Common Avian Radio-tracking Methods
&
Global Location Sensor Systems (geolocators)

Commonly used radio-tracking techniques

VHF transmitters (Very High Frequency)

Satellite transmitters (PTT, Platform Transmitting Terminal)

GPS (Global Positioning System)

Geolocators (Global Location Sensor Systems)

Case studies that used each system

Radio-tracking systems

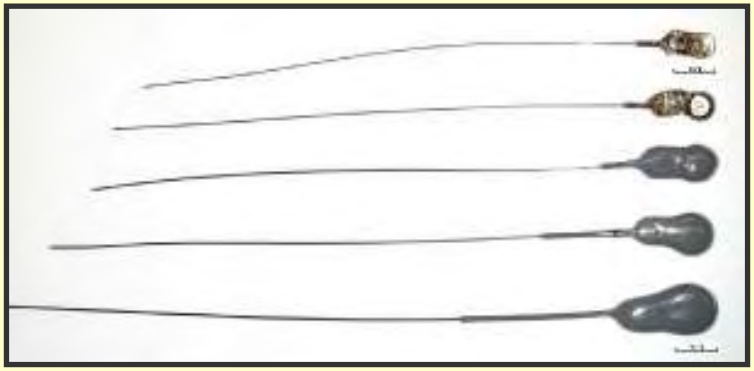
Transmitting subsystem

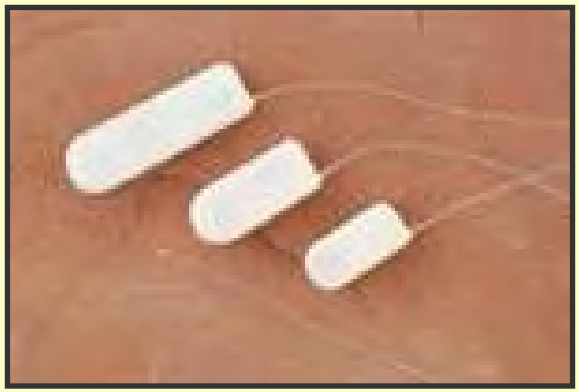
- Radio transmitter
- Power source
- Propagating antenna

Receiving subsystem

- Receiving antenna
- Signal receiver
- Power source

Transmitting systems





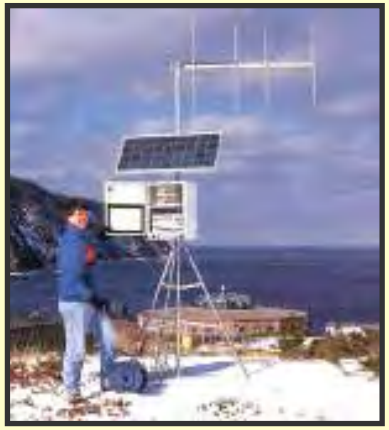
Transmitting systems

Trade-offs between
- Size/mass
- Longevity
- Detection distance

Battery powered transmitters
- 2 weeks to 2+ years

Solar powered
- location, seasonal or habitat limitations

Receiving systems

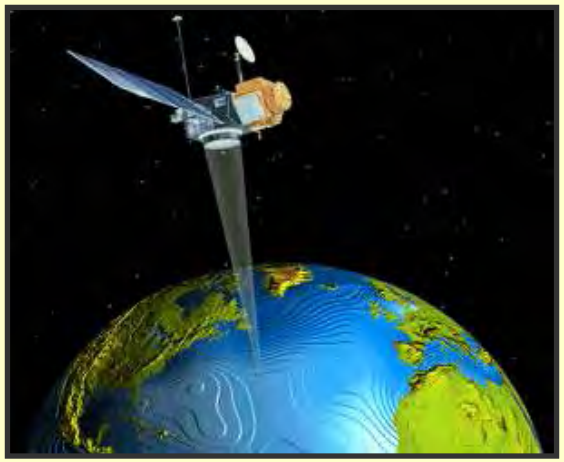


Three common radio-tracking methods in use today:

VHF radio tracking (Very High Frequency)

Satellite tracking (PTT, Platform Transmitting Terminal)

GPS tracking (Global Positioning System)



Brief description of VHF radio-tracking

Attach transmitter to bird

Brief description of VHF radio-tracking

Attach transmitter to bird

Transmitter emits a signal than can be picked up by a receiver

Brief description of VHF radio-tracking

Attach transmitter to bird

Transmitter emits a signal than can be picked up by a receiver

When a directional antenna is plugged into the receiver and pointed directly at the transmitter, a strong signal is received

Brief description of VHF radio-tracking

Attach transmitter to bird

Transmitter emits a signal than can be picked up by a receiver

When a directional antenna is plugged into the receiver and pointed directly at the transmitter, a strong signal is received

As the antenna is pointed away from the transmitter the signal fades

Brief description of VHF radio-tracking

Attach transmitter to bird

Transmitter emits a signal than can be picked up by a receiver

When a directional antenna is plugged into the receiver and pointed directly at the transmitter, a strong signal is received

