Lecture Note on

WILDLIFE CONSERVATION

[PWM 555]

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UNIT-ONE

1.1 Introduction to WL conservation in Nepal
1.2 Legislation concerning WL conservation in Nepal
1.3 History, Status and Problems of WL conservation in Nepal
1.4 Some successes in conserving WL

1.1 Introduction to WL Cons. in Nepal

Wildlife:

- Animals, birds, insects, etc that are wild and live in a natural environment (Oxford)
- A vast assemblage of plants and animals in their natural environment (Trippensee, 1953)

Wildlife Management:

WL Mgt is an art of producing desired population of wild animals. It includes restoring, protecting, conserving and maintaining the animal population

Conservation:

[Management/ preservation/ protection/ sustainable development/wise-use/ welfare]

- To protect the value
- To increase importance
- To make favorable environment for living
- To increase the extent in number, their quantity as well as quality
- Conservation for whom? ... for human welfare so extent of conservation depends up on the nature of interest or degree of attitude of human

Wildlife Conservation:

It is a scientific program through which WL population is maintained by establishment of protected areas and any suitable habitat hence it seeks towards-preservation of natural resources, protection and sustainable (wise) use and development (maintenance) of the WL and their respective habitat.

- WL Cons. history is relatively new in Nepal
- Before 1950s abundance and surplus of WL resources were seen around the country
- At that time, no problems of real WL mgt so no need for conservation
- Royal family and Rana minister used organised hunting in Terai dense forest of Chitwan, Bardia, *Charkoshe Jhadi* and Kanchanpur

Development Phase in WL Conservation:

- 1970's establishment phase:
  - Complete protection was provided to species and conservation of habitat
  - Boundary delineation
  - Research

- 1980's development phase:
  - Public involvement, public demand, need identification was made
  - Park-people relation identified
  - Partnership with NGO's started
  - Expansion of legal basis: BZ, CAs, policies strengthening and expansion took place
- 1990's development as well as maintenance phase:
  - Identified and development of BZs arround Pas, direct benefit from BZ mgt to the local people
  - Initiation of park-people conflict resolution program
- 2000's expansion of landscape level:
  - Initiation of eco-region or landscape level concepts
  - Conservation, protection and management initiated in broad level

WWF views: Development Phase

- Era-1. 1960-1980's:
  - Species preservation era
- Era-2. 1980's-mid 1990's:
  - Conservation and development era
- Era-3. Mid 1990's to present:
  - Started regional level cooperation, eco-regional cooperation
  - Initiation of trans-boundary concept has been set up
  - Started landscape level project (Jamuna river in India in the west to Bagmati river in Nepal in the east)

Summary: WL Conservation Development in Nepal (After 1950)

- Wildlife conservation initiatives were taken because of rapid human population increased, massive resettlement program, eradication of malaria in the terai
- Alarmingly/increasing hunting and poaching
- Some WL species were push to threat of extinction; rhino, tiger, gharial, etc
- In response this, in 1957 first act for rhino habitat protection was passed and enforced

- Special conservation legislation was passed in 1973, named as National Park and conservation act 1973
- This is a remarkable date for WL conservation in Nepal
- Under this act, establishment of RCNP, formulation of rules and regulation, establishment of separate department;DNPWC
- This act made the provision for establishment of 4 types of Pas (NP, WLR, HR, SNR), 20 spps of mammals, 4 spps of birds were put protected animal list
- Deployment of Army for protection
- Special power to warden

- Nepal embarked upon modern era of wildlife conservation with the enactment of National Parks and Wildlife Conservation Act in 1973
- Remarkable progress in conservation during the decades of 1970's and 1980's by creating of all together 15 Pas, covering nearly 14% of country geographical areas
- Later 1990's it was increased 18.33% (16 Pas including 6 BZ)
- National park and Pas management workshop held in Kathmandu in 1985 with theme of **Conservation for Sustainable Development** brought in historic change in the prevalent western concept of Pas management
- At present the rhino population has increased from 50/60 in 1960's to over 350, gharial from 200 to abundance and tiger to around 200

- The decade of 1990's brought in many management initiatives as different research recommendation such as: rhino translocation, better mgt of habitats act and regulation for BZ management
- Legislation concerning WL conservation was changed/modified according to changing needs of the country (Act amendment in 75, 83, 89 and 93)
- Emphasis and importance is placed over conservation awareness and people are participating for successful conservation

1.2 Legislation concerning WL conservation in Nepal

In Short:

- Conservation policy is broadly guided by the National Conservation Strategy (NCS)-1987
- It is implemented through periodic 5 year plans; basis of Master plan
- GON has adopted the Nepal Environmental and Action Plan (NEPAP)-1993 to integrate environment and development
- PAs of Nepal are managed under the National Park and Wildlife Conservation Act, 1973 with periodic amendments
- GON has made provision to plough back 30-50 % of park revenue to the people of the park vicinity in order to mitigate park-people conflict

Long-term policy guidelines:

- Under the direction of WCS, the NCS for Nepal 1987 and NEPAP 1993 are long terms policy of Nepal according to which acts and regulation are farmed to achieve stated objectives

Long and short terms plans:

- MPFS 1988, a 21 year long sectoral plan of Nepal, and National periodic 5 year plans of GON/NPC are long and short term plan respectively.. to develop and formulate for WL conservation program

Policy and Program:

- **Policy**: NCS, NEPAP and 5 year plan
- **Program**: The programs related to PAs and WL Cons. is included in the MPFS (conservation of ecosystem and genetic resources as one of the primary development program

Six supportive programs (MPFS):
In support of primary programs, six supportive development programs are provided by MPFS:
1. Policy and legal reform
2. Institutional reform
3. HR development
4. Research and extension
5. Resources information and planning assistance, and
6. Monitoring and evaluation

NCS and NEPAP identify and stress:
- **NCS**
  - Stresses the need to draft park and reserve management plan through a consultative process involving local communities
  - Stresses on zoning and development of tourism policies and active role of DNPWC for conservation
- **NEPAP**
  - Identifies and stresses the need to local people in park management
  - To preparation of management plans to better conserve WL and fulfill basic needs of people depending on it
  - To develop sustainable mechanism for better sharing with people whose livelihood are adversely affected by the PAs

National Park and WL Conservation Act 1973: Silent features

- This is a main act related to conservation of WL and PAs in Nepal
- It provides basis for establishment and administration of PAs
- Responsible for conservation of WL animals, birds, reptiles and their respective habitats

It indicates 2 objectives:
  - Primary; protection of sites or landscapes of scientific, geographical, aesthetic importance together with associated flora and fauna
  - Secondary; development of such areas for tourism

Act 1973: Provision concerning conservation:
[34 section and 4 times amendments (1975, 1983, 1989 and 1993)]

- **Section 2:** describes 5 different categories of PAs and BZ
- **Section 3:** power to declare PAs, BZ, Conservation areas
- **Section 4 & 5:** deals with entry permit to enter PAs and prohibition of activities
- **Section 6:** operation of hotel and other service under special permit
- **Section 10**: allotment of total 38 species in protected list
- **Section 11-15, 17-20:** deals with hunting; license, quotas fixing, imposed closed season, cancel license, sale and transfer of trophies, etc
- **Section 16:** in mgt of PAs, power conferred to warden
- **Section 23-31:** special power to warden for inspection and search, arrest without warrant, investigation
- **Section 25:** rewards up to 50,000, 30-50% park revenue for community development

- **Section 26:** penalty from 50,000-100,000 fine or 5-10 years of jail or both

Legislative doc. For WL Conservation:

- NPWC regulation 2030 (1973/74), 2nd amendments in 2035 (1978/79), 3rd in 2042 (1985)
- RCNP regulation 2030 (1973/74)
- WLR regulation 2034 (1977), 2nd amendments in 2042 (1985)
- Himalayan NP regulation 2036 (1979)
- Khaptad NP regulation 2044 (1987)
- RBNP regulation 2053 (1998)
- Conservation area regulation 2053 (1998)
- BZ management regulation 2052 (1996)
- BZ guidelines 1999

Other related acts:

- Forest act 2049 (1993) and regulation 2051 (1995)
- KMTNC act 2040 and regulation 2042 (1985)
- Soil conservation act 2042 (1982)
- Tourism act 2035, Water resource act 1992
- Environmental protection act 1996, Local self government act 1998, etc

International Agreements:

- **CITIES 1973**: Convention on International Trade in Endangered Species of wild flora and fauna- Nepal signed this treaty and became member parts in 1975

Lists of Nepal's flora and fauna in CITIES appendices

	I- totally banded	**II- permission from cities HQ**	**III- can be exchange**
Flora	10	1	10
Fauna			
Mammals	28	7	22
Birds	16	9	19
Reptiles	7	4	2
Amphibians	-	1	-
Insects	-	2	-

Ref. Table 2. 26 of NBS2002

- **WHC 1972:** Convention for the protection of the World cultural and natural heritages/World Heritage Conservation under UNESCO 1972
  - Nepal became party member to this Convention in 1987 to protect cultural and natural areas of international importance
  - Sagarmatha NP 1979
  - RCNP 1984
- **Ramsar or Wetland Convention 1971:** Convention of wetland of international importance especially as: KT WL Reserve-1987, Ghodaghodi Tal (Kailali)-2003, Bishazari Tal (Chitwan)-2003 and Jagdishpur Reservoir (Kapilbastu)-2003

- **CBD 1992:** Convention on Biological Diversity (Earth Summit)
  - Nepal became a member on this convention and established the National biodiversity conservation action plan
  - GEF (Global Environment Facility) project under this convention is acting in this kingdom

1.3 History, Status and Problems of WL conservation in Nepal

HISTORY and STATUS:

A. Before 1955:
- WL resources are plenty
- No concern for WL protection
- Rana protect and conserve the forest as well as WL for their hunting purpose

B. 1951-1955 [King Tribhuvan Era]:
- No significant work in WL conservation
- Only organized hunting in yearly basis

C. 1st to 4th five year plans; 1956-1975 [King Mahendra Era]:
- Most work was initiated and done in WL conservation and protection

A Golden Era in WL Conservation/King Mahendra Era

1957
- Nationalization of forest Act 1957 (2013)
- Proposed Chitwan for protection
- Made and passed constitution of WL protection Act 1957
- This may be regarded as the initial effort in WL conservation in Nepal

1961
- Increasing the Gaida poaching in Chitwan, result of that Gaida Gasti was established

