Thermal optics and their use; a researcher's perspective and experience from the neotropics.

"How far that little candle throws its beams!"

Thermal optics are still relatively rare amongst the general public, most of the main optics manufacturers make a version yet uptake seems to be relatively slow. Is this slow uptake because of lack of advertising and target marketing or is it because there is no market?

Traditional optics are easy to find and found in most sporting stores. They often stock a variety of models from several manufacturers giving the prospective buyer a large choice, in quality and price. You can try them in the shop if you desire.

Thermal and night vison optics are not quite as easy to test, in my experience, as they are simply not that common and most retail outlets only stock a limited range. Those that do stock larger ranges tend to be hunting outlets where mammal watchers may not feel comfortable shopping.

Thermal optics are, however, definitely worth the effort to trial and test across the ranges of the manufacturers. Please trial as many as you can and then make your own decision based on your potential use. They may well become your preferred primary optic in some situations and conditions.

For the past two years in Panama, we have been using thermal and night vison optics as part of a long-term study. They have proved to be an incredibly useful tool at locating and observing mammals.

I would like to share with you my experiences using thermals and night vison optics in the hope that they are of use to you.

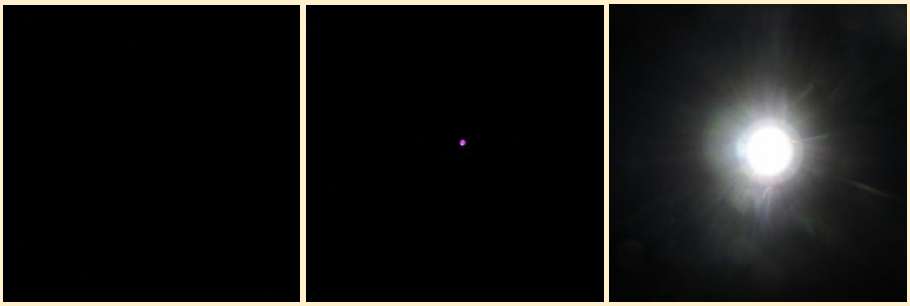
As full disclosure: we at the Margay Project Panama would like to thank the following for providing equipment for the project: ATN Europe, DMM Wales, Yale Cordage and Petzl Fondation.

Why use a thermal optic?

Thermal optics enable the observer to find and observe mammals without disturbing or potentially altering their behaviour.

This may or may not be your primary goal but the following is worth considering: What does the animal see? Try the following experiment to see for yourself.

With a willing assistant stand in the middle of a very dark field (or place) 20m apart. Wait for 10 minutes for your eyes to become adjusted. Now ask the assistant to simulate your prospective observation method at your eyes for 60 seconds. Record or verbalise how you feel.



The three images above are from my own test. On the left I am being observed through a pair of thermal binoculars.

In the centre frame I am being observed through infra-red night vision binoculars (IR binoculars). The LED infra-red illuminator (850nm) is visible but only just noticeable at 20m.

The right is a flash light. Not a wonderful experience, it was quite painful on my eyes.

In our study, over the last two years, no animals have been seen to alter their behaviour whilst being observed by thermal optics. Mammals move through the observation area, forage, feed and interact without seemingly being aware they are being observed.

We have noticed that some species do react and alter their behaviour when observed through the IR binoculars. Some species are startled but then settle and ignore the “light” within a few seconds but others (noticeably sloths) actively move away from the area.

Thermal optics enable relative quick scanning of areas to locate mammals.

Scanning with traditional optics for stationary mammals is not easy especially in a visually complex environment such as the rainforest. Thermals can be a time and energy efficient way of detecting the presence of a mammal. It may be partially hidden but the heat signature will be obvious to warrant further investigation/observation rather than scanning past it. Even during the day time, we have found scanning with thermals a very valuable way to detect mammals.

With IR binoculars we do get some eyeshine but it is very rare that we have not detected it first with thermal optics.

Thermal optics, issues to consider.

When buying traditional daytime optics some consideration is normally taken on their prospective use before purchase. Experience and testing help to determine if a set of 8.5 x 42 or a set of 12 x 50 or even a telescope is best for your use.

