Progress Report on Spurdog Survivability in Irish Fisheries

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BIM Ireland's Seafood Development Agency

Progress Report on Spurdog Survivability in Irish Fisheries

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Key Findings

- Trawl-caught spurdog condition was clearly related to their size with most spurdog over 80 cm in length observed to be in excellent or good condition.
- 90% of trawl-caught spurdog between 80 and 100 cm in excellent or good condition survived the capture process.
- The preliminary survival estimate for trawl-caught spurdog between 80 and 100 cm is 68%.
- Trawl caught spurdog over 100 cm in length are also highly likely to survive the capture process.
- Spurdog condition was not as good in gillnets and further assessment when greater catches occur is needed.

Rialtas na hÉireann
Government of Ireland

Arna chomhchistiú ag an Aontas Eorpach

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Introduction

Following positive advice on spurdog (*Squalus acanthias*) stock status, the fishery reopened and an annual quota of around 1900 tonnes has been allocated to Irish fishers since 2023. Spurdog has traditionally been targeted by gillnet vessels in Ireland with more sporadic catches taken in bottom trawls (Fahy, 1988; MI, 2018). Fisheries mainly occur inshore along the west coast (Fahy, 1988).

Council Regulation (EU) 2024/257 requires that in Union waters, a maximum conservation reference size (MXCRS) of 100 cm shall be respected and any catches above that size when caught accidentally, shall not be harmed and specimens shall be promptly released back into the sea.

The spurdog MXCRS of 100 cm is established in EC waters to deter targeting of mature females based on research demonstrating that low fishing mortality on mature females may be beneficial to population growth rates and ICES simulations of potential benefits to the stock by protecting mature females. ICES has acknowledged that improved estimates of discard survivorship from various commercial gears are required to better examine the efficacy of such measures (ICES, 2019).

Under the landing obligation (LO), spurdog less than the maximum conservation reference size (MXCRS) of 100 cm are required to be landed and deducted from quotas. This potentially results in cessation of fishing activities when quotas are exceeded. The Irish Fishing Industry is keen to assess spurdog survivability towards potential LO exemptions in trawl and gillnet fisheries.

A number of studies conducted in other countries have assessed short-term condition and survival of spurdog. In the UK, 59% of spurdog taken as bycatch on board commercial gillnet fishing vessels were categorised as lively when first taken aboard, 8% were sluggish, and 33% were dead when first taken aboard. Data from three electronically tagged fish in lively condition exhibited long-term survival for two fish while one fish died 10 days after release (Bendall et al., 2012). Such delayed mortalities have also been observed in previous BIM survival assessments of cuckoo ray and cod (Baulier et al., 2024; Oliver et al., 2023).

On the US East coast, a 55% mortality rate was observed for gillnet caught spurdog after 48 hours in captivity in fish cages. No mortalities occurred in trawl-caught spurdog held under the same conditions (Rulifson, 2007). The latter study was conducted during winter months when temperatures, which are known to be positively correlated with mortalities, were relatively low. Also, most of the trawl hauls were 30-minute duration in depths less than 18 m which likely contributed to the low mortalities observed in that fishery.

A further US East coast study assessed trawl-caught spurdog survival in summer months in water depths up to 73 m and observed a 29% mortality rate after 72 hours captivity in sea pens with total catch weight significantly affecting survival. Results from these studies suggest that post-capture survival is likely to be poor in gillnets but may fare better in trawl fisheries.

Longer-term observations of spurdog survival are needed as a survival rate of at least 50% after a minimum of 15 days observations is generally needed before a plausible case for an exemption can be made.

Survivability assessments can be conducted using captive observation (e. g., Uhlmann et al., 2016; Van der Reijden et al., 2017; Fox et al., 2020) but may be prone to experimental biases such as capture induced stress and mortality from handling and holding wild fish in captivity (Portz et al., 2006).

We discounted the captive holding option in the current study due to potential method-induced mortality. Spurdog is thought to be a ram-ventilating species, i.e. they generally need to swim to breathe. Kelly et al. (2020) observed an individual specimen spending sustained periods of inactivity resting on the bottom of a water tank suggesting that the species can continue to breathe while static. However, Mandelman and Farrington (2007) suggested a 24% observed mortality rate in control spurdog caught using hook and line was potentially caused by captivity in holding pens.

