

# Observations of bowhead whales along the Northern Chukotka peninsula 2010–2012 with comparisons to 1994–1996 and 2002–2005

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## ABSTRACT

This paper contains information on the seasonal distribution of bowhead whales (*Balaena mysticetus*) in coastal waters of Chukotka (northeast Russia) in 2010–2012. Data from shore-based observation posts provides spatial and temporal information about whale distribution and migration in the coastal zones, as well as information about their relative numbers. The spring migration was observed only from Uelen, Russia (66°N, 149°W), near the northwestern entrance to the Bering Strait, and extended from the end of May through the first half of June. Some year-to-year differences in numbers and migration dynamics were observed. During summer, bowhead whales were sighted in the waters of the northern coast of Chukotka Peninsula in July and August. In 2010–2012, single whales and small groups of up to 4–8 whales were observed in the area for days making non-directed movements. Our observations in 2010–2012 demonstrated that many bowhead whales visited Chukotka coast in the autumn (September) before sea ice formation. From past observations, it appears that the autumn migration begins 2–3 weeks earlier on the northwestern coast of the Chukotka Peninsula than in the (northern) entry of the Bering Strait. The autumn migration of bowhead whales began with ice formation and ended with the complete freezing of the waters. Ice conditions appear to drive high variability in timing of the bowhead autumn migration. The northeastern Chukotka coast is one of the most important feeding areas for the Bering-Chukchi-Beaufort (BCB) bowhead whale population.

KEYWORDS: BOWHEAD WHALE; SHORE-BASED VISUAL OBSERVATIONS; NORTHERN CHUKOTKA PENINSULA; CHUKCHI SEA; BERING STRAIT; MIGRATION

## INTRODUCTION

It has been known for some time (e.g. Bogoslovskaya *et al.*, 1982) that bowhead whales (*Balaena mysticetus*) can be found around the Chukotka Peninsula in summer and early autumn. To better quantify sighting records, a new program began in 1990 using shore-based observations of bowhead whales from capes of the Chukotka Peninsula. Whale monitoring is limited by the vast areas that the whales inhabit. Because of this, coastal observations of marine mammals along their migration routes provide a useful proxy means of measuring population changes for coastal migrators like the bowhead and gray whale (*Eschrichtius robustus*). Data from coastal observation posts provides spatial and temporal information about whale distribution and migration in the coastal zones, as well as information about their relative numbers.

Summarised spring, summer and autumn sightings made between 1990–1996 and 1998, as well as earlier sightings are reported in the literature (Melnikov, 1991; Bobkov, 1991; Melnikov *et al.* 1998; 2002). These investigations showed that in the spring northward migration of bowheads along the eastern coast of the Chukotka Peninsula are seen much later than along the coast of northwestern Alaska. As early as August or September, the bowhead whales start approaching the northern coast of the Chukotka Peninsula, probably for feeding. Hunters reported whales skim feeding (mouths open at the surface). The area of approach depends on the specific ice and hydrological conditions in the Chukchi Sea. Along the northern coast of Chukotka, the bowhead whales migrate toward the Bering Strait before freeze-up. They proceed in several waves, feeding all the

while (Melnikov, 1993; Bobkov, 1993; Melnikov *et al.*, 1997; 1998; 2002; Melnikov, 2014).

The main objective of this work is to continue the long term monitoring (numbers, timing, distribution and behaviour) of bowhead whales near the coast of the Chukchi Peninsula in 2010–2012 during the spring and autumn migrations and during summer.

## MATERIAL AND METHODS

Bowhead whales were observed during daylight hours using binoculars from two elevated sites (perches) near the communities of Neshkan along the northern coast of Chukotka, and near Uelen at the north-west entrance of Bering Strait 2010–2012 (Fig. 1). This is a small portion of the study area where observations were made during 1992–1996 and later in 2002–2004 (Melnikov *et al.*, 1993; 2002). The observations allow us to track the course of the seasonal whale migrations in the southwestern Chukchi Sea.

Data collected included: elevation of the observation perch, duration of observations, observation conditions (wind speed and direction, visibility, presence or absence of whitecaps), approximate visual percentage of ice cover, number of bowhead whales sighted, approximate distance from shore, swim direction, and whether there was feeding activity as determined by slowly moving in various directions, whales swimming with open mouths at the surface.

Few observers recorded the observation duration by minutes or hours, therefore the unit of observation was number of whales per day effective observation. Under ‘effective observation’ we consider observation in acceptable

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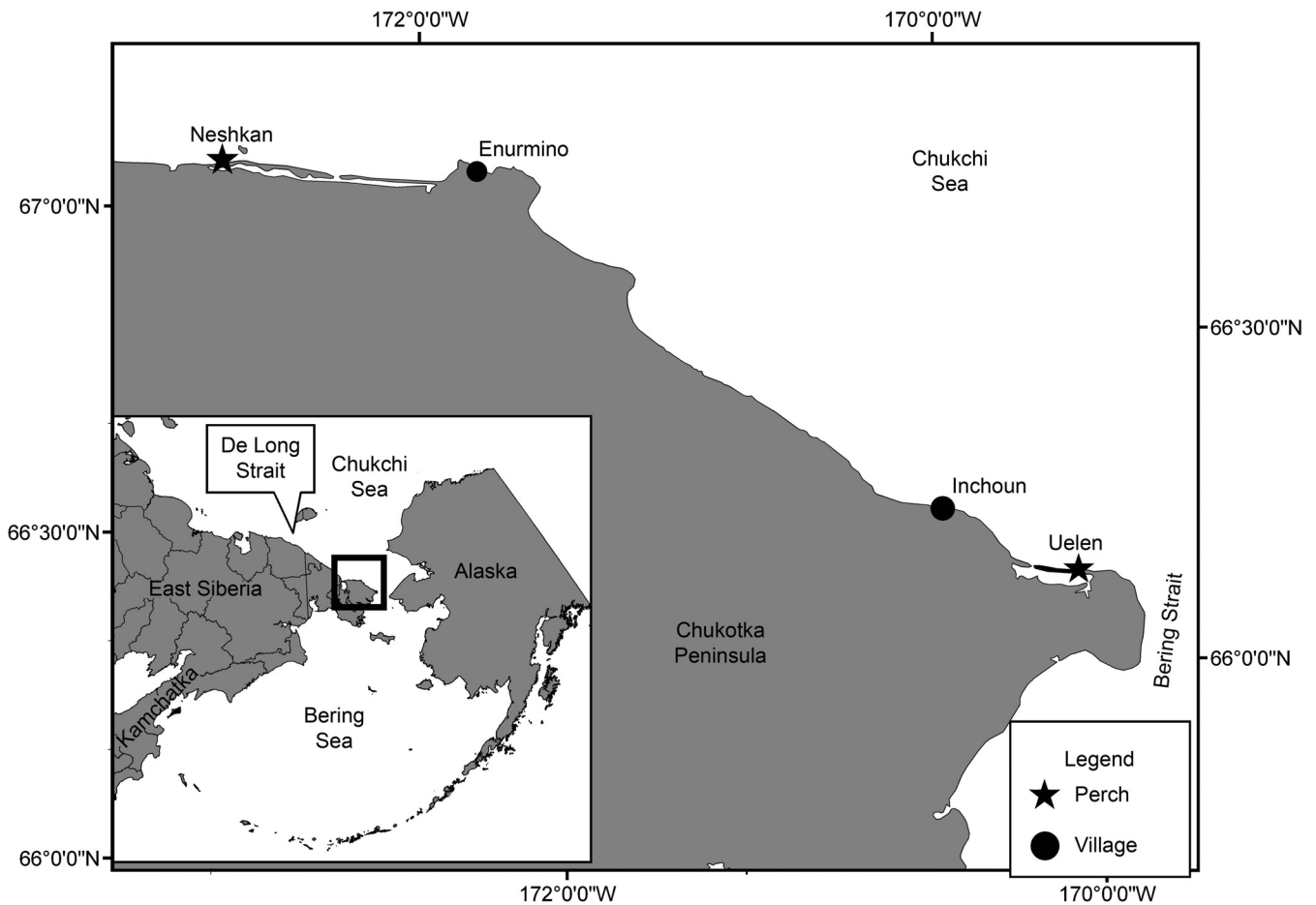


