THE N2K GROUP

European Economic Interest Group

OVERVIEW OF THE POTENTIAL INTERACTIONS AND IMPACTS OF COMMERCIAL FISHING METHODS ON MARINE HABITATS AND SPECIES PROTECTED UNDER THE EU HABITATS DIRECTIVE

Contents

GLOSSARY

Sensitivity[1]*;* Sensitivity is dependent on the **intolerance** of a species or habitat to damage from an external factor and the time taken for its subsequent **recovery.**

- ***'Intolerance'*** is the susceptibility of a habitat, community or species (i.e. the components of a biotope) to damage, or death, from an external factor. Intolerance must be assessed relative to change in a specific factor.
- ***'Recoverability'*** is the ability of a habitat, community, or species (i.e. the components of a biotope) to return to a state close to that which existed before the activity or event caused change.

Pressure; The mechanism through which an activity has an effect on any part of the ecosystem

Vulnerability; A habitat, community or species becomes 'vulnerable' to adverse effects when it is both sensitive and exposed to an external factor (pressure). Vulnerability thus combines sensitivity and exposure to a pressure

Exposure; The presence or likelihood of encountering the pressure/activity (temporally and/or spatially)

FISHING GEARS DEFINITIONS[2]

Dredge; an apparatus usually in the form of an oblong iron frame with an attached bag net

Dredge (hand); Small, light dredge, pulled behind by hand in shallow waters, from the shore or from a boat.

Dredge (boat); dredge of varying weight and size, but usually fairly heavy, equipped with or within diving boards.

Dredge (mechanised); Water jets dislodge molluscs from the seabed ahead of the dredge. The catch may be transferred to the boat by a conveyor belt device or by pump.

Drift longline; Longline set in midwater or near surface and allowed to drift with the current.

Drift net; drifting gillnet. Net kept on the surface, or at a certain distance below it by numerous floats. It drifts freely with the current, separately or, more often, with the boat to which the net is attached.

Fish trap: trap; trap net; an inshore fishing apparatus consisting of a series of funnels, with their mouths kept open by hoops, opening into each other and finally closing into a sack forming a trap. This type of net, of which there are many variations, is fastened to the bottom

Fixed net; General term for any simple net when it is held in fishing trim by anchors, sinkers and/or stakes

Fyke net; Trap normally used in shallow water which consists of cylindrical or cone-shaped bags mounted on rings or other rigid structures, completely covered by netting and completed by wings or leaders which drive the fish towards the opening of the bags. Fyke nets, fixed on the bottom by anchors, ballast or stakes, may be used separately or in groups.

Gill net; usually rectangular in shape, made of thin twine, which catches fish by holding them in the meshes, e.g. drift net, set gill net. Held vertically in the water by floats and weights.

Gill net (fixed); net mounted on stakes driven into the bottom, used essentially in coastal waters. The fish are collected at low tide.

Gill net (encircling); Gear generally used in shallow water with the floatline remaining at the surface. After the fish have been encircled by the net, noise or other means are used to force them to gill or entangle themselves in the netting surrounding them.

Handline; a hand-held line with weighted end and hooks used to fish above the seabed

[1] http://www.marlin.ac.uk/sensitivityrationale.php

[2] CEC (1992) Multilingual Dictionary of Fishing Gear. 2nd Edition. Fishing News Books. EUR 14426. 333pp.

Lampara net; the particular design of this net, with a central bunt in the form of a spoon and two lateral wings, makes it possible to retain the shoal of fish when the two wings are hauled up at the same time. Lampara nets are generally operated by a single boat, most often of small tonnage.

Long line; a number of connected lines, either set at the bottom or drifting, each bearing a large number of baited hooks.

Longline (bottom set): Long line set near the seabed.

Net; fishing net; a fishing implement comprised mainly of netting. An open-work fabric forming meshes of suitable size for catching fish

Otter twin trawl; gear comprising two identical trawl nets working together, opened horizontally by a single pair of otter boards. The inner wings are attached to a sledge towed simultaneously with the otter boards from a common crowfoot.

Otter trawl (midwater); trawl towed by a single boat. The horizontal opening of the net is controlled by otter boards, usually of a hydrodynamic shape, and which normally do not touch the ground.

Otter trawl (bottom); Trawl towed by a single boat; its horizontal opening is obtained by the use of other boards which are relatively heavy and equipped with a steel sole designed to withstand rough contact with the bottom.

Pair seine; similar to pair trawl but using long seine ropes instead of wires, and often a seine nets.

Pair trawl (midwater); towed by two boats, thus ensuring the horizontal opening of the net, this net is designed and rigged to work in midwater. Surface trawls are also included in this category.

Poleline; a hook with or without natural or artificial bait is attached to a line on the end of a pole of similar length to the line. Pole-lines are usually operated from a boat.

Pot; fish pot; Trap designed to catch fish or crustaceans, in the form of cages or baskets made from various materials and with one or more openings or entrances. It is usually set on the bottom, with or without bait, singly or in rows, connected by ropes (buoy lines) to buoys showing its position on the surface.

Pound net; General term for any moored or staked net comprising a leader and one or more enclosures e.g. bag net, stake net, kettle net.

Purse seine; A large, single-panel multi-sectioned net used to encircle pelagic fish, the bottom of which is then drawn together to enclose them.

Seine net; net which is usually set from a boat and which can be operated from the shore or from the boat itself. The manner of capture is to surround an area of water with a very long net, with or without a bag at the centre.

Seine (beach); a type of seine net, which is usually set from a boat and operated from the shore.

Seine (boat); Net, consisting of two wings, a body and a bag, operated from a boat, generally used on the bottom, where it is hauled by two ropes, usually very long, set in the water so as to ensure that as many fish as possible are driven or herded towards the opening of the net. The type most representative of this category is the Danish seine.

Set net; bottom-set gillnet: net fixed to the bottom, or at a certain distance above it, by means of anchors or ballast sufficiently heavy to neutralize the buoyancy of the floats.

Trammel; trammel net; bottom-set net which is made with three walls of netting, the two outer walls being of a larger mesh size than the loosely hung inner netting panel.

Trawl; trawl net; Towed net consisting of a cone-shaped body, closed by a bag or cod end and extended at the opening by wings. It can be towed by one or two boats and, according to the type, is used on the bottom or in midwater (pelagic). In certain cases, as in trawling for shrimp or flatfish, the trawler can be specially rigged with outriggers to tow two or even four) trawls at the same time (double rigging).

Trawl (midwater); trawl usually much larger than the bottom trawl, designed and rigged to work in midwater, including surface water. The front net sections are very often made with very large meshes or ropes, which herd the fish schools toward the net aft sections. The fishing depth is usually monitored by means of a net sounder. They may be towed by one or two boats.

Trawl (bottom pair); Trawl towed by two boats at the same time, the distance between the boats ensuring the horizontal opening of the net.

Trawl (beam); The horizontal opening of this trawl is provided by a beam, made of wood or metal, which may be 10 long or more. Beam trawls are used mainly for flatfish and shrimp fishing.

Trawling; most commonly used method of catching fish, which involves dragging a trawl net through the water.

Trolling; a method of fishing which consists essentially of dragging through the water a bait or bright object to which a hook is attached. It is employed for the capture of predaceous surface-feeding fish.

PRESSURES[3]

Substratum loss. The physical removal of the substratum inhabited or required by the species or community in question.
Smothering. The physical covering of the species or community and its substratum with additional sediment (silt), spoil, detritus, litter, oil or man-made objects.
Changes in suspended sediment. The concentration of suspended matter in the water column.
Desiccation. The removal of water or drying.
Changes in emergence. The time spent immersed and exposed to air.
Changes in water flow rate. The movement of water associated with the rise and fall of the tide (tidal streams), prevailing winds and ocean currents.
Changes in temperature. A change in the ambient temperature of seawater, or in air temperature during emersion.
Changes in turbidity. The turbidity (clarity or opacity) of water is dependent on the concentration of substances that absorb or scatter light; for example, inorganic or organic particulates (suspended matter), plankton and dissolved substances. The water clarity scale refers to the effect of changes in light penetration.
Changes in wave exposure. Exposure on an open shore is dependent upon the distance of open seawater over which wind may blow to generate waves (the fetch) and the strength and incidence of the winds.
Noise. Generally defined as unwanted or disruptive sound. Noise can cause sensitivity in three ways:

- Actual discomfort, damage or death;
- interference with the use of hearing for feeding or communication reducing viability;
- disturbance of breeding or other behaviours reducing viability.