We identified survivorship pop-up satellite archival tagging (SPAT) as the most feasible method of obtaining sufficiently long-term observations of fish survival. Carlson et al. (2014) successfully used standard pop-up archival tags to monitor long-term spurdog behaviour while Oliver et al. (2023) demonstrated the effectiveness of SPATS in assessing cod survival in an Irish fishery. These tags are relatively expensive, however, and there needs to be reasonable chance of success before engaging in such a programme. We assessed spurdog condition using detailed criteria around injuries and body movement to help determine the feasibility of full-scale survival assessment.

We developed a tailored approach to spurdog survival assessment which takes account likely differences in survival between fisheries, results of condition assessments, and practicalities and costs of deploying SPATs. We outline progress, next steps and discuss findings to date in relation to a potential survival exemption.

Methods

Fishing operations and catch sampling

Gillnetting

We assessed spurdog condition on board the 11 m gillnet vessel, MFV Barnacle II which fished off the southwest Irish coast in ICES 7j (Figure 1) during January and February 2024. The vessel used 100 mm mesh size gillnets, deployed as one long sheet or split into smaller individual sheets under normal commercial fishing conditions (Table 4). The vessel deployed its gear during day light hours except for one trip where gillnets were set overnight. We measured, weighed and condition assessed all spurdog caught by the gillnet vessel. This occurred during hauling or at the end of fishing operations in line with variable catch rates and normal fish handling practices.

Trawling

We conducted condition and survival assessment work onboard a 12 m otter trawler, the MFV Karen Mary off the mid-west coast in ICES 7b (Figure 1) during October 2023. The vessel fished a single-rig otter trawl (OTB) and targeted non-quota demersal fish species. The ground gear was constructed of 2” rubber discs in the wings and 4” rubber disks in the bosom. The vessel deployed an 80 mm diamond (T0) mesh codend and 80 mm square mesh panel (SMP) (Table 1).

The vessel landed spurdog onto the deck before sorting commenced. Where relatively large catches of spurdog occurred, random representative sub samples were collected, measured, weighed and condition assessed during trawling.

