

8th SESSION OF THE MEETING OF THE PARTIES*26 – 30 September 2022, Budapest, Hungary***DRAFT AEWA INTERNATIONAL SINGLE SPECIES ACTION PLAN FOR THE
CONSERVATION OF THE COMMON EIDER**

***Somateria m. mollissima* (Baltic, North & Celtic Seas, and Norway & Russia populations) and
S. m. borealis (Svalbard & Franz Josef Land population)**

Introduction

This draft AEWA International Single Species Action Plan for the Conservation of the Common Eider (*Somateria mollissima*) - Baltic, North & Celtic Seas, Norway & Russia and Svalbard & Franz Josef Land populations, was co-financed by the Finnish Ministry of Agriculture and Forestry and the regional Government of Åland. The production of the plan was facilitated by the Finnish Wildlife Agency, the Government of Åland, the Finnish Museum of Natural History, Aarhus University and the UNEP/AEWA Secretariat.

Drafts of the plan have gone through several rounds of rigorous consultations with experts and government officials of the Range States of the species as well as relevant international stakeholder organisations during 2020. The action-planning workshop was held online from 15-17 September 2020 during which the threat assessment and action framework were agreed. During the formal consultation of the 4th draft with the governments of the principal Range States some substantial comments were received from Germany, which required a circulation of a 5th draft back to the Range States for their review. Further proposed changes and amendments were submitted by the European Commission which were presented as part of the 6th draft and constituted an agreed draft by the European Union and its Member States. The 6th draft was circulated to the Range States in June 2021, with particular request for feedback from the non-EU countries. By the deadline for feedback, the Secretariat received either confirmation of acceptance or no comments from the non-EU countries. Following this final round of consultations, the Standing Committee approved the 6th draft for submission to MOP8.

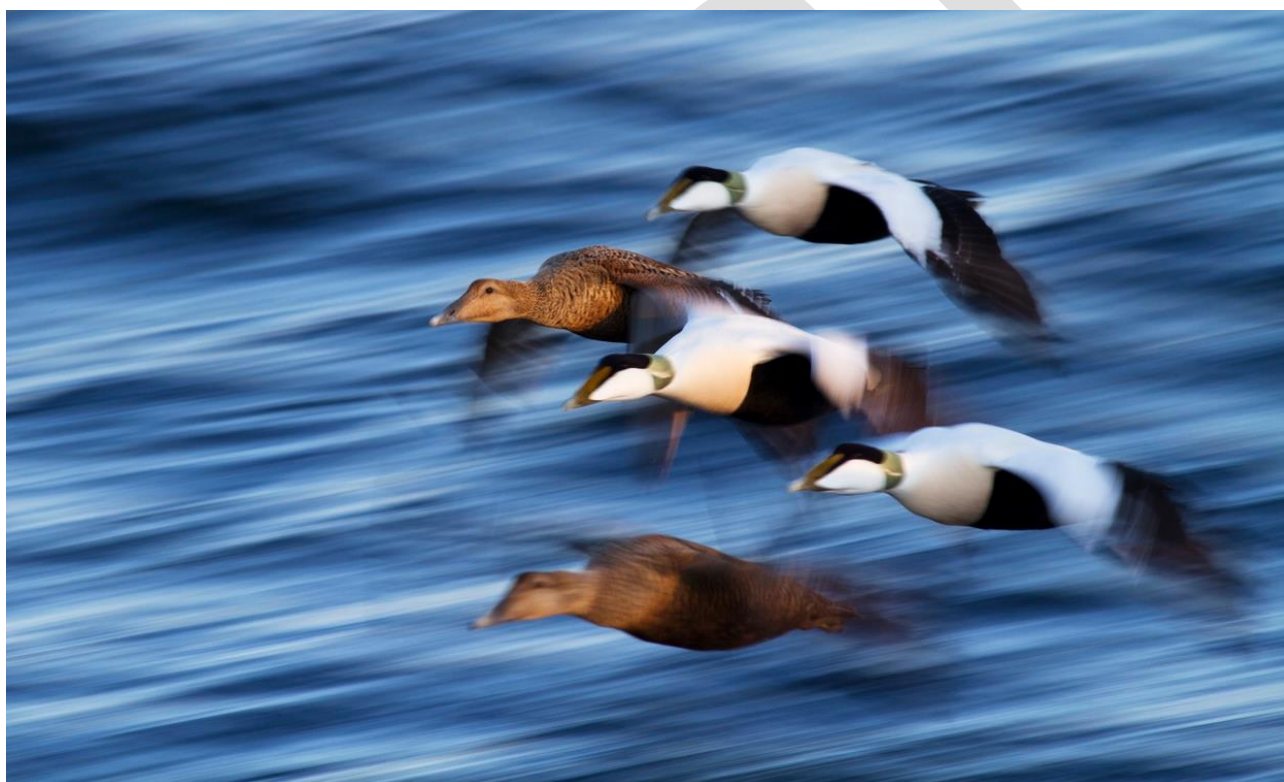
It should be noted that an initial assessment of the status of the East Greenland/Iceland population proposed to be listed under the Agreement as a new population, concluded that the population is considered stable at present. As such, it was not considered for inclusion into the Action Plan at this time.

Action Requested from the Meeting of the Parties

The Meeting of the Parties is invited to review this draft ISSAP and adopt it for further implementation.

– DRAFT –

International Single Species Action Plan for the
Conservation of the Common Eider *Somateria m.*
mollissima (Baltic, North & Celtic Seas, and Norway &
Russia populations) and *S. m. borealis* (Svalbard & Franz
Josef Land population)



Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA)

International Single Species Action Plan for the
Conservation of the Common Eider *Somateria m.
mollissima* (Baltic, North & Celtic Seas, and Norway &
Russia populations) and *S. m. borealis* (Svalbard & Franz
Josef Land population)

AEWA Technical Series No. XX

June 2021

(Draft 6)

Produced by
The Finnish Wildlife Agency
The Finnish Museum of Natural History, University of Helsinki

Funded by
The Ministry of Agriculture and Forestry of Finland
The Government of Åland

Adopting Framework:

Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA)

Organisations leading on the production of the plan and donors supporting the planning process:

Funding for the action-planning process was provided by the Finnish Ministry of Agriculture and Forestry and the regional Government of Åland. The production of the plan was facilitated by the Finnish Wildlife Agency, the Government of Åland, the Finnish Museum of Natural History, Aarhus University and the UNEP/AEWA Secretariat.

Compilers: Petteri Lehtikainen¹ (Lead Compiler), Mikko Alhainen², Morten Frederiksen³, Kim Jaatinen⁴, Robin Juslin⁵, Mikael Kilpi⁶, Nina Mikander⁷, Szabolcs Nagy⁸

¹The Finnish Museum of Natural History, University of Helsinki, Finland; petteri.lehtikainen@helsinki.fi.

²The Finnish Wildlife Agency, Finland; mikko.alhainen@riista.fi

³Department of Bioscience, Aarhus University, Denmark; mfr@bios.au.dk

⁴Nature and Game Management Trust Finland, Finland; kim@luontojariista.fi

⁵The Government of Åland, Finland; robin.juslin@regeringen.ax

⁶Tvärminne Zoological Station, University of Helsinki, Finland; mikael.kilpi@gmail.com

⁷UNEP/AEWA Secretariat; nina.mikander@un.org

⁸Wetlands International & Rubicon Foundation, Netherlands; Szabolcs.Nagy@wetlands.org

List of contributors: Bernard Baerends (the Common Wadden Sea Flyway Secretariat), Louise Bednarz (Swedish Environmental Protection Agency, Sweden), Antti Below (Metsähallitus, Finland), Thomas Bregnballe (Aarhus University, Denmark), Alain Caizergues (Office Français de la Biodiversité, France), Thomas Kjær Christensen (Aarhus University, Denmark), Alexandre Czajkowski (OMPO Migratory Birds of the Western Palearctic, France), Sergey Dereliev (UNEP/AEWA Secretariat, Germany), Volker Dierschke (Gavia EcoResearch, Germany), Søren Egelund (Miljøstyrelsen, Denmark), Geir Gabrielsen (Norwegian Polar Institute, Norway), Roderick Enzerink (Royal Dutch Hunters' Association, Netherlands), Petr Glazov (Institute of Geography Russian Academy of Sciences, Russia), Gildas Glemarec (Technical University of Denmark, Denmark), Eleonor Glad (Swedish Environmental Protection Agency, Sweden), Cy Griffin (FACE), Fredrik Haas (Biological Institute, Biodiversity, University of Lund, Sweden), Martti Hario (Natural Resources Institute Finland, Finland), Danny Heptinstall (Joint Nature Conservation Committee, UK), Magnus Irgens (Norwegian Environment Agency, Norway), Verena Keller (Swiss Ornithological Institute, Sempach, Switzerland), Tom Langendoen (Wetlands International, Netherlands), Karsten Laursen (Aarhus University, Denmark), Aleksi Lehtikainen (The Finnish Museum of Natural History, Finland), Niklas Liljebäck (Svenska Jägarförbundet, Sweden), Svein-Håkon Lorentsen (Norwegian institute for Nature Research – NINA, Norway), Leho Luigujõe (Estonian University of Life Sciences, Estonia), Gerold Lüerßen (the Common Wadden Sea Flyway Secretariat, Germany), Nele Markones (FTZ, Kiel University, Germany), Sanna Mäkeläinen (LUOMUS, University of Helsinki, Finland), Alex Nicol-Harper (University of Southampton and Wildfowl & Wetlands Trust, UK), Sophie Ouzet (European Commission), Matt Parsons (JNCC, UK), Ib Krag Petersen (Aarhus University, Denmark), Janne Pitkänen (Ministry of Agriculture and Forestry, Finland), Timm Reinhardt (Federal Agency for Nature Conservation, BfN, Germany), Wilmar Remmelts (Dutch Ministry of Agriculture, Netherlands), Per Risberg (Swedish Environmental Protection Agency, Sweden), Mia Rönkä (CBird/CAFF), Gregor Scheiffarth (Lower Saxon Wadden Sea National Park Authority, Germany), Christian Sonne (Aarhus University, Denmark), Joseph van der Stegen (European Commission), Hallvard Strøm (Norwegian Polar Institute, Norway), Iben Hove Sørensen (Danish Hunters' Association, Denmark), Grigori Tertitski (Russian Academy of Sciences, Russia), Kate Thompson (NatureScot [operating name for Scottish Natural Heritage], UK), Rune S. Tjørnløv (Aarhus University, Denmark), Jonna van Ulzen (BirdLife / Vogelbescherming Nederland, Netherlands), Markus Öst (Åbo Akademi University, Finland).

Date of adoption: [September 2022]

Lifespan of Plan: 2023–2032

Milestones in the production of the Plan:

First draft: April 2020

Second draft: August 2020

Species Action-Planning Workshop: 15–17 September 2020, online

Third draft: September 2020

Fourth draft sent for formal consultations to all Range States in December 2020 and presented to the AEWA Technical Committee at its 16th Meeting on 25–29 January 2021.

[Final draft presented the AEWA Standing Committee at its 16th Meeting on the 4–6 May 2021]

Please send any additional information or comments regarding this International Single Species Action Plan to Petteri Lehtikainen (petteri.lehtikainen@helsinki.fi).

Photo cover: Common Eider (*Somateria mollissima*) © Heikki Eriksson / Avescapes: heikkieriksson.com

Recommended citation:

Lehikoinen, P., Alhainen, M., Frederiksen, M., Jaatinen, K., Juslin, R., Kilpi, M., Mikander, N. & Nagy, S. (compilers) 2022. International Single Species Action Plan for the Conservation of the Common Eider *Somateria m. mollissima* (Baltic, North & Celtic Seas, and Norway & Russia populations) and *S. m. borealis* (Svalbard & Franz Josef Land population). AEWa Technical Series No. [XX], Bonn, Germany.

Disclaimer:

The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of UNEP/AEWa concerning the legal status of any State, territory, city or area, or of its authorities, or concerning the delimitation of their frontiers and boundaries.

[This publication can be downloaded from the AEWa website (link to be added)]

TABLE OF CONTENTS

1-BASIC DATA	7
Species and populations covered by the Plan	7
List and map of Range States	7
2-FRAMEWORK FOR ACTION.....	9
ANNEX 1. BIOLOGICAL ASSESSMENT.....	19
Distribution throughout the annual cycle	19
Habitat requirements	19
Survival and productivity.....	20
Population size and trend.....	21
ANNEX 2. PROBLEM ANALYSIS	26
General overview	26
Reduced food quality and supply	26
Increased predation	30
Hunting	33
Diseases	36
Oil and other pollutants	37
Bycatch in fishing gear	40
Anthropogenic disturbance	42
Windfarms	43
Climate change	44
Habitat change	45
ANNEX 3. Provisional Flyway Management Units Suggested for the Baltic, North & Celtic Seas population of the Common Eider.....	48
Provisional Delineation of Management Units	48
An Overview of Common Eider Migration in the Baltic, North & Celtic Seas population.....	48
Sources	50
ANNEX 4. REFERENCES	51

1-BASIC DATA

Species and populations covered by the Plan

A total of 13 populations of Common Eider belonging to six subspecies are recognized across its global range. This International Single Species Action Plan covers the three migratory populations of two sub-species (*mollissima* and *borealis*) listed in Table 1 of Annex 3 of the African-Eurasian Migratory Waterbird Agreement: 1) Baltic, North & Celtic Seas; 2) Norway & Russia; 3) Svalbard & Franz Josef Land (Figure 1).

For the purposes of the implementation of this Action Plan the delineation of Management Units within the populations may be required. As outlined in Annex 3, the following preliminary delineation of three management units within the Baltic, North and Celtic Seas population is suggested:

- Baltic and North Seas management unit (Management Unit 1);
- Wadden Sea management unit (Management Unit 2); and
- UK/Ireland management unit (Management Unit 3).

List and map of Range States¹

Range states for the three populations of Common Eider covered by this Action Plan are listed in Table 1 and shown in Figure 1.

Table 1. Range states of the three Common Eider populations under AEWA. Principal range states – **in bold** (regularly hosting 1% or more of a population); other range states (regular occurrence in low numbers – mean population of 200 or more) – normal text; occasional records – *in italics*. Based on Article 12 reporting for 2013–2018 data (for EU Member States, including the UK), IWC data for 2015–2019 and information provided by the range states.

AEWA Population	Breeding	Migration	Wintering
Baltic, North & Celtic Seas	Denmark	Denmark	Denmark
	Estonia	Estonia	Germany
	Finland	Finland	Netherlands
	Germany	Germany	Norway
	Netherlands	Netherlands	Sweden
	Norway	Norway	United Kingdom
	Sweden	Sweden	France
	United Kingdom	United Kingdom	Ireland
	Ireland	France	Poland
	Russian Federation	Latvia	<i>Belgium</i>
	<i>France</i>	Lithuania	<i>Estonia</i>
	<i>Poland</i>	Russian Federation	<i>Finland</i>
		Poland	<i>Latvia</i>
Norway & Russia	Norway	Norway	Norway
	Russian Federation	Russian Federation	Russian Federation
Svalbard & Franz Josef Land	Norway	Norway	Iceland
	Russian Federation	Russian Federation	Norway
			Russian Federation

¹Each Contracting Party to AEWA is equally responsible under the Agreement for all the AEWA species/populations they host as per the obligations set out in the AEWA legal text. All the countries which host a specific species (whether in small or large numbers) are considered Range States for that species. The identification of Principle Range States in AEWA Action Plans, is an approach used to prioritize coordinated international conservation efforts to those countries considered to be crucial for ensuring the favourable conservation status of the species/population in question.

It should be noted that, under no circumstances does the identification of Principle Range States in AEWA International Species Action Plans, diminish the legal obligations of potential remaining Range States which are Contracting Parties to AEWA to equally ensure the adequate protection and conservation of the species/populations in question, including through implementation of relevant actions from the respective Species Action Plan

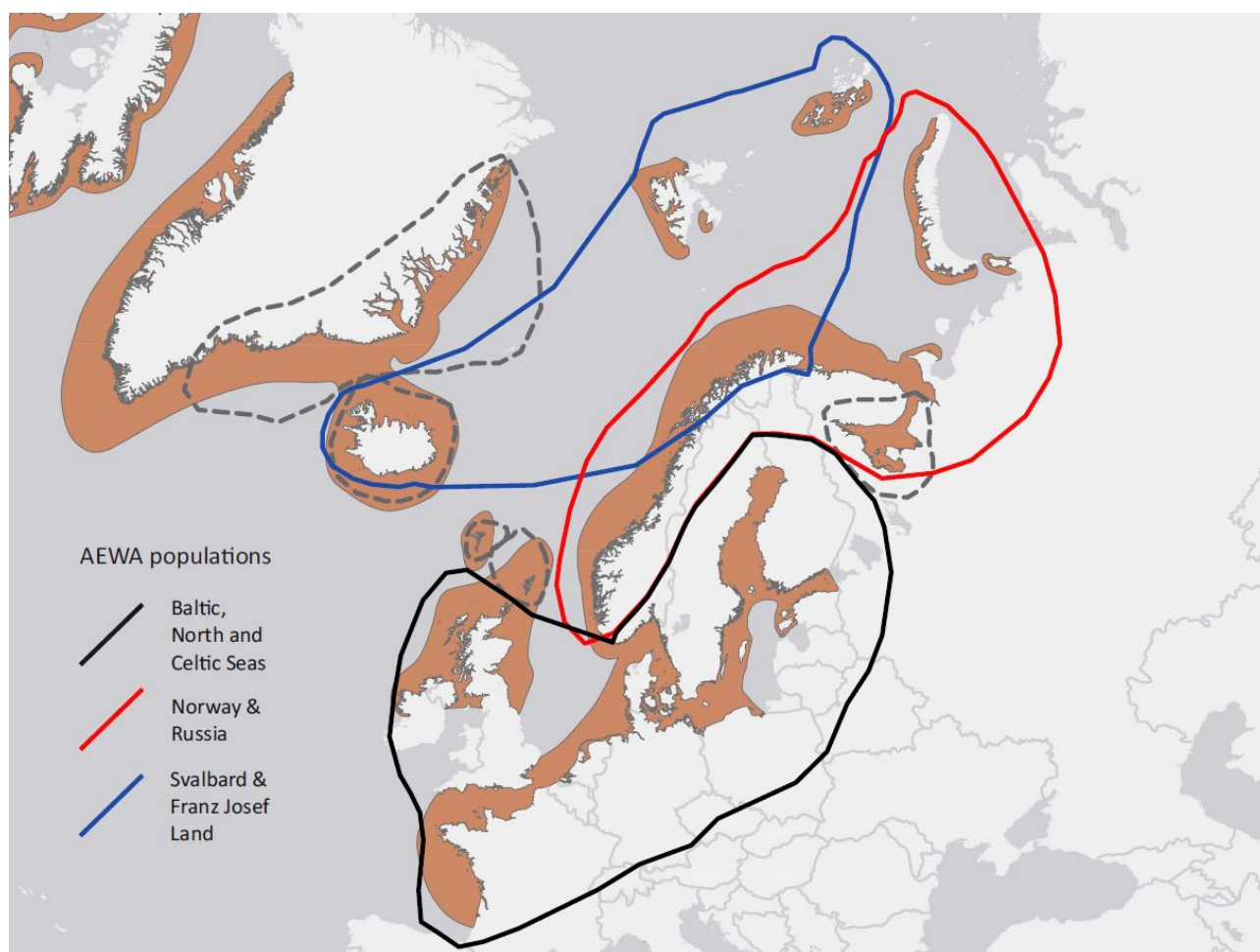


Figure 1. Population delineations of the Common Eider in the African-Eurasian Migratory Waterbird Agreement (AEWA) area. The three AEWA-listed migratory populations are Baltic, North & Celtic Seas (*Somateria m. mollissima*; black), Norway & Russia (*S. m. mollissima*; red) and Svalbard & Franz Josef Land (*S. m. borealis*; blue). The sedentary populations with which the migratory populations interact are marked with dashed delineations; East Greenland and Iceland (*S. m. borealis*), Faeroe Islands and Shetland (*S. m. faeroeensis*) and White Sea (*S. m. mollissima*).

Table 2. Summary of international conservation and legal status of the Common Eider

IUCN Red List status	
IUCN Global assessment	Near threatened
IUCN European regional assessment	Vulnerable
IUCN EU27 regional assessment	Endangered
HELCOM/Baltic Sea breeding	Vulnerable
HELCOM/Baltic Sea wintering	Endangered
International legal status	
African-Eurasian Migratory Waterbird Agreement	Column A, category 4 (all three populations)
Convention on Migratory Species (Bonn Convention)	Appendix II
Convention on International Trade in Endangered Species (CITES)	Not listed
Bern Convention	Appendix III
EU Birds Directive	Annexes II part B ² ; III part B

²Applies to countries in the EU: Belgium, Denmark, Estonia, Finland, France, Germany, Netherlands, Ireland, Latvia, Lithuania, Poland and Sweden, making this species a potential game species in these countries (currently hunted in Denmark, Finland, France and Sweden).

2-FRAMEWORK FOR ACTION

Goal: To restore the three AEWA-listed migratory populations of the Common Eider (*Somateria mollissima*) to a favourable conservation status.

Purpose: To halt the decline of these populations and to start their recovery by 2031.

Favourable Reference Values (FRVs) for all three populations (and their respective management units, if deemed applicable) will be elaborated and agreed on amongst the Range States during the implementation phase of the Action Plan.

Governance: The implementation of the Action Plan will be overseen by the Seaduck Working Group. For EU Member States, the sub-expert group on the Birds and Habitats Directives (NADEG) will be consulted to ensure compatibility of the ISSAP and AHMP with the Birds Directive ahead of any decision making.

The detailed Framework for Action of this ISSAP is presented in Table 3 below.

Table 3-1. Framework for Action for Objective 1: Increase survival rates. Time scale: Immediate – launched within the next year; Short – launched within the next 3 years; Medium – launched within the next 5 years; Long – launched within the next >5 years; Ongoing – currently being implemented and should continue; Rolling – to be implemented perpetually (any action above from immediate to ongoing can be also qualified as rolling).

Direct problem: Additive mortality	Objective 1: Increase survival rates (all life stages)				
Underlying problems³	Result	Action	Priority	Time scale	Organisations responsible
Increased mortality from non-native predators during the breeding season	Result 1.1. Predation by non-native predators (e.g. American mink, Raccoon dog, Brown rat) is minimised and eliminated where possible.	1.1.1. Breeding Range States to develop and implement control plans for non-native invasive carnivores. Applicable to: Principal range states with breeding Common Eiders from the Baltic, North & Celtic Seas and the Norway & Russia populations (DE, DK, EE, FI, NL, NO, RU, SE, UK)	Medium	Immediate/Ongoing	State conservation and wildlife management agencies in cooperation with conservation and hunting stakeholders
Increased mortality from native predators during the breeding season	Result 1.2. Predation by native predators is reduced, at breeding sites where a local or regional population level effect has been identified.	1.2.1. Breeding Range States to develop and apply methods to manage native predator pressure taking into account applicable national and	Medium	Immediate	State conservation and wildlife management agencies in cooperation with conservation and

³ For details, see Annex 2.

Direct problem: Additive mortality	Objective 1: Increase survival rates (all life stages)				
Underlying problems³	Result	Action	Priority	Time scale	Organisations responsible
		<p>international legislation and the conservation status of the predator species.</p> <p>Applicable to: Principal range states with breeding Common Eiders in the Baltic, North & Celtic Seas and Norway & Russia populations (DE, DK, EE, FI, NL, NO, RU, SE, UK)</p>			<p>hunting stakeholders.</p> <p>Note: this should include non-lethal methods and take into account the harmful effects of any breeding time disturbance on Common Eiders and other species.</p>
Additional mortality from hunting	Result 1.3. Additional mortality from hunting is excluded or sustainability of legal hunting is ensured.	<p>1.3.1.</p> <p>a) In the context of certain range states covered by the ISSAP the legal protection or hunting moratorium of the population is the most effective action to minimize the additional mortality from hunting and to maximize the conservation benefits. These countries are encouraged to implement or continue legal protection or moratorium.</p> <p>b) In the context of certain range States, the legal sustainable use of this population can/may provide incentives for the conservation of the population. Sustainability of hunting shall be ensured via the Adaptive Harvest Management Programme (AHMP) referred to under point 1.3.2. Pending the development of the AHMP, range States</p>	Medium	Short/rolling	AEWA European Seaduck IWG, government authorities, state conservation and wildlife management agencies, hunting organizations

Direct problem: Additive mortality	Objective 1: Increase survival rates (all life stages)				
Underlying problems³	Result	Action	Priority	Time scale	Organisations responsible
		<p>willing to authorise hunting shall do so only if its sustainability can be demonstrated and in line with the precautionary principle⁴.</p> <p>Applicable to: ALL</p> <p>1.3.2. Develop, adopt and implement an Adaptive Harvest Management Programme (AHMP) for the Common Eider in order to ensure, assess and manage the sustainability of hunting within the relevant management units. When a sustainable hunting quota is identified through an AHMP, ensure hunting in the EU only takes place in compliance with the requirements of the Birds Directive (no hunting during the rearing season or during the various stages of reproduction, no during the return to the rearing grounds, without prejudice to Article 9 of the Birds Directive.)</p> <p>Applicable to: Range states of the Baltic, North & Celtic Seas population in which Action 1.3.1 b) applies.</p> <p>Range states implementing Action</p>			

⁴ see Article II of the AEWa Agreement and, for EU Member States, Article 191 of the Treaty on the Functioning of the European Union.

