Bottlenose dolphins in Connemara and Mayo 2008-2009.

Movement patterns between two coastal areas in the west of Ireland.

Report to the National Parks and Wildlife Service
Department of the Environment, Heritage and Local Government
November 2010

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Abstract

A total of 46 dedicated and 33 opportunistic boat-based surveys were conducted in the coastal waters off Connemara and Mayo in 2008 and 2009, resulting in 31 encounters with groups of bottlenose dolphins. Between the two coastal areas, a total of 201 photo-identification records of dolphins were obtained, resulting in a minimum number of 177 individual dolphins identified. More dolphins were observed in northwest Mayo (n=179, 89% of the total number of identifications) than in Connemara (n=92, 46%).

A total of 19 individuals (10.7%) were resighted in northwest Mayo between 2008 and 2009. The matching analysis of the Mayo photo-ID catalogue with the Connemara catalogue identified 70 individual dolphins that were sighted in both locations, representing 39.5% of the Mayo and 76.1% of the Connemara catalogues respectively. Twelve animals were recorded in both years in Mayo and in Connemara in 2009.

The discovery curve for the combined catalogues showed a decline in the rate at which new dolphins were being added to the catalogue, suggesting that a substantial part of the total population occurring in these coastal areas in the summer of 2008-2009 has been identified. The large number of resightings, within groups and between both coastal sites, in combination with similar patterns of mark severity and age-class composition, strongly suggests that these dolphins all belong to the same social community.

The mean sighting frequency per individual was higher in Mayo in 2009 (2.6 ± 1.4 SD) compared to frequencies recorded in Mayo in 2008 (1.2 ±1.2 SD) and Connemara (1.6 ± 1.0 SD). Individual movement patterns detected between both sites were identified as: (a) no movement (n=131); (b) single, one-way movements between the sites (n=24); (c), return journeys (n=36); or (d) a return journey followed by another one-way journey, described as the single-return move (n=7).

Twenty-nine of the 31 encounters were recorded within 1-2 km off the coast, indicating that these inshore waters form an important habitat for these coastal communities. Two encounters with groups recorded in Mayo in September 2008 may belong to an offshore community. None of the dolphins encountered on these two occasions were resightings of known individuals from either coastal study area, and both groups consisted of dolphins of which a large proportion carried significant markings on the dorsal fin.

1 Introduction

1.1 The bottlenose dolphin

The Common bottlenose dolphin (*Tursiops truncatus*) has a worldwide distribution across a wide range of habitats throughout temperate and tropical waters (Leatherwood & Reeves 1983). Its occurrence in coastal waters enables land-based monitoring and makes it one of the best studied cetacean species in the world. Despite their potential for long-distance movements, intraspecific differences in behaviour, site fidelity and ranging patterns have been described for geographically distinct populations (Würsig & Würsig 1977; Wells 1986; Bearzi *et al.* 1997; Wilson *et al.* 1999).

Individual bottlenose dolphins can be recognised from their natural markings using photography (Würsig & Würsig 1977). Photo-identification of bottlenose dolphins relies on marks and nicks which the animal develops on its dorsal fins and flanks through social interaction with other dolphins and through interactions with human activities (Würsig & Würsig 1977). Photo-identification can be used to study social structure and population size, and to investigate movement patterns and habitat use by individual animals.

Cetacean species that inhabit coastal areas are likely to be affected by human activities (Wells *et al.* 1994). Anthropogenic effects may be of particular concern for small coastal communities (Stockin *et al.* 2006), such as bottlenose dolphins along the west coast of Ireland. Recent concerns about effects of human activities on the Irish marine environment, especially the development of offshore hydrocarbon exploration, has induced the initiation of a series of research projects studying the distribution and abundance of cetaceans in Irish inshore, as well as offshore waters (Ó Cadhla *et al.* 2003, 2004; Wall *et al.* 2006; Roycroft *et al.* 2007; Visser *et al.* 2009).

1.2 Protection and conservation status

All cetacean species occurring in Irish waters are protected under the 1976 Wildlife Act. In 1991, the Irish Economic Exclusion Zone (EEZ) was declared a whale and dolphin sanctuary by the Irish government. Under European law, the bottlenose dolphin is considered a priority species for conservation in European waters (Annex II of the European Union Habitats Directive [92/43/EEC]). The EU Habitats Directive requires countries to designate Special Areas of Conservation (SAC), based on i) population parameters ii) habitat vulnerability iii)

species' range and iv) species' conservation value. Given the protection status of bottlenose dolphins, it is important that any long- or short-term management decisions impacting on either the dolphins or their habitat are made with the support of detailed and current scientific information (Rogan & Berrow 1995).

1.3 Bottlenose dolphins in Ireland

Bottlenose dolphins are commonly sighted in Irish coastal waters (see www.iwdg.ie). Surveys to date have primarily focused on the resident population of bottlenose dolphins in the Shannon Estuary (Ingram 2000; Ingram & Rogan 2002, 2003; Englund *et al.* 2007, 2008). Outside the Shannon estuary, dedicated studies have been conducted in several coastal sites along the south and west coast (Ingram *et al.* 2001, 2003; Ingram & Rogan, 2003; Englund *et al.* 2007, 2008) and along the northwest coast of Mayo (Ó Cadhla *et al.* 2003; Englund *et al.* 2006; Coleman *et al.* 2008; Oudejans *et al.* 2008; Visser *et al.* 2009). More recently, projects have been carried out that focused on the genetic structure of bottlenose dolphin populations inside as well as outside the Shannon Estuary (Miller *et al.* 2009; Mirimin *et al.* in press).

These studies have shown that 1) bottlenose dolphins occur year-round within Irish coastal waters, 2) individual bottlenose dolphins conduct long-distance journeys (O'Brien *et al.* 2009), and 3) the bottlenose dolphin population in the Shannon Estuary form a distinct, resident population (Ingram 2000, Englund *et al.* 2007, 2008). However, the overlap in habitat use and ranging patterns of the bottlenose dolphins encountered at different locations along the Irish coast remains unclear.

1.4 Project aims and objectives

Here we combine the results of two studies on bottlenose dolphins in the coastal waters off Connemara (Ingram *et al.* 2009) and northwest Mayo (Oudejans *et al.* 2008), to gain insight into the population size, site fidelity and movement patterns of the bottlenose dolphins within and between these two locations.
We aim to:

- Evaluate whether the bottlenose dolphins off Connemara and Mayo belong to the same social community, or form two distinctive communities.
- Examine individual ranging patterns of bottlenose dolphins between two coastal areas along the Irish west coast.

2 Methods

2.1 Boat-based surveys

Two types of boat-based surveys were conducted in the coastal waters off Connemara and Mayo in 2008-09. In Connemara dedicated boat surveys were conducted using a 6m rigid hull inflatable (RIB). The surveys followed two standardised routes covering the waters between Clare Island and Mannin Bay (Fig. 1, see Ingram *et al.* 2009 for a detailed map). In Mayo, dedicated surveys were conducted between Achill Island and Downpatrick Head using a 38 ft aluminium vessel operated by Dúlra Nature Tours containing a 4.5m high observation platform (Fig. 1). Survey speed was maintained at approximately 20 km per hour for the duration of the surveys, with a reduction in speed during encounters with dolphins.

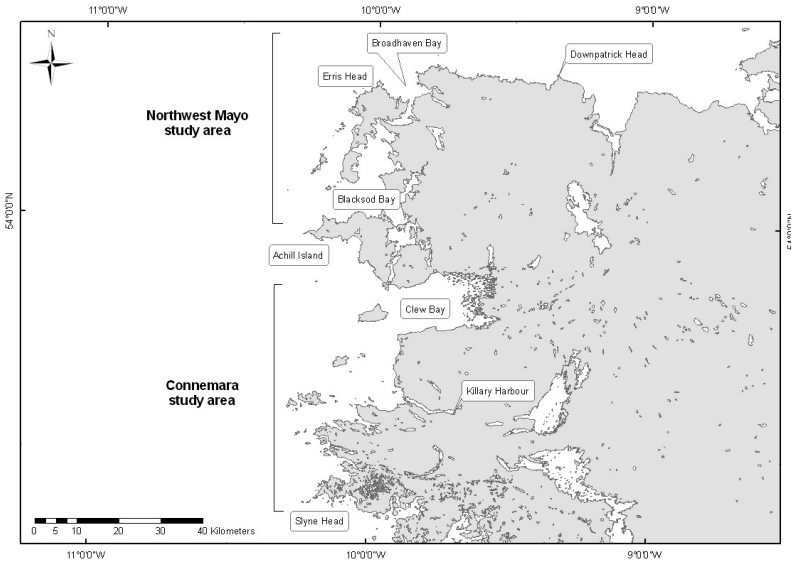

Figure 1. The study areas off northwest Mayo covering the coastal waters between Achill Island and Downpatrick Head, Co Mayo, and off Connemara, covering the coastal waters between Slyne Head Co. Galway, and Clew Bay, Co. Mayo.

