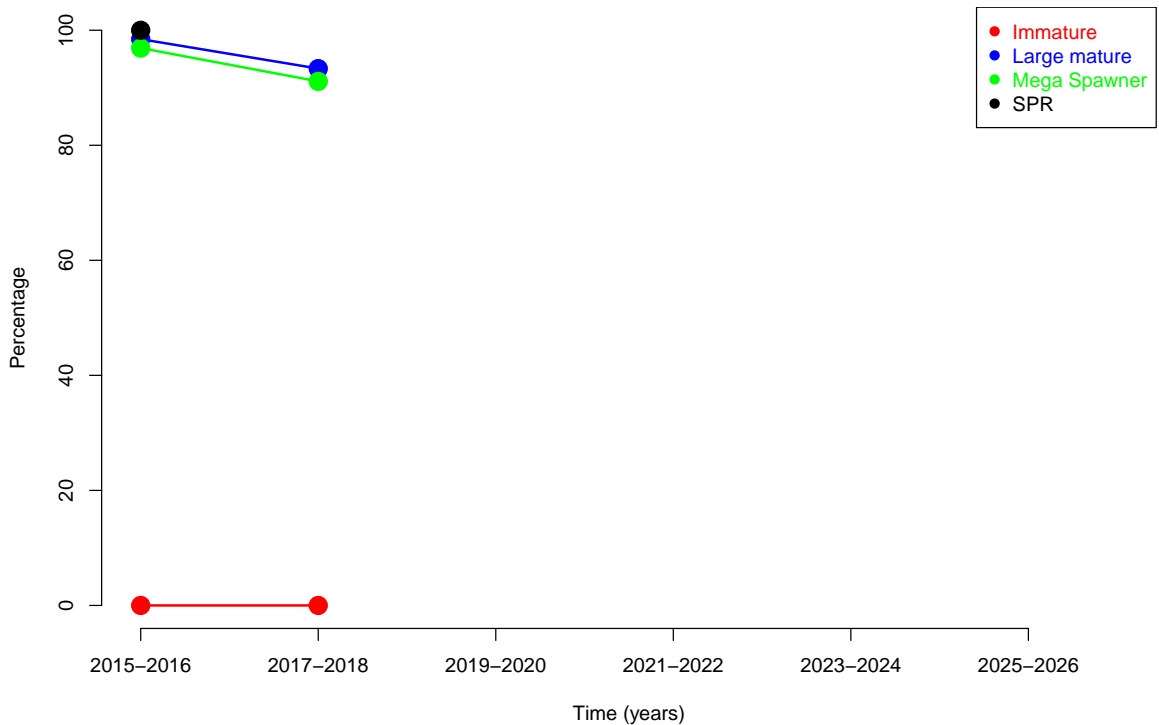
SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low.

Trends in relative abundance by size group for *Epinephelus miliaris* (ID #47, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.
% Immature no trend over recent years, situation stable. P: not available
% Large Mature falling over recent years, situation deteriorating. P: not available
% Mega Spawner falling over recent years, situation deteriorating. P: not available
% SPR no trend over recent years, situation stable. P: not available

2015–2016, Catch length frequency for *Epinephelus bilobatus* (ID #48, Epinephelidae), n = 258



Trends in relative abundance by size group for *Epinephelus bilobatus* (ID #48, Epinephelidae)



The percentages of *Epinephelus bilobatus* (ID #48, Epinephelidae) in 2015-2016, n = 258
Immature (< 23cm): 0%
Small mature (\geq 23cm, < 30cm): 2%
Large mature (\geq 30cm): 98%
Mega spawner (\geq 33cm): 97% (subset of large mature fish)
Spawning Potential Ratio: near 100%

At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low.

The trade limit is significantly higher than length at first maturity. This means that the trade puts a premium on fish that have spawned at least once. The trade does not cause any concern of recruitment overfishing for this species. Risk level is low.

The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

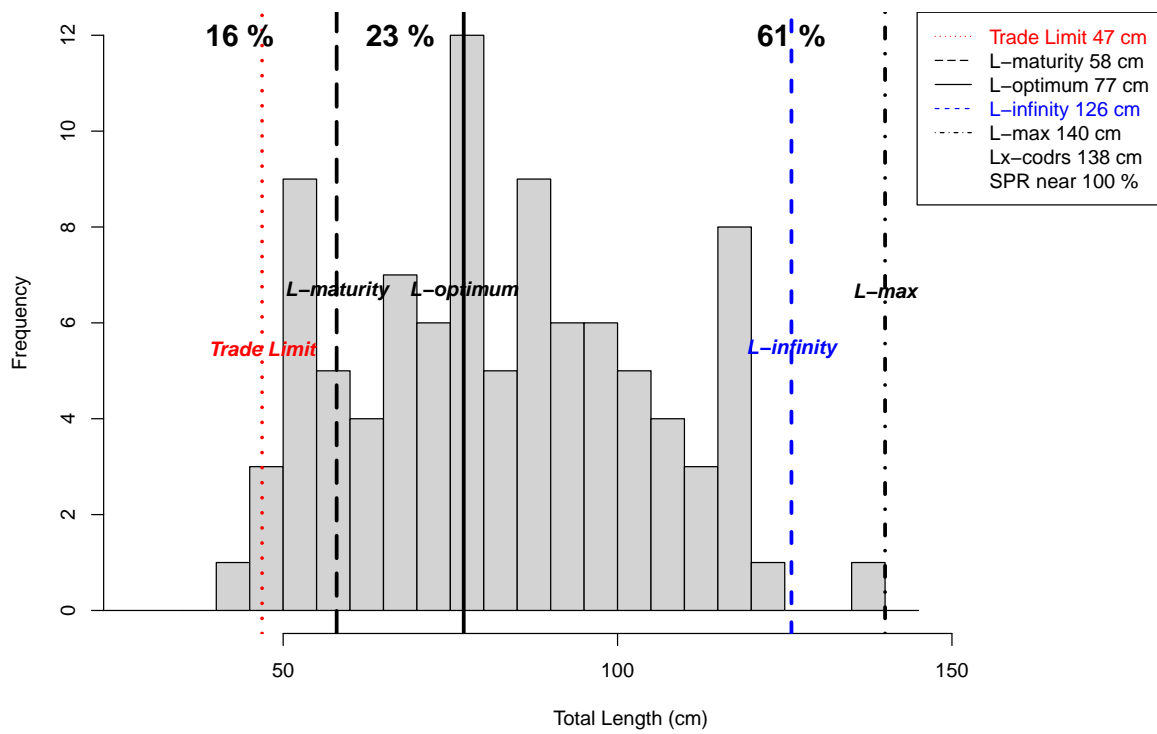
More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is at or below a level equal to half the natural rate of mortality. This means that impact of fishing is minimized and this fishery is currently probably operating at a sustainable level of effort. Risk level is low.

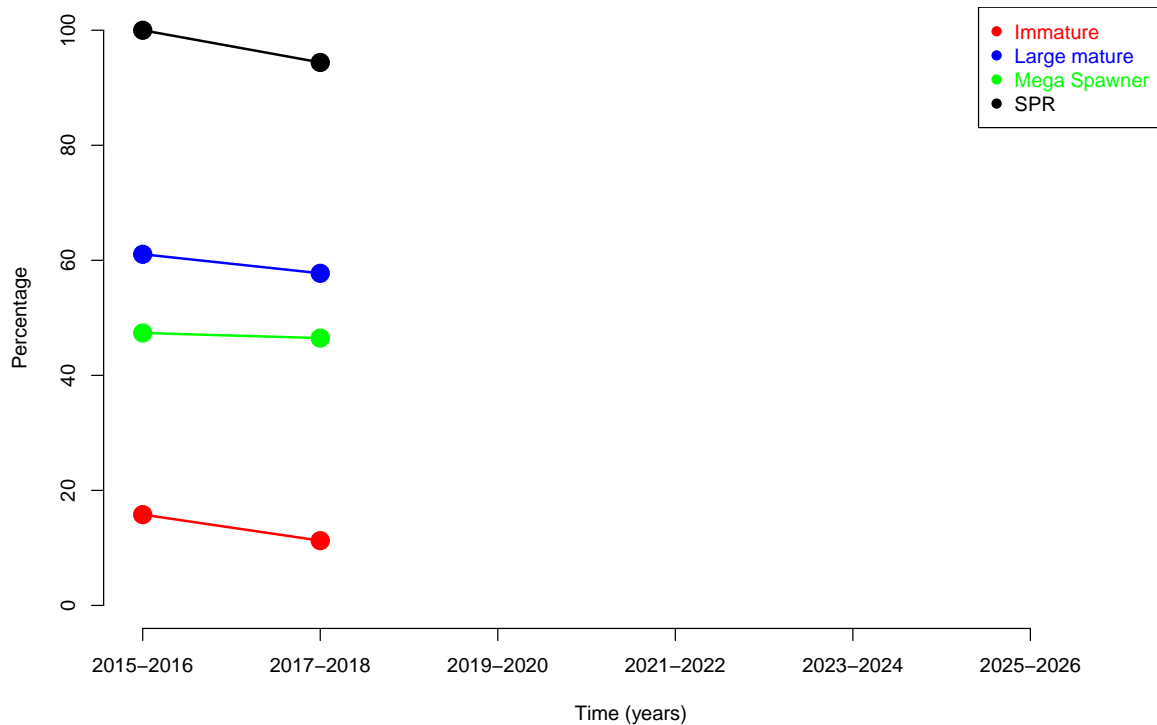
SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low.

Trends in relative abundance by size group for *Epinephelus bilobatus* (ID #48, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.
% Immature no trend over recent years, situation stable. P: not available
% Large Mature falling over recent years, situation deteriorating. P: not available
% Mega Spawner falling over recent years, situation deteriorating. P: not available
% SPR no trend over recent years, situation stable. P: not available

2015–2016, Catch length frequency for *Epinephelus malabaricus* (ID #49, Epinephelidae), n = 95



Trends in relative abundance by size group for *Epinephelus malabaricus* (ID #49, Epinephelidae)



The percentages of *Epinephelus malabaricus* (ID #49, Epinephelidae) in 2015-2016, n = 95
Immature (< 58cm): 16%
Small mature (>= 58cm, < 77cm): 23%
Large mature (>= 77cm): 61%
Mega spawner (>= 84.7cm): 47% (subset of large mature fish)
Spawning Potential Ratio: near 100%

Between 10% and 20% of the fish in the catch are juveniles that have not yet reproduced. There is no immediate concern in terms of overfishing through over harvesting of juveniles, but the fishery needs to be monitored closely for any further increase in this indicator and incentives need to be geared towards targeting larger fish. Risk level is medium.

The trade limit is significantly lower than the length at first maturity. This means that the trade encourages capture of immature fish, which impairs sustainability. Risk level is high.

The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

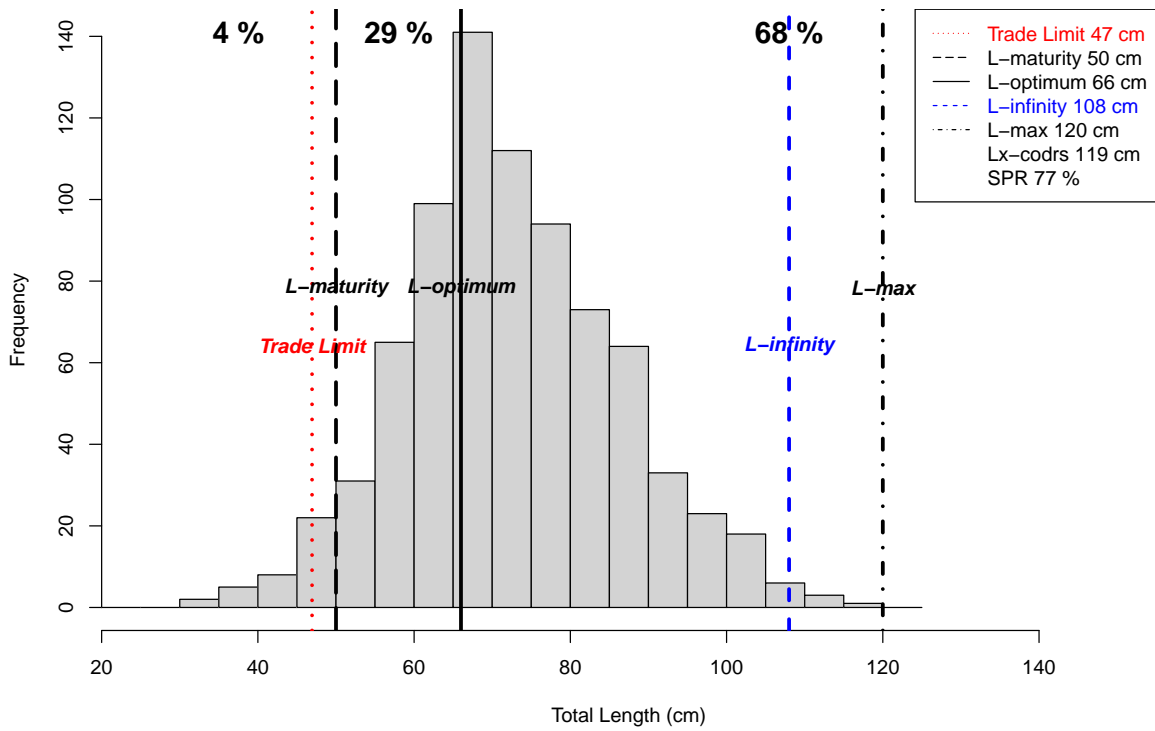
More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is at or below a level equal to half the natural rate of mortality. This means that impact of fishing is minimized and this fishery is currently probably operating at a sustainable level of effort. Risk level is low.

