

Novel Approaches to Tracking Fish Movements



Presenters:

Julie Claussen, Director of Operations

David Philipp, Chair Board of Directors

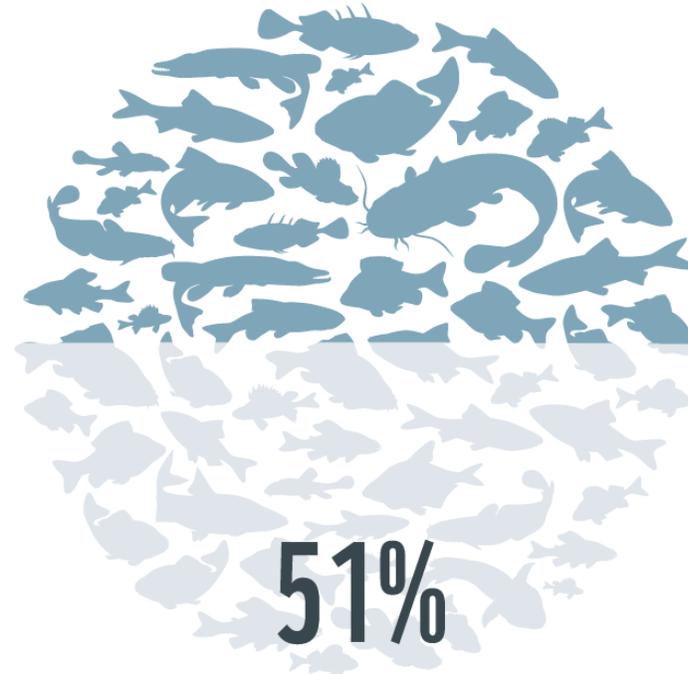
Fisheries Conservation Foundation, USA

March 16, 2021

WHY DO WE CARE ABOUT FISH?

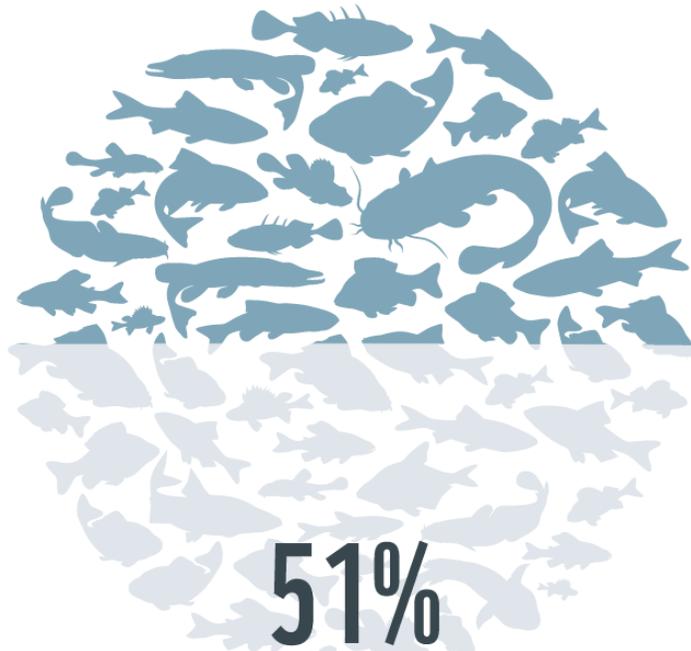


OF AQUATIC
HABITAT IS
FRESHWATER



OF KNOWN FISH
SPECIES ARE FOUND
IN FRESHWATER

WHY DO WE CARE ABOUT FISH?



51%
OF KNOWN FISH
SPECIES ARE FOUND
IN FRESHWATER

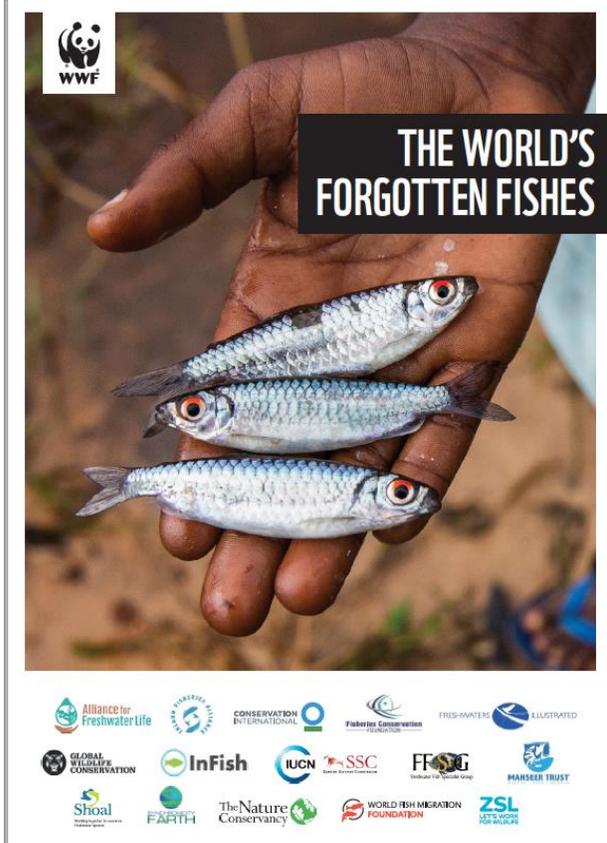
THE WORLD'S FORGOTTEN FISHES

WWF

Logos of partner organizations:

- Alliance for Freshwater Life
- CONSERVATION INTERNATIONAL
- Fisheries Conservation
- FRESHWATERS ILLUSTRATED
- GLOBAL WILDLIFE CONSERVATION
- InFish
- IUCN
- SSC
- FFSG
- MANSEER TRUST
- Shoal
- EXACTLY EARTH
- The Nature Conservancy
- WORLD FISH MIGRATION FOUNDATION
- ZSL

WHY DO WE CARE ABOUT FISH?



<http://www.fishconserve.org/2021/02/23/new-report-worlds-forgotten-fishes/>



中外对话
China Dialogue

TOPICS ▾ EXPLORE ▾ SUBSCRIBE

NATURE

We cannot afford to overlook the importance of freshwater fish

Species in lakes, rivers and wetlands represent over half of the world's fish and are critical to the livelihoods of millions, writes WWF's Stuart Orr

ENVIRONMENT | NEWS

Rivers and lakes are the most degraded ecosystems in the world. Can we save them?

We rely on fresh water for drinking, food, and sanitation, and they're in trouble. But freshwater issues are becoming a higher priority for conservationists.

ENVIRONMENT

South Africa's freshwater fish face extinction

Sheree Bega 12 Mar 2021

Half a century ago, Clanwilliam sawfinns thrived in most of the rivers draining South Africa's spectacular Cederberg Wilderness Area. Today, this muscular rugged-finned freshwater fish is listed as 'near threatened' by the IUCN Red List, with just 11 riverine populations now remaining. Predation by invasive bass on young sawfinns is the number one cause behind the re...

Bangkok Post

THAILAND WORLD BUSINESS OPINION AUTO LI

WORLD

Cambodia's dwindling fish stocks put spotlight on changing rivers

PUBLISHED : 8 MAR 2021 AT 10:13 WRITER: REUTERS

Freshwater Fish Across the World are Facing 'Catastrophic' Decline

23 hours ago

By Eliza Esikine

POLLUTION

A third of freshwater fish face extinction: Report

As many as 16 species were declared extinct in 2020 alone

By Madhumita Paul
Published: Friday 26 February 2021

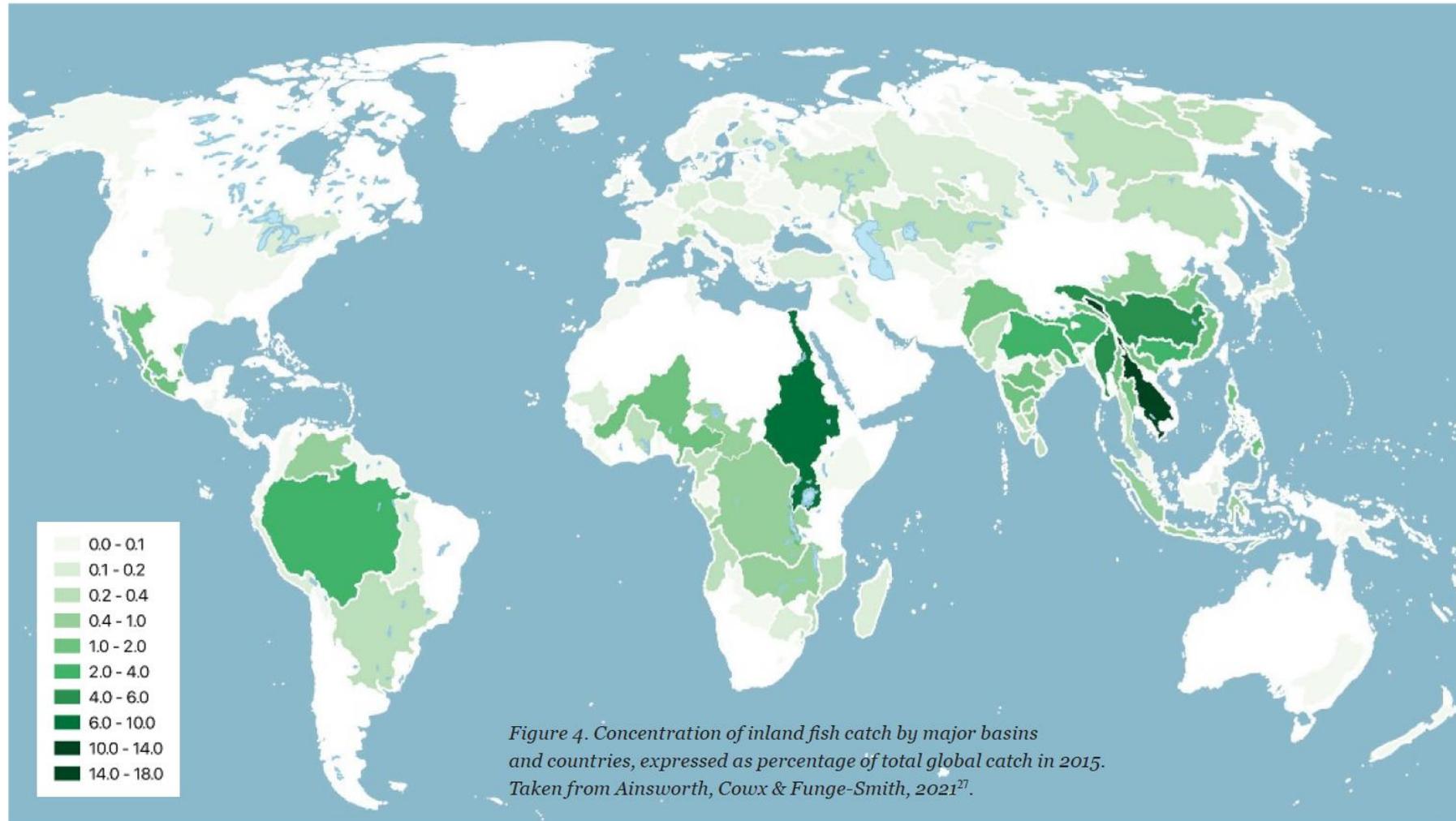
WHY DO WE CARE ABOUT FISH?

