Variation in eider down quality among individuals and colonies

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SAMMENDRAG/SUMMARY:

Denne rapporten oppsummerer resultatene fra er treårig forskningsprosjekt vedrørende den unike ærfuglduna. Dunprøver fra 19 kolonier i fire ulike land ble renset på en standardisert måte og ulike parametere ble målt og testet som fill power, sammenhengskraft og resiliens. Det ble dokumentert variasjon i ulike parametere både mellom kolonier og mellom individer. Dette er den største og mest dyptgående studien av ærfugldun som har blitt utført.

This report sums up the result from a three-year lasting study regarding the unique eider down. Eider down from 19 colonies was collected and we measured various parameters such as fill power, cohesion and resilience. Overall, this is the largest and most in-depth study of eider down ever performed.

GODKJENT /APPROVED	PROSJEKTLEDER /PROJECT LEADER
Knut Anders Hovstad	Thomas H. Carlsen
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NIBIO
NORSK INSTITUTT FOR BIOØKONOMI

Preface

A research project was established during a stay in Iceland between 2012 and 2015. The objective of this study was to document properties and geographical variation in eider down. We gathered down from different colonies in Iceland, Norway, Svalbard, Faroe Islands, Denmark, Canada and Greenland.
The project was funded by Framleiðnisjóður landbúnaðarins (Agricultural Productivity Fund) in Iceland, Æðarræktarfélags Íslands (the Eider Farmers Association in Iceland), the University of Iceland and Norwegian Institute of Bioeconomy (Nibio)

We collected eider down from 19 colonies and we measured various parameters such as fill power, cohesion, resilience and turbidity. Overall, this is the largest and most in-depth study of eider down ever performed.

Thanks to all eider farmers and people that collected down samples to this project. Participants from Iceland were Erla Friðriksdóttir (Hvallátur), Smári Lúðvíksson (Ríf), Sigurður K. Eiríksson (Norðurkot), Kristjana Bergsdóttir (Melrakkaslétta), Björn Ingi Knutsson (Fáskrúðsfirði), Pétur Guðmundsson (Ófeigsfjörður), Árni Þór Gunnarsson (Vestmannaeyjar), Salvar Baldursson (Vigur), Guðrún Gauksdóttir (Kaldaðarnes) and the town of Stykkishólmur (Hjallsey and Landey). Participants from Norway including Svalbard were Svein Morten Eilertsen (Rana), Eivind Hansen (Selvær), Børge Moe (Tromsø) and Sveinn Are Hanssen (Svalbard). On the Faroe Islands Jens-Kjeld Jensen collected down (Nólsoy). The people involved in Denmark were Thomas Kjær Christensen (Saltholm) and Peter Lyng (Christiansø). Down was also obtained from different colonies in west Greenland by Flemming Ravn Merkel and from Southampton Island, Nunavut in Canada by Grant Gilchrist. Unfortunately, these samples did not reach the project in time to be analysed for this report. Thanks to all of you who made this project possible.

Special thanks to Erla Friðriksdóttir, Rafn Júlíus (Rabbi) Rafnsson and Friðrik Jónsson at King Eider, Stykkisholmur for cleaning the down for this study and use of cleaning machines and drying cabinets.

Thanks also to Torfinn Torp, Nibio that helped us with the statistical analysis.

Finally, I would like to thanks to my co-authors and colleagues Árni Ásgeirsson and Jón Einar Jónsson at the research centre in Stykkishólmur, University of Iceland for all the support and help with ideas, development and testing experience in relation to this project.

Tjøtta, 22.03.17

Thomas Holm Carlsen

Project leader

Forord

I forbindelse med et studieopphold på Island mellom 2012 til 2015 ble det etablert et forskningsprosjekt med målsetning om å dokumentere egenskaper og geografisk variasjon på ærfugldun fra ulike kolonier på Island, Norge, Svalbard, Færøyene, Danmark, Canada og Grønland. Prosjektet ble finansiert med midler fra Framleiðnisjóður landbúnaðarins (Agricultural Productivity Fund) på Island, Æðarræktarfélags Íslands (ærfugllaget på Island), Universitetet på Island og NIBIO (tidl. Bioforsk Nord)

Det ble samlet inn ærfugldun fra 19 kolonier og gjort tester på ulike parameter som fylleevne (fill power), sammenhengskraft, kompresjonsmotstand og turbidity. Alt i alt er dette den største og mest dyptgående studien av ærfugldun som har blitt utført.

Takk til alle fuglevokterne og dunsamlerne som har samlet inn dunprøver til prosjektet. De involverte fra Island er Erla Friðriksdóttir (Hvallátur), Smári Lúðvíksson (Ríf), Sigurður K. Eiríksson (Norðurkot), Kristjana Bergsdóttir (Melrakkaslétta), Björn Ingi Knútsson (Fáskrúðsfirði), Pétur Guðmundsson (Ófeigsfjörður), Árni Þór Gunnarsson (Vestmannaeyjar), Salvar Baldursson (Vigur), Guðrún Gauksdóttir (Kaldaðarnes) og Stykkishólmur (Hjallsey og Landey). De involverte fra Norge inkl. Svalbard er Svein Morten Eilertsen (Rana), Eivind Hansen (Selvær), Børge Moe (Tromsø) og Sveinn Are Hanssen (Svalbard). På Færøyene har Jens-Kjeld Jensen samlet dun (Nólsoy). De involverte i Danmark er Thomas Kjær Christensen (Saltholm) og Peter Lyngs (Christiansø). Det ble også samlet inn dun på ulike kolonier på vest-Grønland av Flemming Ravn Merkel og fra Southhamton Island, Nunavut i Canada av Grant Gilchrist, men prøvene rakk ikke frem tids nok for å bli analysert ferdig til denne rapporten. Tusen takk til dere alle som gjorde dette prosjektet mulig.

En stor takk til Erla Friðriksdóttir, Rafn Júlíus (Rabbi) Rafnsson og Friðrik Jónsson ved King Eider, Stykkishólmur for rensing av dun og disponering av rensemaskiner og tørkeskap.

Torfinn Torp, NIBIO har hjulpet til med de statistiske analysene.

Til slutt vil jeg rette en stor takk til mine kollegaer Árni Ásgeirsson og Jón Einar Jónsson ved forskningssenteret i Stykkishólmur, Universitetet på Island for all støtte og hjelp med ideer, utvikling og testinger i forbindelse med dette prosjektet.

Tjøtta, 22.03.17

Thomas Holm Carlsen

Prosjektleder

Inngangur

Rannsókn þessi var framkvæmd á Íslandi árin 2012 til 2015 en markmið hennar var að kanna eiginleika og hvort um landfræðilegan mun í æðardún væri að finna. Dúnsýnum var safnað frá æðarvörpum á Íslandi, Noregi, Svalbarða, Færeyjum, Danmörku, Kanada og Grænlandi. Verkefnið hlaut styrk frá Framleiðnisjóð landbúnaðarins á Íslandi, Æðarræktarfélagi Íslands, Háskóla Íslands og Nibio (Norwegian Institute of Bioeconomy).

Æðardúnn frá samtals 19 æðarvörpum var safnað allt í allt og voru eiginleikar dúns líkt og þéttni (fill power) og samloðun, resilience og hreinleika. Það má segja að þessi rannsókn sé ein sú viðamesta sem gerð hefur verið á æðardún.

Þakkir fá æðarbændur víðsvegar að sem aðstoðuðu við söfnun á dúnsýnum í rannsóknina. Samstarfsaðilar frá Íslandi voru: Erla Friðriksdóttir (Hvallátur), Smári Lúðvíksson (Rif), Sigurður K. Eiríksson (Norðurkoti), Kristjana Bergsdóttir (Melrakkaslétta), Björn Ingi Knútsson (Fáskrúðsfirði), Pétur Guðmundsson (Ófeigsfirði), Árni Þór Gunnarsson (Vestmannaeyjar), Salvar Baldursson (Vigur), Guðrún Gauksdóttir (Kaldaðarnes) og Stykkishólmsbær/Árni Ásgeirsson (Landey og Hjallsey). Samstarfsaðilar frá Noregi og Svalbarða voru: Svein Morten Eilertsen (Rana), Eivind Hansen (Selvær), Børge Moe (Tromsø) and Sveinn Are Hanssen (Svalbard). Í Færeyjum sá Jens-Kjeld Jensen um aðsafna dún á Nólsoy og frá Danmörku fengum við dún frá Christiansø með aðstoð Peter Lyng og frá Saltholm með aðstoð Thomas Kjær Christensen.

Sérstakar þakki frá Erla Friðriksdóttir, Rafn Júlíus Rafnsson og Friðrik Jónsson hjá King Eider Stykkishólmi en þau aðstoðu og lögðu til tækjabúnað til hreinsunar, þvottar og þurrkunar á dúninum.

Einnig fær Torfinn Torp hjá Nibio þakkir fyrir gagnaúrvinnslu.

Síðan en ekki síst vil ég þakka samstarfsmönnum mínum Árna Ásgeirssyni og Jóni Einari Jónssyni hjá Rannsóknasetri Háskóla Íslands á Snæfellsnesi fyrir stuðninginn og aðstoð með hugmyndir og þróun verkefnisins sem og mælingar.

Tjøtta, 22.03.17

Thomas Holm Carlsen

Verkefnisstjóri

Contents

1 Introduction

Down feathers are unique to waterfowl (geese, ducks and swans) (Todd 1996; D'Alba *et al.* in pres.), and are only developed in species in which the female incubates their eggs alone (Kear 2005b). Ducks and geese were domesticated more than 4000 years ago (RSPCA Research Animals Department 2011). The Greylag Goose (*Anser anser*) and Swan Goose (*Anser cygnoides*) are thought to be the first goose species to be domesticated and provided humans with meat, down, feathers, and quills for use in arrows and pens (Kear 2005a). These two species are the wild ancestors of most domestic geese (Todd 1996; Guy & Buckland 2002), which are found worldwide from the Northern Trophic to the Arctic areas (up to 73°N in Northern Norway). The Mallard (*Anas platyrhynchos*) and Muscovy (*Cairina moschata*) were almost certainly the first ducks to be domesticated (Kear 2005a). The Mallard is ancestor to many of the farmyard breeds in Europe and Asia and is the world's most common duck (Young 2005; Kleyheeg *et al.* 2017). The Muscovy duck is farmed in warmer climes (RSPCA Research Animals Department 2011), such as in South America (Kear 2005a).

Down feathers (herafter down), in a business point of view, largely are a by-product of meat industry. As dictated by our diet, geese and ducks are the major sources of down, not swans. Down has excellent properties to help keep a clutch of eggs warm and, according to some academics, moist (Kear 2005a). The vast majority (90 %) of industrial duck down comes from China, the remainder mostly comes from Europe. Goose down is more mixed: 49 % of goose down comes from China but Hungary (24 %), the Ukraine (9 %) and other Eastern European countries are major suppliers (Fuller 2015). Because down is sorted alongside flight feathers, a portion of flight feathers inevitably mixes with the down and as a result '100 % down' is not commercially available: the highest quality down is usually 93:7, down vs. feather (Fuller 2015). However, eider down is a remarkable exception in that it actually exclusively is 100 % down.