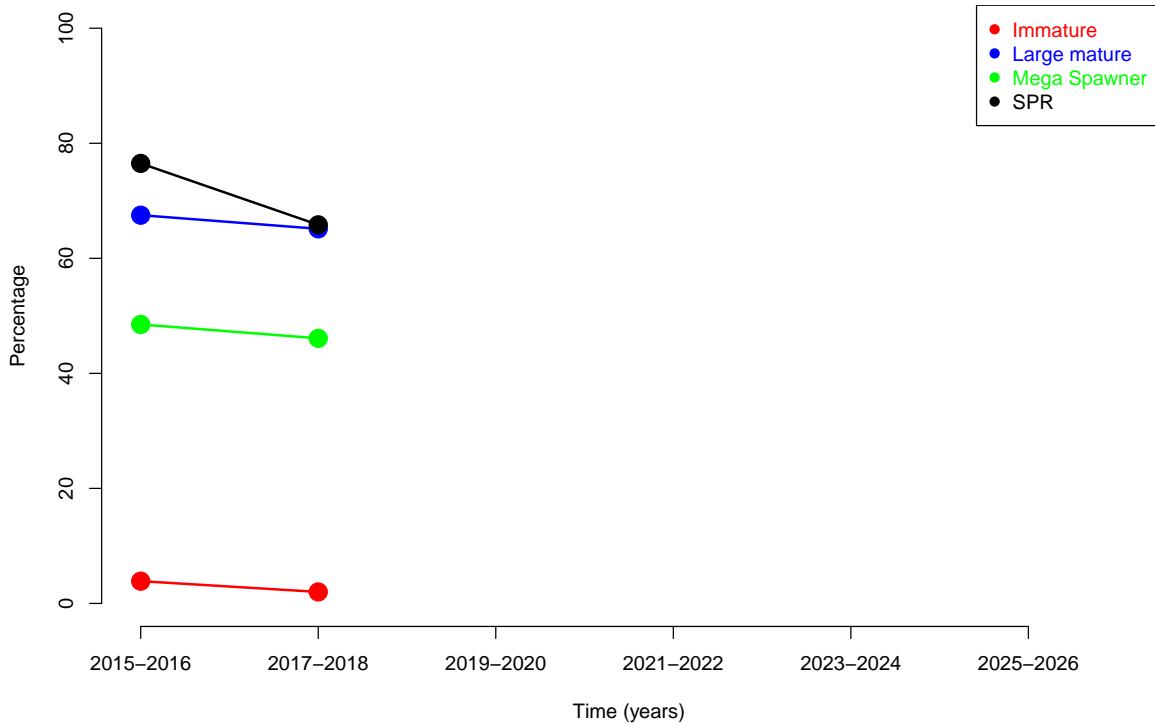
SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low.

Trends in relative abundance by size group for *Epinephelus malabaricus* (ID #49, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.
% Immature falling over recent years, situation improving. P: not available
% Large Mature falling over recent years, situation deteriorating. P: not available
% Mega Spawner falling over recent years, situation deteriorating. P: not available
% SPR falling over recent years, situation deteriorating. P: not available

2015–2016, Catch length frequency for *Epinephelus coioides* (ID #50, Epinephelidae), n = 800



Trends in relative abundance by size group for *Epinephelus coioides* (ID #50, Epinephelidae)



The percentages of *Epinephelus coioides* (ID #50, Epinephelidae) in 2015-2016, n = 800
Immature (< 50cm): 4%
Small mature (>= 50cm, < 66cm): 29%
Large mature (>= 66cm): 68%
Mega spawner (>= 72.6cm): 48% (subset of large mature fish)
Spawning Potential Ratio: 77%

At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low.

The trade limit is about the same as the length at first maturity. This means that the trade puts a premium on fish that have spawned at least once, which improves sustainability of the fishery. Risk level is medium.

The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

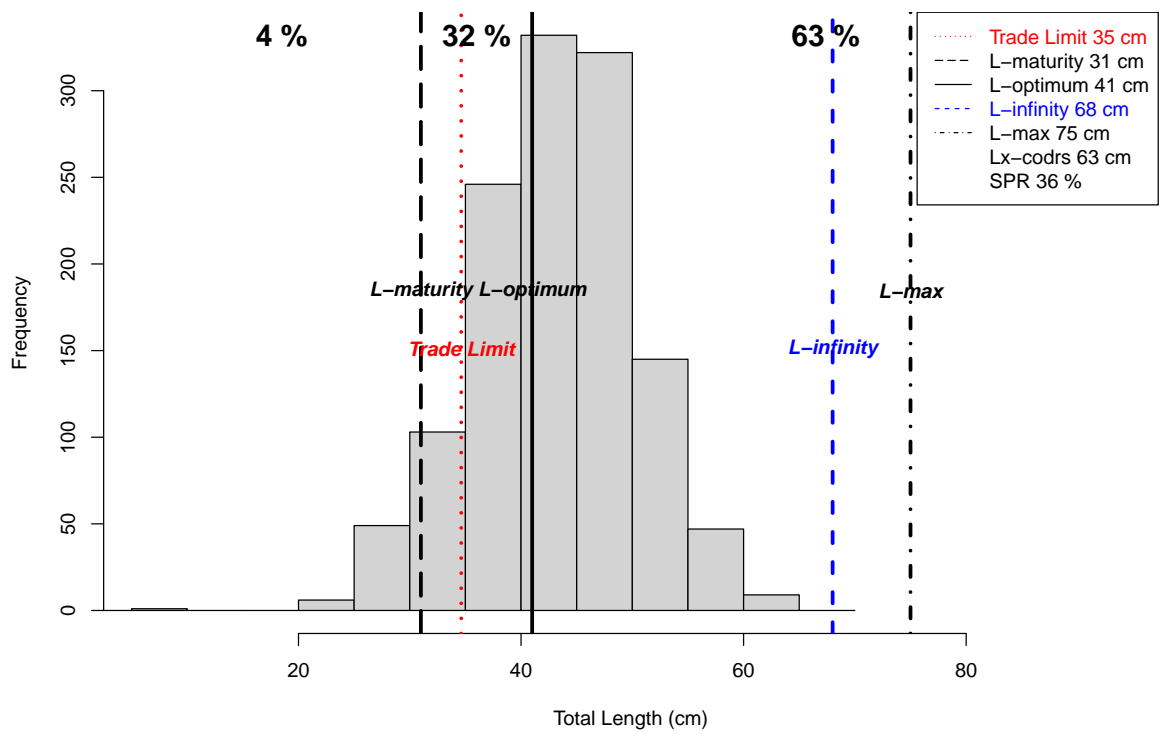
More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is at or below a level equal to half the natural rate of mortality. This means that impact of fishing is minimized and this fishery is currently probably operating at a sustainable level of effort. Risk level is low.

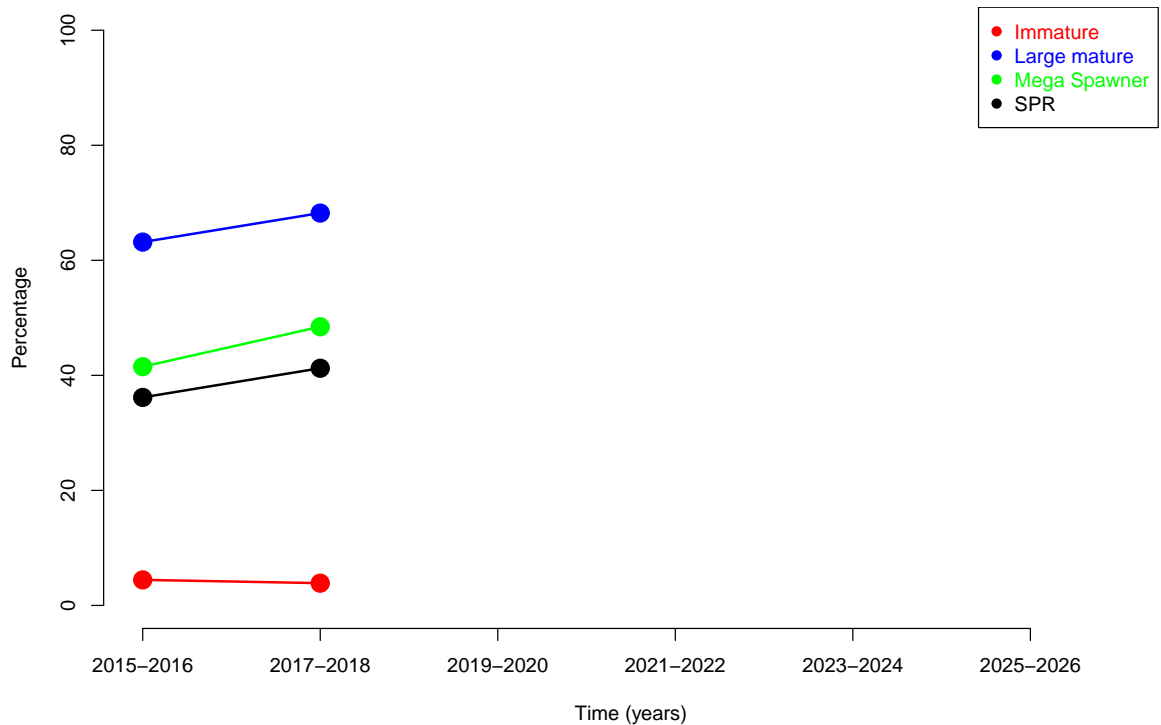
SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low.

Trends in relative abundance by size group for *Epinephelus coioides* (ID #50, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.
% Immature falling over recent years, situation improving. P: not available
% Large Mature falling over recent years, situation deteriorating. P: not available
% Mega Spawner falling over recent years, situation deteriorating. P: not available
% SPR falling over recent years, situation deteriorating. P: not available

2015–2016, Catch length frequency for *Epinephelus chlorostigma* (ID #51, Epinephelidae), n = 1,260



Trends in relative abundance by size group for *Epinephelus chlorostigma* (ID #51, Epinephelidae)



The percentages of *Epinephelus chlorostigma* (ID #51, Epinephelidae) in 2015-2016, n = 1,260
Immature (< 31cm): 4%
Small mature (\geq 31cm, < 41cm): 32%
Large mature (\geq 41cm): 63%
Mega spawner (\geq 45.1cm): 42% (subset of large mature fish)
Spawning Potential Ratio: 36%

At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low.

The trade limit is significantly higher than length at first maturity. This means that the trade puts a premium on fish that have spawned at least once. The trade does not cause any concern of recruitment overfishing for this species. Risk level is low.

The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

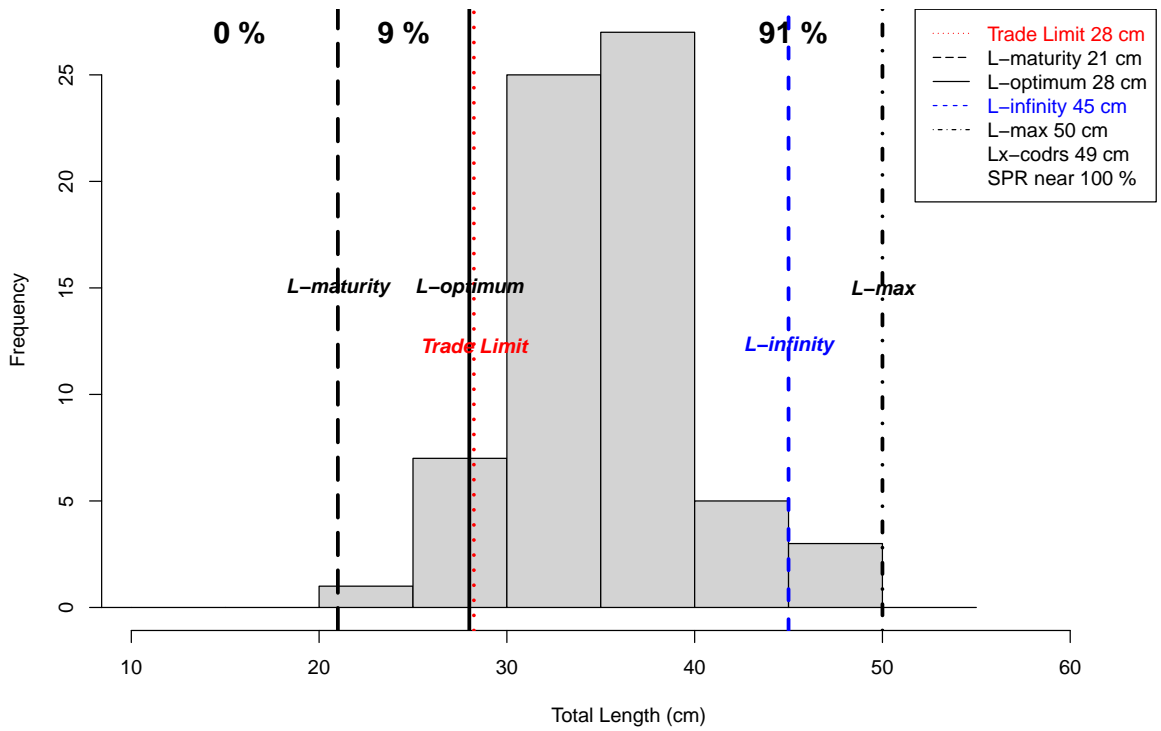
More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is greater than or equal to the natural rate of mortality. This means that impact of fishing is severe and that fishing is unlikely to be sustainable at the current level of effort. Risk level is high.