As the antenna is pointed away from the transmitter the signal fades

Each birds has a different frequency, individual identification

Brief description of satellite tracking

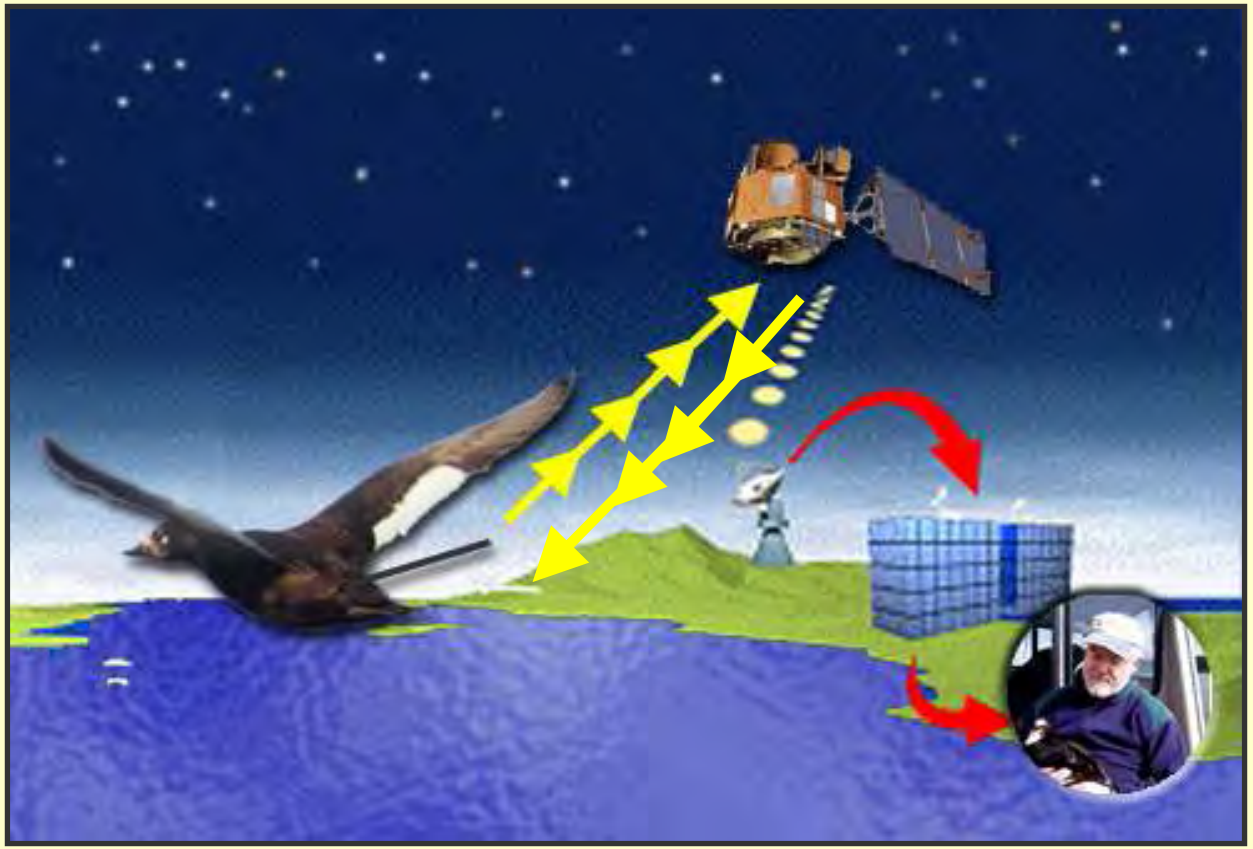
PTT's

PTT (Platform Transmitting Terminal) attached to the bird uses orbiting satellites to relay the bird's location signal to other receiving stations

Brief description of GPS tracking

Orbiting satellites, GPS units, and PTT's

function as transmitting and receiving subsystems



Transmitters may be attached in numerous ways

study species
habitat
scale (temporal and spatial)
life history stage

VHF

Very high frequency (VHF)

radio frequency range from 30-300 MHz

VHF

Frequencies < VHF are called High frequency (HF)

Very high frequency (VHF)

radio frequency range from 30-300 MHz

VHF

Frequencies < VHF are called High Frequency (HF)

Very high frequency (VHF)
radio frequency range from 30-300 MHz

Frequencies > VHF are called Ultra High Frequency (UHF)

VHF

Frequencies for individual transmitters/birds are usually spaced 10-25 KHz apart

Tuning in specific radio stations

It is very important to be aware of any other radio-tracking studies in the same area when specifying transmitter frequencies!

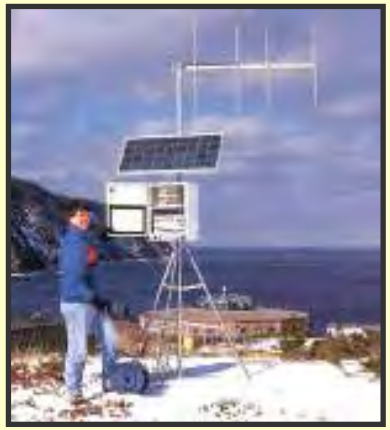
VHF

A bird wearing a VHF transmitter can be tracked with a receiver and directional antenna by a person on the ground, on the water, or in the air

VHF

A bird wearing a VHF transmitter can be tracked with a receiver and directional antenna by a person on the ground, on the water, or in the air

Alternately, fixed stations may be erected to remotely track birds



VHF

Trade-offs between
- Size/mass
- Longevity
- Detection distance

Battery powered transmitters
- 2 weeks to 2+ years

Solar powered
- location, seasonal or habitat limitations

VHF

Duty cycles

save battery life

Various switches

reduce battery life

mortality (relatively low cost & mass)

VHF

Maximum range is not only dependent on the type of transmitter selected, but also…

Length and position of transmitter antenna
Receiver sensitivity
Receiver antenna gain
Height (transmitter & receiver)
Vegetation
Humidity
Topography

VHF

RECEIVERS –

detect and distinguish signals of specific frequencies

Receiver frequency range MUST include the range of transmitter frequencies

Seems silly, issue when borrowing equipment

VHF

RECEIVERS –

detect and distinguish signals of specific frequencies

Receiver frequency range MUST include the range of transmitter frequencies

Seems silly, issue when borrowing equipment

Volume & Gain controls

An increase in gain increases signal sensitivity

up to a point

Increasing volume affords no greater signal sensitivity

VHF

RECEIVER ANTENNA size is determined by frequency

In general, the higher the frequency, the smaller the antenna

To receive signals from a transmitter @ 150 MHz

1 meter long antenna

To receive signals from a transmitter @ 27 MHz

5.5 meters long antenna

VHF

Antennas serve to:

Increase receiver gain (signal gathering capacity)

Assist in determining signal direction

Larger antennas (lower frequencies)
Yield greater gain and directionality

Reduce portability

VHF

Multi-element Yagi antennas are one of the most commonly used antennas in radio-tracking

horizontal length of metal (aluminum)

3-17 vertical elements

Length & spacing of the vertical elements depend on signal frequency

VHF

Twin Yagi systems can be set up for greater range and more precise directionality

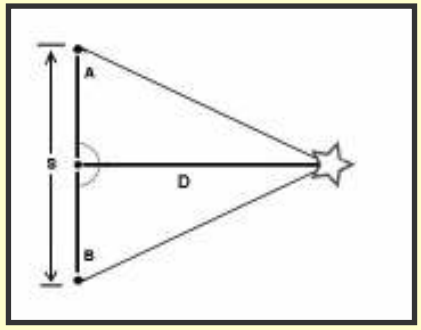
Requires careful spacing of the antennas

