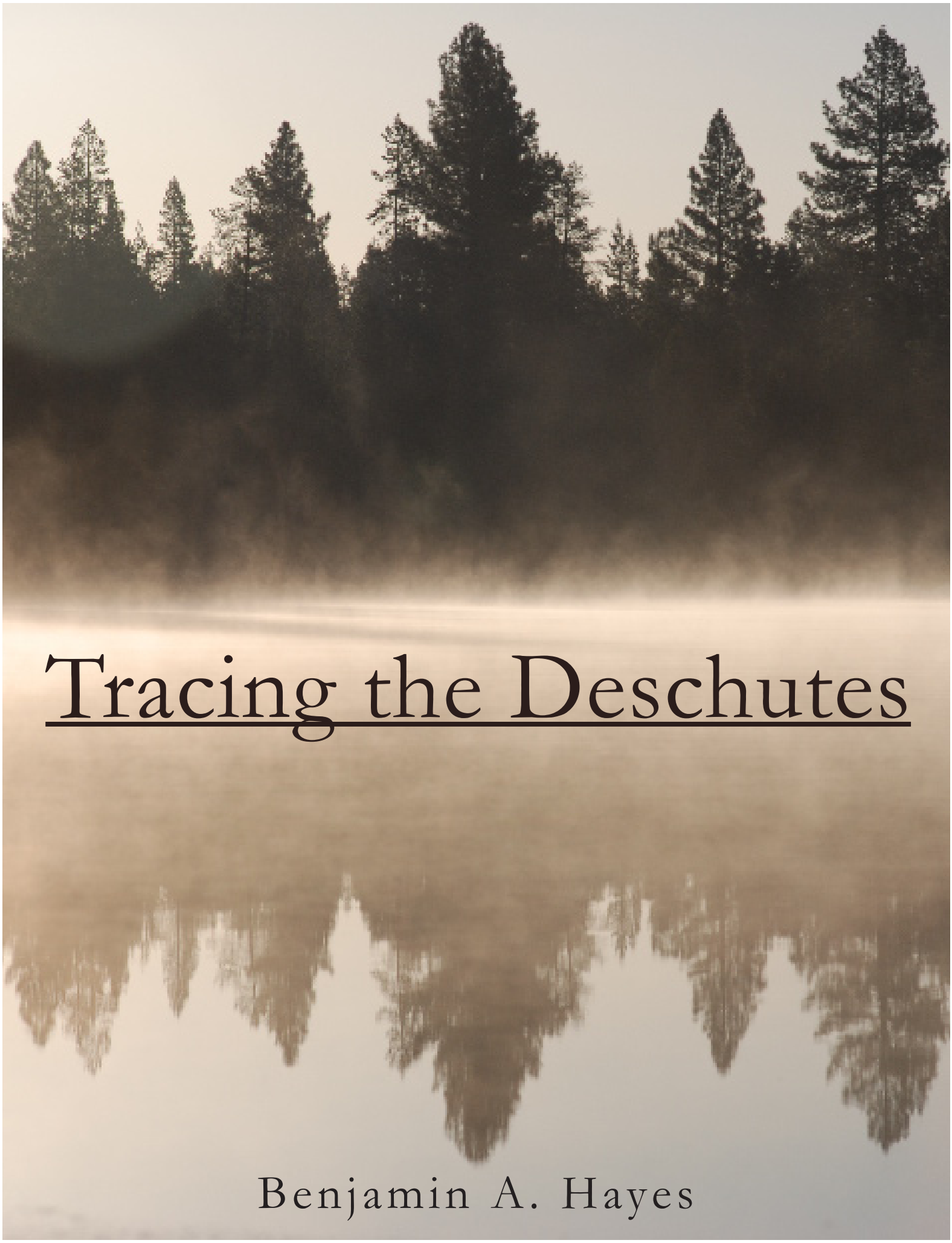

Tracing the Deschutes

Benjamin A. Hayes

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-All Photography and writing for this project was completed by Ben Hayes as part of a senior project at the Catlin Gabel School during the winter and spring of 2006 and 2007 unless otherwise marked.

-This project was completed with the help of the following people and orgainizations-

Kolleen Yake
Bruce Ronning
John Schubert
Ben Moon
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The Upper Deschutes Watershed Council
Oregon Trout and The Healthy Waters Institute
Pam, Peter, and Molly Hayes
Claire Stewart
Art Leo, Kathryn Shimmons, and Nadine Fiedler
The Catlin Gabel School
and many others

Cover Photo- Reflected trees in early morning mist near Sunriver.

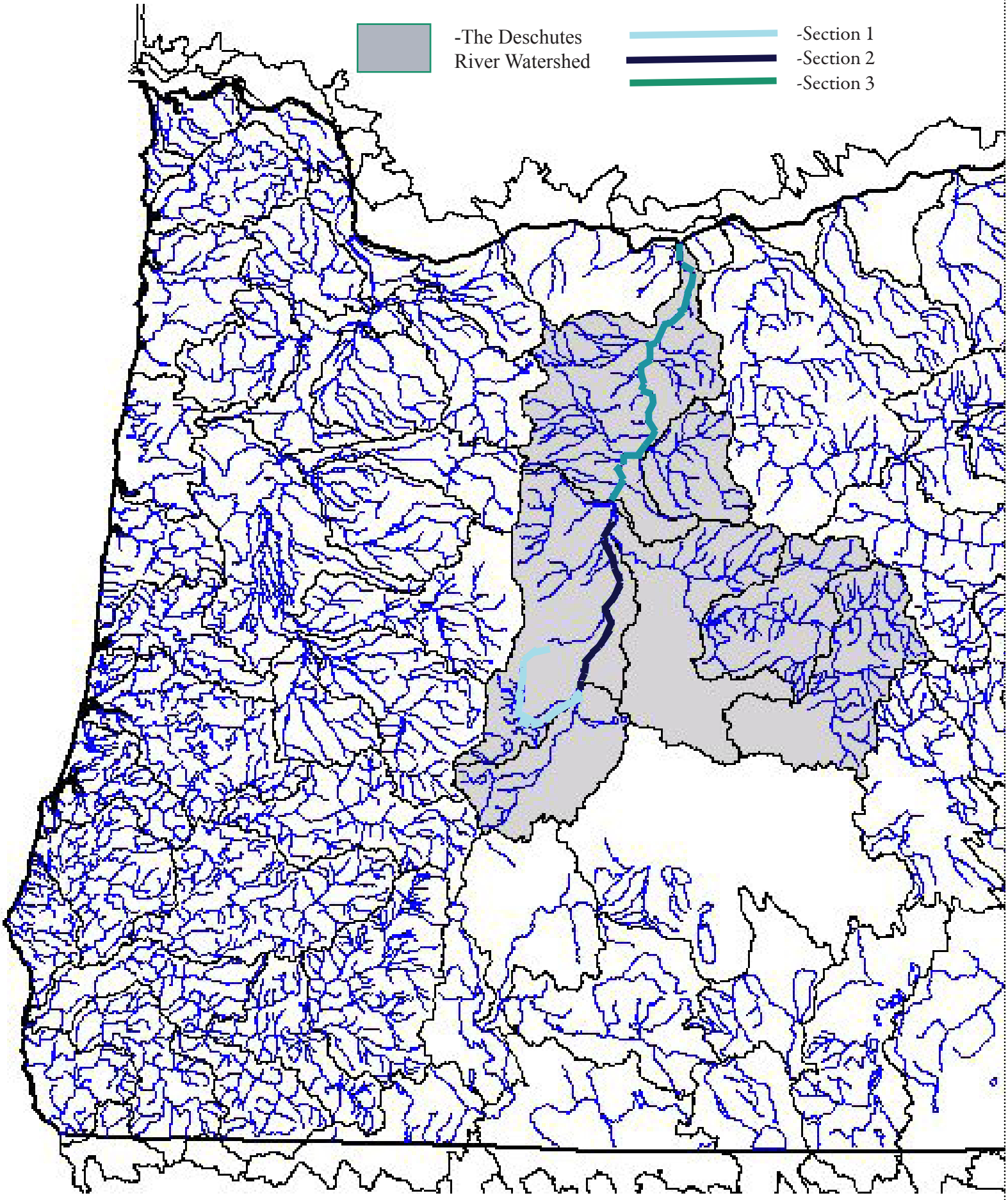
A late evening riffle on the Deschutes upstream of Tumalo.

Project Summary

A willow lined river bank upstream of Benham Falls.

This publication is the final product of having traced the Deschutes River from its headwater near the Three Sisters, to its confluence with the Columbia under my own power over the course of the winter and spring of 2006 and 2007. I began in December of 2006, skiing into the headwaters area to find some of the highest drops of water flowing into the Deschutes River drainage. From there I skied downhill, following the water to Sparks Lake. From there the river flows south, to Wickiup Reservoir. In March I began canoeing along the Deschutes starting at Wickiup and ending at Benham Falls. In May I set out on my mountain bike, headed for Bend. I visited select areas along the river from Bend to Lake Billy Chinook, including a day spent searching for all the waterfalls we could find. From Warm Springs, just downstream of Lake Billy Chinook, I set off in floating the river in a drift boat and a canoe. After a shuttle around Sherars Falls I floated right down to where the Columbia River mingle with the water that has accompanied me for the last two hundred and fifty odd miles. The goal of this project is to create awareness for a special area and protect a precious environmental resource. My project will approach the goal of protecting wild and beautiful places one step a time. A positive future relies on young people caring about the places that surround them. To care about places they need to know that they exist. My project aims to create excitement and education centered on the Deschutes. This will hopefully inspire young people to care for and protect the Deschutes River which is incredibly important to central Oregon and needs help.

-Ben Hayes


-The Deschutes River Watershed
-Section 1
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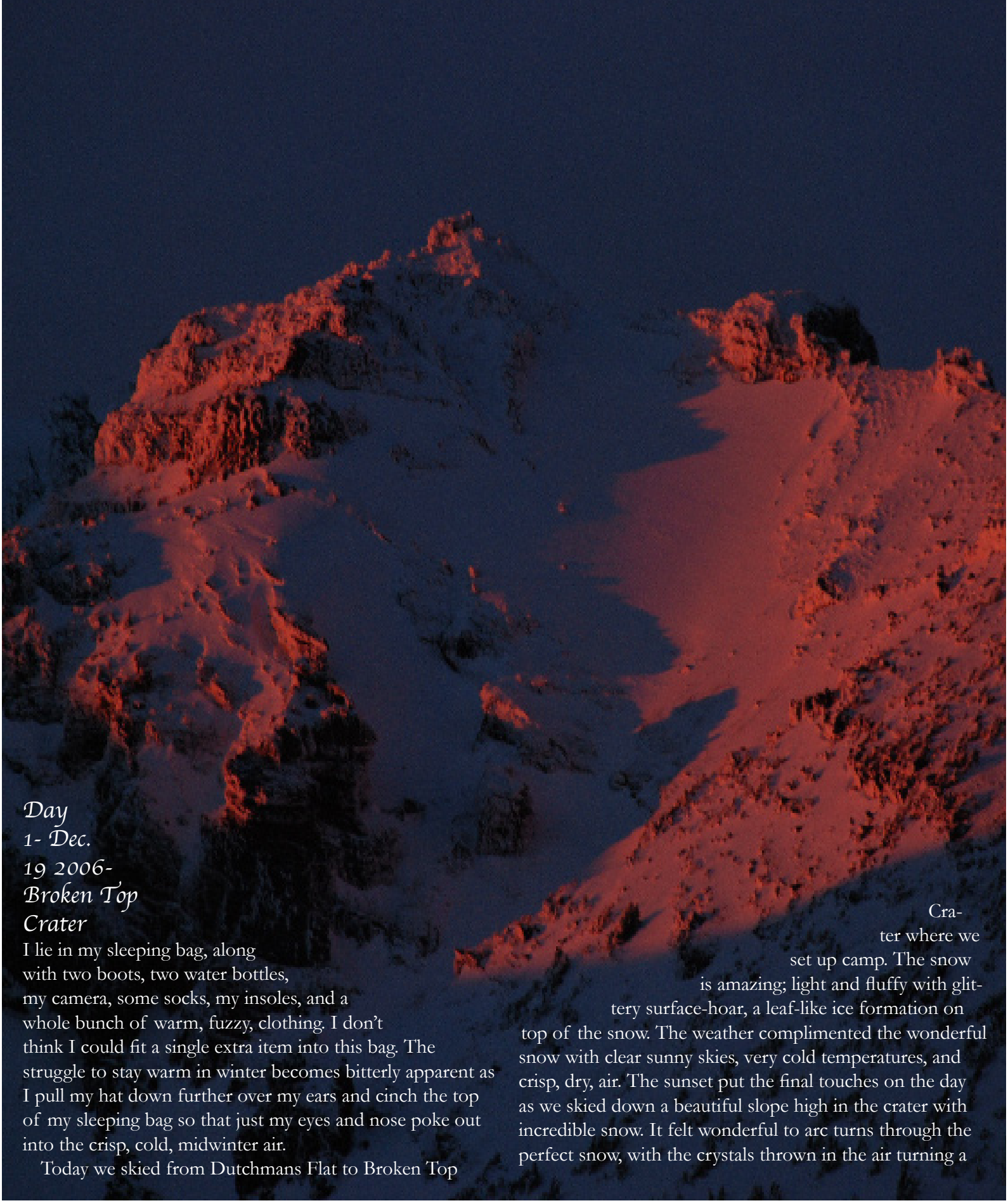
The rim of Broken Top crater bathed in late evening alpenglow.



Day 1- Dec. 19 2006- Broken Top Crater

I lie in my sleeping bag, along with two boots, two water bottles, my camera, some socks, my insoles, and a whole bunch of warm, fuzzy, clothing. I don't think I could fit a single extra item into this bag. The struggle to stay warm in winter becomes bitterly apparent as I pull my hat down further over my ears and cinch the top of my sleeping bag so that just my eyes and nose poke out into the crisp, cold, midwinter air.