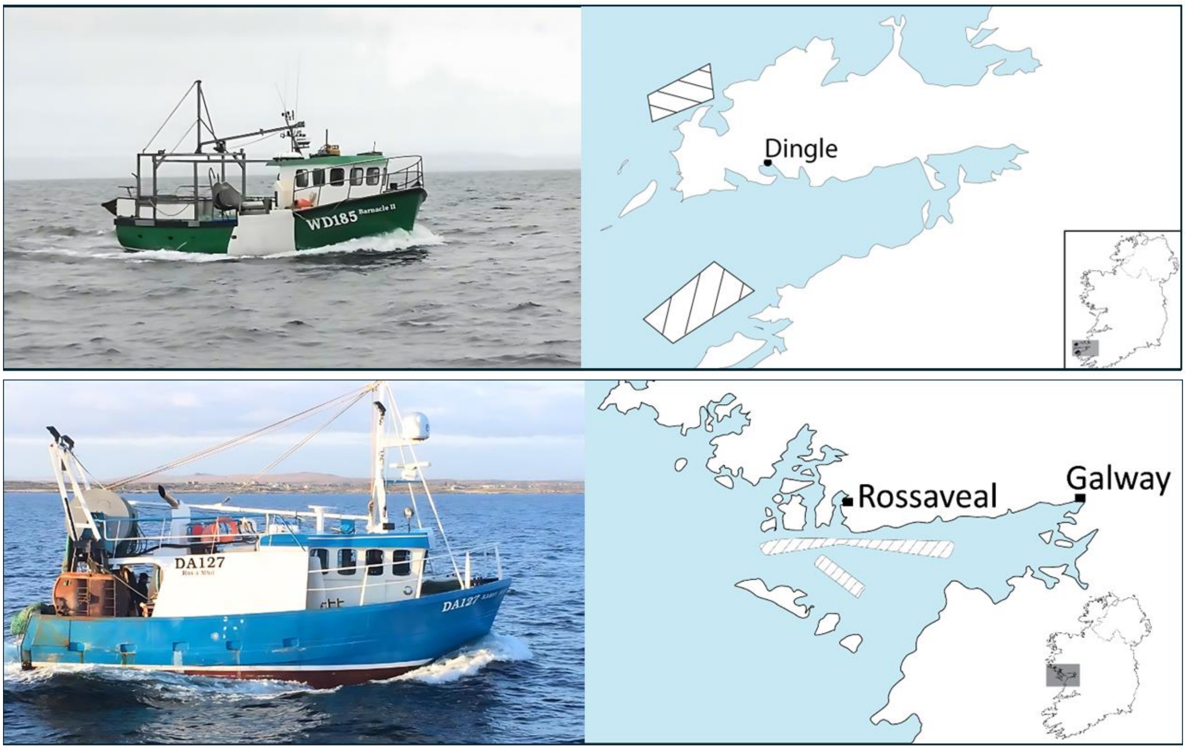

Figure 1. Fishing vessels and areas of operation. Top: MFV Barnacle II; bottom: MFV Karen Mary

Table 1. Trawl gear characteristics

Vessel	Karen Mary (DA127)
Length (m)	11.6
Engine (kW)	150
Trawl type	Demersal fish
Trawl manufacturer	Marine Suppliers
Trawl configuration	Single
Headline length (m)	37
Estimated headline height (m)	1
Footrope length (m)	42
Fishing-circle (meshes × mm)	400 × 80
Number of panels in trawl	2
Nominal codend mesh size (mm)	80

Condition assessments

The condition assessments followed guidelines developed by the ICES Guidelines on Methods for Estimating Discard Survival (Breen and Catchpole, 2021). We assessed vitality based on a combination of reflexes and injuries using an approach adapted from Benoît et al. (2010) which included a fifth vitality category for dead fish (Table 2). We examined vitality in relation to spurdog size in line with our survival assessment which was size restricted.

We conducted more detailed assessment of injuries to provide further supporting information on fish condition. The Injury assessments followed the protocol from Braccini et al. (2012) (Table 3). Mean injury scores with standard deviation (SD) for "wounds and bleeding" and "skin damage and bruising" were compared for ≥ and < 80 cm. We also recorded air exposure for tagged spurdog as the time elapsed from when the codend was lifted out of the water to when each spurdog was condition assessed.

Table 2: Vitality categorisations modified from Benoît et al. (2010)

Vitality	Category	Description
1	Excellent	Vigorous body movement; no or *minor external injuries only
2	Good	Weak body movements; responds to touching; *minor external injuries
3	Poor	No body movement; limited spiracular movement; *minor or **major external injuries
4	Moribund	No movements of body or spiracle, (no response to touching), **major external injuries
5	Dead	Clear sign of dead fish e.g., rigor mortis, decomposition

*Minor injuries: bleeding, tear/ bruising of fins or mouthparts (≤10% of the diameter), gill-net marks or surface abrasion, all on minor scale
Major injuries: bleeding, tear/ bruising of fins or mouthparts, gill-net marks, or surface abrasion, all on major scale

Table 3: Injury assessments from Braccini et al. (2012)

Index	Description	Survival category High	Moderate	Low	Nil
Wounds and Bleeding	Presence of wounds and bleeding	1 (no cuts or bleeding observed)	0.66 (1-3 small cuts or lacerations not deep only on skin, some bleeding but not flowing profusely, no exposed or damaged organs)	0.33 (>3 small cuts or one severe cut or wound, some bleeding but not flowing profusely, little organ exposure and if exposed organs are undamaged)	0 (extensive small cuts or very severe wounds or missing body parts, excessive bleeding, blood flowing freely and continuously in large quantities, internal organs exposed and damaged, may be protruding
Skin damage and bruising	Skin damage and surface bruising by physical trauma	1 (0% of skin body damage or bruises or redness)	0.66 (<5% of skin body damage or bruises or redness)	0.33 (5-40% of skin body damage or bruises or redness	0 (>40% of skin body damage or bruises or redness)

