MONTANA COOPERATIVE WILDLIFE RESEARCH UNIT

MONTANA STATE UNIVERSITY
MONTANA FISH AND GAME COMMISSION
WILDLIFE MANAGEMENT INSTITUTE
FISH AND WILDLIFE SERVICE, UNITED STATES DEPARTMENT OF THE INTERIOR

MONTANA STATE UNIVERSITY
MISSOULA, MONTANA

February 10, 1960

Dear Frank:

This is the abstract of the paper we are giving at the North American. Still have some refining to do on the final paper and probably can't get it to you in less than a week.

I got the copy of the Geographic article and have read it over hastily. Will do a more thorough job later.

In one of your letters you mentioned a new drug but did not indicate where we could get it. Would you check further on this. Apparently some work is being done with radio transmitters at the Ohio Unit. The following is a quote from the November-December Activities Report of the Branch of Wildlife Research:

"Use of Radio Transmitters on Cottontails. Some progress has been made by Dr. Peterle in the design and testing of a harness used to fit a miniature radio transmitter to cottontails. Several fabrics and leathers proved inadequate. Presently, a coated nylon fabric made for U. S. Army ponchos seems usable. Electrical engineers are studying the design of current transmitters and expect to make needed modifications."

That's about all the news for now.

Regards,

John

JJC:AB

Will send you copies of the water paper delivered before the Senate Water Resource Comm. here in Missoula. J. J. C.

Could you get a photo from Geog. of the 710 lb. grizzly we immobilized, preferably with some of us in picture. I took many photos. JJC

Would like to use as to illustrate the scientific article.

Will send you some of the polyethylene braided rope. It looks good.

Abstract

TRAPPING, IMMOBILIZING AND COLOR-MARKING GRIZZLY BEARS

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An intensive long-term study of the grizzly bear, Ursus horribilis, was initiated in Yellowstone National Park during the summer of 1959.

Thirty grizzlies were captured and 27 ear tagged, color marked, and released for future observation. Twenty-three bears were captured in mobile culvert traps and 7 were shot free-roaming with propulsive syringe darts using a gas-operated rifle. All bears handled, whether trapped or shot free-roaming, were immobilized by propulsive injection of succinylcholine chloride, a rapid muscle relaxant. Of the grizzlies immobilized, some evidenced definite aggressive behavior when muscular control returned, others were aggressive only when pressed, and the majority were relatively submissive.

Cubs were captured at night by "shooting" them at the sides of their mothers. Behavior of the sows varied but in no case did they charge.

Both multiple and single dose injections of succinylcholine chloride were administered. Thirty per cent of the grizzlies treated required multiple doses; the average initial dose being 1 mg. of drug per 3.6 pounds of body weight with an average second dose of 1:4.5.

Single dose injections proved more satisfactory than multiple doses. A satisfactory dose immobilized a grizzly for 10 to 25 minutes

with complete recovery time of one hour or less. There was a basic correlation between dosage and body weight of bears that appeared to be modified by such factors as age, amount of body fat and injection site. In general, single doses of 1 mg. of drug per 3.5 pounds of body weight gave minimum immobilization and recovery times. Doses of 1 mg. of drug to 3 pounds of body weight yielded optimum results on medium sized bears, but resulted in prolonged immobilization and recovery in the larger bears. The larger bears were more sensitive to succinylcholine chloride than either the small or the medium sized ones. The build-up of body fat throughout the summer also seemed to have an effect on dosage.

Grizzlies were individually color marked by slitting the base of each ear and inserting polyvinyl chloride tape. Each marker consisted of an ear loop and a tail of a different color, secured with rivets. Both visibility and retention were excellent and most marked bears probably went into hibernation with their color markers intact. One hundred and sixty observations were made of color-marked bears yielding information on range, population composition and behavior. During the same time only two bears were retrapped. A yet more durable color marker was made from polyethylene diamond braided rope and will in the future be used experimentally for ear markers.

The largest bear trapped weighed 710 pounds. The greatest distance traveled exceeded 50 air miles over the rugged Absaroka Range in Wyoming.

spend time on research to

What good is a grizzly? Why save a ferocious killer? The question why is always difficult for a scientist to answer. I was about to beg the question with an enumeration of the grizzlies finer qualities, and his place in the scheme of things. It might have satisfied the range but it wouldn't have answered the question for him or for me.

Lance spoke up in a matter of fact way. We want to save him because when he's gone he's gone forever and we can't make another one. There was the answer simple as any a child could and I knew too that it explained why we must preserve and keep the grizzly wilderness home. This single fact gave meaning to our efforts purpose to our work.

But what good is a grizzly you may ask? Why spend time and money on research to save a ferocious killer? The question why is always difficult ~~for a scientist~~ to answer. I could beg the question with an enumeration of the grizzlies fine qualities and his place in the scheme of things. These are important. They might satisfy many but they wouldn't have answered our question. In the course of an evening discussion ~~this~~ essentially this same question arose. John's twelve year old daughter Karen sitting quietly ~~outside~~ beyond the light of our Coleman lantern listened and then spoke up in a matter of fact way. "We want to save the grizzly" ~~she said~~ because when he's gone, he is gone forever and we can't make another one." How was the simple answer with all it implied. No ~~other~~ animal species has been known to exterminate another. His list is long. Other than man Though he wields the power does man possess the right to this god-like act? We sent to oblivion the passenger pigeon and the Carolina parakeet — unintentionally ~~but~~ to be sure. What would we now give to bring them back & thus soothe mankind's conscience? A great deal I believe. The simple truth of Karen's answer gave meaning to our efforts, purpose to our work.

John

Grizzly Paper

Geog. — radio agency

Eliz. Cushman

Furniture ? ✓ price

[Douglas Longhurst]

[Flower Book]

O'Dea



Artack — no longer Chicago

added paragraph on why same grizzly

21 — Name & Title

p. 14

p. 15 — omit autopsies

p. 16 — omit Trapping cubs

16 at dawn

16 hot

[Wildlife Research Unit]

Li. 4-9716

Li. 9-3358

John Craighead

CAPTURING GRIZZLIES

by

Frank and John Craighead

The bolt of the large-caliber rifle clicked shut. In the light of a powerful flashlight I sighted on the neck of a grizzly cub and pulled the trigger. The cub whirled and snapped angrily at his innocent litter mate. His mother, a rangy sow, sprang to his side with frightening speed--a single, rippling, rhythmic motion that belied her huge bulk. The cub neither dropped nor staggered as might have been expected. Seeking solace, he brushed against his mother's front legs, paused under the reassuring protection of her powerful neck, then moved on to forget and apparently forgive. Had I overshot? Could I have missed at such close range? No--for I heard John's assuring "Nice shot" and now Maurice's light-beam came to rest on a syringe dart hanging from the cub's neck like a giant mosquito. Instead of withdrawing a blood meal, however, this mosquito-dart had just injected a powerful muscle relaxant. We had shot to capture, not to kill.

The seconds ticked into suspenseful minutes as the three of us waited and watched for some slight sign that the drug was taking effect. Two minutes by the sweep hand of the watch: the cub sensed or felt that all was not well. Rising to his hind legs he pawed at his mother's shoulder. She ignored his puppy-like attempt to communicate. Three minutes: the cub lay down. The sow alerted, suddenly whirled around, stood upright, glanced fixedly at us and

then dropped to lead the faltering cub to the edge of the slope. Will they descend the steep creek bank? Three and a half; we tensed. He stopped at the brink of the slope and looked back. A flutter of his eyes, a tremble to his legs, and he took the easier path--down, down to the stream bank. He wavered there as the drug took full effect. The watch hand swept past four. Then he crumbled, tumbling into the black waters of the pool.

This was a situation we had anticipated because only a few days earlier John and Maurice had dropped a sow on a gravel bar with her front paws in the water. They had rushed over to her before she was fully immobilized. It had been risky work.

Now a similar circumstance confronted us but the odds were greater. We knew what had to be done, but was it possible at night? Unless we got to him, and quickly, the cub could drown. But perhaps the sow, motivated by instinct toprotect her own, would get there first.

Having watched the drug's effect on the skeletal muscles of boars nearly 15 times his size, we knew that right now the cub couldn't move his legs to swim, couldn't even hold up his head or open or close his jaws. These characteristics effects of succinylcholine chloride (sucostrin chloride) made it ideal for the task of immobilizing and color-marking grizzlies but with the present turn of events it had created a dilemma.

We reacted as a team on a course of action planned in advance. John and Maurice flashed their lights and yelled to scare off the sow and her other cub. Momentarily startled, they disappeared into the darkness, but how far had they gone? I hoped they had kept moving but suspected they had not. While John's light probed the darkness that had engulfed the bears, Maurice's played over the rough ground in front of me as I raced down to the cub. When I left the

comparative safety of our panel truck I caught the glint of a high powered rifle barrel swinging in unison with John's light. I hoped he would have no need to use it and I wondered when the mother grizzly would miss her cub and what she would do about it.