Nest down from the Common Eider (*Somateria mollissima*) is collected in the breeding season in a sustainable way, not harming the birds or reducing the breeding success (see e.g. Bédard *et al.* 2008; Kristjánsson & Jónsson 2011). The two methods for collecting eider down are either to take the down from the nest during incubation and replace it with dry hay, or collect the down after the ducklings have left the nest, usually from man-made eider-houses or shelters. In the cleaning process, all other feathers than down feather are separated, resulting in a product of 100% pure down (E. Friðriksdóttir pers. comm.).

The unique and highly exclusive eider down is collected only a few places in the arctic areas of the northern hemisphere (CAFF 1997; Bédard *et al.* 2008; Carlsen 2013). Yearly world production fluctuates between four and five tonnes (Bédard *et al.* 2008). Iceland tops the short list of producers with approximately three tonnes of cleaned eider down per year, in the northeast of Canada the annual amount of eider down reaches one ton. In Norway, including Svalbard, the total amount of down produced annually is estimated to be 50-100 kg (Carlsen 2013; Carlsen & Jóhannesdóttir 2014). Some down is collected from Greenland, Finland and Russia, but quantities are not known.

During the nineteen and twenty century, the amount of eider down collected worldwide was much higher than it is today. In the northern part of Norway, up to one ton of cleaned down was produced in good years during the peak period between 1900 and 1960. Svalbard is not included in this estimate. In 1914 Svalbard shipped of 2 451 kg of raw down to Norway for cleaning (Suul 2012). Reports from Greenland tells us that that the common eider used to be much more common earlier. In the beginning of 1900 around five tonnes (!) of uncleaned down was shipped to Denmark for cleaning annually (F. Merkel pers. comm.). Depending of the raw dawn quality and utilization degree after cleaning, the annually amount of cleaned down from Greenland hundred years ago almost reach the annually worldwide production today. Iceland's annually eider down production has been quite stable since the common eider became preserved in 1849 (Carlsen & Jóhannesdóttir 2014).

Today, the exclusive eider down is exported to different markets depending on where it is produced. Eider down from Iceland is sold to Japan, Germany and some few other countries, whereas eider down from Norway is sold to Norwegians or to tourists who visit the eider farms (Carlsen & Jóhannesdóttir 2014). Down from Canada also is sold to the European market and only a small portion to North America (Bédard *et al.* 2008). For Iceland, the eider down is a significant business annually trading down for over ISK 500.000.000,- (NOK 40.000.000,- or € 3.500.000,-). In 2013 Iceland exported 3,2 tonnes of eider down for ISK 613.000.000,- (Jónsson *et al.* 2015) making a prize per kilo of almost ISK 200.000,- (€ 1.400,- /kg). The prize of the Norwegian hand cleaned eider down even exceeds the Icelandic eider down reaching up to € 5.500,- per kilo.

What makes eider down unique and how is it possible that some people are willing to pay up to € 5.500,- for a duvet that contains one kilo of pure eider down? Exclusiveness is an important factor, especially regarding the Norwegian 100 % hand-cleaned eider down that takes many hours to make and is extremely difficult to get because of low quantity produced. The fact that an eider down duvet will last for several generations, if treated correctly, is also something to have in mind buying a new duvet. Despite the long history of trading eider down and the business impact, almost no research has been done to explain properties of eider down quality. This report tries to answer some question about unique properties, down qualities and geographical variations of eider down, and simultaneously it contributes with new research to the eider down business. First, we will define some properties that characterize eider down. Most important are fill power and cohesion.

Fill power is defined as "the volumetric measurement of a specific amount of down and feathers subject to a standard compression weight" (IDFL 2010). Fill power is more or less correlated to insulation (thermal resistance, m^2K/W) and therefore fill power is related to the ability to stand a cold environment. There are different international standards for testing fill power (IDFL 2011), but each relies on the same fundamental hethodology, whereby a down sample is conditioned, weighed, and put in a large cylinder. It is then aerated and a plunger or a disc applied until it rests on the down. The weight of the down under the plunger or disc is then measured and the volume of down occupied is calculated and divided by the sample mass to produce the value of fill power (Fuller 2015). The higher the fill power the more air an ounce of the down can trap, and thus the more insulating ability an ounce of the down will have. Fill power ranges from about 300 CUIN (in^3/oz) for feathers to around 900 CUIN for the highest quality goose down. Higher fill powers are associated with a larger percentage of down clusters and a larger average down cluster size. Standardized and conditioned fill power tests of eider down is rare. IDFL has nine measurements the last few years, mainly samples from Iceland, that shows the main value of 700 CUIN (n = 9), ranging from 530 to 820 CUIN (I. Sanabria, IDFL, pers. comm.). This gives us a good indication that the best eider down samples almost reach the highest quality goose down.

Eider down has one down property not found for any other birds: cohesion, or at least strong cohesion. In addition to a high level of insulation potential, the unique cohesion holds the down together, preventing it to blow away from strong winds. It is likely to believe that cohesion has been a strong evolutionary impact factor to increase the breeding success in the harsh, windy arctic north. The reason for the strong cohesion in eider down has been a puzzle for a long time. It is easy to think that eider down has some kind of hooks that down from goose does not have. However, studying different down samples in microscope (shown in figure 1), it is very hard to distinguish eider down from goosedown. There are no hooks, at least not "hooks" that looks like hooks. Recently, D'Alba and her team figured out some significant differences in microstructure between down from Eiders and Greylag Goose, which changes our view of how a hook looks like in an eider down feather (D'Alba *et al.* in pres.)

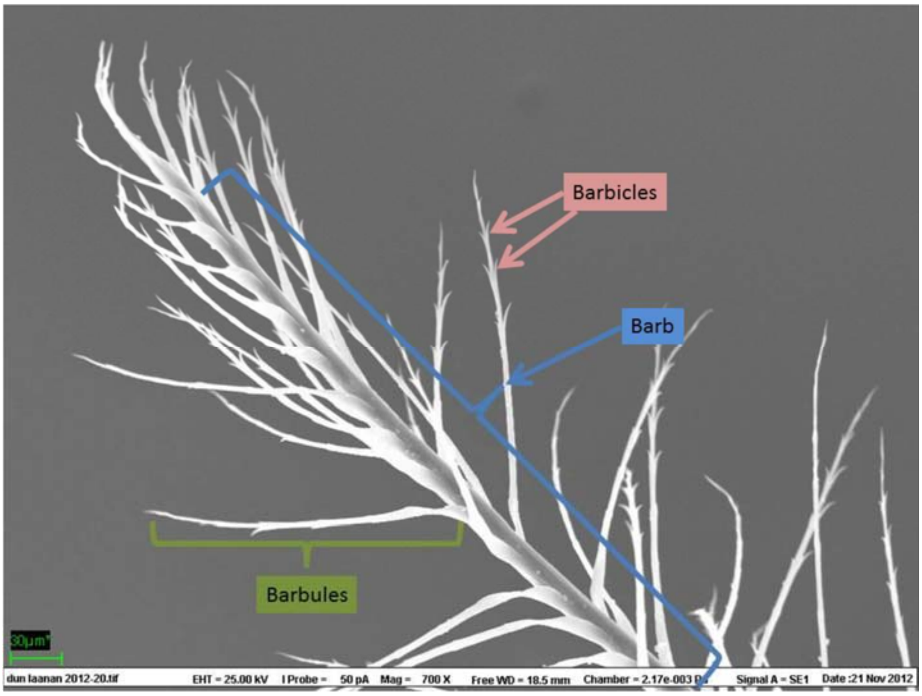

Figure 1. Picture of the smallest parts of the eider down feather (700x) including the barb (blue), barbules (green) and barbicles (red). Graphic: T. H. Carlsen.

In 2013, Carlsen demonstrated an interesting relationship between fill power and cohesion in eider down (Carlsen 2013). A trade-off between fill power and cohesion was found when different samples of eider down were tested and measured. The results showed that the samples were categorized in two groups: one group of down samples had low fill power and high cohesion, whereas the other group of samples had high fill power and low cohesion. Why was that? This difference could largely be explained by the cleaning method. Hand-cleaning – the traditional method used in Norway – gave eider down lower fill power and higher cohesion compared to machine-cleaning – the commercial method used in Iceland (Jónsson 2001) and Canada (Bédard *et al.* 2008).

Thus, the next question was: Is variation in cohesion levels related exclusively to cleaning methods or is there significant variation in cohesion and fill power as well in nature – between individuals or between colonies?

What if we cleaned down samples from different colonies in exactly the same way, would down properties differ among colonies? Would we find the same trade-off in fill power vs. cohesion that we found studying different cleaning methods? Alternatively, could it be that down found in more harsh condition (i.e. related to latitude) express higher values for both fill power and cohesion?

2 Methods

2.1 Down-collecting

In May 2014, eider farmers in pre-selected eider colonies around Iceland were contacted with a request of loaning eider down from 10 nests per colony. Eider down samples were obtained from colonies in Norway, Svalbard, the Faroe Islands, Denmark, Greenland and from Canada as well. All down from each nest were collected and replaced with dry hay or old, discarded down. Down from each nest were packed in separate bags and labelled with the date and type of nesting habitat. Habitat types were grouped into grassland, heather, scrub, seaweed, rocks or sand. In addition, it was noted if eiders were breeding into small houses (typical for farming in Norway) or man-made shelters in any form. The down was dried before it was sent to us at the Research Centre at Snæfellsnes, Iceland.

When we had received all the down samples, we decided that down from the single nests had to be mixed colony wise. It would be way too time-consuming to clean all single nests. To be sure not to totally eliminate a potential significant factor - the individual level - all single nests for two colonies in Iceland were cleaned and tested separately. The uncleaned down from each colony were weighed after mixing (±0,5 g).

After mixing the down within the colonies, it was evaluated by three experienced down testers or certified assessor of down quality, and two neutral, unexperienced persons. These persons gave the different down samples a score of the raw down quality. This is a subjective score based on the amount of dirt, mould, sand, trash, smell or other things unwanted in eider down. A high amount of dry hay will not necessary affect the score value. However, if the hay is or has been wet resulting in a molding process and is smelly, the score value would be much lower. The value for scoring the raw down was set from zero (very bad) to 10 (excellent). In addition to the raw down score, other contents like grass, mosses, ling, seaweed, eggshell, sand and other particles like plastic and trash were quantified (1-3).

2.2 Cleaning of eider down

After evaluating and scoring of the uncleaned eider down, the down cleaning manufacturer King Eider Co. Ltd. in Stykkishólmur, Iceland cleaned all samples. First, all down samples were dried and heat-sterilized in a special made oven at 110°C for 16 hours (figure 2). When the samples had cooled down they were cleaned using a unique cleaning machine that separate down and feather from everything else found in the raw down (grass, ling, sand etc.). The machine was programmed to different cleaning procedures. We used a combination of 36 second/45 Hz + 36 second/52 Hz (program 1) and 36 second/52 Hz (program 4). This cleaning procedure was identical for all samples. The final step of removing the feathers was done by hand. The cleaning process was done when the samples contained nothing else perceptible that down (figure 3). All samples were weighed (±0.01 g) by the model Scaltec SAC 51 (200g x 0.01g) in the same acclimated condition (22.0±0.5°C, 28±1% humidity).

Figure 2. Special made oven designed to dry and sterilize eider down before cleaning. Photo: T. H. Carlsen.