During dedicated surveys the observer(s) would scan 180° in front of the vessel, from one side of the boat, to the other side (90°left - 90° right). If there were two observers present, the 180° field of view was divided into 2 x 90° per observer. Vessel position, speed and direction were recorded automatically using a GPS handheld device. For each sighting, the distance and bearing of the animal(s) relative to the research vessel were recorded. Dedicated surveys were conducted in Beaufort sea-states <4, with suitable ambient light and swell conditions, in order to minimise the effect of weather and sea conditions on the probability of sighting dolphins and obtaining high quality photographs. If weather conditions deteriorated during a survey, the survey was abandoned.

In northwest Mayo, opportunistic surveys were conducted in response to reports of bottlenose dolphins in the area, and as part of marine ecotourism activities. These surveys did not follow a fixed survey route or constant speed. In addition, four land-based sightings were included in the Mayo catalogue. The close proximity of the dolphins to the coast (<25m) allowed to conduct photo-id from land during these encounters. Because the Connemara surveys also covered parts of the coastal waters off Mayo, south of Achill Island, *Connemara* hereafter refers to all sightings and survey effort recorded south of Achill Island, and *Mayo* hereafter refers to the northwest Mayo study area, north of Achill Island (Fig. 1).

A bottlenose dolphin school was defined 'as all dolphins within a 100m radius of each other' (Irvine *et al.* 1981) and hereafter encounters refer to periods of data collection whilst with dolphin schools. When sighted, dolphins were approached slowly and carefully, minimising speed and direction changes to reduce disturbance, and attempts were made to photograph all school members. GPS coordinates were recorded at the beginning of encounters. The number of animals present was estimated and the presence of calves and neonates was recorded. The behaviour of dolphins around the survey vessel (including any signs of stress or evasive behaviours) was monitored and recorded. If strong avoidance behaviours were observed, the survey protocol was suspended and approaches within 50m of dolphins were avoided for 5 minutes. If such avoidance behaviours were repeated on resuming the approach, the encounter was terminated. Dolphin identification photos were taken perpendicular to the dorsal fin as much as possible and within a distance of <20m of the animal, using an digital SLR camera (Connemara: Canon EOS 1DS mark II and 70-200mm f2.8 telephoto zoom lens; Mayo: Nikon D70 and 70-300mm f4.5 telephoto zoom lens). Each encounter continued until all animals had been photographed, preferably from both sides, or until the school was lost. Following the end of an encounter the survey route was resumed.

2.2 Photograph analysis

Digital photographs of dolphins were processed following methods described by Englund and colleagues (2007). The quality of the photographs was scored from 1 to 4 with no consideration to the degree of marking of the individual (Table 1). Each photographed individual was assigned one of three grades of mark-severity (Plate 1). Selected photographs were then matched against the catalogue archive of dolphins photographed during previous encounters. If a match could not be found in the archive, the animal was given a new catalogue number and subsequently added to the catalogue as a new identification.

Table 1. *Scoring criteria for the identification photographs (independent of the degree of marking of individual dolphins).*

Grade	Criteria
1.	Well lit & focused photo taken perpendicular to the dorsal fin at close range
2.	More distant & less well lit or slightly angled photo of the fin
3.	Poorly lit or to some extent out of focus photo, or photo taken at an acute angle to the fin
4.	Poorly focused, backlit or angled photo taken at long distances to the dolphin

2.3 Severity of markings

Individual bottlenose dolphins can be identified using their natural markings. These marks mostly consist of scars and nicks from interactions with conspecifics and they include permanent marks, such as deep nicks on the trailing edge of the dorsal fin, as well as other types of marks, which may or may not be permanent, such as fin shape, scratches or skin lesions on the dorsal fin, flank or peduncle. "Permanent" marks may last for several years, which allow the long-term identification of an individual dolphin. "Temporary" markings, such as tooth rakes and small nicks may fade and heal within a relatively short period of time.

Plate 1*. Examples of bottlenose dolphin fins showing the three grades of mark severity following Ingram and colleagues (2009). Left image: Grade 1: significant fin damage or deep scarring that is considered permanent; Middle image: Grade 2: temporary, marking that consist of deep tooth rakes and lesions, with only minor cuts present; Right image: Grade 3: superficial rakes and lesions.*

2.4 Matching catalogues

Since it was not always possible to match left and right identifications and since photographs were frequently only obtained from one side, there were effectively two separate catalogues of 'right-side' and 'left-side' identifications for both study areas. The Connemara catalogue,

developed and maintained by UCC and the Mayo catalogue, maintained by M. Oudejans, were compared with each other, to search for matches between individuals identified in both areas. The data for all matched and unmatched individuals were then combined into a single database.

2.5 Analysis of group structure

The identified dolphins were categorised into four age-classes, Neonate, Calf, Adult, or Not determined. Neonates (<1 year old) were identified by the presence of foetal folds or lines and their very close association with a larger animal assumed to be the mother. Calves (i.e. 1+ year) were identified due to their smaller size, the absence of significant markings, and their close association with a larger animal assumed to be their mother. Adult animals were identified based on their body size. A number of dolphins with grade 2 or grade 3 marks were classed as adults since they were noted as likely females based on their association with a calf or neonate. A large number of dolphins could not be assigned to an age class with certainty. Many of these animals had physical characteristics of the stages of sub-adult. Because a number of dolphins identified as potential adult females shared similar physical characteristics (i.e. size and markings) with animals for which age-class could not be determined, the discrimination between sub-adult and adult was often uncertain. Because calves and neonates lack permanent markings, their identification depends on temporal scars, toothrakes or skin lesions, which decreases the chance of resightings between years. Therefore, to a large extent, this depends on the presence of, and close association with, a large adult dolphin, which is commonly assumed to be the mother. During surveys in Mayo, when in most cases one dedicated observer was aboard, the priority was given to collect photo-id data and to try to photograph each member of the group, rather than collect information on the social group structure.

3 Results

3.1 Survey effort

A total of 79 surveys were conducted between June 2008 and September 2009 off Mayo and Connemara. 21 dedicated surveys were conducted in the coastal waters of Connemara, of which four occurred in September 2008 and 17 took place between June and September 2009. All surveys in Connemara followed fixed survey routes, with the exception of one survey conducted on September 16th 2009, which was conducted in the waters immediately to the south and east of Slyne Head in response to a sighting report of bottlenose dolphins in that area in the preceding days (Ingram *et al.* 2009) (Fig.2, Appendix I).

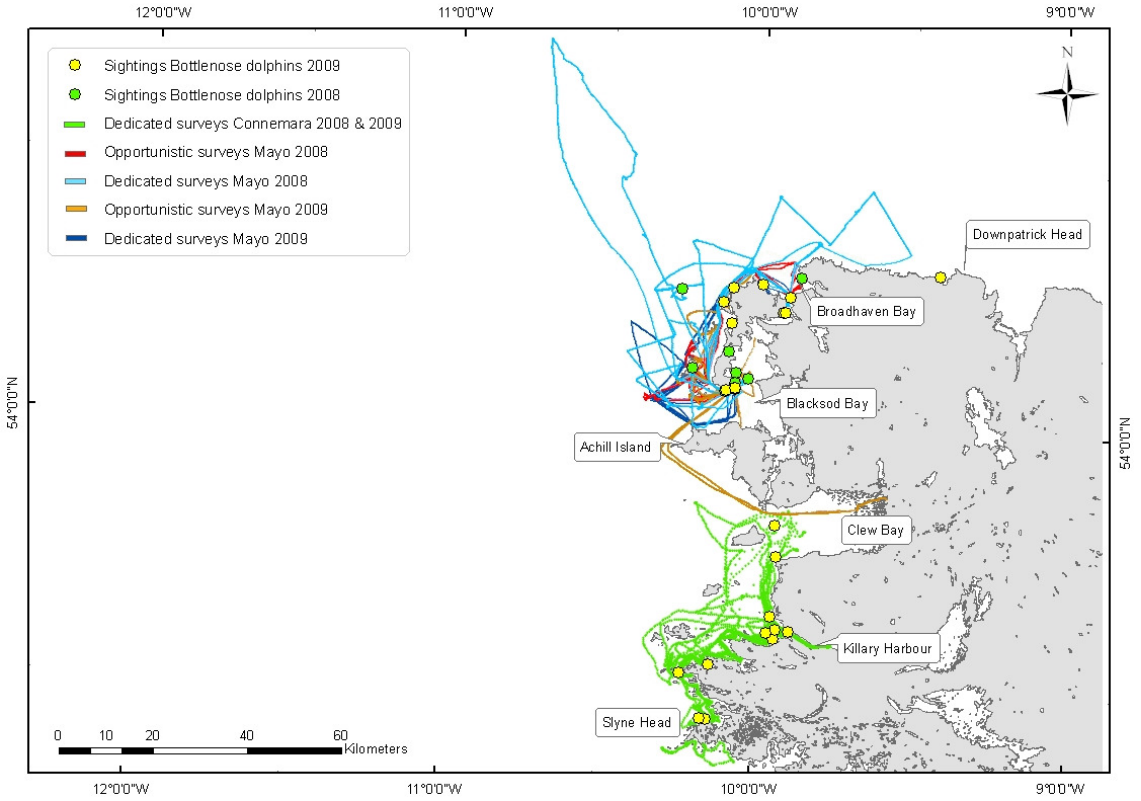

Figure 2. GPS tracks of all surveys conducted in Mayo and Connemara (red, blue, green and orange lines). Filled circles indicate the location of encounters with bottlenose dolphins.

