The effect of foraging method on stopover duration in migratory waders

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Abstract

In this literature study I will focus on the effect of foraging method on stopover duration in waders. I compared species based on their foraging method: visually and tactile foragers. Data on stopover length and fuel deposition was compiled for thirteen wader species. Visual surface waders had a shorter stopover time than tactile waders (7.1 days and 13.4 days, respectively). The effect of travel distance before and after a stopover on stopover duration was investigated in more detail in Red Knots (*Calidris canutus rufa*). The longer a Knot flies the longer it will prepare for the flight. Tactile waders had a higher mass-specific fuel deposition than visual waders (2.5%/day and 1.8%/day respectively). When a tactile wader has the same mass as a visual surface wader and also flies the same distance between stopovers, the tactile wader is able to refuel quicker than the visual surface wader. Tactile waders are thus able to refuel quicker but in reality they stay on the stopovers longer then visual surface waders. This is possible if tactile waders have a longer travel time between stopovers as this requires a longer preparation. In conclusion, foraging methods are not the only affecting factor. Also the travel time between stopovers had an effect on stopover length. . The combined effect of fuel deposition and travel time between stopovers seems to determine the stopover duration. More research is required to find out if the travel time of tactile waders is in fact longer. Many different species need to be observed and caught on the same place at the same time to make sure environmental factors are all the same for each species. With such data it is possible to make a good comparison between species based on their foraging method.

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Introduction

Migratory birds often cover distances of several 1,000 km's between wintering and breeding areas. When the chicks are independent, the birds have to cover the whole distance again to return to their wintering areas. There are many different ways in which birds can migrate. There are short and long range migrants and some migrants use "stopovers" to refuel halfway the trip (Nebel et al. 2000, Arizaga et al. 2010, Yosef et al. 2011). To refine this literature study, only migratory waders will be discussed as most of these do use stopovers.

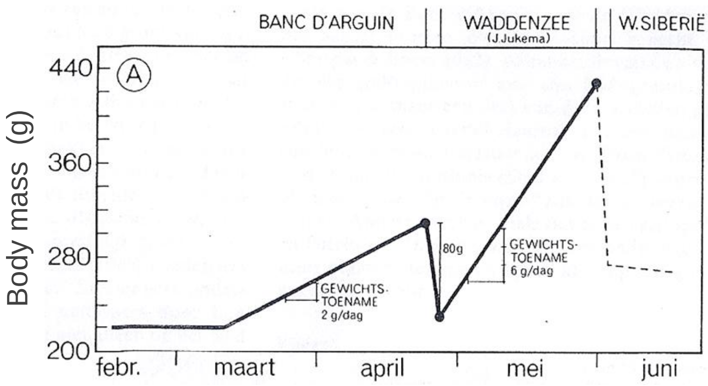

Figure 1: body mass change of Black-tailed Godwits from Banc d'Arguin to W. Siberië (Fig. 3a Piersma 1987)

All these long flights are not without dangers. The long trips cost a massive amount of energy which causes the birds to loose substantial amounts of body mass (Piersma 1987). Figure 1 gives an example of the average body mass fluctuations of Black-tailed Godwits *Limosa lapponica* during northward migration. On the final trip to west Siberia they use up more than one third of their total body mass. In general waders do not cover the distance between breeding and wintering areas in one long flight (but see Gill et al. 2009), but stopover at least once to refuel before continuing their migration. When making stopovers, birds may be relatively unfamiliar with the area, which may result in (initially) inefficient foraging, but may also make them vulnerable to predation (Németh & Moore 2007, Hope et al. 2011). Some species breed in areas which are covered with snow and ice for most of the year. Birds that arrive too early in these areas will find their food still snow-covered which may have a large impact on survival and reproduction (Reneerkens et al. Unpubl. data). Not only snow and ice can restrict food availability. Arriving too late can cause a decline in survival or reproductive success as the females need time to gather resources before they lay their eggs. (Yohannes et al. 2010). To minimize the burden of these problems timing is of big importance.