Fig. 1. Location of the observation perches from which bowhead whales were observed as they migrated along the Chukotka coast. Villages of the Northern Coast of the Chukchi Peninsula are also shown.

good or fair visibility. It is important to point out that in spring and summer day length is 24 hours but in autumn it is only 4 hours. Numbers of bowhead whales sighted by observers were augmented by information received from other people and hunters sighting marine mammals from villages, camps, and from boats. Such information is reliable and important to the success of the hunters, and therefore of use to the project as well. Although a hunter in a boat during a hunting expedition may have had a low vantage point, they were constantly on the move, and all members of the crew watched out for marine mammals, often from dawn until dark. Information was compiled and visualised using the programs Excel, Access and GraphPad Prism 4.

## RESULTS

### Spring

Bowhead whales were seen as early as 21 May in 2011 and as late as 18 June in 2010 during spring observations near Uelen. No bowhead whales were seen from Neshkan during spring of any year.

In 2010, compact ice remained near Uelen before 22 May. Observation started at Uelen village 20 May, the first bowhead whale was seen on 28 May 2010, the last spring whale was reported on 18 June (Fig. 2). A total of 35 whales were observed during a 28 day observation period (Table 2). The average number of whales per day was 1.25 and the maximum was 11 on 6 June.

In 2011, the shorefast ice near Uelen broke up on 26 May, and the ice left completely on 22 June. Bowhead whales were first observed on 21 May and last on 2 June. A total of 45 whales were observed during the 30-day effective observation. The average number of whales per day was 1.73 and the maximum was 16 (Fig. 2).

In 2012, the ice break up was later than in previous years.

Table 1

Duration of observations in waters of Neshkan off the Chukotka Peninsula in 2010–12.

| Years | Number of observers | Survey start | Survey end | Total days |
|-------|---------------------|--------------|------------|------------|
| 2010  | 2                   | 28 May       | 30 Nov.    | 120        |
| 2011  | 3                   | 18 May       | 28 Nov.    | 145        |
| 2012  | 2                   | 01 Jun.      | 13 Dec.    | 359        |

Table 2

Results of observations of bowhead whales in the area of Uelen village during spring migration 2010, 2011, and 2012.

| Values                 | Years of observation |             |             |
|------------------------|----------------------|-------------|-------------|
|                        | 2010                 | 2011        | 2012        |
| Range of dates         | 20/05–28/06          | 05/05–30/06 | 04/06–30/06 |
| Number of observations | 28                   | 24          | 8           |
| Minimum of whales/day  | 0                    | 0           | 0           |
| Maximum of whales/day  | 11                   | 16          | 2           |
| Mean/day               | 1.3                  | 1.9         | 0.5         |
| Total whales           | 35                   | 45          | 4           |

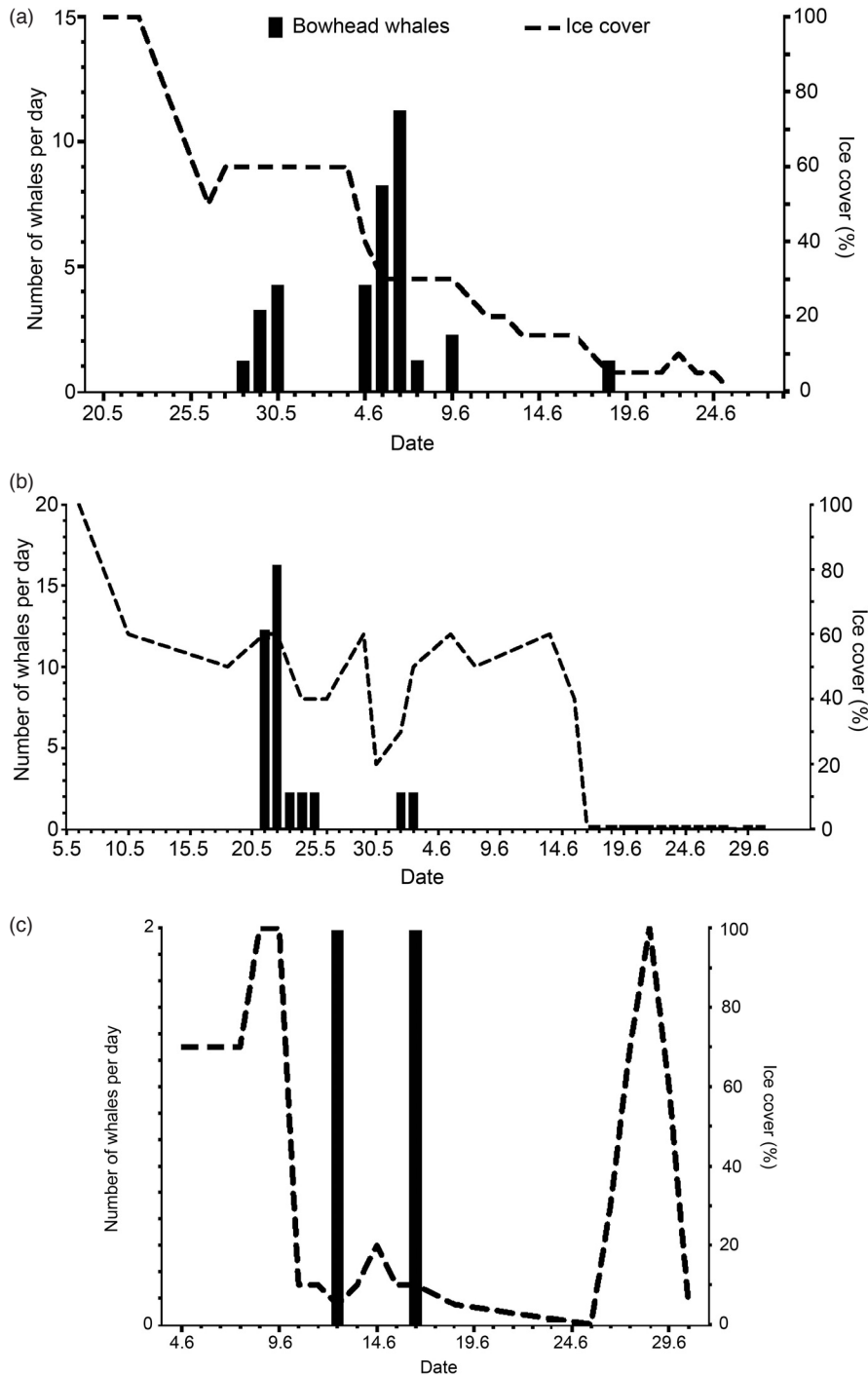


Fig. 2. Numbers of bowhead whales seen and ice cover for observations near Uelen during the spring 2010, 2011, 2012 ■ – effective observation in acceptable good or fair visibility.

