

Case Study Report, Task 7.3

Synthesis and suggestions for Discard Mitigation Strategies by case study

Year 2 : March 2016-February 2017

Case Study: Azores

Date: **March 2017**

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1 What has been going on in this area during the last 12 months?

1.1 Important changes in stock development, discard data and ecosystem

- Fishery resource management strategy in the Azores is based on the EU Common Fishery Policy, implemented primarily through total allowable catches (TACs) for various species including blackspot seabream, alfonsinos, and deep-water sharks (EC Reg. 2340/2002; EC Reg. 2270/2004).
- Apart from fish quotas, the regional government of the Azores has implemented technical measures over the years, such as minimum landing sizes or weights, minimum mesh sizes, limitation of licences for some specific gears (e.g. trammel nets), area and temporal closures, and bans on the use of specific gears. An example is the Azores regulation that prohibited deep-sea trawling, which recently became an EC regulation (EC 1568/2005).
- The main source of information and advice on fish stocks for some of the target deep-sea species is the ICES Working Group on the Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP).
- ICES WGDEEP provides generic ecosystem overviews covering the Azores area but no information on recent trends is provided anywhere.
- The most recent assessments of some exploited deep water stocks within the Azores ICES statistical area X were conducted by ICES in 2017 (ICES, 2017¹).
- Landings of black scabbard in the Azores area have been variable and low but in recent years landings have increased, reaching 441 ton in 2015 but only 86 ton in 2016. It has been recently suggested that despite the variability on the overall landings along years, the Azores is an area of major concentration of this species. The TAC adopted for areas 8, 9 and 10 has been constant at 3700t from 2013 to 2016.
- Landings of alfonsinos, *Beryx splendens* and *Beryx decadactylus* in recent years have been highly dependent on the adopted TAC. Landing in the Azores region were 131 tons in 2014, and 151 tons in 2015 and 156 tons in 2016. Survey abundance indices as described in ICES (2017) suggested that abundance of *B. splendens*, declined significantly between 1995 and 1997 and has remained at very low levels until 2007, with an increasing trend during the last four years and a decrease in 2016. For *B. decadactylus* a decrease is observed from 1995 to 1996, maintained thereafter until 2003 at low levels. It increased then from 2003 to 2007 and maintained thereafter at high levels until 2011 decreasing thereafter.
- In the case of blackspot seabream, the ICES advice for 2015 and 2016 was “Catches should be no more than 400 tonnes” but the agreed TAC was slightly higher (Table 1).” Survey abundance indices showed no trend in the last 20 years with but showing a high value every three years until 2005 and for 2016. The occurrence of sporadic high values have been suggested to be related to catchability variability, fish behaviour, life-history or environmental effects. ICES (2017) also reported the lowest abundance indexes and landings for 2010–2013 with a decreasing trend.
- There’s a general perception that the majority of stocks are at unsustainable levels but no assessments have been agreed by ICES. This loss of fishing opportunities may not favour the introduction of the Landing Obligation.

¹ ICES. 2017. Report of the Working Group on the Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP), 24 April–1 May 2017, Copenhagen, Denmark. ICES CM 2017/ACOM:14. 702 pp.

- Estimates of discards are not available in the ICES (2017) report for the blackscabbard fish. For alfonsinos and blackspot seabream discards were estimated as % of sampled fisheries trips for 2004–2011 (0.8% to 8.6% for alfonsinos and 0.6% for blackspot seabream) but no recent values were reported. Discard rates have been suggested to result from management measures such as TAC and minimum landing size regulations. Discardless have produced some independent discard estimates for most fisheries and species in the Azores (see below).

	Reg (CE) N°. 2015/2006				Reg (CE) N°. 1359/2008			
<i>P. bogaraveo</i>	2007		2008		2009		2010	
ICES Sub-Area	TAC	Landings	TAC	Landings	TAC	Landings	TAC	Landings
Xa2	1136	1070	1136	1089	1136	1042	1136	687
	Reg (CE) N°. 1225/2010				Reg (CE) N°. 1262/2012			
<i>P. bogaraveo</i>	2011		2012		2013		2014	
ICES Sub-Area	TAC	Landings	TAC	Landings	TAC	Landings	TAC	Landings
Xa2	1136	624	1136	613	1022	692	920	663
	Reg (CE) N°. 1367/2014				Reg (CE) N°. 2285/2016			
<i>P. bogaraveo</i>	2015		2016		2017		2018	
ICES Sub-Area	TAC	Landing	TAC	Landing	TAC	Landing	TAC	Landing
Xa2	678	701	507	515	507		507	

Figure 1: TAC and official landings for blackspot seabream in the Azores region (from ICES, 2017).

1.2 Important changes in terms of fisheries and stakeholders perception

- The LO has not been applied to the Azores deep-sea fisheries yet. Therefore, no changes in the fisheries were observed until March 2017.
- During year 2, DiscardLess members interacted with stakeholders on several occasions: i) a second stakeholder workshop (the first one being hold during the kick-off meeting) that was organized by DiscardLess in the context of the “Forum Internacional das Pescas dos Açores” in June 2017; ii) several meetings with the Government to discuss about the implementation of the LO in Azores; and iii) semi-structured interviews carried out mainly with fishers/skippers for WP4, but other stakeholders were also met at this occasion.
- Even though the implementation of the LO in the Azores will only start in 2019, all stakeholders met were concerned about this upcoming regulation.
- At the moment, representatives of the Administration and of the fish auction company are still studying how they would/could adapt to the LO, and are waiting to see what is happening in the other European countries.
- For most fishers met, the interviews were the first time they heard about the LO, and even for those who knew about it, in most cases there was a big misunderstanding of the details/practicalities of the regulation, and the likely impacts on their activity. All of them strongly disagreed with the LO - and especially disliked the fact that they cannot sell the unwanted catch and that it will be counted against their quota - and stated that they have no intention to comply with it. They do not see how it could be enforced anyway - some even stated that it would actually be an incentive for them to discard.
- The LO is perceived as inadequate to Azorean fisheries given the high selectivity of the fishing gears, the small-scale of the fisheries, and the geographic isolation and dispersion (9 islands) of this outermost region. These factors greatly increase the complexity and costs of dealing with/processing unwanted catches, especially as it cannot be sold/used for direct human consumption.

- Further, this regulation is considered artificial and in complete contradiction with the long-lasting obligation of the previous CFPs to discard undersize/and over quota fishes. The Region has already implemented a large number and variety of management tools that are considered to be more appropriate, efficient, and adapted to the reality and specificities of the local fisheries, and with which most fishers agree.

1.3 Important changes in management

- The LO will only be implemented in 2019 in the Azores bottom (longline and handline) fishery. Several management measures that influence discarding apply to this fishery, several of which have been adapted in the recent years. Table 2 below summarizes those management measures and how they have evolved since 2010.

Table 2- Summary of changes in management measures since 2010.

