THE USE OF THE SET CAMERA AS A TECHNIQUE IN WILDLIFE PHOTOGRAPHY

by

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INTRODUCTION

General Objectives

The purpose of this study was to investigate as thoroughly as possible the many and varied uses of the set camera in obtaining wildlife photographs. As used in this thesis, a set camera is any camera placed in position so that an animal, by some natural act such as walking along a trail or picking up food, will trip the shutter and take its own picture. In this thesis the types of equipment applicable to this kind of work are investigated, the advantages and disadvantages of set camera photography are discussed, the various groups of animals most practical to work with are listed, and the possibilities of additional work with set cameras are considered.

Need for Wildlife Photographs

Studies have shown that approximately 80 per cent of the total of human knowledge is gained through the use of the sense of sight. Knowledge of many things is gained through direct observation. Other things are read about or pictures of them are seen. Both the printed word and the picture add greatly to human knowledge. The most accurate type of picture in the reproduction of the

original object is the photograph, and photographs have played a tremendous part in adding to practically every field of human knowledge.

Persons working in the field of conservation education have long known that a good photograph of an interesting subject will catch and hold a person's attention far more readily than pages of type on the same subject lacking illustrations. Often the photographs first draw attention to what a written piece is trying to say. This is very important, for printed information is worthless unless the public will read it.

Photographs also play an important part in wildlife research, for the human eye is not fast enough, and the human memory not good enough, to record permanently certain details. Much action which is too rapid to be seen clearly by the human eye can be recorded through the use of photography, for a photograph can record details and retain them indefinitely.

General Methods Used in Wildlife Photography

Wildlife photography probably began shortly after the invention of the camera several hundred years ago, but it first became prominent in this country about 1887 when George Shiras III began trying to record the images

of animals on sensitized glass plates.[1] Shiras, who has been called by some "the father of wildlife photography," did a tremendous amount of work in this field. While Shiras had to be content with heavy glass plates, slow emulsions, and heavy, bulky cameras, the modern worker has available small, quickly operated cameras and films with emulsions fast enough to take pictures in very dim light.

The improvements in photographic equipment have been great since the early days of photography, but the basic techniques used in wildlife photography have changed very little. Modern wildlife photographers still use three basic methods of obtaining their photographs, just as Shiras did years ago.

One wildlife photographer, using a telephoto lens mounted on a gunstock, very cautiously approaches a water hole in the early morning light and attempts to get close enough to a drinking deer to photograph it. This is stalking, the most commonly used method of obtaining wildlife photographs. The camera need not be mounted on a gunstock. It may be on a tripod, or simply held in the hands. The photographer is in direct contact with the camera and operates the camera directly (See figures 4 and 5).

[1] A glossary of photographic terms used is included in the Appendix.

Another photographer fastens his camera to a small tree near the water hole and runs long wires to his hiding place in another tree about 100 feet away. When the deer comes to the water hole to drink, the photographer pushes a button and the deer is photographed. This is remote control photography, the second most popular general method of obtaining wildlife photographs. The camera is operated from a distance by the photographer.

A third photographer places his camera in the same tree near this water hole, but instead of running wires to a tree 100 feet away, he stretches a thin black thread across the trail at the edge of the water hole. Then he goes home, hoping that during the night a deer on its way to drink will push against the thread, thus setting off the camera and taking its own picture. This is set camera photography. The animal, not the photographer, sets the camera off. The photographer merely positions the equipment so that the animal will cause the film to be exposed.

The three methods of wildlife photography mentioned above have been available to photographers since the invention of cameras, and although the general methods have not changed, the development of more and better equipment has made differences in the application of these methods. Of the three methods, the third, set camera photography, is least used by wildlife photographers.

Advances in Set Camera Work

The earliest reference found in the literature to any set camera photography was an article by Shiras (37, p. 425), written in 1908, in which he discussed getting photographs of mink, (Mustela vison Schreber) (31), by this method.

Shiras used a camera having a top shutter speed of only 1/100 of a second, and flashpowder for a light source. This flashpowder was of an explosive type and animals photographed with it must have been badly frightened. Shiras (38, p. 179), mentioned seeing the glow from a flashpowder explosion up to 20 miles away. However he was able to get some rather good photographs with this equipment and was recognized as one of the most successful of the early wildlife photographers. Shiras used very simple equipment to trigger his cameras, such as strings fastened across game trails, and bait tied to strings. Many of his photographs showed the strings and other equipment used, and photographs were often blurred because of the slow shutter speed used. Nevertheless he had great faith in set camera photography and stated in one of his articles (39, p. 763):

> "The purpose of this article is to show that a camera and accessories can be so arranged that any animal or bird and many a reptile, however large or small, agile or cunning, may have its picture faithfully recorded, during daylight or darkness, without the immediate presence of a human

assistant."

Since these early attempts at set camera photography, cameras having much faster shutter speeds and higher quality lenses of greater speed have been produced. Faster films and better light sources have been developed. Flashbulbs and electronic flash have replaced the flash-powder. Electrical devices have been utilized to greatly improve the equipment available to the set camera photographer.

Even as this is being written, much new equipment is coming on the market that will be of great help to the set camera user. In the years to come many more technical advances will undoubtedly be made.

Detailed Objectives of the Thesis

It is the intention in this thesis to describe some of the photographic equipment now available, mentioning in detail the important parts of the camera as they pertain to set camera photography. The various types of lighting will be discussed. A few of the many triggering devices that can be used will be considered. Effective baits and lures, important in this type of photography, will be listed for some of the animals. Methods of concealment and protection of photographic equipment will be discussed, as will the various procedures necessary in attempting set camera photography.

The results of two years of work with set cameras will be discussed and analyzed. The disadvantages and advantages of set camera photography, the types of persons who are most apt to use set cameras for wildlife photographs, and some methods and equipment not actually used in this study will be considered. In general, the entire field of set camera photography of wildlife will be discussed.

METHODS AND MATERIALS

Cameras

Any camera may be used in set camera photography. Some, however, are very difficult to use, some are only fair choices for this type of work, while others are very well suited to this type of wildlife photography. Rather than discuss the various types and makes of cameras on the market and their good and bad points, the various parts of a camera will be discussed as they relate to what is needed or desirable for set camera work. Some features, considered very desirable for other purposes, are not needed in set camera photography. On the other hand, some features required for set camera work are not needed for other types of photography. The essential features to be discussed include the camera lens and diaphragm, shutter, flash synchronization, film size, focusing methods, and viewfinder.

Lenses. The camera lens is the part of the camera that is responsible for focusing the light onto the film. Basic optics of camera lenses will be discussed only briefly in this thesis. For more detailed information consult Kingslake (27) or Quarles (33, p. 20-47). In theory, a lens that is perfect in resolving power will focus each point of light from the subject as an extremely small circle on the film. Actually, however, perfect

lenses are not yet possible, though lens makers will approach this more closely as new manufacturing techniques are developed. A point of light reflected from a subject is actually focused as a very small circle on the film. The smaller the circle, the higher the resolving power of the lens. The resolving power of a lens is one of the factors which determines the quality of that lens. The quality of lens needed will depend on the use to which the finished photograph will be put. For some types of research in which all that is desired is a record of what species of animal was present, a lens of only fair quality would be adequate, and in fact may often be preferred because of the lower equipment cost. However, for work done to produce the best wildlife photographs, a lens of high quality should be used.

The speed of the lens needed will depend on such other variables as the speed of film, shutter speed, and the amount of light available. Other factors being equal, a faster lens will be needed with the slower films, with a more rapid shutter speed, or with a weaker light. For most uses it was found that a setting of f 5.6 was adequate, and all but the most inexpensive cameras usually have lenses which are that fast. It must be remembered that the smaller the f number, the more shallow the depth of field. For a more complete explanation of depth of field as it is related to the size of diaphragm opening refer

to Kingslake (27, p. 74-93). The depth of field should be great enough to get the entire animal in focus. As an example, a 50 millimeter lens set at f 2, and focused at three feet will have a depth of field of only about one or two inches on either side of the three foot mark. The same lens, focused at the same distance, but stopped down to f 22 will be in focus from about two feet to approximately five feet, giving a much greater depth of field than when set at f 2.

The focal length of the lens used will again depend upon circumstances, but it was found that the normal lens for most cameras being used was generally suitable. If a wide angle lens is used, the equipment must be placed close to the animal which may cause it to become frightened. Use of a telephoto lens, on the other hand, requires that the camera be set a considerable distance away in order to get the entire animal in the picture area. Since the amount of light from a flashbulb loses intensity very quickly as distance is increased, it is usually not desirable to have the source of light too far from the subject. As the normal lens is the one most commonly available and most generally used for other purposes, it is the lens most apt to be employed for set camera work. A wide angle lens might be desired for photographing very large animals, so that the camera and lights would not have to be placed too far away from the subject. Likewise,

a telephoto lens might be desired for use on very small animals, so that the equipment would not need to be set up too close to the subject to be photographed.

Shutter. The shutter is one of the most important parts of the camera, as it regulates how much light passes through to the film. The two common types are the leaf and the focal plane shutter.

The leaf type is mounted between the parts of the lens, or directly behind the lens. These are then referred to as a between the lens shutter or behind the lens shutter, respectively.

Leaf type shutters usually have a top speed of about 1/500 of a second, which has been found to be adequate for most set camera work. Shutters of this type are easily synchronized to handle either flashbulbs or electronic flash at all shutter speeds.

The focal plane shutter is mounted just in front of the film, or plane of focus, as the name suggests. Shutters of this type usually consist of two curtains that move past in front of the film. One curtain moves across and the second one follows. The time lapse between movements of the two curtains determines the shutter speed. At the higher shutter speeds the second curtain starts across before the first is completely past, so actually there is a narrow slit moving across the film. The narrower the slit, or the faster the slit moves, the faster the

shutter speed. Although theoretically there is no maximum speed for this type of shutter, in practice the top speed normally to be expected on cameras having focal plane shutters is 1/1000 of a second. This type of shutter is easily synchronized for use with special flashbulbs, called focal plane flashbulbs.

However, it is possible to use electronic flash only at the slower shutter speeds. Since at the higher shutter speeds a narrow slit moves across the film, the only part of the film that will be exposed is that area which happens to be uncovered by this slit at the instant the flash goes off. At the slower shutter speeds the entire area of film is uncovered at one time, so the flash will expose it all. The maximum shutter speed at which electronic flash can be used varies with the make of camera, but is usually between 1/20 and 1/50 of a second.

