JELLYFISH STRANDING OBSERVATIONS AROUND THE ISLE OF ANGLESEY IN THE SUMMER OF 2014

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Abstract. Jellyfish populations have been multiplying in an explozive manner at global level during the last decades, with major social and economic implications. These phenomena have attracted the attention of the scientific community, translated in an ever increasing number of studies, which try to understand and quantify the mechanisms behind jellyfish development, growth and dynamics. The present study proposes a relatively easy to perform and cost effective study for the monitoring of jellyfish, that can be adapted also to the Black Sea coast. The work presented in this paper focuses on the spatial and temporal distribution of five Scyphozoan jellyfish that were present at beaches along of the Isle of Anglesey, North Wales, United Kingdom during the summer of 2014. Stranded jellies were surveyed for a period of 3 months, from June 2nd until August 29th. The Scyphozoan species that were encountered during beach surveys belong to the orders Rhizostomeae: *Rhizostoma octopus* and Semaeostomeae: *Aurelia aurita, Chrysaora hysoscella, Cyanea lamarckii* and *Cyanea capillata*. Their total abundance demonstrated a fluctuating pattern during summer but a clear seasonal effect was noticed for the studied species.

Key words: jellyfish, coastal observation, Scyphozoa, beach survey

1. INTRODUCTION

Jellyfish have attracted the curiosity of scientists for a long time, but have lately received more attention due to their interactions with human activities, with important socio-economic implications (CIESM, 2001). As jellyfish outbreaks are becoming more common place, there is an urgent need to enhance our understanding of their population dynamics and distribution.

When present in high numbers, jellyfish represent a potential threat for fisheries and aquaculture. Fish mass mortality (Doyle *et al*., 2008), damaged fishing equipment (Mills, 2001; Richardson *et al*., 2009, Uye, 2008), or injured fishermen being just few of their negative implications. Jellyfish are considered to be top planktonic predators (Barz and Hirche, 2005), can have major negative impact on fish larvae (Purcell *et al*., 2007; Boero, 2013), compete for the same food resources (Purcell and Arai, 2001; Purcell *et al*., 2007), and therefore have an important impact on fish recruitment (Lynam *et al*., 2005). Jellyfish stinging capabilities represent a direct threat for humans; Jellyfish can cause injuries and fatalities in different locations around the world and create losses in tourist revenue (Richardson *et al*., 2009). Moreover, recent reports refer to power disruptions created by jellyfish clogging salt water intakes and power plants with a potential to create emergency situations for nuclear stations, significant economic losses, and threats to human lives (Purcell *et al*., 2007).

While the scale of the problems jellyfish blooms are creating is increasing, studies have revealed links between their occurrences and the factors driving them (Licandro *et al*., 2010; Mills, 2001). It was found that human activities, which are unbalancing ecosystems, such as overfishing, eutrophication and intense industrialization of coastal areas, are driving jellyfish proliferation (Mills 2001, Purcell *et al*., 2007, Pauly *et al*., 2009). Several jellyfish blooms from the last century, created great economic losses and led to a general belief that jellyfish populations are on the rise (Mills, 2001). Studies conducted around the world aiming to clarify this assumption revealed that their abundance may be influenced also by natural climate fluctuations (Lynam *et al*., 2004, 2005). The study of recurrent jellyfish outbursts as a consequence of natural climate oscillations conducted by Condon *et al*. (2012) revealed that during early 1990's global jellyfish populations were on the rise, which contributed to a global perception of continuous increasing abundances. However, this recent widespread belief has not been fully verified (Sanz-Martin *et al*., 2016). Global increase in temperatures from the previous decade has determined species which have been characteristic to warm waters to migrate and populate colder northern areas (Doyle *et al*., 2006). Long time-series observations can help to confirm if jellyfish blooms are occurring more often and they are lasting longer compared to the blooms in the past (Kogovšek *et al*., 2010; Licandro *et al*., 2010; Uye, 2008). In order to assess and quantify the real impact jellyfish have on the environment, it is important to evaluate their temporal and spatial distribution (Uye *et al*., 2003).

This study intends to propose a methodology that could be adapted to the Black Sea specific marine conditions, even though previously tested under different oceanographic conditions. It presents data on scyphozoan medusa strandings along popular tourist beaches on The Isle of Anglesey, North Wales, United Kingdom in the summer of 2014 and provides a model for an assessment of the population composition, spatial and temporal distribution.

2. MATERIALS AND METHODS

2.1. Study area

Field data was gathered over a 13-week period from June 2nd until August 29th, 2014 from six locations on the Isle of Anglesey (Fig. 1). Situated in North Wales, United Kingdom, the waters around the Isle of Anglesey are an important area for commercial fisheries, industry, and tourism. Anglesey itself covers a surface area of 714 km^2 and has more than 30 beaches and important fisheries resources. Jellyfish are assumed to be present in local waters year round but populations increase dramatically during the warm Summer months (Doyle *et al*., 2006; Houghton *et al*., 2007, Pikesley *et al*., 2014).

The sites of interest for sampling were initially selected using aerial imagery Google Earth version 7.1.2.2041**.** These selected locations were classified in 4 areas: Red Wharf Bay, Beaumaris, South Anglesey (Newborough, Aberffraw and Rhosneigr) and Holyhead (Fig. 1). During the first day of surveying each location, the start and finish positions of each beach survey was recorded using GPS. Dates of all surveys for each site are reported in Table 1.

Table 1. Dates when beach surveys were performed in Red Wharf Bay, Beaumaris, South Anglesey and Holyhead, Anglesey, North Wales, United Kingdom, in the summer of 2014.

