Stock Annex: Thornback ray (*Raja clavata*) in divisions 8.a–b and 8.d (Bay of Biscay)

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Thornback ray (Raja clavata) in divisions 8.a-b and 8.d (Bay of Biscay) (rjc.27.8abd)
Working Group:	Working Group on Elasmobranch Fishes (WGEF)
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A. General

A.1 Stock definition

Based on analyses carried out for WKELASMO (ICES, 2022a) and a genetic analysis (Trenkel *et al*., 2022), it was concluded that thornback ray in divisions 8.abd and thornback ray in Division 8.c (Cantabrian sea) are demographically independent, with only minor flow of individuals. There is further a meta-population structure within the assessment unit 8.abd but assessment at a higher spatial resolution is not practically achievable (Lorance, 2022 WD).

A.2 Fishery

A.2.1 General description

Countries involved:

France and Spain catch the thornback ray in the Bay of Biscay, minor catch are landed by other countries (Belgium and UK).

Spain

The Spanish demersal fishery in ICES divisions 8.abd catches skates and rays using several gears, but most Spanish landings are bycatch of trawl fisheries targeting other demersal species such as hake, anglerfish and megrim. The thornback ray is one of the common rays in these bycatch.

France

Skates and rays are traditional food resources in France, where directed fisheries for skates and rays were known to occur since the 1800s. In the 1960s, skates and rays were primarily taken as bycatch of bottom trawl fisheries operating off the northern part of the Bay of Biscay, the southern Celtic Sea and the English Channel. By this time the thornback ray was seasonally targeted by fisheries, being the dominant skates and rays species landed in France. In the Bay of Biscay, the main ray species in French landings in 2000–2020 was the cuckoo ray (*Leucoraja naevus*), the thornback ray was the second in the landings accounting for about 10% of rays landings and an average 240 tonnes per year in 2010–2019. Placing the species at the 20th rank amongst bentho-demerssal fish species caught by French fleets, France being the main fishing country in ICES divisions 8.abd.

A.2.2 Fishery management regulations

Until 2009 there was no TAC regulation of skates and rays in the Bay of Biscay. Management measures susceptible to impact ray catches were the general regulation on mesh sizes and fishing capacities and effort. From 2009, a TAC for all skates and rays combined was set. In the first years after the introduction of this TAC it was not constraining catches but it became restricting from 2014–2015.

Since 21 March 2017 landing Rajiformes smaller than 45 cm is illegal in France. This regulation generated a change in landing practises with small individuals no longer being landed in contrast to what happened previously.

A.3 Ecosystem aspects

In divisions 8.abd, thornback ray occurs on the offshore shelf down to about 200 m depths and in coastal waters with the Gironde estuary being home to one of the major coastal patches of abundance. Further abundance patches occur along the southern coast of Brittany.

There are few studies describing the interaction of thornback ray in the Bay of Biscay with the ecosystem. Ecosystem aspects are not explicitly included in the assessment. However, possible effects of the environment on the stock productivity would be conveyed by the biomass indicator so that changes in e.g. growth, predation mortality are accounted for implicitly.

B. Data

B.1 Commercial catch

B.1.1 Landings data

International landings data are provided to ICES through Intercatch. Landings (quantities) are considered reliable since 2009. In years prior to 2009, landings were not reported by species and most landings of thornback ray were reported as "skates and rays".

The bulk of landings of thornback ray in divisions 8.abd are from French fleets, landings from Spain represent 10–20% of total landings and landings from other countries are minor.

B.1.2 Discards estimates

The abundance of thornback ray is moderate. Based on the ranking of benthic and demersal fish species from division 8.abd, it was only the 20th species in landings from 8.abd. Therefore most fishing operations recorded in on-board observations have no catch of thornback ray and estimated discards are uncertain or not available for fleets and years where there were not enough observations with catches of the species.

Discards are therefore estimated for blocks of years (2009–2014 and 2015–2020), based on the average levels of discards for the three broad gear categories bottom trawls, nets and lines. These blocks of years were chosen because TACs became restrictive from about 2015, so potentially implying more discards.

Assuming discard survival by gear similar to estimates from the SUMARIS project for the same species in the North Sea and Eastern English Channel (Van Bogaert *et al.*, 2020), estimated dead discard rate were 0.3–2% of total catch and are considered neglible in the assessment (ICES, 2022a).

As a consequence a landings only assessment is carried out.

