

How many diurnal migrants cross the Baltic Sea at night?

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Introduction

Whereas nocturnal migration across the Baltic Sea is generally thought to occur in broad front different spatial migration patterns occur in diurnal migrants. However, besides the obvious migration of soaring raptors along the "Vogelfluglinie" (Fig. 1) the crossing behaviour of other diurnal landbirds remains largely unexplored. Observations on visible bird migration at two offshore sites between the islands Møn and Bornholm carried out between 2002 and 2004 enabled us to quantify the visible autumn migration of passerines offshore across the Baltic Sea in relation to the "Vogelfluglinie" (counts at Falsterbo). The migration strategies and routes of several species can be quantified now by a combination of 1) data on breeding populations in Sweden, 2) simultaneous data on visible bird migration at coastal sites (Falsterbo, Darßer Ort), and 3) simultaneous data on visible bird migration offshore (carried out in combination with radar observations). The application of vertically operated surveillance radars on research vessels offshore provided important information about the intensity and altitude distribution of bird migration, which also allow us to judge the portion of nocturnal migration in so-called "diurnal" migrants.

Results

The migration characteristics of three common "diurnal" Scandinavian passerines are presented in Tab. 1. By adding the total turnover estimates at Falsterbo ("Vogelfluglinie") and offshore in the western Baltic Sea, it became obvious, that only up to 6% of all "diurnal" migrants in autumn are visible during daytime. Migration rates at Adlergrund generally exceeded the rates at Kriegers Flak. Total numbers of Chaffinch/Brambling recorded at Falsterbo were much higher than the offshore estimate (indicating a preferred daytime passage over land) while Skylarks and Meadow Pipits seem to pass on broad front also offshore (compare total number of birds per season and traffic rates). Swallows and martins also cross the western Baltic on broad front (Tab. 2) with highest rates for the Barn Swallow (31% of visible migration over sea) followed by House Martin and Sand Martin. Although the Swedish population estimate is rather similar for all three species, the number of observed individuals differs considerably between Barn Swallow and the two martins. This difference probably reflects different flight altitudes during migration.

Tab. 1. Migration characteristics of three different species of passerines.

	Chaffinch Brambling	<i>Fringilla coelebs</i> <i>F. montifringilla</i>	Skylark <i>Alauda arvensis</i>	Meadow Pipit <i>Anthus pratensis</i>
mean migration traffic rates [ind.*h⁻¹]				
Falsterbo	1,002.0		4.7	16.5
Kriegers Flak	1.1		0.2	0.5
Adlergrund	3.8		0.5	1.9
Darßer Ort	22.3		4.0	4.1
individuals visible migration				
mean no. in Falsterbo (1973-2001) ¹	746,241		1,302	8,260
no. per season offshore ²	435,600		79,200	165,000
Swedish pop. size/migr. volume				
breeding pairs ³	13,000,000		700,000	750,000
ind. during autumn migration ⁴	52,000,000		2,800,000	3,000,000
visible migration (% of migr. volume)				
at Falsterbo	1.44		0.05	0.28
offshore betw. Møn and Bornholm	0.84		2.83	5.50
% visible migration	2.27		2.88	5.78
-->% non-visible migration	97.73		97.12	94.22

¹ http://www.skof.se/fbo/index_e.html
² assumptions: broad-front migration of Swedish population with migration rates of Kriegers Flak between Møn and Bornholm (200km) registration 250m around research vessel; length of migration period according to www.skof.se/fbo/index_e.html (Falsterbo) and Lausten & Lyngs (2004, Christiansø), average day-length in period
³ breeding pairs within range in Heath et al. 2000 according to given trend status and TRIM-index for Swedish population (<http://www.biol.lu.se/zoekologi/birdmonitoring/index.html>)
⁴ with conservative estimate for reproductive rate (=2 fledged chicks per pair in passerines); individuals autumn migration=(2ad.+3juv.)*breeding pairs

Tab. 2. Migration characteristics of three species of swallows/martins.