Location	Survey Date
Red Wharf Bay	June: 4, 7, 25 July 3, 9, 16, 23, 30 August: 4, 14, 24,29
Beaumaris	June: 5, 12, 16, 24 July: 1, 7, 14, 23, 29 August: 11, 19, 27
South Anglesey	June: 2, 10, 18, 30 July: 8, 14, 21, 25, 28 August: 5, 13, 20, 27
Holyhead	June: 6, 27 July: 2, 10, 17, 24, 31

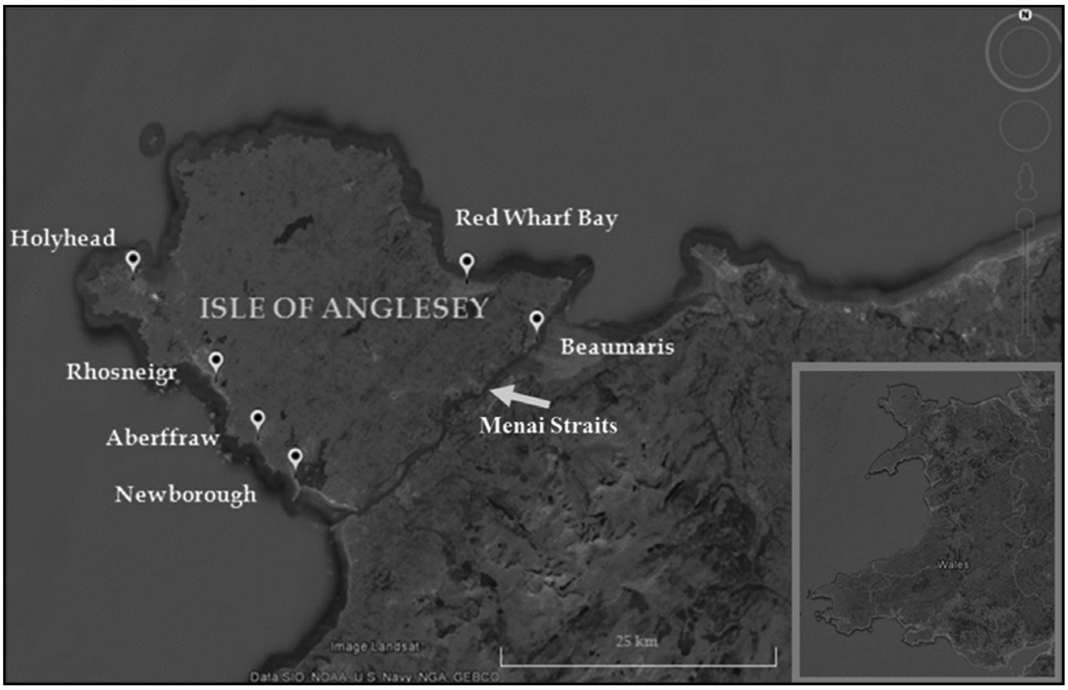


Fig. 1. Survey locations for jellyfish stranding events during the summer of 2014, Isle of Anglesey, North Wales, United Kingdom (Google Earth v.7.1.2.2041).

2.2. Sampling Strategy

The Scyphozoan medusa survey strategy chosen for current study was adapted after the method described by Doyle *et al*. (2006) where it was used for the study of the distribution of five jellyfish species across the Irish and Celtic Sea shores. This strategy was also used by Fleming *et al*. (2013) while identifying potential jellyfish blooms in Northern Ireland. In this study, the survey method consisted of walking along a designated beach transect during low tide. More specifically, walking along the water edge to the end of the transect and returning along the tide upper limit, while counting and identifying stranded medusa. In order to have consistency between surveys, this transect situated between low tide and high tide limit was chosen for each survey location. Transects start and end points were recorded and are described in Table 2.

Table 2. Transects start and end point coordinates for each beach survey location: Red Wharf Bay, Beaumaris, Newborough, Aberffraw, Rhosneigr and Holyhead.

Location	Red Wharf Bay	Beaumaris	Newborough	Aberffraw	Rhosneigr	Holyhead
Start point	53°18’26”N 4°12’23.6”W	53°15’43.2”N 4°05’27”W	53°15’43.2”N 4°25’13,3”W	53°10’52.7”N 4°28’12,5”W	53°13’19.2”N 4°31’11,7”W	53°18’13.9”N 4°36’16”W
End point	53°19’10.7”N 4°12’38.9”W	53°15’54.5”N 4°05’01.7”W	53°08’35.9”N 4°24’32”W	53°10’31.2”N 4°27’32.9”W	53°13’07.2”N 4°30’43.8”W	53°18’14.3”N 4°36’37.8”W
Length (m)	1133	600	1693	989	635	400

2.3. Species identification

The most common Scyphozoan species of the UK include *Rhizostoma octopus*, *Aurelia aurita*, *Chrysaora hysoscella*, *Cyanea capillata* and *Cyanea lamarckii*. The total number of stranded jellyfish encountered were recorded and each specimen was identified when possible to the lowest taxonomic level (Russell, 1970). Intact Cyanea specimens were identified and recorded as *Cyanea capillata* and *Cyanea lamarkii*. *Cyanea* sp. were recorded specimens that couldn’t be distinguished between *Cyanea capillata* and *Cyanea lamarckii*, two different species that occur in the area and which can occasionally have the same colour pattern (Russell, 1970). *Chrysaora hysoscella* with Type I pattern of coloration (Russell, 1970), was recorded as *Chrysaora* sp. Degraded or *undistinguishable* specimens were recorded as unidentified.

