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1 Individual transferable effort quotas for Italian fisheries? A 2 preliminary analysis

3 4 5 **Abstract**

6 In the context of transferable fishing concessions, the most well-known tool
7 is probably the individual transferable quota, whereas the case of individual
8 transferable effort quotas (ITEs) is much less often discussed. This study is
9 the result of a project realized in collaboration with Italian fishery
10 associations with the objective of valuating, in a participatory framework,
11 the possible consequences of the introduction of ITEs. A semi-quantitative
12 survey was carried out over a sample of key stakeholders being experts of
13 bottom trawling fisheries in the Tyrrhenian and Adriatic Seas and the pelagic
14 trawling fishery in the Adriatic Sea. The results and elaborations of the
15 surveys were discussed and validated by a focus group composed of
16 delegates of fishery associations. Two aspects were investigated: the
17 relationships between fishing capacity (i.e. engine power and gross tonnage),
18 fishing activity (i.e. fishing days and fishing hours), revenues, and variable
19 costs (e.g. fuel) and the suitability of different proposals and alternative
20 approaches for the introduction of ITEs. The participation of stakeholders
21 allowed the building of some simple pedagogical tools based on realistic
22 figures collected through the surveys that could be used by managers of
23 associations, cooperatives, and producer organizations to better understand
24 the functioning and possible consequences of ITEs schemes.

25
26 **Keywords:** transferable fishing concessions; participative management;
27 transferable effort quotas; Mediterranean; fishers' behaviour.

28 29 **1. Introduction**

30 Regulation (EU) No 1380/2013 of the European Parliament and of the Council
31 on the Common Fisheries Policy introduces the concept of 'transferable

32 fishing concessions' (TFCs) as a revocable user entitlement to specific fishing
33 opportunities. This scheme is included in the regulation as a voluntary
34 approach for Member States. Importantly, in the first version of the
35 regulation prepared by the European Commission in 2011, TFCs were
36 mandatory for all vessels longer than 12 m. This strategy was considered
37 optimal in order to adjust the overcapacity of EU fleets and increase fishery
38 efficiency, but criticisms from several sources, including the Regional
39 Advisory Council for the Mediterranean and the Italian Senate, led to a
40 softer, voluntary regulation.

41 However, TFCs remain a recurring theme in EU policy debates, and it is
42 important for stakeholders to better understand their application and
43 possible consequences in order to take an objective position. In the
44 framework of TFCs, the most well-known tools are probably individual
45 transferable quotas (ITQs), whereas the case of individual transferable effort
46 quotas (ITEs) is much less discussed (MRAG et al., 2009; OECD, 2006; Squires
47 et al., 2016, 2012). ITEs were mentioned by the European Commission in
48 their preliminary documents on fishery policy reform, and, more precisely,
49 they were associated with the Mediterranean case, where management is
50 already driven by fishing effort regulation¹ and where multispecificity may
51 represent an obstacle for ITQs, inducing overquota discards (Baudron et al.,
52 2010; Ulrich et al., 2002). Furthermore, ITEs provide automatic feedback
53 control (i.e. catch changes) when fish stocks increase or decrease, which may
54 be more effective than ITQs at managing fishing mortality when there is a
55 high unpredictable annual recruitment variation and short-lived species,
56 which is the case for several Mediterranean stocks, and when biomass data
57 is of low availability or quality (Squires et al., 2016).

58 The introduction of TFCs (or market-like instruments, as the OECD calls them)
59 is often met with resistance from participants in the fisheries sector. For this
60 reason, the OECD (2006), based on several experiences, presented a list of
61 tracks that policy makers can draw upon in meeting these challenges and

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Total allowable catches are not generally used in Mediterranean fisheries, with an exception made for tuna (*Thunnus thynnus*).

62 that can ease the introduction and improve the design of these instruments.
63 The first of these tracks is 'making all stakeholders comfortable with the
64 concept of market-like instruments', followed by others, such as 'preferring
65 an incremental or gradual implementation', 'not necessarily adopting a one-
66 size-fits-all strategy', and 'involving stakeholders in the reform process'
67 (OECD, 2006).

68 In this framework, this study is the result of a project realized for the Italian
69 Ministry of Agriculture, with the active participation of three Italian fishery
70 associations (Agci Agrital, Federcoopesca-Confcooperative, and Lega Pesca-
71 Legacoop)² joined in the 'Alliance of Italian Cooperatives', with the objective
72 of valuating the possible consequences of the introduction of ITEs. These
73 three associations combined represent more than 1500 cooperatives
74 involved in fisheries or aquaculture with more than 20,000 members who
75 are responsible for about 80% of Italian fish production. It is very important
76 that stakeholder associations, with the collaboration of research institutions,
77 lead similar initiatives, fostering the participation of fishers and the
78 dissemination of results. The main objective of the project, and the paper, is
79 to build, through a participative approach, a few pedagogical tools that can
80 be used by fishers' associations to evaluate the possible effects of the
81 introduction of ITEs.

82 This paper follows the approach used in the project and is organized as
83 follows. In the next chapter, we consider how ITEs have been applied in other
84 contexts. In chapter three, we present the methodological approach used for
85 the study. In chapter four, we illustrate the results, including the models
86 generated from focus groups with stakeholders. Chapter five concludes the
87 paper. Two appendices are included in order to illustrate, more formally and
88 with simulations, some bioeconomic aspects linked to the introduction of
89 ITEs; these tools were useful to prepare the questionnaire and the discussion
90 with the fishery associations' delegates.

91

2

Administratively, this project was led by Federcoopesca-Confcooperative.

