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LEGAL BASE: COMMISSION DECISION*2005/629IEC*
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EUROPEAN COMMISSION, DIRECTORATE-GENERAL FOR MARITIME AFFAIRS AND FISHERIES
Policy development and co-ordination, Brussels, MAREA2

Request for services
Survival of discarded fish

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A rapid review of studies on discard survival rates

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Background and briefing for the work

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Subject: Request for services - Survival of discarded fish

Description of the work: Background

Under Article 15 of the draft Basic Regulation as part of the reform of the CFP, the Commission has proposed the introduction of a discard ban. One of the provisions of the proposed ban is that fish with a high survival rate and vulnerable/protected species (e.g. basking shark, common skate and porbeagle) should be released back into the sea. However, it is not entirely clear what species should be excluded due to good survivability after capture. Studies on the mortality of different fish species discarded from the decks of fishing vessels generally show high mortality rates, although the types of injuries and their severity are highly species-specific. The main factors affecting the stress, injury and mortality of discarded fish are related to capture stresses, fishing conditions and biological attributes. Capture stressors include such factors as net entrainment, crushing, wounding and sustained swimming until exhaustion. Fishing conditions include towing time and speed, light conditions, water and air temperature, anoxia, sea conditions, size and species. Biological attributes are also important. Generally it has been shown that most fish with swim bladders that inflate after capture die because of pressure changes during the capture process. The post-release mortality of other fish and aquatic organisms (i.e. those without swim bladders) is more variable and sometimes can be low. Mortality is also related to the overall fragility and physical characteristics of species. For some species, discard mortalities can be reduced through reduced exposure to air and improved on deck handling procedures, but in many cases a significant reduction in discard mortality is difficult to achieve.

Terms of Reference
To develop a list of species with high survivability that could be excluded under the landing obligation and should be returned to the sea after capture.

For establishing this list you should:

• Review all studies carried out that have investigate the survivability of discarded fish by species and by fishing method.

• Extrapolate data on survival rates by species and fishing method based on this review and indicate species with high survivability and could be safely excluded from the list of species included under the landing obligation.

You shall send the final report (including raw data raw data in documented XL worksheet) by Friday 12 April 2012 at 16:00 CET

Time allocated for this study: 6 days

Method used

- Searched the literature, purchased and downloaded relevant papers on discard survival (3 days)
  - Literature search focussed on studies undertaken since 2000
  - Studies likely to be most relevant to EU fisheries
  - A total of Eighty eight (88) studies were identified. These were purchased and downloaded (of which 5 were review papers)

- The review paper by Broadhurst et al. (2006) was used as the template to tabulate new findings and structure our report

- A *rapid* review of 88 papers was undertaken and new findings were added to the tabulated existing findings of Broadhurst et al (2006) (2 days)

- A summary table was compiled and a brief overview report was written (1 day)[1]

Results

- Details of discarded survival rates are given in the table 1.

Findings

- There is a significant amount of data on discard survival published.

- We note that the discard studies undertaken to date are patchy and do not provide a complete understanding of this issue within European fisheries.

- We note that there is often significant variation in the survival rates of discarded species within individual studies.

- We note that there are also large variations in discard survival rates between studies.

- The studies undertaken confirm that many factors can affect the survival rates of discards (for example: exposure on deck, seasonality, surface sea temperature, air temperature, body size, age of fish, depth caught, catch composition, haul duration, breeding and health status of fish etc. (examples - see: Parker et al (2003), Benoit et al (2010), Smith and Scharf (2011), Giomi et al. (2008) Cicia et al (2011)). This particular finding is in-line with the briefing document provided by the Commission for this work.

- It may be erroneous and mis-leading to make extrapolations on discard survival rates beyond the scope of the individual studies themselves. Such extrapolations are therefore not made at this point.

[1] The table (1) is also provided as a separate excel document

- The six days allocated by the European commission to this task has limited the depth to which the large quantity of available study material could be analysed and reviewed.

- In the absence of a clearly defined parameter 'high survivability' the data is presented in a ranked tabulated format to allow the reader to evaluate for themselves the survival rates across the entire spectrum of available results.

Recommendations

- That the parameter 'high survivability' be clearly defined.

