Assessment of the effect of tidal currents on Nephrops catches in the Irish Sea

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Prepared by Matthew McHugh

BIM, New Docks, Galway, Ireland

Email: matthew.mchugh@bim.ie

Key Findings

- No significant difference in Nephrops catches in 3-, 4- or 5-hour haul durations
- Suggests a saving of at least 60 litres of fuel and equivalent carbon emissions by fishing for 3-hour periods compared with 5-hour periods around slack tides
- Likely explained by effects of tidal current on Nephrops behaviour and/or on gear performance and catch retention
- Further work planned to confirm the results and assess gear effects

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Introduction

Fishing is a high energy (fuel) dependent industry and optimising this in terms of catch rates is key to its long-term sustainability. Carbon emissions from fuel usage are a concern and must be reduced in line with the EU transition away from a reliance on fossil fuels in the seafood sector. Additionally, it is essential to catch fish and shellfish at the lowest rate of fuel consumption (litres of fuel used per kilogram caught) possible to ensure economic viability. Dublin Bay Prawns or Nephrops (*Nephrops norvegicus*) are one of Ireland's most important fisheries species and were the most valuable demersal species landed in 2024 (BIM 2025). BIM is working with the Irish Fishing Industry to help improve the Nephrops fishery in terms of energy, and catch, efficiency.

The Irish Sea Nephrops fishing grounds are important for Irish fishers with a recommended catch for 2025 of 10,000 tons (ICES 2024). Typically, prawn trawling in the Irish Sea involves vessels towing across the slack. Slack tide occurs when the tidal current is at its weakest during the transition between tidal states, e.g., from high to low tide (or the reverse). Fishing in the Irish Sea starts up to 3 hours before the high or low slack tide and hauling when the slack has passed and is a continuous cycle for the duration of a fishing trip. These fishing trips typically occur when tides are not at their peak, with many fishers choosing to only fish during neap tides.

Nephrops catches are linked to availability following their burrow emergence, which is typically related to their crepuscular behaviour where they are active at dawn and dusk (Hammond and Naylor 1977; Hillis 1971). However, other burrow emergence pattens are also likely; for example, Hillis (1996) suggested that at 0.4 ms^{-1} (0.78 kts) many Nephrops will not emerge from their burrows.

One key consideration is knowing when the slack tide occurs, the onboard plotters have predictive software that allows high and low tide times to be predicted for any location. However, the tidal predictions do not consider the existing environmental variations (e.g. wind, atmospheric pressure, etc) and tidal timings can vary accordingly.

Here, we used a range of tow durations around slack tides to help determine the effect of tidal strength on Nephrops catches. We used a doppler current indicator to obtain localised real-time measurements of current speed and direction to inform our results.

Methods

The trial was conducted on board MFV Emerald Shore (DA137), a 16.89 m demersal trawler targeting Nephrops in the western Irish Sea (ICES Division 7.a, Nephrops functional unit 15), towing four two-panel 26 m footrope Nephrops trawls (Figure 1; Table 1). The four trawls were deployed simultaneously in quad-rig configuration. Standard two-panel codends fitted with a 3 m long 300 mm square-mesh panel installed 9–12 m from the codline were deployed on each trawl.

The trawling protocol involved four tow durations —2, 3, 4, and 5, hours—centered around the high and low tide slack waters (Table 2). The high and low tide times were taken from the onboard Sodena track plotter and were based upon where the following tow starts. Each tow duration was assigned two high- and two low-slack tides and then randomly arranged to give the shot plan (Table 2). For each tow the corresponding high or low slack tide was scheduled to be in the middle of the predetermined tow time.

A Simrad CP60 current indicator system was used to measure up to five individual layers of water current with current direction and velocity in 6 m bands (based on the ping length) (https://www.kongsberg.com/discovery/fish-finding/echo-sounders-and-current-indicator-systems/simrad-cp60/#downloads) (Figure 2). The CP60 system consisted of a deck box with laptop computer and wide band tansceiver with the transducer deployed via a pole on the port side (Figure 3). The over the side pole mount was because this CP60 system is portable and for use on any vessel, typically the transducer is hull mounted. The CP60 allows the data to be recorded to the laptop's hard drive and reviewed later. Here the Simrad CP60 was focused on the current speed and direction at the surface and seabed.