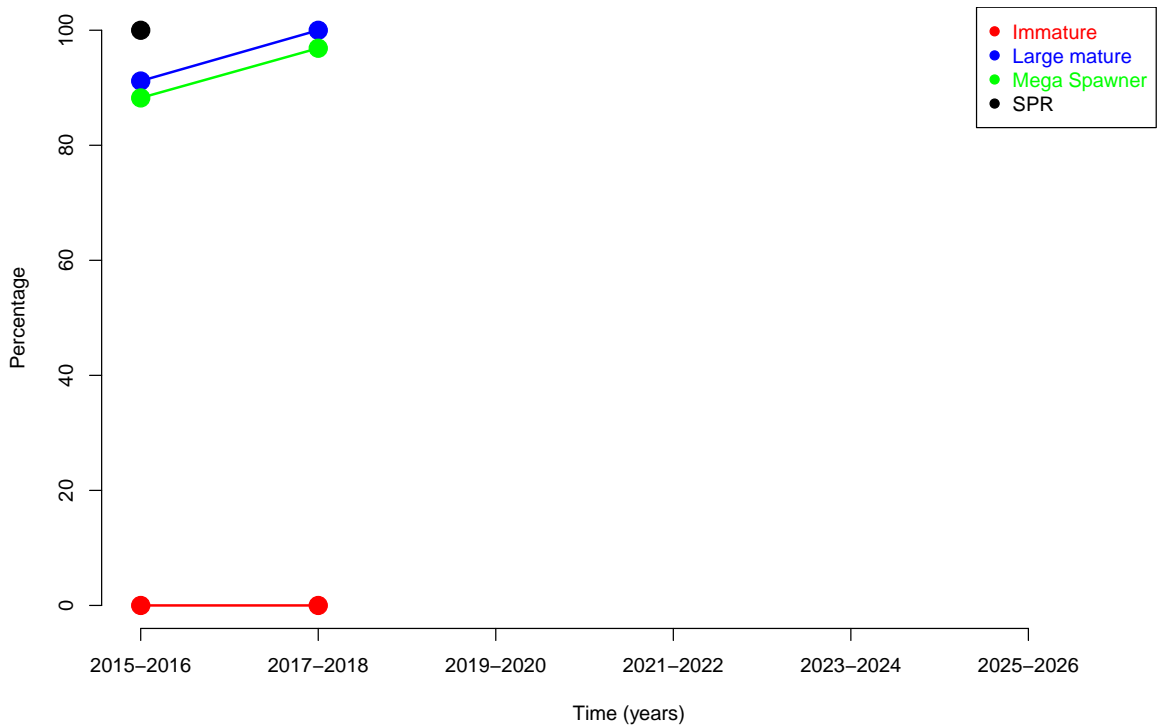
SPR is between 25% and 40%. The stock is heavily exploited, and there is some risk that the fishery will cause further decline of the stock. Risk level is medium.

Trends in relative abundance by size group for *Epinephelus chlorostigma* (ID #51, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.
% Immature falling over recent years, situation improving. P: not available
% Large Mature rising over recent years, situation improving. P: not available
% Mega Spawner rising over recent years, situation improving. P: not available
% SPR rising over recent years, situation improving. P: not available

2015–2016, Catch length frequency for *Epinephelus retouti* (ID #52, Epinephelidae), n = 68



Trends in relative abundance by size group for *Epinephelus retouti* (ID #52, Epinephelidae)



The percentages of *Epinephelus retouti* (ID #52, Epinephelidae) in 2015-2016, n = 68
Immature (< 21cm): 0%
Small mature (>= 21cm, < 28cm): 9%
Large mature (>= 28cm): 91%
Mega spawner (>= 30.8cm): 88% (subset of large mature fish)
Spawning Potential Ratio: near 100%

At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low.

The trade limit is significantly higher than length at first maturity. This means that the trade puts a premium on fish that have spawned at least once. The trade does not cause any concern of recruitment overfishing for this species. Risk level is low.

The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

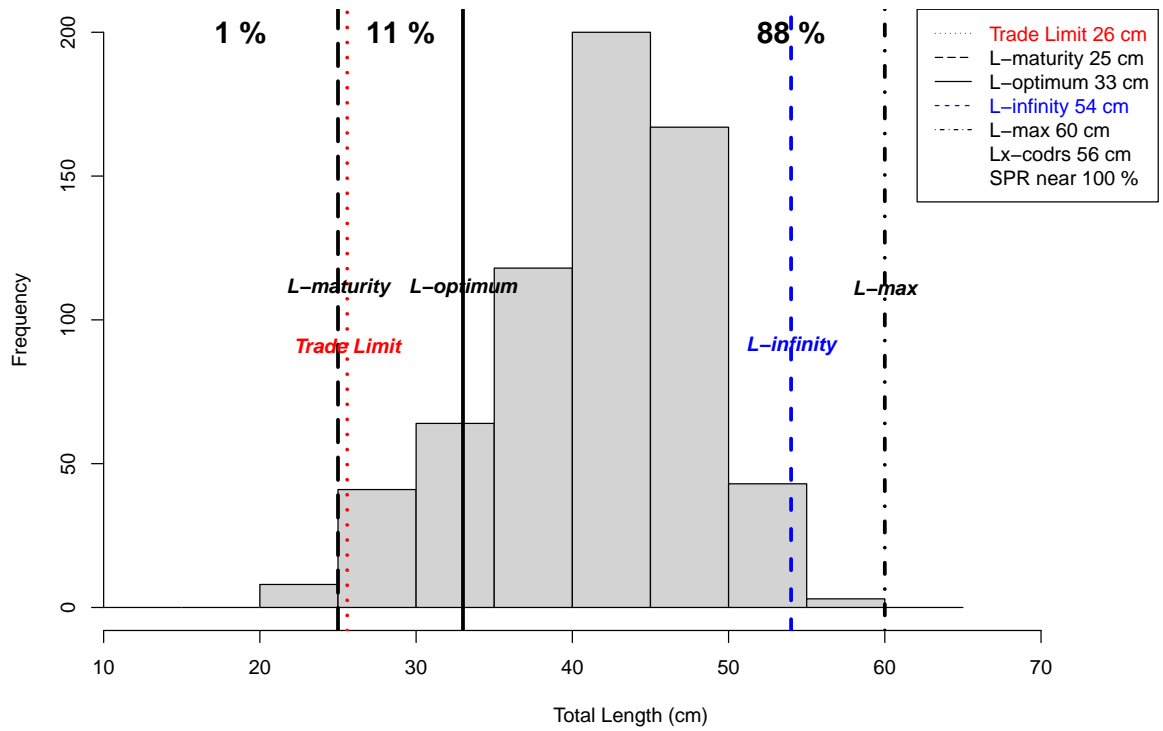
More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is at or below a level equal to half the natural rate of mortality. This means that impact of fishing is minimized and this fishery is currently probably operating at a sustainable level of effort. Risk level is low.

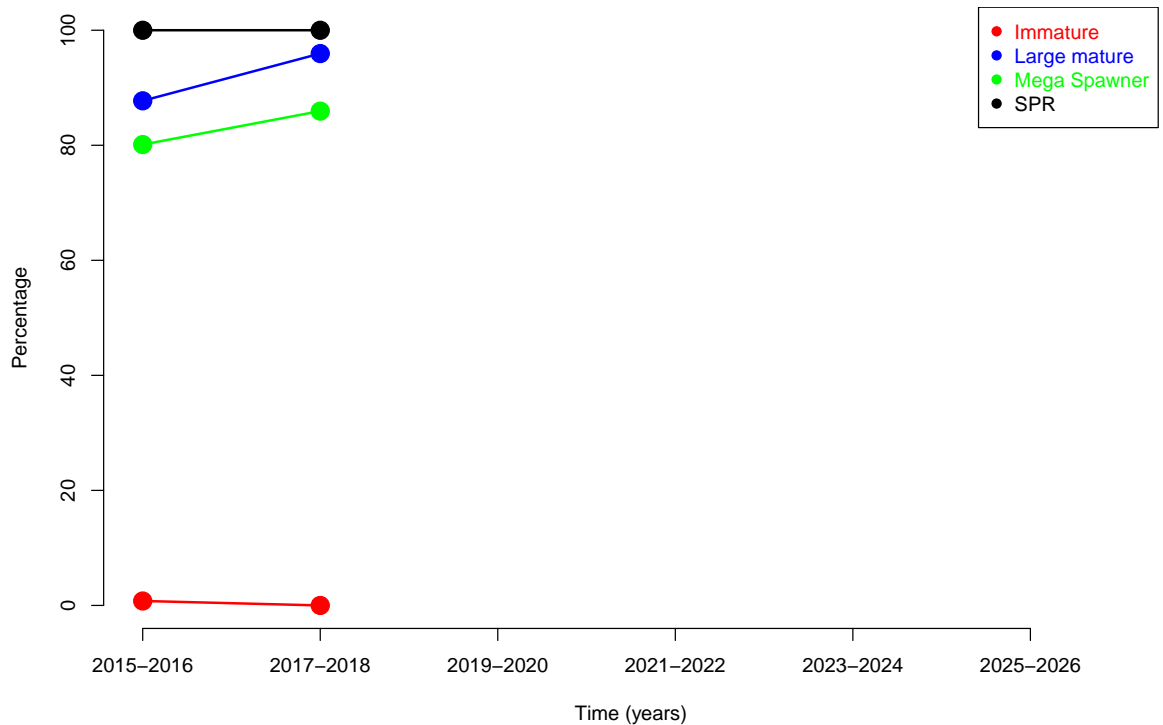
SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low.

Trends in relative abundance by size group for *Epinephelus retouti* (ID #52, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.
% Immature no trend over recent years, situation stable. P: not available
% Large Mature rising over recent years, situation improving. P: not available
% Mega Spawner rising over recent years, situation improving. P: not available
% SPR no trend over recent years, situation stable. P: not available

2015–2016, Catch length frequency for *Epinephelus heniochus* (ID #53, Epinephelidae), n = 644



Trends in relative abundance by size group for *Epinephelus heniochus* (ID #53, Epinephelidae)



The percentages of *Epinephelus heniochus* (ID #53, Epinephelidae) in 2015-2016, n = 644
Immature (< 25cm): 1%
Small mature (\geq 25cm, < 33cm): 11%
Large mature (\geq 33cm): 88%
Mega spawner (\geq 36.3cm): 80% (subset of large mature fish)
Spawning Potential Ratio: near 100%

At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low.

The trade limit is about the same as the length at first maturity. This means that the trade puts a premium on fish that have spawned at least once, which improves sustainability of the fishery. Risk level is medium.

The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is at or below a level equal to half the natural rate of mortality. This means that impact of fishing is minimized and this fishery is currently probably operating at a sustainable level of effort. Risk level is low.

SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low.

Trends in relative abundance by size group for *Epinephelus heniochus* (ID #53, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.

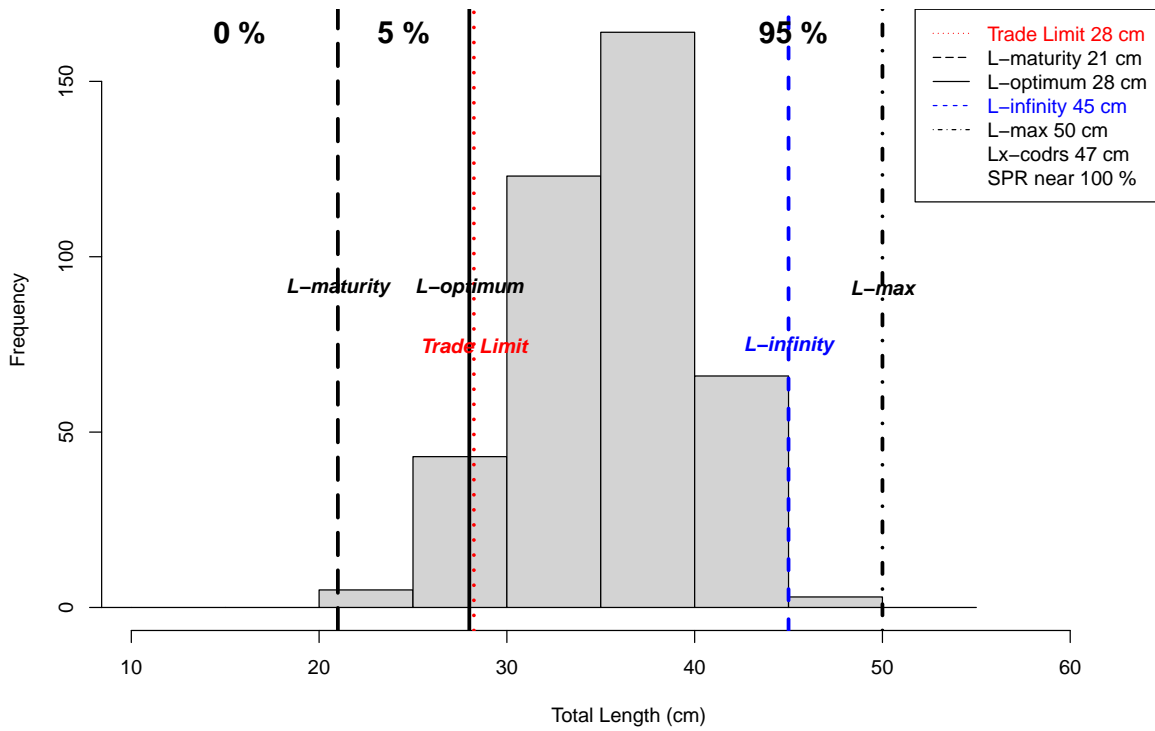
% Immature falling over recent years, situation improving. P: not available

% Large Mature rising over recent years, situation improving. P: not available

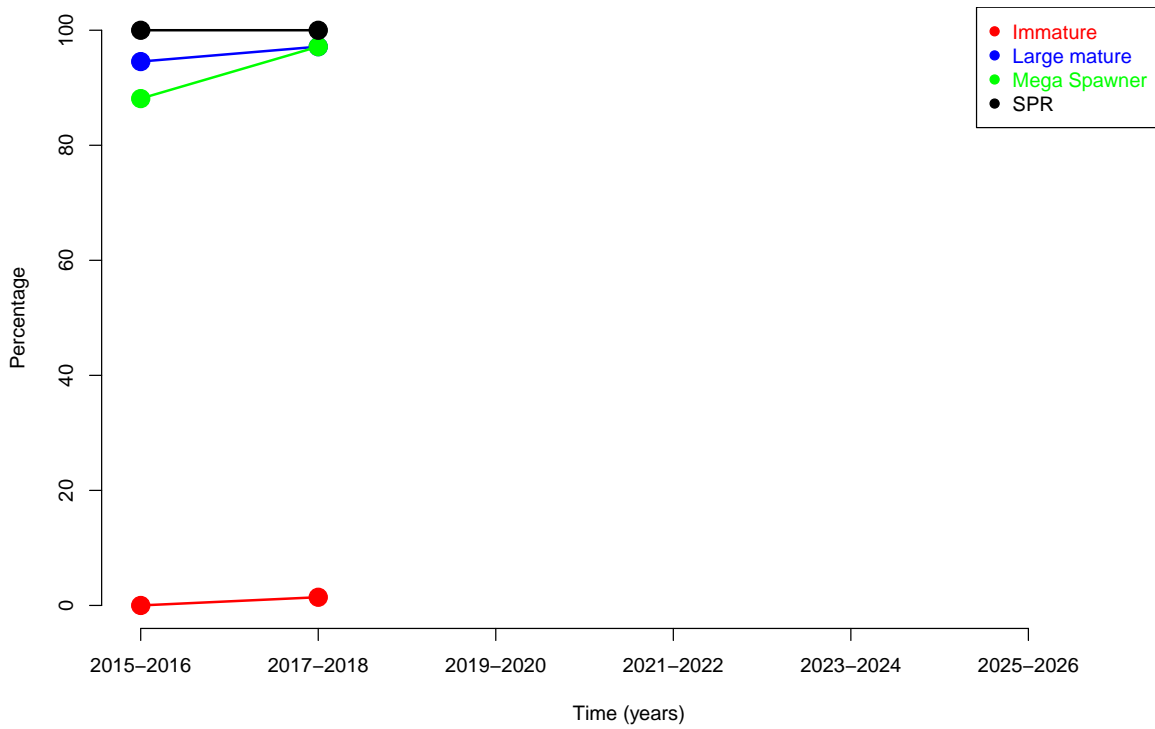
% Mega Spawner rising over recent years, situation improving. P: not available

% SPR no trend over recent years, situation stable. P: not available

2015–2016, Catch length frequency for *Epinephelus stictus* (ID #54, Epinephelidae), n = 404



Trends in relative abundance by size group for *Epinephelus stictus* (ID #54, Epinephelidae)



The percentages of *Epinephelus stictus* (ID #54, Epinephelidae) in 2015-2016, n = 404
Immature (< 21cm): 0%
Small mature ($\geq 21\text{cm}$, < 28cm): 5%
Large mature ($\geq 28\text{cm}$): 95%
Mega spawner ($\geq 30.8\text{cm}$): 88% (subset of large mature fish)
Spawning Potential Ratio: near 100%

At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low.