Freshwater fisheries are the primary source of animal protein for **200+ million people** globally



WHY DO WE CARE ABOUT FISH?

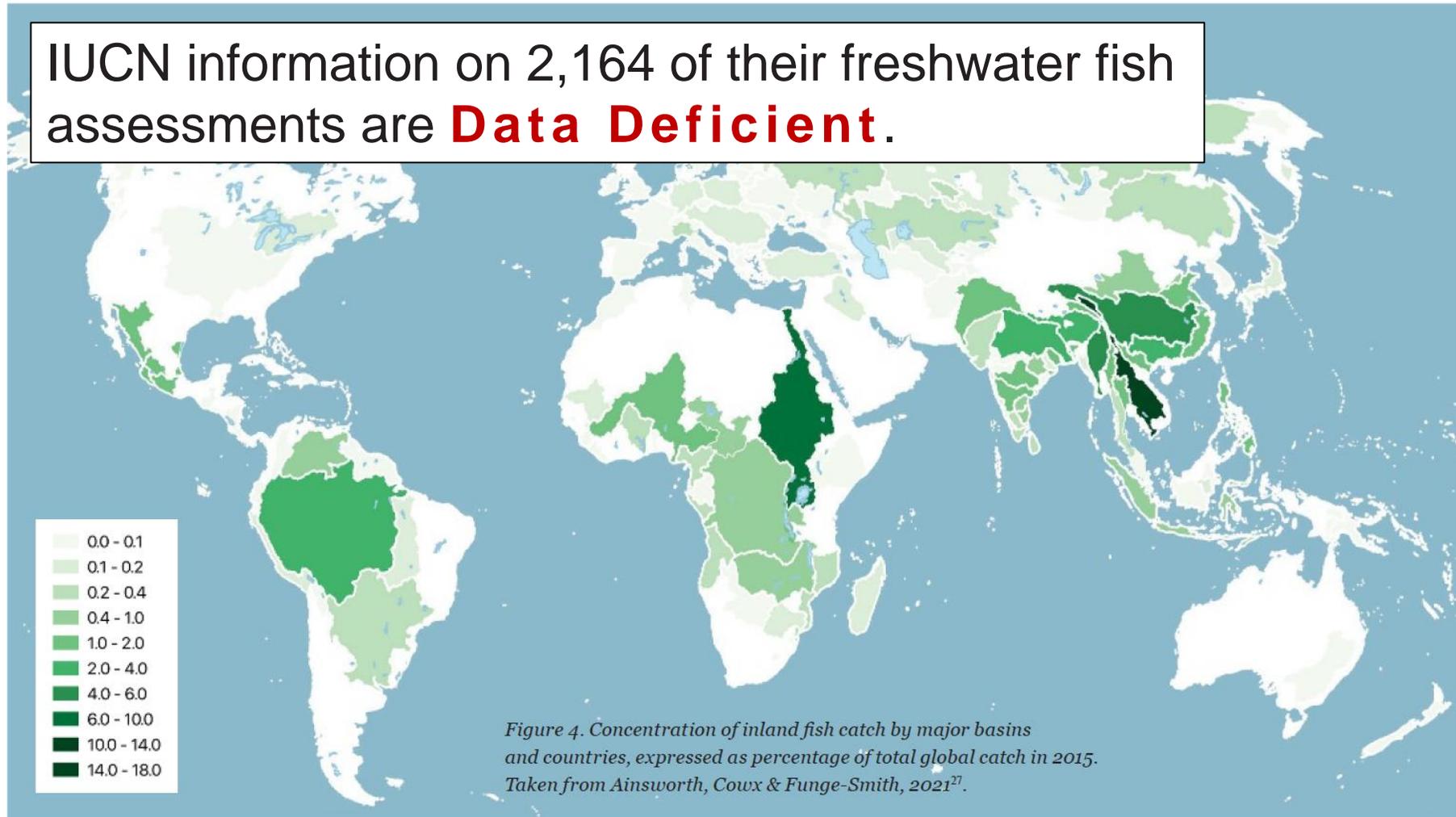
Wild capture freshwater fish are around 13% of the world's annual catch



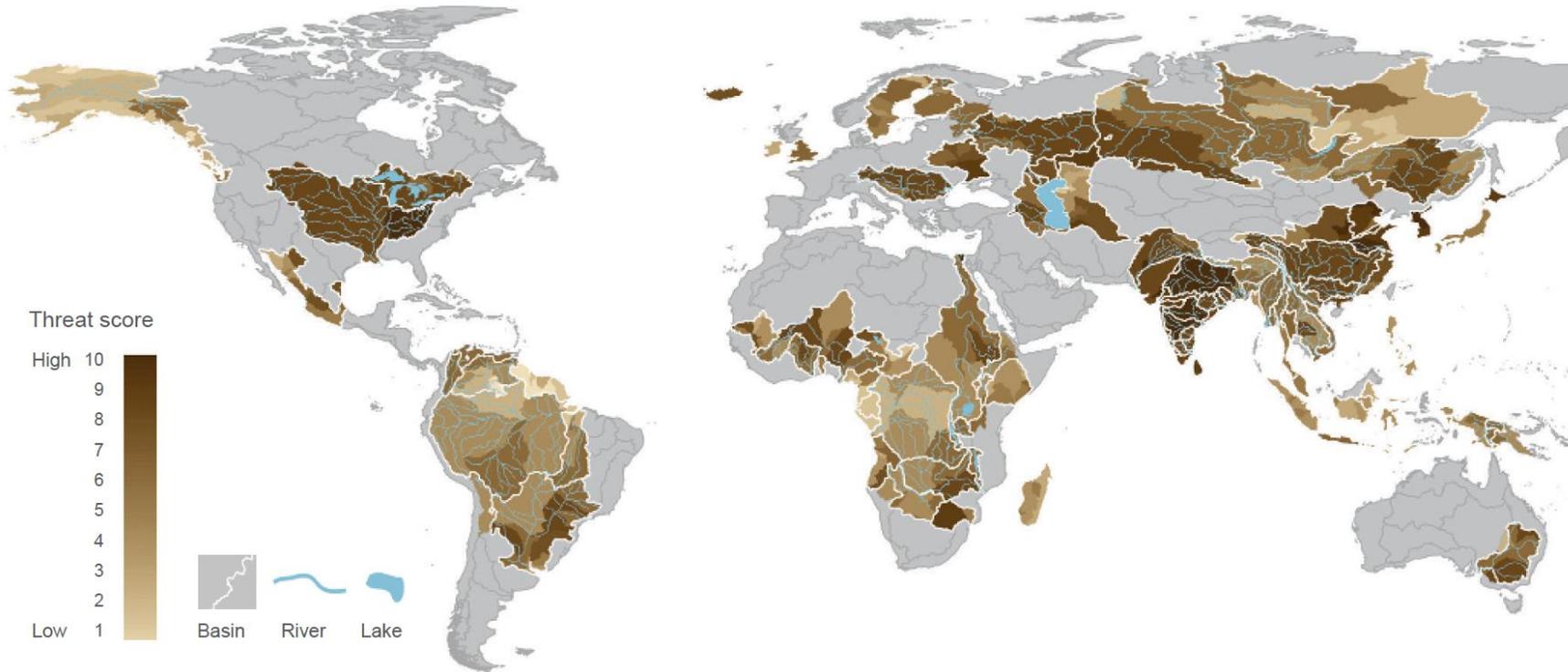
WHY DO WE CARE ABOUT FISH?

Wild capture freshwater fish are around 13% of the world's annual catch
BUT the data is very limited to truly assess this amount

IUCN information on 2,164 of their freshwater fish assessments are **Data Deficient**.



WHY DO WE CARE ABOUT FISH?



**90% OF GLOBAL
FRESHWATER FISH
CATCH COMES FROM
RIVER BASINS WITH
ABOVE-AVERAGE
STRESS LEVELS³¹**

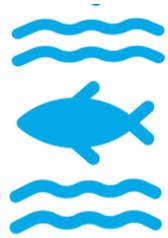
Figure 5. Threat scores for river basins that support (indicative) freshwater fisheries. Out of the 87 basins assessed, 15 are considered at 'high' threat, and 33 at 'moderate' threat due to pressures from pollution, water use (abstraction), climate variability, land use, loss of riverine connectivity and population density. Taken from FAO, 2020³⁰.

REASONS TO ASSESS FISH MOVEMENT

UNDERSTANDING THE IMPACT WILD FRESHWATER FISHERIES

➔ Requires understanding their biology

➔ Requires understanding movement patterns



MOVEMENT PATTERNS OF KEY SPECIES

What habitats do the species use and when, and how do they move between them?



IMPACTS

How do human activities/development impact these movement patterns, and what does that mean for fish?



MITIGATION

What can be done to mitigate for those impacts, and how do we know if it is working?

