EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR MARITIME AFFAIRS AND FISHERIES

Directorate C: Fisheries Policy Atlantic, North Sea, Baltic and Outermost Regions
Unit C3: Scientific Advice and Data Collection

Call MARE/2020/08
Grant Agreement SI2.839815

Streamlining the establishment of regional work plans in the Mediterranean and Black Sea

STREAMLINE

European Maritime and Fisheries Fund (EMFF)
WP2 – Filling information gaps

Task 2.1 Sampling design optimization in all the metiers, including SSF, and identification of sampling hierarchy

Deliverable D2.1 – Reports of the workshops and results of sampling design optimization for selected case studies

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1. EXECUTIVE SUMMARY

This document, Deliverable D2.1 “Reports of the workshops and results of sampling design optimization for selected case studies”, describes the activities performed and the results achieved under Task 2.1 “Sampling design optimization in all the metiers, including SSF, and identification of sampling hierarchy” of the STREAMLINE project.
One training workshop was organized online (Microsoft Teams) on 29th November – 1st December 2021, and was attended by 36 experts from nine EU Member States of the Mediterranean and Black Sea. The Workshop was chaired by Isabella Bitetto (COISPA, Italy), Task 2.1 Leader, in cooperation with Alessandro Ligas (CIBM, Italy), STREAMLINE Coordinator.
The workshop opened with a general overview of the main objectives of the STREAMLINE regional grant and the strict cooperation with the RCG Med&BS activities with the common target of achieving the expected results of coordinated regional work for the fisheries data collection in the Mediterranean and Black Seas. The training activity started from an overview of the sampling optimization tools with a description of the new features to be developed under STREAMLINE project. The main objective of this training was to allow the experts to familiarize with the tools utilizing a dummy dataset. After the presentation of each script, specific sessions were dedicated to the individual work on the codes; during these sessions clarifications were asked by the participants and the answers were given in plenary.
Taking into consideration the experience gained in the previous grants, and criteria such as the relevance of the stocks/fisheries, data availability and enforcement of multi-annual management plans, four case studies were identified and a reference group of experts were also identified for each case study.
In the following months, specific quality checks on the datasets to be utilized for the four case studies were carried out in preparation of the optimization analysis.
Then, a series of virtual meetings by case study were organized during the 2022 in order to support experts in carrying out the optimization and the simulation of alternative sampling design scenarios.
Preliminary results for each case study, including an idea of the possible change of sampling costs associated to alternative sampling designs, were presented during the RCG annual meeting in September 2022 and the feedback of the national correspondents were collected to be considered in the finalization of the analyses.
Finally, the results of the four case studies, summarized in this deliverable, were finalized and shared among the National Correspondents in order to be taken into consideration for the draft non-binding Regional Work Plans.

2. INTRODUCTION

Task 2.1 has been focusing on the sampling design optimization in the metiers relevant in the study areas, including SSF.
This task has been aimed at:

- The generalization of the SDTool and BioSimTool originally developed in the STREAM project (Ligas, 2019). In particular, an upgrade of the SDTool was carried out to allow to take into account a different number of positive trips for each species included in the case study. Moreover, additional quality indicators, focusing on the variability of the corresponding relevant estimates (e.g. von Bertalanffy parameters, size at first maturity, modes, anti-modes, amplitude ratio) have been included in BioSim Tool.
- Application of SDTool and BioSim Tool to the four selected case studies to provide a set simulations on alternative sampling design scenarios widely discussed with the experts of the study areas to support the drafting of the Regional Work Plans for the Mediterranean and Black Sea.

3. OUTCOMES OF THE TRAINING WORKSHOP

Under STREAMLINE Task 2.1, a training workshop on sampling design optimization R tools met online from the 29th November to the 1st December 2021, and was attended by 36 experts from nine EU Member States of the Mediterranean and Black Sea. The Workshop was chaired by Isabella Bitetto (COISPA, Italy), Task 2.1 Leader, in cooperation with Alessandro Ligas (CIBM, Italy), STREAMLINE Coordinator.

The training activity started with a presentation by Ms Bitetto providing an overview of the sampling optimization tools with a description of the new features foreseen under STREAMLINE project. The main objective of this training was to allow the experts to familiarize with the tools utilizing a dummy dataset. To facilitate the use of the scripts and avoid conflict problems due to the use of the *knitr* package, the SDTool scripts have been extracted from the .Rmd.

SD Tool was implemented for the first time within MARE/2014/19 Med&BS project and further improved within STREAM project (MARE/2016/22). This tool allows, through bootstrap technique, to resample the historical data studying the Coefficient of Variation (CV), the raised LFDs and the Earth Mover Distance (EMD) for different stratifications (spatial, temporal, and technical) in association with the number of primary sampling units (i.e. trips) for a set of species.

The SD Tool v.2 includes options allowing a flexible definition of the sampling scheme. The optimization can be carried out on:

- different technical stratifications, introducing options to define the technical strata on the basis of gear (level 4) and/or metier, grouping strata with similar characteristics;
- different temporal aggregations, in order to make flexible the stratification by quarter and/or semester, depending on fisheries and target species specifications;
- different spatial aggregations, grouping data of stocks considered shared among MSs in order to get results on the whole area of the stock (not only by GSA).

The statistical principle behind the SDTool is represented by the CV decreasing curve, when increasing the number of sampling units. This curve is, firstly, interpolated and, secondly, the part of the curve where the tangent changes and begins to flatten (i.e. the curvature range) is considered as a suitable trade-off between the precision and the sampling effort. Then, the sample size (in term of sampling units) corresponding to that part of the curve is proposed as “optimal” sample size.

BioSim Tool was implemented for the first time within STREAM project (MARE 2016/22), taking advantage of the work carried out by ICES WKBIOPTIM. This tool allows, through bootstrap technique as well, to resample the historical data studying the Coefficient of Variation (CV) and the Earth Mover Distance (EMD) and to derive possible sub-samples to be applied on length measurements. Moreover, an optimal number of individuals to be sampled for sex, maturity and age (the latter stratified by length class) by species can be derived.

The new developments foreseen under STREAMLINE projects are mainly represented by the implementation of additional quality indicators to the ones developed and tested in STREAM taking into account the work carried out in the ICES WKBIOPTIM3 and the work by Wischnewski et al. (2020). The new indicators are:

- Admissible dissimilarity Value (ADV), as a measure of sampling reliability based on the comparison of the modes, anti-modes and amplitude of the LFDs under different sampling scenarios;
- Mean length-at-age, mean age-at-length, parameters of the von Bertalanffy growth model, maturity ogive parameters, root mean squared prediction error (RMSPE), mean squared prediction error (MSPE) and the mean average percentage error (MAPE), to evaluate the variability of the relevant estimates (e.g. von Bertalanffy parameters, size at first maturity) under different scenarios and to identify a satisfactory sub-sampling strategy.

The technical requirements are:

- R version 3.6.3, due to the use of COST packages;
- libraries: Fishpifct, COSTcore, COSTdbe, COSTeda and data.table.

A detailed presentation of each step needed to run the scripts implemented in **SDTool** was made:

1. *Data preparation*: transformation of the data from the RCG format to the COST objects (CS and CL, for the SDTool) and to the SDEF tables (CA, HH, HL, SL, TR, CL) (for BioSim Tool); this step is carried out through the two scripts: Conversion from RCG CS to CS cost object and Conversion from RCG CL to CL cost object.
2. *InvestigateData* script: it provides information on the temporal, spatial and technical coverage of the dataset.
3. *RunOptimizationBYspecies* script: it allows to find the optimal range in terms of number of trips for each defined stratum on the basis of the density kernel function.
4. *RunScenario* and *RunEvaluation* scripts: allow to simulate different sampling designs and to evaluate the impact on precision and on LFDs respect to the baseline.

Similarly, a detailed presentation of each script implemented in **BioSimTool** was made:

1. *Data preparation*: transformation of the CA and HH SDEF tables in the format required by BioSim in Rdata format.
2. B_data_simulation_LENGTH script: it allows to derive an optimal number of length measurements for each defined stratum without significantly losing in precision (e.g.CV);
3. B2_calculate_subsample script: allows to estimate a subsample factor to be used in the *RunScenario*script of SDTool, to simulate scenarios involving the sub-sampling;
4. C_data_simulation_MATURITY: allows to derive an optimal number of maturity data to be collected without significantly losing in precision (e.g. ogive CV);
5. D_data_simulation_SEX-RATIO: allows to derive an optimal number of sex data to be collected without significantly losing in precision (e.g. sex ratio CV);
6. E_data_simulation_AGE: allows to derive an optimal number of age data per length class to be collected without significantly losing in precision (e.g. ALK CV).

After the presentation of each script, specific sessions were dedicated to the individual work on the codes; during these sessions clarifications were asked by the participants and the answers were given in plenary. Moreover, some results of the individual exercises (e. g. different sampling scenarios results) were shown by the participants to the whole group and the interpretation of them were discussed and clarified.

An overview of the a priori quality check script, developed in STREAM under WP6, to verify the consistency of the detailed data, was also provided by Ms IB. These quality checks should be carried out before starting to work on the case studies.

A plenary discussion took place on the identification of the case studies to be implemented under STREAMLINE and to be presented to the RCG Med&BS as possible regional work plans on commercial fisheries (including SSFs) in the Mediterranean and Black Seas.

Taking into consideration the experience gained in the previous grants, and criteria such as the relevance of the stocks/fisheries, data availability and enforcement of multi-annual management plans, the following case studies were identified:

Case Study n.	GSAs	Countries	Stocks	Fisheries
1	**29**	Bulgaria, Romania	*Sprattus sprattus, Scophthalmus maximus*	PTM, GNS
2	**1-2-5-6-7**	Spain, France	*Aristeus antennatus, Merluccius merluccius, Parapenaeus longirostris*	OTB_DES, OTB_MDD, OTB_DWS, LLS, GNS
3	**17-18**	Croatia, Italy, Slovenia	*Merluccius merluccius, Mullus barbatus, Nephrops norvegicus, Parapenaeus longirostris, Solea solea*	OTB_DES, FPO, TBB, GNS, GTR, LLS
4	**17-18**	Croatia, Italy, Slovenia	*Engraulis encrasicolus, Sardina pilchardus*	PTM, PS

This list was provided to the RCG Med&BS for their consideration and final approval.

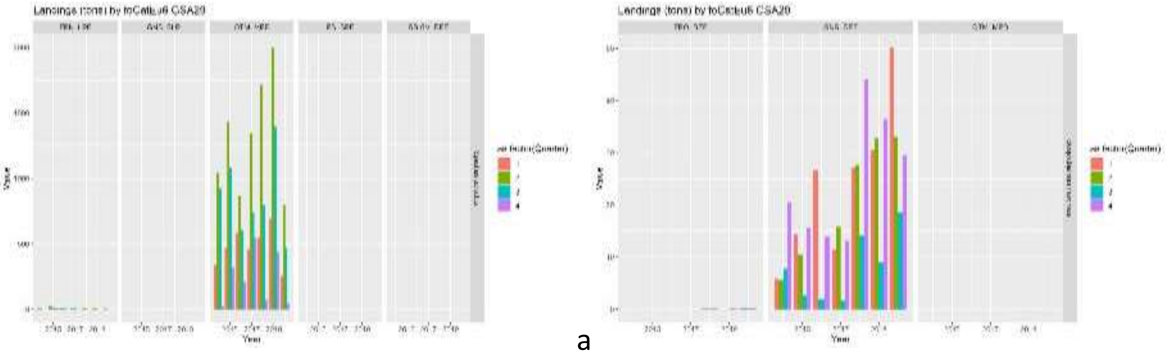
4. RESULTS OF THE FOUR CASE STUDIES

The analyses for the four case studies were performed by national experts with the support of Task 2.1 leader, Isabella Bitetto. The work was done both offline and through the organization of online workshops and meetings in the period March-September 2022.

4.1 CASE STUDY 1

DATA AVAILABILITY AND EXPLORATION

In the Black Sea (GSA 29), the species *Sprattus sprattus* (SPR) and *Scophthalmus maximus* (TUR) are mainly exploited respectively by the OTM and GNS métiers. The dataset provided by Bulgaria and Romania included data for both stocks for the two métiers. In addition, the métier FPN_LPF, targeting *S. sprattus*, was present in Romania (Figure 4.1.1). Although not originally included in the case study, also this métier was considered.



a b

Figure 4.1.1 – *S. sprattus* (a) and *S. maximus* (b) in GSA 29. Landings by year, quarter and Fishing activity category European lvl 6.

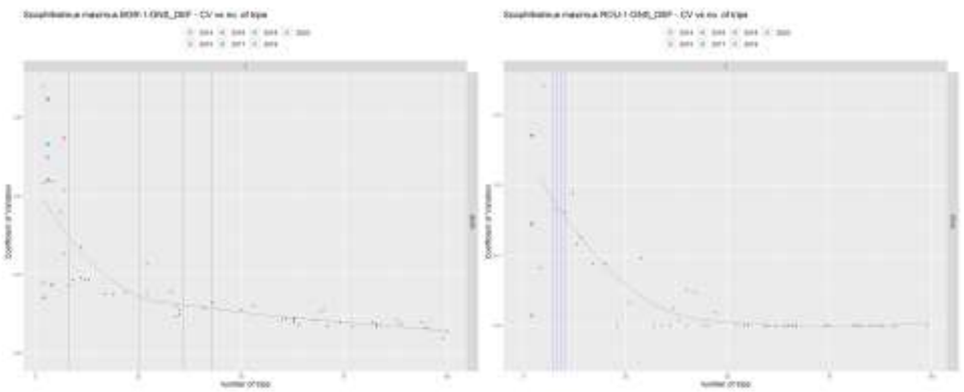
OPTIMIZATION RESULTS

The “optimal” sampling size was calculated through the 05_runOptimizationBYspecies.Rmd script from the SD Tool. The analysis was based on the calculation of the CV associated to raised LFDs of a given species per year and per métier (Tab. 4.1.1). The CVs versus the number of trips are shown in Fig. 4.1.1, where vertical blue lines are referred to the first 4 local maxima of the density kernel function, used to derive the optimal sampling size range based on the historical sampling data and expert knowledge. Only the species characterizing the fishery were reported.

The results showed that *S. maxima* was every year under-sampled, whilst *S. sprattus* was in an optimal range or slightly under-sampled several years; in FPN_LPF, it was under-sampled every year.

Table 4.1.1 – Solutions (trips) of the optimization algorithm

Species	Var1	Var3	solutions	maxCV	minCV	maxRR	minRR	meanRR	noIterations
SPR	BGR	OTM_MPD	10	0.49	0.16	0.11	0	0.03	7
SPR	BGR	OTM_MPD	17	0.29	0.11	0.24	0.06	0.15	6
SPR	BGR	OTM_MPD	34	0.22	0.11	0.24	0.06	0.15	13
SPR	BGR	OTM_MPD	40	0.17	0.15	0.25	0.18	0.22	2
SPR	ROU	FPN_LPF	5	0.16	0.16	0.4	0	0.2	2
SPR	ROU	FPN_LPF	12	0.25	0.11	0.42	0.22	0.3	6
SPR	ROU	FPN_LPF	13	0.13	0.09	0.46	0.38	0.42	2
SPR	ROU	OTM_MPD	29	0.42	0.11	0.33	0	0.18	11
SPR	ROU	OTM_MPD	37	0.12	0.08	0.35	0.25	0.31	3
SPR	ROU	OTM_MPD	42	0.16	0.09	0.42	0.39	0.4	3
SPR	ROU	OTM_MPD	>42	0.13	0.05	0.66	0.4	0.56	32
TUR	BGR	GNS_DEF	8	0.68	0.17	0.43	0	0.09	8
TUR	BGR	GNS_DEF	25	0.27	0.15	0.41	0	0.26	8
TUR	BGR	GNS_DEF	36	0.23	0.09	0.48	0.33	0.42	7
TUR	BGR	GNS_DEF	43	0.13	0.11	0.54	0.44	0.5	3
TUR	ROU	GNS_DEF	8	0.16	0.16	0.38	0.38	0.38	1
TUR	ROU	GNS_DEF	10	0.16	0.16	0.3	0.3	0.3	1



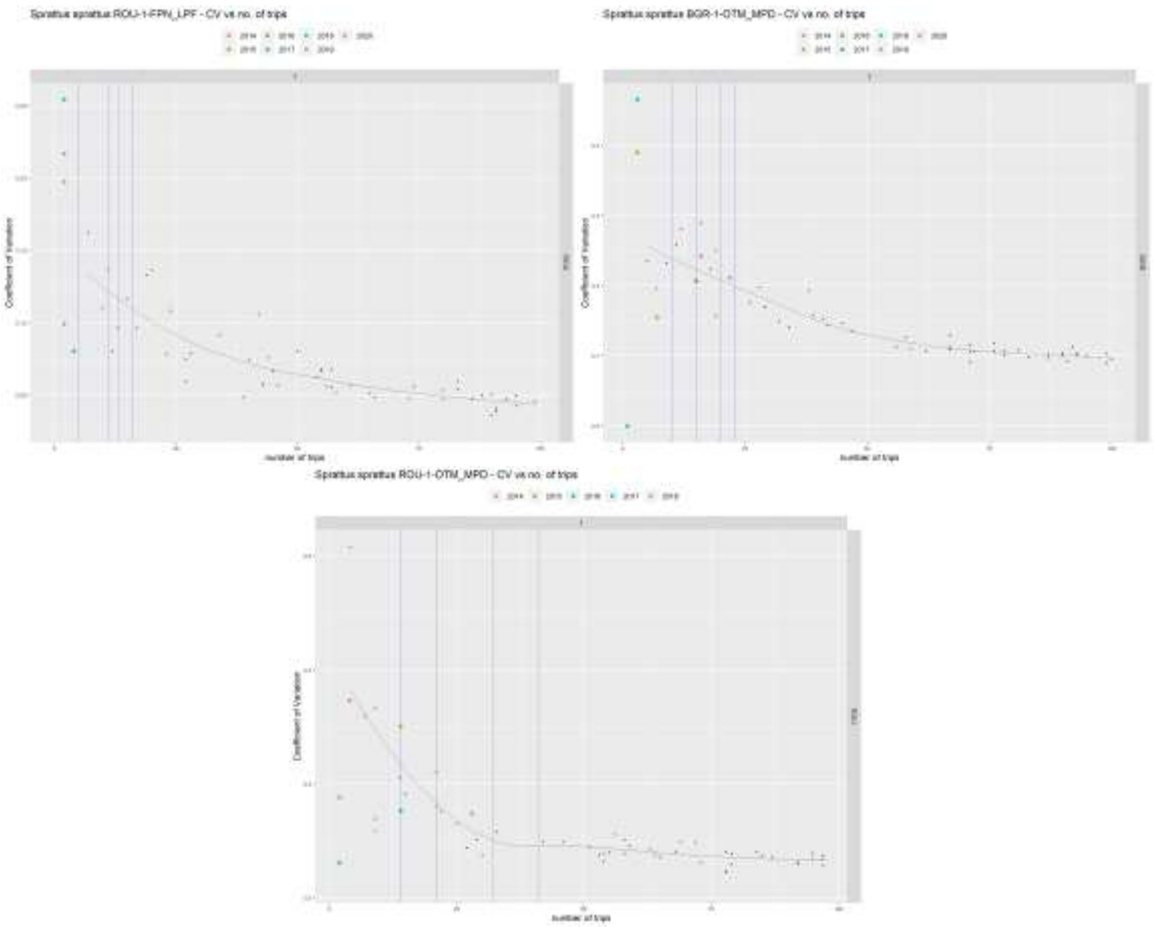


Figure 4.1.2 – CV versus number of trips for Case study 1. Vertical blue lines are referred to the optimal sampling size range inferred via the method.

SCENARIOS DESIGN

When analyzing the solutions derived from optimization results, the experts of the study area decided to explore the following scenarios, corresponding to an increase of the number of trips respect to the current Work Plan (indicated as Baseline; Tab. 4.1.2). Moreover, a scenario characterized by the decrease of the number of individuals against the increase of the number of trips (based on a subsample of ½ applied only to samples with more than 30 specimens) was explored.

Table 4.1.2 – Sampling design for the Case Study 1.

Country	Métier	Scenario	n. of trips
BGR	GNS_DEF	Baseline	8
BGR	GNS_DEF	Scenario 1	12
BGR	GNS_DEF	Scenario 2	20
BGR	GNS_DEF	Scenario 2 + subsampling	20
BGR	OTM_MPD	Baseline	10
BGR	OTM_MPD	Scenario 1	12
BGR	OTM_MPD	Scenario 2	16
BGR	OTM_MPD	Scenario 2 + subsampling	16
ROU	FPN_LPF	Baseline	11
ROU	FPN_LPF	Scenario 1	13
ROU	FPN_LPF	Scenario 2	15

Country	Métier	Scenario	n. of trips
ROU	FPN_LPF	Scenario 2 + subsampling	15
ROU	GNS_DEF	Baseline	8
ROU	GNS_DEF	Scenario 1	9
ROU	GNS_DEF	Scenario 2	10
ROU	GNS_DEF	Scenario 2 + subsampling	10
ROU	OTM_MPD	Baseline	14
ROU	OTM_MPD	Scenario 1	16
ROU	OTM_MPD	Scenario 2	20
ROU	OTM_MPD	Scenario 2 + subsampling	20

SCENARIOS RESULTS

The results on the Case Study 1 are reported in Table 4.1.3. The increase in the number of trips improved the CV in all cases. Specifically, for *S. maximus* and *S. sprattus* in Romania, the increase of the number of trips would be counter-balanced by the decrease of the number of specimens' measures. This could potentially impact the sampling costs.

