

One cold December night, a polar bear cub was born. This story begins when she was only four months old, a few weeks after she had left the mountain den that she was born in which kept her safe from the harsh winter winds. With fur as white as the snow she played in and a nose as black as the sky she slept under, she was not so ragged and worn by years of age, like her mother. She walked behind her mother, following her scarred and yellowed backside as her twin brother trotted alongside her. They were in search of the sea ice, for her mother said that was what would keep their bellies full and warm.

A strange scent seemed to trail behind her family, and the curious cub had to wonder why her mother did not respond to it. She had to have smelled it, she could smell up to twenty miles away after all. As they got closer to the sea ice, the scent only got nearer.

Once they reached the ice, the scent was quickly forgotten by the cub as she watched her mother hunt a seal for the first time. Using her strong sense of smell and patience, her mother found a hole in the ice, which she explained was a breathing hole. Seals use it to come up for air when they roam the sea. After locating the hole, mother bear crouched down as quietly as she could and hushed the cub and her brother, telling them not to move or make a sound. They waited for hours for a seal to appear. When the target, an unfortunate ring seal, finally emerged for air mother bear pounced before pulling it out of the hole and bringing it down. The cub and her brother jumped around in celebration, their limbs sore from crouching and relieved that the long hunt was over.

Once her mother had eaten her fill, the cub finally caught sight of the source of the strange scent, which revealed itself to be a small brown animal with pointy ears and beady eyes.

“Mom, who is that?” The cub asked.

“Oh, that is a fox dear. A young one too. Don't mind her, she only wants to pick on our leftovers.”

“Mom, why didn't you just hunt the fox? Wouldn't that have been easier than the seal? She's been following us for days.”

“Oh, well because we are very big, and that fox is very small. We need to eat a lot of fat to survive, that is why we hunt seals.”

The bear cub watched the fox nervously gulp down the rest of the seal meat that still clung to the bones, and thought about how she did look quite small. She couldn't have been much older than the cub herself. So where was her mother? The cub decided that if the fox stuck around after she had eaten, then she would ask.

The bears moved on, and sure enough the fox followed. This time the fox wasn't so far behind the bears, moving in plain sight rather than hiding. So, the bear cub decided to ask her question:

“Hey fox... how old are you?”

The fox seemed stunned that the cub spoke to her and stood there for a bit, before replying:

“I am two months old.”

The bear cub was shocked by this, the fox was younger than she was and already lived by herself and ate meat! She could tell by the fox's voice that she was not an adult either.

“Don't you have a family? Why are you all by yourself? Why are you following us?”

“Honestly, I do have a family. They live far away, and I had to leave them before I was ready. We were going hungry - there hasn't been enough lemmings, which we count on for food. My mother told me to travel towards the sea and find a bear, like your mother, to follow. One might be kind enough to let me eat after them. Usually foxes wait until winter to do this, but food is so scarce that I have to follow you and your family through the summer.” The fox replied.

“I'm sorry you had to leave home. I'm glad my mother is letting you follow us. You won't go hungry with her, she's a great hunter!” The bear cub said with pride.

The fox only laughed at the bear. And so began a great friendship between the two, they would chase one another and talk for hours. The bear cub's brother often made fun of her for talking to a fox, but the small family didn't come across many other bears, and the cub liked the fox's company.

“Fox, how do you hunt lemmings?”

“I do what your mother does. Except I don't smell the lemmings to find them, I listen for them. When I think I've found one, I jump high in the air and pounce! Then I pull it from its burrow like how your mom pulls the seals from their breathing holes.” The fox replied.

“Wow, I can't believe foxes and bears hunt the same way!” Said the bear cub

“We're both working with many layers of frozen water, it was bound to end up the same.” Said the fox.

As summer turned into winter, the fox grew. She grew much faster than the bear cub, and as she grew her coat changed from short and brown to fluffy and white. By the time December hit, she was an adult. However the bear cub did not grow so fast. Though she got taller and stockier off her mother's hunts, she was nowhere near adulthood. Still though, she and the fox remained best friends.