93 **2. Background**

94 Management schemes based on transferable fishing concessions, property
95 rights, or market-like instruments generally assume that private forces,
96 spontaneously, may drive economies toward maximum efficiency. The OECD
97 and FAO (OECD, 2006) agree that these instruments have to be considered
98 as ‘use rights’ rather than property rights. In this context, ITQs are the tools
99 that are more studied in the literature (they were analytically considered for
100 the first time by Christy (1973)) and more applied to the management of
101 fisheries (applications begun in the eighties (Breen et al., 2016)). ITEs, on the
102 contrary, have been considered less frequently (Squires et al., 2016). In the
103 appendices, we present an analytical framework for interpreting ITEs,
104 whereas, in the following paragraphs, we discuss some applications,
105 especially in European waters.

106 Squires et al. (2016, 2012) review several ITEs management approaches
107 around the world. These approaches can be roughly classified into two
108 groups: those where total allowable effort (TAE) is expressed as days at sea
109 (which is closer to our interests), and those where it is expressed as the
110 number of gears, such as pots, traps, or hooks.

111 Among days-at-sea schemes, the Faroe Islands demersal fishery is a well-
112 known example. In the mid-1990s, the Faroe Islands rejected the TAC system
113 that was in place, especially due to extensive discarding when single-species
114 quotas were filled, and substituted it with a TAE scheme consisting of ITEs
115 (fishing days) for specific fleet categories (small trawlers, pair trawlers,
116 longliners, and coastal fishing) (Baudron et al., 2010; Jákupsstovu et al.,
117 2007). For example, due to catchability differences, one fishing day of a
118 longliner <110 GT was equivalent to two fishing days using jigs. Since its
119 introduction, the total number of fishing days allocated has been reduced
120 several times, but these days have not been fully utilized, suggesting that the
121 effort allocation is too high and is not able to reduce overcapacity and
122 overfishing (Baudron et al., 2010; Jákupsstovu et al., 2007; Squires et al.,
123 2012).

124 Inside the European Union, the Netherlands and Denmark have applied
125 hybrid systems where ITEs (e.g. transferable kilowatt days) were
126 complementary tools to support ITQs, mainly to reduce the number of
127 fishing days and bycatches of overquota stocks (Andersen et al., 2010; MRAG
128 et al., 2009; OECD, 2006). More interesting and easy to analyse is probably
129 the case of the Spanish '300 fleet', so called due to the number of Spanish
130 vessels that the European Community allowed to fish in the Communitarian
131 Atlantic EEZ when Spain entered into the Community (1986) (González Laxe,
132 2006; MRAG et al., 2009; OECD, 2006). In fact, only 150 'standard vessels' (of
133 the 300) could fish simultaneously. The standard vessel was considered a
134 vessel with a braking power of 700 hp, and conversion coefficients were
135 defined for vessels with different powers. Conversion coefficients and
136 braking power do not have a linear relationship, and, in fact, the coefficient
137 changes less than proportionally compared with braking power, with an
138 elasticity coefficient³ around 0.3. After 1997, firms could exchange fishing
139 day quotas, with a minimum and a maximum number of days that could be
140 owned. In 2007, the TAE and ITEs scheme was substituted with a TAC and
141 ITQs scheme.

142 The literature shows that in Spain, ITEs have been effective to reduce the size
143 of the fleet (González Laxe, 2006; MRAG et al., 2009; OECD, 2006). However,
144 the parameterization of 'standard vessels' on the basis of braking power has
145 caused a decrease in average power and a contemporaneous increase in
146 average gross tonnage (GT); at the same time, the spatial distribution of
147 vessels has changed, fostering Galicia to the detriment of the Basque
148 country.

149 Around the world, other ITEs schemes based on days at sea are found in New
150 England ground fish fishery in the U.S., the Western and Central Pacific
151 Ocean purse seine tuna fishery, and the Falkland Islands squid fishery
152 (Squires et al., 2016, 2012).

3

The elasticity coefficient is calculated as the percentage increase in the coefficient factor divided by the percentage increase in the braking power.

153 Concerning Mediterranean countries, one study was carried out by Lucchetti
154 et al. (2014) to compare the strengths and weaknesses of different, possible
155 TFCs schemes, including ITQs and ITEs. Opinions were collected by several
156 public authorities. The conclusion of the study is that TFCs would not be
157 appropriate for the Mediterranean context (with the partial exception of
158 pelagic fisheries). Several motivations for this conclusion are expressed, such
159 as, in particular, the risk that smaller companies would disappear in favour
160 of larger, economically stronger companies.

161

162 **3. Data and Methods**

163 ***3.1 Study area***

164 The objective of this study is to evaluate the possible consequences of ITEs
165 in Italian fisheries, involving stakeholders through a participative approach.
166 This research has focused in particular on three Italian fisheries: the Adriatic
167 pelagic trawling fishery, the Adriatic bottom trawling fishery, and the
168 Tyrrhenian bottom trawling fishery. The Adriatic pelagic trawling fishery
169 includes 127 vessels (representing around 90% of the Italian pelagic trawling
170 fishery) with an annual production of around 41 million Euros (95% of Italian
171 production). The two bottom trawling fisheries (Adriatic and Tyrrhenian,
172 excluding Sicily and Sardinia) include, respectively, 1,130 and 500 vessels
173 (48% and 21% of the Italian bottom trawling fishery), with an annual
174 production of around 200 and 82 million Euros (48% and 20% of Italian
175 production) (Mipaaf and NISEA, 2014).

176 In mid-2014, a Ministerial Decree introduced a new management scheme for
177 the Adriatic fisheries (effective for both pelagic and bottom trawling) stating
178 that, in order to reduce fishing efforts, each vessel had to choose either i)
179 fishing five days per week for a maximum of 72 weekly hours or ii) fishing
180 only four days per week⁴.

181

4

Fishing is always forbidden on Saturdays and Sundays in all sea areas.

182 **3.2 Participatory management**

183 Fishers' participation in fisheries research and management is becoming
184 more and more common despite the strong biological/positivistic tradition
185 in fisheries management and the high level of government involvement.
186 Without fishers' participation in research, the ability of fisheries managers is
187 limited and new policy decisions can lead to low compliance and tension
188 between stakeholders and authorities (Silver and Campbell, 2005). However,
189 there is much uncertainty on how to best elicit stakeholders' information,
190 objectives and options in a rigorous manner that support management
191 decisions (Silver and Campbell, 2005).