- To commission a systematic and thorough review of the available literature on discard survival with an appropriate time and resource allocation. We estimate the resources required would be around 3 month's man time (based on the review conducted by Broadhurst et al (2006). This review could potentially include a meta-analysis of the data if possible.

Results: (Table 1.) Table of discard survival rates from research studies

Location	Fishing method	Common name	Grouping	*Latin Name*	Discard survival lower limit	Discard survival rate higher limit	Study period	Reference
Portugal	Clam dredge	Gastropods	Mollusc	*Misc. gastropods*	100	100	Immediate	Gasper et al. (2001)
U.K.	Crustacean trawl	Hagfish	Myxini	*Myxine glutinosa*	100	100	15 minutes	Evans et al. (1994)
U.K.	Crustacean trawl	Harbour crab	Crustacean	*Liocarcinus depurator*	100	100	1 day	Bergmann et al. (2001b)
U.K.	Crustacean trawl	Rugose squat lobster	Crustacean	*Munida rugosa*	100	100	1 hour	Bergmann et al. (2001b)
Finland	Fish trawl	Brown trout	Teleost	*Salmo trutta*	100	100	1 day	Hyvarinen et al. (2004)
U.S.A.	Hook and line	Gag grouper	Teleost	*Mycteroperca microlepis*	100	100	Immediate	Rudershausen and Buckel (2007)
U.S.A.	Hook, line & recompression	Canary rockfish	Teleost	*Sebastes pinniger*	100	100	48 hours	Hannah et al. (2012)
U.S.A.	Hook, line & recompression	Copper rockfish	Teleost	*Sebastes caurinus*	100	100	48 hours	Hannah et al. (2012)
U.S.A.	Hook, line & recompression	Quillback rockfish	Teleost	*Sebastes maliger*	100	100	48 hours	Hannah et al. (2012)
U.S.A.	Hook, line & recompression	Yelloweye rockfish	Teleost	*Sebastes ruberrimus*	100	100	48 hours	Hannah et al. (2012)
Ireland	Scallop dredge	King scallop	Bi-valve	*Pecten maximus*	100	100	1 week	Maguire et al. (2002)
Australia	Shrimp trawl	Molluscs	Mollusc	*Molluscs*	100	100	7 days	Wassenberg and Hill (1993)
Germany	Shrimp trawl	Shorthorn sculpin	Teleost	*Myoxocephalus scorpius*	100	100	5 days	Berghahn (1990)
Australia	Shrimp trawl	Tunicates	Tunicate	*Tunicates*	100	100	7 days	Wassenberg and Hill (1993)
Canada	Longline	Sculpins	Teleost	*Sculpins*	99	99	2 days	Benoit and Hurlbut (2010)
U.K.	Fish beam trawl	European plaice	Teleost	*Pleuronectes platessa*	98	98	Immediate	Fulton (1890)
Australia	Scallop dredge	Sea cucumber	Echinoderm	*Holothurians*	97	97	6 weeks	Currie and Parry (1999)