Direct problem: Additive mortality	Objective 1: Increase survival rates (all life stages)				
Underlying problems³	Result	Action	Priority	Time scale	Organisations responsible
		1.3.1 a) are invited to provide data to establish and implement the Adaptive Harvest Management Programme for the Common Eider to ensure that decision are made on robust data concerning the whole population.			
By-catch of birds in fishing gear	Result 1.4. By-catch is eliminated and where this is not possible minimised ⁵	1.4.1. Develop and test seaduck-friendly fishing gear suitable for Common Eider as part of overall efforts for seaducks ⁶ . Deploy seaduck-friendly fishing gear at key Common Eider sites if and when such is available. Applicable to: Range states with staging, wintering and moulting aggregations of Common Eiders of the Baltic, North & Celtic Seas and Norway & Russia populations (DE, DK, EE, FI, NL, NO, RU, SE, UK)	Medium	Ongoing – Medium	State research and fisheries institutions, NGOs, research institutions, international organisations (AEWA, HELCOM, OSPAR, CAFF etc.). State conservation and fishery agencies
		1.4.2. Implement (temporary) closures of gill nets at key sites for Common Eider during times when they are	Medium	Immediate/Rolling	State conservation and fishery agencies

⁵ [EU Biodiversity Strategy](#): “Furthermore, the by-catch of other species must be eliminated or, where this is not possible, minimised so as not to threaten their conservation status.”

⁶ Linkages with AEWA International Single Species Action Plans for the Long-tailed Duck and the Velvet Scoter as well as the EU Biodiversity Strategy for 2030 which aims to reduce by-catch and the EU Action Plan for reducing incidental catches of seabirds in fishing gears of 2012.

Direct problem: Additive mortality	Objective 1: Increase survival rates (all life stages)				
Underlying problems³	Result	Action	Priority	Time scale	Organisations responsible
		<p>present unless other effective mitigation measures (such as seaduck-friendly fishing gear) are available and being used.</p> <p>Applicable to: Principal range states with staging, wintering and moulting aggregations of Common Eiders of the Baltic, North & Celtic Seas and Norway & Russia populations (DE, DK, EE, FI, NL, NO, RU, SE, UK)</p>			

Table 3-2. Framework for Action for Objective 2: Increase breeding success. Time scale: Immediate – launched within the next year; Short – launched within the next 3 years; Medium – launched within the next 5 years; Long – launched within the next >5 years; Ongoing – currently being implemented and should continue; Rolling – to be implemented perpetually (any action above from immediate to ongoing can be also qualified as rolling).

Direct problem: Low breeding success	Objective 2: Increase breeding success				
Underlying problems	Result	Action	Priority	Time scale	Organisations responsible
Reduced food supply and quality due to water temperature rise, toxic algae blooms, reduced salinity, climate change etc.	Result 2.1. Sufficient high-quality food is available both on wintering and breeding grounds.	2.1.1. Work with HELCOM and OSPAR to implement agreed provisions in order to reduce pollution in the Baltic Sea, North & Celtic Seas particularly in the vicinity of breeding and key wintering areas. Applicable to: Principal range states to the Baltic, North & Celtic Seas (DE, DK, EE, FI, NL, NO, RU, SE, UK)	Medium	Medium - Ongoing	State research and fisheries institutions, NGOs, research institutions, international organisations
Reduced food supply due to overharvest by fisheries	Result 2.2. Human harvesting of key shellfish species (i.e. Blue Mussel and Cockle) is regulated to ensure sufficient food availability for Common Eiders.	2.1.2 Regulate shellfish harvest in identified key areas to ensure that sufficient food is available. Applicable to: Principal range states to the Baltic, North & Celtic Seas population (DE, DK, NL, UK)	Medium	Medium	State conservation and wildlife management agencies in cooperation with state research and fisheries institutions
Reduced breeding success as a result of increased predation and disturbance by predators	Result 2.3. Disturbance and predation by both non-native and native predators is reduced where it is having a local or regional population level effect.	2.3.1. <i>See actions 1.1.1 and 1.2.1 above</i> Applicable to: Principal range states with breeding Common Eiders in the Baltic, North & Celtic Seas and Norway & Russia populations (DE, DK, EE, FI, NL, NO, RU, SE, UK)	High	Short/Rolling	State conservation and wildlife management agencies in cooperation with conservation and hunting stakeholders
Reduced breeding success as a result of certain	Result 2.3. Detrimental access to key moulting and staging areas is in particular regulated	2.3.1. Identify internationally and nationally important moulting, staging and breeding areas where	Medium	Short	State conservation agencies, research institutes

anthropogenic disturbance ⁷	(shipping, boating and other outdoor activities)	<p>anthropogenic disturbance is a high threat.</p> <p>Applicable to: Principal range states to the Baltic, North & Celtic Seas and Norway & Russia populations (DE, DK, EE, FI, NL, NO, RU, SE, UK)</p>			
		<p>2.3.2. Implement appropriate management actions to minimize disturbance in the key areas identified in 2.3.1 above</p> <p>Applicable to: Principal range states to the Baltic, North & Celtic Seas and Norway & Russia populations (DE, DK, EE, FI, NL, NO, RU, SE, UK)</p>	Medium	Medium	State conservation agencies in collaboration with other relevant authorities

⁷ Note: need to distinguish between unwanted temporary disturbance and deliberate disturbance aimed at increasing breeding success. In parts of Finland, Norway and Sweden breeding birds have been shown to benefit from careful (and consistent) presence of humans as predators are deterred by the humans. The carefully organized presence of humans at/near breeding sites can therefore be an important tool to increase breeding success.

Table 3-3. Framework for Action for Objective 3: Close knowledge gaps. Time scale: Immediate – launched within the next year; Short – launched within the next 3 years; Medium – launched within the next 5 years; Long – launched within the next >5 years; Ongoing – currently being implemented and should continue; Rolling – to be implemented perpetually (any action above from immediate to ongoing can be also qualified as rolling).

<i>Direct problem: Lack of knowledge</i>	<i>Objective 3: Close knowledge gaps</i>				
Underlying problems	Result	Action	Priority	Time scale	Organisations responsible
Lack of knowledge on essential population parameters of Common Eider ecology, movements and distribution, as well as on scale and impacts of limiting factors	Result 3.1. Research and monitoring work on priority issues are undertaken	3.1.1. Develop non-lethal methods to reduce predation and disturbance by protected native predators and assess their effectiveness.	High	Short/ongoing	State conservation and hunting agencies, research institutes, NGOs
		3.1.2. Assess the cumulative impact of harvest related mortality on the Baltic, North & Celtic Seas population (harvest, disturbance, lead poisoning, crippling etc.). Applicable to: Principal range states of the Baltic, North & Celtic Seas population (DE, DK, EE, FI, FR, NL, NO, SE	Medium	Medium	State conservation and hunting agencies, research institutes, NGOs
		3.1.3. Develop monitoring programmes to collect and share standardised data on by-catch, fishing effort and capacity for all relevant fishing gears for both commercial and non-commercial fisheries (including vessels <12m); data analysed for accurate by-catch estimates and identification of the most problematic fishing gears, vessels, locations. Report Common Eider by-catch and fishing effort (as required under the EU CFP, the EU Seabird Plan of Action, EU Marine Strategy	Medium	Immediate/Rolling	State conservation and fishery agencies, NGOs, fishermen

Direct problem: Lack of knowledge	Objective 3: Close knowledge gaps				
Underlying problems	Result	Action	Priority	Time scale	Organisations responsible
		Framework Directive, OSPAR and HELCOM) and collaborate on by-catch research with HELCOM, OSPAR, ICES and CAFF, as relevant. Applicable to: All range states			
		3.1.4. Assess the severity and sources of poisoning from lead and other pollutants (e.g. mercury) on Common Eiders in the Baltic, North & Celtic Seas population. Applicable to: Principal range states of the Baltic, North & Celtic Seas population (DE, DK, EE, FI, NL, NO, SE, UK)	Medium	Medium	State conservation and hunting agencies, research institutes, NGOs
		3.1.5. Monitor and document climate change impacts on the Common Eider (including the potential loss and deterioration of habitat to climate change) to increase knowledge of the current and potential future effects and to determine what possible mitigation measures could be. Applicable to: All range states	Medium	Medium	State conservation agencies, research institutes, NGOs
		3.1.6. Analyse and publish existing Common Eider aerial survey datasets to increase understanding of the baseline population size.	High	Immediate	Responsible research institutes and NGOs

Direct problem: Lack of knowledge	Objective 3: Close knowledge gaps				
Underlying problems	Result	Action	Priority	Time scale	Organisations responsible
		Applicable to: Principal range states of the Baltic and North Seas Management Unit (DE, DK, EE, FI, NL, NO, SE, RU)			
		3.1.7. Develop and implement a coordinated monitoring scheme for the Common Eider (including population size, trend and harvest bag where applicable etc.), preferably linked to existing reporting obligations and generic monitoring schemes, reflecting the monitoring needs of the different populations and management units Applicable to: All range states	High	Immediate	State conservation and research institutes, NGOs
		3.1.8. Carry out ring recovery and telemetry studies (including the analyses of existing data) of Common Eiders to increase understanding of movements of different populations between the breeding and wintering areas. Applicable to: All range states	High	Short/ongoing	State conservation and research institutes, universities, NGOs
		3.1.9 Identify changes in food resources and assess whether common eiders are adapting. Applicable to: All range states	Medium	Medium	State conservation and research institutes, universities, NGOs

ANNEX 1. BIOLOGICAL ASSESSMENT

Distribution throughout the annual cycle

Three migratory populations of two subspecies of Common Eider are listed on Annex 3 Table 1 of the African-Eurasian Migratory Waterbird Agreement (AEWA): Subspecies *mollissima* in i) Baltic, North & Celtic Seas and ii) Norway and Russia, as well as the subspecies *borealis* in iii) Svalbard and Franz Josef Land.

Baltic, North & Celtic Seas population

The breeding range of the Baltic, North & Celtic Seas population extends from the archipelagoes of the northern Baltic Sea, where the highest proportions of the flyway population occur (Finland and Sweden), along the Swedish east coast to Denmark and northern Germany, the west coast of Sweden and the south coast of Norway. Breeding areas are also located on the Wadden Sea islands of Denmark, Germany and the Netherlands, and on the coasts of Scotland, northern England and northern parts of Ireland. Males and non-breeding juveniles congregate from mid-May in moulting areas close to either breeding or wintering grounds. Females moult while raising young and after breeding mainly near breeding grounds. The moulting flocks may be especially vulnerable to disturbance from June to September. Post-nuptial migration takes place from late September to December. The main wintering grounds of the Baltic, North & Celtic Seas population lie in the Wadden Sea and the southwestern Baltic Sea, near the coasts of Denmark, Germany, Netherlands, Norway and Sweden. The subpopulations within Baltic Sea may differ in their wintering areas, and although this information is important for management and conservation, it remains unstudied in more detail. UK birds winter mainly in Scotland, but with substantial numbers also in England and Northern Ireland.

Norway and Russia population

The Norway and Russia population breeds throughout the coasts of the Norwegian and Barents Sea (Fauchald et al., 2015) and reaching the Pechora Sea, where densities are low, and further to Novaya Zemlya, where the breeding population is likely much higher, but the current population size is unknown (35 000 pairs in 1940s) (Krasnov et al., 2016). Norwegian breeders show little wintering movements and are expected to winter close to the breeding grounds. Birds breeding in Novaya Zemlya are expected partly to winter in the SW Barents Sea (Murmansk region) and White sea Funnel, where the number of birds increase significantly in mid-October totaling 100 000 birds in winter (Koryakin, 2016; Krasnov et al., 2016). Most birds from Murmansk region leave probably east to moult to the southern coastal area of Novaya Zemlya or to the mainland coast of the Pechora Sea, where moulting flocks are described, but migrate west to Western Murman and Norwegian coast of Scandinavia for winter, some even reaching Faeroe Islands (Koryakin, 2016).

Svalbard and Franz Josef Land population

The population breeding in Svalbard and Franz Josef Land is fully migratory. A geolocator study revealed that the majority (77%) of the females tagged in Svalbard migrated to Iceland for winter, the rest wintering in northern Norway (Hanssen et al., 2016). Autumn migration spanned from late August to late December and birds migrating to Norway departed later than birds wintering in Iceland. Spring migration took place in late March to late May. The population size, migratory routes and timing of Eiders breeding in Franz Josef Land are largely unknown but are suspected to winter in same areas as birds breeding in Svalbard (Koryakin, 2016, Krasnov et al., 2016).

Habitat requirements

The Common Eider is a marine species, although small populations breed in Lake Ladoga, Lake Vättern and larger lakes in Central Europe. It breeds along coasts but prefers small islands offering adequate nest cover from low vegetation to avoid disturbance and nest predation (Heinänen et al., 2012; Laurila, 1989). In the Finnish archipelago, the habitat use has shifted from open islands in the outer archipelago to forested islands in the middle and inner archipelago due to increased predation and disturbance (Kurvinen et al., 2016; Laurila, 1989). Nesting habitat availability has not been shown to limit the distribution of the Common Eider to date.

The main food resource is bivalves, but diet also includes other marine invertebrates and fish egg which can be regionally important (Bustnes & Erikstad, 1988; Camphuysen et al., 2002). During the winter, the availability of the Blue Mussel (*Mytilus* spp.) drives the abundance and distribution of the species in the southern Baltic and North Sea (Cervencel et al., 2015; Larsen & Guillemette, 2000). In the Baltic Sea, brood-tending females forage like their young, feeding mainly on gammarids in shallow water, whereas non-tending females feed on mussels throughout the brood-rearing season (Öst & Kilpi, 1999). Females show high fidelity to feeding sites during the breeding season (Bustnes & Erikstad, 1993). Feeding sites of broods are separated between colonies, and the home range size increases with brood size (Öst & Kilpi, 2000). During winter and staging, Common Eiders prefer shallow (< 10 m) areas close to the coast with hard substrate and high Blue Mussel biomass (Bräger et al., 1995; Heinänen et al., 2017). In early winter, Eiders also use offshore shallow waters, but leave these in the second half of the winter (Bräger et al., 1995).

Water depth in foraging areas is usually less than 10 meters and in summer usually only up to 3 meters (Bustnes & Lønne, 1997; Guillemette et al., 2004). In winter, birds favour water-depths of 0–6 meters with intermediary-sized mussels with highest flesh-to-shell ratio and avoid 6–12-meter depths with large-sized mussels (Hilgerloh & Pfeifer, 2002; Larsen & Guillemette, 2000). The occurrence of Eiders has been shown to follow annual variations in food abundance and during winter Common Eiders can consume between 22–64% of the total biomass of mussel beds at 0–6 meters of depth (Larsen & Guillemette, 2000). Salt intake in marine conditions hardly limits foraging (Nehls, 1996), but low salinity can limit the availability of Blue Mussels (Hario & Öst, 2002; Westerborn et al., 2019).

Low salinity and low food availability restrict the distribution in the eastern Gulf of Finland and northern Bay of Bothnia, despite suitable breeding habitat being widely available (Kilpi et al., 2018; Westerborn et al., 2019). The low availability of high-quality food may have restricted population growth of a study colony in Denmark, where the quality of Blue Mussels in autumn and winter have been found to affect the survival of female Eiders (Tjørnløv, 2020). Food shortage may also have been the driver of a decline in a study area in Northumberland, UK (Waltho & Coulson, 2015). Furthermore, scenario-driven projections of population demographics based on multiple biological and environmental factors suggested that improvements in the autumn and winter body condition of Blue Mussels could stabilize and increase the Baltic Sea segment of the population in the long-term (Tjørnløv, 2020). Some signs of density-dependence have been found in the central Gulf of Finland, where the fledging rate, but not clutch size or number of ducklings leaving the nest, has been shown to be negatively related to population size (Hario & Rintala, 2006). Furthermore, fledging rate was positively associated with growth rate, and together with density-dependence in fledging rate could suggest a carrying-capacity limited population (Hario & Rintala, 2006). This population shows signs of mussel resource limitation due to low salinity leading to lowered body condition of breeding females (Hollmén, 2002) and might thus not be representative of the whole flyway population. However, similar density-dependence was found in the Netherlands, where nest density had negative association with fledging rate, but not clutch size (Gunnarsson et al., 2013; Swennen, 1991). In northern Norway, clutch size has, however, shown negative density-dependence (Bårdsen et al., 2018).

Survival and productivity

The Common Eider is a female-philopatric species with a long lifecycle, high adult survival and delayed maturity (Hario et al., 2009). Females breed for the first time at an age of 2–5 years (Hario & Rintala, 2009) and show low breeding and natal dispersal (Ekroos, Öst, et al., 2012; Hario et al., 2012; Öst et al., 2011; Swennen, 1990). Clutch sizes usually vary between 3–7, with an average of 4–5 eggs (Kilpi & Lindström, 1997; Mehlum, 2012). Clutch size is limited by body reserves, but females also limit the clutch size in relation to conspecific brood parasitism, which is common in the species (Erikstad & Bustnes, 1994).

Females fast during incubation, which imposes trade-offs between body condition and reproductive investments (Yoccoz et al., 2002). This in turn leads to diverse and complex life-history strategies which are affected by interactions between female body condition (Selmann et al., 2012), kinship (Andersson et al., 2019), stress hormone levels (Selmann et al., 2014), immunity (Hanssen, 2006; Neggazi et al., 2016), sociality (Öst, Smith, et al., 2008) and even brain-size (Jaatinen & Öst, 2016) and environmental factors, such as habitat (Öst, Wickman, et al., 2008) and predation risk (Jaatinen et al., 2014; Jaatinen et al., 2011; Öst et al., 2018). In

general, nest and brood survival increases with female body condition and breeding experience, and females with low body condition and/or limited breeding experience are more likely to fail their breeding attempts and abandon the nest or brood (Bustnes et al., 2002; Erikstad & Bustnes, 1994; Erikstad et al., 1993; Hanssen, Erikstad, et al., 2003; Öst & Steele, 2010).

Fledgling production shows considerable variation between years, so that in some studies low production years outnumber high production years (Hario & Rintala, 2006). Long-term fledgling production rates show spatial variation: 0.15 fledglings / female in central Gulf of Finland (Hario, 2016; Hario & Rintala, 2006), 0.29 in Scotland (Mendenhall & Milne, 1985), 0.34 in the Wadden Sea (Swennen, 1991) and 0.47 & 0.72 in two localities in the western Gulf of Finland (A. Lehtikoinen & M. Öst *in litt.*). The low productivity of the central Gulf of Finland was associated with low body condition and immune response of females challenged by insufficient feeding resources (Hollmén, 2002). Duckling production rates and duckling body condition are positively related to the rate of recruitment of females into the breeding population (Christensen, 2001; Hario & Rintala, 2009), and high duckling production rates are also associated with females recruiting earlier to the breeding population (Hario & Rintala, 2009). In the Baltic population, first-year survival seems to have decreased from the 1990s to the present and is currently historically low. (Hollmén et al., 1999; Tjørnløv et al., 2019).

The majority of studies report high female survival rates ranging between 0.80–0.96 (Bårdsen et al., 2018; Hario et al., 2009; Yoccoz et al., 2002); and the references therein). The lowest subpopulation survival rate (0.72) has been reported from the western Gulf of Finland, where predation is the main driver of low survival (Ekroos, Öst, et al., 2012). High predation pressure was also associated with a high number of non-breeding birds and low fledging (Öst et al., 2018). The increased natural mortality of females in the Baltic Sea population has led to a strong male-bias (approx. 2/3) (Lehtikoinen et al., 2008; Ramula et al., 2018). The female survival has been stable until early 1990s, but declined markedly after the mid-1990s (Tjørnløv et al., 2019). A demographic comparison between the central and western Gulf of Finland revealed spatial and temporal differences in survival and fecundity driving the population decline, but the difference between population growth rate mainly depended on female survival (Öst et al., 2016). Due to predation-induced increased mortality of females, hunting is currently targeted only at males or completely banned to ensure that the population recovery is not jeopardized by hunting (Tjørnløv et al., 2019). Disease outbreaks, especially avian cholera, can cause a strong local increase in mortality (Tjørnløv, 2020). Climatic effects on survival appear to be spatially variable, with no found effects in Baltic Sea colonies (Ekroos, Öst, et al., 2012; Tjørnløv, 2020) and direct and lagged effects on survival in Norway, Svalbard and Netherlands being negatively related to NAO-index and sea surface temperature (Bårdsen et al., 2018; Guery et al., 2017; Tjørnløv, 2020).

Demographic approaches have not been able to identify universal factors affecting survival in the Baltic – Wadden Sea segment of the population, and a combination of local conditions are likely to have a high influence on survival and productivity (Tjørnløv, 2020). In Svalbard, the combined pressure from predation, pollutants and winter sea surface temperature negatively affected population viability (Bårdsen et al., 2018).

Population size and trend

The population estimates were derived from questionnaires submitted by the Principal Range States within the framework of the action-planning process in 2020 as well as the EU Birds Directive Article 12 reporting for the EU Member States (including the UK) for the period 2013-2018 (Tables 4-6).

Baltic, North & Celtic Seas population

Eider relics suggest that the Common Eider inhabited northern Europe already during the Pleistocene (Lauritzen et al., 1996). However, in the late Pleistocene, nearly the whole current breeding range became inaccessible at the Weichsel glaciation maximum c. 20 000 years ago, limiting ice-free coasts to the southwestern parts of the Baltic Sea (Mangerud, 2004; Nilsson, 1983). Molecular studies have shown that the entire European Eider population originated from this Pleistocene refugium and underwent a remarkable postglacial range expansion (Tiedemann & Noer, 1998; Tiedemann et al., 2004). Due to philopatry, even local populations show signs of genetic differentiation, but although gene flow between local populations is mainly

driven by dispersing males, female dispersal can also occur as the result of migration if suitable habitat is available at or near the wintering grounds (Tiedemann et al., 2004; Tiedemann et al., 1999).

The population trend in the southern parts of the Baltic – Wadden Sea population segment has been documented since the late 1800s. In Germany, the Wadden Sea islands were colonized in the 1870s and the species is now regular on most of the Wadden Sea islands (Waltho & Coulson, 2015). The first breeding in the Netherlands occurred in 1906, when the population in Denmark comprised only one colony (Joensen, 1973; Tjørnløv, 2020). By the 1950s the Danish population had grown considerably and continued to grow, resulting in the colonization of new regions (Bregnballe, 2002). The Danish and German populations grew until the 1990s, reaching c. 32 000 pairs (Desholm et al., 2002). Similar growth was documented in the northern Baltic Sea, where a steady 5-10% annual increase was recorded between the 1970s and 1990s (Ekroos, Fox, et al., 2012), when c. 315 000 and 180 000 pairs were estimated in Sweden and Finland, respectively (Desholm et al., 2002; Valkama et al., 2011). Information before the 1970s from the northern Baltic Sea population is scarce, but apparently the population in Finland was low in the beginning of the 1900s, after which it started to increase, reaching 12 000 pairs in 1930s (HELCOM, 2013), which according to nest counts in Åland in 1920s and 1930s might be an underestimate (R. Juslin pers. comm.). The population in Finland continued to grow until a collapse during WWII (HELCOM, 2013).

Since the population peak in the 1990s, breeding populations in the northern Baltic Sea, southern Norway and the Netherlands declined drastically and populations roughly halved, but remained stable in Denmark and Germany (Desholm et al., 2002; Ekroos, Fox, et al., 2012). In 2008, the Swedish population was estimated to number 150,000 pairs (Ottosson et al., 2012). Wintering numbers were estimated to have declined by 36% from 1.2 million to 760,000 birds between 1991 and 2000 (Desholm et al., 2002). Skov et al. (2011) report a further decline of 51% in 1991–2009 within the Baltic Sea. Contradicting the breeding population trend, wintering numbers are estimated to show a moderate increase since 2010 (Wetlands International, 2017). However, both breeding censuses in Sweden and Finland (Below et al., 2019) and range state questionnaires and migration counts in Denmark and Sweden (Berg & Bregnballe, 2020) have shown that breeding populations of the northern Baltic Sea have continued to decline by 10–40%.

According to the EU Birds Directive Article 12 reporting, the Baltic - Wadden Sea segment of the population shows a long-term increase in the breeding range in Denmark (64% 1974–2017) and the Netherlands (68% 1977–2015), whereas decreases have been witnessed in Estonia (-20% 1980–2018) and France (-40 – -50% 1985–2017), where the Eider was never common and has currently largely disappeared as a breeding bird (Keller et al., 2020). Stable, long-term trends in range sizes were reported in Germany, Sweden and Finland. Short-term range trends were positive in Germany (11–40% 2004–2016) and in the Netherlands (10% 2000–2015), stable in Denmark and Sweden, but negative in Estonia (-24% 2007–2018). Recent trends are unknown in Finland.

The British breeding population increased during the late 1800s and continued to increase through the 1900s (Holloway, 2010). The increase continued on the west coast of Scotland spreading south- and westwards, resulting in regular breeding in Northumberland by the 1930s and colonization of Walney, in northwest England in 1949 (Holloway, 2010). Reporting under Article 12 of the EU Birds Directive showed that the UK breeding population is estimated to have increased in the short term (17% between 1990–2015) and long term (40% between 1970–2015) but the wintering population is estimated to have decreased in the short term (18% between 2005–2016) and long term (22.5% between 1980–2016). It is thought predation by non-native American mink (*Neovison vison*) led to a breeding range contraction in western Scotland (Balmer et al. 2013). Common Eider has disappeared from most of southern England, where it was never an abundant breeder (Keller et al., 2020). First breeding in Ireland occurred in 1912 (Holloway, 2010), where currently 160 pairs breed.

Norway and Russia population

The Norway & Russia population is estimated at c. 80 000 pairs, although the estimate of Novaya Zemlya (30 000 pairs) dates back to 1940s and the current population size is unknown (Krasnov et al., 2016). The

Norwegian population has decreased by one third (2000-2019) (Fauchald et al., 2015). No published data on changes in range size was found.

Svalbard & Franz Josef Land population

The Svalbard & Franz Josef Land population is estimated to be c. 20 000 pairs, with the majority concentrated in Svalbard (17 000 pairs). Despite high uncertainty, the small population on Franz Josef Land is estimated to have doubled or tripled since the 1980s (Krasnov et al., 2016). In Svalbard, the population in Kongsfjord (2 000–3 500 pairs in 2000-2016) showed a 2% annual decline for the period of 2007–2016, with population lows in 2013 and 2016 (Norwegian Polar Institute, 2020). The long-term trend (1982–2016) exhibited a 0.6% annual decline. Possible changes in the range size remain unknown.