I stopped running only when the cold water reached for my belt. With one hand I caught the cub by the scruff of the neck, with the other I grabbed hide and hair and rump. In a continuing motion I pivoted, swinging the dripping cub up and around. Not completely immobilized, as I had thought, he began to struggle while I climbed the steep embankment. By holding him at arm's length I avoided his sharp claws. A few more steps and he let out a bawl, a cross between the bellow of a range cow and the frightened baa of a sheep. To my pounding ears it sounded like a desparate, instinctive call for mother.

Mother might be anywhere in the close darkness beyond. Knowing she could cover ground with the speed of a horse, and imagining her to be doing so, I redoubled my efforts to reach the doubtful safety of our car. At the rear of the panel wagon other hands took over, pushed the cub into a cage and slammed the door shut. My gasps for breath all but drowned out the starting motor. The swinging car lights reflected two burning coals, the amber eyes of a big sow bear moving fast--but late. Excitement, exertion and fast action here in Yellowstone's high plateau had left me temporarily gulping the thin air. As my breathing subsided, the bellows of the enraged grizzly cub behind us increased proportionately.

The effect of the drug was rapidly wearing off. The "Fifty-pound Cub" as we later named him was trying with teeth, claws, and awesome strength to destroy the walls that held him captive. The bear hunt, however, was a success. We had literally snatched a cub from a

mother grizzly--and we had him alive. Tomorrow we would mark him with colored plastic streamers and fit him out with numbered ear tags. When released he would join a growing number of marked bears. He would become a recognizable, known-age individual in the grizzly bear population, one whom we might frequently identify and observe. Such observations might tell us when he left his mother, at what age he sired a family of his own, where his wanderings took him, who his close companions were and perhaps where he chose to sleep through the cold Yellowstone winter.

We were embarked on the initial stages of a long-range cooperative study of the grizzly bear, a detailed ecological study to help insure the survival of this fast disappearing carnivore by learning more about his habits and behavior both as an individual and as a population.

We needed to learn more about the movements of a grizzly bear, the size and character of home ranges; about population structure and numbers as well as about the breeding age, frequency of breeding, litter size at birth, infant mortality, condition during the deep sleep of winter, the average life span, age specific mortality, and many other things.

These would all contribute to our basic knowledge of grizzly bears and be helpful in managing and preserving the remaining grizzly populations. Present rough estimates indicate that the number of grizzlies left in the United States, omitting Alaska, lies somewhere between 500 and 1000 with perhaps the largest concentration of protected bears in Yellowstone National Park. Because of this and encouragement and assistance from the National Park Service, we started work in Yellowstone with the intention of expanding some phases of the research throughout the grizzly's present range.

This big bear that so impressed early western explorers has already disappeared from Texas, Arizona, New Mexico, Oregon, Utah and the Dakotas. Though once numerous in California (its nickname, The Bear State, came from its grizzlies), there have been no records of it in this state for 38 years. It is fast being exterminated wherever it is unprotected or where there is no extensive wilderness country. Montana, including Glacier National Park, probably has more left than any other state.

It was only natural, therefore, that the Montana Cooperative Wildlife Research Unit, headed by John and located at Montana State University in Missoula, should undertake this research. Your National Geographic Society made it possible for me to collaborate in the undertaking.

Biologists in Michigan were the first to trap and immobilize black bears for study and this work stimulated investigations in New York and Virginia. But could the formidable grizzly be brought to bay for intimate study?

For some years past John and I had discussed the need for grizzly bear research and had recently explored possibilities for a cooperative study. While we planned the project John was looking for a graduate student with the outdoor training and physical and educational qualifications needed to participate. He found him in Maurice Hornocker, who is working on one aspect of the overall study for his master's degree as well as collaborating in other phases of the work. John had a grant from the Wildlife Management Institute and support from the Montana State Fish and Game Department which he could use to finance Maurice's summer work. It was a chance to start.

In order to study individual grizzlies as well as to gather a body of knowledge on their population ecology, it would be necessary to positively identify bears whenever and wherever seen. This called for the use of marking methods, which in turn implied that we must immobilize or anaesthetize these formidable animals in order to mark them. Would the recently developed syringe dart gun be effective on grizzlies? What drug could be used to safely immobilize them and what dosages would be required? Would the tough colored vinyl ear markers successfully used on geese, mountain sheep, elk and other wildlife be suitable for grizzlies? Might they not tear out such markers? How would other bears react to these colored plastic tapes? These were problems and questions that confronted us during our first season of marking bears.

We were well on our way to solving these at the time we captured the Fifty-Pound Cub. When we released him on the morning following the shooting he took off at full speed, crossed a stream without breaking stride and sprinted another 300 yards before stopping--and then only momentarily to glance back. He was still running when he disappeared from sight with a raven diving at him, apparently just to heckle him or perhaps to see if that red ear marker was something to eat. Several days later we observed the cub united with his mother. If she disapproved of the colorful markers, she made no attempt to remove them. Scrutinizing the little fellow through our scope, we had to admit he presented a quite distinctive appearance. We were inclined to believe his mother thought so too.

We were experimenting with dosages. I put my eye to the peep hole in the metal culvert trap. Inside, I glimpsed a fierce-faced, large dark brown grizzly. He lunged toward me. I jumped back to avoid

the long lethal claws flashing out through the opening. Then I stepped around to look in another hole and said, "He'll go 450 pounds."

Wes Woodgerd, John's Assistant Unit Leader and Biologist for the Montana State Fish and Game Department, shaded his eyes and looked in through the drop gate. "Closer to five," bet Wes.

"475" and "490" hazarded John and Maurice in quick succession as they guessed between our fifty pound difference. Our bets were made.

Now we hitched the trailer-trap to the car, pulled it to level ground and weighed trap and bear on our portable scale. This would do more than determine the winner. We had to know the bear's weight to compute the drug dose needed to immobilize him. Two careful readings came to 520, plus or minus a few pounds. This was close enough. With a graduated syringe, Maurice measured out 150 milligrams of sucostrin chloride, or about one milligram for every 3.5 pounds of body weight. He now carefully squeezed this drug into the front end of the dart and added sterile water to fill the chamber. John had loaded the rear chamber of the dart with a tablet and a fluid sepapated by a metal washer. The drug and the charge that would inject it were separated by a sliding rubber plug. When Maurice screwed on the combination of cap and hollow needle the dart was ready for firing.

This was the fourteenth grizzly we had worked on. Starting with minimum doses we had found that one mg. of sucostrin chloride to five pounds of body weight would not effectively immobilize grizzlies. One to three we had found to be satisfactory, but was it optimum? Would a reduction of the dosage to one to 3.5 be equally effective? We were about to find out. John poked the CO_2 gun through an opening in the trap and pulled the trigger. The sudden acceleration of the dart brought fluid and tablet together, producing

a gas such as is formed when baking soda and vinegar are combined. The gas pressing against a rubber partition plunger forced the drug through the hollow needle and into the bear's neck muscles. In flight, air pressure prevented the drug from squirting out.

The grizzly appeared to notice the needle no more than we would a tetanus shot. Huge, powerful, he glared at us seemingly confident of his ability to meet this or any situation. Seconds later his eyelids fluttered, the challenge left his eyes, his head slumped forward on his chest. One minute after dart impact and he was down--and out. To act so fast the drug must have entered a vein. The average time required to take effect was four minutes. Maurice prodded bruin's jaws with a stick but elicited no response. He wasn't "playing possum"--we hoped.

Wes was still winding up the heavy iron door when Maurice leaned inside and grabbed a handful of bear while I got a grip on a thick fore leg. Heaving in unison, we slowly pulled the bear out of the trap and into the open. John had pliers, punch, eartags, disinfectant and an emergency syringe of drug laid out for the job ahead. Working rapidly, he and Maurice snapped a metal eartag in place and recorded the number. Through a small slit in the ear they looped a strip of purple plastic. Between the open ends of the loop they laid a white tail piece and fastened loop and tail together with brass rivets. By using one color for the loop and another for the tail we could get over sixty separate color combinations with the colored plastics available to us.

Wes had been measuring the foot pads and overall length, but all these routine tasks were not going off on schedule. The big bear was constantly growling and was spasmodically moving his head and legs. He was clearly underdosed. A tremor would go through him as he vainly

tried to gain his feet. It was like working over a stick of dynamite with a damp fuse--lit, smoldering, but neither burning correctly nor going out. Quickly we rolled the grizzly over to tag his other ear and tatoo him under the front leg. With a frustrated growl he tried to regain control of that terrific muscular force that had always served him. The effort brought him to a near sitting position. Then he dropped back, his normally swift sure movements faltering. Wes reached for the hypodermic and gave him an additional dose in a rear quarter. We waited for the drug to take effect, but once again the massive boar struggled to a near sitting position. Muscles rippled and flowed beneath his glossy hide. We backed off as he went down. Now surely we would see a change.

He struggled to rise again--gained his feet, wobbly, but moving toward us. Glancing back, I saw his next step was firmer, more sure. Mine became faster. He seemed fully coordinated, almost lightfooted as he passed close by me headed for the nearby timber. I was already inside the panel truck and so were the others. I can't remember holding car doors open and I am sure no one politely held one for me. We shot inside like a bunch of filings drawn to a magnet--overtop of equipment and over one another. The niceties of human behavior were dropped for the law of self-prservation.