In the western part of the Chukchi Sea heavy pack ice of 7/10 – 8/10 was present to the end of July. Only four bowhead whales were observed near Uelen; two on 12 June, and two on 16 June, during a 9-day effective observation (Fig. 2). As previous years, the whales were first seen during the breakup of the shorefast ice. It should be noted that Cape Peek on the south side of Cape Dezhnev, is the best place to view the spring migration. Observers saw 23 bowheads during ten intermittent observations from 18 May to 7 June.

**Summer**

During most of the summer of 2010 in De Long Strait, an ice bridge remained in place. Ice was absent for only a short

period in the last third of September. In July, bowhead whales were seen only twice. On 7 July a single whale was observed near Uelen community, and on 31 July three bowheads were seen near Neshkan village. Whales were 20km away from the shore among the drifted ice, which covered 50% of the water surface. In August, bowhead whales were sighted only once on 7 August, where six animals were seen 25km away from the coast in the ice-free waters (Fig. 3).

Most bowheads were seen in the middle of September in the ice free water ~5–10km off the northern shore of Chukotka Peninsula during hunting expeditions (Fig. 3). Bowheads were seen on four consecutive days in September

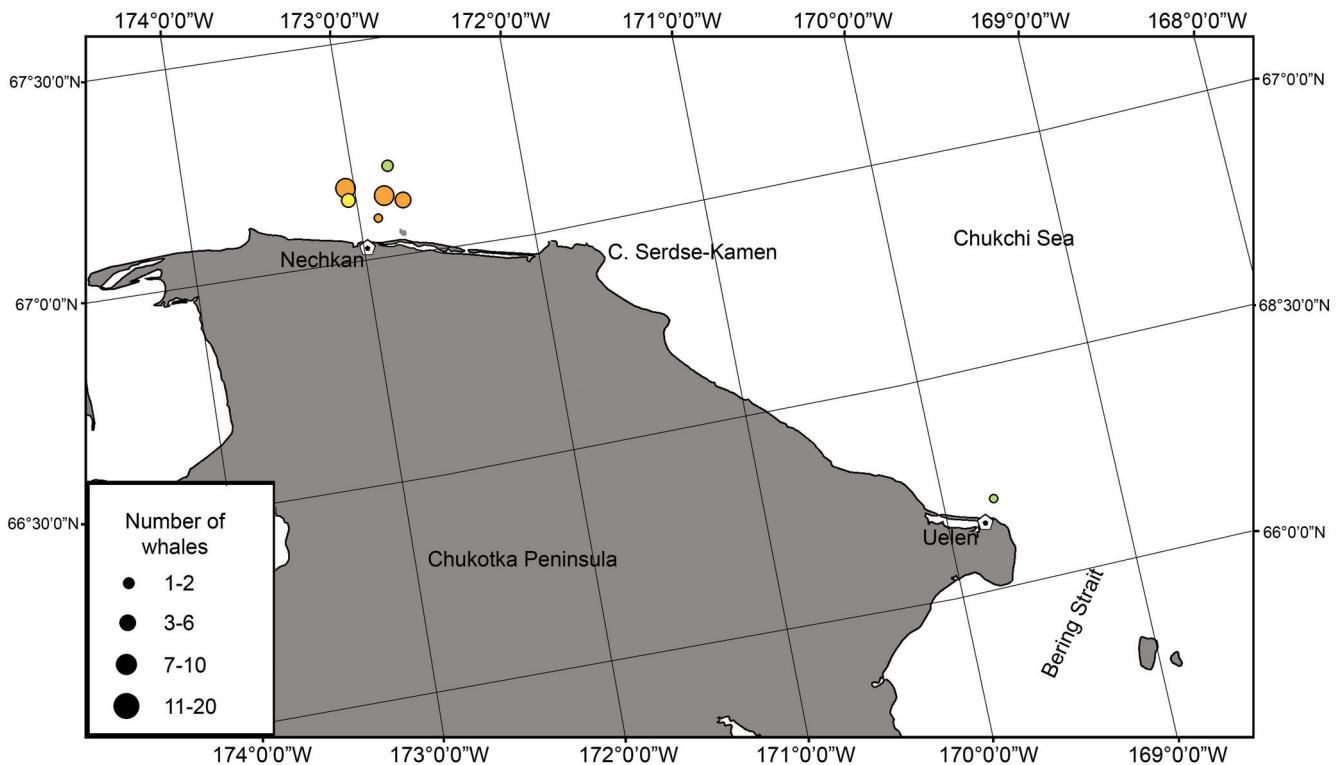


Fig. 3. Sightings of bowhead whales during July–September 2010. ● – July, ● – August, ● – September.

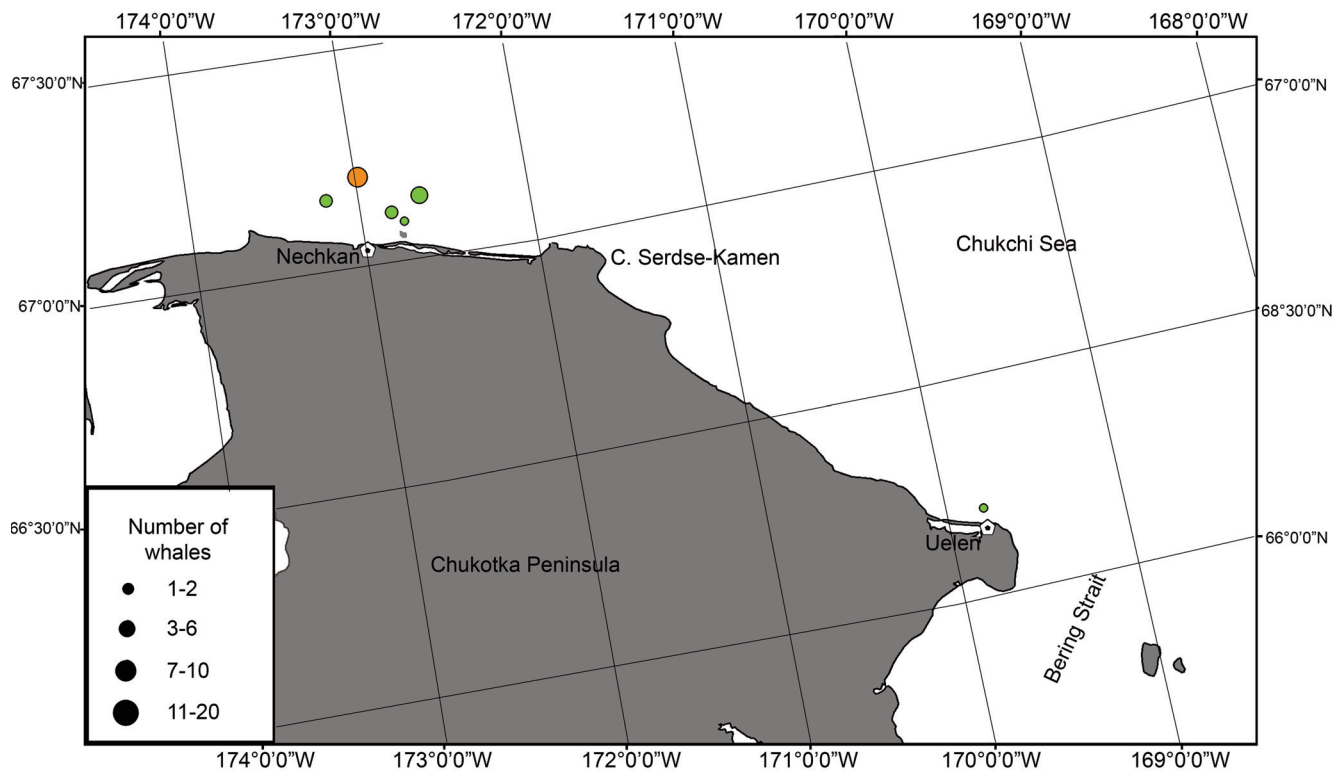


Fig. 4. Sightings of bowhead whales in July–September 2011. ● – July, ● – September.