Figure 3. Eider down before cleaning containing seaweed, hay, eggshell and feathers (left) and machine cleaned eider down (right). Photo: T. H. Carlsen

2.3 Subjective score of down properties

Ahead of the scientific measurements of the eider down properties, we arranged a blind-test of the cleaned down from the different colonies performed by five experts on down quality to give the different down samples a subjective score based on parameters like cohesion, resilience and purity. The score value range from 1-10, 1 is worst and 10 is best.

2.4 Fill power measurement

Fill power is expressed as cubic inches per ounce, CUIN (in^3/oz.). One ounce is 28.35 gram. To perform fill power measurements of the eider down samples we had to make a device suitable for the purpose. A fill power-measuring device described by Japan Down Products Corporative Association (1986) was made by the company Skipavík, Stykkishólmur (figure 4). The device consists of a base with adjustable legs and a levelling instrument. A Plexiglas cylinder with graduations (in mm.) is attached upon the base. A weighting disk with three indexes is attached to a guide string and a spool on the top weighing device (shown in figure 4). The diameter of the Plexiglas cylinder is 29.0 cm and the length is 50.0 cm. The weighting disk was an aluminium plate with 28.5±0.1 cm diameter and weight of 128.35 g.

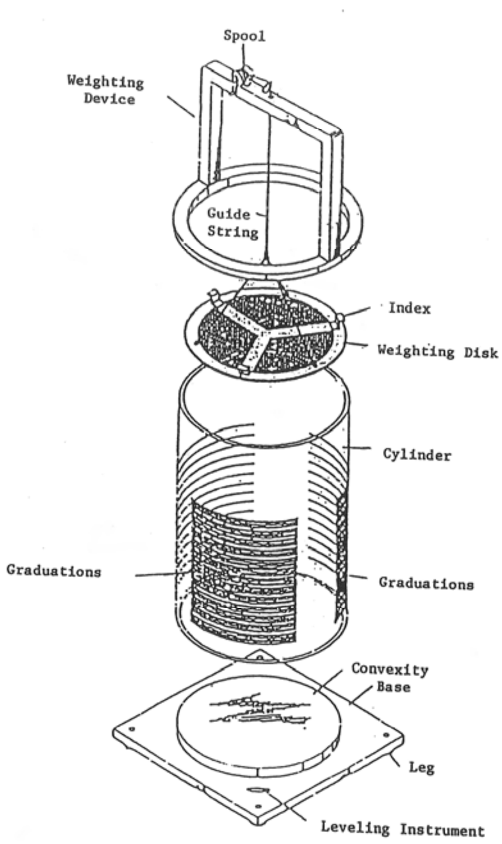

Figure 4. The fill power measuring device (from Japan Down Products Corporative 1986) to the left. The replicate made by Skipavík, Stykkishólmur used in this project to the right (photo: Á. Ásgeirsson).

Before measuring the fill power of the down from the different colonies, the down was acclimatized in the fill power testing room for 12 hours at 22.0±0.5°C, 28±1% humidity. We weighed up exactly 1 oz. (28,35 g) of eider down and spread the 1 oz. down samples to the bottom of the fill power measuring device. We then lowered the weighting disk using the spool until it reached the down sample until the weight of the weighing disk was supported by the compression resilience of the down. Then we waited one minute (60 seconds) before reading the graduations on the cylinder shown by the three indexes attached on the weighting disk. The fill power value from one test is the mean value of the three graduations from the three weighting disk indexes. Depending on the amount of cleaned down, we measured two to five (n=2-5) samples (1 oz) from each colony.

To convert the measuring unit from the graduations (cm) on the cylinder to CUIN we used the equation: CUIN (in^3/oz.) = (x/2,54) * 102,38, where x is cm measured.

2.5 Resilience measurement

In addition to fill power measurement described in the chapter above, we also measured fill power after a complete "compress-and-release" of the down. This gives us a clue how strong the resilience or the resistance to compression is for the different down samples. After the ordinary fill power test, we compressed the 1 oz. sample completely for 10 seconds. This was done by pushing the weighting disk that lays on top of the down sample all the way down to the bottom of the filling power measuring device. When we released the pressure, we waited for one minute (60 sec.) before reading the graduations on the cylinder shown by the three indexes attached on the weighting disk. The recompressed fill power value from one test in the same way described in the chapter above (2.4).

2.6 Cohesion measurement

We measured cohesion in eider down using a precision spring scale from Pesola AG, Switzerland (100 g or 500 g) attached to the down samples by a clip (8 g). The spring scale was tared (adjusted), a 10.0±0.2 g down sample was attached to the spring scale's clip, the down sample was pulled downward away from the spring scale and the maximum force (expressed in grams) was measured the moment just before the down sample was teared apart (figure 5). To convert the force from grams to Newton, we used the equation N = kg m/s^2. Each down sample (10 g) was measured once, but if possible, we measured up to ten 10-g-samples from each colony. Before measuring, the dots were totally compressed and fully recovered (60 sec.) before the test was performed. The same person did all the tests of cohesion (THC). If a dot of down broke apart at the attaching point of the clip, the test was rejected and the down dot was totally compressed and fully recovered (60 sec.) before the test was repeated.

Figure 5. To measure the maximum cohesion of the sticky eider down, the sample was pulled downward away from the spring scale and the maximum force (expressed in g and converted to N) was measured the moment just before the down sample was teared apart. Photo: Liv Jorunn Hind.

2.7 Washing of down and turbidity-test

We washed all down samples after measuring fill power, resilience and cohesion. We used a special made soap for down washing and we were content getting rid of the soap remains by rinsing the down thoroughly. We had to use soap to break the hydrophobic force of eider down to get it soaked in water (figure 6). We dried the down in a couple of days in electric drying cabinets and acclimatized the down at the fill power testing room for 48 hours at 22.0±0.5°C, 28±1% humidity before further testing. We then repeated the testing of fill power, resilience and cohesion in the same way described in chapter 2.4, 2.5 and 2.6.

Figure 6. Washing of eider down was impossible without using a special made soap because of the hydrophobic property of down. Photo: Á. Ásgeirsson.

To estimate how much micro particles in form of dust still remain in the down samples after cleaning (but before washing), we performed a turbidity test. From each colony we soaked 3.00 g (±0.05) of down in 300 ml of distilled water. Then, we added 20 µl of soap specially made for down washing to get water into the down. We put mix of down, water and soap in the Erlenmeyer 500 ml glass flask into an orbital shaker (150 x/min) for 15 minutes. Then we separated the water from the down using a filter (G-1 glass filter). A turbidity meter (JIS K 0102 – 1981) was made from the specification given in Japan Down Products Corporative Association (1986). We poured the dust-polluted water from the down into the turbidity meter with the marking plate in the bottom until it was no longer possible to see the black crosses on the marking plate (figure 7). The score of turbidity ranged from 0 – 100 ml meaning that a sample close to "0" is extremely dirty and almost impossible to look through and in the other hand if you still can see the crosses on the marking plate with up to 100 ml of "down water" the sample is almost completely cleaned with no dust in it. We measured turbidity three times and calculated the mean value based on these measurements for each colony.

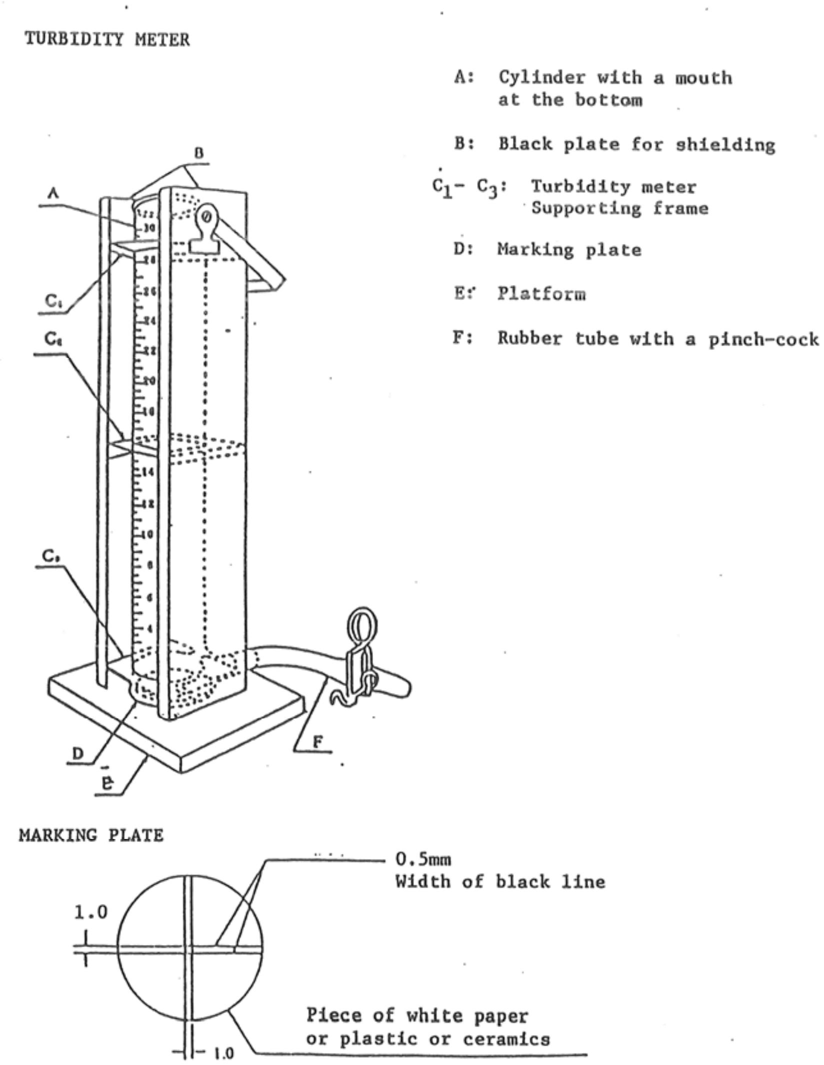

Figure 7. The turbidity meter with specifications given by Japan Down Products Corporative Association (1986).

2.8 Statistical testing

To test for differences among colonies in fill power or cohesion we performed separate one-way analyses of variance (ANOVA). If the ANOVA test shows p-values under $\alpha = 0.05$, a Tukey pairwise comparisons was performed to test which colonies have significantly different mean values for fill power or cohesion.

We used Student's t-test to test differences in mean values for two groups. In cases we treated the down in a special way, like washing, we performed paired t-tests to test for the effect of treatment, i.e. cohesion of eider down before and after washing.

In those cases we wanted to test if values of different variables co-varies linearly, we performed Person's test of correlation.

We used Minitab 17 and Microsoft Excel to perform the analyses and to draw figures.

3 Results

3.1 The eider down samples

In this project, we analysed eider down from 18 different colonies in four different countries. We got down samples from 10 colonies spread around Iceland (Landey, Hjallsey, Hvallátur, Norðurkot, Melrakkaslétta, Fáskrúðsfirði, Strandir, Vestmannaeyjar, Vigur and Kaldaðarnes), down from two colonies in Denmark (Saltholm and Christiansø), from three different colonies in Northern Norway (Rana, Træna and Tromsø), one on Svalbard and down from one colony in the Faroe Islands (Nólsoy) (figure 8). In addition, we also got down from Canada (Southampton Island), Greenland and from a 40-years old eider down duvet from Elliðaey, Iceland. We also analysed a small amount of greylag goose down from Breiðafjörður, West-Iceland. Further in this chapter, we decided to anonymize the sensitive results from the different colonies, giving each colony names as colony 1, colony 2, colony 3 and so on.