VHF

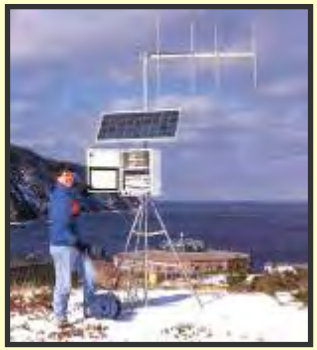
Tracking Methods

Homing

Triangulating



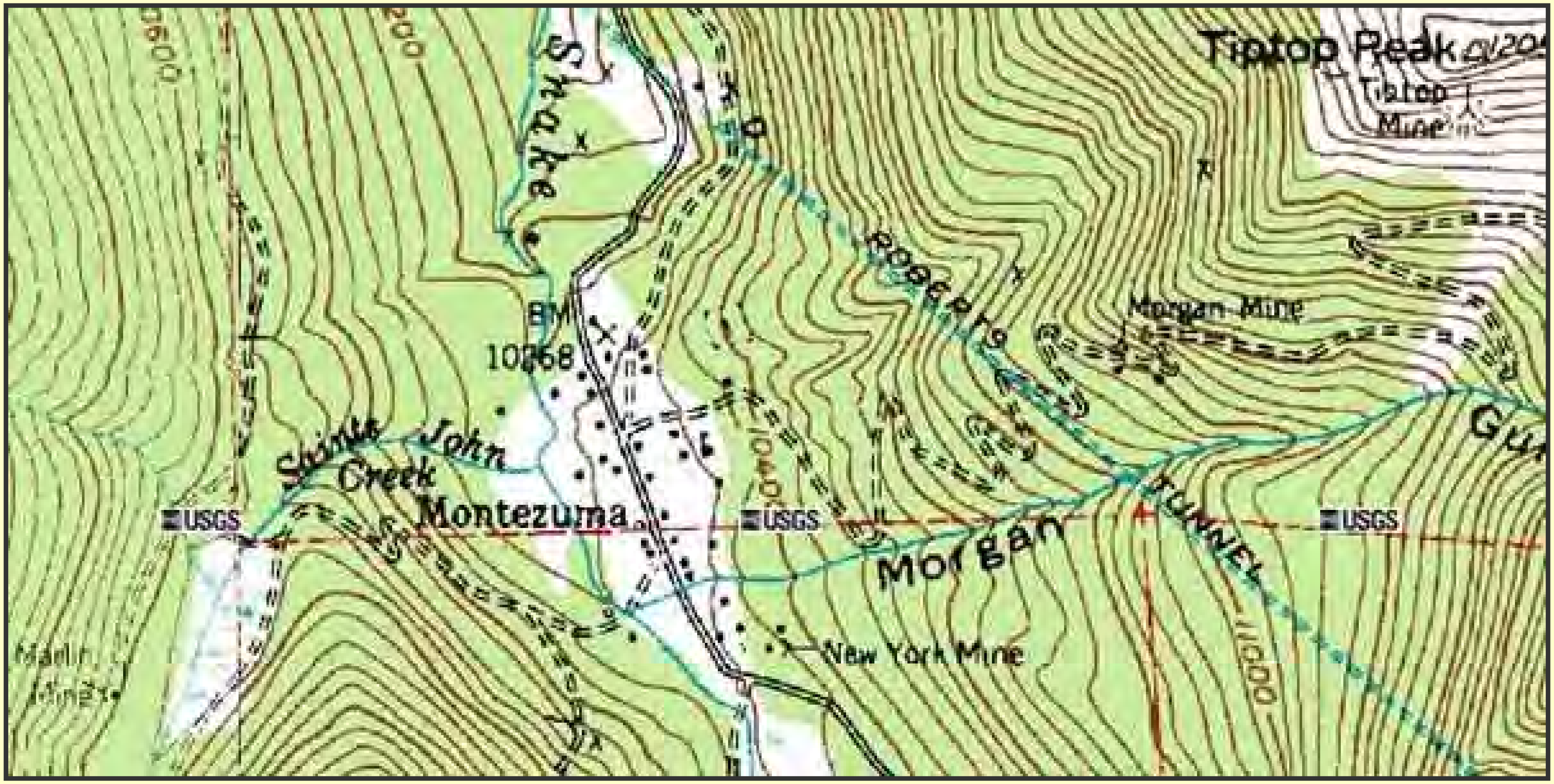
Passive remote tracking



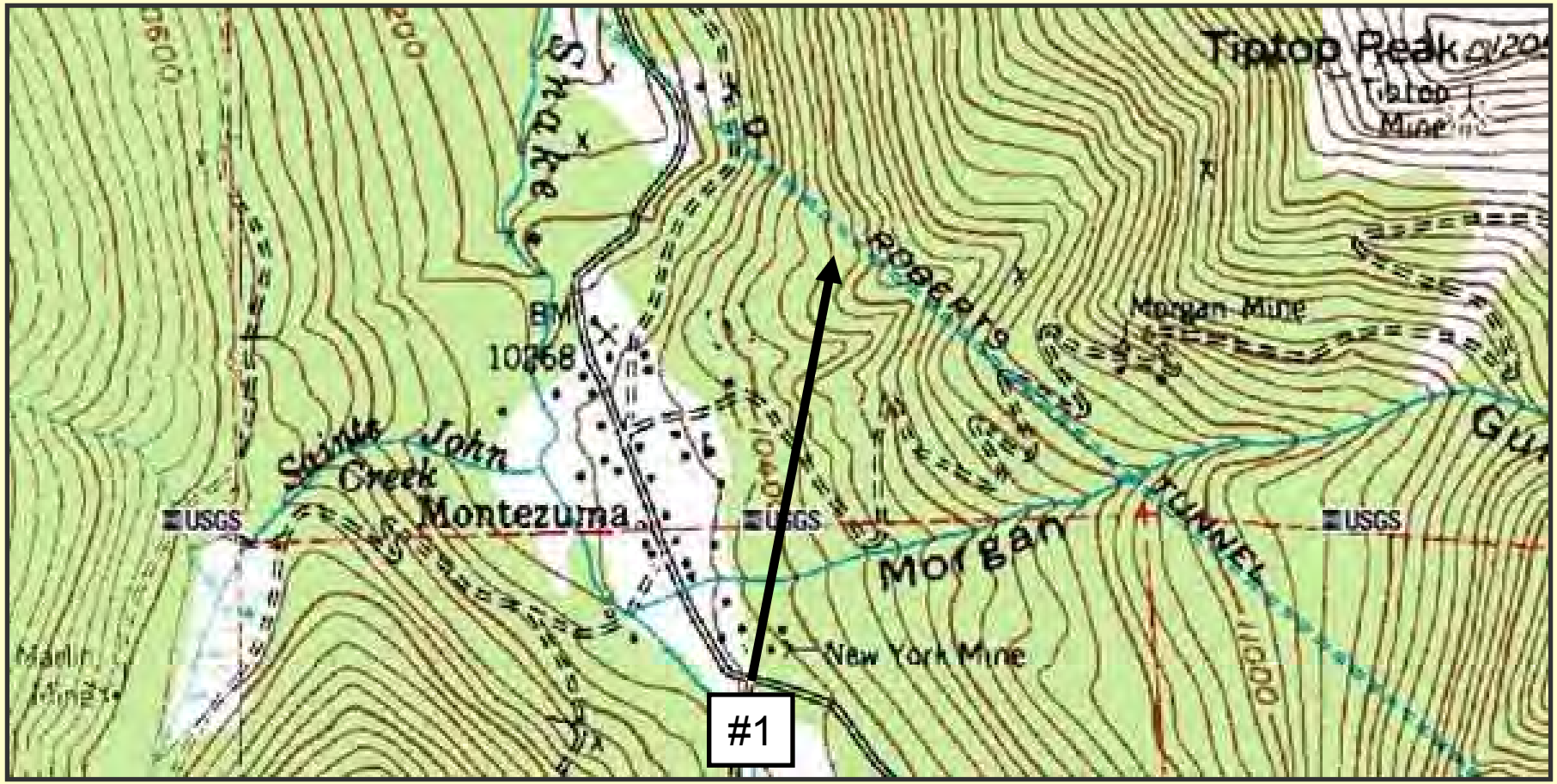
VHF

Known Position
&
Bearing

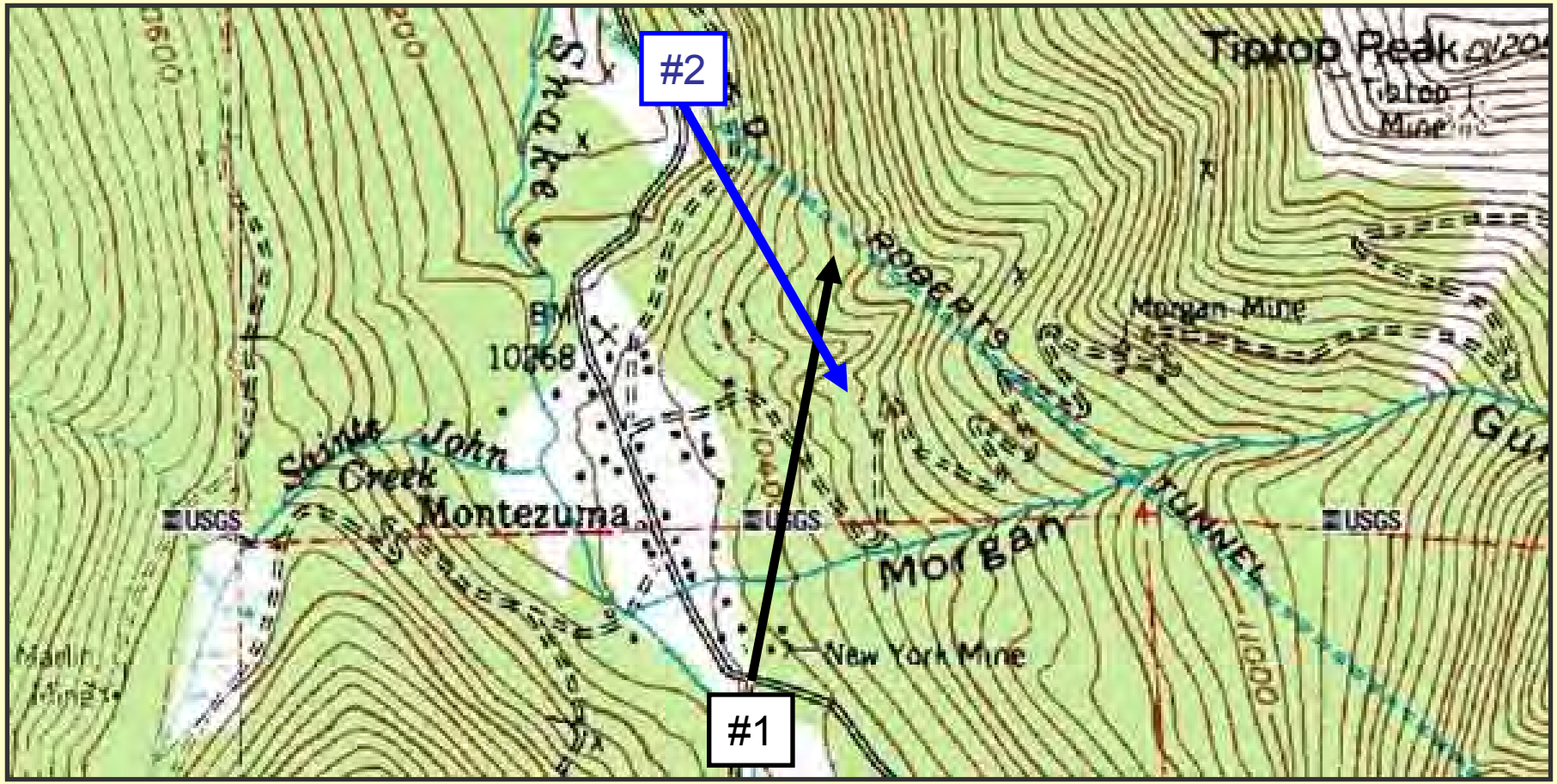
VHF


Tiptop Peak
Tiptop Mine