Visual presence.This benchmark applies only to species that have sufficient visual acuity to resolve moving objects or at least differentiate between rapid changes in light intensity (as in a moving shadow).
Physical disturbance or abrasion. This factor includes mechanical interference, crushing, physical blows against, or rubbing and erosion of the organism of interest. Protrusive species may be crushed, and delicate organisms with a fragile skeleton or soft bodies may be physically damaged or broken (snapped).
Displacement. Physical removal or transportation of the species or community of interest.
Changes in levels of synthetic chemicals. Synthetic chemicals are by definition man-made and include, for example, organotins (tri butyl tin, tri phenyl tin), pesticides (lindane, atrazine, dichlorvos, DDT), organochlorides, organophosphates, solvents (carbon tetrachloride, chloroform) and poly-chlorinated biphenyls (PCBs).
Changes in levels of heavy metals. Heavy metals include, for example, Arsenic (As), Cadmium (Cd), Mercury (Hg), Lead (Pb), Zinc (Zn) and Copper (Cu).
Changes in levels of radionuclides. Isotopes of elements that emit alpha, beta or gamma radiation.
Changes in levels of nutrients. Nutrients include substances required for growth, for example, nitrogen, phosphorus, silicon, and micro-nutrients (heavy metals and vitamins).
Changes in salinity. Changes in dissolved salt content of water bodies.
Changes in oxygenation. Oxygen is required by the majority of organisms for respiration; the process by which organic molecules are broken down to provide energy for work and metabolism.

[3] See http://www.marlin.ac.uk/sensitivitybenchmarksdetailed.php for further elaboration of definitions with examples

1. BACKGROUND

The guidelines for the management of *Natura 2000* sites state that national authorities may need to regulate human activities to ensure the favourable conservation status of the features for which the sites have been selected.

A systematic approach to determining what and why activities might need to be regulated is desirable. One possible methodology, suggested in the guidelines, is to identify activities that could have "a priori" significant negative impacts on features for which Natura 2000 sites have been selected.

Several Member States have undertaken such analyses and summarised their conclusions in matrices showing whether different external factors or human activities are expected to have significant effects on conservation features. This type of assessment may be referred to as a 'vulnerability assessment' where the external factor is described in terms of effects (e.g. substratum loss, changes in nutrient levels, selective extraction of non-target species), or a 'conflict analysis' when described with reference to human activities (e.g. fisheries, dredging, mineral extraction).
Analyses of this type usually involve four stages:

1. Assessing the **sensitivity** of the feature to pressures
2. Identifying which pressures are associated with which activities
3. Assessing **exposure** of the feature to pressures/activities
4. Combining sensitivity and exposure to highlight **vulnerability** or areas of potential conflict.

Definitions

Sensitivity
The innate capacity of a habitat, community or species to suffer damage or death from an external factor (pressure) beyond the range of environmental parameters normally experienced (Holt *et al.*, 1995; McLeod, 1996).

Two attributes are frequently used to define or measure sensitivity
- The ability to withstand an impact
- The ability to recover from an impact

Potential impact is also considered in some studies.

Pressure
The mechanism through which an activity has an effect on any part of the ecosystem.

Vulnerability
A habitat, community or species becomes 'vulnerable' to adverse effects when it is sensitive to an external factor (pressure or activity) and that external factor is likely to affect the habitat, community or species (Holt et al., 1995, Tyler-Walters et al., 2001). Vulnerability combines sensitivity and exposure to an impact and exposure to that impact will determine the likelihood of damage.

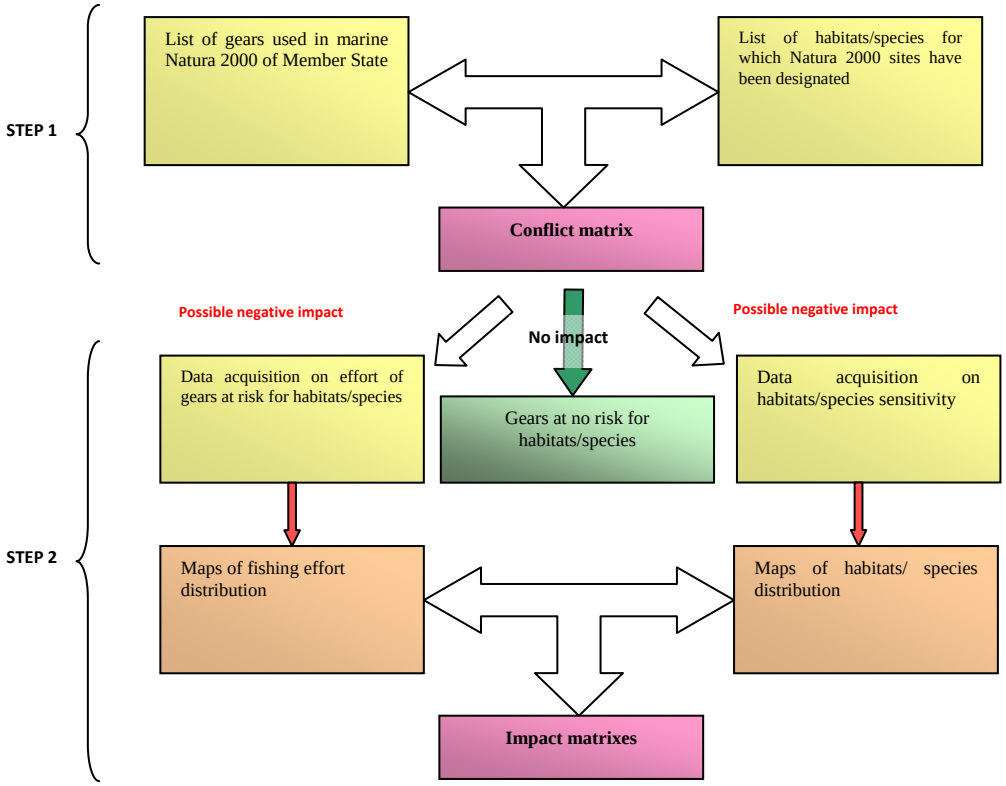
Exposure
The presence or likelihood of encountering the pressure/activity (temporally and/or spatially).

The overall analysis can be done at different geographic scales from global to local. Sensitivity is likely to be similar regardless of scale (although local environmental conditions might influence sensitivity at the site scale), whereas the vulnerability of a habitat or species will depend on details such as the level and extent of pressures in a particular location, sometimes described in terms of a risk assessment. A further, more complex aspect of vulnerability assessment is determining the combined effects of different pressures. Methodologies for this type of analysis have still to be fully developed.

1.1 Fisheries interactions

Commercial fisheries are acknowledged to be a group of activities that have the potential to affect the conservation status of habitats and species which are protected in *Natura 2000* sites[4]. Any interactions need to be described and potential impacts need to be assessed if appropriate measures are to be introduced. A common methodology, using a two-step process, for this type of assessment was agreed in 2012 (Figure 1). Step 1 is underpinned by a qualitative assessment of the impact of fishing gears on habitats/species for which marine *Natura 2000* sites have been designated. Step 2 is a semi-quantitative assessment of impact.

Figure 1. Common methodology for assessing the impact of fisheries on marine Natura 2000[5]



This report contributes to the qualitative assessment required for Step 1 and the first stage of Step 2 by presenting summaries of:

(a) the potential physical, chemical and biological pressures associated with various fishing methods,
(b) the interaction of *Natura 2000* features with these pressures,
(c) the possible vulnerability arising from the use of particular fishing gears on *Natura 2000* features.

This is based on peer-reviewed and grey literature sources. The information presented will need to be refined in light of national considerations (such as the most relevant fisheries or any gear modifications) but can be used by Member States for Step 2 – the preparation of site specific matrices of the impact of fisheries on *Natura 2000* sites and features. Cumulative and in-combination effects will be site specific and have therefore not been considered in the generic matrices which follow. Sensitivity is not evaluated directly, nor quantified in this document. Habitat sensitivity assessments will ultimately be required for more precise evaluations of vulnerability on a site basis.

[4] Guidelines for the establishment of the Natura 2000 network in the marine environment (2007)
[5] The N2K Group (2012) Common methodology for assessing the impact of fisheries on marine Natura 2000.

2. FISHERIES AND NATURA 2000 - PRESSURES, INTERACTIONS, AND IMPACTS

There are many studies investigating and reporting on the potential effects of commercial fisheries on marine biodiversity and habitats in European waters. In recent years these have included studies on the interactions with habitats and species that are identified features of marine *Natura 2000* sites. Taken together, they provide a good body of information on the potential effects of a range of fisheries on habitats and species protected under the EU Habitats Directive.

The following summary is based on reviews in the scientific literature and particularly, international peer-reviewed journals, research reports and conference publications from internationally recognised scientific institutions. They include the following:

- *ICES reports* on the effects of fishing on Natura 2000 habitats, species and sites
- *MarLin Sensitivity analysis* http://www.marlin.ac.uk/marinenaturaleffects.php#matrix
- *Regional analyses* of the effects of fishing on Natura 2000 habitats and species (e.g. BALTIFIMPA, EMPAS, NERI)
- *National and site specific reviews* of the effects of fishing on Natura 2000 habitats and species

The main background references are listed at the end of this paper. It should be noted that this report is a selective review and not a consideration of the impacts of all types of fishing gears on all European marine habitats and species. It should also be noted that this is a continuing field of research with ongoing international studies and regular publications[6].