A total of 25 dedicated surveys were conducted off Mayo, of which 11 were conducted between May and September 2008, and 14 between May and August 2009. In addition to these surveys, 18 opportunistic surveys were conducted between May and September 2008, and 15 between May and August 2009 (Fig.2, Appendix I). On September 24th 2008, an additional dedicated survey was conducted in the offshore waters near the continental shelf edge, extending approximately 50 km northwest of Erris Head. On May 9th 2009, another

opportunistic survey covered the coastal waters west and south of Achill Islands into Newport in Clew Bay (Fig. 2, Appendix I).

3.2 Encounters with bottlenose dolphins

A total of 31 groups of bottlenose dolphins were encountered and photo-identified during 28 surveys carried out between May 2008 and October 2009, including four land-based encounters (Table 2). Twelve encounters occurred in Mayo in 2008. No sightings were recorded in Connemara during 2008 despite four days of survey effort in September. In 2009, 19 encounters with bottlenose dolphins were recorded, of which eight occurred in the waters off Mayo and 11 occurred in Connemara. The majority of encounters was recorded in June (n=11), followed by August (n=4) and September (n=3). One encounter occurred in October 2009 (Table 2). In May and July 2009, no surveys were carried out in Connemara. Despite extensive survey effort carried out off Mayo in these months no sightings were recorded (Table 2, Appendix I).

Table 2. Date, location and group characteristics of bottlenose dolphin groups recorded off Mayo in 2008 and 2009 and in Connemara in 2009. Opp = Opportunistic, Ded = Dedicated, Lan = Land-based.
** multiple encounters during one survey.*

							Group composition			
	Survey date	Type	Location	Number of encounters	Field estimate of group size	Number of dolphins identified	Adult	Calf	Neonate	Not deter-mined
Mayo 2008	28-05-08	Opp	Blacksod - Inishglora	1	3	1	1			
	7-06-08	Opp	Blacksod	1	3	3	2			1
	8-06-08	Opp	Blacksod	1	3	3	2			1
	23-06-08	Opp	Elly Bay, Blacksod	1	3	3	3			
	5-07-08	Lan	Fallmore, Blacksod	1	3	3	3			
	12-07-08	Ded	Blacksod - Inishkee - Achill	1	12	11	7	1	1	2
	27-07-08	Opp	Ballyglass - Kid Island - Ballyglass	1	4	4	4			
	28-07-08	Ded	Broadhaven - Glinsk - Broadhaven	1	4	4	4			
	29-07-08	Ded	Broadhaven - Offshore west	1	4	4	4			
	7-09-08	Ded	Offshore West of the Mullet Penin.	1	50	43	29	2	3	8
	13-09-08	Opp	Inishkee North	1	8	9	9			
	25-09-08	Ded	Broadhaven Bay	1	15	18	10	3	2	3
Mayo 2009	14-06-09	Ded	Ballyglass - Blacksod	1	45	43	31	2	2	8
	15-06-09	Opp	Ballyglass, Broadhaven Bay	1	65	59	39	5	1	14
	24-06-09	Opp	Blacksod - Dooagh - Blacksod	1	65	63	43	3	3	14
	28-06-09	Lan	Annagh Head	1	55	17	12	1		3
	29-06-09	Ded	Frenchport - Eagle Island	1	75	73	39	6	2	16
	12-08-09	Ded	Broadhaven - Achill - Blacksod	1	10	9	7	2		
	29-09-09	Lan	Belderra	1	35	1	1			
	5-10-09	Lan	Downpatrick Head	1	35	16	12		1	3
Connemara 2009	1-06-09	Ded	South	1	20	17	8			9
	2-06-09	Ded	South	1	20	19	10			9
	3-06-09	Ded	South	1	10	10	5			5
	22-06-09	Ded	North *	2	25, 25	53				
	24-06-09	Ded	North & South	1	10	8				
	12-08-09	Ded	North & South *	3	15, 10, 2	28				
	11-09-09	Ded	South	1	2	0				
	18-09-09	Ded	North & South	1	20	9				

3.3 Group size

Bottlenose dolphin group size varied considerably between years and survey location (Fig. 3). Overall mean group size (± SD) estimated for all sightings was 21.2 ± 21.4. Mean group size (± SD) recorded in Mayo in 2008 was estimated as 9.3 ± 13.4 individuals, while in 2009, the mean group size (± SD) was 48.1 ± 21.2. The majority of groups encountered in Mayo in 2008 (n=10), consisted of groups of 12 dolphins or less, while in 2009, only one group of <12 dolphins was encountered. In Connemara, mean group size (± SD) recorded in 2009 was 14.4 ± 8.3, more than three times lower than the mean group size recorded in Mayo during the same period (Fig. 3).

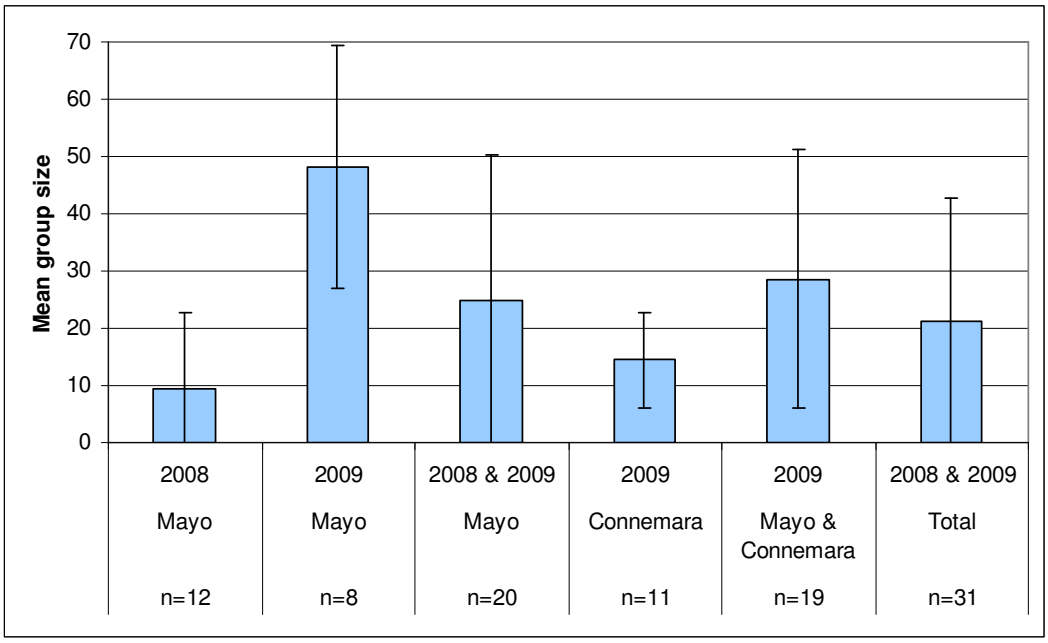

Figure 3. Mean group size (± SD) of bottlenose dolphins recorded in 2008 and 2009 in Mayo and in Connemara 2009, based on field estimate of the group size. n=number of group encounters.

3.4 Community characteristics

3.4.1 Mayo

A minimum of 179 dolphins were identified from photographic encounters in Mayo between 2008 and 2009 (Table 3). This corresponds to a minimum of 159 unique dolphins (Table 3). Of these, 63% were classified as adults, 8% as calves and 6% as neonates. Age-class could not be determined for 23% of the animals encountered.

Over half of the Mayo catalogue (53%, n=95), consisted of animals with distinctive, long term markings on their dorsal fin. The percentage of permanently marked individuals was higher in 2008 than in 2009, 66% versus 46% respectively (Table 3, Fig. 4).

Table 3. Number of individuals identified from the left side, right side or both sides in Mayo and in Connemara. Also given are the severity of the markings on the dorsal fins (grade 1 – 3) and the age structure of both catalogues. Percentages relate to the total number of IDs (Total ID) for each study area/year.