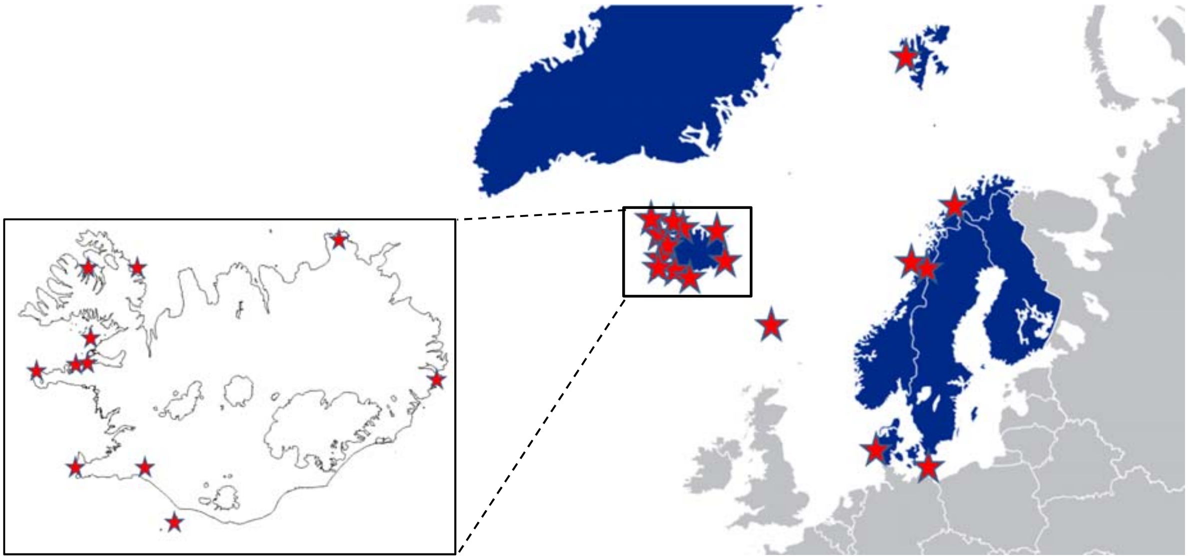

Figure 8. Geographical distribution of the eider colonies involved in this down project.

The amount of raw down we got from the different colonies varied a lot, as well as the utilization degree after cleaning all down samples. The amount of cleaned down ranging from 9.3 grams to 210.0 grams and the utilization degree ranging from 5 % up to almost 40 %, meaning that we did not necessarily got all down we asked for and that some of the raw down included debris i.e. hay, sand and seaweed. Table 1 shows the amount of raw down (before cleaning) compared to the amount of cleaned down for all the colonies.

Table 1. Amount of raw down (in g), clean down (in g) and utilization (in %) from all 18 eider colonies and some greylag goose nests.

Colony #	Raw down (in g)	Cleaned down (in g)	Utilization (in %)
Colony 1	816.0	210.0	25.7
Colony 2	509.0	145.0	28.5
Colony 3	207.0	70.5	34.1
Colony 4	406.5	156.5	38.5
Colony 5	684.0	153.6	22.5
Colony 6	396.0	81.8	20.7
Colony 7	1223.5	196.3	16.0
Colony 8	918.0	131.5	14.3
Colony 9	207.5	80.2	38.7
Colony 10	1249.0	121.0	9.7
Colony 11	996.5	51.8	5.2
Colony 12	561.0	121.0	21.6
Colony 13	206.0	61.0	29.6
Colony 14	77.0	21.6	28.1
Colony 15	501.0	156.0	31.1
Colony 16	81.0	9.3	11.5
Colony 17	755.5	162.5	21.5
Colony 18	489.0	145.9	29.8
Greylag goose	335.0	17.0	5.1
Mean value (±SD) (eider down)	571.3 (±353.5)	115.3 (±55.8)	23.7 (±9.4)

3.2 Subjective score of down properties

Table 2 shows the mean values of the subjective scoring of down from the different colonies (n = 5 for every tests). The score of the raw down ranged highly from very bad (1.0) to very good (8.0). Mean value of raw down quality for all colonies is 5.7±2.2. When we look at the "Score - purity" of the cleaned down the mean value for all colonies is 8.0±0.6. It is obvious that the score to that down after cleaning should be higher than before cleaning, but it is of great interest to see that even the worst raw down samples will be very good after cleaning. Still the correlation between "Score – quality (raw)" and "Score – purity (cleaned)" is statistical significant ($r = 0.612$, $p = 0.012$, $Pearson$) telling us the better the raw down, the better the resulting cleaned down. Another interesting result from this subjective scoring is that it is a clear correlation between scoring of cohesion and scoring of resilience ($r = 0.755$, $p = 0.001$, $Pearson$). This means that if you have a down sample that you feel have a high cohesion, it's also likely to have a strong resilience or the ability to recover after being compressed. Later in this report we tested the correlation between the subjective score of cohesion and the scientific measurement of cohesion to find out if small measured differences in cohesion is possible to feel just using the hands (see chapter 3.5)

Table 2. **Mean values (n=5, all) for the subjective score of pre-cleaned quality, cohesion (cleaned), resilience (cleaned) and purity (cleaned).**

Colony #	Score - quality (raw down)	Score - cohesion (cleaned)	Score - resilience (cleaned)	Score - purity (cleaned)
Colony 1	7.0	8.4	8.3	8.8
Colony 2	7.6	8.7	8.0	8.2
Colony 3	7.4	9.3	8.5	8.2
Colony 4	7.8	9.2	8.7	8.4
Colony 5	6.0	6.7	7.8	7.6
Colony 6	6.4	8.0	7.8	8.2
Colony 7	5.2	7.4	7.6	8.2
Colony 8	3.0	7.6	7.3	7.2
Colony 9	8.0	6.6	7.6	8.2
Colony 10	2.8	7.4	8.2	8.4
Colony 11	1.8	7.5	7.8	7.9
Colony 12	7.4	8.2	7.7	7.9
Colony 13	5.0	7.6	7.8	8.2
Colony 14	5.0	8.8	8.5	8.1
Colony 15	7.4	8.9	8.9	8.0
Colony 16	1.0	7.4	7.3	6.2
Colony 17	7.4	8.4	8.3	8.8
Colony 18	7.2	8.7	8.0	8.2

3.3 Fill power measurement

3.3.1 Variation among colonies in fill power

We measured fill power of eider down in 14 colonies. In addition, we measured fill power for down from a 40 year old duvet ("old"). This down was in bad condition and had almost collapsed. Amount of down from colony 14 and 16 was too small to measure, and in addition, down from colony 17 and 18 was not mixed but nests were measured individually (3.3.2).

The fill power mean value for all colonies except the down from the old duvet was 449.2 (±13.3) CUIN (n=14). In general, the variation among colonies was low, but fill power for colony 10 was significantly higher than all the other colonies and fill power for colony 8 was significantly lower than all the other colonies except of colony 5 ($F\text{-}value = 17.01$, $p < 0.001$, $ANOVA$). Letters (A-E) indicate which colonies had mean values of fill power that differs significantly (unique letters, α = 0.05) from each other (Tukey comparison). Obviously, the fill power from the old, collapsed down ("old") was the lowest, less than half of the mean value (figure 9).

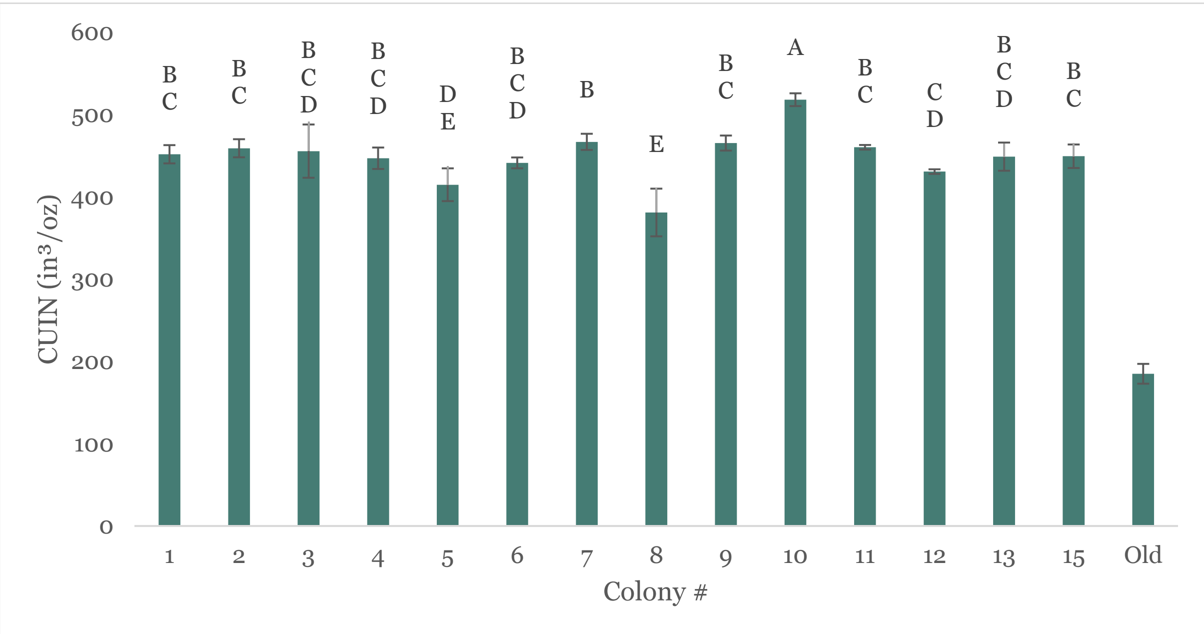

Figure 9. **Fill power values of eider down in different colonies. Means that do not share a letter are significantly different (Tukey comparison).**

3.3.2 Variation among nests in fill power

Despite the small amount of down per nest (between 10-25 g), it was possible to measure fill power at a nest-level and convert the results to CUIN. Figure 10 shows the fill power values from the 10 different nests from both colonies we choose for the individual level. We also included the mean value with SD for both colonies. As shown in figure 10 the fill power among nests varies from 400 to 500 CUIN, one sample even reaches 525 CUIN (18-7). Mean value for colony 17 is 455.0±26.2 CUIN and 467.1±29.5 CUIN which tells us that that fill power was similar between these two colonies (*T = -0.97, p = n.s., t-test*) and that variations among nests is low in both colonies (low SD-value).