Section 2.1 provides an overview of the interactions between fishing methods, pressures and impacts. Section 2.2 summarises the sensitivity and potential impacts in relation to marine Natura 2000 habitats and Section 2.3 summarises the sensitivity and potential impacts on the main marine species groups covered by Natura 2000. Section 2.4 provides an overview of the vulnerability of Natura 2000 habitats and species to different fishing methods. In-combination effects have not been included in this review but may need to be considered when site-specific analyses are carried out.

2.1 POTENTIAL PHYSICAL, CHEMICAL AND BIOLOGICAL PRESSURES AND IMPACTS ASSOCIATED WITH COMMERCIAL FISHING METHODS

The potential pressures and impacts of different fishing methods are described with reference to two lists:

- Gears (boat and shore-based) which may be used in marine *Natura 2000* sites and for which standardised information is likely to be available at a Community level (Table 1). These broad gear types take account of national variability as well as facilitating further elaboration at the level of the Member State if desired.
- Environmental pressures likely to result from anthropogenic activities (Table 2). These are high level categories which may cover a number of scenarios. For example the 'Capture of non-target species' includes by-catch and discards whilst the likelihood of mortality will vary, depending on the species which are caught. There is a correlation with the pressures and impacts listed in the Marine Strategy Framework Directive (Annex III, Table 2) with the exception of three pressures (and impacts); other physical disturbance (marine litter), interference with hydrological processes (significant changes in thermal regime) and systematic and/or intentional release of substances.

Table 3 provides an overview of associations between fishing methods and resulting pressures, and the subsequent text describes the potential impacts resulting from such pressures for each gear group.

[6] E.g. the BENTHIS project (http://www.benthis.eu/en/benthis.htm), the ICES Journal of Marine Science.

Table 1. Main gear types (levels 2, 3 & 4) used in commercial fisheries within EU waters[7] and methods of aquaculture

GEAR CLASS	GEAR GROUP	GEAR TYPE
dredges	dredges	boat dredge mechanised/suction dredge
trawls	bottom trawls	bottom otter trawls multi-rig otter trawl bottom pair trawl beam trawl
	pelagic trawls	midwater otter trawl midwater pair trawl
hooks & lines	rods & lines	hand & pole lines trolling lines
	longlines	drifting longlines set longlines
traps	traps	pots & traps fyke nets stationary uncovered pound nets
nets	nets	trammel nets set gillnet drift net
seines	surrounding nets	purse seine lampara nets
	seines	fly shooting seine anchored seine pair seine beach & boat seine
aquaculture	shellfish	rafts & longlines laid – intertidal & subtidal
	finfish	cages

Table 2. Physical, chemical and biological pressures that may result from anthropogenic activities[8]

PHYSICAL	CHEMICAL	BIOLOGICAL
substratum loss smothering changes in suspended sediment desiccation changes in emergence changes in water flow rates changes in temperature changes in turbidity changes in wave exposure noise visual presence physical disturbance or abrasion displacement	changes in levels of synthetic chemicals changes in levels of heavy metals changes in levels of hydrocarbons changes in levels of radionuclides changes in levels of nutrients changes in levels of salinity changes in oxygenation	Introduction of non-native species Introduction of microbial pathogens/parasites Extraction of target species Extraction of non-target species

[7] Commission Decisions 2010/93/EU, Appendix IV. National and regional differences may be merged or disaggregated for statistical purposes as set out in this Commission Decision. The target assemblages (small pelagic fish, crustaceans etc.) are described level 5.

[8] Based on the MarLin approach (Tyler-Waters & Jackson, 1999) which identifies 24 factors divided into three. Other studies use different terminology but can be cross-referenced to these factors.

Table 3. Matrix of fishing methods and potential resulting physical, chemical and biological pressures

	Dredges	Bottom trawls	Pelagic trawls	Hook and line	Pots & traps	Nets	Seines (pelagic)	Seines (demersal)	Aquaculture - finfish	Aquaculture - shellfish
PHYSICAL										
substratum loss	■	■		I	I	I	I	■	I	I
smothering	■	■			I	I		■	■	■
changes in suspended sediment	■	■			■	I		■	■	■
desiccation										
changes in emergence regime										
changes in water flow rates	I	I			I	I		I	■	■
changes in temperature									I	I
changes in turbidity	■	■			I	I		▒	■	■
changes in wave exposure										
noise	■	■	▒	▒	■	■	▒	■	▒	■
visual presence	■	■	▒	▒	■	■	▒	■	▒	■
physical disturbance or abrasion	■	■		▒	■	■	▒	■	■	■
displacement	■	■			■	■		■	I	I
CHEMICAL										
changes in levels of synthetic chemicals	▒	▒							■	I
changes in levels of heavy metals	▒	▒						I		
changes in levels of hydrocarbons	▒	▒								
changes in levels of radionuclides										
changes in levels of nutrients	■	■							■	■
changes in levels of salinity										
changes in oxygenation	■	■	▒						■	■
BIOLOGICAL										
introduction of non-native species									■	■
introduction of microbial pathogens/parasites									■	■
extraction of target species	■	■							■	■
extraction of non-target species	■	■	■	■	■	■	■	■	■	■

■ Probable interactions
▒ Possible interactions
□ Unlikely interactions
I Insufficient information

Probable: The activity is known to change the relevant environmental factor (induce the relevant pressure) in most instances
Possible: The activity may change the relevant environmental factor (induce the relevant pressure) in some cases or in particular locations or situation

The following information should be viewed as a checklist of **potential** pressures associated with commercial fishing activity. It does not address the magnitude or significance of any environmental effect or indirect and cumulative effects. Some or all may be present in particular locations and the **significance**, if any, of resulting impacts will depend on the **sensitivity** of the habitat and local circumstances, including its recoverability and variety within habitat types. Changes, and hence the impact associated with the use of particular types of fishing gear in high energy environments, subject to frequent natural disturbance, for example, can be less significant or negligible in terms of impact compared to the same activity in low energy environments. The frequency and the extent of the activity as well as variation within gear types, such as size and weight, are also key factors in understanding the likely impact, including the scale of any impact. It is also the case that impacts may be greatest the first time particular techniques are used or that there is an equilibrium with the range of species that can withstand current activities but that the habitat is nevertheless in unfavourable condition. These considerations mean that it is essential to undertake a **site specific analysis** of the likely interactions as the basis for any management proposals although if there is strong evidence that damage from a gear/activity to a designated feature is ubiquitous, further assessment may not be necessary.

DREDGES

Two main types of dredges, boat dredges and suction dredges targeting bivalves (scallop, oyster, clams, mussels, razor shell). Gears are towed along the surface of the seabed or dig into the surface layers of sediment as part of the operation.

PHYSICAL	The main physical pressures described are substratum loss (boulders and stones may be removed or sorted) and suspension of sediment. Also increasing turbidity if conducted in areas where there is low natural disturbance of sediment. Resulting tracks, mounds and ridges alter the surface topography and may be persistent.
CHEMICAL	Some studies have shown that water quality may be reduced because of increasing nutrient loads, oxygen consumption and possibly phytoplankton production. Disturbance of sediments can also lead to remobilisation of contaminated sediments and release contaminants from sediment and sediment pore water.
BIOLOGICAL	Removal of target species and by-catch is the main pressure which can provoke changes in community structure. Species compositions may change as a result of repeated dredging with large fragile organisms particularly at risk (e.g. corals, sponges and gorgonians) as well as less attached epibenthic species including molluscs, and starfish. Increases in number of scavengers at recently dredged sites have also been reported. Suction dredging in sheltered areas has been reported to have effects on birds such as short-term increases of gulls and waders in the harvesting areas, followed by long-term significant reduction in feeding opportunities. Hydraulic dredging and suction dredging also shown to result in reductions in species abundance and biomass on various timescales.
CONCLUSIONS	Physical and biological effects from the use of this type of gear are well documented and principally on benthic habitats and processes. They include high mechanical impact with associated mortality on epibenthos, and changes in the topography and turbidity.

TRAWL - PELAGIC

Mid-water otter trawls and mid-water pair trawls towed above the seabed to catch pelagic species.

PHYSICAL	None identified by the research carried out for this review
CHEMICAL	None identified by the research carried out for this review
BIOLOGICAL	Discards associated with pelagic trawl fisheries known to attract scavengers around the nets as well as on the seabed if they are concentrated in particular areas. The associated decaying process of discards/spill over may result in localised anoxic conditions. There are also reports of seabirds, turtles, and marine mammals such as the white-sided dolphin, common dolphin and grey seal being taken as bycatch in pelagic trawl fisheries.
CONCLUSIONS	Few effects on non-target species reported from use of this type of gear. No habitat effects identified.

HOOK & LINE

Drifting demersal and surface longlines catching swordfish, sharks, albacore and bluefin tuna. Species targeted by bottom longlines include sharks and other groundfish such as cod and other flatfish (halibut, flounder, sole).