As the grizzly turned for a last puzzled glance back, the sun struck the single plastic marker in his left ear--an incomplete job but one marker would do. Two just increased the chances for retention and field identification.

"It looks as if a drug dose of three and a half to one wasn't enough for 'Old Lightfoot'," I said.

"No," mused Maurice. "And the next time we jab one with the

hypodermic it had better not be in the rear end. That needle never came close to penetrating the thick layer of fat."

Sucostrin chloride is a curare-like drug which when injected intramuscularly produces muscular relaxation by blocking nerve impulses to the skeletal muscles at the myoneural junction. It prevents the transfer of the nerve impulses to the skeletal muscles. To be effective it must get quickly, yet not too rapidly, into the blood stream. The dose in the grizzly's haunch had been absorbed into the blood too slowly. Fortunately this incident proved the rare exception. The behavior of 29 other bears under the influence of the drug was largely predictable.

We had retrapped One-Eye, a 260 pounder originally caught attempting to put on weight by foraging at night in the Thumb camp ground. We had immobilized him again to check his tatoo, tags and plastic markers. It had taken him only half as long to regain his feet this second time, though the drug dosages were the same.

While discussing the possible reasons for these different reactions with a group of Park Rangers, John had mentioned that One-Eye as well as the other grizzlies could feel, hear, see and smell us as we handled them, moved them about, and rolled them over to be examined, measured and tagged. Sucostrin chloride does not impair sensory perception.

Was the experience of helplessly submitting to this indignity sufficiently distasteful that we would find it increasingly difficult to retrap or reshoot marked bears? We wondered. Apparently One-Eye had not found it so, or had failed to associate the trap with the subsequent drugging procedure.

Then Ranger Bob Howe popped the question we had already asked ourselves a good many times. "If these grizzlies," said Bob, "Know

what's going on and who's doing it, what's going to happen when and if one of you meet a silvertip again along some lonely trail?"

"Bob, we've got that all worked out," I answered. "The solution came to mind the other day when you and Ranger John Day helped us mark the Fifty-Pound Cub. Now each time we handle one of these grizzlies we slip into ranger jackets and put on ranger hats."

"Joking aside, though," said John, "The reaction of many of these grizzlies on regaining the use of their muscles is to get away from us just as fast as they can. They don't appear to be angry, perhaps puzzled and bewildered. However, some have come at us and it doesn't take another bear to read their intent."

"As the effects of the drug wear off," said Maurice, "They attempt to gain their feet only to fold up like a burplap bag full of jello. Some appear frustrated or disgusted and roll on their backs with feet in the air. If they were human they might be saying, 'What the heck is going on here?' "

"The will is strong but the flesh still weak," I said. "The thousands of nerve impulses that would normally put the bear in full flight, initiate a charge, work powerful jaws or aim a great forepaw are 'shortcircuited' at the juncture of nerve and muscle."

"There is nothing he can do but wait for the body to hydrolize the drug into ineffective normal body compounds. At any rate, our observations of the marked bears to date indicate that they don't remember or associate us with an unpleasant experience. Wouldn't it be unfortunate if, like humans, these powerful carnivores held resentment and bided their time to repay a grudge?"

During the short period in which they have been known to civilized man, grizzlies have gained a reputation for fearlessly attacking when injured, cornered or otherwise provoked. We had

noticed that like many other predators they revealed a complaisant, even gentle nature which under the proper stimulation could instantly change to that of the ruthless, efficient killer.

A scant thirty years after explorer-naturalist Samuel Hearne first came across a "grizzled bear" in 1771 in the Canadian Arctic, Lewis and Clark encountered them on our Western prairies.

Lewis called them brown or white bears to distinquish them from the black bear with which he was already familiar. The name grizzly developed from the white or grizzly hair tips that are common in this species.

In the level open country near the Great Falls of the Missouri a big grizzly charged Lewis, chasing him into the river. Fortunatley for him the bear did not follow, though thoroughly capable of having done so. Lewis had been caught unawares with an unloaded gun, having just shot a buffalo. Later Lewis commented in his journal that in this area there were so many grizzlies and they became so troublesome that he did not think it prudent to send one man alone on an errand of any kind. On another occasion a wounded grizzly followed one of his men into the river where it was finally killed. Eight rifle balls had passed through this animal before he died.

Hugh Glass, one of Ashley's mountain men, came suddenly upon a great white bear, was attacked and so severely bitten and mauled by the grizzly that his comrades left him for dead, taking his gun and effects. His will to live and his superhuman effort in finally fighting his way back to a fur trading fort made him a legend of the West and added to the grizzly's reputation as well.

Such tragic experiences were not uncommon during the exploration and settling of the American West and attacks by grizzlies or

"silvertips" are still reported today.

Dave Condon, Chief Naturalist in Yellowstone for many years and stalwart defender of the grizzly, barely escaped the unprovoked attack of a huge bear he had observed at close range many times. In recounting the episode, Dave said that in those seconds before he reached the safety of his car with the bear at his heels, he learned more about grizzly bear behavior than he had in all his years in the Park.

John Thune, General Secretary of the Oakland, California, YMCA, recently told me of a harrowing experience he had with grizzlies in September 1956 when camping with 26 teen-age boys and six adults at Stoney Indian Pass in Glacier National Park.

"Early in the morning," said Thune, "Sixteen of us departed for a climb. As it grew light I noticed a large grizzly proceeding through a meadow, going in the general direction of our camp. Because of their usual avoidance of man, I did not give the sleeping boys at camp a second thought. When we returned in late afternoon we found that one of the boys, Tobey Johnson, had felt something nudge him as he lay under a makeshift tent. Thinking it was his partner, he pushed back--back against a grizzly. The animal tore down the shelter and sank his teeth through the sleeping bag into the calf of Tobey's leg. The bear then retreated, but remained near camp most of the day.

"That evening three huge grizzlies showed up. We cached all our food in the one large tree and built a big fire. We kept a watch by the fire all night. This didn't faze the animals at all. They roamed among the sleeping boys and opened every rucksack to see if any food might remain. Fortunately no one was hurt. Possibly it was due to the size of our group.

"I shall never forget that long night. As the grizzlies would approach within a few feet of the fire, rear up and look at us, it reminded me of some of those grizzly paintings made by Charley Russell."

Such modern experiences point up the need to learn all we can about managing the grizzly consistent with the rapidly increasing recreational use of our parks and wilderness areas.

We recognized the greatest danger we ourselves must avoid was carelessness or complacency while working with the grizzlies. Their power is evident, so is their purposeful action; but their seemingly slow movements are really rapid and their even temper deceiving.

We gained real respect for the grizzly after an experience with the Fifty-Pound Cub. He had adjusted so quickly to us and to the holding cage in which he spent the night that several hours after being captured he was drinking milk and eating cookies, watermelons and raw bacon. His actions and facial expressions changed from fear, anger and suspicion to those characteristic of a friendly, trusting dog. Then the next morning we tried to push our little friend to the rear of the cage so we could inject him with a dose of sucostrin chloride. Instantly we had a wild, snarling, fighting beast on our hands. He exhibited such power, strength and ferociousness that in spite of his meager weight John Day and I were unable to pin and hold him in the back of the cage. He easily squirmed under and pushed aside our poles even though we had the long ends of the levers. Perhaps this side of the grizzly's character explains the scientific name of Ursus horribilis.

As the number of marked bears increased we began to see many of them time and time again. First they were recognizable

individuals; then they began to take on personality and character. This, of course, was one purpose in marking them. When this h happened they were no longer just another grizzly bear or a number such as 00-152. We needed simplification for the purpose of communication. It was now imperative they have names so we could discuss them. In many cases some incident, character trait, or peculiarity earned it for them. Such names as One-Eye, Lightfoot, The Ninety-Pound Cub, Old Andy, Ingemar, The Disciplinarian, Scarface, Cutlip, The Sucostrin Kid began creeping into our conversation.

One very dark, almost black grizzly was trapped at West Thumb and released near Canyon. Lean and rangy from poor spring pickings he still tipped the scales at 620 pounds of solid muscle. For reasons known only to himself, he remained in the Canyon area. Thus it was inevitable that he eventually come face to face with the dominant bear of the locality, a big brown-colored grizzly that was treated with great deference and respect by all other bears. We had already given him the name of Scarface because of the massive healed scars on his face. A particularly distinctive one resembled a huge dollar sign. These scars were apparently accumulated in the course of numerous battles. They were the price he had paid for becoming and remaining boss. Maurice and Wes had the good fortune to observe the first encounter between these two titans. The new arrival didn't appear the least awed by old Scarface's size or apperance. With his colored ear markers flying like pennants, he moved in on him and in a short furious growl-and-roar battle of teeth and claws he whipped Scarface. The old champ was dethroned and the younger challenger took over. After this Maurice called him "Ingemar". The name proved appropriate and stuck.

Cutlip was another fighter easily recognized by the drooping lower lip that had been torn in such a manner that it exposed his teeth, giving him a permanent expression of snarling. Perhaps this had occurred on some past occasion when he too challenged Scarface.