Today we skied from Dutchmans Flat to Broken Top Crater where we set up camp. The snow is amazing; light and fluffy with glittery surface-hoar, a leaf-like ice formation on top of the snow. The weather complimented the wonderful snow with clear sunny skies, very cold temperatures, and crisp, dry, air. The sunset put the final touches on the day as we skied down a beautiful slope high in the crater with incredible snow. It felt wonderful to arc turns through the perfect snow, with the crystals thrown in the air turning a

gold color with the sunset. Alpenglow bathed Ball Butte and the very top of Broken Top with pinkish light, perfect for pictures. The conditions up here are good enough that I could quite happily spend a couple of days just exploring the crater and skiing run after run.

Tomorrow we will begin the actual tracing of the Deschutes, following water downhill from here to Sparks Lake. The snow that I sleep next to tonight, will melt with the spring sunshine, and flow down hill towards the headwaters of the Deschutes. For now I am going to focus on staying warm and falling asleep without rolling over onto my camera.

Telemark skiing down Broken Top Crater.

Animal tracks along the ski trail from Dutchman's Flat.

Day 2- Dec. 20 2006- Sparks Lake

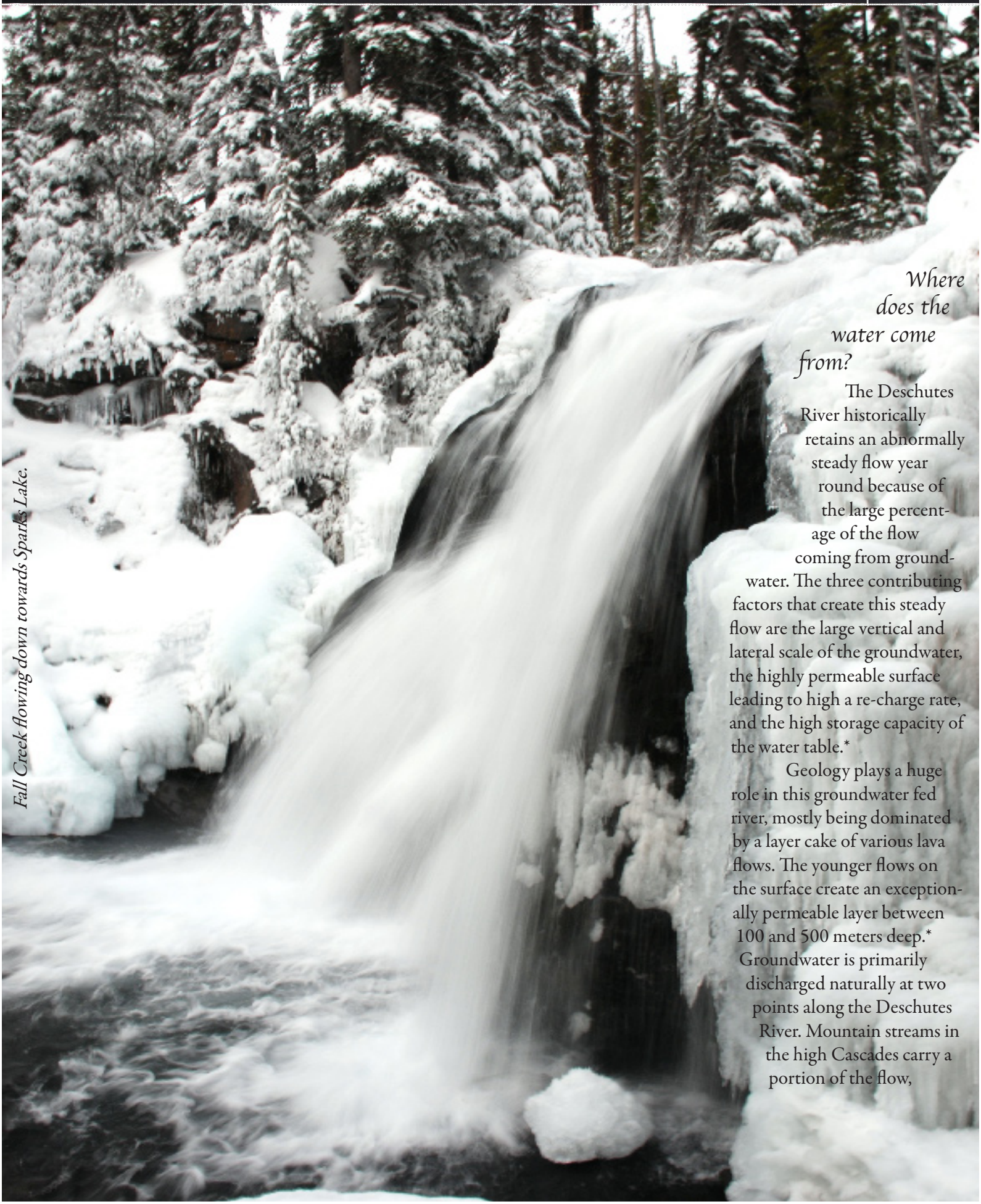
I can hear the creek gurgling past our tent. In some places the water flows under ice covered banks, cutting a perfect line into the bottom of the snow. It seems odd to be sitting next to a flowing stream in the middle of winter with six feet of snow covering the ground while I cook macaroni and cheese on a camp stove.

Today we left our camp in Broken Top Crater after a minor bout of food poisoning and skied to Sparks Lake. We began by cutting across the crater to Fall Creek then following the drainage downhill until rushing waters settled into the tranquility of Sparks Lake. There were an incredible number of animal tracks up high, many of them filled with windblown seeds lending a high-contrast perspective, as if a bunch of wolverines ran around on a white carpet with muddy paws. In fact we thought we may have seen a wolverine this afternoon even though we're not certain.

For dinner we're eating macaroni and cheese, one of our backcountry favorites. We even brought some extra chocolate for dessert, then off to bed. I managed to get in a long nap this afternoon once we arrived, compensating for less than sound sleeping last night.

We still haven't reached the official headwaters of the Deschutes River, however we are solidly within the watershed now. The water flowing past our tent will take months if not years to reach the Columbia through the Deschutes, however every precious little drop of moisture that falls here does eventually, if not evaporated, flow through some section of the Deschutes. Much of the water this high in the watershed actually flows underground, re-filling the water table, and eventually re-entering the Deschutes far downstream.

The forecast is for a few inches of snow overnight, lightening up in the morning. Tomorrow morning we will ski from our camp near Sparks Lake up Century Drive and back to the Dutchmans Flat Snow-park. For now I will stir the macaroni, enjoy a cup of hot chocolate, and try to stay warm in a winter environment.



Fall Creek flowing down towards Sparks Lake.

Where does the water come from?

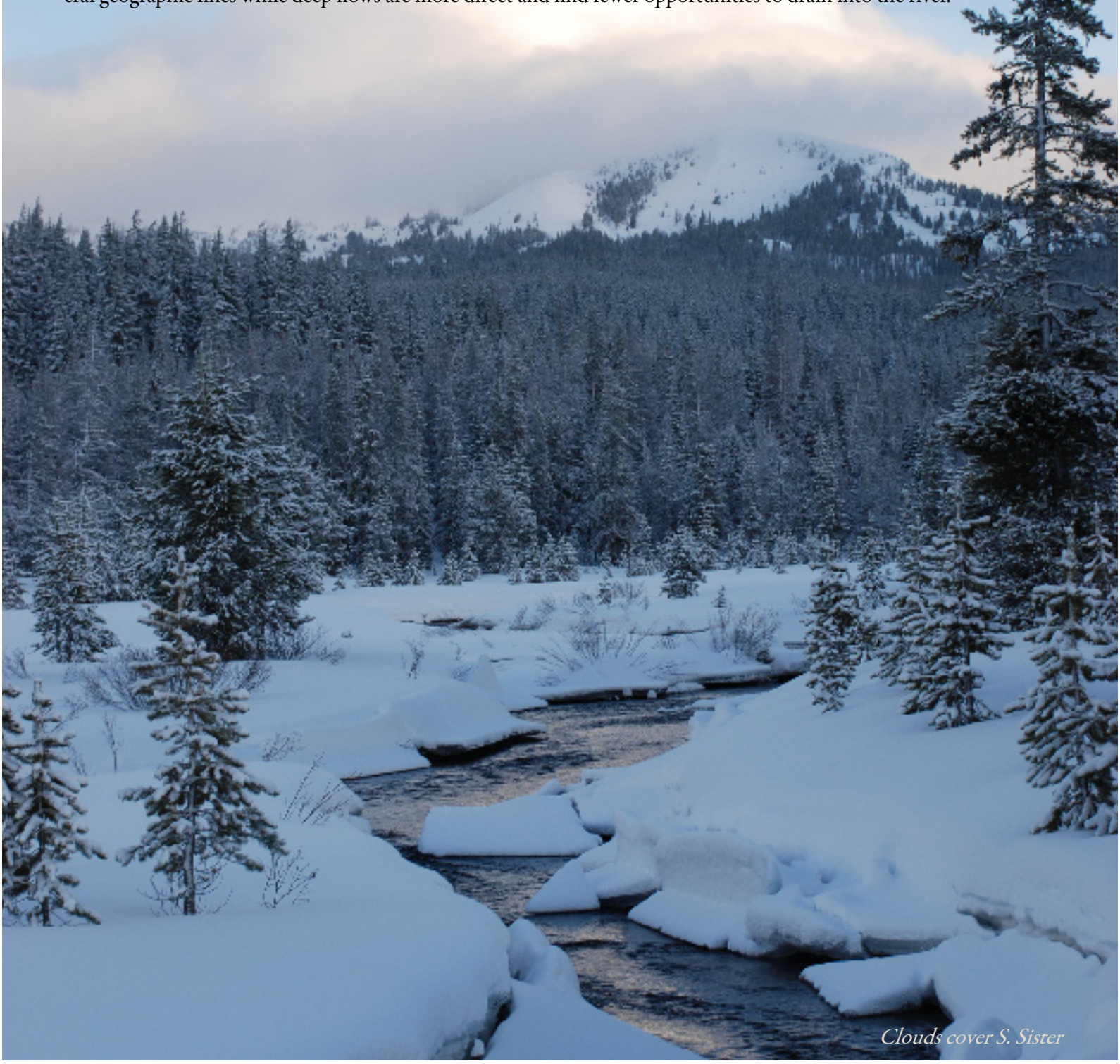
The Deschutes River historically retains an abnormally steady flow year round because of the large percentage of the flow coming from groundwater. The three contributing factors that create this steady flow are the large vertical and lateral scale of the groundwater, the highly permeable surface leading to high a re-charge rate, and the high storage capacity of the water table.*

Geology plays a huge role in this groundwater fed river, mostly being dominated by a layer cake of various lava flows. The younger flows on the surface create an exceptionally permeable layer between 100 and 500 meters deep.* Groundwater is primarily discharged naturally at two points along the Deschutes River. Mountain streams in the high Cascades carry a portion of the flow,

and the region near the confluence of the Deschutes and Crooked Rivers carries another large portion of the flow.* Also many tributaries, such as the Metolius are almost completely spring fed.

Ninety one percent of the flow in the Deschutes River at near Madras originates as groundwater, and eighty percent of the water in the Deschutes at its confluence with the Columbia comes from groundwater. Half of the groundwater flowing into the Deschutes River comes from an area within sixteen kilometers of the confluence of the Deschutes and Crooked Rivers.* Below this area the river flows over rock from the John Day formation that has a much lower permeability, allowing less groundwater to enter the river.†

The water table is recharged primarily from precipitation falling high in the Cascades and water leaking out of irrigation canals through fractured basaltic lava. The flows of the groundwater range from just below the surface to thousands of feet deep and vary hugely in their flows depending on depth. The shallow flows follow general geographic lines while deep flows are more direct and find fewer opportunities to drain into the river.



Clouds cover S. Sister

Skiing into the Headwater Area

Day 3- Dec. 21 2006- Wickiup Reservoir

The warm wood stove of my family's house in Tumalo heats my feet and dries the multitudes of wet clothing that hang over the furniture. The first backcountry adventure of my tracing of the Deschutes River from its headwaters to the Columbia has come to an end.