Most studies focus on individual species (Reneerkens et al. 2009). For example the diet of waders at stopovers (MacDonald et al. 2012) or the migratory routes (Pedro & Ramos 2009). With today's technology recording devices can be made very small which makes it possible to mount them on a bird (Robinson et al. 2009). For example it is possible to equip a bird with a very small transponder which records light intensities. Based on recorded day lengths, the location of the birds can be assessed. Apart from these gadgets more progress has been made because more research has been done in other parts of the world. E.g., the East Asia-Pacific Flyway the most poorly understood flyway of the world, has now become the focus of more studies (e.g. Battley et al. 2005, Gill et al. 2009). These efforts have resulted in a vast increase in detailed information on wader migration, enabling a first comparison of stopover duration between wader species.

Several factors may influence stopover duration. There are so called time minimizers which try to continue their migration as soon as possible by refueling as quick as they can. Energy minimizers however refuel slower but on the whole of their migration they have a low energy turnover (Scheiffarth et al. 2002). Also the distance flown between stopovers may have an impact on stopover duration, as some waders fly long distances before stopping over, refueling thus a limited number of times, while others hop from one stopover to the other and refuel many times before arriving at their destination (Piersma 1987). Diet, food availability and food quality affect stopover duration as well (MacDonald et al. 2012, Myers et al. 1980, Zwarts et al. 1992). When the food is difficult to access or the food is low on energy waders will need a longer time to reach their departure weight. Some prey species are more difficult to access than others. Think of bivalves in the ground. This could cause wader species that feed on prey in the ground to take longer to refuel on stopovers.

In this study I will focus on the effect of foraging methods on stopover duration in waders. The guild system of Ntiamoa-Baidu et al. (1996) will be used to classify wader species in three groups based on their foraging method: visual surface-foragers, tactile surface-foragers and pelagic-foragers. I will compare stopover duration and fuel deposition between the groups in relation to the distance travelled before and after the stopover. Most importantly though, I will look at the interaction of those variables.

Guilds

To answer the question if there are differences in stopover duration between waders it is convenient to divide migratory waders into groups. This can be done in many different ways. For example based on body mass as heavier birds will probably need more energy to fly (Chernetsov 2012), or on migration strategies. Some birds only fly small distances and stop a lot, but others make long flights and only stop once or twice (Piersma 1987). This could mean that birds that fly longer distances will stay longer on a stopover. As stated in the Introduction I will use a grouping system based on foraging methods. Ntiamoa-Baidu et al. (1996) have made such a division and called the groups “guilds”. The original guilds include ducks, herons and terns, but I will only use the guilds which include waders.

The first guild is the “visual surface-foraging waders”. This guild exists of waders that forage by sight, eating insects and mollusks visible on the surface. Visual surface-feeders do not need long legs or long beaks as they usually stay out of the water and only pick up prey available on the surface. These are for example: Grey Plover *Pluvialis squatarola*, Common Sandpiper *Actitis hypoleucos*, Wood Sandpiper *Tringa glareola* and Whimbrel *Limosa phaeopus*.

The second guild is the “tactile surface-foraging waders”. These birds use their usually long beak to probe in the ground searching for mollusks and worms. Examples are: Black-tailed Godwit *Limosa limosa*, Bar-tailed Godwit, Red Knot *Calidris canutus*, Sanderling *Calidris alba* and Dunlin *Calidris alpina*.

The last guild are the “pelagic-foraging waders”. The waders in this guild fish in the water and use both visual as tactile senses to find their prey. They eat small animals that swim in the water. The pelagic-foraging waders need to be in the water to forage which means they benefit greatly from longer legs. Additionally they usually have longer beaks to also be able to reach the bottom of the water to pick up any prey that hides on the bottom. Marsh Sandpiper *Trina stagnatilis*, Greenshank *Tringa nebularia*, Spotted Red-shank *Tringa erythropus*, Black-winged Stilt *Himantopus himantopus* and Avocet *Recurvirostra avosetta* are all examples of pelagic feeders.

Unfortunately there is little information on pelagic waders which makes it difficult to include these in the comparisons. For that reason they are left out of this study.