Whichever type of shutter is used in set camera work, the shutter speed should be sufficiently fast to stop all action. Much animal motion is quite rapid. It was found that a shutter speed slower than 1/100 of a second was not satisfactory. A speed of 1/200 of a second was used most often and sometimes an exposure time of 1/500 of a second was needed to stop fast action. If the other conditions are such that a fast shutter speed may be used, it is advisable to use the fastest speed available, as the action at the time of exposure is not predictable and

it is better to have a shutter speed that is too fast than one that is too slow (See figure 9).

Shutters are either of the self-cocking type in which the shutter is cocked and released in the same motion, or a type that is cocked by one operation and released by another. For set camera work the latter type of shutter is recommended because of the ease with which this shutter may be released. The actual tripping of this type of shutter requires only a very light touch. The self-cocking shutters often require a rather strong pressure to operate them since the work of cocking the shutter springs is done in the same motion that is required to trip the shutter. Therefore, a much greater pressure on the shutter release is required to trip a self-cocking shutter.

Flash Synchronization. Since most set camera photography is done at night, some artificial light is needed. This light source must be synchronized so that the light reflected from the subject reaches the camera at the same instant that the camera shutter is open, otherwise no picture will result.

Most modern cameras are synchronized for use with either flashbulbs or electronic flash, or often for both. The instruction manual or pamphlet will indicate which of these the camera is adapted for. It has been found that synchronization for use with one of the popular sizes of

flashbulbs is best for most set camera work.

It is often possible to have flash synchronization added or built into cameras not originally having this feature, or some form of external synchronization may be used. However, in using external flash synchronization problems might arise as many of these systems are not dependable, and it is strongly felt that a camera with built-in synchronization should be used if possible.

Film Size. The film size will be determined by the use to which the final photographs are to be put. Cameras may be purchased to handle negative sizes from 8 millimeters to 30 by 40 inches. Neither of these extremes is practical except for special uses. The 8 millimeter size is that commonly used by amateur movie photographers. The next larger size, 16 millimeters, is generally used by professional motion picture photographers and advanced amateurs. A few still cameras handle this size, but it is rather small for any serious set camera photography. The next larger size, 35 millimeters, is probably at present the most popular size for still camera work. This film size, which measures 1 by 1 1/2 inches, was once thought to be too small for serious photography, but with the improvement of film emulsions, developers, camera lenses, etc. over the years, this size has proven to be very satisfactory. Enlargements up to and including 16 by 20 inches can be made from a 35 millimeter negative by a careful

worker, and the results may be of very high quality.

The common roll film sizes are 127, 120, and 620. Actual sizes of 120 and 620 film are the same, differing only in the spooling. These follow the 35 millimeter size film in popularity. A roll of 120 or 620 film will make 12 negatives each 1 5/8 by 2 1/4 inches, 10 negatives each 2 1/4 by 2 1/4 inches, or 8 negatives each 2 1/4 by 3 1/4 inches, depending on the design of the particular camera in which it is used.

The common cut or sheet film sizes are 2 1/4 by 3 1/4, 3 1/4 by 4 1/4, 4 by 5, and 5 by 7 inches. The 4 by 5 is probably the most generally used and has become the standard for professional photographers in many fields. Larger sized sheet films are available, up to 30 by 40 inches, for specialized uses.

Each of the film sizes discussed has certain advantages. The greater the film size the larger sized enlargements that can be made without showing graininess or lack of sharpness in the photograph. The smaller the film size the lower the initial cost of film. Film sizes most commonly used are those from 35 millimeters up to 4 by 5 inches. The standard sized black and white print for commercial use is 8 by 10 inches and it has been found that quality prints of this size can be made from a 35 millimeter negative by a careful worker, though it is easier to work from a larger size negative, such as 2 1/4

by 2 1/4 or 4 by 5.

Focusing. The method of focusing the camera to be used for set camera photography is not as important as it is in many other types of photography. Since plenty of time is usually available when making the set, such rapid focusing devices as split-image rangefinders and single lens reflex focusing are not necessary. Many of the inexpensive cameras in fact have no means by which to change focus, depending for sharpness entirely on the considerable depth of field of the fairly slow lens. These, however, cannot be normally used at distances closer than about five to eight feet.

A simple focusing scale which can be set by hand is sufficient for set camera work, as the distance to the subject may easily be measured at the time the set is made. Split-image or ground glass focusing is convenient, and will speed up the operation, but it is not essential.

Viewfinder. All cameras have a viewfinder, as a camera would be worthless if it could not be aimed with accuracy in the right direction. Here again, as with the focusing method, the type of viewfinder is not important, as long as it is fairly accurate.

Although any camera may be used for set camera photography, it is readily evident that certain features are desirable for the best results. The camera lens should be of reasonably high quality, and the lens speed should

be adequate, at least f 5.6. The shutter should be fairly fast, at least 1/100 of a second, should be a cocking type for ease of use with some of the triggering devices, and should be synchronized for flashbulb use. The size of the film will depend on the results desired, but should normally be in the range between 35 millimeter and 4 by 5 inches. The camera should have a viewfinder and a focusing device.

Many good cameras are on the market, most of which will meet the requirements for a good set camera. The one used will probably be that which the photographer already owns. If this equipment is purchased specifically for set camera use, some thought should be given to what is needed for this purpose and to what other uses the camera may be put. A camera adequate for set camera work may lack some features useful or even vital for other types of photography.

Cameras Used. To check the advantages and disadvantages of each general type, three cameras were used in this study. These included an inexpensive 620 roll-film camera, a sheet film camera which used 3 1/4 by 4 1/4 film, and a high quality 35 millimeter camera. Each was found to be useable for certain types of set camera photography.

The inexpensive roll-film camera had a poor quality lens, with a slow speed of about f 11 or f 16, which was not adjustable, and a shutter having one slow speed of

about 1/30 of a second. It was synchronized for use with flashbulbs, made negatives 2 1/4 by 2 1/4 inches, and had an inexpensive viewfinder and a fixed focus lens. Photographs taken with this camera were not sharp because of the poor quality of the lens. The slow shutter speed often caused blurring due to animal movement, and the fixed focus lens allowed a minimum camera to subject distance of about eight feet. These proved to be disadvantages for most work except where a poor quality photograph would be acceptable. Such cases might include research work where only a record of the species taking a bait is required (See figure 8). The advantages of this camera included low cost, synchronized flash, fairly large negative size, and simple operation.

The sheet film camera used had a good quality lens with a speed of f 8 and an adjustable diaphragm, a cocking leaf type shutter which was synchronized for flash and had a top shutter speed of 1/200 of a second. This camera used 3 1/4 by 4 1/4 sheet film, and was focused by means of a ground-glass back which was also used as a viewfinder. Photographs taken with this camera were sharp and generally of good quality. The use of large sized film was also an advantage. The ground-glass type of focusing and framing was slow, but speed is not necessary in this type of work. This camera, though not practical for many other types of photography, was found to be very good for set

camera work.

The third camera used was a 35 millimeter Leica, and was employed for most of the work herein described. This camera was a very good one for set camera photography. It had an f 3.5 lens of very high quality, considered to be one of the world's finest. This largest lens opening, however, was never used. Maximum shutter speeds up to 1/1000 of a second were also available. It had a cocking type shutter that was very easy to release, and the shutter was synchronized for flash at all shutter speeds. The small film size of 1 by 1 1/2 inches was not found to be a disadvantage because with the high quality lens and modern films and developers, good quality enlargements up to 16 by 20 inches could be made from negatives taken with this camera. The optical viewfinder was easy to use, and the camera had a split-image rangefinder for focusing, though this feature is not necessary for set camera work. Possibly the only disadvantage was the high equipment price. This camera cost 250 dollars and some concern was felt for leaving such expensive equipment in the woods for days at a time. A much less expensive camera having similar features would be equally satisfactory.

Lights for Set Camera Photography

Four main types of light sources are available to the set camera photographer: natural light, floodlights,

electronic flash, and flashbulbs. Each could be used in certain specified situations.

Natural Light. Light which is furnished by the sun is known as natural light. Normally it is a poor choice for set camera work because it is not constant in intensity. During the course of a day the intensity of sunlight varies greatly. It is much more intense at noon than at either sunrise or sunset. Clouds and haze come and go, changing the amount of light reaching the subject. Shadows of trees and bushes move during the course of the day also. Therefore, except for those few instances where it may be assumed with some degree of accuracy that the light would remain within certain desirable limits, natural light is not a good choice for the set camera photographer. However, if it is felt that the picture will be taken during that part of the day when there is little variation in light intensity, that no clouds will dim the light, and that no object will cast shadows on the picture area, then natural light might be better than one of the artificial forms.

Floodlights. Floodlights are also a poor choice for set camera photography because of the necessity of having these lights turned on constantly. Unless a source of household current was available, the battery cost would be high, and photographic floodlights have short durations of expected use. No special reason is known to want a

constant light source and such might frighten an animal.

Electronic Flash. Electronic flash is a relatively new development, having been available to the public only since the 1930's. Electronic flash has the advantage of high speed exposures since the duration of the exposure is controlled by the flash itself and not by the shutter speed. The flash duration varies from 1/500 of a second to 1/1,000,000 of a second. Most electronic flash units on the market have flash durations of from 1/500 to 1/2000 of a second with 1/1000 of a second being the most widely used.

Three basic types of power supplies are used for electronic flash units. These are household alternating electric current, rechargeable storage batteries, and non-rechargeable dry-cell batteries. Some units offer a choice of interchangeable power packs and others allow the use of household alternating current as well as either storage or dry-cell batteries. Each of these power sources has certain advantages and disadvantages.

Units using household alternating current offer the lowest cost per flash, being less than 1/10 of a cent per flash. This type of unit also frees the photographer from the worry of wondering whether or not the batteries are properly charged. However, to use this type of unit, an alternating current outlet must be handy, and this is the one major disadvantage.

Rechargeable storage batteries offer a cost per flash only slightly higher than that of alternating current units, and these batteries have the added advantage of complete portability, since they do not require use of an electrical outlet. However, they have the disadvantage of greater weight and of the need to recharge the battery after 60 to 100 flashes.