We began this morning shaking three or four inches of snow off of our tent. Opening the door to the tent was a different

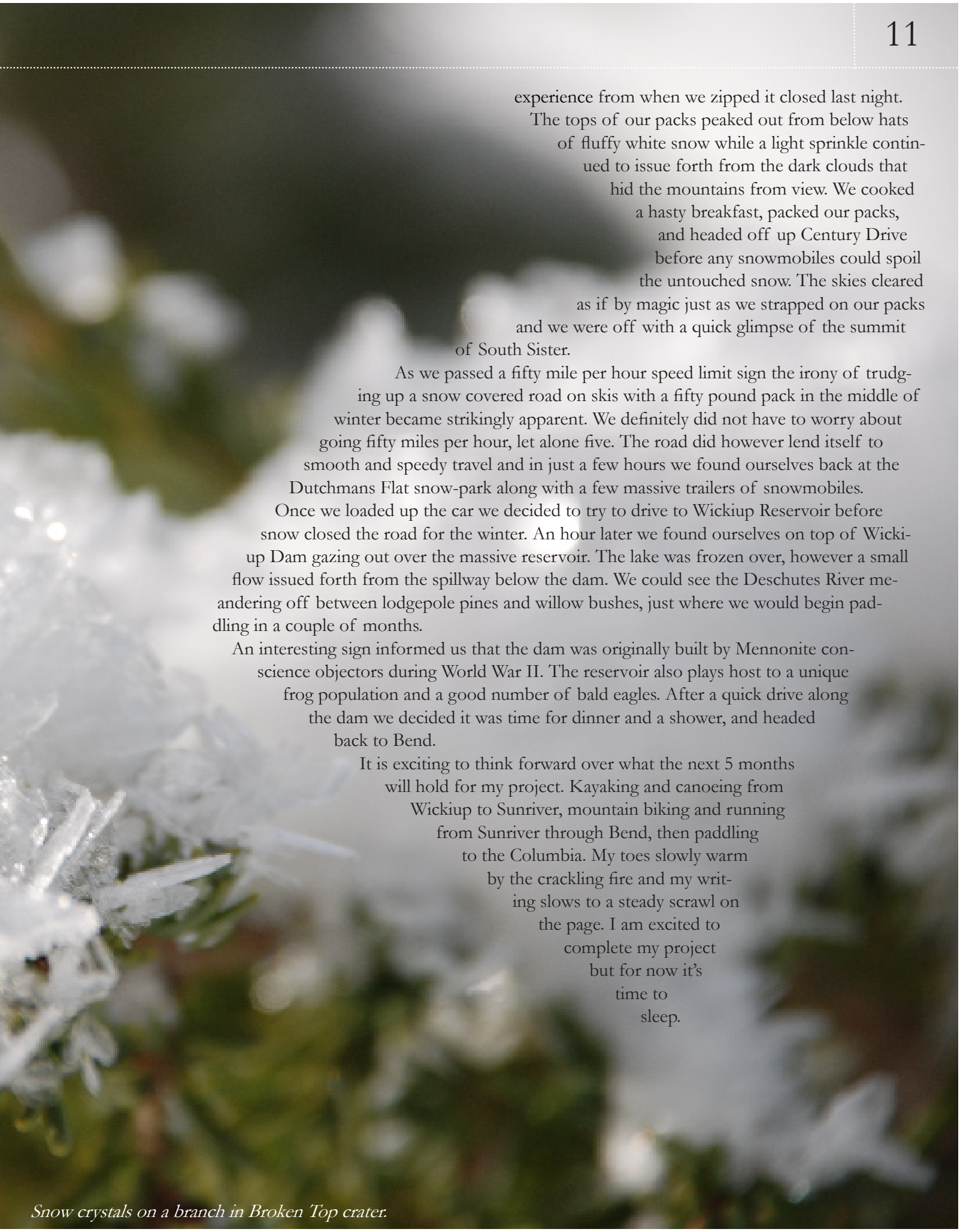
experience from when we zipped it closed last night. The tops of our packs peaked out from below hats of fluffy white snow while a light sprinkle continued to issue forth from the dark clouds that hid the mountains from view. We cooked a hasty breakfast, packed our packs, and headed off up Century Drive before any snowmobiles could spoil the untouched snow. The skies cleared as if by magic just as we strapped on our packs and we were off with a quick glimpse of the summit of South Sister.

As we passed a fifty mile per hour speed limit sign the irony of trudging up a snow covered road on skis with a fifty pound pack in the middle of winter became strikingly apparent. We definitely did not have to worry about going fifty miles per hour, let alone five. The road did however lend itself to smooth and speedy travel and in just a few hours we found ourselves back at the Dutchmans Flat snow-park along with a few massive trailers of snowmobiles.

Once we loaded up the car we decided to try to drive to Wickiup Reservoir before snow closed the road for the winter. An hour later we found ourselves on top of Wickiup Dam gazing out over the massive reservoir. The lake was frozen over, however a small flow issued forth from the spillway below the dam. We could see the Deschutes River meandering off between lodgepole pines and willow bushes, just where we would begin paddling in a couple of months.

An interesting sign informed us that the dam was originally built by Mennonite conscience objectors during World War II. The reservoir also plays host to a unique frog population and a good number of bald eagles. After a quick drive along the dam we decided it was time for dinner and a shower, and headed back to Bend.

It is exciting to think forward over what the next 5 months will hold for my project. Kayaking and canoeing from Wickiup to Sunriver, mountain biking and running from Sunriver through Bend, then paddling to the Columbia. My toes slowly warm by the crackling fire and my writing slows to a steady scrawl on the page. I am excited to complete my project but for now it's time to sleep.



Snow crystals on a branch in Broken Top crater.

Skiing into the Headwater Area

Early morning light bathes the rim of Broken Top crater.

Skiing into the Headwater Area

Late evening sun on the highest tributary to the Deschutes that we found, Fall Creek.

Breaking trail to our camp in Broken Top Crater

Trees reflect in the still water downstream of Pringle Falls

Day 4-
March 26 2007-
Wickiup Reservoir

My knees ache from kneeling behind a tripod and heavy camera for an hour this evening taking pictures of the perfect evening light glancing in between pines, radiating along the river as it placidly swished over a fallen tree. Now I sit, writing a journal entry on a picnic table covered by our tarp, at a campground just downstream of Pringle Falls.

We began our voyage down the upper reaches of the Deschutes River this morning with a hearty breakfast in the warm enclosure of our house. Once the cars were loaded and the weather report had been checked we headed off to paddle from Wickiup Reservoir to Benham Falls on the Deschutes River. An hour of driving later found us rumbling across a bridge just above Pringle Falls.

After setting up a quick shuttle we began carrying our two canoes the two thirds of a mile to the put in directly below the

The Wickiup spillway spews foam into the air.

dam. We were able to slide the boats into water that was still frothing and heaving from the dam release channel, where we had stopped tracing the river on skis and by car a few months ago over winter break. As we neared the put-in, the thundering cacophony of water pouring out of the dam spillway, threw wraiths of mist into the air over our heads.

Once we had admired the rushing water and frozen mist caking a chain link fence, we turned our two canoes downstream and began to paddle through astoundingly clear water. The river level appeared well above the meager three hundred cubic feet per second reported on an internet site, however massive tracts of riverbank were still exposed well above the water.

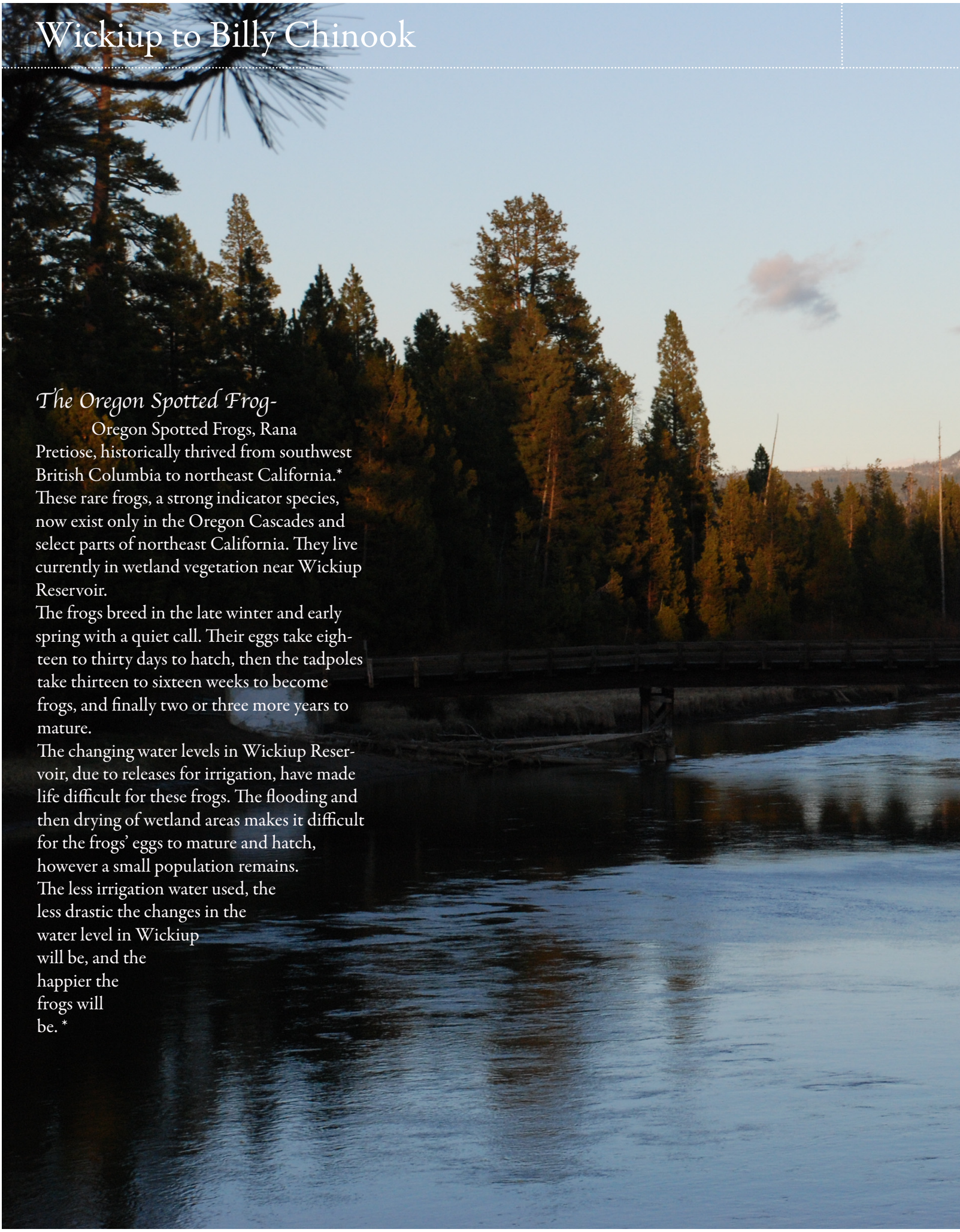
These low winter flows being released from Wickiup have an astounding affect on the Deschutes through its upper reaches, leaving us paddlers with massive, muddy banks to battle every time we want to get to shore. The five miles per hour and "NO WAKE" signs seemed ironic to us as we slowly and serenely paddled our way past, barely leaving a ripple on the pristine surface of the water.

Over the course of the day we saw more and more wildlife. About half way to Pringle Falls we spotted an otter and near the take out a flock of angry crows harassed an eagle. Once we had arrived at the take-out, driven the shuttle, and found a campsite, it was apparent that rain was imminent as the horizon darkened and we could hear thunder in the distance. Within five minutes of setting up a tarp we were in the middle of a full blown thunder storm complete with thrashing winds and enormous hail and some sloppy snow. To our relief the weather eventually cleared, leaving room for a gorgeous sunset.

Our day ends now with macaroni and cheese as I write this journal entry. I feel that a campfire might lighten the evening as the snow begins to fall light and cold. The temperature is plummeting as I scrawl over lined pages and my hands begin to shiver. Tomorrow we will portage around a log jam and paddle approximately twice as far as we did today. For now I will be content to snuggle up in my sleeping bag, pulling the hood up around my ears, and listen to the wind in the trees as I hope the weather gets better, and float off to sleep.

Evening sunlight filters through the branched of a Pine

Wickiup to Billy Chinook



The Oregon Spotted Frog-

Oregon Spotted Frogs, Rana Pretiose, historically thrived from southwest British Columbia to northeast California.* These rare frogs, a strong indicator species, now exist only in the Oregon Cascades and select parts of northeast California. They live currently in wetland vegetation near Wickiup Reservoir.

The frogs breed in the late winter and early spring with a quiet call. Their eggs take eighteen to thirty days to hatch, then the tadpoles take thirteen to sixteen weeks to become frogs, and finally two or three more years to mature.

The changing water levels in Wickiup Reservoir, due to releases for irrigation, have made life difficult for these frogs. The flooding and then drying of wetland areas makes it difficult for the frogs' eggs to mature and hatch, however a small population remains.

The less irrigation water used, the less drastic the changes in the water level in Wickiup will be, and the happier the frogs will be. *

An old military bridge crosses the Deschutes near Sunriver .

Wickiup to Billy Chinook

A polarizing filter exposes the branches of a river blocking log below Pringle Falls.

Day 5- March 27 2007- Pringle Falls

Who would ever guess that Oregon could get as cold as it is now, in the end of March? What ever happened to the beautiful spring weather we had all last week? This journal will have to be short so as my fingers don't freeze off before I finish. The sky has finally completely cleared off from its earlier overcast, making for a very chilly night thanks to radiational cooling.

We began this morning just below Pringle Falls, paddling 16 miles downstream to Big River Campground near La Pine. We quite easily managed the portage over the Tethrow log jam this morning despite having enough gear with us for a couple of weeks. An osprey flew out of a tree right above us just upstream of Tethrow. I managed to squeeze off one shot with a telephoto lens before the auto focus mechanism device broke. Later we saw a bluebird perched on a riverside willow, quite a contrast between the blue of the bird and the rusty red of the willow.

The river has made an incredible transition from a mountain stream this morning with high banks through a ponderosa pine forest, to a meandering river running through marshy grasses. The day began clear, and then snowed lightly through the late morning.

As the weather cleared again for the evening we met an incredibly interesting and talkative couple in our litter strewn campground. The man looks like an overgrown garden gnome, complete with a brightly colored Nepalese hat, sparkling blue eyes, and a mane of white locks that perfectly complements his enormous beard. The couple spends their time traveling all over the world, and are currently driving home to Alaska from Baja.

Our day finished in style with a cherry cheese cake around a blazing campfire listening to stories from India, Tibet, and Nepal. Now however I am fully prepared to fall asleep as my fingers have become completely numb and I can barely write without taking five minute breaks to stick my hands in my pockets and jump up and down.

An Osprey takes flight upstream of Tethrow

Wickiup reservoir full for the winter.

The Bald Eagles of Wickiup

Eagles are a wildlife population that has gained lots of recognition in the Deschutes River Basin, and continues to be a great indicator species for general ecosystem health. In nineteen sixty seven the bald eagle was listed as threatened under the Endangered Species Act. Historically eagles lived in the Lava Lakes area and along many stretches of the Deschutes River. During warm years the eagles will stay year round in the Deschutes area and during cold years they migrate south to the Klamath Marsh area.*

Threats to the eagles range from logging recreation, shooting and pesticide use, to land development and a loss of food. Bald Eagle Management Areas (BEMA) are often forested with ponderosa pine and associated plants. Many forests in the upper Deschutes watershed lack the middle age trees that will replace the current nesting sights when the trees die or become unsuitable for nesting. This lack of middle aged trees combined with a very thing under-story is largely due to the exclusion or natural forest fires from the ecosystem. These fires historically burned out much of the under-story, creating a healthier forest and more opportunities for eagles to make their nests.