Tagging procedure

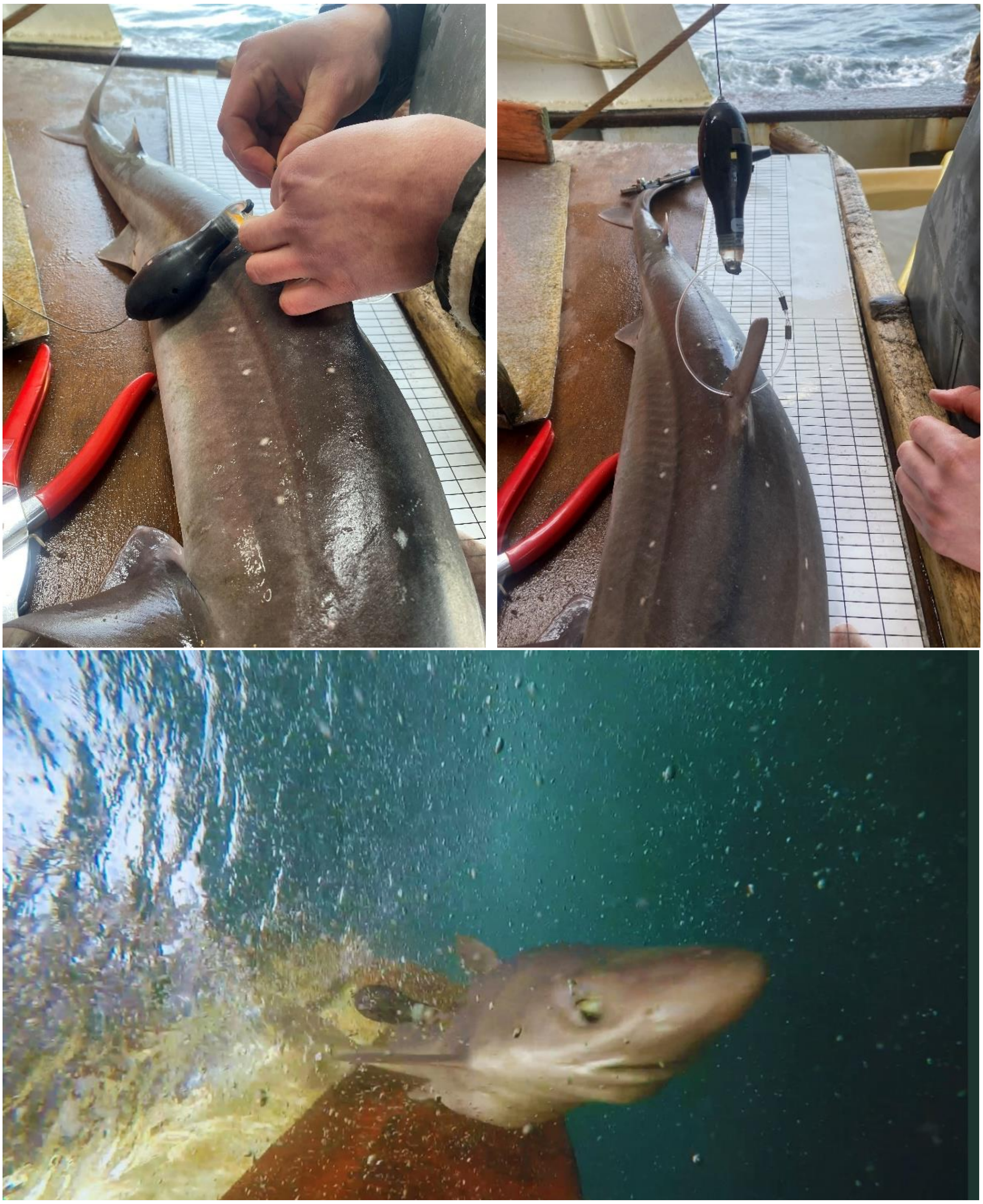

Figure 2. Top: Spurdog with SPAT affixed to primary dorsal fin ready for release, Bottom: spurdog released directly into the water by scientist

Wildlife Computers (Seattle, USA) supplied ten 10 SPATS which record data for a maximum of six days prior to pop up. Tags were set to pop up after a maximum of 30 days deployment or prior to this if vertical movement was restricted for > 24 h: the tag floated at the surface; or depth variance did not exceed 2 m, e.g., the fish stayed on the seabed.