PHYSICAL	Anchors, weights, hooks and the mainline can produce seabed effects depending on how far they travel over the seabed during setting or retrieval.
CHEMICAL	None identified by the research carried out for this review
BIOLOGICAL	Target fisheries (e.g. sharks) and by-catch. By catch associated with pelagic longlining including elasmobranchs (e.g. blue shark, stingrays) turtles (e.g. loggerhead, and leatherback) and seabirds (e.g. Balearic shearwater, Cory's shearwater, Audouins gull Atlantic gannet). Seabirds are also taken as bycatch in demersal longline fisheries. Incidental catches of marine mammals have also been reported e.g. striped dolphins, monk seal and a sperm whale entangled in abandoned gear. Some cetaceans such as long-finned pilot whales, striped dolphins and sperm whales have also been observed feeding opportunistically on illuminated handlines of squid fisheries in the Mediterranean. Demersal longlines (including lost lines) can snare sessile benthic species such as deep water corals.
CONCLUSIONS	The main reported effect is the incidental capture of seabirds, turtles, marine mammals and other species on the baited hooks of longlines.

TRAPS

Pots & traps, fyke nets and uncovered pound nets used to catch crustaceans, molluscs and some fish (seabream, eel). Boat and shore-based deployment.

PHYSICAL	Potential localised physical effects on sediment when hauling and/or deploying traps
CHEMICAL	None identified by the research carried out for this review
BIOLOGICAL	Fragile benthic species potentially damaged during deployment and/or hauling of traps. Bycatch and entanglement of marine mammals, seabirds, fish and turtles observed associated with these gears. Discarded pots are known to "ghost fish" catching both commercial and non-commercial species.

CONCLUSIONS	Minor physical effects reported. The main reported effect is "ghost fishing" by lost gears, taking a variety of species.

NETS

Trammel, set gillnets, drift nets. Bottom set gill nets used to catch demersal finfish, pelagic driftnets catches include mackerel, sardine, bluefin and swordfish. Boat and shore based deployment.

PHYSICAL	Possibility of some localised impact if gear is dragged across the seabed during hauling and potential impact on habitat forming species such as kelps.
CHEMICAL	None identified by the research carried out for this review
BIOLOGICAL	Entanglement and bycatch are the main effects which have been reported associated with these gears. Species taken include large pelagic elasmobranchs (e.g. blue shark), loggerhead and leatherback turtles, small marine mammals including cetaceans, bottlenose dolphins, risso's dolphin, common dolphin harbour porpoise and pinnipeds, minke whales and seabirds. In static nets seabird bycatch is reported for divers, grebes, sea ducks, diving ducks, auks, shearwaters and cormorants. Lost gillnets and trammel nets may also continue to have an effect through "ghost fishing". Indirectly, seals attracted to enmeshed fish may be shot. Dragging of gear across the seabed during hauling can potentially can cause mortality to structural biota and epibenthos.
CONCLUSIONS	Main potential effects noted are incidental catch including marine mammals, seabirds and elasmobranchs. Ghost fishing as well as direct entanglement can take place. Effects on benthos may be some localised damage during hauling.

SEINES

Purse seines, beach & boat seine, anchored seine, fly shooting seine catching small pelagic species as well as bluefin tuna. Boat and shore based deployment.

PHYSICAL	Some physical impact caused by the dragging of nets and ropes along the seabed in demersal seines (e.g. fly shooting, anchored seine). Possibility of some localised impact of pelagic seines if gear is dragged across the seabed during hauling.
CHEMICAL	Significant increases in ammonia, urea, residual organic nitrogen and phosphate concentrations during purse seine fishing have been reported.
BIOLOGICAL	Demersal seines can result in damage and mortality of benthic organisms, impacts on the abundance of several (target and non-target) fish species and changes in benthic community structure which may be damaged and/or replaced) Purse seine fleets fishing at night have been reported to affect feeding behaviour of some seabirds e.g. Audouins gull which take advantage to capture the fish attracted by the lights or concentrated by the gear. Some incidental catch and varying rates of associated mortality of seabirds (shearwaters), sharks, pinnipeds and cetaceans has also been noted. Offshore purse-seining associated with Fishing Attracting Devices (FAD) have a great amount of bycatch of marine mammals, turtles and sharks.
CONCLUSIONS	Demersal seines have physical and biological effects on benthic habitats and communities as a result of contact of gear with the seabed. Species effects include some incidental catches of seabirds and cetaceans. In shallower shelf areas purse seines may take demersal fish as by-catch. Discards can be an important food source for some species.

TRAWLS - BOTTOM TRAWLS

Bottom otter trawls, multi-rig otter trawls, bottom pair trawls & beam trawls. Gear towed along the seabed or partially in contact with the seabed and may also dig into surface sediments. Pulse trawls to be evaluated. Targeted species include demersal fish, Norway lobster, spiny lobster, shrimps, & cephalopods.

PHYSICAL	Changes in topography by removal and flattening of seabed features. Disturbance of sediment surface and penetration into the substrate increasing turbidity and altering the physical structure of the sediment.
CHEMICAL	Disturbance of sediments can also lead to remobilisation of contaminated sediments and release contaminants from sediment and sediment pore water.
BIOLOGICAL	Considerable impact on the abundance of several by-catch species and changes in benthic community structure (damaged and/or replaced) associated with beam trawl fisheries. Reported effects include decreases in habitat heterogeneity and increases in numbers of particular groups which can result in shifts to dominance of highly productive opportunistic species. Fragile infauna and sedentary and slow moving animals in stable sediment are particularly vulnerable to damage. Increase in scavengers with some aggregating over beam trawl tracks to feed. Discards can provide additional food for seabirds. Otter trawls have been observed to have negative effect on benthic species richness and biomass including damage to erect epifauna and reduced diversity. Incidental catch of turtles and marine mammals in bottom trawls can be significant. Some seabirds feed on discards (e.g. gulls, skuas) and are known to alter movement patterns to feed on discards from bottom trawlers (Cory's and Balearic shearwaters)
CONCLUSIONS	Physical and biological effects are most apparent and focused on benthic habitats and communities as a result of contact of gear with the seabed. They include changes in seabed topography and reduction in the complexity of benthic communities. Effects have been observed on epifauna and shallow infauna and can extend over large areas.

AQUACULTURE –SHELLFISH

Methods include rafts, longlines as well as intertidal and subtidal lays. Effects are apparent at different stages from collecting seed stock, to cultivation and harvesting.

PHYSICAL	Variety of physical effects associated with different aspects of aquaculture. Intertidal collection can have trampling effects. Under long lived cultures, e.g. of mussels, faecal matter and detached mussels increased sedimentation under lines, reducing sediment grain size. Abrasion, nutrient and sediment re-suspension and sediment plumes are potential effects associated with harvesting, e.g. by suction dredging.
CHEMICAL	Sedimentation under lines and introduction of faecal matter has increased the organic content and led to a negative redox potential.
BIOLOGICAL	Reported effects on birds include mortalities of eider ducks associated with harvesting of spat for mussel aquaculture and disturbance of foraging birds during intertidal collecting. Harvesting clams by hand raking was reported to reduce diversity and abundance of infauna. Suction dredging can also reduce non-target fauna. Inadvertent introduction of alien species as well as non-native species specifically introduced for mariculture, or to boost native stock has affected natural communities. Another potential pathway is relocating mussel seed which might include mussels acting as a vector for the introduction of some non-native species.

	In high concentrations aquaculture lays can smother existing benthic fauna and compete for space and resources. Concern about removing planktonic larvae of other species through filter feeding and inhibit dispersal has also been raised. Mussel beds can provide food and a complex habitat for a wide range of other organisms, including seabird species such as oystercatchers, however harvesting can remove many of the species they support. Under lines, reported effects include the replacement of existing benthic fauna by opportunistic polychaetes. Under mussel ropes, the attraction of scavengers and shells of dead mussels providing a hard substratum where none existed previously, can alter the benthic ecosystem.
CONCLUSIONS	The main effects are changes in the substratum beneath and around areas of cultivation, and the attraction and inadvertent capture of predators such as birds. The introduction of alien species has been reported and changes in community structure in areas where seed stock is collected.

AQUACULTURE - FINFISH

Finfish for species such as salmon, halibut, turbot. Mostly floating sea cages.

PHYSICAL	Smothering as a result of deposition of fish faeces and uneaten food.
CHEMICAL	Deposition of organic material (faeces and uneaten food) and dispersion of nitrogenous wastes in solution with potential eutrophication effects. Use of chemicals and medicines ranging from antifouling treatments to antibiotics. Potential impact on microbial processes, particularly in the case of antibiotics and also some cases reported of mortality of sediment dwelling worms.
BIOLOGICAL	Changes in abundance and species type of benthos in response to organic enrichment with a gradient out from under cages. Extent and severity most pronounced at low energy locations where water exchange and/or wave action is limited. Seals and seabirds attracted to cages may be shot and predator scaring devices may also displace them. Accidental escape of farmed fish into the wild, interbreeding of wild and cultured stock and transmission of pathogens to wild stocks.
CONCLUSIONS	Impacts on benthos caused by deposition of wastes leading to smothering, changes in oxygenation, as well as species diversity. More widespread effects also reported, associated with the use of antifoulants and medicines.