The same is true of thermal optics. Thermals are not all the same and I would say vary more than traditional optics. The following factors should, in my opinion, be taken into consideration.

Field of view and magnification

Design of thermal optics has been driven (mostly) by the hunting industry and the base magnifications tend to reflect this. I would advise caution and to test the optics at the distance you would like to use them. Optics, sensor configuration and magnification all determine the field of view. Where and how do you anticipate using them? Dropping a large amount of money on the counter and buying the most expensive will not necessarily be the best solution.

In the neotropical rainforest, due to dense vegetation, our target distance was between 5m and 25m, possibly 40m in an exceptional clear area. In our first season we used two types of thermals, one had a base magnification of 2.5x and the other had a base magnification of 6x. We found these to be too high. The field of view (FOV) was small which meant scanning was more time consuming and arduous. One additional disadvantage was that in the dark we found our spatial awareness was compromised with these magnifications and FOV's.

For the second season we used thermals with a base magnification of 1.25x. Scanning was noticeably easier and less strenuous on the eyes and mind. Detection rates versus time noticeably improved.

	Distance from optic and width of cone at distance				
	10m	20m	30m	40m	50m
ATN Binox 4K (6x)	0.85m	1.65m	2.5m	3.35m	4.15m
ATN XLT (2.5x)	1.05m	2.10	3.10m	4.30m	5.40m
Swarovski (8.5x)	1.05m	2.25m	3.5m	4.75m	6.05m
ATN 4T (1.25)	2.50m	5.0m	7.55m	10.10m	12.80m
ATN OTS 4T (1.25)	3.25m	6.70m	10.10m	13.65m	17.20m

Measuring the field of view width at intervals from the optic, the person is at 25m. The inner black lines are the field of view as seen through the optic at a base magnification of 6x. The outer lines are the field of view as seen through the optic with a base magnification of 1.25x.

The optics were tested observing local mammals in Europe in an open terrain scenario (large fields) prior to field mobilization before each season. Whilst the lower base magnification optics were superior in the rainforest it is probably no surprise that the higher magnification thermals performed better on image ID in this longer distance application.

Sensors and resolution

There are some great explanations of the technical side of thermal sensors and optics available on some of the manufacturer's websites. Pulsar has an excellent one.

Generally, the higher the thermal sensor resolution the higher the number of pixels and the more detailed the image. Optics with high resolution thermal sensors tend to cost more than ones with a lower resolution sensor. The question is what level do you need? Your budget and your application will be critical factors in answering this.

Common sensor resolutions

1280x1084 = 1,387,520 total pixels

640x480 = 307,200 total pixels

384x288 = 110,592 total pixels

320x240 = 76,800 total pixels

160x120 = 19,200 total pixels

Image detail increases with resolution.

Cost also increases with sensor resolution

We found using a 160 x 120 sensor worked to locate mammals very well but it was often necessary to change to IR binoculars to determine what the mammal actually was even with medium sized mammals. We could not determine between Kinkajou or Western Olingo with this senor and magnification at our observation distance. However, with a 384 x 288 sensor it was easily possible.

Using thermals with this sensor (384x 288) enabled us to locate, ID and then observe several species without the need to change to IR binoculars (which as mentioned were known to disturb some mammals).

We have yet to test thermal optics equipped with a 640 x 480 sensor or above.

Western Olingo and a Kinkajou at +/- 15m distance and 20m above ground level (384x288 sensor).

Monocular or binocular?

Monocular thermal optics are more compact and tend to be less expensive than their binocular counterparts with the same specifications.

Our surveys observation periods are 12 hours (18:00 to 06:00) divided up into 3-hour segments. Using a monocular for that length of time is surprisingly strenuous on the eyes and facial muscles. Eye patches and switching eyes helps but we found these were not a good long-term solution if you are intending on using thermals for lengthy periods of time night after night.