Tab. 4.1.3 – Final results in terms of CV by species, country and métier.

species	Country	Métier	scenario	CV	n. of trips	No indiv	% change trips	% change lengths
S. sprattus	BGR	OTM_MPD	Baseline	26.9	10	3096		
S. sprattus	BGR	OTM_MPD	Scenario1	24.8	12	3961	20%	28%
S. sprattus	BGR	OTM_MPD	Scenario2	21.9	16	5224	60%	69%
S. sprattus	BGR	OTM_MPD	Scenario2_subsample	34.4	16	2517		-19%
S. sprattus	ROU	FPN_LPF	Baseline	13.4	11	22600		
S. sprattus	ROU	FPN_LPF	Scenario1	11.7	13	26217	18%	16%
S. sprattus	ROU	FPN_LPF	Scenario2	11.4	15	31344	36%	39%
S. sprattus	ROU	FPN_LPF	Scenario2_subsample	11.4	15	15268		-32%
S. sprattus	ROU	OTM_MPD	Baseline	17.6	14	5438		
S. sprattus	ROU	OTM_MPD	Scenario1	17.5	16	5745	14%	6%
S. sprattus	ROU	OTM_MPD	Scenario2	14.7	20	7604	43%	40%
S. sprattus	ROU	OTM_MPD	Scenario2_subsample	14.6	20	3870		-29%
S. maximus	BGR	GNS_DEF	Baseline	28.9	8	444		
S. maximus	BGR	GNS_DEF	Scenario1	22.7	12	794	50%	79%
S. maximus	BGR	GNS_DEF	Scenario2	18.3	20	1255	150%	58%
S. maximus	BGR	GNS_DEF	Scenario2_subsample	42.9	20	712		60%
S. maximus	ROU	GNS_DEF	Baseline	21.1	8	1249		
S. maximus	ROU	GNS_DEF	Scenario1	19.5	9	1399	13%	12%
S. maximus	ROU	GNS_DEF	Scenario2	18	10	1527	25%	22%
S. maximus	ROU	GNS_DEF	Scenario2_subsample	20.7	10	742		-41%

4.2 CASE STUDY 2

DATA AVAILABILITY AND EXPLORATION

Aristeus antennatus (ARA) in the Western Mediaterranean Sea (GSAs 1, 2, 5, 6 and 7) is only exploited by the OTB métiers in the Spanish area; *Merluccius merluccius* (HKE) is exploited by the OTB métiers in both Spanish (GSAs 1, 2, 5, 6 and 7) and French area (GSA 7), by LLS in the Spanish area (GSAs 6 and 7) and by GNS in the Spanish area (GSA 6). *Mullus barbatus* (MUT) caught by OTB_DEF was also included in the analysis for the Spanish areas (GSAs 1, 5, 6 and 7) and for the French area. *Parapenaeus longirostris* (DPS) and *Nephrops norvegicus* (NEP) are exploited by the OTB_DEF in the Spanish area (GSAs 5, 6 and 7) (Figures 4.2.1 a-g).

Some data were considered not robust and were excluded from the analysis, in the Spanish area: *N. norvegicus* for OTB_DEF in the GSA 2, for OTB_DWS in the GSAs 1, 2, 5, 6 and 7, for OTB_MDD in the GSA 5; *P. longirostris* for OTB_DWS in the GSAs 5, 6 and 7, for OTB_MDD in the GSA 5; *M. merluccius* caught for OTB_DWS and OTB_MDD in the GSA 6. In the French area data excluded were: *M. merluccius* caught by GNS and LLS; *M. barbatus* caught by GNS; *N. norvegicus*, *A. antennatus* and *P. longirostris*.

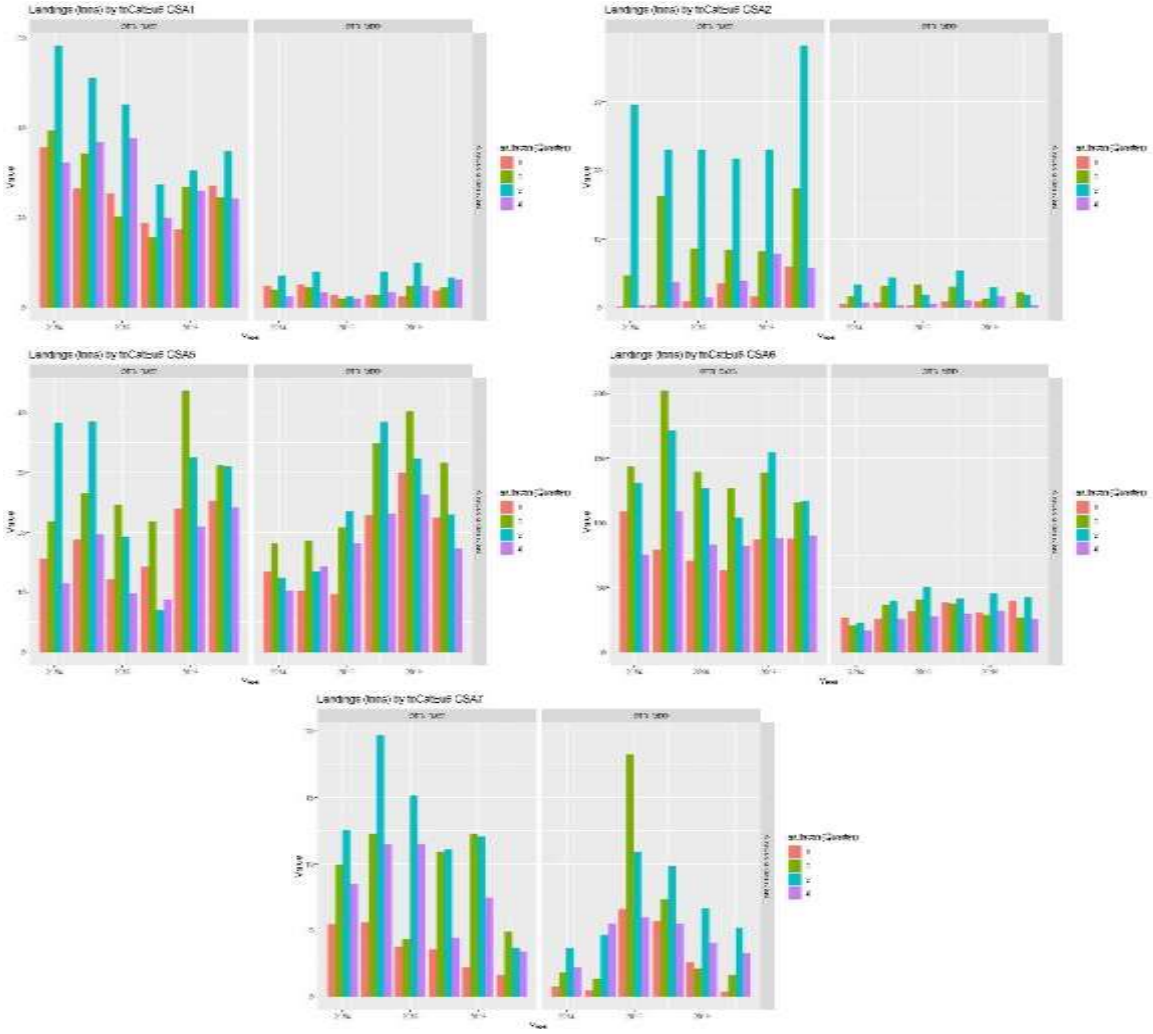


Figure 4.2.1 a – *A. antennatus* in GSAs 1, 2, 5, 6 and 7 (Spanish area). Landings by year, quarter and Fishing activity category European lvl 6.

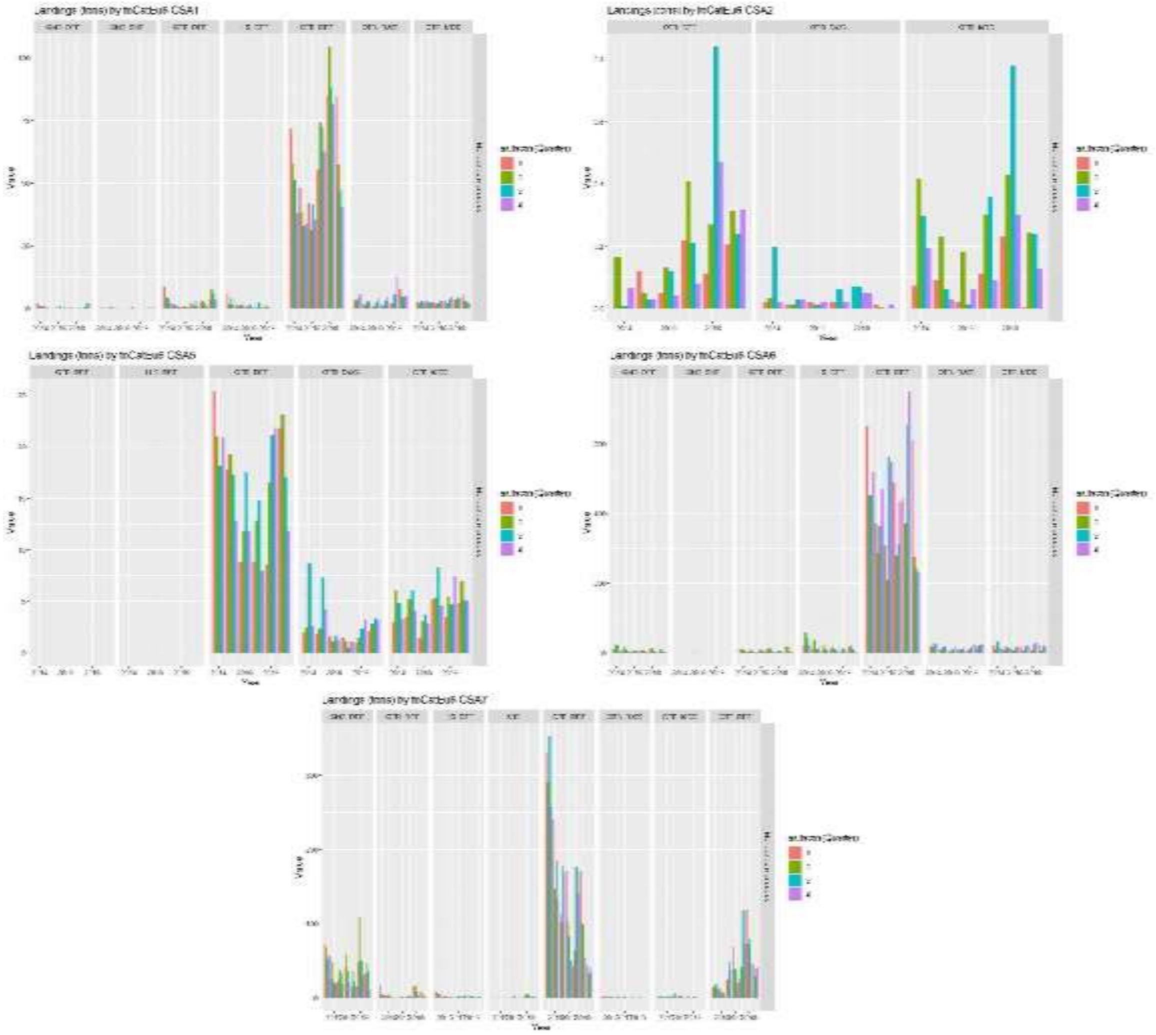


Figure 4.2.1 b – *M. merluccius* in GSAs 1, 2, 5, 6 and 7 (Spanish area). Landings by year, quarter and Fishing activity category European lvl 6.

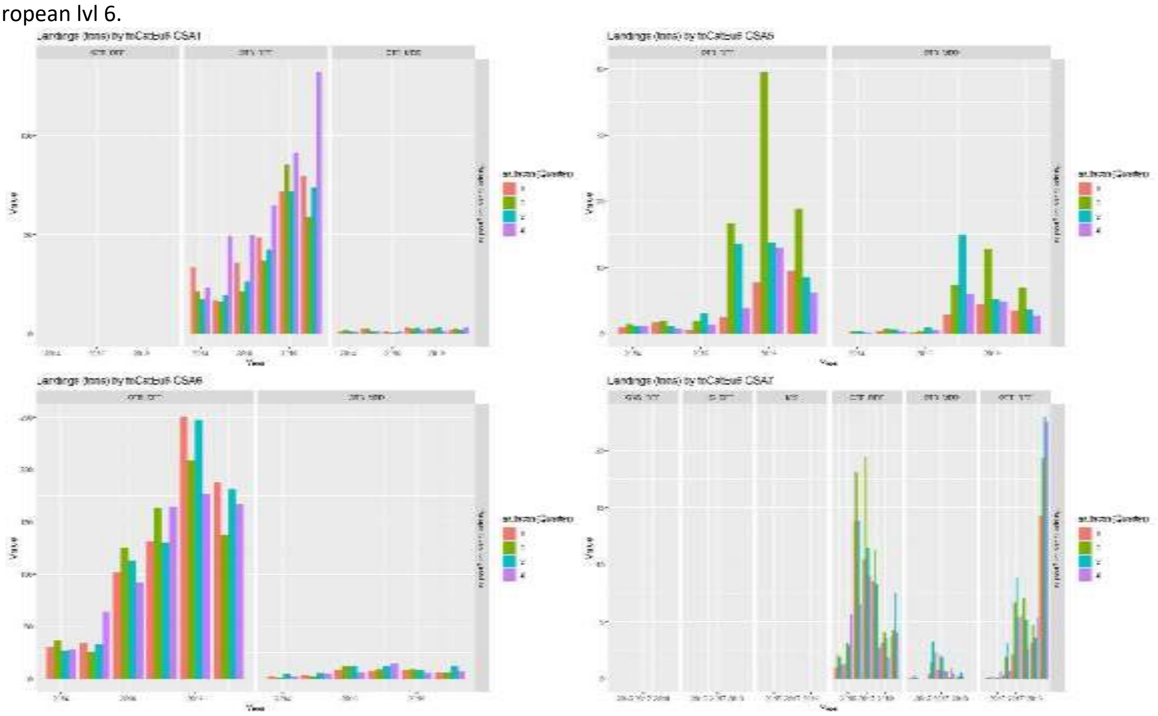


Figure 4.2.1 c – *P. longirostris* in GSAs 1, 5, 6 and 7 (Spanish area). Landings by year, quarter and Fishing activity category European lvl 6.

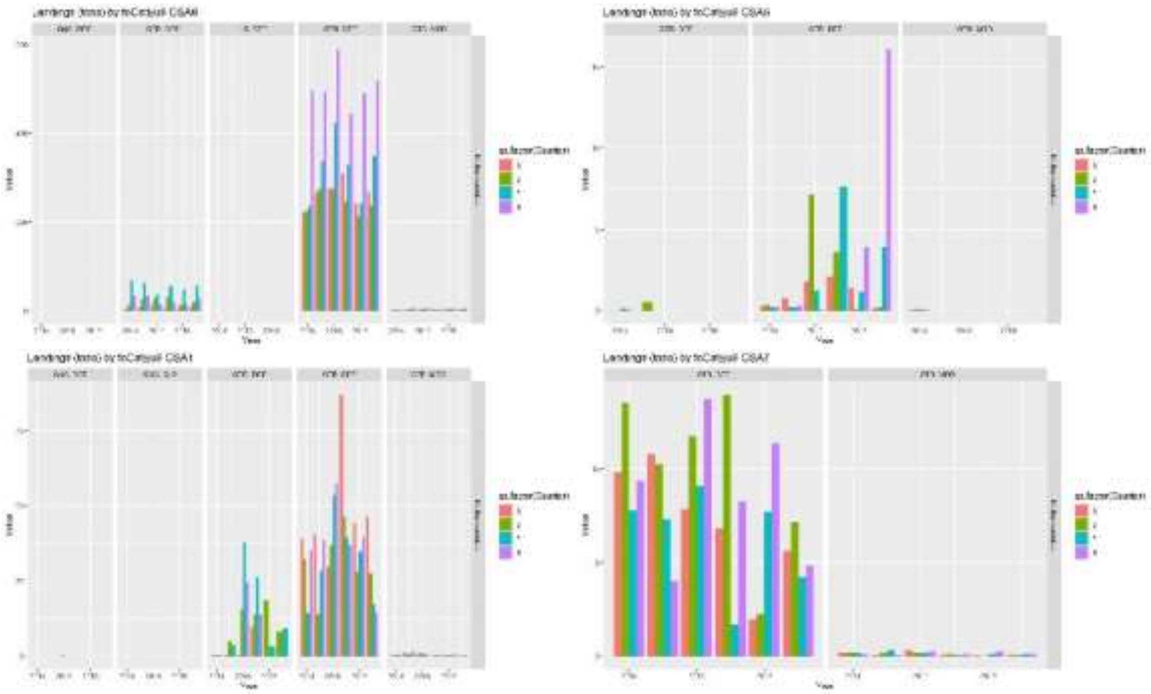


Figure 4.2.1 d – *M. barbatus* in GSAs 1, 5, 6 and 7 (Spanish area). Landings by year, quarter and Fishing activity category European lvl 6.

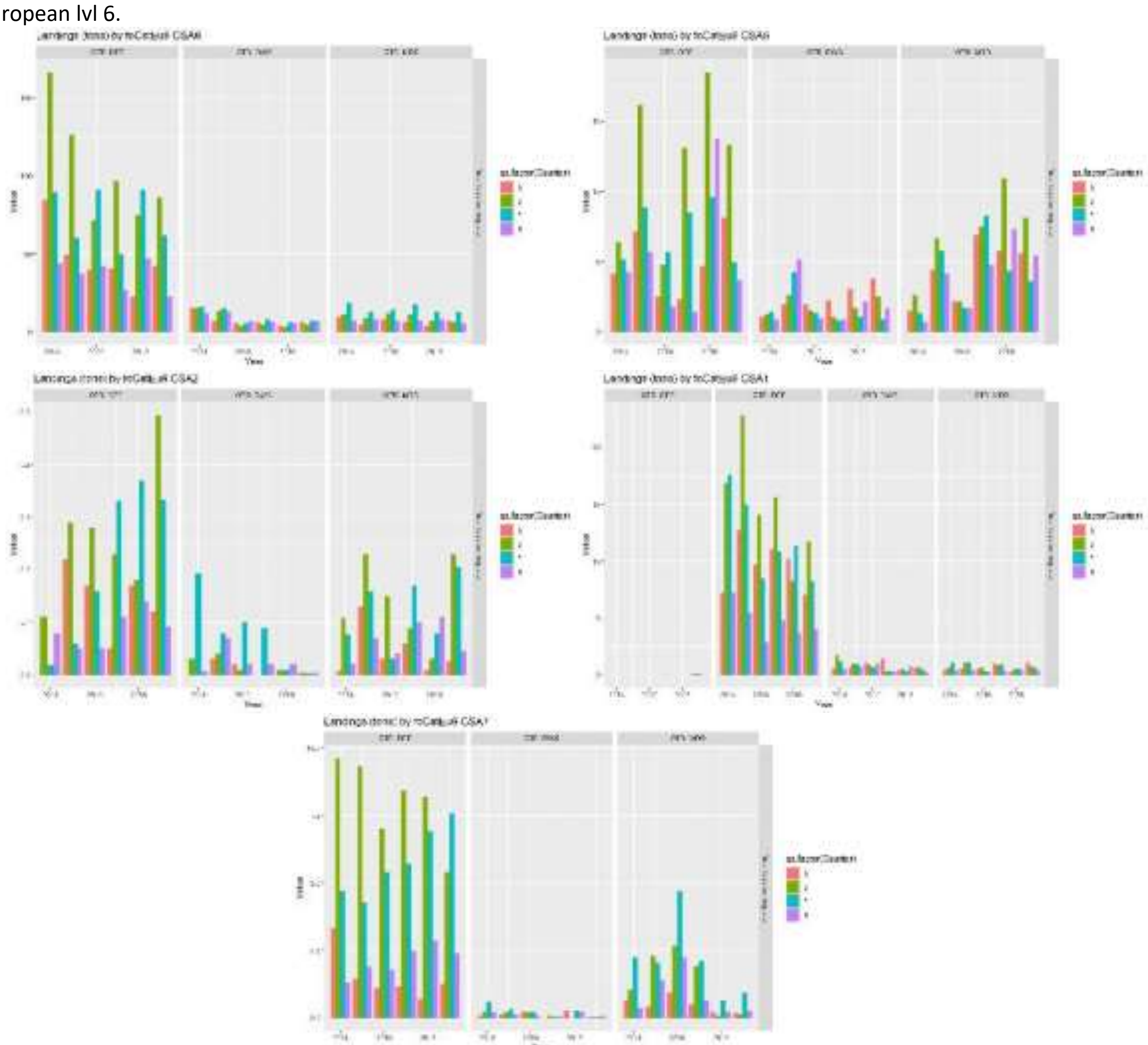


Figure 4.2.1 e – *N.norvegicus* in GSAs 1, 5, 6 and 7 (Spanish area). Landings by year, quarter and Fishing activity category European lvl 6.

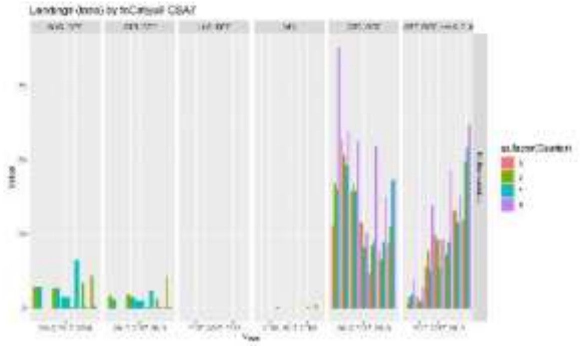


Figure 4.2.1 f – *M. barbatus* in GSA 7 (French area). Landings by year, quarter and Fishing activity category European lvl 6.

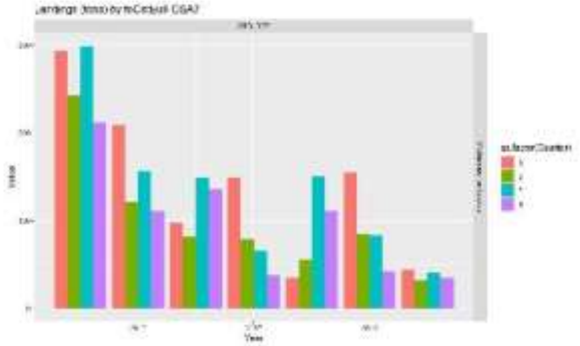


Figure 4.2.1 g – *M. merluccius* in GSA 7 (French area). Landings by year, quarter and Fishing activity category European lvl 6.