(20 on 15 September, 15 on 16 September, 10 on 17 September, and 6 on 18 September).

During the summer of 2011, bowhead whales were regularly sighted in July, 10–20km offshore of Neshkan village during hunting trips (Fig. 4). Sightings of eight bowheads on 9 July, two on 18 July, three on 21 July and three on 27 July occurred among 60% ice cover. Only two bowheads were

observed near Uelen village on 28 August close to shore (1–2km). Observers did not see bowhead whales most of September. On 30 September, however, 17 whales were observed near Neshkan about 10km offshore. The appearance of bowheads on the last day of September 2011 was seemingly linked with the autumn migration because later on 1 October 2011 in this area groups of bowheads were seen moving east.

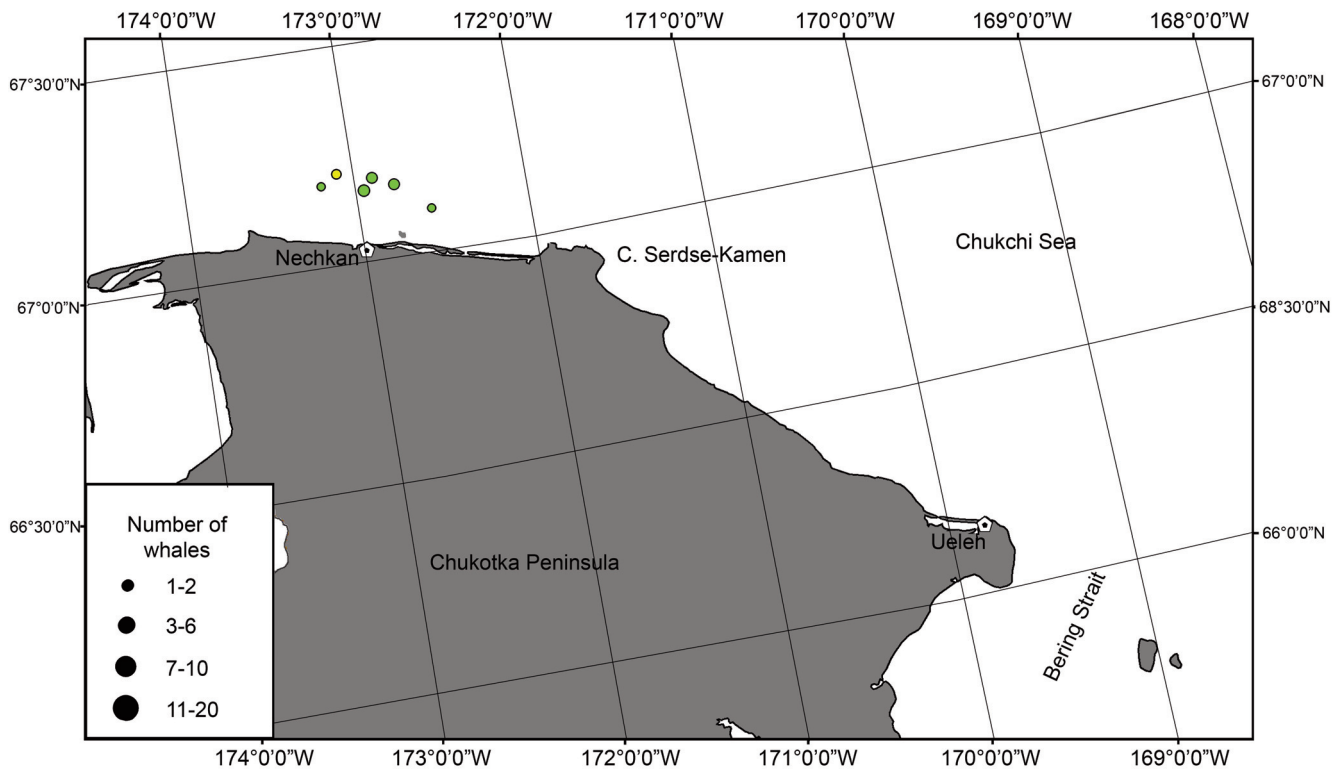


Fig. 5. Sightings of bowhead whales in July–August 2012. ● – July, ● – August.

During July and August 2012, drift ice covered the northern part of the peninsula. The northern coast became ice-free only after about 10 September, while the De Long Strait was still covered with ice.

In July 2012 bowhead whales were regularly observed 10–30km offshore of Neshkan in singles and small groups of up to six individuals (Fig. 5). The last bowhead whale was seen on 2 August. Later observers did not see any bowhead whales in either August or September on the northern coast of the Chukchi Peninsula.

On the whole, the observations in July–September 2010–2012 show that in the northern coastal waters of Chukotka Peninsula, the average number of bowheads seen per day can vary from 0.2 to 1.5 individuals, that is, more than seven times (Table 3).

**Autumn**

In autumn 2010, the De Long Strait and the western part of the Chukchi Sea were filled by young ice in mid-October. The shorefast ice began formation in early November. By the last third week of November, the Chukchi Sea was completely covered by young ice. Along of northeast coast

Chukotka peninsula, shore fast ice formed at beginning of December.

In mid-October, the groups of bowheads observed from Neshkan did not appear to be migrating. On 8 November, when shuga (spongy ice lumps) appeared after an intense snowstorm, whales began moving east (Fig. 6). Observations were recorded in a large group of about 20 migrating whales. In the days following 10 November, numbers of migrating bowheads grew, reaching a maximum of 30 individuals per 4 hours of day light. A long and powerful autumn storm interrupted our observation for 6 days. Afterwards, the next animals seen were observed on 19 November. During the 4 hours of available daylight observers counted 20 animals. Later, the number of animals decreased, but every day with good visibility from 2–10 animals were sighted about 3–5km from the shore, migrating east. The autumn migration in the Neshkan area ended in the last days of November when shorefast ice 8km wide formed and ice floes became numerous.

In the Bering Strait area during autumn 2010, first bowheads appeared on 8 November. Near Uelen, 9 bowheads were ~3 km offshore (Fig. 6). In addition, observers saw a large number of blows on the horizon. The maximum number of whales (90 individuals) were observed on November 10 ~1–3km offshore. This wave of migration continued until November 11 when observations were interrupted by stormy weather. The next wave of the autumn migration observed from 27 November until 30 November. Bowheads moved into small areas of open water between ice fields, which covered ~90% of the water surface. It is likely that migration continued after observations ended on 30 November.