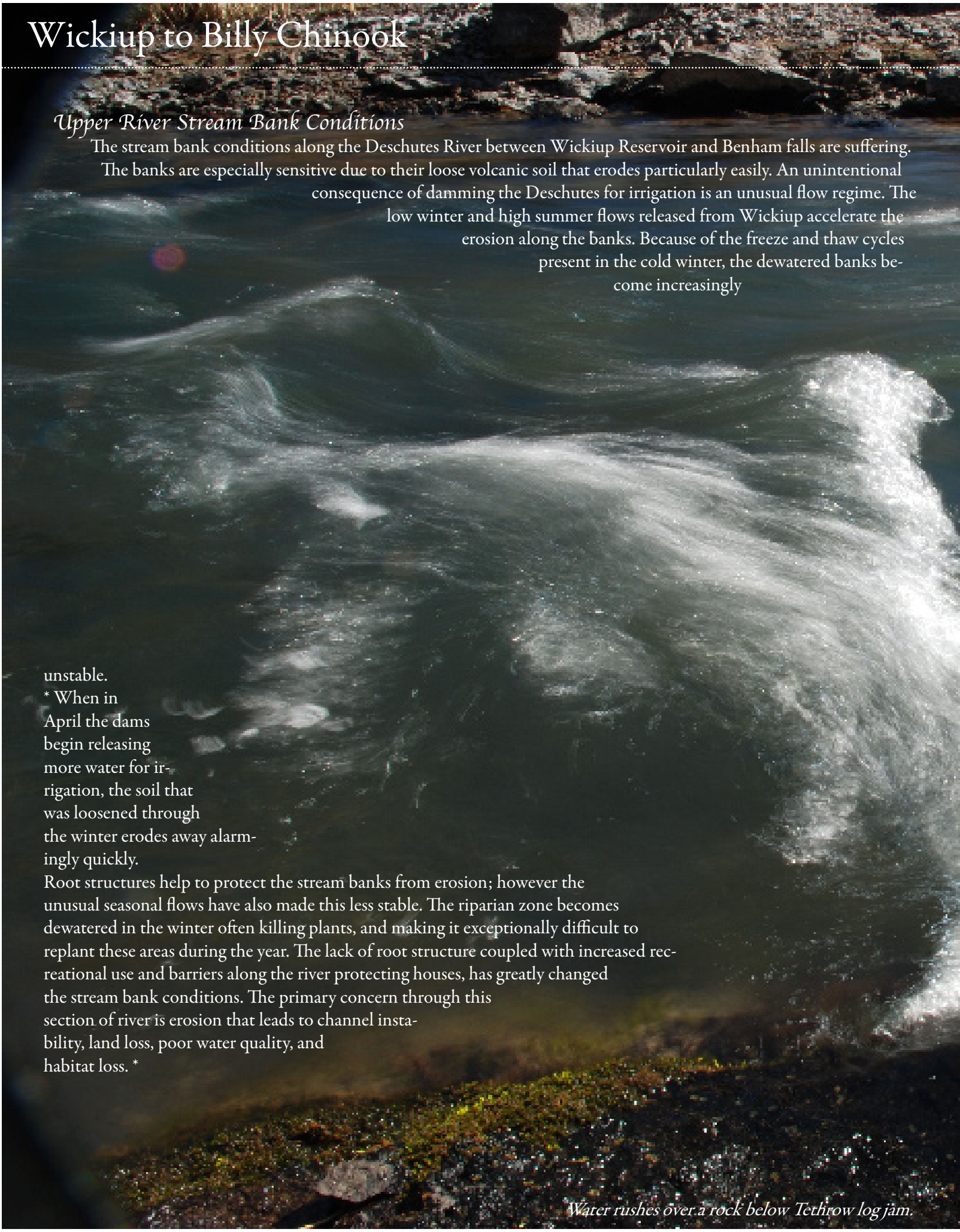
There are currently seven known pairs of nesting eagles at Crane Prairie Reservoir, Hosmer Lake, Lava Lake, and Benchmark Butte. Eagle nesting sights are being significantly depleted due to increased development and recreation along the upper Deschutes River. Efforts to protect the eagles from the pressures of logging, recreation, shooting, pesticide, and land development will have a good effect upon the greater ecosystem. *

Upper River Stream Bank Conditions

The stream bank conditions along the Deschutes River between Wickiup Reservoir and Benham falls are suffering. The banks are especially sensitive due to their loose volcanic soil that erodes particularly easily. An unintentional consequence of damming the Deschutes for irrigation is an unusual flow regime. The low winter and high summer flows released from Wickiup accelerate the erosion along the banks. Because of the freeze and thaw cycles present in the cold winter, the dewatered banks become increasingly unstable.

* When in April the dams begin releasing more water for irrigation, the soil that was loosened through the winter erodes away alarmingly quickly.

Root structures help to protect the stream banks from erosion; however the unusual seasonal flows have also made this less stable. The riparian zone becomes dewatered in the winter often killing plants, and making it exceptionally difficult to replant these areas during the year. The lack of root structure coupled with increased recreational use and barriers along the river protecting houses, has greatly changed the stream bank conditions. The primary concern through this section of river is erosion that leads to channel instability, land loss, poor water quality, and habitat loss. *



Water rushes over a rock below Tethrow log jam.

Water Quality

The water quality of the Deschutes River above Bend has greatly changed in the last 100 years. The advent of irrigation for crops, and now golf courses, has dewatered much of the river through the winter, and sent abnormally high flows through certain stretches below Wickiup in the summer. * Much of the Deschutes River through the sections above Bend does not meet Oregon Department of Environmental Quality (ODEQ) standards for Temperature, pH, dissolved oxygen, sedimentation, turbidity, or chlorophyll a. Problems with water quality are rooted in the impacts humans have had on the ecosystem through irrigation, agriculture, and recreation. *

Nutrients

Nitrogen and phosphorus are the two main nutrients present in the Deschutes River.* High levels of these nutrients stimulate algae blooms and plant growth, in effect increasing pH and dissolved oxygen through increased photosynthesis of aquatic plants. Nutrients come from a variety of sources ranging from wastewater runoff, fertilizers, septic systems, manure, disturbed lands from construction and agriculture, commercial cleaning, soil erosion, and volcanic soils.

A canoe paddles below an eroded river bank along the upper river.

Sediment and Turbidity

Sediment and turbidity are produced by erosion. Excessive sediment in the water leads to decreased photosynthesis, poor water quality, and silt deposits.* Turbidity is a measure of light traveling through a sample of water. The turbidity of the Deschutes is affected by geology, soils, slope, vegetation, precipitation, flows, and land usage. Between Wickiup Reservoir and Bend the Deschutes exceeds ODEQ limits on water turbidity.* This increased turbidity and sediment stems from the increased erosion and is caused by abnormally low winter flows and overwhelmingly high summer flows released from Wickiup for irrigation.

DISSOLVED O_2

The Deschutes River gains dissolved oxygen from photosynthesis of aquatic plants and from aeration. The river loses O_2 from respiration of organisms, and decomposition reactions. The concentration of dissolved oxygen increases with decreasing temperatures and decreasing altitude. The Deschutes is most vulnerable to low O_2 levels in the early morning on hot days when there are low flows.*

The criteria set by ODEQ for dissolved O_2 are the between September first and June thirtieth the river should be at 95% saturation for spawning and between July 1 and Aug 31 the river should be above 90% saturation.* The Deschutes does not meet these criteria above Bend and near Wickiup for spawning or the winter levels between Bend and Sunriver.

Wickiup to Billy Chinook

pH

pH is a measurement of the concentration of hydrogen ions in a solution. The pH of a water ecosystem should be between 6.5 and 8.5. The pH level can affect the ability of all animals to thrive including insects and salmonids with egg and embryo development.

Daily changes in pH levels stem from photosynthesis producing hydroxide and reducing the levels of carbon dioxide. During the day the pH rises with the increased hydroxide. The peak pH is usually in the mid-afternoon with the lowest pH just before sunrise. Seasonally the pH rises through the summer because of the increased sunlight leading to more photosynthesis in aquatic plants and drops through the winter as there is less sunlight.

Humans affect the pH level through leaking septic systems, agricultural runoff, storm water, and sewage which increases productivity of microorganisms in the water. The pH changes naturally from local chemistry and atmospheric deposition from acid rain. The Deschutes has exceeded appropriate levels when tested at Steelhead Falls, Odell Lake, and Lake Billy Chinook.*

Bundled up paddlers head down the upper Deschutes

Day 6- Mar. 28 2007- Benham Falls

It is impressive to think that we traversed the first navigable section of the Deschutes River in only three days. I sit next to a wood stove warming the soles of my feet against the flickering flames.

We began this morning on the river heading downstream through thickly developed neighborhoods along the river. It was striking to see how the houses try to protect themselves from the highly erosive river trying to cut through their property. Many homes are built much too close to the river, protected by cement walls or railroad ties thrown on the bank. As we arrived in Sunriver, the development along the river completely changed. Instead of homes lining every inch of the riverbank there was a tasteful buffer between the development and the river with a bike trail running through it, a sign of what good planning and urban development can do for a river and a community.

We arrived surprisingly quickly at the car we had shuttled to Besson Camp. We unloaded the boats and judging the time left in the day decided to finish the trip to Benham Falls that afternoon by paddling the remaining seven miles. We drove the shuttle

Two brightly lit tents just below Pringle Falls

to the falls, and then set out in our now empty boats.

Once out of Sunriver the river character began to go through a drastic change. Instead of the marshy bends and wide meanders we had become accustomed to, there were ponderosa pines right down to the water and basalt flows poking their ragged noses into the river. There were no houses along the river as it cut an increasingly incised canyon through old lava flows.

We arrived at the take out above Benham Falls in incredibly little time and loaded the canoes onto the car. To finish the day by stretching our legs we took the short walk down to the impressive Benham Falls. The river cuts through a lava flow, going from a slow and serene river, it jostles its way over rocks and boils out of holes. It is impressive to think that whitewater kayakers paddle this less than clean drop. As the light quickly fled we headed home, looking forward to a big dinner, warm bed, and the rest of the tracing of the Deschutes River.

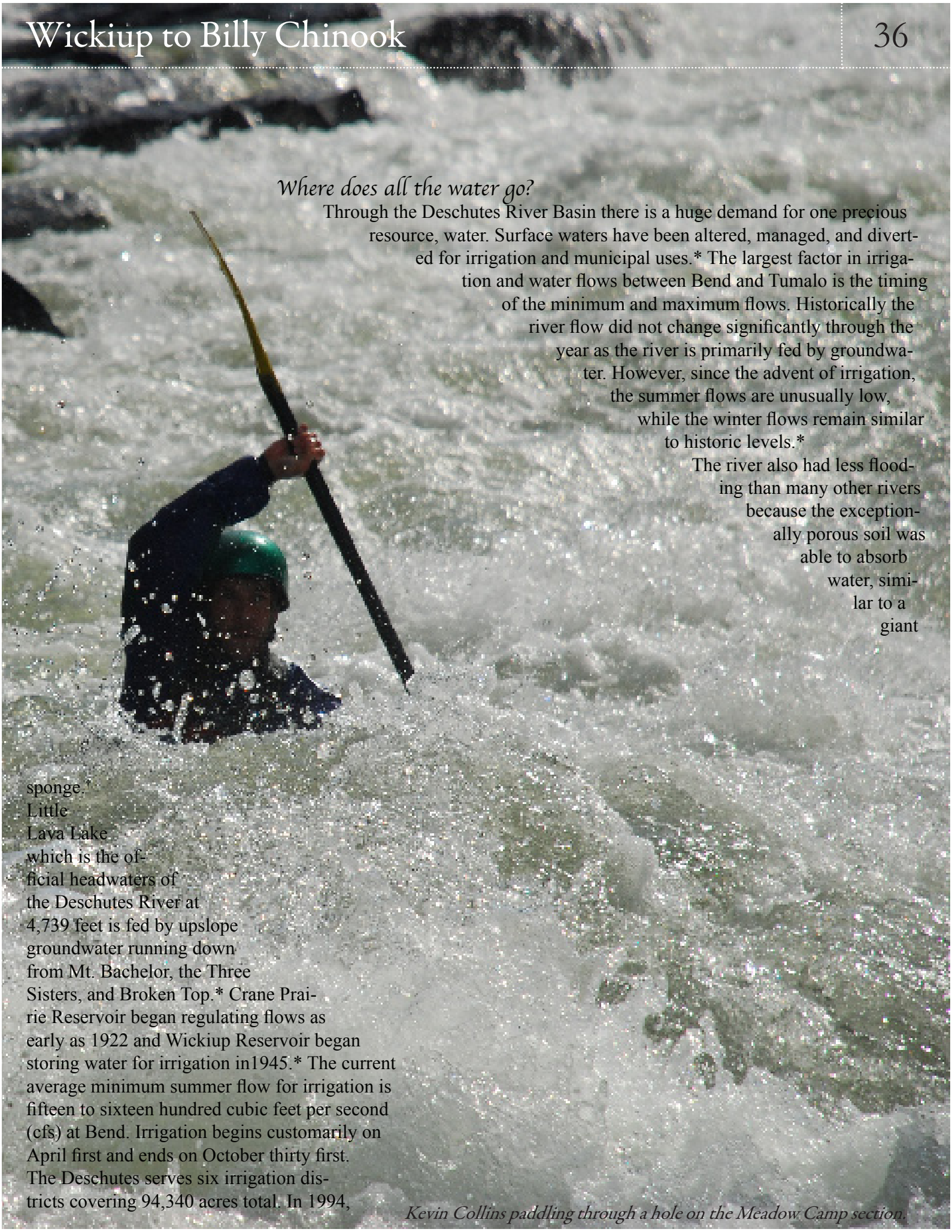
Upper River Geology

The section of the Deschutes River between Benham Falls and Bend is unique and interesting in that it flows through a recent lava flow. These lava flows are made of sedimentary, igneous, and metamorphic rocks aging from two hundred and fifty million to one thousand three hundred million years old.† The vast majority of the rock is volcanic rock less than sixty five million years old.