Stopover duration

Many waders migrate very long distances, up to 30.000 km per year (Koch & Paton 2009). As they usually cannot make that distance in one go, they need to take breaks every now and then. They do this on “stopovers” which are food rich areas where the birds can quickly refuel to continue their journey. The amount of time they spend on these stopovers varies a lot. Many waders have been tracked by color ringing them and observing the birds in the field. This way the date the bird was first seen and the last time it was observed gives an estimate of stopover duration. Recently, detailed information on flight and stopover behavior has become available from geolocators. Geolocators are small devices on the back of a bird which records day length which can tell where the bird is positioned on earth. When used on Red Knot *Calidris canutus rufa*, that migrates from Brazil to the north of Canada and makes multiple stops on the way, they showed that stopover duration can vary from 2 days to over 2 weeks (Niles et al. 2010). Also Turnstones have been equipped with geolocators, showing that they stayed for 3 to 8 days at the stopovers (Minton et al. 2010).

In table 1 an overview of the mean stopover duration is given for 13 different wader species. There are considerable differences in stopover duration. The average length of stay for the tactile waders was 13.4 days while the average length for the visual surface waders was only 7.1 days. The Dunlin as well as the Black-tailed Godwit are tactile waders. They stay at the stopover for 2.5 to 9 days and up to 40 days respectively (Holmgren et al. 1993, Masero et al. 2011). The visual surface waders mostly stayed for only a couple of days. Common Sandpipers stayed for an average of 4 days. (Balmori 2003) Wood Sandpipers stayed a bit longer but usually less than 2 weeks (Strus 2011). The Whimbrel spent around 5 days at the stopover (Watts et al. 2008).

The Black-tailed Godwit seems to have the longest stopover duration (17-40 days) and the Common Sandpiper the shortest (4 days). The Black-tailed Godwit (330g) is a lot bigger than the other tactile waders included in this analysis (average 123.7g) (del Hoyo et al. 1996). As a bigger bird will need to gather more resources to gain the same relative body mass, this could explain why the tactile waders need so much more time on average. However in the group of the visual surface waders the Whimbrel (434g) is also a much larger bird than the other species in its guid (average 164.8g) (del Hoyo et al. 1996). The Whimbrel only needs 5 days to fuel up, which is shorter than most of the smaller waders. Excluding the two bigger species the average stopover durations are respectively 11.8 and 7.6 days for tactile and visual surface waders. So the fact that there are bigger birds in the guilds does not affect the results. This information does however beg the question: Why do the visual surface waders need less time to fuel up?

Table 1 Stopover duration in days and fuel deposition in g/day for 13 different wader species. (body mass from del Hoyo et al. 1996)

Species	Guild	Stopover duration (days)	Average body mass (g)	Fuel deposition (g/day)	Percentage body mass gained (%/day)	Source of fuel deposition and stopover duration.
Western Sandpiper	Tactile	Unk.	30.5	1	3.3	Hope et al. 2011
Dunlin	Tactile	2.5-9	59	1.4	2.4	Holmgren et al. 1993
Sanderling	Tactile	10-12	71.5	Unk.	Unk.	Gudmundsson & Lindstrom 1992
Curlew Sandpiper	Tactile	1-3	80.5	1.7	2.1	Meissner & Górecki 2006
Red Knot (canutus/islandica)	Tactile	18	141.8	2.84	2.0	Nebel et al. 2000
Red Knot (rufa)	Tactile	2-15	152.5	3.5	2.3	Niles et al. 2010, gonzalas 1996
Black-tailed Godwit	Tactile	17-40	330			Masero et al. 2011
Broadbilled Sandpiper	Visual surface	7	48	1.04	2.2	Verkuil et al. 2006
Common Sandpiper	Visual surface	~4	58.5	Unk.	Unk.	Balmori 2003
Wood Sandpiper	Visual surface	<14	66	1.15	1.7	Strus 2011, wlodarczyk et al. 2007
Turnstone	Visual surface	3-8	137	Unk.		Minton et al. 2010
Grey plover	Visual surface	Unk.	245	3.5	1.4	Serra et al. 1999
Whimbrel	Visual surface	~5	434	Unk.	Unk.	Watts et al. 2008

Travel time before or after stopover

Different foraging methods are not the only factor affecting stopover duration. As Piersma (1987) explains in his paper, birds have different ways of getting to their destination. He stated that there are three ways which differ in the distance flown before a bird stops at a stopover site. “Hoppers” travel short distances and stop many times to refuel. “Jumpers” fly long distances and only stop once or twice before they arrive at their destination. Lastly there are the “skippers” which are in between the hoppers and the jumpers (Piersma 1987).