The Disciplinarian was one of numerous sows with cubs, but she was noticeably more nervous and apprehensive. When congregating with other bears she unfailingly placed her two cubs where she could keep a watchful eye on them. Then in bear language and emphatic "Koff Koff" said "Stay there!" The cubs stayed, sometimes for an hour or so without moving or wandering. Other sows required obedience but none had her cubs under such strict and absolute control. Once when one of The Disciplinarian's cubs moved away only a few feet a big boar grizzly appeared over the hill. The sow spun around, raced to her cubs, seized the errant one in her jaws and roughly plopped him back in place. It was evident that these small balls of energy had learned obedience the hard way. The fact that we had tagged one, The Fifty-Pound Cub, with yellow loop-red tail ear markers had perhaps only made the sow more determined to see that they kept on the straight and narrow path.

Then there was Bigfoot, a youngish 505 pounder ear-marked with red plastic loops bearing green tails. His ear tag numbers were 00-284 and -285. As we moved him out of the trap John exclaimed, "Look at the size of that foot!"

His pad measured close to eleven inches, almost as long as the largest we had measured on an older, bigger bear. So the Christmas-colored bear number 00-284 became known as Bigfoot. Perhaps the future will show whether in size and deeds he lives up to the measurements of his feet.

There was also the mean sow with three cubs, one of which we shot and tagged. He became known as the Ninety-Pound Cub. The ungly disposition and unpredictable behavior of this sow with one marked cub distinguished her from others and so she became The Mean Sow, a grizzly that bore watching.

Perhaps I should not even mention The Sucostrin Kid because there is little chance that we will recognize this honey-colored cub another year. We were never able to mark him. It was due to this fact that he earned his name. In the course of several weeks our darts hit this cub seven times, first with minimum doses and then with what should have been sufficient to fully immobilize him. He never went down and showed only slight loss of muscular coordination. It was as though he had a built-in antidote to the drug. It is possible that our 100 to 150 pound estimate of his weight was low. But even this does not explain the apparent ability of The Sucostrin Kid to remain entirely unaffected by the drug.

We did find considerable variation in the susceptibility of individual bears to the drug and there appeared to be a wide tolerance resulting in a very desirable margin of safety. Fortunately for us the sequence of muscular relaxation proceeded from the jaws and neck to the shoulder, limbs, abdomen, and intercostal muscles to the diaphragm. As soon as a bear slumped down and was unable to bite a probe placed in his mouth, we started work.

At one extreme was The Sucostrin Kid: at the other the sow who at the height of the drug action developed a temporary respiratory paralysis, possibly because the drug had entered directly into a vein and was carried rapidly through the blood stream.

This sow was hit while free roaming. In the process of dragging her to a spot where we could work safely on her, we

noticed that her breathing had almost stopped. We immediately administered artificial respiration. Maurice and John accomplished this by holding up her left front leg and pumping rhythymically on her chest cavity in order to fill and empty her lungs. In a few minutes she was breathing regularly and deep.

We admired the grizzly and felt real affection for each one we marked. During the course of the summer we had become almost a part of the bear community. The loss of one would be more than an experimental failure; it would be the loss of an acquaintance. We felt both relief and joy when the sow ambled off unsteadily but unharmed to take her place among our "personality bears".

So far we had been on the outside of the trap looking in at the bears. Now having met our trapping objective of thirty grizzlies, we decided to reverse conditions and from inside the trap look out at the bears. The idea had been germinating all summer. What safer spot was there from which to shoot some night pictures as well as make close-up observations? If the bears couldn't break out of the trap, we reasoned, they couldn't break in. The worst they might do would be to turn the trap over.

About a week before attempting this, we had manouvered the trap to a position on the stream bank where bear trails converged, and had baited the area to attract grizzlies. At sunset John and I crawled inside the metal cylinder, then Maurice dropped the heavy door almost but not quite shut. We wanted to be able to raise the steel door and get out without help once Maurice took off.

We had lined the bottom with our down sleeping bags to keep out the below-freezing cold. We just might have to spend the entire night inside. Ascorlight batteries, extra film, lenses and cameras were arranged about us in the cramped quarters. Not long after dark

the dim shape of the first bear appeared on the far bank of the stream. Immediately other forms took shape. These first arrivals were a group of 2 and 3-year olds that looked much alike and travelled together. They were apparently a single family, that is littered by the same sow. They had found food here on previous nights and their keen noses told them that once again there was more. But after cleaning up the scattered "come-ons" of bacon and meat, they were unable to locate the main bait which their sense of smell told them was right under their noses. And so it was, but well hidden.

A big grizzly is capable of dragging off an elk or moose carcass and we knew they'd make short shift of our scanty offerings. We couldn't fasten a bait that would long resist their power. We resorted to guile, staking and wiring large chunks of meat beneath an overhanging stream bank where it could be reached only by entering the water. Other pieces we buried on top of the bank. Our purpose was to keep the bears moving and searching about while we took pictures.

At the first flashes from our ascorlights, they whirled and ran off, then ignored them as they searched for the bait. Shortly other bears came out of the darkness, joined the first arrivals in the spot of our flashlight, and padded about restlessly, sniffing and digging for the hidden food.

Inside the trap there was greater activity. Our makeshift blind which had been designed to hold bears was not ideal for photographing. We had to flash our light out one peephole and photograph and look out another. John tried to direct the flash where he thought I had the camera pointed. We didn't always coordinate and some unusual poses revealed in the instantaneous

flash went unrecorded. Some censorious thoughts went unspoken from a mutual fear of scaring the bears. One premature flash lighted the trap interior for a brilliant 1/2000 of a second and left us blind for a long minute.

As the grizzlies crossed and recrossed the stream or approached the trap from first one side and then another, I was compelled to unplug the camera from one set of batteries and switch to another. When the distance from the camera to the bear changed, the focus and the lens opening had to be altered. As conditions dictated we switched from a 50 mm. to a wide angle lens. When I came to the end of a film John would rewind it and put in a new one while I reached for a spare loaded camera box, snapped on a lens and plugged into the batteries, ready to shoot some more.

Using two types of film added to the confusion. With the faster ektachrome we hoped to reach into the darkness and photograph the more distant bears. The kodachrome required a filter, the ektachrome did not. These procedures had to be performed largely in the dark, occasionally with the aid of a dim flashlight and all hurriedly and in cramped positions.

While I was switching cameras John whispered, "Quick! A bear is in the water searching under the bank."

I too had heard him. He was less than fifteen feet away--the meat under the bank only twenty. This was a picture we had been waiting to get. John groaned as my groping attempts to hurry and adjust the cameras only bungled the operation. We missed the opportunity for a picture as the grizzly waded past, but I flashed the unit to see what other bears were within range.

In the brief flash I caught sight of The Fifty-Pound Cub reaching over the bank with his fore paw only inches from our

bait--a rare chance to photograph one of our marked cubs. But in the moment it took my eyes to readjust to darkness, the cub too had moved away. It was a long night, though, and I photographed him later when he came again to the water's edge.

This was fascinating but exasperating work. The chill night air added to the tension. We strained our eyes to make out the ghostly forms so close around us. By wading upstream two bears had reached the meat and were slowly tugging it free. A quick look with the flashlight revealed another sliding down from above. They had the bait now. This would be it, the show soon over.

I judged the distance, set the camera and tried to frame the right spot in the view finder--a real shot in the dark. Just then a tremor ran through the trap, a heavy animal brushed the length of the tube and the tube rocked violently. John flicked on the light and the beam settled on a black damp nose protruding through a hole at my elbow. I controlled a strong impulse to punch it and instead moved to kick the block from under the partially raised door. With this much leverage he could, if he tried, raise the door and squeeze on in to join us. Before I could reach the block, the trap shook and the nose disappeared, followed by a splash as the startled bear hit the water at a gallop. I tripped the camera--then looked out again. The other bears and the hidden bait were also gone.

"That last picture we got as the bears left the water should be a good one," John said.

"Yes," I answered. "The flash went off just as the bear jarred the trap." This wasn't the time, I thought, to tell him the camera had been jarred too and was pointing well above the bears when I pressed the release.

Although we shot and immobilized nine free-roaming bears,

seven of which we were able to tag, the majority were captured in culvert traps and then immobilized. Bait was tied to a trigger mechanism far back at the closed end of the metal cylinder. A pull on this released the door which dropped down behind the bear like a descending guillotine. We experimented with various combinations of baits whose tastes and aromas were concocted to make a hungry bear drool.

Bears, like men, are omnivorous feeders, eating both animal and vegetable foods and in great variety. Because of this we went on the assumption that grizzlies would like some of the things we ourselves consider tasty. Many campers have to their regret found this to be true.

Like trappers the world over, when we finally found a successful method we continued to use and perfect it until the whole baiting procedure took on the aspects of a ritual.

We were also a bit surprised to find ourselves falling into the long established pattern of secrecy in such matters. Wes has staked out a claim for having added the irresistible touch that lures the bear into the trap against his instincts and at times contrary to his experience. None of us has challenged this valid claim. In the full knowledge that I may be reproached by Wes, I will divulge, at least in part, our secret formula.