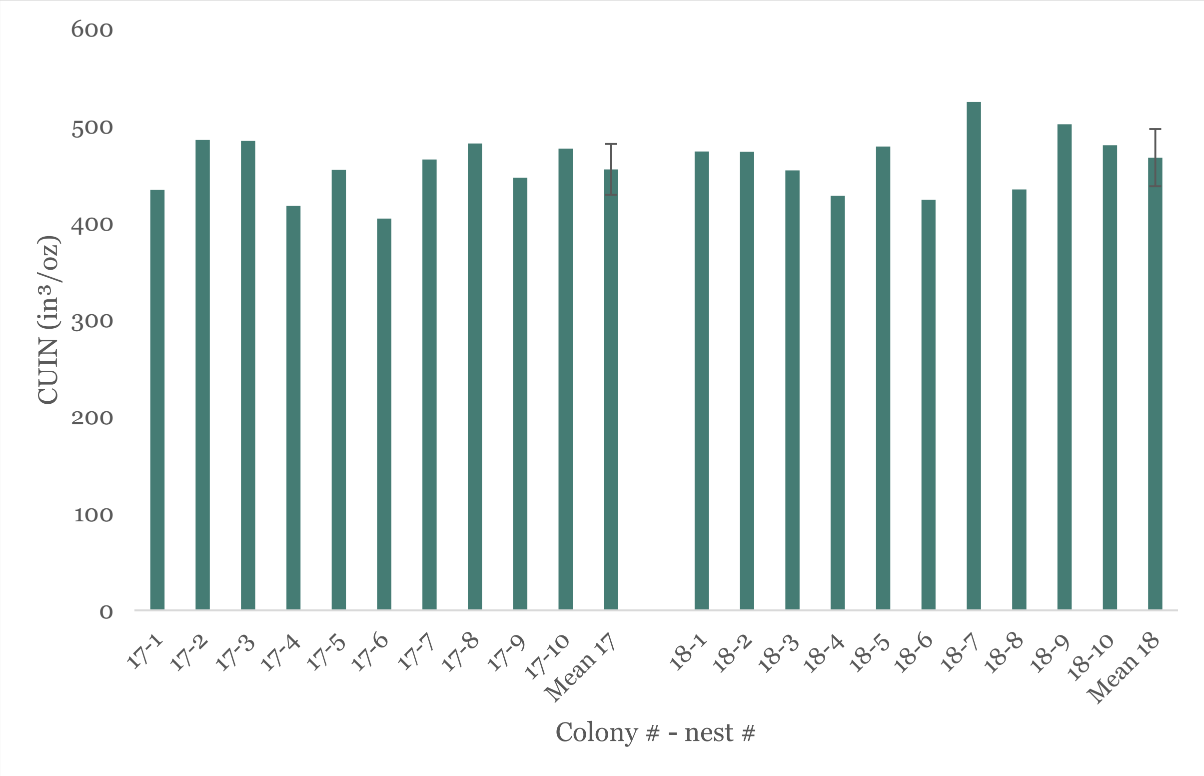

Figure 10. Fill power values from eider down in 20 different nests in two colonies (#17 and # 18).

3.3.3 Geographical effect of fill power

We did not find any relation between fill power measurements and latitude contrary to our prediction (*p = 0.191, p = n.s., Pearson*).

3.4 Resilience measurement

The compressing test gives us an indication to eider down's resilience and shows that the fill power values after compressing are around halved (figure 11). The correlation between CUIN before and after compression is almost perfect ($r = 0.995, p < 0.001, Pearson$) and follows the linear formula y = 0.44x + 33.16 (figure 12).

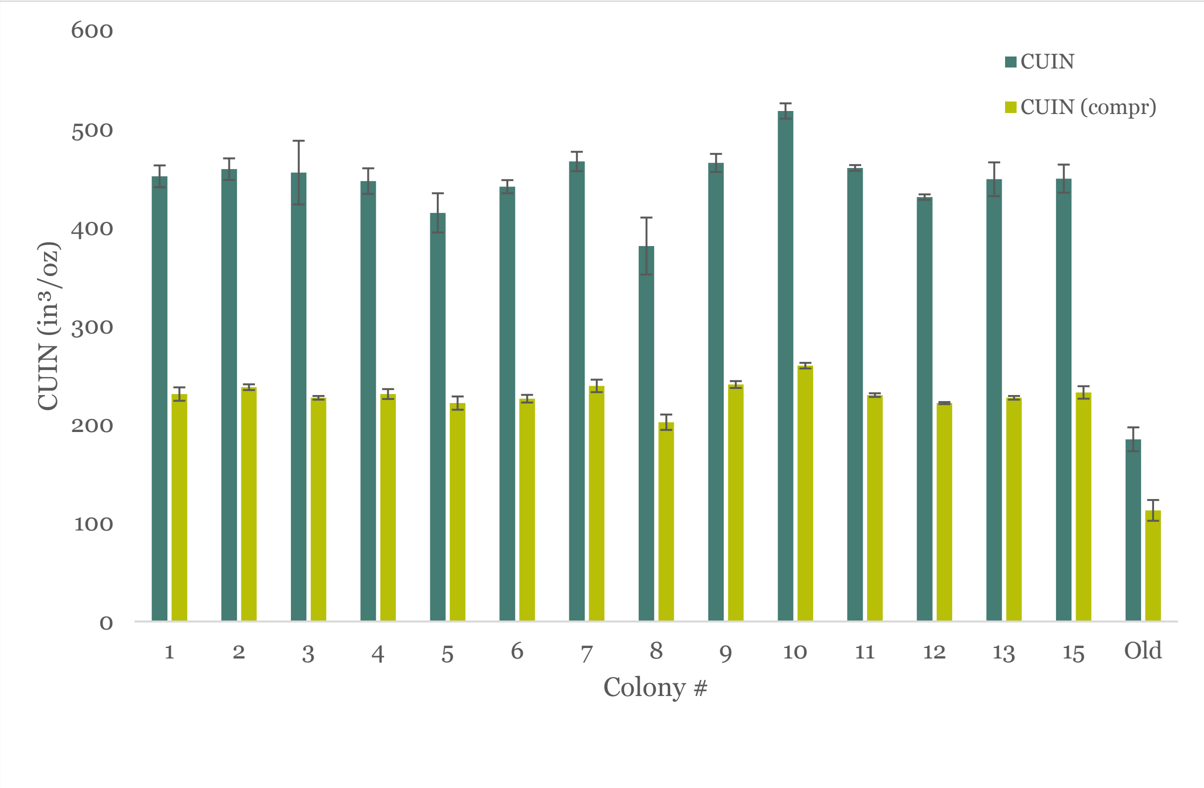

Figure 11. Fill power values of eider down from different colonies before and after compressing. Resilience test.

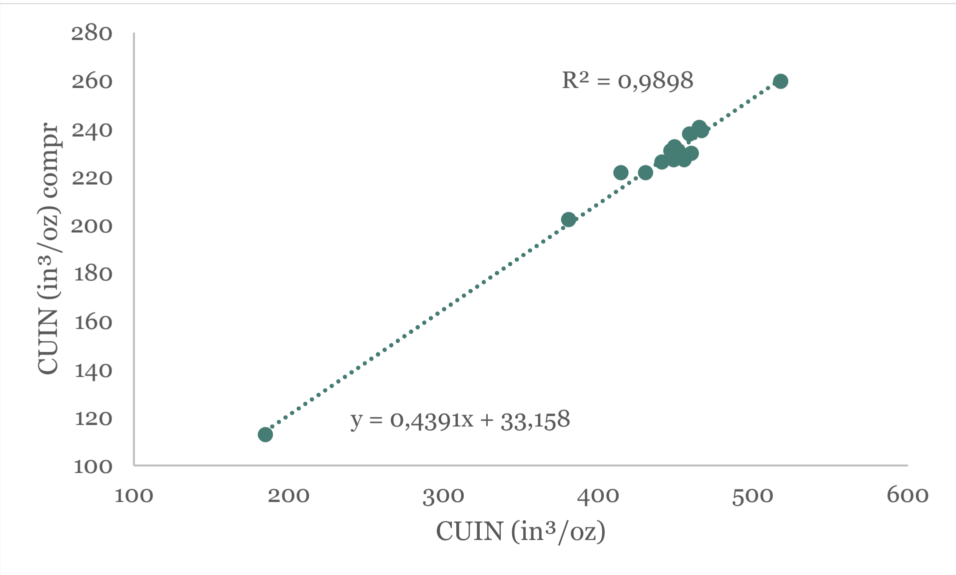

Figure 12. Correlation of fill power before and after compressing fit an almost perfect linear line.

3.5 Cohesion measurement

3.5.1 Variation among colonies in cohesion

The mean values of cohesion for eider down varies significantly among colonies ($F = 9.72, p < 0.001, ANOVA$). The measurements of cohesion varied from 0.54 N (weakest) up to 0.85 N (strongest). Figure 13 shows the mean values of cohesion for the different colonies. For each mean values we added one or more letters (A-E) indicating where the significant differences are. Mean values that do not share a letter are significantly different. Some of the colonies, like # 1, 2, 3, 4 and 15, scores high in cohesion around 0.80-0.85 N and share only letter "A" and "B". On the other side of the scale colony # 7, 9 and 10 scores low with a cohesion mean value under 0.6 N and share only letters "D" and "E" (Tukey comparison test).

In addition to the measurements shown in the figure 13, we also tried to measure cohesion to the old eider down sample from the duvet. This sample actually had no cohesion at all. It was impossible to grab it and it had totally collapsed and acted as commercial goose down which also lack the cohesion property. In contrast, the down from the wild greylag goose actually has a cohesion mean value of 0.30±0.07 N (n = 5). This is probably the first time cohesion for goose down has been measured and reported.

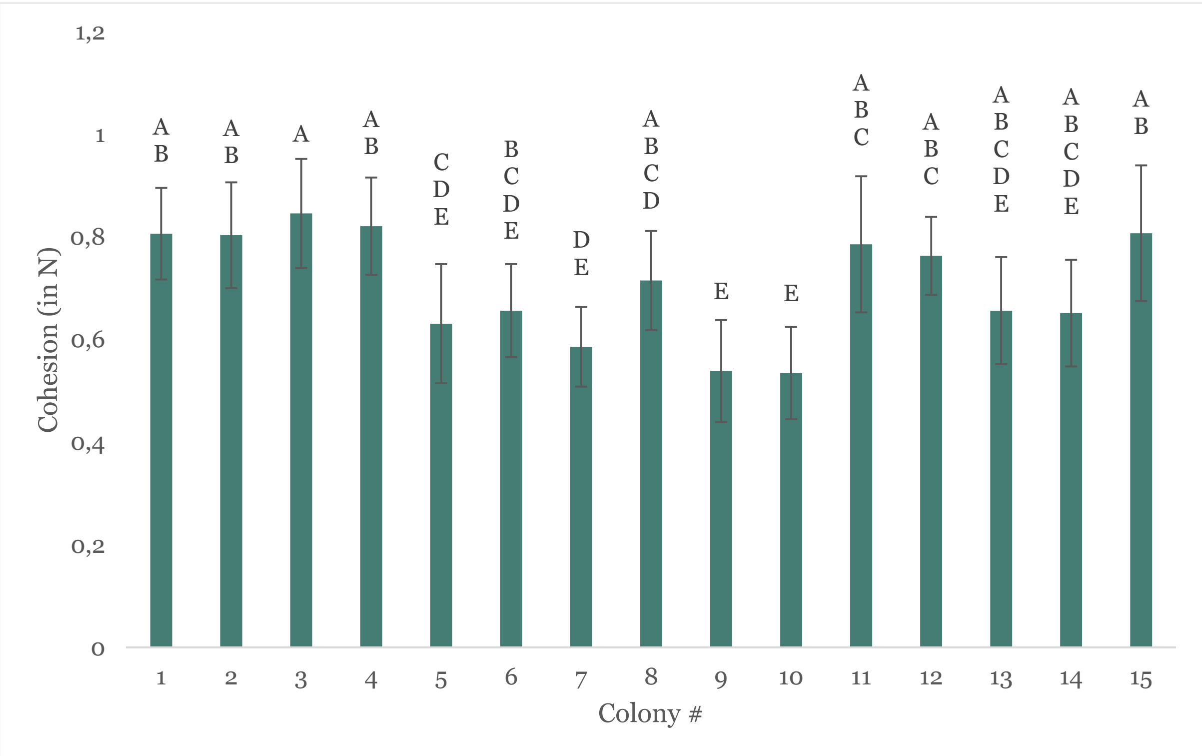

Figure 13. Cohesion mean values (in N) with error bars (±SD) of eider down for different colonies. Means that do not share a letter are significantly different.