2.2 THE POTENTIAL INTERACTIONS AND IMPACTS OF FISHING METHODS ON *Natura 2000* HABITATS

The potential links between fishing methods, their associated pressures and their potential impacts have been summarised in Section 2.1. Section 2.2 provides an overview of the interactions of Natura 2000 habitats with those pressures (Table 4) and the potential impacts on specific habitats per gear type.

Table 4. Potential interactions of Natura 2000 habitats with physical, chemical and biological pressures.	Sandbanks	Posidonia beds	Estuaries	Mudflats & sandflats	Coastal lagoons	Large shallow inlets & bays	Reefs	Submarine structures made by leaking gases	Boreal Baltic narrow inlets	Submerged or partly submerged sea caves
PHYSICAL										
substratum loss										
smothering										
changes in suspended sediment										
desiccation										
changes in emergence										
changes in water flow rates								I		
changes in temperature								I		
changes in turbidity										
changes in wave exposure								I		
noise										
visual presence										
physical disturbance or abrasion										
displacement										
CHEMICAL										
changes in levels of synthetic chemicals	I						I	I		I
changes in levels of heavy metals							I	I		I
changes in levels of hydrocarbons										
changes in levels of radionuclides	I	I	I	I	I	I	I	I	I	I
changes in levels of nutrients								I		I
changes in levels of salinity	I							I		I
changes in oxygenation	I						I	I		I
BIOLOGICAL										
introduction of non-native species	I							I		I
introduction of microbial pathogens/parasites	I	I	I	I	I	I	I	I	I	I
extraction of target species								I		
extraction of non-target species										

Probable interaction
Possible interaction
Unlikely interaction
Insufficient information I

Probable: The pressure is known to change the habitat type in most instances

Possible: The pressure may change the habitat in some cases or in particular locations or situations

The following information should be viewed as a checklist of **potential** impacts of different fishing methods on *Natura 2000* habitats. Some or all may be present in particular locations, and the **significance,** if any, of resulting impacts will depend on the **sensitivity** of the habitat and local circumstances including its recoverability and variety within habitat types. Sensitivity is not evaluated directly nor quantified in these tables. Changes, and hence the impact associated with the use of particular types of fishing gear in high energy environments, subject to frequent natural disturbance, for example, can be less significant or negligible compared to the same activity low energy environments. The magnitude, duration, frequency and the extent of the activity as well as variation within gear types, such as size and weight, are also a key factor in understanding the likely impact, including the scale of any impact. These considerations mean that it is essential **to undertake a site specific analysis** to underpin any management proposals although if there is strong evidence that damage from a gear/activity to a designated feature is ubiquitous, further assessment may not be necessary.

The main impacts described in the literature are summarised below for each of the habitats listed in Table 4. Sub-habitats have not been assessed in this generic level guidance as they have been defined to different levels of detail in different Member States, but they will need to be considered by Member States when examining habitat and gear interactions at the site level.

SANDBANKS

SUB-HABITATS/ FEATURES	May include subtidal eel grass beds, maerl beds, file shell reefs, exposed sandbanks in shallow water
POTENTIAL IMPACTS	- dredge tracks and furrows altering topography of surface - damage to large, soft and fragile organisms - reduction in biomass of target and non-target species - decreases in diversity, richness, and abundance of species - changes in dominant species - reduced structural complexity of habitats - smothering of epifauna - physical damage through abrasion or direct removal e.g. seagrass - modification of suspended sediment concentration, increase of turbidity
GEARS	Dredges - scallops and hydraulic, bottom trawls. Bottom set nets (trammel and gillnets). Purse seine & beach seine. Pots & traps. Finfish aquaculture

POSIDONIA BEDS

SUB-HABITATS/ FEATURES	-
POTENTIAL IMPACTS	- degradation or disappearance of *Posidonia* beds below fish farm cages - uprooting, burial, smothering of plants - reduction in density of plants - short size, reduced meadow cover, reduced rhizome growth - decline in sucrose concentration and photosynthetic capacity - differences in fish assemblages - major changes in demersal communities, including reduction in megabenthos - increase in active filter feeders and sedimentivourous species - decrease in top predators (Scorpaenidae, Serranidae) and apparent increase in mesocarnivores (Labridae) - physical removal or transportation of *Posidonia*
GEARS	Benthic trawling, hydraulic dredges, otter trawls, aquaculture

ESTUARIES

SUB-HABITATS/ FEATURES	Shallow sandbanks, eelgrass beds, maerl beds, mudflats and sandflats, rocky reefs, biogenic reefs and sea caves. Outer parts may be within large shallow inlets and bays.
POTENTIAL IMPACTS	- significant reduction in abundance and biomass of target & non-target species including species which use such areas as nursery and feeding grounds. - smothering , displacement and changes in benthic flora/ fauna under cages & rope culture. - disappearance of some species e.g. eelgrass - displacement of wading birds - sublethal effects of disease and sea lice treatments on lugworm - mammal by-catch with potential associated mortality in anti-predator nets - competition and changes in communities associated with introduction of alien species - attraction of scavengers - new mussel beds with associated infauna and epifauna - changes in balance and numbers of bird species
GEARS	Light dredge, hydraulic dredge, aquaculture (finfish, crustacean, mollusc), beam trawl, beach seine.

MUDFLATS & SANDFLATS

SUB-HABITATS/ FEATURES	Sometimes within estuaries and large shallow inlets and bays. Can include eel grass beds and be directly connected to shallow sandbanks.
POTENTIAL IMPACTS	- displacement and smothering of fauna - disappearance of intertidal eelgrass beds - leaf shearing, damaging and breakup of rhizomes and uprooting eelgrass - reduced biomass and shoot number of eelgrass - decrease in abundance and number of species under crab tiles - decrease in abundance of species in trampled areas - competition and changes associated with the introduction of alien species - increase in density of benthic species (clam mariculture) - changes in infauna and increased sedimentation - seed collection and laying of mussel spat changing food availability for some birds - new mussel beds with associated infauna and epifauna
GEARS	Suction dredging, hydraulic dredging, mariculture (lays, tiles, trays) seed collecting & laying (mussels) beam trawl, beach seine.

COASTAL LAGOONS

SUB-HABITATS FEATURES	e.g. tidal lagoons
POTENTIAL IMPACTS	- changes in benthic communities, including displacement and loss of species - sublethal effects of disease and sea lice treatments on lugworm - mammal by-catch with potential associated mortality in anti-predator nets - competition and changes associated with introduction of alien species - changes to seabed sediment characteristics under ropes - attraction of scavenger species - mussel lays form new habitat with associated infauna and epifauna - changes in balance of bird species
GEARS	Aquaculture (finfish, crustaceans, bivalves) beam trawls, beach seines

LARGE SHALLOW INLETS & BAYS

SUB-HABITATS/ FEATURES	may include shallow sandbanks, reefs, mudflats & sandflats, *Posidonia* beds
POTENTIAL IMPACTS	- damage to large fragile and long-lived species - reduction in biomass or target and non-target species - reduction of benthic species diversity, and abundance - changes in species dominance - reduced structural complexity - influx of scavenging species post fishing - reduced diversity, abundance and biomass of sediment infauna - changes in community structure favouring more mobile species, rapid colonisers and juvenile stages - reduction in epifauna - displacement of fauna - sublethal effects of disease and sea lice treatments of some epifauna - competition and changes associated with introduction of alien species
GEARS	Dredging (scallops, oysters, mussels) beam trawling, otter trawling, hydraulic dredge, fixed or driftnets, tangle nets, pots/creels, aquaculture (cages, trays, lays, ropes).

REEFS

SUB-HABITATS/ FEATURES	e.g. biogenic reefs, coralligenous associations (Mediterranean), boulder fields (Atlantic coast)
POTENTIAL IMPACTS	- loss of reef habitat resulting from physical damage to softer rocks - damage to soft, large, fragile species - damage to large algae such as kelps - reduced structural complexity and reduced biodiversity - removal or erect epifaunal species and large sessile species - loss of reef species from ghost fishing by lost gear - snagging and breaking off sections of fragile biogenic reef - loss and damage of biogenic reefs - changes in benthic flora and fauna of biogenic reefs - reduction in species richness, density and biomass of macrofauna - alien species introduced (trays) - changes in topography and structure of sediments (maerl grounds) - biogenic reefs smothered, buried, damaged or destroyed
GEARS	Scallop dredging, mobile gears, tangle nets, bottom set nets (trammel and gillnets), pots/creels, lightweight beam trawls, finfish farming

BOREAL BALTIC NARROW INLETS

SUB-HABITATS/ FEATURES	
POTENTIAL IMPACTS	See reefs and large, inlets and bays
GEARS	Dredges, bottom trawls, hand & pole lines, longlines, pots, set gillnets, seines

SUBMARINE STRUCTURES MADE BY LEAKING GASES

SUB-HABITATS/ FEATURES	
POTENTIAL IMPACTS	- physical damage to fragile structures - large, fragile species potentially damaged - removal or erect epifauna and large sessile species
GEARS	Towed bottom gears

SUBMERGED OR PARTIALLY SUBMERGED SEA CAVES

SUB-HABITATS/ FEATURES	May be associated with rocky reefs, occur within large shallow inlets and bays and estuaries.
POTENTIAL IMPACTS	- abrasion damage to epifauna - entanglement and potential mortality of larger organisms in lost gear
GEARS	Generally unsuitable areas for fishing therefore effects likely to be indirect, e.g. through fishing related marine litter washed into caves.