Management measure	Species	2010	2011	2012	2013	2014	2015	2016	2017
Quota	Deep-Water Sharks (DWS)	Implementation of the TAC 0; allowance of max 10% of 2009 quota (10t) as bycatch	0; allowance of max 3% of 2009 quota (10t) taken as bycatch	0	0	0	0	0	0; allowance of max 10t taken as bycatch
	DWS species list	15 taxa*			<i>Galeus melastomus</i> removed; <i>Centrophorus spp.</i> added				
Quota	<i>Beryx spp.</i>	-	-	-	Implementation of the "80% notice"***	"80% notice"	"80% notice"	"80% notice"	"80% notice"
Minimum landing size (MLS)	<i>Beryx splendens</i>	-	-	-	-	-	250 g	250 g	30 cm
MLS	<i>Beryx decadactylus</i>	-	-	-	-	-	250 g	250 g	35 cm
MLS	<i>Pagellus bogaraveo</i>	25 cm	25 cm	25 cm	25 cm	25 cm	30 cm	32 cm	33 cm
Seasonal closure	<i>Pagellus bogaraveo</i>	-	-	-	-	-	15/01 to 29/02	15/01 to 29/02	15/01 to 31/01*** to

* List of deep-water sharks (DWS) for which 0 TAC has been applied since 2010: *Apristurus spp.*, *Centroscymnus coelolepis*, *Centroscymnus crepidater*, *Chlamydoselachus anguineus*, *Centroscyllium fabricii*, *Dalatias licha*, *Deania calcea*, *Etmopterus princeps*, *Etmopterus spinax*, *Galeus melastomus*, *Galeus murinus*, *Hexanchus griseus*, *Oxynotus paradoxus*, *Scymnodon ringens*, *Somniosus microcephalus*.

** "80% notice" occurs when 80% of the shared *Beryx spp.* quota has been achieved and implies a 5% catch limit for *B. decadactylus* and a closure for *B. splendens*.

*** A new regulation 13/2017 approved by the Regional Government of the Azores revoked the seasonal closures for *Pagellus bogaraveo*.

2 The Year behind us (2016-2017): What has DiscardLess produced in this case study during the last 12 months?

2.1 Impact assessments

2.1.1 Ecosystem scale

Task 1.1. Current status of ecosystem knowledge and data and identification of knowledge gaps

- To have an accurate knowledge of discard amounts and composition, and more generally of the total catch taken by all fisheries occurring within the Azores EEZ, an update of the total catch reconstruction performed by Pham et al. 2013 was carried out, specifically with estimations of discard at species level for all fisheries. Several observer datasets and fishing experiments that have studied catch and discard composition of the different fleets occurring in the Azores were compiled. Discard amounts were raised to the fleet level using landings, of the species for the main target species, of the target species for non-commercial species.
- Due to the high selectivity of most gears used in the Azores, the small-scale of the fisheries, and the local tradition of wide utilization of the catch, discard generated by Azorean fisheries are low, with 789t discarded in average per year, i.e. 4.2% of their total catch, since 1950 (Figure 2a). In the recent years [2000-2014], the fisheries that discarded the most were the bottom longline and handline fishery (447t in average by year, 10.3% of its total catch), and the small pelagic longline fishery (270t in average per year, 13.0%, Figure 2b, c). The regional pelagic longline fleet generated 249t of discard (44.0% of its catch) due to low local market value for pelagic sharks, contrary to the mainland and foreign fleets that only generated between 21 t and 252 t, i.e. 2.5% and 2.2% of their catch respectively. The livebait fishery discarded 30t in average per year (11.2%), while the pole-and-line tuna fishery only generated 2.0t of discard per year (0.03%). The recreational fishery also generated some discards, with an annual average of 25t (4.6%). In the bottom longline and handline fishery, the main quota species, blackspot seabream and splendid alfonsino were discarded at 2.2% and 10.6% of their total catch respectively. Deep-water sharks, TACs 0 species, were an occasional bycatch of this fishery (3.2% of its total catch weight). Bycatch of deep-water sharks was more common (14.9%) in the drifting deep-water longline fishery, but this fishery is only experimental in the Azores and is currently not occurring.
- Even if discard amounts of quota species are quite limited, the implementation of the LO might have detrimental impacts on Azorean fishers as well as on the Azores fisheries resources (e.g. increased fishing mortality in case of quota uplift with low compliance, and under- or mis-reporting).
- The manuscript "*Overview of the discard situation in the Azores*" describing this study and its results is in preparation and will be submitted shortly.

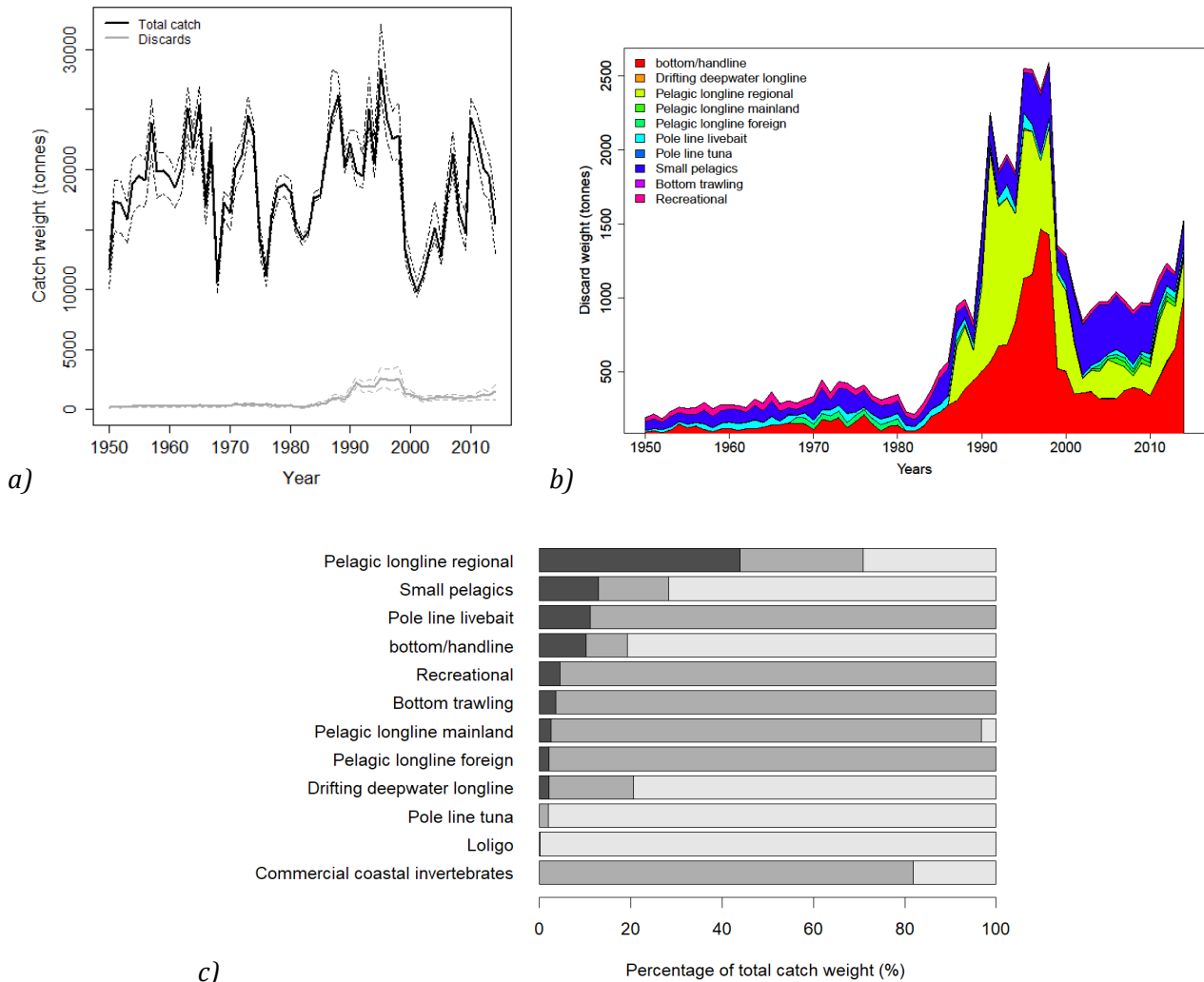


Figure 2: a) Time series of total catch (black line) and total discard (grey line) amounts of Azores fisheries. Dashed lines display 95% confidence intervals; b) Time series of total discard amount by fishery ; c) Repartition of the total catch by fishery by category: discarded (black), other unreported catch (dark grey), and reported (light grey) over the period 2000-2014. Source: Fauconnet et al. in prep.