192 For this scope, several qualitative or semi-quantitative approaches have
193 been applied and can be found in fisheries literature. Martin-Smith et al.
194 (2004) developed an ad hoc iterative process of consultation for the
195 development of management options. Other tools are more focused on
196 research questions rather than management objectives and include semi-
197 structured interviews (Trimble et al., 2014), participatory problem-solution
198 trees (Manrique de Lara and Corral, 2017), excursions, seasonal calendars,
199 historical timelines (Glaser et al., 2015), rapid rural appraisal techniques
200 (Pido, 1995), experimental field games (Cleland, 2017), etc.

201

202 **3.3 Methodology**

203 For this study, a semi-quantitative approach has been used. Consultation
204 with fishers occurred at two different points. First, at the beginning of 2016,
205 a survey was conducted with 38 key stakeholders distributed in sixteen ports
206 of eight Italian regions along the Adriatic and Tyrrhenian coasts (Figure 1).
207 Key stakeholders were chosen by 'Alliance of Italian Cooperatives' experts
208 mainly among vessel owners or captains that also have (or had) formal roles
209 inside local cooperatives or producer organizations (normally, one or more
210 cooperatives can be found in every port). In fact, the information collected
211 is not directly related to the fishery activity of key stakeholders but on their
212 own knowledge (as experts) of regional patterns. Second, the results and
213 elaborations of the surveys were discussed and validated in a focus group
214 composed of ten delegates of the fishery associations (Agci Agrital,

215 Federcoopesca-Confcooperative, and Lega Pesca-Legacoop) at the regional
216 (six delegates for Tuscany, Apulia, Emilia-Romagna, Abruzzo, Calabria and
217 Sicily) and national (four delegates) level.

218 For the survey, eleven stakeholders (from three regions) were interviewed
219 for the Adriatic pelagic fisheries; fifteen (from five regions) for the Adriatic
220 bottom trawling fisheries, and twelve (from three regions) for the Tyrrhenian
221 bottom trawling fisheries. These key stakeholders were consulted about
222 their opinions on:

223 a) The relationships between fishing capacity (i.e. engine power and GT),
224 fishing activity (i.e. fishing days and fishing hours), revenues, and
225 variable costs (e.g. fuel) (for a formal treatment see appendix A).

226 b) The suitability of different proposals and alternative approaches for
227 the introduction of ITEs.

228 The first part of the survey is important in order to understand the
229 relationships among the variables normally used to estimate production
230 functions, in particular how capacity affects activity, revenues, and variable
231 costs (i.e. linearly or non-linearly) and how activity affects catches. These
232 variables were measured by asking about the average daily revenue, daily
233 variable cost, and yearly number of days at sea of an average vessel (given a
234 certain GT and engine power) of a specific Italian region (the region of the
235 person interviewed) using a specific gear (pelagic or bottom trawl). Regional
236 reference values provided by official statistics (Mipaaf and NISEA, 2014) were
237 communicated to the key stakeholders, and they could confirm or change
238 them. Then, stakeholders were asked what difference in revenue, fuel cost,
239 and days at sea should be expected for a vessel with a capacity (both GT and
240 engine power) 20% larger and 20% smaller than the average vessel. The
241 same procedure was followed to calculate the effect of yearly days at sea on
242 yearly revenues.

243 These relationships are essential in order to understand which vessels (i.e.
244 large or small) would take advantage of the introduction of ITEs. Other
245 questions were related to the length of an average day at sea (for which no
246 official data exist) and the reasons that a vessel spends fewer days at sea
247 than would be theoretically allowable.

248 In the second part of the survey, questions addressed the stakeholders'
249 opinions about different aspects of ITEs, in particular:

- 250 a) The introduction of non-transferable quotas (or limits) of fishing days
251 (in the case of the Adriatic Sea something similar was already
252 introduced by the 2014 Ministerial Decree).
- 253 b) The use of weekly or monthly restrictions in the allowed fishing days.
- 254 c) Different patterns in the initial allocation of fishing days (Bellanger et
255 al., 2016).
- 256 d) The introduction of transferability of fishing days.
- 257 e) Different approaches to permit the transferability of fishing days
258 between vessels of different capacities (no constraints, transferability
259 only within classes of vessels with similar capacity, or nominal effort
260 quotas such as capacity*day).

261 The results and elaborations of the surveys were discussed and validated in
262 a focus group composed of ten delegates of fishery associations at regional
263 and national level. With the help of the delegates, starting from revenue and
264 cost data, a generic tool to show the relationship between vessel capacity
265 and daily value added was built for the bottom trawling fisheries. Finally, we
266 built a simplified model indicating how the value added is distributed day by
267 day. This model was used to discuss possible consequences of the
268 introduction of ITEs.

269

270

271 **4. Results**

272 **4.1 Survey**

273 Table 1 shows the main characteristics of the fleets per region, comparing
274 official data (Mipaaf and NISEA, 2014) and key stakeholders' opinions. No
275 significant differences have been found in the daily fuel costs. Considering
276 how stakeholders were chosen (i.e. representative key agent), the number
277 of interviews (i.e. low compared to population of fishers), and the typology

278 of questions (i.e. oriented to get information about standard vessels rather
 279 than specific vessels), the results of the survey must be evaluated in a
 280 qualitative (or semi-quantitative) way rather than in a pure quantitative (i.e.
 281 statistical) way. This means that relationships are validated through
 282 consultation with a set of experts (i.e. focus group) rather than statistical
 283 tests.

284

285 **Table 1.** Daily revenues, daily fuel costs and fishing days/year per region (A: Adriatic; T:
 286 Tyrrhenian) and fishery (BT: bottom trawling; PT: pelagic trawling) of average vessels and
 287 smaller/larger vessels (i.e. GT -20% and +20% compared to average vessels). For daily revenue
 288 and fishing days, in brackets, official data (Mipaaf, Nisea, 2014); out of brackets, figures declared
 289 by stakeholders (all declared figures are the arithmetic mean of stakeholders' answers).