Having decided that no aroma (with the possible exception of steaming coffee, and bears are not known to have yet acquired the coffee habit) could more effectively stimulate gastric secretions and lull suspicious attitudes than the smell of cooking bacon, Wes decided to fry some right inside the trap and let the oils spread through the interior. However, since every trapping night in the short season was important to our venture we also added some

strips of raw bacon and bread soaked in honey.

The next morning we had a grizzly. Obviously a direct result of our baiting procedure. Wes found he could get even better effects by setting fire to bacon rind tied to the trigger.

Five times in a row we trapped a grizzly. Then we failed. Maurice now felt compelled to add a contribution--pineapple juice sprinkled inside the trap. Again we had a successful trapping streak.

Realizing that this snowballing process might get out of control, I began to have visions of our baiting ritual developing to the height and perfection of some native manhood or puberty ceremonies, and perhaps taking from dawn to dusk of each day for the preparation. Concievably it could become even more important than catching the bears.

Fortunately an insignificant though highly symbolic item of modern civilization came to our rescue. And with not a little pride I must admit it was my elder son who introduced it.

We had finished our baiting ritual and adjusted the trigger so it neither pulled too hard nor would release prematurely if jarred. As we were leaving, Lance pulled a piece of hard candy from his pocket and through a peephole dropped it inside under the trigger. Laughing as he did so, he said, "I'll bet this lemon drop will make sure we catch a grizzly."

I glanced at Maurice and still am not sure whether that fleeting expression was one of dismay or horror before he too laughed and said, "Or else really jinx the set."

The next morning we saw from a distance that our trap was not sprung. Closer investigation revealed that a bear had entered the

trap, eaten all the loose tidbits and then left without touching the appetizing bacon rind tied to the trigger. This was the first and only time this happened. We wondered whether it could have been a trap-wise bear we had caught before.

"I guess I did jinx the trap," said Lance in a self-reproving and disappointed voice. "Look. The lemon drop is still there."

That ended the further elaboration of a ritual that might have advanced to the point where it became an institution. The lemon that returned us from the elaborate to the simple was a lemon that paid off.

As the short Yellowstone summer drew to a close, we began to plot [illegible] of capture, some within two or three days or perhaps sooner. Others, like Ingemar, seemed satisfied with their change of location.

Travelling such distances over rough country was routine for the grizzly. It is possible that in the course of a lifetime there are few of Yellowstone's wonders--scattered over about 3170 square miles--that they do not see. We hope to find out. Their spatial requirements may determine whether they can survive in a world where increasing humanity will continually crowd them.

The grizzly moves at a fast walk, carrying his head low. When alerted, his head comes up and he travels at a trot. Full speed is an awe-inspiring gallop. One evening I was given an unusual exhibition of the grizzly's ability to cover ground. I was standing just off the Lake-Canyon highway when out of the semi-darkness there suddenly appeared a close-ranked bank of seven grizzlies moving at a gallop. They were grunting from prolonged exertion and they were wet, having just swum the nearby Yellowstone River. Heading almost directly for me, they gave the impression of irresistible power like an onrushing train, an incoming breaker, or

a rock avalanche. Catching my scent, they raised their heads, veered to the right, breaking ranks only slightly as they crossed the highway and dropped over a steep bank. They took this 40-foot obstacle in a cloud of dust mingled with a spray of water as they crossed the stream below. Without a perceptible slackening of speed they climbed the far bank.

It is doubtful if a horse could have crossed this terrain and certainly not at this breakneck speed. They rolled along at a gallop into the lighter darkness of the west until their dark forms became indistinguishable from the background. This episode lasted only seconds. They had come and gone with the speed and ease of an airplane shadow moving over the countryside. A low-hanging cloud of dust still settling over the water was the only reminder that they had passed.

By the time the aspens were turning yellow and the swamp huckleberry red, a few reports on marked grizzlies had trickled in from fishermen, campers and hikers, as well as from the rangers. By pin pointing on a map such observations as these as well as our own, we should in future summers get some accurate indications of the size and extent of individual bear ranges. Over the years a series of sightings on each marked grizzly will reveal the size and character of home ranges and the nature of seasonal movements and wanderings in search of food, mates or other requirements.

We may learn whether Bigfoot challenges Ingemar, with whom the Ninety-Pound Cub associates as a yearling, how soon his mother has another litter and how many cubs. The largest litter we observed was three, the average number of cubs per sow was 1.8. Many more observations will provide us with different or more representative figures.

An analysis of our counts made throughout the summer in areas of grizzly concentrations provided the basis for an estimate of a minimum population of 150 silvertips. A relationship between the marked and unmarked bears observed in future years should provide continuing and still more accurate counts of grizzlies throughout Yellowstone Park.

The first snow had temporarily blanketed Yellowstone and had accumulated in drifts on Mt. Washburn and other peaks where it would remain until spring. The bull elk were still bugling, still carefully shepherding their harems of cows but with a diminishing ardor and diligence. As I trudged up Mt. Washburn in the snow, an occasional high clear resonant whistle came to me on the gusty mountain winds. A bull elk down in the black timber was challenging other bulls.

Soon I was too far up to hear even the highest pitched notes of the bugles. The drama unfolded by coyote tracks drew my attention; then I was attracted by the slow deliberate movements of some Richardson grouse walking conspicuously from snow to miraculously disappear on rock, where their color and feather patterns turned them to stone. So completely did they disappear before my eyes that I had a feeling of unreality although I knew exactly what had happened.

I looked in vain for the tracks of mountain sheep. Sometime before the first storm they had instinctively left the high country for lower more clement wintering areas. A few persistent lupines, asters and mountain dandelions gave what was perhaps their last touch of color to the windswept ridges.

Dropping on down into the stunted timber of the north slope I finally found what I had been seeking--grizzly tracks in the snow. For perhaps an hour I followed the trail of an inquisitive bear,

definitely not in a hurry. I came upon a packed wet spot where he had recently sat. The view was breathtaking. I lingered awhile, though perhaps for different reasons than had motivated the bear.

Envisioning him sitting there, attuned to the smells, sounds and sights of his beautiful domain, brought to mind another very human activity I had witnessed just the evening before.

A young bear fascinated by the jets of his own breath in the crisp air stood on his hind legs and struck at the moving vapor trails first with one paw and then another. Because bears are so human-like I found myself interpreting his actions in terms of human behavior. I thought, "This bear is impelled largely by curiosity and he appears to be thoroughly enjoying his shadow boxing."

Through a short round he continuously punched at but never connected with what must have seemed a very tangible object. Then his behavior changed--curiosity gave way to suspicion and suspicion to fear. He dropped down from his man pose to all fours and, now a bear, tried to run away from his own breath.

Following further the wandering and rather erratic trail, I entered a dense cluster of stunted firs where already the snow had accumulated to a depth of several feet. Here the bear had dug and trampled around in a secluded spot darkened by drooping fir boughs above and to the sides and closed by the mountain slope to the rear.

Here the snow would pile up twenty feet or more. Under this protective blanket a bear could hibernate--could sleep warm and well.

Actually bears, unlike bats and some rodents, do not hibernate in the truest sense; that is, they exhibit no striking drop in body temperature with accompanying marked decrease in breathing and

pulse rate. They do go into a dormant state but maintain a body temperature considerably above that of their immediate environment. In this condition sows give birth to cubs weighing about 24 ounces.

Could this be a possible hibernating spot, I wondered, and the bear just selecting it and looking it over for later retirement? The answer to this, as to so many other questions, would have to wait for another year. This summer we were just getting started. But if our plans developed as we hoped, Maurice, John, Wes and I would not only mark more bears next summer but might eventually fasten miniaturized radio transmitters to some, perhaps even to this one. Through a signal we could track them in their late fall wanderings and possibly locate them after they had gone off to sleep. Where might we find them? Could we look in on them if we did locate them? What might be their reaction on being awakened?

Again, the answers lie in the future. We can no more anticipate them now than we could have foretold in summer what our colored markers would relate about the bear we called "One-Eye". He wandered out of Yellowstone Park over the rugged Beartooth Range of mountains, out of the protected area of the Park, and on October ____ he was shot some 25 miles south of Cooke City, Montana, approximately 50 air miles from his point of capture.

MONTANA COOPERATIVE WILDLIFE RESEARCH UNIT

MONTANA STATE UNIVERSITY
MONTANA FISH AND GAME COMMISSION
WILDLIFE MANAGEMENT INSTITUTE
FISH AND WILDLIFE SERVICE, UNITED STATES DEPARTMENT OF THE INTERIOR

MONTANA STATE UNIVERSITY

MISSOULA, MONTANA

February 18, 1960

Dear Frank:

I am sending a draft of the grizzly paper. We plan to make final changes in this and mimeograph it Monday, February 22nd, so if you have any important changes or suggestions, please phone me collect. I am not including the tables as they are being typed but will get them to you in a few days.

I am also enclosing copies of the water resource policy and of the statement we made at the Senate Water Hearing.

Had a nice visit with Irving which I will tell you about another time.