2.4. Environmental variables

Several environmental variables were recorded for each survey at each location. These included time (GMT), date, salinity and wind direction. In addition, water temperature (°C) from the Menai Straits was recorded by a HOBO temperature recorder from June 5th to August 28th. These readings were recorded every hour and a daily average was used for correlation analyses with jellyfish abundance.

2.5. Data analysis

Stranding data recorded in Holyhead was only used for total abundance evaluation and was excluded from the analysis of differences between sites and months due to a lower number of surveys performed compared to the other three areas. Data at each location was recorded as number of stranded medusa encountered per meter of beach length and standardized as total number per $100m^{-1}$. The relationship between stranded medusa abundance from different locations and/or survey months was determined using multivariate statistics and a General Linear Model. In order to determine if the presence of stranded jellyfish were influenced by time, and/or wind direction, analysis of variance (ANOVA) was also utilized. The analyses were carried out using SPSS (IBM SPSS Statistics). A test of homogeneity of variance was done prior to all analyses using Levene’s test. Where data were heterogeneous square root transformations were applied.

Water Temperature data recorded in the Menai Straits was tested for correlation with the total abundance data recorded in the four survey locations in order to investigate the possible relationship between the two variables. Spearman’s rank correlations were performed on the total abundance and on the abundance of each species with water temperature for every survey.

3. RESULTS

Between June 2nd and August 29th, five different Scyphozoan species were encountered during beach surveys. These included Rhizostomeae: *Rhizostoma octopus* (Macri, 1778) and Semaeostomeae: *Chrysaora hysoscella* (Linnaeus, 1758), *Cyanea capillata* (Linnaeus, 1758), *Cyanea lamarckii* (Péron & Leseur, 1810) and *Aurelia aurita* (Linnaeus, 1758). *Chrysaora* sp. and *Cyanea* sp. were only identified at genus level, unrecognizable or degraded jellyfish were recorded as unidentified. The total number of stranded jellyfish observed was 364 with a mean abundance of 1.18 ± 1.58 ind. $100m^{-1}$. The overall abundance of encountered stranded jellyfish demonstrated a fluctuating pattern during summer and ranged from 0 ind. $100m^{-1}$ on June 2nd and 18th, July 8th and 9th and August 11th and 14th to 7ind. $100m^{-1}$ on June 16th (Fig. 2a). There was no significant difference between the total abundance recorded in Red Wharf Bay, Beaumaris and South Anglesey (GLM, F1,2=*1.256, P=0.374*) or between survey months (GLM, *F1,2=2.209, P=0.224*).

Aurelia aurita (0.21 ±0.52 ind. $100m^{-1}$) was the most abundant species with 17.94% of the total number of jellyfish recorded per 100m of beach length in the four locations, followed by *Chrysaora hysoscella* (0.18±0.43 ind. $100m^{-1}$) 15.27%, *Cyanea lamarckii* (0.16±0.62 ind. $100m^{-1}$) 13.82%, *Cyanea capillata (*0.13±0.32 ind. $100m^{-1}$) 11.24%, *Chrysaora* sp. (0.1±0.24 ind. $100m^{-1}$) 8.41%, *Cyanea* sp. (0.04±0.12 ind. $100m^{-1}$) 3.64%, and *Rhizostoma octopus* (0.02±0.05 ind. $100m^{-1}$) 1.73%. 27.94% of the total number of jellyfish recorded per 100m of beach length remained unidentified (0,32±1,13 ind. $100m^{-1}$) (Fig. 3, Table 3).

Out of the 43 surveys performed in the four survey areas, 21 were conducted in the morning and 22 afternoon depending on tide times. Analysis of variance showed no significant difference between the abundance (ind. $100m^{-1}$) of stranded medusa observed between the two times of day (ANOVA factor time, *F1,42=0, P=0.333*).

Out of the 43 surveys performed in the four survey areas, 27 surveys were performed while there was no wind or the wind was blowing parallel with the shore line, 11 Surveys were performed while the wind was blowing from shore direction towards the sea and 5 while the wind was blowing from offshore towards shore. The analysis of variance, showed that the wind direction (onshore/offshore) did not