OPTIMIZATION RESULTS

The "optimal" sampling size was calculated through the 05_runOptimizationBYspecies.Rmd script from the SD Tool. The analysis was based on the calculation of the CV associated to raised LFDs of a given species per year and per métier (Tab. 4.2.1 a-f). The CVs versus the number of trips are shown in Fig. 4.2.1 a-f, where vertical blue lines are referred to the first 4 local maxima of the density kernel function used to derive the optimal sampling size range based on the historical sampling data and expert knowledge. Only the species characterizing the fishery were reported. The results showed that in the Spanish GSAs:

- For GSA1 OTB_DEF, the current sampling is within the optimal range for the main target species (MUT and DPS);
- For GSA5 OTB_DEF, the current sampling is within the optimal range for the main target species (NEP);
- For GSA6 OTB_DEF, the current sampling is within the optimal range for the main target species (DPS);
- For GSA7 OTB_DEF, the current sampling corresponds to a slight under-sampling for the main target species (HKE, DPS and NEP);
- For GSA5 OTB_MDD, the current sampling corresponds to a slight under-sampling for NEP and ARA, whilst it in the optimal range for HKE;
- For GSAs 1, 2, 5 and 6 OTB_DWS, the current sampling for ARA (the main target species) is in the optimal range, whilst it corresponds to a slight under-sampling for GSA 7;
- For GSAs 6 and 7 LLS_DEF, the current sampling for HKE (the main target species) is within the optimal range;
- For GSA 6 GNS_DEF, the current sampling for HKE (the main target species) is within the optimal range.

In the French part of the GSA7, the current sampling of OTB_DEF is in the optimal range and in some years highlights a slight over-sampling for the main target species (HKE and MUT).

Table 4.2.1 a – Solutions (trips) of the optimization algorithm GSA7 FRA.

Species	Var1	Var2	Var3	solutions	maxCV	minCV	maxRR	minRR	meanRR	noIterations
MUT	GSA7	FRA	OTB_DEF	60	0.95	0.36	0.06	0	0.01	24
MUT	GSA7	FRA	OTB_DEF	106	0.48	0.3	0.07	0	0.04	19
MUT	GSA7	FRA	OTB_DEF	135	0.43	0.32	0.08	0.03	0.05	5
MUT	GSA7	FRA	OTB_DEF	>135	0.33	0.33	0.1	0.09	0.1	2
HKE	GSA7	FRA	OTB_DEF	42	0.85	0.39	0.06	0	0.01	11
HKE	GSA7	FRA	OTB_DEF	90	0.45	0.3	0.05	0	0.02	19
HKE	GSA7	FRA	OTB_DEF	117	0.34	0.25	0.06	0.01	0.04	14
HKE	GSA7	FRA	OTB_DEF	>117	0.34	0.25	0.04	0.01	0.03	6

Table 4.2.1 b – Solutions (trips) of the optimization algorithm GSA1 ESP.

Species	Var1	Var2	Var3	solutions	maxCV	minCV	maxRR	minRR	meanRR	noIterations
HKE	GSA1	ESP	OTB_DEF	25	1	0.28	0.1	0	0.01	14
HKE	GSA1	ESP	OTB_DEF	72	0.42	0.21	0.06	0	0.02	21
HKE	GSA1	ESP	OTB_DEF	76	0.27	0.27	0.03	0.03	0.03	1
HKE	GSA1	ESP	OTB_DWS	64	0.75	0.3	0.2	0	0.1	8
HKE	GSA1	ESP	OTB_DWS	100	0.28	0.23	0.35	0.29	0.31	3
HKE	GSA1	ESP	OTB_DWS	185	0.18	0.16	0.51	0.47	0.49	5
HKE	GSA1	ESP	OTB_MDD	17	0.2	0.18	0.8	0.73	0.76	2
HKE	GSA1	ESP	OTB_MDD	23	0.13	0.12	0.87	0.83	0.85	2
HKE	GSA1	ESP	OTB_MDD	32	0.14	0.1	0.9	0.88	0.89	2
HKE	GSA1	ESP	OTB_MDD	33	0.1	0.1	0.91	0.91	0.91	1
DPS	GSA1	ESP	OTB_DEF	13	0.45	0.2	0.08	0	0.01	8
DPS	GSA1	ESP	OTB_DEF	20	0.29	0.24	0	0	0	4
DPS	GSA1	ESP	OTB_DEF	29	0.24	0.18	0.11	0	0.04	6
DPS	GSA1	ESP	OTB_DEF	32	0.17	0.17	0.03	0.03	0.03	1
NEP	GSA1	ESP	OTB_DEF	16	0.46	0.28	0.08	0	0.04	4
NEP	GSA1	ESP	OTB_DEF	25	0.29	0.24	0.11	0	0.04	5
NEP	GSA1	ESP	OTB_DEF	37	0.29	0.23	0.14	0.03	0.06	5
NEP	GSA1	ESP	OTB_DEF	46	0.21	0.18	0.16	0.03	0.11	6
NEP	GSA1	ESP	OTB_DWS	20	1	0.26	0.65	0	0.37	9
NEP	GSA1	ESP	OTB_DWS	35	0.29	0.25	0.79	0.73	0.76	5
NEP	GSA1	ESP	OTB_DWS	86	0.21	0.12	0.91	0.83	0.89	22
NEP	GSA1	ESP	OTB_DWS	97	0.17	0.15	0.93	0.92	0.92	2
ARA	GSA1	ESP	OTB_DWS	17	0.17	0.12	0.08	0	0.06	5
ARA	GSA1	ESP	OTB_DWS	21	0.12	0.12	0.06	0	0.03	2
ARA	GSA1	ESP	OTB_DWS	31	0.13	0.11	0.16	0.03	0.08	5
ARA	GSA1	ESP	OTB_DWS	>31	0.11	0.06	0.29	0.03	0.18	33

Table 4.2.1 c – Solutions (trips) of the optimization algorithm GSA2 ESP.

Species	Var1	Var2	Var3	solutions	maxCV	minCV	maxRR	minRR	meanRR	noIterations
NEP	GSA2	ESP	OTB_DEF	16	0.33	0.33	0.2	0.2	0.2	1
NEP	GSA2	ESP	OTB_DEF	30	0.28	0.17	0.67	0.32	0.48	11
NEP	GSA2	ESP	OTB_DEF	39	0.21	0.17	0.61	0.52	0.58	6
NEP	GSA2	ESP	OTB_DEF	>39	0.18	0.1	0.83	0.65	0.76	27

Species	Var1	Var2	Var3	solutions	maxCV	minCV	maxRR	minRR	meanRR	noIterations
NEP	GSA2	ESP	OTB_DWS	97	0.53	0.34	0.85	0.67	0.76	4
NEP	GSA2	ESP	OTB_DWS	141	0.24	0.23	0.93	0.92	0.92	2
NEP	GSA2	ESP	OTB_DWS	188	0.25	0.2	0.94	0.93	0.94	4
NEP	GSA2	ESP	OTB_DWS	235	0.19	0.19	0.96	0.95	0.96	2
NEP	GSA2	ESP	OTB_MDD	29	0.62	0.31	0.72	0.17	0.58	7
NEP	GSA2	ESP	OTB_MDD	49	0.32	0.24	0.84	0.74	0.8	7
NEP	GSA2	ESP	OTB_MDD	61	0.25	0.25	0.85	0.85	0.85	1
NEP	GSA2	ESP	OTB_MDD	78	0.22	0.19	0.89	0.87	0.88	5
ARA	GSA2	ESP	OTB_DWS	16	0.16	0.1	0.08	0	0.03	3
ARA	GSA2	ESP	OTB_DWS	19	0.17	0.11	0.1	0	0.05	6

Table 4.2.1 d – Solutions (trips) of the optimization algorithm GSA5 ESP.

Species	Var1	Var2	Var3	solutions	maxCV	minCV	maxRR	minRR	meanRR	noIterations
HKE	GSA5	ESP	OTB_DEF	42	0.72	0.41	0.24	0.08	0.14	11
HKE	GSA5	ESP	OTB_DEF	67	0.39	0.34	0.4	0.33	0.36	6
HKE	GSA5	ESP	OTB_DEF	89	0.32	0.32	0.44	0.43	0.44	3
HKE	GSA5	ESP	OTB_DEF	117	0.32	0.26	0.56	0.47	0.52	9
HKE	GSA5	ESP	OTB_DWS	72	0.66	0.37	0.71	0.38	0.59	7
HKE	GSA5	ESP	OTB_DWS	246	0.36	0.18	0.92	0.75	0.86	22
HKE	GSA5	ESP	OTB_DWS	271	0.19	0.15	0.92	0.92	0.92	3
HKE	GSA5	ESP	OTB_DWS	>271	0.19	0.09	0.95	0.93	0.95	18
HKE	GSA5	ESP	OTB_MDD	18	0.7	0.26	0.06	0	0.01	8
HKE	GSA5	ESP	OTB_MDD	31	0.36	0.2	0.07	0	0.02	5
HKE	GSA5	ESP	OTB_MDD	38	0.31	0.18	0.12	0.03	0.06	4
HKE	GSA5	ESP	OTB_MDD	56	0.23	0.16	0.09	0	0.04	6
MUT	GSA5	ESP	OTB_DEF	15	0.49	0.22	0.17	0	0.08	5
MUT	GSA5	ESP	OTB_DEF	23	0.27	0.16	0.25	0.18	0.22	2
MUT	GSA5	ESP	OTB_DEF	27	0.15	0.14	0.2	0.15	0.18	2
MUT	GSA5	ESP	OTB_DEF	35	0.17	0.17	0.23	0.23	0.23	1
DPS	GSA5	ESP	OTB_DEF	11	0.37	0.19	0.25	0	0.14	6
DPS	GSA5	ESP	OTB_DEF	21	0.23	0.17	0.43	0.17	0.29	7
DPS	GSA5	ESP	OTB_DEF	26	0.17	0.17	0.3	0.3	0.3	1
DPS	GSA5	ESP	OTB_DEF	35	0.16	0.16	0.5	0.43	0.46	2
DPS	GSA5	ESP	OTB_MDD	12	0.53	0.21	0.6	0	0.38	7
DPS	GSA5	ESP	OTB_MDD	21	0.25	0.2	0.67	0.53	0.62	8
DPS	GSA5	ESP	OTB_MDD	24	0.2	0.2	0.7	0.7	0.7	1
DPS	GSA5	ESP	OTB_MDD	33	0.18	0.16	0.79	0.73	0.76	5
NEP	GSA5	ESP	OTB_DEF	16	0.45	0.29	0.2	0	0.04	5
NEP	GSA5	ESP	OTB_DEF	26	0.32	0.21	0.19	0	0.07	13
NEP	GSA5	ESP	OTB_DEF	39	0.24	0.17	0.16	0.07	0.13	5
NEP	GSA5	ESP	OTB_DEF	>39	0.21	0.13	0.32	0.12	0.22	27
NEP	GSA5	ESP	OTB_DWS	24	0.6	0.31	0.26	0	0.12	12
NEP	GSA5	ESP	OTB_DWS	31	0.31	0.23	0.32	0.22	0.28	3
NEP	GSA5	ESP	OTB_DWS	39	0.39	0.29	0.36	0.18	0.29	4

Species	Var1	Var2	Var3	solutions	maxCV	minCV	maxRR	minRR	meanRR	noIterations
NEP	GSA5	ESP	OTB_DWS	51	0.34	0.27	0.43	0.36	0.39	3
NEP	GSA5	ESP	OTB_MDD	23	0.83	0.33	0.26	0	0.11	7
NEP	GSA5	ESP	OTB_MDD	58	0.43	0.26	0.37	0.17	0.26	21
NEP	GSA5	ESP	OTB_MDD	86	0.26	0.19	0.57	0.37	0.48	14
NEP	GSA5	ESP	OTB_MDD	>86	0.23	0.19	0.55	0.51	0.54	8
ARA	GSA5	ESP	OTB_DWS	12	0.16	0.15	0.18	0	0.06	3
ARA	GSA5	ESP	OTB_DWS	>15	0.13	0.05	0.49	0.07	0.28	46
ARA	GSA5	ESP	OTB_MDD	16	0.17	0.17	0.13	0.13	0.13	1
ARA	GSA5	ESP	OTB_MDD	23	0.16	0.14	0.21	0.05	0.1	3
ARA	GSA5	ESP	OTB_MDD	>23	0.13	0.06	0.39	0.04	0.25	44

Table 4.2.1 e – Solutions (trips) of the optimization algorithm GSA6 ESP.

Species	Var1	Var2	Var3	solutions	maxCV	minCV	maxRR	minRR	meanRR	noIterations
HKE	GSA6	ESP	GNS_DEF	12	0.4	0.22	0.12	0	0.03	9
HKE	GSA6	ESP	GNS_DEF	26	0.21	0.15	0.14	0	0.06	8
HKE	GSA6	ESP	GNS_DEF	37	0.19	0.15	0.14	0.07	0.1	5
HKE	GSA6	ESP	GNS_DEF	>37	0.15	0.09	0.27	0.07	0.19	28
HKE	GSA6	ESP	LLS_DEF	34	0.74	0.42	0.21	0	0.05	5
HKE	GSA6	ESP	LLS_DEF	47	0.4	0.36	0.19	0.08	0.13	5
HKE	GSA6	ESP	LLS_DEF	58	0.38	0.3	0.25	0.08	0.14	6
HKE	GSA6	ESP	LLS_DEF	80	0.31	0.25	0.29	0.15	0.22	8
HKE	GSA6	ESP	OTB_DEF	30	0.84	0.45	0.07	0	0.01	15
HKE	GSA6	ESP	OTB_DEF	47	0.48	0.34	0.07	0	0.02	10
HKE	GSA6	ESP	OTB_DEF	83	0.36	0.28	0.12	0.03	0.08	15
HKE	GSA6	ESP	OTB_DEF	>83	0.32	0.25	0.13	0.07	0.11	10
HKE	GSA6	ESP	OTB_DWS	32	0.71	0.31	0.52	0	0.23	7
HKE	GSA6	ESP	OTB_DWS	48	0.31	0.3	0.6	0.42	0.5	3
HKE	GSA6	ESP	OTB_DWS	66	0.27	0.22	0.67	0.57	0.62	6
HKE	GSA6	ESP	OTB_DWS	86	0.23	0.2	0.74	0.66	0.7	6
HKE	GSA6	ESP	OTB_MDD	17	0.59	0.35	0	0	0	7
HKE	GSA6	ESP	OTB_MDD	36	0.38	0.21	0.03	0	0.01	10
HKE	GSA6	ESP	OTB_MDD	44	0.29	0.21	0.03	0	0.01	3
HKE	GSA6	ESP	OTB_MDD	51	0.18	0.18	0.02	0.02	0.02	1
MUT	GSA6	ESP	GNS_DEF	31	0.44	0.15	0.65	0.29	0.53	5
MUT	GSA6	ESP	GNS_DEF	115	0.29	0.12	0.85	0.8	0.82	7
MUT	GSA6	ESP	GNS_DEF	142	0.14	0.13	0.93	0.93	0.93	2
MUT	GSA6	ESP	GNS_DEF	176	0.11	0.07	0.94	0.94	0.94	3
MUT	GSA6	ESP	OTB_DEF	12	0.43	0.22	0	0	0	6
MUT	GSA6	ESP	OTB_DEF	17	0.27	0.2	0	0	0	3
MUT	GSA6	ESP	OTB_DEF	21	0.28	0.18	0	0	0	4
MUT	GSA6	ESP	OTB_DEF	26	0.29	0.18	0.04	0	0.01	3
DPS	GSA6	ESP	OTB_DEF	13	0.37	0.24	0.12	0	0.02	6
DPS	GSA6	ESP	OTB_DEF	24	0.32	0.2	0	0	0	4
DPS	GSA6	ESP	OTB_DEF	32	0.25	0.19	0.1	0	0.05	4

Species	Var1	Var2	Var3	solutions	maxCV	minCV	maxRR	minRR	meanRR	noIterations
DPS	GSA6	ESP	OTB_DEF	>32	0.2	0.09	0.12	0	0.07	36
DPS	GSA6	ESP	OTB_MDD	14	0.18	0.18	0.77	0.77	0.77	1
DPS	GSA6	ESP	OTB_MDD	20	0.17	0.13	0.84	0.8	0.83	7
DPS	GSA6	ESP	OTB_MDD	30	0.14	0.11	0.9	0.86	0.88	4
DPS	GSA6	ESP	OTB_MDD	39	0.12	0.1	0.92	0.91	0.91	5
NEP	GSA6	ESP	OTB_DEF	15	0.52	0.21	0.09	0	0.02	5
NEP	GSA6	ESP	OTB_DEF	21	0.49	0.17	0	0	0	2
NEP	GSA6	ESP	OTB_DEF	34	0.27	0.18	0.12	0	0.05	7
NEP	GSA6	ESP	OTB_DEF	47	0.26	0.16	0.15	0	0.06	5
NEP	GSA6	ESP	OTB_DWS	20	0.54	0.29	0.12	0	0.02	12
NEP	GSA6	ESP	OTB_DWS	41	0.36	0.22	0.08	0	0.03	8
NEP	GSA6	ESP	OTB_DWS	54	0.29	0.21	0.13	0.04	0.09	10
NEP	GSA6	ESP	OTB_DWS	>54	0.23	0.15	0.21	0.05	0.15	20
NEP	GSA6	ESP	OTB_MDD	15	0.19	0.11	0.67	0.62	0.64	5
NEP	GSA6	ESP	OTB_MDD	19	0.15	0.15	0.75	0.75	0.75	1
NEP	GSA6	ESP	OTB_MDD	>19	0.16	0.06	0.95	0.77	0.9	42
ARA	GSA6	ESP	OTB_DWS	17	0.19	0.16	0	0	0	5
ARA	GSA6	ESP	OTB_DWS	22	0.16	0.14	0	0	0	2
ARA	GSA6	ESP	OTB_DWS	>22	0.13	0.06	0.16	0	0.09	38

Table 4.2.1 f – Solutions (trips) of the optimization algorithm GSA7 ESP.

Species	Var1	Var2	Var3	solutions	maxCV	minCV	maxRR	minRR	meanRR	noIterations
HKE	GSA7	ESP	LLS_DEF	23	0.56	0.24	0.05	0	0.02	5
HKE	GSA7	ESP	LLS_DEF	57	0.33	0.2	0.08	0	0.02	5
HKE	GSA7	ESP	LLS_DEF	75	0.24	0.15	0.08	0.03	0.06	5
HKE	GSA7	ESP	LLS_DEF	109	0.21	0.14	0.1	0.01	0.05	7
HKE	GSA7	ESP	OTB_DEF	24	0.78	0.23	0.33	0	0.12	11
HKE	GSA7	ESP	OTB_DEF	70	0.28	0.18	0.53	0.24	0.4	15
HKE	GSA7	ESP	OTB_DEF	133	0.18	0.13	0.73	0.53	0.64	16
HKE	GSA7	ESP	OTB_DEF	>133	0.13	0.11	0.78	0.72	0.74	8
HKE	GSA7	ESP	OTB_DWS	85	0.65	0.24	0.75	0.21	0.55	4
HKE	GSA7	ESP	OTB_DWS	226	0.27	0.15	0.92	0.8	0.87	8
HKE	GSA7	ESP	OTB_DWS	299	0.14	0.13	0.94	0.93	0.93	6
HKE	GSA7	ESP	OTB_DWS	608	0.12	0.06	0.97	0.94	0.96	18
HKE	GSA7	ESP	OTB_MDD	21	0.63	0.35	0.13	0	0.04	7
HKE	GSA7	ESP	OTB_MDD	38	0.38	0.22	0.19	0.03	0.1	11
HKE	GSA7	ESP	OTB_MDD	50	0.31	0.25	0.22	0.07	0.13	5
HKE	GSA7	ESP	OTB_MDD	55	0.25	0.25	0.24	0.24	0.24	1
MUT	GSA7	ESP	OTB_DEF	28	0.24	0.12	0.3	0.11	0.21	6
MUT	GSA7	ESP	OTB_DEF	32	0.16	0.14	0.35	0.19	0.27	4
MUT	GSA7	ESP	OTB_DEF	42	0.15	0.12	0.34	0.25	0.3	3
DPS	GSA7	ESP	OTB_DEF	12	0.35	0.18	0.14	0	0.05	5
DPS	GSA7	ESP	OTB_DEF	17	0.26	0.19	0.15	0.06	0.11	3
DPS	GSA7	ESP	OTB_DEF	27	0.26	0.18	0.19	0.04	0.13	3

Species	Var1	Var2	Var3	solutions	maxCV	minCV	maxRR	minRR	meanRR	noIterations
DPS	GSA7	ESP	OTB_DEF	32	0.18	0.18	0.17	0.17	0.17	1
DPS	GSA7	ESP	OTB_MDD	21	0.21	0.19	0.71	0.45	0.57	4
DPS	GSA7	ESP	OTB_MDD	30	0.18	0.13	0.73	0.68	0.71	5
NEP	GSA7	ESP	OTB_DEF	16	0.02	0.02	0	0	0	1
NEP	GSA7	ESP	OTB_DEF	25	0.19	0.18	0.14	0.13	0.14	2
NEP	GSA7	ESP	OTB_DEF	31	0.17	0	0.26	0.03	0.15	4
NEP	GSA7	ESP	OTB_DEF	>31	0.17	0	0.46	0.08	0.27	41
NEP	GSA7	ESP	OTB_DWS	40	0.61	0.35	0.36	0	0.21	11
NEP	GSA7	ESP	OTB_DWS	109	0.32	0.2	0.64	0.32	0.53	15
NEP	GSA7	ESP	OTB_DWS	>109	0.2	0.14	0.83	0.66	0.77	24
NEP	GSA7	ESP	OTB_MDD	16	0.23	0.14	0.5	0.33	0.42	4
NEP	GSA7	ESP	OTB_MDD	24	0.15	0.12	0.64	0.53	0.59	3
NEP	GSA7	ESP	OTB_MDD	30	0.12	0.11	0.69	0.68	0.69	3
NEP	GSA7	ESP	OTB_MDD	39	0.1	0.1	0.77	0.72	0.75	3
ARA	GSA7	ESP	OTB_DWS	17	0.19	0.16	0.09	0	0.02	6
ARA	GSA7	ESP	OTB_DWS	27	0.17	0.11	0.27	0.05	0.14	8
ARA	GSA7	ESP	OTB_DWS	>27	0.12	0.06	0.47	0.11	0.31	29