Task 1.2 Standard ecosystem criteria for evaluating discard mitigation strategies

- The standard ecosystem criteria for evaluating the most relevant effects of discards on MSFD descriptors has been identified and deliverable D.1.2 finalised during the first year of the project.

Task 1.3 Discard mitigation strategies scenarios and parameterisation of operational models

- An Ecopath model of the Azores ecosystem was published (Morato et al., 2016). This static model describes the food-web and ecosystem structure of the open-ocean and deep-sea environments of the Azores in 1997 (Figure 3). However, it did not discriminate fisheries discards from the total catch nor reincorporate them in the food-web.
- Therefore, adaptation of this ecosystem model was done by adding a detritus group specifically for discards. Duplicates of the fleets dedicated to discards have been created, allowing discards estimates to be discriminated from the landings in the model. Discards' fate from catch estimates was parameterized 1 to discards group assuming 100% mortality, of which around 90% is being consumed in the ecosystem by adjusting the diet matrix. Diets of the scavengers were updated using literature review and local knowledge. This model compiles therefore 46 functional groups and 20 fleets, of which 8 are discarding. These correspond to the bottom longline and handline, the tuna and baitfish fishery, the pelagic longline fleets (regional, national and foreign), the recreational fishery, the drifting deep-water longline and bottom trawling fisheries.

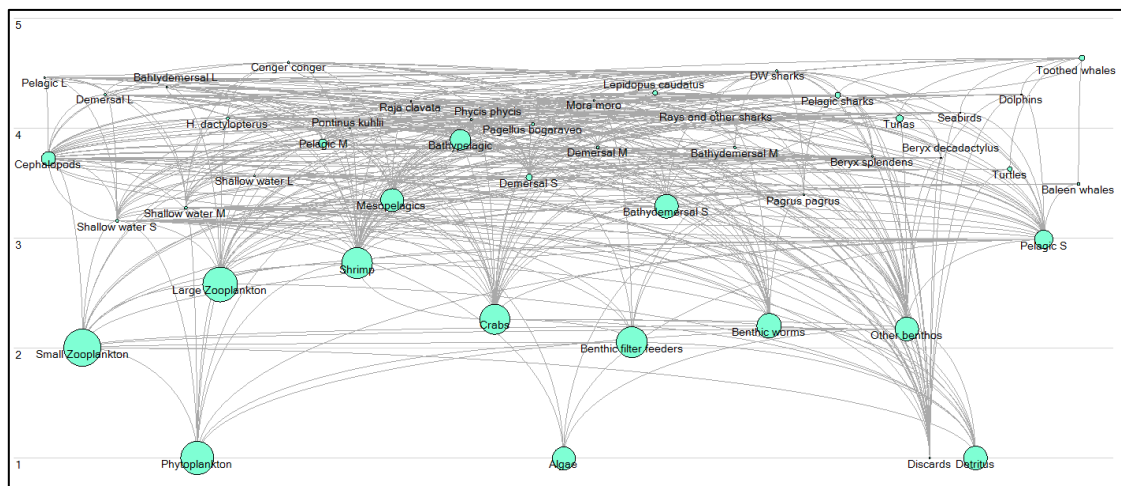


Figure 3: Snapshot of the Azores Ecopath model updated with a discards group (1997).

- This model was fitted in ECOSIM to time series of catch and biomasses for the period 1997-2013 adjusting vulnerabilities and forcing functions on primary producers. Discards fleets were driven by the same fishing effort as the landings fleets, with the assumption that discards rates are constant through time. Following the discards estimations in Task 1.1, the discards proportion input in the model in 1997 corresponds to approximately 10% of the total catch. The 1997-2013 model fitted to time series data had a final sum of squares (SS) of 63.51 for 765 observations. It is believed to give an equally satisfying estimation of catch and biomasses, thus is used with confidence for the following predictions.
- An Ecopath model for 2013 was extracted from the ECOSIM and balanced (Figure 4). The 5 scenarios were run for 2013-2030: Business as Usual, No Discards, No Discards and Selectivity, Landing Obligation, Landing Obligation and Selectivity. Business as Usual model is considered the baseline model with fishing efforts as the average of the last 3 years and landings and discards remaining distinct. The No Discards model was modified by adding discards amount to the landings in 2013 and cancelling fishing efforts for the discarding fleets. The No Discards and Selectivity model was built by keeping the original landing data but cancelling fishing efforts of discarding fleets. The Landing Obligation model was constructed adding discards estimations from quota species to landings. Therefore, some functional groups including these species were affected: the splendid alfonsino *Beryx splendens*, the red bream *Beryx*

decadactylus, the blackspot seabream *Pagellus bogaraveo*, the deep-water sharks group, the Large Pelagics groups (including the swordfish *Xiphias gladius*, blue and white marlins *Makaira nigricans* and *Tetrapturus albidus*), and Large Bathydemersal (black scabbardfish *Aphanopus carbo*). The fishing efforts driving the model were the same as the Business as Usual model. Finally, the Landing Obligation and Selectivity model was run using the landings from the baseline model and the discards data from the Landing Obligation scenario (respecting the quota species), and driven with the baseline fishing efforts.

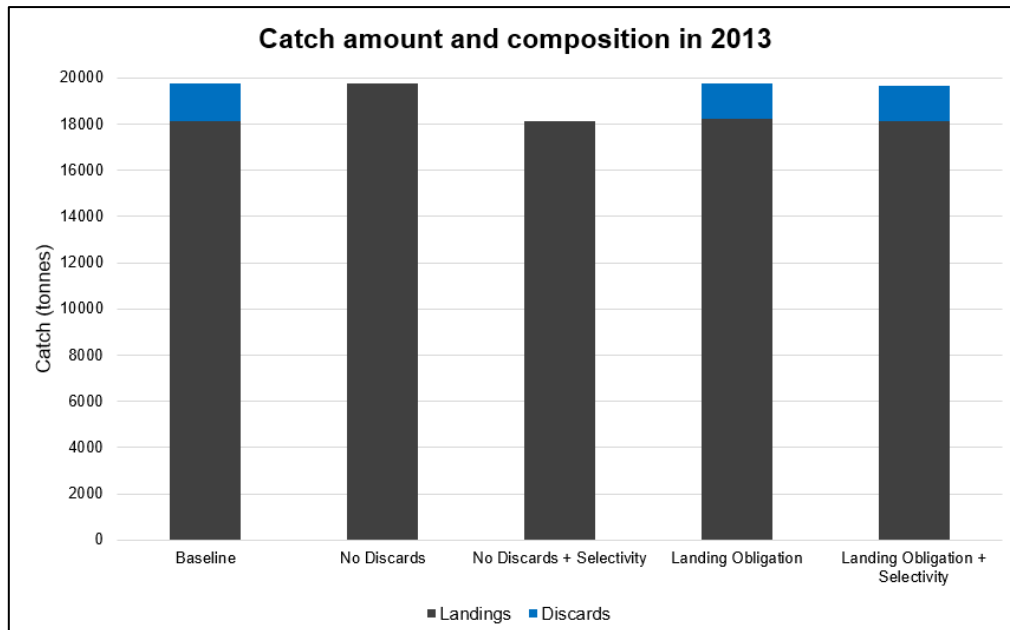


Figure 4: Catch amount (in tonnes) and composition (landings/discards) in the first year of the 5 scenarios (2013).