1964
- For Rhino protection purpose, Chitwan was declared as a Rhino Century

1969
- Under the WL protection Act, 6 Royal hunting reserve in terai and one in mountain was gazetted

1970
- Mahendra proclaimed Chitwan as a 1st National Park
- Nepal Nature Conservation Society established to
  - Encourage and support conservation and mgt of natural environment

1972

- Under the support of UNDP and FAO the government started the Park and WL conservation project with the objectives of-
  - Develop PAs and Conservation laws
  - Propose and survey of PAs and develop list of protected and hunting species

1973

- Marks an important date
- Passed NP and WL conservation Act-1973 (Nepal's 1st conservation laws. the act allow for-
  - 4 types of PAs (NP, WLR, HR and SNR), Dept. of NP and WL resources
  - Special power to Warden
  - Allowed thatch grass cutting in Terai
  - Listed hunting and endangered species (Mammals-20 and Birds-4)
  - Allowed hunting for wild boar
- Gazetted of RCNP as 1st National Park of Nepal
- Tiger Ecology project was started

1974

- Dep. of SCWM…. that added the conservation of WL habitat
- National committee for Man and Biosphere established
- Military protection of PAs, only limited responsibility to them

D. 5th and 6th five year plans; 1974-1985

1975

- Natural History Museum established in Ktm for….
  - Environment and nature conservation
  - Education and awareness
- Nepal became state party member of CITIES
- Protection responsibility was given to Royal Nepal Army
- Management plan of Chitwan, Langtang, Rara, Bardia and Khaptad prepared

1976

- Establishment and gazetted of Langtang NP, Rara NP, Bardia WLR and Koshitappu WLR and Suklaphanta WLR represent the country different ecological zone

1978

- Nepal became state party of World Heritage Convention
- All Hathisar were recognized and transported to DNPWC
- Ghariyal breeding centre was established in Kasara, Chitwan

1979

- Nepal organized 1st Pheasant symposium in Kathmandu
- Sagarmatha NP was declared as WH sites
- Established Elephant breeding centre in Khorsor, Sauraha

1980

- Dept. of NP was established as full phase Dept. under MFSC

1981

- Shey-Phoskundo NP established
- Diploma in Forestry started at IOF, Pokhara

1982

- KMTNC was established as a 1st NGO for nature conservation

1983

- NP act 2nd amendment took place

1984

- Khaptad NP, Parsa WR and Dhorpatan HR field office established and Parsa and Khaptad was gazetted
- RCNP was declared in WH sites

E. Seventh five year plan: 1985-1990

1985

- UNDP/FAO/HMG Parks and PAs monitoring project began to:
  - Monitor nation wide wildlife population
  - Developed environmental program
- ACAP was constituted/established under the KMTNC

1986

- Shivpuri watershed and WL reserve established

1987

- Preparation of NCS, this is the 1st policy for BD conservation
- DHR was gazetted and KTWR declared as 1st Ramsar site under Ramsar Convention in Nepal

1988

- MPFS was prepared..to conserve ecosystem and genetic resources

1991

- Makalu Barun NP and CA established (In 2000, CA converted into BZ areas)

F. Eighth five year plan: 1992-1997

1992

- Environment Protection Council was established for policy formulation and coordination of BD conservation
- Nepal signed the convention of BD in Rio Earth Summit
- GEF was set up to work on BD conservation

- 4th amendment of NPWC Act where BZ provision was included and passed

1993
- NEPAP-I was prepared, WWF field office was established in KTM
- Rhino action plan was prepared by DNPWC

1994
- Park People project started in Terai PAs' BZ of 5 PAs
- Nepal became state party in CBD
- Rhino count took place (544)

1995
- BD profile reports published

1996
- BZ regulation was gazetted and Manaslu CAP was established
- BZ of Chitwan and Bardia declared

G. Ninth five year plan: 1997-2002

1997
- KCA was declared
- Bardia Research project on Tiger, Elephant and Gharial established (NORAD)**1998**
- Shey Phoskundo and Langtang BZ declared
- PP project was extended to Rara and Khaptad NP
- Collaborative mgt of PA's system began
- Tiger action plan was prepared

1999
- Makalu Barun BZ gazetted
- Management Strategy Framework of 9 NP's and WR conducted (ZOPP)

2000
- Rhino count was conducted (Chitwan-612 and Bardia-64)
- GIS database of NP prepared almost Terai parks (except Suklaphanta)
- WWF started TAL scheme established and field office in Bardia setup

2002
- Shivapuri NP gazetted, Sagarmatha BZ gazetted

H. Tenth five year plan (2002 onwards)

2003
- Ghodaghodi, Bishazari tal and Jagdishpur reservior in Ramsar sites

2004

- Koshitappu BZ declared

2005

- Parsa WR and Suklaphanta BZ declared
- Rhino count in chitwan (372)

General Facts (Ref. DNPWC 1980-2005)

IUCN categories

II- 9 NP, IV- 3 WR and VI- 1 HR; 9 BZs & 3 Conservation area

Floral and Faunal Diversity

Ecosystem	F types	F plants	Fungus	Lichens	Mammals	Birds	Reptiles	Fishes	Butterfly	Moths
118	35	6500	1500	350	181	862	147	180	640	>6000

PAs Description

Protected Areas	Number	Areas in KM2	%
National parks	9	10288	6.99
WL Reserves	3	979	0.67
Hunting Reserves	1	1325	0.90
CAs	3	11327	7.69
Total BZ areas	9	4666.67	3017
Total core & BZ areas		28585.67	**19.42**
Proposed BZ	2 (Khaptad and Rara)	413.52	0.28
Total area with proposed PAs		28999.19	19.70

Estimated population of important big mammalian species

R B Tiger	Asian elephant		One horned Rhinoceros		
	Wild	Captive	RCNP	RBNP	RSWR
360-370	120-156	185-200	372 (2005)	67 (2000)	7 (2004)

Problems/Challenges in WL Conservation in Nepal:

There are so many problems appeared in WL conservation in Nepal Categories in 3 ways:

1. **Socio-economic**
2. **Organizational**
3. **Legislation**

Following points cover all the sector of the above

- Key stone species come out of danger line but it is still uncertain either they mention or not their viable population is questionable up to now.
- Some sites need to be brought PA system and connectivity between fragmented land is immediately necessary.
- Some species needs more protection i.e. bear, leopard because they are protected in India also.
- Status unknown: mammals, birds, reptiles etc
- For the low revenue earning PA's, how to earn revenue and conduct the different development program is quite challenging task.
- Barrier in river system must be (re) constructed in such a way that there must be easy in wildlife movement.
- Forest land fragmentation due to migration of people from uphill.
- Deforestation/Degradation of forest –loss of habitat, no strong policy to protect wildlife habitat
- High dependency on forest resources-uncontrolled collection of forest products
- Agricultural expansion and intensification –use of chemical, loss of habitat, decline in biodiversity
- Spreading urbanization centre and infrastructure- river pollution, encroachment of forest land [ultimately gene drift
- Localized and increase in tourist number
    - Habitat destruction
    - Migration of animals form their original habitat
    - Change in animal behavior
    - Ultimately decrease in Wildlife number
- Environmental change due to habitat destruction, soil erosion and pollution
- Poaching, Illegal trade of W/L and their parts- [along the boarders of China and India]
- Poor education and awareness from all levels form politicians to local people
- Financial resources are inadequate to invest in W/L Conservation
- Inadequate compensation means for P & P conflict resolution
- Size of PA's in some core areas are small which cannot keep W/L population inside the PAs [Shivapuri NP and Suklaphanta WR].
- Conservation mainly focus on large mammals so small W/L remains suppressed
- The appendix of animal's list given in NPWC Act are placed without doing research but put only by the personnel judgment [need to re-manage]
- Enforcement of NPWC Act and Law outside the PAs are not allowed, creating some problems in investigate and search for illegal process

Some Success in Conserving W/L in Nepal:

- Enactment of W/L legislation
    - Strong legislation of NPWC Act, 1973 and its timely amendments
- 30 to 50% of park revenue go to community
- KMTNC Act, to contribute for conservation
- Creation of DNPWC, to look in matters related to W/L intensively
- Establishment of 16 PAs and 9 BZs covering 19.42% of total area of Nepal

- Enforcement and timely amendment of some important legislative document concerning W/L Conservation [constitution, mgmt. plan]
- Environment lobbying group, NGOs, researchers and trained staffs of PAs are working in W/L conservation
- Sagarmatha and Chitwan NP in WH sites
- Koshi tappu WR and others three species' Habitat in Ramsar sites
- Provision to regulate hunting
- Success from single species conservation through ecosystem to landscape level conservation
- Nepal receiving external assistance for W/L conservation
- Rhino translocation [1986-13, 1991-25, 1999-14,2000-10 (4 in suklaphanta), 2001-5, 2002-10]
- Captive breeding program of Ghadiyal and Elephant are remarkable example of the country.
- Trans boundary conservation program [KCA]
- Nepal became a party member of different great international convention and commission
- Regular monitoring and counting of animals
- Establishment of anti-poaching units

UNIT-TWO: WL Conservation Technique

2.1 Capturing wild animals
2.1.1 Capturing birds and mammals
2.2 Marking animals for identification
2.2.1 Marking birds and mammals
2.3 Capturing and handling reptiles
2.4 Chemical Immobilization
2.5 Radio telemetry

2.1 Capturing wild animals

In both WL management (including conservation) and research it is often necessary to capture wild animals, including birds, alive

Reasons for capture and handling:

- Treatment of sick animals
- Removal of problem animals such as man-eater
- Translocation to a new area (reintroduction/restocking) or a zoo
- Research such as fixing of an identification tag or radio transmitter
- Collection of samples (blood, hair, stomach contents)

Knowledge necessary in capture/handling:

- Species ecology
  - Animals favored habitat within their range
- Species behavior
  - Diurnal pattern of activity
  - Their sensitivity to disturbance and handling

-Utmost care should be taken to minimize physical and psychological trauma (injury)

-..should plan to restore the animal back to normal condition as soon as possible
-Proper equipment is essential for dangerous animals

2.1.1 Capturing birds and mammals

***Live Trapping**

Capture small mammals or carnivores alive:

- Live trapping, with box or cage traps, is used for the capture of small mammals for study purpose
- Nuisance carnivores (man-eater animals) may also be caught for removal to another area
- Well designed live traps cause little or no physical harm to the captives (captured animals)
- The type of trap depends on the target species