The dry-cell battery units using high voltage batteries have a shelf-life of about a year and will allow from 1000 to 2000 flashes per battery. However, the cost of operating these units is higher, going up to about two cents per flash. Units of this type have the advantages of being light in weight and allowing longer usage before new batteries are needed.

Although electronic flash units are excellent for many types of photography, these are of little help to the set camera photographer. Electronic flash may be used, bu since the unit current must be switched on at all times, the battery drain would be great and the expense excessive. As only one picture may be obtained with each camera per night, no need exists for a repeating type flash unit.

Flashbulbs. Flashbulbs differ in size and shape, and in the length of time required to ignite and burn. Flashbulbs are classed as fast-peak, medium-peak, slow-peak, or focal-plane, based on the time required for each

to reach its peak brightness. The type of flashbulb recommended for any particular camera will usually be specified in the guide pamphlet that comes with the camera. Most cameras having leaf type shutters use the medium-peak bulbs such as General Electric number 5 or Sylvania number 25. All cameras with focal plane shutters use focal-plane type bulbs such as General Electric number 6 or Sylvania number 26.

Flashbulbs are the best choice of light source for most types of set camera work. These give a constant amount of light intensity and are small and convenient, and the flash battery is in use only when the actual exposure is made. When used with all but the very slowest films, flashbulbs give sufficient light for most set camera photography. For instance, using a film with an ASA speed of 200, a shutter speed of 1/100 of a second, and a number 5 or 25 flashbulb, a correct exposure will be obtained at about 15 feet with a diaphragm setting of between f 8 and f 11. Flashbulbs were used as the source of light in all photography listed here, and are the type of light sources recommended for all but special cases for set camera photography.

Batteries should be tested frequently as some flash units may have minor shorts that slowly drain the batteries. Removing the batteries from the flash gun while it is not actually being used will often considerably

prolong the battery life.

The guide numbers printed on the flashbulb cartons should not be used for set camera work in most cases. Guide numbers are computed for use in a medium sized room having walls and ceiling painted a light color. The light colored walls and ceiling reflect the light from a flashbulb so that a high percentage of it reaches the subject. When flashbulbs are used in the woods where few if any reflective surfaces exist, much of the light does not reach the subject. Therefore, for use out-of-doors at night it was found that the guide numbers given were much too high and the camera's diaphragm must be opened approximately two stops. For example, if the guide numbers indicate camera settings of 1/200 of a second at f 16, the correct setting was found to be about 1/200 of a second at f 8. However, the best way to determine the correct guide number to use is to make tests, using the same film, flashbulb, developer, and at least a similar location to the one that will be used for the actual camera set.

Triggering Devices

A good triggering device for set camera work must be one that is easily set off by the animal being photographed, is not apt to fail because of adverse weather conditions or other causes, and is at least partially selective in the choice of animals to be photographed.

The simplest triggering method is merely the use of a string or thread connected to the camera's shutter release. The other end may be fastened across a game trail so that an animal walking along the trail will press against the thread and trip the shutter, or it may be attached to a bait so that an animal taking the bait releases the shutter. This type of triggering device is very easily set up, and is inexpensive, but it does have disadvantages. Most camera shutters do not operate easily enough so that this direct pull would trip the shutter, especially in the case of the use of a trip thread. An animal is apt to feel the thread and back off before enough pressure is applied to set the camera off.

Therefore, a modification may be made that would convert a slight pull on the thread by the animal into a stronger pull on the shutter release. This may be accomplished in many ways. Contracting springs or rubber bands, pneumatic bulbs, and cable releases may all be used to advantage. As shown by Evans (8, p. 161), a slight pull on the thread may dislodge a small weight which falls and pulls on the shutter release. Various metal springs or rubber bands may be rigged so that a slight pull will release them, they in turn pulling on the shutter release. A very common and easily used triggering device is the mousetrap. A camera and mousetrap may be set up in such a way that when the mousetrap is

sprung, a string tied from the mousetrap's bail to the shutter release will set the camera off. A rat-trap might be used to squeeze a pneumatic bulb fastened to a long rubber hose which is in turn attached to the shutter release so that a plunger will trip the shutter. A mousetrap or rat-trap can also be used to push on a long cable release. The number of variations of devices of this type is limited only by the photographer's imagination, though it is felt that the mousetrap is a fairly simple and dependable device for this type of set.

Many of these triggering devices have disadvantages that make them annoying to work with. It was found that when the common black sewing thread became wet it would shrink the thread sufficiently to trip the shutter. Threads should be checked for shrinking or stretching characteristics before they are actually used in a set. To insure that the direction of pull on the shutter release is correct, threads must often be run through screw-eyes, around nails, or around twigs. Each contact causes friction, and sets up a point where the thread might freeze in cold weather. Methods employing stretching the thread across a trail may fail if the animal sees the thread and avoids it. Many of these devices are in part visible to the camera, and will be seen in the final print. Any triggering method where long lengths of thread are exposed is subject to failure due to falling limbs,

twigs, cones, and snow. Once a small bird caused a set failure when it flew into the thread and set the camera off.

Through the use of electricity it was found that camera sets could be made that were not subject to many of the causes of failures already listed. No triggering method is foolproof, but some of the electrical devices are fairly dependable in this respect.

All of the electrical devices have four main components: a solenoid, a power source, electrical wire, and a switch. The solenoid is the key part and consists merely of a small electro-magnet that is caused to release the camera shutter when an electrical current passes through coils of wire in the solenoid. A solenoid especially made for photographic work may be purchased for 20 dollars or less. Benter (4, p. 154) describes in detail how he constructed a solenoid for use in remote control photography which could also be used for set camera work.

The power source for these electrical triggering devices consists of one or more batteries. The photographic solenoids are designed to operate on three standard 1 1/2 volt flashlight batteries, provided that not too much wiring is involved in the circuit. It was found that a slightly higher voltage would compensate for the longer wiring needed in set camera photography, and that for this purpose a six volt lantern battery was a good choice. If

mobility was not a factor, a six volt car battery could be used and it has the advantage of being rechargeable. Car batteries are obviously heavy and awkward to carry.

Extension cord wire was used with these electrical triggering mechanisms. This is an insulated double wire, is inexpensive and may be purchased in any hardware store.

The last part of the electrical triggering device is the switch and each switch must possess certain basic requirements. In its normal position it must be open, it must be rather easily closed by some action of the animal being photographed, and it must open again after the picture is taken.

The switch should also be easily concealed from the animal and it must be of a type that is not adversely affected by the weather.

As with the first mentioned triggering devices, one of the simplest electrical devices also employs a thread stretched across a game trail. Instead of having the thread pull the shutter release directly, however, a pull on the thread will cause a switch to close, the electrical current then setting the camera off (See figure 1 and 13). Various types of homemade spring-mounted switches may be made, or a micro-switch can be purchased from a radio supply house. The same type of switch can be used with a short piece of thread fastened to a choice bait

Figure 1. This bobcat was photographed at a trip thread set made for deer. The switch shows plainly just this side of the animal. The other end of the thread was tied to the bush behind the bobcat. Notice that this bobcat's head is turned away. This sort of thing is difficult to control in set camera work. No bait or lure was used, and the animal just happened along. A side view was obtained because the camera was set up alongside a trail and the bobcat followed the trail. This is a nocturnal animal that would be very difficult to photograph by any other method. The camera was set at nine feet, 1/200 of a second, f 5.6; one FP 26 flashbulb was used, and Plus-X film rated at ASA 160 was used. The photograph was taken just south of Bend along the west bank of the Deschutes River.

(See figure 2, 8, 10, and 14). The two methods described above have advantages over those first mentioned in that the thread used need not be as long, and the electrical wire may be buried under ground to keep it out of sight.

Another electrical triggering device used with success is the buried treadle. In general this consists of two pieces of board, or other material, held apart by springs, and having a contact of some sort in between them. A push-button switch may be used to provide both the spring action and the electrical contact. This device is enclosed in a plastic bag to keep moisture away from the switch and to prevent dirt from getting between the two pieces of the treadle. The entire apparatus is then buried in a location where the animal is apt to step on it (See figures 3, 11, and 12). Another variation successfully used consisted of putting a switch under a small slab cut from a log, but left in place, so that an animal walking along the log would step on the slab, complete the electrical circuit, and trip the camera shutter (See figure 9).

Devices based on the idea of a buried treadle have the definite advantage of being completely hidden from both the animal and the camera. Use of the buried treadle will also often produce a very natural picture, as the animal is completely unaware of the presence of