Snake
ROBERTS
Morgan Mine
BM
10268
Saints John Creek
Montezuma
USGS
USGS
USGS
Morgan
TUNNEL
New York Mine
Marlin Mine
11000
10400

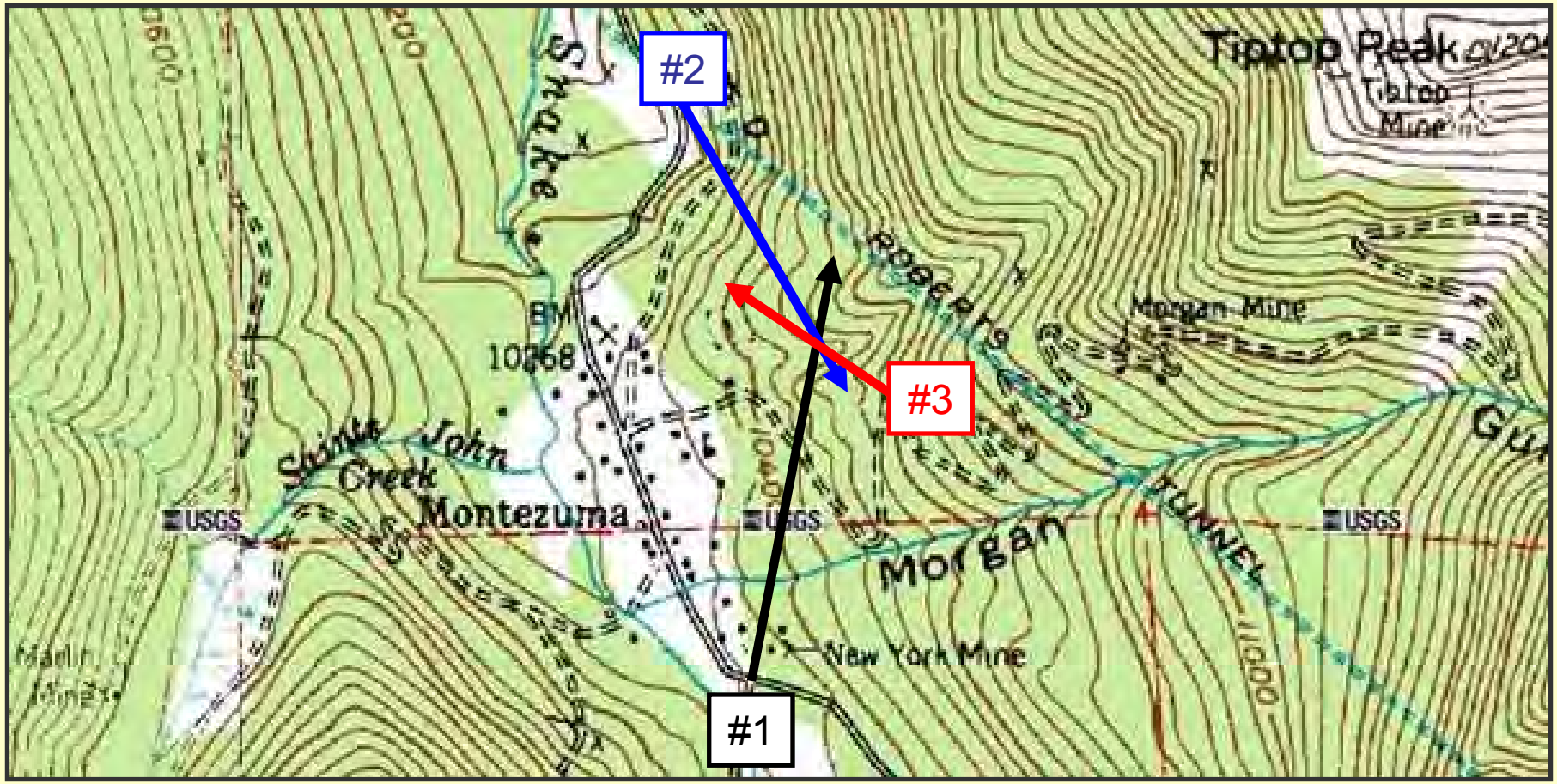
VHF


Tiptop Peak
Tiptop Mine
Morgan Mine
BM 10768
Shanks John Creek
Montezuma
USGS
USGS
USGS
Morgan
TUNNEL
New York Mine
#1