Photo-ID	Mayo 2008		Mayo 2009		Mayo Total		Connemara		Mayo + Connemara	
Left	8	9%	12	9%	20	11%	11	12%	24	12%
Right	13	15%	21	19%	34	19%	22	24%	46	23%
Both	64	75%	80	71%	125	70%	59	64%	131	65%
Total ID	85		113		179		92		201	
Minimum N individuals	**77**		**101**		**159**		**81**		**177**	
Markings Grade 1	56	66%	51	45%	95	53%	35	38%	97	48%
Markings Grade 2	11	13%	29	26%	37	21%	21	23%	40	20%
Markings Grade 3	18	21%	33	29%	47	26%	36	39%	64	32%
Adult	59	69%	70	62%	113	63%	52	57%	118	59%
Calf	6	7%	8	7%	14	8%	2	2%	15	7%
Neonates	6	7%	6	5%	10	6%	4	4%	12	6%
Not determined	14	16%	29	26%	42	23%	34	37%	56	28%

3.4.2 Connemara

A total of 92 individuals were photo-identified in Connemara in 2009, which corresponded to a minimum of 81 unique individual dolphins (Table 3). The individuals were classified predominantly as adults (57%, n= 52), with a smaller proportion of calves and neonates (6%). For 37%, the age-class could not be determined. A smaller percentage of dolphins than was recorded in the Mayo population consisted of Grade 1 animals (i.e. 38%), while a larger percentage of the identified dolphins consisted of Grade 3 animals (i.e. 39%) (Table 3).

3.4.3 Mayo and Connemara catalogues combined

Combining both datasets resulted in a catalogue containing 201 individual dolphins, of which 131 animals were photographed from both sides, 24 from the left side only, and 46 from the right side only, resulting in a minimum number of 177 unique individual dolphins (Table 3). A comparatively large number of 70 individual dolphins were recorded in both study areas. This group was composed of adults (59%), while 13% was made up of calves and neonates. Age-class composition was comparable between years and between the two areas (Table 3).

Close to half of all identified animals had permanent markings (48%; Grade 1), 20% had temporal markings (Grade 2) and 32% had superficial markings (Grade 3; Fig. 4). Comparison of the different identified communities with respect to mark-severity showed a relatively stable pattern between the areas. One exception was formed by the community identified in Mayo in 2008, which showed a higher percentage of Grade 1 individuals (Fig. 4).

A combined total of 14 calves were identified in Mayo in 2008 (n=6) and 2009 (n=8), and two in Connemara in 2009, of which one was resighted in Mayo within the same year. Six neonates were recorded in Mayo in both years, and four were recorded in Connemara in 2009, of which two were resighted in Mayo. Two neonates were resighted between 2008 and 2009 in Mayo, based on the assumption that the presence of the same mother with a neonate indicated a resighting of the same calf the following year.

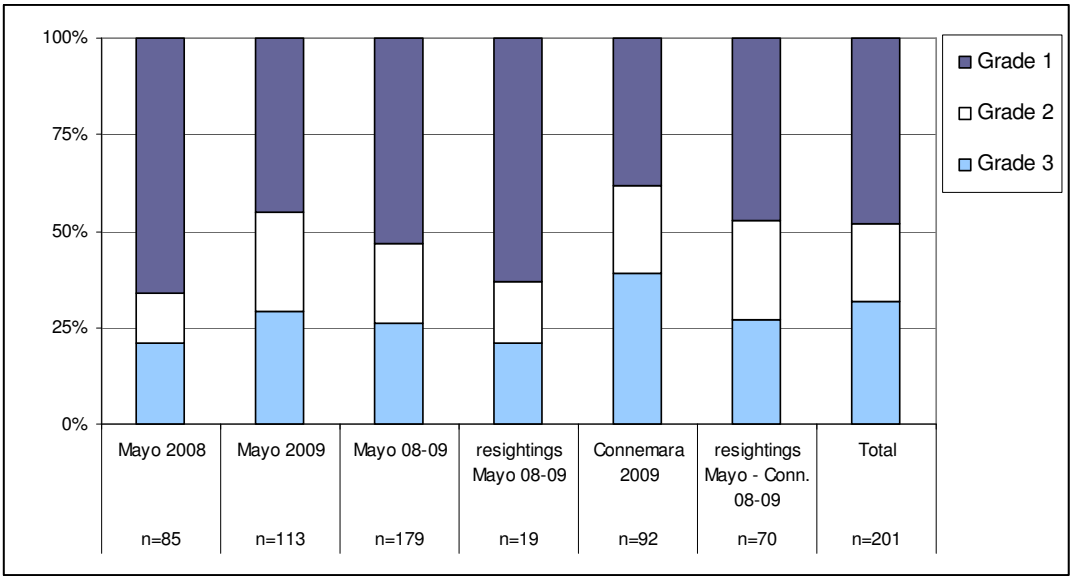

Figure 4. The degree of mark severity of identified dolphins for each study area/year, represented as a proportion of the total. Data for resightings between years and the total number of identified dolphins are included.

3.5 Population size

The discovery curves for the animals identified in Mayo and for the combined catalogues show an initial steep increase which starts to level off once the cumulative number of identifications exceeds approximately 350 dolphins (Fig. 5). This suggests that a substantial part of the total number of individuals using these areas in 2008-09 has been identified. In contrast, the discovery curve for Connemara (2009) does not show a levelling off of the curve, indicating that not all animals using that area in 2009 have been photographed.

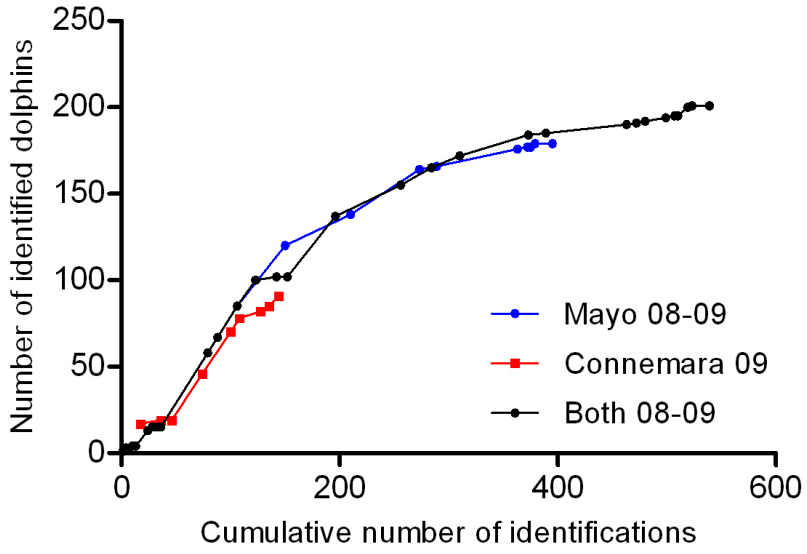

Figure 5.Discovery curves for the Mayo, Connemara and combined (i.e. Both) bottlenose dolphin catalogues plotted as the function between the number of newly identified dolphins and the cumulative number of identified dolphins.

3.6 Resightings between Mayo and Connemara

A total of 19 individuals (10.6%) of the Mayo catalogue were resighted within Mayo between 2008 and 2009 (Table 4). The matching analysis of the Mayo catalogue (n=179) to that of the Connemara catalogue (n=92) identified 70 unique dolphins which were sighted in both locations, representing 39.1% of the identified Mayo catalogue and 76.1% of the Connemara catalogue respectively. Twelve animals were resighted between Mayo in 2008 and Connemara in 2009, all of which were also resighted in Mayo in 2009. Ten dolphins recorded in Connemara in 2009, had been known from previous years' research, of which five individuals were recorded in Connemara, and seven animals were recorded at other coastal sites between Cork and Donegal (Ingram *et al.* 2009). Nine of these dolphins were resighted in Mayo in 2009, of which one dolphin was also recorded in 2008.

Table 4. Number and percentage of matches between the bottlenose dolphin communities identified in Mayo in 2008 and 2009, and in Connemara in 2009.

	N individuals	% of total number of dolphins identified
Mayo		
Mayo 2008: Resighted in 2009	19	10.6%
Mayo 2008: Sighted in Connemara	12	14.1%
Mayo 2009: Sighted in Connemara	70	63.1%
Mayo Total: Sighted in Connemara	70	39.1%
Connemara		
Sighted in Mayo in 2008	12	13%
Sighted in Mayo in 2009	70	76.1%
Sighted in Mayo	70	76.1%
Mayo + Connemara		
Mayo total	179	89.1%
Connemara total	92	45.8%
Mayo + Connemara combined	201	-

3.7 Site fidelity

3.7.1. Mayo

The majority of dolphins (93%) identified in Mayo 2008 were observed only once, with just six animals (7%) resighted on one or more occasions (Fig. 6A). Two dolphins were identified on 9 and 8 separate days, respectively, between May and July 2008. These animals were first sighted near Blacksod Pier, where they were seen on multiple days in June. In July the two dolphins were seen on three consecutive days within Ballyglass Harbour in Broadhaven Bay, accompanied by two other dolphins. A different pattern was observed in Mayo in 2009: a much lower percentage of dolphins (i.e. 21%, n=24), was observed only once, whereas the vast majority of individuals identified (i.e.79%, n=89), was recorded on multiple days during the survey period (Fig. 6A).