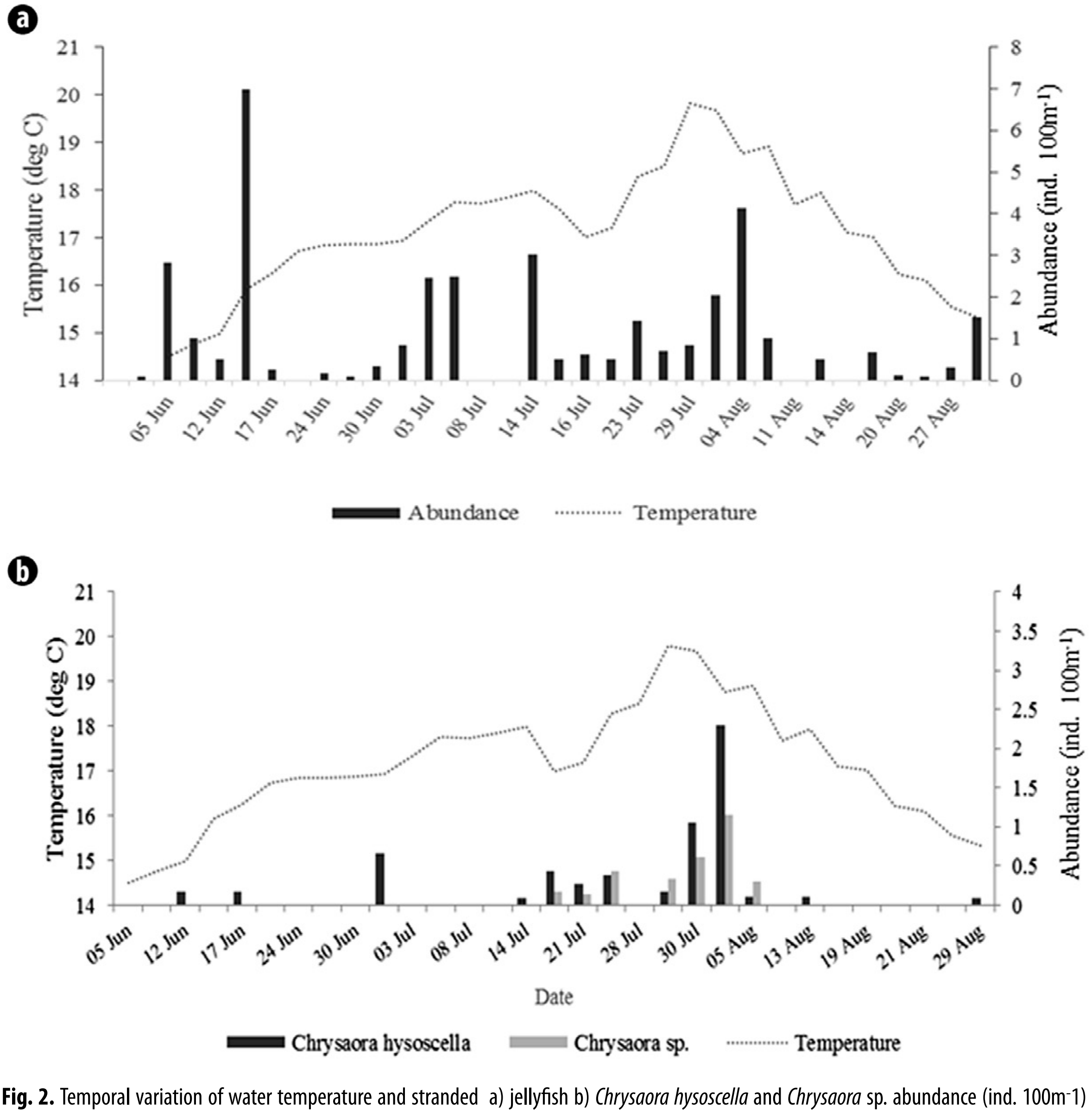


Fig. 2. Temporal variation of water temperature and stranded a) jellyfish b) *Chrysaora hysoscella* and *Chrysaora* sp. abundance (ind. 100m-1) observed across four areas from Anglesey, North Wales, United Kingdom, during the summer of 2014.

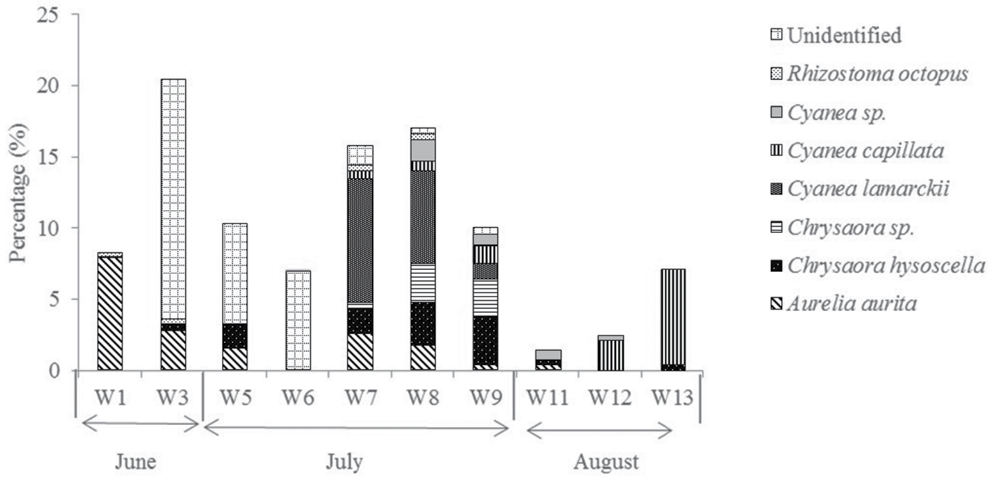


Fig. 3. Temporal variation of stranded jellyfish abundance observed across four areas from Anglesey, North Wales, United Kingdom, during the three months of survey: June (W1- W3), July (W5 - W9) and August (W11 -W13) 2014, expressed as percentage of each species from the total number of stranded jellyfish recorded per $100m^{-1}$.

Table 3. Jellyfish strandings from June 2nd to August 29th, across four areas from Anglesey, North Wales, United Kingdom, showing the total number of individuals recorded, total number of stranding events and the mean jellyfish abundance described as number of jellyfish per 100m of beach length ±SD.

Species	Nr of individuals	Nr of events	Nr of indiv. 100m-1
Aurelia aurita	62	14	0.21 ±0.52
Chrysaora hysoscella	64	13	0.18±0.43
Chrysaora sp	35	7	0.1±0.24
Cyanea lamarckii	53	5	0.16±0.62
Cyanea capillata	43	10	0.13±0.32
Cyanea sp	14	4	0.04±0.12
Rhizostoma octopus	6	5	0.02±0.05
Unidentified	87	7	0,32±1,13

significantly influence abundance (ind. $100m^{-1}$) in any particular survey day during the study period (ANOVA factor wind direction: *F1,15=0.958, P=0.344*).