Possibly jumpers will burn more body mass before they arrive at a stopover than hoppers. In that case jumpers may need a longer time to regain body mass and therefore will also stay

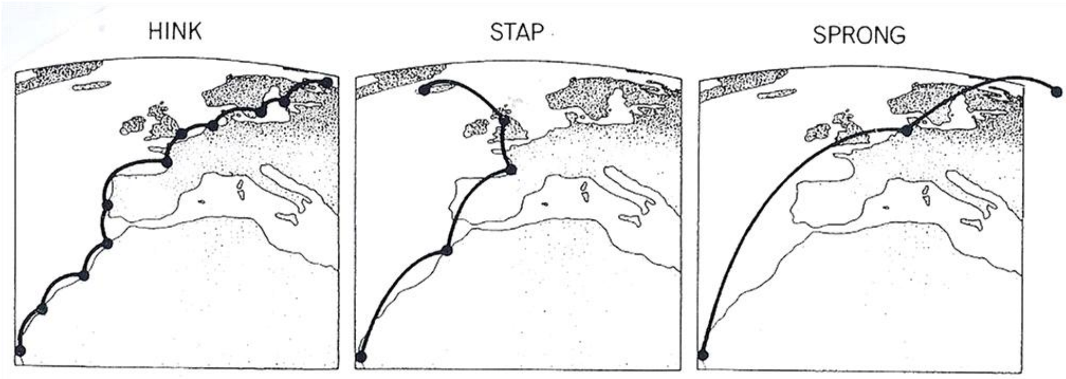

Figure 2: Migratory strategies. Hink = hop, stap = skip, sprong = jump (Piersma 1987)

longer on the stopover. To find out if jumpers, i.e. nonstop long-distance migrants, really do need a longer time to refuel than hoppers, the best option would be to investigate the relationship between flight distance and stopover duration in “hop-species” and “jump-species”. Unfortunately, too little information is available to do this, so I opt for the next best thing, namely detailed information of migration travel distance and stopover within a species that has a large variation in travel distance and stopover duration.

I looked at satellite tracking of Red Knots C. c. rufa that makes several stopovers on their 20,000 km long migration route (Niles et al. 2010) . The distance between those stopovers varied from 1,200 km to 8,000 km. The relationship between travel distances covered by *rufa* Knots in relation to the following stopover duration may be used to say something about the differences in stopover duration that can be expected between “hoppers” and “jumpers”. Figure 3a shows this relationship. In the graph it seems that the longer the flight was before *rufa* knots arrive at a stopover, the shorter they will stay on that stopover. This contradicts the expectations described in the beginning of this chapter. But why is this the case?

To understand this we need to look at other factors that could influence the stopover duration apart from distance traveled by the Knots. Point A and B were made just in front of a major storm. It is possible that the birds knew this storm was in front of them so they decided to wait until the weather got better to continue without the risk of getting caught in the storm. They might not have made this stopover to prepare for the upcoming flight but purely to wait out the storm. This means the length of their stay at these stopovers might have nothing to do with their refueling. Points D and E are stopovers after a significantly longer trip then the rest of the data points. We can see that the Knots seem to be staying only a short while on these places. You would expect them to stay for a long time because they need to regain a lot of weight. When we look at where these stopovers were located however we find that these locations were both nearby either the breeding grounds or the wintering grounds (also the case with point C). So it is possible that the birds knew they only had a little further to go, so they refueled the bit they would need to reach their final destination.

In figure 3a the stopover duration prior to departure was correlated with the distance flown. This will only fit the reality if birds use a strategy in which they fly a distance and then regain their body mass on a stopover until prior take-off mass. In this case they are not specifically preparing for the upcoming trip. If they do know how far they have to fly till the next stopover they would be preparing for the upcoming trip. This means they are expected to stay longer on a stopover when the next trip will have a long distance and shorter on a stopover when they prepare for a short distance.