We tagged spurdog using a phased approach. In phase I, we tagged 10 spurdog in excellent (V1) and good (V2) condition with SPATs. A relatively high survival rate for these fish would justify phase 2, further tagging of spurdog in poor (V3) or moribund (V4) condition.

The tag manufacturer recommends that the tag should weigh less than 3 – 5 % of fish body weight. We restricted tagging to spurdog between 80 and 100 cm in line with the size of fish capable of carrying tags, the MXCRS and condition assessments results. Tags were set to pop off after a period of 30 days at which point it was assumed that spurdog had survived.

Randomly selected spurdog were condition assessed and measured to the nearest cm. Spurdog deemed suitable for tagging (i.e. between lengths 80 and 100 cm and in excellent or good condition) were placed in 310 litre holding tanks prior to tagging.

When ready for tagging, a hose was inserted in the mouth of the spurdog with free flow of sea water over the gills and the head was covered with damp cloth to minimise stress. The SPAT was attached to the fish using 500lb monofilament line affixed through the primary dorsal fin (Figure 2). An additional Floy tag was applied to the bridle to allow for further identification. We released the spurdog headfirst directly over the stern of the vessel (Figure 2).

We conducted tagging work under Health Products Regulatory Authority (HPRA) authorisation (Licence No.: AE19121/P003). HPRA ensures that procedures involving the use of scientific animals follow legislative requirements under EU Directive 2010/63/EU and Irish Statutory Instrument No 543 of 2012.

Environmental data

We recorded data on environmental parameters during the spurdog tagging trip to facilitate their assessment in relation to survivability. The skipper recorded swell height (m), wind speed (knots). Additionally, air temperature (°C) and sea surface temperature (°C) was recorded using a digital thermometer. Bottom water temperature (°C) was recorded using data storage tags (DSTs) attached to the trawl.

Results

Table 4. Fishing operation details

Vessel	Gear	ICES area	Trips (N)	Haul (N)	Mesh size (mm)	Mean haul duration (min)	Mean bulk catch (kg)	Mean depth (m)	Spurdog (N)	Spurdog sampled (N)
Barnacle II	Gillnet	7j	5	5	100	*504	137	68	90	90
Karen Mary	Otter trawl	7b	5	13	80	150	280	42	1019	428

*Soak time

Gillnetting

We carried out five daytrips on board the gillnet vessel with key operational information summarised in Table 4. Spurdog catches were low with a relatively even split between fish in better (V1, V2) and poorer condition (V3 – V5) (Table 5). We observed a relatively narrow size range of spurdog between 60 and 100 cm in the gillnets with no clear size trend in relation to fish condition (Table 6 and 7). Mean injury scores were lower suggesting more injuries for larger compared with smaller spurdog. However, the injury scores were quite variable (Table 8).

Table 5. Overall vitality of gillnet-caught spurdog

Vessel	Spurdog (N)	V1 (%)	V2 (%)	V3 (%)	V4 (%)	V5 (%)
Barnacle II	90	16	36	14	14	20

Table 6. Count (N) and vitality (%) by size class for gillnet-caught spurdog

Size class (cm)	Count (N)	V1 (%)	V2 (%)	V3 (%)	V4 (%)	V5 (%)
≤60	1	100	0	0	0	0
61-70	8	13	25	38	13	13
71-80	43	14	49	9	12	16
81-90	33	15	21	15	21	27
91-100	5	20	40	20	0	20
*(80-100)	52	12	31	13	19	25

*Tagged spurdog size range

Table 7. Grouped V1 & V2 (%) and V3, V4 & V5 (%) vitality for gillnet-caught spurdog