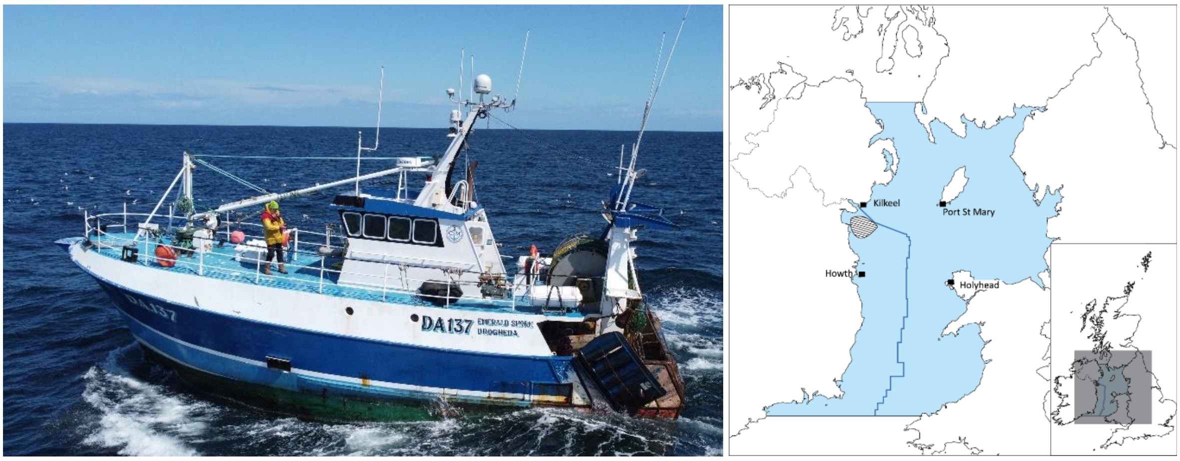

Figure 1. Trial vessel, and Location (hatched area)

Table 1. Vessel and trawl gear characteristics for doppler trial

Vessel	Emerald Shore (DA137)
Length (m)	16.89
Engine (kW)	269
Trawl type	*Nephrops*
Trawl manufacturer	Pepe Trawls
Trawl configuration	Quad
Headline length (m)	20
Estimated headline height (m)	1
Footrope length (m)	26
Fishing-circle (meshes × mm)	340 × 80
Number of panels	2
Codend and SMP	
SMP (mm)	300
Mesh size (nominal) (mm)	80
Number of panels	2