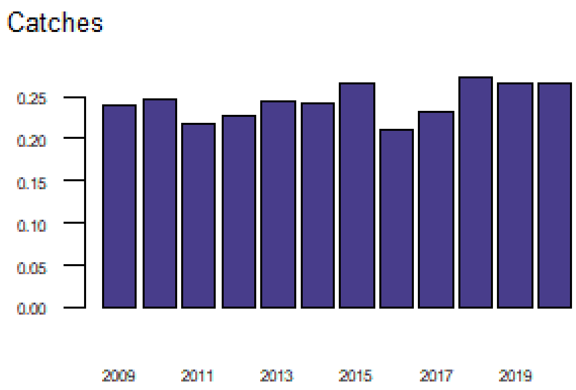

Figure 1. Thornback ray catches from the Bay of Biscay (divisions 8.abd) in thousand tonnes.

B.2 Biological sampling

B.2.1 Maturity, natural mortality and length and age composition

Observed Length and estimated age using growth parameters were used for the close-kin mark-recapture (CKMR) study (Trenkel *et al.*, 2022) included in the assessment (see below) together with a Leslie model derived mortality-at-age and a maturity ogive taken from the literature. Not biologival sampling is used directly in the assessment model.

B.3 Surveys

B.3.1 Survey design and analysis

The biomass index is derived from the EVHOE survey using DATRAS data. Sampling strata are limited to the area where the bulk of catch is made in the commercial fisheries and in the survey. Sampling strata where the species is not caught in the survey or with only occasional catches are excluded. This means that the two largest survey strata are retained (Figure 2).

The biomass index is calculated using a swept area approach where the biomass caught in the area swept by the sampling trawl is raised to the survey area for the two selected strata. Confidendence intervals and the variance of the biomass index are obrtained using a non-parametric data bootstrap conditioning on the total number of hauls in a given year and reassigning resample to the appropriate strata.

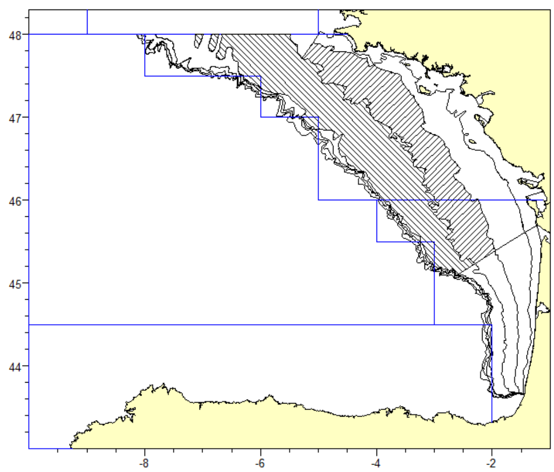

Figure 2. Strata retained in the calculation of the survey index from EVHOE (survey code G9527).

B.3.2 CKMR-derived absolute biomass estimates

Application of the close-kin mark-recapture (CKMR) approach provided absolute abundance estimates for thornback ray in two local populations in the Bay of Biscay, in the Gironde estuary and for the offshore central shelf area (Trenkel *et al.*, 2022). Estimates for the years 2012 to 2015 were considered sufficiently reliable to be used for stock assessment (Figure 3a).

The number of mature individuals in the two local populations was transformed into total biomass in the Bay of Biscay (divisions 8.abd) using the following steps:

1. Raise mature abundance to mature biomass using mean estimated individual weights for mature individuals from the samples used in Trenkel *et al.* (2022): 3.77 kg for females; 2.79 kg for males
2. Raise mature biomass to total biomass for the two local populations based on aged-structured equilibrium simulations: 1.75 conversion factor
3. Raise total biomass in the two local populations to the whole Bay of Biscay (subdivision 8a,b,d) based on the proportion of landings from the two local populations: 1.64 – 2 conversion factors

The resulting total absolute biomass estimates propagating uncertainty in CKMR abundance estimates are shown in Figure 3b.