Equipment for capturing animals alive-

Animals types	Animals like	Trap types	Remarks
Very small animals	Shrews, mice	Sherman trap	Made of thin GI sheet
Larger rodents	Lagomorphs and carnivores up to jackal size	Steel mesh trap	Must be rigid construction and collapsible
Large carnivores	Leopard, tiger	Robust trap of a wooden or iron frame	Having vertical sliding door, closed under gravity

Trapping procedure:

Trap Site

- Traps should be placed inconspicuously by using twigs or grass in shade near to
- Not on a well used trail
- A strange, highly visible object or unfamiliar odors such as human sweat may frighten the animal way
- Hence rub your hands in faecal material of the species or use gloves when setting the trap

Bait

- It helps to attract the sps near to the trapping box or cage
- Select a bait which is attractive to the target sps and scattered very small portions of in it the area, forming a trail leading to the trap
- Some carnivores will only go for live prey, in which case use a trap with a special compartment for a live chicken or rabbit at one end
- "Pre-baiting" with a particular shy sps, advisable to familiarize the animal with the trap for some days by scattering bait around with out setting the trigger mechanism & tying the trap door in the open position

Some important Bait for attracting the sps. near to cage-

Squirrels, small rodents	Peanuts, grains
Birds	Grains, rice seed
Hare	Cabbage, fresh vegetable, carrot
Jackal, fox	Chicken necks and entrails, meat
Otter	Fish
Jungle cat	Fish, meat

Handling a captives

- Do not leave set traps unattended for long periods
- With nocturnal sps, traps should be checked at beginning of light (Dawn)
- With diurnal sps, traps should be checked several times during the day
- Precaution should be taken particularly during very hot or very cold weather
- Once an animal is captured, approach the trap gently and cover with cloth or gunny bag- darkness quietens animals down
- Handling of a highly excited or dangerous animal may be facilitated by manual injection of a mild tranquilizer such as diazepam into the tail or a limb projecting through the mesh of the trap
- Release animals as soon as possible once research procedure or translocation are completed

***Mist Netting**

To capture smaller birds or bats alive:

- Mist Netting is used for the live capture of small birds and bats for study purposes such as Migration study
- Animals are caught in flight by becoming entangled in the fine, relatively invisible black nylon net
- Mist nets are available in rectangular sizes ranging from 2.1 X 10 m to 2.7 x 18 m
- Filament thickness and mesh size depend on the size of birds or bats being trapped [an average mesh would be 3 cm]

Setting the Net

- The net is suspended vertically between two bamboo poles in a known flight path of the target sps, at an appropriate height
- In order to reduce the possibility of the net being seen, mist nets should be set against a background of broken vegetation
- The poles should be firmly fixed in the ground, about 45 cm deep
- Poles should be slightly further apart than the length of the net
- The horizontal cords which pass through the net are held taut by being tied tightly to the poles
- The horizontal section of the net between the cords should not be taut but should hang loosely
- Once set up, nets should be inspected frequently, preferably every hour
    - To minimize distress and injury to captives
- They should not be left for long periods unattended, particularly in extreme climatic conditions

Removing captives from net

- After ringing, weighing or other procedure are completed, release the captive well away from the net

Storage

- After use, all twigs and other material entangled in the net should be removed and the net folded and stored in a dry dark area

***Rocket Netting**

- To capture groups of large ground birds, or small to medium sized ungulates, use the Rocket Netting

2.2 Marking animals for identification

Artificial marking should only be considered in sps where it proves impossible to identify an adequate number of individuals using natural features of the type

Reasons for identifying individual animals:

- To recognize dispersal (emigration/immigration) pattern
- To follow migration (two way movement)
- Observe seasonal changes in physical condition
- Study social interaction
- Estimate population (capture/recapture)
- Growth study (with recapture)
- Study reproductive history-breeding season e.g time of offspring stays with mother
- Mark should not cause irritation, changes in behavior and or mortality
- Marks are permanent, semi- permanent and temporary
- Where possible conduct test on penned animals

***Marking Captured mammals**

There are 3 general systems

1. Mutilation
2. Attachment of the marking device e.g.tag, collar
3. Coloring

1. Mutilation

- Removal of any part of the body
- It involves toe-clipping, tail- docking, ear-cropping, hole-punching, fur-clipping and branding
- All forms of mutilation may affect animal's behavior or their survival
- Investigator may be confused with those incurred by the animal in some other way
- A standard system for marking small mammals are marked by toe-clipping and ear-punching

Advantage:

- Marks may be readily applied with a minimum of equipment
- Marks may be read at a distance

Branding:

- Hot branding
  - Mark for cattle, mostly
  - Permanent and semi permanent types of marks
  - These brands have been successfully read 5 to 20 yrs after its application (depends up on species types)

- Freeze branding (Cryo-branding)
  - Use copper iron super cooled in dry ice and alcohol
  - Or with liquid nitrogen
  - Copper branding instrument chilled to –94oF
  - Seen up to 20-25 yrs of its application

[Lining the brand with paint for better visibility]

Fig: Branding

Toe-clipping

- Especially small mammals
- Making more conspicuous,also marked by toe punching
  - Toe punching (hole punching): the webs between the toes have been punched as an identifying- permanent, visible only at close
- If a lot of animals marked, can further use ear punching

2. Tagging

- It involves attaching to an animal; a piece of metal on which is stamped an individual number often an address
- Tag may be lost due to:
  - Wear (smoother by continuously using/rubbing)
  - Infection
  - Scratching of the marked animals
- Advantage of tags for marking:
  - easy to affix
  - easy to see
  - may be returned to the investigator if found
  - Also they may be discovered after the death of an animal
- Tags are usually placed in the ear of most mammals
- When the ear is small, a fingerling tag is used
- Even mice have been successful ear tagged

- Tags should not pinch or interfere with the blood supply of the animals
- Tag should be as light as possible
- In some mammals the ears are small, tags are applied other than in the ear (eg Muskrats)- use aluminum tag through two slits in the skin of the back

3. Coloring

- Commercial fur dyes have been used successfully to color-mark wild animals
- These dyes are poisonous and must be used with reasonable care
- Dye: Nyanzol 4R (reddish brown) and Nyanzol D (black)
- Mixed with hydrogen peroxide before application
- The series of marks with coloring can be increased by applying spots to different part of the body

2.3 C./M. and handling Reptiles [esp. crocodile]

- It may be useful to mark crocodiles so that a record can be kept of their origins and date of capture
- Marking is essential in growth trials when progress of individuals has to be monitored
- Paint: For short-term requirements a spot of quick-drying, waterproof paint is the simplest for marking
- Tagging: Metal clip-on tags, such as ear-tags used for cattle, can be punched through a large tail scute without any risk of infection or even discomfort to the crocodile; effective for 3 years
- Brand: marks are made between the scales directly under a scute
- Burn Brands: If the skin between two scales is lightly touched with a hot soldering iron it will burn and heal to leave a permanent scar
- Scutes punching/clipping: The scutes can be marked by clipping off the tops or punching holes in them with a leather punch
- Scutes cut off: If scutes are cut off at the base with a very sharp blade they will not grow again and the marks will be permanent.

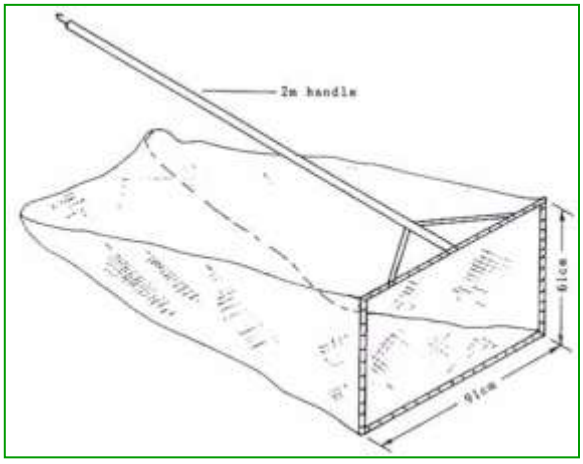


Fig: Steel framed hand net for capture of young crocodiles

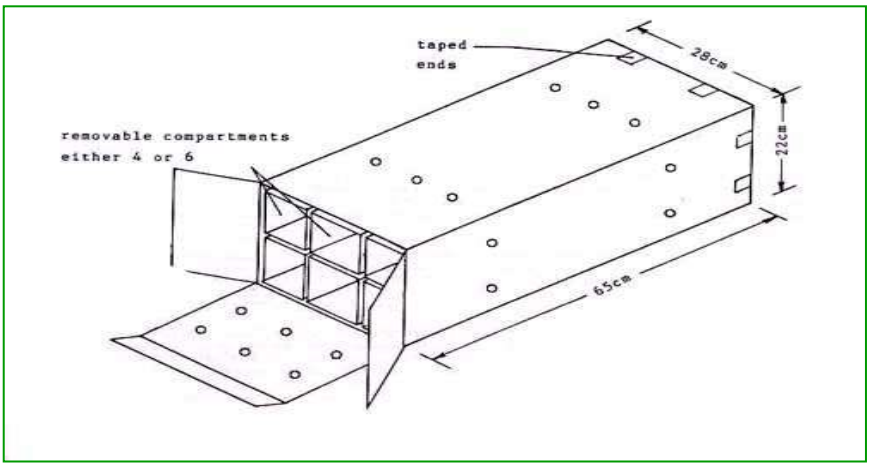


Fig: Cardboard transport box for young crocodiles

Fig: Marking

2.4 Chemical Immobilization

Chemical Restraint:

- Chemical restraint includes any methods that primarily uses a chemical agent or "drug"for restricting animal freedom i.e walking, running and aggressiveness
- The state of restraint can vary from;
  - Immobilization (arresting movement)
  - Tranquilization (calming)

  - Anaesthetization (complete loss of consciousness)
- Respiratory depression is a common occurrence in immobilization
- Safe immobilization of animals by using chemicals was developed about 4 decades ago
- Drug immobilization or darting is now a widely used capture method
- Particularly appropriate for large or dangerous species e.g. wild elephant, tiger, rhino, etc
- Prior training and presence of an experienced person, preferable with veterinary knowledge, are essential
- General information about habitat and behavior of the animal is also essential for deciding the best approach and ideal time
- Information on general anatomy and weight should be known to determine drug dosages and effective darting areas on the body
- Once the drug delivery is confirmed do not leave the animal until the drug effect wears off