Table 4. Common Eider population sizes and trends of the Baltic, North & Celtic Seas population by range state (Principal Range States in bold). Data for European Union Member States (in italics) are predominantly from Birds Directive Article 12 reporting for 2013–2018 (also for UK).

Country	Breeding numbers (pairs)	Year(s) of the estimate	Quality of data	Short-term breeding trend (years: quality of data)	Long-term breeding trend (years: quality of data)	Non-breeding population (individuals)	Year(s) of the estimate	Quality of data	Short-term winter trend (years: quality of data)	Long-term winter trend (years: quality of data)
<i>Belgium</i>	–	–	–	–	–	5–15	2013–2018	M(E)	Stable (2007–2018; G(E))	Decline 90% (1992–2018; G(E))
UK	37209	2012–2015	M(E)	Increase 17% (1990–2015, M(E))	Increase 40% (1970–2015, M(E))	85762	2012–2016	G(O)	Decline 18% (2005–2016; G(O))	Decline 22.5% (1980–2016, G(O))
<i>Denmark</i>	18383	2017	M(E)	Decline 4–40% (2006–2017, G(E))	Decline 16–46% (1996–2017, G(E))	396000–592000	2016	M(E)	Stable (2008–2016, P(S))	Decreasing (1980–2017, P(S))
<i>Estonia</i>	1500–2500	2013–2017	M(E)	Decline 28–29% (2006–2017, M(E))	Decline 87–91% (1980–2017, M(E))	10–30	2013–2018	M(E)	Decline 50% (2006–2017, G(E))	Stable (1980–2017, G(E))
<i>Finland</i>	68528–155511	2013–2018	M(E)	Decline 2–38% (2007–2018; G(E))	Decline 10–36% (1986–2018; M(E))	11–41	2014–2018	M(I)	Stable (2007–2018, G(E))	Decline 92–99% (1980–2011, G(E))
<i>France</i>	2–4	2015–2017	M(E)	Fluctuating (2007–2017, G(E))	Fluctuating (1980–2016, M(E))	95–415	2013–2018	M(E)	Decline 75–95% (2007–2017, G(E))	Decline 82–93% (1980–2018, M(E))
<i>Germany</i>	1500	2014–2016	M(E)	Increase 43% (2004–2016, M(E))	Increase 126% (1980–2016, M(E))	450000–600000	2011–2016	M(E)	Increase 40–100% (2003–2016, G(E))	Unknown (1980–2016, P(S))
<i>Ireland</i>	160	2012	M(I)	Unknown	Unknown	1373	2011–2016	M(E)	Unknown (2004–2016, P(S))	Unknown (1987–2016, P(S))
<i>Latvia</i>	–	–	–	–	–	Unknown	Unknown	Unknown	Unknown	Unknown
<i>Lithuania</i>	–	–	–	–	–	Unknown	Unknown	Unknown	Unknown	Unknown
<i>Netherlands</i>	5500–6700	2013–2015	M(E)	Decline 8–54% (2006–2017, G(E))	Decline 18–20% (1980–2017, G(E))	55546–111805	2013–2017	M(E)	Stable -33 – +13% (2006–2017, G(E))	Decline 7–48% (1981–2017, G(E))
Norway ⁸	10000	2013–2015	M(E)	Decline 38% (2009–2019, G(E))	Stable (1988–2019, G(E))	10000	2009	ME(E)	Stable (2009–2019), G(E))	Increase 55 % (1980–2019, G(E))
<i>Poland</i>	0–1	2013–2018	M(E)	Fluctuating (2007–2018, G(E))	Unknown (1980–2018, P(S))	90–1480	2013–2018	M(E)	Fluctuating (2011–2018, G(E))	Unknown (1980–2018, P(S))
Russia	200	2010	M(E)	Unknown	Increase (1970–2010, P(S))	Unknown	Unknown	Unknown	Unknown	Unknown
<i>Sweden</i>	44000–74000	2013–2018	M(E)	Decline 50–70% (2007–2018, G(E))	Decline 60–80% (1980–2018, M(E))	40000–60000	2015	M(E)	Increase 28–115% (2007–2018, G(E))	Increase 165–231% (1980–2018, M(E))

⁸ Non-breeding data based on Lorentsen and Petersen (2009)

Table 5. Common Eider population sizes and trends of the Norway & Russia population by range states.

Country	Breeding numbers (pairs)	Year(s) of the estimate	Quality of data	Short-term breeding trend (years: quality of data)	Long-term breeding trend (years: quality of data)	Non-breeding population (individuals)	Year(s) of the estimate	Quality of data	Short-term winter trend (years: quality of data)	Long-term winter trend (years: quality of data)
Norway ⁹	77000	2013-2015	M(E)	Decline 29% (2009–2019, G(E))	Decline 61% (2000–2019, G(E))	200000-250000	2019	ME(E)/P(S)	Stable (2009-2019, G(E))	Decline 50 % (1980-2019, G(E))
Russia ¹⁰	30000–35000	1940, 2002–2016	M(E)	Unknown	Unknown	95500	2009	M(E)	Unknown	Unknown

Table 6. Common Eider population sizes and trends of the Svalbard & Franz Josef Land population by range states.

Country	Breeding numbers (pairs)	Year(s) of the estimate	Quality of data	Short-term breeding trend (years: quality of data)	Long-term breeding trend (years: quality of data)	Non-breeding population (individuals)	Year(s) of the estimate	Quality of data	Short-term winter trend (years: quality of data)	Long-term winter trend (years: quality of data)
Norway ⁹	17000	2013-2015	M(E)	Stable (2008-2019, G(E))	Unknown	Small	Unknown	Unknown	Unknown	Unknown
Russia ¹⁰	2000–3000	2016	M(E)	Unknown	Increase 100–200% (1980–2016, P(S))	Unknown	Unknown	Unknown	Unknown	Unknown
Iceland	-	-	-	-	-	Unknown	Unknown	Unknown	Unknown	Unknown

Quality of data:

Good (Observed) [G(O)] = based on reliable or representative quantitative data derived from complete counts or comprehensive measurements.

Good (Estimated) [G(E)] = based on reliable or representative quantitative data derived from sampling or interpolation.

Medium (Estimated) [M(E)] = based on incomplete quantitative data derived from sampling or interpolation.

Medium (Inferred) [M(I)] = based on incomplete or poor quantitative data derived from indirect evidence.

Poor (Suspected) [P(S)] = based on no quantitative data, but guesses derived from circumstantial evidence.

⁹ Breeding data based on Fauchald et al. (2015), Anker-Nilssen et al. (2015) and G. Gabrielsen (pers. comm.); non-breeding data based on The Norwegian monitoring programme for breeding seabird, S.-H. Lorentsen (pers. comm.) and H. Strøm (pers. comm.)

¹⁰ Data based on Krasnov et al. (2016). Status, Number, and Monitoring of the Common Eider (*Somateria mollissima*) Population in the Barents Sea and the White Sea. *Biology Bulletin*, 43(7), 664-669

ANNEX 2. PROBLEM ANALYSIS

General overview

The assessment of threats and limiting factors of the three AEWA-listed Common Eider populations was, in addition to published literature, based on information provided by the Principal Range States in questionnaires submitted during the action-planning process as well as on additional feedback received during the consultations of the Action Plan including the action-planning workshop. The threat assessment was done on population level based on the information available, whilst recognizing that the magnitude of threats may vary both locally and between the different management units.

The decline witnessed especially in the Baltic, North & Celtic Seas population is likely associated with reduced survival and reduced reproductive output due to increased predation risk, diseases and impaired feeding conditions, which are described below in more detail. In addition, bycatch in fishing gear, oil and other pollution, hunting, anthropogenic disturbance from shipping and marine infrastructure may have affected population viability. The Common Eider is a fairly well-studied species, and despite the plethora of studies, no universal reason for population changes between study sites have been found. Many of the threats have been identified and addressed already in the action plan of Conservation of Arctic Flora and Fauna (CAFF) in the 1990s (The Circumpolar Seabird Working Group, 1997), when the populations of Common Eider were still in a healthy state. Many of the factors threatening population viability are interlinked. For example, being the main driver of body condition, food supply is closely linked to other threats and it is susceptible to changes in environmental conditions and to impacts from human activities, e.g. through exposure to pollutants and toxins present in their diet (Sipiä et al., 2004). Furthermore, a good body condition has been associated with increased survival (Ekroos, Öst, et al., 2012), breeding success (Jaatinen et al., 2013), immune defense (Neggazi et al., 2016) and reduced hunting mortality (Christensen, 2001). Taken together, the studies indicate that the underlying drivers for population growth rates act locally and therefore, the solutions required to enhance the population trajectories are also likely to differ spatially (Tjørnløv, 2020).

Reduced food quality and supply

Baltic, North & Celtic Seas population

The Common Eider is considered to be a capital breeder, relying on the energy resources acquired in winter for successful reproduction. However, the body reserves of female Eiders in Finland are acquired during the winter, but only the females with high body mass use stored reserves for producing eggs, while others rely on local resources for egg production (Hobson et al., 2015; Jaatinen et al., 2016). Also the large proportion of time spent feeding after arrival at a Danish breeding colony (62–72% of the daylight hours), and the subsequent rapid growth of ovaries close to egg laying indicate that local food resources at the breeding grounds are allocated to egg production (Christensen, 2000). Therefore, food shortages on both the wintering and breeding grounds could markedly affect female survival and productivity (Hobson et al., 2015). In Denmark, the amount of body reserves acquired at the wintering quarters was found to be a significant predictor of female condition when ducklings hatch (Lehikoinen et al., 2008). On Christiansø in Denmark, exceptional mortality of 5–10% of incubating females caused by starvation occurred in 2007 and 2015 (Garbus et al., 2018), but it is uncertain at what stage of the annual cycle food was lacking and what factors caused the food shortage (Tjørnløv, 2020). A study focusing on body condition development from wintering in Denmark to pre-breeding in Åland suggested, in turn, that acquiring sufficient stored reserves for breeding from local resources was feasible in the Åland area, and concluded that food availability is unlikely restricting the local population size (Laursen, Møller, & Öst, 2019). On the other hand, in Gotland and eastern coast of Sweden, the number of breeding females declined rapidly between 2007 and 2008 with a maximum of 76% decline in Gotland (from 6 650 to 1 620 nests), following an almost as rapid increase in 2009 (Larsson et al., 2014). The declines were associated with simultaneous extensive bloom of the potentially toxic algae *Prymnesium polylepis* in March–May. As the increase in number of breeding females in 2009 could not be explained by recruitment, the rapid decline in numbers was likely a result of large-scale non-breeding. There was some evidence that females affected by the bloom were in poor body condition, and Larsson et al. (2014) suggested that the extensive potentially toxic

bloom reduced or delayed the soft body mass increase and gonad build-up of Blue Mussels, leading to shortage of high-quality food for Eiders during the pre-laying period. In the British Isles, food shortage may have caused the population decline observed in Northumberland (Waltho & Coulson, 2015).

Blue Mussels and Cockles (*Cerastoderma edule*) are the main prey for Eiders in the Wadden Sea (Nehls, 1991), but if these species are not available, the role of other bivalves increases (Cervencel et al., 2015). Eiders favour mussel culture plots, but their importance decreases over the winter, which might be due to human harvesting of mussels at these sites (Cervencel et al., 2015). Shifts in winter distribution have indicated that in poor Blue Mussel years in the Wadden Sea, Common Eiders leave the coast of Netherlands for the North Sea where they utilize bivalve *Spisula* spp. instead of mussels (Camphuysen et al., 2002). The overfishing of mussels and Cockles in the early 1990s is supposed to have resulted in reduced primary food resources, reductions in the extent of foraging area, and increased use of *Spisula* in the North Sea (Beukema, 1993; Camphuysen et al., 2002; Scheiffarth & Frank, 2005). Intense fishing in the summer of 1999 caused a shortage of *Spisula* during the winter of 1999/2000, which was also a poor year for mussels in the Wadden Sea (Camphuysen et al., 2002). The food shortage in both the Wadden and North Sea was suggested to have caused the death of 25 000 Eiders at the time (Camphuysen et al., 2002). Numbers of invasive Razor Clam (*Ensis directus*) have increased steadily in the Dutch Wadden Sea since 2002, when *Spisula* disappeared for 15 years and returning in only 2017 (Perdon et al., 2019). The spread of Razor Clam in the Wadden Sea has been suggested to possibly provide alternative prey for Eider and thus increase food availability (Tulp et al., 2010; Volmer et al., 2014). The spread of the Pacific Oyster (*Magellana gigas*) has most probably reduced the availability of Blue Mussels to Eiders (Scheiffarth et al., 2007).

In Finland, salinity has been shown to have a positive association with Blue Mussel abundance, biomass and recruitment, whereas water temperature has a negative effect on abundance and recruitment (Westerbom et al., 2019). Although salinity limits their growth, the Baltic Sea Blue Mussels in Finland are suggested to be better quality food for Eiders than Atlantic mussels, due to higher flesh-to-shell ratio and ideal size (Öst & Kilpi, 1998). However, new studies based on Finnish data predicts reduced growth rates of mussels under a climate change scenario (Jaatinen et al. 2020) and indicate a decline in blue mussel biomass in an area somewhat north of Stockholm between 1993 and 2016 (Liénart et al. 2020). Warmer water temperature in winter has also been shown to reduce soft body mass of mussels in Denmark (Waldeck & Larsson, 2013). Climate change induced warmer winters may thus lead to reductions in food quality at the wintering grounds and greater reliance on mussels at the breeding areas for reaching breeding condition (Tjørnløv, 2020). This notion is supported by the findings of a stable-isotope study showing more extensive use of body reserves in egg production following a cold winter, which may be due to better feeding conditions at the wintering grounds (Hobson et al., 2015). However, a similar pattern could follow from a late ice breakup at the breeding grounds and warmer climate may offer possibilities for birds to utilize new feeding areas. In the Wadden Sea, increased levels of nutrients in sea water were associated with increasing mussel stocks and Eider abundance (Laursen & Møller, 2014; Laursen, Møller, & Hobson, 2019). The trends of the Baltic Sea segment of the population might be related to nutrients load from land to sea (Laursen & Møller, 2014); as a consequence of planned intervention to reduce anthropogenic pollution the extent of nutrient load has reduced, which has occurred in parallel with the population decline of Eiders.

Climate change can drive long-term changes in Blue Mussel abundance and biomass through increasing water temperature and decreasing salinity in the Baltic Sea, which are both detrimental to Blue Mussel populations and can cause local extinctions (Jaatinen et al., 2020, Westerbom et al., 2019). In addition, climate change induced increasing runoff of carbon and nitrogen from land can impair feeding conditions and physiology of Blue Mussels (Liénart et al., 2021). Being the preferred prey for the Common Eider, alterations in mussel availability can in turn have long-term effects on Eider distribution and abundance (Laursen et al., 2009). Increasing winter water temperature has been shown to severely reduce the Blue Mussel flesh content, and climate change is likely to hamper feeding of the Common Eider on Blue Mussels (Waldeck & Larsson, 2013). However, increasing water temperatures decrease mussel shell strength leading to increased flesh-to-shell ratio (C. L. Mackenzie et al., 2014), which could potentially increase their flesh-to-shell ratio and quality for Eiders to some extent (Fox et al., 2015; Öst & Kilpi, 1998). However, water temperatures rising above the thermal tolerance of benthic invertebrates may cause large-scale reductions in food supply for Common Eider and mass mortalities of Cockles in the Wadden Sea in 2018-2019 have already been associated with warm summer temperatures (Reneerkens, 2020). Rainfall is predicted to increase in the Nordic countries, which is likely to

reduce the salinity of the Baltic Sea (B. R. Mackenzie et al., 2007; Meier et al., 2012). Since both Eiders and Blue Mussels are scarce in the low salinities of the eastern Gulf of Finland and Bay of Bothnia, reduced salinity could potentially diminish the distributions of the two species in the northern Baltic Sea. However, due to increased precipitation, also the runoff of nutrients is projected to increase in the northern Baltic Sea (Meier et al., 2012), which is likely to be beneficial for Blue Mussels.

Climate change has been shown to alter the phenology of the Common Eider, which in turn might affect the spatial distribution over the annual cycle. Eiders have advanced their arrival to the northern Baltic Sea breeding grounds, but similar advances have not been found in their breeding schedule (Jaatinen et al., 2016; Lehikoinen et al., 2006; Öst et al., 2018). More time spent on the breeding grounds before the initiation of incubation might result in higher demands on the local mussel stock, which, however, might be exposed to increasing pressure due to the projected reduction in salinity (Jaatinen et al., 2016). In addition, earlier arrival to breeding grounds may increase the exposure time to predators and hence increase predation pressure if predators are more abundant in breeding than wintering grounds. This in turn might increase mortality, but also affect reproduction if time dedicated to predator avoidance compete with time devoted to foraging.

In the Baltic Sea, rapid increase in Three-spined Stickleback (*Gasterosteus aculeatus*) numbers have been dramatically increased during the past few decades due to climate change and eutrophication (Olsson et al., 2019). The increase has led to regime shift from large predator fish dominance to Stickleback dominance through the food competition in early life stages (Begström et al., 2015; Byström et al., 2015; Eklöf et al., 2020). Sticklebacks prey on small invertebrates, which are the main prey for Eider ducklings. There is likely food competition between Eider ducklings and sticklebacks, but the effects of the competition to duckling survival and Eider reproduction remain unknown. However, the sticklebacks have not increased yet in the Blekinge archipelago in southeastern Sweden, which is the only area where Eider reproduction is still fairly high (F. Haas *in litt.*). This may indicate that Stickleback could have large-scaled impact on Eider reproduction and further studies may be required.

Norway & Russia population

In northern Norway, the diet of wintering Common Eiders was dominated by Blue Mussels (46.3% of wet weight), but also included eggs of the Lumpsucker (*Cyclopterus lumpus*; 25.9%), Northern Horseshoe Mussels (*Modiolus modiolus*; 7.3%), Ocean Quahog (*Arctica islandica*; 2.8%) and Discard Mussels (*Modiolaria discors*; 2.1%) (Bustnes & Erikstad, 1988). The diet of the Common Eider was less species diverse than that of the King Eider and overlap in diet between the two species was limited. Reductions in the availability and energy content of mussels is considered a wide-scale threat in Norway, but the impact on Common Eider is unknown (M. Irgens, S.-H. Lorentsen *in litt.*).

In the Arctic winter, short days may limit the foraging possibilities of Eiders. In northern Norway (70°N), Common Eiders extended their feeding period into lower light intensities when day length decreased and used a higher proportion of the daylight hours foraging (Systad et al., 2000). Time spent foraging during daylight hours on the shortest day of the year was only 51% of the corresponding time spent feeding on the longest day of the year. Feeding at lower light intensities and increased proportions of the daily time spent on foraging did not compensate for the reduced feeding time in midwinter (Systad et al., 2000). The ability to survive during short Arctic winter days was suggested to be enabled by the use of stored nutrient reserves, night feeding and high prey availability (Systad et al., 2000).

Svalbard & Franz Josef Land population

Glaucous Gulls (*Larus hyperboreus*) have been shown to steal bivalves from feeding Common Eiders in spring in Svalbard, and kleptoparasitism is suggested to have potential negative impacts on Eider energy acquisition prior to breeding (Varpe, 2010).

Table 7. Threat assessment of food depletion following the IUCN Threats Classification Scheme (IUCN, 2020)

Threat: Shellfish collection (IUCN threat category 5.4.1 Fishing & Harvesting Aquatic Resources, intentional use) <i>Shellfish collection in the Wadden Sea reduces the food supply of preferred prey, Cockles and Blue Mussels, reducing the feeding possibilities of Common Eiders wintering or breeding in the Wadden Sea. Alternative prey, Spisula spp is available in the North Sea, and economic exploitation of Spisula when Cockles and Blue Mussels are unavailable in the Wadden Sea can cause mass mortalities in Eiders. Spisula has been absent 2002–2016 from the Wadden sea, when increasing Razor Clam might have provided alternative prey for Eider. Effects of shellfish fisheries in other populations are largely unknown.</i>				
Population	Scope (i.e. the proportion of the total population affected)	Severity (i.e. the overall declines caused by the threat)	Timing (i.e. past, ongoing or future)	Overall Threat Impact Score
Baltic, North & Celtic Seas	Affects the minority of the population (<50%)	Unknown*	Ongoing	“Medium impact (score 7)”
Norway & Russia	Unknown	Unknown	Ongoing	Unknown
Svalbard & Franz Josef Land	Unknown	Unknown	Ongoing	Unknown
Threat: reduced food supply and quality (IUCN threat category 12.1 Other threat) <i>Shortage of food and lowered quality can be caused also by several other factors including water temperature rise, reductions in nutrients, toxic algae blooms and reduced salinity, but some of the factors are likely unknown. The effects are likely to fluctuate annually and concern only parts of population or parts of annual cycle. Climate change can have large-scale effects due to increased water temperature and reduced salinity in Baltic Sea due to increased precipitation which may impair conditions of the main prey, the Blue Mussel. However, nutrient inflow to the Baltic Sea may increase due to increased precipitation, which may enhance conditions for Blue Mussels, and the effects of climate change are largely unknown.</i>				
Population	Scope (i.e. the proportion of the total population affected)	Severity (i.e. the overall declines caused by the threat)	Timing (i.e. past, ongoing or future)	Overall Threat Impact Score
Baltic, North & Celtic Seas	Affects the whole population (>90%)	Causing or likely to cause relatively slow but significant declines**	Ongoing	Medium impact (score 7)
Norway & Russia	Affects the majority of the population (50–90%)	Unknown**	Ongoing	“Medium impact (score 7)”
Svalbard & Franz Josef Land	Affects the majority of the population (50–90%)	Unknown**	Ongoing	“Medium impact (score 7)”

* The local severity of food depletion and disturbance deriving from shellfish collection may be high in the Wadden Sea, but the combined effects to Common Eider remain unknown.

** The role of climate change driven alterations in food supply are largely unknown but can potentially have large-scaled negative effects to mussel stocks due to rising water temperature and lower salinity in the Baltic Sea proper.

Increased predation

Baltic, North & Celtic Seas

A scenario-driven population projection based on biological and environmental factors in the Baltic Sea indicated that predation was the most important driver of the population decline in the large Finnish breeding population, where survival of breeding females was much lower than in the southern parts of the Baltic and Wadden Sea segments of the population (Tjørnløv, 2020). The effect and frequency of predation has been studied in the Tvärminne archipelago in the western Gulf of Finland. There, the two main predators are White-tailed Eagle (*Haliaeetus albicilla*) and the invasive American Mink. They both prey on incubating females resulting in the lowest recorded survival for the species (Ekroos, Öst, et al., 2012; Jaatinen et al., 2011; Öst et al., 2018). The predation pressure has increased since the 1990s, especially on open islands in the outer archipelago, where survival was lower (0.68) than on the forested islands in the inner archipelago (0.76) (Ekroos, Öst, et al., 2012). This is in line with predation pressure being higher in the outer open (0.14 killed females per active nest) than in the inner forested archipelago (0.08) (Öst et al., 2018). It is suggested that the outer open archipelago has become an ecological trap for the highly breeding site philopatric Common Eider, which is unable to escape the high predation pressure due to low breeding dispersal (Ekroos, Öst, et al., 2012). The historically large populations in the outer archipelago in SW Finland have declined by 15% annually since 1995, and locally only 5% of the population present in 1993 remains (Kilpi et al., 2018). In this area, the population decline has been much steeper in the outer archipelago than close to the mainland (Kurvinen et al., 2016). A similar association has been seen throughout the Swedish coast, where the population trend in the outer archipelago, more than 10km from the coast, has been considerably lower (-7% annually) than that on the coast or in the inner archipelago (-3–4%) (Lund Bjørnås, 2017). In Britain, the range contractions in western Scotland are supposed to be caused by predation by American Mink. However, there is no direct evidence of mink impact, and specifically no evidence of whether the cause of disappearance was deferral (non-breeding by recruited females), direct mortality, and/or emigration. (Balmer et al. 2013).

The decline in the outer archipelago of the western Gulf of Finland has been associated with increased predation pressure imposed by immature non-breeding White-tailed Eagles, the abundance of which has increased by 13.4 % annually during 2003–2016 (Ekroos, Öst, et al., 2012; Öst et al., 2018), corresponding with the annual increase of 14.2% in White-tailed Eagle-caused mortality in Eiders (Öst et al., 2018). The Common Eider was the most common prey species of White-tailed Eagles in Åland (21.4% of all prey items) and was more frequently consumed in the outer archipelago than in the inner archipelago (Ekblad et al., 2016). In the western Gulf of Finland, the White-tailed Eagle was responsible for 44.5% and the American Mink for 37.2% of all killed Eider females for which the predator was known (Öst et al. 2018). Similarly to mortality imposed by the White-tailed Eagle, American Mink induced Eider female mortality increased annually by 11.0% during the years 2003–2016 (Öst et al., 2018). Other identified predators include the Eurasian Eagle Owl (*Bubo bubo*) (responsible for 11.5% of the killed females in the western Gulf of Finland) and the Raccoon Dog (*Nyctereutes procyonoides*; 6.3%) (Öst et al., 2018). While the White-tailed Eagle occurs mostly in the outer archipelago, the effect of Raccoon Dog in the inner archipelago can be extensive (Dahl & Åhlén, 2019; Ekroos, Öst, et al., 2012). The removal of the American Mink from the outer archipelago in southwestern Finland did not significantly change the number of breeding Common Eiders but increased the number of smaller waterfowl species (Nordström et al., 2002). However, American Mink removal in the western Gulf of Finland has had a positive effect on the number of breeding Common Eider (K. Jaatinen *in litt.*). According to the ‘scarecrow’ theory, humans provide shelter by keeping away the natural predators (Leighton et al., 2010). Supporting this theory, breeding Common Eider females have been found to aggregate to human presence (Arfman, 2019; Fox et al., 2015). This is also supported by personal observations from Finland and Norway reporting that human presence has a positive effect on Eiders breeding success, especially in locations where Eiders are used to humans (M. Kilpi, R. Juslin, M. Irgens *in litt.*). However, in other locations where scarecrow effect is not present, sporadic disturbance from both human and natural predators may increase nest predation by flushing off incubating females and exposing the eggs for crows and gulls, as well as flushing broods to open water (Stien & Ims, 2016; M. Kilpi & R. Juslin *in litt.*). According to studies in Söderskär, gull predation only has minor effects in relation to other factors affecting breeding success (Hario & Selin 1991).