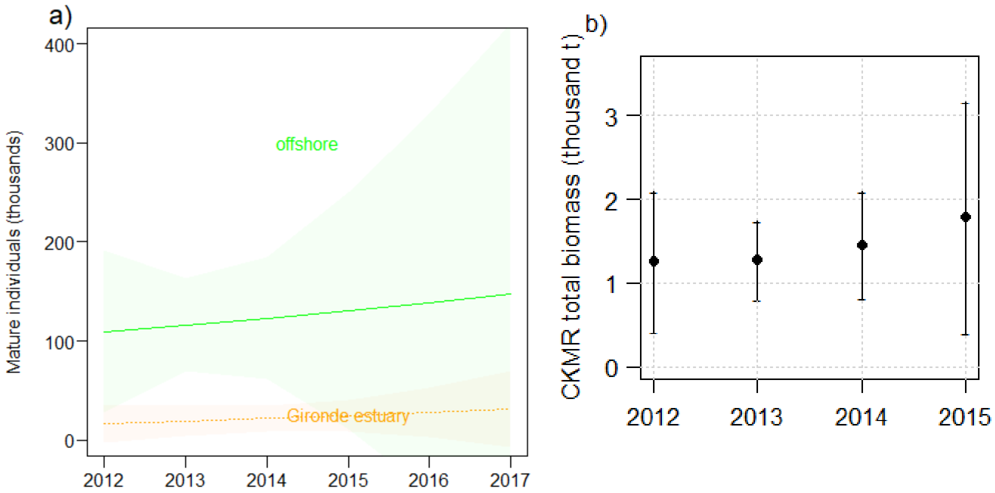

Figure 3. a) CKMR estimated number of absolute mature thornback rays in two subpopulations in the Bay of Biscay (from Trenkel *et al.*, 2022); b) Derived absolute total biomass estimates for thornback ray in the Bay of Biscay (8ab). 95% confidence intervals.

B.4 Commercial CPUE

No commercial CPUE is used for assessment.

B.5 Other relevant data

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C. Assessment methods and settings

C.1 Choice of stock assessment model

Based on the availibity of a survey biomass index, species-specific landings and discard information as well as a Close-Kin Mark-Recapture absolute abundance estimate for a few years (Trenkel *et al.*, 2022), this stock has since 2022 been subject to an analytical assessment and is considered in ICES stock category 2.

C.2 Model used as basis for advice

The Bayesian state-space biomass production model is an extension of the model in Marandel *et al.* (2016). It includes absolute abundance estimates for thornback ray obtained by applying the genetic close-kin mark-recapture (CKMR) approach (Trenkel *et al.*, 2022).

The population dynamics are model as :

$$Y_{t+1} \sim N\left((r+1)Y_t - rY_t^2 - \frac{C_t}{K},\ \ \sigma^2\right) \tag{1}$$

$$Y_t = \frac{B_t}{K}$$

where Y_t is the relative biomass in year t, σ^2 the process variance for relative biomass, B_t absolute biomass, r intrinsic growth rate, K carrying capacity and C_t landings.

Two data sets are used for model fitting. Survey derived biomass indices I_t are modelled by a normal distribution

$$I_t \sim N(qB_t, \tau_t^2) \tag{2}$$

where q is survey catchability τ_t^2 the variance of the biomass index in year t.

The CKMR abundance estimate for thornback ray is transformed into biomass $CKMR_t$ as explained above, which is then modelled as:

$$CKMR_t \sim N(q_{ckmr}\ B_t, \varepsilon_t^2) \tag{3}$$

where ε_t^2 is the estimated variance for the CKMR biomass estimate in year t. The catchability coefficient q_{ckmr} is set to 1 as the CKMR index is assumed to be absolute. Note that, a test run was carried out during WKELASMO for which q_{ckmr} was estimated. The q_{ckmr} .estimated in this run was not significantly diferent from 1.

The model is fitted using a Bayesian approach. Information on prior distributions is summarised in Table 1. An informative prior was created for intrinsic growth rate r using life history parameters (McAllister *et al.*, 2001) while an uninformative prior was used for carrying capacities K (see description in Marandel *et al.*, 2016). The prior for the process variance σ^2 was chosen to be moderately informative while the observation variances (τ_t^2 for biomass indices and ε^2 for CKMR estimates) were assumed known (Table 2). For the EVHOE index, the survey CV was fixed for all years at 0.3. This was the largest value that would allow satisfactory convergence of the model. In the future with more data, it might become possible to use larger CV values. For survey catchabilities q the prior had most mass <0.5, for this Beta(1,3) was used. In the test run estimating q_{ckmr}, an informative prior centred on 1 was used: $q_{ckmr} \sim N(1, 0.1^2)$.

Table 1: Prior distributions for process model (eq. 1 & 3). K is in tonnes.

R~BETA MODE, SD	$YINIT$~BETA MODE, SD	K~UNIFORM MIN,MAX	$1/\varepsilon^2$~GAMMA MODE, SD
0.105, 0.05	0.4, 0.10	20, 250 000	400,1

Y_{init} is the relative biomass at the start of the time-series, corresponding to the initial, i.e. 2009, B/B_{MSY}.