3.5.2 Variation among nests in cohesion

In addition to testing cohesion on a colony level, we also measured cohesion on an individual level. As figure 14 indicates cohesion among individuals (nests) varied a lot, and probably even more than among colonies. The difference between the lowest-cohesion nest (#18-8: 0.44 N) to the highest-cohesion nest (#17-8: 1.13 N) is as much as 0.69 N, or almost three times higher. This is easy detectable, from almost completely loose down to very sticky down that you literally can hear when it breaks apart.

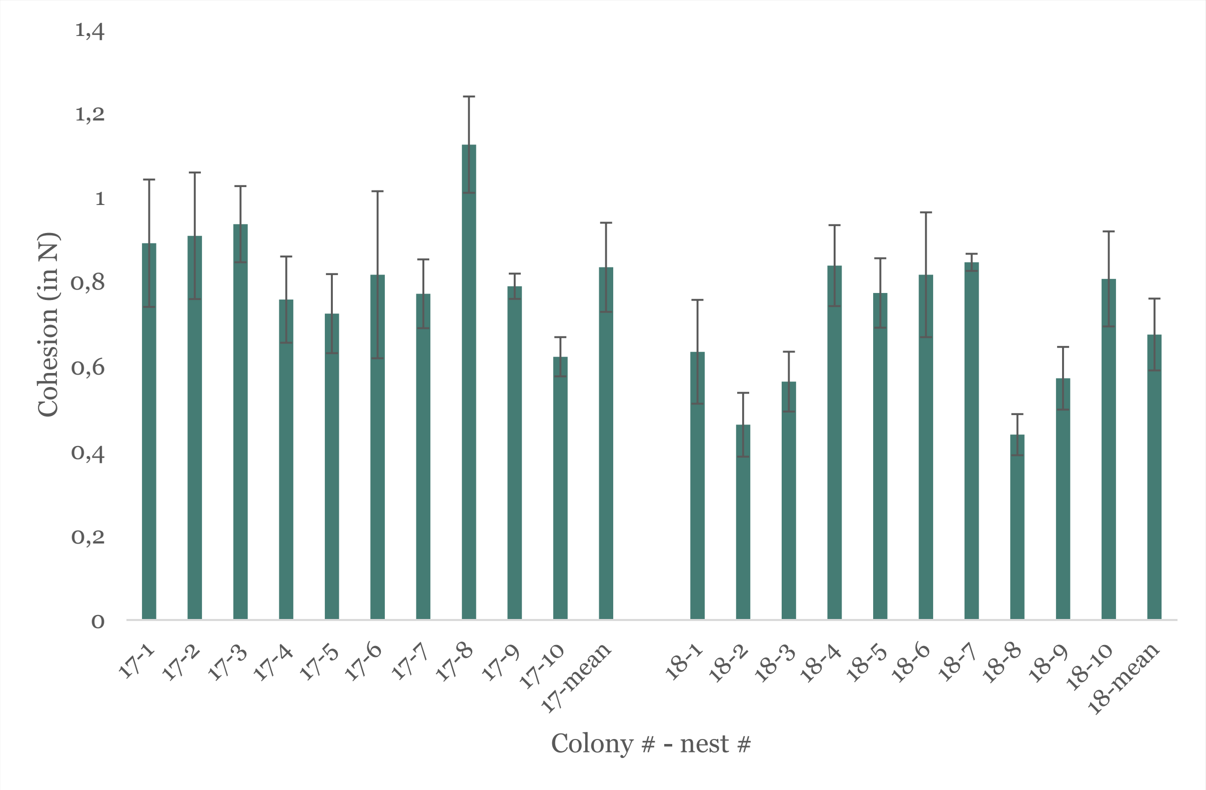

Figure 14. Cohesion values (in N) of eider down for different nests in two colonies.

3.5.3 Measured cohesion vs. scored cohesion

As described in chapter 3.2 experts in down quality scored the down for some parameters like cohesion value before we scientifically measured the down. The result of the subjective scoring of the cleaned down from the experts shows a strong correlation to the measured cohesion ($r = 0.837$, $p < 0.001$, *Pearson*) (figure 15). This shows us that even minor variations in cohesion is possible to detect by hand and is tangible.

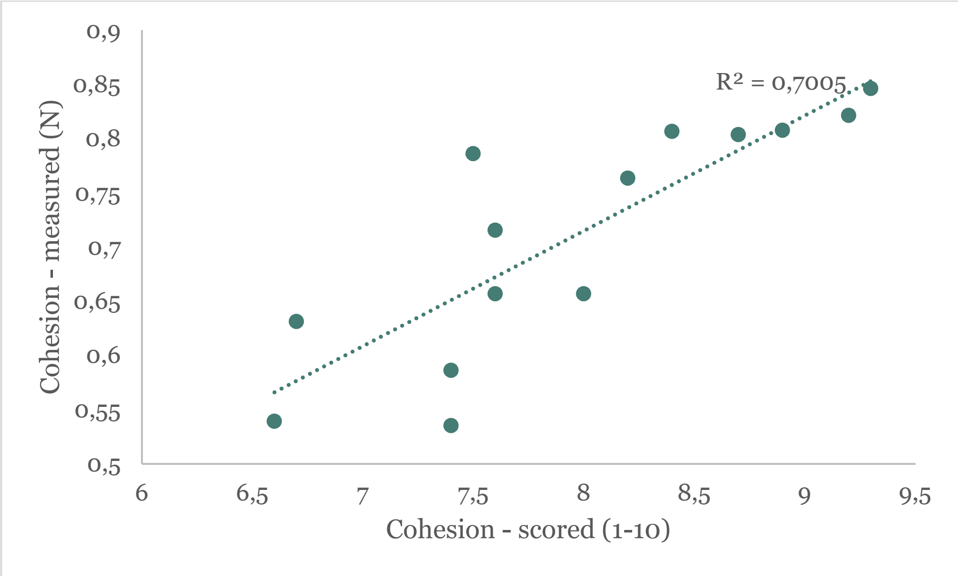

Figure 15. Correlation between "cohesion – measured" and "cohesion – scored" is strong.

3.5.4 Geographical effect of cohesion

Similarly to fill power, we found no relation between cohesion and latitude (*r = 0.152, p = n.s., Pearson*)

3.6 Relationship between fill power and cohesion

We did not find any relationship between fill power and cohesion on a colony level in this study (*r = - 0.273, p = n.s., Pearson*) (figure 16). In addition, we did not find any clear relationship on an individual level, only a tendency within colony 17 (colony 17: *r = - 0.556, p = 0.095*; colony 18: *r = - 0.379, p = 0.281, Pearson*) (figure 17).

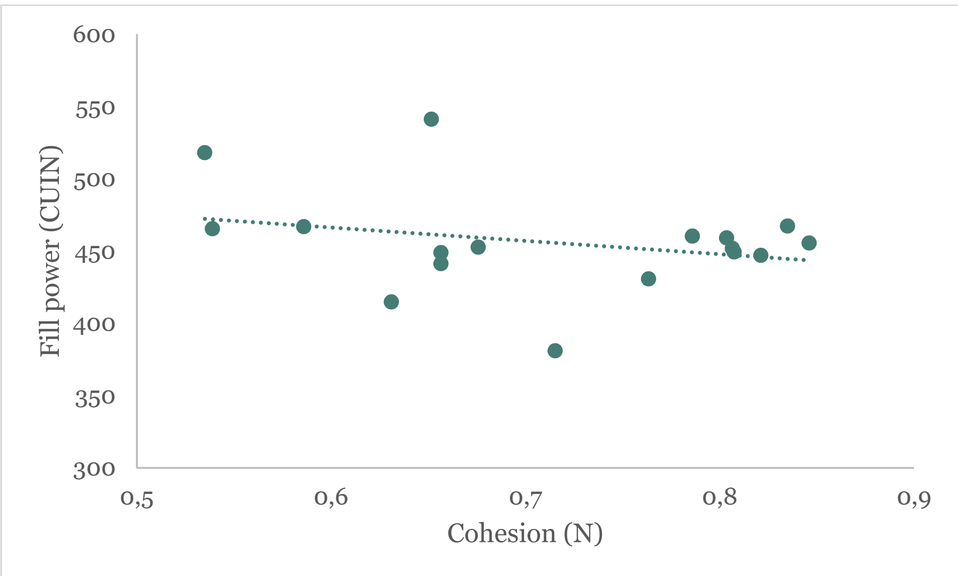

Figure 16. We found no correlation between fill power and cohesion comparing the eider down from all colonies.

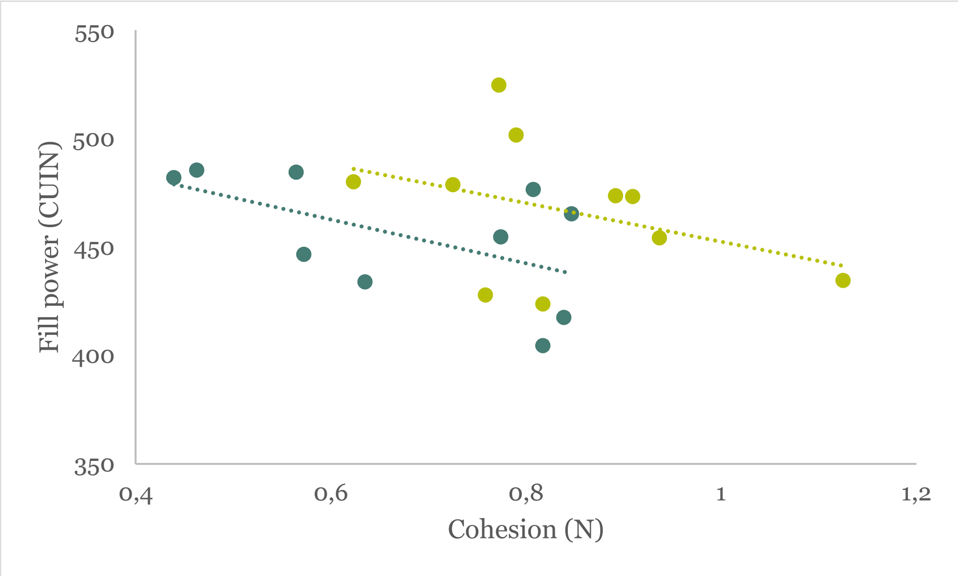

Figure 17. Correlation between fill power and cohesion among individuals in two colonies (dark green = colony 17, light green = colony 18)

3.7 Washing of down

3.7.1 Effect of washing to fill power

Overall, washing of down has a significant reducing effect on the fill power (*T-value = 3.19, p = 0.007, paired t-test*) (figure 18). In general, the mean value of eider down from all colonies except the old sample was reduced from 449.2±13.3 to 422.7±13.3 CUIN. Conversely, the fill power actually increased as an effect of washing of the old, collapsed down.

Figure 18. Fill power measurements before and after washing of the down (mean values±SD).