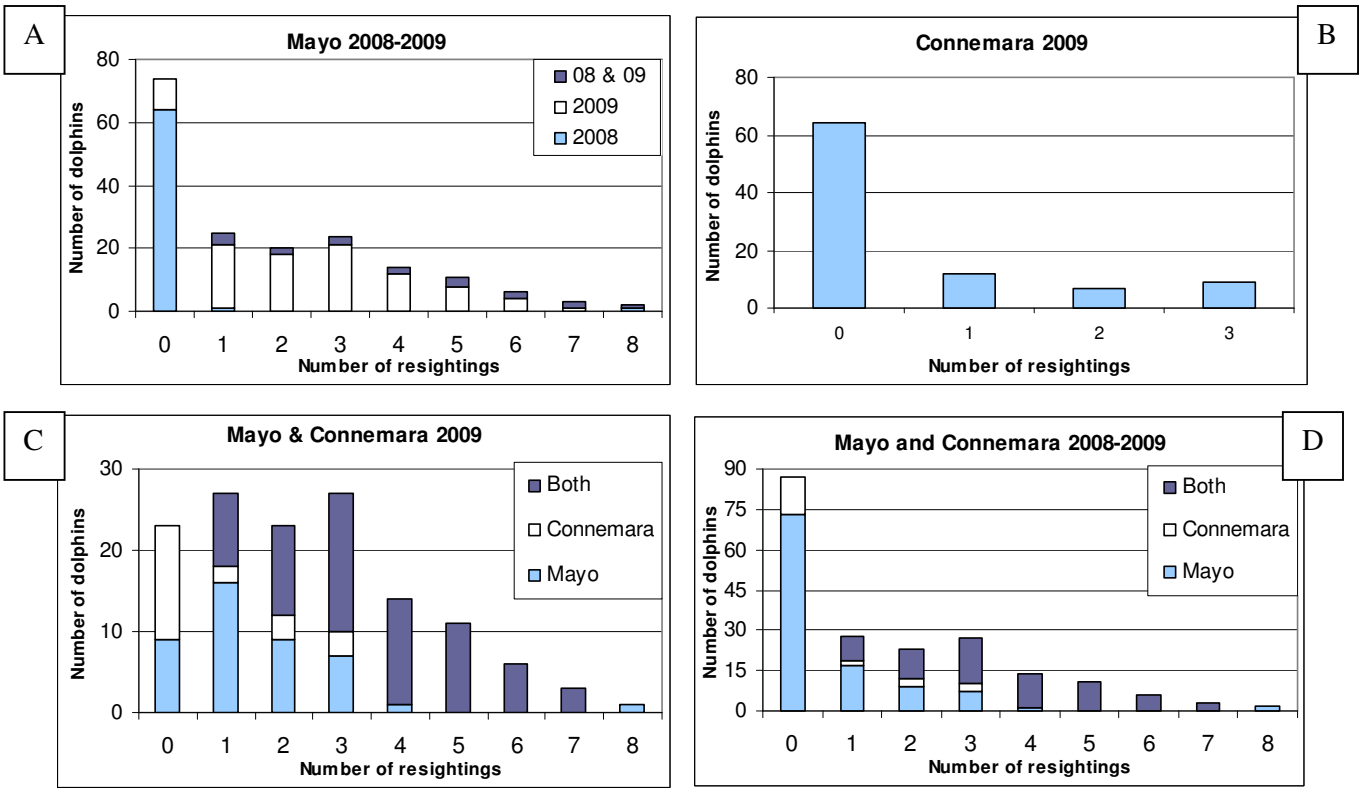

Figure 6. The number of resightings of individually identified bottlenose dolphins recorded off Mayo and Connemara in 2008 and 2009. A: Mayo 2008 & 2009 catalogue; B: Connemara 2009 catalogue; C: Mayo 2009 & Connemara 2009 catalogue; D: Total (Mayo 2008-09 & Connemara 2009 catalogues).

3.7.2. Connemara

Off Connemara, 68% (n=64) of the identified dolphins were seen once and 32% (n=28) of the dolphins were recorded on two or more days (Fig. 6B). While more surveys were conducted in 2009 in Connemara compared to Mayo, resighting rates were higher in Mayo.

3.7.3. Mayo and Connemara catalogues combined

A total of 43.8% (n=88) of all bottlenose dolphins identified were recorded once, 38.3% (n=77) were sighted during 2-4 encounters and 17.9% (n=36) were identified during 4-8 encounters (Fig. 6D). A small portion of the population (11%, n=22) was exclusively seen in Connemara, while over half of the individual dolphins (55%, n=109), were identified within Mayo only. For the individuals recorded both in Mayo and in Connemara, 12.9% (n=9) were resighted once, 15.7% (n=11) twice, 24.3% (n=17) three times, 18.6% (n=13) four times, 15.7% (n=11) five times, 8.6% (n=6) seven times, and 4.3% (n=3) on seven occasions. Accordingly, this represents a higher number of resightings than the individuals which were only recorded either in Mayo or in Connemara (Fig. 6A-D).

The mean sighting frequency per individual (± SD) was higher in Mayo in 2009 (2.6 ± 1.4) than in 2008 (1.2 ±1.2) and in Connemara (1.6 ± 1.0) (Fig. 7). Overall, the mean sighting frequency (± SD) for dolphins with grade 2 markings (3.0 ± 1.85) was higher than for Grade 1 (2.8 ± 2.1) and Grade 3 markings (2.4 ± 1.8) respectively.

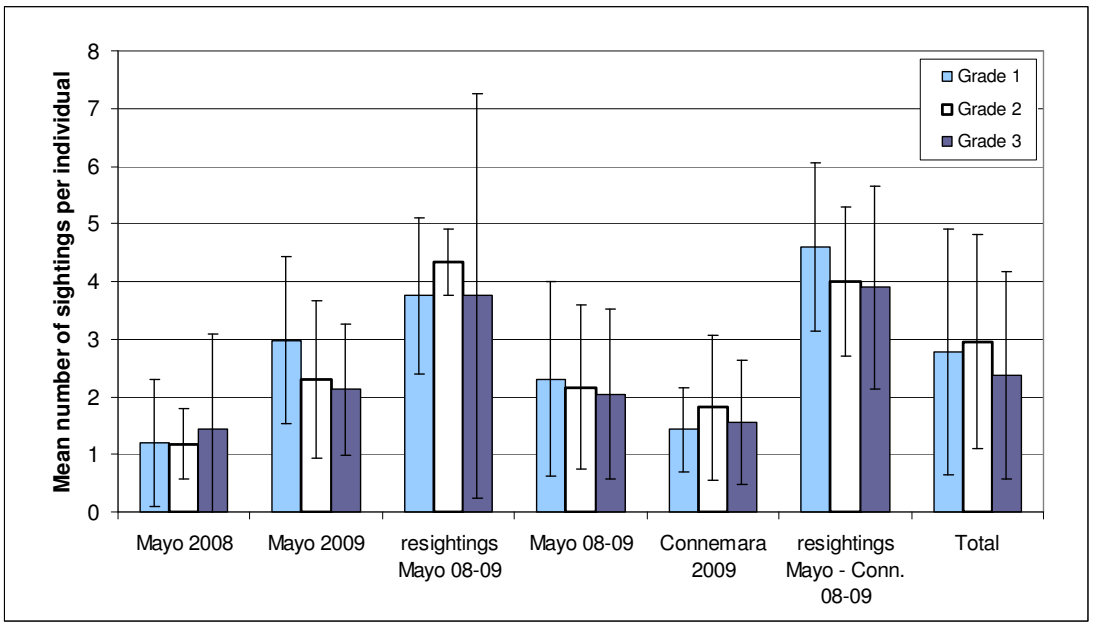

Figure 7. The mean sighting frequency (± SD) calculated per year, survey area, for the matched communities, and for the combined catalogues, for each grade of marking severity (Grade 1-3).

3.8 Individual movement patterns

Of the total number of dolphins identified among both study areas (i.e. 201 individuals), 55% (n=109) and 11% (n=22) were sighted only in Mayo or Connemara respectively (Table 5). Individual dolphins that were sighted in both areas showed quite extensive movement patterns between areas. 27 individual dolphins were recorded to have travelled *one-way* between Mayo and Connemara or *vice versa* (n=15 and n=12 respectively). The majority of these movements (88%, n=23) was recorded within 2009, and only one dolphin recorded in Mayo in 2008 was recorded during the Connemara study in 2009. In addition, 36 dolphins (18%) made a *return* journey, travelling between the two locations and were then resighted in the area in which they were first observed. Even more extensive travels were identified for seven individuals, who travelled between Mayo and Connemara, then returned to Mayo and travelled back again to Connemara, described as a *single-return movement*. Four of these individuals travelled this way within 2009 (Table 5).