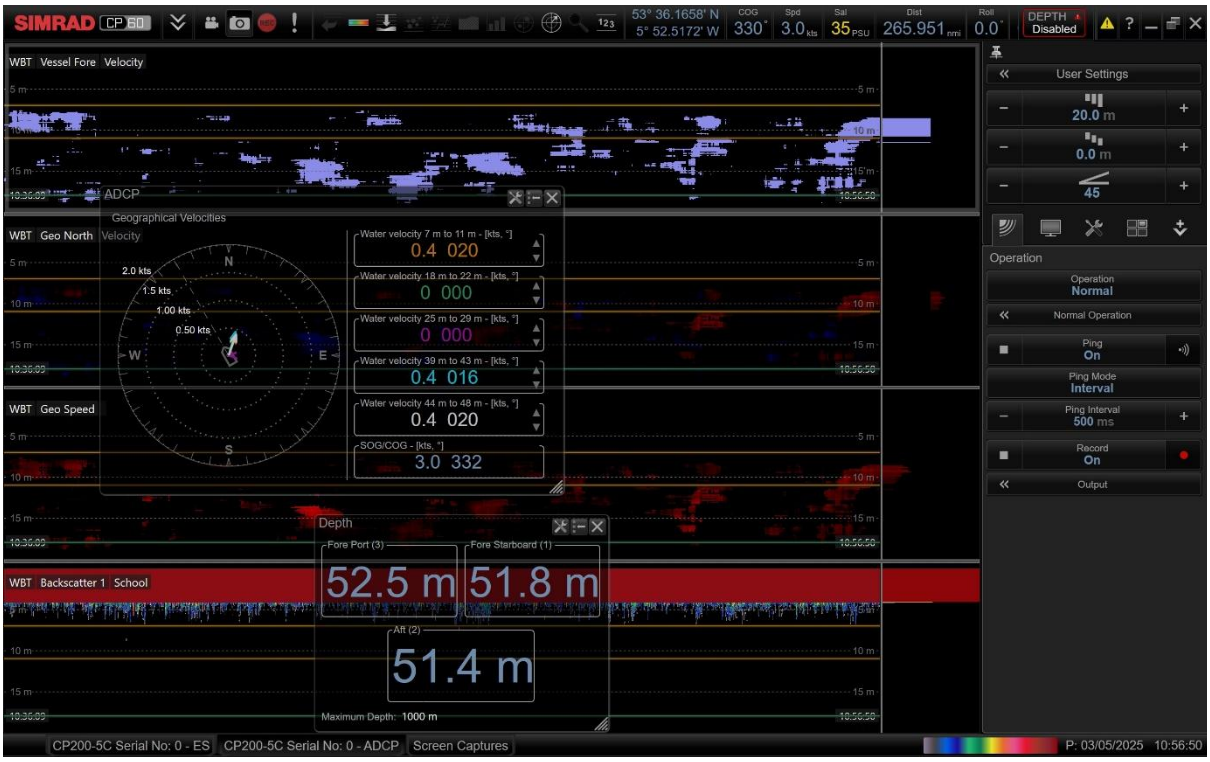

Figure 2. Screen grab of CP60 output

Sampling and analysis

For each haul the nets were emptied onboard, and the catch was collected into baskets and the total bulk weighed. Catch sampling involved subsampling each haul, randomly selecting up to three baskets from the total and the contents sorted to species level and weighed. For each haul the subsampled weights were used to establish raising factors, these were then applied to obtain overall catch estimates. Results are primarily focused on the Nephrops catch per fixed tow duration.

Haul data including fishing position, environmental conditions and fishing depth were recorded by the skipper for every haul. The skipper also recorded the vessels fuel consumption (l/hr), engine load (%), engine revolutions per minute (RPM), and surface and bottom current speed and direction from the doppler several time per haul. The vessels Scanmar door sensors were utilised to record the overall trawl door spread.

In addition to the real-time recording of the current speed a recording of the data collected by the CP60 for each tow was made and reviewed later. On review, the data was manually extracted at 10 min intervals for each tow. The data extracted was tow number, time, vessel speed and heading, depth, and the current speed and heading at the surface and on the seabed.

Additionally, data (e.g. wind and wave information) from the M2 weather buoy located in the Irish sea was downloaded and added to the doppler data.

This was combined with the other data collected and analysed to assess potential differences between the tow durations.

Table 2. Trawling protocol during doppler trial

Tow duration (hr)	Date	Time			High/Low tide	Period of day
		Slack tide	Start tow	End Tow		
4	29/04/2025	19:05	17:08	21:08	Low	Dusk
2	30/04/2025	01:47	00:47	02:47	High	Night
5	30/04/2025	07:30	05:00	10:00	Low	Dawn
3	30/04/2025	14:14	12:45	15:44	High	Day
2	30/04/2025	19:53	18:53	20:53	Low	Dusk
4	01/05/2025	02:34	12:30	04:30	High	Night
3	01/05/2025	08:19	06:49	09:49	Low	Day
5	01/05/2025	15:09	12:39	17:39	High	Day
5	01/05/2025	20:40	18:10	23:10	Low	Dusk
2	02/05/2025	03:25	02:25	04:25	High	Night
2	02/05/2025	09:11	08:11	10:11	Low	Day
5	02/05/2025	16:09	13:40	18:40	High	Day
3	02/05/2025	21:32	20:22	23:00	Low	Dusk
4	03/05/2025	04:23	02:23	06:23	High	Night
4	03/05/2025	10:11	08:11	12:11	Low	Day
3	03/05/2025	17:16	15:46	18:46	High	Day

Figure 3. Over the side transducer pole mount (in raised position)

Results

A total of 16 valid hauls were completed during April and May 2025—four for each set tow duration. The mean operational parameters per tow duration are presented in Table 3. Nephrops were the main commercial species landed with 52, 60, 59 and 55% of total bulk caught for the 2-, 3-, 4-, and 5-hour tow durations, respectively (Table 4). For Nephrops, there was no significant difference between catches for 3-, 4- and 5-hour tow durations with the 2-hour tow duration representing the lowest mean catch (Figure 4).