Canada	Longline	Atlantic halibut	Teleost	*Hippoglossus hippoglossus*	96	96	2 days	Benoit and Hurlbut (2010)
Canada	Longline	Skates	Elasmobranch	*Bathyraja spp.*	96	96	2 days	Benoit and Hurlbut (2010)
U.S.A.	Traps (pots)	Deep water red crab	Crustacean	*Chaceon quinquedens*	95	95	8 days	Tallack (2007)
U.S.A.	Shrimp trawl	Winter flounder	Teleost	*Pseudopleuronectes americanus*	94	97	2.5 hours	Ross and Hokenson (1997)
Australia	Shrimp trawl	Turtles	Reptile	*Misc. turtles*	93	95	Immediate	Poiner et al. (1990)
Canada	Longline	Winter flounder	Teleost	*Pseudopleuronectes americanus*	93	93	2 days	Benoit and Hurlbut (2010)
Australia	Scallop dredge	Cunjevoi	Tunicate	*Pyura stolonifera*	93	93	6 weeks	Currie and Parry (1999)
U.K.	Fish beam trawl	Small-spotted cat shark	Elasmobranch	*Scyliorhinus canicula*	92	100	2.5 days	Revill et al. (2005)
U.S.A.	Hook and line	White grunt	Teleost	*Haemulon plumieri*	92	92	Immediate	Rudershausen and Buckel (2007)
U.K.	Shrimp beam trawl	Brown shrimp	Crustacean	*Crangon crangon*	91	91	1 day	Lancaster and Frid (2002)
U.K.	Fish beam trawl	Bristle worms	Polychaetes	*Polychaetes*	90	91	5 days	Kaiser and Spencer (1995)
U.S.A.	Hook and line	Atlant. sharpnose shark	Elasmobranch	*Rhizoprionodon terraenovae*	90	90	6 hours	Gurshin and Szedlmayer (2004)
U.S.A.	Hook and line	Black sea bass	Teleost	*Centropristis striata*	90	90	Immediate	Rudershausen and Buckel (2007)
U.S.A.	Hook and line	Red grouper	Teleost	*Epinephelus morio*	90	90	Immediate	Rudershausen and Buckel (2007)
U.S.A.	Hook, line & recompression	Black rockfish	Teleost	*Sebastes melanops*	90	90	48 hours	Hannah et al. (2012)
U.K.	Beam trawl, scallop dredge, otter trawl	Common starfish	Echinoderm	*Asterias rubens*	89	96	28 days	Ramsay et al. (2001)
U.S.A.	Hook and line	Vermillion snapper	Teleost	*Rhomboplites aurorubens*	88	88	Immediate	Rudershausen and Buckel (2007)
U.K.	Fish beam trawl	Molluscs	Mollusc	*Molluscs*	87	100	6 days	Kaiser and Spencer (1995)
Germany	Shrimp trawl	Hooknose	Teleost	*Agonus cataphractus*	87	100	5 days	Berghahn (1990)
U.K.	Crustacean trawl	Common hermit crab	Crustacean	*Pagurus bernhardus*	87	94	1.5 hours	Bergmann and Moore (2001a)
Canada	Longline	White hake	Teleost	*Urophycis tenuis*	87	87	2 days	Benoit and Hurlbut (2010)
Argentina	Scallop trawl	Patagonian scallop	Bi-valve	*Zygochlamys patagonica*	86	100	5-12.5	Bremec et al. (2004)

Finland	Fish trawl	Brown trout	Teleost	*Salmo trutta*	86	99	7 days	Jurvelius et al. (2000)
Australia	Shrimp trawl	Flatback turtle	Reptile	*Natator depressa*	86	92	Immediate	Poiner and Harris (1996)
Australia	Shrimp trawl	Green turtle	Reptile	*Chelonia mydas*	86	91	Immediate	Poiner and Harris (1996)
Finland	Fish trawl	Brown trout	Teleost	*Salmo trutta*	85	85	7 days	Turunen et al. (1994)
Australia	Shrimp trawl	Crustaceans	Crustacea	*Misc. crustacea*	85	85	8 hours	Wassenberg and Hill (1989)
North sea	Shrimp beam trawl	Eel pout	Teleost	*Zoarces viviparous*	83	100	5 days	Berghahn et al. (1992)
Germany	Shrimp trawl	Eel pout	Teleost	*Zoarces viviparous*	83	100	5 days	Berghahn (1990)
North sea	Shrimp beam trawl	Hooknose	Teleost	*Agonus cataphractus*	83	97	5 days	Berghahn et al. (1992)
Australia	Shrimp trawl	Turtles	Reptile	*Misc. turtles*	82	100	Immediate	Robins (1995)
Australia	Shrimp trawl	Olive Ridley turtle	Reptile	*Lepidochelys olivacea*	81	92	Immediate	Poiner and Harris (1996)
U.S.A.	Traps (pots)	Blue crabs (ovigerous)	Crustacea	*Callinectes sapidus*	81	81	300 days	Darnell et al. (2010)
U.S.A.	Otter trawl	Spiny dogfish	Elasmobranch	*Squalus acanthias*	80	100	3 days	Mandleman and Farrington (2006)
U.S.A.	Hook and line	Red porgy	Teleost	*Pagrus pagrus*	80	80	Immediate	Rudershausen and Buckel (2007)
Canada	Longline	American plaice	Teleost	*Hippoglossoides platessoides*	80	80	2 days	Benoit and Hurlbut (2010)
U.S.A.	Fish trawl	American lobster	Crustacea	*Homarus amercanus*	79	99	14 days	Smith and Howell (1987)
Spain	Fish trawl	Small spotted catshark	Elasmobranch	*Scyliorhinus canicula*	78	78	1 hour	Rodriguez-Cabello et al. (2005)
U.S.A.	Hook, line & recompression	Blue rockfish	Teleost	*Sebastes mystinus*	78	78	48 hours	Hannah et al. (2012)
Australia	Prawn trawl	School prawns	Crustacean	*Metapenaeus macleayi*	76	83	24 hours	Broadhurst et al. (2009b)
Canada	Gillnet	American plaice	Teleost	*Hippoglossoides platessoides*	76	76	2 days	Benoit and Hurlbut (2010)
North sea	Shrimp beam trawl	Shorthorn sculpin	Teleost	*Myoxocephalus scorpius*	71	100	5 days	Berghahn et al. (1992)
North sea	Shrimp beam trawl	Sole	Teleost	*Solea solea*	71	100	5 days	Berghahn et al. (1992)
Australia	Shrimp and fish trawls	Sea snakes	Reptile	*Sea snakes*	70	70	4 days	Wassenberg et al. (2001)