Almost the entire river through this section flows through a canyon cut into lavas of various compositions or other eruptive products. The bedrock to the west of the Deschutes also tends to be younger than that to the east. The Ochoco and Mutton Mountains near the Deschutes River are John Day and Clarno formations that have been eroded away leaving remnants of volcanic highlands. The northeast section of the watershed is underlain by the Columbia River Basalt Group, a series of accordantly layered basalt flows between seventeen and fourteen and a half million years old.* This leaves the Deschutes squeezed between eruptive material of varying ages to the east and west, stair stepping down over many layers of lava towards the Columbia.

Since 7.4 and 4 million years ago the Deschutes River has flowed along a similar course to where it currently flows.† Over time Pliocene basalt flows covered the relatively flat surface, leading to very little incision, allowing the river to flow where the current mesa tops are now. 1.2 to .4 million years ago the flows from Newbury Caldera filled the Deschutes and Crooked rivers creating very interesting canyon walls in the current canyon.† Between 1 and 4 million years ago there were around two hundred and seventy five meters of incision, down cutting an average of point one millimeter per year.†

Kevin Collins drops into a rapid on the Meadow Camp section of the Deschutes.



Where does all the water go?

Through the Deschutes River Basin there is a huge demand for one precious resource, water. Surface waters have been altered, managed, and diverted for irrigation and municipal uses.* The largest factor in irrigation and water flows between Bend and Tumalo is the timing of the minimum and maximum flows. Historically the river flow did not change significantly through the year as the river is primarily fed by groundwater. However, since the advent of irrigation, the summer flows are unusually low, while the winter flows remain similar to historic levels.*

The river also had less flooding than many other rivers because the exceptionally porous soil was able to absorb water, similar to a giant sponge.* Little Lava Lake, which is the official headwaters of the Deschutes River at 4,739 feet is fed by upslope groundwater running down from Mt. Bachelor, the Three Sisters, and Broken Top.* Crane Prairie Reservoir began regulating flows as early as 1922 and Wickiup Reservoir began storing water for irrigation in1945.* The current average minimum summer flow for irrigation is fifteen to sixteen hundred cubic feet per second (cfs) at Bend. Irrigation begins customarily on April first and ends on October thirty first. The Deschutes serves six irrigation districts covering 94,340 acres total. In 1994,

Kevin Collins paddling through a hole on the Meadow Camp section.

313,930 acre-feet of water were lost due to seepage.* Since irrigation only gains sixty to sixty five percent efficiency with sprinklers and thirty five to fifty percent efficiency with flooding, it is clear that something needs be done to return water to the Deschutes. Between November and March Wickiup Reservoir releases as little as twenty cfs compared to the approximate twelve hundred cfs released between April and October.* The lowest flows occur just below Bend where ninety percent of the water is diverted between June and September leaving only a measly thirty cfs.* These low flows during the irrigation season have a huge impact on streamside vegetation, recreation, wildlife, and water quality throughout the entire river ecosystem.

A paddler floats in the morning fog near Besson Camp

Wickiup to Billy Chinook

The Deschutes in Four Days

When Casey Glick and Justin Thomas set out to paddle the Deschutes, they didn't do what your normal white-water kayaker might think of. Instead of just paddling a day stretch on the upper river, Casey and Justin set off to paddle the entire river from its confluence with the Little Deschutes near Sunriver, to the Columbia, in only four days. For a sense of scale, they paddled in a day and a half what I spent six days floating.

Last year Justin and Casey set off for their first attempt. Putting in at four thirty in the morning in November their goal was Benham Falls by sunrise, some fifteen miles downstream. After running Benham falls it was on to Dillon, Lava Island, and all the rapids in between. The first night was spent in downtown Bend, not as far as they had hoped. The second day took them by lunch to Tumalo, then on down the canyon run between Tumalo and Lake Billy Chinook, paddling Odin and Steelhead falls and the fish ladder on Big Falls. The were however falling behind and by the time they got to Trout Creek with one day left, they knew they had eighty miles to go and the ice was quickly accumulating on their paddling jackets in the sub zero November weather. With the assurance that they could try it again, and hopefully make it, they gave up for that year.

A year later Casey and Justin were back, putting in near Sunriver with light sticks tied to the ends of their boats so they could see each other in the pre-dawn darkness. Running down through Bend, their first night was spent at

Justin Thomas runs Steelhead Falls on his way to the Columbia, Photo courtesy of Casey Glick

Tumalo, where they were the last year for the second day's lunch. The second day took them down to Trout Creek, then onwards the third day to the lower river, leaving on a few hours of paddling on the fourth day to arrive at the Columbia. Their successful traverse of the Deschutes in four days is remarkable to say the least, they did what it took me months to trace, in less than a week.

Wickiup to Billy Chinook

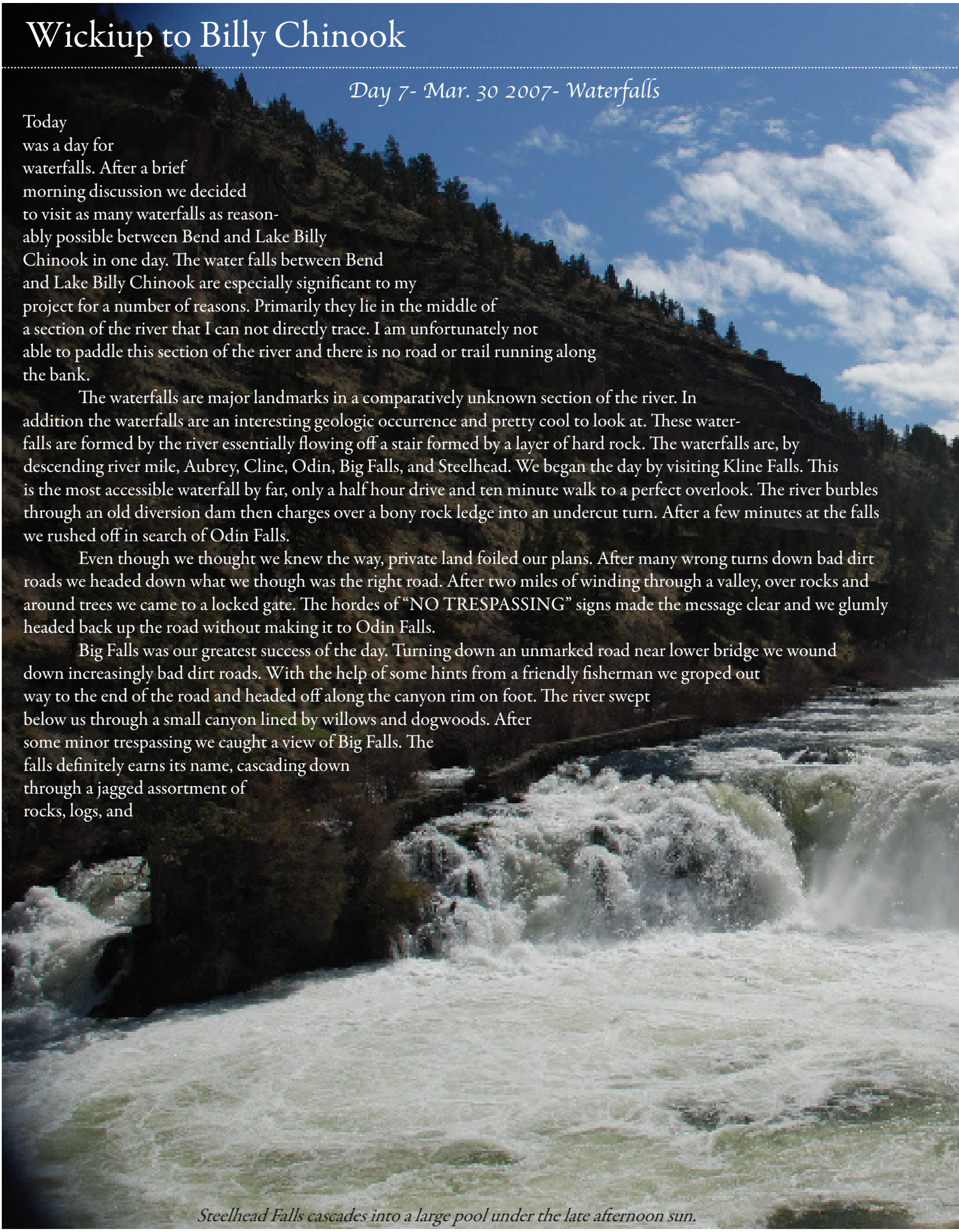
Day 7- Mar. 30 2007- Waterfalls

Today was a day for waterfalls. After a brief morning discussion we decided to visit as many waterfalls as reasonably possible between Bend and Lake Billy Chinook in one day. The water falls between Bend and Lake Billy Chinook are especially significant to my project for a number of reasons. Primarily they lie in the middle of a section of the river that I can not directly trace. I am unfortunately not able to paddle this section of the river and there is no road or trail running along the bank.

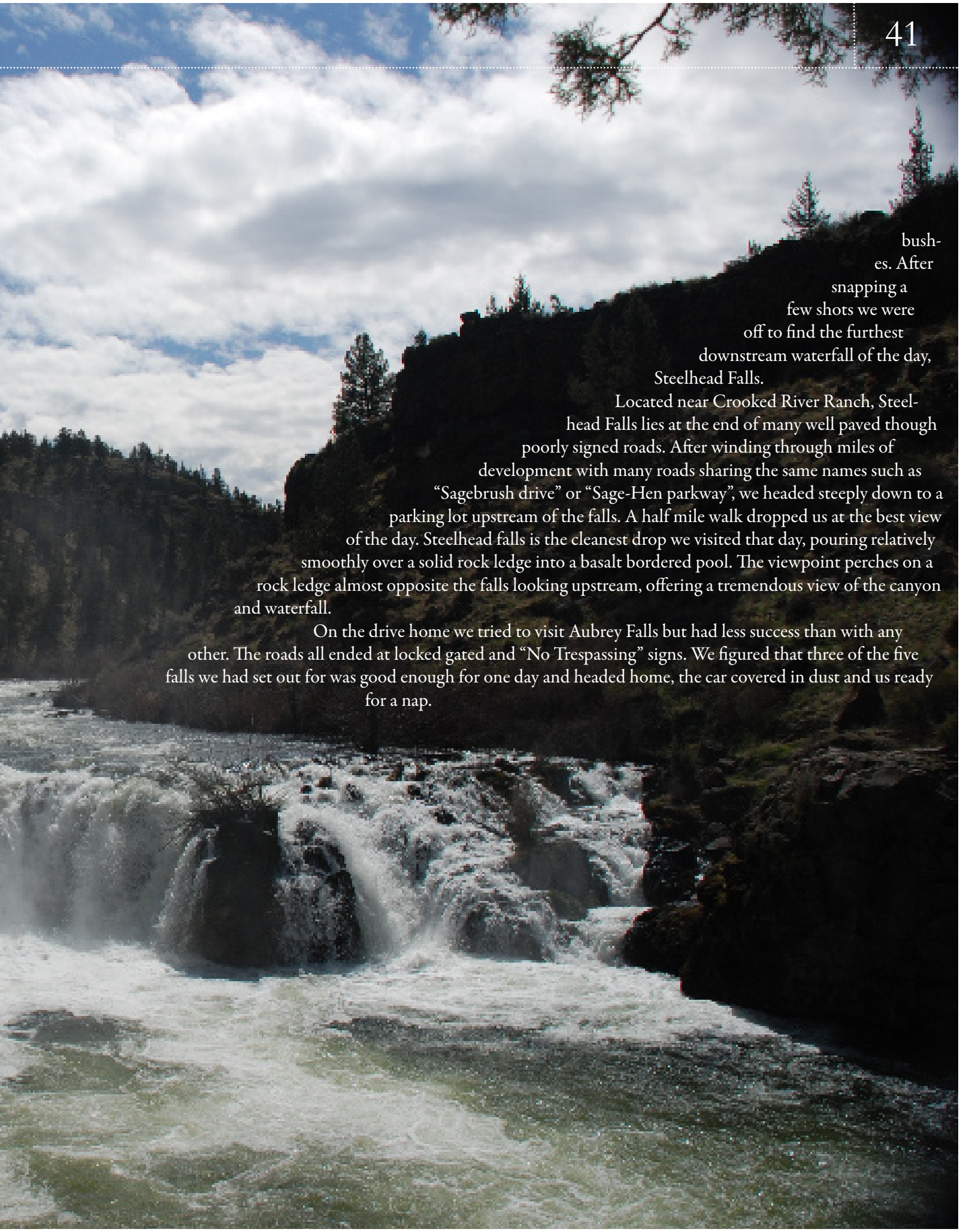
The waterfalls are major landmarks in a comparatively unknown section of the river. In addition the waterfalls are an interesting geologic occurrence and pretty cool to look at. These waterfalls are formed by the river essentially flowing off a stair formed by a layer of hard rock. The waterfalls are, by descending river mile, Aubrey, Cline, Odin, Big Falls, and Steelhead. We began the day by visiting Kline Falls. This is the most accessible waterfall by far, only a half hour drive and ten minute walk to a perfect overlook. The river burbles through an old diversion dam then charges over a bony rock ledge into an undercut turn. After a few minutes at the falls we rushed off in search of Odin Falls.

Even though we thought we knew the way, private land foiled our plans. After many wrong turns down bad dirt roads we headed down what we though was the right road. After two miles of winding through a valley, over rocks and around trees we came to a locked gate. The hordes of "NO TRESPASSING" signs made the message clear and we glumly headed back up the road without making it to Odin Falls.