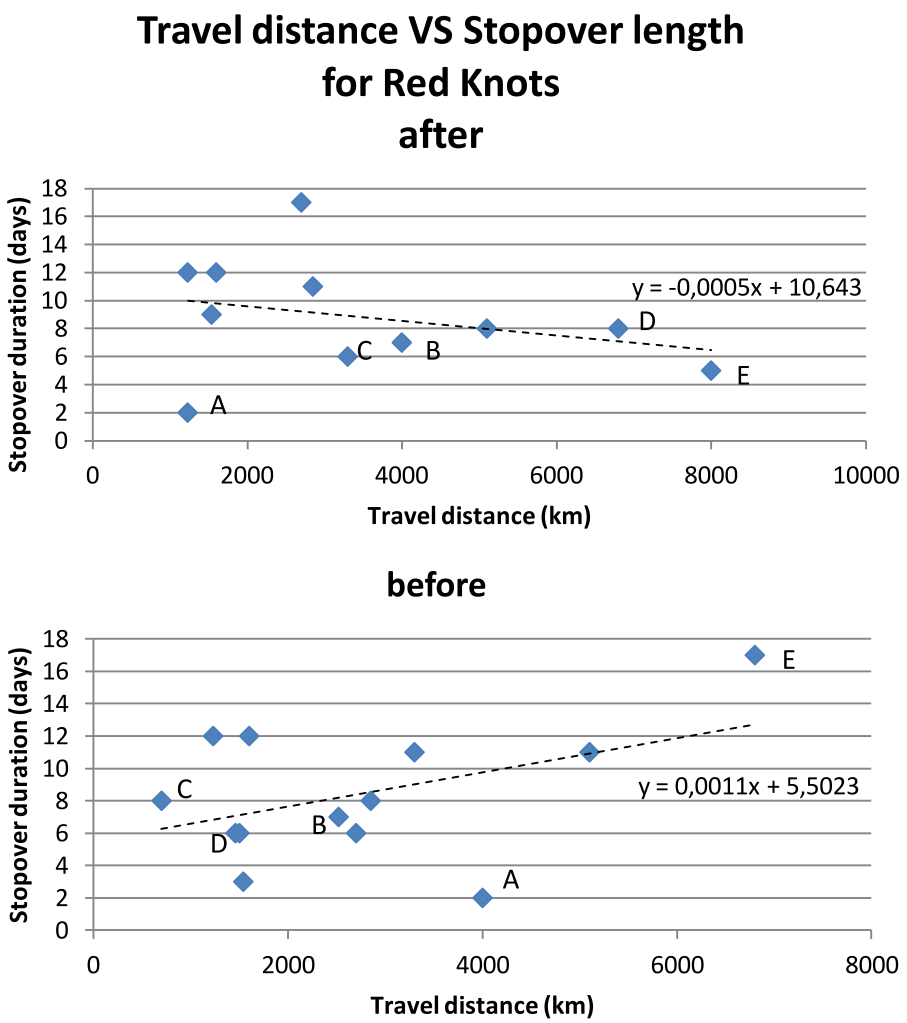

Figure 3: top (a): Travel distance VS Stopover length (stopover after the flight), bottom (b): Travel distance vs Stopover length (stopover before the flight), trend lines are not significant

Graph 3b shows the correlation between stopover duration before the flight and the distance flown thereafter. There does not seem to be a major trend in this and if it can be called a trend it's a positive one. Expectations beforehand pointed towards a positive correlation. Graph 3b resembles this much better than graph 3a as the latter is a negative correlation. This implies that Birds anticipate on the flight to come instead of refuel after a flight. It is possible that both have an influence on the stopover duration but the stopover beforehand is most likely more important. Unfortunately not enough data is available to give a final conclusion on this. For this many more observations need to be done.

Just as in graph 3a, graph 3b contains some questionable data points (A-E) because of the storms and the proximity to the breeding or wintering grounds which were explained already. As the current data is insufficient to give good answers on why there are such differences in stopover duration it is a good idea to look at fuel deposition as well as the stopover duration.