U.S.A.	Gillnet	Black tip sharks	Elasmobranch	*Carcharhinus limbatus*	69	69	Tagging	Hueter et al. (2006)
U.K.	Crustacean trawl	Rugose squat lobster	Crustacean	*Munida rugosa*	68	84	21 days	Bergmann and Moore (2001a)
Iceland	Handline(19-53m)	Cod (< 56cm)	Teleost	*Gadus morhua*	68	68	9 days	Palsson et al. (2003)
Australia	Shrimp trawl	Hawksbill turtle	Reptile	*Eretmochelys imbricata*	67	83	Immediate	Poiner and Harris (1996)
Australia	Shrimp trawl	Loggerhead turtle	Reptile	*Caretta caretta*	67	81	Immediate	Poiner and Harris (1996)
U.S.A.	Hook, line & recompression	Pacific halibut	Teleost	*Hippoglossus stenolepis*	67	67	60 days	Davis and Olla (2001)
Germany	Shrimp trawl	Dab	Teleost	*Limanda limanda*	65	100	5 days	Berghahn (1990)
Australia	Shrimp trawl	School prawn	Crustacean	*Metapenaeus macleayi*	65	65	3 days	Macbeth et al. (2006)
U.S.A.	Shrimp trawl	Loggerhead turtle	Reptile	*Caretta caretta*	62	79	Immediate	Henwood and Stunz (1987)
U.S.A.	Shrimp trawl	Green turtle	Reptile	*Chelonia mydas*	62	78	Immediate	Henwood and Stunz (1987)
U.S.A.	Shrimp trawl	Kemp's Ridley turtle	Reptile	*Lepidochelys kempi*	62	78	Immediate	Henwood and Stunz (1987)
U.S.A.	Gillnet	Bonnet head sharks	Elasmobranch	*Sphyrna tiburo*	60	60	Tagging	Hueter et al. (2006)
U.K.	Fish beam trawl	Dab	Teleost	*Limanda limanda*	59	59	Immediate	Fulton (1890)
Portugal	Shrimp beam trawl	Crustaceans	Crustaceans	*Misc. crustacea*	58	100	30 minutes	Cabral et al. (2002)
Canada	Scallop dredge	Deep-sea scallop	Bi-valve	*Placopecten magellanicus*	58	89	Immediate	Medcof and Bourne (1964)
Sweden	Crustacean trawl	Norway lobster	Crustacean	*Nephrops norvegicus*	58	75	5 days	Harris and Ulmestrand (2004)
U.K.	Fish beam trawl	Crustaceans	Crustaceans	*Misc. crustacea*	55	100	6 days	Kaiser and Spencer (1995)
U.S.A.	Fish trawl	Pacific halibut	Teleost	*Hippoglossus stenolepis*	55	82	7 days	Oddsson et al. (1994)
U.K.	Otter trawl	Rays	Elasmobranch	*Rajidae*	55	67	2 days	Enever et al. (2010)
U.K.	Otter trawl	Rays	Elasmobranch	*Rajidae*	55	55	3 days	Enever et al. (2009)
Finland	Fish trawl	Zander	Teleost	*Stizostedion lucioperca*	53	99	7 days	Jurvelius et al. (2000)
U.S.A.	Line and hook	Vermillion snapper	Teleost	*Pagrus auratus*	52	52	Immediate	Stephen and Harris (2010)
U.K.	Crustacean trawl	Harbour crab	Crustacean	*Liocarcinus depurator*	51	72	21 days	Bergmann and Moore (2001a)
U.S.A.	Shrimp trawl	Saithe	Teleost	*Pollachius virens*	48	89	2 hours	Ross and Hokenson (1997)