The Menai Strait water temperature recorded from HOBO device as a daily average between June 5th and August 28th ranged from 14.49°C on June 5th to 19.8°C July 23rd. *Chrysaora hysoscella* and *Chrysaora* sp. were the only species with a positive correlation with water temperature (Spearman's rank, *Chh rho=0.400, P=0.019; Ch*sp *rho=0.604, P=0.000*) (Fig. 2b, Table 4) showing a gradual increase in abundance from July 14th (*Chh* = 0.08 ind. $100m^{-1}$; *Ch*sp = 0 ind. 100^{-1}) until August 4th (*Chh* = 2.29 ind. 100m-1; *Ch*sp = 1.48 ind. 100^{-1}) while water temperature increased from 17.98°C to 19.67°C. No correlation was found between total strandings recorded in the four locations and average daily water temperature for each survey date (Table 4).

3.1. Temporal distribution

Aurelia aurita was observed in three of the four beach areas, Red Wharf Bay, Beaumaris and South Anglesey. Its abundance exposed a fluctuating pattern with 2 peaks in the first week (2.83 ind. $100m^{-1}$) and one in the seventh week of the survey (1.37 ind. $100m^{-1}$) (Fig. 4a). After week 7, abundance decreased continuously until week 11 when it was sighted for the last time (Aberffraw, August 13th). Overall, between the three areas, Beaumaris had the highest average abundance of *Aurelia aurita* per 100m of beach length (0.35 ind. $100m^{-1}$) followed by South Anglesey (0.14 ind. $100m^{-1}$) and Red Wharf Bay (0.09 ind. $100m^{-1}$).

Chrysaora hysoscella and *Chrysaora* sp were first observed in Beaumaris June 12th and reached a maximum abundance of 3.44 ind. $100m^{-1}$ in Red Wharf Bay on August 4th. Both were observed in higher numbers during the 7th, 8th and 9th week

Table 4. Spearman's rank correlations of total stranded jellyfish abundance (ind. 100m^{-1}) recorded in four areas from Anglesey, North Wales, United Kingdom, during the summer of 2014, with corresponding average daily water temperature recorded in the Menai Straits.

	Spearman's Rank	
Species	**Spearman's rho correlation coefficient**	**Sig.**
Aurelia aurita	-0.175	0.323
Chrysaora hysoscella	0.400	0.019
Chrysaora sp.	0.604	0.000
Cyanea lamarckii	0.241	0.171
Cyanea capillata	0.192	0.277
Cyanea sp.	0.242	0.168
Rhizostoma octopus	-0.023	0.897
Unidentified sp.	**0.337**	**0.051**
Total abundance	**0.184**	**0.297**

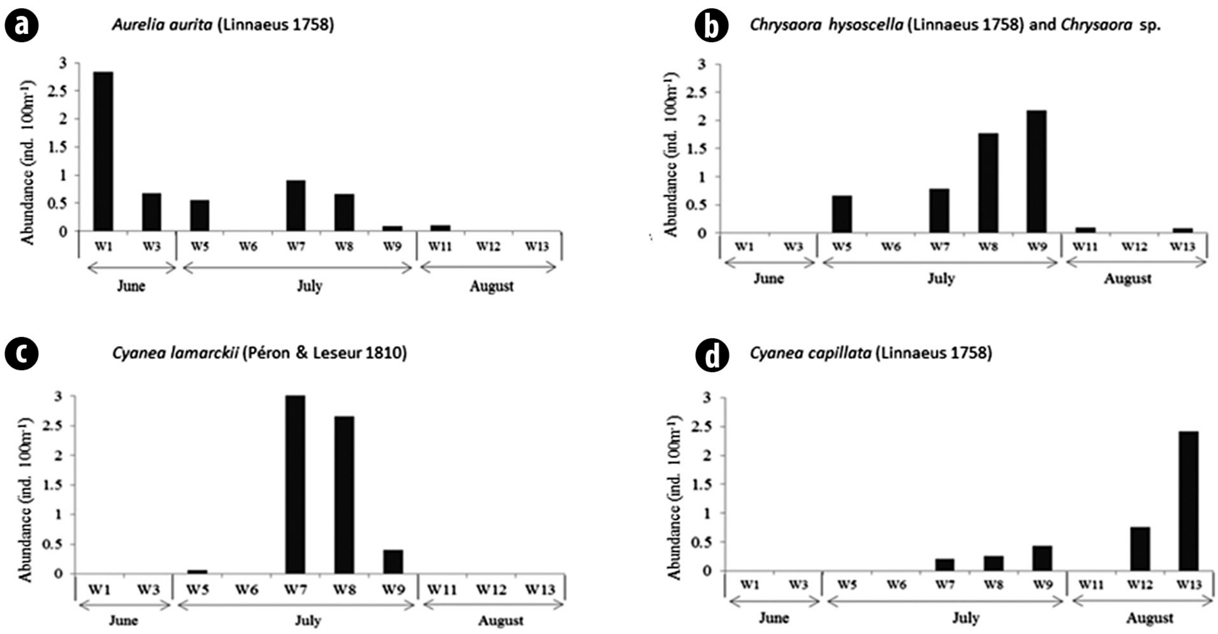


Fig. 4. Observations of **a**) *Aurelia aurita* **b**) *Chrysaora hysoscella* and *Chrysaora* sp. **c**) *Cyanea lamarckii* **d**) *Cyanea capillata* expressed as total number of stranded individuals observed per 100m of beach length by week of survey, in the three beaches they were present (Red Wharf Bay, Beaumaris, South Anglesey) of the Isle of Anglesey, North Wales, United Kingdom, during the summer of 2014.

of survey (Fig. 4b) when their abundance increased from 0.25 ind. 100m^{-1} to 3.31ind. 100m^{-1}. Overall, between the four areas, *Chrysaora hysoscella* and *Chrysaora* sp. were most abundant per 100m of beach length in Red Wharf Bay (0.34 ind. 100m^{-1}) followed by Beaumaris (0.20 ind. 100m^{-1}) and South Anglesey (0.02 ind. 100m^{-1}). One *Chrysaora hysoscella* specimen was recorded in Holyhead on July 17th.