Region	Fishery	GT average vessel (tons)	Daily revenue		Daily fuel cost		Fishing days / year	
			Average vessel (€)	Capacity -20%; +20%	Average vessel (€)	Capacity -20%; +20%	Average vessel (days)	Capacity -20%; +20%
Abruzzo (A)	BT	59	1265 (1265)	-20%; +20%	694	-17%; +17%	120 (152)	-13%; +10%
Campania (T)	BT	34	893 (893)	-20%; +10%	265	-23%; +13%	169 (169)	-13%; +13%
Emilia-Romagna (A)	BT	24	1210 (1415)	-23%; +10%	476	-5%; +5%	110 (83)	-10%; +7%
Lazio (T)	BT	50	1291 (1321)	-15%; +5%	544	-10%; +5%	167.5 (199)	-5%; +3%
Marche (A)	BT	57	1658 (1787)	-13%; +3%	750	-10%; +13%	139 (139)	-7%; +7%
Apulia (A)	BT	25	1007 (1220)	-17%; +17%	435	-13%; +17%	200 (128)	0%; 0%
Tuscany (T)	BT	31	1225 (1256)	-10%; 0%	499	0%; 0%	174 (153)	0%; 0%
Veneto (A)	BT	40	867 (1966)	-10%; +25%	410	-10%; +10%	112 (107)	0%; 0%
Emilia-Romagna (A)	PT	62	2435 (2435)	-5%; +10%	619	-28%; +20%	170 (126)	0%; 0%
Marche (A)	PT	107	1602 (1602)	0%; 0%	870	-14%; +13%	163 (162)	-20%; 0%
Veneto (A)	PT	68	2875 (3188)	-7%; +7%	659	-7%; +20%	120 (126)	-1%; +10%

290

291

292 4.1.1 Effects of fishing capacity

293 Stakeholders estimated the per cent difference between the average daily
 294 revenue and daily fuel cost of a vessel of average capacity (for every region
 295 and fishery) and those of vessels with 20% more or less capacity compared
 296 to the average vessels. The regional results are aggregated in Table 2 by sea
 297 basin and fishery. Since vessels characteristics, fishers' strategies and
 298 available species can differ substantially even in neighbour regions, these
 299 average results should be considered with a little of caution. In general,
 300 stakeholders said that both revenues and fuel costs change less than
 301 proportionally with changes in vessel capacity. Furthermore, for Tyrrhenian
 302 bottom trawlers, the responses indicated that revenue is increasingly

303 inelastic as capacity increases. In fact, daily revenue drops by 15% when
 304 capacity decreases and rises by only 5% when capacity increases. This fishery
 305 exhibits a similar pattern for daily fuel costs.

306

307 **Table 2.** Daily revenues and fuel costs of standard vessels and smaller/larger vessels (data are
 308 aggregated by fishery using the arithmetic mean of regional surveys).

Sea basin	Fishery	Capacity -20%	Average vessel	Capacity +20%
Daily revenue (€)				
Tyrrhenian	Bottom trawling	-15%	1136	+5%
Adriatic	Bottom trawling	-17%	1201	+15%
Adriatic	Pelagic trawling	-4%	2304	+6%
Daily fuel cost (€)				
Tyrrhenian	Bottom trawling	-11%	436	+6%
Adriatic	Bottom trawling	-11%	553	+12%
Adriatic	Pelagic trawling	-16%	716	+18%

309

310 For Adriatic fisheries, on the contrary, the decreasing returns to capacity
 311 seem to be constant. For pelagic trawlers, revenues seem to be much more
 312 inelastic than fuel costs. This result may be due in part to the technical
 313 specificities of this fishery and certainly is due in part to the self-management
 314 habits of some cooperatives (especially in the Marche region), where
 315 voluntary daily quotas are established for all members independent of the
 316 size of the vessels.

317 The relationships between capacity and daily fuel costs are difficult to
 318 analyse because, depending on the region, larger vessels may fish for more
 319 hours than smaller vessels, with a direct effect on fuel costs.

320 In Figure 2, revenue and fuel cost data (i.e. stakeholders' opinion) for all
 321 regional bottom trawling fleets (both Adriatic and Tyrrhenian) are shown.
 322 These data include the eight regional average vessels and the corresponding
 323 higher (+20%) and lower (-20%) capacity vessels (GT is indicated in the
 324 figure). From this figure, large vessels seem to have a very slight advantage
 325 compared to small vessels since the distance between daily costs and daily
 326 revenues increases with capacity.

327 The effect of fishing capacity on fishing activity is very low (i.e. fishing activity
 328 is inelastic) (Table 3). This finding is the same if we consider both fishing days

329 per year and fishing hours per day. Stakeholders in some regions (Apulia,
 330 Tuscany, and Veneto) say that capacity has no effect at all on the number of
 331 fishing days of bottom trawlers. Differences between regions, linked to
 332 differences in the natural environment and in social habits, are much more
 333 significant than differences between vessel sizes within regions. The average
 334 number of fishing days varies from 110 (bottom trawling in Emilia Romagna)
 335 to 200 (bottom trawling in Apulia). The average number of fishing hours
 336 varies from 11 (pelagic trawling in Veneto) to more than 20 (bottom trawling
 337 in Marche and Abruzzi).

338

339 **Table 3.** Fishing days and fishing hours of standard vessels and smaller/larger vessels (data are
 340 aggregated by fishery using the arithmetic mean of regional surveys).