Norway	Pelagic long line	Haddock	Teleost	*Melanogrammus aeglefinus*	47	61	7-11 days	Huse and Soldal (2002)
Portugal	Clam dredge	Surf clam	Bi-valve	*Spisula solida*	46	100	3 hours	Gasper and Monteiro (1999)
Australia	Shrimp trawl	Crustaceans	Crustaceans	*Misc. crustacea*	46	100	7 days	Wassenberg and Hill (1993)
Australia	Scallop dredge	Spider crab	Crustacean	*Leptomithrax gaimardii*	46	78	Immediate	Currie and Parry (1999)
Australia	Traps (pots)	Red snapper	Teleost	*Pagrus auratus*	45	98	Immediate	Stewart (2008)
Irish sea	Crustacean trawl	Norway lobster	Crustacean	*Nephrops norvegicus*	44	88	1 hour	Symonds and Simpson (1971)
U.K.	Fish beam trawl	Lemon sole	Teleost	*Microstomus kitt*	43	43	Immediate	Fulton (1890)
Iceland	Hand line	Cod	Teleost	*Gadus morhua*	43	43	8 days	Palsson et al. (2003)
U.S.A.	Shrimp trawl	American plaice	Teleost	*Hippoglossoides platessoides*	40	97	3.5 hours	Ross and Hokenson (1997)
The Netherlands	Beam trawl	Common whelk	Gastropod	*Buccinum undatum*	40	40	6 weeks	Mensink et al. (2000)
U.K.	Fish beam trawl	Starfish	Echinoderms	*Starfish and brittlestars*	38	100	6 days	Kaiser and Spencer (1995)
U.S.A.	Shrimp trawl	Witch flounder	Teleost	*Glyptocephalus cynoglossuss*	36	93	2 hours	Ross and Hokenson (1997)
Denmark	Fish trawl and Danish Seine	Haddock	Teleost	*Melanogrammus aeglefinus*	35	88	12 days	Hislop and Hemmings (1971)
North sea	Shrimp beam trawl	Flounder	Teleost	*Platichthys flesus*	34	100	5 days	Berghahn et al. (1992)
U.S.A.	Fish trawl	Sablefish	Teleost	*Anoplopoma fimbria*	33	100	7 days	Davis and Parker (2004)
North sea	Shrimp beam trawl	Dab	Teleost	*Limanda limanda*	33	100	5 days	Berghahn et al. (1992)
Australia	Shrimp trawl	Crustaceans	Crustaceans	*Misc. crustacea*	33	80	12 hours	Hill and Wassenberg (1990)
Germany	Shrimp trawl	Sole	Teleost	*Solea solea*	33	59	7 days	Kelle (1976)
U.S.A.	Line and hook	Black sea bass	Teleost	*Centropristis striata*	33	33	Immediate	Stephen and Harris (2010)
U.S.A.	Demersal longline	Cod	Teleost	*Gadus morhua*	31	100	3 days	Milliken et al (2009)
Canada	Gillnet	Coho salmon	Teleost	*Oncorhynchus kisutch*	30	94	2 days	Buchanan et al. (2002)
Gulf of Mexico	Shrimp trawl	Atlantic croker	Teleost	*Micropogonias undulates*	29	62	1 day	Colura and Bumguardner (2001)