"Will you go back to your family once summer comes again?" The bear asked the fox one day when the snow was blowing so hard the bears had to snuggle against one another.

The fox replied from her spot against the bear cub (to her mother and brother's distaste) "I think I might stay a while longer. I would be sad to leave you."

And so another summer passed and the two friends remained close. But the fox was becoming restless, and the bear cub could tell. One night when the weather began to turn cold again, the fox had snuck away. The bear cub waited and waited, for weeks but the fox did not return. And so the bear cried, comforted by her mother.

"Why did she leave mom? And without saying goodbye?"

"Well dear, she isn't as young as you anymore. She has to go and live her own life."

"She is younger than me, by two months." The cub grumbled into her mother's fur.

"Well dear, you are a bear and she is a fox."

Time continued to pass and the bear cub continued to grow. A year later she was almost as tall as her mother now, and her brother had already grown past her mother. She had adopted a few scars, and noted that her fur wasn't quite as white as it had once been. Not so much a cub anymore, she could feel herself begin to separate from her family, though she didn't quite know why. They had one more winter left together. She wondered if this feeling was why the fox had left.

One late December day, the bear caught a familiar scent and almost couldn't believe her nose. Before long, her old friend the fox came into view, this time with a male fox friend. When the two met again they jumped around in excitement, and chased each other like they did when they were young. The mother and brother bear laughed at their antics, while the new fox simply watched on. It didn't take long for the happy reunion to become more serious though.

"Why did you leave? And without saying goodbye! I waited for you, and missed you!" The bear said angrily.

“I didn't want to explain, which was wrong of me, and I should have said goodbye.” The fox replied sadly, “But I needed to go and further my life. Unlike you bears, us foxes mate for life, and I was getting lonely. That’s who I have brought with me here, my mate.”

The bear turned to the male fox, who smiled at her with squinty eyes and small sharp teeth.

“Did you have pups? Is that why you were away so long?” The bear asked.

“Yes, I was able to have 8 thanks to your mother feeding me through those years. We have more pups when food is plentiful.” The fox replied. “You are so much bigger now, not a cub anymore, I'm sure you will have cubs of your own soon as well.”

“But you were always two months younger than me, how did you grow up so fast?” The bear asked, feeling bitter.

“Well I am a fox and you are a bear.” The fox continued, echoing the mother bear’s words from some time ago. “I am me, and you are you. I am small and lean while you are big and bulky. You need to take the time to learn how to hunt seals and survive with your mother, you need to take time to grow. I do not need so much time. This conflict in needs, it doesn't mean we don't have anything in common or that we can’t be friends. It just means we have to explore the world in our own ways at our own times.”

The bear smiled at that, her heart full at the words the fox spoke. She felt like she understood it now.

“And,” the fox continued, “If you’ll allow it, me and my mate would love to follow you guys for the winter, spend your last months growing up together.”

The bear turned to her mother, who only rolled her eyes and nodded, before turning back to the fox to reply “Yes! I'm glad to have you back.”

And so the best friends spent the winter together again. The bear turned from two to three years old and had to leave her mother and brother come spring. But she wasn't so lonely, as she had her two fox friends trailing along with her.

The fox continued to leave the bear for some time to have her pups, and once the bear reached 5 years old she was finally able to have cubs of her own. But the two always reconnected, and their bond stayed strong.

Colette Bender

Final Project Summary & Annotated Bibliography

Key Scientific Concepts

#1: A polar bear and arctic fox have different maturation times despite living in similar climates (and both being carnivorous mammals) because of their food sources, size, and relationships. For arctic foxes, which catch smaller leaner prey, hold less fat on their bodies, and interact with other foxes more frequently than polar bears, their lifespans can be significantly shorter from an evolutionary standpoint.

#2: Polar bears and Arctic foxes are an example of commensalism, as the fox benefits from following and eating the bear's leftovers while the bear has nothing to gain or lose from the fox being around.

#3: Polar bears will ignore an easy food source such as the arctic foxes following them in favor of a bigger, fattier food source such as seal. Unless they are extremely desperate.