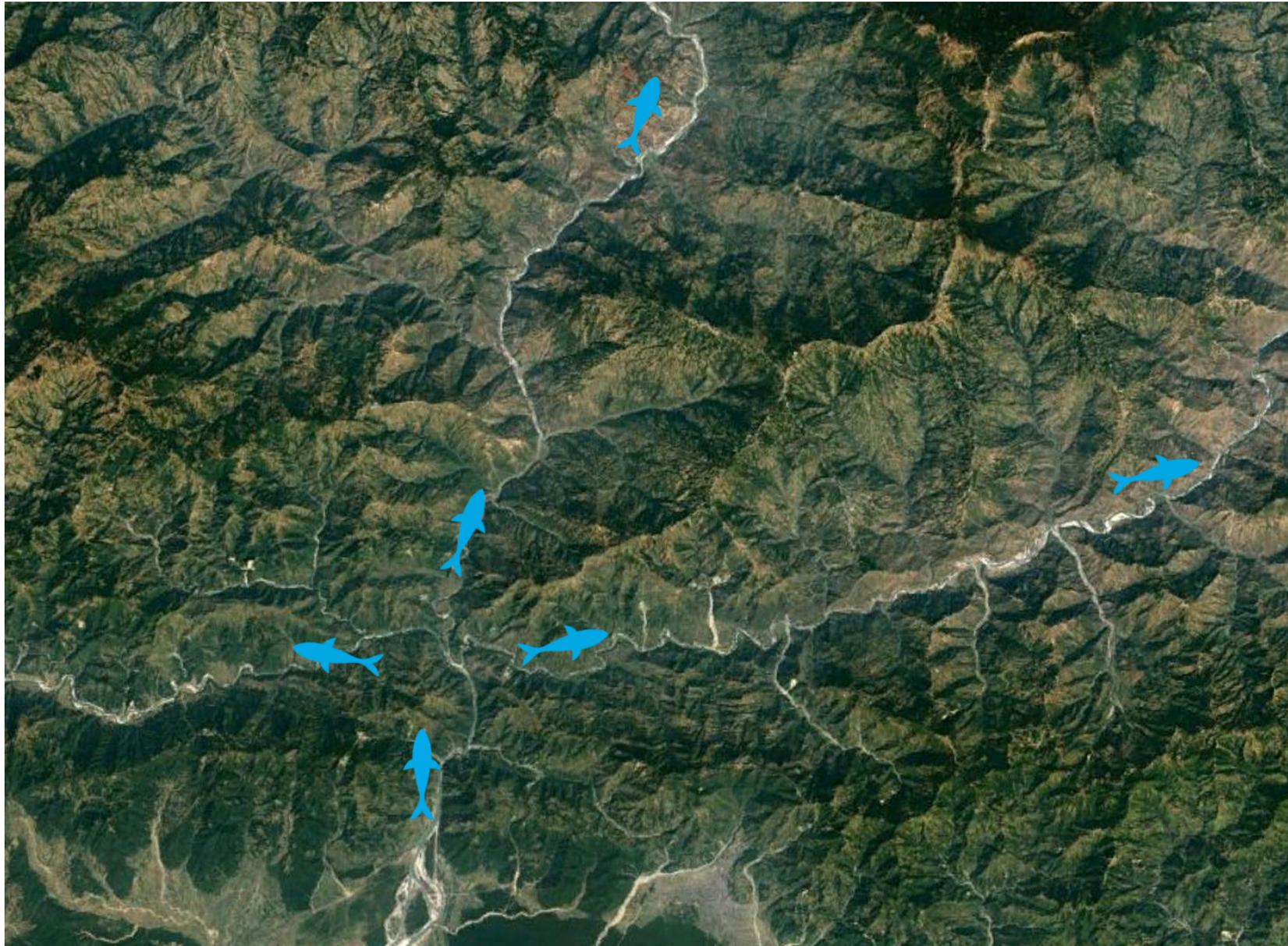
METHODS TO ASSESS FISH MOVEMENT

The research question will dictate the best method.

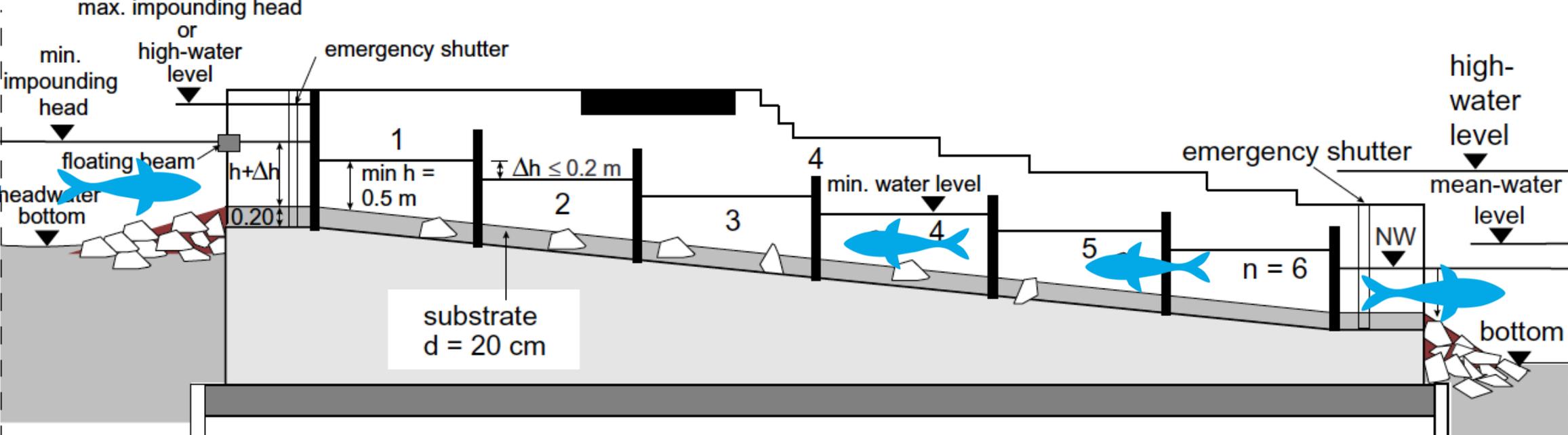
Implementation will depend upon:

- Availability of study fish
- Costs
- Logistics
- Societal will

WHAT IS YOUR QUESTION: WHERE DO FISH GO?



WHAT IS YOUR QUESTION: DO FISH USE FISH PASSAGE?