U.S.A.	Line and hook	Tomtate	Teleost	*Haemulon aurolineatum*	28	28	Immediate	Stephen and Harris (2010)
Japan	Sweeping trammel net	Japanese whiting	Teleost	*Sillago japonica*	27	27	4 days	Purbayanto et al (2001)
Portugal	Shrimp beam trawl	Teleosts	Teleost	*Teleosts*	25	100	30 minutes	Cabral et al. (2002)
U.K.	Scallop dredge	King scallop	Bi-valve	*Pecten maximus*	24	100	30 days	Gruffydd (1972)
U.K.	Fish beam trawl	Pisces	Teleost	*Teleosts*	24	94	6 days	Kaiser and Spencer (1995)
U.S.A.	Fish trawl	Pacific halibut	Teleost	*Hippoglossus stenolepis*	23	58	3 days	Trumble et al. (1995)
U.S.A.	Fish trawl	Pacific halibut	Teleost	*Hippoglossus stenolepis*	22	100	60 days	Davis and Olla (2001)
Canada	Fish trawl	Haddock	Teleost	*Melanogrammus aeglefinus*	22	93	12 hours	Beamish (1966)
U.S.A.	Gillnet	Southern flounder	Teleost	*Paralichthys lethostigma*	22	87	3 days	Smith and Scharf (2011)
U.S.A.	Fish trawl	Tanner crab	Crustacean	*Chionoecetes vairdi*	22	22	2 days	Stevens (1990)
U.K.	Crustacean trawl	Norway lobster	Crustacean	*Nephrops norvegicus*	21	85	4 hours	Evans et al. (1994)
U.S.A.	Fish trawl	Red king crab	Crustacean	*Paralithodes camtschaticus*	21	21	2 days	Stevens (1990)
U.S.A.	Fish trawl	Sablefish	Teleost	*Anoplopoma fimbria*	20	60	35 days	Davis (2005)
Australia	Shrimp trawl	Teleosts	Teleost	*Teleosts*	20	20	8 hours	Wassenberg and Hill (1989)
Portugal	Clam dredge	Starfish	Echinoderms	*Starfish*	18	100	Immediate	Gasper et al. (2001)
Australia	Shrimp trawl	Elasmobranchs	Elasmobranchs	*Starfish*	18	90	Immediate	Stobutzki et al. (2002)
U.S.A.	Line and hook	Red porgy	Teleost	*Pagrus pagrus*	18	18	Immediate	Stephen and Harris (2010)
U.S.A.	Otter trawl	Summer flounder	Teleost	*Paralichthys dentatus*	18	18	Acoustic tags	Yergey et al. (2012)
Australia	Shrimp trawl	Starfish	Echinoderms	*Starfish*	16	16%	7 days	Wassenberg and Hill (1993)
Gulf of Mexico	Shrimp trawl	Total bycatch (up to 33 species)	Misc. species	*Misc. species*	13	34	1 day	Colura and Bumguardner (2001)
Germany	Shrimp trawl	European plaice	Teleost	*Pleuronectes platessa*	12	70	7 days	Kelle (1976)
Portugal	Crustacean trawl	Norway lobster	Crustacean	*Nephrops norvegicus*	12	60	5-9 days	Castro et al. (2003)
Australia	Scallop dredge	Southern scallop	Bi-valve	*Pecten fumatus*	12	22	9 months	McLoughlin et al. (1991)
U.S.A.	Fish trawl	Pacific halibut	Teleost	*Hippoglossus stenolepis*	10	62	Immediate	Williams and Wilderbuer (1995)