	Barn Swallow	House Martin	Sand Martin
	<i>Hirundo rustica</i>	<i>Delichon urbica</i>	<i>Riparia riparia</i>
mean migration traffic rates [ind.*h⁻¹]			
Falsterbo	25.3	12.9	4.1
Kriegers Flak	0.7	0.05	0.02
Adlergrund	1.6	0.2	0.02
Darßer Ort	5.4	0.6	1.9
individuals visible migration			
mean no. in Falsterbo (1973-2001) ¹	22,557	5,527	3,617
no. per season offshore ²	470,400	33,600	15,680
Swedish pop. size/migr. volume			
breeding pairs ³	300,000	150,000	150,000
ind. during autumn migration ⁴	1,500,000	750,000	750,000
visible migration (% of migr. volume)			
at Falsterbo	1.50	0.74	0.48
offshore betw. Møn and Bornholm	31.36	4.48	2.09
% visible migration	32.86	5.22	2.57
-->% non-visible migration	67.14	94.78	97.43

¹ http://www.skof.se/fbo/index_e.html
² assumptions: broad-front migration of Swedish population with migration rates of Kriegers Flak between Møn and Bornholm (200km) registration 250m around research vessel; length of migr. period according to www.skof.se/fbo/index_e.html (Falsterbo) and Lausten & Lyngs (2004, Christiansø), av. daylength
³ breeding pairs within range in Heath et al. 2000 according to given trend status and TRIM-index for Swedish population (<http://www.biol.lu.se/zoekologi/birdmonitoring/index.html>)
⁴ with conservative estimate for reproductive rate (=3 fledged chicks per pair in swallows); individuals autumn migration=(2ad.+3juv.)*breeding pairs