In 2011 young ice and shuga occupied the western part of the Chukchi Sea in the beginning of November. Then

Table 3

Results of observations of bowhead whales in the areas of Uelen and Neshkan villages during summer 2010, 2011, and 2012.

| Values                 | Years of observation |             |             |
|------------------------|----------------------|-------------|-------------|
|                        | 2010                 | 2011        | 2012        |
| Range of dates         | 01/07–19/09          | 01/07–30/09 | 01/07–30/09 |
| Number of observations | 40                   | 84          | 101         |
| Minimum of whales/day  | 0                    | 0           | 0           |
| Maximum of whales/day  | 20                   | 17          | 6           |
| Mean/day               | 1.5                  | 0.4         | 0.2         |
| Total whales           | 61                   | 33          | 16          |



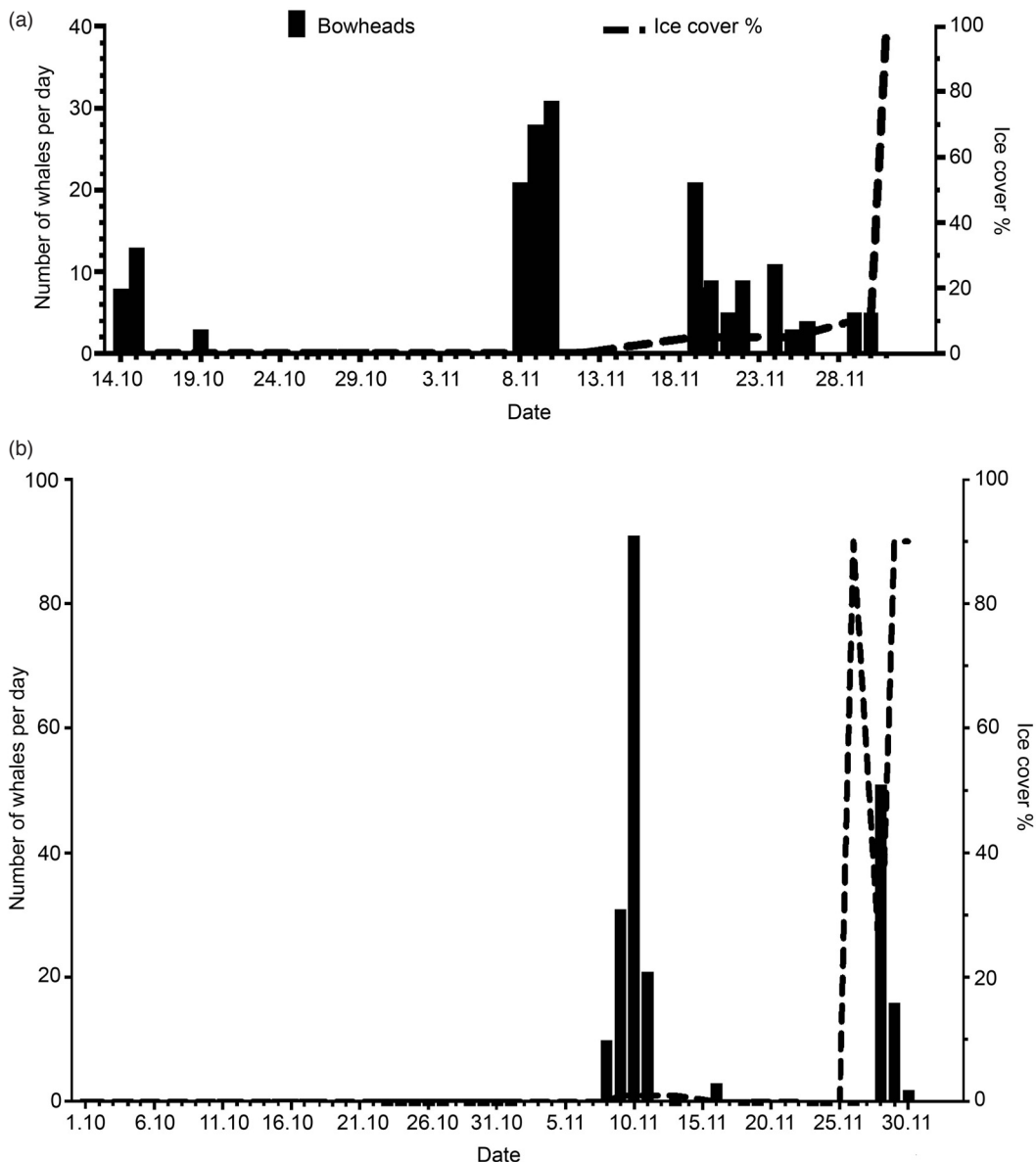


Fig. 6. Number of bowhead whales and percentage ice cover near Neshkan village (a) and Uelen (b) during the autumn 2010. Observation period in Neshkan 14.10–30.11, in Uelen 1.11–30.11. ■ – effective observation in acceptable good or fair visibility.

pancake ice began forming at the northern coast of the Chukchi Peninsula, which became a solid ice field. By the end of the third part of December, all Chukchi Sea was covered with young drifting ice.

Near Neshkan, bowheads were sighted from 30 September until 13 October when observation ended for the season. During hunting trips, groups of up to 54 individuals were observed within 6–10 km of shore (Fig. 7). Whales were reported to be feeding with no signs of ice or migration activity before observations ended near Neshkan village.

For Uelen, 2–8 bowheads were observed per day during the autumn observation period in 2011 (Fig. 7). Bowheads were observed after a heavy snowstorm on 15 November. The whales came in in two brief waves; the first from 16 to 20 November and the second on 26 and 27 November when ice began to form. Possibly the main migration moved through this area in December 2011, after observations ended for the season.

In 2012, ice was forming in the western part of the Chukchi Sea by mid-October and fields of young ice fully covered the western part of the Chukchi Sea by mid-November. Ice was flowing through Bering Strait and it covered the water surface fully on some days. In late November, the ice fields began to freeze together and by early December there was 100% cover.

Near Neshkan village, the first 20 whales were sighted on 1 October in open water at a distance 15–20 km offshore (Fig. 8). Bowheads observed in late October did not show any migration activity and were feeding 3–15 km offshore. Bowheads (1–7 individuals) began to move eastward when ice formation began from 4 to 8 November. On November 9, 40 bowheads were recorded. The last bowheads of the year were recorded on December 1 from the edge of the shorefast ice where 17 whales were seen feeding in a polynya.

Near Uelen, at the entrance to Bering Strait, the first bowhead whales were seen on 6 November, one day after