Final Project Summary

For my final project I focused on the commensal relationship between the arctic fox and the polar bear and turned it into a children's book that talks about maturation. In times of scarcity, it has been observed that arctic foxes will follow around polar bears in order to feed off of their leftover kills (*Arctic Tale*, 2007). Though polar bears have been known to kill foxes, they often allow the foxes to follow them unharmed because they are not suitable prey with a high fat content (Fox, 2021). There are benefits to a constant food source when it comes to breeding in foxes, as having a more reliable food supply leads to a higher litter count (Tannerfeldt, 1998). Female Arctic foxes sexually mature at 9-10 months, whereas female polar bears mature at 4-6 years and stay with their mothers until they are around 2 years old (Arctic Focus, 2023). I created a story about an adolescent female polar bear and an adolescent female fox that tagged along with the polar bear family, and the bond that forms between them (this is fictional, the two species don't typically form bonds while the fox follows the bear.) But the fox eventually separated to have pups, and the bear became saddened by this and did not understand why the fox had to leave. Eventually, the fox came back to the bear and explained why she had to leave her; to continue her species population as well as her own bloodline. The fox then began tagging along again, and the two continued to be friends. The intention is for the story to help kids understand that friends mature at different rates and some may prioritize other things sooner than others (not specifically sexually, just in general). It also is supposed to show how different species can be similar (in this case in the way they hunt) while also being very different.

in other ways. It introduces children to the concept that not all animals grow up at the same rate. I hand drew and typed out the book, which has a lengthier text in comparison to other children's books - I followed the format of *The Velveteen Rabbit* by Margery Williams(1922).

Annotated Bibliography

Arctic Tale. Paramount Vantage, 2007.

A documentary/family film that I watched when I was younger and was the inspiration for the arctic fox and polar bear relationship in my story. It follows a female polar bear as she raises her two cubs and hunts for them. Throughout the film the arctic fox following them gets a significant amount of screen time, and I am able to observe the inter-species interactions in the film so I can use them. Furthermore, this film was made for a younger audience, meaning the language and tone that it uses will be helpful for me in discovering how I want to write a children's book about such scientific subjects. It also provides crucial information on the upbringing of polar bear cubs, from their first steps out of the den to their hunting lessons. This is the timeline my story will be set in for the polar bear character.

Williams, Margery. *The Velveteen Rabbit*. Toronto: George H. Doran Company, 1922.

My favorite book as a child, this will serve as an example for the formatting I choose to use in my book. Lots of text against a few illustrations, the art in them is quite nice so I may use it as a reference of sorts. I also like the tone of this story and am hoping to take inspiration from it as well.

Fox, Chad. "Do Polar Bears Eat Arctic Foxes: Ultimate Guide." All Things Foxes, June 29, 2021.

<https://allthingsfoxes.com/do-polar-bears-eat-arctic-foxes/>.

Though this is not a scholarly source, there are not many that go into depth about the relationship between arctic foxes and polar bears. So I have to settle for this. It confirms that in drastic situations polar bears will eat arctic foxes, though this is not common as they prefer other prey that is higher in fat. Furthermore, foxes will only follow bears around during extremely scarce food conditions, usually only during the winter months. I will have to keep this in mind in my book, and maybe emphasize the idea that food is hard to find when it takes place.

Tannerfeldt, Magnus, Anders Angerbjörn, and Anders Angerbjörn. "Fluctuating Resources and the Evolution of Litter Size in the Arctic Fox." *Oikos* 83, no. 3 (1998): 545.

<https://doi.org/10.2307/3546681>.

This source talks about reproductive success in relation to resource availability among arctic foxes. Though it talks specifically about arctic foxes hunting small rodents and birds, rather than the individuals that feed off of polar bear scraps. The authors found that "litter size in the arctic fox is determined by the combined effect of immediate resource levels and the degree of resource predictability." This is important for my project seeing as foxes follow polar bears around to ensure a better chance at food intake, meaning that doing so can increase the size of their litters, therefore aiding my story.

"The Amazing Breeding Behavior of Polar Bears: Arctic Focus." Arctic Focus. Accessed

March 21, 2023.