The trade limit is significantly higher than length at first maturity. This means that the trade puts a premium on fish that have spawned at least once. The trade does not cause any concern of recruitment overfishing for this species. Risk level is low.

The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

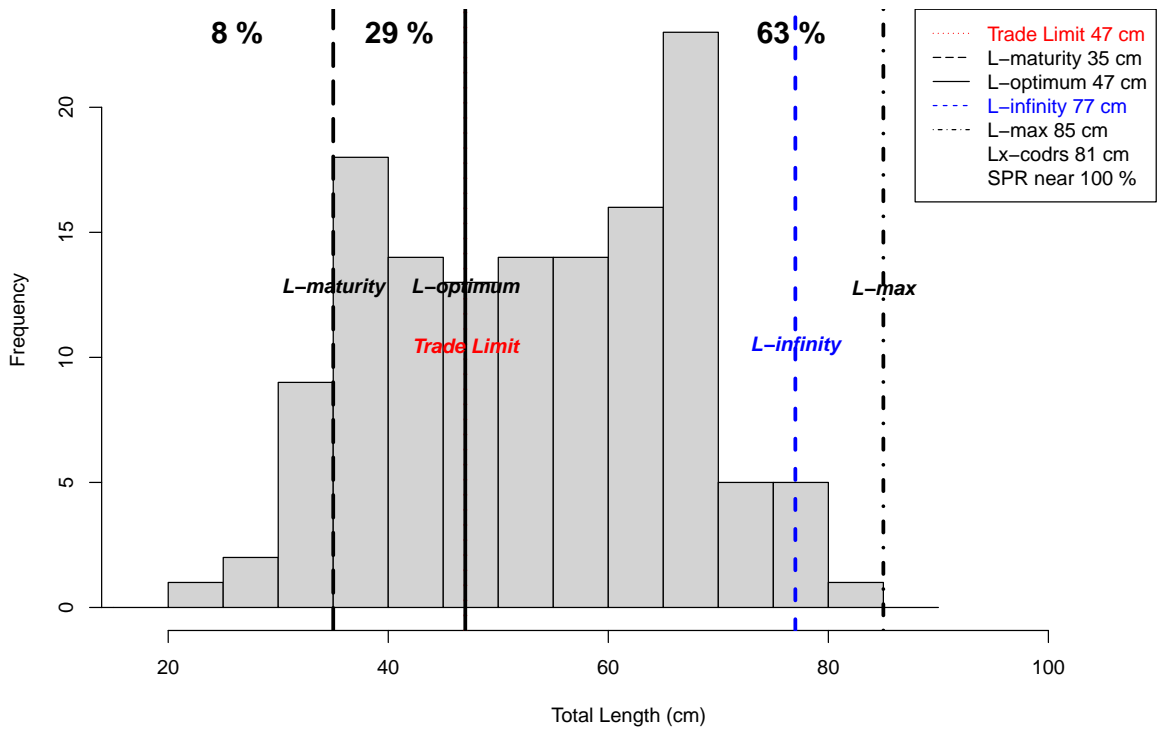
More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is at or below a level equal to half the natural rate of mortality. This means that impact of fishing is minimized and this fishery is currently probably operating at a sustainable level of effort. Risk level is low.

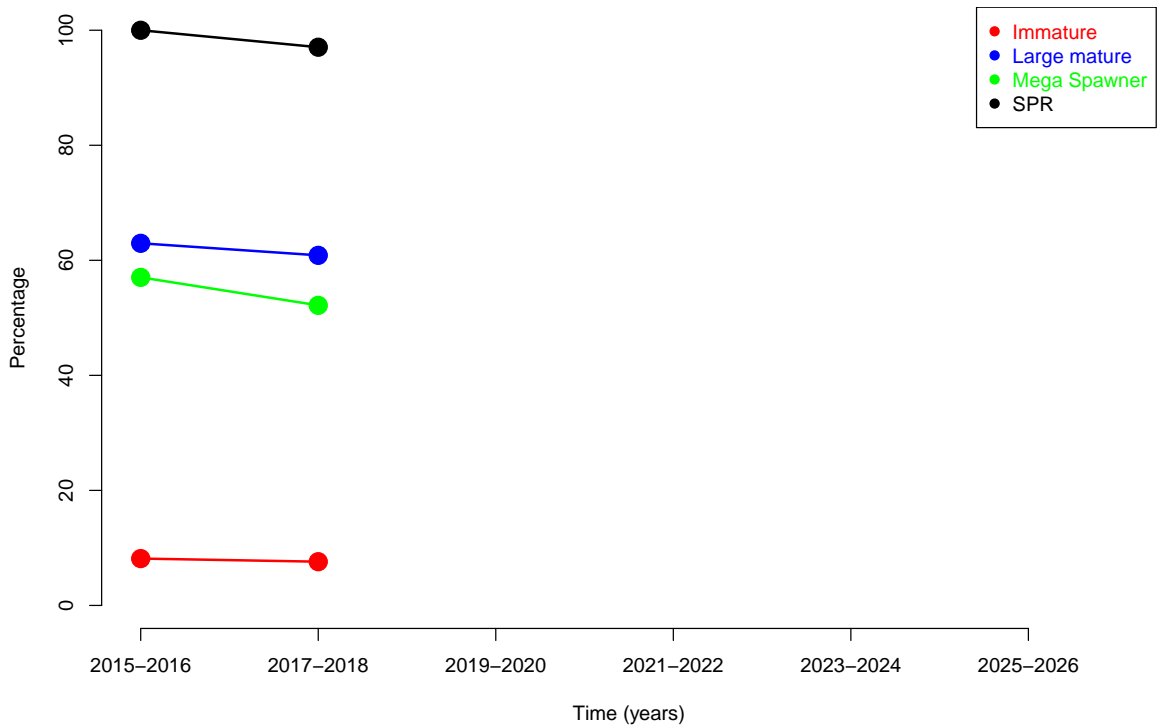
SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low.

Trends in relative abundance by size group for *Epinephelus stictus* (ID #54, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.
% Immature rising over recent years, situation deteriorating. P: not available
% Large Mature rising over recent years, situation improving. P: not available
% Mega Spawner rising over recent years, situation improving. P: not available
% SPR no trend over recent years, situation stable. P: not available

2015–2016, Catch length frequency for *Epinephelus epistictus* (ID #55, Epinephelidae), n = 135



Trends in relative abundance by size group for *Epinephelus epistictus* (ID #55, Epinephelidae)



The percentages of *Epinephelus epistictus* (ID #55, Epinephelidae) in 2015-2016, n = 135
Immature (< 35cm): 8%
Small mature (>= 35cm, < 47cm): 29%
Large mature (>= 47cm): 63%
Mega spawner (>= 51.7cm): 57% (subset of large mature fish)
Spawning Potential Ratio: near 100%

At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low.

The trade limit is significantly higher than length at first maturity. This means that the trade puts a premium on fish that have spawned at least once. The trade does not cause any concern of recruitment overfishing for this species. Risk level is low.

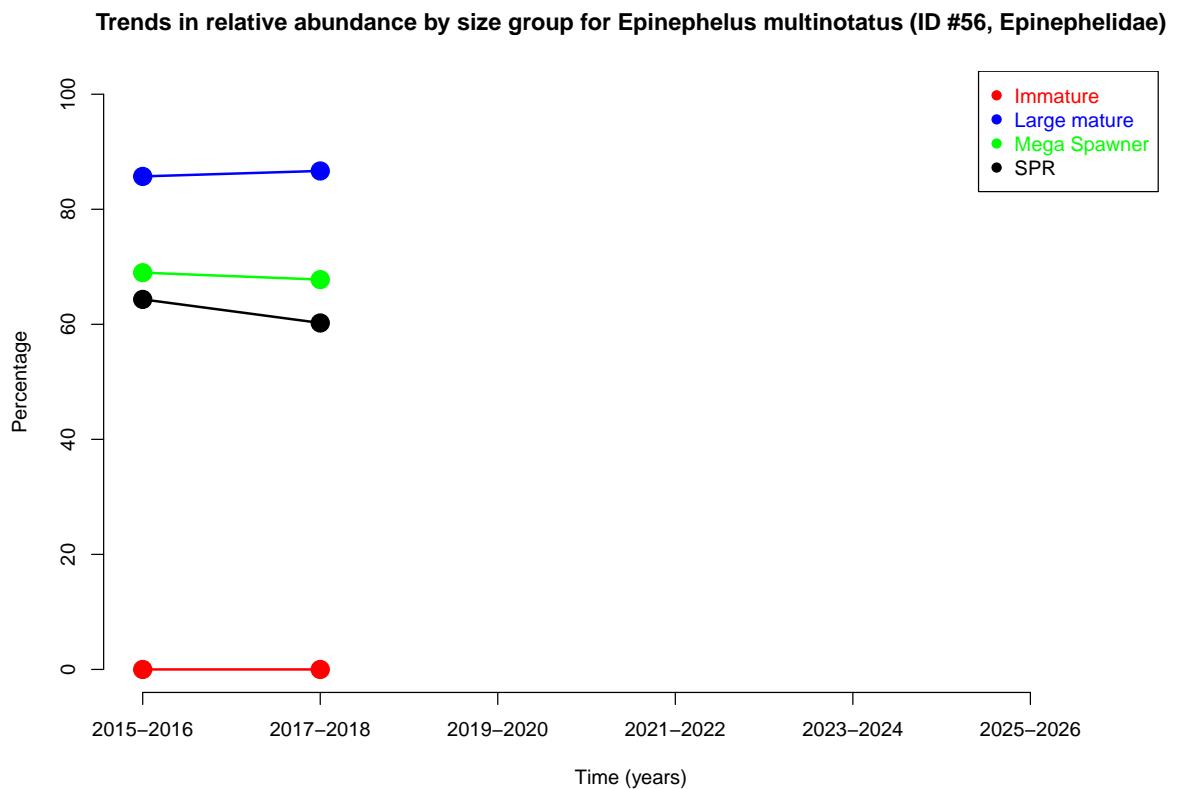
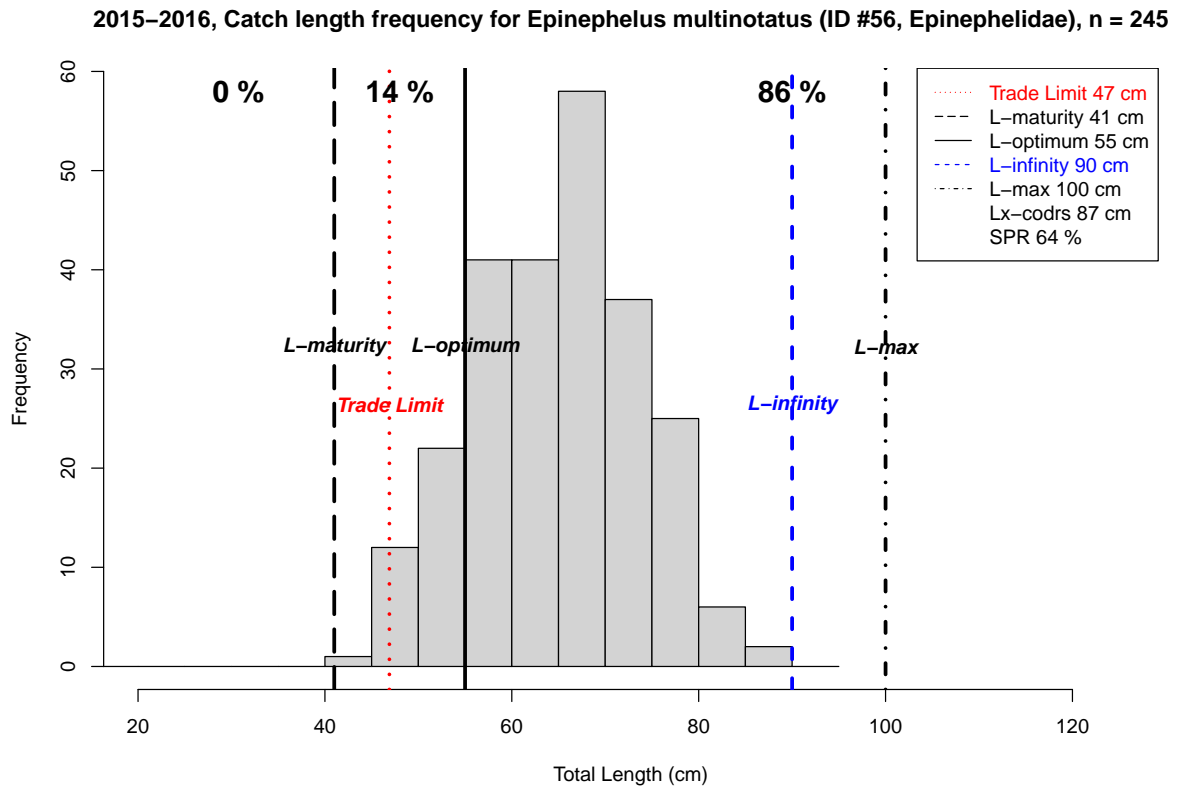
The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is at or below a level equal to half the natural rate of mortality. This means that impact of fishing is minimized and this fishery is currently probably operating at a sustainable level of effort. Risk level is low.

SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low.

Trends in relative abundance by size group for *Epinephelus epistictus* (ID #55, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.
% Immature falling over recent years, situation improving. P: not available
% Large Mature falling over recent years, situation deteriorating. P: not available
% Mega Spawner falling over recent years, situation deteriorating. P: not available
% SPR falling over recent years, situation deteriorating. P: not available



The percentages of *Epinephelus multinotatus* (ID #56, Epinephelidae) in 2015-2016, n = 245
Immature (< 41cm): 0%
Small mature (>= 41cm, < 55cm): 14%
Large mature (>= 55cm): 86%
Mega spawner (>= 60.5cm): 69% (subset of large mature fish)
Spawning Potential Ratio: 64%

At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low.

The trade limit is significantly higher than length at first maturity. This means that the trade puts a premium on fish that have spawned at least once. The trade does not cause any concern of recruitment overfishing for this species. Risk level is low.

The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

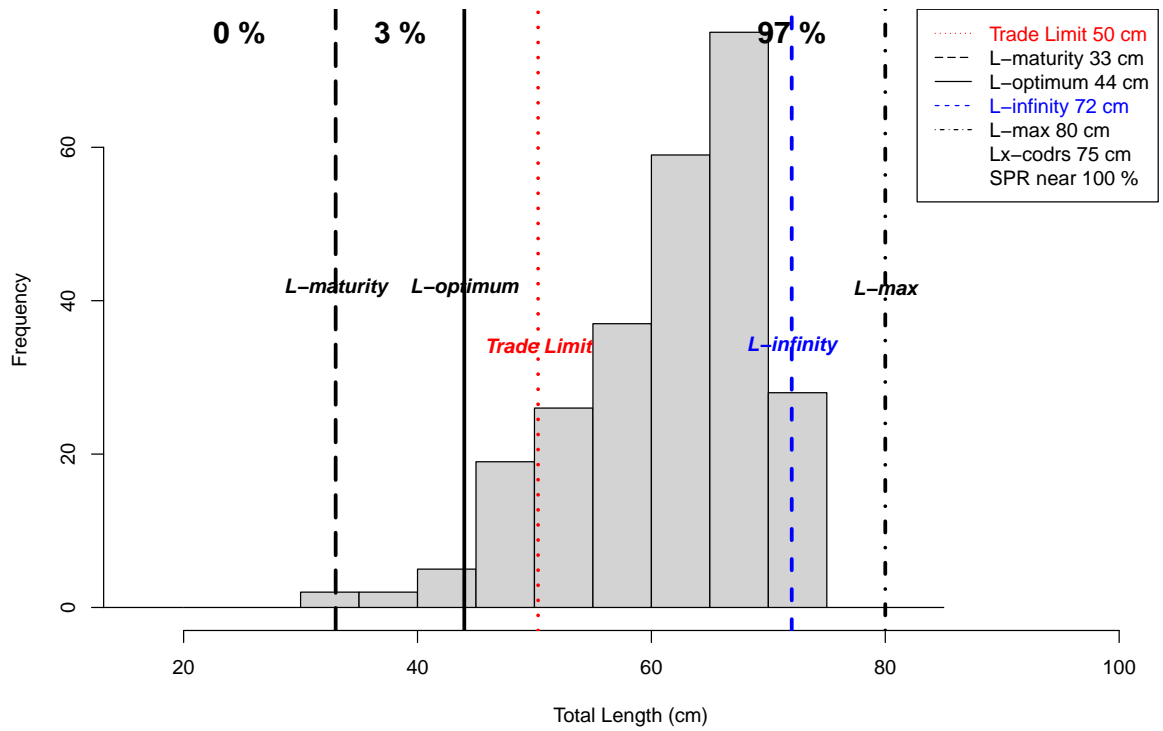
More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is at or below a level equal to half the natural rate of mortality. This means that impact of fishing is minimized and this fishery is currently probably operating at a sustainable level of effort. Risk level is low.

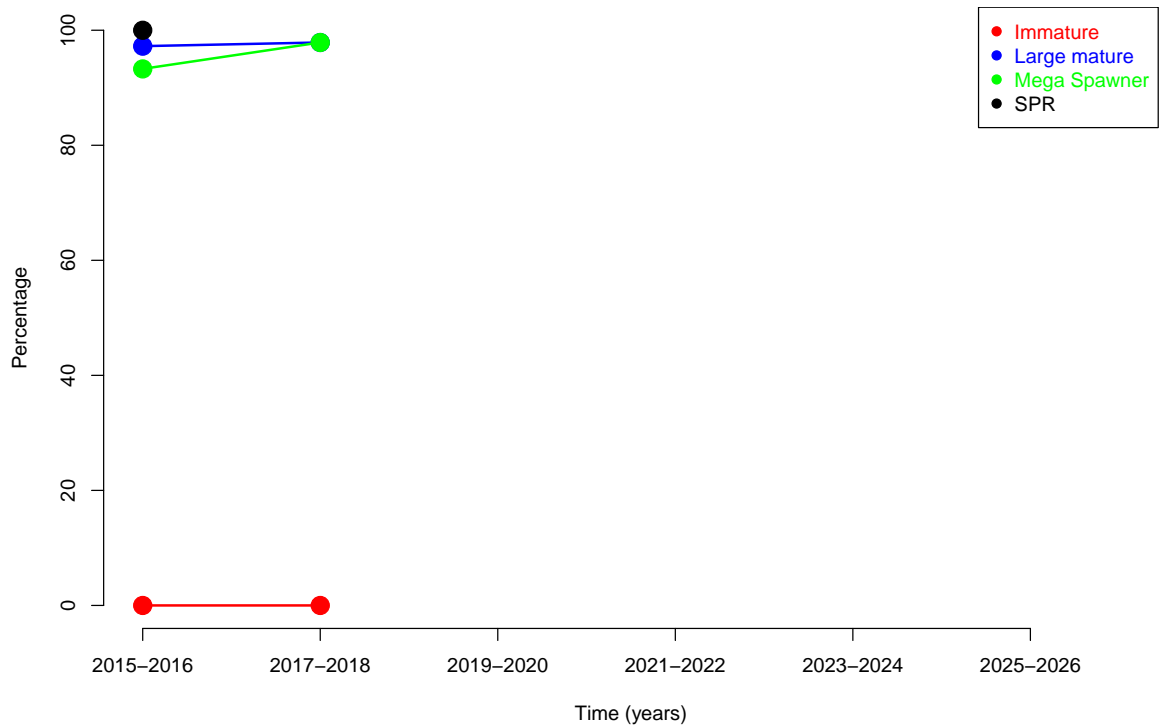
SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low.

Trends in relative abundance by size group for *Epinephelus multinotatus* (ID #56, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.
% Immature no trend over recent years, situation stable. P: not available
% Large Mature rising over recent years, situation improving. P: not available
% Mega Spawner falling over recent years, situation deteriorating. P: not available
% SPR falling over recent years, situation deteriorating. P: not available

2015–2016, Catch length frequency for *Epinephelus undulosus* (ID #57, Epinephelidae), n = 253



Trends in relative abundance by size group for *Epinephelus undulosus* (ID #57, Epinephelidae)



The percentages of *Epinephelus undulosus* (ID #57, Epinephelidae) in 2015-2016, n = 253
Immature (< 33cm): 0%
Small mature (>= 33cm, < 44cm): 3%
Large mature (>= 44cm): 97%
Mega spawner (>= 48.4cm): 93% (subset of large mature fish)
Spawning Potential Ratio: near 100%

At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low.

The trade limit is significantly higher than length at first maturity. This means that the trade puts a premium on fish that have spawned at least once. The trade does not cause any concern of recruitment overfishing for this species. Risk level is low.

The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

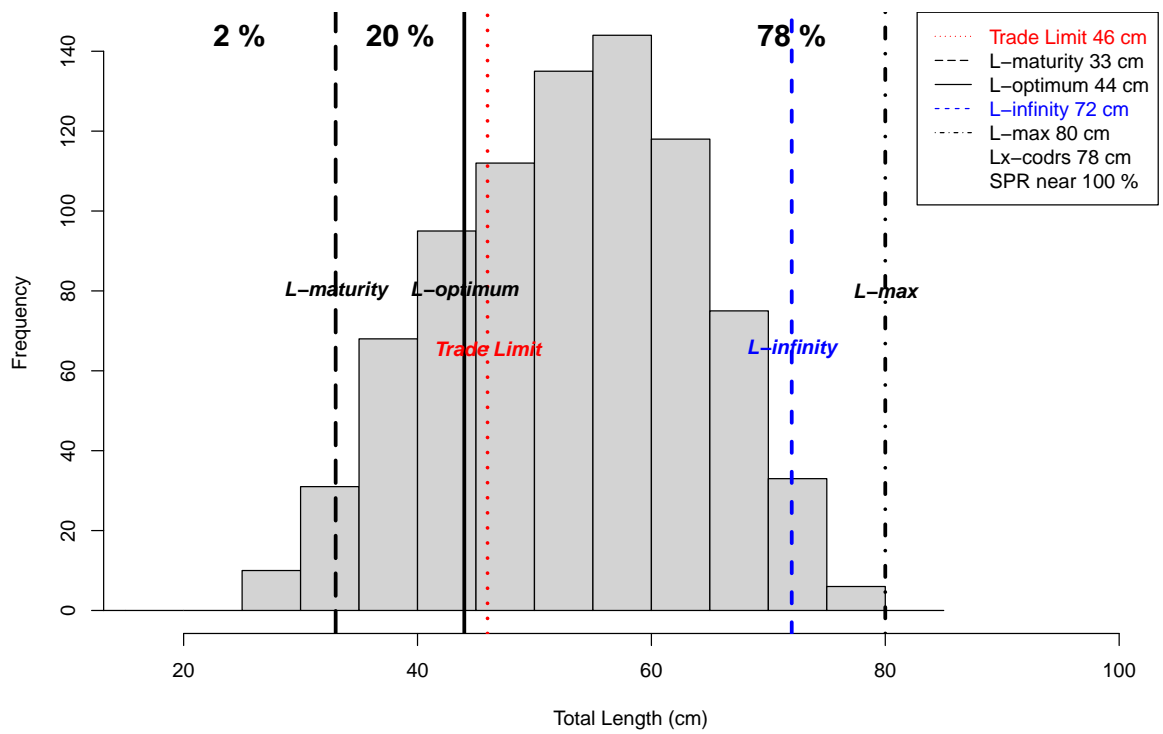
More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is at or below a level equal to half the natural rate of mortality. This means that impact of fishing is minimized and this fishery is currently probably operating at a sustainable level of effort. Risk level is low.

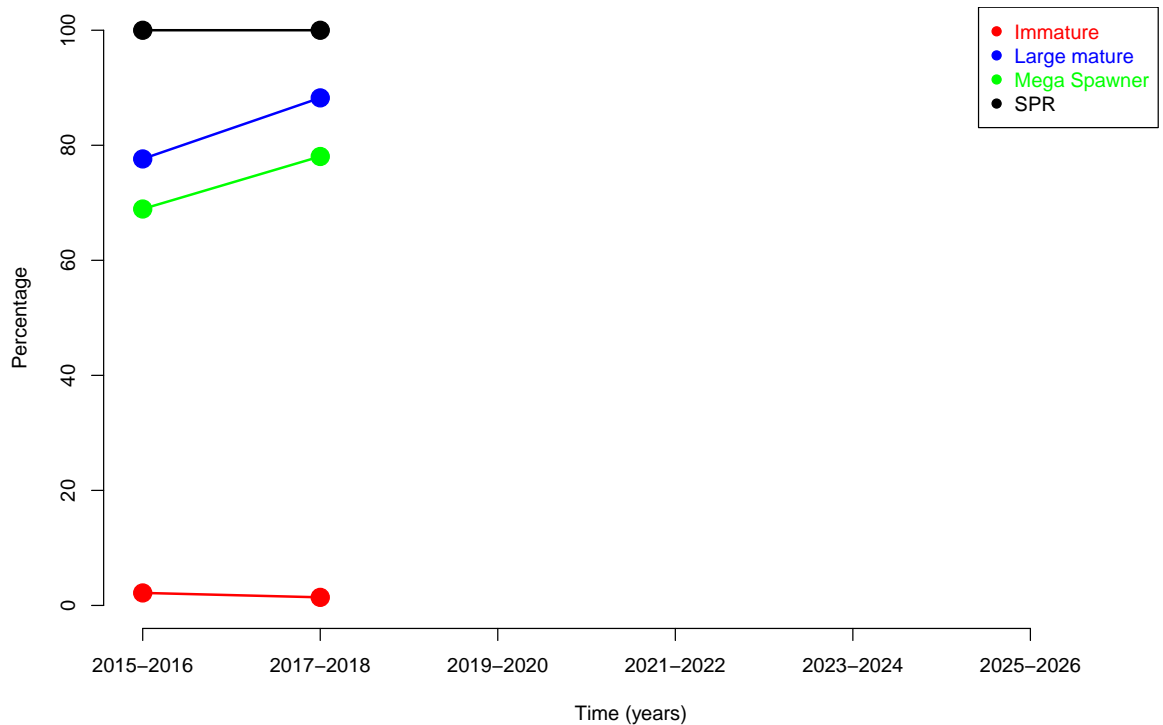
SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low.