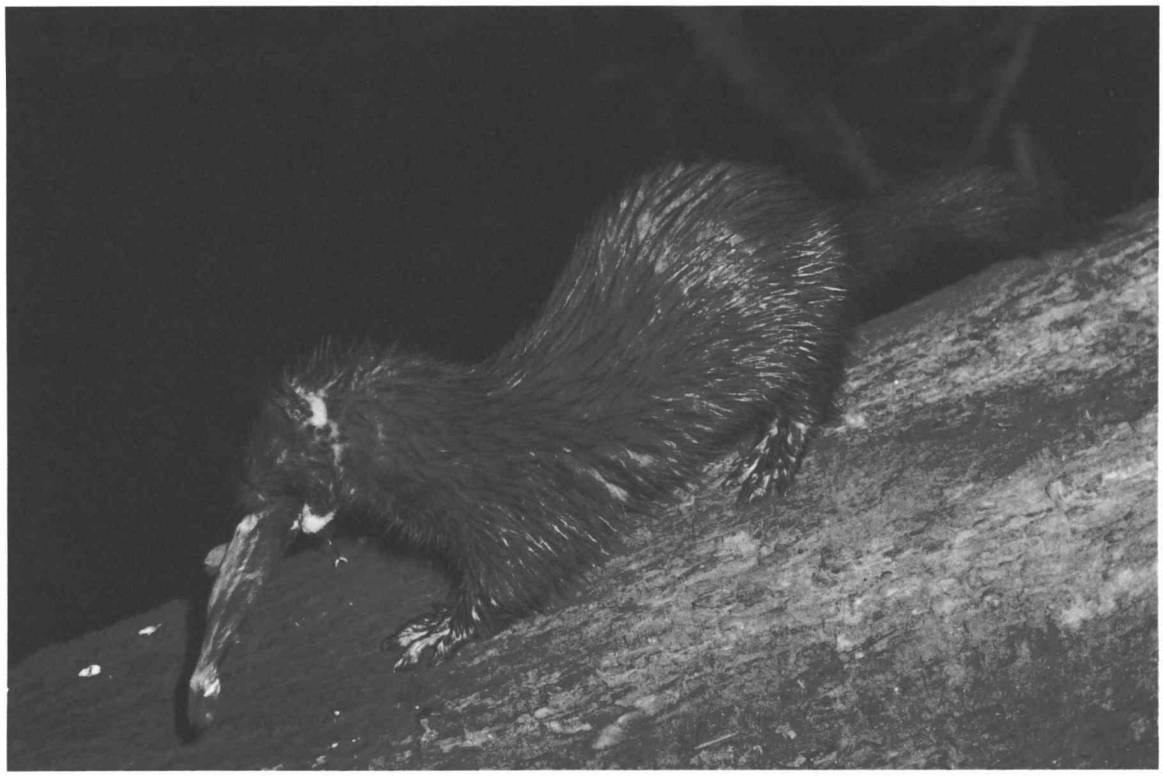

Figure 1. This mink was photographed when he siezed the fish which was tied to a switch by a short length of thread. The switch is on the far side of the log. The screw-eye through which the thread ran is clearly visible beneath the mink's chin. The animal was forced to stay in the correct plane by having it walk a log. Nocturnal furbearers such as this would be very difficult to photograph by any method other than the set camera. The camera was set at four feet, 1/500 of a second, f 4; one FP 26 flashbulb was used, and the film was Panatomic-X rated at ASA 50. The photograph was taken just south of Corvallis along the Mary's River.

Figure 3. This spotted skunk has just stepped on a buried treadle. Note that nothing is visible in the photograph to indicate how the photograph was made. Kippered herring and cheese were used as bait. The animal was kept in the correct plane by its habits alone. Spotted skunks like to follow along rock walls and fallen logs. It would be very difficult, and possibly unwise, to attempt photographs of skunks by methods other than the set camera. The camera was set at four and a half feet, 1/200 of a second, f 11; one FP 26 flashbulb was used, and the film was Plus-X rated at ASA 160. This photograph was taken a few miles southeast of Bend, Oregon.

any of the equipment. The treadle may be mounted on springs with varying strengths so that the species of animal to be photographed can be partially controlled, depending upon its weight. When the treadle is mounted on strong springs, small animals such as squirrels and birds will not be heavy enough to trip the shutter.

Many other variations of these triggering mechanisms may be devised. Some self-cocking shutters require too much pressure on the shutter release to be set off by a solenoid, so some other equipment must be added. Karcher (26, p. 202) used a spring powered plunger, held by a catch, which pushed a cable release. The solenoid was used to release the plunger from its catch. Wing (43, p. 387) used a spring powered plunger, held by a catch, which was attached directly to the shutter release lever. A solenoid again was used to release the plunger catch. Gysel (23, p. 452) used the pull on a thread to close the switch. The solenoid then sprung a mouse trap, the bail of which hit the shutter button on the camera, thereby tripping the shutter. Shepard (35, p. 186) used a mouse trap, which when sprung, actuated a button-type switch which completed the circuit and triggered the camera. Roselle (34, p. 180) used two mouse traps and two switches. When the first trap was sprung, the bail struck a toggle switch which closed the circuit and set off the camera. Springing of this first trap also released the bail on

the second trap which in turn hit another toggle switch to break the circuit. Evans (7, p. 160) refers to the use of a mercury switch for set camera photography. This switch consists of a sealed vial containing mercury and two electrical contact points. In the open position the mercury is kept away from the contact points by gravity. When the switch is tipped to the closed position the mercury flows over the two contact points and completes the electrical circuit.

Obviously some of these devices are rather complicated and could easily fail to operate properly. Any satisfactory switch must be easily operated by some action of the animal to be photographed, should open again after the picture is taken, and should not be adversely affected by the weather.

Films and Developers

The discussion of the types of films and developers to use for set camera photography will be brief as many available publications thoroughly cover the choice of films and developers for various photographic purposes. The large photographic equipment companies, such as Kodak and Ansco, distribute free information of this type.

The type of film used will depend mainly on the results desired. For high quality enlargements of any good wildlife photographs, a film of high resolving power and

relatively fine grain is usually desired. However, if the photographs being taken are merely record shots to add evidence to some bit of research, the film need not be of a type that will allow a great degree of enlargement. In this case one of the super-fast but rather grainy films might be a good choice.

The type of developer used will again depend on the use to which the final photographs will be put. Many different effects can be obtained by using different developers. Some developers produce more grain than others, some give more contrast, and some produce a wide range of tones. Some developers are slow working, and others are fast. The developer used is again a matter of personal preference, depending on the results desired.

Probably the most logical choice of a film and developer combination is one with which the photographer is familiar. Each photographer usually has one or two favorite films and one or two favorite developers. He has experimented with these films and developers and knows how they will react under many different circumstances. He knows that if he overexposes the film and underdevelops it he will get one result, while if he underexposes and overdevelopes, he will get another result. He is very familiar with that combination, so this film and developer would be a logical choice for him to use in his set camera photography. It is probably more important

to use film and developer that are familiar than to try to determine which ones would be the best for every different situation.

The films most used in this work were Panatomic-X and Plus-X, both Eastman Kodak Company films. The developers used most often were Microdol and D-76, also both Eastman products.

Lures and Baits

Even if the set a photographer uses is excellent in all respects, it would be of no value unless an animal comes along to set off the camera. Therefore, something must be done to attract the animal to a given spot. This is where a good knowledge of trapping techniques is important in set camera photography.

Of course, some of the sets would be considered blind sets, as the animal is brought to a certain location solely by its own habits. If the animal consistently uses a certain game trail, a trip thread or a buried treadle placed along that trail might result in a photograph (See figures 1, 7, and 11).

However, since some animals aren't consistent in their habits, some lure must often be used to attract them to the camera. It is in this area of lures and baits that some of the top secrets of the trapping industry would be of great help to the set camera photographer.

Many trappers have worked up pet lures, using various and strong smelling ingredients, to get what they feel are "sure-fire" scents. Many are sold on the market and their contents kept a secret. The formulas for other scents may be found in various books on trapping.

A thorough knowledge of the habits of the animal chosen to be photographed will provide a basis for deciding which baits or scents to use. Some animals will eat only fresh foods, while other animals will eat food that is spoiled. Often some bait or scent may be enticing that is normally not thought of as even being attractive to that animal. For instance, Newby (32, p. 453), while working on a live-trapping study of marten (Martes americana Turton) in Montana, found that the best scent was a mixture of catnip oil and fish oil, and the best bait for the trap itself was kippered herring. Some baits or lures may be attractive at some seasons of the year and not at other times. McCabe (29, p. 418), while working on a live-trapping study of mink, found that feces from female mink were a good lure during the breeding season.

Danvers (6, p. 107) states in an article on trapping that shiny objects fastened to the pan of the trap often attracted and caught raccoons (Procyon lotor Linnaeus). This attraction to shiny objects might also be used in set camera photography.

Gregory (17, p. 79) and Young (44, p. 5) (46, p. 169) used a mixture of 35 drops of catnip oil and two ounces of petrolatum as a successful lure in the set camera photography of cougars (Felis concolor Kerr) in northern Mexico. Catnip is well known for its attraction to all members of the cat family. Shiras (40, p. 299) was also able to get a set camera photograph of a bobcat (Lynx rufus Schreber) by using a caged live chicken as an attractor.

Fresh fish is a good choice of bait for both otter (Lutra canadensis Schreber) and mink, and Gregory (16, p. 234) found that as the fish began to spoil it was also a good bait for striped skunks (Mephitis mephitis Schreber).

A mixture of peanut butter and oatmeal is a good bait for rodents and other herbivorous animals and was used by Gregory as a bait for white-footed mice (Peromyscus maniculatus Wagner) (11, p. 205), for snowshoe rabbits (Lepus americanus Erxleben) and white-tailed deer (Odocoileus virginianus Zimmermann) (20, p. 291), and for cottontail rabbits (Sylvilagus sp.) (15, p. 201).

Lewis (28, p. 101) also found that the best bait for muskrats (Ondatra zibethicus Linnaeus) was parsnips, though carrots, apples, potatoes, and celery were also found to be good. Gregory (12, p. 222) used mice, fish, and raw beef as bait in obtaining set camera photographs of

weasels (Mustela sp.).

Many types of twigs, such as aspen and willow, are attractive to beaver (Castor canadensis Kuhl) and Gregory (18, p. 120) found that if poplar was used in an area in which none existed, it was readily taken by beavers.

Young (45, p. 11) (47, p. 40), while using set cameras to photograph red wolves (Canis niger Bartram) in Louisiana, found that the urine of a strange wolf was an attractive scent to the wolves in the area in which he was working. The urine from an Arkansas wolf was used.

During this study, muskrats (Ondatra zibethicus osoyoosensis Lord) were photographed by using apples and carrots for bait (See figure 9); striped skunks (Mephitis mephitis occidentalis Baird) were photographed by using cheese and road-killed pheasants for bait; and mink (Mustela vison aestuarina Grinnell) were attracted to fresh smelt (See figure 2). Beaver (Castor canadensis pacificus Rhoads) came ashore to get willow (Salix sp.) (24) sticks. Marten (Martes caurina caurina Merriam) readily came to a catnip and fish oil scent and a kippered herring bait (See figure 14). Bobcats (Lynx rufus pallescens Merriam) came to a catnip oil lure, and mule deer (Odocoileus hemionus hemionus Rafinesque) were photographed by using apples for bait (See figure 13). Spotted skunks (Spilogale gracilis saxatilis Merriam) were photographed at sets using kippered herring, cheese, or

crawfish for bait (See figures 3 and 8).

Lists of other baits and lures that have been tried and proven successful may be found by reading one of the several excellent books on trapping such as McCracken(30). Baits similar to the natural foods of the animals are usually good choices, if used with some strong smelling scent to attract the animal to the immediate area of the bait.

It cannot be too greatly emphasized that a thorough knowledge of the animal's habits is important to the set camera photographer, just as this knowledge is important to the trapper.