2.3 THE POTENTIAL INTERACTIONS AND IMPACTS OF FISHING METHODS ON *Natura 2000* SPECIES

The links between fishing methods, potential resulting pressures and impacts have been summarised in Section 2.1. Section 2.3 provides an overview of the interactions of Natura 2000 species with those same pressures (Table 5) and the potential impacts on specific species/species groups per gear type.

The following information should be viewed as is a checklist of **potential** impacts of different fishing methods on five groups of marine species protected by the *Natura 2000* network and listed on Annex II of the Directive; cetaceans, seals, turtles, fish and birds. Invertebrates have not been included due to limited availability of specific information on potential impacts of different fishing methods on Annex II marine invertebrates.

The grouping of species means that conclusions may not apply to all of the species within the group, however where potential impacts have been linked to particular species, examples of these species are named. When referring to this information it is also essential to bear in mind that the **significance,** if any, of resulting impacts will depend on the **sensitivity** of the species and local circumstances. Sensitivity is not evaluated directly nor quantified in these tables. The magnitude, duration, frequency and the extent of the activity as well as variation within gear types, such as size and weight, are also a key factor in understanding the likely impact, including the scale of any impact. These considerations mean that it is essential **to undertake a site specific analysis** to underpin any management proposals although if there is strong evidence that damage from a gear/activity to a designated species is ubiquitous, further assessment may not be necessary.

The main potential impacts on individuals in each species group (i.e. not necessarily on populations of those species), as described in the literature, are summarised below.

Table 5: Potential interactions between Natura 2000 species and physical, chemical and biological pressures.

SPECIES GROUPS	Cetaceans		Seals				Turtles		Fish	Seabirds, wildfowl & waders
	Harbour porpoise	Bottlenose dolphin	Grey seal	Common seal	Ringed seal	Med Monk Seal	Loggerhead turtle	Green turtle		
PHYSICAL										
substratum loss										
smothering							I	I		
changes in suspended sediment	I	I	I	I		I	I	I		I
desiccation										
changes in emergence										
changes in water flow rates										
changes in temperature	I	I	I	I		I	I	I	I	I
changes in turbidity							I	I		I
changes in wave exposure										
noise										
visual presence										
physical disturbance or abrasion										
displacement										
CHEMICAL										
changes in levels of synthetic chemicals										
changes in levels of heavy metals										
changes in levels of hydrocarbons										
changes in levels of radionuclides										
changes in levels of nutrients	I	I	I	I	I	I	I	I		
changes in levels of salinity	I	I	I	I	I	I	I	I		I
changes in oxygenation	I	I	I	I	I	I	I	I		
BIOLOGICAL										
introduction of non-native species										
introduction of microbial pathogens/parasites										
extraction of target species										
extraction of non-target species										

Probable interaction	
Possible interaction	
Unlikely interaction	
Insufficient information	I

Probable: The pressure is known to affect individuals of the species in most instances.
Possible: The pressure may affect the species in some cases or in particular locations or situations.

CETACEANS

● mortality following accidental entanglement and capture in fishing gear. For example:
- by-catch in drift nets (striped dolphin, common dolphin, sperm whale, pilot whale, Risso dolphin, bottlenose dolphin)
- by-catch in fixed nets (gill and trammel nets) (sperm whales, Risso dolphin, striped dolphin, common dolphin, bottlenose dolphin, harbour porpoise, minke whales)
- entanglement in surface longlines (Rissos dolphin, fin and sperm whale, harbour porpoise)
- by-catch in purse seines (striped dolphin, common dolphin, bottlenose dolphin, harbour porpoise)
- by-catch in pair trawls (common dolphin)
- by-catch in bottom trawls (striped dolphin, common dolphin, bottlenose dolphin)
- entanglement in anti-predator nets around fish farms

● changes in feeding behaviour such as opportunistically around fishing gears; striped dolphins, Risso's dolphin, long-finned pilot whale and sperm whale (near squid fishery using illuminated handlines), striped and bottlenose dolphins near trawl nets and bottlenose dolphins near bottom set gillnets

● Disturbance and disruption of feeding activity (harbour porpoise) and changes in food supply (sandeel fisheries)

GEARS: purse seines, drift nets, handlines, fixed nets (gill nets, tangle nets and trammel nets)

SEALS

● mortality resulting from entanglement in nets (fixed and anti-predator nets)
- by-catch in towed demersal gears
- by-catch in gill, drift and tangle nets (grey seal, common seal ,monk seal, ringed seal)
- by-catch in anti-predator nets and abandoned nets (monk seal)

● changes in feeding behaviour such as attraction to feed opportunistically around nets and on discards

GEARS: Fixed nets (trammel & gill nets), towed gear, pair trawls, cages

TURTLES

● drowning following accidental entanglement and capture in fishing gear. For example:
- entanglement in pelagic long lines (loggerhead, green, leatherback)
- entanglement in fixed nets (loggerhead, green, leatherback)
- entanglement in drift nets (loggerhead, leatherback, green)
- entanglement in bottom trawls, trammel nets (leatherback, loggerhead)
- entanglement in pot fishing gear (leatherback, loggerhead)

● changes in food availability (attracted to feed around some gears)

GEARS: pelagic longlines, driftnets, bottom trawls, gill nets, trawlers and purse seiners, pot fisheries

FISH

● mortality following accidental entanglement in fishing gear. For example:
- by-catch in demersal fishing gear (sturgeon)
- by-catch in pelagic fishing gear (twaite shad, allis shad)

GEARS: trawls (beam, otter & pair), eel & salmon traps/fixed nets, drift nets, gill nets; pelagic and demersal hook and line gears

SEABIRDS, WADERS & WILDFOWL

● mortality following accidental entanglement in fishing gear. For example:
- entanglement in static nets such as gill nets, entangling nets and trammel nets (guillemot, razorbill, Leach's petrel, gannet, Cory's shearwater, Balearic shearwates, red-throated diver, black throated diver, common scoter, velvet scoter, eider, scaup)
- entanglement in drift nets (guillemot, razorbill northern fulmar)
- entanglement in anti-predator nets
- entanglement in discarded fishing gear (gannet, cormorants)
- entanglement in longlines (Cory's shearwater, Balearic shearwater, Audouins gull, yellow-legged gull, Atlantic gannet, black guillemot, Manx shearwater)
- by-catch in purse seines (Balearic shearwater, Cory's shearwater, petrels, guillemot, razorbill, gannet)
● reduced reproductive success due to overfishing of some fish stocks
● visual disturbance due to presence of fishing vessels (common guillemot)
● increases/attraction due to changes in food source (Audouin's gull, yellow-legged gull, fulmar, gannet, skua, lesser black backed gull, great black-backed gull, herring gull common gull, Cory's and Balearic shearwater)
● disruption of feeding activity (Common scoter, common eider, oyster catcher)

GEARS: set nets (gill nets, bottom set cod nets, tangle nets) drift nets, trammel nets, longlining, beam trawls, aquaculture

2.4 THE POTENTIAL VULNERABLITY OF *Natura 2000* HABITATS AND SPECIES TO DIFFERENT FISHING METHODS

The main physical, chemical and biological pressures associated with different fishing methods, and the potential impacts on Natura 2000 habitats, species and species groups are summarised in Tables 3, 4 and 5. Table 6 and 7 combine this information to show the **potential vulnerability** of *Natura 2000* habitats to different fishing methods. The **significance,** if any, of resulting impacts will depend on the **sensitivity** of the habitat/species and local circumstances. Sensitivity is not evaluated directly, nor quantified in these tables. Changes in, and hence the impact associated with the use of particular types of fishing gear in high energy environments, subject to frequent natural disturbance, for example, can be less significant or negligible compared to the same activity low energy environments. The frequency and the extent of exposure to the activity is also a key factor in understanding the likely impact, including the scale of any impact. These considerations mean that it is essential **to undertake a site specific analysis** to underpin any management proposals although if there is strong evidence that damage from a gear/activity to a designated feature is ubiquitous, further assessment may not be necessary. A summary of the underpinning information for three of these interactions for habitats and three interactions identified for species are provided in Boxes 1 and 2.
Gear combinations are not considered here.