The other main commercial species landed were whiting with an average 13% of the bulk per tow duration with other species caught in low volumes (Table 4).

Surface and bottom current speeds were similar for each tow duration, and they averaged between 0.56 and 0.62 knots for the 2-, 3-, and 4-hour tows with averages of 0.75 to 0.78 knots for the 5-hour tows (Figure 5).

There was slight gradual increase in fuel usage per hour from the 2- to 5-hour tow durations; overall this increase was 3% or 1.16l/Hr between the 2- and 5-hour tow durations (Table 4). With each increase in tow duration there is an overall mean increase of ~41.6 l per fishing hour.

The environmental conditions were relatively consistent throughout the trial with a slight increase in wind and wave height towards the end of the trial (Table 5).

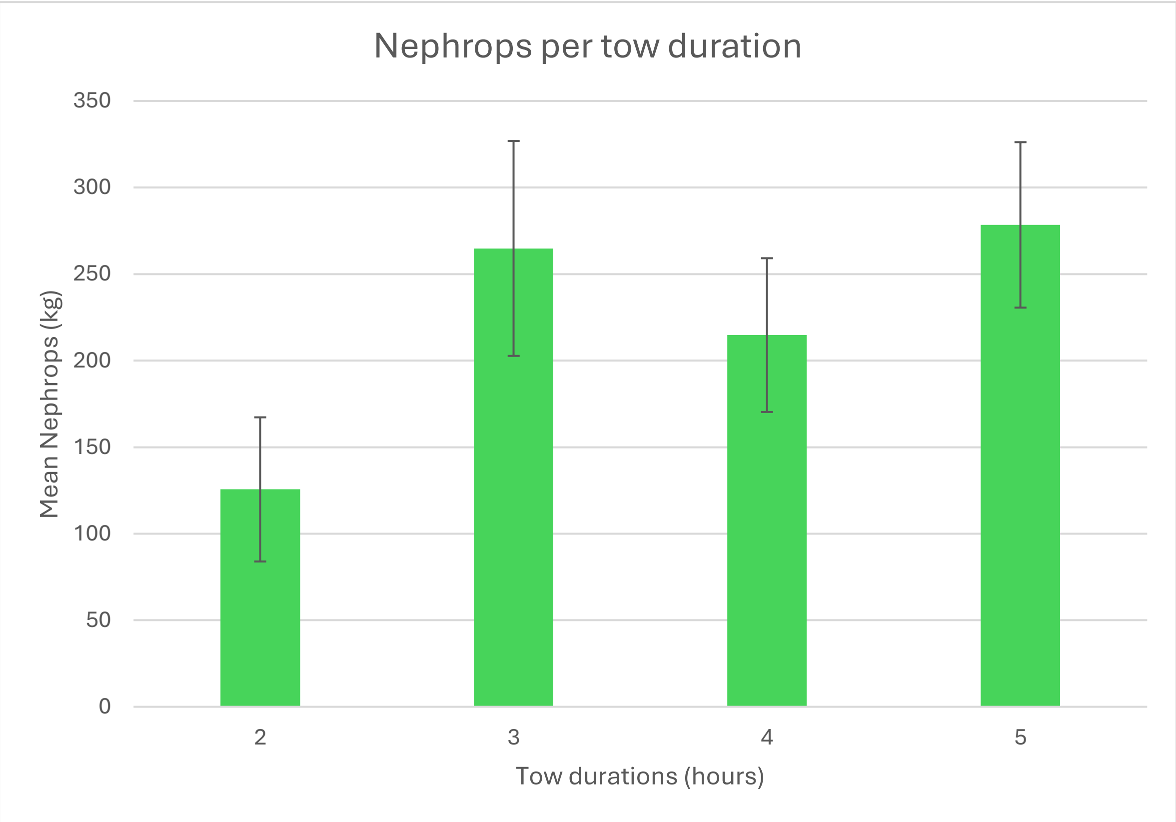

Figure 4. Mean Nephrops catches (kg) per fixed tow duration with standard error bars