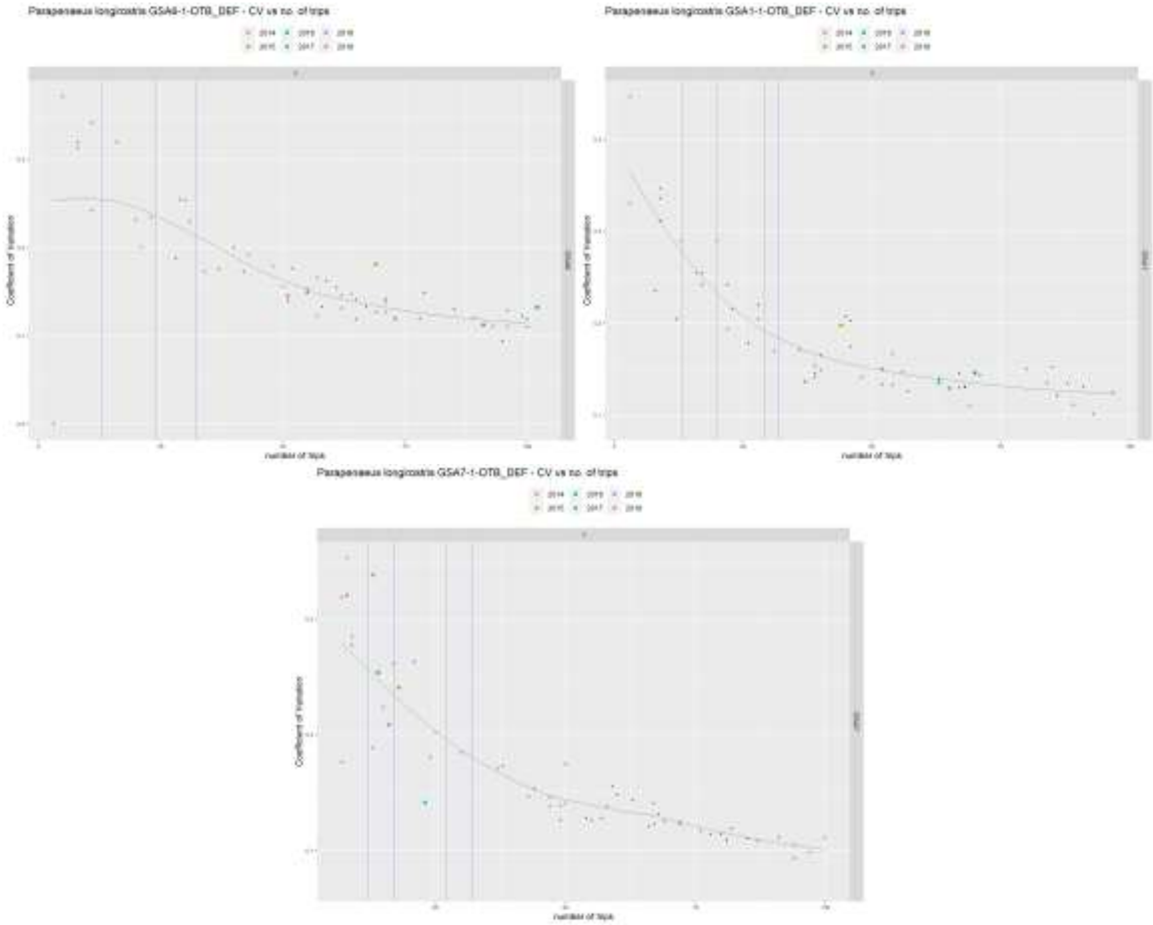


Figure 4.2.2 a – CV versus number of trips for *P. longirostris* in the Spanish GSAs.

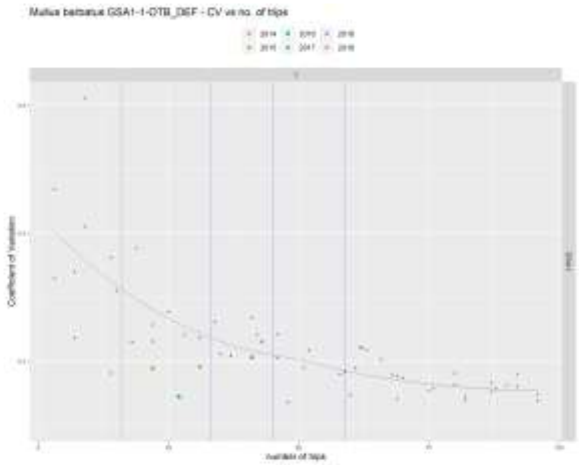


Figure 4.2.2 b – CV versus number of trips for *M. barbatus* in the Spanish GSAs.

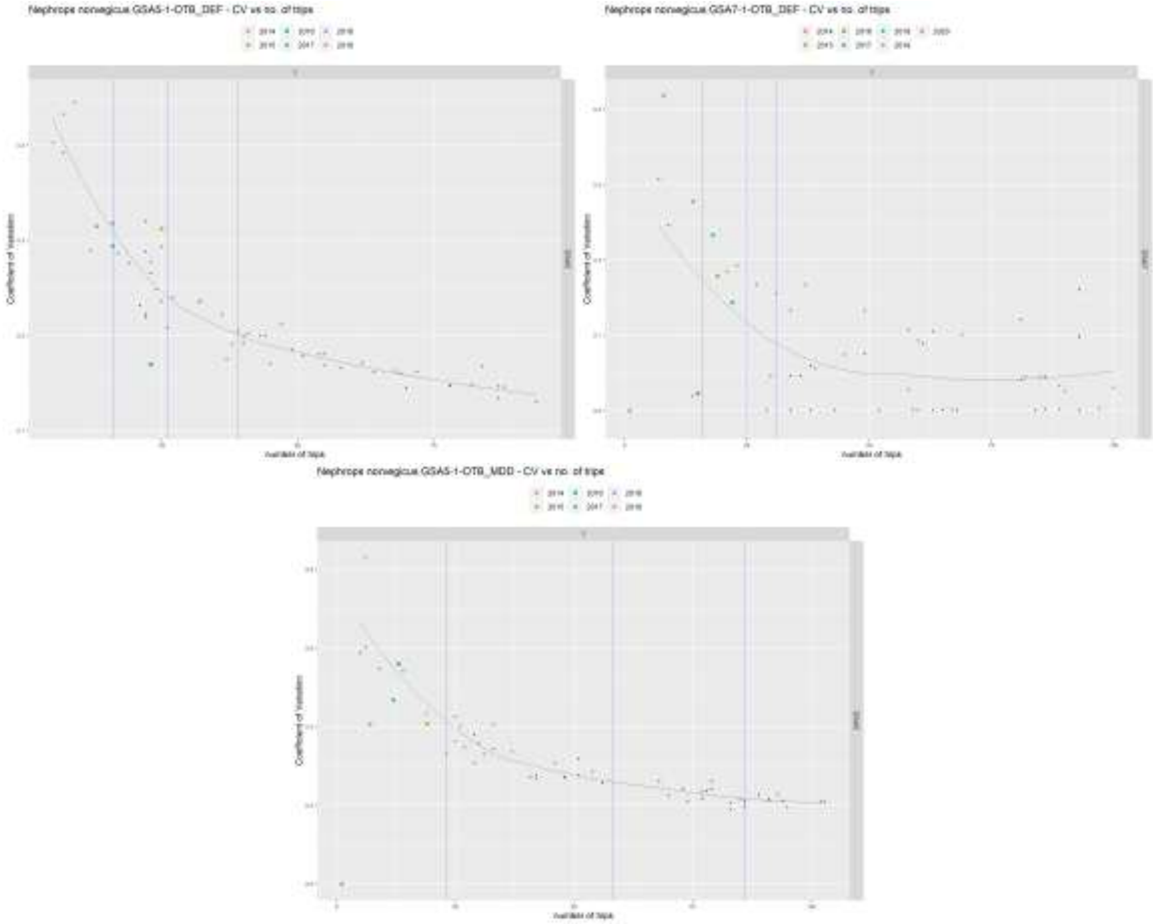


Figure 4.2.2 c – CV versus number of trips for *N. norvegicus* in the Spanish GSAs.

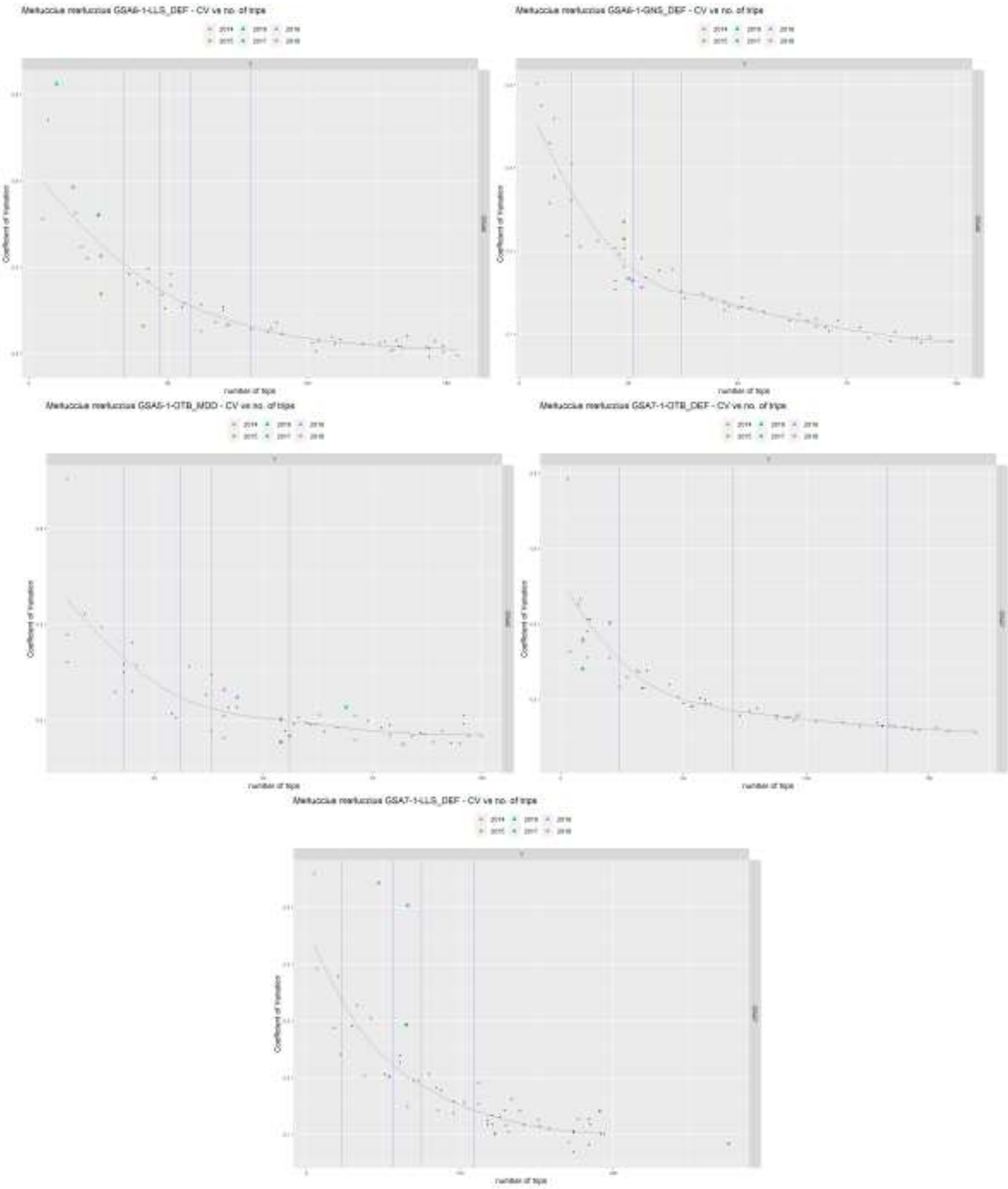


Figure 4.2.2 d – CV versus number of trips for *M. merluccius* in the Spanish GSAs.

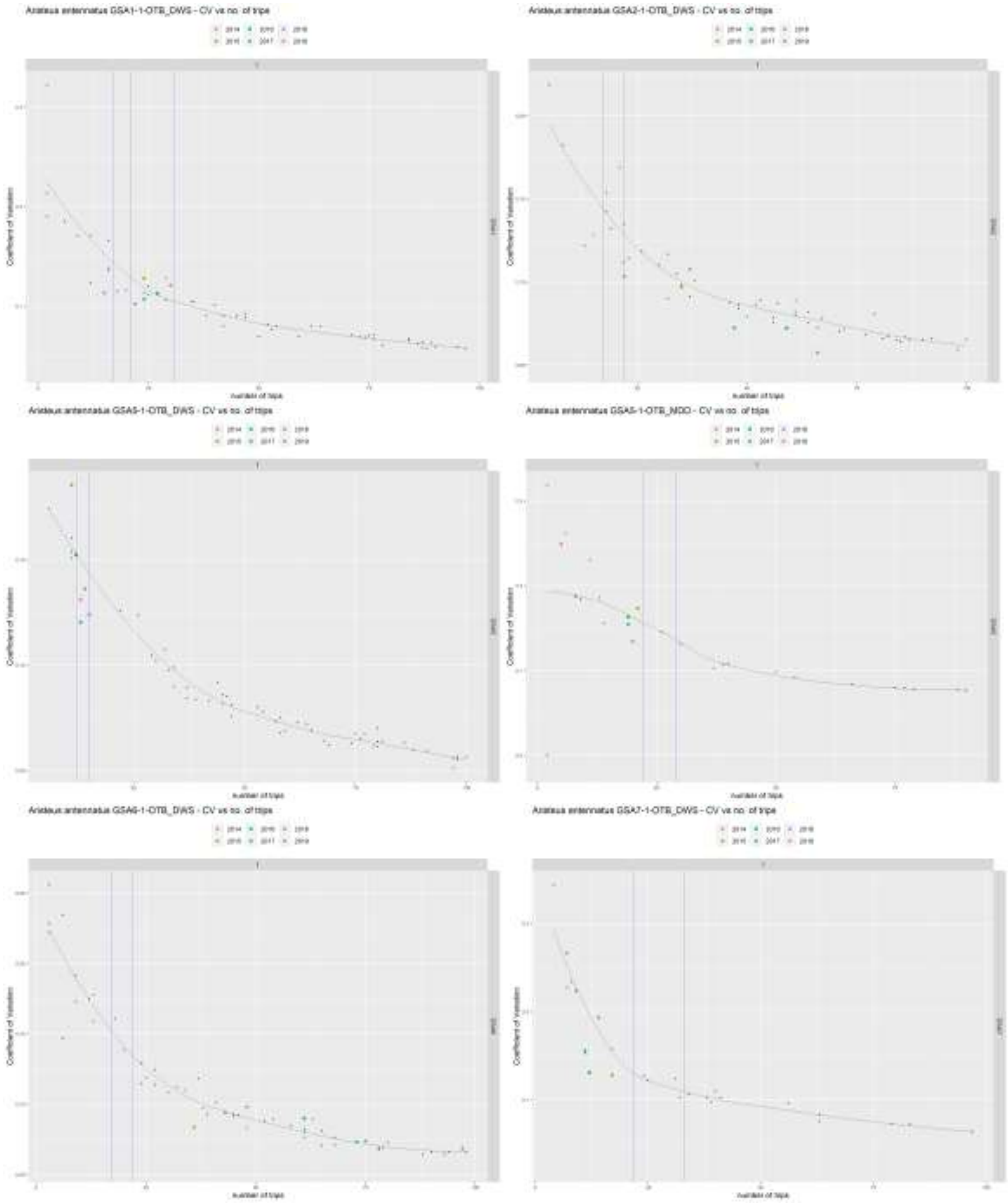


Figure 4.2.2 e – CV versus number of trips for *A. antennatus* in the Spanish GSAs.

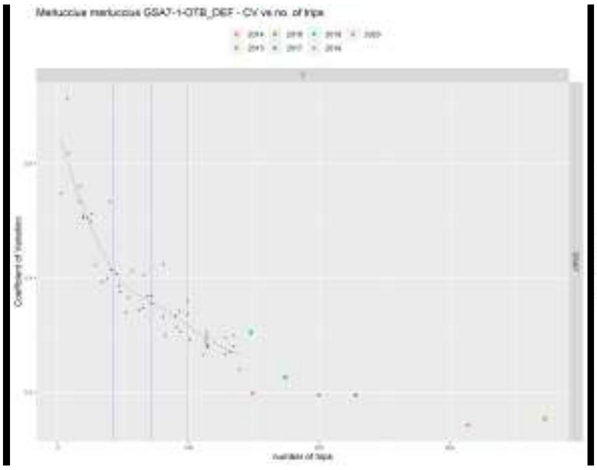


Figure 4.2.2 f – CV versus number of trips in the French GSA.

SCENARIOS DESIGN

For each métier and GSA, the species characterizing the fishery were identified; on these species an occurrence factor was computed as the number of positive trips on the planned trips. The numbers of trips used in the scenarios were obtained multiplying the optimization solutions by the factor of the species characterizing the fishery. In detail, in the Spanish area:

- GSA1 OTB_DEF: the average between the 2^{nd} and the 3^{rd} solutions multiplied by the factor of DPS and MUT was used for the Scenario 1;
- GSA1 OTB_DEF: the 4^{th} solutions multiplied by the factor of DPS and MUT was used for the Scenario 2;
- GSA5 OTB_DEF: the average between the 1^{st} and the 2^{nd} solutions multiplied by the factor of NEP was used for the Scenario 1;
- GSA5 OTB_DEF: the 2^{nd} solutions multiplied by the factor of NEP was used for the Scenario 2;
- GSA6 OTB_DEF: the average between the 2^{nd} and the 3^{rd} solutions multiplied by the factor of DPS was used for the Scenario 1;
- GSA6 OTB_DEF: the 3^{rd} solutions multiplied by the factor of DPS was used for the Scenario 2;
- GSA7 OTB_DEF: the average between the 1^{st} and the 2^{nd} solutions multiplied by the factor of DPS, HKE and NEP was used for the Scenario 1;
- GSA7 OTB_DEF: the 2^{nd} solutions multiplied by the factor by the factor of DPS, HKE and NEP was used for the Scenario 2;
- GSA1 OTB_DWS: the 3^{rd} solutions multiplied by the factor of ARA was used for the Scenario 2;
- GSA1 OTB_DWS: the average between the number of trips of Baseline and Scenario 2 was used for the Scenario 1;
- GSA2 OTB_DWS: the 1^{st} of ARA solutions was used for the Scenario 1 (number of trips positive higher than the planned);
- GSA2 OTB_DWS: the 2^{nd} solutions was used for the Scenario 2 of ARA (number of trips positive higher than the planned);
- GSA5 OTB_DWS: the 1^{st} solution multiplied by the factor of ARA was used for the Scenario 1;
- GSA5 OTB_DWS: the 2^{nd} solution multiplied by the factor of ARA was used for the Scenario 2;
- GSA6 OTB_DWS: the 1^{st} solution multiplied by the factor of ARA was used for the Scenario 1;
- GSA6 OTB_DWS: the 2^{nd} solution multiplied by the factor of ARA was used for the Scenario 2;
- GSA7 OTB_DWS: the 1^{st} solution multiplied by the factor of ARA was used for the Scenario 1;
- GSA7 OTB_DWS: the 2^{nd} solution multiplied by the factor of ARA was used for the Scenario 2;
- GSA5 OTB_MDD: the average of the 1^{st} solutions multiplied by the factor of ARA, NEP and HKE was used for the Scenario 1;

- GSA5 OTB_MDD: the average of the 2nd solutions multiplied by the factor of ARA, NEP and HKE was used for the Scenario 1;
- GSA6 GNS_DEF: the average between the 2nd and the 3rd solutions multiplied by the factor of HKE was used for the Scenario 1;
- GSA6 GNS_DEF: the 3rd solutions multiplied by the factor of HKE was used for the Scenario 2;
- GSA6 LLS_DEF: the 1st solution multiplied by the factor of HKE was used for the Scenario 1;
- GSA6 LLS_DEF: the 2nd solution multiplied by the factor of HKE was used for the Scenario 2;
- GSA7 LLS_DEF: the average between the 2nd and the 3rd solutions multiplied by the factor of HKE was used for the Scenario 1;
- GSA7 LLS_DEF: the 3rd solutions multiplied by the factor of HKE was used for the Scenario 2.

In detail, in the French area:

- GSA7 OTB_DEF: the average between the 1st and the 2nd solutions of HKE and MUT was used for the Scenario 1;
- GSA7 OTB_DEF: the 3rd solutions of HKE and MUT was used for the Scenario 2.

Moreover, a scenario characterized by the decrease of the number of individuals against the increase of the number of trips (based on a subsample of ½ applied only to samples with more than 30 specimens) was explored.

The Table 4.2.2 shows the scenarios explored in the Case Study 2.

Table 4.2.2 – Sampling design for the Case Study 2.