3.7.2 Effect of washing to cohesion

In contrast to reducing of fill power, the cohesion force increased significantly after washing and it increased for every single colonies ($T\text{-}value = -6.69$, $p < 0.001$, *paired t-test*) (figure 19). The results of the fill power and the cohesion before and after washing give us a clear indication of the negative correlation between fill power and cohesion first described in Carlsen (2013). That means there seems to be a relationship between fill power and cohesion in a way that strong cohesion prevent the down to expand to its maximum potential. In other word, the stronger the cohesion is, the more the down sample holds together and less air is trapped within the down mass.

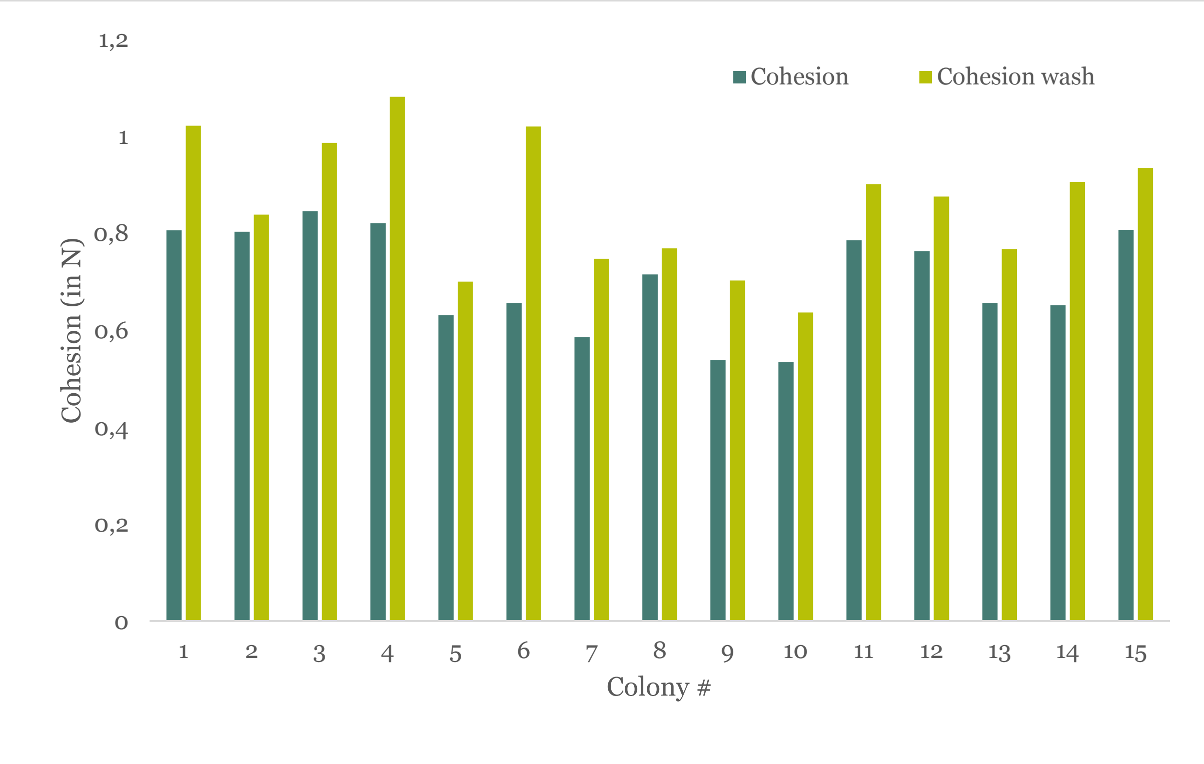

Figure 19. Measurements of cohesion before and after washing of the down.

3.7.3 Turbidity

Figure 20 and 21 shows that turbidity differed widely among colonies and among nests within colonies as well. The down was a little less dusty and the variation among nests is smaller in colony 17 (61.3±1.8) compare to colony 18 (70.4±2.9), but not statistically significant (t-value = -1.42, p = 0.182)

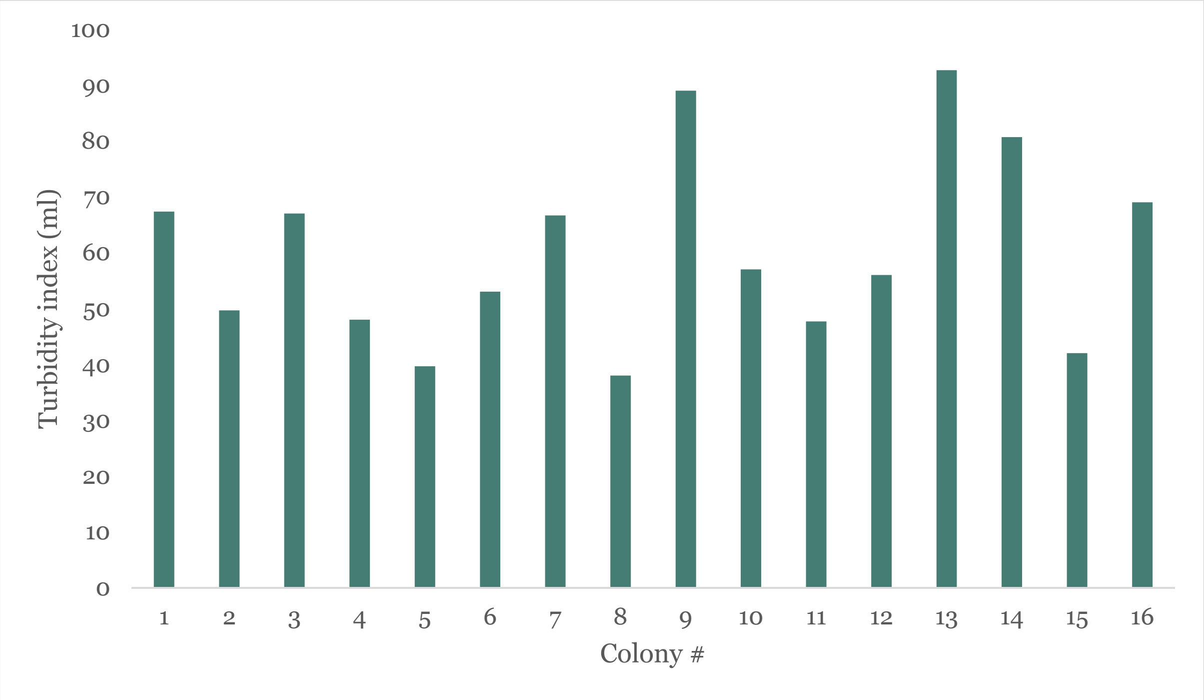

Figure 20. The amount of dust in the down from different colonies varies a lot. The turbidity index tells us how dirty the water from the washing process is for all samples. The less score, the more dust in the samples.

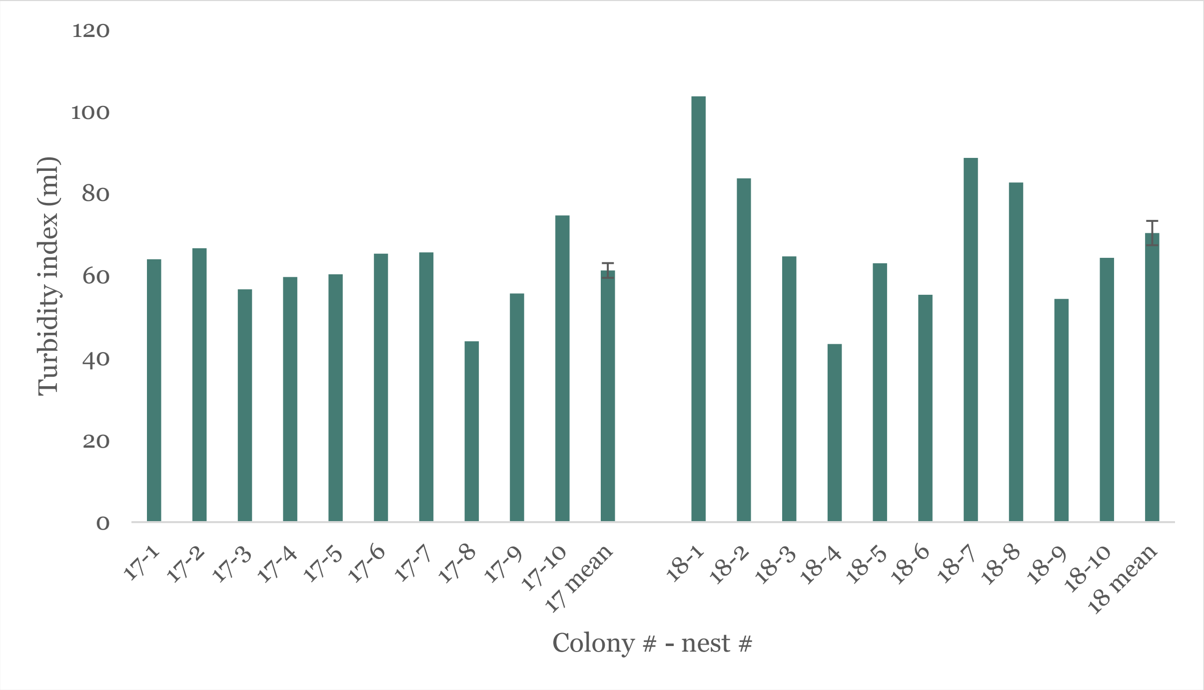

Figure 21. Turbidity index score for individual nests in two colonies of eider ducks. The less score, the more dust in the samples.

3.7.4 How does dust affect the properties of down

As demonstrated in chapters 3.7.1 and 3.7.2, washing has a significant effect on both fill power and cohesion. Especially, the effect on cohesion is convincing, making the force of eider down cohesion much stronger after washing. The fact that washing has a significant positive effect on cohesion points out the question whether there is any relationship between the turbidity test and measurement of cohesion. In other words, is the amount of dust particles in the down correlated to the force of cohesion? In fact, there is a significantly correlation, but it is negatively correlated meaning that more dust particles (lower turbidity), the higher measured cohesion (r = -0.404, p = 0.014, *Pearson*). This is off course surprising and the opposite of what we expected, but could be explained by some outliers (see figure 22).

If the amount of dust in the down (expressed from the result of the turbidity-test) is important for cohesion of the down, we should expect the difference between before and after washing (3.6.1 and 3.6.2) to be correlated to turbidity. In fact, it does not correlate at all (r = 0.057, p = n.s., *Pearson*). This tells us that despite the great variation in differences between cohesion before and after washing, the amount of dust in the samples does not affect this variation.