Methods and study area

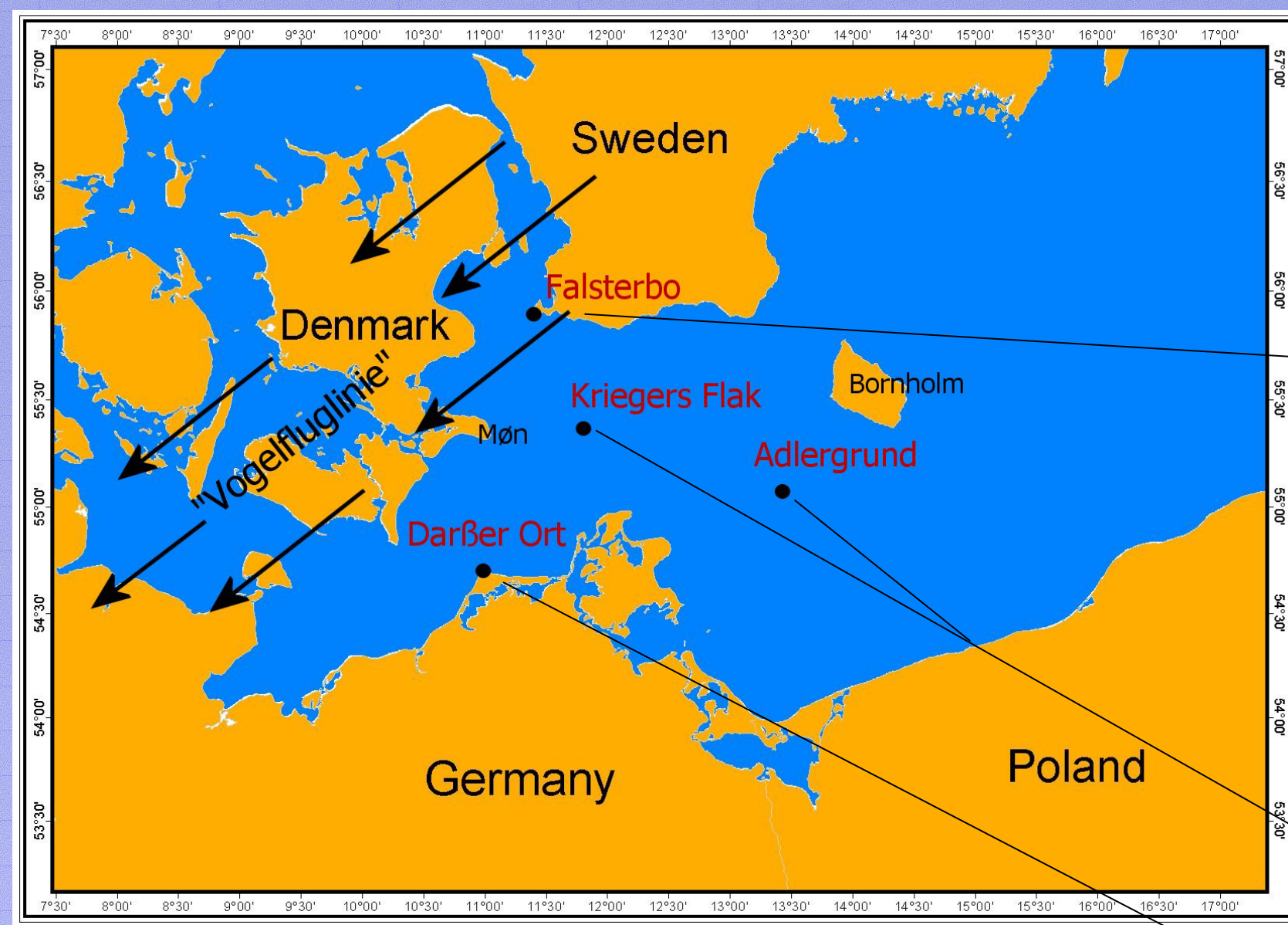


Fig. 1. Study sites in the western Baltic Sea

The population sizes of Swedish passerines are based on Heath et al. (2000, European Bird Populations; Cambridge, UK, BirdLife Int.). Within the given population range, trend and TRIM-index (<http://www.biol.lu.se/zoekologi/birdmonitoring/index.html>) are considered. The estimate of total autumn migration volume is based on a conservative estimation of either 2 or 3 (for swallows) fledged chicks per pair per season. Bird numbers at Falsterbo are long-term average numbers from 1973-2001 for autumn migration (http://www.skof.se/fbo/index_e.html). The observation sites were located either at coastal sites (Sweden: Falsterbo, Germany: Darßer Ort) or at two sites offshore (Fig. 1). The intensities are calculated as the number of birds per hour (average per season). The analyses are restricted to autumn values. A vertically tilted surveillance radar (Furuno/Bridgemaster) on research vessels at the offshore sites recorded migration intensities (see twin poster for method).



Falsterbo. Systematic migration counts each year in autumn from August to mid November from dusk up to 14:00 local time. Data used for calculation of traffic rates: autumn 2002 and 2003.



Offshore (Kriegers Flak, Adlergrund). Migration counts from research vessels in two different offshore areas during the period of daylight on approximately 100 days (for each area) in spring and autumn of the years 2002-2004.



Darßer Ort. Systematic migration counts from an observation tower (building on photo next to radio tower) during the period of daylight on approximately 100 days in autumn 2002/2003.