- Additionally, a spatially oriented ecosystem based model to evaluate ecosystem impacts of fisheries was developed during year 2. The model expanded the Ecopath with Ecosim model of the Azores to its explicit spatio-temporal dimension, using the ECOSPACE routine. This model derives from the static model described in Morato et al., 2016, where discards were not reported separately. For that reason, this version of the model was not yet used to run scenarios under the DiscardLess project.
- The underlined Ecosim model was driven by time series of fishing effort from 1997 to 2014 and fitted to observed data of catch and biomass by adjusting the most sensitive predator-prey vulnerabilities. The total ECOSPACE model area was defined by establishing a grid map of 9542 active square cells with 100km² in order to cover the overall extension of the EEZ of the Azores. Geographic Information Systems derived layers of bathymetry (in meters), primary production (in mg C/m²/day) and Euclidean distance to shore (in nautical miles) were included as non-dynamic habitat features of grid map cells. In Ecospace, the ability of each functional group to thrive within each cell-specific habitat attribute is defined using the habitat capacity model developed by Christensen, et. al (2014). The parameterization of the habitat foraging capacity of each functional group is currently being finalized. The rate at which fractions of biomass move between cells (base dispersal rate, expressed in km/year) were modified from default values to distinguish the performance of some groups to escape from predation. The fishing effort was spatially distributed by a gravity model, assuming that fleets behaviour depends on the profitability of fishing in specific cells. This profitability is calculated by balancing the

- income from a given cell (biomass × catchability × market value) and the cost of sailing to that cell.
- During both the Ecosim and Ecospace models parameterisation, a number of issues were identified in Ecopath with Ecosim software:
 - By manually calculating the goodness of fit of the temporal explicit predictions of Ecospace, it was found a bug in the routine that estimates the sum of squares deviation in the software. The scaling factor used for relative abundance data (biomass) in the formula was not working, giving a wrong value of the sum of squares. This problem was fixed for the release of the most recent version of the software 6.5.
 - Forcing catches for the Ecosim model fitting procedure are not inherited to Ecospace.
 - Suggested improvements of the software (next versions) include:
 - The calculation of the AIC in the fitting procedure and fixing some issues in the extraction of an Ecopath model from an Ecosim year function. It was also suggested to include a measurement of the trophic level of the ecosystem.
 - It could also be convenient to have a plug in Ecospace to extract the values of the same ecological indicators estimated by Ecosim. This way it would be easier to have a more detailed picture of the ecosystem status when spatial attributes of the system impact the predator-prey interactions being modelled.

Task 1.4 Estimating the outcome of selected scenarios

- Results of the discards mitigation scenarios (year 2030) were compared with the baseline scenario to assess impacts on the ecosystem and its components.
- Four ecosystem indicators for D4 were selected: the Total System Throughput (TST), the Ascendency, the Global Primary Production, and the Development Capacity (Table 2). A decrease of 0.02% in the TST and Development Capacity of the No Discards and No Discards + Selectivity scenarios was observed compared to the baseline scenario. The other observed differences are considered negligible.
- The Trophic Level of the catch (TLc) was compared between scenarios (D4) (Table 3). An increase of 0.03% of the TLc can be observed in the No Discards scenario, as well as an increase of 0.1% in the No Discards and Selectivity scenario. The Landing Obligation and Selectivity scenario however showed a decrease of 0.03%.

Table 2: Ecosystem indicators in the final stage of the 5 scenarios (GPP: Global Primary Production; TST: Total System Throughput; Development Capacity; Ascendency).

	GPP	TST	Development Capacity	Ascendency
<i>Business as Usual</i>	1679.8	3662.5	8662.2	4585.8
<i>No Discards</i>	1679.8	3661.7	8660.1	4585.8
<i>No Discards + Selectivity</i>	1679.8	3661.7	8660.1	4585.8
<i>Landing Obligation</i>	1679.8	3662.5	8661.6	4585.8
<i>Landing Obligation + Selectivity</i>	1679.8	3662.5	8661.6	4585.8

Table 3: Trophic Level of the catch (TLc) of the five scenarios.

	TLc
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<i>Business as Usual</i>	3.936
<i>No Discards</i>	3.937
<i>No Discards + Selectivity</i>	3.940
<i>Landing Obligation</i>	3.936
<i>Landing Obligation and Selectivity</i>	3.934

- Functional groups were classified in 4 categories from the lowest consumption on discards to the highest (0 to 3) to facilitate analysis. The variation in biomass (D1) of the functional groups in the discards mitigation scenarios was compared with the baseline scenario for the final stage of the run (Figure 5). Out of the 45 functional groups (excluding discards), 9 groups were found to show a variation in biomass equal to or greater than 1% in some scenarios. Therefore, the variation rate was plotted for these 9 groups and the 4 discards mitigation scenarios.
- It can be observed that most of the groups show a lower biomass in the No Discards and No Discards + Selectivity scenarios, with the exception of Large Bathydemersal fish and Large Pelagics, exhibiting a higher biomass in the No Discards, Landing Obligation and Landing Obligation + Selectivity scenarios. These two functional groups showed issues in the initialisation and parameterization of the models, therefore the outputs relative to these groups should be taken with caution.
- Among functional groups, Dolphins and Large Pelagics groups have a discards consumption of level 2. All other groups were attributed a discards consumption level of 3, which the highest in this study. Thus, a reasonable hypothesis would be that the lower observed biomasses are linked with the decrease of discards amount as a food source in the No Discards and No Discards + Selectivity scenarios.