VHF

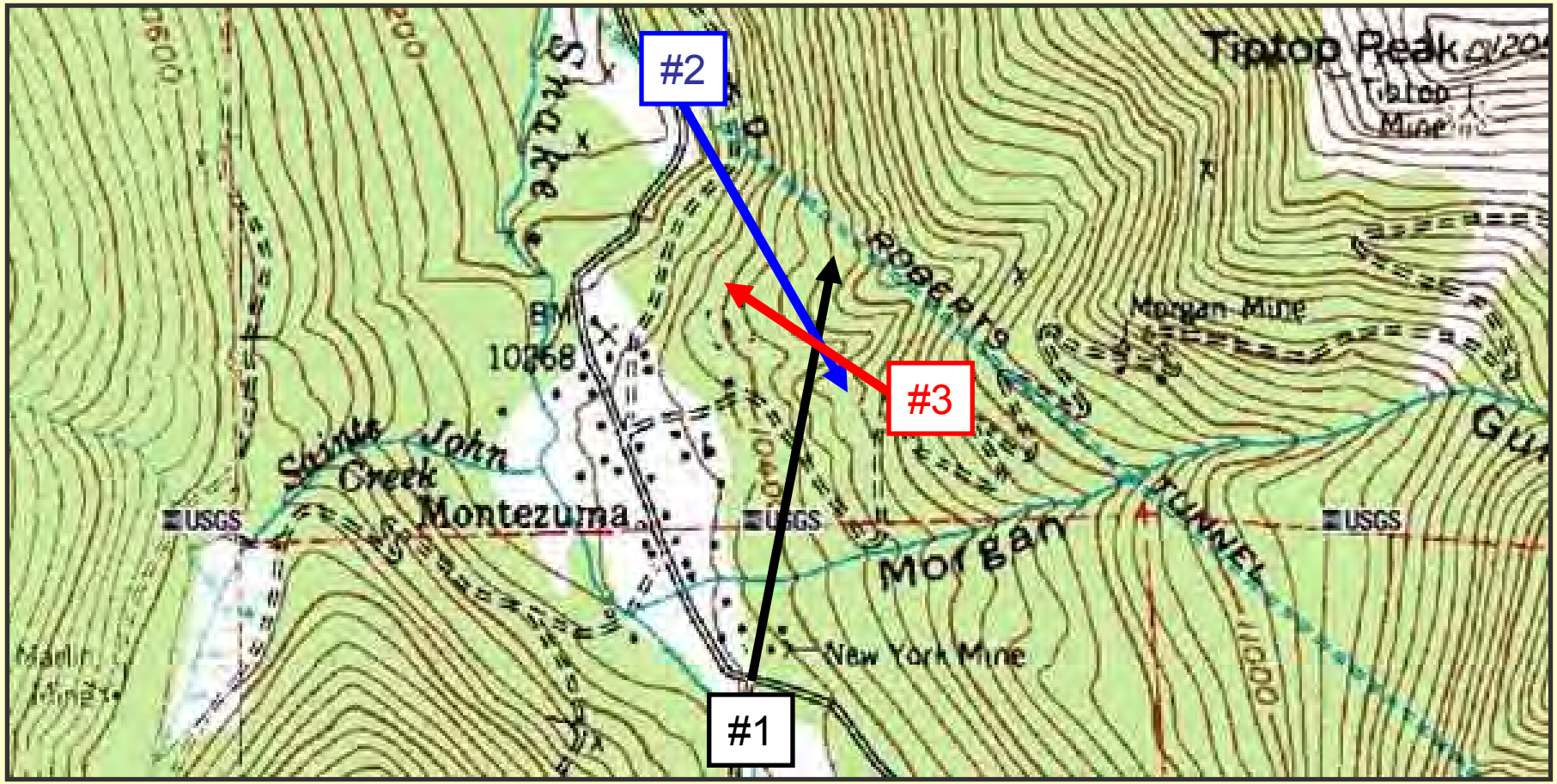

#2
#1
Tiptop Peak
Tiptop Mine
Morgan Mine
New York Mine
Montezuma
Shingle Creek
John
Morgan
TUNNEL
USGS
USGS
USGS
BM
10768

VHF


#2
#3
#1
Tiptop Peak
Tiptop Mine
Morgan Mine
BM 10768
Shingle John Creek
Montezuma
USGS
USGS
USGS
Morgan
TUNNEL
New York Mine
Rogers
Shingle

VHF

Avoid error



VHF

Automatic radio-tracking does not require that the researcher be in the field to obtain the animal's location

Bearings are recorded automatically
without subjective error

High initial investment in equipment

Limited coverage (often)

Maintenance

VHF

Relatively low cost

Reasonable accuracy for many purposes

Labor-intensive

Weather-dependent if aircraft-based

Platform Transmitter Terminals (PTT)