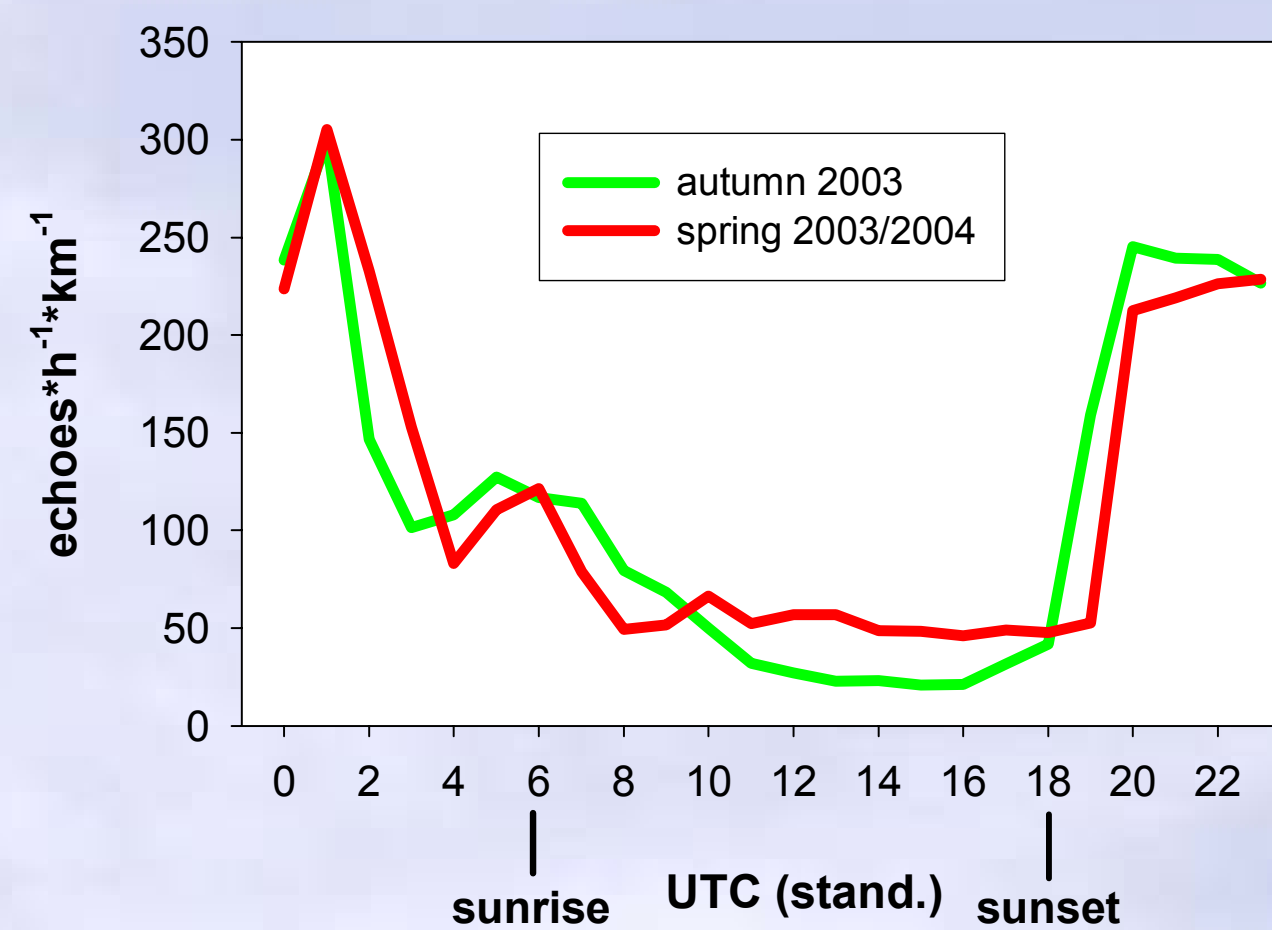


Fig. 2. Migration intensity in the course of daytime (standardized) during spring and autumn migration at the offshore site „Kriegers Flak“.