Sea basin	Fishery	Capacity -20%	Average vessel	Capacity +20%
Fishing days / year				
Tyrrhenian	Bottom trawling	-6%	170	+5%
Adriatic	Bottom trawling	-6%	136	+5%
Adriatic	Pelagic trawling	-9%	158	+2%
Fishing hours / day				
Tyrrhenian	Bottom trawling	-5%	14.6	3%
Adriatic	Bottom trawling	-1%	17.9	1%
Adriatic	Pelagic trawling	-3%	13.2	6%

341

342 *4.1.2 Effects of fishing activity*

343 For most of the stakeholders, the first factor limiting the number of fishing
 344 days is weather conditions. Other reasons vary depending on the sea basin
 345 and fishery. In the case of pelagic trawling in the northern Adriatic (Veneto
 346 and Emilia Romagna), vessels remain inside the port if demand and prices
 347 are low. For Adriatic bottom trawling, stock seasonality and vessel
 348 maintenance periods are equally important in determining fishing days.

349 In the Adriatic Sea, the application of the 2014 Ministerial Decree has not
 350 been uniform. Depending on the geographic area, fishers have preferred to
 351 either fish five days per week for a maximum of 72 weekly hours or to fish
 352 only four days per week. The 'four days' option has been naturally preferred
 353 in areas, such as Marche and Abruzzi, where boats are larger and can fish for
 354 more hours.

355 All stakeholders indicated that this new rule has caused both time at sea and
356 revenues to decrease, but the decrease in revenue of about 9% is less than
357 proportional compared to that of time (about 13%). Adriatic fishers also said
358 that if they could fish for the same number of days but without weekly limits,
359 revenues would increase around 5%. Finally, if a new regulation called for a
360 30% reduction in days at sea, Adriatic stakeholders would expect a less than
361 proportional reduction in revenues (around 16% for bottom trawling and
362 24% for pelagic trawling).

363 These opinions are not shared by Tyrrhenian fishers, where fishing day limits
364 have never been applied. In fact, when they were asked the potential effects
365 of a 20% or a 50% reduction in days at sea, they estimated a roughly
366 proportional revenue reduction.

367

368 *4.1.3 Opinions on ITEs schemes*

369 Most of the Adriatic key stakeholders, in particular those in pelagic trawling,
370 declared that they were satisfied by the introduction of the fishing time limits
371 imposed by the 2014 Ministerial Decree. However, fishers who adopted the
372 72 weekly hours option would not appreciate the introduction of limits on
373 the number of fishing days. Similarly, most of the Tyrrhenian fishers are
374 opposed to such schemes.

375 In the case of the introduction of fishing day limits, Adriatic stakeholders
376 would prefer to adopt a weekly allocation (i.e. four fishing days per week),
377 whereas Tyrrhenian stakeholders would prefer to be free to allocate fishing
378 days throughout the whole year (i.e. no weekly or monthly limits).
379 Stakeholders who prefer weekly limits indicated that they would allow for
380 easier control and management; furthermore, they would be critical to allow
381 a more regular flow of products to the markets.

382 Most of the Adriatic stakeholders indicated that fishing day limits should be
383 distributed equally to all vessels (as done by the 2014 Ministerial Decree)
384 independent of vessel sizes or time series. On the contrary, on the Tyrrhenian
385 side, opinions were less uniform, and half of the stakeholders expressed that

386 larger vessels that currently use more fishing days would need more fishing
387 days to recover fixed costs.

388 Both Adriatic and Tyrrhenian fishers think that the transferability of fishing
389 days would not be a good idea. Fishers said that larger vessels would buy or
390 lease fishing days from smaller vessels. Smaller vessel owners would simply
391 earn rents. Control and management would be very difficult.

392 Finally, the responses were very diversified when different transferability
393 schemes between vessels of different sizes were proposed. Key stakeholders
394 representing Adriatic pelagic trawling said that no constraints should be
395 imposed; this argument can be reasonable if it is true that large vessels have
396 no sensible advantage over small vessels (i.e. if landings are rather inelastic
397 to vessel capacity, as in some simulations shown in the appendix).
398 Stakeholders in Adriatic bottom trawling said that transferability should be
399 allowed within classes of vessels with similar capacities. Stakeholders in
400 Tyrrhenian bottom trawling perceived all schemes as more or less equal,
401 including 'no constraints', 'capacity classes', and 'effort indices' (expressed
402 as $GT \times \text{fishing days}$ or $\text{engine power} \times \text{fishing days}$, which permit to maintain a
403 constant total fishing effort).

404

405 **4.2 Focus group**

406 The focus group permitted to validate (and discuss) the data collected in the
407 survey. This further allowed to build, together with the fishery associations
408 delegates, the bottom trawling model and the ITEs model that we present in
409 the next sections.

410

411 *4.2.1 The bottom trawling model*

412 Starting from revenue and cost data collected through the survey (see Figure
413 2), a generic capacity-daily value added relationship was built for the bottom
414 trawling fisheries of the Adriatic and Tyrrhenian Seas. It is important to
415 highlight that for every Italian region there are specificities (linked to gear
416 differences, distributions of main and secondary species, distance, depth of

417 fishing areas, etc.) that make our generic model only a very rough and
418 pedagogical tool and not an instrument for developing positivistic
419 bioeconomic models. Gross value added is used as the output variable
420 instead of profit due to problems in the estimation of labour costs.

421 The model (shown in Figure 3), validated by the associations delegates, has
422 the following properties:

- 423 • The daily revenue curve fits the data shown in Figure 2 with decreasing
424 returns to capacity (expressed in GT).
- 425 • Daily variable costs are derived from fuel costs, which represent
426 approximately 76% of variable costs. The data shown in Figure 2 are
427 used to estimate a linear relationship with a positive vertical intercept
428 between variable costs and capacity.
- 429 • The daily value added is slightly increasing. Associations delegates
430 indicated that the maximum daily profit is probably obtained by
431 vessels of around 120 GT⁵.

432

433 Fishery association delegates also confirmed that capacity has only a
434 marginal effect on fishing days. Although large vessels may potentially stay
435 at sea for more days, as they are less affected by weather conditions, market
436 conditions represent a constraint that limits the actual number of fishing
437 days.