Finland	Trawl	Pike perch	Teleost	*Sander lucioperca*	9	73	2 days	Hyvarinen et al. (2008)
Australia	Shrimp trawl	Teleosts	Teleost	*Teleosts*	8	84	7 days	Wassenberg and Hill (1993)
Canada	Fish trawl	Atlantic halibut	Teleost	*Hippoglossus hippoglossus*	7	89	Predicted	Neilson et al. (1989)
U.S.A.	Line and hook	Gray triggerfish	Teleost	*Balistes capriscus*	7	7	Immediate	Stephen and Harris (2010)
U.S.A.	Fish trawl	Lingcod	Teleost	*Ophiodon elongatus*	6	100	21 days	Parker et al. (2003)
U.S.A.	Line and hook	Great amberjack	Teleost	*Seriola dumerili*	6	6	Immediate	Stephen and Harris (2010)
U.K.	Crustacean trawl	Common starfish	Echinoderm	*Asterias rubens*	4	100	29 days	Bergmann and Moore (2001b)
Portugal	Shrimp beam trawl	Brown shrimp	Crustacean	*Crangon crangon*	4	100	30 minutes	Gamito and Cabral (2003)
Italy	Rapido trawl	Harbour crab	Crustacean	*Liocarcinus depurator*	4	98	up to 20 mins	Giomi et al. (2008)
The Netherlands	Fish trawl and beam trawl	Sole	Teleost	*Solea solea*	4	37	3.5 days	van Beek et al. (1990)
U.S.A.	Line and hook	Scamp	Teleost	*Mycteroperca phenax*	2	2	Immediate	Stephen and Harris (2010)
Germany	Shrimp trawl	Dab	Teleost	*Limanda limanda*	1	58	7 days	Kelle (1976)
Australia	Shrimp trawl	Teleosts	Teleost	*Teleosts*	1	3	12 hours	Hill and Wassenberg (1990)
Portugal	Clam dredge	Bivalves	Bi-valve	*Bi-valves*	0	100	Immediate	Gasper et al. (2001)
Portugal	Clam dredge	Crustaceans	Crustacea	*Crustacea*	0	100	Immediate	Gasper et al. (2001)
Canada	Fish trawl	Atlantic cod	Teleost	*Gadus morhua*	0	100	1 hour	Jean (1963)
U.S.A.	Fish trawl	Sablefish	Teleost	*Anoplopoma fimbria*	0	100	60 days	Davis et al. (2001)
U.S.A.	Fish trawl	Lingcod	Teleost	*Ophiodon elongatus*	0	100	60 days	Davis and Olla (2002)
U.S.A.	Fish-trawl	Sablefish	Teleost	*Anoplopoma fimbria*	0	100	60 days	Olla et al. (1998)
Norway	Purse seine	Mackerel	Teleost	*Scomber scombrus*	0	100	3-6 days	Huse and Vold (2010)
North sea	Shrimp beam trawl	European plaice	Teleost	*Pleuronectes platessa*	0	100	5 days	Berghahn et al. (1992)
Finland	Fish trawl	Atlantic salmon	Teleost	*Samo salar*	0	95	7 days	Jurvelius et al. (2000)
Australia	Shrimp trawl	By-caught teleosts	Teleost	*Variety of species*	0	89	up to 5 days	Broadhurst et al (2008)
Canada	Fish trawl	American plaice	Teleost	*Hippoglossoides platesoides*	0	78	2 hours	Jean (1963)

Falkland Islands	Squid trawl	Skates	Elasmobranch	*Rajidae*	0	71	3 hours	Laptikhovsky (2004)
Australia	Shrimp trawl	By-caught teleosts	Teleost	*Variety of species*	0	65	5 days	Uhlmann and Broadhurst (2007)
Australia	Shrimp trawl	Snapper	Teleost	*Pagrus auratus*	0	65	8 hours	Sumpton and Jackson (2005)
The Netherlands	Fish trawl and beam trawl	European plaice	Teleost	*Pleuronectes platessa*	0	48	3.5 days	van Beek et al. (1990)
North sea	Shrimp beam trawl	Whiting	Teleost	*Merlangius merlangus*	0	35	5 days	Berghahn et al. (1992)
Australia	Shrimp trawl	Cephalopods	Cephalopods	*Cephalopods*	0	12	12 hours	Hill and Wassenberg (1990)
U.K.	Crustacean trawl	Brittle star	Echinoderm	*Ophiura ophiura*	0	9	29 days	Bergmann and Moore (2001b)
Canada	Fish trawl	American plaice	Teleost	*Hippoglossoides platesoides*	0	5	50 minutes	Powles (1969)
U.K.	Crustacean trawl	Mixed teleosts (nine species)	Teleost	*Teleosts*	0	0	15 minutes	Evans et al. (1994)
U.K.	Fish beam trawl	Atlantic cod	Teleost	*Gadus morhua*	0	0	Immediate	Fulton (1890)
U.K.	Fish beam trawl	Grey gurnard	Teleost	*Eutrigla gurnardus*	0	0	Immediate	Fulton (1890)
U.K.	Fish beam trawl	Whiting	Teleost	*Merlangius merlangus*	0	0	Immediate	Fulton (1890)
Germany	Shrimp trawl	European smelt	Teleost	*Osmerus eperlanus*	0	0	Immediate	Berghahn (1990)

Note: There are references in this table that are not listed in the reference section of this document. They are however cited by Broadhurst et al (2006) wherein full details can be found.

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