PTT

Polar orbit at 850 km
revolution around the Earth ~ 100 minutes

PTT

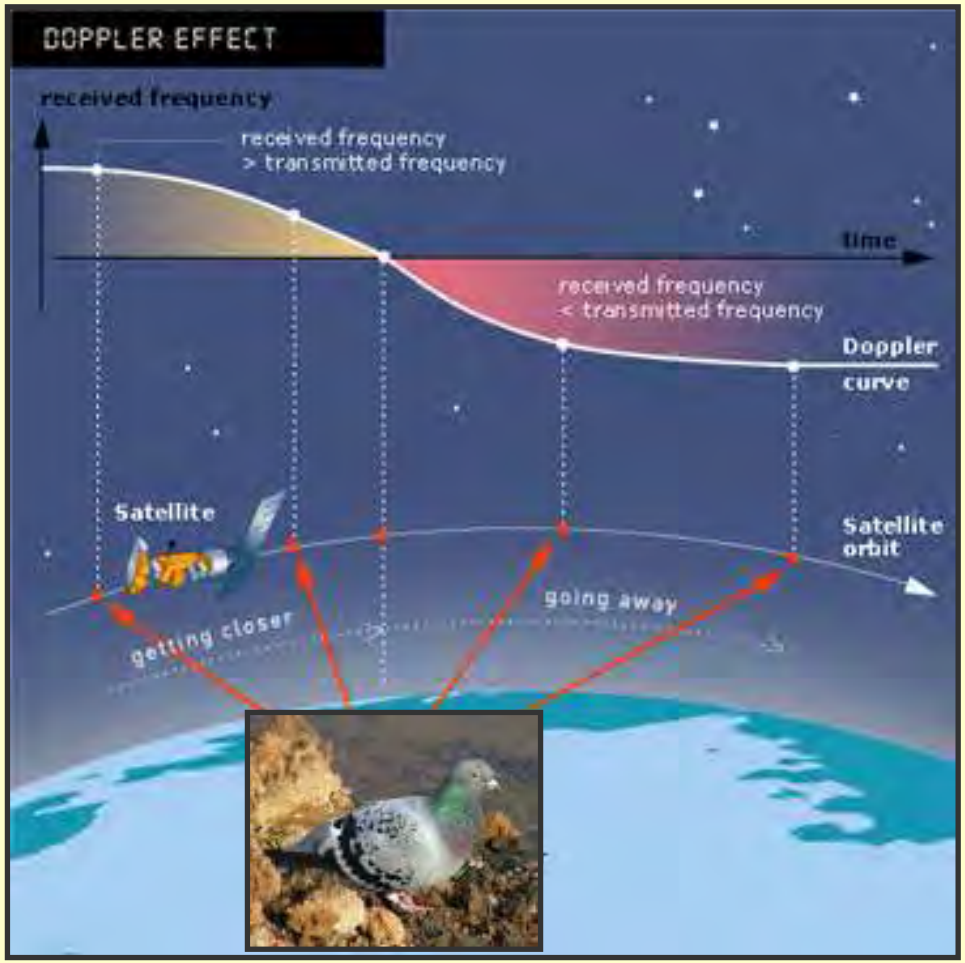
Number of daily passes increases with latitude

At the poles, the satellites can see each PTT on every pass, approximately 14 times per day per satellite per day

The period during which the satellite can receive messages from the PTT is ~10 minutes