Table 5. Chronological history of movement records for identified dolphins between Mayo 2008, 2009 and Connemara 2009; M8=Mayo 2008, M9=Mayo 2009, C09=Connemara 200, M8-9=Mayo 2008-2009.

	Chronological sighting history	Number of dolphins	Total	%	Shortest Direction of movement
Mayo	M8	65			-
	M9	37			-
	M8 ➔ M9	7	109	54%	-
Connemara	C9	22	22	11%	-
One-way	M8-9 ➔ C9	4			South
	C9 ➔ M9	12			North
	M9 ➔ C9	11	27	13%	South
Return	C9 ➔ M9 ➔ C9	9			North → South → North
	M8 ➔ C9 ➔ M9	1			South → North → South
	M9 ➔ C9 ➔ M9	21			South → North → South
	M8-9 ➔ C9 ➔ M9	5	36	18%	South → North → South
Single-Return	M8 ➔ C9 ➔ M9 ➔ C9	3			North → South → North → South
	M9 ➔ C9 ➔ M9 ➔ C9	4	7	3.4%	North → South → North → South

A group of 20 animals were resighted within two days in June 2009 between Clew Bay and Blacksod Harbour, a distance of 47 km. One dolphin travelled between Broadhaven and Connemara within four days, a minimum distance of 100 km. Of particular interest was a land-based observation of a group of 35 animals observed on the October 5th 2009 near Downpatrick Head, Co. Mayo. This group travelled eastwards within 500m from the shoreline and could be tracked from land, passing Kilcummen Head, Killala Bay, Easky and was last seen at Aughris Head, Co. Sligo, still moving at a constant speed travelling in an easterly direction. These dolphins covered a distance of at least 50 km within 6 hours.

4 Discussion

Based on the photo-identification encounters between June and September 2009, Ingram *et al.* (2009) estimated a population of 171 ± 48 (SE) bottlenose dolphins using the coastal waters off Connemara. A comparatively large number of individual dolphins (i.e. 179 dolphins) was identified in Mayo waters in 2008 and 2009. Also in 2009, when survey effort was conducted in both study areas, a comparable number of dolphins was recorded in both areas (i.e. Mayo: n=113, Connemara; n=92). Considering the population size of other well-studied bottlenose dolphin populations in the Shannon Estuary (140 ± 12 animals; Englund *et al.* 2007), the Moray Firth, Scotland (129 ± 15 animals; Wilson *et al.* 1999) and Cardigan Bay, Wales (213 animals; Baines *et al.* 2002), the bottlenose dolphins in the coastal waters off Mayo and Connemara are part of a population of considerable size in Irish waters and internationally. The high number of dolphins identified and large number of resightings within both study areas show that the coastal waters off Connemara and northwest Mayo form an important part of the home-range of a large number of bottlenose dolphins.

The presence of calves and neonates in the summer and autumn months, indicate that these areas act as nursing and possible breeding habitat for this community. Further research, incorporating behavioural patterns and year-round research effort is necessary to better understand the importance of these coastal waters for nursing and breeding bottlenose dolphins.

A total of 70 individual bottlenose dolphins were resighted between Connemara and Mayo, representing 76% and 39% of the total number of individuals identified in these areas respectively. This is the first time such a high overlap between two distinct coastal areas has been described for coastal bottlenose dolphins in Irish waters. This large proportion of resighted individuals between these areas, in combination with similar community characteristics (i.e. age-class distribution and severity of markings) strongly suggests that the dolphins identified in Mayo and Connemara waters are both part of the same social community. This would also be consistent with the findings of a recent genetic study by Mirimin and colleagues (in press) examining fine scale population structure along the west coast of Ireland.

One striking difference between the two areas does exist: the mean group sizes recorded in Mayo in 2009 (mean group size: 48.1) were two to three times larger than those recorded in Connemara in 2009 (mean group size: 14.4). Interestingly, mean group size recorded in Mayo in 2008 was also much lower (mean group size: 9.3). A similar pattern was recorded independently in Broadhaven Bay, Co. Mayo. Extensive research in this bay has concluded that this bay represents an important habitat for the coastal population of bottlenose dolphins (Visser *et al.* 2009). Between March and October 2009, 19 sightings of bottlenose dolphins were recorded in the bay as part of an ongoing monitoring study by the Coastal & Marine Resources Centre (CMRC; Visser *et al.* 2009). In 2009, the presence and abundance of bottlenose dolphins in Broadhaven Bay differed substantially from patterns recorded in previous years. In particular, group size and the number of individuals observed were found to be 2.5 to 4 times higher than recorded in this area in previous years (Ó Cadhla *et al.* 2003; Englund *et al.* 2006; Coleman *et al.* 2008; Visser *et al.* 2009). Large aggregations of 80-100+ bottlenose dolphins have been observed occasionally in Broadhaven Bay in 2007 and in 2010 (M. Oudejans, CMRC unpublished data). These records illustrate that bottlenose dolphin group size and abundance in this area show inter-annual variability. Further analysis including the matching comparison of the current Mayo catalogue with that developed by CMRC for Broadhaven Bay is required to determine the overlap in catalogues within Mayo. Such analysis might allow an extension of the temporal and spatial scales of this study. Based on the location of Broadhaven Bay within the waters of northwest Mayo, the large number of sightings in spring/early summer, and the corresponding large group sizes recorded, it is likely that this exercise would result in similar resighting rates.

Our results show that individual dolphins conduct regular, moderate-scale movements between the two coastal areas over short time periods. The distances between encounters recorded in Mayo and Connemara range from 47 km to 168 km. These distances correspond well with short-term movements of 190 km and 65 km covered within 5 and 2 days by bottlenose dolphins in the Moray Firth, Scotland (Wilson *et al.* 1997). While these distances remain small compared to the long distance movements reported by O'Brien *et al.* (2009), by comparison, they cover the length of the Shannon Estuary, home to a resident population bottlenose dolphins.

A large number of resighted individuals travelled back and forth between the two coastal sites. The *single-return* movement and *return* movements both to and from both areas suggest

that these dolphins remained within, or purposely revisited these areas rather than merely travelling through them. The high number of resightings within and between years, and between locations also support this hypothesis. Frequent and extended periods of bottlenose dolphin presence has also been detected by acoustic monitoring within the coastal waters off Connemara in previous years (Ingram *et al.* 2003).

Ten dolphins recorded in Connemara, of which nine were seen in Mayo in 2009, have been sighted in previous years during surveys in coastal waters off Donegal and Cork. These inter-annual resightings suggest that a part of the bottlenose dolphins occurring in these areas have much larger home-ranges that cover large parts of the coastal waters off the Irish west coast. Long distance movements of individual bottlenose dolphins along the Irish coast have previously been reported between the south and west coast (Ingram & Rogan 2003) and between the south and north coast (O'Brien *et al.* 2009). The majority of these long distance resightings were recorded between years, rather than within months or weeks. For management purposes it would be interesting to investigate if there are differences in movement patterns between communities, social groups and/or age-classes. Our results indicate that both adults, calves and neonates conduct similar moderate-scale movements, and that there is little difference in sighting frequencies within age-classes based on the Grade marking categories. Expending the survey effort into new areas and conduct matching analysis with catalogues from other coastal areas in Ireland would allow studying these long- and short-term movements in more detail on a larger spatial scale.

Similar to the coastal distribution of sightings in Connemara (Ingram *et al.* 2009), and despite offshore survey effort, all encounters in Mayo were recorded within 1-2 km from the mainland coast, with the exception of two encounters in Mayo in 2008 (see below). This indicates that these inshore waters form an important habitat for these coastal communities. As stated by Ingram *et al.* (2009), the coastal waters of Connemara represent a suitable site for designation of an additional SAC for this species, enhancing the protection of these communities outside the Shannon Estuary SAC. The Mayo study shows that such suitable coastal sites also exist in northwest Mayo, including Broadhaven Bay. Further research into the habitat use and behaviour of the bottlenose dolphin within these areas is necessary to determine the importance of this habitat for the species in terms of foraging, resting, breeding and nursing.