There are several observations of Grey Seals (*Halichoerus grypus*) and Harbour Seals (*Phoca vitulina*) killing and eating Common Eiders (Kirkham, 2008; Moore, 2001; Morgan, 1986), which has led to concern of additional predation pressure from the increasing Grey Seal population in the Baltic Sea. Although the diet of seals in the Baltic Sea is dominated by fish (Lundström et al., 2010), 8% of the Grey Seals in the Bay of Bothnia had remnants of birds in their stomachs and intestines, whereas no traces of birds were detected in the other parts of the Baltic Sea (Strömberg et al., 2012). The predation by one or few seals could potentially have a high local impact, but the subject would need to be studied in more detail.

Further evidence of the detrimental effect of predation-induced female mortality is provided by the rapidly increasing male bias in the sex ratio in the Baltic and Wadden Sea segments of the population (Lehikoinen et al., 2008). The cause of the skewed sex ratio has been shown to be a result of increased mortality of breeding females and not by a sex skew in productivity or duckling mortality (Ramula et al., 2018; Tjørnløv et al., 2019). The increased proportion of males might lead to increased pre-breeding harassment of females, which may in turn disrupt the acquisition of reserves required for breeding (Christensen, 2000). However, an empirical study about the role of the male in securing feeding of the female showed that females were able to feed normally even when surrounded by other than their own breeding partners (Hario & Hollmen 2004). In addition, male disturbance did not, whereas predation pressure did, explain the high proportion of non-breeding females in a population in the western Gulf of Finland (Öst et al., 2018).

Predation pressure on breeding females can also have indirect adverse effects on population size through reduced productivity. The clutch size on open islands is lower than on forested ones due to increased egg predation (Öst, Wickman, et al., 2008). Increasing predation pressure increases the abundance and size of brood coalitions (Jaatinen & Öst, 2013; Jaatinen et al., 2011), which are effective in reducing predation of ducklings by gulls due to increased vigilance and defense (Öst, Smith, et al., 2008). However, coalitions are found to be ineffective against White-tailed Eagles, which force the females to dive exposing the ducklings to predation by gulls (Kilpi et al., 2018). The increased predation pressure has increased the proportion of females that skip breeding, and this in turn contributes to the low productivity in recent years (Öst et al., 2018). Previous studies have shown that earlier breeding females have higher breeding success (Jaatinen et al., 2013). However, due to the current increase in predation pressure, the start of breeding has been delayed, which together with high number of non-breeding females suggests that predation pressure is again the driver behind the observed pattern (Öst et al., 2018). A rising trend in the breeding female body condition also suggests that only females in very good body condition are able to, or willing to, breed under the stringent predation regime reigning in the western Gulf of Finland (Öst et al., 2018).

Norway & Russia population

Detailed studies on egg predation have been carried out in northern Norway. In one colony, Crow removal during a single year increased the nesting success from 61% to 80%, which then decreased again to 74% in the subsequent year (Stien et al., 2010). In another colony, crow removal had no significant effect on nesting success, and this was likely a consequence of higher predation pressure by other nest predators, which was supported by the overall low nesting success (38–40%) (Stien et al., 2010). The causes of nest predation in the same colonies was studied with camera traps during 2009–2011, and the results showed that departures from the nest due to human disturbance increased nest predation risk considerably, whereas natural recess from the nest or the camera traps itself had no influence (Stien & Ims, 2016). The most common nest predators were Hooded Crow (*Corvus cornix*) and Greater Black-backed Gull (*Larus marinus*), which seemed to use both the presence of researchers and the flushing females as cues to finding the nests and subsequently depredating on them (Stien & Ims, 2016).

Predation by White-tailed Eagle throughout the year and predation of breeding females by American Mink were both recognised as wide-scale, high severity threats also in Norway (M. Irgens, S.-H. Lorentsen *in litt.*). Active predator control is taking place in the Vega archipelago in central Norway, which is a UNESCO world heritage site focusing on the down production from Eiders. The down production tradition and human settlements – together with predator control – are gone from outer archipelago in most of coastal Norway, which could partly explain the reduction of the Common Eider population (M. Irgens *in litt.*).

Svalbard & Franz Josef Land population

In Svalbard, egg predation was studied in two populations, where egg predators (Arctic Fox *Vulpes lagopus*, Polar Bear *Ursus maritimus*, Arctic Skua *Stercorarius parasiticus*, and Glaucous Gull) were chased away or shot by trappers/down collectors in one, while no predator control was performed in the other (Hanssen et al., 2013). The predator control increased the growth rate and carrying capacity considerably compared to the uncontrolled population (Hanssen et al., 2013). Population size and growth rate were positively linked to reduced ice-cover as a consequence of climate change (Hanssen et al., 2013). However, reduced ice cover in Svalbard and Greenland has been associated with increasing numbers of Polar Bears on land and increased predation pressure on breeding birds, including Common Eider (Prop et al., 2015). The effects of climate change were further modelled in Svalbard. Whereas the predation by polar bears will increase where the species occur in sympatry, the climate mediated increases in breeding propensity and clutch size will compensate the losses, and the Eider population is projected be stable for the next 50 years (Dey et al., 2018).

Table 8. The threat assessment of predation following the IUCN Threats Classification Scheme (IUCN, 2020)

Threat: Predation by American Mink and Raccoon Dog (IUCN threat category 8.1 Invasive Non-Native Species)* <i>The American Mink and Raccoon Dog prey on eggs and incubating females decreasing fecundity and female survival. Raccoon Dog is absent from Svalbard & Franz Josef Land, Norway, Russia and majority of Sweden. Raccoon Dog numbers has increased rapidly in Denmark and northern Germany (Miljøstyrelsen, 2020) and could further expand its range. American Mink is absent from Svalbard and Franz Josef Land, northern Norway, parts of Germany and Russia outside the Kola peninsula.</i>				
Population	Scope (i.e. the proportion of the total population affected)	Severity (i.e. the overall declines caused by the threat)	Timing (i.e. past, ongoing or future)	Overall Threat Impact Score
Baltic, North & Celtic Seas	Affects the majority of the population (50–90%)	Causing or likely to cause rapid declines	Ongoing	Medium impact (score 7)
Norway & Russia	Affects the majority of the population (50–90%)	Causing or likely to cause relatively slow but significant declines	Ongoing	Medium impact (score 6)
Svalbard & Franz Josef Land	Not applicable	Not applicable	Not applicable	Not applicable
Threat: Predation by White-tailed Eagle, Hooded Crow, Arctic and Red Fox & Polar Bear (IUCN threat category 8.2. Problematic Native Species)* <i>Predation of White-tailed Eagle has increased in the northern Baltic Sea and is high also in Norway & Russia affecting birds throughout the year but especially breeding and chick rearing females. Other avian predators mainly prey on eggs and duckling. Red Fox is absent from some larger islands in UK (e.g. Orkney), Novaya Zemlya and Svalbard & Franz Josef Land. In Novaya Zemlya, Svalbard & Franz Joseph Land Arctic Fox and Polar Bear are the main natural mammal predators.</i>				
Population	Scope (i.e. the proportion of the total population affected)	Severity (i.e. the overall declines caused by the threat)	Timing (i.e. past, ongoing or future)	Overall Threat Impact Score
Baltic, North & Celtic Seas	Affects the majority of the population (50–90%)	Causing or likely to cause rapid declines	Ongoing	Medium impact (score 7)
Norway & Russia	Affects the majority of the population (50–90%)	Causing or likely to cause rapid declines	Ongoing	Medium impact (score 7)
Svalbard & Franz Josef Land	Affects the majority of the population (50–90%)	Causing or likely to cause fluctuations	Ongoing	Medium impact (score 6)

*The combined impact of non-native and native predators on a flyway scale is more severe than for each predator group in isolation, because their effects differ geographically in the Baltic, North & Celtic Seas and the Norway & Russia populations. Jointly, these likely affect the whole Baltic, North & Celtic Seas population (>90%) and cause very rapid declines, and impact is high (score 9).

Hunting

At the time of writing all three populations of the Common Eider covered by this Action Plan are listed on AEWA Table 1 Column A, category 4. Hunting may therefore continue on sustainable use basis under the provisions of the Agreement, by way of an exception within the framework of an International Species Action Plan through which Parties will implement adaptive harvest management.

Baltic, North & Celtic Seas

Regular hunting of the species is currently only known to take place within the Baltic, North & Celtic Seas population. The Common Eider is listed under Annex II of the Birds Directive, and hunting is currently allowed in certain EU countries (Denmark, Finland, France and Sweden). Outside of the EU, hunting is allowed in southern Norway. Due to the observed decline in population size and proportion of females, many countries have ceased hunting, and the countries continuing to hunt have restricted the season and banned hunting of females and juveniles.

Historically, the highest bag sizes occurred in Denmark. Bag sizes there increased from ca 100 000 in the late 1950s to ca 140 000 in the 1970s–1980s, and then decreased to c. 83 000 during the 1990s due to decrease in the number of Eider hunters (Christensen, 2005). Bag size declined to 75 000 in the early 2000s. In Sweden, historical hunting bags were highest in the 1960s–1980s, with c. 20 000 birds shot annually. After that, a moderate decline occurred until 1997, followed by a sudden drop to only 1 000 birds. Regarding Norway, the average bag size in years 2000–2017 was 10 500 birds, with the peak of 14 950 birds in 2003/2004 (H. C. Pedersen et al., 2016).

Currently, bag sizes have declined to the 25 000 in Denmark, which has been stable for the last three seasons. The Danish hunting season was restricted in several steps over time from 2004 onwards to the current hunting season of 1 October – 31 January, and only males are allowed to be hunted. In Finland, the estimated bag size has decreased by 96% from 1993, and the average for the last three years has been 1 500 birds. Hunting in mainland Finland is nowadays restricted to the outer archipelago and to males only. Also, the season has been restricted to two weeks during 1–15 June. In Åland, 2 000 males were allowed to be hunted annually during 1–14 May within the framework of a local management plan, while females and juveniles are protected year-round. The management plan of Common Eider in Åland focuses on reducing predation pressure on breeding females by increased efforts by hunters to reduce the abundance of terrestrial predators in the archipelago, as well as increasing the knowledge on the size and distribution of the breeding population through increased monitoring. The bag size in Åland has declined by 80% since the 1980s due to stricter regulation with yearly maximum and personal bag limits. In April 2020 the European Court of Justice declared that, “by recurrently granting authorisations for spring hunting of male common Eiders (*Somateria mollissima*) in the province of Åland since 2011 and up to and including 2019, the Republic of Finland failed to fulfil its obligations under Article 7(4) and Article 9(1)(c) of Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (European Court of Justice, 2020). The open season for (not sex specific) hunting of Eider in Sweden is under revision. The Swedish Environment Protection Agency have suggested to Swedish Government to ban hunting until adaptive harvest management (AHM) is in practice but no decision has been taken yet. Currently, bag numbers are low and stable, fluctuating between 800–5 000 birds including hunting both in the Baltic Sea and Kattegat. In Norway, hunting is only allowed in the southern counties of Viken, Vestfold, Telemark and Agder, which are included in the Baltic and Wadden Sea segments of the population. After the last revision of the hunting legislation in 2017, restricting the hunting to males only between 1 October and 30 November, bag numbers have dropped markedly and for the last two seasons they have been at around 3 400 males. Finally, hunting eiders is allowed in France without restrictions, but bag sizes remain anecdotal.

Table 9. Availability of bag statistics and recent bag sizes for the Common Eider.

Range State	Annual statutory bag statistics	Bag size	Period
Denmark ¹¹	Yes	25770	2018
Finland ¹²	Yes	1400	2018
France ¹³	No	See footnote	
Sweden ¹⁴	Yes	812	2017-2018
Norway ¹⁵	Yes	3010	2017-2018

Bregnballe et al. (2006) suggested that the effect of hunting had likely changed from reducing the Baltic and Wadden Seas population increase until the 1990s to potentially adding to the population decline after this. Simple demographic matrix projections showed that the restrictions of sex-specific hunting regulations in Denmark reduced the killing of adult females by 82% and juvenile females by 58%, corresponding to an increase in the annual growth rate from -6.3% to -1.6% (Christensen & Hounisen, 2014). The model assumed constant natural mortality and projected that a full ban of hunting females would lead to positive growth rate of 0.7% (Christensen & Hounisen, 2014). However, a later reconstructed population trajectory indicated that restrictions in hunting have decreased hunting induced mortality, and that hunting has had a minor role in the recent population decline, supported by the continuing population decline after the full ban on female hunting (Tjørnløv et al., 2019). Although the hunting bags have decreased in parallel with the population decline, the evaluation of causality between the two is difficult due to changes in hunting regulations, number of hunters and hunters effort, which are more likely to explain the changes in hunting bag sizes (Christensen, 2005).

Christensen (2001) found differences in hunting vulnerability and body condition in Denmark, suggesting that hunting vulnerability is associated with poor body condition attained prior to fledging, and hunting removes the individuals with the poorest body condition at the start of the hunting season. Therefore, hunting mortality may have concerned individuals which contribute less to the population growth, as body condition has been shown to correlate positively with fecundity and survival (Ekroos, Öst, et al., 2012; Öst et al., 2018).

Crippling is a direct effect of hunting in addition to mortality and is likely to affect also Eiders. A study in Denmark revealed that the occurrence of embedded shotgun pellets in females declined remarkably from 34.1% to 5.5% from 1997 to 2009–2011 following the implementation of an action plan to reduce crippling (Holm & Haugaard, 2013).

Disturbance induced by hunting may cause wide-scale effects and displacement if hunting is targeted at valuable feeding and staging areas. This was studied in the Danish part of the Wadden Sea where motorboat hunting was banned from certain areas to reduce disturbance and hunting pressure (Laursen & Frikke, 2008). The study found that the density of hunter motorboats was negatively associated with Eider density on a small geographical scale (1.8-2.5 km). In autumn, but not in winter motorboat hunting also affected Eider distributions at a larger geographical scale (4-12 km), displacing Eiders from the Wadden Sea into the North Sea. In a single study area (682 km²) in the Wadden Sea, Eider numbers increased by 56% following the ban on motorboat hunting in 1991 regardless of a parallel 50% reduction in the flyway population (Laursen & Frikke, 2008). However, the total eider numbers in the Danish Wadden Sea showed no significant change before and after 1992 suggesting that the eiders had locally redistributed themselves after the hunting ban (Laursen & Frikke, 2008). Wintering numbers have been declining in the Danish part of the Wadden Sea since

¹¹ <https://fauna.au.dk/en/hunting-and-game-management/bag-statistics/statistics-online-since-1941/bar-charts/>
https://cdr.eionet.europa.eu/Converters/run_conversion?file=dk/eu/art12/envxbrwfg/DK_birds_reports_20191106-110316.xml&conv=612&source=remote#A063_W

¹² https://cdr.eionet.europa.eu/Converters/run_conversion?file=fi/eu/art12/envxabcra/FI_birds_reports_20191031-102330.xml&conv=612&source=remote#A063_B
http://statdb.luke.fi/PXWeb/pxweb/fi/LUKE/LUKE_06%20Kala%20ja%20riista_02%20Rakenne%20ja%20tuotanto_16%20Metsastys/9_Mets_salis_aikasarja.px/?rxid=001bc7da-70f4-47c4-a6c2-c9100d8b50db

¹³ For France - bag sizes too small in sample survey to allow accurate estimate - Guillemain, Matthieu & Aubry, Philippe & Folliot, Benjamin & Caizergues, Alain. (2016). Duck hunting bag estimates for the 2013/14 season in France. *Wildfowl*. 66. 126-141.

¹⁴ https://cdr.eionet.europa.eu/Converters/run_conversion?file=se/eu/art12/envxbcxqa/SE_birds_reports_20191031-150346.xml&conv=612&source=remote#A063_B

¹⁵ <https://www.ssb.no/en/statbank/table/07514/tableViewLayout1/>

the beginning of 2000s despite the ban on motorboat hunting (Clausen et al. 2013; I. H. Sørensen *in litt.*). The disturbance of hunting has also affected the grouping behavior of wintering Eiders in Denmark and the effect differed between seasons (Laursen et al., 2016). At preferred autumn feeding sites, group size increased with hunting activity, whereas during the winter the effect was opposite (Laursen et al., 2016). Low body condition was associated with Eiders located outside preferred feeding sites and increasing hunting activity increased the displacement from preferred feeding sites to areas with low hunting activity and low food availability (Laursen et al., 2016). The changes in group sizes were considered as adjustments to avoid hunting pressure and reduce detectability related to energy requirements during the two seasons (Laursen et al., 2016).

In Åland, males have been hunted in spring, which might have had indirect effects on the fecundity of females. Removal of paired males in spring lowered the female fecundity, reducing hatching success by 35% compared to long-term averages (Hario et al., 2002). The lower hatching success derived from a higher amount of added eggs and dead embryos in the nests of widowed females (Hario et al., 2002). Paired males have been shown to defend their females from other pairs and single males and reduce interruptions to female pre-breeding foraging (Christensen, 2000). However, because of the skewed sex ratio resulting in a large surplus of males, not all males that are harvested are paired with a female. Recent studies indicate that the sex ratio of birds coming within range of the hunters is comparable to the sex ratio observed in the population (R. Juslin *in litt.*).

Hunting of Common Eider is not allowed in Svalbard and in the mainland of Norway except the southern counties. Details on the hunting season and bag sizes in Russian Federation remain unknown.

The cumulative impact of hunting-induced mortality, crippling, disturbance (particularly during spring and summer months) and possible lead poisoning is likely to have a stronger effect on the survival rates of the Baltic, North & Celtic Seas population (or segments thereof) than reflected in the direct harvest bag reports, but the magnitude of the impact of these cumulative factors is currently unknown. As highlighted below in the chapter on oil and other pollutants, high levels of lead have been detected in Eiders particularly in the Baltic Sea. Although the exact sources for the contamination are unknown, it should be noted that whilst the use of lead gunshot is totally banned in some countries it still remains in use in others. In a colony on Christiansø, southern Baltic Sea the lead isotopic ratios on breeding females suggested multiple lead sources, but the highest exposure resulting from ingestion of lead shot pellets (McPartland et al., 2020).

On the other hand, hunting is likely to have an indirect positive effect as hunters have a key role in terrestrial predator control and the ability to hunt Common Eiders increases the motivation to participate in predator control. While scientific evidence suggests that hunting has a minor role in the recent population decline (Tjørnløv et al., 2019), further investigations are required, and this will be accounted in the Adaptive Harvest Management Process.

Norway & Russia and Svalbard & Franz Josef Land

No legal hunting is allowed and therefore the threat is not applicable to these two populations.

Table 10. The threat assessment of hunting following the IUCN Threats Classification Scheme (IUCN, 2020)

Threat: Hunting (IUCN threat category 5.1 Hunting & Collecting Terrestrial Animals) <i>Hunting only takes place in the Baltic, North & Celtic Seas population, where bag sizes have decreased significantly. More information of the cumulative impact of hunting-induced mortality, crippling, disturbance and possible lead poisoning is needed.</i>				
Population	Scope (i.e. the proportion of the total population affected)	Severity (i.e. the overall declines caused by the threat)	Timing (i.e. past, ongoing or future)	Overall Threat Impact Score
Baltic, North & Celtic Seas	Affects the minority of the population (<50%)	Unknown	Ongoing	“Medium impact (score 6)”
Norway & Russia	Not applicable	Not applicable	Not applicable	Not applicable
Svalbard & Franz Josef Land	Not applicable	Not applicable	Not applicable	Not applicable

Diseases

Baltic, North & Celtic Seas population

Outbreaks of avian cholera, caused by the bacteria *Pasteurella multocida*, caused mass mortalities in breeding and wintering Common Eiders in the southern Baltic Sea and in the Wadden Sea in 1996 (Christensen et al., 1997; Tjørnløv, 2020). Based on findings of dead birds, Christensen *et al.* (1997) estimated that 35-90 % of the female Eiders breeding in five Danish colonies, and at least 900 birds died during an avian cholera outbreak in the late winter of 1996. The worst affected colony, Stavns Fjord, with 95% mortality in 1996, was also hit by a less severe avian cholera outbreak in 2001 (K. Pedersen et al., 2003). In another colony, Helleholm, lower survival of breeding females was witnessed in years with avian cholera outbreaks (2001, 2003, 2008) (Tjørnløv et al., 2013). Local population sizes in the southern Baltic Sea have been stable or increasing in the near past, indicating low flyway population level effects despite the high local mortality rates (Tjørnløv, 2020). A demographic model revealed that even if the observed outbreaks of avian cholera were excluded from the model, the flyway population continued to decline (Tjørnløv, 2020). However, the model predicted that at the highest mean frequency simulated (every 5 years), avian cholera would cause the loss of 56 000 females and have a strong negative impact on flyway population growth rate (Tjørnløv, 2020). Thus, avian cholera poses a potential population-level risk if epidemic events occur more frequently or cause mass mortalities in the larger population in the northern Baltic Sea, where it has not yet been found (Tjørnløv, 2020).

Viral diseases are found to be fatal to ducklings. An experiment showed that 65% of newly hatched Eider ducklings infected with Goose Hepatitis Virus died, whereas the survivors showed retarded growth and bill deformities (Swennen, 1991). Mass mortalities of ducklings within the first weeks after hatching in the central Gulf of Finland were caused by viral diseases: Reo virus and infectious bursal disease virus (IBDV) (Hollmén et al., 2000; Hollmén et al., 2002). The outbreaks were suggested to be caused by malnutrition of the breeding females leading to decreased disease resistance and increased disease prevalence for both the females and the ducklings (Hollmén, 2002). Supporting this notion, the innate immune defense of ducklings has been shown to be positively associated with maternal physiological state and reproductive investment (Neggazi et al., 2016). During a die-off of Common Eider males in the northern Baltic Sea, 6 out of 10 studied birds were positive for adenoviruses, while 22 tested breeding females were negative, indicating that the adenovirus contributed to male mortality (Hollmén et al., 2003).

Thiamine (vitamin B1) deficiency causing lethal paralytic syndrome has been suggested to affect negatively several demographic traits and be responsible for large scale declines of the Common Eider population (Balk et al., 2016; Balk et al., 2009; Mörner et al., 2017). However, thiamine deficiency has not been found to cause mortalities e.g. in Finland, and the declines in reproduction and survival have been associated with other causes (Kilpi et al., 2018).

The role of endoparasites on Eider mortality was studied in the Wadden Sea in 102 victims of an oil spill (Thieltges et al., 2006). The study identified 13 parasite taxa of high prevalence values and showed that prey is the main source of infections by being intermediate hosts. Concentrations of the acanthocephalan *Profilicollis botulus*, suspected to cause Eider mortalities, were especially high in juveniles but lower in adults. However, these were not associated with any mass mortalities at the time, indicating a minor effect of the parasites on the condition of Eiders. Furthermore, an investigation of endoparasite loads from the mass mortality event in the winter of 1999/2000 revealed that parasite concentrations were not exceptional, indicating that parasites alone are unlikely to have caused this mortality (Garbus et al., 2018; Thieltges et al., 2006). The role of parasites on duckling survival has been studied in Finland (Hario, M. & Selin, K., 1991).

Norway & Russia population

The connections between immune defense and breeding investments have been studied widely in northern Norway, where breeding females were injected with a non-pathogenic antigen and control group with sterile saline water (Hanssen, 2006). The experiment showed that the immune challenge led to larger body weight loss and longer incubation period, increasing incubation costs. However, a higher percentage of the immune-challenged birds cared for their ducklings and thus increased their investment in reproduction after hatching compared to control females. The return rate of the immune-challenged females was lower than control birds, suggesting that increased immune challenge might cause increased mortality or reduced probability to breed in subsequent years (Hanssen, 2006). The immune defense is related to body condition, and Eider females with low body mass at the start of incubation showed signs of immunosuppression and increased response towards stressors in the late incubation period, and again, had higher probability of abandoning their brood and returning the next breeding season (Hanssen, Folstad, & Erikstad, 2003). Furthermore, unsuccessful breeding females with antiparasitic treatment had higher return rate to breed in coming years than untreated females (Hanssen, Folstad, Erikstad, et al., 2003), and non-pathogenic antigen injected females had 45% lower return rate than the control group (Hanssen, Folstad, & Erikstad, 2003). In another experiment, clutch size manipulation showed that females incubating larger clutches had lower body weight and immune function and reduced breeding success the year after manipulation compared to the females incubating smaller clutches (Hanssen et al., 2005). These studies show that brood care and immuno-defense are costly for breeding Common Eider females and can have complex effects on their fecundity.