PTT

Doppler shift



PTT

Trade-offs between
- Size/mass
- Longevity

Battery vs. solar power

Solar powered
- location, seasonal or habitat limitations

Duty cycles

PTT

Work best near the poles
- more transmissions/day

Gross movements
- Dispersal path
- Migration path
- Breeding, nonbreeding ranges

Large error
- 0.25 – 1.5 km

Low number transmissions per day

PTT

$3,000 – $4000 US

Heavy

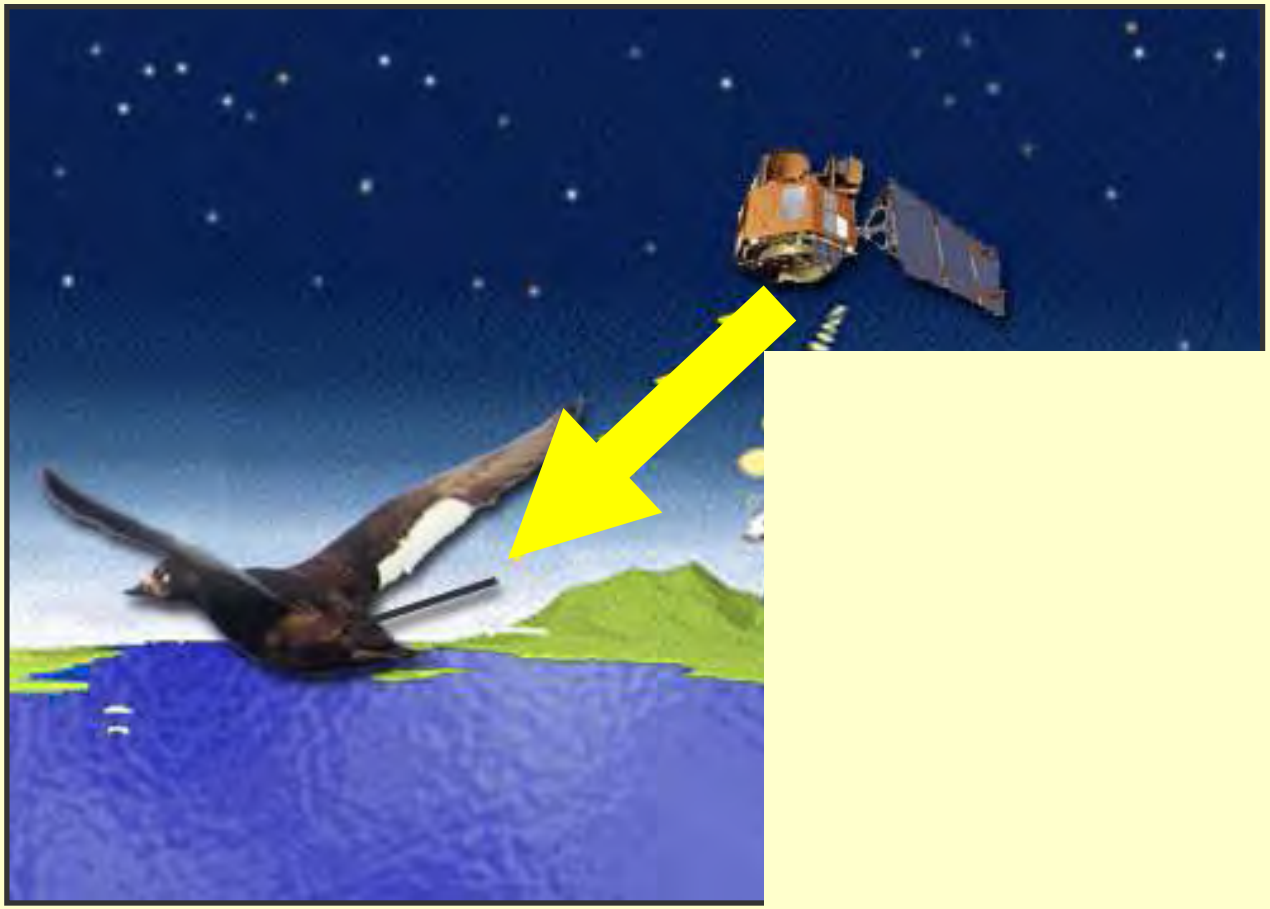
$1-2 US per location

GPS

Global Positioning System

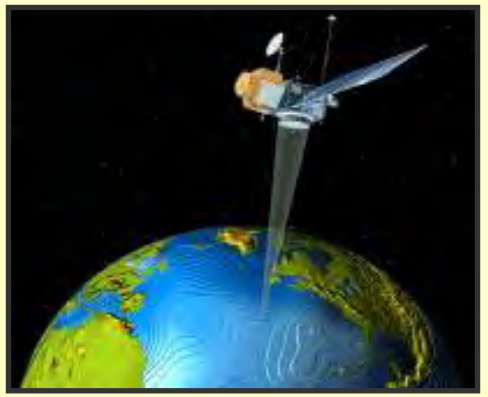
GPS

GPS

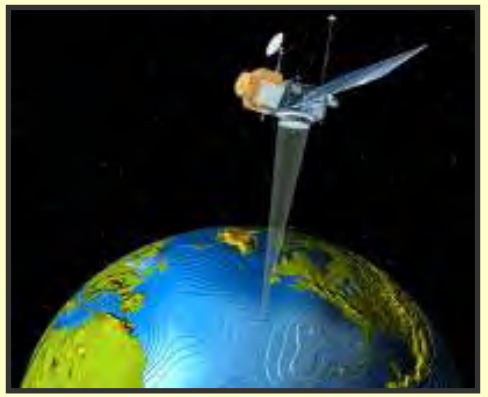


GPS

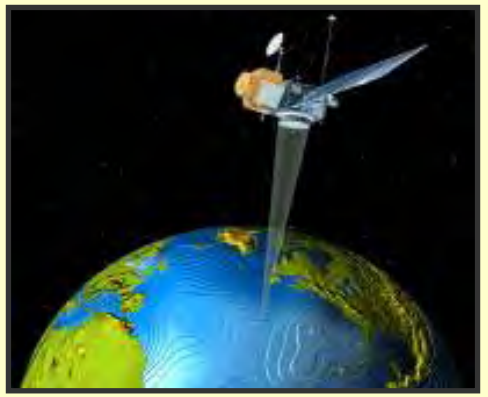
GPS



GPS



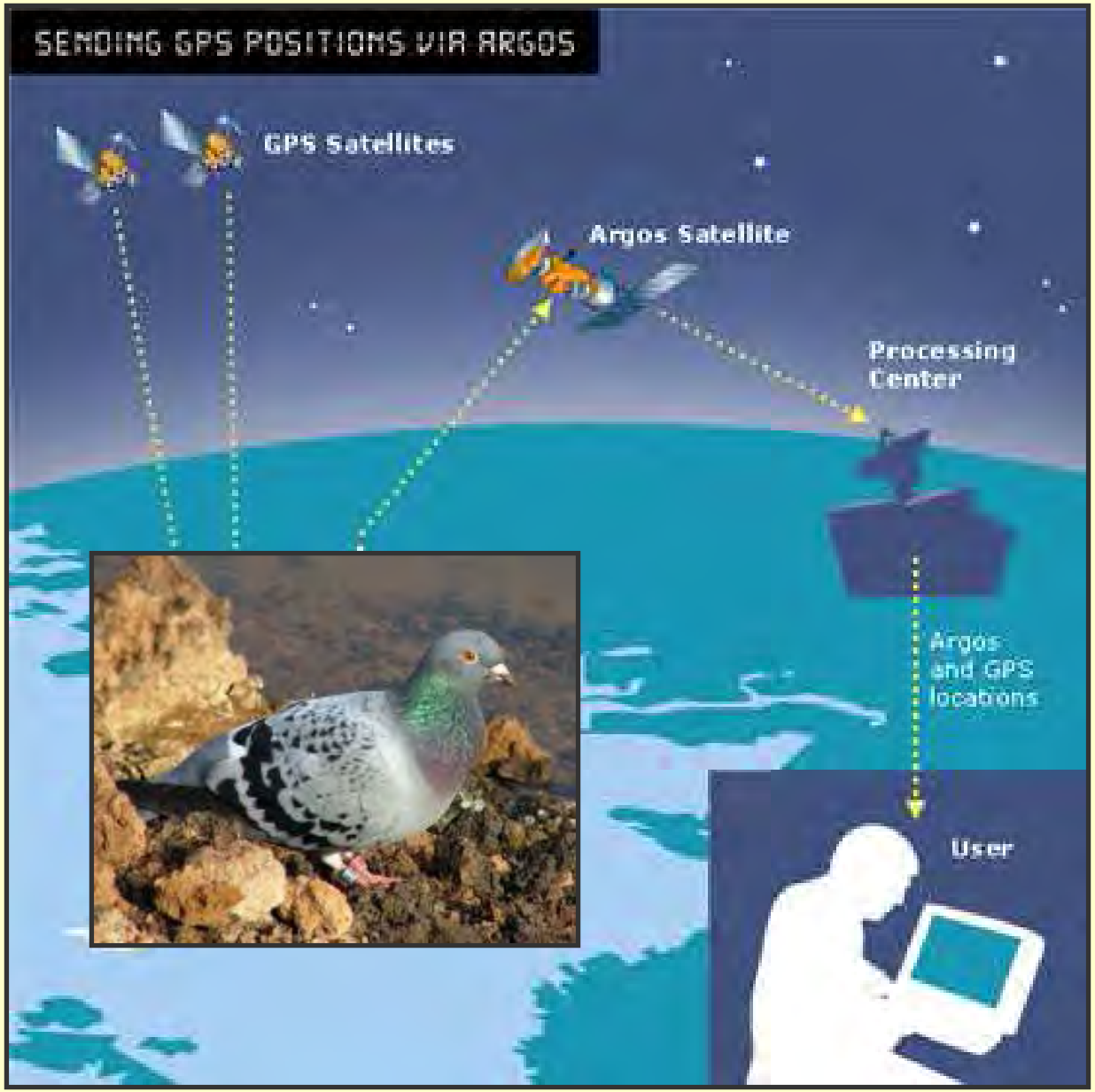
GPS



Best of both worlds

GPS
+
PTT

GPS
+
PTT


SENDING GPS POSITIONS VIA ARGOS
GPS Satellites
Argos Satellite
Processing Center
Argos and GPS locations
User

Data Retrieval

GPS device functions as a data logger

Data Retrieval

GPS device functions as a data logger

GPS device linked to orbiting satellite through PTT

Data Retrieval

GPS device functions as a data logger

GPS device linked to orbiting satellite through PTT

GPS data relayed to a central data store or internet-connected computer using cellular, radio or satellite modem

GPS

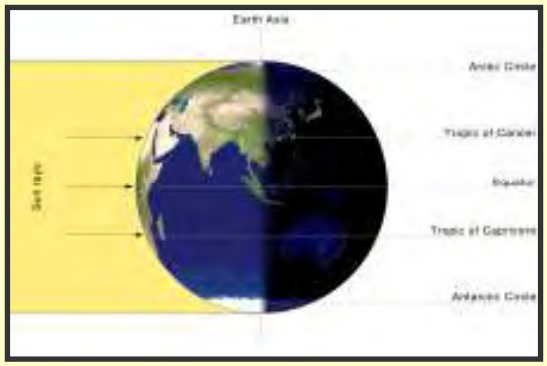
$3,000 – $4000 US

Heavy

$7 - $8 US per unit per day

Geolocators
(Global Location Sensor Systems)