The offshore waters of the European continental shelf are inhabited by an estimated 19,295 bottlenose dolphins (CODA 2008). The population structure of this pelagic group(s) is unknown, nor is anything known about the relationship between these animals and the "coastal" individuals recorded in the coastal waters. In the western Atlantic Ocean, along the east coast of the US, two ecotypes of bottlenose dolphins have been identified based on differences in haematological, morphological and genetic differences (Hersch and Duffiels 1990; Kenny 1990; Mead and Potter 1995; Hoelzel *et al.* 1998). More recently, Torres *et al.* (2003) found a difference in distribution between both ecotypes in relation to water depth and distance from shore. The "coastal" bottlenose dolphin ecotype is described to be smaller and occurs in coastal waters within 7.5 km from shore and less than 34 m deep. The offshore ecotype is larger and occurs in pelagic/offshore waters ranging from 34 m to 4.900 m deep located at 34-500 km distance from shore.

Current information regarding bottlenose dolphins occurring on the continental shelf and pelagic waters in the Eastern Atlantic Ocean is based on a limited number of sightings (Hammond *et al.* 2002; CODA 2008). Based on genetic sampling of stranded individuals, Mirimin *et al.* (in press) suggested that at least one other population exists in the waters around Ireland, which possibly have a more pelagic origin. In recent years a number of offshore sightings of bottlenose dolphins have been recorded near the shelf edge northwest of Erris Head (www.iwdg.ie, M. Oudejans unpublished data). Two encounters recorded in September 2008 in Mayo may consist of bottlenose dolphins belonging to a possible "offshore/pelagic" community. These encounters were recorded further offshore than all other sightings (9 and 4 km off the mainland). Photo-identification of these groups, encountered west off the Mullet peninsula, resulted in 52 newly identified dolphins of which none were resighted within the inshore waters of Mayo or Connemara, despite extensive survey effort in both years. In addition, of the 52 dolphins identified, 41 (79%) had permanent markings (Grade 1). This is substantially higher than was recorded for the total population (Grade 1= 48%). This may imply that 33 individuals belonging to the "inshore community" and 52 individuals belonging to a possible "offshore community" were identified in Mayo in 2008. The occurrence of offshore bottlenose dolphin groups could explain the relatively low percentage of dolphins, 19%, which were resighted within Mayo between 2008 and 2009. This percentage is much lower than recorded between Mayo and Connemara in 2009.

The fact that both sightings were recorded within 10 km of the mainland coast indicates that the coastal waters of Mayo could form an overlap in the home-range of both communities. Additional survey effort in this area, in particular, in the offshore waters west of the Mullet

peninsula is required to gain more insight into the bottlenose dolphin community occurring in these waters and their relationship with the coastal community described in this study.

5 Acknowledgements

We like to thank all the people who helped with the data collection and photo-identification analysis. In particular, the Mayo research project would like to thank Anthony Irwin of Dúlra Nature Tours, Vincent and Simon Sweeney, crew of the 'Dúlra na Mara', the CMRC Broadhaven Bay monitoring research team, Oliver Ó Cadhla of SIAR Environment , Dave Suddaby of Birdwatch Ireland and Brain Mac Suibhne of the RNLI Ballyglass. In addition to the people mentioned above the UCC team would like to thank Alibhe Kavanagh, Roseanne Miller, Katie Cole, and Evelyn Philpott for their assistance during the Connemara fieldwork. For valuable sighting information we are thankful to John Britain, John Mongan and Ger O'Donnel and the crews and captains of the Connemara Lady and the Queen of Connemara. The Mayo research project was funded by the Heritage Council/An Chomchairle Oidhreachte, under the wildlife grant scheme 2008, and received sponsorship from the following companies; Degreef & Partner, Sokkia Nederland, Schweitzer Import and Sailtron BV. The Connemara project was funded by the National Parks and Wildlife Service.

6 References

Baines, M.E., Reichelt. M., Evans, P.G.H. & Shepherd, B. 2002. Comparison of the Abundance and Distribution of Harbour Porpoises (*Phocoena phocoena*) and Bottlenose Dolphins (*Tursiops truncatus*) in Cardigan Bay, UK. pp. 12-13. In: Abstracts, 16th Annual Conference of the European Cetacean Society, 7-11 April, Liège, Belgium.

Bearzi, G., Notarbartolo-Di Scaria, G. & Politi, A. 1997. Social ecology of bottlenose dolphins in Kvarneric (northern Adriatic Sea). Marine Mammal Science 13: pp. 650-668.

Coleman, M., Philpott, E., O'Donovan, M., Denniston, H., Walshe, L., Haberlin, M. & Englund, A. (2009). Marine Mammal Monitoring in Broadhaven Bay SAC, 2008. Project report to RSK
Environment Ltd. Coastal and Marine Resources Centre, University College Cork. 68 pp.

CODA 2008. http://biology.st-andrews.ac.uk/coda/documents/CODA_Final_Report_11-2-09.pdf

Englund, A., Coleman, M. & Collins, C. 2006. Marine mammal monitoring in Broadhaven bay: June –September 2005. *Project report to RSKENSR Group Plc*. Coastal and Marine Resources Centre, University College Cork. 40 pp.

Englund, A., Ingram, S.N. & Rogan, E. 2007. Population status report for bottlenose dolphins using the Lower River Shannon SAC, 2006 – 2007. Final report to the National Parks and Wildlife Service, Ireland, 37 pp.

Englund, A., Ingram, S.D. & Rogan, E. 2008. An updated population status report for bottlenose dolphins using the Lower River Shannon SAC in 2008. Report to the National Parks and Wildlife Service. 36 pp.

Hammond, P.S., Berggren, P., Benke, H., Borchers, D.L., Collet, A., Heide-Jørgensen, M.P., Heimlich, S., Hiby, A.R., Leopold, M.F. & Øien, N. 2002. Abundance of harbour porpoises and other cetaceans in the North Sea and adjacent waters. *J. App. Ecol.* 39: pp. 361-376.

Hersch, S. L., & Duffield, D. A. 1990. Distinguishing between northwest Atlantic offshore and coastal bottlenose dolphins based on hemoglobin profile and morphometry. pp. 129–139. in The bottlenose dolphin (S. Leatherwood and R. Reeves, eds.). Academic Press, San Diego, California.

Hoelzel, A. R., Potter, C. W., & Best, P. B. 1998. Genetic differentiation between parapatric 'nearshore' and 'offshore' populations of bottlenose dolphin. Proceedings of the Royal Society of London, B. Biological Sciences 265. pp. 1117–1183.

Ingram, S.N., Englund, A. & Rogan, E. 2001. An extensive survey of bottlenose dolphins (*Tursiops truncatus*) on the west coast of Ireland. Heritage Council Report no. WLD/2001/42 17 pp.

Ingram, S.N., Englund, A. & Rogan, E. 2003. Habitat use, abundance and site-fidelity of bottlenose dolphins (*Tursiops truncatus*) in Connemara coastal waters, Co. Galway. *Heritage Council Wildlife Grant* #12314. 27 pp.

Ingram, S.N. & Rogan, E. 2002. Identifying critical areas and habitat preferences of bottlenose dolphins (*Tursiops truncatus*). *Marine Ecology Progress Series* 244: pp. 247-255.

Ingram, S.N. & Rogan, E. 2003. Bottlenose dolphins (*Tursiops truncatus*) in the Shannon Estuary and selected areas of the west-coast of Ireland. *Report to the National Parks and Wildlife Service*, Ireland. 28 pp.

Ingram, S.N. 2000. The ecology and conservation of bottlenose dolphins in the Shannon estuary, Ireland. PhD thesis University College Cork, 213 pp.

Kenney, R. D. 1990. Bottlenose dolphins off the north eastern United States. pp. 369–386. in The bottlenose dolphin (S. Leatherwood and R. Reeves, eds.). Academic Press, San Diego, California.

Leatherwood, S. & Reeves, R.R. 1983. The Sierra Club handbook of whales and dolphins. Sierra Club Books, San Francisco.

Mead, J. G., & C. W. Potter. 1995. Recognizing two populations of the bottlenose dolphin (*Tursiops truncatus*) off the Atlantic coast of North America: morphological and ecological considerations. IBI Reports 5: pp. 31–44.

Miller, R., Mirimin, L., Ingram, S., Berrow, S., Cross, T. & Rogan, E. (2009) Insights into the genetic structure of bottlenose dolphins (*Tursiops truncatus*) in the Shannon estuary, as revealed by nuclear genetic markers. Poster presented at the 23rd Annual European Cetacean Society Conference. Instanbul, Turkey 2-4 March, 2009.

Mirimin, L., Miller, R., Ingram, S., Berrow, S., Cross, T & Rogan, E. (in press). Fine-scale population genetic structuring of bottlenose dolphins in Irish coastal waters Animal Conservation.

O'Brien, J.M., Berrow, S.D., Ryan, C, McGrath, D., O'Connor, I., Pesante, P., Burrows, G., Massett, N., Klötzer, V. & Whooley, P. (2009). A note on long-distance matches of bottlenose dolphins (*Tursiops truncatus)* around the Irish coast using photo-identification. *J. of Cetacean Research and Management*11(1):pp. 71–76.