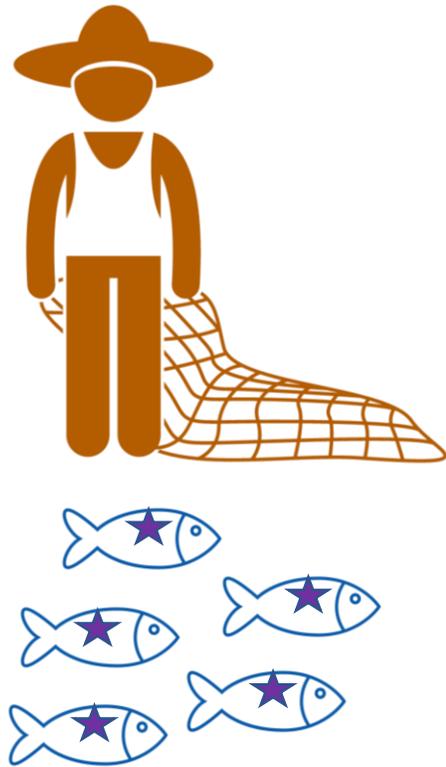
METHODS TO ASSESS FISH MOVEMENT

MARK and **RECAPTURE/DETECTION**

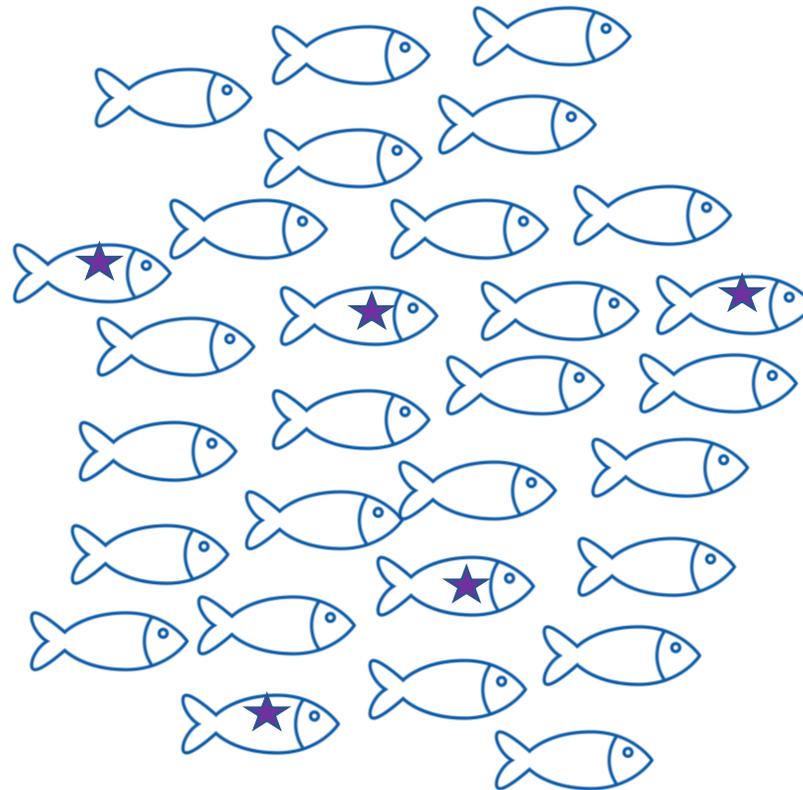
- 1. EXTERNAL TAGS**
- 2. PIT TAGS**
- 3. TELEMETRY**

MARK and RECAPTURE - EXTERNAL TAGS

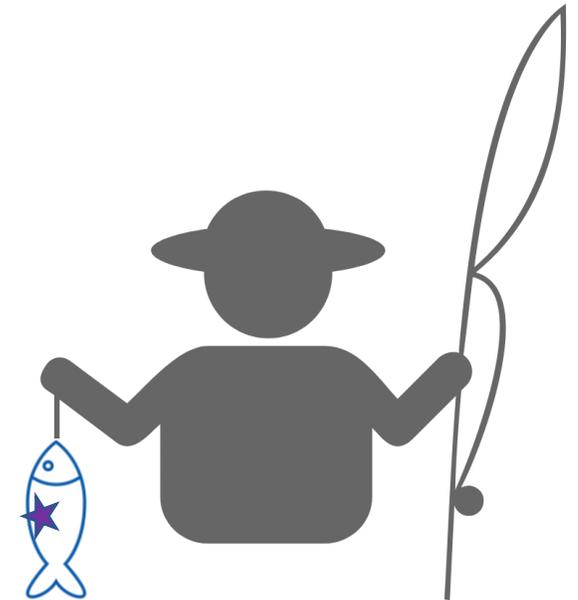
Fish are captured and tagged



Fish are released



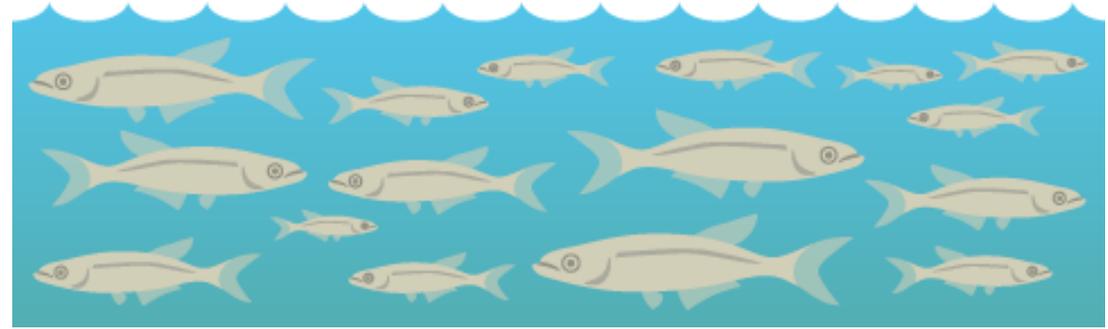
Fish are recaptured
Tags are reported



MARK and RECAPTURE - EXTERNAL TAGS



MARK AND RECAPTURE FOR ESTIMATING POPULATION SIZE

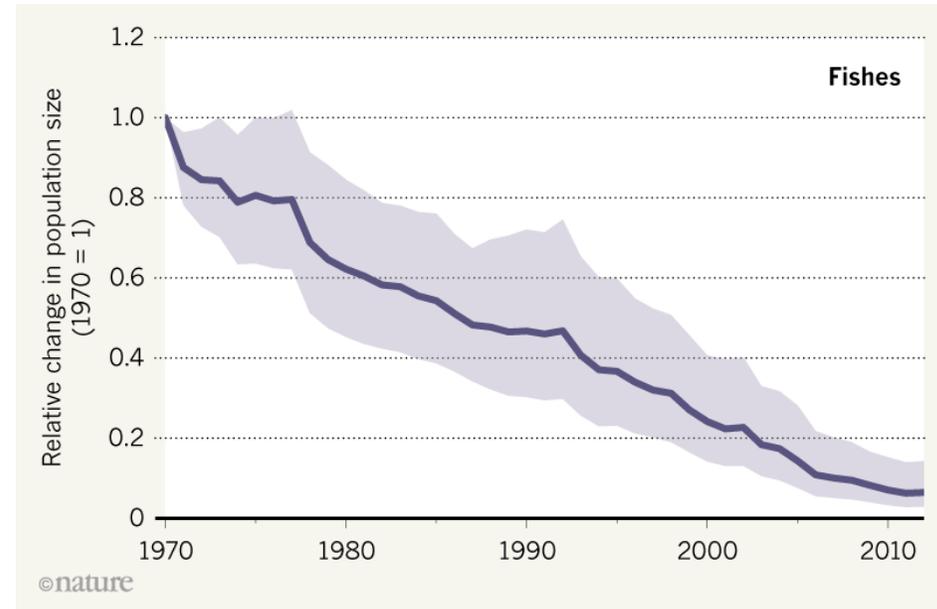


Estimating a population size is highly complex (if not impossible) in an open system (river) that allows for undocumented harvest.

versus

TRENDS

Standardized sampling over time



The trend is what is important. Are population numbers stable or going down?

MARK and RECAPTURE - EXTERNAL TAGS

ADVANTAGES

- Can mark small fish
- Can mark lots of fish
- Inexpensive
- Low technology

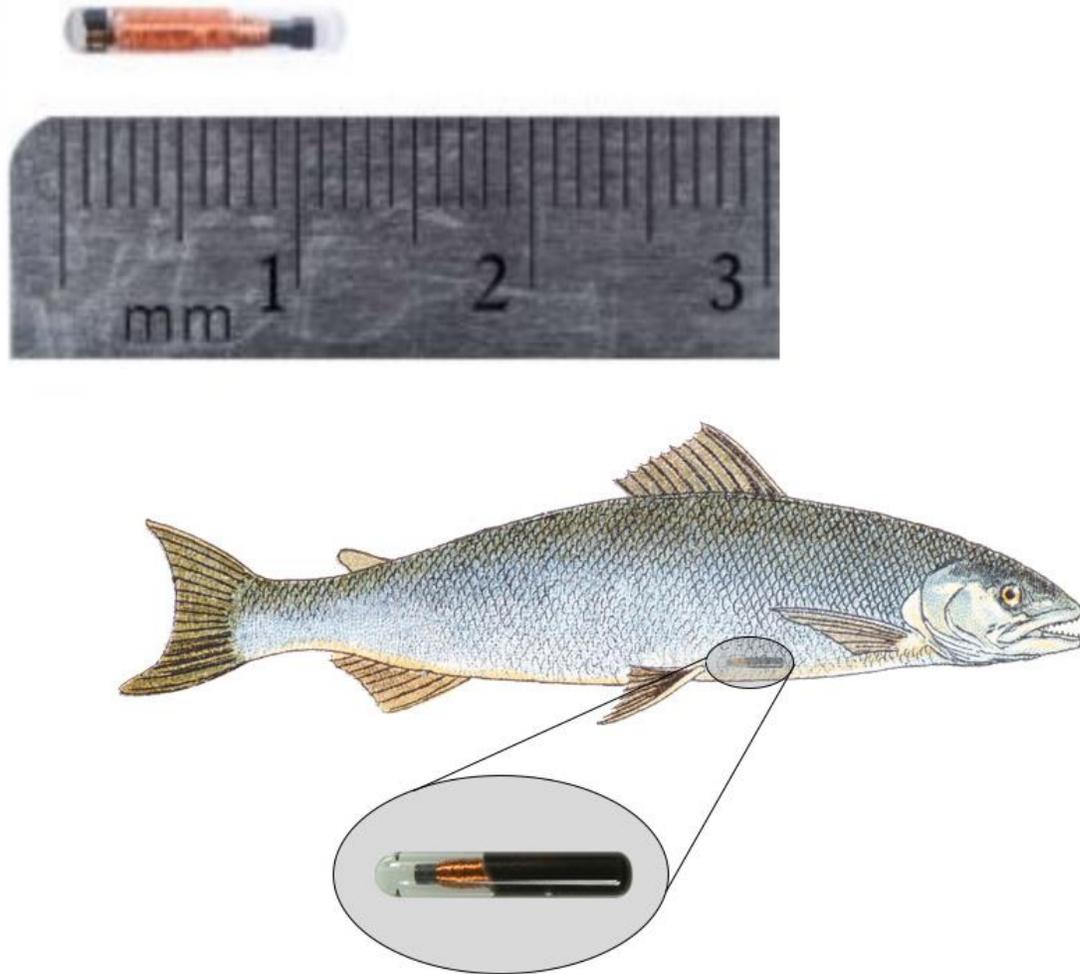


DISADVANTAGES

- Need very large numbers of fish tagged
- Need a good percentage of recaptures
- Only get point to point data
- Large effort for capture and recapture