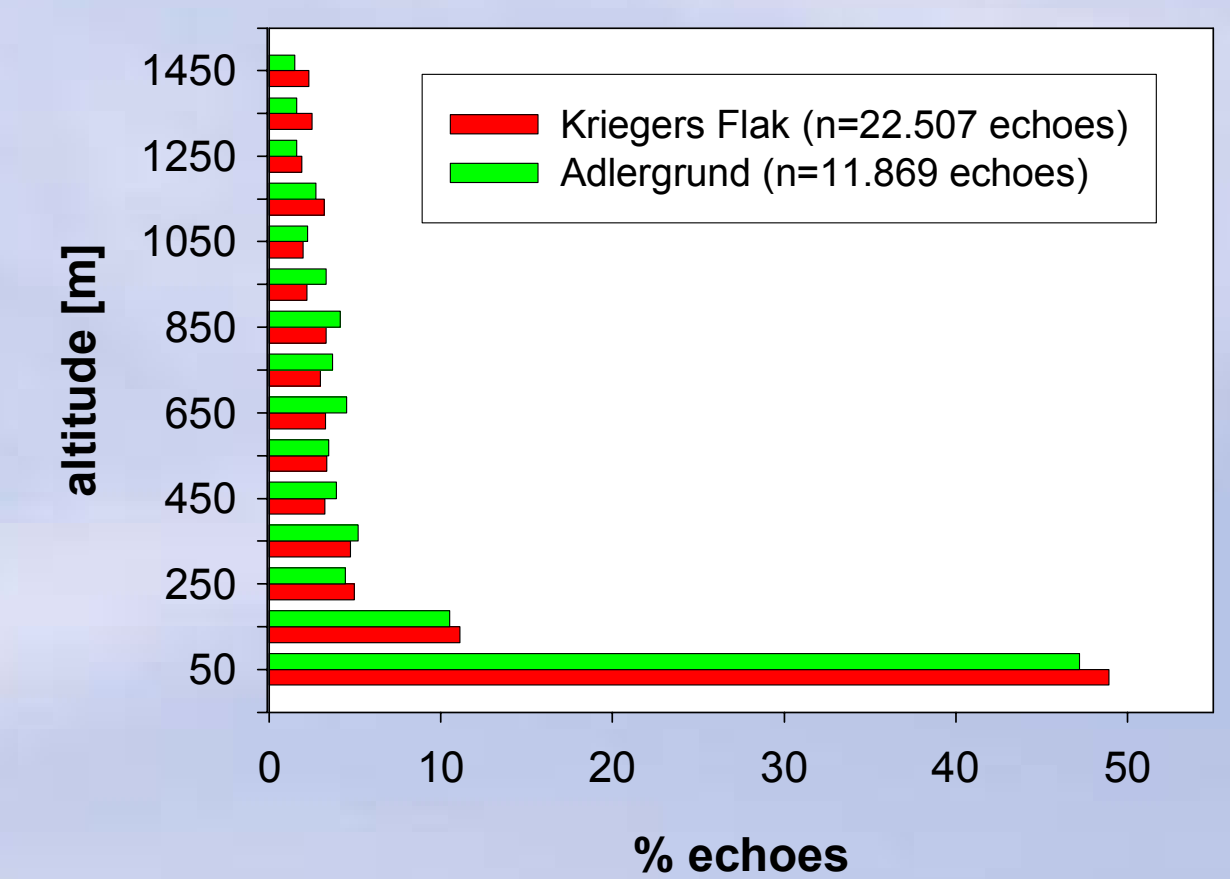


Fig.3. Altitude distribution of bird echoes during diurnal migration at the two offshore sites „Kriegers Flak“ and „Adlergrund“.

Radar measurements of bird migration offshore revealed mean traffic rates of less than 50 echoes h⁻¹km⁻¹ during daytime (especially from mid-day to afternoon), which represent only about 10 % of the nocturnal migration intensity (Fig. 2). Most echoes were recorded at heights of about 50-100m (Fig. 3). The majority of echoes below 100 m were caused by large gulls (especially *Larus argentatus*).

Discussion

The examples shown here represent a first approach to quantify bird migration in the western Baltic Sea according to (1) spatial distribution and (2) temporal distribution in the course of the day. Our data clearly show that:

- a considerable amount of diurnal migrants passes commonly at heights outside visibility (above 50-100 m), (see Tab. 2 for swallows, and Fig. 4 for Chaffinch migration at high altitude recorded by radar),
- according to overall low mean traffic rates at heights of up to 1,000 m during daytime (as recorded by radar), a large portion of "diurnal" migrants have to cross the western Baltic at night.

Still some difficulties have to be considered:

- the migration route "Vogelfluglinie" is not restricted to Falsterbo (though it surely is a major focus) but substantial numbers of birds cross the Danish islands also north of Falsterbo,
- not all birds which cross the western Baltic breed in Sweden. Individuals of several populations from Finland regularly pass Bornholm (ring recoveries from Christiansø, Fig. 5). Birds breeding in Norway seem to be of minor importance. Thus population estimates for Sweden represent only minimum estimates for the number of passing birds. Various Finnish diurnal landbirds seem to follow the Swedish east coast and cross the western Baltic via Öland-Bornholm-Rügen. This assumption is in line with a generally higher intensity of daytime migration at "Adlergrund" compared to "Kriegers Flak" (Tab. 1).