Purpose

- Capture of problematic animals or animals in distress
- Veterinary care of wild and captive animals
- Population building and control; e.g translocation, reintroduction, hormonal implant and sterilization
- Research studies; e.g radio collaring, surgical implant
- Drug experimentation

Advantages

- Compared to mechanical capture methods, it causes little disturbance to the animal fear, shock and physical damage are practically eliminated
- It enables capture of carefully selected individuals
- It can be used in various situation
- It enables selection of the time of capture
- The equipment is easy to carry and shift from one place to another in the field

Disadvantage

- Occasionally equipment failure: e.g. faulty charges or any other equipment fault
- Animal injury due to operator error;
  - dart delivery on the wrong site
  - use of more than the required charge for the particular distances
- As with all drug use, undesirable side effects are possible
- Due to drug induction delay (due to oblique hitting of the dart, unsuccessful location of the animal), darted animal is occasionally lost
- Procurement of drugs and equipment from overseas can be tedious and expensive
- Danger to human operator if certain drugs used carelessly
- can not be used for capturing animals on a large scale

Approaching wild animals for Immobilization:

- Wild animals can be approached within their flight or from a safe distance (in case of aggressive animals)
- Crossing the limit of safe distance in case of aggressive animals can be dangerous
- Use of vehicle, elephant, hideout, vantage point or camouflage can be facilitate approaching the animal
- Smaller animal need to be closer as compared to the large animals for they have a smaller darting area

- Types of forest cover, available road network, terrain, behavior of animal (coming to a salt-lick, water-point) are factors that would help select the mode of approach
- In terai grasslands, riding elephants could be the only choice
- In dense vegetation, following an elephant on foot will be more profitable

Basic Considerations for Chemical Imm.:

- **Purpose of capture** should be ecologically, socially, ethically and technically justified
- **Type of terrain**: areas with dense cover, steep slopes, large water bodies nearby (for terrestrial animals) should be avoided. A compete understanding of terrain is essential
- **Type of animal**: whether aggressive, powerful, potentially dangerous to operator, with young to defend or prone to stress-should be assessed. Territorial, behavioral, hierarchical and health status of animal should be known
- Emaciated (thin/weak), **sick or old animals** should not be captured or restrained. Such animals have a very unpredictable drug response
- High (more than 35oc) and low (less than 10oc) **temperature regimes** are not ideal, for the animal may suffer from the temperature stresses
  - The drug effect may further cause an increase (hyperthermia) and decrease (hypothermia) in body temperature
  - Suitable temperature regime for immobilization can be obtained by selecting different time period in different seasons
- Human antidote (Narcan) kept ready for use before approaching/operating the immobilization
- Safety drugs to meet emergency situation in case of captured animals should always be taken to the field
- Sufficient daylight for searching for the darted animal should always be ensured- in winter not after 2 pm (day light during winter is short)
- Stay with the immobilized animal till it has completely recovered from the drugs effect, and is able to take care of itself from accidentally falling or becoming an easy victim to predation

Equipment:

- A wide range of equipment is available for delivering chemical agents or drugs to animals
- Drugs delivery to the animal's body can be done in various way:
  - Oral: mixed with food or water
  - Hand-held syringes: with ordinary syringe or jab-stick
  - Projected syringe or dart: Blow-pipe, blow-gun, cross bow, gas or powder charge gun or pistol
- For successful capture, selection of appropriate equipment and familiarity with its use are essential
- There are 2 essential items of immobilization equipment:

1. The Projector
   - Blow pipe
   - Rifle
   - Pistol
2. Projectile
   - Dart or flying syringe (needle is a vital component)

Projected Syringe or "Dart"

- Modern chemical restraint technique demands equipment capable of projecting a dart to considerable distance
- Drug deliver equipment and projectile syringes have undergone a series of modifications and development since their discovery around 4 decades ago
- A dart has basic three components:
  - Anterior needle
  - Middle drug chamber or barrel, and
  - Rear stabiliser
- Projections can be created by air pressure, compressed gas cartridges, and through powder charges

{PROJECTOR}

1. Blow-pipe:

- This is the simplest type of dart projector, consisting of a straight PVC or aluminum pipe 1 to 2 meter in length and 8.0 to 10.0mm in diameter
- It propels a small plastic dart over distance of up to 10 meter
- Mainly used for thin skinned animals in enclosures
- The range can be increased by using a special mouth piece or joining two pipes together
- The projectile (dart/flying syringe) carry up to 3ml of drug
- Darts work on the principle of compressed air or gas effect
- After placing the loaded dart inside its rear end, the blow pipe is held to the mouth and pointed steadily toward the target area of the animal's anatomy.
- After taking a deep breath a rapid "blow" is made to propel the dart toward the most muscular part of animal
- Blowpipe is entirely silent in operation, causing minimum disturbance to non-target members of a group of animals
- It has no operating costs/only minimum cost for maintaining and repairing of the dart components

2. Blow-gun/Air pressure gun/Blow gun rifle:

- This equipment comes under the commercial trade name-Telinject
- The dart is similar to a blow pipe in structure but bigger and can carry a drug load up to 5.0ml
- It consist of blowpipe fitted on to a gun stock which has compression chamber pressurized via rubber tubing connected to the tyre foot pump
- It is quite versatile for use in captivity and in wild situations, particularly on thin skinned animals with an accuracy range of 30m
- Gun stock has a compression chamber that can be pressurized by connecting it to an ear pump or through a CO2 gas cartridge.
- Compressed air is released into the barrel to propel the dart by pulling a trigger-a mechanism similar to air gun
- The pressure developed in the compression chamber can be measured with a pressure guage into a gun.

3. **Powder charged rifles/ Dist-Inject or Cap-chur:**

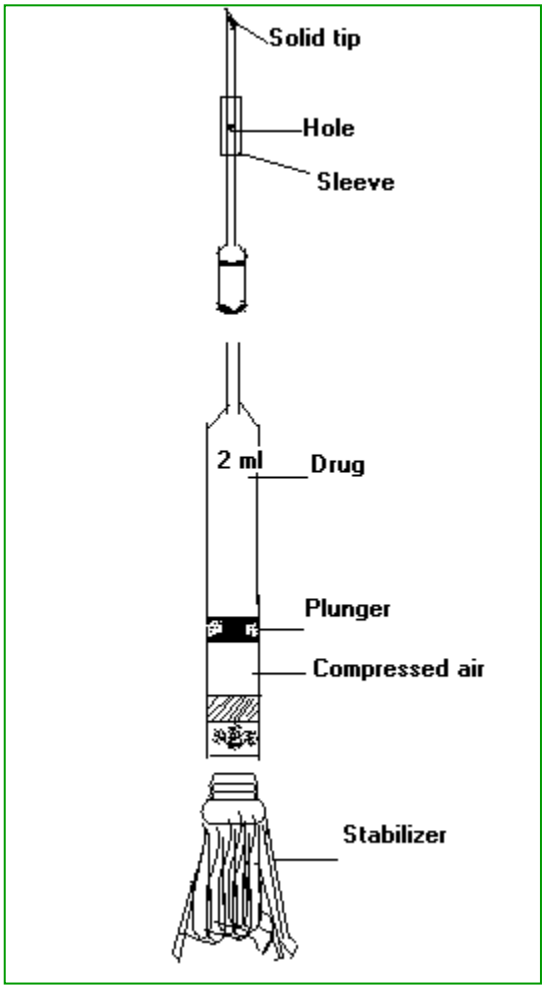
- Propels darts up to 15 ml capacity to a range of over 50 m by means of an explosive charge
- The impact is obtained by a small explosive charge known as a cap-chur charge or syringe charge
- When the dart hits the animal, the impact sets up a reverse pressure of the drug inside the syringe barrel that causes the charge to explode
- The expanding gas pushes the rubber plunger forward to inject the drug into the animal
- 2 types of dart are used in Cap-chur:
  - Plastic dart (ready and disposable) : for single use and carry up to 5 ml drugs
  - Metal (aluminium) dart: reusable, capable of taking a maximum of 15 ml of drug
- In muscular animals where there are chances of needle coring, the needle of the impact sensitive dart should preferably have both front and side holes
- A pistol is available for short range up to 20 m
- It is the most widely used darting system at the present (accuracy, shooting range, variety of dart types and sizes)

{PROJECTILE}

DARTS

1. **Reusable Plastic Darts:**

- The Blowpipe and Blow gun fire a reusable light-weight plastic dart
- Available in sizes between 1 and 3.5 ml capacity
- The drug is loaded into the front chamber of the dart from a syringe and appropriate needle then attached
- The needle opening is at the side and covered with a tight fitting plastic sleeve which prevents loss of the drug when the dart is pressurized
- This is achieved by introducing compressed air or an inert gas into the rear chamber of the dart, behind the plunger
- The stabilizer is then attached
- After firing, as the needle penetrates the animal's skin the sleeve is pushed backwards, allowing the drug to exit from the side hole into the animal's tissue

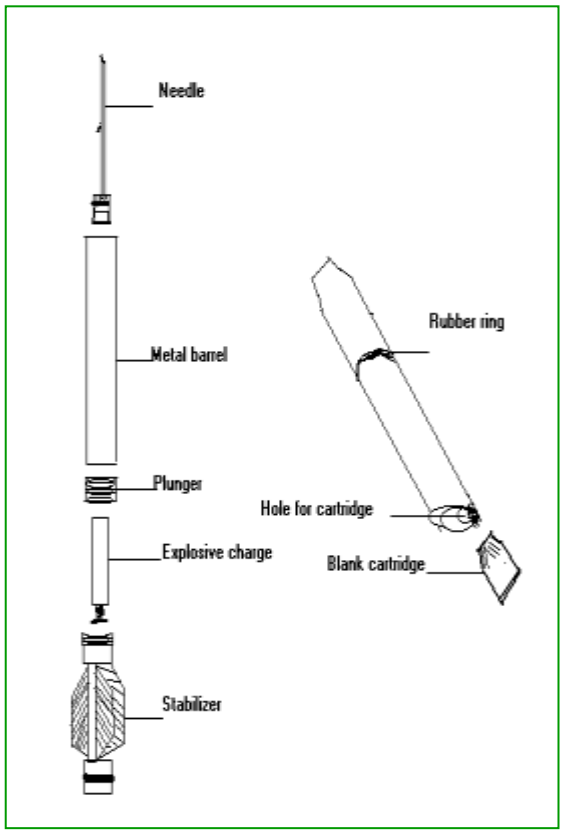


2. Disposable Plastic Darts:

- It cannot be re-used
- Ready prepared plastic darts with a fixed needle
- Explosive cap to activate the plunger are available for powder charged rifles, in sizes varying between 1 and 3.5 ml
- Light weight
- Due to their lightness these darts are less liable to cause tissue injury on impact
- But more subject to wind deflection than heavier metal darts