Trends in relative abundance by size group for *Epinephelus undulosus* (ID #57, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.
% Immature no trend over recent years, situation stable. P: not available
% Large Mature rising over recent years, situation improving. P: not available
% Mega Spawner rising over recent years, situation improving. P: not available
% SPR no trend over recent years, situation stable. P: not available

2015–2016, Catch length frequency for *Epinephelus amblycephalus* (ID #58, Epinephelidae), n = 827



Trends in relative abundance by size group for *Epinephelus amblycephalus* (ID #58, Epinephelidae)



The percentages of *Epinephelus amblycephalus* (ID #58, Epinephelidae) in 2015-2016, n = 827
Immature (< 33cm): 2%
Small mature (\geq 33cm, < 44cm): 20%
Large mature (\geq 44cm): 78%
Mega spawner (\geq 48.4cm): 69% (subset of large mature fish)
Spawning Potential Ratio: near 100%

At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low.

The trade limit is significantly higher than length at first maturity. This means that the trade puts a premium on fish that have spawned at least once. The trade does not cause any concern of recruitment overfishing for this species. Risk level is low.

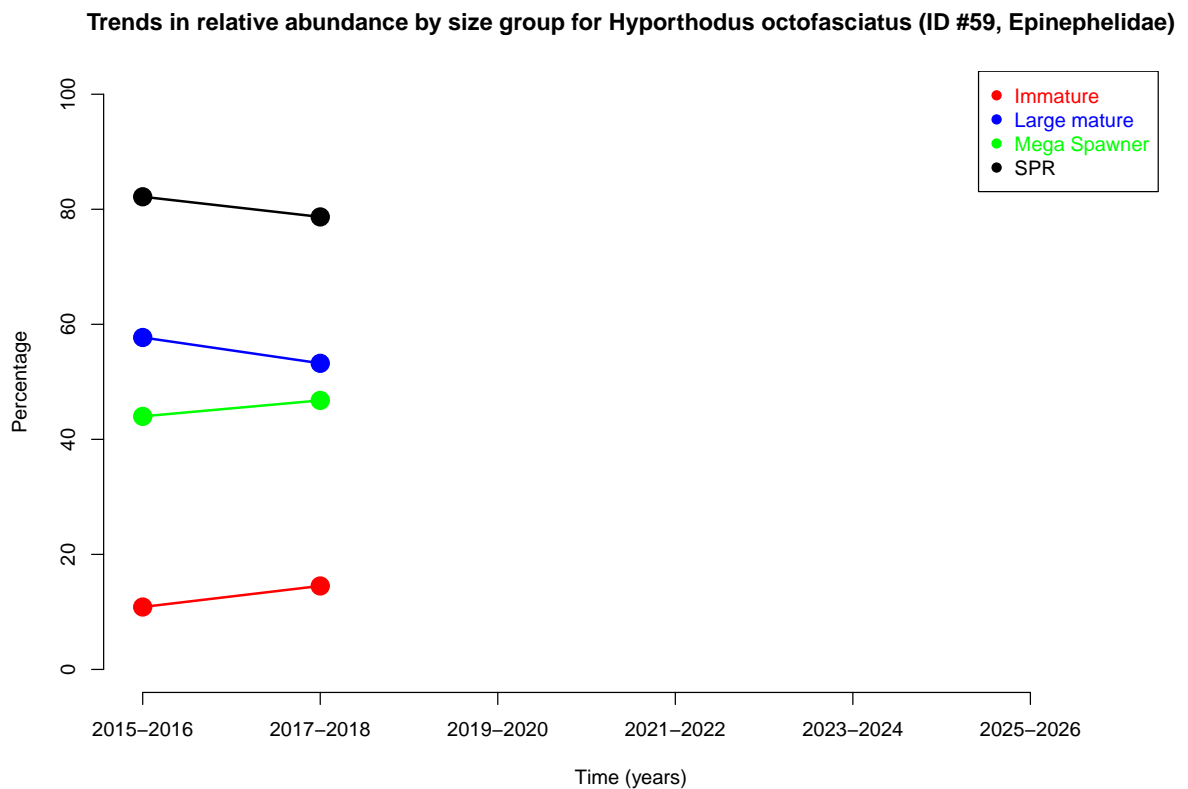
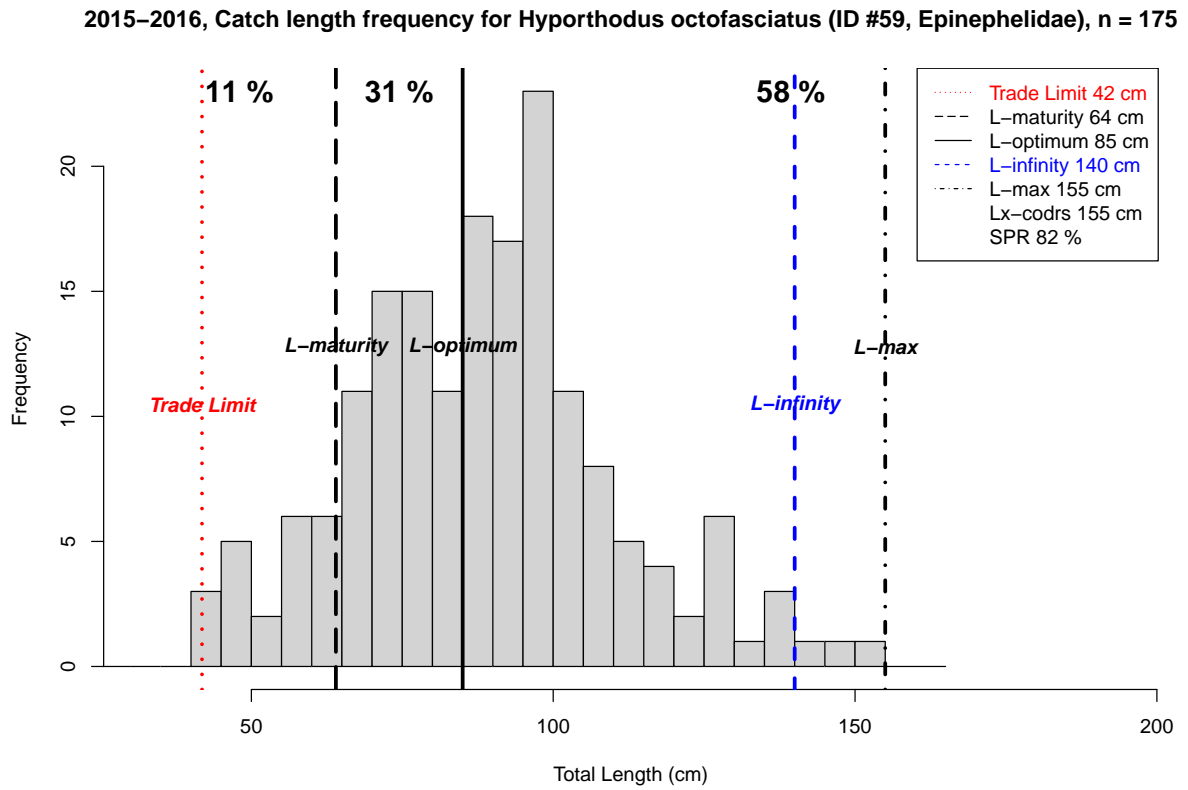
The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is at or below a level equal to half the natural rate of mortality. This means that impact of fishing is minimized and this fishery is currently probably operating at a sustainable level of effort. Risk level is low.

SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low.

Trends in relative abundance by size group for *Epinephelus amblycephalus* (ID #58, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.
% Immature falling over recent years, situation improving. P: not available
% Large Mature rising over recent years, situation improving. P: not available
% Mega Spawner rising over recent years, situation improving. P: not available
% SPR no trend over recent years, situation stable. P: not available



The percentages of *Hyporthodus octofasciatus* (ID #59, Epinephelidae) in 2015-2016, n = 175
Immature (< 64cm): 11%
Small mature (>= 64cm, < 85cm): 31%
Large mature (>= 85cm): 58%
Mega spawner (>= 93.5cm): 44% (subset of large mature fish)
Spawning Potential Ratio: 82%

Between 10% and 20% of the fish in the catch are juveniles that have not yet reproduced. There is no immediate concern in terms of overfishing through over harvesting of juveniles, but the fishery needs to be monitored closely for any further increase in this indicator and incentives need to be geared towards targeting larger fish. Risk level is medium.

The trade limit is significantly lower than the length at first maturity. This means that the trade encourages capture of immature fish, which impairs sustainability. Risk level is high.

The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

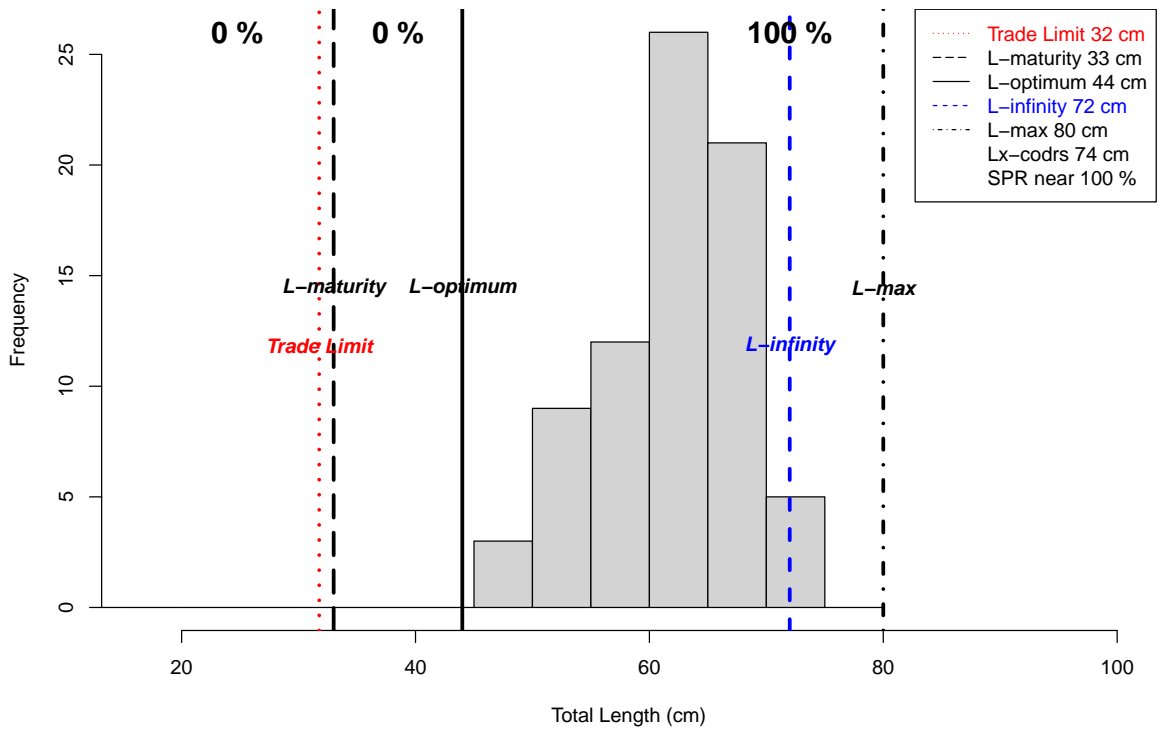
More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is at or below a level equal to half the natural rate of mortality. This means that impact of fishing is minimized and this fishery is currently probably operating at a sustainable level of effort. Risk level is low.

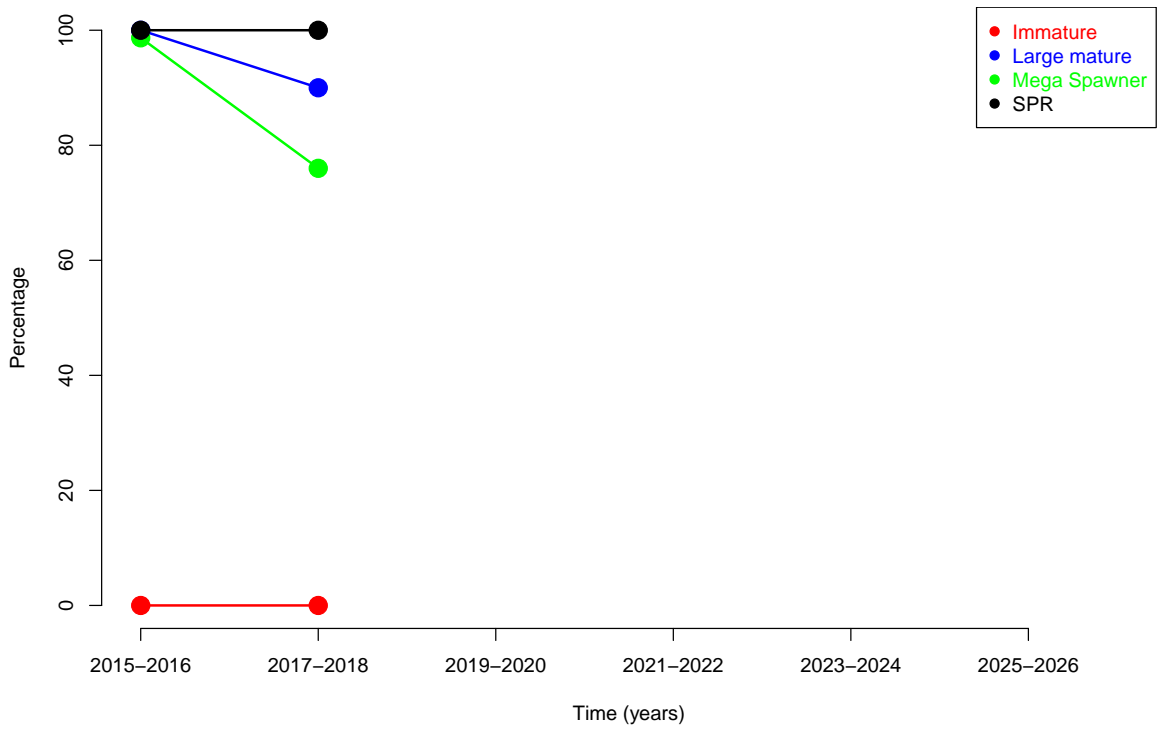
SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low.

Trends in relative abundance by size group for *Hyporthodus octofasciatus* (ID #59, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.
% Immature rising over recent years, situation deteriorating. P: not available
% Large Mature falling over recent years, situation deteriorating. P: not available
% Mega Spawner rising over recent years, situation improving. P: not available
% SPR falling over recent years, situation deteriorating. P: not available

2015–2016, Catch length frequency for *Plectropomus maculatus* (ID #60, Epinephelidae), n = 76



Trends in relative abundance by size group for *Plectropomus maculatus* (ID #60, Epinephelidae)



The percentages of *Plectropomus maculatus* (ID #60, Epinephelidae) in 2015-2016, n = 76
Immature (< 33cm): 0%
Small mature (>= 33cm, < 44cm): 0%
Large mature (>= 44cm): 100%
Mega spawner (>= 48.4cm): 99% (subset of large mature fish)
Spawning Potential Ratio: near 100%

At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low.