I was very disappointed with the meetings in Portland. It seemed to both myself and Paul Dalke that the big shots in the Regional Office have no use for the Research Units and actually go out of their way to show their disapproval. Both Paul and I arrived at this conclusion independently. In view of the general calibre of the men in charge, I think it is quite understandable.

Guess thatts about all for now.

Sincerely,

John

JJC:AB

Frank — the water stuff is going under another cover.

Jim

TRAPPING, IMMOBILIZING AND COLOR-MARKING GRIZZLY BEARS

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This investigation was initiated by the Montana Cooperative Wildlife Research Unit[1] to gather information on population dynamics, behavior, and other ecological data concerning the grizzly bear, Ursus horribilis. Recently a number of bear studies have been conducted and in each the investigators have encountered similar problems inherent in working with these large mammals as well as unique problems peculiar to the study area and the species of bear involved. Our experiences in adapting live-trapping and immobilizing techniques and developing color-marking methods for grizzly bears in Yellowstone National Park constitute the subject matter of this progress report which we hope will prove helpful to others pursuing similar lines of investigation. A grizzly bear population has not until now been the subject of intensive trapping and marking. Therefore a brief discussion of the general status of this large carnivore in the United States and in Yellowstone in particular seems desirable.

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[1] Contribution from the Montana Cooperative Wildlife Research Unit; U. S. Fish and Wildlife Service, Montana State Fish and Game Department, Montana State University, and Wildlife Management Institute cooperating.

Since Lewis and Clark first saw grizzly bears on our western prairies in 1805, their numbers have steadily declined. In the United States (with the exception of Alaska) they now exist only as remnant populations in wilderness areas, national parks, and national forests of the Rocky Mountains.

The grizzly, an endangered species, has disappeared from Texas, Kansas, Arizona, New Mexico, Oregon, Utah, and the Dakotas. In California, where it was once numerous, there has been no record of a grizzly for 38 years (Storer, 1955). Cooney (1956) has reviewed the status of the grizzly in the United States and concludes that the state of Washington may have a few, Colorado possibly 10, Idaho approximately 60, and Wyoming, excluding Yellowstone National Park, not more than 50. Montana lists about 450 exclusive of Glacier National Park. Estimates for Glacier and Yellowstone at that time showed 100 and 125 grizzlies respectively. Rough estimates indicate the number of grizzlies left in the United States, excluding Alaska, may lie between 500 and 1,000. Thus there is need for detailed ecological studies of the grizzly throughout its present range if it is to be preserved and intelligently managed. This has been recognized for some time but formidable obstacles have prevented intensive research.

Obstacles to such a study in western United States have been:

1. Solving the tremendous physical problem of gathering data and supplying an operation over thousands of square miles of wilderness grizzly habitat.
2. Locating a grizzly bear population sufficiently large and localized that data could be obtained on a quantitative basis.

3. Adapting and improving methods of immobilizing wild bears for detailed inspection and measurement.

4. Developing a method or methods of marking grizzlies so individuals and known-age animals could be observed in the field.

After much fruitless searching in Montana for a suitable study site, Yellowstone National Park was investigated and found to have a wild grizzly population sufficiently free of artificiality that fundamental biological data could be obtained and on a quantitative basis. Advantages of the Yellowstone area are that grizzlies are numerous, readily observable, and can be studied both in the vicinity of man and in the back country - a situation that should yield basic ecological data as well as information on the adaptation of this large carnivore to man. The National Park Service indicated interest in a proposal for research and offered to cooperate in the study. Park records and literature dealing with the fauna of Yellowstone provide a wealth of general information on the grizzly and its history in the Park.

Skinner (1925) notes that as early as 1889 black bears, Ursus americanus, in Yellowstone began to frequent garbage piles but it was not until three or four years later that grizzlies followed their example. On August 2, 1916, he had 29 grizzlies in sight - the most he had ever seen at one time. At about this time he estimated a total of 40 grizzlies in Yellowstone. His descriptions of the grizzlies in those early days indicate the relations of these bears to man and to artificial food in the park have changed little if any in the past 50 to 60 years. Regarding this he says, "Three-fourths of the bears we ordinarily see in the park are near scrap piles, yet it is evident that this is not their principal food, or even any considerable part."

In 60 years of close association with man, the grizzlies in Yellowstone have not basically changed their behavior nor their habits. They have not become "roadside bums" like the black bear. From June through September they frequent the half dozen large garbage dumps chiefly during evening and night. Early in the season the bears are wary and come to the dumps only at night. Soon they get bolder and some begin arriving in the afternoon. This habit of concentrating where food is available has been characteristic of the grizzly from the time his numbers and behavior were first recorded and there are innumerable references to this in the literature. Storer and Trevis (1955) in citing early writers, quote such phrases as . . . "regiment of bears", . . ."countless troops", . . . "bears are very plentiful", . . . "are often seen in herds," . . . "not unusual to see fifty or sixty within twenty-four hours" . . . "the whole lake and swamp seemed alive with bears."

"Many early accounts tell of the grazing habits of grizzlies. The bears congregated locally to forage in wild pastures and made seasonal migrations to such places." (Storer and Trevis op. cit.). The same authors summed up the behavior of the California grizzly in these words, "But when grizzlies congregated with their kind to relish some desirable food - clover, acors, or whale - they ate together peaceably."

Lewis and Clark found grizzlies particularly abundant near the Great Falls of the Missouri where game and carrion were abundant. They stated (from Skinner 1925) "they constantly infest our camp" and . . . "become exceedingly troublesome."

Food disposal areas attract bears in Yellowstone, just as the salmon streams of Alaska concentrate the Alaskan brown bear, Ursus middendorfii during the spawning runs. While feeding at these areas some bears

are indifferent to man, but most are alert and sufficiently shy to run at the least disturbance. Skinner (1925) states, "Out in the wilderness that covers so much of the Yellowstone National Park, they (grizzlies) are just as wild, just as cautious, and just as difficult to find as bears anywhere else." This statement is essentially true today. The grizzlies in Yellowstone are relatively indifferent to man only when they are feeding; and this is a trait readily acquired by bears anywhere.

It seems the grizzlies habit of concentrating where food is abundant and of seeking it boldly in the vicinity of man is not of modern origin.

With regard to their food, Skinner (op. cit.) says of grizzlies in Yellowstone . . . "grass is eaten as much, if not more, than any other single item, and this is true of the lordly grizzly as well as of the common bear . . . . bears do not depend upon garbage."

Murie (1943 unpublished) studied the food habits of Yellowstone grizzlies and black bears and concluded that vegetation comprises 81 per cent of their food and garbage 6 per cent. He stated, "It was found too, that even at the camp grounds, where bears habitually sought garbage, natural food still constituted 89 per cent, garbage 10 per cent." Our examinations of grizzly bear feces at disposal areas during the summer of 1959 indicated heavy use of natural foods. The situation in Yellowstone where grizzlies concentrate to feed on garbage is not as artificial a situation as first appears.

It is the grizzlies' nature to scavenge and to congregate wherever food is available and we believe these natural traits of the grizzly are intensified under the conditions prevailing in Yellowstone. We seriously doubt if this will invalidate the basic data we plan to obtain; in fact,

the behavior of grizzlies in Yellowstone is so reminiscent of the early accounts of the California grizzly as they came in contact with the settlers (Storer and Trevis, 1955) that we suspect "historic" bear and man relationships have been preserved rather than altered in Yellowstone.

Trapping

Techniques for capturing and handling black bears were developed by Erickson (1957). This work stimulated black bear investigations in New York, Pennsylvania, West Virginia, Virginia, and Montana. It was inevitable that the basic techniques used should be applied to the grizzly bear. We captured grizzlies in culvert traps on trailer frames similar to those used by the U. S. National Park Service for capturing and moving nuisance bears. The basic design with modifications as well as the trapping techniques have been described by Erickson (1957) and Black (1958).

Counts made throughout the summer of 1959 indicated a minimum population of 150 grizzlies for Yellowstone National Park. Most of these bears concentrated in the disposal areas at night, but daily moved considerable distances. Thus sets were made at these feeding areas, along the back roads, and outside camp grounds. Fourteen grizzlies were captured in the two traps during 21 nights of trapping and in addition two were retrapped. This constituted a trapping success of 76 per cent or 1 bear for every 1.3 trap nights. Black (1958) captured one black bear for every 3 culvert trap nights in 1956, less in 1957. Troyer (conversation) informed us that he was unable to trap the Alaskan brown bear in culvert traps, but was successful in capturing 30 in steel traps - obtaining a trap-night index of _____. Information on trapping success is lacking for nine grizzlies trapped by park rangers which we marked and released. However, the sex, age, and weight of all trapped bears appear in Table 1. The bears range from yearlings to a 710-pound boar. Lactating sows were taken but no cubs were captured in culvert traps.

Immobilizing and Handling Trapped Grizzlies

All bears handled, whether trapped or shot free-roaming were immobilized by propulsive injection of succinylcholine chloride (Sucostrin) using a syringe dart and gas (CO_2) operated rifle. The automatic projectile type syringe and rifle are described by Crockford et al (1958).