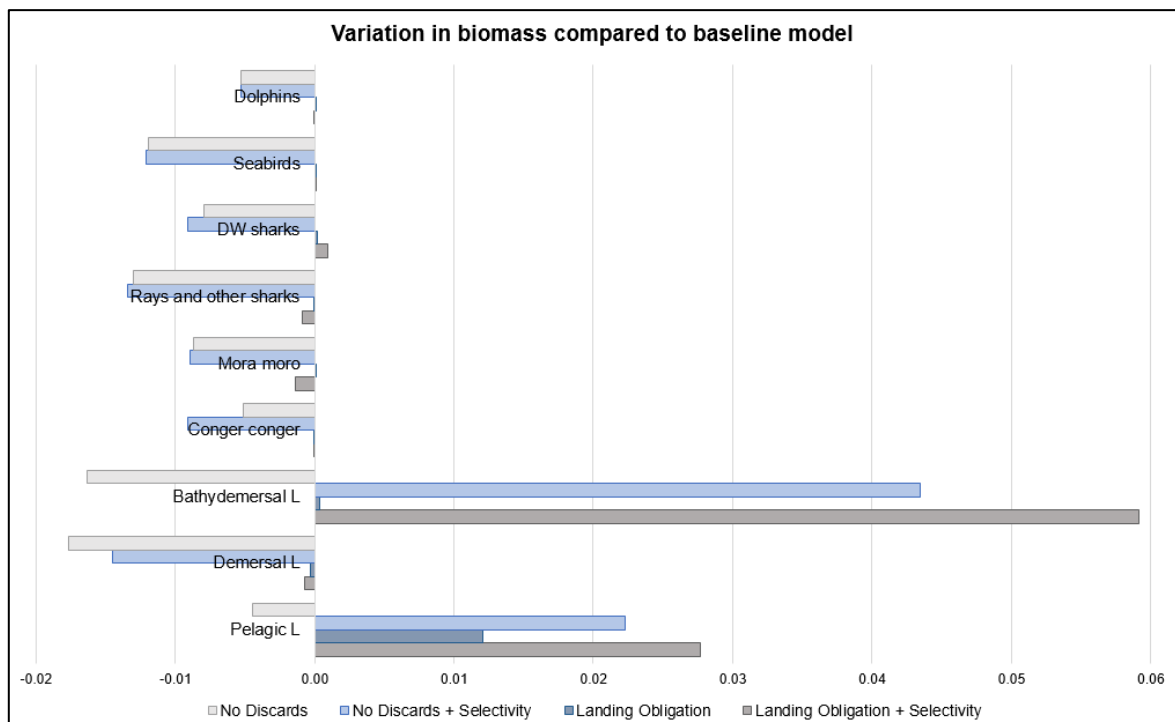


Figure 5: Variation in biomass for 9 functional groups in the discards mitigation scenarios compared to the Business as Usual scenario in 2030. Groups: Dolphins, Seabirds, Deep-water sharks (DW sharks), Rays and other sharks, *Mora moro*, *Conger conger*, Large Bathydemersal, Large Demersal, Large Pelagics.

- The discard consumption rate was plotted against the variation in biomass for these two scenarios (Figure 6). A visual interpretation of this plot showed that the decrease is proportional to the level of consumption of discards of the functional groups. Large Pelagics and Large Bathydemersal, which had positive variation in biomass in the No Discards + Selectivity scenario was an outlier and do not appear on this graph. Extrapolation of this relationship would mean that a 10% dependence on discards would likely result on a 20% decrease in biomass while a 50% dependence on discards would likely results on about 90% decrease on the group's biomass.

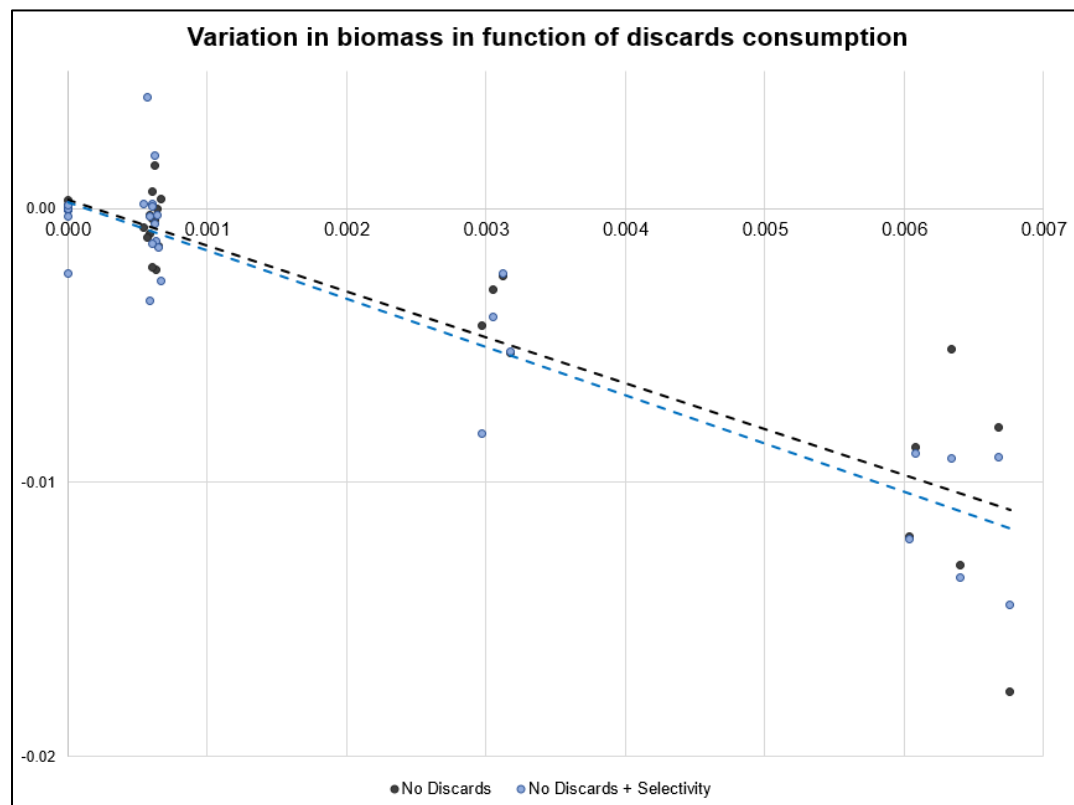


Figure 6: Variation in biomass of consumer groups in the No Discards and No Discards + Selectivity scenarios compared to the Business as Usual scenario, in function of the attributed level of consumption of discards in the diets.

- Other indicators such as landings and discards amount and structure (D3), trophic level of the functional groups (D4), or fishing mortality (D3) were also extracted from the models.
- These preliminary results suggest that the No Discards and No Discards + Selectivity strategies, which completely remove discards from the food-web, would have negative impact on the biomass of some scavenger groups. However, such as for the ecosystem indicators and trophic

level of the catch, the measured variations are low (from 0.02% to 2% roughly). Whether they would actually have negative ecological consequences is still to assess.

Task 1.5 Monitoring changes in fish stocks and sensitive components of the marine ecosystems during the implementation of the Landing Obligation policy

- A fisheries observer program was implemented in January 2017 in collaboration with the data collection team. The program will monitor the changes in discard practice due to a) the deep-sea shark 0 quota (ongoing but a new fleet is coming in to fish BS), b) the blackspot seabream minimum size (ongoing) and seasonal closure (new in 2016), and c) quota species (mostly blackspot seabream and alfonsinos).

2.1.2 Fishery scale

During year 2, a second stakeholder workshop was organized in June 2016 in the context of the *Forum Internacional das Pescas dos Açores*, in which 4 members of Discardless, about 30 fishermen, about 20 scientists, about 5 members of the buyers association, and 10 representatives of local authorities, including policy makers participated.

- The workshop included presentations by Telmo Morato about “*Discards in the Azores fisheries: the DiscardLess project and the Azores case study*”, by Laurence Fauconnet about “*By-catch and discards of deep-sea sharks in the Azores: impacts and mitigation measures*”, and by Lisa Borges (DiscardLess partner, FishFix, Belgium) about “*One year of landing obligation in Europe*”. The president of the Azorean fishers’ Federation also presented the “*perspectives from the fishing industry on the application of the landing obligation in the Azores fisheries*”.
- Presentations were followed by discussions with stakeholders about the LO. Several concerns were raised by stakeholders about: i) the practicalities of the implementation of the LO, especially due to the geographic dispersion and outermost character of the region, absence of transformation plants for fishmeal in the archipelago, and the disproportionate costs of transporting unwanted catches would incur; ii) the consequences of the LO in terms of quota, iii) lack of assessment of deep-water shark status, and subsequent consequences for the fisheries, iv) risks in terms of data collection, knowledge on discard that would likely be difficult to assess when the LO will be implemented, difficulties in maintaining observers programs and problems of unreported or misreported data can be expected.
- By way of summary, it was highlighted that if the sector considers that (i) the fishery is multispecies, (ii) there is technical difficulties to reduce unwanted catch, (iii) the adoption of measures to reduce discards would be very costly (if possible at all), (iv) the levels of discarding are small enough, (v) high survivability rates of some species (not all) can be proven, and (vi) the geographical discontinuity, small scale and reduced fishing yields, make the utilization of discards too difficult, the sector could have a case to present to EU.