3. Metal Darts:

- Required drug volume 1- 15 ml
- Almunium syringe barrel
- A greased rubber plunger, fitted with an impact sensitive explosive charge, is placed inside the barrel towards the rear end
- A flight stabilizer is screwed in behind it
- After loading the drug, a needle is screwed into the front of the barrel
- After loading the prepared dart into the rifle a cylindrical steel cartridge holder is placed into a rifle



4. Radio Darts:

- Radio darts are useful in marking and locating an animal in heavily wooden terrain or thickets
- A small powerful impact resistant transmitter is attached behind the drug barrel with a projecting and trailing antenna
- Radio darts are quite expensive and their increased weight reduces the range of the dart
- Because of the heavy weight, the radio darts usually fall from the body of thin-skinned animals
- In such cases, a double barb needle (barbed needle) is useful
- Radio dart facilitates animal location by use of a compatible receiver set
- The cost and other difficulties limit its application

Chemical Capture Drugs

- Most of the immobilizing drugs used today are **Central Nervous system depressant** which have a relatively wide safety margin
- Some of these drugs are highly dangerous to the human operator
- should not be handled by inexperienced or junior staff
- The time required for a drug to have an effect depends upon the factors such as:
  - The injection site
  - Absorption rate
  - Physiological state of the animal (sick to young energetic)
  - Concentration of the drugs
- Some of the variable that can impair the drug effect due to:
  - Variations in species of animal
  - Age, Sex
  - Seasons, time of day
  - Animal temperature and emotional state

Attributes/Characteristics of an "Ideal" drug:

- Wide safety margin
- Readily soluble in water
- Non-interference with respiration or temperature regulation
- Have minimum side effect
- Requires a small dosage (1-5 ml)
- Have fast absorption and rapid action
- Have a specific antidote (antagonist), allowing quick reversal of drugged condition
- Not hazardous to operator
- Easily available at reasonable cost and not restricted by legislation

Chemical Capture Drugs: CNS depressants

<u>Diazepam (Valium, Tranimal, Tranimul)</u>

- It Has marked timing effect on animals
- Reduces aggression and fear
- It acts in the thalamic or hypothalamic part (part of autonomic nervous system) of the brain
- The drug is used more in relocating captured animals shifting caged animals from one place to another place (to reduce excitement when handling or transporting animals)
- May not be used in actual capture operation
- Available in 5mg/ml solution
- It can be given orally (not recommended in immobilization), intra-venously or intra-muscularly
- There is no antidote available for Diazepam (sometimes Antepamazol may acts as its antidote)

<u>Acepromazine Maleate (Acetylpromazine maleate)</u>

- It is a CNS depressing agent and potent tranquilizer
- Available in 10 1nd 20 mg/ml, stronger solution up to 40 mg/ml
- It is normally used to calm aggressive animals and make them tractable

- It is also used before performing minor surgical operations as per a pre-anaesthetic agent
- For immobilization purposes it is rarely used alone
- It is used frequently in conjunction with Etorphine to reduce the initial excitement of the animal and Ketamine to facilitate muscle-relaxtion
- Dosage varies with species, can be administered orally in tablet form but effect is unpredictable (effect seen within 30-60 min.)
- Insoluble form, the agent may be injected IV (1-3 min.) or IM (15-25 min.)
- Side effects: hypothermia/hyperthermia
- There is no known antidote for Acepromazine

Xylazine Hydrochloride (Rompun)

- It is a non-narcotic compound that acts as a sedative (a sleep like state), analgesic (general elimination of pain), and muscle relaxant [Ranging from tranquillisation to anaesthesia]
- The product comes in dry substance in 500 mg vials and is supplied with a solvent
- Eg. 500 mg + 10 ml solvent = 5% solution, 500 mg + 5 ml solvent = 10 % solvent solution
- A slight disadvantage for use with darts is that Xylazine is not as readily soluble as some drugs and therefore larger volumes are required
- Drug dosages of 0.1-0.2 or 0.3 mg/kg Rompun have often been sufficient to produce powerful sedation, for immobilization used 1 or 2 mg/kg
- Side effect: reduce respiratory rate, at that time artificial respiration required, Antidote: Yohimbine hydrochloride, also used Tolazoline hydrochloride

Ketamine hydrochloride (Ketaset, Ketalar, Vetalar)

- Ketamine has been safely and effectively used for anaesthesia on a large number of wild animals
- Particularly effective in wild carnivores, reptiles and birds, but not suitable for most ungulates
- At lower dosages of Ketamine, complete recovery usually occurs in 4-5 hours, but at higher dosages it can take up to 24 hours in some animals
- Ketamine crosses the placental barrier in all sps, thus the anaesthetic effects reaches the foetus, so does not used on pregnant animals
- The product is available in concentrations of 20, 50 and 100 mg/ml sol.
- Side effects: causes erratic and delayed recovery, excessive salivation, muscular tremors (involuntary vibration)
- There is no known antidote for Ketamine

Hellabrunn mixture (HBM)- mixture of Ketamine and Xylazine

- Addition of Xylazine hydrochloride (Rompun) to Ketamine in a specific ratio of 500 mg to 400 mg respectively=HBM
- HBM was first developed and tested in Hellarbrunn animal sanctuary, Munich
- Wide range and less hazardous to the operator
- Here Xylazine provides the advantage of a tranquilizer as well as enhance the pain killing and muscle relaxing qualities of Ketamine
- Mixture: 4 ml of 100 mg/ml Ketamine is mixed in 500 mg of Xylazine powder
- Suitable and a safe drug for most ungulate speies

- Induction time-7 to 10 min and anaesthetic effect prolonging for 45-50 min., completely recovery in 1-2 hours

Etorphine hydrochloride (M-99; USA, Immobilon; Europe)

- Morphine (An alkaloid narcotic drug extracted from opium; a types of herbs) like agent having analgesic potency
- A strong narcotic (lead to addiction) and higly toxic in humans
- Side effect: blood pressure rise, excitement, tremors
- It is available in 1 mg/ml solution under the trade name of M-99
- Also used as mixture of 2.45 mg/ml Etorphine with 10 mg/ml Acepromazine maleate. Here Maleate reduces the initial excitement caused by morphine drugs and also acts as a residual tranquilizer
- It has been tested on a wide range of sps.
- It is particularly useful for immobilizing large mammals such as elephants, rhinos, and gaurs
- Low drug requirement and fast immobilization are advantage of the drugs
- Absorbed fast with an intra-muscular administration
- Anaesthesia may take place after 10-15 minutes with IM injections
- Antidote makes recovery as fast as 3-5 min (IV) or 4-10 min (IM)
- NO antidote is administered recovery may takes as much as 7 hrs.
- Antidote: M50-50 or Revivon or Diprenorphine ---Animal antidote
    - Human antidote = Narcan (Naloxone hydrochloride); 0.006 mg/kg, effects in 2-3 min.

2.5 Radio Telemetry (R. tracking, beacon-telemetry, eco-telemetry, ecological bio-telemetry)

Introduction:

- Radio telemetry is used by wildlife biologists to study animal movements
- Animals wear a radio transmitter that gives off a silent signal which can be received by using a special antenna
- By reading the signal, wildlife biologists can pinpoint which animal's radio is signaling, determine its exact location and follow its movements.
- Conveying any types of information from WL to another location through use of carrier frequencies
- Radio waves are most common carrier, sound (ultra sonic for fish) or light may rarely be used
- The first free-ranging animals were tracked around 1962
- Types of information conveyed:
  - Location
  - Motion sensing
  - Transmitter temp. (indicates body temp.of animal if internal)
  - Side temperature (transmitter or sensor external)
  - Bio-physiological data (heart beat, eye movement, defection, urination)

Definition:

- Tele = Distance, Metry = Measurement
- RT is one of the research tools
- RT is a process of creating, measuring or transforming information from source to the distance location via radio waves in the form of electro-magnetic energy

In WL biology, it has been used in two primary implications

1. To provide information about the location of animals that area not readily seen
2. To measure and transfer information about events at distance location

Radio-telemetry has 4 essential components:

1. Source of signal-Radio collar
2. Detector-Receiver
3. Antenna
4. Head phone

Radio collar

- It generates signal like pulse rate which can be picked up or identified and traced from a distance
- Transmitter : smaller the better, 4 % of the body weight (ideal)
- Homing: it is the method rather observes moves towards to animal until a desired degree of proximity is achieved (by intersection of bearing; < 300 is best for intersection
- Electromagnetic "Radio" waves
  - LF 300 KHZ-3 MHZ (AM radio)
  - HF 3 MHZ-30 MHZ (CB; citizen band)
  - VHF 30 MHZ-300MHZ (TV, FM radio, most Bio-telemetry)
  - UHF 300 MHZ-1800 MHZ (TV)

Most used frequencies for Bio-telemetry:

  - Fish at lower end = 47 MHZ
  - Most effective for terrestrial WL = 148-158 MHZ

  - For birds = 200-220 MHZ
  - To penetrate dense vegetation = 30-50 MHZ
  - Under rain forest canopy = 150 MHZ
- Cost: usually increases with increasing frequencies because crystal in receiver and transmitters more expensive at higher frequencies
- Transmitter Package: animal must be influenced by transmitter package, weight normally 0.5-5 % of body weight
- Special sensors: are also present in collar which are able to take an information about motion sensing, pulse interval, temp. of internal transmitter package, heart rate, etc.