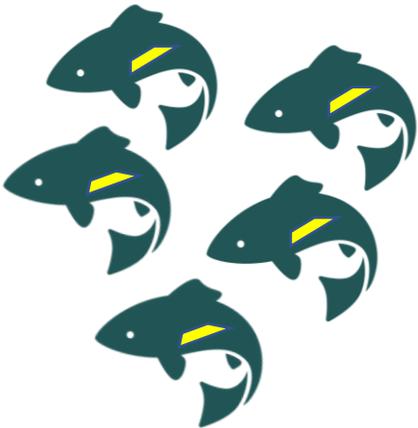


Passive Integrated Transponder (PIT) Tags

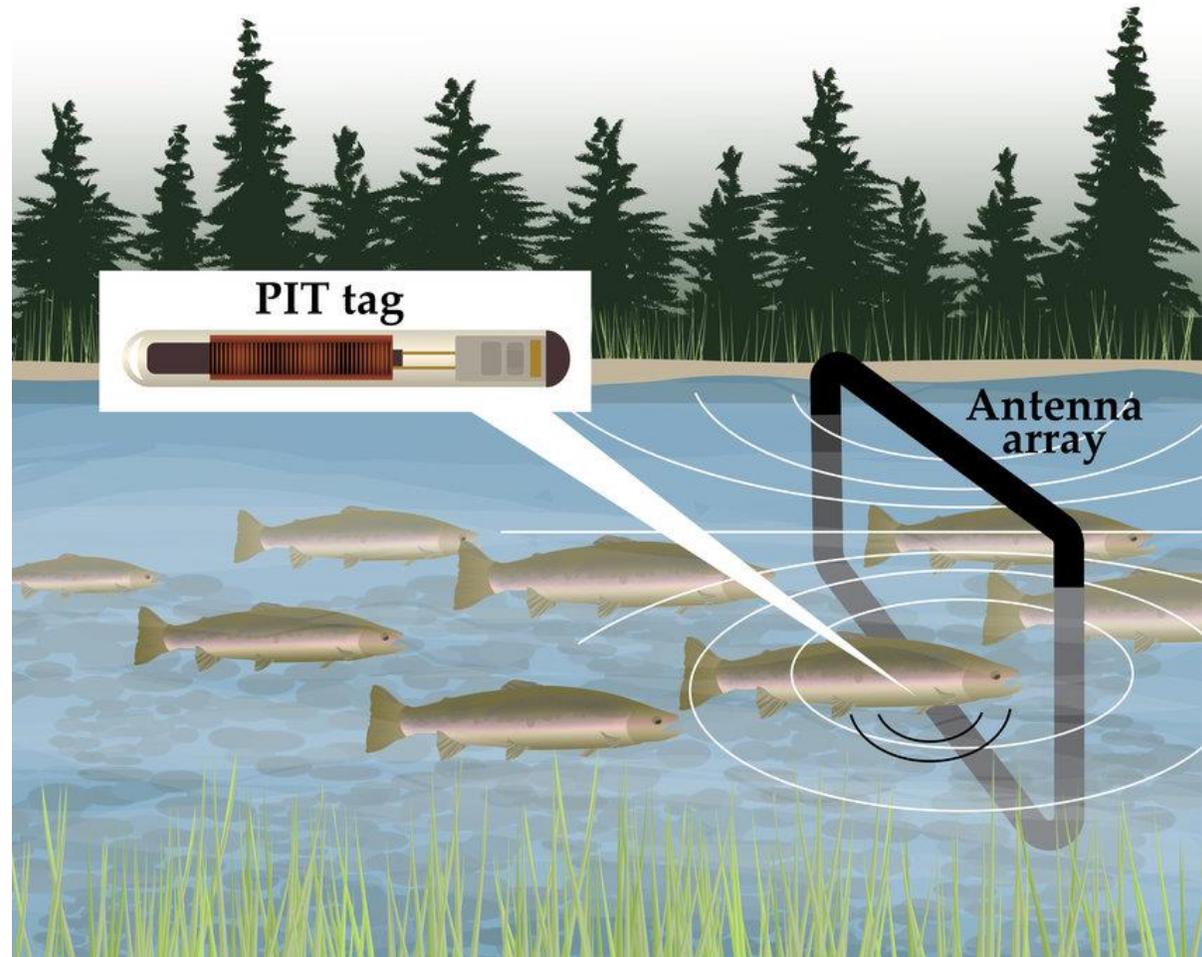


PIT TAGS

Fish are captured and PIT-tagged



Data is recorded with tagged fish passes by a tag reader



PIT TAGS: Stream Movement



PIT TAG: Fish Passage



PIT TAGS

ADVANTAGES

- Small body sizes can be tagged
- Large numbers of fish can be tagged
- No need to physically recapture fish
- Tags last for the lifetime of the fish
- Depending on design - cost can be low



DISADVANTAGES

- Seasonal limitations for having reader in the river
- Fish has to swim directly over the PIT Tag reader
- Need a large number of tagged fish
- Technology required
- Depending on design – cost may be moderate-high



ASSESSING FISH PASSAGE

Fish Traps

Advantages:

- Catch fish directly for species ID
- Collect size and condition data
- Counting them manually

Disadvantages:

- Fish may avoid traps
- Manpower
- Needs regular maintenance
- Risks of injury or stress to the fish



ASSESSING FISH PASSAGE

Visual Counts

Fish are guided into an area where they are visible to be counted



ADVANTAGES

Counting without the need to handle or release fish

DISADVANTAGES

Time consuming

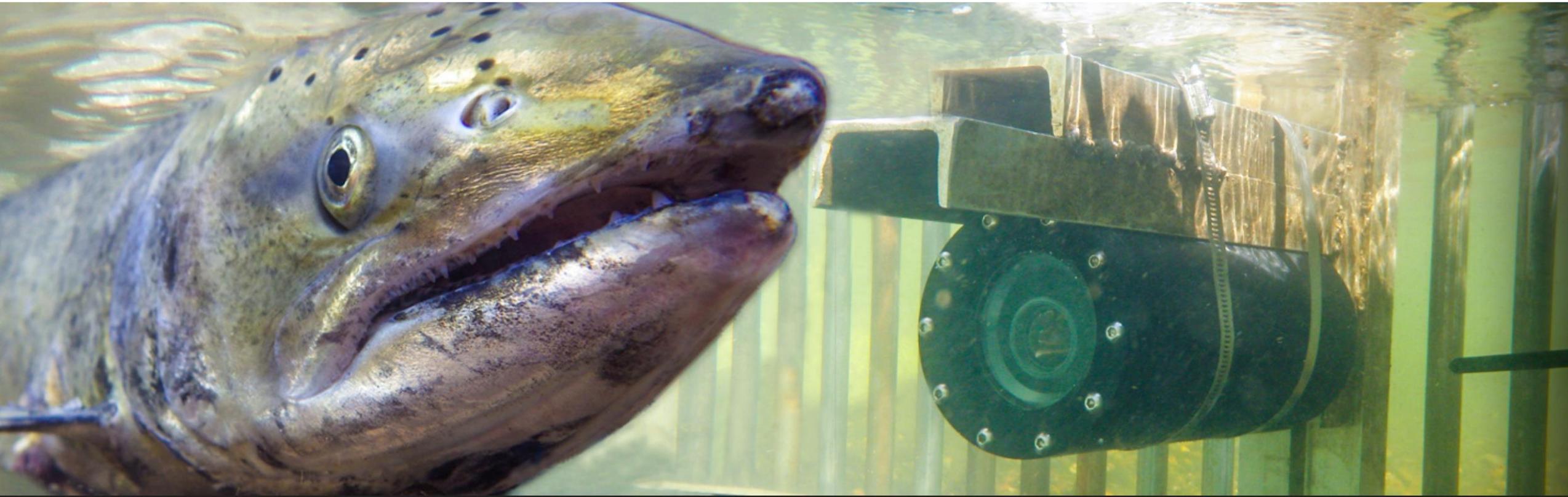
Difficult for species identification

Cannot assess maturity

ASSESSING FISH PASSAGE

Video Monitoring Systems

Fish ladder video monitoring systems : Cameras mounted in fish passage record fish passing by

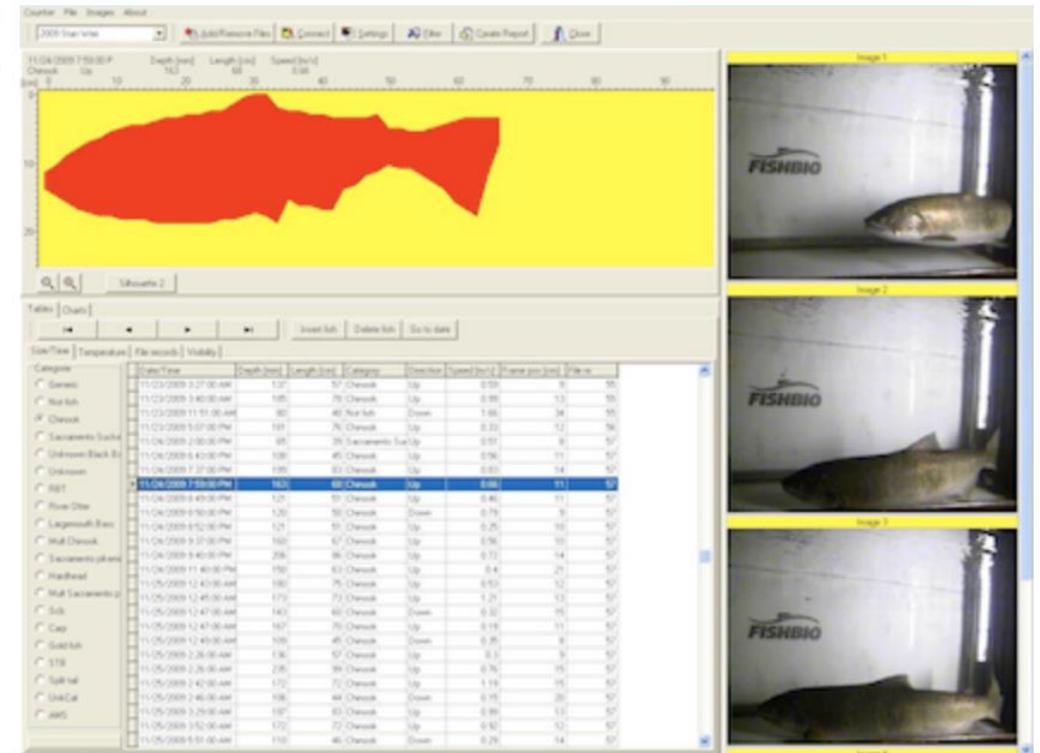


ASSESSING FISH PASSAGE

Video Recording

Motion-detection software

Imaging software > counts fish + determines species



CAMERA MONITORING

ADVANTAGES

- No need to handle or release fish
- Can review film for species ID, size, etc
- Software can provide details
- Can detect external tags



DISADVANTAGES

- Depending on design – cost may high
- Difficult in turbid water
- Film viewing time consuming
- Technology required
- Regular cleaning and maintenance



METHODS TO ASSESS FISH MOVEMENT

MARK and **RECAPTURE**

- 1. EXTERNAL TAGS**
- 2. PIT TAGS**
- 3. TELEMETRY**

TYPES of TELEMETRY

RADIO TELEMETRY

[FIXED ARRAY vs MANUAL]