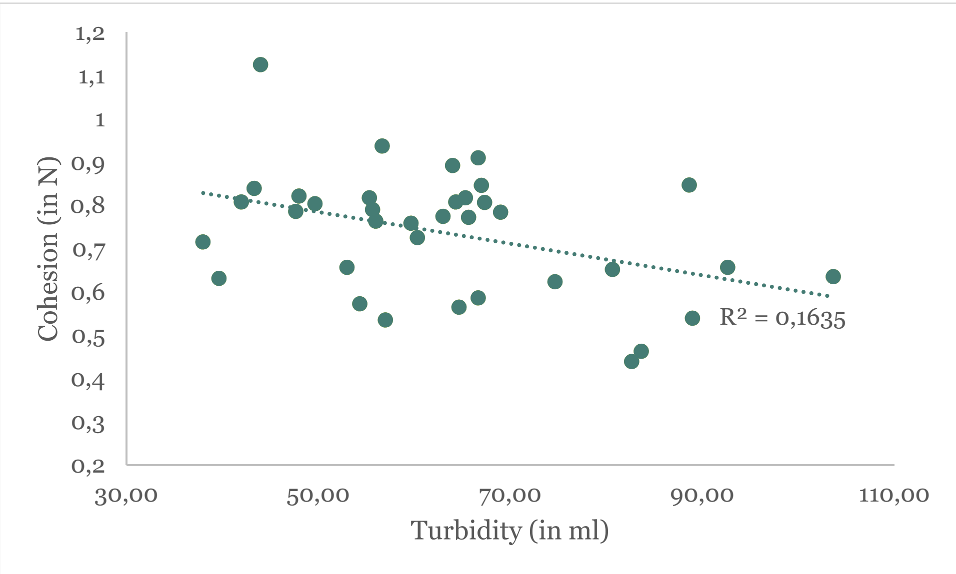

Figure 22. There is a negative correlation between cohesion and turbidity.

4 Discussion

The main goal of this project was to measure the unique properties of eider down and to test if there is any variation in down quality among colonies and among individual eider females. In a pre-study of eider down, Carlsen (2013) demonstrated that the cleaning method had a significant impact on the quality of down in which a hand-cleaned sample of down had superior cohesion over the machine-cleaned eider down. However, the fill power was lower in the hand-cleaned, high-cohesion down sample indicating a trade-off between the two properties. In this project, we controlled for the cleaning process and wanted to document variation in properties of eider down eliminating the impact of down handling.

4.1 Fill power

The result of testing eider down from 18 colonies showed variation both in fill power and in cohesion among colonies and among individuals. In general, the difference in fill power among colonies was minor with an average fill power of 450 CUIN, ranging from 414 to 465 CUIN. One colony scored significantly lower with an average of 380 CUIN (colony 8), and another colony scored significantly higher reaching 518 CUIN (colony 10). A likely explanation why colony 8 scored that low in fill power was the quality of the down when collected in the colony. It was collected late and was very wet when collected, it had begun to mould a little bit, had a low utilisation degree and was the dirtiest down as indicated by the turbidity test. In other words, the bad condition of the down from colony 8 resulted in a low fill power value. Down from colony 10 was significantly higher in fill power than all other colonies. This could be explained by down from this colony also scoring low as raw, uncleaned down and having a very low utilisation degree as for colony 8 but scored average in the turbidity test. The key point here is probably the very low score in cohesion for colony 10. In the case of handling the down, there seems to be a negative correlation or a trade-off between fill power and cohesion (as pointed out in the beginning of the discussion) so the low cohesion measurement can explain the high fill power value for colony 10.

Intra-colony (among nests) variation in fill power was more or less similar to the inter-colony (among colonies) variation with fill power, both ranged from 400 to 500 CUIN. Furthermore, we found some outliers telling us that there is a variation in down quality among individuals as well. It is hard to try to explain why, but there is two options: difference in the nesting ground and other external factors (humidity, degree of moulding, dirt or dust in the down), or individual variation resulting in different fill power values. Bédard pointed out that down quality increases with age of a goose and peaks during the two or three years of its life (Bédard *et al.* 2008). An interesting question for further research is whether there is an age effect on down quality in common eiders as well.

4.2 Cohesion

Cohesion was even more variable than fill power, both among colonies and among nests within the two colonies studied. The most interesting result is shown in figure 14: cohesion values (in N) of eider down for different nests in two colonies. The nest with the highest cohesion down (1.13 N) has almost three times stronger cohesion force than the nest with the lowest cohesion down (0.44 N). Could it be that the unique property of cohesion is an evolutionary driving force for breeding success in the cold, windy and harsh weather condition in the high arctic north? The idea is that maximizing cohesion is more important for the common eider than max fill power (equivalent with degree of insulation). If the down blows away during incubation, it will possibly affect the breeding success negatively (Cole 1979). Cohesion could be the conclusive factor that allows the common eider to breed in open, exposed areas in the artic north.

Another very interesting finding in this study is the measurement of cohesion from colony 10. As pointed out above, down from colony 10 scores the best in fill power, but the lowest in cohesion. We speculate that the explanation could lay within the colony, in the nesting ground or something like it. Actually, colony 10 is the only colony in this study where the down has been collected from nest shelters and small eider houses. This is very interesting and actually quite striking, because this can likely not to be an evolutionary adaption due to the short history of man-eider interaction. Is this an indication that eider down requires some exposure to the elements to fully develop its maximum cohesion? This has already been suggested by Bédard (*et al.* 2008). If this is the case, we should find a positive correlation between the level of cohesion and the degree of exposure to the weather (especially wind and cold). However, we did not find any relationship between cohesion nor fill power and latitude, but we didn't get any good eider down samples from the high arctic areas such as Greenland, Svalbard or from northeast Canada, so it remains an interesting question.

4.3 Conclusions

We found no relationship between fill power and cohesion except of a tendency for a negative correlation on the individual level (nests in colony 17). Despite the control over the cleaning process, the great variation in the raw down quality probably affected the result in fill power and cohesion significantly. Down from some colonies was of low quality when we received it (low score in raw down testing) and had already started moulting a little bit. This down scored low in both fill power and cohesion. The most striking example is the old, collapsed down from a very old duvet. It scored only 185 CUIN in fill power, less than half of the average score, and did not have cohesion at all. High quality raw down collected early in the incubation stage with a high level of utilisation degree usually scored very well in both fill power and cohesion. However, for some outliers like the down from colony 10, the significant higher value of fill power had a consequence of significantly lower cohesion. Is this a consequence of breeding in the small, protected eider houses?

The down handling processes probably best explain a trade-off between fill power and cohesion. We have already pointed out that the cleaning process affects the properties of eider down (Carlsen 2013). Here, we demonstrated that washing of eider down increases the force of cohesion significantly, and reduces the level of fill power. What is best for the eider down business, high cohesion or high fill power? No doubt, the washing of the eider down makes it even more exclusive and more expensive, and there is an increasing demand for washed eider down. However, this study does not answer if washing affects the durability of the eider down. Will washed eider down last longer than unwashed down? What about the hydrophobic characteristic of down? Will that be reduced after washing away some of the fat component naturally covering the down feather?

The mean value of fill power for all samples in this study, except from the old duvet, was around 450 CUIN. This is not a representative value of fill power if comparing to the maximum 900 CUIN, commercial goose down on the market. There are at least two reasons why we cannot compare results from this study to others directly. First, we used a Japanese standardized method for testing down (JIS L 1903-2011, see IDFL 2014) that uses a much heavier disk resulting in a more compressed sample and lower fill power measurements. Secondly, we did not use the standardized conditioning method, but focused to have the same humidity and temperature in the testing room for our testing. Therefore, the results of fill power measuring is consistent for testing samples within this project, but is not directly comparable to other standardized tests. The only measurements of eider down done in a standardized way is some few tested samples done by IDFL. An average fill power value of 700 CUIN, ranging from 530 to 820 CUIN is the result from testing nine samples of eider down, mainly down from Iceland (I. Sanabria, IDFL, pers. comm.). Fuller claims in his PhD-thesis (2015) that 700 CUIN is the upper-limit for duck down and that only goose down of very high quality will exceed this. Four of the nine eider down samples tested by IDFL was 800 CUIN or higher, almost reaching the very best goose down possible to obtain. This tells us something about the extraordinary quality of eider down. Even more impressive is the fact that the unique property of eider down – the cohesion – actually lower the fill power as a consequence of the negative correlation and trade-off between fill power and cohesion. The eider down clumps together, traps less air the higher cohesion force, but still had the highest values for fill power. This is amazing, but a puzzle as well. Could the answer be that eider down always consists of 100 % down and the goose down usually consists of up to 93 % down and 7 % feathers? Alternatively, could it be the fact that eider down feathers are much larger in average than a goose down feather? (Fuller 2015).

For further studies of the quality of eider down, it is important to strive to get the method of fill power testing standardized and conditioned (IDFL 2014). Our focus in this project was to have the same condition for all samples, and we chose an ordinary room condition during mid-winter (22.0±0.5°C, 28±1% humidity). One problem we experienced weighing the down was that some samples of eider down had high levels of static electricity. This force has an unexpected drawback: the high static sample of down attracts the weighting scale (Scaltec SAC 51) actually making the sample up to 10% heavier that it was. The static force had to be removed before weighing of the sample, and was easiest done by compressing the sample or neutralizing the static using a wet cloth touching the sample (without adding any moisture). Maybe it's less static in down had has been conditioned to 65±2% humidity, which is the standard for all fill power test methods (IDFL 2014). Alternatively, we could have been using a spring scale or a balance scale to weigh the down samples.

Another challenge, unique for eider down, was to spread the down evenly to the bottom of the fill power-measuring device (figure 4). The cohesion of the eider down complicated the procedure so we had to be very careful not to make any open airspace in the sample or between the sample and the plexiglas-wall. Any open airspace would affect the result by increased fill power value. However, the weight of the metal disc compresses the down sample and reduces the chance of open airspace significantly.

The tradition of collecting eider down is probably the best example of sustainable harvesting and use of a natural resource, forming a win-win situation for man and nature. It's very important this tradition will survive and it should be possible to increase the production of pure eider down. The world needs this school-example of a true ecological way of product development in a period of history mankind consume more and more of the natural resources without giving enough in return. Production of food and materials has a one-sided focus on efficiency and economic profit and forgets about sustainability. We all have something to learn from the eider farmers in the way they think and handle in a sustainable way, and hopefully the market will grow bigger and ask for more exclusive, expensive and highly sustainable produced eider down. The potential is great for getting more eider down, but it has to be produced in the same traditional and sustainable way as today. From a researchers point of view, the most interesting next step is to go into variation in fill power and cohesion between years for the same individuals. Some eider farmers claim that the down from old females are much looser than down from young females. In contrast, Bédard (*et al.* 2008) pointed that down quality increases in goose with age. Could it be the case with eiders as well? This is something we will go deeper into in the next step of the research of the unique eider down.

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NOTATER

NIBIO
NORSK INSTITUTT FOR BIOØKONOMI

Norsk institutt for bioøkonomi (NIBIO) ble opprettet 1. juli 2015 som en fusjon av Bioforsk, Norsk institutt for landbruksøkonomisk forskning (NILF) og Norsk institutt for skog og landskap.

Bioøkonomi baserer seg på utnyttelse og forvaltning av biologiske ressurser fra jord og hav, fremfor en fossil økonomi som er basert på kull, olje og gass. NIBIO skal være nasjonalt ledende for utvikling av kunnskap om bioøkonomi.

Gjennom forskning og kunnskapsproduksjon skal instituttet bidra til matsikkerhet, bærekraftig ressursforvaltning, innovasjon og verdiskaping innenfor verdikjedene for mat, skog og andre biobaserte næringer. Instituttet skal levere forskning, forvaltningsstøtte og kunnskap til anvendelse i nasjonal beredskap, forvaltning, næringsliv og samfunnet for øvrig.

NIBIO er eid av Landbruks- og matdepartementet som et forvaltningsorgan med særskilte fullmakter og eget styre. Hovedkontoret er på Ås. Instituttet har flere regionale enheter og et avdelingskontor i Oslo.

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