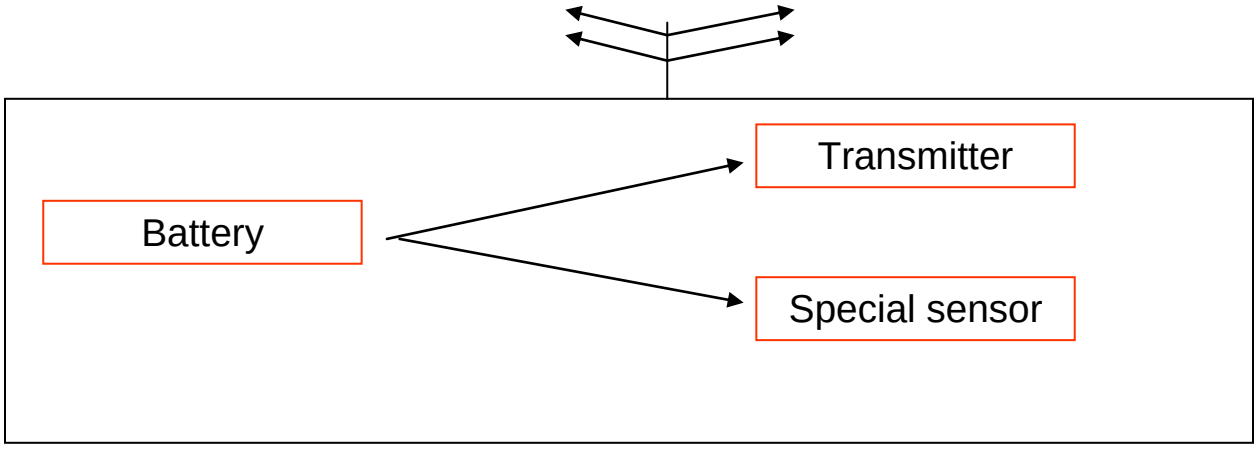
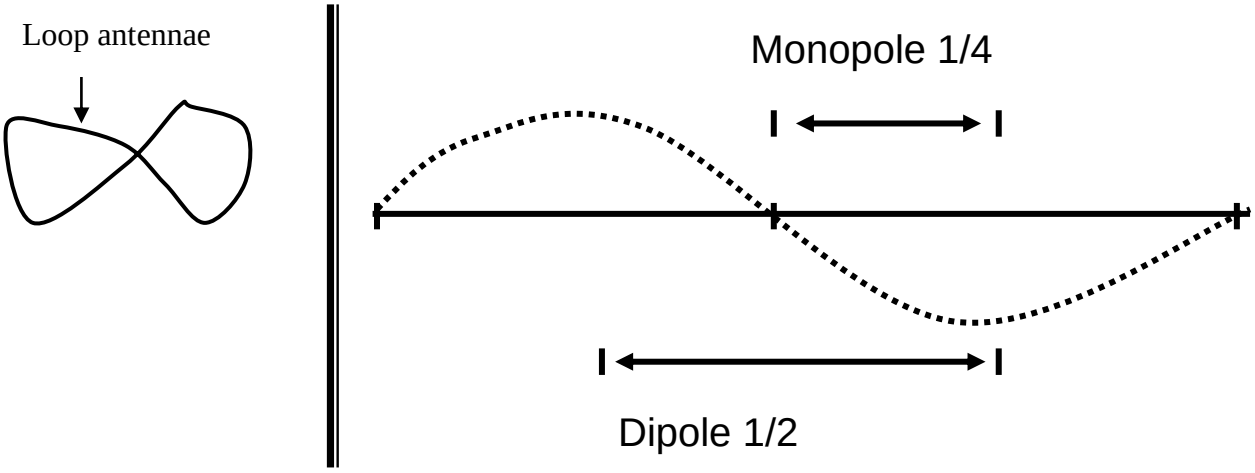


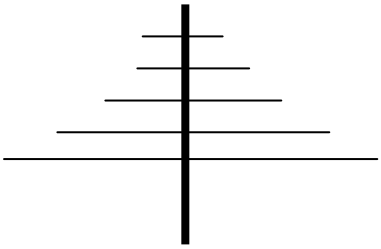
Fig :Collar

Antennae

- Ideally should be ½ wavelength long for best range (a dipole)
- Usually is ¼ wavelength long (a monopole)
- Whip antenna: should be used on transmitter, greater range than loop antenna
- Loop antennae: inside collar and around neck, also used for internal transmitter

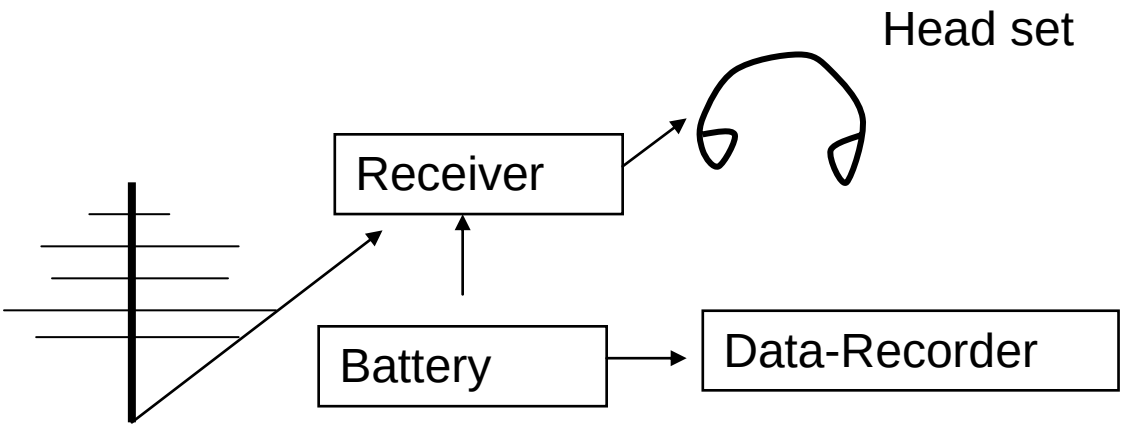


Yagi antenna



Receiver Package:

- Receiver
- Battery
- Data recorder
- Head set
- Antenna: hill- horizontal, plain- vertical polarization



Receiver

- Most expensive part of most simple radio telemetry systems
- May have **gauges** (measure) to display signal strength, but listening to the **audible signal** is usually best for radio-location
- **Band of frequencies** covered depends on the receiver
- **Scanner** will scan all frequencies covered and stop when a signal is received
- Setting frequency can be done with switches, buttons, dials or all
- Gain (power): of antenna can be controlled-at higher gain there may be too much noise

Power sources: Runoff car battery, RC Ni-cad cells, RC internal battery, regular power cells

Head phone

- It is not so important and necessary often used in optional but good to have

Data recorder

- For complex system-may record on continuous graph (hard copy)
- May store on computer disk

UNIT-Three: Habitat Evaluation and Mgt.

Habitat Evaluation and Management

Wildlife Habitat:

- A habitat is a space or environment to which a species is suited
- It is a sum total of environmental factors: FOOD, COVER, and WATER- that a given WL species needs to survive and reproduce in a given area
- A habitat requirements of WL varies from species to species
- Therefore a habitat suitable for one species might be worthless for another species
- A given habitat can share and support only those sps that are suited to it and can fulfill the specific habitat requirements of the species
- **NICHE**: a habitat can shared by many species, however each of these sps use that habitat in its own way and play unique role called Niche

Habitat Components:

To understand how habitat affects wild populations of animals, one must examine its components

The four basic components of habitat are:

1. **Food**
2. **Cover**
3. **Water**
4. **Space**

1 Food

- The most obvious component of habitat for any animal is FOOD
- Availability of food usually changes with seasons (temperature)
- Food may be plentiful in one season and critically short in another
- Energy flows unidirectional, can be stored temporarily
- Food for growth, maintenance and reproduction
- Carbohydrate, protein, fats, enzymes for metabolic activities
- According to the feeding behavior; WL may be classified as:
  - Herbivores
  - Carnivores
  - Omnivores
- Herbivores spend much less energy in search of food than carnivores
- Herbivores spend much time in eating food than carnivores
- Herbivores need low energy content food than the carnivores
- The metabolic requirement of carnivores is much higher because they have to spend much time in locating, capturing and killing the preys

Food types (According to feeding behavior of Browsers and Grazers):

- Preferred: first choice, contains all essential elements, more frequently grazed, usually the terminal shoot
- Staple: second choice but provide all essential nutrients
- Emergency: fulfill short term nutritional needs

- Stuffers: nutritionally poor but ingested apparently to relieve from hunger, cause malnutrition problems

2. Cover

- Nutritional requirement is met by the food
- Structural requirement is met by cover and vegetation (Physical structure)
- Cover is defined as "any variation in the habitat that provides protection from weather or predators or that offer vantage point"
- Protection against severe weather conditions such as heat, cold, wind, extremes of temperature, storm, rain, hails, hurricanes, snow, etc
- Resting place while animals are inactive (Loafing Cover)
- Place to lay eggs, give births, rear young
- Hide for protection against predators and hunters
- Better vantage:
    - To predators-to locate prey, hide to reach close enough to preys to make a kill
    - To preys-to know the presence of predators
- Types of cover:
    - Escape cover
    - Roosting cover (resting/sleeping purpose)
    - Nesting cover
    - Ambush cover

3. Water

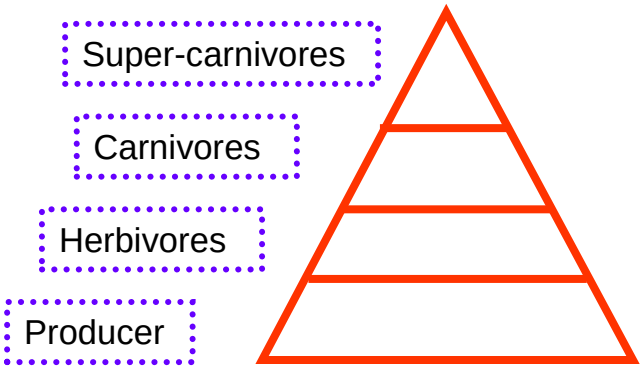
- For internal metabolism and to make body cool (eg. Wallowing)
- Home range size depends on availability of water source nearer
- Seasonal migration to nearby water available areas during dry season
- First preferred surface water for consumption. When surface water is not available, some species can sustain themselves by, taking in morning dew (Shrews) or by ingesting the water contained in succulent plants
- Water may be a limiting factor in arid zone
- Artificial water hole for improving water condition-Guzzlers
- Kangaroo, Oryx- don't drink water but fulfill through metabolic process

4. Space

- Individual animals require varying amounts of space in which to find enough food, cover, water, and to locate mates (pair of animals/birds)
- The amount of space or suitable habitat depends upon the size of the population desired
    - Size of sps = Generally the larger the animal, the larger the area required
    - Its diet = Carnivores require larger areas than herbivores

Trophic Level:

- Ladders at which animals are placed according to the general mode of obtaining food or having reserved energy/productivity
- Aquatic eco-systems may contain 10 or more TLs
- Terrestrial community = more than 4 TLs, some have 3