ACOUSTIC TELEMETRY



SATELLITE TELEMETRY



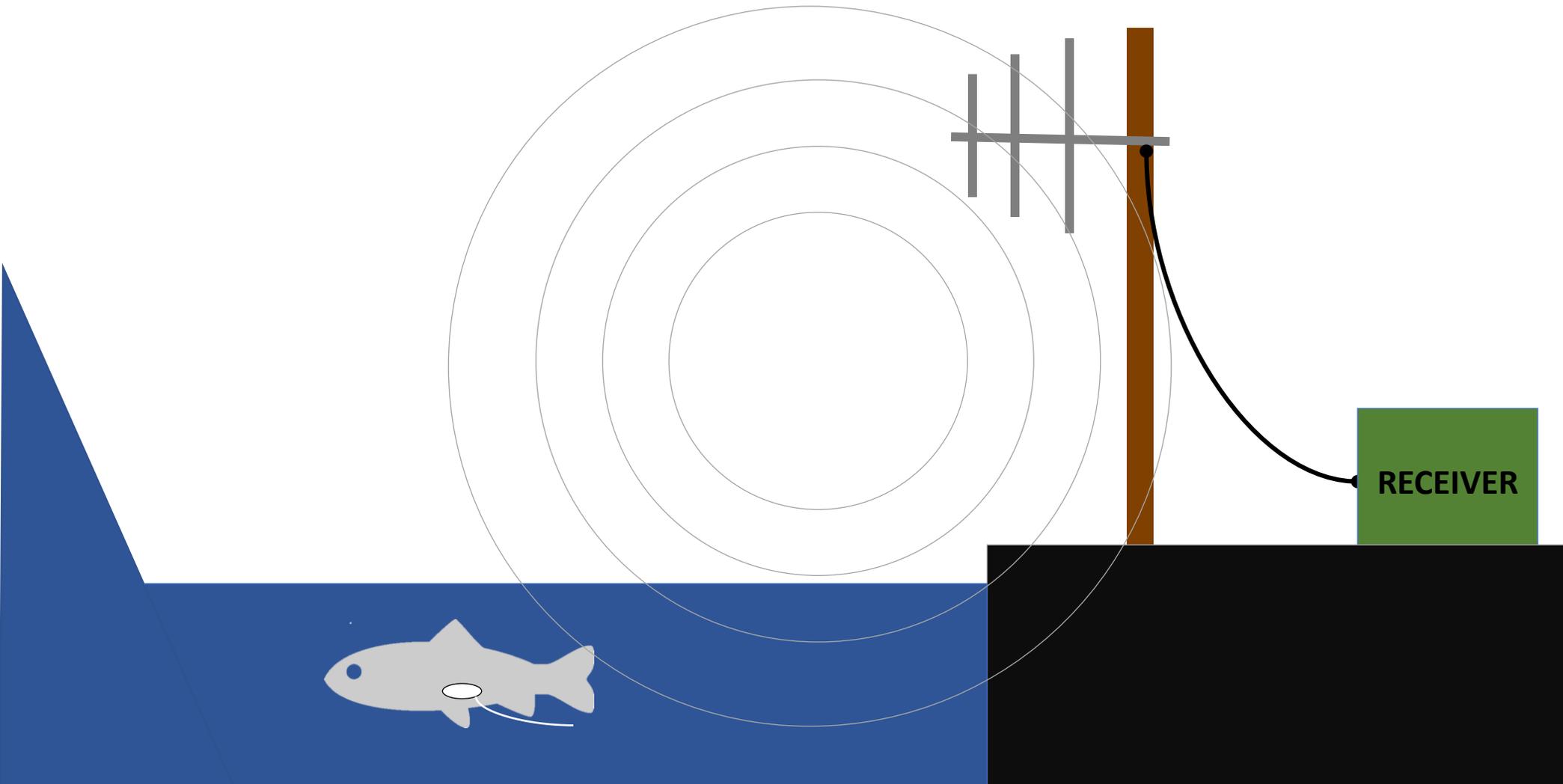
METHODS TO ASSESS FISH MOVEMENT

Research question(s) will dictate the best method.

Radio telemetry is excellent for:

- Assessing daily, seasonal, annual movements**
- Determining migration timing and routes**
- Identifying spawning locations**
- Defining habitat usage**