Table 11. The threat assessment of diseases following the IUCN Threats Classification Scheme (IUCN, 2020)

Threat: Diseases (IUCN threat category 8.2 Problematic Native Diseases and 8.5 Viral/Prion-induced Diseases)				
<i>Avian cholera, and viral diseases can cause high temporal mortality of adults and young but appear usually only locally.</i>				
Population	Scope (i.e. the proportion of the total population affected)	Severity (i.e. the overall declines caused by the threat)	Timing (i.e. past, ongoing or future)	Overall Threat Impact Score
Baltic, North & Celtic Seas	Affects the minority of the population (<50%)	Causing or likely to cause fluctuations	Ongoing	Low impact (score 5)
Norway & Russia	Affects the minority of the population (<50%)	Causing or likely to cause fluctuations	Ongoing	Low impact (score 5)
Svalbard & Franz Josef Land	Unknown	Unknown	Ongoing	Unknown

Oil and other pollutants

Common Eiders concentrate in high densities in certain sea areas especially during winter, making them vulnerable to oil pollution (HELCOM, 2013). Oiling is recognized as one of the main threats to waterbirds, and especially the large number of small spills and illegal tank washing can cause severe but local effects on

sea ducks (Žydelis & Dagys, 1997; questionnaires to Range States). While the chronic small oil spills have been reduced substantially during the past decade, the accidental oil spills occurring near major eider concentrations could have devastating effects, particularly if taking place in ice-covered waters when clean-up is challenging (Nordic Council of Ministers, 2010). The likelihood of such a low probability – high impact event will increase with increasing shipping and offshore oil production in the high Arctic where eider is also identified as one the most vulnerable species to the acute effects of oil spills and oils spills in general are considered the most important threat to seabirds (Nordic Council of Ministers, 2010, Anker-Nielsen et al., 2000). An experimental study to 70ml oil contamination revealed that in 5.5°C water temperature, the rate of heat loss exceeded the thermoregulatory heat production capacity and Eiders became hypothermic within 70 minutes after contamination (Jenssen & Ekker, 1991).

Levels of lead, selenium, mercury, arsenic and cadmium become increasingly concentrated in the kidney and liver during periods of fasting (Franson et al., 2000; Wayland et al., 2002). This suggests that such chemicals are deposited in fat tissue prior to breeding and as females deplete fat stores during incubation, they leak into the bloodstream (Fox et al., 2015). Furthermore, the positive correlation between concentrations of selenium and mercury in eggs and blood (Franson et al., 2000) and strong negative association with clutch size and daily increase in PCB concentration in blood following lipid-metabolism during fasting, indicate that females are able to reduce the pollutant load through egg production (Bustnes et al., 2010). Although many toxic elements have been found in all the three migratory populations, these have not been associated with population level declines, but in addition to other stressors can have negative effects on population viability (Bårdsen et al., 2018).

Baltic, North & Celtic Seas

Pollutants have potential for substantial negative impact on eider populations, and evidence from this is reported from the Wadden Sea in 1960–1968, when the eider population declined by 77% due to organochlorine pollutants (Swennen, 1972). Exposure to organochlorine pollutants derived through mussel prey during the non-breeding season, and lead to death of female during incubation when pollutants were released from fat repositories to blood (Swennen, 1972). The mortality due to organochlorine pollutants seized in 1968 in parallel to decrease of the concentration of organochlorine pollutants in the prey (Swennen, 1972). Concentrations of lead in the blood of breeding females was higher in the central than western Gulf of Finland in the 1990s (Franson et al., 2002). Lead exposure of common Eiders that nest in the central Gulf of Finland is of concern, according to the findings of direct lead poisoning and resulting mortality (Franson et al. 2000) or elevated tissue residues in 10 of the studied 31 adults (Hollmén et al., 1998). Blood lead concentrations have declined in Baltic Sea Eiders since the 1990s (Fenstad et al., 2017). However, a study sampling breeding females in 2017 and 2018 at Christiansø, Denmark showed that 13% of the birds had blood lead concentrations above the clinical poisoning and 48% above the subclinical poisoning threshold in year 2018, whereas no toxic thresholds were exceeded in 2017, and high concentration in 2018 likely occurred due to a new source of exposure (Lam et al., 2020). A further study on Christiansø suggested that 25% of the eiders in the Baltic & Wadden Sea flyway population may be facing health risks posed by lead pollution (McPartland et al., 2020). While the origin of the lead in Eiders at Christiansø remains unknown, such high concentrations increasing the risk of neuro-muscular symptoms (clinical poisoning), and tissue damage, anemia and reproductive impairment (subclinical poisoning), thus posing a considerable threat to energetically challenged incubating females (Lam et al., 2020). In Netherlands, the lead concentrations in bone were elevated for Common Eider, but concentration in blood and liver remained low, whereas levels of cadmium in blood and liver were ten times higher than in Common Buzzard (*Buteo buteo*) and Grey Heron (*Ardea cinerea*) (Hontelez et al., 1992). Unlike lead, mercury concentrations in the Baltic Sea have risen since the 1990s (Fenstad et al., 2017). The observed mercury concentrations were above the level associated with adverse oxidative effects in other bird species (Fenstad et al., 2017). Furthermore, Baltic Eider females had higher levels of persistent organic pollutants (POPs) than birds in Svalbard (Fenstad et al., 2016).

The residues of selenium, mercury, arsenic, and 17 organochlorines that were found in eggs were below concentrations generally considered to affect avian reproduction (Franson et al., 2000). Lead, arsenic and selenium concentrations were lower in ducklings than adults in the central Gulf of Finland, and concentrations of trace elements in ducklings were not above those considered toxic to birds (Hollmén et al., 1998).

Furthermore, the concentrations of polybrominated diphenyl ethers (PBDE) in Eider eggs on the west coast of Sweden were low (Carlsson et al., 2011).

Norway & Russia population

Bustnes (2013) studied the effects of Polycyclic Aromatic Hydrocarbons (PAHs) on reproductive success in central Norway. A breeding colony was exposed to pollutants, in particular PAHs, from mining, steel and coking industries for several decades until 1990. The pollution peaked in the 1980s and coincided with a halving of the number of breeding Eiders. The duckling mortality peaked in 1991, when 8% of hatched ducklings were found dead in the nest. Since 1993, the rate of dead ducklings per breeding female stabilized at one third of the rate before the PAH discharge halted. The numbers of breeding females increased by 50% during 1994–1999, and females were in better condition and laid larger clutches than in a control colony which was not known to be affected. This study indicated that the PAHs affected adversely the reproduction of the Eiders exposed to the pollution (Bustnes, 2013). Furthermore, the localized effect of pollutants was studied in Norway where a concentration gradient of POPs in eggs of common Eider indicated a pollution source connected with the urbanised area of Trondheim (Herzke et al., 2009).

Svalbard & Franz Josef Land population

POP concentrations in blood were examined in northern Norway and Svalbard, and were in general higher in northern Norway, with the exception of 1-dichloro-2,2-bis (p-chlorophenyl) ethylene (p,p'-DDE), and hexachlorobenzene (HCB), which were higher in Svalbard later in the incubation period (Bustnes et al., 2012). In Svalbard, lipid-metabolism and POP concentrations were highest in the coldest year of the study, and because birds in Svalbard metabolized relatively more lipids than in northern Norway, the Arctic breeders might be more susceptible to POPs than in the lower latitudes (Bustnes et al., 2012). Moreover, poor body condition late in the incubation period was associated with strong daily increase of DDE and PCB, and although the concentrations were relatively low, their rapid build-up during incubation can be troublesome to females when occurring parallel with poor body condition and weakened immune system (Bustnes et al., 2010).

Birds breeding in Franz Josef Land might be less exposed to pollution due to the remote location, as the lowest mean level of PCB sampled throughout the Barents Sea was found in the liver of juvenile common Eider from Franz Josef Land (Savinova et al., 1995).

Table 12. The threat assessment of pollutants following the IUCN Threats Classification Scheme (IUCN, 2020)

Threat: Small chronic oil spills (IUCN threat category 4. Transportation & Service Corridors, 9.2 Industrial & Military Effluents)				
<i>Frequent small oil spills from vessels and illegal tank washing has likely the highest impact on Common Eider and can have severe but local effects.</i>				
Population	Scope (i.e. the proportion of the total population affected)	Severity (i.e. the overall declines caused by the threat)	Timing (i.e. past, ongoing or future)	Overall Threat Impact Score
Baltic, North & Celtic Seas	Affects the minority of the population (<50%)	Causing or likely to cause fluctuations	Ongoing	Low impact (score 5)
Norway & Russia	Affects the minority of the population (<50%)	Causing or likely to cause fluctuations	Ongoing	Low impact (score 5)
Svalbard & Franz Josef Land	Affects the minority of the population (<50%)	Causing or likely to cause fluctuations	Ongoing	Low impact (score 5)

Threat: Large oil accidents (IUCN threat category 4. Transportation & Service Corridors, 9.2 Industrial & Military Effluents) <i>A large oil accident could cause mass mortality if occurring at high Eider densities. The oil exploitation and shipping especially in Arctic Norway and Russia is likely to increase the risk of major oil accident occurring at important areas for Eiders in the future.</i>				
Population	Scope (i.e. the proportion of the total population affected)	Severity (i.e. the overall declines caused by the threat)	Timing (i.e. past, ongoing or future)	Overall Threat Impact Score
Baltic, North & Celtic Seas	Affects the minority of the population (<50%)	Causing or likely to cause rapid declines	Ongoing	Medium impact (score 6)
Norway & Russia	Affects the minority of the population (<50%)	Causing or likely to cause rapid declines	Ongoing	Medium impact (score 6)
Svalbard & Franz Josef Land	Affects the minority of the population (<50%)	Causing or likely to cause rapid declines	Ongoing	Medium impact (score 6)
Threat: Lead and other pollutants (IUCN threat category 9.1 Domestic & Urban Waste Water, 9.2 Industrial & Military Effluents) <i>Elevated lead concentrations have been recorded in rather high proportion of the Baltic, North & Celtic Seas population, but concentrations have declined in time. The sources or effects remain widely unknown. Other pollutants, except mercury, have been estimated below toxic levels. In general, the concentrations have been higher in birds closer to human settlements and activities and thus the likely emission sources.</i>				
Population	Scope (i.e. the proportion of the total population affected)	Severity (i.e. the overall declines caused by the threat)	Timing (i.e. past, ongoing or future)	Overall Threat Impact Score
Baltic, North & Celtic Seas	Affects the minority of the population (<50%)	Unknown	Ongoing	“Medium impact (score 6)”
Norway & Russia	Affects the minority of the population (<50%)	Causing or likely to cause negligible declines	Ongoing	Low impact (score 4)
Svalbard & Franz Josef Land	Affects the minority of the population (<50%)	Causing or likely to cause negligible declines	Ongoing	Low impact (score 4)

Bycatch in fishing gear

By-catch in gillnets in shallow coastal areas important for both wintering and breeding Common Eiders can increase the mortality and pose a potential population level threat (Žydelis et al., 2009; Žydelis et al., 2013). This might concern especially the southwestern Baltic Sea, where gillnetting and bird concentrations show marked spatial and temporal overlap (HELCOM, 2013). Information on bycatch is scarcely available, hampering the assessment of its importance (Fox et al., 2015; Žydelis et al., 2013). Drowning in the nets protecting shellfish farms can pose an additional threat, but can be prevented with correct mesh size (Varennnes et al., 2013) and motorboat engine sounds replayed with underwater loudspeakers (Ross et al., 2001). Similar methods reducing drowning in gill-net fisheries has not yet been found for seaducks (Field et al., 2019). As noted during the workshop for the preparation of this Action Plan bycatch data are still lacking in many areas, and where it exists, differences in data quality exists (e.g. self-reporting vs independent observers). Hence there is a risk of underestimating the problem in many areas which calls for a precautionary and a more standardized approach to bycatch data collection within the species' range.

It was estimated that at least 76 000, but possibly up to 100 000–200 000 seabirds die annually in gillnets in the Baltic and North Sea (Žydelis et al., 2009). Bellebaum et al. (2013) suggested that annual bycatch has declined to half since the early 1990s, most likely due to population declines, comprising currently 17 550 seabird deaths annually along the eastern part of the German Baltic Sea coast. However, the large overlap of fisheries and high numbers of wintering Common Eiders and their estimated medium vulnerability to fisheries confirms that bird bycatch in set-nets is an issue of high relevance in the southern Baltic Sea (Sonntag et al., 2012).

The Common Eider is one of the frequent victims of gillnet by-catch in the southwestern part of the Baltic Sea, which is an important wintering area for the species (Žydelis et al., 2009). In the early 1980s, a total of 9 400 Eiders were estimated to have drowned annually in gillnets for the Baltic Sea coast of Schleswig-Holstein only, presenting 63% of all the birds died in nets in this study (Kirchhoff, 1982). Similar proportion of 58% of Common Eiders in the total avian bycatch in gillnet fisheries was reported in a recent study in eastern Denmark, in 2010–2018 (Glemarec et al., 2020). However, only 0–5.5% of birds found dead as bycatch on the southern coast of the Baltic Sea and the Netherlands were Common Eiders (Erdmann et al., 2005); and the references therein). Adult males presented 69.7% of all Eiders dying in nets in Denmark, indicating that gillnet mortality was not sex biased, but reflected the overall sex ratio of the Baltic Sea population (Glemarec et al., 2020). A conservative estimate of annual bycatch numbers in the Danish commercial gillnet fishery in the Kattegat and Belt Sea (FAO fishing areas 27.3.a.21 and 27.3.a.22) was between 1 100 and 1 450 Common Eiders, excluding recreational fishers and commercial vessels below 8 meters, from which data are not available (G. Glemarec *in litt.*). In Sweden, c. 2 500 Eiders were estimated to have died as bycatch of fisheries in 2002 (Lunneryd et al., 2004), whereas in Finland estimates are lacking but for instance ring recoveries indicate bycatch mortality. An extensive preliminary report summarizing the results of the UK Bycatch Monitoring Programme (BMP) between 1996-2018 found no Common Eiders among the 600 identified waterbirds caught as bycatch (Northridge et al., 2020). The study covers over 21,000 monitored fishing operations from all around the UK and adjacent waters on vessels ranging from less than 5m to over 70m in length. The extent to which the absence of Common Eider in BMP is a real effect, or due to a mismatch between areas of high Eider density and fisheries that pose potential risks, is unknown (D. Heptinstall *in litt.*).

Norway & Russia population

In northern Norway, based on interviews, 7 000–8 000 birds were estimated to have been caught annually in nets set for Salmon (*Salmo salar*), Cod (*Gadus morhua*) and Lumpsucker (*Cyclopterus lumpus*) (Fangel et al., 2011). However, another study monitoring fishery vessels estimated the total bycatch ranging between 3 100 and 3 400 seabirds for each of Cod gillnet and Lumpfish gillnet fisheries in 2009, with the share of ducks being low (Fangel et al., 2015). Studies of Lumpsucker fisheries in inshore waters in Greenland has shown that it may threaten local Eider populations (Merkel, 2004), and may be applicable to Norway & Russia and Svalbard & Franz Joseph Land populations as well (Christensen-Dalsgaard et al., 2019). However, bycatch in Norway has been estimated as a low severity, but wide-scale threat to Common Eider (M. Irgens, S.-H. Lorentsen *in litt.*).

Svalbard & Franz Josef Land

Lumpsucker fisheries occur also in Iceland from late March to August and thus making the wintering birds from Svalbard and Franz Joseph Land susceptible to bycatch. The bycatch rate of birds in the Iceland Lumpsucker fisheries was higher than in Norway and half of the identified individuals were Common Eiders (Christensen-Dalsgaard et al., 2019). However, it remains unknown in which proportions of the bycatch belong to the sedentary Iceland population and to the wintering Svalbard & Franz Josef Land population.

Table 13. The threat assessment of bycatch following the IUCN Threats Classification Scheme (IUCN, 2020)

Threat: Bycatch in gillnet fisheries (IUCN threat category 5.4.4 Fishing & Harvesting Aquatic Resources, unintentional) <i>Depending on study site, Common Eider can comprise a low or high proportion of seabirds caught as bycatch in gillnet fisheries. Estimates of bycatch usually include only commercial fisheries and are completely lacking in some countries. Information on recreational fishing bycatch rates are widely lacking.</i>				
Population	Scope (i.e. the proportion of the total population affected)	Severity (i.e. the overall declines caused by the threat)	Timing (i.e. past, ongoing or future)	Overall Threat Impact Score
Baltic, North & Celtic Seas	Affects the majority of the population (50–90%)	Unknown	Ongoing	“Medium impact (score 7)”
Norway & Russia	Affects the majority of the population (50–90%)	Unknown	Ongoing	“Medium impact (score 7)”
Svalbard & Franz Josef Land	Affects the majority of the population (50–90%)	Unknown	Ongoing	“Medium impact (score 7)”

Anthropogenic disturbance

On the Scottish coast, the Common Eider has been assessed as a medium sensitivity species for marine activities, and whereas Eiders show very low response to passing ferries and flight response to activities within a 200–300 meter band, abundance and flight activity was associated negatively and positively with local marine activity, respectively (Jarrett et al., 2018). On German coasts, a general study of ship traffic vulnerability based on reactions to traffic but also on population metrics placed Common Eider as well in a medium risk category (Fliessbach et al., 2019). This study revealed that Eider numbers returned to pre-disturbance levels locally within 1 to 3 hours after disturbance. Another study on the northern German coast revealed that Eiders had short flight distances ahead of approaching vessels, and the flight-distance was shorter in regular traffic lanes than outside them, suggesting that Eiders habituate to marine traffic (Schwemmer et al., 2011). However, in the Wadden Sea Common Eiders are strongly disturbed by recreational boat traffic, causing displacement from suitable feeding areas (Ketzenberg, 1993). During the energy-consuming phase of moult, Common Eiders are suggested to be vulnerable to disturbance caused by ship traffic or tourism and are dependent on undisturbed sea areas with sufficient food resources (Nehls, 1991). There is also evidence of disturbance to broods due to motorboats in the Swedish Baltic, whereby diving causes scattering and therefore gull predation on unprotected ducklings (Åhlund and Götmark, 1989). Similar evidence exists for windsurfers (Koepff & Dietrich, 1986 [German], cited in Keller, 1991).

The effects of disturbance are likely local and short-term, but identifying the most important staging or feeding areas and protecting them from shipping and other disturbance might be a good conservation strategy (Fliessbach et al., 2019). Disturbance by recreational use, fishing and breeding time hunting is harmful also in breeding areas, as it increases predation on ducklings and eggs and flushes broods to open water.

Table 14. Threat assessment of human disturbance following the IUCN Threats Classification Scheme (IUCN, 2020)

Threat: Recreational disturbance (IUCN threat category 6.1 Recreational Activities) <i>Recreational boating and other outdoor activities both on land and on water can cause disturbance in breeding sites for breeding birds and broods, which in turn can increase the vulnerability of nests and chicks to predation. In addition, recreational boating can cause displacement of moulting and wintering birds, which can be energetically constrained.</i>				
Population	Scope (i.e. the proportion of the total population affected)	Severity (i.e. the overall declines caused by the threat)	Timing (i.e. past, ongoing or future)	Overall Threat Impact Score
Baltic, North & Celtic Seas	Affects the majority of the population (50–90%)	Unknown	Ongoing	“Medium impact (score 7)”
Norway & Russia	Affects the majority of the population (50–90%)	Causing or likely to cause fluctuations	Ongoing	Medium impact (score 6)
Svalbard & Franz Josef Land	Unknown	Unknown	Ongoing	Unknown
Threat: Shipping disturbance (IUCN threat category 4.3 Shipping Lanes) <i>Common Eider has been estimated in a medium vulnerability to shipping, but the impacts are likely local and short-term. Eiders have shown some signs of habituation towards the disturbance which could mitigate the effects, especially on busy shipping lanes.</i>				
Population	Scope (i.e. the proportion of the total population affected)	Severity (i.e. the overall declines caused by the threat)	Timing (i.e. past, ongoing or future)	Overall Threat Impact Score
Baltic, North & Celtic Seas	Affects the minority of the population (<50%)	Causing or likely to cause fluctuations	Ongoing	Low impact (score 5)
Norway & Russia	Affects the minority of the population (<50%)	Causing or likely to cause negligible declines	Ongoing	Low impact (score 4)
Svalbard & Franz Josef Land	Unknown	Unknown	Ongoing	Unknown

Windfarms

Wind farms may have negative effects on Eider populations through habitat loss, barrier effects and collisions between birds and turbines during both destruction and deployment phase (Fox et al., 2006). An assessment of vulnerability of marine birds to offshore wind farms in Scotland gave low collision risk to Common Eider, but high potential risk for displacement (Furness et al., 2013). Habitat loss may be considered if wind turbines displace birds, which has been found common in ducks (Hötter et al., 2006) and for Common Eiders as well in some case studies (Dierschke & Garthe, 2006). However, Eiders have shown signs of habituation to wind turbines over time (Hötter et al., 2006), counteracting the possible displacement induced habitat loss (Fox et al., 2015). The underwater platforms of wind turbines have provided a suitable surface of substrate for mussels to anchor and these artificial mussel beds have attracted feeding Eiders.

Wind farms seem to act as barriers to migration, and are avoided by Eiders (Christensen et al., 2004; Desholm & Kahlert, 2005; Dierschke & Garthe, 2006; Larsen & Guillemette, 2007). The small proportion of birds which

enter wind farms fly between turbine rows at low altitude and avoid the collision risk (Desholm & Kahlert, 2005). Existing studies of collision risks have been performed in daylight, and the possible risks during night or in otherwise low visibility remain unknown (Larsen & Guillemette, 2007). In Kalmar Sound, Sweden, a study to observe collision risk of spring and autumn migrating waterfowl was conducted in vicinity of two offshore wind farms (5+7 turbines) in 1999–2003 (Pettersson, 2005). During observations, approximately 1.5 million waterfowls belonging to 20 000 flocks were tracked and observed and only five near-accidents and one collision were observed. In the observed collision one Common Eider got killed while four other got hit; apparently this remains the only documented collision of waterfowl with offshore wind farm. Individuals belonging to the Svalbard and Franz Josef Land population are not considered to face off-shore windfarms, but this may change in the future (M. Irgens & P. Glazov *in litt.*).

Table 15. The threat assessment of windfarms following the IUCN Threats Classification Scheme (IUCN, 2020)

Threat: Windfarms (IUCN threat category 3.3 Renewable Energy) <i>Windfarms can cause displacement of Common Eiders from feeding areas, and although the effect of a single wind park would be low, the total effect of wind industry can be considerable, but remains unknown. In addition, the collision risk to wind turbines might increase mortality, but studies indicate this risk is low.</i>				
Population	Scope (i.e. the proportion of the total population affected)	Severity (i.e. the overall declines caused by the threat)	Timing (i.e. past, ongoing or future)	Overall Threat Impact Score
Baltic, North & Celtic Seas	Affects the minority of the population (<50%)	Causing or likely to cause negligible declines	Ongoing	Low impact (score 4)
Norway & Russia	Affects the minority of the population (<50%)	Causing or likely to cause negligible declines	Ongoing	Low impact (score 4)
Svalbard & Franz Josef Land	Affects the minority of the population (<50%)	Causing or likely to cause negligible declines	Future	Negligible or no impact (score 2)

Climate change

Climate change is linked to some threats introduced and discussed above. However, changes in temperature and climate have been associated with survival and productivity. Winter temperatures might have spatially variable effects; in Finland cold winters were associated with low breeding body condition of females and low fledging rate (Lehikoinen et al., 2006), whereas in the Netherlands, low temperature in winter and high temperature at the end of May and the beginning of June increased the fledging success (Swennen, 1991). Again, in Finland climate showed no effects on female survival (Ekroos, Fox, et al., 2012; Hario et al., 2009), but in Norway, Svalbard and Netherlands winter NAO-index and sea surface temperature had direct and lagged adverse effects on survival (Bårdsen et al., 2018; Guery et al., 2017; Tjørnløv, 2020). Although climate change is likely to have a strong effect on water temperatures, the causality of this to survival and productivity remains largely unknown. Higher water temperatures are projected to impair the conditions for bivalves (Reneerkens, 2020), and decrease in the food supply may be among the most important indirect threats to Common Eider (see section “Reduced food quality and supply”). However, the severe weather events may largely impair feeding opportunities of eiders and cause mass mortalities through starvation as witnessed in other seabirds following heat waves (Piatt et al., 2020) and through starvation, exhaustion and drowning due to prolonged storms (Morley et al., 2016). Such examples of stranding Eiders have been already witnessed in Norway.

Climate change is projected to contribute to sea level rise which threatens to reduce the area of available coastal habitats (FitzGerald et al., 2008; Hughes, 2004). Whereas mussel beds are unlikely to become unavailable for Eiders due to increasing sea levels, potential reductions of breeding sites and sporadic nest losses due to flooding may be more frequent in the future, especially in the southern Baltic Sea (Van De Pol et al., 2010). In the northern Baltic Sea, the land is still rising following the depression from the covering ice sheet during the Last Glacial Maximum and thus mitigating the sea level rise (Johansson et al., 2014).

Table 16. The threat assessment of climate change following the IUCN Threats Classification Scheme (IUCN, 2020)

Threat: Climate change (IUCN threat category 11. Climate Change & Severe Weather) <i>The direct effects of climate change include severe weather events such as temperature extremes, storms and flooding, but also habitat loss and alterations due to sea level rise,. Despite the severity is currently evaluated to be low, the impacts in the future are projected to increase and all the affecting mechanisms are not fully understood. In addition, climate warming will have indirect effects to food supply, predation etc. which are likely to increase in the future. The severity of direct and indirect effects combined is likely to be high and more research is required to fully understand all the impacts.</i>				
Population	Scope (i.e. the proportion of the total population affected)	Severity (i.e. the overall declines caused by the threat)	Timing (i.e. past, ongoing or future)	Overall Threat Impact Score
Baltic, North & Celtic Seas	Affects the majority of the population (50–90%)	Unknown	Ongoing	“Medium impact (score 7)”
Norway & Russia	Affects the majority of the population (50–90%)	Unknown	Ongoing	“Medium impact (score 7)”
Svalbard & Franz Josef Land	Affects the majority of the population (50–90%)	Unknown	Ongoing	“Medium impact (score 7)”

Habitat change

In the Russian Finnish Gulf, Estonia & Wadden Sea breeding habitat overgrowth is recognized as a threat to Common Eiders. Due to eutrophication and closure of pastures, breeding habitats are overgrown with dense vegetation preventing Eiders to access the breeding sites (L. Luigujoe, P. Glazov, J. van Ulzen *in litt.*). Overgrowth has not been recognized as a threat in Denmark, UK, Sweden or Finland.