Meeting with the Government of the Azores (Director for Fisheries Affairs) on the 12th January 2017 to discuss a plan to mitigate discards in the black-scabbard fish fisheries.

- Telmo Morato and Pedro Afonso represented DiscardLess in the meeting and presented the most recent estimates of discards in the black scabbard fish fisheries, discussed the need for a full observer coverage of this fishery, and discussed research work necessary to achieve reduced deep-water sharks’ unwanted catch and increased survival.

Meeting with the government of the Azores (Secretary for Sea Affairs and Director for Fisheries Affairs) in April 2016 to present DiscardLess and discuss the implementation of the LO in the Azores.

- Telmo Morato and Pedro Afonso represented the project in the meeting and presented the main goals of the DiscardLess, discussed how the project could contribute to the implementation of the LO in the Azores, and discussed the government expectations of the project. The government suggested the project to evaluate deep-sea sharks biomass to support the argument of the allocating a quota to these species. The project members emphasized that this topic is out of the scope but in alternative could adjust the work to try to answer the survival questions related to quota species.

Interviews were carried out in year 2, in 4 of the 9 islands of the archipelago in collaboration with Katia Frangoudes (DiscardLess, Ifremer, France) and Cristina Pita. The main objective of the interviews was to gather data for WP2 and 4, but they are also useful for WPs 7 and 8. In total, 24 interviews were conducted: 20 with fishers (mostly skippers and boat owners, 3 of which are also presidents of fishers associations), 2 with other representatives of fishers associations, 1 with a representative of the Administration, and 1 with a representative of the fish auction. A local NGO helped us planning, organizing and carrying out some interviews.

- Even though the implementation of the LO in the Azores will only start in 2019, all stakeholders were concerned about this upcoming regulation.
- Most fishers heard about the LO for the first time during the interviews, and even for those who knew about it, in most cases there was a big misunderstanding of the practicalities of the regulation, and the likely impacts on their activity.
- All of them strongly disagreed with the LO - and especially disliked the fact that they cannot sell the unwanted catch and that it will be counted against their quota - and stated that they have no intention to comply with it. They do not see how it could be enforced anyway. Some even stated that it would actually be an incentive for them to discard.
- The LO is perceived by all stakeholders as unappropriated to Azorean fisheries, given the high selectivity of the fishing gears already used, the small-scale of the fisheries, the insularity and geographic dispersion of this outermost region, which greatly increase the complexity and subsequent costs of collecting and processing the unwanted catch, especially as it cannot be used for direct human consumption.
- Further, they consider this regulation artificial and believe it would not bring any benefit neither for them nor for the resources. The Region has already implemented a great number and diversity of management tools that are considered much more appropriate, efficient, and adapted to the reality and specificities of the local fisheries, and with which most fishers agree.

2.2 Avoiding unwanted catch

2.2.1 gear technology

Task 3.1 Increasing awareness of existing solutions

- The main focus of the Azores case study on this topic is to evaluate the survivability of discard species in relation to handling practices.
- During year 2 (starting in January), we started an observer's program to collect detailed information on the condition of the fishes when they come onboard (including barotrauma),

- the position of the hook (mouth hooked versus gut hooked) and the condition of the fishes upon release (e.g. vigorous swimming versus dead or moribund). This observers program will last 2 months, with the data analysis to be finished during year 4.
- The standard tagging and electronic tagging database has been used during year 2 to look at potential survivability of released fishes. Preliminary results show a surprisingly high survivability (>2/3) of released individuals caught with handlines including quota species (e.g. *P. bogaraveo*) and deep-sea sharks such as *D. licha* (Table 4). During year 3, complementary telemetric experiments will be conducted in conjunction with the selectivity experiments (task 3.4 bellow) in order to have some information allowing comparison of survivability of discards in handline versus longline fishing and on other deep-water sharks. This analysis will be complemented with survivability analysis on the standard tagging database.
 - A best practices/handling manual is being prepared and is expected to be finished during year 3. The objective is to provide fishers with tools towards achieving increased survival of the released discard species, including deep-water fish quota species (e.g. *P. bogaraveo*) and vulnerable / zero quota deep-sea sharks. This manual is being developed in conjunction with the deep-water shark ID manual (task 4.3)

Table 4 – Summary of survivability per species as inferred from acoustic experiments in the Azores; survival reports acoustically ‘recaptured’ tagged animals after a minimum 8 days after release (Afonso and Fontes, unpublished data).

Species	Scientific name	Tagged Survival		
		n	n	%
Blackspot seabream	<i>Pagellus bogaraveo</i>	155	105	67
Kitefin shark	<i>Dalathias licha</i>	25	24	96
Wreckfish	<i>Poyprion americanus</i>	2	1	50
Bueshark	<i>Prionace gauca</i>	37	37	100
Tope shark	<i>Galeorhinus galeus</i>	2	2	100
Hammerhead shark	<i>Sphyrna zygaena</i>	17	15	88
Porgy	<i>Pagrus pagrus</i>	27	26	96
Dusky grouper	<i>Epinephelus marginatus</i>	11	11	100
White trevally	<i>Pseudocaranx dentex</i>	32	29	90
Parrotfish	<i>Sparisoma cretense</i>	22	22	100

Task 3.4 Innovative technologies

- The proposed field work – experiments on the catchability and survival related to hooking position of circle hooks vs J-hooks, and testing the efficiency of shark deterrents (Rare Earth elements) – was dependent on the re-start of the black scabbard fishery in the Azores. This hasn't happened yet during the project, given that during the last year the Madeiran fleet ended up not fishing in the Azores. This situation may very well continue during the project. Therefore, the project team decided to conduct independent experiments onboard a research vessel for during year 3.

2.2.2 fishing strategies

Task 4.1 The Fishers story – documenting suggested discard reduction fishing

Semi-structured interviews were carried out to document suggested discard reduction fishing practices. Twenty fishers, mostly skippers were interviewed on 4 of the 9 islands of the archipelago, the most important ones in terms of number of vessels and landings of the bottom longline and handline fishery. Interviews addressed a range of issues relating to the fishermen's responses to the Landing Obligation regulation. Solutions proposed by fishermen were separated into technical (gear changes), tactical (fishing behaviour changes) and management.