438

439 *4.2.2 The ITEs model*

440 Since stakeholders confirm decreasing returns to fishing time (see appendix
441 A), we built a simplified model indicating how the value added is distributed
442 day by day, from the most rentable to the least (Figure 4), and we used this
443 tool to discuss the consequences of ITEs schemes. The yearly value added

5

It is important to stress that in the Adriatic and Tyrrhenian seas, there are only a few vessels larger than 150 GT. This is not the case for vessels fishing in waters around Sicily.

444 (73,400 euro) of an average bottom trawler (40 GT) is derived in Figure 3.
445 The number of days at sea is 150, which is an average number for the
446 Tyrrhenian and Adriatic regions.

447 Now, suppose that, in order to reduce pressure on fish stocks, the number
448 of fishing days has been limited by the management authority to 120 (-20%).
449 The effects on yearly revenues depend on two variables: i) the existence of
450 weekly constraints (i.e. a maximum of four days per week) and ii) whether
451 the distribution of more and less rentable days follow a seasonal pattern (i.e.
452 all of the worst days of the year are found within the same week) or a weekly
453 pattern (i.e. every week has a perfect distribution of good, average, and bad
454 days). We have the following cases:

- 455 • Weekly constraints and seasonal patterns of rentable days: The
456 revenue drop (19%) is almost proportional to the drop in fishing time.
457 In fact, fishers are not free to discard all of the worst days of the year.
- 458 • No weekly constraints and seasonal patterns of rentable days: The
459 revenue drop is very small (4%), since fishers may select and discard
460 all of the worst days (Figure 4).
- 461 • Weekly patterns of rentable days: The revenue drop is always 4%,
462 regardless of weekly constraints.

463 Thus, weekly constraints may affect fishers' revenue much more than
464 unconstrained limits, depending on the distribution of bad and good fishing
465 days within the year. Seasonal patterns are driven by biological cycles (i.e.
466 revenue decreases due to catch cycles), whereas weekly patterns can be the
467 result of market forces (i.e. revenue decreases due to weekly price cycles).
468 Focus group participants indicate that the truth is in the middle. On the other
469 hand, stakeholders acknowledge that in the case of seasonal patterns (i.e.
470 cycles of catches), only weekly constraints may have a significant effect on
471 effective effort reduction, which should be the true objective of the
472 management.

473

474 Now, consider the case where there are no weekly constraints and the
475 transferability of quotas is allowed. Several such situations were discussed

476 with stakeholders. In Figure 5a, Vessel A is an average bottom trawler. Vessel
477 B is more efficient than A; historically, it used the same number of fishing
478 days, but the value added obtained was 60% higher. With the introduction
479 of a 120-day limit, A and B have different marginal values added⁶. It is
480 possible to calculate that seven days should be sold from A to B. However,
481 this exchange increases the effective fishing effort and catches (see appendix
482 B), which should be taken into account by the management authority.

483 In Figure 5b, a different situation is shown. Vessel C has the same value
484 added as B in the previous example, but C used to fish 180 days per year. The
485 management authority must decide if the day limit has to be equal for all
486 vessels (e.g. 150 days) or proportional to a vessel's historic number of fishing
487 days (e.g. 9% reduction). The two methods allow the same number of total
488 days for the fleet. In the first case, Vessel A is not affected by the new
489 measure. However, A will sell 16 days to C, which is strongly motivated to
490 buy days due to its high marginal value added. This situation confirms the
491 results of interviews, in which fishers said that a small vessel would enjoy
492 free rents without needing to fish. In order to avoid this situation, limits
493 proportional to a vessel's historic number of fishing days should be adopted,
494 a proposal that was not appreciated in the interviews. In this second case,
495 many fewer days would be exchanged (only two); the same equilibrium
496 would be obtained, but without rents for A.

497

498 In order to avoid an increase in effort due to the exchange of day quotas,
499 effort quotas (expressed as $GT \cdot \text{fishing days}$) could be used. We have said
500 that the value added of B is 60% higher than that of A (Figure 5a); from Figure
501 3, due to decreasing returns to input, we can see that this situation occurs if
502 the GT of B (80) is double that of A (40). In other words, in order to maintain
503 a constant nominal effort quota, B should buy two days from A in order to
504 fish one day more. However, this exchange is not worthwhile for A and B. On

6

Considering the marginal value added instead of the marginal profit is as if the whole crew decided to sell or buy quotas.

505 the contrary, it is worthwhile for A to buy one day from B in order to fish two
506 days more.

507 This example showed to stakeholders how an effort quota might prevent the
508 sale of fishing days from small vessels to large vessels. However, because of
509 the difference between nominal effort and effective effort, this measure
510 could still cause an increase in effective effort (i.e. two days of small vessels
511 represent more pressure than one day of large vessels) and may artificially
512 advantage inefficient vessels (see appendix B).

513

514 **5. Discussion and conclusions**

515 The results of the survey show that the application of the 2014 Ministerial
516 Decree in the Adriatic Sea has made these stakeholders more open to fishing
517 day restrictions compared to Tyrrhenian fishers. Adriatic fishers have seen
518 positive effects in terms of cost reductions and price increases. Furthermore,
519 they would maintain the current conditions (i.e. weekly constraints, equal
520 limits for everybody, and no transferability), whereas Tyrrhenian fishers, if
521 forced to limit the number of fishing days, would prefer different conditions
522 (i.e. no weekly constraints and different limits by vessel size). The results also
523 indicate that Adriatic stakeholders acknowledge a less than proportional
524 drop in revenues due to a decrease in fishing time (indicating decreasing
525 returns to fishing time). On the contrary, Tyrrhenian stakeholders suppose
526 that the revenue decrease would be proportional to fishing time.

527 All of these results show how important direct experimentation, pilot
528 projects, and information sharing are to change fishers' ideas about
529 management schemes and how difficult it is for fishers to accept new
530 proposals.