Geolocators



Record light intensity levels

Calculate sunrise and sunset times

Latitude and longitude estimated from sunrise-sunset

Low power + data compression

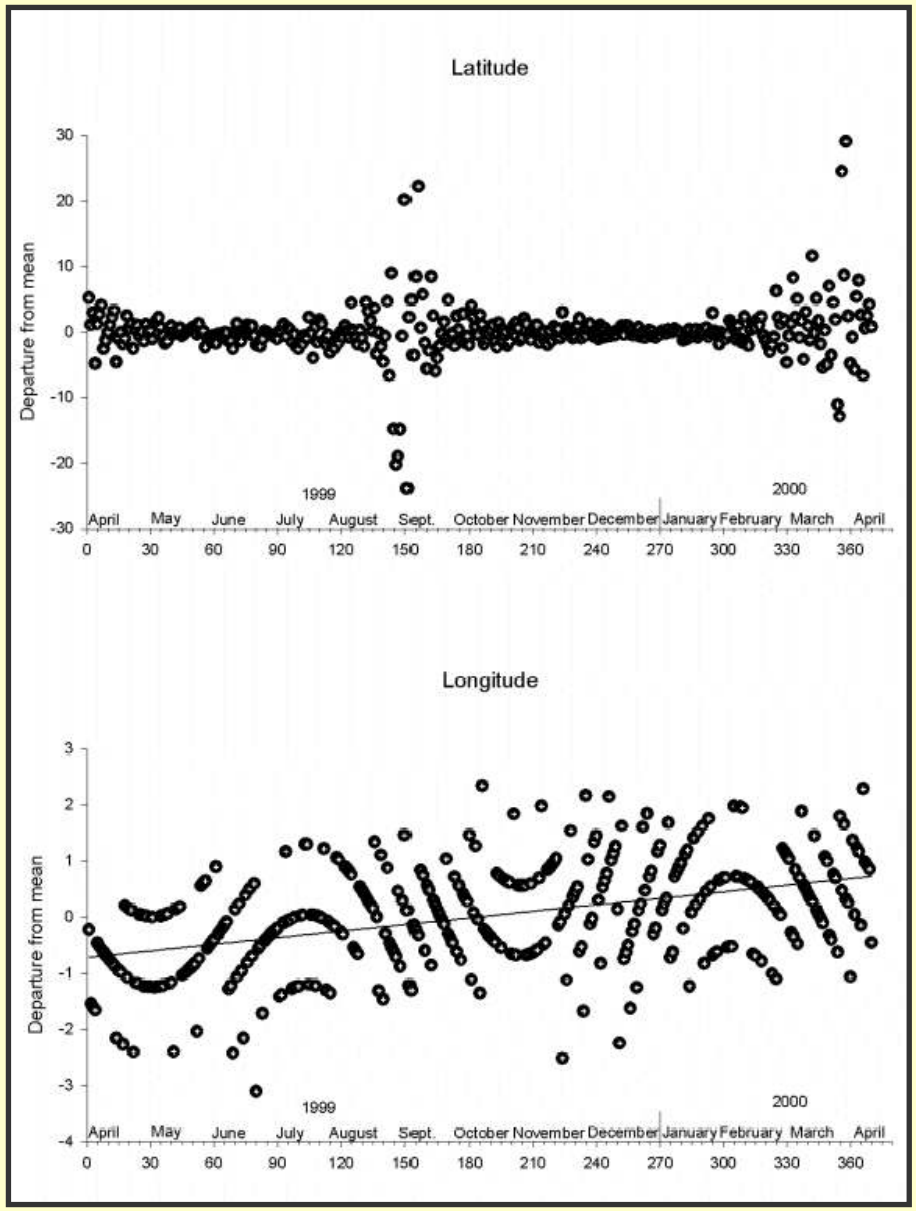
Collect and store data 2+ years

Geolocators

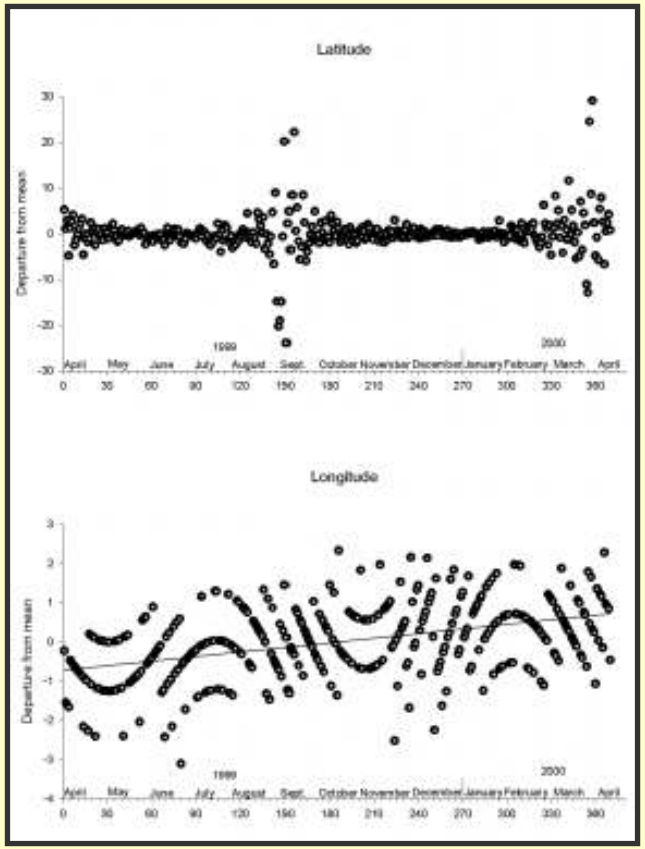
Geolocators

Spatial resolution in coarse 185-200 km

Geolocators



Geolocators



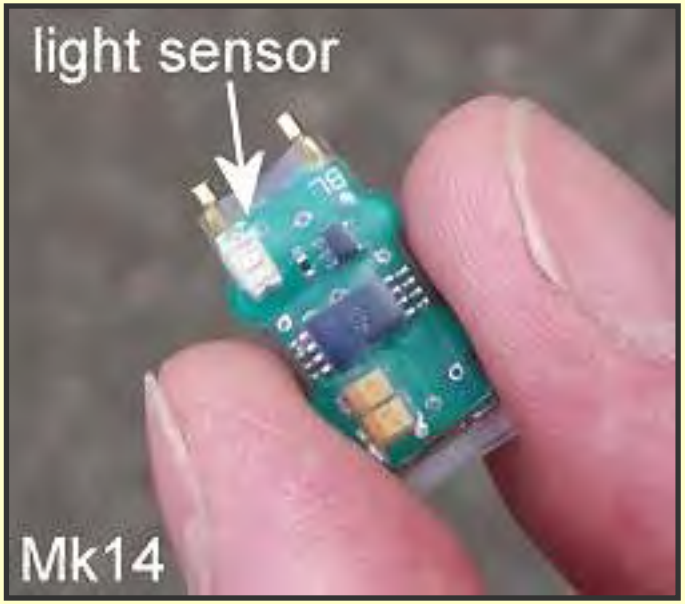
The addition of temperature sensors can refine location estimates

1–2° error reduction

Geolocators

Coarse data

Recapture necessary



Inexpensive ($200+ US)

Light weight (1.5+ grams)

Long lasting (2+ years)


92



What data are necessary to address my research question?

What data are necessary to address my research question?

What tracking technique(s) can provide these data?

What data are necessary to address my research question?

What tracking technique(s) can provide these data?

What system will work best?
for the bird and researcher



What data are necessary to address my research question?

What tracking technique(s) can provide these data?

What system will work best?

for the bird and researcher

Behavioral plasticity (ornithologist)

each species and habitat are different

pre-packaged equipment uncommon