During the survey period, *Cyanea lamarckii* was observed stranded in South Anglesey, between the 7th and the 9th week of survey, with one individual observed in Newborough on June 30th and zero sightings in weeks 1, 3, 6, 11, 12 and 13 (Fig. 4c). Maximum abundance reached was 3.13 ind. 100m^{-1}, on July 14th in Aberffraw. *Cyanea lamarckii* was completely absent from Red Wharf Bay and Beaumaris surveys, and only one specimen was recorded in Holyhead on July 17th.

Cyanea capillata was absent from the first 6 weeks of survey but reached maximum abundances towards the end of the study period, in week 13 (2.4 ind. 100m^{-1}) (Fig. 4d). It appeared for the first time on July 14th in South Anglesey (0.20 ind. 100m^{-1}) and its abundance continuously increased towards the end of the summer. Overall, between the four areas, Beaumaris had the highest abundance of *Cyanea capillata* per 100m of beach length (0.29 ind. 100m^{-1}) followed by Red Wharf Bay (0.20 ind. 100^{-1}) and South Anglesey (0.02ind.

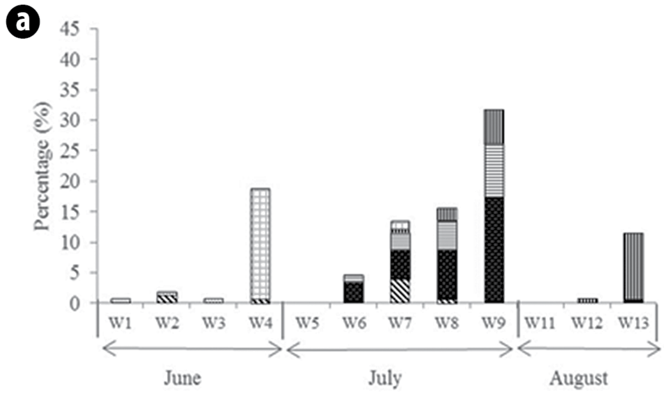
100m^{-1}). *Cyanea capillata* was completely absent from the surveys performed in Holyhead.

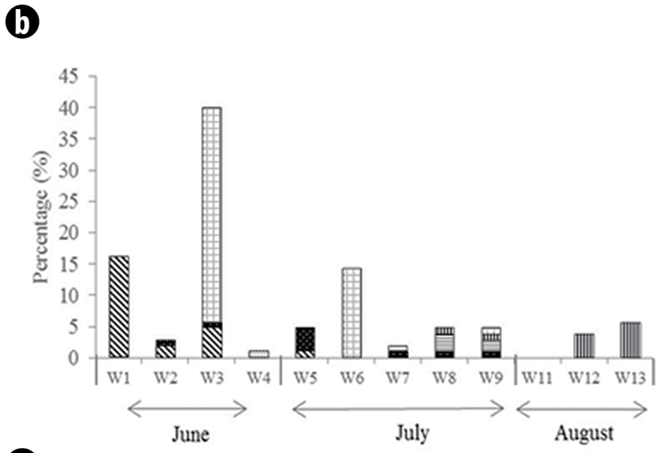
3.2. Spatial distribution

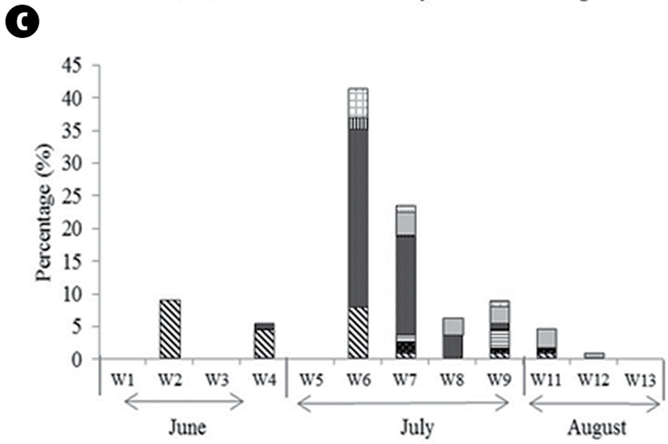
The total number of stranded jellyfish observed in Red Wharf Bay was 148, ranging from 0 on July 9th and August 14th to 47 on August 4th with a mean abundance of 1.09 ± 1.32 ind. 100m^{-1}. June, July and August were each characterized by the higher abundance of certain species; *Rhizostoma octopus* was dominant in June with 75%, *Chrysaora hysoscella* and *Chrysaora* sp. in July with 47.44% and *Cyanea capillata* in August with 38.46% of all sightings recorded in that particular month (Fig. 5a). Overall, during the three months, the jellyfish community from Red Wharf Bay was composed of: 34% *Chrysaora hysoscella*, 20% *Cyanea capillata*, 18% *Chrysaora* sp., 7% *Aurelia aurita,* 2% *Rhizostoma octopus* and 20% remained unidentified.