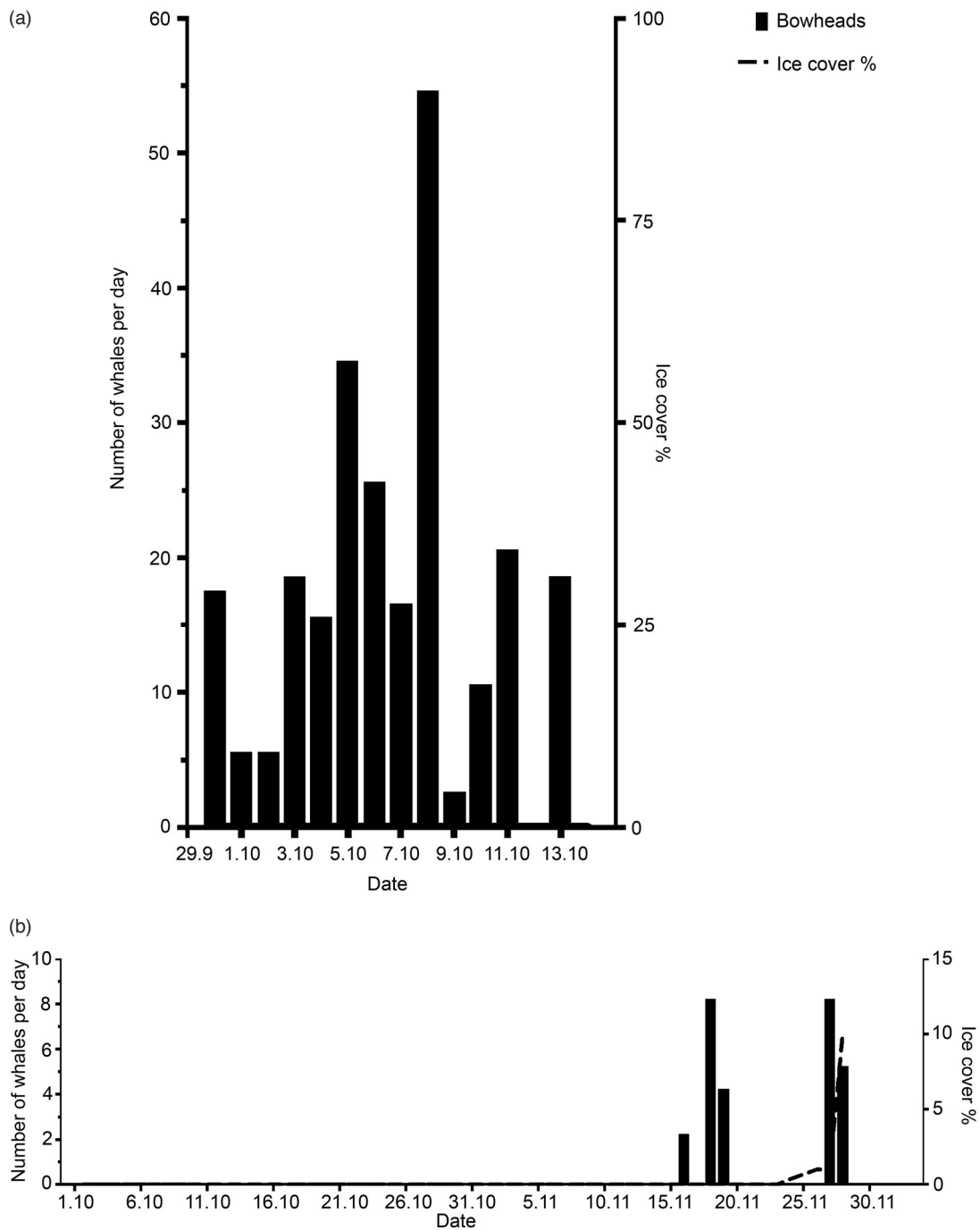


Fig. 7. Number of bowhead whales and percentage ice cover near Neshkan village (a) and Uelen (b) during the autumn 2011. Observation period in Neschkan 30.09–13.10, in Uelen 1.10–30.11. ■ – effective observation in acceptable good or fair visibility.

shuga ice, 2km in width, formed. The number of whales observed increased to a maximum of 50 on 13 November (Fig. 8). Many blows were seen on the horizon indicating more whales (perhaps several thousand) were passing through the Strait than could be counted from shore during that period. Observations were not possible on 15 November because of a storm, but then whales came toward the Strait with about the same intensity and many blows were seen on the horizon. No whales or blows were seen on 18–19 November, even though the weather was calm and the visibility was good. The migration started again on November 20 along with arrival of a large mass of ice, which almost covered the entire sea. Observers saw the

Table 4  
Results of observations of bowhead whales in the Chukchi Sea off the north coast of the Chukotka Peninsula.

|                         | Years of observation |             |             |
|-------------------------|----------------------|-------------|-------------|
|                         | 2010                 | 2011        | 2012        |
| Range of dates          | 29/09–01/12          | 01/10–30/11 | 01/10–05/12 |
| Number observation days | 54                   | 53          | 86          |
| Minimum                 | 0                    | 0           | 0           |
| Maximum                 | 90                   | 90          | 50          |
| Mean                    | 7.2                  | 7.3         | 6.5         |
| Std. deviation          | 15.56                | 15.68       | 11.59       |
| Std. error              | 2.12                 | 2.15        | 1.25        |
| Total whales            | 388                  | 388         | 555         |

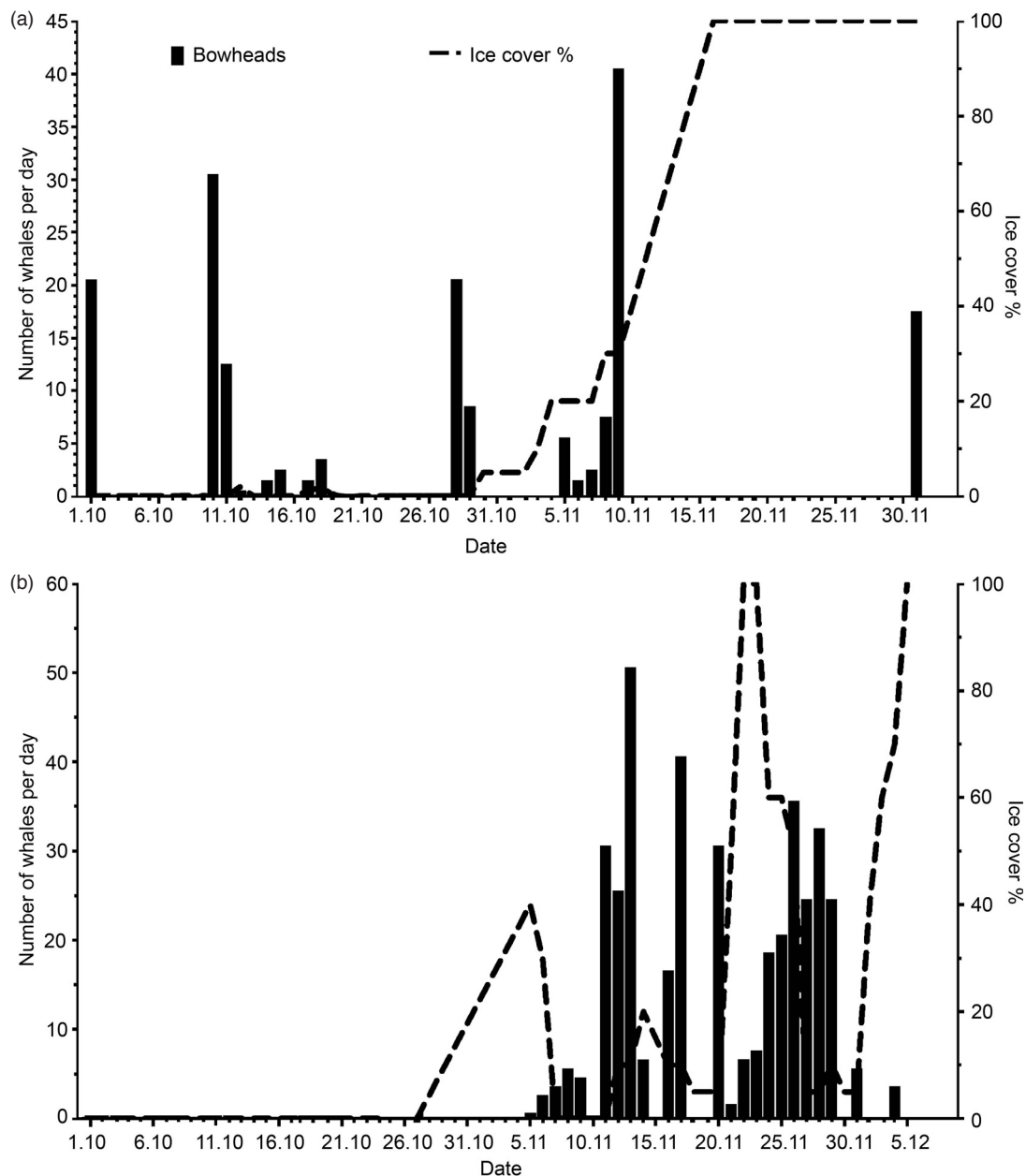


Fig. 8. Number of bowhead whales and percentage ice cover near Neshkan village (a) and Uelen (b) during the autumn 2012. Observation period in Neshkan 1.10–1.12, in Uelen 1.10–5.12. ■ – effective observation in acceptable good or fair visibility

last whales in the freezing ice-holes at the beginning of December.

Summary of bowhead whale observations in the Chukchi Sea off the north coast of the Chukotka Peninsula in autumn 2010, 2011 and 2012 show that the number of whales registered on average per day remained stable and varied only from 6.5 to 7.3 animals (Table 4).