Country	GSA	Métier	Scenario	n. of trips
ESP	GSA1	OTB_DEF	Baseline	96
ESP	GSA1	OTB_DEF	Scenario_1	47
ESP	GSA1	OTB_DEF	Scenario_2 + sub-sample	69
ESP	GSA1	OTB_DWS	Baseline	24
ESP	GSA1	OTB_DWS	Scenario_1	27
ESP	GSA1	OTB_DWS	Scenario_2 + sub-sample	30
ESP	GSA2	OTB_DWS	Baseline	18
ESP	GSA2	OTB_DWS	Scenario_1	16
ESP	GSA2	OTB_DWS	Scenario_2 + sub-sample	19
ESP	GSA5	OTB_DEF	Baseline	36
ESP	GSA5	OTB_DEF	Scenario_1	24
ESP	GSA5	OTB_DEF	Scenario_2 + sub-sample	44
ESP	GSA5	OTB_DWS	Baseline	12
ESP	GSA5	OTB_DWS	Scenario_1	24
ESP	GSA5	OTB_DWS	Scenario_2 + sub-sample	31
ESP	GSA5	OTB_MDD	Baseline	12
ESP	GSA5	OTB_MDD	Scenario_1	20
ESP	GSA5	OTB_MDD	Scenario_2 + sub-sample	37
ESP	GSA6	GNS_DEF	Baseline	36
ESP	GSA6	GNS_DEF	Scenario_1	41
ESP	GSA6	GNS_DEF	Scenario_2 + sub-sample	48
ESP	GSA6	LLS_DEF	Baseline	30
ESP	GSA6	LLS_DEF	Scenario_1	39
ESP	GSA6	LLS_DEF	Scenario_2 + sub-sample	54
ESP	GSA6	OTB_DEF	Baseline	144

Country	GSA	Métier	Scenario	n. of trips
ESP	GSA6	OTB_DEF	Scenario_1	40
ESP	GSA6	OTB_DEF	Scenario_2 + sub-sample	45
ESP	GSA6	OTB_DWS	Baseline	72
ESP	GSA6	OTB_DWS	Scenario_1	26
ESP	GSA6	OTB_DWS	Scenario_2 + sub-sample	34
ESP	GSA7	LLS_DEF	Baseline	72
ESP	GSA7	LLS_DEF	Scenario_1	88
ESP	GSA7	LLS_DEF	Scenario_2 + sub-sample	100
ESP	GSA7	OTB_DEF	Baseline	24
ESP	GSA7	OTB_DEF	Scenario_1	31
ESP	GSA7	OTB_DEF	Scenario_2 + sub-sample	43
ESP	GSA7	OTB_DWS	Baseline	12
ESP	GSA7	OTB_DWS	Scenario_1	30
ESP	GSA7	OTB_DWS	Scenario_2 + sub-sample	36
FRA	GSA7	OTB_DEF	Baseline	367
FRA	GSA7	OTB_DEF	Scenario_1	215
FRA	GSA7	OTB_DEF	Scenario_2	238
FRA	GSA7	OTB_DEF	Scenario_3+ sub-sample	238

SCENARIOS RESULTS

In Tables 4.2.3 a-f, the results on the Case Study 2 are reported.

In GSA1 (Spain), for OTB_DEF mainly targeting *M. barbatus* and *P. longirostris*, the 50% reduction of the trips monitored would increase the CV of about 4-6%, highlighting that an important reduction of the trip monitoring costs would have a limited impact on the sampling precision of these stocks. For OTB_DWS, mainly characterized by *A. antennatus* landings, the 25% increase of the fishing trips do not reduce sensitively the CV.

For GSA2 (Spain), where OTB_DWS targets mainly *A. antennatus*, the decrease of about 11% of trips would maintain approximately the same sampling precision of the current sampling design. This could significantly impact the sampling costs.

In GSA5 (Spain), for OTB_DEF, mainly targeting *N. norvegicus*, the 33% reduction of the trips monitored would maintain the CV approximately at the same level of the current sampling, while decreasing of one third the costs associated to the trips monitoring. For OTB_DWS, the 100% increase of fishing trips would allow to have a slight improvement in sampling precision of *A. antennatus* (-4% CV); also for OTB_MDD, the 67% increase of fishing trips would allow to have a slight improvement in sampling precision (-4% on the CV) for *A. antennatus*.

In GSA6 (Spain), for GNS_DEF and LLS_DEF the increase in fishing trips would not allow to improve the sampling precision for *M. merluccius*; for OTB_DEF, mainly characterized by *P. longirostris* and *M. barbatus* landings, the 72% reduction would increase the CV of deep-water pink shrimp from 16 to 26%, while maintaining the CV around 20% for red mullet; for OTB_DWS, mainly targeting *A. antennatus*, the reduction of 64% of fishing trips and relevant costs, in combination to a 76% reduction in length measurements, would allow to have a CV below 20%, with an important reduction in sampling costs (e.g. trip and man-hours).

In GSA7 (Spain), for all the métier explored, the increase in fishing trips would allow to maintain or increase the current sampling precision on all the species at different extents.

In GSA7 (French), the reduction of the number of trips does not affect positively the CV. The results show that on one hand for hake scenario 3 would increase the CV by 5%, while reducing the costs associated to the sampled trips by 35%.

Tab. 4.2.3 a – Final results in terms of CV by species, country and métier GSA1 ESP.

country	Species	Area	Métier	Scenario	CV	n. of trips	measured specimens	% change length	% change trips
ESP	*M. merluccius*	GSA 1	OTB_DEF	Baseline	74.1	96	5060		
ESP	*M. merluccius*	GSA 1	OTB_DEF	Scenario 1	82.7	47	2541	-50%	-51%
ESP	*M. merluccius*	GSA 1	OTB_DEF	Scenario 2	89.6	69	2149	-58%	-28%
ESP	*M. barbatus*	GSA 1	OTB_DEF	Baseline	18.1	96	5885		
ESP	*M. barbatus*	GSA 1	OTB_DEF	Scenario 1	24.1	47	2881	-51%	-51%
ESP	*M. barbatus*	GSA 1	OTB_DEF	Scenario 2	43.5	69	2398	-59%	-28%
ESP	*N. norvegicus*	GSA 1	OTB_DEF	Baseline	23	96	4173		
ESP	*N. norvegicus*	GSA 1	OTB_DEF	Scenario 1	30	47	2048	-51%	-51%
ESP	*N. norvegicus*	GSA 1	OTB_DEF	Scenario 2	37	69	1960	-53%	-28%
ESP	*P. longirostris*	GSA 1	OTB_DEF	Baseline	25.3	96	11141		
ESP	*P. longirostris*	GSA 1	OTB_DEF	Scenario 1	29	47	5515	-50%	-51%
ESP	*P. longirostris*	GSA 1	OTB_DEF	Scenario 2	61.1	69	3976	-64%	-28%
ESP	*A. antennatus*	GSA 1	OTB_DWS	Baseline	12.8	24	4949		
ESP	*A. antennatus*	GSA 1	OTB_DWS	Scenario 1	12.2	27	5574	13%	13%
ESP	*A. antennatus*	GSA 1	OTB_DWS	Scenario 2	14	30	3167	-36%	25%
ESP	*M. merluccius*	GSA 1	OTB_DWS	Baseline	58.6	24	148		
ESP	*M. merluccius*	GSA 1	OTB_DWS	Scenario 1	55.1	27	170	15%	13%
ESP	*M. merluccius*	GSA 1	OTB_DWS	Scenario 2	55.9	30	192	30%	25%

Tab. 4.2.3 b – Final results in terms of CV by species, country and métier GSA2 ESP.

country	Species	Area	Métier	Scenario	CV	n. of trips	measured specimens	% change length	% change trips
ESP	*A. antennatus*	GSA 2	OTB_DWS	Baseline	13.6	18	5449		
ESP	*A. antennatus*	GSA 2	OTB_DWS	Scenario 1	14.5	16	4613	-15%	-11%
ESP	*A. antennatus*	GSA 2	OTB_DWS	Scenario 2	27	19	2749	-50%	6%

Tab. 4.2.3 c – Final results in terms of CV by species, country and métier GSA5 ESP.

country	Species	Area	Métier	Scenario	CV	n. of trips	measured specimens	% change length	% change trips
ESP	*M. merluccius*	GSA 5	OTB_DEF	Baseline	55.8	20	599		
ESP	*M. merluccius*	GSA 5	OTB_DEF	Scenario 1	65.9	13	359	-40%	-35%
ESP	*M. merluccius*	GSA 5	OTB_DEF	Scenario 2	62.2	24	602	1%	20%
ESP	*M. barbatus*	GSA 5	OTB_DEF	Baseline	26.7	9	178		
ESP	*M. barbatus*	GSA 5	OTB_DEF	Scenario 1	28.1	6	132	-26%	-33%
ESP	*M. barbatus*	GSA 5	OTB_DEF	Scenario 2	51.1	11	194	9%	22%
ESP	*N. norvegicus*	GSA 5	OTB_DEF	Baseline	20.5	32	5690		
ESP	*N. norvegicus*	GSA 5	OTB_DEF	Scenario 1	23.7	21	3916	-31%	-34%
ESP	*N. norvegicus*	GSA 5	OTB_DEF	Scenario 2	47.6	39	3778	-34%	22%
ESP	*P. longirostris*	GSA 5	OTB_DEF	Baseline	30.1	9	1464		
ESP	*P. longirostris*	GSA 5	OTB_DEF	Scenario 1	33.6	6	1010	-31%	-33%

country	Species	Area	Métier	Scenario	CV	n. of trips	measured specimens	% change length	% change trips
ESP	*P. longirostris*	GSA 5	OTB_DEF	Scenario 2	68.7	11	924	-37%	22%
ESP	*A. antennatus*	GSA 5	OTB_DWS	Baseline	15.2	12	5151		
ESP	*A. antennatus*	GSA 5	OTB_DWS	Scenario 1	11.2	24	10369	101%	100%
ESP	*A. antennatus*	GSA 5	OTB_DWS	Scenario 2	23	31	6790	32%	158%
ESP	*M. merluccius*	GSA 5	OTB_DWS	Baseline	73.5	11	133		
ESP	*M. merluccius*	GSA 5	OTB_DWS	Scenario 1	61.5	22	255	92%	100%
ESP	*M. merluccius*	GSA 5	OTB_DWS	Scenario 2	55.9	28	339	155%	155%
ESP	*A. antennatus*	GSA 5	OTB_MDD	Baseline	17.7	12	4457		
ESP	*A. antennatus*	GSA 5	OTB_MDD	Scenario 1	14	20	7341	65%	67%
ESP	*A. antennatus*	GSA 5	OTB_MDD	Scenario 2	15	37	6823	53%	208%
ESP	*M. merluccius*	GSA 5	OTB_MDD	Baseline	37.5	12	770		
ESP	*M. merluccius*	GSA 5	OTB_MDD	Scenario 1	45.7	20	1551	101%	67%
ESP	*M. merluccius*	GSA 5	OTB_MDD	Scenario 2	67.3	37	1463	90%	208%

Tab. 4.2.3 d – Final results in terms of CV by species, country and métier GSA6 ESP.

country	Species	Area	Métier	Scenario	CV	n. of trips	measured specimens	% change length	% change trips
ESP	*M. merluccius*	GSA 6	GNS_DEF	Baseline	18.9	28	1452		
ESP	*M. merluccius*	GSA 6	GNS_DEF	Scenario 1	17.6	32	1639	13%	14%
ESP	*M. merluccius*	GSA 6	GNS_DEF	Scenario 2	25.9	37	1381	-5%	32%
ESP	*M. merluccius*	GSA 6	LLS_DEF	Baseline	78.5	26	818		
ESP	*M. merluccius*	GSA 6	LLS_DEF	Scenario 1	77	34	1089	33%	31%
ESP	*M. merluccius*	GSA 6	LLS_DEF	Scenario 2	73.7	47	1129	38%	81%
ESP	*M. merluccius*	GSA 6	OTB_DEF	Baseline	57.7	84	6194		
ESP	*M. merluccius*	GSA 6	OTB_DEF	Scenario 1	81.7	23	1703	-73%	-73%
ESP	*M. merluccius*	GSA 6	OTB_DEF	Scenario 2	90.6	26	1143	-82%	-69%
ESP	*M. barbatus*	GSA 6	OTB_DEF	Baseline	8.8	144	26322		
ESP	*M. barbatus*	GSA 6	OTB_DEF	Scenario 1	16.2	40	7162	-73%	-72%
ESP	*M. barbatus*	GSA 6	OTB_DEF	Scenario 2	48.7	45	4181	-84%	-69%
ESP	*N. norvegicus*	GSA 6	OTB_DEF	Baseline	25.4	68	8305		
ESP	*N. norvegicus*	GSA 6	OTB_DEF	Scenario 1	38	19	2301	-72%	-72%
ESP	*N. norvegicus*	GSA 6	OTB_DEF	Scenario 2	64.6	21	1346	-84%	-69%
ESP	*P. longirostris*	GSA 6	OTB_DEF	Baseline	16.1	102	19135		
ESP	*P. longirostris*	GSA 6	OTB_DEF	Scenario 1	26.8	28	5251	-73%	-73%
ESP	*P. longirostris*	GSA 6	OTB_DEF	Scenario 2	60.9	32	3111	-84%	-69%
ESP	*A. antennatus*	GSA 6	OTB_DWS	Baseline	8.1	62	15303		
ESP	*A. antennatus*	GSA 6	OTB_DWS	Scenario 1	13.1	22	5298	-65%	-65%
ESP	*A. antennatus*	GSA 6	OTB_DWS	Scenario 2	16.1	29	3656	-76%	-53%

Tab. 4.2.3 e – Final results in terms of CV by species, country and métier GSA7 ESP.

country	Species	Area	Métier	Scenario	CV	n. of trips	measured specimens	% change length	% change trips
ESP	*M. merluccius*	GSA 7	LLS_DEF	Baseline	36.9	54	1435		
ESP	*M. merluccius*	GSA 7	LLS_DEF	Scenario 1	34.2	66	1681	17%	22%

ESP	*M. merluccius*	GSA 7	LLS_DEF	Scenario 2	36.9	75	1417	-1%	39%
ESP	*M. merluccius*	GSA 7	OTB_DEF	Baseline	38.2	20	551		
ESP	*M. merluccius*	GSA 7	OTB_DEF	Scenario 1	34	26	700	27%	30%
ESP	*M. merluccius*	GSA 7	OTB_DEF	Scenario 2	31.2	36	899	63%	80%
ESP	*M. barbatus*	GSA 7	OTB_DEF	Baseline	28.6	7	289		
ESP	*M. barbatus*	GSA 7	OTB_DEF	Scenario 1	26	9	373	29%	29%
ESP	*M. barbatus*	GSA 7	OTB_DEF	Scenario 2	55.6	13	340	18%	86%
ESP	*N. norvegicus*	GSA 7	OTB_DEF	Baseline	34.5	22	2438		
ESP	*N. norvegicus*	GSA 7	OTB_DEF	Scenario 1	32.2	28	3169	30%	27%
ESP	*N. norvegicus*	GSA 7	OTB_DEF	Scenario 2	39.9	39	2351	-4%	77%
ESP	*P. longirostris*	GSA 7	OTB_DEF	Baseline	30.1	23	2721		
ESP	*P. longirostris*	GSA 7	OTB_DEF	Scenario 1	27	30	3733	37%	30%
ESP	*P. longirostris*	GSA 7	OTB_DEF	Scenario 2	45.5	41	2721	0%	78%
ESP	*A. antennatus*	GSA 7	OTB_DWS	Baseline	21.3	8	1524		
ESP	*A. antennatus*	GSA 7	OTB_DWS	Scenario 1	14.1	20	3828	151%	150%
ESP	*A. antennatus*	GSA 7	OTB_DWS	Scenario 2	49.4	24	2406	58%	200%
ESP	*M. merluccius*	GSA 7	OTB_DWS	Baseline	72.7	8	40		
ESP	*M. merluccius*	GSA 7	OTB_DWS	Scenario 1	59	20	101	153%	150%
ESP	*M. merluccius*	GSA 7	OTB_DWS	Scenario 2	55.3	24	123	208%	200%

Tab. 4.2.3 f – Final results in terms of CV by species, country and métier GSA7 FRA.

country	Species	Area	Métier	Scenario	CV	n. of trips	measured specimens	% change length	% change trips
FRA	*M. merluccius*	GSA 7	OTB_DEF	Baseline	24.8	170	5858		
FRA	*M. merluccius*	GSA 7	OTB_DEF	Scenario 1	31.2	100	3492	-40%	-41%
FRA	*M. merluccius*	GSA 7	OTB_DEF	Scenario 2	29.7	110	3787	-35%	-35%
FRA	*M. merluccius*	GSA 7	OTB_DEF	Scenario 3	33.1	110	3455	-41%	-35%
FRA	*M. barbatus*	GSA 7	OTB_DEF	Baseline	32.1	135	4545		
FRA	*M. barbatus*	GSA 7	OTB_DEF	Scenario 1	39.2	79	2620	-42%	-41%
FRA	*M. barbatus*	GSA 7	OTB_DEF	Scenario 2	37.8	88	2943	-35%	-35%
FRA	*M. barbatus*	GSA 7	OTB_DEF	Scenario 3	38.5	88	2877	-37%	-35%

4.3 CASE STUDY 3

DATA AVAILABILITY AND EXPLORATION

The métier to be explored were OTB_DEF, FPO, TBB, GNS, GTR, LLS in the Adriatic Sea (GSAs 17 and 18).None of the selected species (*Merluccius merluccius*, *Mullus barbatus*, *Nephrops norvegicus*, *Parapenaeus longirostris*, *Solea solea*) is targeted by FPO, which was then excluded from the analysis. *M. merluccius* (HKE) is mainly caught by OTB and LLS (GSA18 only); *M. barbatus* (MUT) is mainly caught by OTB and nets (GNS and GTR, GSA18 only); *N. norvegicus* (NEP) and *P. longirostris* (DPS) are mainly caught by OTB; *S. solea* (SOL) is caught by nets and TBB (GSA17 only). The dataset we used included data from Italy and Croatia; Slovenian data were excluded (Figures 4.3.a-e).

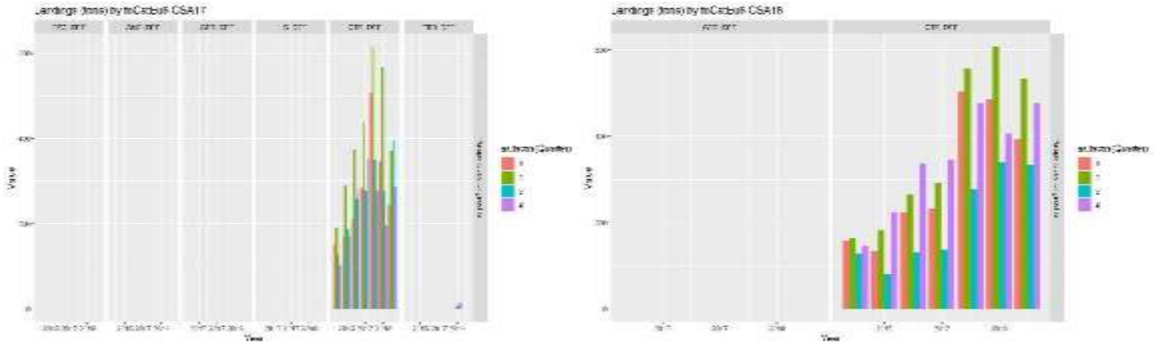


Figure 4.3a – *P. longirostris* in GSAs 17 and 18. Landings by year, quarter and Fishing activity category European lvl 6.

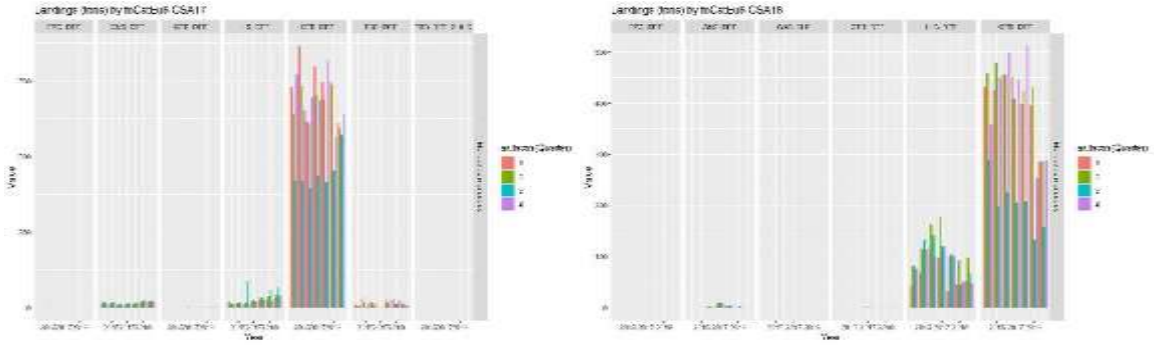


Figure 4.3b – *M. merluccius* in GSAs 17 and 18. Landings by year, quarter and Fishing activity category European lvl 6.

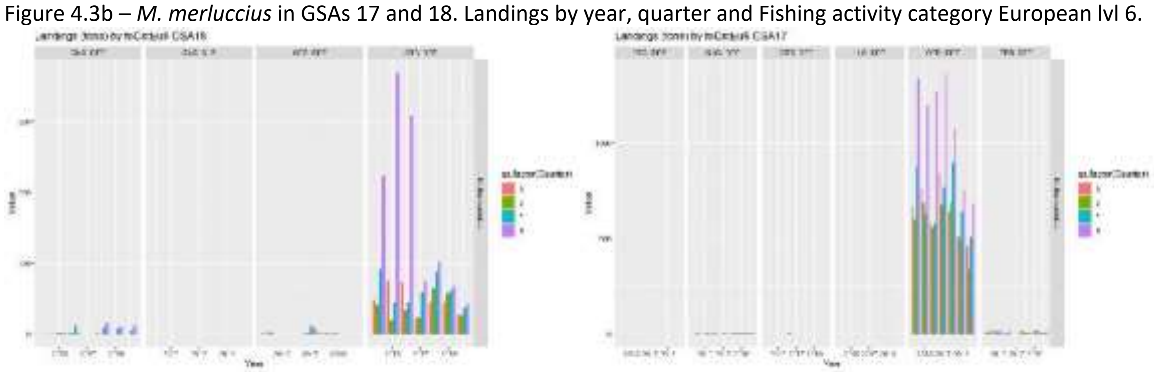


Figure 4.3c – *M. barbatus* in GSAs 17 and 18. Landings by year, quarter and Fishing activity category European lvl 6.