Table 17. The threat assessment of habitat change following the IUCN Threats Classification Scheme (IUCN, 2020)

Threat: Habitat overgrowth (IUCN threat category 7. Natural system modification) <i>Breeding habitats in Estonia and Russia and in the Dutch Wadden Sea are impaired and inaccessible to Common Eider due to overgrowth..</i>				
Population	Scope (i.e. the proportion of the total population affected)	Severity (i.e. the overall declines caused by the threat)	Timing (i.e. past, ongoing or future)	Overall Threat Impact Score
Baltic, North & Celtic Seas	Affects the minority of the population (<50%)	Causing or likely to cause slow declines	Ongoing	Low impact (score 5)
Norway & Russia	Not applicable	Not applicable	Not applicable	Not applicable
Svalbard & Franz Josef Land	Not applicable	Not applicable	Not applicable	Not applicable

Figure 2. Problem tree - threat assessment of factors causing additional direct mortality following the IUCN Threats Classification Scheme (IUCN, 2020).

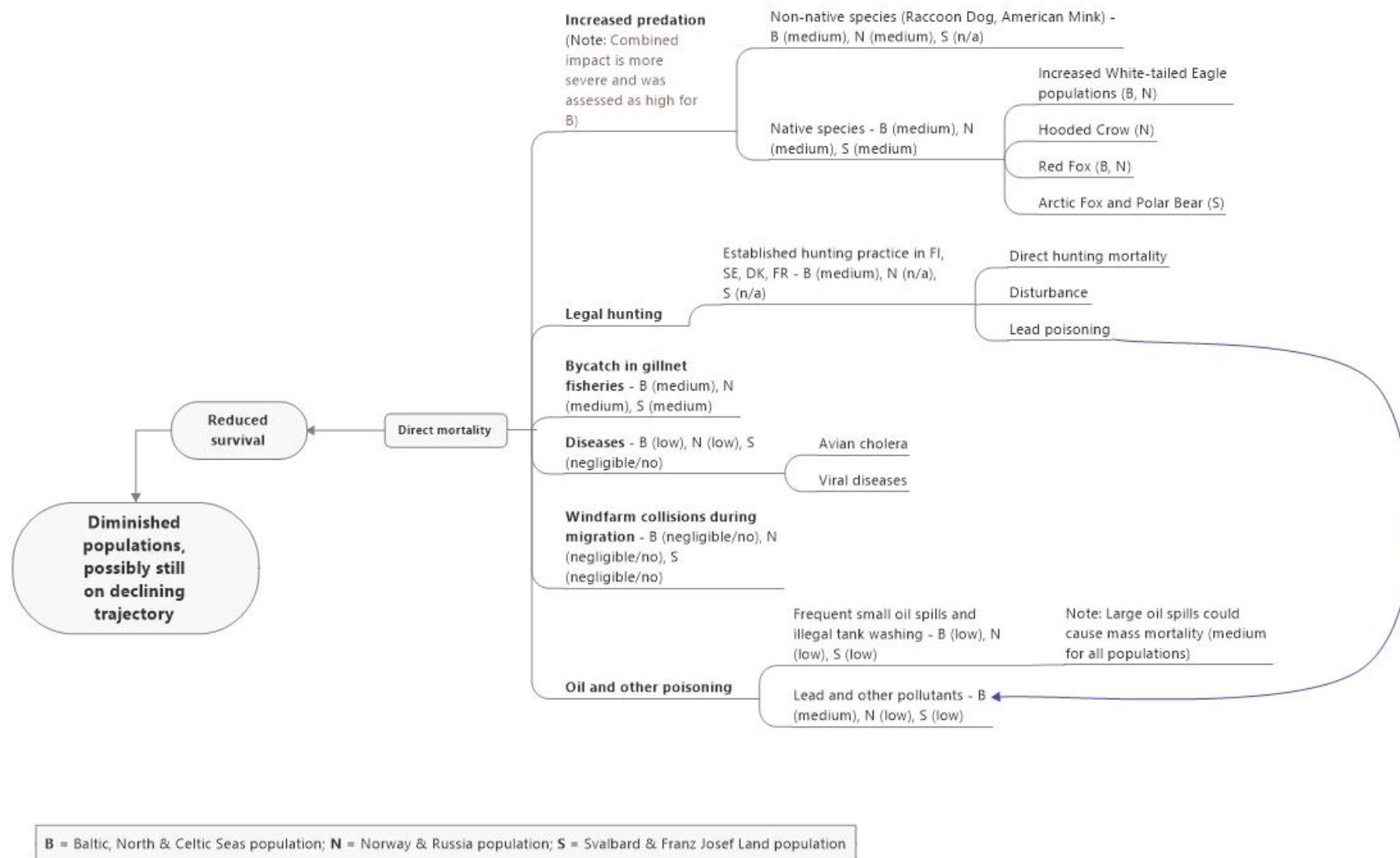
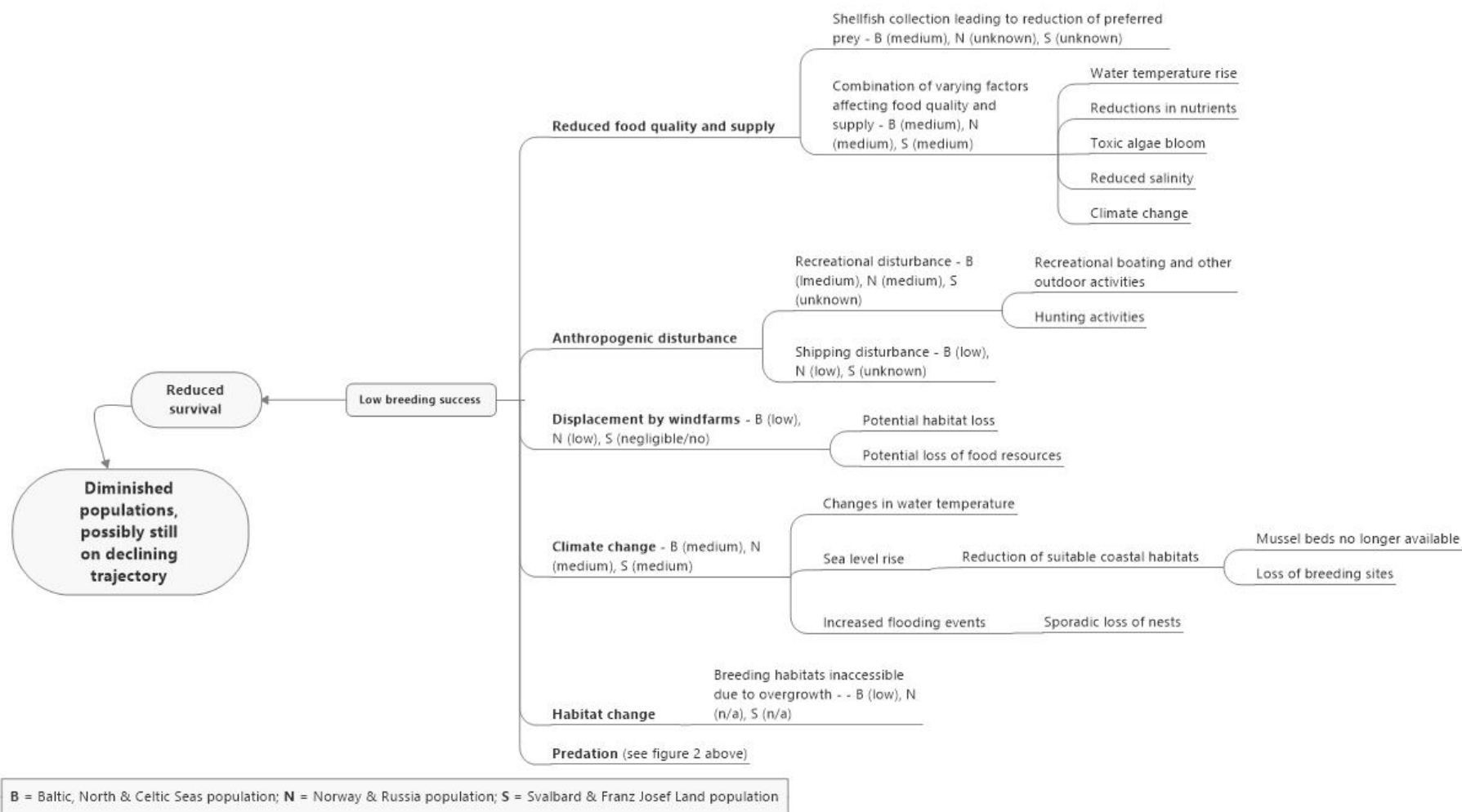


Figure 3. Problem tree - threat assessment of factors causing reduced breeding success following the IUCN Threats Classification Scheme (IUCN, 2020).



ANNEX 3. Provisional Flyway Management Units Suggested for the Baltic, North & Celtic Seas population of the Common Eider

Provisional Delineation of Management Units

The definition of discreet management units within the Baltic, North & Celtic Seas population will help to define spatially explicit management actions, their priority and urgency during the implementation of the Action Plan. The delineation of management units should be based on both biological (distribution and annual cycle of the species concerned) and practical considerations (e.g. national borders and management requirements).

Based on the overview of the migration patterns of the Baltic, North & Celtic Seas population presented below as well the fact that all three segments of the population can be and are already to a certain extent monitored separately on their breeding grounds, the AEWA Common Eider International Action Plan Drafting Team in consultation with the UNEP/AEWA Secretariat recommended that for the purposes of strengthening the implementation of conservation and management efforts the population be split into three management units:

- Baltic and North Sea management unit (Management Unit 1);
- Wadden Sea management unit (Management Unit 2), and;
- UK/Ireland management unit (Management Unit 3).

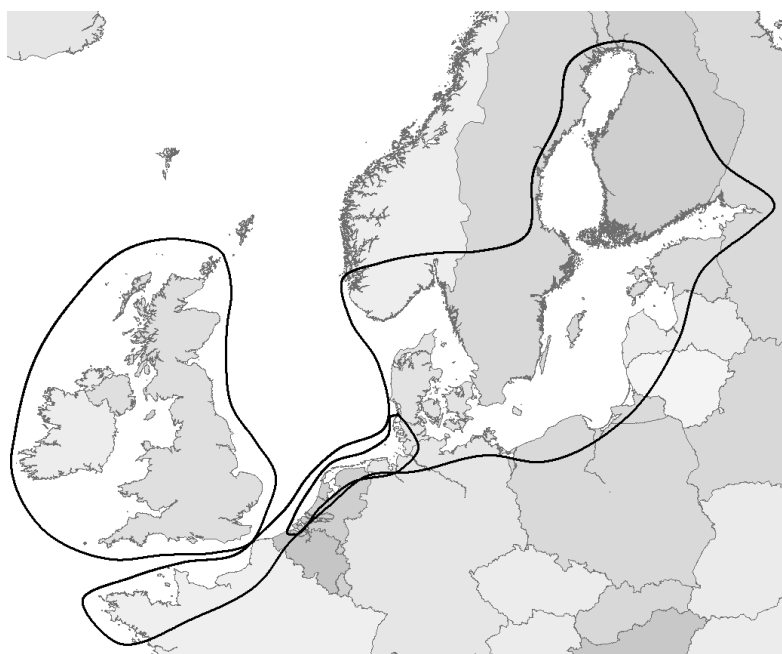


Figure 4. Three management units.

This provisional delineation was supported by the Principle Range States during the consultation of this Action Plan. It should be noted however, that as implementation of the Action Plan progresses new information - for example with respect to migratory patterns etc. - may lead to a further reconsideration of the management units.

An Overview of Common Eider Migration in the Baltic, North & Celtic Seas population

- Eider biology

Throughout its range, the Common Eider is variously sedentary or migratory. Migratory populations occur in areas where food availability in winter is too low, mainly due to ice cover preventing foraging. Eiders in the central and northern Baltic are traditionally fully migratory, and they seem not to have changed their migration behavior although winter ice cover in the central Baltic has decreased dramatically in the last 20-30 years.

Like most other ducks, female Eiders are highly faithful to their breeding sites, and also tend to recruit into breeding colonies near their natal site. Pair formation takes place in winter, and males follow their mates back to the breeding site. This can lead to males recruiting into breeding populations far from their natal site, a phenomenon known as abmigration. Whether males exhibit site fidelity once they have started to breed, or conversely follow a new mate to a new breeding

site each year, is poorly studied. Males leave the breeding site early in the season, soon after females have laid their eggs, and move to good feeding areas to moult. This moult migration can be quite extensive. Little is known about where and how young pre-breeders (1-2 years old) spend the summer.

- Data sources

The main source of information on the migration of Eiders in the Baltic, North & Celtic Seas flyway is standard metal ringing, which has taken place in all the main breeding countries over several decades. When a dead ringed Eider is found and its identity reported to the relevant ringing office, information on migration patterns may be obtained (depending on e.g. the time of year that the bird dies and is found). For many species of birds, tracking by various electronic devices has largely replaced standard ringing as a source of information on migration patterns, as much more information can be obtained for each bird marked. However, such tracking has only to a limited extent been applied for Eiders in the Baltic, North & Celtic Seas population (see section on Norway below).

- Ringing effort

In most countries, Eiders are only ringed in the breeding colonies. In most cases, breeding females are caught on the nest, but in some study areas, large numbers of unfledged ducklings have also been rounded up and ringed. This leads to a large bias towards females in the marked sample, particularly in the last 20 years or so when few ducklings have been ringed. The exception is the Netherlands (and to some extent Britain), where considerable numbers of non-breeding Eiders have been ringed. This sample appears to contain both moulting males in summer, and mixed groups of non-breeders in autumn, winter and spring.

- Recoveries

The probability of a dead bird being recovered and reported to the relevant ringing office depends strongly on the cause of death. In particular, birds which are shot have a much higher probability of being reported than those dying from natural causes. This can lead to a bias in the spatial distribution of recoveries. In the case of the Eider, hunting has been most common in Denmark in autumn and winter, and in Finland (particularly Åland) in spring (where only males are hunted). These patterns are very obvious in the distribution of recoveries of ringed Eiders and should be taken into account in any interpretation of these patterns.

- Country by (ringing) country

Finland (13138 own recoveries (incl. recaptures)). Finnish birds winter in the southern part of the inner Danish waters, and along the German Baltic coast. Some reach the Wadden Sea from Denmark to the Netherlands, and a few move as far as France or Norway.

Estonian birds seem to behave like the Finnish, judging from recoveries in Denmark and Germany. No overview is available from the Estonian ringing office.

Sweden (1996 own recoveries (online)). Most Swedish Eiders winter in the inner Danish waters. Birds from the west coast winter in central and northern Kattegat, while those from the east coast winter further south. A small proportion of birds, mainly from the east coast, winter in the Wadden Sea and occasionally as far south as France. Some males have been recovered in summer in Finland.

Denmark (9232 own recoveries, 3029 foreign). Eiders ringed in Denmark mainly stay in Danish waters all year. This is particularly true for those ringed in the Wadden Sea and the inner Danish waters, which remain near their colonies. Birds from Christiansø in the Baltic are more migratory, and some reach the Wadden Sea as far as the Netherlands. Some ducklings turn up as breeding males in Finland. Very few records in France and Britain.

Norway (549 own recoveries (online), 27 foreign). Birds from southern Norway (south of Stavanger) winter in the Skagerrak, northern Kattegat and exceptionally in the Wadden Sea south to the Netherlands. These patterns are confirmed by tracking using light-based geolocation of eiders from colonies in southern Norway since 2014, although the results of this study seem to indicate a larger proportion of birds remaining in Skagerrak. There is a major gap in ringing effort north of Stavanger, so the exact location of the divide between this flyway and the non-migratory population along the Norwegian west coast is difficult to determine based on ringing data.

Germany (131 own recoveries, 874 foreign). German birds appear to show little migratory tendency, and are mostly found close to their colonies, both in the Baltic and Wadden Sea. A few recoveries from the Netherlands to Finland.

The Netherlands (9222 own recoveries (incl. recaptures), 324 foreign recoveries). Dutch breeders are largely sedentary, with a few moving southwest to France. Many birds have been ringed in summer in the Netherlands and are recovered in southern Danish waters (and Germany) in winter and in Finland in summer. These are probably largely moulting males.

Britain and Ireland (3389 own recoveries, 13 foreign). British Eiders are largely sedentary or show small-scale migration movements along the east coast (the Forth and Tay estuaries constitute the most important wintering areas). British birds found in Danish waters in autumn and winter, and in Finland in summer, are almost exclusively males. These have probably mated with Baltic females wintering along the east coast of Britain.

- Summary

Eiders breeding in the Baltic proper (Bornholm and eastwards) are migratory, and winter in the western Baltic (including the southern part of the inner Danish waters), and to some extent in the Wadden Sea. An unknown, but potentially large, proportion of males perform a moult migration to the Dutch (and German?) Wadden Sea and return to the western Baltic in winter.

Eiders breeding in Kattegat (including the inner Danish waters) and Skagerrak are largely dispersive or short-distance migrants, although most birds breeding on the Swedish and Norwegian coasts appear to winter in Danish waters. Few birds from this area winter in the Wadden Sea.

Eiders breeding in the Wadden Sea (the Netherlands, Germany and Denmark) are largely dispersive or short-distance migrants. Eiders breeding in Britain are largely dispersive or short-distance migrants. Abmigration of males occurs from all breeding populations in the flyway, mostly (documented) to Åland and the Finnish archipelago.

Sources

Migration atlases

Baillie, S. R. 2002. Common Eider (Eider) *Somateria mollissima*. Pages 214-216 in C. V. Wernham, M. P. Toms, J. H. Marchant, J. A. Clark, G. M. Siriwardena, and S. R. Baillie, editors. The migration atlas: movements of the birds of Britain and Ireland. T. & A.D. Poyser, London.

Bairlein, F., J. Dierschke, V. Dierschke, V. Salewski, O. Geiter, K. Hüppop, U. Köppen, and W. Fiedler. 2014. Atlas des Vogelzugs. Ringfunde deutscher Brut- und Gastvögel. Aula-Verlag, Wiebelsheim.

Bakken, V., O. Runde, and E. Tjørve. 2003. Norsk ringmerkingsatlas (Norwegian bird ringing atlas), vol. 1. Stavanger Museum, Stavanger, Norway.

Bønløkke, J., J. J. Madsen, K. Thorup, K. T. Pedersen, M. Bjerrum, and C. Rahbek. 2006. Dansk trækfugleatlas (The Danish bird migration atlas). Rhodos, Humlebæk, Denmark.

Fransson, T., and J. Pettersson. 2001. Svensk ringmärkningsatlas (Swedish bird ringing atlas), Volym 1, Lommarovfåglar. Naturhistoriska riksmuseet och Sveriges Ornitologiska Förening, Stockholm.

Saurola, P., J. Valkama, and W. Velmala. 2013. Suomen rengastusatlas (The Finnish bird ringing atlas), vol. 1. Finnish Museum of Natural History and Ministry of Environment, Helsinki.

Ringing office web sites

<https://birdrecoveries.nrm.se/>

<http://must.ringmerking.no/kart.asp>

<http://www.vogeltrekatlas.nl/index.html?-1>

Web site of Norwegian tracking programme SEATRACK

<http://seatrack.seapop.no/map/>

ANNEX 4. REFERENCES

- Andersson, M., Åhlund, M., & Waldeck, P. (2019). Brood parasitism, relatedness and sociality: a kinship role in female reproductive tactics. *Biological Reviews*, 94(1), 307-327. doi:10.1111/brv.12455
- Anker-Nilssen, T., Barrett, R. T., Lorentsen, S.-H., Strøm, H., Bustnes, J. O., Christensen-Dalsgaard, S., . . . Systad, G. H. (2015). *SEAPOP. De ti første årene. Nøkkeldokument 2005-2014*. Universitetsmuseet. Trondheim, Tromsø.
- Anker-Nilssen, T., Bakken, V., Strøm, H., Golovkin, A., Bianki, V., & Tatarinkova, I. P. (2010). The Status of Marine Birds Breeding in the Barents Sea Region. Rapportserie nr. 113, Norsk Polarinstitutt, Tromsø, Norway.
- Arfman, T. (2019). Bengtskärlin haahkaihme. *Metsästäjä*, 2019(3), 50-53.
- Ashcroft, R. E. 1976: A function of the pair bond in the Common Eider. - *Wildfowl* 27: 101-105.
- Balk, L., Hägerroth, P.-Å., Gustavsson, H., Sigg, L., Åkerman, G., Ruiz Muñoz, Y., . . . Hansson, T. (2016). Widespread episodic thiamine deficiency in Northern Hemisphere wildlife. *Scientific Reports*, 6(1), 38821. doi:10.1038/srep38821
- Balk, L., Hägerroth, P.-Å., Åkerman, G., Hansson, M., Tjærnlund, U., Hansson, T., . . . Sundberg, H. (2009). Wild birds of declining European species are dying from a thiamine deficiency syndrome. *Proceedings of the National Academy of Sciences*, 106(29), 12001. doi:10.1073/pnas.0902903106
- Balmer, D. E., Gillings, S., Caffrey, B. J., Swann, R.L., Downie, I.S. and Fuller, R.J. (2013). Bird Atlas 2007–11: The Breeding and Wintering Birds of Britain and Ireland. BTO Books, Thetford, UK.
- Below, A., Lehtikainen, A., Mikkola-Roos, M., Kurvinen, L., & Laaksonen, T. (2019). Bird populations in Finnish archipelago in 1980–2018 (In Finnish with English Summary). *Linnut-vuosikirja*, 2018, 56-67.
- Berg, P., & Bregnballe, T. (2020). Spring migration of Common Eider *Somateria mollissima* through Fehmarn Belt: Timing of migration and changes in numbers and sex ratio (In Danish with an English summary). . *Dansk Ornitologisk Forenings Tidsskrift*, (in press).
- Bergström, U., Olsson, J., Casini, M., Eriksson, B. K., Fredriksson, R., Wennhage, H., & Appelberg, M. (2015). Stickleback increase in the Baltic Sea – a thorny issue for coastal predatory fish. *Estuarine, Coastal and Shelf Science*, 163: 1–9. doi:10.1016/j.ecss.2015.06.017
- Byström, P., Bergström, U., Hjälten, A., Ståhl, S., Jonsson, D., & Olsson, J. (2015). Declining coastal piscivore populations in the Baltic Sea: where and when do sticklebacks matter? *Ambio*, 44: 462–471. doi:10.1007/s13280-015-0665-5.
- Eklöf, J.S., Sundblad, G., Erlandsson, M., Donadi, S. Hansen, J. P., Eriksson, B. K., & Bergström, U. (2020). A spatial regime shift from predator to prey dominance in a large coastal ecosystem. *Communications Biology* 3, 459 (2020). doi:10.1038/s42003-020-01180-0.
- Beukema, J. J. (1993). Increased mortality in alternative bivalve prey during a period when the tidal flats of the Dutch Wadden Sea were devoid of mussels. *Netherlands Journal of Sea Research*, 31(4), 395-406. doi:10.1016/0077-7579(93)90056-x
- Bregnballe, T. (2002). Development of Common Eider *Somateria Mollissima* colonies in the southwestern Kattegat, Denmark: Influence of Predators and Immigration. *Danish Review of Game Biology*, 15, 15-24.
- Bregnballe, T., Noer, H., Christensen, T. K., Clausen, P., Asferg, T., Fox, A. D., & Delany, S. (2006). Sustainable hunting of migratory waterbirds: the Danish approach. In G. C. Boere, C. A. Galbraith, & D. A. Stroud (Eds.), *Waterbirds around the world*. Edinburgh, UK: The Stationery Office.
- Bräger, S., Meißner, J., & Thiel, M. (1995). Temporal and spatial abundance of wintering Common Eider *Somateria mollissima*, Long-tailed Duck *Clangula hyemalis*, and Common Scoter *Melanitta nigra* in shallow-water areas of the southwestern Baltic Sea. *Ornis Fennica*, 72(1), 19-28.
- Bustnes, J. O. (2013). Reproductive Recovery of a Common Eider *Somateria mollissima* Population Following Reductions in Discharges of Polycyclic Aromatic Hydrocarbons (PAHs). *Bulletin of Environmental Contamination and Toxicology*, 91(2), 202-207. doi:10.1007/s00128-013-1041-4
- Bustnes, J. O., & Erikstad, K. E. (1988). The diets of sympatric wintering populations of Common Eider *Somateria mollissima* and King Eider *S. spectabilis* in northern Norway. *Ornis Fennica*, 65(4), 163-167.
- Bustnes, J. O., & Erikstad, K. E. (1993). Site fidelity in breeding Common Eider *Somateria mollissima* females. *Ornis Fennica*, 70(1), 11-16.
- Bustnes, J. O., Erikstad, K. E., & Bjørn, T. H. (2002). Body condition and brood abandonment in common eiders breeding in the high Arctic. *Waterbirds*, 25(1), 63-66. doi:10.1675/1524-4695(2002)025[0063:Bcabai]2.0.Co;2
- Bustnes, J. O., & Lønne, O. J. (1997). Habitat partitioning among sympatric wintering Common Eiders *Somateria mollissima* and King Eiders *Somateria spectabilis*. *Ibis*, 139(3), 549-554. doi:10.1111/j.1474-919X.1997.tb08860.x
- Bustnes, J. O., Moe, B., Hanssen, S. A., Herzke, D., Fenstad, A. A., Nordstad, T., . . . Gabrielsen, G. W. (2012). Temporal Dynamics of Circulating Persistent Organic Pollutants in a Fasting Seabird under Different Environmental Conditions. *Environmental Science & Technology*, 46(18), 10287-10294. doi:10.1021/es301746j