## DISCUSSION

The spring migration of bowhead whales was observed near Uelen village, on the northwestern entrance to the Bering Strait, but not at Neshkan on the northern coast of the Chukotka Peninsula, indicating that the spring migration route does not follow the Chukotka coast. The migration occurred from the end of May to mid-June. Numbers observed ranged from 4–45 and were lowest in 2012 (Table 2). During spring 2012, the ice cover in the western part of the Chukchi Sea stayed longer than in previous years and

likely negatively affected the number of bowheads observed. Perhaps observers did not see whales, as their silhouettes and spouts can be particularly difficult to observe among the ice floes. Whales may also avoid cohesive ice masses as this can complicate their migratory movements.

Bowhead whales typically migrate to the Canadian Beaufort Sea and the Gulf of Amundsen in spring and remain there during summer months (Moore and Reeves, 1993). However, not all whales stay there for the summer and some leave and return within the summer season. Satellite telemetry data tracked one whale that left the Canadian Beaufort Sea on 13 July and arrived near Barrow AK on 21 July. The same whale went to the northern part of the Chukchi Peninsula by 28 July and stayed there until the end of feeding season in November (Quakenbush, 2007; Quakenbush *et al.*, 2012). Another tagged whale left the Canadian Beaufort Sea and went to Barrow before returning to the Canadian Beaufort. It moved west again to the



northern part of the Chukchi Sea on July 29 and remained near Chukotka until the beginning of the autumn migration. Results of satellite tagging demonstrated that bowhead whales can migrate long distances in a short period of time. Such mobility allows them to quickly form aggregations in feeding areas separated by long distances. Therefore, bowhead whales seen in the Chukchi Sea and the northern coast of the Chukchi Peninsula in summer could be whales that have returned from the Canadian Beaufort Sea. However, there is also evidence that some whales may summer in the Chukchi Sea exclusively: one whale tagged near Barrow in August 2009 migrated past Uelen on approximately the 26 May 2010 and continued to travel parallel to the Chukotka coast but was too far offshore to be seen from Neshkan (see fig. 8 in Quakenbush *et al.*, 2013). This whale spent July and most of August moving southward along the northern Chukotka coast until the tag stopped transmitting near Enurmino on 21 August 2010.

Summer observations 2010–2012 show that the relative abundance in the northern coastal Chukotka Peninsula varied by seven times between years, which coincides with the differences in the approaches of whales in the coastal waters of Alaska in the Beaufort Sea (Treacy, 1997). In summer, bowhead whales occur in the Chukchi Sea in years with high ice coverage as well as in years that are ice free. Based on the long-term data for summer distribution in the coastal waters of the Chukchi Peninsula, we conclude that bowheads occur regularly and their occurrence is not related to the ice conditions (Melnikov, 2014).

The BCB bowhead population is increasing with annual increase rate 3.7% (Givens *et al.*, 2013). Even though research effort for 2010–2012 was less than 1994–1996, and 2002, 2003 and 2005, the number of sightings of bowhead whales along the north shore waters Chukotka Peninsula increased by 1.3 times (Table 5). Although, Mann-Whitney test shows no significant differences in median ( $p = 0.49$ ), we think that in summer time the bowhead whale population near Chukotka coast is increasing, but the rate of growth is not so significant as a result of accounting in the Barrow area.

It has long been known that large numbers of bowheads visit the northern coast of the Chukotka Peninsula in autumn (Tomilin, 1957; Miller *et al.*, 1986; Moore *et al.*, 1995). Observations from 1990–2003 also demonstrated that whales

visited the Chukotka coast in autumn before ice formation, appearing first along the northern coast, then moving southward towards Bering Strait as the ice forms. Typically, the autumn migration was first observed 2–3 weeks earlier near Neshkan than near Uelen in Bering Strait (Melnikov, 1993; Bobkov, 1993; Zelensky *et al.*, 1995; 1996; 1997; Melnikov *et al.*, 2002; Melnikov, 2014).

Averages of bowhead whale numbers along the northern coast of the Chukotka Peninsula for all years of observations prior to this study show that large fluctuations in numbers of whales per day is typical for the autumn migration (Fig. 9). Two peaks in the numbers are seen at both locations suggesting two waves of whales moving south during migration. The first wave begins with the ice formation both in the northwestern and northeastern coasts of Chukotka. The number of whales in the northwestern coast can increase rapidly. Although the migration occurs in waves a relatively large number of whales can remain in the area until early December. As observed from Neshkan and Enurmino, the migration occurs in two waves, but both waves are longer in duration than in Inchoun and Uelen area. The number of migrating bowhead whales drops when ice cover reaches 50%–60% in the northwestern and northeastern coasts of the Chukchi Sea. The last whales pass by when the ice coverage increases to 100%.

Thus, the autumn migration of bowhead whales began with ice formation and ended with the complete freezing of the waters off the Chukchi Peninsula. However, this varies in both time and amplitude.

The result of studies from 1990 to 2003 (Melnikov, 2014) and this study 2010–12 show that the north coast of the Chukotka Peninsula is an important bowhead whale autumnal feeding area. As the sea ice formation increases in the feeding area, bowheads begin migrating towards Bering Strait (Melnikov, 1993; Bobkov, 1993; Melnikov *et al.*, 1998; 2002; Melnikov, 2014). The results of the satellite tagging in the recent years are consistent with our shore-based observations (Quakenbush *et al.*, 2010; 2012; 2013). The vast majority of the tagged bowhead whales spent two months in the northern coast of Chukotka in autumn. This confirms that the northeastern Chukotka coast is one of the most important feeding areas for BCB bowhead whales anywhere in their range. The observations allow us to track the course of the seasonal whale migrations in the Chukchi Sea.

Table 5

Summary of bowhead whale observations in the Chukchi Sea off the north coast of the Chukotka Peninsula in summer only for all years monitored.

|                           | Observation years |                  |         |
|---------------------------|-------------------|------------------|---------|
|                           | 1994–96           | 2002, 2003, 2005 | 2010–12 |
| Number of observations    | 1,107             | 530              | 172     |
| Mean no. of whales/day    | 0.19              | 0.25             | 0.24    |
| Maximum no. of whales/day | 9                 | 20               | 8       |
| Minimum no. of whales/day | 0                 | 0                | 0       |
| Std. deviation            | 0.92              | 1.58             | 1.04    |
| Std. error                | 0.028             | 0.07             | 0.08    |
| Lower 95% CI of mean      | 0.14              | 0.11             | 0.09    |
| Upper 95% CI of mean      | 0.24              | 0.38             | 0.4     |
| Total whales              | 210               | 130              | 42      |