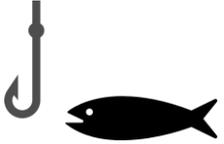
RADIO - TELEMETRY



IMPLEMENTING RADIO - TELEMETRY



CONSTRUCT AN ARRAY OF RECEIVER STATIONS



CAPTURE FISH USING ANGLING

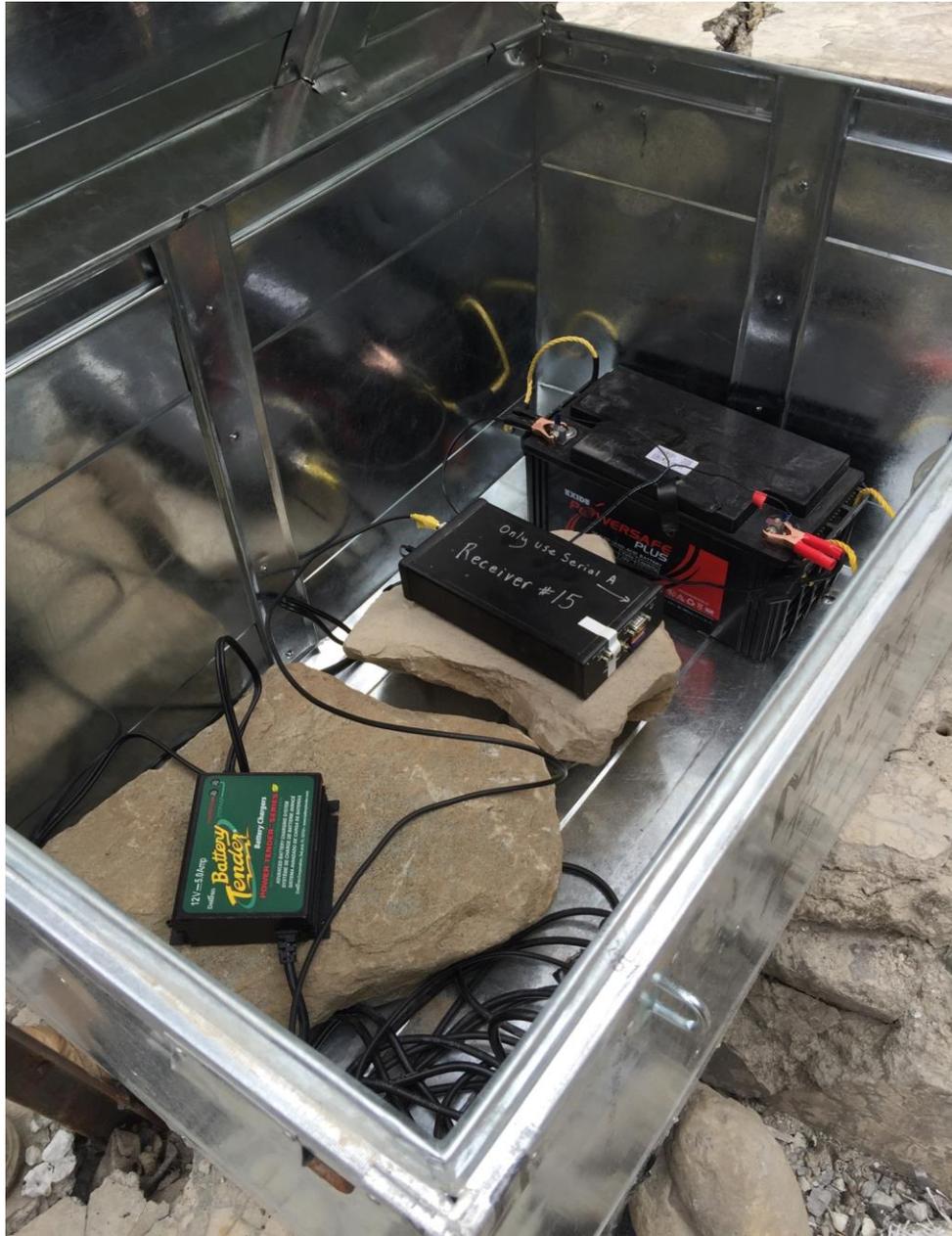


SURGICALLY IMPLANT FISH WITH TRANSMITTERS



DOWNLOAD DATA FROM RECEIVER STATIONS

CONSTRUCTING RECEIVER STATIONS



CONSTRUCTING RECEIVER STATIONS



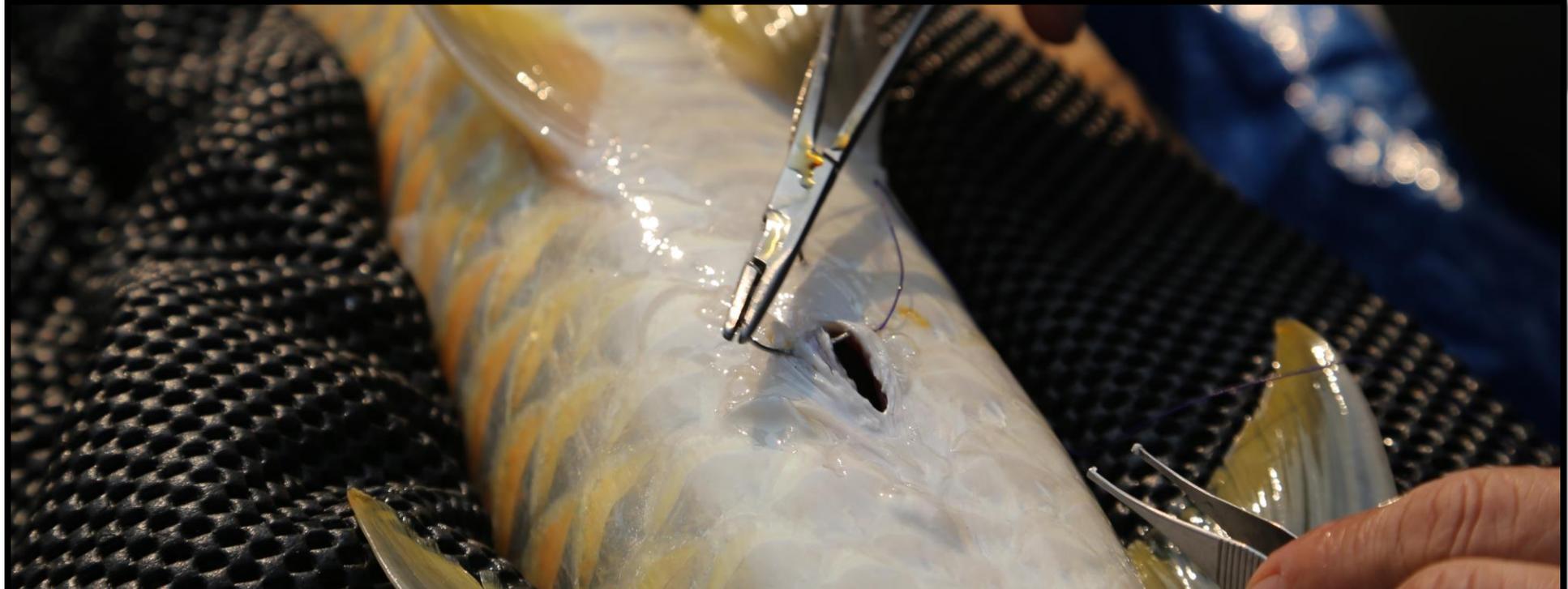
CAPTURING FISH



SURGERY



SURGERY



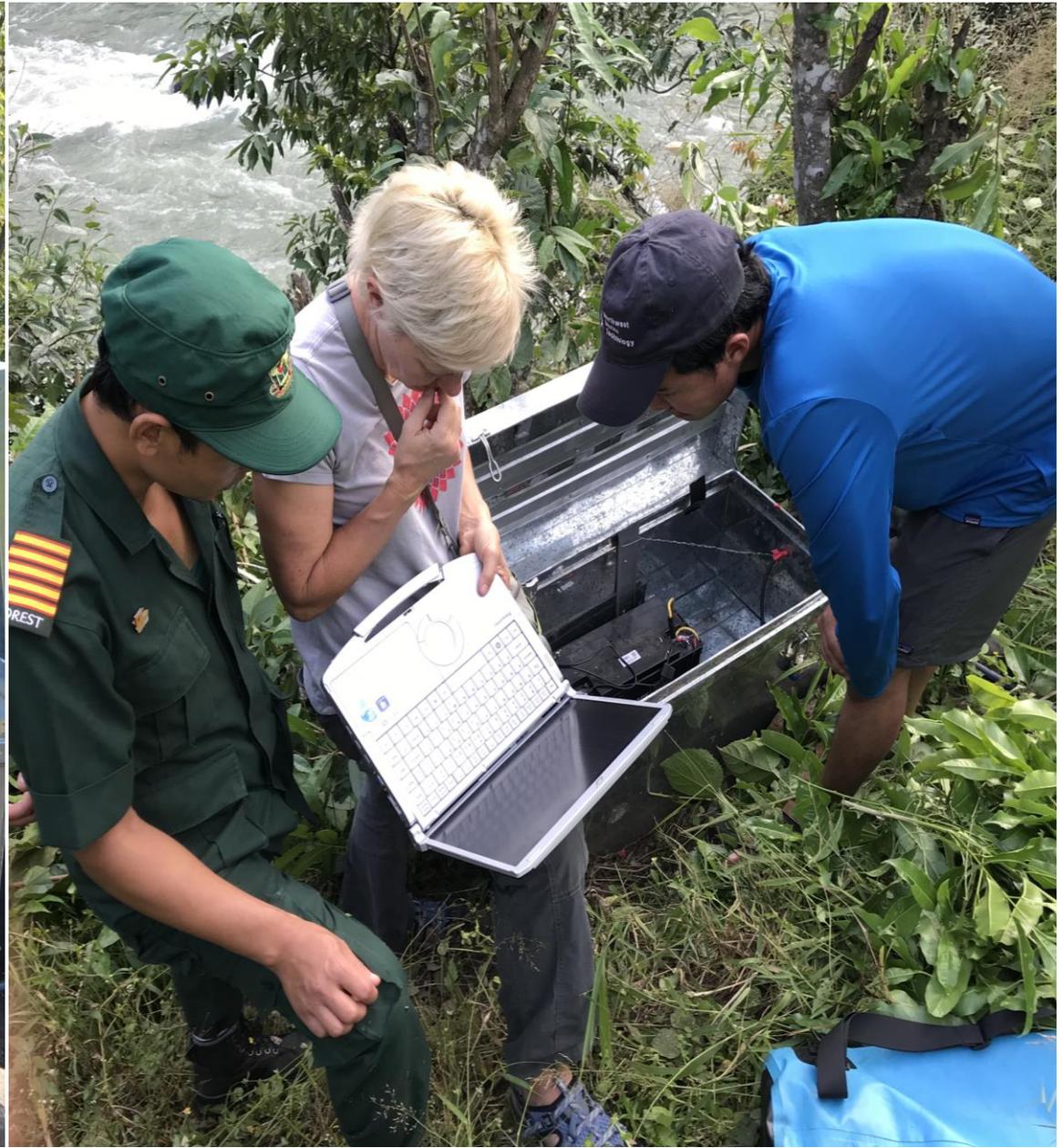
RECOVERY and RELEASE



BIG TAGS FOR BIG FISH



DATA RETRIEVAL



DATA ANALYSIS

DATA COMES IN BY RECEIVER

EXPORT TEXT FILE TO EXCEL
SPREADSHEET

SORT BY FISH, ELIMINATE NOISE

IDENTIFY EVENT AND MAKE LOGS

REASSEMBLE DATA FOR EACH FISH
INDIVIDUALLY

Date	Time	Site	Ant	Freq	Type	Code	Power
2019-04-17	16:39:28	3	1	149.800	LOTEK	20	-79
2019-04-17	16:39:38	3	1	149.800	LOTEK	20	-78
2019-04-17	16:39:48	3	1	149.800	LOTEK	20	-82
2019-04-17	16:39:58	3	1	149.800	LOTEK	20	-82
2019-04-17	16:40:02	3	1	149.340	LOTEK	3	-94
2019-04-17	16:40:08	3	1	149.800	LOTEK	20	-81
2019-04-17	16:40:18	3	1	149.800	LOTEK	20	-77
2019-04-17	16:40:28	3	1	149.800	LOTEK	20	-79
2019-04-17	16:40:38	3	1	149.800	LOTEK	20	-78
2019-04-17	16:40:48	3	1	149.800	LOTEK	20	-78
2019-04-17	16:40:59	3	1	149.800	LOTEK	20	-78
2019-04-17	16:41:09	3	1	149.800	LOTEK	20	-79
2019-04-17	16:41:19	3	1	149.800	LOTEK	20	-78
2019-04-17	16:41:29	3	1	149.800	LOTEK	20	-79
2019-04-17	16:41:39	3	1	149.800	LOTEK	20	-81
2019-04-17	16:41:49	3	1	149.800	LOTEK	20	-79
2019-04-17	16:44:41	3	1	149.800	LOTEK	20	-67
2019-04-17	16:44:51	3	1	149.800	LOTEK	20	-67
2019-04-17	16:45:01	3	1	149.800	LOTEK	20	-67
2019-04-17	16:45:03	3	1	149.340	LOTEK	3	-104
2019-04-17	16:45:11	3	1	149.800	LOTEK	20	-78
2019-04-17	16:45:21	3	1	149.800	LOTEK	20	-88
2019-04-17	16:45:31	3	1	149.800	LOTEK	20	-90
2019-04-17	16:45:41	3	1	149.800	LOTEK	20	-96
2019-04-17	16:45:52	3	1	149.800	LOTEK	20	-95
2019-04-17	16:46:02	3	1	149.800	LOTEK	20	-79
2019-04-17	16:46:12	3	1	149.800	LOTEK	20	-96
2019-04-17	16:46:22	3	1	149.800	LOTEK	20	-96
2019-04-17	16:46:32	3	1	149.800	LOTEK	20	-98
2019-04-17	16:47:12	3	1	149.800	LOTEK	20	-109
2019-04-17	16:50:03	3	1	149.340	LOTEK	3	-110
2019-04-17	16:55:04	3	1	149.340	LOTEK	3	-110
2019-04-17	17:00:04	3	1	149.340	LOTEK	3	-110
2019-04-17	17:05:05	3	1	149.340	LOTEK	3	-110
2019-04-17	17:15:06	3	1	149.340	LOTEK	3	-109
2019-04-17	17:19:42	3	1	149.800	LOTEK	20	-87
2019-04-17	17:20:02	3	1	149.800	LOTEK	20	-109
2019-04-17	17:20:07	3	1	149.340	LOTEK	3	-110
2019-04-17	17:20:12	3	1	149.800	LOTEK	20	-102
2019-04-17	17:25:07	3	1	149.340	LOTEK	3	-110
2019-04-17	19:55:45	3	1	149.800	LOTEK	20	-108
2019-04-17	19:56:26	3	1	149.800	LOTEK	20	-104
2019-04-18	09:57:01	3	1	149.340	LOTEK	3	-109
2019-04-18	10:02:01	3	1	149.340	LOTEK	3	-110
2019-04-18	10:07:02	3	1	149.340	LOTEK	3	-109
2019-04-18	10:11:02	3	1	149.340	LOTEK	3	-110

METHODS TO ASSESS FISH MOVEMENT

Research question(s) will dictate the best method.

Radio telemetry is excellent for:

- **Assessing daily, seasonal, annual movements**
- **Determining migration timing and routes**
- **Identifying spawning locations**
- **Defining habitat usage**