- Bustnes, J. O., Moe, B., Herzke, D., Hanssen, S. A., Nordstad, T., Sagerup, K., . . . Borgå, K. (2010). Strongly increasing blood concentrations of lipid-soluble organochlorines in high arctic common eiders during incubation fast. *Chemosphere*, 79(3), 320-325. doi:10.1016/j.chemosphere.2010.01.026
- Bårdsen, B.-J., Hanssen, S. A., & Bustnes, J. O. (2018). Multiple stressors: modeling the effect of pollution, climate, and predation on viability of a sub-arctic marine bird. *Ecosphere*, 9(7), e02342. doi:10.1002/ecs2.2342
- Camphuysen, C. J., Berrevoets, C. M., Cremers, H., Dekinga, A., Dekker, R., Ens, B. J., . . . Piersma, T. (2002). Mass mortality of common eiders (*Somateria mollissima*) in the Dutch Wadden Sea, winter 1999/2000: starvation in a commercially exploited wetland of international importance. *Biological Conservation*, 106(3), 303-317. doi:10.1016/S0006-3207(01)00256-7
- Carlsson, P., Herzke, D., Wedborg, M., & Gabrielsen, G. W. (2011). Environmental pollutants in the Swedish marine ecosystem, with special emphasis on polybrominated diphenyl ethers (PBDE). *Chemosphere*, 82(9), 1286-1292. doi:10.1016/j.chemosphere.2010.12.029
- Cervencel, A., Troost, K., Dijkman, E., de Jong, M., Smit, C. J., Leopold, M. F., & Ens, B. J. (2015). Distribution of wintering Common Eider *Somateria mollissima* in the Dutch Wadden Sea in relation to available food stocks. *Marine Biology*, 162(1), 153-168. doi:10.1007/s00227-014-2594-4
- Christensen, T. K. (2000). Female pre-nesting foraging and male vigilance in Common Eider *Somateria mollissima*. *Bird Study*, 47, 311-319. doi:10.1080/00063650009461191
- Christensen, T. K. (2001). Effects of duckling body condition on hunting vulnerability in juvenile and immature common eiders *Somateria mollissima*. *Wildlife Biology*, 7(2), 97-104.
- Christensen, T. K. (2005). Factors affecting the bag size of the common eider *Somateria mollissima* in Denmark, 1980-2000. *Wildlife Biology*, 11(2), 89-99. doi:10.2981/0909-6396(2005)11[89:Fatbso]2.0.Co;2
- Christensen, T. K., Bregnballe, T., Andersen, T. H., & Dietz, H. H. (1997). Outbreak of Pasteurellosis among wintering and breeding common eiders *Somateria mollissima* in Denmark. *Wildlife Biology*, 3(2), 125-128.
- Christensen, T. K., & Hounisen, J. P. (2014). Managing hunted populations through sex-specific season lengths: a case of the Common Eider in the Baltic-Wadden Sea flyway population. *European Journal of Wildlife Research*, 60(5), 717-726. doi:10.1007/s10344-014-0840-1
- Christensen, T. K., Hounisen, J. P., Clausager, I., & Petersen, I. K. (2004). *Visual and radar observations of birds in relation to collision risk at the Horns Rev offshore wind farm: Annual status report 2003 — Report commissioned by Elsam Engineering A/S 2003*. National Environmental Research Institute, Rønde, Denmark.
- Christensen-Dalsgaard, S., Anker-Nilssen, T., Crawford, R., Bond, A., Sigurðsson, G.M., Glemarec, G., . . . Bærum, K.M. (2019). What's the catch with lumpsuckers? A North Atlantic study of seabird bycatch in lumpsucker gillnet fisheries. *Biological Conservation* 240 (108278). doi:10.1016/j.biocon.2019.108278
- Clausen, P., Holm, T.E., Laursen, K., Nielsen, R.D. & Christensen, T.K. 2013. Rastende fugle i det danske reservatnetværk 1994-2010. Del 1: Nationale resultater. Aarhus Universitet, DCE - Nationalt Center for Miljø og Energi nr. 72
- Dahl, F., & Åhlén, P.-A. (2019). Nest predation by raccoon dog *Nyctereutes procyonoides* in the archipelago of northern Sweden. *Biological Invasions*, 21(3), 743-755. doi:10.1007/s10530-018-1855-4
- Desholm, M., Christensen, T. K., Scheiffarth, G., Hario, M., Andersson, Å., Ens, B. J., . . . Fox, A. (2002). Status of the Baltic/Wadden Sea population of the Common Eider *Somateria m. mollissima*. *Wildfowl*, 53, 167-203.
- Desholm, M., & Kahlert, J. (2005). Avian collision risk at an offshore wind farm. *Biology Letters* 1, 296-298.
- Dey, C. J., Semeniuk, C. A. D., Iverson, S. A., Richardson, E., McGeachy, D., & Gilchrist, H. G. (2018). Forecasting the outcome of multiple effects of climate change on northern common eiders. *Biological Conservation*, 220, 94-103. doi:10.1016/j.biocon.2018.02.007
- Dierschke, V., & Garthe, S. (2006). Literature review of offshore wind farms with regards to seabirds. In C. Zucco, W. Wende, T. Merck, I. Köchling, & J. Köppel (Eds.), *Ecological research on offshore wind farms: international exchange of experiences. Part B: literature review of ecological impacts*. (Vol. BfN-Skripten 186, pp. 131-198).
- Ekblad, C. M. S., Sulkava, S., Stjernberg, T. G., & Laaksonen, T. K. (2016). Landscape-Scale Gradients and Temporal Changes in the Prey Species of the White-Tailed Eagle (*Haliaeetus albicilla*). *J Annales Zoologici Fennici*, 53 (3-4), 228-240, 213.
- Ekroos, J., Fox, A. D., Christensen, T. K., Petersen, I. K., Kilpi, M., Jónsson, J. E., . . . Öst, M. (2012). Declines amongst breeding Eider *Somateria mollissima* numbers in the Baltic/Wadden Sea flyway. *Ornis Fennica*, 89, 81-90.
- Ekroos, J., Öst, M., Karell, P., Jaatinen, K., & Kilpi, M. (2012). Philopatric predisposition to predation-induced ecological traps: habitat-dependent mortality of breeding eiders. *Oecologia*, 170(4), 979-986.
- Erdmann, F., Bellebaum, J., Kube, J., & Schulz, A. (2005). *Losses of seabirds and waterfowl by fisheries with special regards to the international important resting, moulting, and wintering areas in the coastal waters of Mecklenburg–Western Pomerania*.: Study for the Mecklenburg–Western Pomerania State Agency for Environment, Nature Conservation, and Geology. I. L. N. Greifswald, Institute for Landscape Ecology and Nature Protection and IfAO, Institute for Applied Ecology Greifswald and Neu Broderstorf. (In German with English Summary).

- Erikstad, K. E., & Bustnes, J. O. (1994). Clutch size determination in common eiders: an egg removal and egg addition experiment. *Journal of Avian Biology*, 25(3), 215-218. doi:10.2307/3677077
- Erikstad, K. E., Bustnes, J. O., & Moum, T. (1993). Clutch-size determination in precocial birds: a study of the common eider. *Auk*, 110(3), 623-628. doi:10.2307/4088426
- European Court of Justice. (2020). Judgment of the Court (First Chamber) of 23 April 2020. Retrieved from <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:62019CJ0217>
- Fangel, K., Aas, Ø., Vølstad, J. H., Bærum, K. M., Christensen-Dalsgaard, S., Nedreaas, K., . . . Anker-Nilssen, T. (2015). Assessing incidental bycatch of seabirds in Norwegian coastal commercial fisheries: Empirical and methodological lessons. *Global Ecology and Conservation*, 4, 127-136. doi:10.1016/j.gecco.2015.06.001
- Fangel, K., Wold, L. C., Aas, Ø., Christensen-Dalsgaard, S., Qvenild, M., & Anker-Nilssen, T. (2011). *Bifangst av sjøfugl i norske kystfiskerier. Et kartleggings- og metodeutprøvningsprosjekt med fokus på fiske med garn og line*: NINA Rapport 719. Lillehammer, Norway.
- Fauchald, P., Anker-Nilssen, T., Barrett, R., Bustnes, J., Bårdsen, B.-J., Christensen-Dalsgaard, S., . . . Systad, G. (2015). *The status and trends of seabirds breeding in Norway and Svalbard*: NINA Report 1151.
- Fenstad, A. A., Bustnes, J. O., Lierhagen, S., Gabrielsen, K. M., Öst, M., Jaatinen, K., . . . Krøkje, A. (2017). Blood and feather concentrations of toxic elements in a Baltic and an Arctic seabird population. *Marine Pollution Bulletin*, 114(2), 1152-1158. doi:10.1016/j.marpolbul.2016.10.034
- Fenstad, A. A., Jenssen, B. M., Gabrielsen, K. M., Öst, M., Jaatinen, K., Bustnes, J. O., . . . Krøkje, A. (2016). Persistent organic pollutant levels and the importance of source proximity in Baltic and Svalbard breeding common eiders. *Environmental Toxicology and Chemistry*, 35(6), 1526-1533. doi:10.1002/etc.3303
- Field, R., Crawford, R., Enever, R., Linkowski, T., Martin, G., Morkūnas, J., Morkūne, R., Rouxel, Y., Oppel, S. (2019). High contrast panels and lights do not reduce bird bycatch in Baltic Sea gillnet fisheries. *Global Ecology and Conservation* 18, e00602. doi:10.1016/j.gecco.2019.e00602
- FitzGerald, D. M., Fenster, M. S., Argow, B. A., & Buynev-ich, I. V. (2008). Coastal impacts due to sea-level rise. *Annual Review of Earth and Planetary Sciences*, 36, 601-647.
- Fliessbach, K. L., Borkenhagen, K., Guse, N., Markones, N., Schwemmer, P., & Garthe, S. (2019). A Ship Traffic Disturbance Vulnerability Index for Northwest European Seabirds as a Tool for Marine Spatial Planning. *Frontiers in Marine Science*, 6. doi:10.3389/fmars.2019.00192
- Fox, A. D., Desholm, M., Kahlert, J., Christensen, T. K., & Krag Petersen, I. B. (2006). Information needs to support environmental impact assessment of the effects of European marine offshore wind farms on birds. *Ibis*, 148(s1), 129-144. doi:10.1111/j.1474-919X.2006.00510.x
- Fox, A. D., Jónsson, J. E., Aarvak, T., Bregnballe, T., Christensen, T. K., Clausen, K. K., . . . Therkildsen, O. R. (2015). Current and Potential Threats to Nordic Duck Populations — A Horizon Scanning Exercise. *Annales Zoologici Fennici*, 52(4), 193-220. doi:10.5735/086.052.0404
- Franson, J. C., Hollmén, T., Hario, M., Kilpi, M., & Finley, D. L. (2002). Lead and delta-aminolevulinic acid dehydratase in blood of Common Eiders (*Somateria mollissima*) from the Finnish archipelago. *Ornis Fennica*, 79(2), 87-91.
- Franson, J. C., Hollmén, T., Poppenga, R. H., Hario, M., Kilpi, M., & Smith, M. R. (2000). Selected trace elements and organochlorines: Some findings in blood and eggs of nesting common eiders (*Somateria mollissima*) from Finland. *Environmental Toxicology and Chemistry*, 19(5), 1340-1347. doi:10.1002/etc.5620190517
- Furness, R. W., Wade, H. M., & Masden, E. A. (2013). Assessing vulnerability of marine bird populations to offshore wind farms. *Journal of Environmental Management*, 119, 56-66. doi:10.1016/j.jenvman.2013.01.025
- Garbus, S. E., Lyngs, P., Christensen, J. P., Buchmann, K., Eulaers, I., Mosbech, A., . . . Sonne, C. (2018). Common Eider (*Somateria mollissima*) body condition and parasitic load during a mortality event in the Baltic Proper. *Avian Biology Research*, 11(3), 167-172. doi:10.3184/175815618x15263798903780
- Glemarec, G., Kindt-Larsen, L., Lundgaard, L. S., & Larsen, F. (2020). Assessing seabird bycatch in gillnet fisheries using electronic monitoring. *Biological Conservation*, 243, 108461. doi:10.1016/j.biocon.2020.108461
- Guery, L., Descamps, S., Pradel, R., Hanssen, S. A., Erikstad, K. E., Gabrielsen, G. W., . . . Bety, J. (2017). Hidden survival heterogeneity of three Common eider populations in response to climate fluctuations. *Journal of Animal Ecology*, 86(3), 683-693. doi:10.1111/1365-2656.12643
- Guillemette, M., Woakes, A. J., Henaux, V., Grandbois, J. M., & Butler, P. J. (2004). The effect of depth on the diving behaviour of common eiders. *Canadian Journal of Zoology-Revue Canadienne De Zoologie*, 82(11), 1818-1826. doi:10.1139/z04-180
- Gunnarsson, G., Elmqvist, J., Pöysä, H., Nummi, P., Sjöberg, K., Dessborn, L., & Arzel, C. (2013). Density dependence in ducks: a review of the evidence. *European Journal of Wildlife Research*, 59(3), 305-321. doi:10.1007/s10344-013-0716-9
- Hanssen, S. A. (2006). Costs of an immune challenge and terminal investment in a long-lived bird. *Ecology*, 87(10), 2440-2446. doi:10.1890/0012-9658(2006)87[2440:Coaica]2.0.Co;2
- Hanssen, S. A., Erikstad, K. E., Johnsen, V., & Bustnes, J. O. (2003). Differential investment and costs during avian incubation determined by individual quality: an experimental study of the common eider (*Somateria mollissima*). *Proceedings of the Royal Society B-Biological Sciences*, 270(1514), 531-537. doi:10.1098/rspb.2002.2262

- Hanssen, S. A., Folstad, I., & Erikstad, K. E. (2003). Reduced immunocompetence and cost of reproduction in common eiders. *Oecologia*, 136(3), 457-464. doi:10.1007/s00442-003-1282-8
- Hanssen, S. A., Folstad, I., Erikstad, K. E., & Oksanen, A. (2003). Costs of parasites in common eiders: effects of antiparasite treatment. *Oikos*, 100(1), 105-111. doi:10.1034/j.1600-0706.2003.12162.x
- Hanssen, S. A., Gabrielsen, G. W., Bustnes, J. O., Bråthen, V. S., Skottene, E., Fenstad, A., . . . Moe, B. (2016). Migration strategies of common eiders from Svalbard: implications for bilateral conservation management. *Polar Biology*, 39(11), 2179-2188. doi:10.1007/s00300-016-1908-z
- Hanssen, S. A., Hasselquist, D., Folstad, I., & Erikstad, K. E. (2005). Cost of reproduction in a long-lived bird: incubation effort reduces immune function and future reproduction. *Proceedings of the Royal Society B-Biological Sciences*, 272(1567), 1039-1046. doi:10.1098/rspb.2005.3057
- Hanssen, S. A., Moe, B., Bårdsen, B. J., Hanssen, F., & Gabrielsen, G. W. (2013). A natural antipredation experiment: predator control and reduced sea ice increases colony size in a long-lived duck. *Ecology and Evolution*, 3(10), 3554-3564. doi:10.1002/ece3.735
- Hario, M. (2016). Saaristolintujen lentopoikastuotto Porvoon Söderskärillä vuosina 1981–2007 (Summary: Fledgling production of archipelago birds at Söderskär bird sanctuary in 1981–2007). *Linnut-vuosikirja 2015*, 159–165.
- Hario, M., Hollmén, T., Morelli, T. L., & Scribner, K. T. (2002). Effects of mate removal on the fecundity of common eider *Somateria mollissima* females. *Wildlife Biology*, 8(3), 161-168.
- Hario, M., Koljonen, M. L., & Rintala, J. (2012). Kin structure and choice of brood care in a Common Eider (*Somateria m. mollissima*) population. *Journal of Ornithology*, 153(3), 963-973. doi:10.1007/s10336-012-0825-3
- Hario, M., Mazerolle, M. J., & Saurola, P. (2009). Survival of female common eiders *Somateria m. mollissima* in a declining population of the northern Baltic Sea. *Oecologia*, 159(4), 747-756. doi:10.1007/s00442-008-1265-x
- Hario, M., & Rintala, J. (2006). Fledgling production and population trends in Finnish common eiders (*Somateria mollissima mollissima*) - evidence for density dependence. *Canadian Journal of Zoology-Revue Canadienne De Zoologie*, 84(7), 1038-1046. doi:10.1139/z06-077
- Hario, M., & Rintala, J. (2009). Age of first breeding in the Common Eider *Somateria m. mollissima* population in the northern Baltic Sea. *Ornis Fennica*, 86(3), 81-88.
- Hario, M. & Selin, K., 1991: Mihin haahkanpoikaset, katoavat? (Summary: Where have all the eider ducklings gone?) – Suomen Riista 37: 35–43.
- Hario, M., & Öst, M. (2002). Does heavy investment in foraging implicate low food acquisition for female Common Eiders *Somateria mollissima*? *Ornis Fennica*, 79, 111-120.
- Heinänen, S., Erola, J., & von Numers, M. (2012). High resolution species distribution models of two nesting water bird species: a study of transferability and predictive performance. *Landscape Ecology*, 27(4), 545-555. doi:10.1007/s10980-012-9705-8
- Heinänen, S., Żydelis, R., Dorsch, M., Nehls, G., & Skov, H. (2017). High-resolution sea duck distribution modeling: Relating aerial and ship survey data to food resources, anthropogenic pressures, and topographic variables. *Condor*, 119(2), 175-190. doi:10.1650/condor-16-57.1
- HELCOM. (2013). Red list of species: Common Eider *Somateria mollissima*. Retrieved from <https://helcom.fi/media/red%20list%20species%20information%20sheet/HELCOM-Red-List-Somateria-mollissima.pdf>
- Herzke, D., Nygård, T., Berger, U., Huber, S., & Røv, N. (2009). Perfluorinated and other persistent halogenated organic compounds in European shag (*Phalacrocorax aristotelis*) and common eider (*Somateria mollissima*) from Norway: A suburban to remote pollutant gradient. *Science of the Total Environment*, 408(2), 340-348. doi:10.1016/j.scitotenv.2009.08.048
- Hilgerloh, G., & Pfeifer, D. (2002). Size selection and competition for mussels *Mytilus edulis*, by oystercatchers, *Haematopus ostralegus*, herring gulls, *Larus argentatus*, and common eiders, *Somateria mollissima*. *Ophelia*, 56(1), 43-53. doi:10.1080/00785236.2002.10409488
- Hobson, K. A., Jaatinen, K., & Öst, M. (2015). Differential contributions of endogenous and exogenous nutrients to egg components in wild Baltic Common Eiders (*Somateria mollissima*): A test of alternative stable isotope approaches. *The Auk*, 132(3), 624-633, 610.
- Hollmén, T. (2002). *Biomarkers of health and disease in Common Eiders (Somateria mollissima) in Finland*. (PhD), University of Helsinki, Retrieved from <https://helda.helsinki.fi/handle/10138/18948>
- Hollmén, T., Franson, J. C., Docherty, D. E., Kilpi, M., Hario, M., Creekmore, L. H., & Petersen, M. R. (2000). Infectious bursal disease virus antibodies in Elder ducks and Herring Gulls. *Condor*, 102(3), 688-691. doi:10.1650/0010-5422(2000)102[0688:Ibdvai]2.0.Co;2
- Hollmén, T., Franson, J. C., Kilpi, M., Docherty, D. E., Hansen, W. R., & Hario, M. (2002). Isolation and Characterization of a Reovirus from Common Eiders (*Somateria mollissima*) from Finland. *Avian Diseases*, 46(2), 478-484.
- Hollmén, T., Franson, J. C., Kilpi, M., Docherty, D. E., & Myllys, V. (2003). An adenovirus associated with intestinal impaction and mortality of male common eiders (*Somateria mollissima*) in the Baltic Sea. *Journal of Wildlife Diseases*, 39(1), 114-120. doi:10.7589/0090-3558-39.1.114

- Hollmén, T., Franson, J. C., Poppenga, R. H., Hario, M., & Kilpi, M. (1998). Lead poisoning and trace elements in common eiders *Somateria mollissima* from Finland. *Wildlife Biology*, 4 (2), 193-203.
- Hollmén, T., Lehtonen, J. T., Sankari, S., Soveri, T., & Hario, M. (1999). An experimental study on the effects of polymorphiasis in Common Eider ducklings. *Journal of Wildlife Diseases*, 35(3), 466-473. doi:10.7589/0090-3558-35.3.466
- Holloway, S. (2010). The historical atlas of breeding birds in Britain and Ireland 1875-1900: A&C Black. Holm, T. E., & Haugaard, L. (2013). Effects of a Danish action plan on reducing shotgun wounding of Common Eider *Somateria mollissima*. *Bird Study*, 60(1), 131-134. doi:10.1080/00063657.2012.748715
- Hontelez, L. C. M. P., Vandendungen, H. M., & Baars, A. J. (1992). Lead and cadmium in birds in the Netherlands - a preliminary survey. *Archives of Environmental Contamination and Toxicology*, 23(4), 453-456. doi:10.1007/bf00203808
- Hughes, R. G. (2004). Climate change and loss of saltmarshes: Consequences for birds. *Ibis* 146, 21-28.
- Hötter, H., Thomsen, K.-M., & Jeromin, H. (2006). *Impacts on biodiversity of exploitation of renewable energy sources: the example of birds and bats - facts, gaps in knowledge, demands for further research, and ornithological guidelines for the development of renewable energy exploitation*: Michael-Otto-Institut im NABU, Bergenhusen, Germany.
- IUCN. (2020). Threats Classification Scheme (Version 3.2). Retrieved from: <https://www.iucnredlist.org/resources/threat-classification-scheme>
- Jaatinen, K. et al. (2020). Detrimental impacts of climate change may be exacerbated by density-dependent population regulation in blue mussels. *Journal of Animal Ecology*, doi: 10.1111/1365-2656.13377.
- Jaatinen, K., Seltmann, M. W., Hollmén, T., Atkinson, S., Mashburn, K., & Öst, M. (2013). Context dependency of baseline glucocorticoids as indicators of individual quality in a capital breeder. *General and Comparative Endocrinology*, 191, 231-238. doi:10.1016/j.ygcen.2013.06.022
- Jaatinen, K., Seltmann, M. W., & Öst, M. (2014). Context-dependent stress responses and their connections to fitness in a landscape of fear. *Journal of Zoology*, 294(3), 147-153. doi:10.1111/jzo.12169
- Jaatinen, K., Westerborn, M., Norkko, A., Mustonen, O. & Koons, D. N. (2020) Detrimental impacts of climate change may be exacerbated by density-dependent population regulation in blue mussels. *Journal of Animal Ecology* 00:1-12. doi: 10.1111/1365-2656.13377
- Jaatinen, K., & Öst, M. (2013). Brood Size Matching: A Novel Perspective on Predator Dilution. *American Naturalist*, 181(2), 171-181. doi:10.1086/668824
- Jaatinen, K., & Öst, M. (2016). Brain size-related breeding strategies in a seabird. *Oecologia*, 180(1), 67-76. doi:10.1007/s00442-015-3468-2
- Jaatinen, K., Öst, M., & Hobson, K. A. (2016). State-dependent capital and income breeding: a novel approach to evaluating individual strategies with stable isotopes. *Frontiers in Zoology*, 13(1), 24. doi:10.1186/s12983-016-0157-x
- Jaatinen, K., Öst, M., & Lehikoinen, A. (2011). Adult predation risk drives shifts in parental care strategies: a long-term study. *Journal of Animal Ecology*, 80(1), 49-56. doi:10.1111/j.1365-2656.2010.01757.x
- Jarrett, D., Cook, A. S. C. P., Woodward, I., Ross, K., Horswill, C., Dadam, D., & Humphreys, E. M. (2018). Short-Term Behavioural Responses of Wintering Waterbirds to Marine Activity (CR/2015/17). *Scottish Marine and Freshwater Science*, 9(7). doi:10.7489/12096-1
- Jenssen, B. M., & Ekker, M. (1991). Dose dependent effects of plumage-oiling on thermoregulation of Common Eiders *Somateria mollissima* residing in water. *Polar Research*, 10(2), 579-584. doi:10.1111/j.1751-8369.1991.tb00675.x
- Joensen, A. H. (1973). Ederfuglen (*Somateria mollissima*) som ynglefugl i Danmark. (In Danish with English summary). *Danske Vildtundersøgelser*, 20.
- Johansson, M. M., Pellikka, H., Kahma, K. K., & Ruosteenoja, K. (2014). Global sea level rise scenarios adapted to the Finnish coast. *Journal of Marine Systems*, 129, 35-46. doi:10.1016/j.jmarsys.2012.08.007
- Keller, V. E. (1991). Effects of human disturbance on Eider ducklings *somateria mollissima* in an estuarine habitat in Scotland. *Biological Conservation*, 58(2), 213-228.
- Keller, V., Herrando, S., Voříšek, P., Franch, M., Kipson, M., Milanese, P., . . . Foppen, R. P. B. (2020). *European Breeding Bird Atlas 2: Distribution, Abundance and Change*: European Bird Census Council & Lynx Edicions.
- Ketzenberg, C. (1993). Auswirkungen von Störungen auf nahrungssuchende Eiderenten (*Somateria mollissima*) im Königshafen/Sylt. *Corax*, 15 241-244.
- Kilpi, M., Jaatinen, K., & Öst, M. (2018). Suomen haahkakannan kato - mitä oikein tapahtui? *Suomen Riista*, 64, 7-20.
- Kilpi, M., & Lindström, K. (1997). Habitat-specific clutch size and cost of incubation in common eiders, *Somateria mollissima*. *Oecologia*, 111(3), 297-301. doi:10.1007/s004420050238
- Kirchhoff, K. (1982). Wasservogelverluste durch die Fischerei an der schleswig-holsteinischen Ostseeküste. *Vogelwelt*, 103, 81-89.
- Kirkham, P. (2008). Common Eiders attacked and killed by Harbour Seal. *British Birds* 101, 442-447.