- Azorean fishers **already** take several actions to limit the amount of unwanted catch.
- The **technical changes** already implemented include i) hook size, the most efficient way to reduce the catch of undersize individuals according to all, several fishers even use larger hook than the legal requirements. ii) hook shape is also being used by several fishers but without proved efficacy, iii) change of gear: 3 out of 7 handline fishers interviewed used to fish with the bottom longline, and had recently changed for handline. The handlines catch less but bigger individuals that they can sell for a higher price with lower expenses, making them a more cost-effective gear.
- **Tactical changes** to avoid unwanted catch include i) "moving on", with most fishers asserting changing fishing areas when they catch high proportions of small individuals, ii) area avoidance, though it is not as widely used since most fishers stated that, in most areas, small and large individuals are mixed and it is highly variable, ii) adaptation of fishing time, depth, and season is also used by some fishers.
- In terms of **management**, most fishers agree with the current quota system, especially in islands where there is ITQ for blackspot seabream, even though the sharing is considered unfair. Most fishers agree with the seasonal biological closure that has been implemented for blackspot seabream since 2015, but they do not want more closures, considered as not making much sense since the resources are too mixed and variable. Several fishers also feel that the number of vessels is currently too high and should be limited. The lack of control and enforcement perceived by most fishers is also limiting confidence in the current management system, and is believed to limit its efficacy.
- Most fishers argue that they are already using the most selective gear that exist and that they are already doing everything they can to avoid the unwanted catch but "*We are not at the bottom of the sea choosing which fish bite the hook*", so most of them did not see what else they could do, or were not willing to do even more. There is also a wide diversity of management measures that have already been implemented, and they are not willing to have more, especially as the LO is perceived as an artificial measure, disconnected from the reality of the local fisheries. It must be noted that for many fishers, the interviews were the 1st time they were hearing about the LO, or if not, there was a general misunderstanding of the practicalities of the regulation and its implementation, making it difficult for them to project into the LO.
- **Interest in scientific "advice"**: Most of the interviewed fishers were not interested in the maps of potential unwanted catch planned as an output of task 4.3. They were more interested in scientists providing proofs for the exemptions, especially on survivability since several species, including blackspot seabream (juveniles) and DWS, are believed to have high probability of post-release survival. There was little concern about the impact of the implementation of the LO on TAC 0 species (such as DWS) and limited interest in experiments to reduce their catch. Some would actually prefer to catch them since they are considered as too abundant and perceived as a nuisance.

Task 4.3 The Scientists story – identification of locations, times and practices to fish to avoid unwanted catch

- Acoustic telemetry experiments with deep-sea sharks (kitefin and sixgill sharks) and bottom fish (wreckfish) were initiated or continued during year 2, with permanent data acquisition and periodic retrieval of the acoustic receivers (last retrieval round in February 2017). These experiments are being used to refine the spatial models and expand the understanding of the species' spatio-temporal distribution (SDMs, see below) and essential fish habitat identification (Figure 7).
- The species distribution modelling (SDM) work is in progress and environmental and geomorphological layers have been produced. Raw data on the occurrence of deep-sea sharks is being compiled.
- Recent (2010-2015) VMS data has been received from the Azores Government, but analyses of the data have not started yet.
- Members of DiscardLess Azores participated in the WP4 workshop organized in Dublin in September 2016 to show progress on the different tasks, discuss and exchange ideas and methods. The approach developed on task 4.3 was presented: 1) Spatial Ecology: Predicting essential (critical) habitat for target species, 2) Mapping Fishing Effort, 3) Combine EFH with fishing hotspots, and 4) Identifying survival rates of discarded fish; and the first results obtained so far (SDMs, telemetry experiments on blackspot seabream and kitefin shark, analyses of VMS and GIS) were displayed.
- An ID manual for deep-sea sharks is under development. This will be one of the decision making tools offered to fishers to reduce discards.

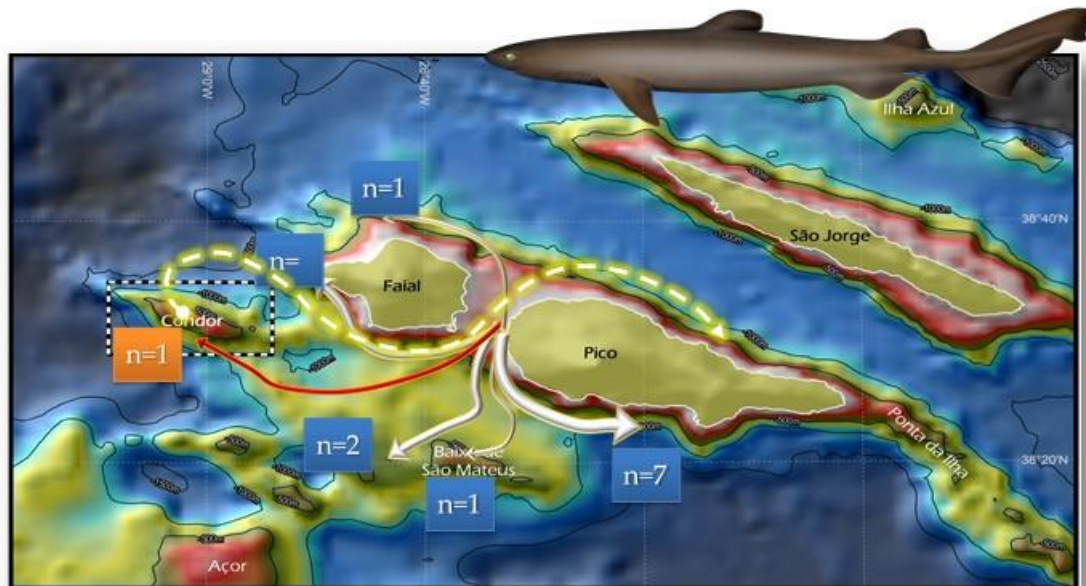


Figure 7 – summary results of the multi-habitat long-term acoustic monitoring program in the Azores showing the representative movements of the 0 quota deep-sea kitefin shark, *Dalathias licha*

2.3 Policy Outreach

Task 7.1 Analyse the background, objectives and motivation of the discard policy

- In year 1, the Azores government asked to the Government of Portugal for clarifications on the starting date for the implementation of the LO for the deep-sea fisheries. It is their understanding that for this particular fleet LO would be applied only in 2019. The local fisheries is concerned with issues related to choke and 0 TAC species.
- The regional government of the Azores have consulted Discardless members to evaluate the data being collected by the project, analyses produced and the conclusion achieved. It is likely that the Regional Government may try to build a case for exemption of the LO for some fisheries sectors.

Bringing results to users

- The Azores case study description and list of species subject to the LO has been provided to Jérôme Guitton to feed the DiscardLess Online Atlas <http://www.discardless.eu/atlas>. STECF data reported for the Azores has been extracted by Jérôme Guitton and displayed in the Atlas. Only landings data were available.
- Results of the “discard overview” study (WP1) were presented at the World Fisheries Congress in Busan (South Korea) on M14 (May 2016).

2.4 Summary:

During year 2 the work plan and development made a substantial effort to adapt to the stakeholder perception and concerns for the Azores case study, and to transfer the information produced to the local authorities. Work thus broadened to include fisheries other than just the black scabbard fish fishery. This effort will continue in year 3. The contribution to transversal themes was impaired by the lack of LO implementation in the Region.

3 The Year ahead of us (2017-2018): What do we expect for the next year?

3.1 WP1 (ecosystem scale assessment)

Task 1.1 Current status of ecosystem knowledge and data and identification of knowledge gaps

- T1.1 is now finalised. The publications on the discards estimates for the deep-water longline and handline and on the general overview of discard practices in the Azores will be submitted shortly.

Task 1.2 Standard ecosystem criteria for evaluating discard mitigation strategies

- Although T1.2 was finalised in M6 and deliverable 1.1 produced, the ecosystem indicators for evaluating the impact of LO finished per modelling tool and case study will constantly be further evaluated in year 3.