531 The focus group, carried out with the participation of Italian fishery
532 associations, has permitted the building of some simple pedagogical tools
533 based on realistic figures obtained through surveys that can be used by
534 stakeholders, in particular managers of associations, cooperatives, and
535 producer organizations, to better understand the functioning and possible
536 consequences of ITEs schemes.

537 Some of the opinions on ITEs collected in the survey were confirmed by the
538 models (e.g. small vessels could obtain rents with the introduction of ITEs),
539 whereas others were rejected (e.g. quotas proportional to historic fishing
540 days are better in order to avoid gratuitous rents for small vessels). In any
541 case, this exercise has increased stakeholders' knowledge about a
542 management scheme that offers some advantages in the case of mixed
543 fisheries. These advantages are particularly relevant in the case of bottom
544 trawling fisheries, whereas, for pelagic fisheries that focus on only two
545 species (sardine and anchovy), an ITQ scheme could also be applied
546 (Mulazzani and Malorgio, 2013).

547 In 2016, in conjunction with the realization of this study, the regulation for
548 pelagic fisheries has changed again. For the Adriatic Sea, a limit of 144 fishing
549 days (and a minimum of 70 days) has been imposed, with a maximum of 20
550 days per month. This limit is less than the amount that an average pelagic
551 trawler normally used to fish. Without an explicit announcement by the
552 Italian management authority, the management scheme seems to have
553 shifted toward non-transferable effort quotas, which does not exclude the
554 possibility that private interests, driven by differences in marginal profits, will
555 transform it in a transferable effort quota scheme.

556 Several issues have to be considered in more depth in future analysis.
557 Biological aspects have been completely ignored in this study. Biologists
558 should have to identify the most suitable fishing day limits in the context of
559 mixed fisheries, where the maximum sustainable yield cannot be achieved
560 for every species. Difficult choices are required, balancing the needs of
561 fishers and environment. The exchange of quotas between vessels may
562 entail an increase in average catchability (i.e. efficiency), and, thus, further
563 reductions in fishing days could be required over time (see appendix B). From
564 an economic perspective, the advantages of vessels from one region over the
565 vessels from other regions have not been considered in detail, but, in fact,
566 the exchange of quotas between regions can affect local supply chains.
567 Furthermore, as several stakeholders have highlighted, considering day
568 restrictions without considering hours per day can be misleading, especially
569 when fishing time patterns differ among regions.

570

571

572 **Appendix A – Static model**

573 In the scientific literature, there is a lack of formal treatment of ITEs. Clark
574 (1980) builds a predictive model of fisheries management where, he says,
575 ‘quotas on catch are equivalent to quotas on fishing effort’, which trivially
576 follows from the assumed direct relationship between catch and effort,
577 $Y_i=qBE_i$, where B is the biomass of the fish stock, q is the catchability
578 coefficient, and Y and E are, respectively, the catches and the fishing effort
579 of vessel i . However, this direct relationship between effort and catches is
580 true only if q is equal for every vessel.

581 Danielsson (2002) and Ulrich et al. (2002) discuss the efficiency of total
582 allowable effort quotas (TAEs), but they do not consider the case of ITEs.
583 However, Ulrich et al. (2002) recognize that TAEs require a model of the
584 catchability dynamics. As Squires et al. (2016) highlight, effort is less well
585 defined and homogeneous as an input than catch is as an output; controlling
586 a single dimension of effort (e.g. days) leaves out unregulated dimensions
587 that can be expanded (‘capital stuffing’) and technological progress (‘effort
588 creep’) that can increase catch (i.e. effective effort increases). In contrast to
589 catch rights, ITEs do not create incentives to overcome biological overfishing
590 and to minimize costs but rather create incentives to maximize revenue
591 (Squires et al., 2016).

592 For this work, we developed a model that takes into consideration
593 differences between single vessels (Andersen et al., 2010; Clark, 1980). For
594 every vessel, we consider the following Cobb-Douglas production function

595

(A.1)

$$Y = mS^a D^b B^g$$

596

597 where Y is yearly catches; S is a measure of fishing capacity (e.g. GT or engine
598 power); D is a measure of fishing activity (such as days at sea); B is the
599 biomass of fish stocks; m is a technological parameter; and a , b , and g are
600 other parameters that make the function non-linear, indicating increasing or

601 decreasing returns to inputs. Decreasing returns to inputs should be
602 expected for S and D , even though the fishery literature includes empirical
603 estimations where the elasticity is greater than one, indicating some sort of
604 economies of scale (Bjorndal and Conrad, 1987; Eide et al., 1998).

605 Profit is given by

$$606 \quad \quad \quad (A.2)$$

$$607 \quad \pi = p(mS^a D^b B^g) - (sS^t + xS^y D)$$

608 where p is the price of fish, sS^t are fixed costs, and $xS^y D$ are variable costs.
609 Both fixed costs and variable costs are functions of the fishing capacity S .

610 We stress that, all other coefficients constant, the effect on profit of
611 increasing capacity S depends on the values of a , t , and y . In fact, if $a > y$ and
612 $a > t$, profit increases with S , and profit decreases otherwise. However, this
613 result is certain only for infinitely high values of S ; for values of S closer to
614 reality, profits can increase also if a is lower than y and t .

615 In the short term, profit depends only on days at sea D (we suppose there is
616 no difference in the length of a fishing day). Let us assume that $b < 1$, meaning
617 that there are decreasing returns to fishing days. This assumption simply
618 means that fishers always choose more rather than less suitable days for
619 fishing. Vessel owners will decide to fish the number of days that maximize
620 profit. Thus, from Equation A.2, we obtain that fishing days will be

$$621 \quad \quad \quad (A.3)$$

$$622 \quad D = \left(\frac{xS^y}{pqS^a B^g b} \right)^{\frac{1}{b-1}}$$

623 From this equation, it is possible to see if vessels of larger capacity S will tend
624 to be active for more days or not. In fact, if $a > y$, D increases with S ; if $a < y$, D
625 decreases; and, finally, if $a = y$, S has no effect and all vessels choose the same
626 number of days at sea.