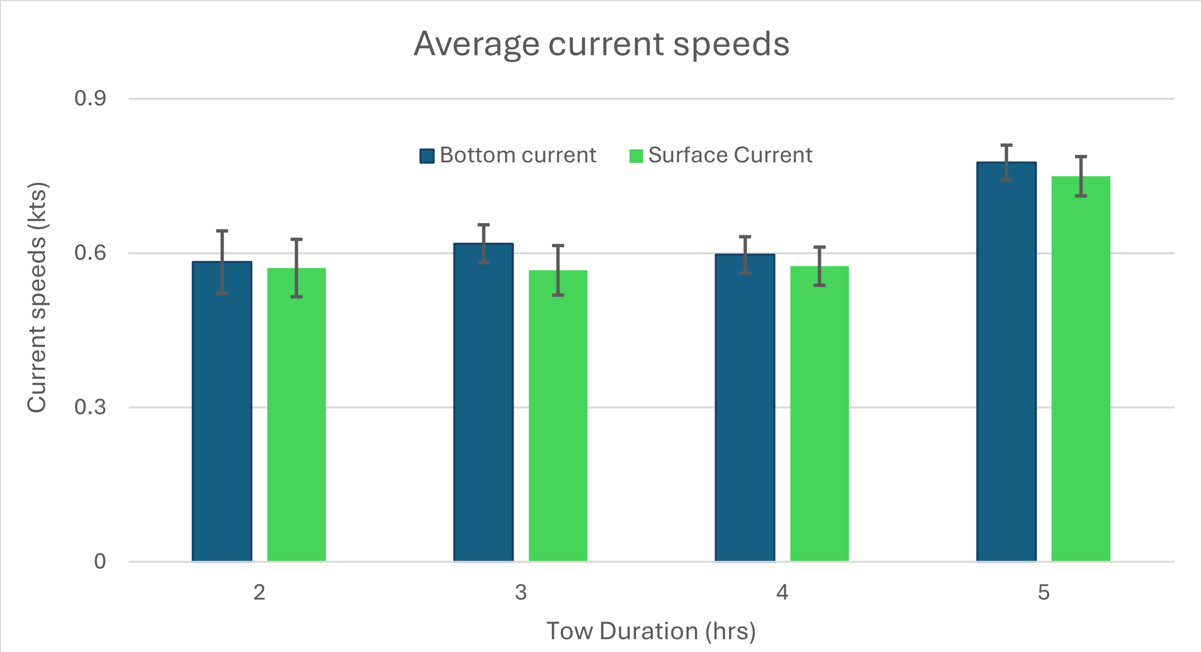

Figure 5. Average bottom and surface current speeds per tow duration with standard error

Table 3. Total estimated catch (kg) per tow duration

Species	2 hr	3 hr	4 hr	5 hr
Nephrops	502	1,059	859	1,114
Whiting	122	239	174	272
Haddock	4	15	42	44
All Flatfish[$]	90	115	135	89
Non-commercial fish[&]	74	51	70	63
Cod, Monkfish	3	2	18	8
Skate and Ray*	4	23	12	7
Dogfish	38	194	63	339
Benthic items[£]	124	80	75	74
Total bulk	962	1,778	1,447	2,009

[$]Brill, turbot, black sole, lemon sole, plaice, turbot, dab,
[&]Gurnards, pouting
*Thornback-, spotted-, and cuckoo-ray
[£]Seaweed, whelks, jellyfish, octopus

Table 4. Mean operational parameters per tow duration

	2 hr	3 hr	4 hr	5 hr
Fuel (l/Hr)	41.39	41.48	42.05	42.55
RPM	1,440.89	1,571.67	1,450.33	1,459.23
SOG (Kts)	2.98	2.90	2.99	2.79
Bottom Current Speed (kts)	0.58	0.62	0.60	0.78
Surface Current Speed (kts)	0.57	0.57	0.57	0.75
Door spread (m)	71.49	71.19	70.52	70.50
Door spread swept area (km^2)	0.76	1.10	1.56	1.85
Depth (m)	26.33	34.00	26.64	42.41

Table 5. Mean environmental information from M2 wave buoy during trial

Date	Wind Speed (kn)	Wind Direction (˚)	Max Wave Height (m)	Wave Direction (˚)	Sea Temp (˚C)
29-April	4.70	87	0.43	252	11.13
30-April	3.83	110	0.50	171	10.56
01-May	9.48	130	0.96	168	10.60
02-May	10.61	59	1.02	31	10.39
03-May	13.11	152	1.52	103	10.23

Discussion

The four fixed tow durations centred on the slack tides represent a simple approach to understanding the catchability of Nephrops across the tidal range and the inclusion of the doppler data with other data (operational and environmental) facilitates an understanding of whether current flow can be attributed to any differences in catches.