II law of Thermodynamics:
"Energy cannot be transferred from one form to another form without enormous loss in the form of dissipated heat"

- The main and ultimate source of energy to the Eco-system is the SUN
- The amount of energy stored in the producers is always greater than the herbivores and herbivores store more energy than the carnivores
- The amount of energy contained in the lower trophic level is always greater than higher trophic level because huge amount of energy is always lost during energy transfer from one to another trophic level

Habitat Evaluation:

- Habitat evaluations is fall in to two categories
  - First type of evaluation is done for Specific mgt objectives, specially involving the assessment in term of needs of a single species
  - The second type of evaluation is broader, aimed primarily at determining habitat values for Several species or even for entire biological communities

***Evaluation for special management objectives:**

- WL managers often evaluate habitat for specific objectives such as estimating habitat quality for a particular game species
- In such cases, food production, availability of cover, and amount of edge are 3 important measurement
- Experienced field-workers can often estimate the population of herbivores in relation to the CC by checking the condition of key plants as indicator species
- Other methods estimate habitat quality from:
  - Blood chemistry
  - Parasite loads
  - Bone marrow condition in individual animals, and
  - Reproductive success

Food production

- All plant materials consumed by WL are collectively known as Forage
- It includes grasses, the narrow-leafed herbaceous members of the b family Graminae
- Forage also includes broad-leafed herbaceous plants called- Forbs
- Seed consumed by wild animals are termed as Mast
  - Fruit consumed called Soft mast and nut (Usually large hard-shelled seed) consumed

- Some habitat evaluations require sampling of all forage available to the animal
- To do this, biologist clip and weigh all grass, forbs, and browse with in small sample plots as high as the sps under study can reach
    - 1.5 m for deer, 2.75 m for moose, 6 m for Giraffa
- This method is expensive, laborious procedure, required more time
- Faster forage inventories can be made through visual estimates of forage weight, confirmed by clipping and weighing forage from a small fraction of the plots, randomly
- Soft mast is estimate= by clipping and weighing
- Hard mast is estimate = by using Mast trap

Cover

- The distribution of cover types can be measured by cover mapping
- Depending upon the region, cover types might include trees, shrubs, pasture, cultivated field, marsh, etc
- Cover types are determined through aerial photographs, field surveys, or both; they are then delineated on a map of the study area
- Dot grid and/or planimeter
- Density of cover is measured by:
    - Vertical density; a rating scale (e.g. 1 through 10)
    - Horizontal cover, using photoelectric devices- these tools measure the amount of light admitted through the forest or shrub canopy cover in comparison with that recorded in full sunlight

Indicator Species:

- Indicator sps allow assessment of habitat conditions in relation to a herbivore population
- Preferred or staple foods that occur at low to moderate frequency can serve as indicator species
- Sometimes exclosures are constructed around sample plots to exclude herbivores
- The indicator sps protected within the exclolsure may, after a given period of time, be compared with those outside the exclosure
- Measure of grazing and browsing intensity

Condition of Individual Species:

- Indirect method of habitat evaluation through the condition of individual animals
- Capture and handling; in hunter check station to examine freshly killed game animals (by physical condition)
- It tells about quality, quantity of food, diseases frequency, parasite levels and various types of stress-all of which relate to habitat quality
- Weight of animals vary with habitat conditions
- In the deer family (Cervidae), antler size, including diameter and circumference of the beam-relates directly to quality and quantity of food
- Amount of fat deposited (Kidney fat) is a good indicator of nutritional condition, which, when seasonally adjusted, serves as a sign of habitat quality
- Femur marrow: the marrow consists of fat, water and nonfat residue
    - When an animal is under nutritional stress, the marrow fat is depleted and the relative amount of water increases, color of marrow becomes Pink or reddish
    - The marrow of healthy animals has a whitish appearance and a waxy feel (low water content)

- Poor nutrition, brought on by poor habitat quality, can lead to increases in parasitism and diseases (parasite level is another index of Habitat condition)
- Parasite (abomasal) in deer found that deer from population below CC-had low parasite loads, while those from populations exceeding CC-had heavy loads
- Blood samples analysis can reveal a great deal about habitat conditions in some species
    - Blood chemistry, hormones (relate to protein and energy intake)

***Evaluation of Natural Communities:**
[Habitat value for several species or for even entire biological communities]

Species Diversity

Environmental assessments of this sort require examinations of entire biotic communities, not just the few economically important species e.g. Game species.

The measurement of Species diversity is important in assessing the Biological value, Natural richness and Uniqueness of an area. The most basic and objective measure of species diversity is simply the number of species within a particular group (birds, for example) found per sample. But used alone, this measurement, called species richness, can be misleading. The greater the number of species and the more even the distribution, the higher the diversity value.

Standard Evaluation Procedure:

All habitat evaluation procedure ranks certain characteristics, including physical and biological properties, for each proposed area. Rankings area usually made on a scale of 1 to 10. The different procedures vary according to the characteristics measured and the relative importance given each.

Nature conservancy in Britain (Gold Smith, 1975)…

1. Extent (E) = area or for linear features; Length
2. Rarity (R) = recorded for each habitat type and calculated from R = 100-% area per candidate area
3. Plant species richness (S) = the number of following plant species in a 20 by 20 meters sample plot
4. Animal richness (V) = assumed to relate to vertical stratification on a 1 to 4 scale (grass land to wood land)

3.2 Habitat Management

<u>Adjustment of seral stages:</u>

The most common form of habitat mgt. is adjustment of Seral stages or successional stage so the management area becomes better studied to the desired species.

Setting back succession by fire: It is the least expensive method of habitat management. It is most natural and universal way of setting back succession in terrestrial habitats is fire. Although fire are often popularly regarded as destructive and harmful to wildlife, ecologist have long

recognized the importance of fire in the perpetuation (make continuous) of many wild plants and animal species, particularly those- best adopted to early to mid successional stage.

In other word fire is helpful to manage setting back succession by continuous firing (control fire) in adopted species and wild plants. But it has some drawbacks. Moreover fire is not always beneficial to WL. Burns that are too hot from combustion of too much fuel or fires occurring at the wrong time of years can have serious consequences for local WL population.

Deer population often increases in the years following fires. Burned areas have been observed to have produced about three times the herbaceous forage per unit area than unburned areas and deer made greater use of the burned areas.

On the other hand, fire reduces WL population of species best adopted to late-successional condition. Intense fire in a Boreal forest region in Alaska resulted in a 60 % reduction in the bre3dding population of Alaska Spruce grouse, and number on unburned areas remained same.

Bendell found that bird and mammals diversity showed only a slight increase in grass land and shrub land regions following fires, and a slight decrease in forested regions.

Grazing: Livestock grazing sets back succession. Some cattle are kept on refuges under grazing leases because they help retard succession and maintain better feeding areas for water fowl.

Logging: the cutting of forest sets back succession. Deer- cut over forest produce considerably more browse (types of forage) than do nature forest.

Mechanical treatment: much more expensive than fire, many treatment are safer, out comes are more predictable, set back through Bulldozers.

-Disking: commonly used in Agricultural lands to set back succession. It is particularly useful for breaking up dense stands of sod forming (*Chappra)* perennial grasses to favor the food-rich annuals.

-Mowing: is a good to create Edge

Herbicides: chemical herbicides offer a relatively inexpensive and potentially highly selective means of manipulating succession. Herbicides can be sprayed, injected or even painted onto undesirable plants.

Advancing Succession:	
Manipulation of edge:	Refer: Text Book of J H Shaw (page 53-55)
Mitigation:	

UNIT – 4: POPULATION ESTIMATION AND ANALYSIS

Census: It is defined as an actual count which includes details as to Sex, Age, etc. of a given species for a given area. True census is a count of all individuals on a given area. As such it means direct or total count in areas of concentration. Aerial photographs can be used for counting concentrated populations.

Example-

- Deer or antelopes on a open country (Black buck in Khairapur)
- Herds of water buffalo (in Koshi Tappu)
- Water fowl in wintering ground (migratory water fowl in Koshi Barrage)

Estimates: When complete census is not practical, samples are used to estimate population of the species groups/individual in a given area.

Indices: Indices are census or estimates of animal populations from counts of animal signs, call etc.

Things to be considered when choosing a technique:

1. size of an area to be covered
2. species to be dealt with
3. habitat it occurs in
    - visibility of animals
    - ease of access by researchers
4. activity patterns
    - daily movement
    - seasonal concentration
5. social structure
    - solitary or in group
    - may be count groups rather than individual
    - can not easily use track counts, if animal is in large groups
6. level of precision required
    - What do you need the number for? If you need only a rough estimate of population size, do not waste time and money on a complex technique
    - **Accuracy:** how close as estimate is to the truth, what is the degree of human error
    - **Precision:** it can be measured freedom from statistical or sampling error of an estimate. The smaller the standard error, the more precise the estimate; 95 % confidence interval $[\cong X \pm 2S.E]$
7. costs
    - both in time and money
8. available personnel, facilities, equipment

Objectives:

1. to determine the rate of increasing, stable and decreasing of animals
2. to compare density of WL for area before and after management intervention like burning

3. to compare density in different areas e.g. in core and in Buffer or habitats such as plantation and natural forest
4. exact count of wild animal is not possible in nature

Which species to count:

1. generally it is not possible to count all the animals species in an area and probably it is not required
2. those species which are importance in the view point of management
3. species which are of international importance
4. rare endangered (threatened category of IUCN)
5. view point of tourism or research

Classification of census techniques:

1. Count animals (True census and estimate)
2. Count signs (Tracks, call, etc.)

Assumptions:

- Loss rate (mortality and emigration) and recruitment (natality and immigration) during the period when data are collected are negligible
- All the members of population have an equal probability of being counted

Population Estimating Techniques-

1. **Mark and Recapture (Paterson estimate):**
   - Whole area is divided into smaller plots
   - Randomly or systematically, samples are draw from among the plots
   - From these plots animals are trapped, they are marked and released
   - After a certain time interval, another trapping is conducted in the same plots or different plots and then the marked and unmarked trapped animals are counted separately
   - The population is estimated by the ratio of marked to unmarked animals as follows:-

   Where, population size = N, Number of marked initially = M, total count in ret-rapped sample = n, and number of marked in re-trapped sample = m

   Now, $\frac{N}{M} \equiv \frac{n}{m}$ or N = $\frac{n \times M}{m} \equiv \frac{Mn}{m}$

Example; Sample area = 200 Hectares, trapped and marked initially (M) = 25, re-trapped (n) = 30, number of marked in re-trapped sample (m) = 15, N (Population size) =?