Big Falls was our greatest success of the day. Turning down an unmarked road near lower bridge we wound down increasingly bad dirt roads. With the help of some hints from a friendly fisherman we groped out way to the end of the road and headed off along the canyon rim on foot. The river swept below us through a small canyon lined by willows and dogwoods. After some minor trespassing we caught a view of Big Falls. The falls definitely earns its name, cascading down through a jagged assortment of rocks, logs, and



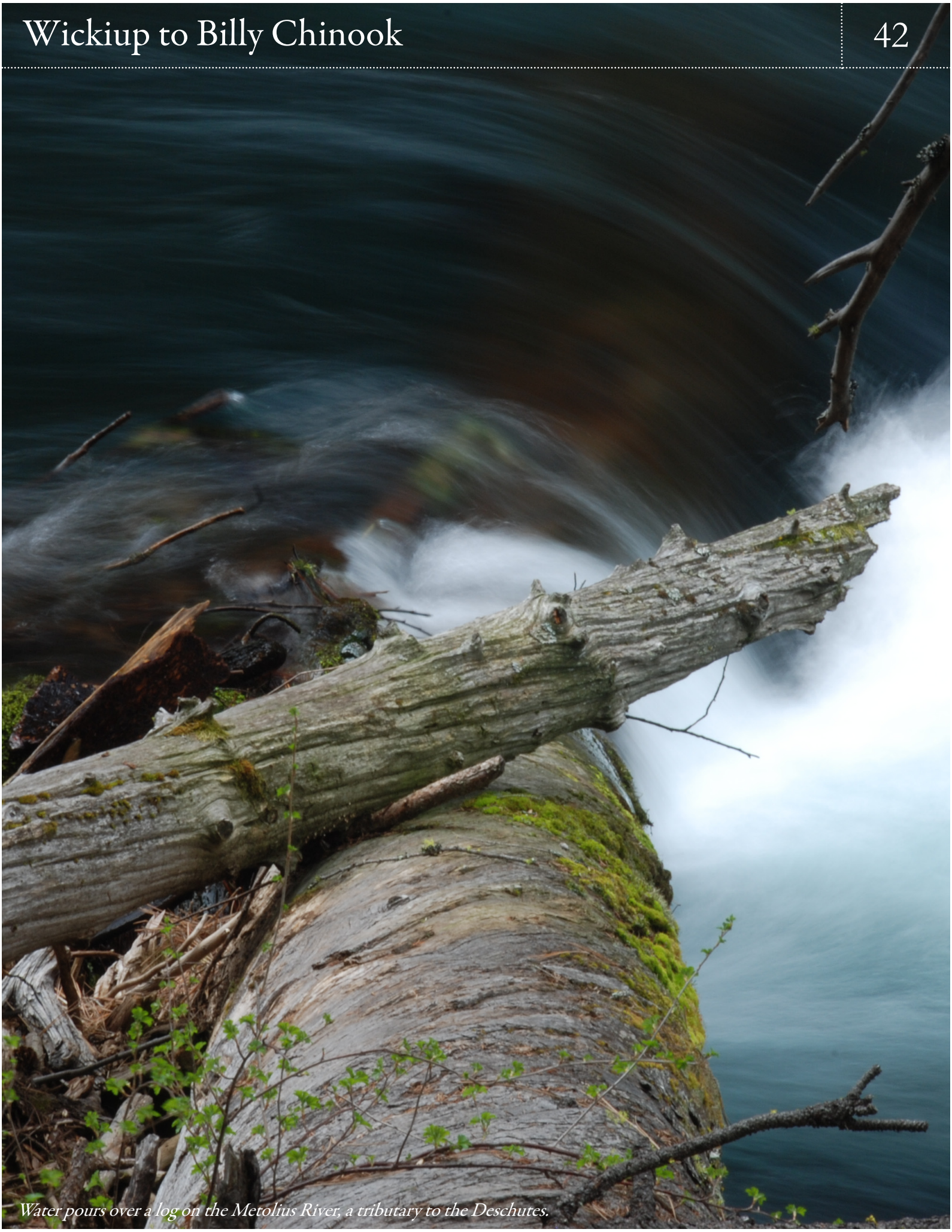
Steelhead Falls cascades into a large pool under the late afternoon sun.



bushes. After snapping a few shots we were off to find the furthest downstream waterfall of the day, Steelhead Falls.

Located near Crooked River Ranch, Steelhead Falls lies at the end of many well paved though poorly signed roads. After winding through miles of development with many roads sharing the same names such as "Sagebrush drive" or "Sage-Hen parkway", we headed steeply down to a parking lot upstream of the falls. A half mile walk dropped us at the best view of the day. Steelhead falls is the cleanest drop we visited that day, pouring relatively smoothly over a solid rock ledge into a basalt bordered pool. The viewpoint perches on a rock ledge almost opposite the falls looking upstream, offering a tremendous view of the canyon and waterfall.

On the drive home we tried to visit Aubrey Falls but had less success than with any other. The roads all ended at locked gated and "No Trespassing" signs. We figured that three of the five falls we had set out for was good enough for one day and headed home, the car covered in dust and us ready for a nap.



Water pours over a log on the Metolius River, a tributary to the Deschutes.

The sun sets down the canyon on the lower Deschutes

Warm Springs to the Columbia

Day 8- May 9 2007- Warm Springs

I hear the river rushing by our first night's camp, mingling with the guitar and mandolin played by my two companions on this section of my voyage to the Columbia, Ken and Peter. The sun has just set over the canyon rim leaving us with stars like points of light in a black sheet, glittering through the branches of a honey locust tree.

We began this morning in Portland. After I finally finished my AP calculus test at noon we headed off in a loaded pickup truck towing two drift boats stacked on a trailer, with my canoe riding high on top of the whole rig. The bed of the truck was stuffed to the brim with coolers of food, boxes and bags holding our other gear, along with oars, paddles, and a bright orange kayak that resembles an oversized jellybean.

Upon our arrival in Warm Springs we unloaded the truck, hauling coolers over the tailgate and sliding the boats into the water. Just as I was heaving a particularly large dry bag over the side of the truck, I heard a voice behind me inquiring as to what we were doing. An Indian woman from the nearby homeless camp at the end of the parking lot had come over, wondering why three people were putting in on the river with four boats, in the late afternoon. She proceeded to drag her boyfriend Randy across the parking lot to talk to us

too. They explained that the homeless population of Warmsprings is desperate, some living in Bureau of Indian Affairs or tribal housing, however that is difficult to get into and the unlucky ones end up in what they described as "the housing we aint goin to": jail. They currently live at the end of the parking lot in a miserably looking camp. Once the shuttle driver arrived and the boats were ready, we headed off downstream. The wind rose as clouds swept across the hazily blue sky. Progress was slow, but a few river miles later we were able to pull off at a grassy camp surrounded by stubby trees and high sagebrush.

Later, as my companions head off to bed, I feel the cold air brushing its way up the canyon, whispering through the trees and rustling through the grass. For now it is time to sleep under the brilliant stars, saving energy for an early start tomorrow to beat the afternoon wind.

The rig loaded and ready to go for section three.

A Redband trout about to be released on the lower river.

A Story for the Fish

Ever since the Oregon Fish and Game Commission, known now as the Oregon Department of Fish and Wildlife, began introducing stocked fish to the Deschutes River Basin in 1913, there have been significant issues.* The introduced fish tend to pressure and dominate the native species, diseases spread rapidly, and the general ecosystem is unnaturally altered. Combining the introduction of non-native fish with barriers such as dams, waterfalls, irrigation canals, and the pressure from a heavy handed management program, the Deschutes River ecosystem has gone through enormous changes in the last one hundred and fifty years.*

Stocking began in the early twentieth century with the packing of rainbow and brook trout on horseback and mule strings. In 1996, 100,000 legal size, and 733,000 fingerling trout and salmon were stocked in the Deschutes River sub basin.*

In Odell Lake the bull trout are now almost extinct due to pressures from introduced lake trout. This trend of introduced species putting unnatural pressures on native species such as bull trout, redband trout, mountain whitefish, sculpins, summer steelhead, chinook, and pacific lamprey, has continued throughout the Deschutes River, dramatically changing the fish populations.

Fish management has always been a tough issue on the Deschutes. In the 1940s chemical controls were used on undesirable fish. Tui-Chub were controlled primarily by Piscicide and Rotenone. In 1973 all the fish in Fall River were poisoned to control Bacterial Kidney Disease and Infectious Pancreatic Necrosis Virus.* In the last twenty years a big change has taken place with wild fish management policy. To protect wild population there is currently less stocking and more restrictive fishing regulation.

The Deschutes River contains many natural barriers such as the waterfalls between Benham Falls and Lake Billy Chinook. Lake Billy Chinook itself is formed by a non-natural barrier, a dam. Since the eighteen hundreds there has been concern over the ability of fish to pass natural and human barriers through fish ways such as fish ladders. In eighteen seventy two law required fish ways over obstacles of barriers.*

Through the actions of conservation and fishing groups, many of the native fish in the upper Deschutes River are on their way to a happier and easier existence. The non-native species are being stocked less, and in more selective areas, fishing has become more restricted, and stream conditions are improving.

The dory floats through wreck rapids.

Day 9- May 10 2007- Trout Creek.

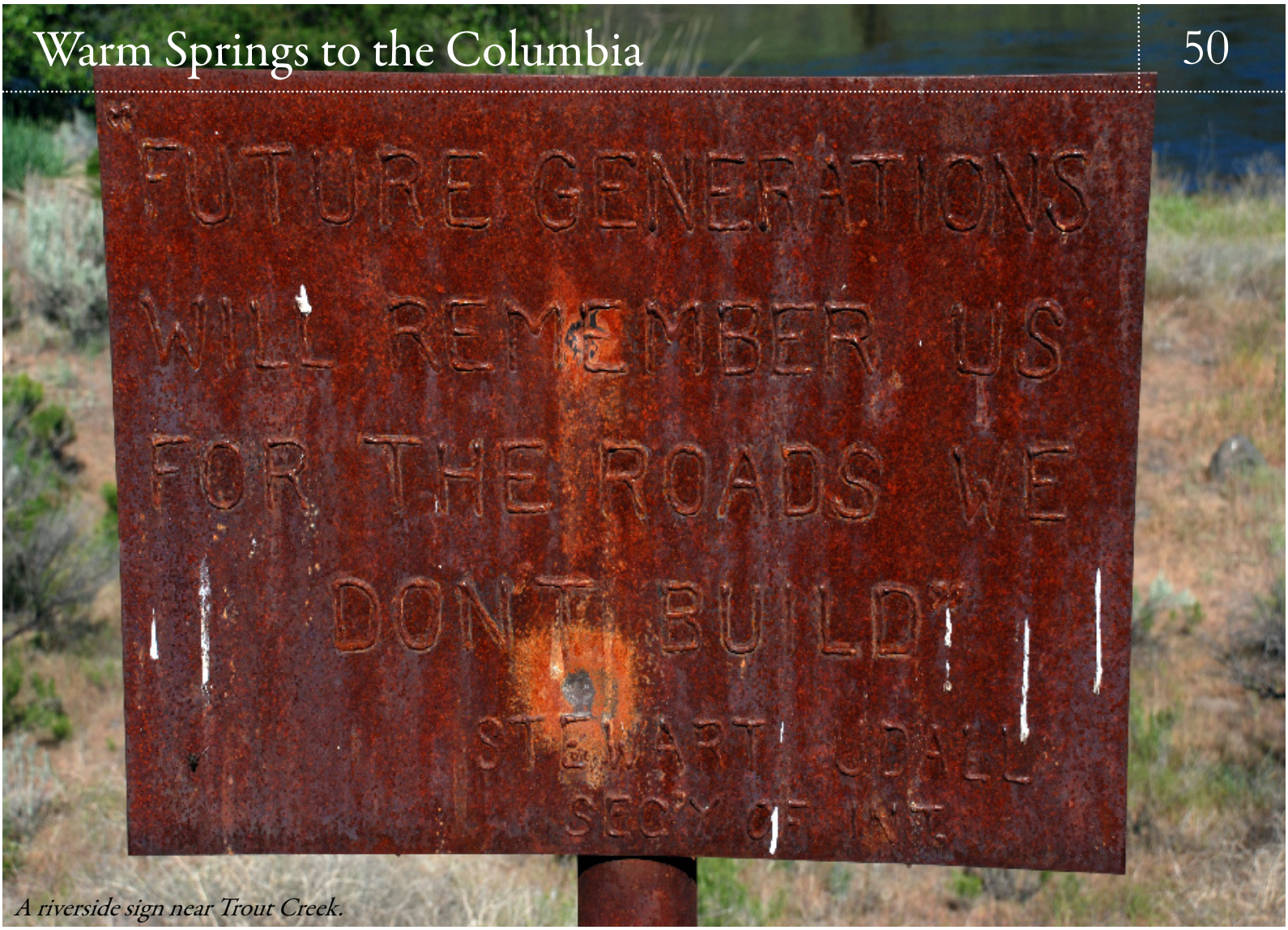
A huge pine tree in the middle of our camp obscures part of the night sky above my sleeping bag. Looking straight up though I can see the Big Dipper. Following the end of the dipper straight out I see Polaris, telling me that my head is pointing due north.

We began with an early start this morning so as to avoid the dreaded wind. The river miles passed quickly, splashing through Trout Creek rapids by ten in the first real test of my new red whitewater canoe. As the river continued its mellow nature through a wide canyon the birds came out to greet us as an osprey swooped over-head. An otter popped its head up just behind our boats, and a mink followed us along the bank for a few hundred feet. Later a great egret, a bird is not usually seen in this area, swooped out of a riverside tree.