<https://www.arcticfocus.org/stories/amazing-breeding-behavior-polar-bears/>.

This website dives deep into the breeding behaviors and adaptations of polar bears. Though this is not entirely important to my story as I don't plan on my bear character ever producing offspring of their own, seeing as they do not mature as fast as foxes do, it is still important. Understanding reproductive evolution of one of my target species could prove useful to me throughout my process. The source states that most adult females keep their cubs with them for 2 ½ years. Thus, on average, in most years, only about a third of the adult females are available for breeding. Also that females have induced ovulation, meaning the males have to spend significant time with them in order to stimulate egg release, about a week. Other than during this time, males are typically enemies to female polar bears, especially those with cubs.

Two Months Younger

Book by Colette Bender

Inspiration: Margery Williams' *The Velveteen Rabbit*

The Velveteen Rabbit

into anything else. For nursery magic is very strange and wonderful, and only those playthings that are old and wise and experienced like the Skin Horse understand all about it.

"What is REAL?" asked the Rabbit one day, when they were lying side by side near the nursery fender, before Nana came to tidy the room. "Does it mean having things that buzz inside you and a stick-out handle?"

"Real isn't how you are made," said the Skin Horse. "It's a thing that happens to you. When a child loves you for a long, long time, not just to play with, but REALLY loves you, then you become Real."

"Does it hurt?" asked the Rabbit.

"Sometimes," said the Skin Horse, for he was always truthful. "When you are Real you don't mind being hurt."

"Does it happen all at once, like being wound up," he asked, "or bit by bit?"

"It doesn't happen all at once," said the Skin Horse. "You become. It takes a long time. That's why it doesn't happen often to people who break easily, or have sharp edges, or who have to be carefully kept. Generally, by the time you are Real, most of your hair has been loved off, and your eyes drop out and you get loose in the joints and very shabby. But these things don't matter at all, because once you are Real you can't be ugly, except to people who don't understand."

"I suppose you are real?" said the Rabbit. And then he wished he had not said it, for he thought the Skin Horse might be sensitive. But the Skin Horse only smiled.



The Skin Horse Tells His Story

"The Boy's Uncle made me Real," he said. "That was a great many years ago; but once you are Real you can't become unreal again. It lasts for always."

The Rabbit sighed. He thought it would be a long time before this magic called Real happened to him. He longed to become Real, to know what it felt like; and yet the idea of growing shabby and losing his eyes and whiskers was rather sad. He wished that he could become it without these uncomfortable things happening to him.

There was a person called Nana who ruled the nursery. Sometimes she took no notice of the playthings lying about, and sometimes, for no reason whatever, she went swooping about like a great wind and hustled them away in cupboards. She called this "tidying up," and the

playthings all hated it, especially the tin ones. The Rabbit didn't mind it so much, for wherever he was thrown he came down soft.

One evening, when the Boy was going to bed, he couldn't find the china dog that always slept with him. Nana was in a hurry, and it was too much trouble to hunt for china dogs at bedtime, so she simply looked about her, and seeing that the toy cupboard door stood open, she made a swoop.

"Here," she said, "take your old Bunny! He'll do to sleep with you!" And she dragged the Rabbit out by one ear, and put him into the Boy's arms.

That night, and for many nights after, the Velveteen Rabbit slept in the Boy's bed. At first he found it rather uncomfortable, for the Boy hugged him very tight, and sometimes he rolled over on him, and sometimes he pushed him so far under the pillow that the Rabbit could scarcely breathe. And he missed, too, those long moonlight hours in the nursery, when all the house was silent, and his talks with the Skin Horse. But very soon he grew to like it, for the Boy used to talk to him, and made nice tunnels for him under the bedclothes that he said were like the burrows the real rabbits lived in. And they had splendid games together, in whispers, when Nana had gone away to her supper and left the night-light burning on the mantelpiece. And when the Boy dropped off to sleep, the Rabbit would snuggle down close under his little warm chin and dream, with the Boy's hands clasped close round him all night long.