Size class (cm)	V1 & V2 (%)	V3 & V4 &V5 (%)
≤60	100	0
61-70	38	63
71-80	63	37
81-90	36	64
91-100	60	40
(80-100)	42	58

Table 8. Mean injury scores for gillnet spurdog ≥ and < 80 cm (±SD)

Injury assessments	≥ 80 cm (±SD)	< 80 cm (±SD)
Wounds and bleeding	0.54 (±0.29)	0.68 (±0.25)
Skin damage and bruising	0.48 (±0.29)	0.69 (±0.27)

Trawling

We carried out a total of five trips under normal fishing conditions on board the trawler (Table 4). Spurdog catches were greater than the gillnetter. Depth, haul duration and bulk catch ranged from 39-43 meters, 120 – 210 minutes and 91 – 728 kg: mean figures in Table 4. We observed a total of 1019 spurdog with 428 or 42% of these sampled. This equates to an average of 78 spurdog caught per haul while the largest catch of spurdog observed in a single haul was 371 fish.

The condition of these trawl-caught spurdog was relatively poor overall with just over 26% of fish in V1 and V2 condition (Table 9). However, condition was clearly related to size with most spurdog over 80 cm in length observed to be in better condition. Smaller fish were in poorer condition (Table 10).

Some 76% of spurdog between 80 and 100 cm were in excellent or good condition. Most of the fish in poorer condition in that size range were in V3 rather than V4 condition. 100% of spurdog over 100 cm were in excellent or good condition. (Table 11). Mean injury scores were higher suggesting fewer injuries for larger compared with smaller spurdog. However, the injury scores were again quite variable (Table 12).

Table 9. Total count (N) and vitality (%) for trawl-caught spurdog

Spurdog (N)	V1 (%)	V2 (%)	V3 (%)	V4 (%)	V5 (%)
428	9.1	17.1	33.6	40.9	0.2

Table 10. Count (N) and vitality (%) by size class for trawl-caught spurdog

Size class (cm)	Count (N)	V1 (%)	V2 (%)	V3 (%)	V4 (%)	V5 (%)
< 31	2	0	0	50	50	0
31-40	10	0	0	30	70	0
41-50	140	0	5	37	58	0
51-60	65	3	9	28	60	0
61-70	74	3	19	45	32	1
71-80	93	13	34	30	23	0
81-90	23	17	39	39	4	0
91-100	12	75	25	0	0	0
> 100	9	89	11	0	0	0
*(80-100)	45	38	38	20	4	0

*Tagged spurdog size range

Table 11. Grouped V1 & V2 (%) and V3, V4 & V5 (%) vitality for trawl-caught spurdog

Size class (cm)	V1 & V2 (%)	V3 & V4 & V5 (%)
< 31	0	100
31-40	0	100
41-50	5	95
51-60	12	88
61-70	22	78
71-80	47	53
81-90	57	43
91-100	100	0
> 100	100	0
(80-100)	76	24

Table 12. Mean injury scores for trawl caught spurdog ≥ and < 80 cm (±SD)

Injury assessments	≥ 80 cm	< 80 cm
Wounds and bleeding	0.80 (±0.25)	0.65 (± 0.17)
Skin damage and bruising	0.77 (± 0.27)	0.63 (± 0.18)