The trade limit is about the same as the length at first maturity. This means that the trade puts a premium on fish that have spawned at least once, which improves sustainability of the fishery. Risk level is medium.

The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is at or below a level equal to half the natural rate of mortality. This means that impact of fishing is minimized and this fishery is currently probably operating at a sustainable level of effort. Risk level is low.

SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low.

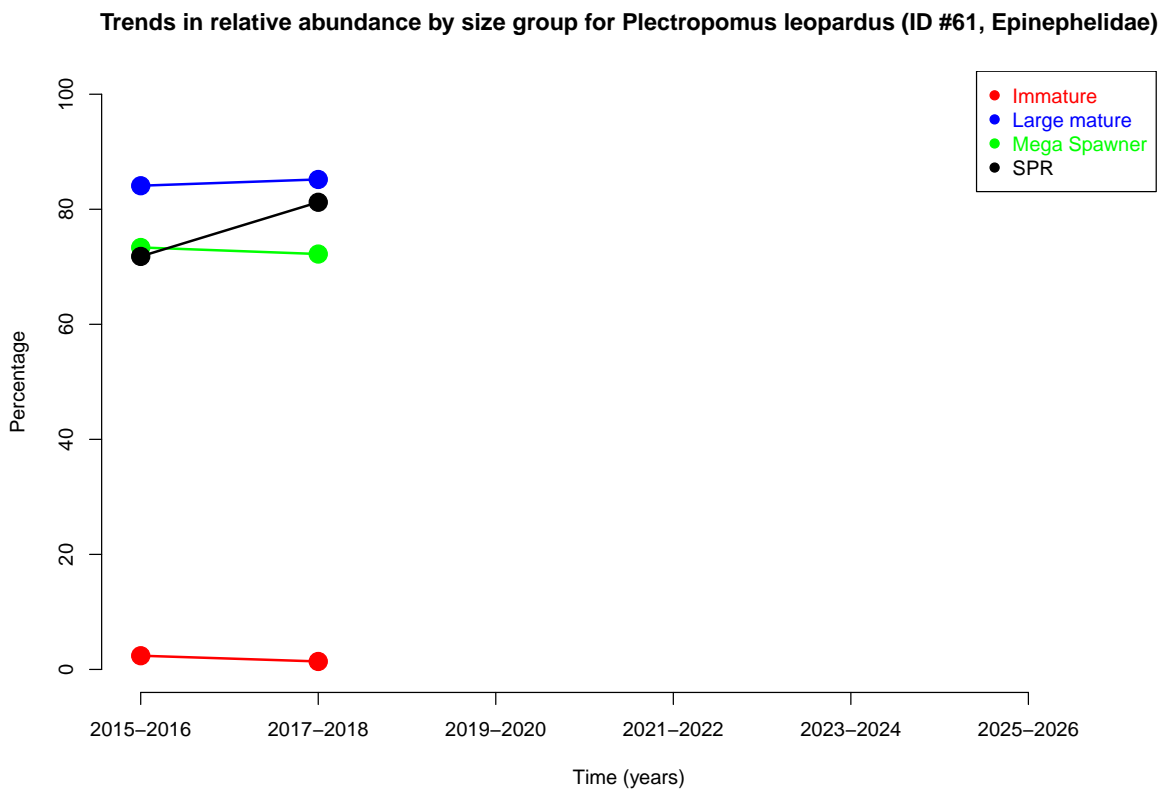
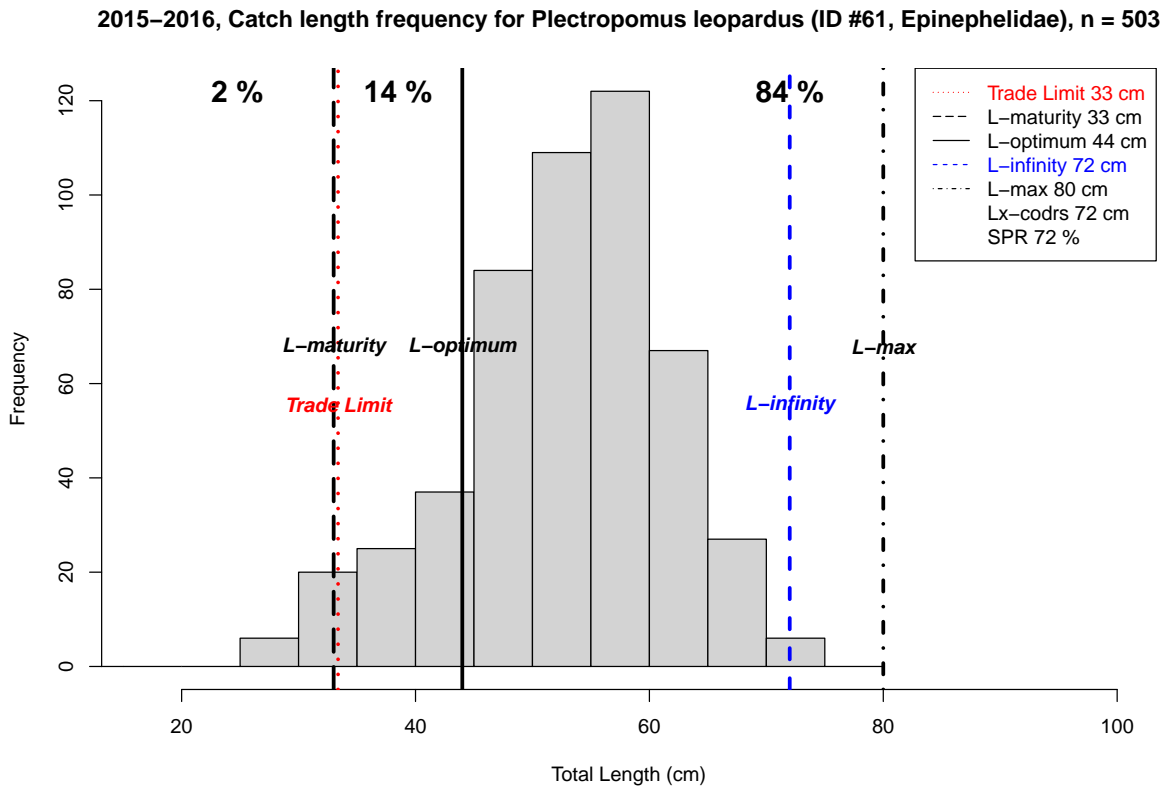
Trends in relative abundance by size group for *Plectropomus maculatus* (ID #60, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.

% Immature no trend over recent years, situation stable. P: not available

% Large Mature falling over recent years, situation deteriorating. P: not available

% Mega Spawner falling over recent years, situation deteriorating. P: not available

% SPR no trend over recent years, situation stable. P: not available



The percentages of *Plectropomus leopardus* (ID #61, Epinephelidae) in 2015-2016, n = 503
Immature (< 33cm): 2%
Small mature (>= 33cm, < 44cm): 14%
Large mature (>= 44cm): 84%
Mega spawner (>= 48.4cm): 73% (subset of large mature fish)
Spawning Potential Ratio: 72%

At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low.

The trade limit is about the same as the length at first maturity. This means that the trade puts a premium on fish that have spawned at least once, which improves sustainability of the fishery. Risk level is medium.

The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

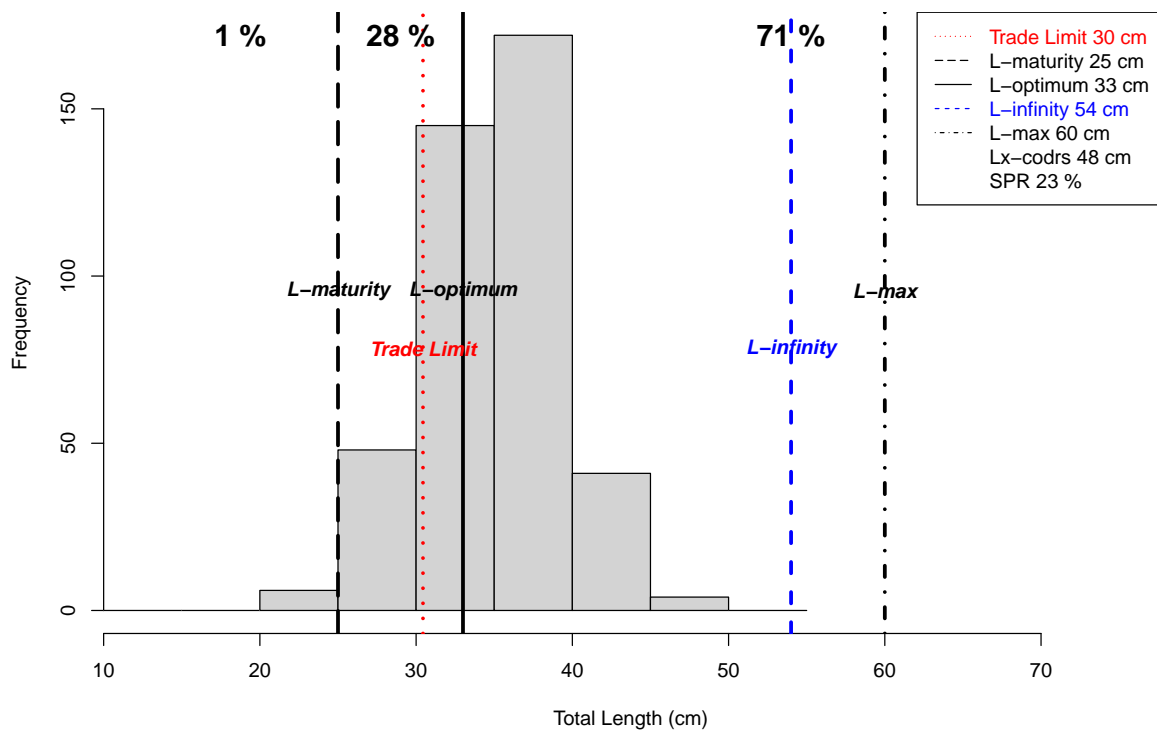
More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is at or below a level equal to half the natural rate of mortality. This means that impact of fishing is minimized and this fishery is currently probably operating at a sustainable level of effort. Risk level is low.

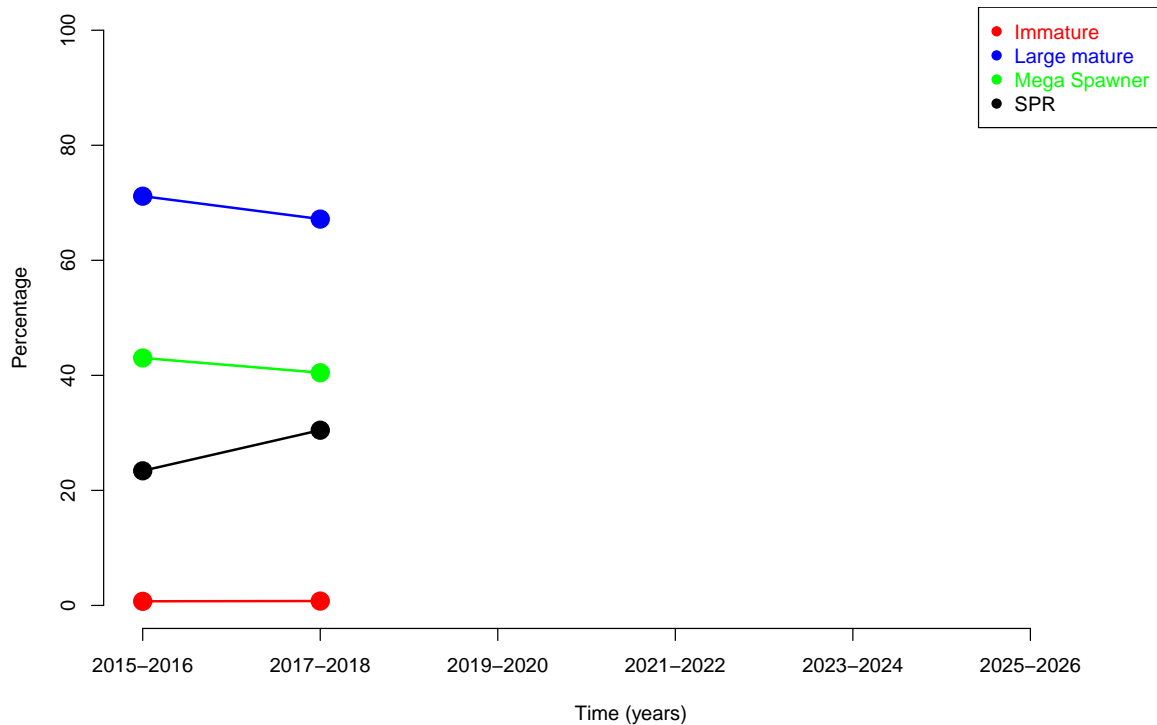
SPR is more than 40%. The stock is probably not over exploited, and the risk that the fishery will cause further stock decline is small. Risk level is low.

Trends in relative abundance by size group for *Plectropomus leopardus* (ID #61, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.
% Immature falling over recent years, situation improving. P: not available
% Large Mature rising over recent years, situation improving. P: not available
% Mega Spawner falling over recent years, situation deteriorating. P: not available
% SPR rising over recent years, situation improving. P: not available

2015–2016, Catch length frequency for *Variola albimarginata* (ID #62, Epinephelidae), n = 416



Trends in relative abundance by size group for *Variola albimarginata* (ID #62, Epinephelidae)



The percentages of *Variola albimarginata* (ID #62, Epinephelidae) in 2015-2016, n = 416
Immature (< 25cm): 1%
Small mature (>= 25cm, < 33cm): 28%
Large mature (>= 33cm): 71%
Mega spawner (>= 36.3cm): 43% (subset of large mature fish)
Spawning Potential Ratio: 23%

At least 90% of the fish in the catch are mature specimens that have spawned at least once before they were caught. The fishery does not depend on immature size classes for this species and is considered safe for this indicator. This fishery will not be causing overfishing through over harvesting of juveniles for this species. Risk level is low.