Fuel deposition

Fuel deposition rate is the speed at which a bird can gain body mass at a stopover. A bird of a certain body mass with a high fuel deposition should need less time on a stopover to reach the same departure mass as a bird of the same body mass with a lower fuel deposition. It is not possible however to predict a birds stopover duration from just its fuel deposition. The departure weight is needed for this as well. Departure weight is not always the same on each stopover (Dietz pers. comm.). In table 1 the fuel deposition in grams per day is shown for a variety of species of both the tactile as the visual surface guild. The Red knot and the Grey plover seem to have a much higher fuel deposition with around 3.5 gram per day than the other species which usually have a bit more than 1 gram per day. This does not mean however that these 2 species would need 3 times less time to fuel up to continue their migration.

The Red Knot and the Grey Plover are much larger birds then the other species in table 1. Fuel deposition is given in gram per day. This makes it difficult to compare fuel deposition of different species of waders. To enable this, the fuel deposition first needs to be converted to the mass-specific fuel deposition: the percentage of body mass gained per day (second to last column, Table 1).The Grey Plover, which had the highest gram per day gain, has the lowest mass-specific fuel deposition, while the much smaller Western Sandpiper has the highest mass-specific fuel deposition with 3.3% per day.

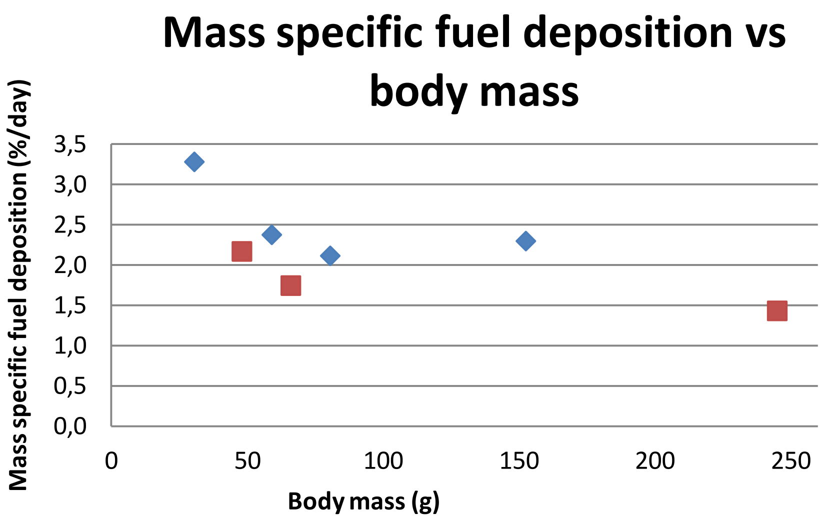

Figure 4: Mass specific fuel deposition (%/day) vs body mass (g), diamonds are tactile waders and squares are visual surface waders

Figure 5 shows the mass-specific fuel deposition of 7 wader species with different body masses. On average the tactile waders have a refueling rate of 2.5% per day and the visual surface waders only 1.8% per day. This would mean tactile waders are able to refuel quicker at stopovers than visual surface waders allowing them to continue their migration earlier. The results from the actual stopover durations contradicts this. An explanation for this will be discussed further on.

Because the stopover duration is known as well as the percentage body mass gained per day, it is possible to calculate the total percentage gained in the time a bird spends on a stopover. The Red Knot seems to refuel the most of the 5 species with 31% of his total body mass. The Curlew Sandpiper on the contrary only gains slightly more than 4% of his body mass. This most probably has to do with the fact that some species make long flights before they stop at a stopover and some take small leaps which means they use less fuel between each stopover, but they stop more often. Looking at the averages of the tactile and visual surface waders they gain 16.3% and 19.8% respectively. However this is difficult to interpret as there can be “hoppers” and “jumpers” in both guilds (Piersma 1987).

Conclusions

Stopover duration

There is a lot of variation in the stopover duration between the guilds. Within guilds there seems to be a variation in stopover duration as well. The visual surface waders need a lot less time (7.1 days) to refuel on average than the tactile waders (13.4 days). But what does this mean? It is possible that visual surface waders are more efficient when it comes to refueling at a stopover. This might have something to do with food availability. Visual surface waders eat insects and mollusks. Tactile waders eat worms and bivalves under the ground (Ntiamoa-Baidu 1996). It's possible that probing around for prey under the ground is less efficient than visually finding your prey.