The total number of stranded jellyfish observed in Beaumaris was 105, ranging from 0 on August 11 to 42 on June 16th with a mean abundance of 1.46 ± 1.94 ind. 100m^{-1}. June, July and August were each characterized by the higher abundance of certain species; *Aurelia aurita* was dominant in June with 36.76%, *Chrysaora hysoscella* and *Chrysaora* sp in July with 29.62% of all sightings of that particular month. *Cyanea capillata* was the only species observed over the 3 weeks length in August (Fig. 5b). Overall, during the three months, the Beaumaris strandings were composed of: 23.8% *Aurelia aurita*, 11.43% *Cyanea capillata*, 8.57% *Chrysaora hysoscella*, 4.76% *Chrysaora* sp. 1.9% *Rhizostoma octopus* and 49.52% remained unidentified.

The total number of strandings observed along the beaches in South Anglesey (Newborough, Aberffraw, and Rhosneiger) was 111, ranging from 0 on June 2nd and 18th, July 8th and August 27th to 46 on July 18th and with a mean abundance of 11.86 ± 1.58 ind. 100m^{-1}. South Anglesey area was characterized in June by the high abundance of *Aurelia aurita* with 93% in July by *Cyanea lamarkii* with 70% and in August by *Cyanea* sp. with 43% of all sightings, however the numbers of stranded jellyfish observed in June and August compared to July were very low (Fig. 5c). Overall during the three months, the South Anglesey strandings were composed of: 47.74% *Cyanea lamarckii,* 24.32% *Aurelia aurita*, 12.61% *Cyanea sp.*, 3.6% *Chrysaora hysoscella*, 3.6% *Chrysaora* sp., 1.80% *Cyanea capillata,* 0.9% *Rhizostoma octopus* and 5.4% remained unidentified.







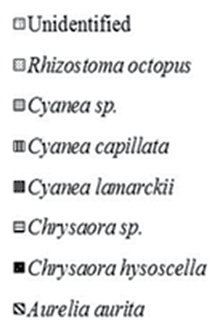


Fig. 5. Temporal variation in stranded jellyfish abundance observed in **a**) Red Wharf Bay, **b**) Beaumaris, **c**) South Anglesey, North Wales, United Kingdom, during the three months of survey: June (W1- W3), July (W5 - W9) and August (W11 -W13) 2014, expressed as percentage of each species from the total number of stranded jellyfish recorded per 100m^{-1}.

During the survey period only 2 stranded jellyfish were encountered, one *Chrysaora hysoscella* and one *Cyanea lamarckii*, both on July 17th.

4. DISCUSSION

The population dynamics of the jellyfish around UK coastal waters is poorly understood. This study evaluated the spatial distribution and sequence of occurrence of five Scyphozoan jellyfish species that appeared around the Isle of Anglesey, North Wales in the summer of 2014. During the three months of the survey, five Scyphozoan medusa species (*Rhizostoma octopus, Aurelia aurita, Chrysaora hysoscella, Cyanea lamarckii* and *Cyanea capillata)* were observed. Water temperature did not appear to be directly shaping jellyfish stranding occurences or abundance. However, jellyfish distribution and pattern of occurrence were similar to the ones presented in studies conducted over a longer period of time and at a larger scale in the Irish Sea by Doyle *et al*. (2006) and Houghton *et al*. (2007), with *Rhizostoma octopus* strandings observed in low numbers during the whole survey, and the other four exposing a monthly pattern during summer. These findings can be explained by the fact that *Rhizostoma octopus* over-winters in the area (Russell, 1970) while the other four species were completing their reproduction cycle and washing ashore at different times during summer.

Aurelia aurita was the first group observed on the beaches, followed by *Cyanea lamarckii* and *Chrysaora hysoscella*. All three species were found mostly in June and July. *Cyanea capillata* appeared after the first half of July and was still present in the water column at the end of August. In each month a certain species was observed to be more abundant compared to the others.

Aurelia aurita was the dominant species in the month of June. It recorded maximum abundances in the first week of survey, followed by a decreasing oscillating trend and disappeared completely from all the surveys by the second week of August. The life cycles of this species are relatively well known (Van der Veer and Oorthuysen, 1985), compared to other scyphozoan species and it exposes a homogeneity in its year to year behaviour similar in different locations. *Aurelia aurita* have ephyrae that appear in spring (Van der Veer and Oorthuysen, 1985), become mature in the summer months and die in autumn. This pattern is reflected in their seasonality of strandings observed in the present study and described in other studies by Doyle *et al*. (2006) that observed *Aurelia aurita* washed ashore from April until September with most of the individuals recorded during summer, by Van der Veer and Oorthuysen (1985) recorded the first *Aurelia aurita* in hauls sampled in Western Wadden Sea in April and noticed an increase in abundance until summer, by Pikesley *et al*. (2014), in the analysis of pubic sightings of Cnidarians from the United Kingdom coastal waters and by Love (unpublished data) that recorded and analysed jellyfish abundance in water column while using time-lapse photography in the Menai Straits, North Wales, United Kingdom during the summer of 2014.