The trade limit is significantly higher than length at first maturity. This means that the trade puts a premium on fish that have spawned at least once. The trade does not cause any concern of recruitment overfishing for this species. Risk level is low.

The majority of the catch consists of size classes around or above the optimum harvest size. This means that the impact of the fishery is minimized for this species. Potentially higher yields of this species could be achieved by catching them at somewhat smaller size, although capture of smaller specimen may take place already in other fisheries. Risk level is low.

More than 30% of the catch consists of mega spawners which indicates that this fish population is in good health unless large amounts of much smaller fish from the same population are caught by other fisheries. Risk level is low.

Mortality caused by fishing is greater than or equal to the natural rate of mortality. This means that impact of fishing is severe and that fishing is unlikely to be sustainable at the current level of effort. Risk level is high.

SPR is less than 25%. The fishery probably over-exploits the stock, and there is a substantial risk that the fishery will cause severe decline of the stock if fishing effort is not reduced. Risk level is high.

Trends in relative abundance by size group for *Variola albimarginata* (ID #62, Epinephelidae), as calculated from linear regressions. The P value indicates the chance that this calculated trend is merely a result of stochastic variance.
% Immature no trend over recent years, situation stable. P: not available
% Large Mature falling over recent years, situation deteriorating. P: not available
% Mega Spawner falling over recent years, situation deteriorating. P: not available
% SPR rising over recent years, situation improving. P: not available

Table 3.1: Values of Indicator in 2015-2016 Length-Based Assessment

#ID	Species	Immature %	Trade Limit Prop. Lmat	Exploitation %imm+%smat	Mega Spawn %	F vs M Ratio	SPR %
36	<i>Saloptia powelli</i>	0.00	1.19	2.33	93.02	0.42	70
37	<i>Cephalopholis miniata</i>	0.00	1.39	5.77	84.62	0.87	57
38	<i>Cephalopholis sexmaculata</i>	0.56	1.34	10.67	81.46	0.38	72
39	<i>Cephalopholis sonnerati</i>	1.92	1.12	19.80	73.85	0.10	86
40	<i>Cephalopholis igarashiensis</i>	0.00	1.40	4.92	86.07	near 0	near 100
41	<i>Epinephelus latifasciatus</i>	7.41	1.04	37.91	45.10	0.27	69
42	<i>Epinephelus radiatus</i>	2.68	0.83	26.76	54.99	0.24	74
43	<i>Epinephelus morrhua</i>	16.40	0.83	70.51	16.14	0.94	30
44	<i>Epinephelus poecilonotus</i>	0.86	0.94	14.22	74.14	near 0	near 100
45	<i>Epinephelus areolatus</i>	0.33	1.37	16.09	68.13	1.37	44
46	<i>Epinephelus bleekeri</i>	0.22	0.85	13.88	75.70	near 0	near 100
47	<i>Epinephelus miliaris</i>	0.00	1.27	3.64	96.36	near 0	near 100
48	<i>Epinephelus bilobatus</i>	0.00	1.21	1.55	96.90	near 0	near 100
49	<i>Epinephelus malabaricus</i>	15.79	0.81	38.95	47.37	near 0	near 100
50	<i>Epinephelus coioides</i>	3.88	0.94	32.50	48.50	0.18	77
51	<i>Epinephelus chlorostigma</i>	4.44	1.12	36.83	41.51	1.04	36
52	<i>Epinephelus retouti</i>	0.00	1.34	8.82	88.24	near 0	near 100
53	<i>Epinephelus heniochus</i>	0.78	1.02	12.27	80.12	near 0	near 100
54	<i>Epinephelus stictus</i>	0.00	1.34	5.45	88.12	near 0	near 100
55	<i>Epinephelus epistictus</i>	8.15	1.34	37.04	57.04	near 0	near 100
56	<i>Epinephelus multinotatus</i>	0.00	1.14	14.29	68.98	0.48	64
57	<i>Epinephelus undulosus</i>	0.00	1.52	2.77	93.28	near 0	near 100
58	<i>Epinephelus amblycephalus</i>	2.18	1.39	22.37	68.92	near 0	near 100
59	<i>Hyporthodus octofasciatus</i>	10.86	0.65	42.29	44.00	0.14	82
60	<i>Plectropomus maculatus</i>	0.00	0.96	0.00	98.68	near 0	near 100
61	<i>Plectropomus leopardus</i>	2.39	1.01	15.90	73.36	0.30	72
62	<i>Variola albimarginata</i>	0.72	1.22	28.85	43.03	1.52	23

Table 3.2: Risk Level in Fisheries by Species and by Indicator for 2015-2016

#ID	Species	Immature	Trade Limit	Exploitation	Mega Spawn	F vs M	SPR
36	Saloptia powelli	low	low	low	low	low	low
37	Cephalopholis miniata	low	low	low	low	medium	low
38	Cephalopholis sexmaculata	low	low	low	low	low	low
39	Cephalopholis sonnerati	low	low	low	low	low	low
40	Cephalopholis igarashiensis	low	low	low	low	low	low
41	Epinephelus latifasciatus	low	medium	low	low	low	low
42	Epinephelus radiatus	low	high	low	low	low	low
43	Epinephelus morrhua	medium	high	high	high	medium	medium
44	Epinephelus poecilnotus	low	medium	low	low	low	low
45	Epinephelus areolatus	low	low	low	low	high	low
46	Epinephelus bleekeri	low	high	low	low	low	low
47	Epinephelus miliaris	low	low	low	low	low	low
48	Epinephelus bilobatus	low	low	low	low	low	low
49	Epinephelus malabaricus	medium	high	low	low	low	low
50	Epinephelus coioides	low	medium	low	low	low	low
51	Epinephelus chlorostigma	low	low	low	low	high	medium
52	Epinephelus retouti	low	low	low	low	low	low
53	Epinephelus heniochus	low	medium	low	low	low	low
54	Epinephelus stictus	low	low	low	low	low	low
55	Epinephelus epistictus	low	low	low	low	low	low
56	Epinephelus multinotatus	low	low	low	low	low	low
57	Epinephelus undulosus	low	low	low	low	low	low
58	Epinephelus amblycephalus	low	low	low	low	low	low
59	Hyporhamphus octofasciatus	medium	high	low	low	low	low
60	Plectropomus maculatus	low	medium	low	low	low	low
61	Plectropomus leopardus	low	medium	low	low	low	low
62	Variola albimarginata	low	low	low	low	high	high

Table 3.3: Trends in Relative Abundance by Size Group and Species Over Recent Years

#ID	Species	% Immature	% Large Mature	% Mega Spawner	% SPR
36	Saloptia powelli	deteriorating	deteriorating	deteriorating	stable
37	Cephalopholis miniata	stable	deteriorating	deteriorating	stable
38	Cephalopholis sexmaculata	deteriorating	deteriorating	deteriorating	improving
39	Cephalopholis sonnerati	improving	improving	improving	improving
40	Cephalopholis igarashiensis	stable	improving	improving	stable
41	Epinephelus latifasciatus	improving	improving	deteriorating	improving
42	Epinephelus radiatus	improving	improving	improving	deteriorating
43	Epinephelus morrhua	improving	improving	improving	improving
44	Epinephelus poecilonotus	deteriorating	deteriorating	deteriorating	stable
45	Epinephelus areolatus	stable	improving	improving	improving
46	Epinephelus bleekeri	stable	deteriorating	deteriorating	deteriorating
47	Epinephelus miliaris	stable	deteriorating	deteriorating	stable
48	Epinephelus bilobatus	stable	deteriorating	deteriorating	stable
49	Epinephelus malabaricus	improving	deteriorating	deteriorating	deteriorating
50	Epinephelus coioides	improving	deteriorating	deteriorating	deteriorating
51	Epinephelus chlorostigma	improving	improving	improving	improving
52	Epinephelus retouti	stable	improving	improving	stable
53	Epinephelus heniochus	improving	improving	improving	stable
54	Epinephelus stictus	deteriorating	improving	improving	stable
55	Epinephelus epistictus	improving	deteriorating	deteriorating	deteriorating
56	Epinephelus multinotatus	stable	improving	deteriorating	deteriorating
57	Epinephelus undulosus	stable	improving	improving	stable
58	Epinephelus amblycephalus	improving	improving	improving	stable
59	Hyporthodus octofasciatus	deteriorating	deteriorating	improving	deteriorating
60	Plectropomus maculatus	stable	deteriorating	deteriorating	stable
61	Plectropomus leopardus	improving	improving	deteriorating	improving
62	Variola albimarginata	stable	deteriorating	deteriorating	improving

4 Discussion and conclusions

Whereas I-Fish generates daily updates of the graphs and conclusions on indicator values by species as presented in this report, it does not provide discussions on overall status and trends in the fisheries. In this chapter, we discuss broad conclusions based on the status on January 25, 2017. Versions of this report generated after January 25, 2017, are based on a mix of data collected before this date as well as data collected thereafter. It is therefore likely that some details presented in this chapter differ somewhat from the more up-to-date values presented in chapter 3.

Overall, the status of deepwater grouper drop line and bottom long line fisheries in central and eastern Indonesia is not as bleak as might be expected for an open-access fishery on valuable species. The impact of these fisheries on groupers in general seems much less than it is on snapper resources which are the main target of these fisheries. Without a doubt, several of the grouper species covered in this report are severely at risk from the impact of other fisheries, in different habitats in Eastern Indonesia, but the impact that can be contributed to the deep slope hook and line fisheries seems limited.

Several of the grouper species that occur in the deep slope fisheries are under severe pressure from shallow-water reef fisheries in our region, mostly by small-scale vessels (less than 5 GT), which are currently unregulated. Recruitment of species that start their life-history on shallow coral reefs to the deeper waters will be severely depressed by intensive shallow-water fisheries. Improvements in fisheries management in shallow water habitats and especially in small scale coastal fisheries, could potentially greatly improve outputs from deeper water fisheries that target groupers among other species.

The indicators for *Plectropomus leopardus*, for example, show a “low” to “medium” level of risk from our target fisheries, whereas it is common knowledge that this species has suffered severe depletion in our region. The relatively low risk level reported here, indicates the impact from deep slope fisheries only. The few *P. leopardus* who survive the extremely high fishing mortality in shallow waters, and who make it to deeper waters, are subject to only moderate exploitation pressure by the deepwater snapper and grouper fishery. A low risk level as indicated in this report refers to the effect of the deepwater dropline and longline fishery only, and a low risk level does not mean that the population as a whole is in good shape.

Some species covered in this report do indicate reasons for serious concern, including for especially *Epinephelus morrhua* and possibly also *Variola albimarginata*. The important species of *Epinephelus morrhua* (2nd most abundant species of grouper in our target fisheries) seems to be highly vulnerable to the deep slope hook and line fisheries and is being caught in relatively high numbers just around its size of female maturation, mostly before reaching the optimum harvesting length. Fishing mortality is very high from the moment this species enters the catch and very few specimen reach lengths anywhere near "mega spawner" size. As is the case for a number of other species, the current trading limit (the minimum size at which traders start paying premium price) is well below the size of female maturation and far below the optimum size for harvesting. The trading limit clearly needs to be increased to improve the status of this species. In general, low trading limits, below size of female maturation, pose a significant potential threat to the status of a large number of species in the deep slope drop line and long line fisheries.

Variola albimarginata shows an extremely low level of SPR, indicating that the potential for recovery of this species has been severely diminished. *Epinephelus morrhua* shows medium to high levels of threat for most indicators. A few other species like *Epinephelus areolatus* show medium to high levels of risk for some of the indicators. Most other species of grouper seem to be impacted only at acceptable levels by the deep slope hook and line fisheries.

The highly productive *E. areolatus* is the most abundant grouper species in the deep slope hook and line fisheries, and it is the number 3 most important species in these fisheries overall. However, for *E. areolatus* most indicators show only low levels of risk, while only F/M risk is high. Fishing mortality is very high once this species enters the catch, but it has already reached optimum harvest size at that time. This species is doing so well because it has a small maximum size and matures at 21 cm total length, spawning and even reaching optimum harvest size before it is seriously impacted by the fisheries.

For most groupers in our target fisheries, the percentage of immature fish in the catch appears to be low, even where risk levels for other indicators are medium to high, and even though juveniles are well within the commercial size range (as can be seen from the number of species showing medium to high risk level in respect to the Trade Limit). This may indicate that the deepwater grouper fishery is not targeting these species in areas where juveniles occur. This finding is consistent with the common tendency among many groupers to inhabit shallower water as juveniles, and move to deeper waters as they grow to a larger size. Note that in the same deep slope fishery, the percentage of immature specimen of Eteline snappers, which complete their life cycle in deeper waters, is much higher (see other I-Fish reports on these fisheries).

For most of the grouper species targeted by the deep slope hook and line fisheries all the above means that regulation of fishing effort in combination with industry agreements on a minimum size may suffice to guarantee sustainable harvesting by these fisheries. Other than that, in order to improve the status of the stocks of these species, fisheries management needs to start dealing with the immense problem of over-fishing by small scale fisheries in shallower coastal waters, where juveniles as well as adults of many species are being decimated.

This report on groupers pools all observations from the entire study area of the TNC Indonesia Fisheries Conservation Program, which means that it does not show differences between fishery management areas (WPPs). However, such differences do exist. For example, the I-Fish reports of WPPs 573, 714-715, and 718 show that the percentage of immature fish in the catch of *Epinephelus morrhua* is highest in WPP 573 (19%), and substantially lower in WPP 714, 715, and 718 (10-11%). The indicators for WPP 573 and WPP 718 suggest that a relatively high number of species are at higher risk in WPP 573 and WPP 718 compared to WPP 714-715. This may be a consequence of a relatively intense fishery in WPP 573, with many fishing vessels concentrating in Indonesian waters around the Sahul banks and the Arafura Sea.

A more detailed analysis is necessary to disentangle the effects of fishing gear and depth of fishing grounds. This report pools data from longliners and dropliners, where longliners tend to fish somewhat shallower waters. Hence, the size compositions in the catch are affected by the relative contribution of each of these two gears.

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