And so time went on, and the little Rabbit was very happy—so happy that he never noticed how his beautiful velveteen fur was getting shabbier and shabbier, and his tail becoming unsewn, and all the pink rubbed off his nose where the Boy had kissed him.

Spring came, and they had long days in the garden, for wherever the Boy went the Rabbit went too. He had rides in the wheelbarrow, and picnics on the grass, and lovely fairy hats built for him under the raspberry canes behind the flower border. And once, when the Boy was called away suddenly to go out to tea, the Rabbit was left out on the lawn until long after dusk, and Nana had to come and look for him with the candle because the Boy couldn't go to sleep unless he was there. He was wet through with the dew and quite earthy from diving into the burrows the Boy had made for him in the flower bed, and Nana grumbled as she rubbed him off with a corner of her apron.



Spring Time

One cold December night, a polar bear cub was born. This story begins when she was only four months old, a few weeks after she had left the mountain den that she was born in which kept her safe from the harsh winter winds. With fur as white as the snow she played in and a nose as black as the sky she slept under, she was not so ragged and worn by years of age, like her mother. She walked behind her mother, following her scarred and yellowed backside as her twin brother trotted alongside her. They were in search of the sea ice, for her mother said that was what would keep their bellies full and warm.

A strange scent seemed to trail behind her family, and the curious cub had to wonder why her mother did not respond to it. She had to have smelled it, she could smell up to twenty miles away after all. As they got closer to the sea ice, the scent only got nearer.

Once they reached the ice, the scent was quickly forgotten by the cub as she watched her mother hunt a seal for the first time. Using her strong sense of smell and patience, her mother found a hole in the ice, which she explained was a breathing hole. Seals use it to come up for air when they roam the sea. After locating the hole, mother bear crouched down as quietly as she could and hushed the cub and her brother, telling them not to move or make a sound. They waited for hours for a seal to appear. When the target, an unfortunate ring seal, finally emerged for air mother bear pounced before pulling it out of the hole and bringing it down. The cub and her brother jumped around in celebration, their limbs sore from crouching and relieved that the long hunt was over.

Once her mother had eaten her fill, the cub finally caught sight of the source of the strange scent, which revealed itself to be a small brown animal with pointy ears and beady eyes.



"Mom, who is that?" The cub asked.

"Oh, that is a fox dear. A young one too. Don't mind her, she only wants to pick on our leftovers."

"Mom, why didn't you just hunt the fox? Wouldn't that have been easier than the seal? She's been following us for days."

"Oh, well because we are very big, and that fox is very small. We need to eat a lot of fat to survive, that is why we hunt seals."

The bear cub watched the fox nervously gulp down the rest of the seal meat that still clung to the bones, and thought about how she did look quite small. She couldn't have been much older than the cub herself. So where was her mother? The cub decided that if the fox stuck around after she had eaten, then she would ask.

The bears moved on, and sure enough the fox followed. This time the fox wasn't so far behind the bears, moving in plain sight rather than hiding. So, the bear cub decided to ask her question:

"Hey fox... how old are you?"

The fox seemed stunned that the cub spoke to her and stood there for a bit, before replying:

"I am two months old."

The bear cub was shocked by this, the fox was younger than she was and already lived by herself and ate meat! She could tell by the fox's voice that she was not an adult either.

"Don't you have a family? Why are you all by yourself? Why are you following us?"



"Honestly, I do have a family. They live far away, and I had to leave them before I was ready. We were going hungry - there hasn't been enough lemmings, which we count on for food. My mother told me to travel towards the sea and find a bear, like your mother, to follow. One might be kind enough to let me eat after them. Usually foxes wait until winter to do this, but food is so scarce that I have to follow you and your family through the summer." The fox replied.

"I'm sorry you had to leave home. I'm glad my mother is letting you follow us. You won't go hungry with her, she's a great hunter!" The bear cub said with pride.

The fox only laughed at the bear. And so began a great friendship between the two, they would chase one another and talk for hours. The bear cub's brother often made fun of her for talking to a fox, but the small family didn't come across many other bears, and the cub liked the fox's company.