$\therefore$ N = $\frac{Mn}{m} = \frac{25X30}{15}$ = 50 individual

Total area of sample is 200 ha, therefore, 1 individual per 4 ha

Assumptions:

- Each individual has an equal chance of being captured
- There is no births or immigration into the study area during first and second trapping seasons
- There is no differential, mortality or emigration between marked and unmarked of the population
- No marks are lost during the survey period

2. Transect Survey:

- This method is also known as strip census method or line transect method and is applied to many conscious vertebrates
- In this method, survey routes or transects are randomly or systematically placed through out the study area
- An observer then walks or flies in a light aircraft along each transect route at the same time of day, season and weather condition, and count animals seen with in a constant distance of the survey line
- The length and width of the transect line provide estimates of the area samples and thus allow an estimate of density
- It may be a meter when frogs are counted, 100 m when large mammals are counted in heavy forest, or 500 m when animals of this size are census in grassland
- Also frequently used for monitoring population abundance
- This method is one of the rapid and relatively inexpensive means to estimate population density of many conspicuous mammals and migratory birds

Example; 10 km of transect lines are randomly placed through a study area. The researcher walks along the line, counting a total of 11 Laguna with in 25 m (.025 km) on either side of transect.
Average area survey = Line length X Twice the strip width
= (10 X .025 X 2) km^2 or 0.5 km^2
Therefore, density = 11 Laguna per 0.5 km^2 or 22 Laguna per km^2
So, $P = \frac{AZ}{2xy}$ Where; P- population size, A- total area of study, x- width of strip, y- average flushing distance, and Z- no. of animals flushed seen

3. Pellet Group Counts:

- Dung/pellet is a reliable indicator of animal presence and has frequently been used for estimating abundance
- When condition of terrain and climate permit, biologist can estimate the population densities of some large ungulates by estimating the densities of fecal pellets and the rates at which they are deposited
- The usual assumption is that cervids deposit an average of 13 pellet groups each day
- Deposition rate should be determined for species, region, and season before the technique can be employed with confidence
- By clearing a series of sample plots (may attracting or repelling animals from the plots due to clearing operation) of "old" pellet groups and then counting the numbers of pellet

groups found on those plots a known number of days later, biologist can convert pellet group density into an estimate of population density

- This technique is obviously ill-suited for areas of dense, tall ground cover, where finding/searching pellets would be difficult
- It works poorly in tropics or in warm, humid climates, where rapid decomposition of pallets could restrict the time interval between surveys
- It is an indirect census technique

$\therefore$ Deer population = $\frac{\text{Mean Pellet group per plot X 1/Plot size X Size of area}}{\text{Deposition period X Defection rate}}$

Density (D) = P/tda

Where; D- density, P- no. of average pellet group in plot, t- time interval, d- average daily defection rate, and a- specific area (circular plot)

Example; 200 sample plots of 10 m^2 each area randomly placed within a study area of 1 km^2. Cleared old pellet groups and returned after 60 days, found 33 pellet groups on the 200 plots.
So, Area of sample plot = 10 m^2
Average area surveyed = 200 sample plots X 10 m2
= 2000 m^2 or 0.002 km^2
Pellet group density = $\frac{33}{0.002}$ = 16500 pellet groups/km^2
Pellet groups per deer during 60 days = 13 X 60 = 780
Deer density = $\frac{16500}{780}$ = 21.2, $\approx$ 21 deer/km^2

4. Road side Counts:

- Road side counts have long been a standard procedure for obtaining trend of indices in up-land game
- In this method, country roads are traveled for the specific purpose of counting the numbers of individuals of the species being censused which are the related to the number of miles traveled.
- Thus in the case of rabbit seen, if 20 mile census rout was driven, and 10 rabbits seen, the census index would be given as 1.5 rabbits per mile

$\therefore$ Number of animals seen or observed / miles or km traveled = $\frac{10}{20}$ = 1.5

- This method, unlike transect survey, can be suited only as indexes of abundance and not for density
- Very common method because it is rapid, therefore inexpensive and is suitable over large areas
- Fixed speed, constant time of day (usually early morning or late evening), and at a constant time of year
- Daily weather changes have an effect on animal activity, which is not yet clearly known. It creates inaccuracy in your data.

5. Road Kills:

- Road kill rates do not correlate with daily traffic volume but do correlate with average vehicle speed
- Road kills showed peak during May and October (in USA), probably relating to periods of reproduction and dispersal
- If standardized for vehicle speed, it could provide a useful index of population trends

6. Scent Station Surveys:

- This was developed by US Fish and WL Survey to estimate in Coyote population
- Survey line consist of 50 station placed at 0.48 km (0.3 mile) intervals on alternate sides of secondary or tertiary dirt road
- Each station consists of sifted soil with a diameter of 0.91 m (3 ft.)
- A synthetic chemicals potent smell (attractant) goes in the center of each station
- Attracted to the chemical's potent smell, the coyote leaves footprints in the fine sifted soil
- Checking stations the morning after they are set out, the biologist tallies the visitation rate as "no. of stations visited / total scent station nights"

7. Nest Counts:

- Many species build nest either for daily use or for raising young
- This method has been used for Orangutan and other primates, as well as for several bird species (water fowl, herons, etc.)

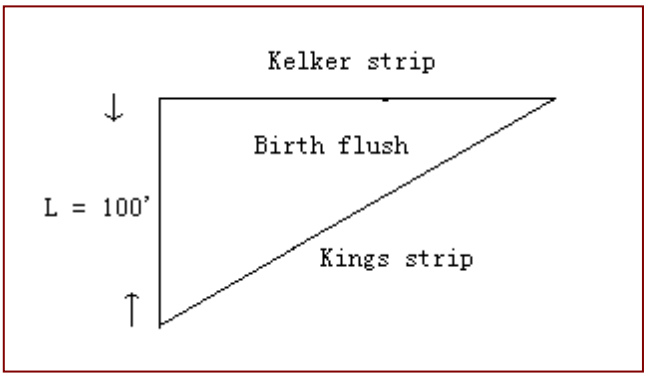
a) Density of nests is determined using plot or line transect method; N = $dn/(a)(t)$

Where; N- population density /sq. km, dn- average nest density/sq. km, a- number of nest made/individual/day, and t- time in days that a nest remains visible

b) This method must be adjusted if more than one individual uses a nest

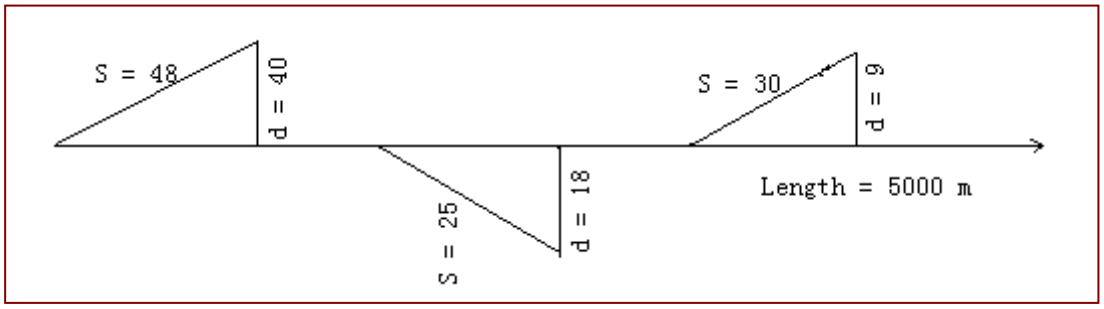
Example-Birds:
Kings strip – Angular distance, and Kelker strip – perpendicular distance
No. of bird/acre = no. of birds flushed / 2D x L

Where; no. of bird flush = 50
Main Distance (D) = 100'
Length of the transect (L) = 100'
So, No. of birds = $\frac{50}{2X100X100}$ = 5/400
= 0.0025 birds
[1 acre = 43560 sq. ft.]
So, = (0.0025 X 43560) birds/acre
$\therefore$ 108.9 $\approx$ 109 birds/acre



Webb's Method:

- Mean perpendicular distance used



$\therefore$ D = $\frac{3n}{2\bar{d}l}$ Where; S- Sighting distance, D- Density, n- no. of animals counted along transect, $\bar{d}$ - mean distance from transect, d- perpendicular

E.g. $\bar{d}$ = $\frac{40+18(3)+9(2)}{6}$ = 18.7 m

D = $\frac{6}{2X18.7X5000}$ = 32/Km^2

8. Change in-Ratio method:

- This method is useful in a variety of circumstances where animals are selectively removed or added to a population
- Designate 2 classes as X and Y (this could be; sexes, two species, age classes, etc.)
- Conduct a census that will give a ratio of the two classes to one another
- Selectively add or remove one class from the population
- Conduct follow-up survey and estimate the ratio again

N_1= population size of first survey
N_2= population size of second survey
P_1= population of X-individuals in N_1
P_2= population of X-individuals in N_2
Cx= no. of X-individual added (+) or removed (-) from the population between surveys
Cy= no. of Y-individual added (+) or removed (-) from the population between surveys
$\therefore$ C = Cx+Cy

- The population size at the time of the first survey is; N_1 = $\frac{Cx-(P_2)(C)}{P_2-P_1}$

Example;

- Suppose, we are doing a study of deer reproduction and we are going to remove some females from the population, first we estimate the proportion of the females in the population, P_1 = 0.64
- We collect a sample of 50 females (Cx = -50) and males (Cy = -10)

- Second survey immediately after the sample estimates the proportion of females to be P_2 = 0.51

$$\therefore N_1 = \frac{Cx-(P_2)(C)}{P_2-P_1} = \frac{(-50)-(0.51)(-50-10)}{0.51-0.64} = 382 \text{ deer of both sexes}$$

Assumption:

- The two classes are equally available in each survey
- No natural mortality between surveys
- All removals and additions are recorded
- Closure population

Variation:

$N/t_1 = (N-C)/t_2$

[e.g.]Where; N- original population, C (20) - no. of individual removed or added, t_1 (10) - tracks/km in first survey, t_2 (6) - tracks/km in second survey

$$\therefore N = \frac{t_1(N-C)}{t_2}$$

$$N = \frac{10(N-20)}{6}$$

$$-4N = -200$$

$$N = 50$$

9. Call counts
10. Track counts
11. Bounded count