Protection and Concealment of Equipment

Since much of the photographic equipment used in set camera photography is expensive, some thought should be given to its protection and concealment. Weather, falling limbs, and even wild animals can cause damage to equipment left in the woods. Unfortunately, some humans are dishonest and would quickly steal or damage any photographic equipment they might find while in the woods. Therefore, equipment should not be left in exposed, unprotected locations.

Precipitation is probably the most annoying weather condition to the set camera photographer. Moisture on a camera lens can distort any photograph taken. Moisture

on any of the electrical equipment can cause a short circuit which will run down the batteries, or can cause rust on cameras and other metal objects.

As much of the equipment as possible should be protected from moisture by covering it with plastic bags, wooden or metal boxes, or anything that will give sufficient protection. Boxes of wood or metal may be used to cover the camera, leaving only a small hole for the lens. The lens itself may then be partially protected with a lens shade, though there is no way to protect the lens completely as nothing must be between it and the animal being photographed. The flashgun and reflector may be protected by fastening a plastic bag over the entire reflector. A plastic bag may cut down the light intensity from the flashbulb but this light reduction was not found to be serious.

The camera and its protective cover should also be fastened solidly in place. A camera on a tripod can be easily knocked over and damaged if a frightened deer should bolt in that direction when startled by the flash going off, or if the wind should blow too hard, or if falling limbs hit it. Accidents of this type are not common, but are possibilities and should be considered. If equipment is placed on the shores of lakes or streams, be sure that it cannot be knocked or pulled into the water.

Wild animals usually have quite highly developed

senses, and keen eyesight. Some effort should therefore be made to conceal the camera and other equipment, especially when working with any of the more wary animals. A coating of black paint on the protective boxes will help, as will using dark colored wires, stakes, and other exposed equipment. In snow, a covering of white will conceal the equipment quite well. Branches and twigs can be used to break up the outline of boxes or other equipment, though care should be taken to see that nothing gets in front of the lens or flash reflector.

The lens and the flash reflector are the only two parts of all the equipment that cannot be completely concealed. Both must be visible from the place where the animal will be when photographed. However, any metal around the lens can be covered with black tape, and a black lens shade can be used. The flash reflector presents the greatest problem in concealment. Concealment of the flash reflector can best be handled by placing it in such a position that it will not pick up and reflect light, such as light from the moon. Keeping the flash reflector in deep shadows will make it far less visible.

Concealment from humans is often a greater problem than concealment from wildlife, for an animal at least will not take equipment. Much thought should be given to when and where to make sets, taking into consideration times of year and habits of humans.

During the summer campers and hikers may be expected in the woods. In the fall hunters are commonly seen. During the winter trappers and skiiers are found in many areas, and in the spring fishermen are found along most streams and lakes. At no time of the year are most areas completely free of humans, though in some localities fewer are present during some seasons than others. During fishing seasons, especially the opening days, it would not be a good idea to make sets along streams or lakes. Later in the season there are fewer fishermen and hence less risk. Due to the great number of hunters, deer season is a poor time to put equipment out anywhere in the woods. During the rest of the year equipment is fairly safe if other precautions are followed.

It is advisable to set the equipment out in the evening just before dark, and then pick it up early the following morning, shortly after dawn. The only equipment that was stolen during the course of this study was some left out during the day. Equipment should be set out during the day only if it is reasonably certain that no one else will find it.

If equipment is left out during daylight hours, care should be taken to make the set in such a location that it is not visible from roads, trails, or other commonly traveled areas. Dark colored, well camouflaged equipment will help prevent detection. It is also well not to

tell too many persons of the exact location of sets or of the value of equipment being used. A few hundred dollars worth of camera equipment might tempt even a normally honest person.

Procedure

Much work and time is often wasted by poor preliminary project planning. The choice of an animal for a subject is the logical first step in set camera photography. In general, if it is possible to obtain the necessary photographs by some other method of photography, the set camera should not be used. Most big game animals and most birds may be more easily photographed by other methods (See figures 4 and 5). It usually would not be practical to attempt to photograph them with a set camera except in special situations. The furbearer and predator animal groups are best suited for set camera photography, for these animals are quite wary, nocturnal, and not often seen by humans (See figures 1, 2, 3, 6, 9, 11, and 14). Shiras (36, p. 583), after doing much work with the set camera, came to this conclusion:

> "This latter method (in reference to the set camera) is by far the most effective in taking night pictures of many predaceous animals."

The specific animal chosen to be photographed will usually be determined by other research work being done, such as studies of predation, or ecological relationships of

Figure 4. This Dall sheep (Ovis dalli dalli Nelson) was stalked and photographed by use of a telephoto lens. It is fairly easy to photograph big game animals by stalking as they are diurnal, so in most cases they are poor choices for a set camera subject. When stalked and photographed, control of sex, age, and position of legs and head is possible. This photograph was taken on Sable mountain in Mount McKinley National Park, Alaska.

Figure 5. These two young horned owls (Bubo virginianus pacificus Cassin) were photographed with a hand-held camera and a normal lens. Since most birds are diurnal, they would be a poor choice for set camera subjects. Again, as with big game animals, there is control over age, sex, and position of the bird when the camera is hand-held and operated. This photograph was taken just east of Bend, Oregon, near the community of Alfalfa.

Figure 6. This photograph of a mother wolverine and her two young is a very unusual photograph indeed. It was just pure luck that such a photograph was ever taken. If a photographer went out to try to photograph an animal such as the wolverine, the odds against his doing so would be great. Although this photograph was taken with a hand-held camera, it is felt that more success on nocturnal animals would be had in the long run with a set camera. This photograph was taken in the Igloo Creek Canyon area of Mount McKinley National Park, Alaska.

certain species or groups.

Once the animal to be photographed is chosen, an area of activity of that animal must be found. Often, if a study is already underway, such an area will be known and therefore present no problem. If an area of activity is not known, many shortcuts can be followed to gain this knowledge. Various animal books will give information concerning the general ranges and habitats. Persons working out doors can be consulted for information. Trappers, hunters, fishermen, foresters, game technicians, loggers, and ranchers are all apt to have some information concerning areas in which animals are active (See figure 11). Both fur and predator control trappers are very good sources of information as they are more apt to notice indications of the presence of animals in these groups. The photographer should then spend some time in specific areas looking for animal signs such as tracks, feces, dens, houses, cuttings, runways, and even glimpses of the animal itself (See figure 7). If baits are placed on mud or sand bars, or on snow, any animal taking the bait is apt to leave tracks.

A set should be made only after a good location is found. The best equipment to use should be determined, with special care being paid to the triggering arrangement, as this is the part of the equipment with which the animal

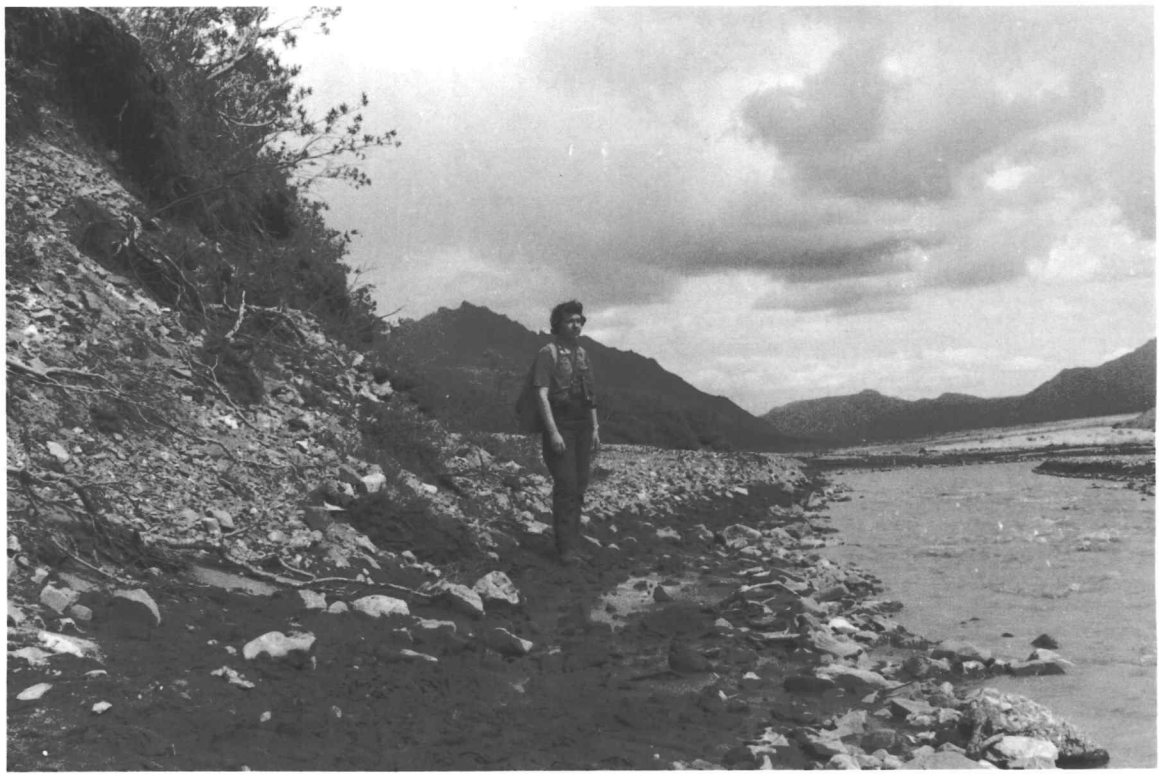

Figure 7. The place where this person is standing would be a good choice as a location for placing a set camera. Very fresh fox, grizzly, wolf, and wolverine tracks were found at this point where the animals are crowded between the river and the high bank. The camera could be set across the stream to the right and the animal in walking along the trail would be in the right plane for a good side view. Such locations as this should be looked for when set camera photography is being attempted. This picture was taken along the Teklanika River in Mount McKinley National Park, Alaska.

comes in direct contact.

An important consideration when making the set is the habits of the particular animal to be photographed. Is the animal very wary or would it walk into an uncovered trap? Will it shy away from human scent? Will strange objects cause it to move to another locality? The more the photographer knows about the animal's habits, the better the chances of his success will be. If the animal is wary, human scent should be washed away and the equipment should be well concealed. Trapping experience would be very helpful for the set camera photographer, and books on trapping should be read.