"Fox, how do you hunt lemmings?"



"I do what your mother does. Except I don't smell the lemmings to find them, I listen for them. When I think I've found one, I jump high in the air and pounce! Then I pull it from its burrow like how your mom pulls the seals from their breathing holes." The fox replied.

"Wow, I can't believe foxes and bears hunt the same way!" Said the bear cub

"We're both working with many layers of frozen water, it was bound to end up the same." Said the fox.

As summer turned into winter, the fox grew. She grew much faster than the bear cub, and as she grew her coat changed from short and brown to fluffy and white. By the time December hit, she was an adult. However the bear cub did not grow so fast. Though she got taller and stockier off her mothers hunts, she was nowhere near adulthood. Still though, she and the fox remained best friends.

“Will you go back to your family once summer comes again?”
The bear asked the fox one day when the snow was blowing so hard the bears had to snuggle against one another.

The fox replied from her spot against the bear cub(to her mother and brother’s distaste) “I think I might stay a while longer. I would be sad to leave you.”

And so another summer passed and the two friends remained close. But the fox was becoming restless, and the bear cub could tell. One night when the weather began to turn cold again, the fox had snuck away. The bear cub waited and waited, for weeks but the fox did not return. And so the bear cried, comforted by her mother.

“Why did she leave mom? And without saying goodbye?”

“Well dear, she isn’t as young as you anymore. She has to go and live her own life.”

“She is younger than me, by two months.” The cub grumbled into her mom’s fur.

“Well dear, you are a bear and she is a fox.”

Time continued to pass and the bear cub continued to grow. A year later she was almost as tall as her mother now, and her brother had already grown past her mom. She had adopted a few scars, and noted that her fur wasn’t quite as white as it had once been. Not so much a cub anymore, she could feel herself begin to separate from her family, though she didn’t quite know why. They had one more winter left together. She wondered if this feeling was why the fox had left.

One late December day, the bear caught a familiar scent and almost couldn't believe her nose. Before long, her old friend the fox came into view, this time with a male fox friend. When the two met again they jumped around in excitement, and chased each other like they did when they were young. The mother and brother bear laughed at their antics, while the new fox simply watched on. It didn't take long for the happy reunion to become more serious though.

"Why did you leave? And without saying goodbye! I waited for you, and missed you!" The bear said angrily.

"I didn't want to explain, which was wrong of me, and I should have said goodbye." The fox replied sadly, "But I needed to go and further my life. Unlike you bears, us foxes mate for life, and I was getting lonely. That's who I have brought with me here, my mate."

The bear turned to the male fox, who smiled at her with squinty eyes and small sharp teeth.

"Did you have pups? Is that why you were away so long?" The bear asked.

"Yes, I was able to have 8 thanks to your mother feeding me through those years. We have more pups when food is plentiful." The fox replied. "You are so much bigger now, not a cub anymore, I'm sure you will have cubs of your own soon as well."

"But you were always two months younger than me, how did you grow up so fast?" The bear asked, feeling bitter.

“Well I am a fox and you are a bear.” The fox continued, echoing the mother bear’s words from some time ago. “I am me, and you are you. I am small and lean while you are big and bulky. You need to take the time to learn how to hunt seals and survive with your mother, you need to take time to grow. I do not need so much time. This conflict in needs, it doesn’t mean we don’t have anything in common or that we can’t be friends. It just means we have to explore the world in our own ways at our own times.”

The bear smiled at that, her heart full at the words the fox spoke. She felt like she understood it now.

“And,” the fox continued, “If you’ll allow it, me and my mate would love to follow you guys for the winter, spend your last months growing up together.”

The bear turned to her mother, who only rolled her eyes and nodded, before turning back to the fox to reply “Yes! I’m glad to have you back.”

And so the best friends spent the winter together again. The bear turned from two to three years old and had to leave her mother and brother come spring. But she wasn’t so lonely, as she had her two fox friends trailing along with her.

The fox continued to leave the bear for some time to have her pups, and once the bear reached 5 years old she was finally able to have cubs of her own. But the two always reconnected, and their bond stayed strong.