C.3 Assessment model configurations

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes	2009–last data year	all	Yes
Biomass index	Biomass index from EVHOE survey	2009–last data year	all	Yes
Biomass index	Absolute biomass index derived for CKMR	2012–2015	all	Yes

D. Short-Term Projection

Model used: Bayesian production model

Software used: Tailor made code in R

Initial stock size: total biomass at the start of the first years of forecast, assuming F = Fsq in the intermediate year.

Short-term prediction is carried for two years as the advice for this stock is biennial. The catch in the intermediate year (assessment year) is assumed to correspond to Fsq, fishing mortality in the last year with data (year prior to assessment year).

For the two years of forecast, the catch is projected under several scenarios:

1. MSY approach (catch 35th percentile of predicted catch distribution under F = F_{MSY})
2. F = F_{MSY}: standard scenario presented for all stocks in ICES categories 1 and 2
3. F = Fsq

4. Catch = 20th percentile of predicted catch distribution under F = F_{MSY}
5. Catch = 10th percentile of predicted catch distribution under F = F_{MSY}
6. F = 0

Scenario 1 is the standard scenario for ICES category 2 stocks according to the ICES approach to advice on fishing opportunities (ICES, 2022b). Scenarios 2, 3 and 6 are other scenarios presented for all ICES category 2 stocks. Scenarios 4 and 5 were added in WGEF 2022 for all stocks assessed in ICES category 2 following the benchmark WKELASMO (ICES, 2022a) because for some of these, the advised catch was much larger than previous advices given under the precautionary approach and it was decided to present a larger range of option to managers.

E. Medium-Term Projections

No medium-term prediction is carried out for this stock

F. Long-Term Projections

No long-term prediction is carried out for this stock

G. Biological Reference Points

	Type	Value	Technical basis
MSY Approach	MSY $B_{trigger}$	0.5 Bmsy=0.25 K t	Relative value. B_{MSY} is estimated directly from the assessment model and changes when the assessment is updated
MSY Approach	F_{MSY}	r/2	Relative value. *r* is estimated directly from the assessment model and changes when the assessment is updated
Precautionary Approach	B_{lim}	0.3 x B_{MSY} t	Relative value. (equilibrium yield at this biomass is 50% of MSY)
Precautionary Approach	B_{pa}	Not defined	**
Precautionary Approach	F_{lim}	1.7 F_{MSY}	Relative value (the F that drives the stock to B_{lim})
	F_{pa}	Not defined	**

**** Bpa and Fpa are not defined. The assessment provides probability distributions for B and F, so it is possible to directly estimate the probabilities of B<Blim and of F>Flim.**

H. Other Issues

H.1 Biology of species

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H.2 Stock dynamics, regulations in 20th century – historic overview

There was not regulation in the 20th century. Historical catch data are unreliable. Catch data before 2009 were considered poorly reliable because of mostly landings of skates and rays not being reported species-by-species.

H.3 Current fisheries

Catches from this stock are mainly bycatch from several fisheries in the stock area although some directed catch occur in particular with net and longlines.

H.4 Management and advice

There is no stock-specific management. The advice for the stock is combined with the advice for other stocks of skates and rays in subareas 8 and 9 to derive the TAC of skates and rays in union waters of 8 and 9(SRX/89-C.). Advice for skates and rays stocks in subareas 8 and 9 is delivered every second year and the new TAC is calculated as the previous TAC multiplied by the average of the advice change for all skates and ray stocks of the two subareas.

H.5 Others (e.g. age terminology)

H.5.1 Complements on survival

In addition to studied from which assumptions on survival are derived to estimate dead removals corresponding to discards, other studies also suggest high survival. Categorical vitality assessment (CVA) after capture in trammelnet fisheries in Division 9.a showed generally high vitality of thornback ray with 92% to 100% of specimens caught after soak time < 24h in Excellent condition. These percentage fell to 52% to 72% in hauls longer than 24h (Serra-Pereira and Figueiredo, 2019 WD). Experiments conducted in 2018 during PTGFS-WIBTS-Q4 and PT-CTS (UWTV (FU 28–29)) surveys to collect CVA and short-term survival estimates of *R. clavata* caught by otter trawl resulted in 60–72% of specimens categorized in Excellent or Good conditions (60–72%), with at-vessel-mortality of 6–7%. The preliminary estimated survival, based on captivity observations of *R. clavata* during a maximum of 4 days, was 64%.

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