Table 6. Matrix summarising potential vulnerability of Natura 2000 habitats to different fishing methods.

GEAR CLASS	GEAR GROUP	GEAR TYPE	Sandbanks	Posidonia beds	Estuaries	Mudflats & sandflats	Coastal lagoons	large shallow inlets/bays	Reefs	Submarine structures made by leaking gases	Boreal Baltic narrow inlets	Submerged or partly submerged sea caves
dredges	DREDGES	boat dredge										
		mechanised/suction dredge										
trawls	BOTTOM TRAWLS	bottom otter trawl										
		multi-rig otter trawl										
		bottom pair trawl										
		beam trawl										
	PELAGIC TRAWLS	midwater otter trawl										
		midwater pair trawl										
hooks & lines	RODS & LINES	hand & pole lines										
		trolling lines										
	LONGLINES	drifting longlines										
		set longlines										
traps	TRAPS	pots & traps										
		fyke nets										
		stationary uncovered pound nets										
nets	NETS	trammel nets										
		set gillnet										
		drift net										
seines	SURROUNDING NETS	purse seine										
		lampara nets										
	SEINES	fly shooting seine										
		anchored seine										
		pair seine										
		beach & boat seine										
GEAR CLASS	FISHERY	GEAR TYPE										
aquaculture	shellfish	rafts & longlines										
		laid - intertidal & subtidal										
	marine finfish	cages										

Probable vulnerability
Possible vulnerability
Unlikely vulnerability
Limited information

Probable: The habitat is known to be vulnerable to the fishing method in most instances
Possible: The habitat may be vulnerable to the fishing method in some cases or in particular locations or situations

Table 7. Matrix summarising potential vulnerability of *Natura 2000* species/species groups to different fishing methods

SPECIES GROUPS			Cetaceans		Seals				Turtles		Fish					
SPECIES			Harbour porpoise	Bottlenose dolphin	Grey seal	Common seal	Ringed Seal	Med Monk Seal	Loggerhead turtle	Green turtle	Sturgeon (Adriatic & Atlantic)	Houting	Lamprey (sea, river)	Shad (Twiate, Allis, Caspian, Pontic, Black Sea, Azov)	Canestrini's goby	Seabirds, wildfowl & waders
GEAR CLASS	GEAR GROUP	GEAR TYPE														
dredges	DREDGES	boat dredge														
		mechanised/suction dredge														
trawls	BOTTOM TRAWLS	bottom otter trawl														
		multi-rig otter trawl														
		bottom pair trawl														
		beam trawl														
	PELAGIC TRAWLS	midwater otter trawl														
		midwater pair trawl														
	RODS & LINES	hand & pole lines														
hooks & lines		trolling lines														
	LONGLINES	drifting longlines														
		set longlines														
traps	TRAPS	pots & traps														
		fyke nets														
		stationary uncovered pound nets														
nets	NETS	trammel nets														
		set gillnet														
		drift net														
seines		purse seine														
	SURROUNDING NETS	lampara nets														
	SEINES	fly shooting seine														
		anchored seine														
		pair seine														
		beach & boat seine														
GEAR CLASS	FISHERY	GEAR TYPE														
aquaculture	shellfish	rafts & longlines														
		laid - intertidal & subtidal														
	marine finfish	cages														

Probable vulnerability
Possible vulnerability
Unlikely vulnerability
Limited information

Probable: Individuals of the species are known to be vulnerable to the fishing method in most instances
Possible: Individuals of the species may be vulnerable to the fishing method in some cases or in particular locations or situations

BOX 1. Examples from Table 6 of interactions between fishing gears and Natura 2000 habitats and the likely significant effects

POTENTIAL INTERACTION: *POSIDONIA OCEANICA* MEADOWS x AQUACULTURE–FINFISH-CAGES

CONCLUSION: LIKELY SIGNIFICANT EFFECT

FURTHER INFORMATION

Finfish aquaculture is a significant industry in shallow inshore parts of the Mediterranean. Species such as sea bass, gilthead sea bream and amberjack are farmed in these inshore areas in floating net pens/cages. They are given dry pellet feeds and various chemicals are also added to the water to maintain the condition of the fish and as to act as antifoulants. The effects of finfish aquaculture on *Posidonia oceanica* beds have been studied and reported in the scientific literature.

Studies on the interaction between fish farming operations and *P. oceanica* beds have identified significant negative effects. These effects have been associated with facilities whose production varies from a few tons to several hundred tons, where cages are sited in very shallow waters (2-5m) as well as those of intermediate depth (30-40m), and on *P. oceanica* beds which lie directly beneath fish farm cages as well situations where the cages are some distance from the seagrass beds. The observed effects are direct as well as indirect, and are apparent as changes in physical, chemical and biological factors.

Impacts of fish farming on *P. oceanica* beds have been assessed using a variety of factors (light, sediment, interstitial waters) and biotic variables (meadow density, leaf biometry, primary production, epiphytes, reserve carbohydrates in the rhizomes) in the field and in the laboratory. The significance of any changes has been determined by comparing seagrass beds under fish farm cages to control sites with no cages. Comparisons have also been made over time by recording changes before and after facilities are set up as well as for a period of time after they have ceased to be operational.

A variety of effects on the *Posidonia* plants have been recorded. These include significantly lower shoot productivity, standing crop and leaf morphometrics in seagrass patches adjacent to fish farms compared with control patches. Different effects may be apparent at different stages of the operation of fish farms and depend on the depth of water. For example, one study did not record any effects on the number of leaves and growth rates of the rhizomes after the start-up of fish farms, but particularly highly developed root system of *Posidonia* plants near existing facilities. They attributed this to an adaptation to silting. There were also higher levels of Copper and Zinc recorded in the rhizomes of *P. oceanica* closer to the cages.

Seasonal effects have been noted. In one study, the average number of leaves per shoot did not appear to be influenced by presence of fish farms in spring, although the average length of adult and intermediate leaves did increase significantly. In summer, however the average length of the leaves close to the cages decreased, perhaps due to higher grazing pressure during the time where leaf growth is reduced and when development of epiphytic algae could lead to competition.

For beds as a whole, significant reported effects include a decrease in the density (number of shoots per m^2) in the vicinity of cages as well as several hundred meters away where the density was still low compared to values regarded as typical for a similar depth. In some cases *P. oceanica* beds have completely disappeared from under cages and in others they have been significantly degraded as measured by a decrease in shoot density. The affected area is not necessarily restricted to directly under cages. In one study, changes were seen in an area seven times larger than the area occupied by the cages.

An increase in turbidity and excessive enrichment of sediment with organic matter are other changes that have been recorded in the vicinity of *P. oceanica* beds under fish farm cages. Direct effects include altered sediment chemistry, increased porewater toxicity and bacterially induced anoxic events. Indirect effects have been the reduction of ambient light through shading from net structures, effluent discharges or nutrient mediated epiphytic overgrowth which can also stress seagrass. Sediment can be black and anoxic, giving off methane and hydrogen sulphide. Benthic macrofauna in the matte of *P. oceanica* has been recorded as being more abundant in control areas compared to that in seagrass beds close to fish farming facilities, with the distribution of several species of macrofauna (echinoderms, decapods and molluscs) changing with distance from the cages.

Enhanced intense herbivore grazing pressure has been recorded around fish farms with some species, e.g. *Paracentrotus lividus* and the sparid fish *Sarpa salpa* directly contributing to seagrass meadow decline. Overgrazing also reduces the photosynthetic potential of the seagrass and consequently the storage of carbohydrate reserves in the rhizomes. The annual growth cycle of the plant whose carbon balance is negative for much of the year depends on these reserves.

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POTENTIAL INTERACTION: SANDBANKS x TRAPS

CONCLUSION: POSSIBLE SIGNIFICANT EFFECT

FURTHER INFORMATION

Pots and traps may be deployed on sandy as well as rocky areas. In the sand, limited adverse effects have been reported on epifauna as a result of impact and snagging. There may be localised disturbance of the sediment when they are set and hauled. Ghost fishing and entanglement of operational pots have been reported. One species of seapen has been observed to 'bend' avoiding impact, or if uprooted showing some ability reinsert itself in the sea bed. Fragile species are likely to be crushed.

The potential effects on the physical structure of sandbanks are interpreted from understanding the operation of the gear rather than specific reported effects. Effects on associated fauna have been reported, but have not been quantified in terms of sandbank features. On this basis the potential interaction is likely to be a "possible significant effect".

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POTENTIAL INTERACTION: SUBMERGED AND PARTIALLY SUBMERGED SEA CAVES x TRAWLS

CONCLUSION: UNLIKELY SIGNIFICANT EFFECT

FURTHER INFORMATION

Caves are generally not suitable locations for fishing activity and especially the use of mobile gears such as trawls. Any potential impact on the habitat would be from discarded or lost gear of various types which may be carried into cave systems. Potential effects which are mentioned in the literature are abrasion of cave wall communities and entanglement of seals which may use caves as haul out and pupping areas. No specific reports were found in the literature of such interactions or the likely significance of any such interactions associated with trawls gears.