The type of photograph desired should be considered when making a set. If a high quality close-up view of an animal is needed, the set will be different from one in which it is desired to show only what species of animal is taking the bait (See figure 8). The use to which the final picture will be put should be given major consideration. A high quality photograph showing the animal to the best advantage might be required for the frontispiece of a monograph on the species. On the other hand, a study of nest predation might require only a photograph that would identify the animal.

In making the set, much can be done to control the position of the animal at the time the photograph is taken. If an animal walks along a log, ledge, runway,

Figure 8. This is a poor photograph of a spotted skunk taking a bait. For some purposes, this type of photograph would be entirely adequate. It shows which species is taking the bait and is adequate as this was the only information desired. No attempt was made at this set to control the position of the animal. The camera was set quite far back to insure getting a photograph of any sized animal. The camera was set at 15 feet, 1/200 of a second, f 4; one FP 26 flashbulb was used, and the film was Plus-X rated at ASA 160. The picture was taken just north of Bend, Oregon, along the east shore of the Deschutes River.

trail, or other travel route in which his movements are restricted, the set can be constructed so that a photograph showing a good side view of the animal may be obtained (See figures 1, 2, 3, 7, 9, 11, 12, 13, and 14). Baits can be placed so that they will cause the animal to be in the right position as it takes the bait and sets off the camera. Sticks, stones, or other objects may be used as obstructions which might influence the action of the animal.

Controlling the species of animal to be photographed is another item to be considered in set camera photography. Birds present one of the major problems whenever a bait is used (See figure 10). Gregory (14, p. 8-9) found that to avoid chipmunks and birds, it was advisable to make the set after dark and pick it up before dawn, or if practical not to use any bait. If baits must be used, these should be hidden so that birds cannot easily see them.

Many animals have specific food preferences. If these are known, baits may be used that will attract the species specifically desired. Books on trapping will list the baits commonly used by trappers for the various fur-bearing animals.

If a buried treadle is used, the size of the treadle and the weight needed to set it off can be adjusted to the size and weight of the animal to be photographed. A

Figure 9. This photograph of a muskrat was taken with the aid of a switch placed under a slab of wood cut from this log. This piece of wood is directly under the muskrat. The animal was kept in the right plane by causing it to walk a log to get to the apple and carrot baits. Note that the hind foot is blurred. A faster shutter speed would have stopped this action. The camera was set at four feet, 1/100 of a second, f 11; one FP 26 flashbulb was used, and Adox KB 17 film, rated at ASA 64, was used. The picture was taken just south of Bend, Oregon, along the west bank of the Deschutes River.

Figure 10. Whenever baits are used in set camera work, birds will be a problem. This Canada Jay (Perisoreus canadensis capitalis Ridgway) is pecking at a Pine squirrel (Tamiasciurus douglasii mollipilosus Audubon and Bachman), placed on a log as bait for marten. If the camera had been set out after dark this would not have happened. The camera was set at 3 1/2 feet, 1/500 of a second, f 13.5; one FP 26 flashbulb was used, and the film was Plus-X rated at ASA 250. This photograph was taken just northwest of Elk Lake along the Century drive west of Bend, Oregon.

small sized treadle is less apt to be set off by a large animal because of the smaller area on which it is likely to step. A treadle requiring several pounds of pressure to compress the springs will not be set off by most small birds and squirrels.

If a trip thread is used, its height above the ground can be adjusted for animals of a desired size. If the thread is set 18 or 20 inches above the ground for some of the larger animals, anything smaller than that will pass under it. For small animal photography, the thread may be placed close to the ground and then an obstruction, such as a large limb, can be placed above it, out of the camera's view, to cause the larger animals to find another route.

After the set is completed, it should be thoroughly tested to see that everything is functioning correctly (See figure 11). Much time and effort are put into setting up the equipment, and only one picture can be obtained per night. A wasted frame of film and a flashbulb cost little in comparison to the time and effort required to locate an area where animals are active, and to make the set. It is very annoying to return to a set in the morning, find a fresh track on top of the buried treadle, but discover that through carelessness the equipment failed to operate.

Figure 11. The camera was checked each and every time it was set out to be sure everything worked right. Even then equipment failures were common. This photograph shows Dr. Frederick Dean, head of the department of wildlife Management at the University of Alaska, setting off the camera to check it. This set was made by placing a buried treadle along a well-used trail near a wolf den. The trail would have kept the wolf in the correct plane for a good side view. The camera and flash were set back 20 feet from the trail but no photographs were obtained here. The photograph was taken along the Teklanika River in Mount McKinley National Park, Alaska.

RESULTS

The first set camera used in this study was placed along one of the sloughs of the Willamette River just east of Corvallis, Oregon, on December 2, 1956. The last set was made near Camp Sherman, Oregon, on December 2, 1958. During the two years, sets were made in many places in the Willamette Valley from near McMinnville to Corvallis, along the Oregon Coast, in Central Oregon near Bend, in British Columbia and the Yukon Territory of Canada, and in Alaska.

During this period a total of 236 sets were made, this being 32.3 per cent of the possible nights available. Of these 236 sets, 17 were made using the inexpensive 620 roll film camera, 69 sets were made using the sheet film camera, and 150 sets were made using the 35 millimeter camera.

A total of 48 photographs of animals was obtained as a result of these 236 sets, or approximately one photograph for each five sets made. However, only 29 successful photographs were made. A successful picture is considered to be a useable photograph of the animal that the set was primarily made for. The other 19 photographs were of animals other than the one desired to be photographed. During this study a successful photograph was obtained from 12.27 per cent of the total sets made, or about one

satisfactory picture every eight nights.

Triggering devices of five different general types were used, including those devices consisting of a bait and a mousetrap, a trip thread and a mousetrap, a bait and an electrical switch (See figures 2, 8, 10, and 14), a trip thread and an electrical switch (See figures 1 and 13), and those using a buried treadle (See figures 3, 9, 11, and 12).

The devices utilizing a trip thread and mousetrap were used 22 times, with no success. No animals were photographed by this method. The buried treadle was used 52 times, and only four successful photographs were obtained. This represents one successful photograph for each 13 sets using a buried treadle. The trip thread and electrical switch was used 44 times, with four satisfactory pictures being taken, or one successful photograph for each 11 sets. The devices using a bait and a mousetrap were used 64 times, with 11 successful photographs being obtained. One satisfactory photograph resulted from each 5.8 sets. The devices utilizing a bait and an electrical switch were used a total of 54 times. Ten satisfactory photographs were taken, one for each 5.4 sets.

Failures were common because of a number of causes, and a total of 61 failures was recorded. The most common reason for failure was the camera's being set off by the

wrong animal (See figures 1, 10, and 12). The wrong animal in this sense being any other than the one for which the set was made. This happened 19 times, and included photographs of white-footed mice, an owl, a rat (Rattus norvegicus Berkenhout), house cats (Felis catus Linnaeus), a small bird, a spotted skunk, a dog (Canis familiaris Linnaeus), a hawk, Canada jays (Perisoreus canadensis capitalis Ridgway), porcupines (Erethizon dorsatum epixanthum Brandt), magpie (Pica pica hudsonia Sabine), a bobcat, and a bushy-tailed woodrat (Neotoma cinerea alticola Hooper).

The second most common reason for failure was the equipment's being set off but the resulting photograph showing no animal. This occurred ten times. A total of eight other times the flashbulb misfired, though in only one case did the bulb prove to be faulty. The other failures were due to corrosion on the contacts of the flashbulb. The baits were taken six times by some animal, but the camera was not set off. Other reasons for failures included dead or weak solenoid battery, snow weighing the treadle down, flash batteries dead, mud over a treadle freezing solid, the animal being too light to trigger the treadle mechanism, the solenoid being out of adjustment, the mousetrap not setting the camera off, and rising water making the set inoperative.

During the two years of this study, sets were made

for 16 different species of animals. The largest number of sets were made for muskrats, followed by mink, striped skunk, beaver, bobcat, raccoon (Procyon lotor pacificus Merriam), muledeer, spotted skunk, red fox (Vulpes fulva cascadensis Merriam), otter (Lutra canadensis pacificus Rhoads), marten, wolverine (Gulo hylaeus Elliot), coyote (Canis latrans lestes Merriam), gray wolf (Canis lupus pambasileus Elliot), fisher (Martes pennanti columbiana Goldman), and golden eagle (Aquila chrysaetos canadensis Linnaeus)(9).

These sets produced successful photographs of mink, muskrat, striped skunk, marten, spotted skunk, beaver, and mule deer.

DISCUSSION AND CONCLUSIONS

Discussion of Results

It was found that much time was needed to look for areas in which to make sets (See figure 7), put out baits, and to look for other signs that would indicate that an animal was active in a particular area. Therefore, it was not possible to make sets every night with any hope for success.

While the success ratio was not high for the time spent, it is felt that this is not too low considering the animals that were being photographed. Gregory (18, p. 121), while attempting to get set camera photographs of beavers, found that he could hope for only one or two good pictures in three or four weeks' work.

The greatest degree of success was obtained through the use of the two triggering methods in which a bait was used, which gave successful results nearly 20 per cent of the time. The trip thread and electrical switch was the next most successful device but had only a nine per cent success ratio. The treadle triggering mechanism was successful only 7.5 per cent of the time. Many of the animals that treadle sets were made for, such as the fisher, wolverine, fox, coyote, and wolf, are very wary animals, and it is felt that the treadle would show a

higher percentage of successful photographs on other animals. The treadle, rather than one of the other triggering mechanisms, was used in an attempt to photograph these animals because it is the only device which can be completely concealed.

Most failures were due to the triggering device being tripped by some animal other than the one desired (See figures 1, 10, and 12). Some of these failures might have been avoided by taking greater care in the making and the placement of sets, though it is doubted if this problem could be eliminated entirely, due to the many species of smaller animals about in the woods at night. The second most common type of failure resulted in the camera and flash being set off but no animal being shown in the resulting photograph. It is felt that this is caused by tripping of the triggering device due to shrinkage of the trip thread, since all of these failures occurred where long lengths of thread were used. Although the thread used was soaked to pre-shrink it, some shrinkage evidently occurred. The problem of shrinkage can be eliminated by using triggering devices not requiring long threads. Careful checking of the equipment every day will eliminate such things as corrosion on the electrical contacts, dead or weak batteries, and an out of adjustment solenoid.