The most abundant species in July was *Chrysaora hysoscella*. Known to be a southern temperate species (Russell, 1970), it reached its highest abundance at the end of July and vanished completely by the end of August. This pattern was observed by Houghton *et al*. (2007) and is considered characteristic for *Chrysaora hysoscella* in the Irish Sea by Doyle *et al*. (2006). Taking advantage of its tolerance to lower temperatures (Russell, 1970), *Cyanea capillata* was the dominant species in the last month of survey. Its abundance continuously increased while water temperature decreased from 19.8°C on July 23rd to 15.32°C on August 29th and it was still observed in the area in September. The sequence of occurence followed by *Aurelia aurita* and *Cyanea capillata* were observed and discussed by Grondahl (1988), Houghton *et al*. (2007), and Pikesley *et al*. (2014). Their results suggested as main contributor the reproductive cycles of each species that is influenced by their interspecific competition. *Aurelia aurita* and *Cyanea capillata* share a similar ecological niche (Grondahl, 1988), use the same food sources (Russell, 1970), and compete for space from the first life stages. Completing their reproduction cycles earlier in the year (Van der Veer and Oorthuysen, 1985), *Aurelia aurita* polyps feed on *Cyanea capillata* larvae (Grondahl, 1988), and occupy their potential settling space. However, when optimum food demand is met, and with the potential to grow fast (Van der Veer and Oorthuysen, 1985), *Aurelia aurita* ephyrae transform into medusa, that become potential prey for mature *Cyanea capillata i*n the summer (Hansson, 1997; Bamstedt *et al*., 1997). This can explain the why the two species are visible in certain periods of the year and why there is a time-lapse between their sequence of occurrence. Pikesley *et al*. (2014) noticed that there was a clear spatial distribution of *Chrysaora hysoscella* and *Cyanea capillata.* Most of *Chrysaora* specimens were sighted along the south and the west coast of the UK and *Cyanea capillata* in north. In the present study, the two species were found in the same locations suggesting either that the studied area was too small to make such a spatial difference or, that 2014 was warmer than previous years. The first suggested explanation can be contradicted by the fact that the fifth species encountered during surveys, *Cyanea lamarckii*, appeared stranded exclusively in South Anglesey representing, as described by Russell (1970), a characteristic south boreal species that can't tolerate colder northern waters. *Cyanea lamarckii*'s clear spatial distribution difference from the northern species *Cyanea capillata* was evident in other studies (Russell, 1970). Doyle *et al*. (2006) found *Cyanea capillata* most abundant in the north part of the Irish Sea and *Cyanea lamarckii* in south; Pikesley *et al*. (2014) recorded most of the *Cyanea lamarckii* sightings along the south west and east coast of the United Kingdom and *Cyanea capillata* in north.

Influenced by a possible warmer summer in 2014, *Chrysaora hysoscella* may have stranded in northern locations because this species has less specific habitat preferences

(Houghton *et al*., 2006). *Chrysaora hysoscella* is a carnivorous species which, among other prey, feeds on fish juveniles (Flynn and Gibbons, 2007) therefore together with a possible tolerance to this year's temperature it appeared in Red Wharf Bay, an important flat fish nursery area for Anglesey (Macer, 1967). Other Cnidarians species which occasionally occur in UK coastal waters, and have been mentioned in other studies performed in the area (Doyle *et al*., 2008, Pikesley *et al*., 2014), include *Pelagia noctiluca*, *Vellea vellea* and *Phisalia phisalis*. These species were absent from this study, probably due to the short length of the survey.

The beach stranding survey method proved to be applicable for the scale of the current research and is an important step in the understanding of jellyfish population dynamics around the United Kingdom. Although beach surveys may not reflect actual jellyfish numbers offshore, a concurrent evaluation of jellyfish abundance in the water column over the same period of time would be useful in the future to give a comparative estimation of spatial and temporal distribution. Jellyfish stranding surveys can reveal species seasonality and patterns of occurrence and is a useful tool for observing these patterns over time. While evaluating the results of this study it should be taken in account that jellyfish strandings are directly influenced by currents dynamics and coastal degree of exposure therefore different patterns can appear in different areas. In order to gather more accurate estimations of abundance, Doyle *et al*., (2006) suggested that this method should be used together with other survey techniques that can evaluate the presence of jellyfish in the water column. Fundamental and targeted research conducted at any scale is an important step towards a global understanding of the distribution and behaviour of these important pelagic predators of marine ecosystems (Barz and Hirche, 2005, Purcell *et al*., 2007, Richardson *et al*., 2009).

As a final conclusion, we consider that the methodology presented in this study could be easily adapted and expanded along the Black Sea coast, by taking into account the specificities of the euxinic basin. In the Black Sea the astronomic tides are irrelevant, whilst wind circulation plays a significant role (ex. Stanica *et al*., 2007). Hence, we suggest that the same measurements / countings of stranded jellyfish are made in well determined beach areas, immediately after storms (max 24 hours after the end of storms). The high tide limit is to be replaced by the limit of storm waves / storm berm crests, while the low tide mark could be the shoreline position from the period of the measurements. Other parameters need to be recorded – both before, as well as during the field survey: water temperature in the superficial layer, water level at the closest maregraph, wind velocities and directions (critical role in understanding the appearance or not of upwelling phenomena).Selection of beach perimetres where this method should be tested is also critical, as the Black Sea water and related plankton circulation is influenced also by the interaction with main rivers (Stanev and Staneva, 2000).This is why beach perimetres of the same dimensions with those introduced in this study should be selected both along low lying coasts near river mouths (e.g. the Danube Delta coast) as well as along pocket beaches and beaches with less sediment longitudinally transported by waves and currents.

This proposal by no means wishes to replace the existing methods used nowadays in the Black Sea for jellyfish monitoring (Boero, 2013), but to add to them, as an extra method to collect data – critically needed to better understand their populations dynamics and numbers.

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