Erickson (1957) produced effective anaesthesia in black bear using one grain of Pentobarbital Sodium for each 5 pounds of body weight. Complete sedation was achieved in approximately 11 minutes. Black (1958) used one cubic centimeter of Pentobarbital Sodium per $5\frac{1}{2}$ pounds of body weight to produce anaesthesia. Black (1958) accomplished complete relaxation with intramuscular injection of succinylcholine chloride with doses averaging approximately 1 milligram for every 3.7 pounds of body weight.

During the summer of 1959 this rapid muscle relaxant was used successfully on black bear in Montana by Jonkel and Hawley, on the Alaskan brown bear by Troyer on Kodial Island, and by the authors on grizzly bear in Yellowstone ( ).

After capturing a grizzly, we pulled bear and trailer onto portable loadometer scales recording the weight of trap, trailer, and bear. This was generally repeated three times or until constant weights (within 10 pounds) were recorded. The weight of the bear was then obtained by subtracting the known weight of trap and trailer from the recorded weight. Cubs were weighed on spring scales.

Dosages of Sucostrin were prepared on a basis of body weight. On large bears, crude adjustments in dosages were made to allow for estimated body fats. The grizzly was then maneuvered into position with a probe and shot in the side of the neck with a syringe dart. Injection was intramuscular with a few exceptions where the dart may have penetrated a blood vessel.

After the bear collapsed, probing of the jaw accurately indicated the degree of immobilization. Normally the jaws relaxed first followed by the forearms and finally the hind legs. The intercostal muscles and the diaphragm are last affected; respiration becomes depressed but with proper dosage breathing is quiet and regular. Normally, first symptoms were a fluttering of the eyelids. As the drug took effect the bear's head would lower until the muzzle rested on the chest, then the bear might sit on its haunches or roll directly to its side. With proper dosage, complete relaxation would occur within minutes. At first the door of the trap was raised with trepidation but as we gained confidence in the drug the procedure of hauling a large grizzly out of the culvert became routine.

Ear tags were placed on the upper leading edge of each ear as close to the base of the ear as possible. It was necessary to slit the tough hide in order to insert the tag. Color markers were put in the lower edge of both ears; a tattoo was placed under the forearm where the hair is thin and measurements and other data recorded. All bears were kept under observation until sufficiently recovered to move off. Of the grizzlies immobilized, some evidenced definite aggressive behavior when muscular control returned, others were aggressive only when pressed by the observers, and the majority were relatively submissive.

The aggressive bears turned on the observers and in several instances made sustained efforts to reach us but collapsed short of their objectives. If prodded or teased, probably all the bears would have fought back or "charged." We observed that aggressive bears or those handled as the effect of the drug wore off sometimes experienced a temporary relapse after recovery appeared imminent. We suspect that the sudden activity and excitement from handling increased absorption of the drug and they again received a paralyzing or near paralyzing dose.

Immobilizing and Handling Free-Roaming Grizzlies

To shoot a free-roaming grizzly it was necessary to approach within 50 feet as the dart gun was unreliable at greater distances. Of seven bears obtained in this manner, five were shot from a vehicle and two (a yearling and a cub) were shot by stalking in the open.

The general procedure was to estimate the bear's weight, prepare three darts with dosages of succinylcholine chloride ranging above and below the indicated dosage. The bear was then approached as close as possible and shot in the neck. The supplemental darts were used if the initial dose was unsatisfactory.

Each bear shot in this manner presented a different situation and little in the way of standardized procedure evolved. A 370-pound sow with two cubs wheeled and fled when the dart struck her. She collapsed in a stream and had to be hauled out while still not completely immobilized.

Cubs were captured at night by shooting them at the sides of their mothers. A flashlight was used to spot the cubs and the marksman was covered with a rifle. Behavior of the sows varied widely but in no case did one charge, and all but one deserted their downed cubs when the car motor was raced or a rifle discharged. One sow, however, returned before we could get to the cub and she did not leave until the cub could walk away. Captured cubs were held overnight in a holding cage and released the next day after being immobilized a second time for tagging and marking.

Evaluation of Succinylcholine Chloride

Succinylcholine chloride is not an anaesthetic but a short acting skeletal muscle relaxant that blocks nervous transmission at the myoneural junction. Succinylcholine chloride is sold under various trade names

(Sucostrin, Anectine) and chemically is diacetylcholine. It substitutes for acetylcholine - the chemical compound that activates skeletal muscles and depolarizes the myoneural junction. Muscular paralysis persists until the diacetylcholine is hydrolyzed by cholinesterase in the blood and normal nervous transmission at the myoneural junction is again resumed. The amount of cholinesterase varies widely in blood and different organs of different species (Grollman and Slaughter, 1947). This probably accounts for its selective action on certain parts of the body.

The muscles of the eyelids are first to be affected when succinylcholine chloride is given to conscious human patients. Thereafter the muscles of the jaws, arms, legs, and abdomen are affected in the order given. Paralysis of the upper intercostal muscles then occurs and respiration becomes depressed. The diaphragm is last to be affected.

In humans, the level of relaxation can be carefully controlled by administering a dilute succinylcholine chloride solution as an intravenous drip. This, of course, was impossible in this study and intramuscular injections of high potency solutions were used to produce complete relaxation. Ten minutes were sufficient to allow the animal to be removed from the trap, tattooed, measured, ear tagged and color marked for future individual recognition. Whenever a drug is administered intramuscularly it is difficult to control its absorption. This difficulty probably accounted for some unexpected reactions to the drug but individual susceptibility as well as other factors undoubtedly were also important. Literature supplied with the drug stated "The optimum intravenous dose for such purposes" (short duration) "will vary among individuals, usually ranging from 10 to 40 milligrams." A similar variation may be expected among individual grizzlies.

We experimented with dosages of succinylcholine chloride on the first half dozen grizzlies captured and arrived at a working dosage of approximately 1 milligram of Sucostrin per 3 pounds body weight administered in a single dose. This rule-of-thumb dosage was used on all bears with modifications discussed later. No attempt was made to cage a grizzly and determine minimum, average, and lethal doses as it appeared there was considerable individual susceptibility to the drug as well as the probability that susceptibility was altered by confinement.

Multiple Doses

There is need for more precise information on dosages, to avoid mortality and reduce stress in treated animals, as well as to increase the safety of the bear handlers. With this in mind we have analyzed our data and experiences during a summer's work and present our findings for the benefit of other workers, recognizing that our conclusions are tentative.

Multiple doses were administered at first in an attempt to arrive at an effective single dose injection and whenever a bear failed to immobilize completely. A bear was considered immobilized only during the time it was prostrate and unable to bite. This served as a criterion for computing time interval immobilized (Tables 1 and 2). Recovery time (Tables 1 and 3) includes time interval immobilized plus the time required to regain sufficient muscular control to leave the area. Ten of 30 bears or 30 per cent required jultiple doses. The averageinitial dose was 1 milligram of Sucostrin per 3.6 pounds of body weight with an average second dose of 1:4.5. The maximum initial dose that failed to achieve immobilization was 1 milligram per 3.3 pounds of body weight; the minimum 1:6.4.

Since succinylcholine chloride is hydrolized by cholinesterase, the time interval between injections is important in determining second or

additional doses. Our experience and data are as yet too limited to suggest desirable multiple doses in terms of milligrams of drug per pounds of body weight, but we can offer some helpful observations.

Forty per cent of the animals requiring multiple doses were not immobilized with an initial dose. These bears upon receiving a second dose were either still not immobilized or if so, only for a brief period of time. On the other hand all bears immobilized to some extent with an initial dose were subsequently satisfactorily kept in that state or re-immobilized by a second dose.

Thus, indicated procedure for administering multiple doses is:

1. Where immobilization occurs with the initial dose but is of brief duration, administer a light second dose as soon as there are signs of returning muscle coordination.

2. Where immobilization does not occur with the initial dose, wait a minimum of 45 minutes, preferably longer, then administer a more potent second dose.

Whenever the initial dose failed and additional doses were given without a considerable time lapse, the recovery time was greatly prolonged. A heavy second dose (equal or greater than the initial dose) administered prematurely can be lethal.

The procedure recommended for administering multiple doses is far from perfected and exceptions are to be expected. The complexity of administering multiple doses to either trapped or free-roaming bears is illustrated by the following examples.

Bear 11, Table 1, received five injections within a period of approximately three hours. The initial dose was 3¼ milligrams or 1 milligram per 3.5 pounds of body weight and did not immobilize; seven minutes later

25 milligrams were administered with no apparent effect. About two hours later a 42 milligram injection failed to immobilize. This was followed 24 minutes later with a 50 milligram injection which caused partial paralysis but failed to immobilize. A final dose of 60 milligrams, 39 minutes after last injection, caused immobilization in three minutes. The total dose received was 211 milligrams or 1 milligram per 0.6 pounds of body weight.