627 We can see in Figure A.1 some simulations of profit given different days at
628 sea and different parameters a , y , and t .

630 Appendix B – Long term equilibrium model

631 The previous model is static and can represent the behaviour of vessels in
632 the short term. In the long term, it is necessary to consider the dynamics of
633 the fish stocks. In this section, we assume a simple logistic growth function,
634 which permits us to calculate steady maximum sustainable yield (MSY),
635 maximum economic yield (MEY), and bioeconomic equilibrium (BE). Given
636 Equation A.3, changes in the sizes of stocks directly affect the number of days
637 at sea chosen by fishers in order to maximize their profit (i.e. lower biomass
638 implicates fewer days at sea). MSY, MEY, and BE are functions of the number
639 (n) of vessels in the fishery and the capacity (S) of each vessel. Given n and S
640 for each vessel, MSY or MEY can be obtained through management imposing
641 a maximum number of days at sea (D) per vessel, since D chosen by single
642 fishers to maximize their short-term profits cannot guarantee these yield
643 levels.

644 For simplicity, we have simulated a situation where there are $n/2=60$ large
645 vessels ($S=300$) and $n/2=60$ small vessels ($S=60$) (Figure B.1). As expressed in
646 the questionnaire to fishers, the management authority can choose between
647 two options. It can decide to either establish equal fishing day limits for all
648 vessels, or it can establish a fishing day limit that is proportional to the
649 historic days at sea of each vessel. For example, if we consider the case
650 shown in Figure A.1a as historical information, large vessels used to work 296
651 days per year and small vessels 198 days per year, and, thus, the restriction
652 should be applied proportionally. In Figure B.1a, steady profits⁷ (i.e. at
653 equilibrium) are shown for small and large vessels for different levels of TAE.
654 The total profit of the fleet as a whole does not change considerably across
655 the two management strategies, but the distribution of the benefits between
656 the two groups of vessels is very different. Large vessels, in particular, are
657 negatively affected by equal fishing day limits.

7

Steady solutions have been calculated simulating the dynamics of the fish stock for a 60-year period until the equilibrium is obtained.

658 The situation can change further if fishing days are transferable between
659 vessels in an ITEs scheme. The exchange should happen when vessel owners
660 have different marginal profits for the last fishing day they are allowed to
661 use. With this management scheme, given a certain total number of fishing
662 days for the fleet, the final distribution of fishing days between small and
663 large vessels is not affected by the initial allocation of limits (i.e. equal for all
664 or proportional to historical fishing days) since the exchange of quotas
665 continues until all of the vessels have the same marginal profit. However, a
666 higher concession of fishing days at the moment of the initial allocation can
667 be converted into rents when the quota exchange occurs. In a situation as
668 shown in Figure A.1a, large vessels tend to buy some fishing days from small
669 vessels.

670 Given a certain TAE, the total catches and profits of the fleet change if the
671 distribution of days between vessels is determined by fixed (i.e. equal for all
672 vessels) quotas, proportional quotas, or transferable quotas. Fixed quotas
673 entail the lowest average catchability for the fleet, which means low short-
674 term efficiency. On the contrary, transferability permits the highest
675 catchability or short-term efficiency for the fleet. However, this high
676 efficiency also entails high exploitation of the fish stock, which affects the
677 long-term potential of the fishery. In other words, in equilibrium (as shown
678 in Figure B.1b), a transferable fishing days scheme can obtain the same
679 catches or profits of a fixed days scheme only through a further reduction of
680 the TAE.

681 To avoid an increase in fishing mortality, a different approach is a
682 management scheme that explicitly considers capacity to maintain a
683 constant total effort of the fleet. Here, the choice is between an index of
684 nominal effort and an index of effective effort (Figure B.2).

685 In the first case, capacity*fishing day ($S*D$) could be easily applied and
686 understood by fishers and authorities. The problem is that the nominal effort
687 cannot perfectly reflect the ability of vessels to catch fish (i.e. effective effort
688 or fishing mortality). In other words, assuming decreasing returns to capacity
689 (i.e. $\alpha < 1$), a vessel A that is five times larger than a vessel B catches less than
690 five times the catches of B. In this situation, also considering a relationship

691 between variable costs and capacity that is favourable to large vessels (such
692 as in Figure A.1a, where $a > \gamma$), small vessels may have higher marginal profits
693 than large vessels for the last unit of nominal effort (S^*D) that they are
694 allowed to use.

695 Thus, ITEs based on indices of nominal effort may affect the long-term
696 efficiency of the fishery as much or more than those based on transferable
697 fishing days since less efficient vessels (the small ones) are artificially
698 advantaged by the ITE scheme, leading to an increase in effective effort.

699 ITEs based on indices of effective effort, on the contrary, are the only
700 schemes where the average catchability of the fleet does not change due to
701 the exchange of quotas between vessels of different sizes (i.e. in the short-
702 term, the total catches of the fleet do not change). In this way, vessels that
703 are truly efficient, those that have the lowest marginal cost per unit of catch,
704 or those that get the best prices (e.g. improving fish quality) can emerge and
705 buy effort quotas (Figure B.2).

706 The potential advantage of effective effort quotas, however, increases in the
707 very long-term when, beyond the exchange (or leasing) of days at sea (i.e.
708 activity) weighed in effort quota terms, firms may decide to exchange
709 capacity, also weighted in effort quota terms. In other words (assuming
710 parameters as in Figure A.1a), small vessels are retired and replaced by a
711 smaller number of large vessels. In fact, assuming different efficiencies of
712 vessels (i.e. different cost per unit of catch), less efficient vessels should,
713 theoretically, be completely substituted by more efficient ones. This
714 substitution would permit greater profits for the fleet at both the MSY and
715 the MEY level.

716

717

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721

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