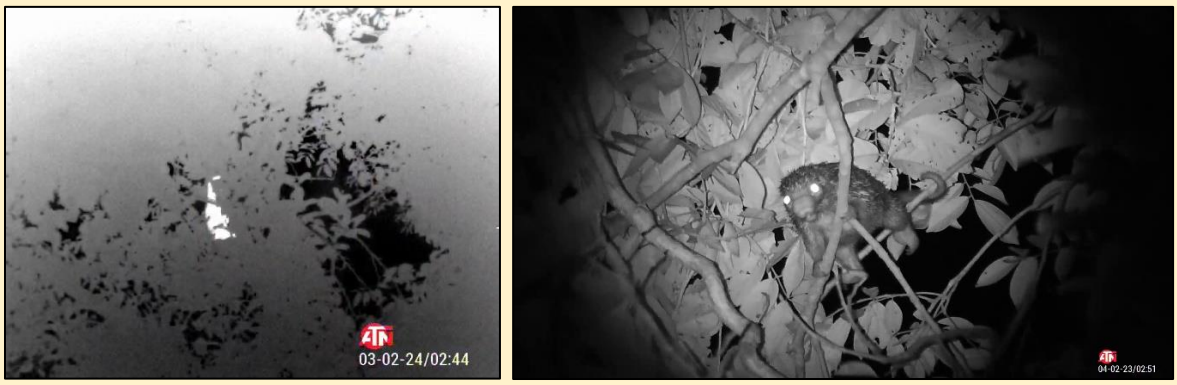
We trialed observation periods using monocular and binocular with the same sensor and similar FOV in our second season and found the binocular version to be more suited for our purpose ie that of long term observations. After three days/nights we stopped using the monocular optics for our long observation periods.

Combined thermal and night vision optics

Locate, identify, observe.

In our study we have separate optics for thermal and night vision. So far >95% of all mammals we locate in the neotropics are with the thermal optics. With higher resolution sensors we are able to identify some species but the thermal signature in some cases is not clear enough to do this. If necessary, we then move over to the night vison optics to identify (if possible) on the clearer image.

In our situation the base magnification and FOV between the two types of optics is quite large. Transition between the two optics can be difficult in the dark and sometimes results in loss of the subject which can be frustrating. When a smooth transition is achieved the results are impressive.



Thermal binocular (Binox4T 1.25x) to night vision (Binox4K 6x) transition. Andean Porcupine.

Some of the optics manufacturers have started making a combined optics unit, these allow the user to transition between thermal and night vision without switching optic. HicMicro's Raptor and the Pulsar Merger Duo are such optics and look very promising. The base magnification of both these is advertised at 2.9x and 3x respectively. A lower base magnification combined optic would be ideal for our purpose but most typical users do not (yet) require this.

Suggestions and advice

In the neotropical rainforest the conditions are not ideal for the use of thermal optics but they can work very well. From day to day and even within the same night atmospheric conditions change and this can be seen in the image quality. Knowing this happens will possibly prevent frustration and calls to the retailer. It will not always be optimum conditions where you are on that day.

Below are four images taken from the same tree stand on the same night but at different times. The settings have not been changed between the pictures.

Video

Video capability is advisable. Getting into the habit of pressing record every time you detect a mammal is worth it. We found that this not only meant we had a date time stamp of every event from the recorded meta-data but it also meant that we could review the footage later with basic editing software frame by frame to help identify the mammal and its behavior.

This kinkajou had an injured front left foot. It was accompanied through the canopy by a second who travelled ahead returning to this individual every tree transition.

Settings and palates.

Knowing the settings on the optic will make for a better experience, being able to change them without referring to the manual will make for an even better experience.

One of these settings is the ability to choose between palletes; black hot, white hot, red hot, fusion etc etc. Knowing these pallates and being able to quickly change from one to another we found to be very important.

In certain conditions and environments, white hot was found to be far more effective at locating mammals than using black hot. On clear nights white hot did not function as well whilst scanning the upper canopy, black hot worked better. In difficult conditions the fusion pallete was the best choice to locate a subject but, once located, it was best to switch back to black or white hot to identify or observe the mammal.

Black hot pallete when scanning the upper canopy can often be better than white hot

So to conclude: The dark is there to be enjoyed and remember……

Know your thermal settings and practice transitioning between optics before you locate a Margay.