A cub and litter mate to bear 29 (Table 1) was estimated to weigh between 100 and 120 pounds. On two successive nights this cub was shot a total of five times in attempts to immobilize it. The first night, while feeding at its mother's side, the cub received an initial dose of 25 milligrams in the neck at a distance of 30 feet. It staggered but did not fall. A second dose of 15 milligrams similarly delivered, 15 minutes later, had no noticeable effect as did also a third dose of 20 milligrams approximately 10 minutes later. The second night, dosages of 33 and 22 milligrams were injected in the neck from approximately 30 feet. The first dose caused the cub to arch its neck and lie down momentarily; the second dose had no apparent effect. The sow became aroused and dangerous and no further attempts were made to capture her cub.

Single Doses

Single dose injections proved more satisfactory than multiple doses. However, not all single dose injections were satisfactory nor successful (Table 1). The basic data for computing a dosage was body weight, but it early became evident that other factors such as age, sex, physical condition, injection site, amount of body fat, and perhaps the age of the drug itself might be affecting the drug action. An analysis of this type data showed no correlation between sex and drug action or between age of drug and its action. The succinylcholine chloride was kept under refrigeration to

prevent deterioration and none was opened and used for longer than 23 days. Comparison of the action of fresh solution and dosages prepared from bottles carried about and used for as long as 19 and 23 days showed no evidence of loss of potency with age.

Selected data from 17 bears (18 dosages) in which satisfactory immobilization occurred are presented in Table 2. An immobilization was considered satisfactory and selected for presentation in Table 2 if the time immobilized lay between 10 and 25 minutes and the recovery time one hour or less. This excluded bears that died and those exhibiting other atypical behavior.

We can infer from the data of Tables 2 and 3 that an average dose of 1 milligram of Sucostrin per 3.5 to 3.6 pounds of body weight gave minimum immobilization and recovery times. An average dose of 1 to 3.1 yielded optimum results on medium-sized bears ranging in average weight between 246 and 264 pounds but resulted in prolonged immobilization and recovery in the larger bears (average weight 462 and 364).

If we consider an average immobilization time of 16 to 20 minutes and recovery time of 25 to 39 minutes to be optimum (Tables 2 and 3), then in general we tended to underdose small bears, administered optimum doses to medium-sized bears and overdosed the large bears. Data show that the larger bears were probably more sensitive to succinylcholing chloride than medium-sized bears.

There is a basic correlation between dosage and body weight of bears that appears to be modified by other factors. Age and amount of body fat were suspected as being important. We do not yet have sufficient data to determine the degree of susceptibility of cubs and other young bears. However, if we can consider weight as a function of age (Tables 2 and 3) then the inference is that older bears require less drug per pound of body

weight to immobilize them satisfactorily than young bears. This is further supported by data on multiple doses. The average weight of all bears requiring 2 or more doses was 170 pounds and those failing to immobilize with the initial dose averaged 139 pounds.

We had no way of accurately estimating amount of body fat, but it was evident from field observation and from autopsies that the bear population in general did not begin to put on fat rapidly until about the first of August. By grouping data on 18 bears (receiving what we considered optimum drug doses) by time of year, we find that bears immobilized between August 1 and August 28 required an average dose of 1 milligram per 3.4 pounds of body weight whereas bears immobilized between June 29 and July 31 required 1:3.0. It appears that the smaller average doses required late in the season were due to the fact that body fat was included as weight in dosage determination. Erickson (1957) found in using Halatal that "estimates of body fats should not be included as weight in dosage determination." We tentatively concur with this statement in regard to succinylcholine chloride.

In summarizing our data on single dose injection we recommend the following rule-of-thumb procedure until more information is available: For all grizzlies under 360 pounds administer 1 milligram of S ucostrin per 3 pounds of body weight. The fat weight should be subtracted from the total weight to give the weight for dosage determination. Except in the case of retrapped bears, fat weight will have to be an estimate. In time, data on fat accumulation during the summer months will be obtained and this information should lead to more accurate estimates. For bears over 360 pounds administer somewhere between 1:3 and 1:4 compensating for body fat. Very old bears may be quite susceptibile and the dose should be conservative.

Mortalities

Three mortalities occurred and though this is regrettable the information obtained proved highly valuable. Bear No. 13 (Table 1) was immobilized in four minutes and died within seven minutes from a dosage of 1:3.0. The bear was very old and we believe death resulted from an overdose considering age and physical condition.

Bear No. 23, a lactating female, evidenced prolonged immobilization and recovery from a dosage of 1:3.7. Breathing became depressed and artificial respiration was administered after which breathing improved and the bear recovered completely but slowly. This bear was held in the trap for 36 hours in an attempt to trap her cubs. She was then administered a dose of 1:4.6, became immobilized in 2 minutes, was color marked, ear tagged, and was regaining muscular control when she relapsed and breathing stopped. Fifteen minutes of artificial respiration failed to revive her. All or any of the above factors may have contributed to her death. However, we suspect death resulted directly from cardiac fibrillation caused by adrenalin release due to excitement, and hypercapnia resulting from poor pulmonary ventilation.

Bear No. 24, a 70-pound cub, was shot free-roaming with a dose of 1:5.0. He went down but regained muscular control rapidly. The sow was alerted and nearby. A second dose of 1:3.5 was administered with a syringe. We believe this second dose was too heavy considering the bear had been immobilized by the first injection. It is possible that the second injection was intravenous since it caused paralysis in one minute. The total dosage was 1:3.1 and proved lethal in spite of artificial respiration. In this case we believe death resulted directly from an overdose of drug which may have been carried rapidly through the blood stream paralyzing the diaphragm. Use of a resusitator with tracheal catheter should practically eliminate fatalities in the future. For those who may be critical of the loss of

is regretted

three grizzlies, we wish to point out that our operations probably saved some grizzlies that ordinarily would have been disposed of as dangerous. This was accomplished by immobilizing and removing them from contact with tourists. The use of immobilizing techniques in the future will no doubt save grizzlies in the park each year.

Color Marking

Color marking permits field recognition and observation of individuals and age classes. To be useful markers should be both visible and durable; the ideal marker would last the lifetime of the animal marked. We were doubtful that grizzlies with their predisposition to fight and chew one another would long retain conventional color markers. We therefore proceeded on the theory that a number of markers had a better chance of retention than only one. Accordingly we slit the lower leading edge of each ear and inserted plasticized polyvinyl chloride tape (Craighead and Stockstad, in press). In addition, the tough hide on the back of the neck was punctured and tape threaded through and secured with rivets. Eight basic colors were used and this gave _____ combinations for individual identification when like markers were used for each ear of every individual marked. Each marker consisted of an ear loop and a tail of different color. Both ends of the ear loop close over the tail strip and are secured with brass rivets. The neck marker was experimental and used to designate original site of capture.

Visibility of markers was excellent in daylight and good at close range at night with flashlights. Reflective tape can be attached over the basic color combinations for nocturnal observation.

Of 27 grizzlies marked and released, 13 were observed and identified. One was sighted 27 times, the average being 12 observations per bear (Table 5). Fourteen other marked bears were not seen but most of these were marked and released with no attempt made to obtain sight records.

Retention of the markers surpassed our expectations. Prior to hibernation one bear had lost its neck marker and the tail of the left ear marker but the right ear marker was still intact. Two other bears lost an ear marker or part of one (Table 5).

A small male, shot outside the park boundaries in October, still had both ear markers and neck marker in excellent condition 84 days after marking. Table 5 records the observed retention. We believe most of the marked bears went into hibernation with their color markers intact. Elk marked in a similar manner with vinyl tape (Craighead and Stockstad) still had color markers when shot 20 and 21 months later.

The value of color marking grizzlies is evident. During the summer we obtained 160 specific observations yielding information on range, population composition, and behavior. During the same period of time only two grizzlies were retrapped.

In an attempt to find a material that will meet the requirements of a permanent color marker, we experimented with polyethylene diamond braided rope. This material can be readily fused and bonded by the heat from a match. Color retention appears satisfactory, it does not stiffen at low temperatures and a rope one-quarter inch in diameter has a tensile strength of 1,100 pounds. Various color ropes can be fused to yield color combinations similar to those obtained with vinyl tape. An expandible neck collar has been designed from three-eighths inch polyethylene rope which can be constructed and placed on a bear in less than 10 minutes.

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Literature Cited

Black, H. C. 1958. Black bear research in New York. N. A. Wildl. Conf. Trans. 23:443-461.

Cooney, Robert F. 1956. Wilderness Monarch. Montana Wildlife VI:14-17.

Craighead, J. J. and D. S. Stockstad. (Unpublished) Color marker for big game.

Crockford, A. J., Frank A. Hayes, James H. Jenkins, and Seldon D. Feurt. 1957. Nicotine salicylate for capturing deer. J. Wildl. Mgmt. 21:213-220.

Erickson, A. W. 1957. Techniques for live-trapping and handling black bears. N. A. Wildl. Conf. Trans. 22:520-543.

Grollman and Slaughter (1947. Pharmacology and therapeutics. 868 pp. Lea and Febiger, Philadelphia, Pa.

Murie, O. J. 1943. Progress report of the Yellowstone bear study. Unpublished.

Skinner, M. P. 1925. Bears in the Yellowstone. 158 pp. A. C. McClurg & Co. Chicago.

Storer, T. I. and L. P. Trevis, Jr. 1955. California grizzly. 335 pp. Univ. of Calif. Press, Berkeley, Calif.