Another possibility is that the prey of the visual surface wader contains more energy, which would mean they need to find less prey to gain the same amount of energy then the tactile waders do. Because they need to spend less time searching for food they will need less time on a stopover. Both possibilities would result in a higher fuel deposition so it is not possible to say if either of these options is correct with the current dataset.

When we looked at the travel time before and after stopovers of Red Knots we found that at some stopovers the birds stopped for only a couple of days and on other stops they could stay for almost two weeks. This would mean that one bird can already have different stopover durations in one migration trip.

Travel time before or after stopover

When we looked at the distance traveled before the Red Knots reached their stopovers we found that the longer a Knot flew before a stopover the shorter he would stay at that particular stopover. As explained above, not all data was usable. Storms could have made a bird hold on a stopover for a while when that same bird might have just skipped that stopover completely if that storm wouldn't have been there. Also the fact that some of the measurements were done near the winter or breeding grounds could have messed up the results. If a bird is near its destination it could decide to depart before it completely refueled or the other way around it could decide to just stay there for a while as he is almost there already anyway. When a Knot is on a stopover near the wintering area where there is sufficient food available and the weather is favorable, why would this Knot continue to the wintering area. He will not know how the weather and food supply will be. This results in a longer stopover duration.

The result of longer flights mean shorter stopover duration is interesting though. why would a Knot decide to stay shorter on a stopover when he just flew a long distance. And why would it stop for longer if it only flew a short while. Maybe because they flew so far already that they have no other choice then to stop at the first stopover available. They could be doing this on a stopover which isn't as good as other stopovers but they have no choice as they are just out of energy. Because that stopover isn't very good they decide to continue quickly after they regained the essential amount of energy to find a better stopover area. This theory would also explain why the birds stay longer after shorter flights. When they continue quickly after a less food rich stopover to find a better one they won't go as far but when they find a good stopover they will stay for a long time to gain the energy they used on that short trip from the last stopover but also to regain the energy they lost and had not regained yet from the long trip they did before.

A more logical explanation would be that we looked at the wrong stopover. Until now we looked at the stopover after a flight. This only works if the Knots plan their stopover to regain energy after a flight. It's possible that they don't do this but instead prepare for their next trip while they are on a stopover. When we looked at the stopover before the trip and put this in a graph we didn't find a perfect relation but if there was a trend it would be that the Knots stay longer on a stopover when they are preparing for a long flight. This was also what was expected so it is more likely that birds prepare for the next flight on a stopover then that they would be refueling after a flight.

I was hoping to be able to say something about the difference in stopover duration between hop- and jump-species (Piersma 1987) by looking at the distance traveled before and after a stopover by Red Knots. Looking at the stopover before the flight we saw that the further a bird flies the longer it needs to prepare for it. This could mean that jumpers would need longer to prepare for their flights as well. To find out if this is really the case more information is needed on travel time of hop- and jump-species. If it is known of those species in which guild they are it would be possible to look at differences between guilds as well. If there are more short distance migrants in the visual surface wader guild it could explain why visual surface waders spend less time on stopovers. We just saw that when a Knot has a short travel time it doesn't stay long on the stopover before that either. This could be the case with short distance migrants as well. If a species makes shorter leaps between stopovers it should stay shorter on the stopover as well. To find out if this is the case more research needs to be done.

Fuel deposition

Tactile waders had a higher mass-specific fuel deposition (2.5% per day) than visual surface waders (1.8% per day). This implies that tactile waders are in fact more efficient then the visual surface waders. The conclusion from the stopover durations pointed towards visual surface waders being able to refuel quicker. But didn't we just see that tactile waders had the higher fuel deposition? I'll come back to that. Combining the information on stopover duration and fuel deposition yielded for five species the percentage of their body mass gained at a stopover .