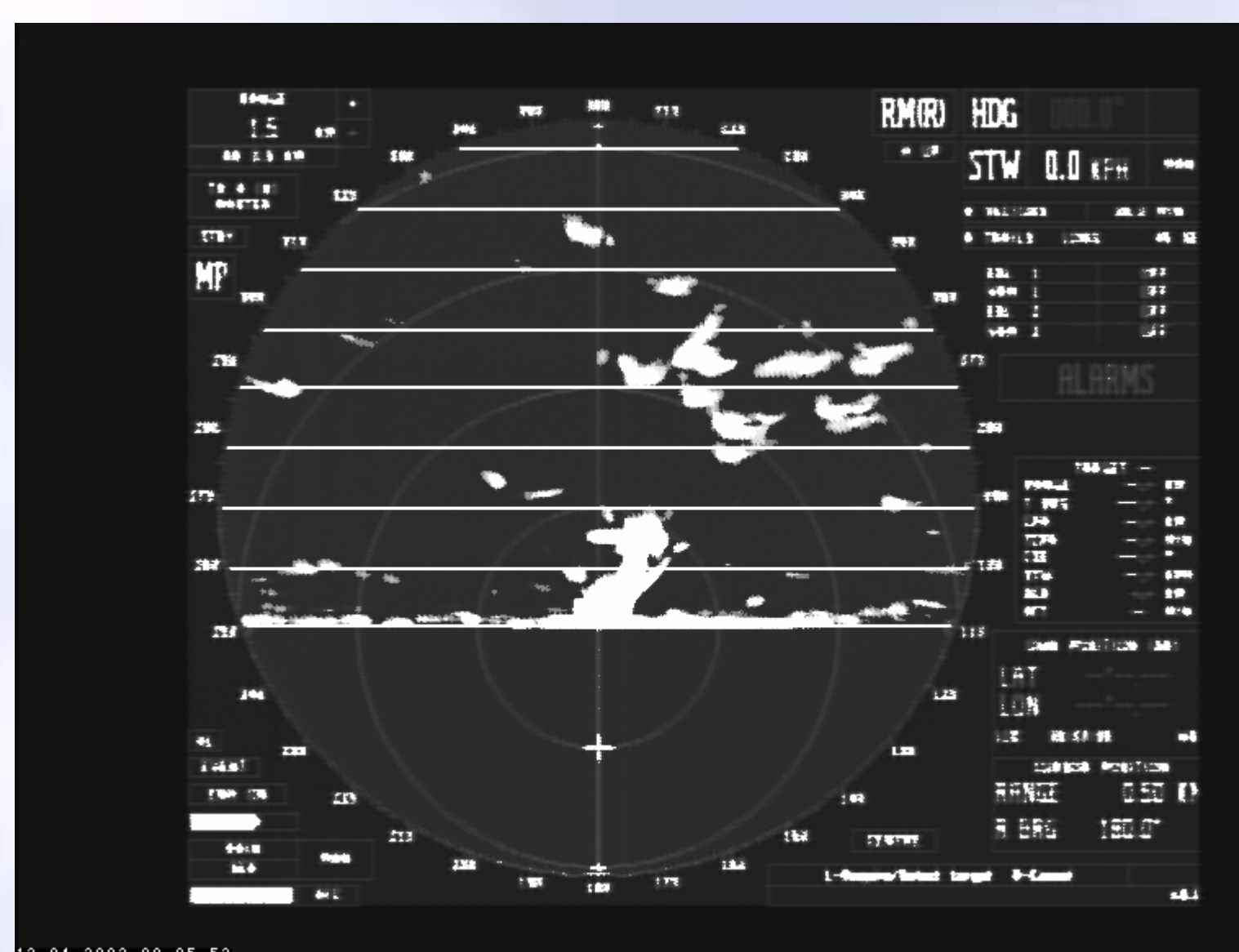


Fig. 4 (left). Intense Chaffinch migration at „Darßer Ort“ (13.4.03, 11.00 CEST) at higher altitude (echoes of large flocks at 750-1,250 m height, photo: 1min. integrated screen shot of Bridgemaster 25 kW radar, antenna tilted vertically, horizontal lines denote 250 m intervals above ground, the large echo in the centre results from a telecommunication tower, see photo in methods).