Towing for three hours instead of five has clear benefits in terms of fuel savings and wear and tear on the trawl gear. While for three- versus five-hour tows it means that the gear has two hours less wear and tear from being dragged along the seabed. The fuel savings are not worth a full two hours because the vessel is still using its engines to maintain its position and the onboard equipment. It is likely that the fuel savings should be approx. 70% (~30 l) of the average usage (42 l) per hour, when towing the gear.

The similar catches for Nephrops at 3-, 4-, and 5-hour tow durations highlights a potentially interesting insight into their behaviour. Most of the information available suggest that Nephrops observe a crepuscular cycle where they are active at dawn and dusk (Hammond and Naylor 1977; Hillis 1971). However, laboratory experiments show that under simulated tidal flow, Nephrops reduce emergence during periods of increasing current velocity (Sbragaglia et al. 2015). The similarity between the Nephrops catches at 3-, 4-, and 5-hour tow durations somewhat suggests that increasing current flows might impact on Nephrops burrow emergence and their availability for capture. This is supported by recent work by Bahamon et al. (2025) where they suggested that there is a relationship between Nephrops burrow emergence and tidal cycle in a Bay of Biscay fishery.

Typically, tidal height and flow is estimated by the rule of twelfths, a rule of thumb used to describe how the rate of tidal height change accelerates toward mid-tide and slows near slack tide at high and low water. This reduced Nephrops burrow emergence during higher current flows is likely why the fishing cycle in the Irish Sea is centred around the slack tide when they are expected to emerge from their burrows. However, despite fishing vessels sticking to this cycle there have been very few studies at sea to understand Nephrops burrow emergence patterns but see Bahamon et al. (2025).

It is likely that changes in current velocity influenced Nephrops catches with Hillis (1996) suggesting that at 0.4 ms^{-1} (0.78 kts) up to 97% of Nephrops will not emerge from their burrows. It was not evident in Hillis (1996) where the current was being measured but here both the mean surface and bottom currents did not exceed 0.4 m s^{-1} (0.78 kts) for the 2-, 3- and 4-hour tow durations. However, during the 5-hour tows there were mean highs of up to 0.88 Kts (0.45 m s^{-1}) bottom currents recorded. This increased bottom current for the 5-hour tow durations might partially explain the differences in catches. While there was overall increased current for the 5-

hour tows there was no clear pattern of peak currents throughout the tows to discern when lower catches were likely to occur.

While the rule of twelfths is useful for estimating when the greatest current flow will occur during a tidal cycle it is more difficult to estimate the current strength, direction, or if there are slight variations. The doppler is useful for real-time current direction and strength measurement but it cannot predict future current strengths. At present doppler current profilers are mostly used in pelagic fisheries, however if a clear link to current speed and the availability of Nephrops (and/or fish) for capture can be established their use and installation could be warranted, especially in areas with large variations in current flow or in other fisheries where target species are influenced by stronger current flow.

In addition to the observed similarities in catches from towing for shorter periods around the slack tides the codend type might also influence catches. There are potential gear effects because catch weight influences Nephrops retention because as the tow progresses the codend mesh openings increase in size and impact overall selectivity (Browne et al. 2017). The changes in selectivity are because as the catch increases there will be likely changes to the overall codend geometry and the extent to which meshes will open (O'Neill et al 2005; Masden et al 2015). Codends with more stable mesh openings (e.g., four panel, SELTRA) that are less influenced by catch increases will likely improve overall selectivity.

The similarities observed here between the 3-, 4-, and 5-hour tows are interesting and represent a potential rethink of how best to reinforce Nephrops fishing in the Irish Sea in terms of tow durations and maximising energy usage.

Overall, the concept of reducing tow times for the same catch represents a simple option to reduce overall fuel usage (carbon emissions) and wear and tear on the fishing gear. This will be further evaluated considering Nephrops sizes and different codend types to fully understand its potential.

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