Ó Cadhla, O., Englund, A., Philpott, E., Mackey, M. & Ingram, S.N. 2003. Marine mammal monitoring in the waters of Broadhaven Bay and Northwest Mayo: 2001-2002. *Report to Enterprise Energy Ireland Ltd*, 74 pp.

Ó Cadhla, O. Mackey, M., Aguilar de Soto, N., Rogan, E. & Connolly, N. 2004. Cetaceans and seabirds of Ireland's Atlantic margin. Report on research carried out under the Irish Infrastructure Programme (PIP): Rockall Studies Group (RSG) projects 98/6 and 00/13, Porcupine Studies Group project P00/15 and Offshore Support Group (OSG) project 99/38. 51pp.

Oudejans, M.G., Ingram S., & Ó Cadhla, O. 2008. Bottlenose dolphins in northwest Ireland a study to determine population size, habitat use and site fidelity in the coastal waters of County Mayo. Report to the Heritage Council. 29 pp.

Ryan, C., Rogan, E. & Cross, T.C. 2010. The use of Cork harbour by bottlenose dolphins (*Tursiops truncatus* (Montagu 1821)). *Ir. Nat. J.*.

Roycroft, D., Cronin, M., Mackey, M., Ingram S.N. & Ó Cadhla, O. 2007. Risk Assessment for Marine Mammal and Seabird Populations in South-Western Irish Waters (R.A.M.S.S.I.). Higher Education Authority - An tÚdarás um Ard-Oideacha., 198 pp.

Rogan, E & Berrow, S.D., 1995. The management of Irish waters as a whale and dolphin sanctuary. In: Whales seals fish and man (eds Blix, A.S., Walle, L. & Ulltang,.), Elsevier Science: pp. 671-681.

Stockin, K., .Weir. C. & Pierce, G. 2006. Examining the importance of Aberdeenshire (UK) coastal waters for North Sea bottlenose dolphins (*Tursiops truncatus*) J. Mar. Biol. Ass. U.K. 86, 6 pp.

Torres, L., P., Rosel, A., Read, & C. D'Agrosa. 2003. Improving management of overlapping bottlenose dolphin ecotypes through spatial analysis and genetics. *Marine Mammal Science*19(3): pp. 502-514.

Visser, F., Coleman, M., Denniston, H., O'Donovan, M. Walshe, L., Ponzo, A. & Cronin, M. 2010. Marine mammal monitoring in Broadhaven Bay *2009*. Progress report to RSK Environment Limited Group. Coastal and Marine Resources Centre, University College Cork, Cork. 61 pp.

Wall, D., O'Brien, J., Meade, J. & Allen, B. 2006. Summer distribution and relative abundance of cetaceans off the west coast of Ireland. *Biology and Environment*, 106B(2): pp. 135-143.

Wilson, B., P. M. Thompson, P.M., & Hammond, P.S. 1997. Habitat Use by Bottlenose Dolphins: Seasonal Distribution and Stratified Movement Patterns in the Moray Firth, Scotland, Journal of Applied Ecology, Vol. 34, No. 6: pp. 1365-1374.

Wilson, B., Hammond, P. & Thompson, P. 1999. Estimating size and assessing trends in a coastal bottlenose dolphin population. *Ecological applications* 9(1): pp. 288-300.

Würsig, B, & Würsig, M. 1977. The photographic determination of group size, composition, and stability of coastal porpoises (*Tursiops truncatus*). Science 198: pp. 755-756.

7 Appendix I

Summary of the dedicated (=Ded) and opportunistic (=Opp) surveys conducted in the coastal waters off Connemara and Mayo between May 2008 and October 2009. Included are four land-based sightings (=Lan).

	Survey date	Type	Location	Number of encounters	Field estimate of group size	Number of dolphins identified
Mayo 2008	17-05-08	Opp	Ballyglass - Blacksod			
	28-05-08	Opp	Blacksod - Inishglora	1	3	1
	1-06-08	Opp	Blacksod – Duvilaun - Blacksod			
	5-06-08	Opp	Blacksod - Inishkea North - Blacksod			
	7-06-08	Opp	Blacksod	1	3	3
	8-06-08	Opp	Blacksod	1	3	3
	14-06-08	Opp	Blacksod - Inishkea - Blacksod			
	23-06-08	Opp	Elly Bay, Blacksod	1	3	3
	3-07-08	Opp	Blacksod - Inishkea North			
	4-07-08	Opp	Blacksod - Duvillaun			
	5-07-08	Lan	Fallmore, Blacksod.	1	3	3
	12-07-08	Ded	Blacksod - Inishkea - Achill	1	12	11
	17-07-08	Opp	Inishkea South - Duvillaun - Blacksod			
	20-07-08	Opp	Inishkea South - Blacksod			
	26-07-08	Ded	Blacksod - Ballyglass			
	27-07-08	Opp	Ballyglass - Kid Island - Ballyglass	1	4	4
	28-07-08	Ded	Broadhaven - Glinsk - Broadhaven	1	4	4
	29-07-08	Ded	Broadhaven - Offshore West	1	4	4
	31-07-08	Ded	Ballyglass - Blacksod			
	15-08-08	Ded	Blacksod - Ballyglass			
	16-08-08	Opp	Ballyglass - Broadhaven Bay			
	17-08-08	Ded	Ballyglass - Blacksod			
	7-09-08	Ded	Offshore West of the Mullet Peninsula.	1	50	43
	8-09-08	Ded	Blacksod - Ballyglass			
	9-09-08	Opp	Ballyglass - Blacksod			
	13-09-08	Opp	Blacksod - Inishkea North	1	8	9
	24-09-08	Ded	Blacksod - NW shelf area			
	25-09-08	Ded	Broadhaven Bay	1	15	18
	27-09-08	Opp	Inishkea South- Blacksod			
	28-09-08	Opp	Blacksod - Blackrock			
Mayo 2009	9-05-09	Opp	Blacksod - Newport - Blacksod			
	10-05-09	Opp	Duvaillaun			
	16-05-09	Ded	Inishkea South - Duvillaun			
	19-05-09	Ded	Broadhaven Bay			
	20-05-09	Opp	Blacksod - Inishkea North			
	31-05-09	Opp	Blacksod - Blackrock - Inishkea			
	1-06-09	Opp	Inishkea south - Cleggan			
	1-06-09	Opp	Blacksod - Inishkea South			
	2-06-09	Ded	Blacksod - Inishkea North			
	4-06-09	Opp	Blacksod - Inishkea South			
	13-06-09	Opp	Blacksod - Inishkea - Ballyglass			
	14-06-09	Ded	Ballyglass - Blacksod	1	45	43

	15-06-09	Opp	Ballyglass, Broadhaven Bay	1	65	59
	22-06-09	Ded	Achill - Blackrock - Inishkea			
	23-06-09	Opp	Blacksod - Inishglora - Duvillaun			
	24-06-09	Opp	Blacksod - Dooagh - Blacksod	1	65	63
	25-06-09	Opp	Blacksod Bay			
	28-06-09	Lan	Annagh Head	1	55	17
	29-06-09	Ded	Frenchport - Eagle Island	1	75	73
	1-07-09	Ded	Blacksod - Blackrock - Inishkea			
	8-07-09	Opp	Blacksod - Inishkea - Duvillaun			
	9-07-09	Ded	Inishkea - Blackrock - Inishkea			
	16-07-09	Ded	Blacksod - Achill - Blacksod			
	18-07-09	Ded	Blacksod - Broadhaven Bay			
	19-07-09	Ded	Broadhaven Bay - Blacksod			
	24-07-09	Ded	Blacksod - Achill - Blacksod			
	30-07-09	Opp	Blacksod - Inishkea South			
	10-08-09	Opp	Broadhaven Bay - Eagle island			
	12-08-09	Ded	Broadhaven - Achill - Blacksod	1	10	9
	17-08-09	Ded	Blacksod - Inishkea - Annagh			
	29-09-09	Lan	Belderra	1	35	1
	5-10-09	Lan	Downpatrick Head	1	35	16
	19-09-08	Ded	South			
	24-09-08	Ded	South			
	25-09-08	Ded	North & South			
	26-09-08	Ded	South			
	1-06-09	Ded	South	1	20	17
	2-06-09	Ded	South	1	20	17
	3-06-09	Ded	South	1	10	11
	4-06-09	Ded	South			
Connemara 2009	22-06-09	Ded	North	2	25,25	53
	23-06-09	Ded	North & South			
	24-06-09	Ded	North & South	1	10	8
	29-06-09	Ded	North & South			
	7-08-09	Ded	North			
	12-08-09	Ded	North & South	3	15,10,2	28
	13-08-09	Ded	North & South			
	10-09-09	Ded	North & South			
	11-09-09	Ded	South	1	2	0
	12-09-09	Ded	South			
	16-09-09	Ded	South			
	17-09-09	Ded	South			
	18-09-09	Ded	North & South *	1	20	9