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BOX 2.
Examples from Table 7 of interactions between fishing gears and Natura 2000 species and the likely significant effects

POTENTIAL INTERACTION: SEABIRDS x GILL NETS

CONCLUSION: LIKELY SIGNIFICANT EFFECT

FURTHER INFORMATION

Gill nets are a type of static fishing gear which is used to catch demersal fin fish such as flatfish, herring and cod. The fact that various species of seabird are taken as incidental catch in these nets is well established. Diving birds are particularly at risk with the likelihood of entanglement and subsequent drowning varying according to the species, season and location. Birds which pursue they prey underwater are more susceptible to entanglement than those which dive straight to the bottom to feed. Surface feeding birds, such as gulls and fulmars, rarely become entangled in gillnets. Catches of divers, grebes, sea ducks and diving ducks are highest in winter and during migration

when they are present in marine waters. In the case of bottom set nets (trammel and gillnets) the period of higher risk of entanglement may occur during the set or during the haul-out of the nets, when the gears are in the water column near the surface and birds may be attracted to the fish caught in the net. During the period that the net is in the bottom the risk of entanglement is low, unless the gears are used in shallow waters (10s of metres).

A review of studies reporting bird mortality in fishing nets across the Baltic and North Sea region reported that sea ducks (e.g. common eider, common scoter) dominate by-catch in gill nets in the eastern Baltic; sea ducks and diving ducks dominate catches in the southern Baltic; and auks, particularly the common guillemot are most commonly caught in the western Baltic and the North Sea. Data relating to seabird by-catch in gill nets has also been collected from other sea areas in Europe including off the coast of Norway, North-west Spain, Portugal and in the Mediterranean.

Evidence of by-catch comes from a variety of sources including ringed bird recoveries, on board observers on fishing vessels, information from fishermen and beached bird surveys. Some studies provide annual estimates of birds that drown in fishing nets. Combining these estimates suggest that annual figures for the Baltic and North Sea may be in the order of tens of thousands. The estimated numbers for individual species vary from tens (e.g. Stellers eider *Polysticta stelleri*) to tens of thousands (e.g. Long-tailed duck *Clangula hyemalis)*. In some cases drowning in nets is believed to be the commonest source of mortality of birds e.g. on the Polish coast or taking significant numbers of particular populations, e.g. numbers of common eider and common scoter along the east coast of Schleswig-Holstein, representing up to 17% of the maximum winter population.

The type of mesh and the operation of the fishery are factors influence by catch. For example, larger mesh sizes (>60mm) used for catching species such as salmon in the Eastern Baltic were reported as more frequently resulting in by-catch as was the use of monofilament nylon nets compared to those constructed from more traditional material. Fishing intensity and depth of setting also influenced by catch rates with more caught when fishing effort is highest and in shallower waters (<20m).

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POTENTIAL INTERACTION: TURTLES x BOTTOM TRAWLS

CONCLUSION: POSSIBLE SIGNIFICANT EFFECT

FURTHER INFORMATION

Bottom trawls operate near or along the seabed and are primarily designed to catch demersal species. Incidental catch of turtles in bottom trawls are known to occur and, in some parts of the world take large numbers of a variety of species, including loggerhead and green turtles. This is most likely to take place when turtles are foraging on the seabed. Studies in the Mediterranean suggest that the mortality risk is generally low where trawling is undertaken over short time periods (less than 60 mins) but can be significant where towing times are increased (up to 50% where fishing time increase to 200 min). Loggerhead, leatherback and green turtles are known to be trapped in bottom trawls and one study has estimated that the annual mortality of turtles in the Mediterranean is around 7,800 individuals. Turtle excluding devices (TEDS) at the entrance to the cod end of the nets are designed to allow the trapped sea turtles to escape. They are used in some parts of the world for certain fisheries e.g. shrimp trawls where the interaction is recognised as a risk factor.

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POTENTIAL INTERACTION: CETACEANS x POTS & TRAPS

CONCLUSION: UNLIKELY SIGNIFICANT EFFECT

FURTHER INFORMATION

A variety of designs of pots and traps are used in crustacean and molluscan fisheries. These may be deployed individually or in 'strings' on areas of rocky seabed as well as areas where the seabed is comprised of sands, gravels and muds. There are reports of otter becoming caught in traps and turtles being caught in associated ropes and drowning. There are some reports of small numbers of cetaceans being entangled in the ropes of pots and traps (common dolphin, bottlenose dolphin, pilot whales and minke whale). No reports were found in relation to the harbour porpoise, bottlenose dolphin or any other cetaceans nor any suggestions that there might be significant effects from any interaction if they were to occur.

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2.5. THE POTENTIAL VULNERABLITY OF *Natura 2000* HABITATS AND SPECIES TO RECREATIONAL FISHING METHODS

Recreational fishing is a significant activity in European seas. It can be boat based, shore based or undertaken in the water (e.g. spearfishing, collecting). Participants target some of the same species as commercial fishers and the fishing methods include some of those deployed in commercial fisheries such as pots and traps. As with commercial fisheries, the scale and intensity of the activity, gear modifications, variations within a particular habitat type and the recoverability of the habitat are all relevant factors in determining potential impact. The uneven spatial distribution of recreational fishing, for example influenced by public access to the shoreline, is also a consideration as it determines the likely pressure. Site specific assessment is therefore also required to determine the impact of recreational fishing activity on Natura 2000 habitats and species. Potential impacts are listed below.

Potential impacts on Natura 2000 habitats

- Propeller and anchor damage to seagrass beds by recreational fishing vessels operating in shallow near shore environments
- Erosion of shorelines and increased turbidity from waves and wake created by vessel tracks in sheltered inlets
- Reduced abundance and changes in the size structure of species collected for live bait and also of non-target species which may be buried or exposed to predation as a result of bait digging operations.
- Localised damage to littoral habitats as a result of access/trampling
- Changes to sediment structure in areas subject to bait collection
- Localised damage to rocky shore communities from overturning of boulders and short term effects on the abundance of sessile organisms collected for bait and for human consumption.

Potential impacts on Natura 2000 species

- Entanglement of fish, birds, cetaceans and turtles by litter in the form of discarded or lost fishing gears (lines, hooks, sinkers, nets). Benthic species may be also be vulnerable to snagging, dislodging and tissue abrasion
- Disturbance of wildlife such as waders and wildfowl, particularly if access to shoreline to feed is continually disrupted
- Removal of top predators. Fish taken for human consumption.
- Effects on fish population dynamics, though high fishing mortality in combination with other stressors, size/age selectivity when catches are retained but also to some extent in catch and release fishing if there is immediate or delayed post-release mortality. Non-lethal injuries may also expose fish to parasites or bacterial and fungal infections or reduce their ability to forage effectivity or scape predators. Effects on trophic cascades, depending on the role and dominance of the targeted species within the ecosystem and what proportion of the population is removed.

CONCLUSIONS

This report contributes to the qualitative assessment required for Step 1 and the first stage of Step 2 of the 'Common methodology for assessing the impact of fisheries on marine Natura 2000'. Peer reviewed and grey literature sources have been used to prepare summaries of:

(a) the potential physical, chemical and biological pressures associated with various fishing methods,
(b) the interaction of *Natura 2000* features with these pressures,
(c) the possible vulnerability arising from the use of particular fishing gears on *Natura 2000* features.

The information presented will need to be refined in light of national considerations (such as the most relevant fisheries or any gear modifications), but can be used by Member States for Step 2 – the preparation of site specific matrices of the impact of fisheries on *Natura 2000* sites and features. Cumulative and in-combination effects will be site specific and have therefore not been considered in the generic matrices. Sensitivity is not evaluated directly, nor quantified in this document therefore habitat sensitivity assessments will ultimately be required for more precise evaluations of vulnerability on a site basis.

The tables provide a checklist of **potential** impacts of different fishing methods on *Natura 2000* habitats and species. Some or all may be present in particular locations, and the **significance,** if any, of resulting impacts will depend on the **sensitivity** of the habitat and species and local circumstances including its recoverability and variety within habitat types. Sensitivity is not evaluated directly nor quantified in these tables. These considerations mean that it is essential **to undertake a site specific analysis** to underpin any management proposals although if there is strong evidence that damage from a gear/activity to a designated feature is ubiquitous, further assessment may not be necessary.

The matrices show that marine Natura 2000 habitats and species are potentially vulnerable to a range of physical, chemical and biological pressures associated with different fishing methods. In some cases the habitat or species is known to be vulnerable to the fishing method/pressure in most instances. In other cases they may be vulnerable in some cases or in particular locations or situations. There are also interactions which are considered unlikely or where there is currently insufficient information to draw any conclusions. These tables can be used by Member States as part of their assessment of activities that have the potential to affect the conservation status of habitats and species which are protected in marine Natura 2000 sites.

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