Task 1.3 Discard mitigation strategies scenarios and parameterisation of operational models

- The discards mitigation scenarios for the Ecosim run 2013-2030 are considered final. We plan to have the description of the Ecosim model 1997-2013 published in a few months as a support for this study.
- During year 3, will be developed the spatio-temporal version of the Ecopath with Ecosim model reporting discards from 1997 to 2013. This model will have a similar parameterisation as the Ecospace model of the Azores, developed during year 2.
- Ecospace does not inherit Ecosim time varying productivity functions resulted from the fitting procedure. In doing so, the underlined time dynamic model will be simply fitted to the most sensitive vulnerabilities. This limitation of the software will compromise the ability of the Ecospace model in replicating observed oscillations of biomass between 1997 and 2013. Nonetheless, it is expected that the space-time model will be able to replicate observed temporal catches and discards trends during the modelled period and ideally it will exhibit a better goodness of fit than the underlined time dynamic model.
- Once the model is parameterised and fitted, it is aimed to develop the spatially-oriented versions of the Ecopath with Ecosim models simulating the DiscardLess management scenarios in order to address the impact of such regulations on the spatial distribution patterns of biomass pools, catch and fishing effort.
- The attempt of building Ecospace models to address discards issues is pioneer and will possibly face several challenges in terms of software development. It is still unclear whether all Ecosim settings, defining each of the scenarios, will be transferred to the space-time routine of the software, similarly to the forced catches issue.

Task 1.4 Estimating the outcome of selected scenarios

- Outcomes of the Ecosim scenarios still require further analysis. The very low variations in ecosystem indicators measured until now do not suggest high impacts of discards mitigations strategies on the ecosystem of the Azores, however further analysis will support or not this preliminary conclusion. Relevant results for the case studies comparison will be included in the common paper. Besides, we plan to publish a detailed description of discards management scenarios in the Azores with more in-depth analysis which would not have been tackled in the common paper.
- Before taking conclusions on the spatial impact of each scenario, an analysis on the reliability of Ecospace results must be performed by comparing some results with Ecosim. Thereupon, the ecological indicators possible to be estimated by Ecospace for the final stage of the discards mitigation strategies will be compared with the baseline. Then, a focus will be given on the functional groups whose biomasses have been impacted by the discards scenarios. Indeed, under the assumption that a functional group is affected by a cut in discards as a food source, we can hypothesize that its foraging area will be impacted. Thus, the spatial distribution of these groups predicted by the different scenarios will be investigated to highlight variations of the patterns with the baseline.

Task 1.5 Monitoring changes in fish stocks and sensitive components

- Data from the fisheries observer program will be collected and the analyses will start during year 3.

3.2 WP2 (Fishery scale assessment)

- During year 3, Katia Frangoudes may carry out some additional stakeholders interviews to assess the changes in perception regarding discards and the LO. A scientific paper is in preparation.

3.3 WP3 (gear technology)

Task 3.1 Increasing awareness of existing solutions

- During year 3 we will continue and complete the fisheries observer's program (until January 2018) to collect detailed information on the quantities discarded and the condition of these fishes when they come onboard (including barotrauma), the position of the hook (mouth hooked versus gut hooked) and the condition of the fishes upon release (e.g. vigorous swimming versus dead or moribund). The data analysis will be performed during years 3 and 4.
- IMAR will produce a manual for best handling practices of deep-sea sharks. Discussions with the WP leader led to the conclusion that this manual should not be included in the WP 'regular' manual (deliverable 3.1), which will focus on technical solutions for bottom trawling. The objective is to provide local fishers with tools towards achieving increased survival of the released discard species, including deep-water fish quota species (e.g. *P. bogaraveo*) and vulnerable / zero quota deep-water sharks. The manual is currently being developed and will be finalized during year 3 in order to be partially included in D3.3. It was also decided to produce the manual in a simple poster format that can be used onboard fishing vessels by fishermen. This manual is being developed in conjunction with the deep-water shark ID manual (task 4.3).
- Additionally, the team will review and provide information to fishermen on the potential technical solutions (e.g. circle hooks, deterrents, gear configuration, other techniques) and a survival analysis from previous tagging (both electronic and standard) programs to evaluate optimal release conditions, not only of deep-sea sharks but also some key deep-water bottom fishes. These results will be developed through year 3 to be partially included in D3.3. However, some of the outputs for fishermen will be finalized and presented during year 4 in local fora and the project's dissemination platforms.

Task 3.4 Innovative technologies

- It was discussed with the WP leader that the reporting of the experiments should be done under this task and not 3.2 (as originally in the project), in which case it should go under the final report (M36).

- We expect most of the field and laboratorial experiments to be conducted during year 3: 1) captivity holding and rare Earth elements (REE) tests using a deep-sea shark model species (*Dalatias licha*). These tests will be conducted at the 'Aquario de Porto Pim' facilities in collaboration with the company 'FlyingSharks' and the Faial Natural Island Park; 2) experimental fishing sets will be conducted using modified deep-water longline onboard the R/V 'Arquipelago' in late summer and fall 2017. The aim of these experiments will be to test the catchability and the hooking position (mouth versus deep-gutted) of circle hooks versus j-hooks (which are used in the Portuguese commercial fleet) for deep-sea shark species; 3) experiments 1) and 2) will be complimented with a set of baited remote underwater video (BRUV) tests in the wild to document the behaviour of the sharks when they approach and bite the baited hook 3.1) with vs. without REE attached, and 3.2) with a circle versus a J-hook. This task will be completed in year 3, except some of the analyses which will be finalised during year 4.

3.4 WP4 (fishing strategies)

Task 4.1 The Fishers story – documenting suggested discard reduction fishing

- Questionnaires or interviews maybe developed, sent to fishermen, collected, analysed and reported during year 2. This task will require collaboration from other patterns with expertise on collecting this type of data and local NGOs and fishers organization. It will adapt the general questions from to be sent to the group by the WP coordination. It will include also technical (WP3) and overall LO (WP1) questions.
- This task and subsequent deliverable are finalised. A publication presenting the results of the interviews carried out to assess the technical and tactical avoidance strategies already developed by fishers to avoid unwanted catches is under preparation and will be submitted during Year 3.
- A common paper dealing with all the fishers interviews from the different case studies is under consideration.

Task 4.3 The Scientists story – identification of locations, times and practices to fish to avoid unwanted catch

- We will continue the spatially explicit data compilation and run Species distribution models.
- Deep-sea shark telemetric experiments will be continued in year 3. We are exploring the possibility of complementing these with video experiments to evaluate release conditions and survivorship of some deep-sea sharks and fishes in year 3.
- Monitoring of acoustically tagged deep-sea sharks and bottom fish will continue during year 3, with permanent data acquisition and periodic retrieval of the acoustic receivers. We also expect some additional data on habitat use to be provided by the additional survival experiments to be conducted in another deep-water shark species (see WP 3). These data will also be used during year 3 to refine the spatial models and expand the understanding of the species' spatio-temporal distribution and essential fish habitat identification.
- IMAR will produce a manual for ID'ing deep-sea sharks. The manual is currently being developed and will be finalized during year 3. It was also decided to produce the manual in a simple poster format that can be used onboard fishing vessels by fishermen.

3.5 WP7 (Framing and implementing the discard policy)

Task 7.1 Analyse the background, objectives and motivation of the discard policy

- Continue transferring information on the implementation, discussions and developments of the LO in the Azores case study.
- Discardless results will be formally transferred to the regional government of the Azores in Year 3. It is likely that the Regional Government will try to build a case for exemption of the LO for some fisheries sectors.

3.6 WP8 (Bringing results to users)

- Continue working with Jerome Guillon to include Azores case study data into the DiscardLess Atlas and identify potential Discard Mitigation Strategies for the Azores to be included in the Online DiscardLess Atlas.
- The results of the ecosystem models: Ecosim with discard and Ecospace will be presented in the “Advances in Marine Ecosystem Modelling Research” conference in Plymouth in July 2017. The results of the fishers’ interviews carried out for WP2 and 4 will be presented at the MARE Conference in Amsterdam in July 2017.