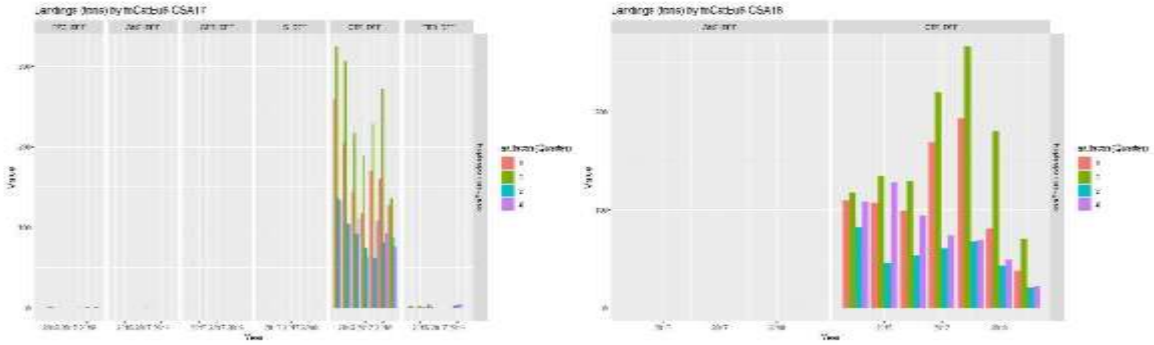


Figure 4.3d – *N. norvegicus* in GSAs 17 and 18. Landings by year, quarter and Fishing activity category European lvl 6.

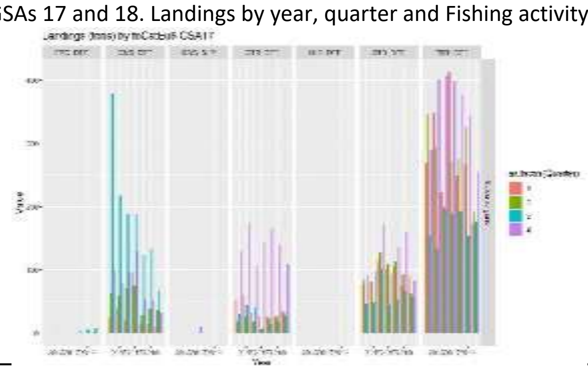


Figure 4.3e – *S. solea* in GSA 17. Landings by year, quarter and Fishing activity category European lvl 6.

OPTIMIZATION RESULTS

The “optimal” sampling size was calculated through the 05_runOptimizationBYspecies.Rmd script from the SD Tool. The analysis was based on the calculation of the CV associated to raised LFDs of a given species per year and per métier (Tab. 4.3.1). The CVs versus the number of trips are shown in Fig. 4.2.1 a-c, where vertical blue lines are referred to the first 4 local maxima of the density kernel function used to derive the optimal sampling size range based on the historical sampling data and expert knowledge. Only the species characterizing the fishery were reported. The figures showed that:

- In GSA18, the current sampling of OTB_DEF is optimal for the main target species (MUT, HKE and DPS);
- In GSA18, the current sampling of LLS_DEF is under-sampling the main target species (HKE);
- In GSA18, the current sampling of NETS (GNS+GTR) is under-sampling the main target species (MUT);
- In GSA17, the current sampling of OTB_DEF in Italy and in Croatia is optimal for the main target species (MUT, HKE and NEP);
- In GSA17, the current sampling GNS, GTR and TBB is optimal for the main target species (SOL).

Table 4.3.1 – Solutions (trips) of the optimization algorithm

Species	Var1	Var2	Var3	solutions	maxCV	minCV	maxRR	minRR	meanRR	noIterations
DPS	GSA18	ITA	OTB_DEF	16	0.52	0.22	0	0	0	13
DPS	GSA18	ITA	OTB_DEF	27	0.3	0.15	0.1	0	0.03	16
DPS	GSA18	ITA	OTB_DEF	36	0.23	0.14	0.17	0	0.06	8
DPS	GSA18	ITA	OTB_DEF	42	0.22	0.17	0.11	0.03	0.06	8
NEP	GSA18	ITA	OTB_DEF	15	0.42	0.28	0.15	0	0.03	15
NEP	GSA18	ITA	OTB_DEF	23	0.37	0.23	0.11	0	0.06	7
NEP	GSA18	ITA	OTB_DEF	29	0.27	0.22	0.12	0.04	0.08	3
NEP	GSA18	ITA	OTB_DEF	35	0.26	0.2	0.06	0.03	0.04	5
HKE	GSA18	ITA	LLS_DEF	18	0.67	0.37	0.24	0	0.09	10
HKE	GSA18	ITA	LLS_DEF	32	0.34	0.3	0.35	0.18	0.26	5
HKE	GSA18	ITA	LLS_DEF	38	0.3	0.23	0.42	0.29	0.35	4
HKE	GSA18	ITA	LLS_DEF	48	0.25	0.23	0.4	0.28	0.35	4
HKE	GSA18	ITA	OTB_DEF	19	0.52	0.24	0.07	0	0.01	8
HKE	GSA18	ITA	OTB_DEF	47	0.35	0.17	0.15	0	0.07	24
HKE	GSA18	ITA	OTB_DEF	>47	0.24	0.14	0.2	0.05	0.12	18
MUT	GSA18	ITA	OTB_DEF	21	0.56	0.26	0.14	0	0.03	13
MUT	GSA18	ITA	OTB_DEF	42	0.32	0.25	0.11	0	0.05	10
MUT	GSA18	ITA	OTB_DEF	55	0.35	0.16	0.17	0.04	0.08	10
MUT	GSA18	ITA	OTB_DEF	>55	0.25	0.16	0.21	0.05	0.13	17
MUT	GSA18	ITA	NETS	26	0.74	0.33	0.21	0	0.07	18
MUT	GSA18	ITA	NETS	44	0.46	0.25	0.23	0.07	0.16	8
MUT	GSA18	ITA	NETS	>44	0.36	0.13	0.48	0.19	0.34	24
DPS	GSA17	HRV	OTB_DEF	15	0.71	0.21	0.2	0	0.07	15
DPS	GSA17	HRV	OTB_DEF	28	0.34	0.15	0.32	0	0.16	11
DPS	GSA17	HRV	OTB_DEF	34	0.31	0.15	0.38	0.18	0.27	5
DPS	GSA17	HRV	OTB_DEF	37	0.21	0.16	0.33	0.11	0.22	5

Species	Var1	Var2	Var3	solutions	maxCV	minCV	maxRR	minRR	meanRR	noIterations
DPS	GSA17	ITA	OTB_DEF	59	4.92	3.28	0.29	0	0.15	39
DPS	GSA17	ITA	OTB_DEF	84	5.11	0.22	0.37	0.14	0.26	25
DPS	GSA17	ITA	OTB_DEF	161	0.94	0.15	0.36	0.23	0.31	15
NEP	GSA17	HRV	OTB_DEF	22	0.66	0.16	0.15	0	0.05	13
NEP	GSA17	HRV	OTB_DEF	49	0.62	0.14	0.24	0.04	0.14	37
NEP	GSA17	HRV	OTB_DEF	61	0.35	0.14	0.25	0.13	0.2	11
NEP	GSA17	HRV	OTB_DEF	>61	0.34	0.11	0.35	0.18	0.27	39
NEP	GSA17	ITA	OTB_DEF	34	0.68	0.24	0.19	0	0.05	36
NEP	GSA17	ITA	OTB_DEF	55	0.52	0.2	0.26	0.03	0.16	25
NEP	GSA17	ITA	OTB_DEF	68	0.35	0.21	0.29	0.13	0.21	9
NEP	GSA17	ITA	OTB_DEF	>68	0.42	0.17	0.33	0.19	0.26	30
HKE	GSA17	HRV	OTB_DEF	24	0.54	0.28	0.33	0	0.04	21
HKE	GSA17	HRV	OTB_DEF	29	0.41	0.29	0.14	0	0.07	9
HKE	GSA17	HRV	OTB_DEF	41	0.36	0.25	0.15	0	0.07	15
HKE	GSA17	HRV	OTB_DEF	47	0.31	0.23	0.16	0.02	0.09	5
HKE	GSA17	ITA	OTB_DEF	24	0.75	0.23	0.13	0	0.03	21
HKE	GSA17	ITA	OTB_DEF	73	0.44	0.19	0.19	0	0.1	53
HKE	GSA17	ITA	OTB_DEF	>73	0.29	0.16	0.22	0.07	0.14	26
MUT	GSA17	HRV	OTB_DEF	19	0.67	0.17	0.1	0	0.01	17
MUT	GSA17	HRV	OTB_DEF	27	0.44	0.26	0.12	0	0.06	7
MUT	GSA17	HRV	OTB_DEF	34	0.28	0.16	0.1	0.03	0.07	7
MUT	GSA17	HRV	OTB_DEF	44	0.33	0.17	0.12	0	0.06	10
MUT	GSA17	ITA	OTB_DEF	13	0.37	0.17	0.12	0	0.03	11
MUT	GSA17	ITA	OTB_DEF	21	0.3	0.22	0.12	0	0.04	7
MUT	GSA17	ITA	OTB_DEF	26	0.27	0.17	0.09	0	0.04	6
MUT	GSA17	ITA	OTB_DEF	34	0.27	0.13	0.12	0	0.06	9
SOL	GSA17	HRV	GTR_DEF	27	0.84	0.3	0.6	0	0.36	16
SOL	GSA17	HRV	GTR_DEF	64	0.36	0.22	0.77	0.57	0.69	14
SOL	GSA17	HRV	GTR_DEF	75	0.23	0.19	0.83	0.79	0.81	9
SOL	GSA17	HRV	GTR_DEF	128	0.24	0.15	0.89	0.82	0.86	31
SOL	GSA17	ITA	GNS_DEF	13	0.43	0.22	0.08	0	0.01	9
SOL	GSA17	ITA	GNS_DEF	17	0.28	0.19	0	0	0	2
SOL	GSA17	ITA	GNS_DEF	28	0.36	0.14	0.11	0	0.03	15
SOL	GSA17	ITA	GNS_DEF	34	0.19	0.15	0.03	0	0.02	6
SOL	GSA17	ITA	GTR_DEF	17	0.49	0.18	0.44	0	0.17	16
SOL	GSA17	ITA	GTR_DEF	28	0.27	0.19	0.41	0.11	0.27	10
SOL	GSA17	ITA	GTR_DEF	36	0.27	0.2	0.44	0.28	0.36	6
SOL	GSA17	ITA	GTR_DEF	58	0.21	0.12	0.59	0.38	0.5	18
SOL	GSA17	ITA	TBB_DEF	13	0.37	0.23	0.1	0	0.02	11
SOL	GSA17	ITA	TBB_DEF	20	0.33	0.22	0.07	0	0.02	6
SOL	GSA17	ITA	TBB_DEF	30	0.21	0.2	0.2	0	0.11	7
SOL	GSA17	ITA	TBB_DEF	36	0.2	0.17	0.19	0.12	0.16	5

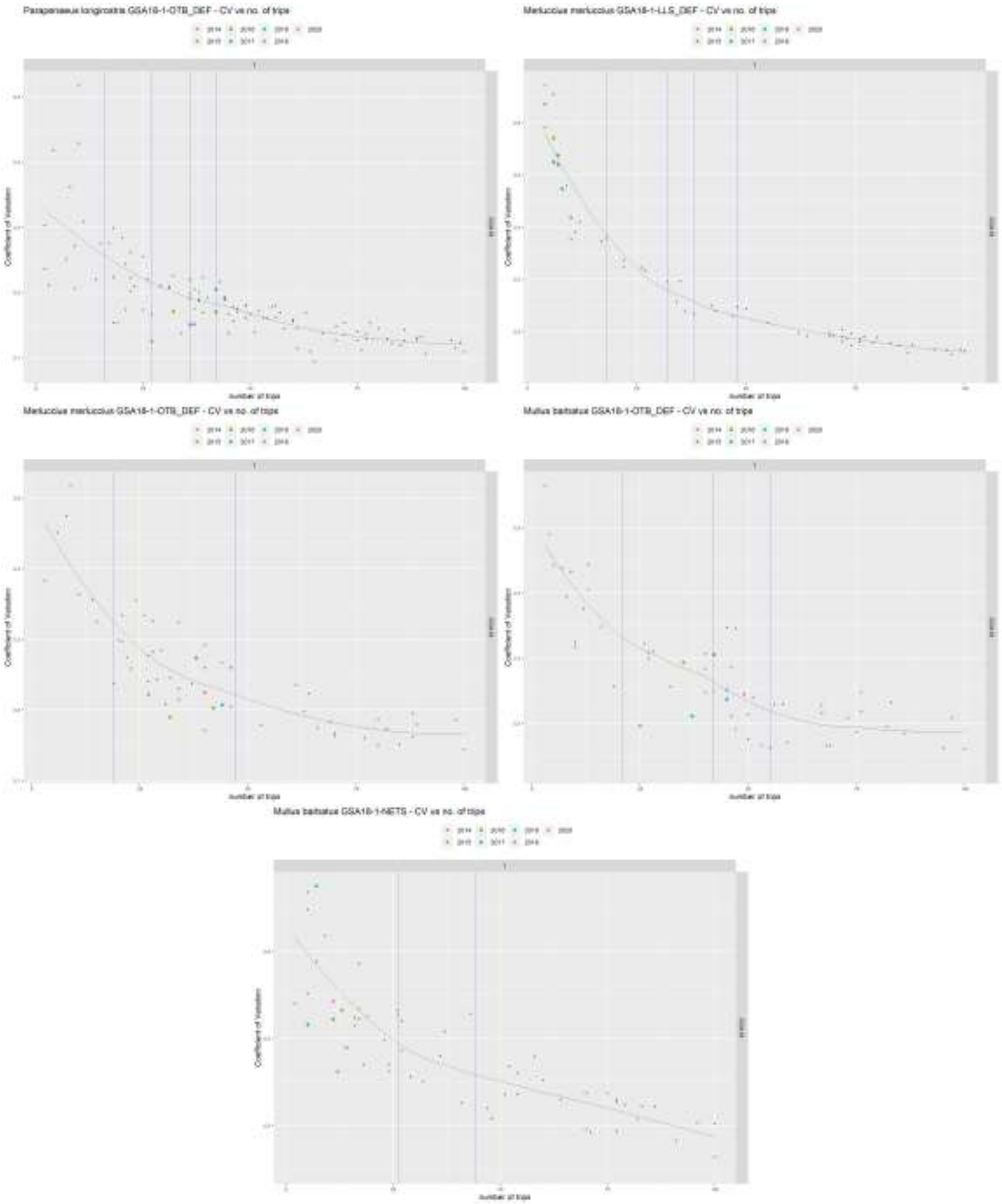
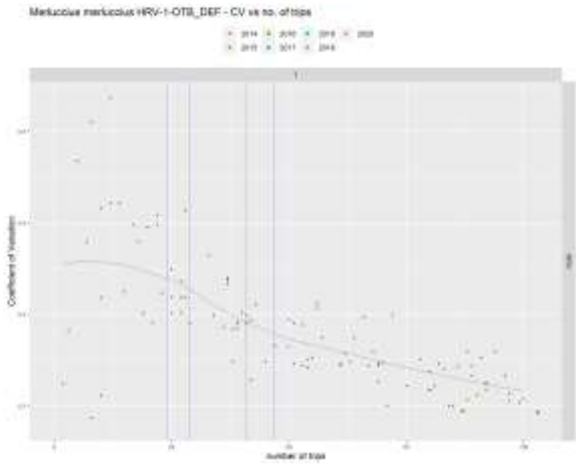
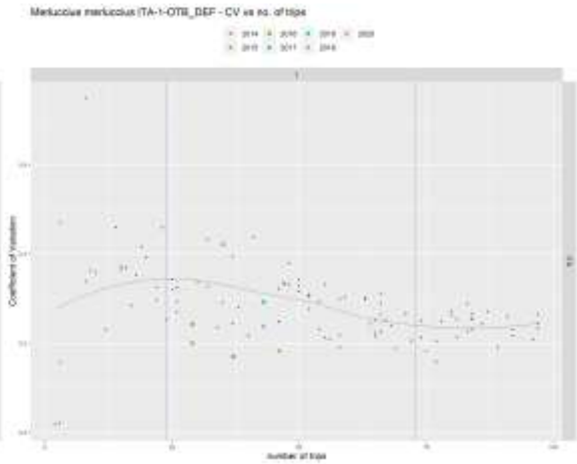
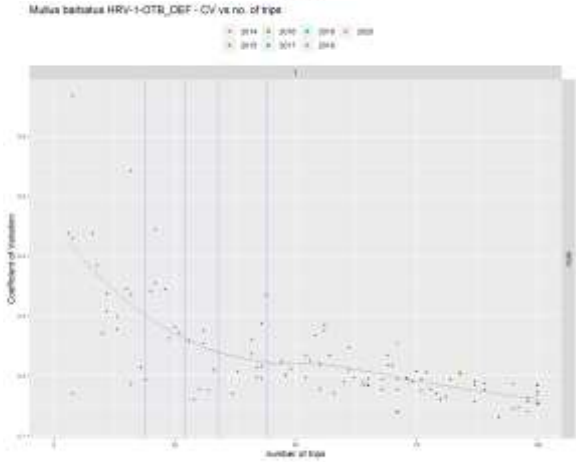
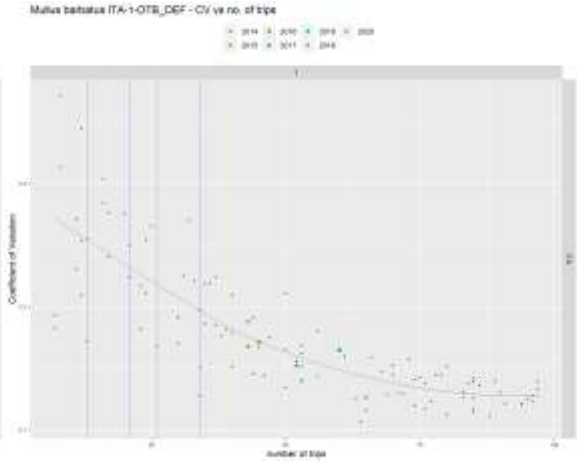


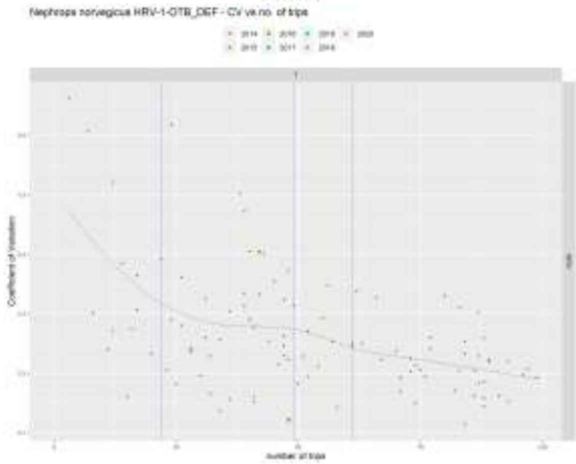
Figure 4.3.2 a – CV versus number of trips by species and métier in GSA 18 at year level.

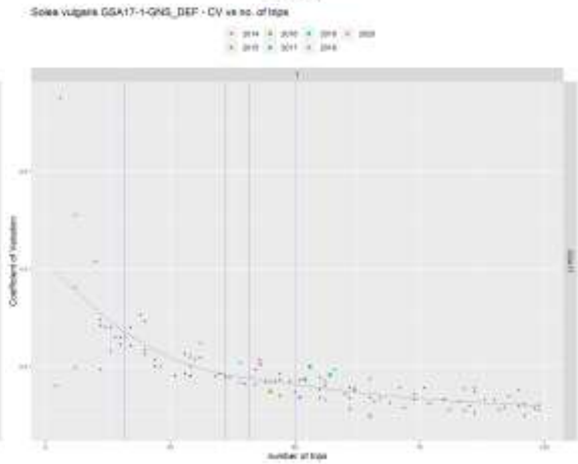

Merluccius merluccius HRV-1-OTB_DEF - CV vs no. of trips

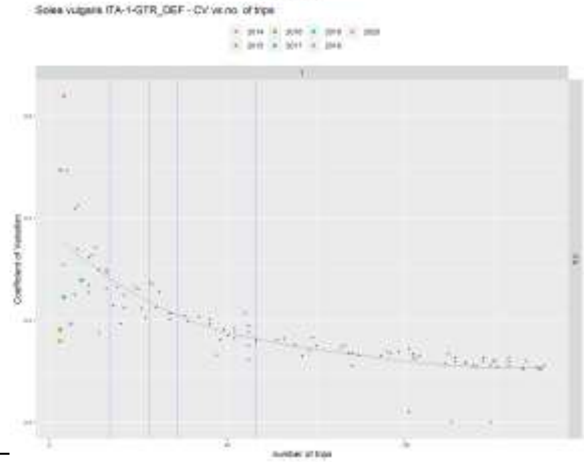

Merluccius merluccius ITA-1-OTB_DEF - CV vs no. of trips


Mullus barbatus HRV-1-OTB_DEF - CV vs no. of trips


Mullus barbatus ITA-1-OTB_DEF - CV vs no. of trips


Nephrops norvegicus HRV-1-OTB_DEF - CV vs no. of trips


Solea vulgaris GSA17-1-GNS_DEF - CV vs no. of trips


Solea vulgaris ITA-1-GTR_DEF - CV vs no. of trips

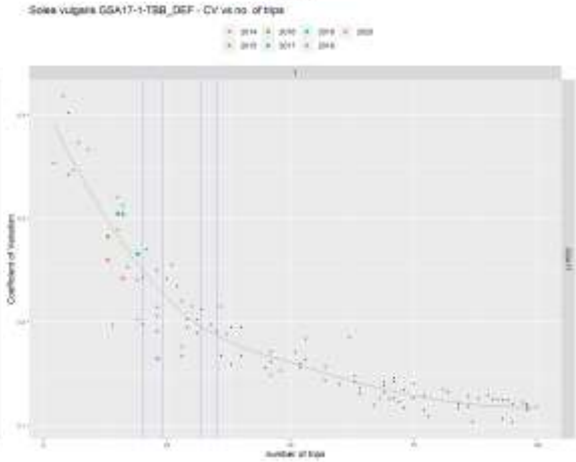
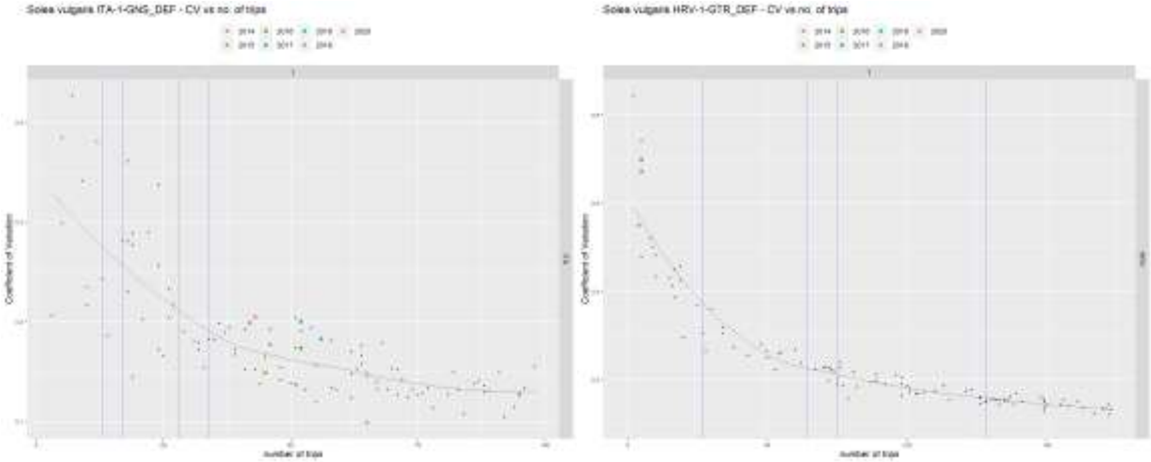

Solea vulgaris GSA17-1-TBB_DEF - CV vs no. of trips

Figure 4.3.2 b – CV versus number of trips by country, species and métier in GSA 17 at year level.