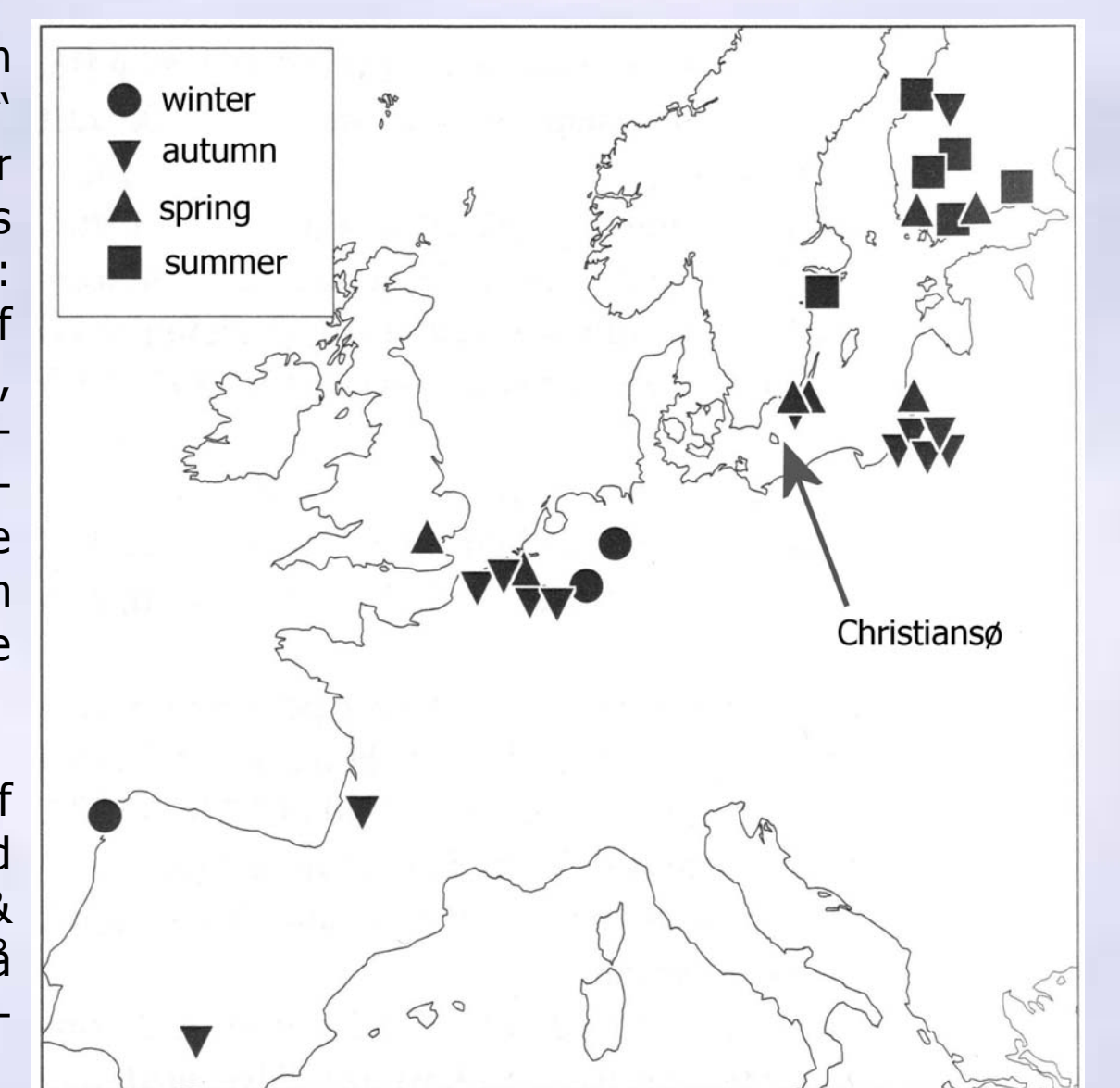


Fig. 5 (right). Recoveries of Chaffinch ringed or controlled on Christiansø (from Lausten & Lyngs 2004: Trækfugle på Christiansø 1976-2001. Narayana Press, Gylling.).