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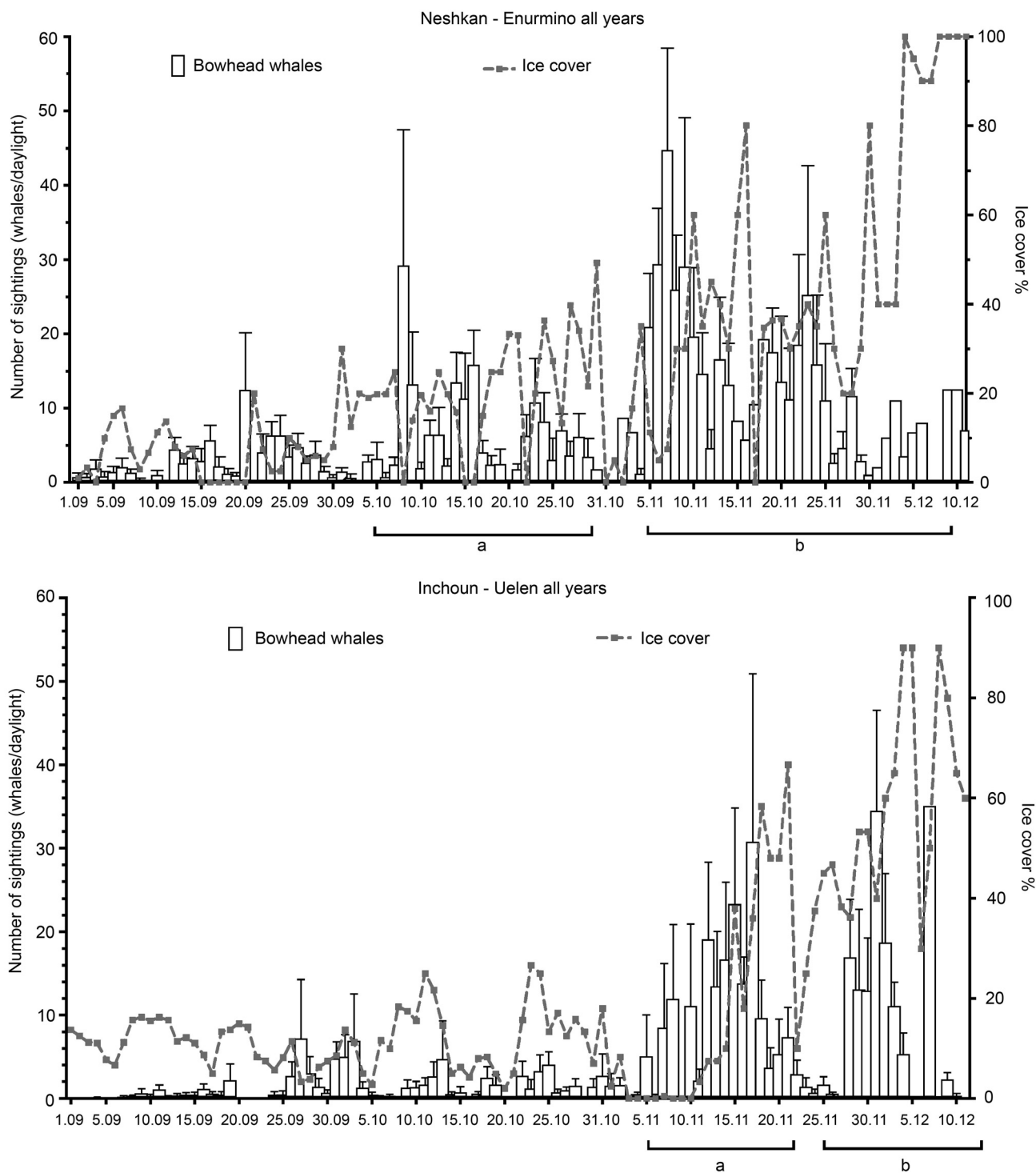


Fig. 9. Arithmetic mean number of bowhead whales for the 1990–2003 in September, October, and November and mean percent sea ice cover along the northern coast of the Chukchi Peninsula (Neshkan and Enurmino, upper panel) and near Inchoun and Uelen (lower panel) (Melnikov, 2014). Vertical line designates the standard error. **a** – first wave of autumn migrants. **b** – second wave of autumn migrants. In 2005 observations were ended on 25 July for the season.

#### REFERENCES

- Givens, G.H., Edmondson, S.L., George, J.C., Suydam, R., Charif, R.A., Rahaman, A., Hawthorne, D., Tudor, B., DeLong, R.A. and Clark, C.W. 2013. Estimate of 2011 abundance of the Bering-Chukchi-Beaufort Seas bowhead whale population. Paper SC/65a/BRG01 presented to the IWC Scientific Committee, June 2013, Jeju Island, Republic of Korea (unpublished). 30pp. [Paper available from the Office of this Journal].
- Melnikov, V. and Bobkov, A.V. 1991. On the bowhead whale migrations in the Chukchi Sea. *Oceanology* 33(5): 643–47.
- Melnikov, V., Zelensky, M. and Bichkov, V. 1997. Seasonal migration and distribution bowhead whale in waters of Chukotka. *Russ. J. Mar. Biol.* 23(4): 199–208.
- Melnikov, V.V. 2014. *Whales (Cetacea) of the Pacific Sector of the Arctic: History of Whaling, Modern Distribution, Migration, Abundance*. Dalnauka, Vladivostok: 396pp.
- Melnikov, V.V. and Bobkov, A.V. 1996. Distribution and migration of marine mammals in the Chukchi Sea and northern Bering Sea. Vladivostok. Dep. VINITI N1053-B96, 96pp.
- Melnikov, V.V., Zelensky, M.A. and Ainana, L.I. 1998. Observations on distribution and migration of bowhead whales (*Balaena mysticetus*) in the Bering and Chukchi Seas. Paper SC/50/AS3 presented to the IWC Scientific Committee, April 1998 (unpublished). 31pp. [Paper available from the Office of this Journal].
- Miller, R.V., Rugh, D.J. and Johnson, J.H. 1986. The distribution of bowhead whales, (*Balaena mysticetus*) in the Chukchi Sea. *Marine Mammal Science* 2(3): 214–22.

- Moore, S.E., George, J.C., Coyle, K.O. and Weingartner, T.J. 1995. Bowhead whales along the Chukotka coast in autumn. *Arctic* 48(2): 155–60.
- Moore, S.E. and Reeves, R.R. 1993. Distribution and movement. pp.313–86. In: Burns, J.J., Montague, J.J. and Cowles, C.J. (eds). *The Bowhead Whale*. Special Publication No. 2. Society for Marine Mammalogy, Lawrence, KS. 787pp.
- Quakenbush, L. 2007. Preliminary satellite telemetry results for Bering-Chukchi-Beaufort bowhead whales. Paper SC/59/BRG12 presented to the IWC Scientific Committee, May 2007, Anchorage, USA (unpublished). 2pp. [Paper available from the Office of this Journal].
- Quakenbush, L., Citta, J., George, J.C., Heide-Jørgensen, M.P., Small, R., Brower, H., Harwood, L., Adams, B., Brower, L., Tagarook, G., Pokiak, C. and Pokiak, J. 2012. Seasonal movements of the Bering-Chukchi-Beaufort stock of bowhead whales: 2006–2011 satellite telemetry results. Paper SC/64/BRG1 presented to the IWC Scientific Committee, June 2012, Panama City (unpublished). 22pp. [Paper available from the Office of this Journal].
- Quakenbush, L.T., Small, R.J. and Citta, J.J. 2013. Satellite tracking of bowhead whales: movements and analysis from 2006 to 2012. Report to the US Department of Interior. OCS Study BOEM 2013-01110. 123pp.
- Tomilin, A.G. 1957. *Zveri SSSR i Prilezhasfchikh Stran. Zveri Vostochnoi Evropy i Severnoi Azii*. Vol. IX. Kitoobraznye. Izdatel'stvo Akademi Nauk SSSR (Soviet Academy of Sciences Publishers), Moscow. 756pp. [Translated in 1967 as *Mammals of the USSR and Adjacent Countries. Mammals of Eastern Europe and Adjacent Countries. Vol. IX. Cetacea* by the Israel Program for Scientific Translations, Jerusalem, 717pp. [In Russian].
- Treacy, S.D. 1996. Aerial surveys of endangered whales in the Beaufort Sea, Fall 1995. US Department of the Interior, Anchorage, AK. (OCS Study MMS 96-0006). 5pp.