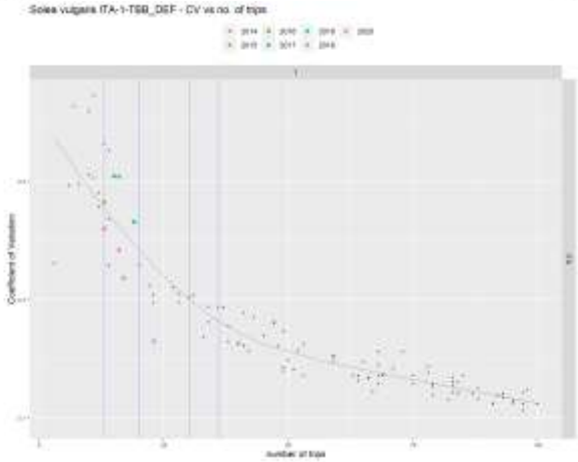


Figure 4.3.2 c – CV versus number of trips by country, species and métier in GSA 17 at year level.

SCENARIOS DESIGN

In this exercise, two sampling designs (Tab.4.3.2) have been compared with the current one (baseline) to explore the impact on precision, using the CV (of LFDs) on the target species (*M. merluccius, M. barbatus, P. longirostris, S. vulgaris, N. norvegicus*) of the métier listed in the previous paragraph,.

For each Country, GSA and métier, the optimal number of trips has been estimated both by quarter and year. The trade-off among the species for each métier has been found on the basis of the species characterizing the fishery, using the following ratio: total number of planned trips/positive trips to the species. The species with ratio <2.5 were selected as characterizing the fishery.

Scenario 1 was defined following these criteria:

- For OTB_DEF, an average of the 1st solutions of the main species (optimization at quarter level) was considered for both GSA;
- For LLS (present only in GSA 18), the 1st solution (optimization at year level) on European hake was used;
- Considering NETS, the optimization was actually based on a unique species, occurring often in less than 40% of the trips; therefore, Scenario1 was carried out doubling (based on local experts knowledge) the number of trips provided by the first solution for red mullet;
- According to the same rationale, for GNS, GTR and TBB in GSA 17, the 1st solution for common sole was used, and Scenario 1 was defined with a 50% (based on local experts knowledge) increased number of trips respect to the 1st solution.

Scenario 2 is like Scenario 1 for all the Countries and métier, except GSA 17 Italian OTB_DEF and GNS:

- For OTB_DEF, an average of the 2nd solutions of the main species (optimization at year level) was considered;

- For GNS an average of the 1st and 2nd solutions of sole was considered.

For Scenario 2, sub-sampling by species and category, where possible, was applied (Tab. 4.3.3). The sub-sampling factors were estimated by means of the BioSim Tool 1.01 scripts.
In the simulations, the different number of positive trips for each species, Country and métier has been taken into account.

Tab. 4.3.2 – Scenarios applied in the Case Study 3

Area	Métier (short code)	Baseline	Scenario_1	Scenario_2
GSA 18	OTB_DEF	52	69	69 + sub-sample by cat and species
GSA 18	GNS	30	33	33 + sub-sample by cat and species
GSA 18	GTR	17	19	30 + sub-sample by cat and species
GSA 18	LLS	12	22	None
GSA17_ITA	OTB_DEF	70	78	101 + sub-sample by species
GSA17_ITA	GNS	62	58	82
GSA17_ITA	GTR	18	26	None
GSA17_ITA	TBB	20	22	22 + sub-sample by species
GSA17_HRV	OTB_DEF	85	101	101 + sub-sample by species
GSA17_HRV	GTR	24	41	None

Tab. 4.3.3 – Sub-samplings by species and category applied in the Case Study 3

Area	commCat	Métier_Gear	Sub_sample	SPECIE
GSA 18	1	OTB_DEF	0.5	DPS
GSA 18	2	OTB_DEF	0.25	DPS
GSA 18	3	OTB_DEF	0.5	DPS
GSA 18	S	OTB_DEF	0.5	DPS
GSA 18	1	OTB_DEF	0.5	HKE
GSA 18	2	OTB_DEF	0.5	HKE
GSA 18	3	OTB_DEF	0.25	HKE
GSA 18	4	OTB_DEF	0.25	HKE
GSA 18	LM	OTB_DEF	1	HKE
GSA 18	S	OTB_DEF	0.25	HKE
GSA 18	1	GNS_DEF	0.5	MUT
GSA 18	2	GNS_DEF	0.5	MUT
GSA 18	1	GTR_DEF	0.5	MUT
GSA 18	2	GTR_DEF	0.5	MUT
GSA 18	1	OTB_DEF	1	MUT
GSA 18	2	OTB_DEF	0.5	MUT
GSA 18	3	OTB_DEF	0.5	MUT
GSA 18	S	OTB_DEF	0.5	MUT
GSA 18	1	OTB_DEF	1	NEP
GSA 18	2	OTB_DEF	0.5	NEP
GSA 18	3	OTB_DEF	0.5	NEP
GSA 18	S	OTB_DEF	1	NEP
GSA17 HRV	ALL	OTB_DEF	0.5	DPS
GSA17 ITA	ALL	OTB_DEF	0.25	DPS
GSA17 HRV	ALL	OTB_DEF	0.25	HKE

GSA17 ITA	ALL	OTB_DEF	0.5	HKE
GSA17 HRV	ALL	OTB_DEF	0.5	MUT
GSA17 ITA	ALL	OTB_DEF	0.25	MUT
GSA17 HRV	ALL	OTB_DEF	0.5	NEP
GSA17 ITA	ALL	OTB_DEF	0.5	NEP
GSA17 ITA	ALL	TBB	0.5	SOL

SCENARIOS RESULTS

The results on the Case Study 3 are reported in Table 4.3.3 .

In Croatia, the increase in fishing trips monitored does not show an important improvement in the precision (2-7%), and the reduction of the number of length measurements through sub-sample has the effect of worsening the precision for the 5 species monitored.

In the Western side of GSA17, the increase in fishing trips monitored does not show an important improvement in the precision (1-2%), and in some cases there is no improvement, and the reduction of the number of length measurements through sub-sample has the effect of worsening the precision for the 5 species monitored.

In GSA18, the increase in fishing trips monitored improves the CV, especially for longlines, and the reduction of the number of length measurements through sub-sampling scenarios highlighted the possibility of reducing or maintaing the man-hours while diversifying the sampling (monitoring more fishing trips).

Tab. 4.2.3 - – Final results in terms of CV by species, country and métier.

country	species	GSA	Var3	scenario	CV	no_trip	no_indiv	% change length	% change trips
HRV	*S. vulgaris*	GSA17	GTR_DEF	Baseline	57.3	24	146		
HRV	*S. vulgaris*	GSA17	GTR_DEF	Scenario_1	50.14	41	267	83%	71%
HRV	*P. longirostris*	GSA17	OTB_DEF	Baseline	25.97	85	1378		
HRV	*P. longirostris*	GSA17	OTB_DEF	Scenario_1	23.72	101	1724	25%	19%
HRV	*P. longirostris*	GSA17	OTB_DEF	Scenario_2	32.71	101	855	-38%	19%
HRV	*M. merluccius*	GSA17	OTB_DEF	Baseline	21.8	85	10612		
HRV	*M. merluccius*	GSA17	OTB_DEF	Scenario_1	19.74	101	13088	23%	19%
HRV	*M. merluccius*	GSA17	OTB_DEF	Scenario_2	29.48	101	6817	-36%	19%
HRV	*M. barbatus*	GSA17	OTB_DEF	Baseline	16.48	85	9397		
HRV	*M. barbatus*	GSA17	OTB_DEF	Scenario_1	15.32	101	11260	20%	19%
HRV	*M. barbatus*	GSA17	OTB_DEF	Scenario_2	37.96	101	6774	-28%	19%
HRV	*N. norvegicus*	GSA17	OTB_DEF	Baseline	23.5	85	3135		
HRV	*N. norvegicus*	GSA17	OTB_DEF	Scenario_1	24.9	101	3703	18%	19%
HRV	*N. norvegicus*	GSA17	OTB_DEF	Scenario_2	34.02	101	2451	-22%	19%
ITA	*S. vulgaris*	GSA17	GNS_DEF	Baseline	16.58	62	3436		
ITA	*S. vulgaris*	GSA17	GNS_DEF	Scenario_1	16.57	58	3186	-7%	-6%
ITA	*S. vulgaris*	GSA17	GNS_DEF	Scenario_2	14.53	82	4538	32%	32%
ITA	*S. vulgaris*	GSA17	GTR_DEF	Baseline	36.03	18	164		
ITA	*S. vulgaris*	GSA17	GTR_DEF	Scenario_1	35.38	26	226	38%	44%
ITA	*P. longirostris*	GSA17	OTB_DEF	Baseline	39.35	70	2627		
ITA	*P. longirostris*	GSA17	OTB_DEF	Scenario_1	52.96	78	2910	11%	11%

country	species	GSA	Var3	scenario	CV	no_trip	no_indiv	% change length	% change trips
ITA	*P. longirostris*	GSA17	OTB_DEF	Scenario_2	64.46	101	1605	-39%	44%
ITA	*M. merluccius*	GSA17	OTB_DEF	Baseline	28.45	70	4470		
ITA	*M. merluccius*	GSA17	OTB_DEF	Scenario_1	27.66	78	4864	9%	11%
ITA	*M. merluccius*	GSA17	OTB_DEF	Scenario_2	35.32	101	4249	-5%	44%
ITA	*M. barbatus*	GSA17	OTB_DEF	Baseline	16.5	70	10003		
ITA	*M. barbatus*	GSA17	OTB_DEF	Scenario_1	15.02	78	11512	15%	11%
ITA	*M. barbatus*	GSA17	OTB_DEF	Scenario_2	18.76	101	7707	-23%	44%
ITA	*N. norvegicus*	GSA17	OTB_DEF	Baseline	35.96	70	1566		
ITA	*N. norvegicus*	GSA17	OTB_DEF	Scenario_1	36.96	78	1810	16%	11%
ITA	*N. norvegicus*	GSA17	OTB_DEF	Scenario_2	45.12	101	1850	18%	44%
ITA	*S. vulgaris*	GSA17	TBB_DEF	Baseline	25.11	20	4018		
ITA	*S. vulgaris*	GSA17	TBB_DEF	Scenario_1	24.8	22	4388	9%	10%
ITA	*S. vulgaris*	GSA17	TBB_DEF	Scenario_2	32.57	22	2433	-39%	10%
ITA	*M. barbatus*	GSA18	GNS_DEF	Baseline	50.8	30	309		
ITA	*M. barbatus*	GSA18	GNS_DEF	Scenario_1	46.93	33	436	41%	10%
ITA	*M. barbatus*	GSA18	GNS_DEF	Scenario_2	45.95	33	303	-2%	10%
ITA	*M. barbatus*	GSA18	GTR_DEF	Baseline	55.42	17	195		
ITA	*M. barbatus*	GSA18	GTR_DEF	Scenario_1	51.75	19	337	73%	12%
ITA	*M. barbatus*	GSA18	GTR_DEF	Scenario_2	54.53	30	195	0%	76%
ITA	*M. merluccius*	GSA18	LLS_DEF	Baseline	43.97	12	846		
ITA	*M. merluccius*	GSA18	LLS_DEF	Scenario_1	34.92	22	1500	77%	83%
ITA	*M. merluccius*	GSA18	OTB_DEF	Baseline	22.52	52	7773		
ITA	*M. merluccius*	GSA18	OTB_DEF	Scenario_1	19.85	69	10325	33%	33%
ITA	*M. merluccius*	GSA18	OTB_DEF	Scenario_2	20.19	69	8500	9%	33%
ITA	*M. barbatus*	GSA18	OTB_DEF	Baseline	24.85	52	10986		
ITA	*M. barbatus*	GSA18	OTB_DEF	Scenario_1	22.01	69	14852	35%	33%
ITA	*M. barbatus*	GSA18	OTB_DEF	Scenario_2	22.99	69	10760	-2%	33%
ITA	*N. norvegicus*	GSA18	OTB_DEF	Baseline	26.03	52	5501		
ITA	*N. norvegicus*	GSA18	OTB_DEF	Scenario_1	23.16	69	7583	38%	33%
ITA	*N. norvegicus*	GSA18	OTB_DEF	Scenario_2	24.49	69	5028	-9%	33%
ITA	*P. longirostris*	GSA18	OTB_DEF	Baseline	17.55	52	28936		
ITA	*P. longirostris*	GSA18	OTB_DEF	Scenario_1	15.84	69	36983	28%	33%
ITA	*P. longirostris*	GSA18	OTB_DEF	Scenario_2	16.21	69	16501	-43%	33%

4.4 CASE STUDY 4

DATA AVAILABILITY AND EXPLORATION

The small pelagic species *E. encrasicolus* (ANE) and *S. pilchardus* (PIL) in the Adriatic Sea (GSAs 17 and 18) are mainly exploited by the PS and PTM métiers. The dataset we used include data for Croatia and Italy, Slovenian data were excluded (Figures 4.4.1 a-b).

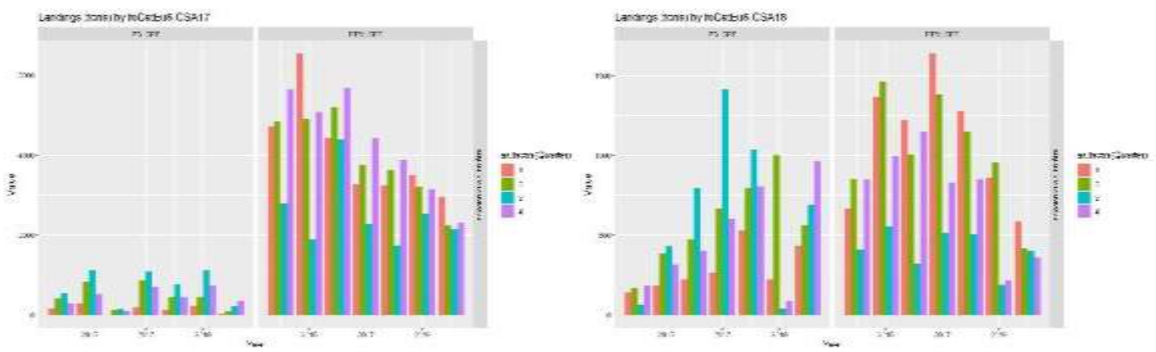


Figure 4.4.1 a – *E. encrasicolus* in GSAs 17 and 18. Landings by year, quarter and Fishing activity category European lvl 6.

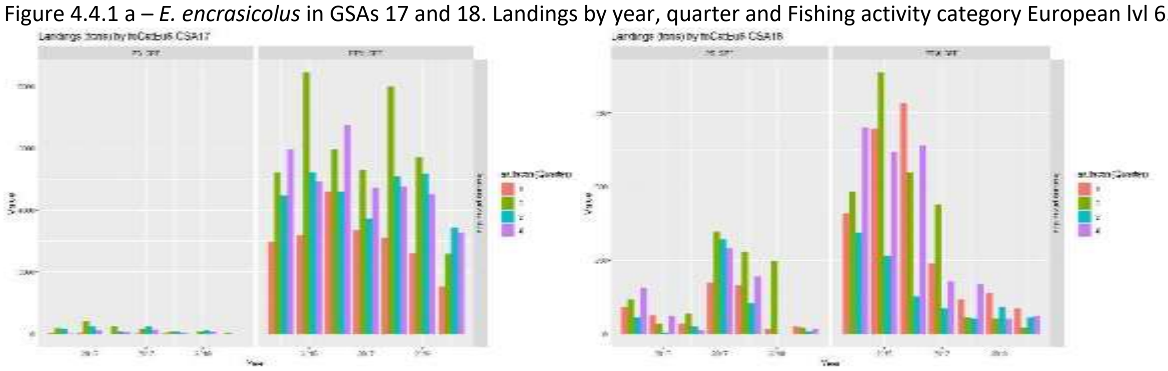


Figure 4.4.1 b – *S. pilchardus* in GSAs 17 and 18. Landings by year, quarter and Fishing activity category European lvl 6.

OPTIMIZATION RESULTS

The “optimal” sampling size was calculated through the 05_runOptimizationBYspecies.Rmd script from the SD Tool. The analysis was based on the calculation of the CV associated to raised LFDs of a given species per year and per métier (Tab. 4.4.1). The CVs versus the number of trips are shown in Fig. 4.4.2, where vertical blue lines are referred to the first 4 local maxima of the density kernel function used to derive the optimal sampling size range based on the historical sampling data and expert knowledge. Only the species characterizing the fishery were reported. The figures showed that the current monitoring has been under-sampling every year PIL caught by PS in Italy, whilst the current sampling of the other combination species/métier has been in the optimal range for several years.

Table 4.4.1 – Solutions (trips) of the optimization algorithm

Species	Var1	GSA	Var2	solutions	maxCV	minCV	maxRR	minRR	meanRR	noIterations
ANE	HRV	17	PS_SPF	29	1.12	0.26	0.13	0	0.04	33
ANE	HRV	17	PS_SPF	68	0.44	0.26	0.2	0.02	0.11	29
ANE	HRV	17	PS_SPF	110	0.36	0.18	0.25	0.11	0.18	38
ANE	ITA	17-18	PS_SPF	12	0.42	0.22	0.08	0	0.01	11
ANE	ITA	17-18	PS_SPF	24	0.29	0.14	0.21	0	0.07	10
ANE	ITA	17-18	PS_SPF	35	0.22	0.15	0.11	0.03	0.06	6
ANE	ITA	17-18	PS_SPF	42	0.18	0.14	0.15	0.05	0.11	11
ANE	ITA	17-18	PTM_SPF	13	0.6	0.15	0.17	0	0.02	14
ANE	ITA	17-18	PTM_SPF	19	0.3	0.2	0.06	0	0.04	3
ANE	ITA	17-18	PTM_SPF	27	0.3	0.18	0.08	0	0.01	6
ANE	ITA	17	PTM_SPF	30	0.21	0.19	0.04	0.03	0.04	2
PIL	HRV	17	PS_SPF	22	0.85	0.33	0.11	0	0.02	11
PIL	HRV	17	PS_SPF	63	0.34	0.2	0.11	0	0.04	22
PIL	HRV	17	PS_SPF	75	0.24	0.18	0.14	0	0.07	7

PIL	HRV	17	PS_SPF	84	0.21	0.18	0.13	0.04	0.08	6
PIL	ITA	17-18	PS_SPF	27	0.55	0.28	0.33	0	0.17	14
PIL	ITA	17-18	PS_SPF	>27	0.45	0.16	0.68	0.28	0.52	36
PIL	ITA	17-18	PTM_SPF	31	0.31	0.12	0.17	0	0.04	8
PIL	ITA	17-18	PTM_SPF	42	0.23	0.17	0.08	0	0.05	5
PIL	ITA	17-18	PTM_SPF	>42	0.23	0.11	0.22	0.04	0.11	34

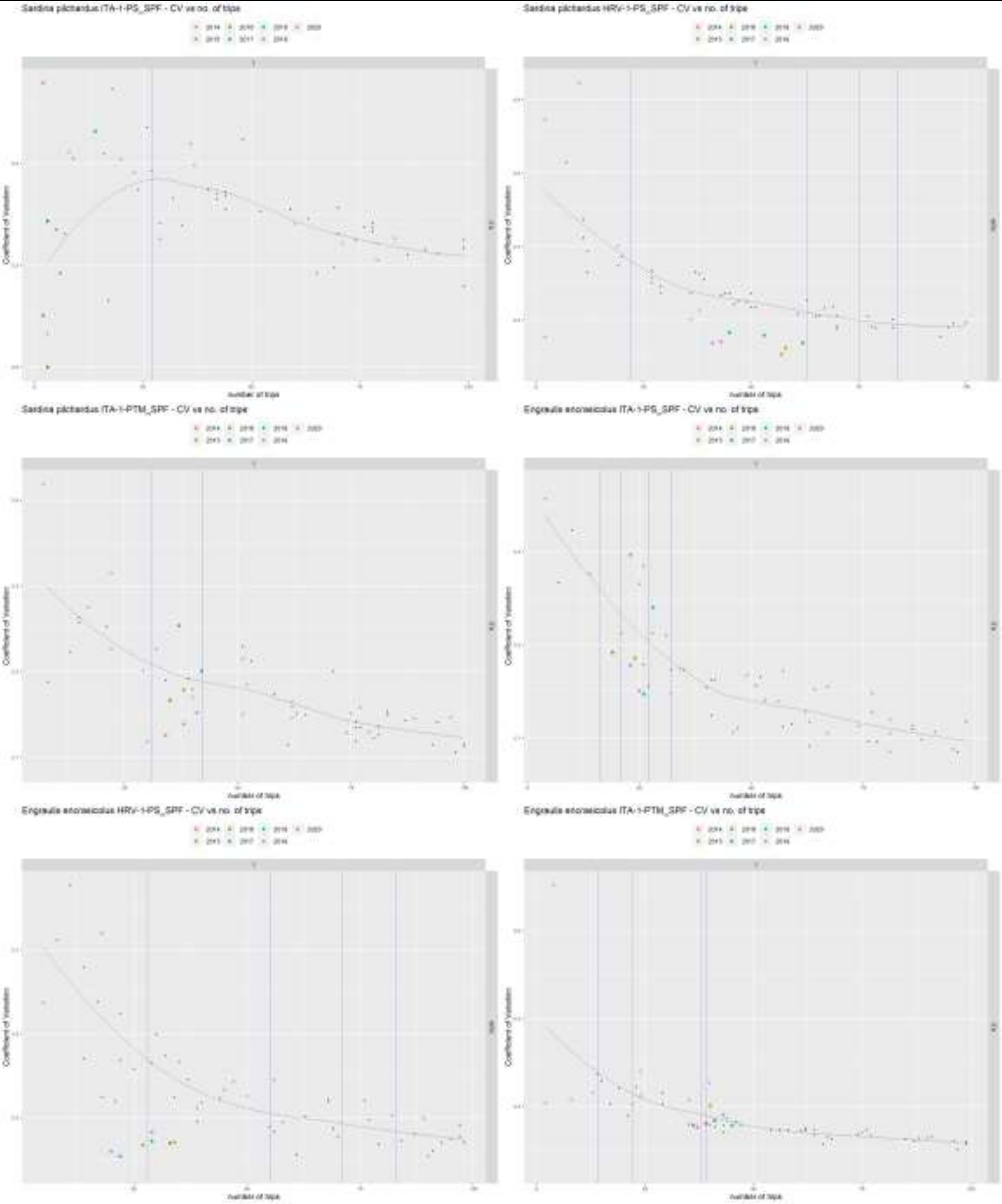


Figure 4.4.2 – CV versus number of trips for Case study 1. Vertical blue lines are referred to the optimal sampling size range inferred via the method.