Spurdog survival

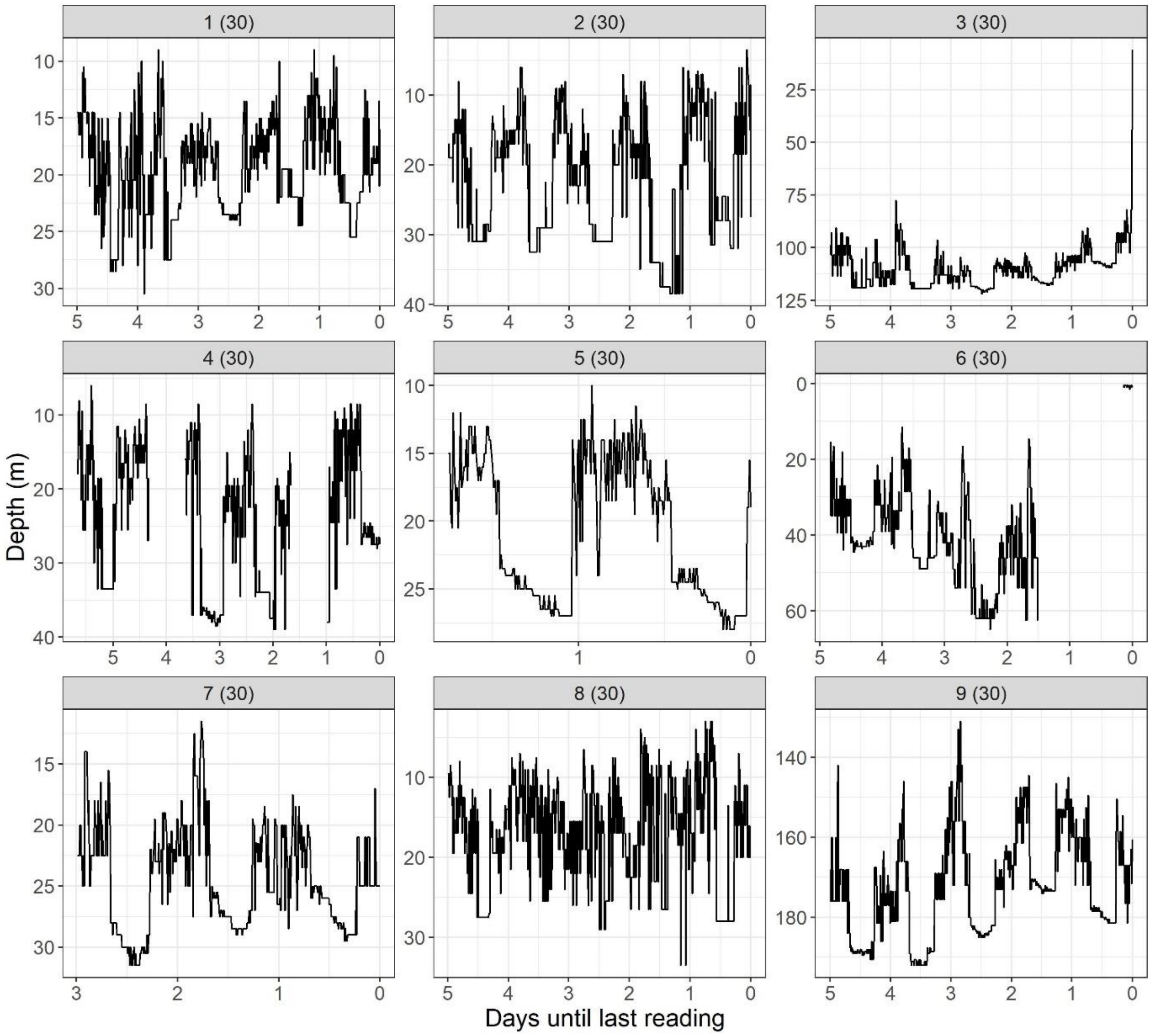

Figure 3. Vertical behaviour of spurdog in days preceding tag pop-ups

Tagging was conducted in the outer Galway Bay area in ICES area 7b on the 26th of October 2023 onboard the trawler, MFV Karen Mary. Tagged spurdog were caught during two hauls with mean towing speed, haul duration, depth and bulk catch of 2.8 kt, 3 h, 42.2m and 563 kg. The greatest catches of spurdog from all observed hauls occurred in these two hauls with 371 spurdog caught in the first and 223 caught in the second haul. Key environmental parameters did not vary much given that tagging was restricted to one day at sea; mean values are outlined in Table 13. Mean tagged-spurdog air exposure time was nine minutes.

Six spurdog in V1 condition and four spurdog in V2 condition between 80 and 100 cm were tagged with SPATS. Nine out of ten or 90% of the tags popped up after the full 30-day monitoring period. No data were received from the other tag, and we assumed that this fish died. All nine survivors demonstrated typical vertical behaviour by occupying deeper water during daytime and shallower water at nighttime (Figure 3). Seven SPATS popped up in relatively localised areas within Galway Bay while three others travelled greater distances off the southwest coast of Ireland.