Figure 12. The most common problem encountered in this study was having the wrong animal setting the camera off. In this case a house cat was attracted to the fish oil put out for raccoons. The location of the fish oil bait shows clearly on the limbs above the cat's head. This cat has just stepped on a buried treadle, tripping the camera shutter. The animal was kept in the correct plane by utilizing a trail. The camera was set at six feet, 1/200 of a second, f 11; one FP 26 flashbulb was used, and the film was Plus-X rated at ASA 200. This picture was taken along the west bank of the Deschutes River just south of Tumalo, Oregon.

Advantages and Disadvantages of Set Camera Photography

Set camera photography is a last resort measure that should be used when it would be extremely difficult to obtain the desired photograph by any other general method of photography. It is not recommended for most wildlife photography because of the many disadvantages mentioned, and the general uncertainty involved in working with it.

One of the greatest disadvantages of set camera photography is that only one photograph can be obtained from each set per night. If that picture is not satisfactory an entire day is lost. At best, set camera photography is a slow method of obtaining wildlife photographs.

Another disadvantage of set camera photography is that much time must be spent locating the desired species of animals, making the sets, and checking the equipment each day.

Loss of equipment by theft might be a problem in many situations, but this can usually be minimized by exercising care in the placing of equipment, in picking the equipment up early each morning, and in placing it out only toward evening, except in areas where humans are not apt to be present.

Little or no control is possible in the selection of the sex, age, and condition of the animal being photographed, or in the position of head, feet, or tail (See

figure 1). Gregory (19, p. 45) found that set camera pictures of deer were usually poor because the head of the animal was usually down (See figure 13). A photographer using a hand controlled camera can select an animal of the correct sex, age, and condition and photograph it when it is in the right position (See figures 4, 5, and 6), but this is not usually possible in set camera photography.

The problem of the camera being set off by the wrong species of animal can be dealt with by careful selection of triggering devices and baits, and in the choice of locations for sets.

Equipment failures, such as thread shrinking, batteries going dead, flashbulbs misfiring, and the solenoid's being out of adjustment, plague the set camera photographer much more than those using other methods of photography. If a photographer is hand-holding a camera when a flashbulb fails, he simply replaces the bulb and continues taking pictures. The set camera photographer loses the picture. The only way to minimize numbers of these failures is to check all equipment thoroughly each time it is put out. Even then something may go wrong. A battery which checks out as efficient in the evening may be weakened by the night's cold so that it will not operate.

Sometimes problems may arise that cannot be controlled. All set camera photography attempted in Alaska

Figure 13. This young buck mule deer has just run into a trip thread which was stretched across a well-used deer trail. The switch is visible along the bridge of the deer's nose. Notice that the deer's head is down and that the camera was too close - one leg was not included in the photograph. Although big game animals may be photographed with a set camera, it is much simpler to stalk them, and the results are usually better. The deer was kept in the right plane by using this particular trail. The camera was set at 12 feet, 1/200 of a second, f 5.6; one FP 26 flashbulb was used, and the film was Plus-X rated at ASA 160. The area is just south of Bend, Oregon, along the west bank of the Deschutes River.

failed. Some of the failures were undoubtedly due to the wariness of the animals concerned. However, during the time work was being done in Alaska, light lasted all night long. The flash reflector and camera lens were visible even at midnight, and to an animal as wary as the wolf or wolverine, this would probably be noticed, even when the equipment was placed 20 feet back from a trail. Some sets were made along a well-used trail only a few hundred feet from an active wolf den, yet no photographs were obtained (See figure 11). At another time a wolverine was seen within 100 yards of the camera, yet no animals were photographed there either. Foxes took bait several nights in a row, yet stopped coming to the bait as soon as the camera was put in place. While no proof exists of course, it is felt that the presence of light all night long was a major factor in causing these photographic failures in Alaska.

Unfavorable weather conditions will also be a continual problem to the set camera photographer. Wind may upset cameras, and rain may ruin batteries or other equipment. Gregory (13, p. 143-144), while doing set camera work in the winter, found that snow covered his lenses, set the camera off by falling on the trip wire, and on occasion even covered all his equipment.

The main advantage of a set camera is in the photography of nocturnal animals, for a set camera does not

need to see to take a picture, and after the set is made the human element plays no part in the success or failure of the equipment used.

Another advantage of a set camera is that time may be taken to correctly set the shutter speed and the diaphragm, and to accurately focus and aim the camera. Using the unvarying source of light, the flashbulb, any pictures taken should be excellent as far as framing, focus, and exposure are concerned. In some other types of wildlife photography, necessary haste often results in errors of exposure, focus, or framing.

Who Should Use the Set Camera

Not everyone should use a set camera, for to be even partially successful much more work is required of the photographer than with other methods. Set camera photography would not normally become popular with game departments and other groups using wildlife photographs, because the time and expense required would be more than the finished photograph would be worth for most purposes.

Set camera photography may or may not appeal to a professional wildlife photographer, depending on how much value he thinks the photographs will be to him. A professional photographer takes photographs for a living, and he must realize a suitable return for time and money spent in the field. However, in certain cases it might

be worth while for him to attempt to obtain set camera photographs of some of the nocturnal species. If he is attempting to gain a reputation as a photographer of mammals in their natural habitats, it would improve his reputation to have a good collection of prints of some of these hard-to-photograph mammals. A picture buyer might write this photographer for a picture of one of these nocturnal mammals. If the photographer does not have the photographs the buyer needs, the buyer will be forced to go elsewhere for the pictures. Later if this individual needs a picture of a common animal such as a deer, he is more apt to return to the photographer from whom he got the more difficult-to-get subjects, as he knows that photographer has a larger selection to choose from. In such cases it might pay a wildlife photographer to spend some time and money doing set camera photography even though actual pictures taken by this method may never pay for themselves (See figures 1, 2, 3, 9, and 14).

The set camera can be of definite help to wildlife research workers by obtaining information about specific animals that would be difficult to obtain by other methods.

The set camera might also be used in research with animals whose movements are too rapid for the human eye to record. Through the use of a set camera many facts were learned about the way a rattlesnake (Crotalus sp.) (41) strikes. Van Riper (42, p. 310-311), while studying

Figure 14. This marten came readily to a scent of catnip and fish oils, and took a bait of kippered herring. He was kept in the correct plane by causing him to walk along the small log. In this case a hole was drilled in the log and the switch, connected to the bait, was placed inside. A nocturnal furbearer such as this would be very difficult to photograph by any method other than with the set camera. The camera was set at 3 1/2 feet, 1/500 of a second, f 8; one FP 26 flashbulb was used, and the film was Panatomic-X rated at ASA 40. The picture was taken just northwest of Elk lake, along the Century drive west of Bend, Oregon.

rattlesnakes, used a set camera, an electric eye, and a high-speed electronic flash to show that rattlesnakes stab instead of bite, that they strike slowly, only about eight feet per second, that they can eject venom without biting, and that they can strike straight upward.

In general, anyone can use set camera photography who has need to do so. The greatest uses for set camera photography are in obtaining photographs of wary, nocturnal mammals, in the photography of rapidly moving action, and in certain types of wildlife research field work. Anderson (2, p. 81-82) (3, p. 119), while working on waterfowl nest predation in California, obtained photographs of the predators involved by using a set camera and attaching a wire to each egg of a nest in such a way that if any egg was moved the shutter was tripped. In this way he obtained conclusive proof of the identity of the predators without the necessity of trapping the animals.

Future Considerations

Since work was begun on this research problem, new products have been developed that may be of use to persons interested in set camera photography. However, much of this new equipment is quite expensive and was, therefore, not used in this study.

At least two new camera models are on the market at the present time for which an electric motor may be

purchased. This motor driven type of camera allows a series of pictures to be taken, simply by closing an electrical switch each time an exposure is desired. As the switch is closed, the shutter is released, the film advanced, and the shutter cocked again. A camera of this type, with an electronic flash, could eliminate one of the great disadvantages of the set camera: Namely, a limit of only one picture per camera per night. It would be necessary to use this type of camera in conjunction with some triggering device which would allow more than one picture to be taken. The trip thread could not be used, nor could any set-up in which the animal took a bait. Use of the buried treadle would be a good choice, as would an electric eye. An electric eye is a device which uses a beam of light shining on a photo-electric cell to hold a circuit open. When the light beam is interrupted, the circuit is closed. For use with wildlife an infra-red light beam, invisible to animals, could be used.

The possibilities of taking series of photographs each night immediately suggests many situations for the use of such equipment. A treadle or an electric eye set on a well-used game trail would record on film each animal passing that way during the period of time the equipment was left in place, instead of obtaining a photograph of only the first animal to pass. A set-up such as this could possibly be used in census work in conjunction with

a salt station or watering hole.

A repeating camera could also be used in recording the number of times an animal or bird left or entered a den or nest box. If a clock was placed so that it would also show in the picture, the photograph would even indicate the time of day that each passage took place. Clocks may be purchased that are absolutely silent while running. Carey (5, p. 281), while doing set camera work, noted that the literature up to 1926 stated that woodchucks (Marmota monax Linnaeus) are never active at night. However, he used a clock in his set camera work and photographed active woodchucks at 10:15 P.M. and 4:30 A.M.

Another possible use for a repeating camera is in the study of the food habits of birds. Greenewalt (10, p. 543) used an electric eye placed just in front of the nest box of house wrens (Troglodytes aedon Audubon), to photograph the parent bird as it brought food to the young. Greenewalt obtained approximately 400 pictures, 90 per cent of which showed the insect prey in the bird's beak. An entomologist easily identified the insects from the photographs. Any bird that does not pre-digest its food could be studied in this way. However, Greenewalt had to stay near the nest box so he could change the film after each exposure. By using a repeating camera the need for constant attendance would be eliminated.