The "hop, skip or jump" theory of Piersma (1987) may give some insight in why there are such differences (1.4-3.3 %/day) in the results of those five species. It was said before that the average mass-specific fuel deposition of the tactile and visual surface waders would not be very relevant as the species in these guilds can be short or long distance migrants. It might be possible to say something about the relation of mass-specific fuel deposition and the distance they fly between stopovers. It is known that the Red Knot is a jumper which means it flies long distances before it stops at a stopover. The dunlin is a skipper which is in between the hoppers and jumpers. (Piersma 1987) The Red Knot has the highest fuel gain of them all which fits with the fact that it also flies the longest distance. The dunlin has an average fuel deposition which also fits with it being a skipper. Not enough information is available to determine of each species which of Piersma's migratory strategy they use. It does however make a good hypothesis that the longer a bird flies between its stopovers the more of its body mass it will have to regain.

Taking the three together

We concluded two completely contradicting things in the previous 2 parts. We first looked at the stopover duration and found that visual surface waders needed less time to refuel. Therefore I expected that the visual surface waders have a higher fuel deposition to allow for a quick refueling at the stopover. However, fuel deposition was higher in tactile waders. How is it possible that we find two results so contradictory to each other? Tactile waders have longer stopovers but higher fuel deposition. It could be that there are more long distance migrants in the tactile wader guild. These will take longer to prepare for their next flight because they need to reach a higher departure weight. So it explains the longer stopover duration for tactile waders.

The mass-specific fuel deposition is higher than that of the visual surface waders. This means the tactile waders would need less time to gain the same amount of relative mass. This is convenient for the tactile waders as they also need to gain more weight because of their higher departure weight. This suggests that birds that make longer flights between stopovers will have a higher fuel deposition to make sure they can reach the necessary departure weight in the shortest time possible.

In the beginning of this study we questioned what effects foraging methods had on the stopover duration of migratory waders. It can be concluded that foraging methods is not the only effecting factor. We saw that the travel time between stopovers will have an effect on stopover duration as well. It is possible that the tactile guild has more “jumpers” in it then the visual surface wader guild (Piersma 1987). This has to be studied more thoroughly to say if this is really the case. The mass-specific fuel deposition of the tactile waders were all higher than the visual surface wader species. This suggests that tactile waders are either better at finding their food or their food has more energy in it. The combined effect of fuel deposition and travel time between stopovers determines the stopover duration.

Discussion

There seem to be interesting differences between species which are related in foraging methods. There are some issues which make the results unreliable though. All the data used to get to the conclusions described above were gathered in different places in the world by different people in a variety of ways. This gives some issues in analyzing this data. A lot of variables differ between those places. Variables like food availability, food quality and predation. Also the errors made by a person looking at a bird and a transmitter recording flight information are not the same. To get a scientifically reliable result more research needs to be done. In a single place, where a great number of species and many individuals of those species make a stopover, the length of stay should be measured. This way all species have the same environment and can choose from the same available prey species. All of the species should be caught and color ringed. The color rings will help with determining the length of stay. When they are caught they should be weighed and caught once again to determine the fuel deposition.

Geolocators are also a very good tool to find out the stop over duration of many different wader species in other stopovers. This will give information about the travel time before and after the stopovers. If such data would be available a good comparison could be made between the visual surface and tactile waders. With this data it is possible to say if the variation within guilds is because of the variety of places the birds were observed or if there really is so much difference between the species in a guild. If the difference within guilds is to big it might not be a good idea to group the waders on foraging methods.

In the beginning of this paper it was already stated that there is not enough information on the pelagic wader guild. Think of Greenshank *Tringa nebularia,* Black-winged Stilt *Himantopus himantopus* or Avocets *Recurvirostra avosetta*. (Ntiamoa-Baidu et al. 1996) If the same type of observations would be done on such species the comparison would become even more interesting. These species have again a different diet. We found a difference in fuel deposition between tactile and visual surface waders so it could be that pelagic waders have a different fuel deposition as well. To find out of there is a difference in stopover duration before or after either a long or a short flight it is better to use data of "hoppers" and "jumpers" (Piersma 1987). They might react differently than when Red Knots make short or long trips. To find out if this could be the reason more research needs to be done on the migration strategies of a lot of different birds to find out if they are "hoppers", "skippers" or "jumpers".

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