In the entire day we only saw two other groups, remarkable considering the beautifully sunny weather. Our early arrival in camp around noon prompted a walk up to the scarp above Whitehorse rapids. From our vantage

Grasses turned green with spring rain along the lower river.

point
high
above
the river we
could see the
entire area where
a landslide had oc-
curred, naturally dam-
ming the river and creating
the rapid.
As the daylight receded up the
hillside above us, chasing the setting
sun skyward, we read, wrote, fished, and
took pictures of the smoothly flowing river.
As my headlamp dims I snuggle deeper into
my sleeping bag. The river rushes past, scurry-
ing in its race to the ocean. My race to the ocean
will have to wait though until the morning, I am most
likely still far ahead of those water crystals that I photo-
graphed frozen to a stubby tree in Broken Top crater.

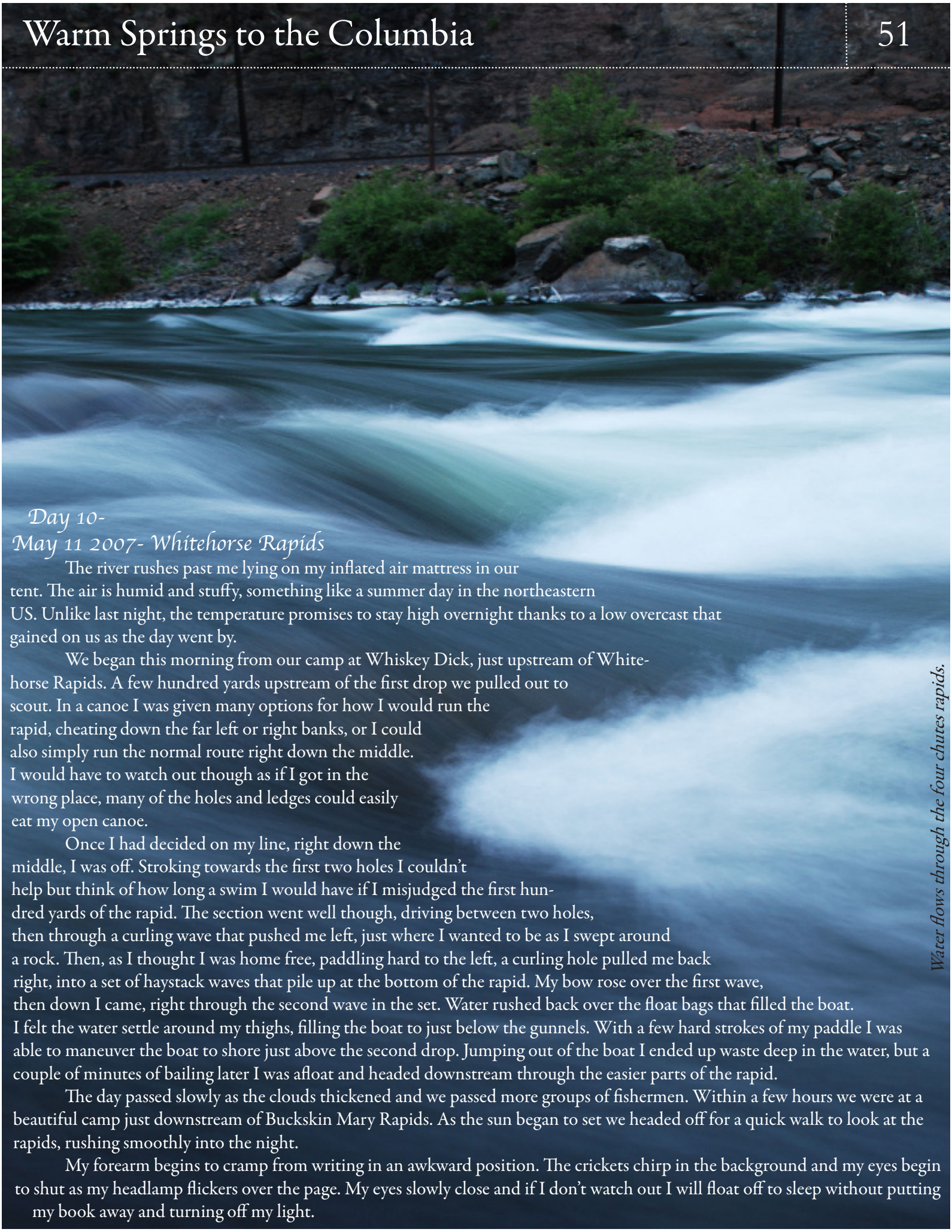


A riverside sign near Trout Creek.

Birds of the Lower River

Over the course of traversing the lower river from Warm Springs to the Columbia, my companions Peter and Ken kept a detailed list of the birds we saw. Day in and day out Ken could be spotted with his binoculars, crouching around bushes, or bouncing down the wrong side of a rapid in his drift-boat, all so he could see another bird. In the end we collectively had spotted forty three birds in the ninety seven miles that we floated. Even though I personally only contributed two, the Great Egret and Golden Eagle, the list has great relevence to the project. Not only do all these birds live in the Deschutes River Basin, but for all but a few of them, we saw more than one, even of species that are considered rare.

-Bewick Tern
-Mallard
-Merganser
-Bulleck's Oriel
-Chuckar
-Red Wing Black Bird
-Spotted Sandpiper
-Canada Goose
-Belted Kingfisher
-Brown Headed Cowbird
-Song Sparrow
-Western Kingbird
-Western Meadowlark
-Ringbilled Gull
-Yellow Warbler
-Brewer's Blackbird
-Great Blue Heron
-Violet Green Swallow
-Cliff Swallow
-Bank Swallow
-Great Egret
-Cooper's Hawk
-Eastern Kingbird
-American Kestrel
-California Gull
-Killdeer
-Redtail Hawk
-Northern Raven
-Bald Eagle
-Northern Raven
-N. Harrier
-Bushtit
-American Goldfinch
-American Robin
-Spotted Fohee
-California Quail
-Canyon Wren
-Lazuli Bunting
-Northern Flicker
-Starling
-Rock Dove
-White Throated Swift
-Golden Eagle



Water flows through the four chutes rapids.

Day 10-
May 11 2007- Whitehorse Rapids

The river rushes past me lying on my inflated air mattress in our tent. The air is humid and stuffy, something like a summer day in the northeastern US. Unlike last night, the temperature promises to stay high overnight thanks to a low overcast that gained on us as the day went by.

We began this morning from our camp at Whiskey Dick, just upstream of Whitehorse Rapids. A few hundred yards upstream of the first drop we pulled out to scout. In a canoe I was given many options for how I would run the rapid, cheating down the far left or right banks, or I could also simply run the normal route right down the middle. I would have to watch out though as if I got in the wrong place, many of the holes and ledges could easily eat my open canoe.

Once I had decided on my line, right down the middle, I was off. Stroking towards the first two holes I couldn't help but think of how long a swim I would have if I misjudged the first hundred yards of the rapid. The section went well though, driving between two holes, then through a curling wave that pushed me left, just where I wanted to be as I swept around a rock. Then, as I thought I was home free, paddling hard to the left, a curling hole pulled me back right, into a set of haystack waves that pile up at the bottom of the rapid. My bow rose over the first wave, then down I came, right through the second wave in the set. Water rushed back over the float bags that filled the boat. I felt the water settle around my thighs, filling the boat to just below the gunnels. With a few hard strokes of my paddle I was able to maneuver the boat to shore just above the second drop. Jumping out of the boat I ended up waste deep in the water, but a couple of minutes of bailing later I was afloat and headed downstream through the easier parts of the rapid.

The day passed slowly as the clouds thickened and we passed more groups of fishermen. Within a few hours we were at a beautiful camp just downstream of Buckskin Mary Rapids. As the sun began to set we headed off for a quick walk to look at the rapids, rushing smoothly into the night.

My forearm begins to cramp from writing in an awkward position. The crickets chirp in the background and my eyes begin to shut as my headlamp flickers over the page. My eyes slowly close and if I don't watch out I will float off to sleep without putting my book away and turning off my light.

Day 11- May 12 2007- Maupin

My headlamp dimly illuminates the page as my tired hand scrawls line after line onto crinkled paper. The roar of the river fills my ears as it rushes by our tiny camp on a gravel bar precariously perched beneath the railroad tracks.

We began this morning knowing that the day held some excitement. With most of the stretch's major rapids in this section I had a feeling that I very easily might end up swimming as I descended through Wapinitia, Boxcar, Oak Springs, and Elevator.

I pushed my red canoe down off of the bank into the water, the bow quickly bobbing to the surface. My seal launch, as it's called in boating terms, managed to deposit the first few drops of water of the day right into my lap.

We headed downstream as the wind strengthened, nearing the boat ramp at Harpham Flat just as gusts managed to spin the boats in the river. The drift boats were quickly stacked onto the waiting trailer while the canoe and kayak would continue on downstream. The boat-ramp was crowded with groups doing guide training for the season along with a couple of small day trip groups. Once the drift boats were secured on the trailer, with Ken at the helm of our pickup truck "Tiny", Peter and I headed off downstream towards Wapinitia and Boxcar.

We decided not to scout Wapinitia, we both knew the well and could tell where we wanted go. As I dropped down the first chute in my canoe, following Peter in the orange jellybean of a kayak, I drove right to avoid the second of two mid-channel rocks. Paddling hard through a lateral wave I looked forward, just long enough to see the bottom of an orange kayak cresting a wave downstream. Within seconds Peter had rolled up and was paddling furiously to avoid the growling behemoth that waited downstream.

The excitement continued with Boxcar rapids, just downstream, named for a boxcar from a train wreck that fell into the river. After managing to swamp my canoe in the hole on river left, I bailed like a mad man, standing waste deep in the cold water.

From the excitement of boxcar our day passed relatively serenely. A stop in Maupin prompted lunch at the classic Oasis Café. At the café we found a copy of a newspaper article from the Oregonian chronicling a river trip in

1938 down the Deschutes before there were any dams. We headed downstream from Maupin, however it was soon clear the weather was not going to cooperate. As Peter, who was now paddling the canoe, got blown clear out of a rapid and up on the bank, we began to look for other options. Just by chance Ken had forgotten to fill the propane tank, so as he drove past we waved him down and hopped in, finding shelter from the wind and rain while we drove back to Maupin, then downstream to Sherars Falls.

We could see cars parked along either side of the river before we could see Sherars Falls itself. Fisherman lined the banks, baiting their hooks for Chinook waiting in the roiling water just downstream from the waterfall. The sun peaked through a cloud, bathing the torrent in afternoon light as we briefly walked up the shore to the falls.

Heading further downstream we arrived at our put-in at Buck Hollow. Our late start sent us searching for a suitable campsite just downstream from the put-in. We finally found a sight, quickly creating our home away from home on a riverside gravel bar. With some pasta and cookies in our stomachs it was time for bed, listening to the trains rush my on the tracks just overhead, making our tent flicker with their headlights.

A short depth of field leaves the background of a rocky beach blurred below two stems

Day 12- May 13 2007- Mack's Canyon

The gentle plucking of a guitar floats upstream with the light evening breeze. My chair looks directly out on the river, affording a perfect view of the raggedly sweeping canyon walls. A mandolin joins the guitar and I yawn, struggling to stay awake long enough to write.

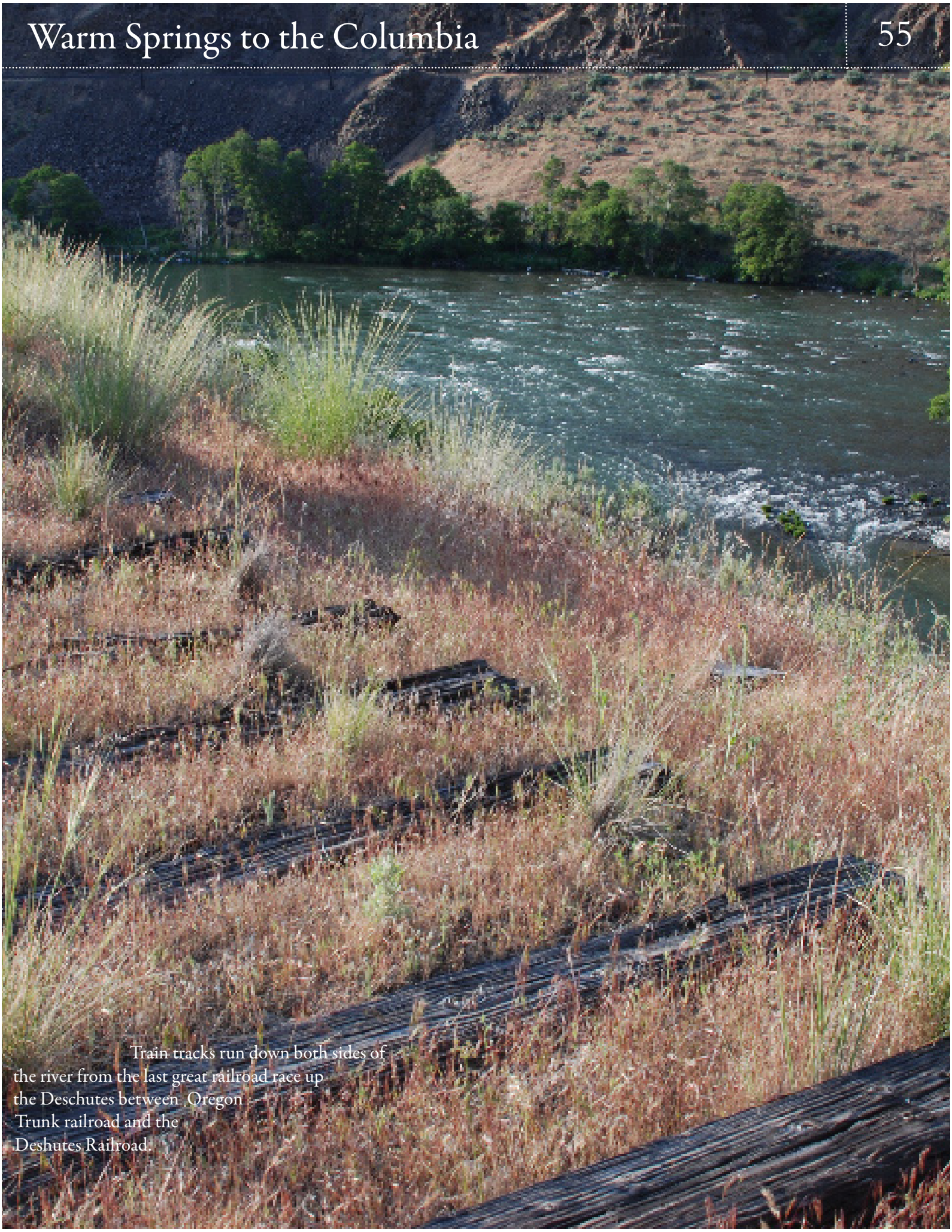
We began this morning at our camp just downstream of Sherars Falls. After a breakfast of scrambled eggs we packed the boats and headed off downstream. A few miles into the day's float we got to Wreck rapids, where a train wreck once spilled off the tracks and down the bank towards the rapids. Perching on an outcropping of basalt, sticking like a tongue into the river, I was able to snap shots of the drift boats splashing their way through a hole. Peter was able to also take a few pictures of me after pulling his boat out on an island on the river right.