Another piece of equipment that has been useful for

studies of fast action is a very high speed electronic flash unit. These high speed flashes, used in conjunction with an electric eye, are capable of recording actions much too fast for the human eye to follow, and in this way are able to add greatly to our knowledge. Flash units are available with flash durations as short as 1/1,000,000 of a second. Griffin (22, p. 119) used a flash with a speed of 1/100,000 of a second and an electric eye, to study how bats fly. Jones (25, p. 243-249) used two crossed electric eye beams and a high speed flash to get pictures of insects in flight. Other uses have included photographing of birds in flight and of jumping fish. This type of equipment has been used to make some rather spectacular photographs that would have been extremely costly in time and wasted film if human reaction times were relied on. Allen (1, p. 18), in trying to photograph birds in flight, found that his first attempts were complete failures. He tried to photograph the birds as they flew between a perch and a feeding station. As soon as they left the perch, Allen pushed the button that triggered his shutter. The first few pictures were total failures. Further attempts showed that if he pushed the shutter release as soon as the bird was seen to leave the perch, the bird was about 18 inches from the perch when the camera went off. Human reaction times are slow. An electric eye set-up would

eliminate this delay problem.

As more and better equipment becomes available, new uses for the set camera will be tried. Some will prove to be impractical, but others will be very useful for specific purposes that would be very difficult, if not impossible, to accomplish by other photographic methods.

SUMMARY

1. The general purpose of this thesis was to investigate as thoroughly as possible the many and varied uses of the set camera in obtaining wildlife photographs.

2. Through the use of photographs the printed page is made more interesting. Photographs command attention. Photography is important in obtaining facts that the human eye is incapable of recording, and retaining facts the human mind might not be able to recall.

3. Wildlife photographs are obtained by one of three general methods of wildlife photography: stalking, remote control photography, or the use of a set camera.

4. Photographic equipment available to the set camera photographer has been vastly improved during the last few years.

5. The objectives of this thesis were to investigate the cameras, types of lighting, triggering devices, baits and lures, methods of concealment and protection of the equipment, the advantages and disadvantages of set cameras, and some of the uses for set cameras not actually covered in this study.

6. A camera suitable for set camera photography should have a lens of fairly high quality, with a speed of at least f 5.6, a top shutter speed of 1/100 of a second or faster, a cocking type shutter, internal synchronization

for flash, a film size between 35 millimeter and 4 by 5 inches, a viewfinder, and a focusing lens mount.

7. The four types of lighting which are available to the set camera user are natural light, floodlights, electronic flash, and flashbulbs. Flashbulbs are recommended for most set camera photography.

8. A good triggering device for set camera work should be simple in construction, should be easily set off by some action of the animal, and should not be readily inactivated by unfavorable weather conditions. The number and types are limited only by the photographer's imagination and ingenuity, though some of the simple electrical devices are felt to be most practical for set camera photography.

9. The best films and developers to use are usually those with which the photographer is already most familiar.

10. Lures and baits are as important in set camera photography as they are in trapping, and books on trapping are good sources of information on this subject. In general, a bait or lure similar to the food naturally preferred by the animal to be photographed will usually be a good choice.

11. Since much of the equipment used in set camera work is quite valuable, some means of protecting it from weather and from theft or vandalism should be used. Proper concealment of equipment will reduce the chances of

theft and lessen the possibility of frightening the animals.

12. Since much work is necessary to obtain a few wildlife photographs with a set camera, much thought should be given to what is needed before any work is started. The species to be photographed should be chosen, and an area in which an animal of this species is active should be found. Then a set should be made that will produce a photograph of the type and quality desired. After the set is made, it should be checked thoroughly to see that all equipment is operating correctly.

13. In this study a total of 29 successful photographs was obtained from a total of 236 sets made over a two year period. The sets in which the animal pulled a bait to trigger the camera shutter were the most successful. Failures were due to many causes, the most common being that of a species other than the one desired setting off the camera.

14. Though a successful photograph was obtained on an average of only about once in eight nights, it is felt that this was a fair success ratio considering the species of animals being photographed. These were mainly predators and furbearers which are noted for their wariness and nocturnal habits.

15. The main disadvantages of set camera photography are that a maximum of only one photograph per camera per night

may be obtained, a great deal of time is required to get even this one photograph, that there is little control over sex, age, and position of the animal, and that equipment failures are common. The advantages are that pictures may be obtained of nocturnal animals which would be very difficult to photograph by any other method, that plenty of time may be taken to insure correct lens, shutter, and focusing settings, and that action too rapid to be photographed by methods which rely on human reactions may be recorded by this method.

16. The set camera should be used only by persons having a specific interest in this type of wildlife photography. Since set camera work does take so much time, the person doing the work should be able to justify the time being spent in attempts at obtaining photographs of wildlife by this method.

17. Recent new equipment available on the market, such as repeating cameras and high speed electronic flash units, make it possible to do many more things with the set camera than could be accomplished a few years ago. Additional improvements in equipment will probably increase possibilities for set camera photography even more in the future.

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APPENDIX

APPENDIX

Glossary of Photographic Terms Used

ASA film speed. The light sensitivity of a film which is expressed by a number, and is given each film by the American Standards Association to indicate the amount of light required to correctly expose that film.

Aperture. An opening. The lens aperture is the opening in a diaphragm, more commonly referred to as the f value of the lens.

Camera. A light tight chamber fitted with a lens or lensless aperture and a support for sensitive material, and used for the purpose of making photographs.

Depth of field. The space between two extremes of distance through which an object may move without going too far out of lens focus for satisfactory reproduction.

Developer. The chemical solution used to make visible the latent image caused by exposing film to light.

Diaphragm. That part of a camera which limits the size of the opening through which the light passes. Usually a series of metal blades adjustable to any size.

Electronic flash. An instrument which produces a flash of light of very short duration and high intensity, when a high voltage charge of electricity flashes between two contact points in a tube filled with rare gasses such as Xenon or Krypton.

Emulsion. A coating of a mixture of light sensitive silver salts and gelatin which is put on celluloid in film manufacturing.

f. The numerical value of the effective aperture of the lens expressed in terms of fractional focal lengths. Obtained by dividing the focal length by the diameter of the effective aperture.

Film. A thin, flexible, transparent sheet of cellulose nitrate, acetate, or similar material, coated with a light-sensitive emulsion, and used in photography.

Film, cut. Flat sheets of film cut to specified sizes for use in cut film holders. Also known as sheet film.

Film, roll. Film spooled in a roll on a wooden or metal core, for use in roll film cameras.

Film, sheet. Flat sheets of film cut to specified sizes for use in sheet film holders. Also known as cut film.

Flashbulb. A glass bulb filled with oxygen and loosely crumpled aluminum foil. A short filament in the bulb is covered with flash powder which burns when an electric current is applied. This burning flash powder ignites the aluminum foil which burns rapidly in the oxygen, producing an intense light of short duration.

Flashbulb, fast peak. Flashbulbs which are burning their brightest six milliseconds after being ignited, and then diminish in intensity immediately.

Flashbulb, focal plane. Flashbulbs which reach their brightest peak 20 milliseconds after being ignited, then hold this peak for another 20 milliseconds.

Flashbulb, medium peak. Flashbulbs which reach their peak brightness 20 milliseconds after being ignited, then diminish in intensity immediately.

Flashbulb, slow peak. Flashbulbs which reach their peak brightness 30 milliseconds after being ignited, then diminish in intensity immediately.

Flashgun. A device which holds a flashbulb and ignites it when the camera shutter is released.

Flashpowder. Magnesium compound in powder form. It has been replaced by the flashbulb and electronic flash for most uses.

Flash synchronization. The act of having the flashbulb or electronic flash at its peak of brilliance at the same instant the camera shutter is open.

Focal length. The distance from the optical center of a lens to the point at which a far distant light, such as the sun, will be in sharp focus.

Focus, fixed. Refers to a lens that is fixed in one position so that it cannot be moved to adjust the focus of the lens. Found only on inexpensive cameras.

Focusing. The act of adjusting the lens position to obtain satisfactory focus.

Focusing, ground glass. A method of focusing a lens in which the image is brought into sharp focus on a piece of ground glass. This ground glass is at the same distance from the lens as the film will be when the exposure is made.

Focusing, single-lens reflex. A method of focusing, by use of a mirror, in which the object to be photographed is focused through the same lens the photograph is taken through, and focused on a ground glass. As the shutter release is pressed, the mirror flips out of the way and the object is focused on the film as the shutter is released.

Focusing, split-image. A method of focusing a camera lens in which an image, as seen through the viewfinder, is split in two by mirrors if the lens is not in focus. If the lens is in focus, the image appears as one.

Focusing scale. A numbered scale (the numbers representing distance from camera) which shows the point at which a lens is in focus for various distances.

Guide number, flash. A number which represents the distance in feet between the flashbulb and the object to be photographed, multiplied by the f stop. This is different for each shutter speed and each film speed. It is used as a guide to determine what f stop to use for various flash to subject distances.

Lens. The optical unit mounted in the camera which makes possible the formation of the image.

Lens, long focus. A lens having a longer focal length than the normal lens for the camera on which it is being used.

Lens, normal. A lens whose focal length is approximately equal to the diagonal distance of the film. Normal lenses cover a field of approximately 50 degrees.

Lens, telephoto. A lens having a longer focal length than the normal lens for the camera on which it is being used, and also having an actual lens to film distance shorter than its focal length.

Lens, wide-angle. A lens having a shorter focal length than the normal lens for the camera on which it is being used.

Lens speed. The largest aperture of the lens, referred to

by the largest f stop the lens has.

Open up. Enlarge the size of the diaphragm's aperture.

Photography. The process of producing images on sensitized surfaces by the action of light.

Plates, glass. A glass sheet coated with a light-sensitive emulsion. Commonly used before the invention of film.

Reflector, flash. A device used to increase the efficiency of a flashbulb or electronic flash by reflecting the light in the desired direction.

Resolving power. The ability of a lens to form distinguishable images of objects separated by small angular distances.

Sensitized. Made sensitive to light, so that a chemical change will take place when exposed to light.

Shutter. A device for regulating the length of time the film is exposed to light when a photograph is being made.

Shutter speed. The length of time, usually expressed in seconds or fractions of a second, that the film is exposed when the shutter is activated.

Stop down. Decrease the size of the diaphragm's aperture.

Stop. An f point on a lens, designating the size of the diaphragm's aperture at that point. The even stops normally used are f1, f1.4, f2, f2.8, f4, f5.6, f8, f11, f16, f22, f32, f44, and f64.

Tripod. A three legged supoort for a camera.

Viewfinder. An instrument which shows the same field of view as that which the camera lens will focus on the film.