For Croatia, the scenarios were based on the optimal solutions on sardine (main target of the fishery), while for Italy on anchovy. Despite for Croatia and Italy PS_SPF the optimal number of trips was found in line with the current number of positive trips to sardine (Croatia) and anchovy (Italy), it was decided to explore an increase by about 50% of trips to evaluate the actual improvement in precision. For Italy PTM_SPF, the results of the optimization show a situation of oversampling for anchovy; for this reason the optimal number of trips was decreased by 30%, corresponding to the higher solution (Table 4.4.2). An additional scenario, requested by local experts, was included for PS_SPF in Croatia.

Tab. 4.4.2 – Scenarios applied in the Case Study 4

Area	Country-métier	Baseline	Scenario 1	Scenario 2	Scenario 2
GSA 17	HRV-PS	72	105	105 + sub-sample by species	82
GSA 17-18	ITA PS	28	39	39 + sub-sample by species	None
GSA 17-18	ITA PTM	46	30	46 + sub-sample by species	None

For Scenario 2, sub-sampling by species was applied. The sub-sampling factors were estimated applying BioSim Tool (Tab.4.4.3).
In the simulations, the different number of positive trips for each species, Country and métier has been taken into account.

Tab. 4.4.3 – Sub-samplings by species and category from BioSim tool and applied in the Case Study 4

Area	commCat	Métier_Gear	Sub_sample	SPECIE
GSA17 HRV	ALL	PS	0.25	ANE
GSA 17-18 ITA	ALL	PS	0.25	ANE
GSA 17-18 ITA	ALL	PTM	0.5	ANE
GSA17 HRV	ALL	PS	0.25	PIL
GSA 17-18 ITA	ALL	PS	1	PIL
GSA 17-18 ITA	ALL	PTM	0.5	PIL

SCENARIOS RESULTS

The results on the Case Study 4 are reported in Table 4.4.3.
For Croatia, it would be advisable to increase by 45% the number of fishing trips to reduce by a half the length measurements needed to achieve a CV equal or smaller than the CV corresponding to current sampling design. For Italy, the increase by 40% of the number of monitored trips for PS would allow to reduce the CV of anchovy by 3% only. For PTM, the decrease of monitored trips (35%) is not advisable. The results show that, while maintaining the same number of trips, it would be possible to reduce by a half the number of measurements.

Tab. 4.4.3 – Final results in terms of CV by species, country and métier.

species	Var1	Var3	scenario	CV	no_trip	no_indiv	% change length	% change trips
ANE	HRV	PS_SPF	Baseline	48.67	72	7114		
ANE	HRV	PS_SPF	Scenario_1	41.26	105	10105	42%	46%
ANE	HRV	PS_SPF	Scenario_2	43.68	105	3428	-52%	46%
ANE	HRV	PS_SPF	Scenario_3	43.91	82	8027	13%	14%
ANE	ITA	PS_SPF	Baseline	19.12	28	4816		
ANE	ITA	PS_SPF	Scenario_1	16.36	39	6782	41%	39%
ANE	ITA	PS_SPF	Scenario_2	19.39	39	4199	-13%	39%

ANE	ITA	PTM_SPF	Baseline	16.57	46	12212		
ANE	ITA	PTM_SPF	Scenario_1	20.46	30	7915	-35%	-35%
ANE	ITA	PTM_SPF	Scenario_2	18.37	46	6524	-47%	0%
PIL	HRV	PS_SPF	Baseline	26.6	72	10074		
PIL	HRV	PS_SPF	Scenario_1	22.03	105	14604	45%	46%
PIL	HRV	PS_SPF	Scenario_2	24.37	105	5773	-43%	46%
PIL	HRV	PS_SPF	Scenario_3	24.62	82	11938	19%	14%
PIL	ITA	PS_SPF	Baseline	27.83	28	516		
PIL	ITA	PS_SPF	Scenario_1	27.72	39	676	31%	39%
PIL	ITA	PS_SPF	Scenario_2	33.41	39	604	17%	39%
PIL	ITA	PTM_SPF	Baseline	17.72	46	8946		
PIL	ITA	PTM_SPF	Scenario_1	20.74	30	5947	-34%	-35%
PIL	ITA	PTM_SPF	Scenario_2	17.32	46	5165	-42%	0%

5 CONCLUSIONS

In this deliverable, the outcomes of the training workshop on sampling optimization tools held in November-December 2021 were presented. The workshop was organized to allow the experts of the different Member States to familiarize with the STREAM R tools on design optimization for biological sampling.

During the workshop four case studies were identified, because of relevance for Management Plans in Mediterranean and Black Sea. For each case study, reference experts were identified for running the analyses.

After the workshop a series of virtual meetings were organized by case study, providing technical and methodological support.

The application of SDTool and BioSim Tool to the Black Sea, Western Med (Spain and France) and Adriatic Sea allowed to provide a quantitative idea of how the sampling design could be optimized in each investigated fishery, in terms of number of trips to be monitored and length measurements.

Task 2.1 results allowed to evaluate the impact of alternative sampling designs on the precision of raised LFDs of relevant stocks and to derive the possible impact of the trip monitoring costs and man-hours costs associated to the sampling.

The results of the four case studies were described and discussed during the RCG Med&BS 2022 annual meeting (6-9 September 2022) in order to be used for the draft non-binding RWPs submitted in October 2022. Feedback from the MS were collected and taken into account to refine the analyses.

The present results are expected to be complemented by an ad hoc evaluation of the sampling effort dedicated to the collection of biological information (e.g. maturity, age), requiring the purchase of samples and a dedicated laboratory work for samples processing. This part of the analysis was not carried out because the data provided presented, except in few specific cases, important gaps and/or high uncertainty on the individual data (e.g., age, sex, maturity). Nevertheless, the results achieved so far represent a robust basis for the further work that will be performed in the future by the incoming ISSG on Sampling Optimization (Scientific Network) to better refine the analyses and propose future sampling plans based on an optimized sampling strategy.

7. REFERENCES

Ligas A. (2019). Strengthening REgional cooperation in the Area of fisheries biological data collection in the Mediterranean and Black Sea (STREAM). MARE/2016/22 SI2.770115. Final Report. 86 pp. + Annexes

Wischnewski J., Bernreuther M., Kempf A., 2020. Admissible dissimilarity value (ADV) as a measure of subsampling reliability: case study North Sea cod (*Gadus morhua*). Environ Monit Assess (2020) 192: 756. https://doi.org/10.1007/s10661-020-08668-6

8. ANNEX I

STREAMLINE

Streamlining the establishment of regional work plans in the Mediterranean and Black Sea, STREAMLINE (SI2.839815)

Task 2.1 Sampling design optimization in all the métiers, including SSF, and identification of sampling hierarchy

Report of the Online Workshop on sampling design optimization R tools

29th November – 1st December 2021, Microsoft Teams

The Workshop on sampling design optimization R tools organized under the Task 2.1 of the STREAMLINE project met online from the 29th November to the 1st December 2021 (Microsoft Teams platform; see Annex I – Agenda), and was attended by 36 experts from nine EU Member States of the Mediterranean and Black Sea (see Annex II – List of participants). The Workshop was chaired by Isabella Bitetto (COISPA, Italy), Task 2.1 Leader, in cooperation with Alessandro Ligas (CIBM, Italy), STREAMLINE Coordinator.

The workshop opened with a general overview of the main objectives of the STREAMLINE regional grant and the strict cooperation with the RCG Med&BS activities with the common target of achieving the expected results of coordinated regional work for the fisheries data collection in the Mediterranean and Black Seas.

Ms Charis Charilaou, who led the Work Package 7 under the previous STREAM regional grant (MARE/2016/22), provided a presentation on the outcomes of STREAM WP7 and the feedback from the experts who attended the training workshops organized under the STREAM project. This knowledge and experience were taken into account in updating the R scripts and tool, and organizing the present workshop.

The training activity started with a presentation by Ms Bitetto providing an overview of the sampling optimization tools with a description of the new features foreseen under STREAMLINE project. The main objective of this training was to allow the experts to familiarize with the tools utilizing a dummy dataset. The use of the dummy dataset was also suggested by STREAM WP7 and is aimed to focus on the methodological and technical aspects rather than the possible issues on the data. A set of other workshops and trainings will be organized in the next weeks to apply the tools on the identified case studies to run the sampling scenarios and to interpret the results. The results of the case studies analyses will be presented to the RCG for their consideration as possible draft regional work plans to be submitted by October 2022.

To facilitate the use of the scripts and avoid conflict problems due to the use of the *knitr* package, the SDTool scripts have been extracted from the .Rmd.

SD Tool was implemented for the first time within MARE/2014/19 Med&BS project and further improved within STREAM project (MARE/2016/22). This tool allows, through bootstrap technique, to resample the historical data studying the Coefficient of Variation (CV), the raised LFDs and the Earth Mover Distance (EMD) for different stratifications (spatial, temporal, and technical) in association with the number of primary sampling units (i.e. trips) for a set of species.

The SD Tool v.2 includes options allowing a flexible definition of the sampling scheme. The optimization can be carried out on:

- different technical stratifications, introducing options to define the technical strata on the basis of gear (level 4) and/or métier, grouping strata with similar characteristics;
- different temporal aggregations, in order to make flexible the stratification by quarter and/or semester, depending on fisheries and target species specifications;
- different spatial aggregations, grouping data of stocks considered shared among MSs in order to get results on the whole area of the stock (not only by GSA).

The statistical principle behind the SDTool is represented by the CV decreasing curve, when increasing the number of sampling units. This curve is, firstly, interpolated and, secondly, the part of the curve where the tangent changes and begins to flatten (i.e. the curvature range) is considered as a suitable trade-off between the precision and the sampling effort. Then, the sample size (in term of sampling units) corresponding to that part of the curve is proposed as “optimal” sample size.
BioSim Tool was implemented for the first time within STREAM project (MARE 2016/22), taking advantage of the work carried out by ICES WKBIOPTIM. This tool allows, through bootstrap technique as well, to resample the historical data studying the Coefficient of Variation (CV) and the Earth Mover Distance (EMD) and to derive possible sub-samples to be applied on length measurements.
Moreover, an optimal number of individuals to be sampled for sex, maturity and age (the latter stratified by length class) by species can be derived.
The new developments foreseen under STREAMLINE projects are mainly represented by the implementation of additional quality indicators to the ones developed and tested in STREAM taking into account the work carried out in the ICES WKBIOPTIM3 and the work by Wischnewski et al. (2020). The new indicators are:

- Admissible dissimilarity Value (ADV), as a measure of sampling reliability based on the comparison of the modes, anti-modes and amplitude of the LFDs under different sampling scenarios;
- Mean length-at-age, mean age-at-length, parameters of the von Bertalanffy growth model, maturity ogive parameters, root mean squared prediction error (RMSPE), mean squared prediction error (MSPE) and the mean average percentage error (MAPE), to evaluate the variability of the relevant estimates (e.g. von Bertalanffy parameters, size at first maturity) under different scenarios and to identify a satisfactory sub-sampling strategy.

The technical requirements are:

- R version 3.6.3, due to the use of COST packages;
- libraries: Fishpifct, COSTcore, COSTdbe, COSTeda and data.table.

A detailed presentation of each step needed to run the scripts implemented in **SDTool** was made:

5. *Data preparation*: transformation of the data from the RCG format to the COST objects (CS and CL, for the SDTool) and to the SDEF tables (CA, HH, HL,SL, TR, CL) (for BioSim Tool); this step is carried out through the two scripts: Conversion from RCG CS to CS cost object and Conversion from RCG CL to CL cost object.
6. *InvestigateData* script: it provides information on the temporal, spatial and technical coverage of the dataset.
7. *RunOptimizationBYspecies* script: it allows to find the optimal range in terms of number of trips for each defined stratum on the basis of the density kernel function.
8. *RunScenario* and *RunEvaluation* scripts: allow to simulate different sampling designs and to evaluate the impact on precision and on LFDs respect to the baseline.

Similarly, a detailed presentation of each script implemented in **BioSimTool** was made:

7. *Data preparation*: transformation of the CA and HH SDEF tables in the format required by BioSim in Rdata format.
8. B_data_simulation_LENGTH script: it allows to derive an optimal number of length measurements for each defined stratum without significantly losing in precision (e.g.CV);
9. B2_calculate_subsample script: allows to estimate a subsample factor to be used in the *RunScenario*script of SDTool, to simulate scenarios involving the sub-sampling;
10. C_data_simulation_MATURITY: allows to derive an optimal number of maturity data to be collected without significantly losing in precision (e.g. ogive CV);
11. D_data_simulation_SEX-RATIO: allows to derive an optimal number of sex data to be collected without significantly losing in precision (e.g. sex ratio CV);
12. E_data_simulation_AGE: allows to derive an optimal number of age data per length class to be collected without significantly losing in precision (e.g. ALK CV).

After the presentation of each script, specific sessions were dedicated to the individual work on the codes; during these sessions clarifications were asked by the participants and the answers were given in plenary. Moreover, some results of the individual exercises (e. g. different sampling scenarios results) were shown by the participants to the whole group and the interpretation of them were discussed and clarified.
An overview of the a priori quality check script, developed in STREAM under WP6, to verify the consistency of the detailed data, was also provided by Ms IB. These quality checks should be carried out before starting to work on the case studies.
Finally, an overview on the script developed under the task 3.4 of STREAM project to evaluate the impact on the sampling costs of alternative sampling designs was given by Ms IB.
For further details, the material of the training workshop was made available the first day of the workshop on the sharepoint of the STREAMLINE Teams Group (https://streamline2021project.sharepoint.com/sites/STREAMLINETask2.1/Shared%20Documents/Forms/AllItems.aspx?RootFolder=%2Fsites%2FSTREAMLINETask2%2E1%2FShared%20Documents%2FGeneral&FolderCTID=0x01200018D5646BE891864089458B3BCC98D181), subdivided in scripts, presentations, packages and background documents.
Presentations on the main outcomes and problems encountered of the five case studies implemented under the STREAM project were made by the experts who coordinated those case studies. The presentations served to feed the plenary discussion on the identification of the case studies to be implemented under STREAMLINE and to be presented to the RCG Med&BS as possible regional work plans on commercial fisheries (including SSFs) in the Mediterranean and Black Seas.
Taking into consideration the experience gained in the previous grant, and criteria such as the relevance of the stocks/fisheries, data availability and enforcement of multi-annual management plans, the following case studies were identified:

Case Study n.	GSAs	Countries	Stocks	Fisheries
1	29	Bulgaria, Romania	Sprattus sprattus, Scophthalmus maximus	PTM, GNS
2	1-2-5-6-7	Spain, France	Aristeus antennatus, Merluccius merluccius, Parapenaeus longirostris	OTB_DES, OTB_MDD, OTB_DWS, LLS, GNS
3	17-18	Croatia, Italy, Slovenia	Merluccius merluccius, Mullus barbatus, Nephrops norvegicus, Parapenaeus longirostris, Solea solea	OTB_DES, FPO, TBB, GNS, GTR, LLS
4*	17-18	Croatia, Italy, Slovenia	Engraulis encrasicolus, Sardina pilchardus	PTM, PS

*This case study was added after the consultation with the RCG Med&BS and the NCs.
This list was provided to the RCG Med&BS for the consideration and feedback before the implementation and analysis will be started.
A tentative list of case study leaders/teams was also drafted. An invitation to join the case study team was extended to all the participants. In addition, a roadmap was also drafted to organize the next steps towards the implementation of the case studies (data checks, analysis, identification and run of scenarios, estimation of costs, etc.) and their presentation to the RCG Med&BS by June 2022, at the very latest. This will allow the process of considering the submission of draft regional work plans on commercial fisheries.
The workshop closed at 13.00 CET on Wednesday 1st December 2021.

References
Wischnewski J., Bernreuther M., Kempf A., 2020. Admissible dissimilarity value (ADV) as a measure of subsampling reliability: case study North Sea cod (*Gadus morhua*). Environ Monit Assess (2020) 192: 756. https://doi.org/10.1007/s10661-020-08668-6

Annex I - Agenda

Monday 29th November, 09.00-16.30 CET

- 9.15-9.30, Connection to the online meeting
- 9.30, Welcome and opening of the works – A. Ligas (STREAMLINE Coordinator)
- 9.45, Presentation of the STREAMLINE project – A. Ligas
- 10.15, Summary of STREAM WP7 outputs – C. Charilaou
- 10.45, Coffee break
- 11.00, Overview of the sampling optimization tools with new features – I. Bitetto (Task 2.1 Leader)
- 13.00-14.30, Lunch break
- 14.30, Familiarization with the optimization tools using a dummy dataset – I. Bitetto
- 16.30, Closing of the works.

Tuesday 30th November, 09.00-16.30 CET

- 9.30, Familiarization with the optimization tools using a dummy dataset – I. Bitetto
- 11.00, Coffee break
- 11.15, Running of the optimization tools, solving technical problems, discussion on methodological aspects
- 13.00-14.30, Lunch break
- 14.30, BioSim Tool– I. Bitetto
- 15.30, Familiarization with the BioSim tool using a dummy dataset
- 16.30, Closing of the works.

Wednesday 01st December, 09.00-13.00 CET

- 9.30, A priori quality checks on RCG CS format and costs evaluation– I. Bitetto
- 10.35, Coffee break
- 10.50, Summary of the case studies presented in STREAM, highlight on drawbacks and future developments in STREAMLINE – Persons in charge of STREAM case studies (10 minutes each)
- 11.45, Plenary discussion on possible case studies for future regional work plans
- 12.45, Wrap-up and drafting of the roadmap of the activities under Task 2.1
- 13.00, Closing of the works.

Annex II - List of participants

Name and surname	Affiliation	Member State
Aina De Mesa	IEO	Spain
Alberto Santojanni	CNR-IRBIM	Italy
Alessandro Ligas	CIBM	Italy
Cristian Danilov	NIMRD	Romania
Charis Charilaou	DFMR	Cyprus
Claudia Musumeci	CIBM	Italy
Danilo Scannella	CNR-IRBIM	Italy
Elitsa Petrova	IFR	Bulgaria
Encarnacions Garcia	IEO	Spain
Fabio Falsone	CNR-IRBIM	Italy

Farrugia Hazel	MAFA-DFA	Malta
Feriha Tserkova	IFR	Bulgaria
Francesco Masnadi	CNR-IRBIM	Italy
Gema Martínez	IEO	Spain
George Tiganov	NIMRD	Romania
Gregoire Certain	IFREMER	France
Grigoraș Daniel	NIMRD	Romania
Ioannis Thasitis	DFMR	Cyprus
Isabella Bitetto	COISPA	Italy
Ivelina Zlateva	IO-BAS	Bulgaria
Kostas Touloumis	FRI	Greece
Lazaros Tsiridis	FRI	Greece
Livia Menziani	MIPAAF	Italy
Loredana Casciaro	COISPA	Italy
Madalina Galatchi	NIMRD	Romania
Martina Scanu	CNR-IRBIM	Italy
Matteo Chiarini	CNR-IRBIM	Italy
Miguel Vivas	IEO	Spain
Norbert Billet	IFREMER	France
Orfanidis Georgios	FRI	Greece
Paola Pesci	UNICA	Italy
Paun Catalin	NIMRD	Romania
Violin Raykov	IO-BAS	Bulgaria
Stefanos Kavadas	HCMR	Greece
Vanja Čikeš Keč	IOF	Croatia
Vita Gancitano	CNR-IRBIM	Italy