- Koryakin, A.S. (2016). Common Eider *Somateria mollissima*. In: Noskov, G.A., Rymkevich, T.A. & Gaginskaya A.R. (Eds.) *Migrations of Birds of North-West Russia*. Renome, Saint-Petersburg.
- Krasnov, Y. V., Gavrilov, M. V., & Shavykin, A. A. (2016). Status, Number, and Monitoring of the Common Eider (*Somateria mollissima*) Population in the Barents Sea and the White Sea. *Biology Bulletin*, 43(7), 664-669. doi:10.1134/s1062359016070098
- Kurvinen, L., Kilpi, M., Nordström, M., & Öst, M. (2016). Drivers of decline and changed nest site preference of the Baltic eider: an island level analysis from southwestern Finland. *Ornis Fennica*, 93, 55-66.
- Lam, S. S., McPartland, M., Noori, B., Garbus, S. E., Lierhagen, S., Lyngs, P., . . . Sonne, C. (2020). Lead concentrations in blood from incubating common eiders (*Somateria mollissima*) in the Baltic Sea. *Environment International*, 137, 105582. doi:10.1016/j.envint.2020.105582
- Larsen, J. K., & Guillemette, M. (2000). Influence of annual variation in food supply on abundance of wintering common eiders *Somateria mollissima*. *Marine Ecology Progress Series*, 201, 301-309. doi:10.3354/meps201301
- Larsen, J. K., & Guillemette, M. (2007). Effects of wind turbines on flight behaviour of wintering common eiders: implications for habitat use and collision risk. *Journal of Applied Ecology*, 44(3), 516-522. doi:10.1111/j.1365-2664.2007.01303.x
- Larsson, K., Hajdu, S., Kilpi, M., Larsson, R., Leito, A., & Lyngs, P. (2014). Effects of an extensive *Prymnesium polylepis* bloom on breeding eiders in the Baltic Sea. *Journal of Sea Research*, 88, 21-28. doi:10.1016/j.seares.2013.12.017
- Laurila, T. (1989). Nest site selection in the Common Eider *Somateria mollissima* - differences between the archipelago zones. *Ornis Fennica*, 66(3), 100-111.
- Lauritzen, S. E., Nese, H., Lie, R. W., Lauritsen, A., & Loevlie, R. (1996). Interstadial/interglacial fauna from Norcemgrotta, Kjoepsvik, Northern Norway. In S. E. Lauritzen (Ed.), *Climate Change: the Karst Record*. Petersburg, PA.: Karst Waters Institute Special Publication.
- Laursen, K., Asferg, K. S., Frikke, J., & Sunde, P. (2009). Mussel fishery affects diet and reduces body condition of Eiders *Somateria mollissima* in the Wadden Sea. *Journal of Sea Research*, 62(1), 22-30. doi:10.1016/j.seares.2009.02.004
- Laursen, K., & Frikke, J. (2008). Hunting from motorboats displaces Wadden Sea eiders *Somateria mollissima* from their favoured feeding distribution. *Wildlife Biology*, 14(4), 423-433. doi:10.2981/0909-6396-14.4.423
- Laursen, K., & Møller, A. P. (2014). Long-Term Changes in Nutrients and Mussel Stocks Are Related to Numbers of Breeding Eiders *Somateria mollissima* at a Large Baltic Colony. *PLOS ONE*, 9(4), e95851. doi:10.1371/journal.pone.0095851
- Laursen, K., Møller, A. P., & Hobson, K. A. (2019). N-Isotopes in Feathers and Abundance of Eiders Respond to Nutrients in Seawater. *Ecosystems*, 22(6), 1271-1279. doi:10.1007/s10021-018-00334-w
- Laursen, K., Møller, A. P., & Holm, T. E. (2016). Dynamic group size and displacement as avoidance strategies by eiders in response to hunting. *Wildlife Biology*, 22(4), 174-181. doi:10.2981/wlb.00197
- Laursen, K., Møller, A. P., & Öst, M. (2019). Body condition of Eiders at Danish wintering grounds and at pre-breeding grounds in Åland. *Journal of Ornithology*, 160(1), 239-248. doi:10.1007/s10336-018-1609-1
- Lehikoinen, A., Christensen, T. K., Öst, M., Kilpi, M., Saurola, P., & Vattulainen, A. (2008). Large-scale change in the sex ratio of a declining eider *Somateria mollissima* population. *Wildlife Biology*, 14(3), 288-301. doi:10.2981/0909-6396(2008)14[288:Lcitsr]2.0.Co;2
- Lehikoinen, A., Kilpi, M., & Öst, M. (2006). Winter climate affects subsequent breeding success of common eiders. *Global Change Biology*, 12(7), 1355-1365. doi:10.1111/j.1365-2486.2006.01162.x
- Leighton, P. A., Horrocks, J. A., & Kramer, D. L. (2010). Conservation and the scarecrow effect: Can human activity benefit threatened species by displacing predators? *Biological Conservation*, 143(9), 2156-2163. doi:10.1016/j.biocon.2010.05.028
- Liénart, C., Garbaras, A., Qvarfordt, S., Sysoev, A.Ö., Högländer, H., Walve, J., Schagerström, E., Eklöf, J. & Karlson, A.M. (2021), Long-term changes in trophic ecology of blue mussels in a rapidly changing ecosystem. *Limnology and Oceanography*. doi: 10.1002/lno.11633
- Lorentsen, S.-H., & Petersen, I. K. (2009). *Counts of seabirds from plain in Skagerrak*. . Oral presentation in SEAPOP seminar 2009.
- Lund Bjørnås, C. (2017). *Population trends of breeding birds along the Swedish coast*. (MSc), Lund University,
- Lundström, K., Hjerne, O., Lunneryd, S.-G., & Karlsson, O. (2010). Understanding the diet composition of marine mammals: grey seals (*Halichoerus grypus*) in the Baltic Sea. *ICES Journal of Marine Science*, 67(6), 1230-1239. doi:10.1093/icesjms/fsq022
- Lunneryd, S. G., Königson, S., & Sjöberg, N. B. (2004). *By-catch of seals, harbour porpoises and birds in Swedish commercial fisheries*. : Fiskeriverket informerar 2004/8. Öregrund, Göteborg, Sweden.
- Mackenzie, B. R., Gislason, H., Möllmann, C., & Köster, F. W. (2007). Impact of 21st century climate change on the Baltic Sea fish community and fisheries. *Global Change Biology*, 13(7), 1348-1367. doi:10.1111/j.1365-2486.2007.01369.x

- Mackenzie, C. L., Ormondroyd, G. A., Curling, S. F., Ball, R. J., Whiteley, N. M., & Malham, S. K. (2014). Ocean warming, more than acidification, reduces shell strength in a commercial shellfish species during food limitation. *PloS one*, 9(1), e86764-e86764. doi:10.1371/journal.pone.0086764
- Mangerud, J. (2004). Ice sheet limits on Norway and the Norwegian continental shelf. In J. Ehlers & P. Gibbard (Eds.), *Quaternary Glaciations — Extent and Chronology* (Vol. 1. Europe). Amsterdam: Elsevier.
- McPartland, M., Garbus, S.E., Lierhagen, S., Sonne, C., Krøkje Å. (2020). Lead isotopic signatures in blood from incubating common eiders (*Somateria mollissima*) in the central Baltic Sea Environ. Int., 142, p. 105874. doi:10.1016/j.envint.2020.105874
- Mehlum, F. (2012). Effects of sea ice on breeding numbers and clutch size of a high arctic population of the common eider *Somateria mollissima*. *Polar Science*, 6(1), 143-153. doi:10.1016/j.polar.2012.03.004
- Meier, H. E. M., Hordoir, R., Andersson, H. C., Dieterich, C., Eilola, K., Gustafsson, B. G., . . . Schimanke, S. (2012). Modeling the combined impact of changing climate and changing nutrient loads on the Baltic Sea environment in an ensemble of transient simulations for 1961-2099. *Climate Dynamics*, 39(9-10), 2421-2441. doi:10.1007/s00382-012-1339-7
- Mendenhall, V. M., & Milne, H. (1985). Factors affecting duckling survival of Eiders *Somateria mollissima* in northeast Scotland. *Ibis*, 127(2), 148-158. doi:10.1111/j.1474-919X.1985.tb05051.x
- Merkel, F. R. (2004). Impact of Hunting and Gillnet Fishery on Wintering Eiders in Nuuk, Southwest Greenland. *Waterbirds*, 27(4), 469-479. doi:10.1675/1524-4695(2004)027[0469:IOHAGF]2.0.CO;2
- Miljøstyrelsen, M.-o. F. (2020). Status for projekt om bekæmpelse af invasive rovdyr. *Arter og Naturbeskyttelse J., nr. 2020(9161)*.
- Moore, P. G. (2001). Concerning Grey seals killing eider ducks in the Clyde sea area. *Journal of the Marine Biological Association of the United Kingdom*, 81, 1067-1068.
- Morgan, R. (1986). Eider attacked by Grey Seal. *British Birds*, 79, 338-339.
- Morley, T. I., Fayet, A. L., Jessop, H., Veron, P., Veron, M., Clark, J., & Wood, M. J. (2016). The seabird wreck in the Bay of Biscay and South-Western Approaches in 2014: A review of reported mortality. *Seabird*, 29, 22-38.
- Mörner, T., Hansson, T., Carlsson, L., Berg, A.-L., Ruiz Muñoz, Y., Gustavsson, H., . . . Balk, L. (2017). Thiamine deficiency impairs common eider (*Somateria mollissima*) reproduction in the field. *Scientific Reports*, 7(1), 14451. doi:10.1038/s41598-017-13884-1
- Neggazi, S. A., Noreikiene, K., Öst, M., & Jaatinen, K. (2016). Reproductive investment is connected to innate immunity in a long-lived animal. *Oecologia*, 182(2), 347-356. doi:10.1007/s00442-016-3657-7
- Nehls, G. (1991). Bestand, Jahresrhythmus und Nahrungsökologie der Eiderente, *Somateria mollissima*, L. 1758, im Schleswig-Holsteinischen Wattenmeer. *Corax* 14, 146-209.
- Nehls, G. (1996). Low costs of salt turnover in common eiders *Somateria mollissima*. *Ardea*, 84(1-2), 23-30.
- Nilsson, T. (1983). *The Pleistocene*. Stuttgart: Enke Verlag.
- Nordic Council of Ministers (2010). Action plan for seabirds in Western-Nordic areas Report from a workshop in Malmö, Sweden, 4-5 May 2010. TemaNord 2010:587.
- Nordström, M., Högmänder, J., Nummelin, J., Laine, J., Laanetu, N., & Korpimäki, E. (2002). Variable responses of waterfowl breeding populations to long-term removal of introduced American mink. *Ecography*, 25(4), 385-394. doi:10.1034/j.1600-0587.2002.250401.x
- Northridge, S., Kingston, A., & Coram, A. (2020). *Preliminary estimates of seabird bycatch by UK vessels in UK and adjacent waters. - Defra report ME6024*: Scottish Ocean Institute, University of St Andrews.
- Norwegian Polar Institute. (2020). MOSJ, Environmental Monitoring of Svalbard and Jan Mayen - Common Eider. Retrieved from <http://www.mosj.no/en/fauna/marine/common-eider.html>
- Olsson, J., Jakubaviciute, E., Kaljuste, O., Larsson, N., Bergström, U., Casini, M., Cardinale, M., Hjelm, J. & Byström, P. (2019). The first large-scale assessment of three-spined stickleback (*Gasterosteus aculeatus*) biomass and spatial distribution in the Baltic Sea. *Ices Journal of Marine Science*, 76, 1653-1665. DOI 10.1093/icesjms/fsz078
- Ottosson, U., Ottvall, R., Elmqvist, J., Green, M., Gustafsson, R., Haas, F., . . . Tjernberg, M. (2012). *Fåglarna i Sverige: antal och förekomst*. Halmstad: Swedish Ornithological Society.
- Pedersen, H. C., Follestad, A., Gjershaug, J. A., & Nilsen, E. B. (2016). *Statusoversikt for jaktbart småvilt*: NINA Rapport 1178.
- Pedersen, K., Dietz, H. H., Jorgensen, J. C., Christensen, T., Bregnballe, T., & Andersen, T. H. (2003). *Pasteurella multocida* from outbreaks of avian cholera in wild and captive birds in Denmark. *Journal of wildlife diseases*, 39, 808-816. doi:10.7589/0090-3558-39.4.808
- Pettersson, J. (2005). *The Impact of Offshore Wind Farms on Bird Life in Southern Kalmar Sound, Sweden - A final report based on studies 1999-2003*.: Lund University and Swedish Energy Agency.
- Piatt, J.F., Parrish, J.K., Renner, H.M., Schoen, S.K., Jones, T.T., . . . Sydeman, W. J. (2020). Extreme mortality and reproductive failure of common murres resulting from the northeast Pacific marine heatwave of 2014-2016. *PLOS ONE* 15(1): e0226087. doi:10.1371/journal.pone.0226087

- Prop, J., Aars, J., Bårdsen, B. J., Hanssen, S. A., Bech, C., Bourgeon, S., . . . Moe, B. (2015). Climate change and the increasing impact of polar bears on bird populations. *Frontiers in Ecology and Evolution*, 3. doi:10.3389/fevo.2015.00033
- Ramula, S., Öst, M., Linden, A., Karell, P., & Kilpi, M. (2018). Increased male bias in eider ducks can be explained by sex-specific survival of prime-age breeders. *Plos One*, 13(4). doi:10.1371/journal.pone.0195415
- Reneerkens, J. (2020). *Climate change effect on Wadden Sea birds along the East-Atlantic flyway*: Position paper 2020-02, Wadden Academy.
- Ross, B. P., Lien, J., & Furness, R. W. (2001). Use of underwater playback to reduce the impact of elders on mussel farms. *Ices Journal of Marine Science*, 58(2), 517-524. doi:10.1006/jmsc.2000.1025
- Savinova, T. N., Polder, A., Gabrielsen, G. W., & Skaare, J. U. (1995). Chlorinated hydrocarbons in seabirds from the Barents Sea area. *Science of the Total Environment*, 160-61, 497-504. doi:10.1016/0048-9697(95)04383-c
- Scheiffarth, G., Ens, B., & Schmidt, A. (2007). What will happen to birds when Pacific Oysters take over the mussel beds in the Wadden Sea? *Wadden Sea Newsletter*, 33, 10-14.
- Scheiffarth, G., & Frank, D. (2005). Shellfish eating birds in the Wadden Sea - What can we learn from current monitoring programmes? *Wadden Sea Ecosystem*, 20, 187-200.
- Schwemmer, P., Mendel, B., Sonntag, N., Dierschke, V., & Garthe, S. (2011). Effects of ship traffic on seabirds in offshore waters: implications for marine conservation and spatial planning. *Ecological Applications*, 21(5), 1851-1860.
- Seltmann, M. W., Jaatinen, K., Steele, B. B., & Öst, M. (2014). Boldness and Stress Responsiveness as Drivers of Nest-Site Selection in a Ground-Nesting Bird. *Ethology*, 120(1), 77-89. doi:10.1111/eth.12181
- Seltmann, M. W., Öst, M., Jaatinen, K., Atkinson, S., Mashburn, K., & Hollmén, T. (2012). Stress responsiveness, age and body condition interactively affect flight initiation distance in breeding female eiders. *Animal Behaviour*, 84(4), 889-896. doi:10.1016/j.anbehav.2012.07.012
- Sipiä, V. O., Karlsson, K. A., Meriluoto, J. A. O., & Kankaanpää, H. T. (2004). Eiders (*Somateria mollissima*) obtain nodularin, a cyanobacterial hepatotoxin, in Baltic Sea food web. *Environmental Toxicology and Chemistry*, 23(5), 1256-1260. doi:10.1897/03-209
- Skov, H., Heinänen, S., Žydelis, R., Bellebaum, J., Bzoma, S., Dagys, M., . . . Wahl, J. (2011). *Waterbird Populations and Pressures in the Baltic Sea. - Tema Nord 2011:550*: Nordic Council of Ministers.
- Sonntag, N., Schwemmer, H., Fock, H. O., Bellebaum, J., & Garthe, S. (2012). Seabirds, set-nets, and conservation management: assessment of conflict potential and vulnerability of birds to bycatch in gillnets. *ICES Journal of Marine Science*, 69(4), 578-589. doi:10.1093/icesjms/fss030
- Stien, J., & Ims, R. A. (2016). Absence from the nest due to human disturbance induces higher nest predation risk than natural recesses in Common Eiders *Somateria mollissima*. *Ibis*, 158(2), 249-260. doi:10.1111/ibi.12338
- Stien, J., Yoccoz, N. G., & Ims, R. A. (2010). Nest predation in declining populations of common eiders *Somateria mollissima*: an experimental evaluation of the role of hooded crows *Corvus cornix*. *Wildlife Biology*, 16(2), 123-134. doi:10.2981/09-060
- Strömberg, A., Svärd, C., & Karlsson, O. (2012). *Dietsstudier av gråsäl (Halichoerus grypus) i Östersjön och knobbsäl (Phoca vitulina) i Skagerrak och Kattegatt insamlade 2010* (Sweden Ed.): Report to Naturvårdsverket NV-02210-11.
- Swennen, C. (1991). Fledgling production of eiders *Somateria-mollissima* in the Netherlands. *Journal Fur Ornithologie*, 132(4), 427-437. doi:10.1007/bf01640382
- Swennen, C. (1972). Chlorinated hydrocarbons attacked the eider population in the Netherlands. *TNO Nieuws* 27, 556-570.
- Systad, G. H., Bustnes, J. O., & Erikstad, K. E. (2000). Behavioral responses to decreasing day length in wintering sea ducks. *Auk*, 117(1), 33-40. doi:10.1642/0004-8038(2000)117[0033:Brtdl]2.0.Co;2
- The Circumpolar Seabird Working Group. (1997). *Circumpolar eider conservation strategy and action plan*: Conservation of Actic Flora and Fauna.
- Thieltges, D. W., Hüssel, B., & Baekgaard, H. (2006). Endoparasites in common eiders *Somateria mollissima* from birds killed by an oil spill in the northern Wadden Sea. *Journal of Sea Research*, 55(4), 301-308. doi:10.1016/j.seares.2005.12.001
- Tiedemann, R., & Noer, H. (1998). Geographic Partitioning of Mitochondrial DNA Patterns in European Eider *Somateria Mollissima*. *Hereditas*, 128(2), 159-166. doi:10.1111/j.1601-5223.1998.00159.x
- Tiedemann, R., Paulus, K. B., Scheer, M., Von Kistowski, K. G., Skirnisson, K., Bloch, D., & Dam, M. (2004). Mitochondrial DNA and microsatellite variation in the eider duck (*Somateria mollissima*) indicate stepwise postglacial colonization of Europe and limited current long-distance dispersal. *Molecular Ecology*, 13(6), 1481-1494. doi:10.1111/j.1365-294X.2004.02168.x
- Tiedemann, R., Von Kistowski, K. G., & Noer, H. (1999). On sex-specific dispersal and mating tactics in the common eider *Somateria mollissima* as inferred from the genetic structure of breeding colonies. *Behaviour*, 136, 1145-1155.

- Tjørnløv, R. S. (2020). *Population dynamics of a declining flyway population of Common Eiders Somateria mollissima*. (PhD), Aarhus University,
- Tjørnløv, R. S., Humaidan, J., & Frederiksen, M. (2013). Impacts of avian cholera on survival of Common Eiders *Somateria mollissima* in a Danish colony. *Bird Study*, 60(3), 321-326. doi:10.1080/00063657.2013.798261
- Tjørnløv, R. S., Pradel, R., Choquet, R., Christensen, T. K., & Frederiksen, M. (2019). Consequences of past and present harvest management in a declining flyway population of common eiders *Somateria mollissima*. *Ecology and Evolution*, 9(22), 12515-12530. doi:10.1002/ece3.5707
- Tulp, I., Craeymeersch, J., Leopold, M., van Damme, C., Fey, F., & Verdaat, H. (2010). The role of the invasive bivalve *Ensis directus* as food source for fish and birds in the Dutch coastal zone. *Estuarine Coastal and Shelf Science*, 90(3), 116-128. doi:10.1016/j.ecss.2010.07.008
- Waldeck, P., & Larsson, K. (2013). Effects of winter water temperature on mass loss in Baltic blue mussels: Implications for foraging sea ducks. *Journal of Experimental Marine Biology and Ecology*, 444, 24-30. doi:10.1016/j.jembe.2013.03.007
- Valkama, J., Vepsäläinen, V., & Lehtikoinen, A. (2011). The Third Finnish Breeding Bird Atlas. Retrieved from <http://atlas3.lintuatlas.fi>
- Waltho, C., & Coulson, J. (2015). *The Common Eider* (Vol. 35): Bloomsbury Publishing.
- Van De Pol, M., Ens, B. J., Heg, D., Brouwer, L., Krol, J., Maier, M., . . . Koffijberg, K. (2010). Do changes in the frequency, magnitude and timing of extreme climatic events threaten the population viability of coastal birds? *Journal of Applied Ecology*, 47(4), 720-730. doi:10.1111/j.1365-2664.2010.01842.x
- Varennnes, E., Hanssen, S. A., Bonardelli, J., & Guillemette, M. (2013). Sea duck predation in mussel farms: the best nets for excluding common eiders safely and efficiently. *Aquaculture Environment Interactions*, 4(1), 31-39. doi:10.3354/aei00072
- Varpe, Ø. (2010). Stealing bivalves from common eiders: kleptoparasitism by glaucous gulls in spring. *Polar Biology*, 33(3), 359-365. doi:10.1007/s00300-009-0712-4
- Wayland, M., Gilchrist, H. G., Marchant, T., Keating, J., & Smits, J. E. (2002). Immune function, stress response, and body condition in arctic-breeding common eiders in relation to cadmium, mercury, and selenium concentrations. *Environmental Research*, 90(1), 47-60. doi:10.1006/enrs.2002.4384
- Westerbom, M., Mustonen, O., Jaatinen, K., Kilpi, M., & Norkko, A. (2019). Population Dynamics at the Range Margin: Implications of Climate Change on Sublittoral Blue Mussels (*Mytilus trossulus*). *Frontiers in Marine Science*, 6(292). doi:10.3389/fmars.2019.00292
- Wetlands International. (2017). Flyway trend analyses based on data from the African-European Waterbird Census from the period of 1967-2015. Retrieved from <http://iw.c.wetlands.org/index.php/aewatrends>
- Volmer, H., Schwemmer, P., & Garthe, S. (2014). Aktuelle Daten zur Nahrungswahl von Eider- *Somateria mollissima* und Trauerenten *Melanitta nigra* im Schleswig-Holsteinischen Wattenmeer. *Die Vogelwarte*, 52, 283-284.
- Yoccoz, N. G., Erikstad, K. E., Bustnes, J. O., Hanssen, S. A., & Tveraa, T. (2002). Costs of reproduction in common eiders (*Somateria mollissima*): an assessment of relationships between reproductive effort and future survival and reproduction based on observational and experimental studies. *Journal of Applied Statistics*, 29(1-4), 57-64. doi:10.1080/02664760120108458
- Žydelis, R., Bellebaum, J., Österblom, H., Vetemaa, M., Schirmeister, B., Stipniece, A., . . . Garthe, S. (2009). Bycatch in gillnet fisheries – An overlooked threat to waterbird populations. *Biological Conservation*, 142, 1269-1281. doi:10.1016/j.biocon.2009.02.025
- Žydelis, R., & Dagys, M. (1997). Winter period ornithological impact assessment of oil related activities and sea transportation in Lithuanian inshore waters of the Baltic Sea and in the Kuršių Lagoon. *Acta Zoologica Lituanica*, 6(1), 45-65. doi:10.1080/13921657.1997.10541397
- Žydelis, R., Small, C., & French, G. (2013). The incidental catch of seabirds in gillnet fisheries: A global review. *Biological Conservation*, 162, 76-88. doi:10.1016/j.biocon.2013.04.002
- Öst, M., & Kilpi, M. (1998). Blue mussels *Mytilus edulis* in the Baltic: good news for foraging eiders *Somateria mollissima*. *Wildlife Biology*, 4(2), 81-89.
- Öst, M., & Kilpi, M. (1999). Parental care influences the feeding behaviour of female eiders *Somateria mollissima*. *Annales Zoologici Fennici*, 36(4), 195-204.
- Öst, M., & Kilpi, M. (2000). Eider females and broods from neighboring colonies use segregated local feeding areas. *Waterbirds*, 23(1), 24-32.
- Öst, M., Lehtikoinen, A., Jaatinen, K., & Kilpi, M. (2011). Causes and consequences of fine-scale breeding dispersal in a female-philopatric species. *Oecologia*, 166(2), 327-336. doi:10.1007/s00442-010-1855-2
- Öst, M., Lindén, A., Karell, P., Ramula, S., & Kilpi, M. (2018). To breed or not to breed: drivers of intermittent breeding in a seabird under increasing predation risk and male bias. *Oecologia*, 188(1), 129-138. doi:10.1007/s00442-018-4176-5
- Öst, M., Ramula, S., Lindén, A., Karell, P., & Kilpi, M. (2016). Small-scale spatial and temporal variation in the demographic processes underlying the large-scale decline of eiders in the Baltic Sea. *Population Ecology*, 58(1), 121-133. doi:10.1007/s10144-015-0517-y

- Öst, M., Smith, B. D., & Kilpi, M. (2008). Social and maternal factors affecting duckling survival in eiders *Somateria mollissima*. *Journal of Animal Ecology*, 77(2), 315-325. doi:10.1111/j.1365-2656.2007.01348.x
- Öst, M., & Steele, B. B. (2010). Age-specific nest-site preference and success in eiders. *Oecologia*, 162(1), 59-69. doi:10.1007/s00442-009-1444-4
- Öst, M., Wickman, M., Matulionis, E., & Steele, B. (2008). Habitat-specific clutch size and cost of incubation in eiders reconsidered. *Oecologia*, 158(2), 205-216. doi:10.1007/s00442-008-1139-2
- Åhlund, M., & Götmark, F. (1989). Gull predation on eider ducklings *Somateria mollissima*: effects of human disturbance. *Biological Conservation*, 48(2), 115-127.