From Wreck rapids the day passed uneventfully, with blustery winds trying to blast us off the river in the late afternoon. We arrived at camp later than expected, around four thirty, but still found one of the best campsites of the entire trip. The small sandy beach under fluttering alder trees bordered on a perfect flat for the kitchen, rising up into a ridge behind camp that wound its way high up above the river.

As the sun began to set we headed up the ridge, following the line of shade skyward, making the sun set over and over. As we crested a ridge high above camp, Peter, scanning a far away ridge with binoculars, exclaimed, "Hey, look, desert bighorn sheep". Sure enough, on a ridge across the river we could barely spot a solitary bighorn sheep, silhouetted against the clear evening sky. The beast, eloquently described by Ken as "an old Filson vest", was soon joined by five more of its companions.

I went back to walking out along an old barbed wire fence, following it towards a view of the canyon. Within minutes though the call returned "no way, look, more bighorns". Yet again Peter had spotted bighorns, this time four of them, barely discernable even with a telephoto lens, on a ridge far downstream. The light quickly faded though, as did my camera battery. We headed back down the ridge to our camp through blowing grasses, blooming lupine, and sagebrush that filled our nostrils with its pungent scent.

Barbed wire blocking cattle from the lower river has had huge impacts on water quality and erosion.



Train tracks run down both sides of the river from the last great railroad race up the Deschutes between Oregon Trunk railroad and the Deshutes Railroad.

Geology of the Lower River

While the lower Deschutes River has been largely shaped simply by the river eroding through layers of earth, larger forces have been at play throughout its entire history.

The river currently flows through a canyon that is as deep as six hundred meters. The canyon is composed of what is essentially a layer cake of lava flows. Along the river above river mile (RM) eighty five, these lava flows are more visible due to less silt from the backwater of the Missoula Floods.[†]

The river flows through a canyon of exposed rock from the John Day Formation, overlaid by one hundred and fifty meters of the Columbia River Basalt Group. These two layers are then covered by around one hundred and fifty meters of basalt from the Deschutes Formation which is capped by smaller and younger lava flows.[†]

Below RM sixty the Deschutes River begins to flow increasingly through the thickening Columbia River Basalt Group, with more of the Dallas formation becoming exposed.[†] Through these areas the river is more susceptible to landslides due to the

unstable nature of the rock. The landslides are largest where the John Day Formation is near the canyon rim such as where the river flows through the Mutton Mountains at RM eighty five. The largest landslides through this area are gargantuan, sliding very slowly up to six km down and along the canyon, and covering up to fifty square km.†

Despite the river having an abnormally stable flow due to it's largely groundwater fed nature, over its distant history a number of enormous floods have helped to sculpt and carve the path through which the river now flows. Because of the absence of large, terrain changing floods, in the last 100 years, the Deschutes River offers a great opportunity for scientists to study the effects of flooding on a river where the evidence is still easily found.†

A variety of flood types have helped to shape the modern day Deschutes River Canyon ranging from volcanic lahars, glacial outbreaks, backwater floods, and more recently meteorological floods and debris flows.† Many of the most well known rapids on the lower Deschutes were formed by partial damming of the river by landslides. Whitehorse Rapids was formed when a landslide blocked the entire river channel, forming a pool upstream. When this pool reached the level of the top of the landslide, it rapidly eroded the soil of the landslide and rushed downstream in a flood, quickly taking the banks downstread with it and greatly changing the nature of the river.†

The more meandering nature of the river as it nears the Columbia is due to the low-gradient historic river that flowed above the Columbia River Basalt Group.† The incision of the river through layers of stone over many years has roughly followed the general local trends and regional structures. Currently the river flows through a canyon that has been deeply incised by the erosive forces of repetitive floods.

The valley bottom nature of the Deschutes River below Pelton Dam often mirrors the overarching geological nature of the area. As the river flows from one local area of geological activity to the next, the breadth and gradient of the valley can quickly change. Often harder rocks surrounding an area cause the valley bottom to narrow, creating less opportunity for the river to spread out and meander. Also, through sections where bedrock is exposed, versus where it is overlaid by deposits from previous floods, the river narrows down and becomes more deeply incised. Floodwaters from the Missoula floods flowed sixty km up the Deschutes River, filling much of the lower river with silt and clay.† This helps to account for the wider nature of the valley towards the lower river where sandbars and large flat banks border the river. Also on these lower sections of the river the canyon walls have more plant growth and lower angles due to silt and clay deposits from flood backwaters. Alternatively, the upper sections of the river above Maupin have bare rocky walls. More recent floods, such as those in December 1964 and February 1996, have had smaller effects upon the local river course because the amount of sediment left by previous floods has made the valley bottom more difficult to erode.†

Water blurs over rocks on the lower river.

Day 13- May 14 2007- Homestead

The evening sun fades from another idyllic camp along the Deschutes. As usual, the guitar and mandolin mingle with the rushing river, tonight joined by the rumbling buzz of thousands of bees feeding on the honey locusts above our heads.

Today began with a particularly early breakfast; we were heading off in search of a better view of the desert bighorn sheep on the hillside across the river from our camp.

Forty minutes later we are stooping, picking our footing carefully so as to not knock rocks off the scree slope we are traversing. I come to a large rock; readying my camera, then climb up over the top, like a sniper readying a shot at the enemy commander. I crawl higher, holding my camera in my right hand, and gripping a miniscule hand hold with my left. I slither out across the grass above the rock, making sure to not slip on the forty-five degree slope that cascades over cliff bands just a short ways downhill.

Then I spot one just across the slope from me. Just as I raise my head enough to see the sheep, it's head pops up, its eyes locking on to the irregularity in its landscape of my light, sage blue shirt, and dark hair.

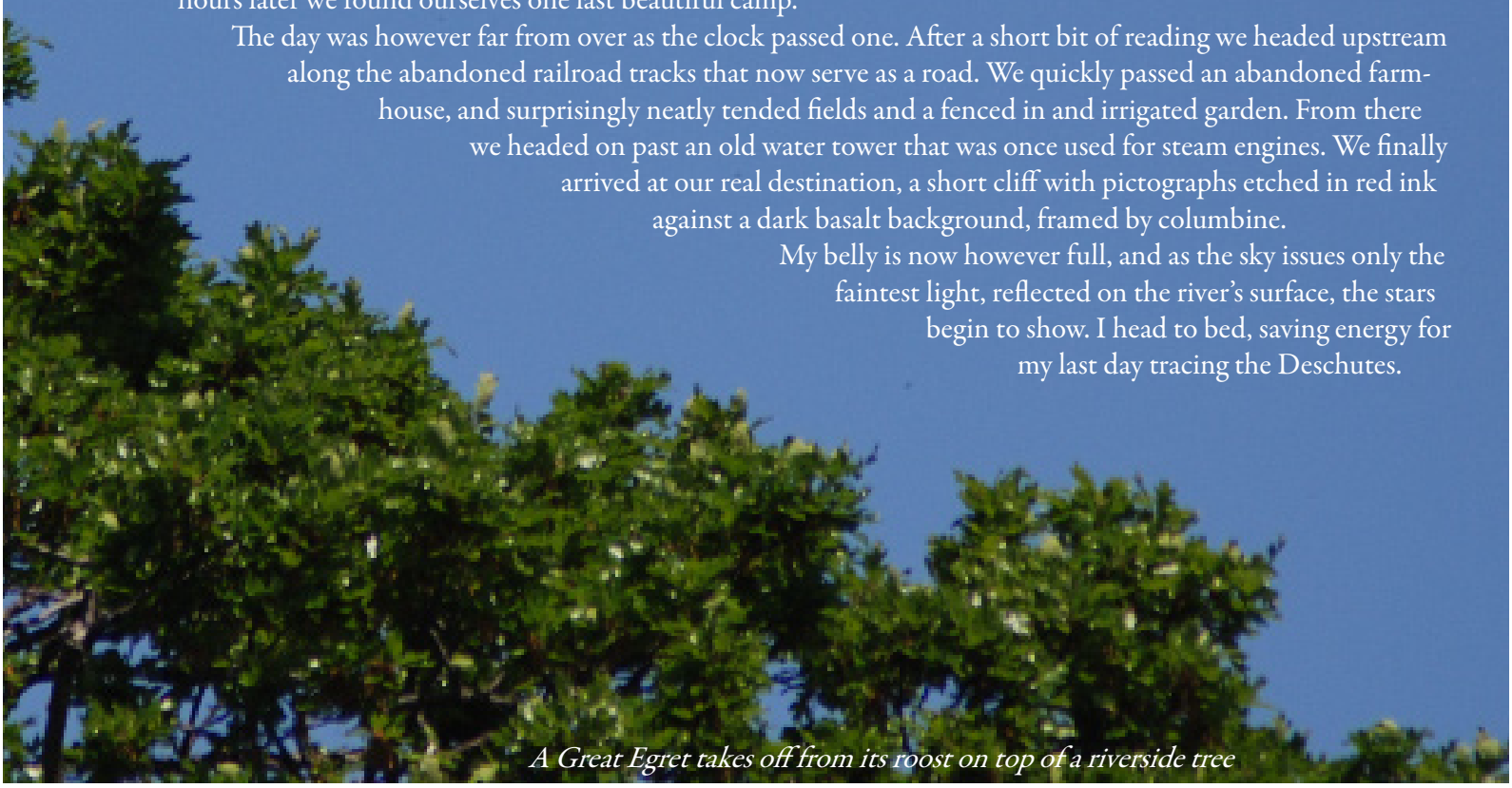
My shutter begins to furiously click, then out of the corner of my eye I spot two more bighorns, and along with them, two lambs. Just as I turn to take pictures of the second pair, a coyote begins yipping on a ridge upstream, and a golden eagle swoops low over our heads; a strange convergence of wildlife right around us.

Once I had what seem like adequate pictures, now that the bighorns fled to the ridge top where we can't easily get without being seen, it was clearly time to head downstream to our last camp on the river. The wind had begun to move the lupine and after a slow descent down a loose scree slope, it was time to go.

A rapid downstream yielded a bald eagle perched on a streamside snag, and surprisingly few hours later we found ourselves one last beautiful camp.

The day was however far from over as the clock passed one. After a short bit of reading we headed upstream along the abandoned railroad tracks that now serve as a road. We quickly passed an abandoned farm-house, and surprisingly neatly tended fields and a fenced in and irrigated garden. From there we headed on past an old water tower that was once used for steam engines. We finally arrived at our real destination, a short cliff with pictographs etched in red ink against a dark basalt background, framed by columbine.

My belly is now however full, and as the sky issues only the faintest light, reflected on the river's surface, the stars begin to show. I head to bed, saving energy for my last day tracing the Deschutes.



A Great Egret takes off from its roost on top of a riverside tree

Day 14- May 15 2007- Columbia River

The truck engine rumbles as we roll past Cascade Locks on our way home to Portland from the Deschutes. Sun shines into the back seat through the broad read window, illuminating my page with flickering light. It is incredible to think that I have finally traced the Deschutes over two hundred and fifty two miles, primarily under my own power. Weeks of editing and designing lie ahead before the project is totally complete, but some level of finality has been achieved.

A few hours ago we floated down through the last rapid, "Moody" taking pictures of our boats floating from the boils and holes of that rapid into the serenely smooth water of the Columbia, rippling under the interstate eighty-four bridge. Trucks rushed by as my journey came to an end. Tracing the Deschutes has changed the way I look at a landscape. I look at the river and see a set of systems, from the solar powered re-charge of water to the headwaters high in the Cascades, to the economic reliance of much of central Oregon on it's water. It is no wonder that the Deschutes is the target of so much attention as it drains from the properties of thousands of individual people. Every person who lives in this watershed owes it to himself or herself to get out and see this river that is the lifeblood of their region. You don't need to become deeply involved with the river, but think about it next time you drive along its rushing banks or ski through its fluffy snow, think about where your drop of water is going and how it will reach the ocean. After following one of those drops of water it is amazing to see how hard of a time they have.

A Desert Bighorn Sheep spots us as we try to get close enough for a picture.

* - Yake, Kolleen E. Upper Deschutes Subbasin Assessment. Bend: Upper Deschutes Watershed Council, 2003.
† - O'Connor, Jim E, and Gordon E. Grant, ed. A Peculiar River: Geology, Geomorphology, and Hydrology of the Deschutes River, Oregon. Washington, DC: American Geophysical Union, 2003.
- Glick, Casey. Personal Interview. 18/5/2007.

UPPER DESCHUTES WATERSHED COUNCIL

Healthy Waters Institute
EDUCATION. COMMUNITY. STEWARDSHIP.

Sunset above the Deschutes River canyon near Bend

Oregon Trout