Based on the condition assessment and tagging work, the preliminary survival estimate for 80 – 100 cm trawl-caught spurdog is 68 % based on a 90 % survival rate (from tagging of V1 and V2 spurdog in this size class) x 76% (overall proportion of V1 and V2 spurdog in this size class) (Table 11).

Table 13. Environmental data collected during tagging study

Parameters	Mean values
Swell height (m)	1
Wind speed (knots)	18
Sea surface temperature (°C)	15
Bottom temperature (°C)	14
Air temperature on vessel (°C)	14

Discussion

Results to date suggest that it is highly likely that the majority of trawl caught spurdog between 80 and 100 cm survive the capture process. Phase 2 of the tagging work needs to be completed but assuming similar vitality scores occur in future trips, 68% is a minimum survival estimate for spurdog between 80 and 100 cm. More survivors in the V3 or V4 category will likely result in greater survival estimate.

Some work has already commenced under Phase 2. To date, two spurdog between 80 and 100 cm in V3 condition were tagged with SPATS. Both fish survived the full 30-day monitoring period. A further 8 fish will be tagged in autumn when the fishery resumes. This preliminary work under phase 2 bodes well for a higher overall survival rate when the results of phases 1 and 2 are combined.

Very low occurrence of moribund, V4 spurdog in the 80 – 100 cm size range (Table 11) suggests that it will be difficult to tag fish in that size range. Instead, we may assume that V4 fish do not survive the capture process which will allow us to focus on V3 fish. This should provide a conservative survival estimate as it would not consider the possibility that some V4 fish may survive.

Findings to date also suggest that it is also highly likely that the majority of trawl-caught spurdog > 100 cm survive the capture process. The condition of spurdog > 100 cm in length (100 % V1 and V2) was better than spurdog between 80 and 100 cm (76% V1 and V2) (Table 11), 90% of which survived the capture process. This suggests that survival of trawl-caught spurdog > 100 cm is likely greater than 90%.

We restricted condition and survivability assessments of trawl-caught spurdog to hauls conducted under normal fishing conditions off the west coast of Ireland where the fisheries traditionally occur (Fahy, 1999). We observed an additional 59 hauls off the west coast as part of gear trials which were not considered representative of otter trawl fisheries due to gear modifications or artificially short haul durations (Browne et al., 2023, McHugh et al., 2023, McHugh et al., (in prep), Oliver et al., 2023). These trials occurred between March and May 2023, and March and April 2024. A total of 36 spurdog were observed in these 59 additional hauls.

The largest observed spurdog catch off the west coast was 371 fish. Catches larger than this may occur and could result in poorer fish condition due to physiological stressors in the codend and increased catch handling times. Observations of fish condition under a broader range of catch conditions would be ideal but are reliant on encountering such events when observers trained in condition assessments are present. However, trawl observations off the west coast during the study period suggest that larger catch events occur rarely.

Higher water temperatures have been found to negatively affect post release survival rates and increase stress levels in a variety of fish species (e.g., Gale et al., 2013; Kraak et al., 2018). The largest catches of spurdog in Irish waters consist of large mature females inshore, especially during the autumn months when whelping is taking place (Fahy, 1988). We assessed spurdog survival in early autumn when water and air temperatures were still relatively high. The observed sea surface temperature of 15°C is close to the maximum off the west coast of Ireland (Oliver et al., 2017). This bodes well for the survival of spurdog caught at other times of the year when temperatures are lower, and fish are likely to be in better condition when released.

We need to conduct further assessment of the condition of gillnet-caught spurdog when greater spurdog catches occur to justify a full-scale survival assessment in that fishery. Reasonable numbers of fish in V1 - V3 categories may justify tagging but a high proportion of spurdog in V4 or V5 categories would make it difficult to proceed. More fish condition assessments scheduled for autumn 2024 will help clarify the next steps in this regard.

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