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Impacts of Human Actions

Success of Mitigation

HYDROPOWER IN BHUTAN



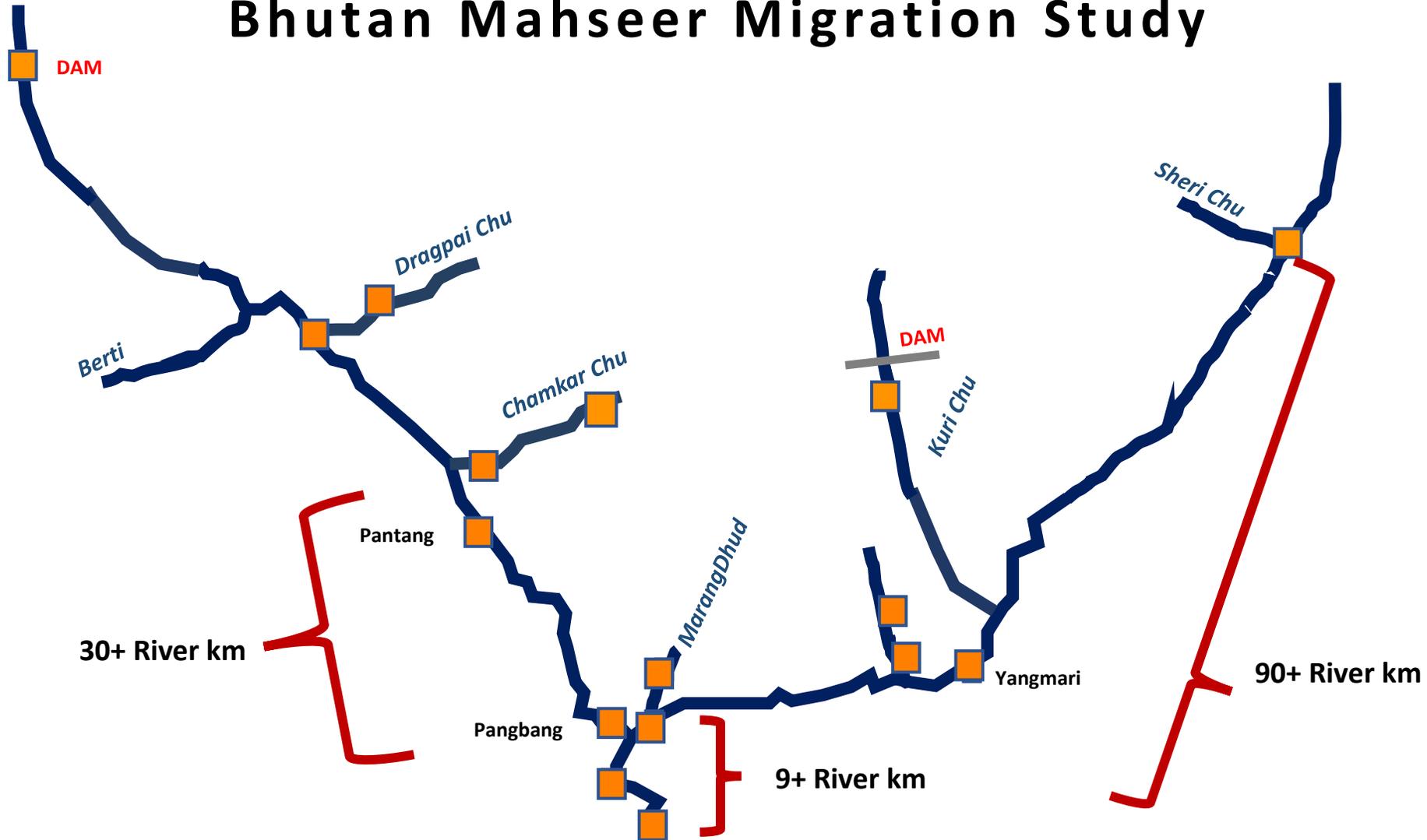
BHUTAN RESEARCH QUESTIONS



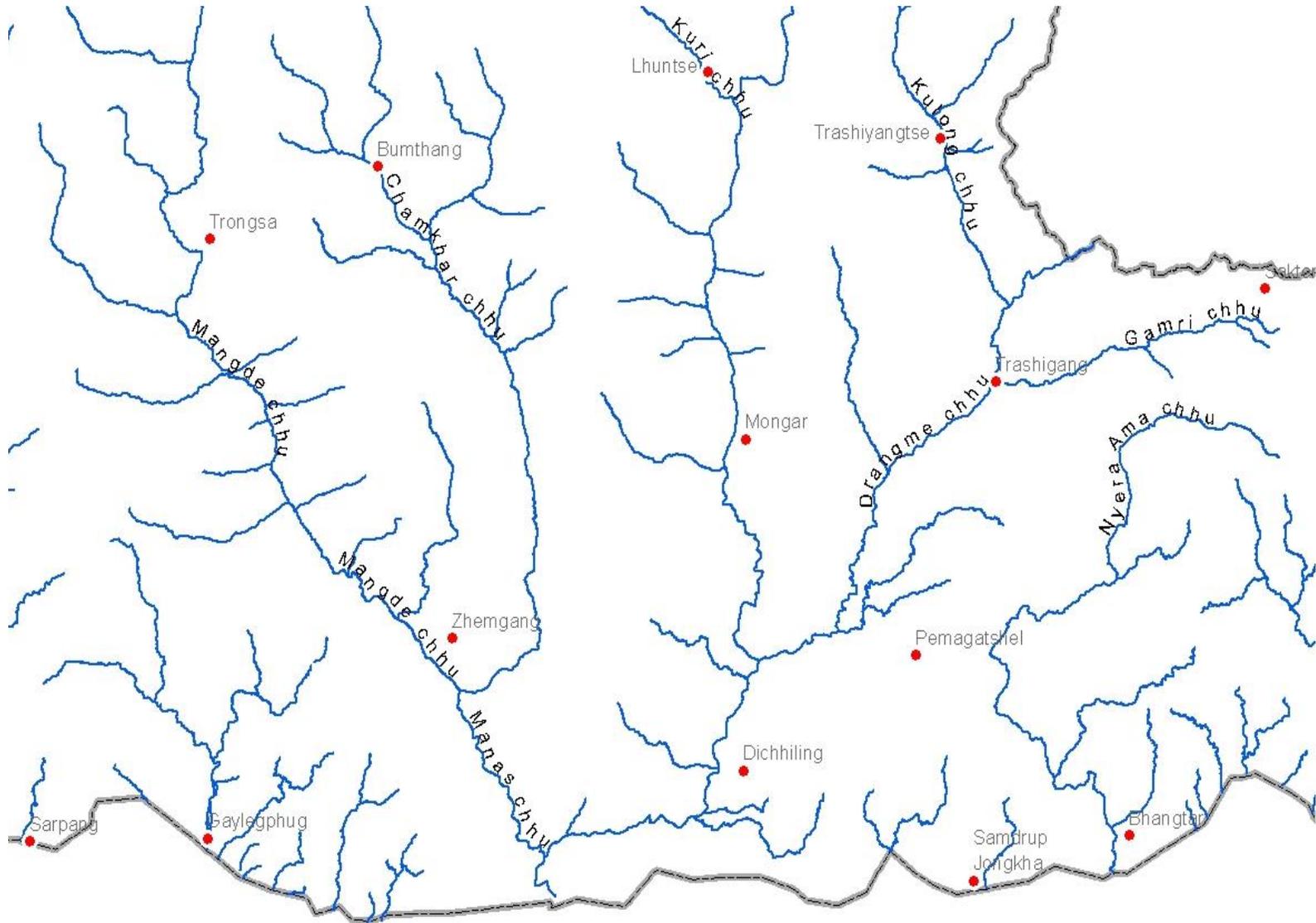
How far do Mahseer migrate each year?
Where do Mahseer spawn?
Where do Mahseer overwinter?

RECEIVER STATION ARRAY

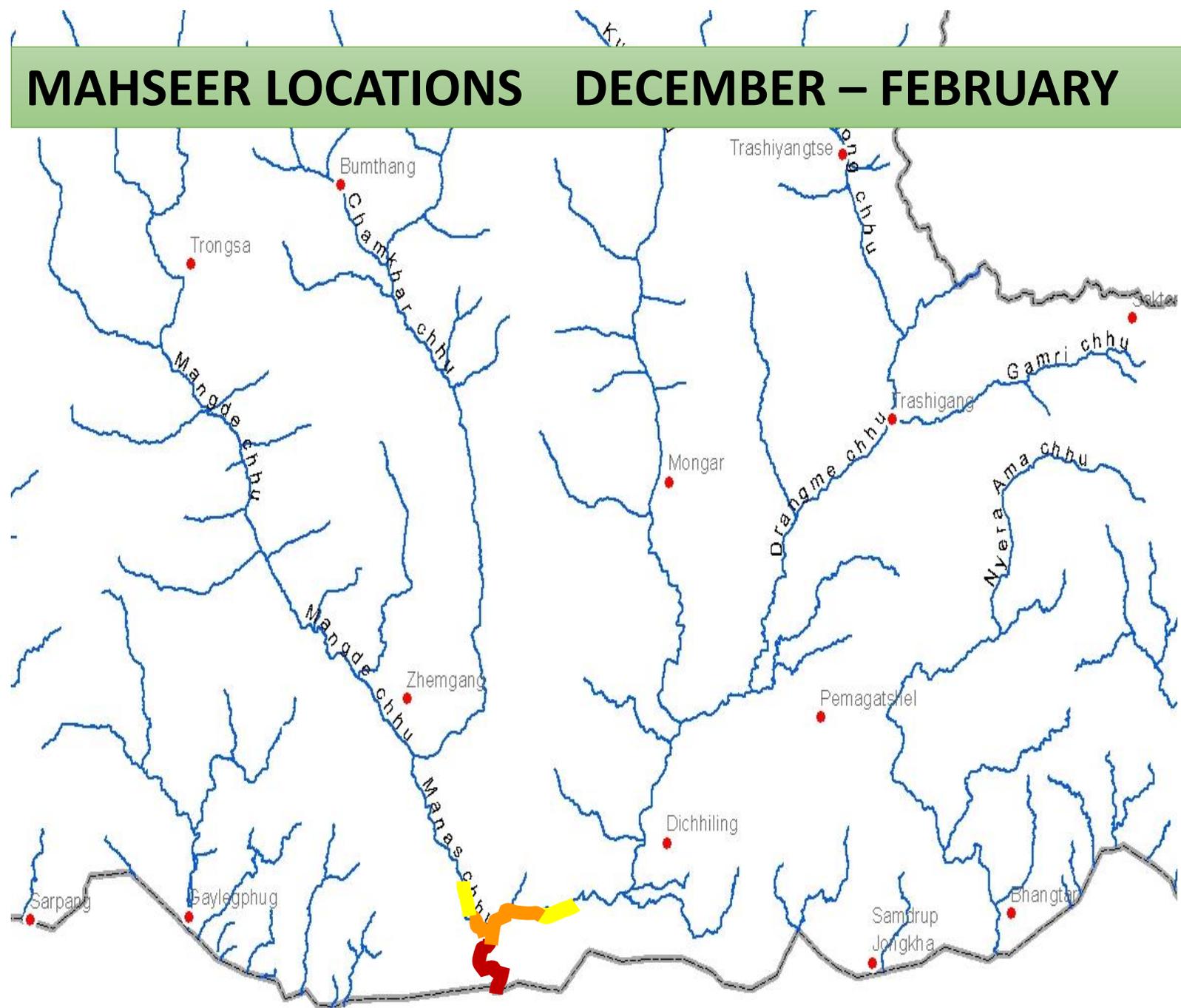
Bhutan Mahseer Migration Study



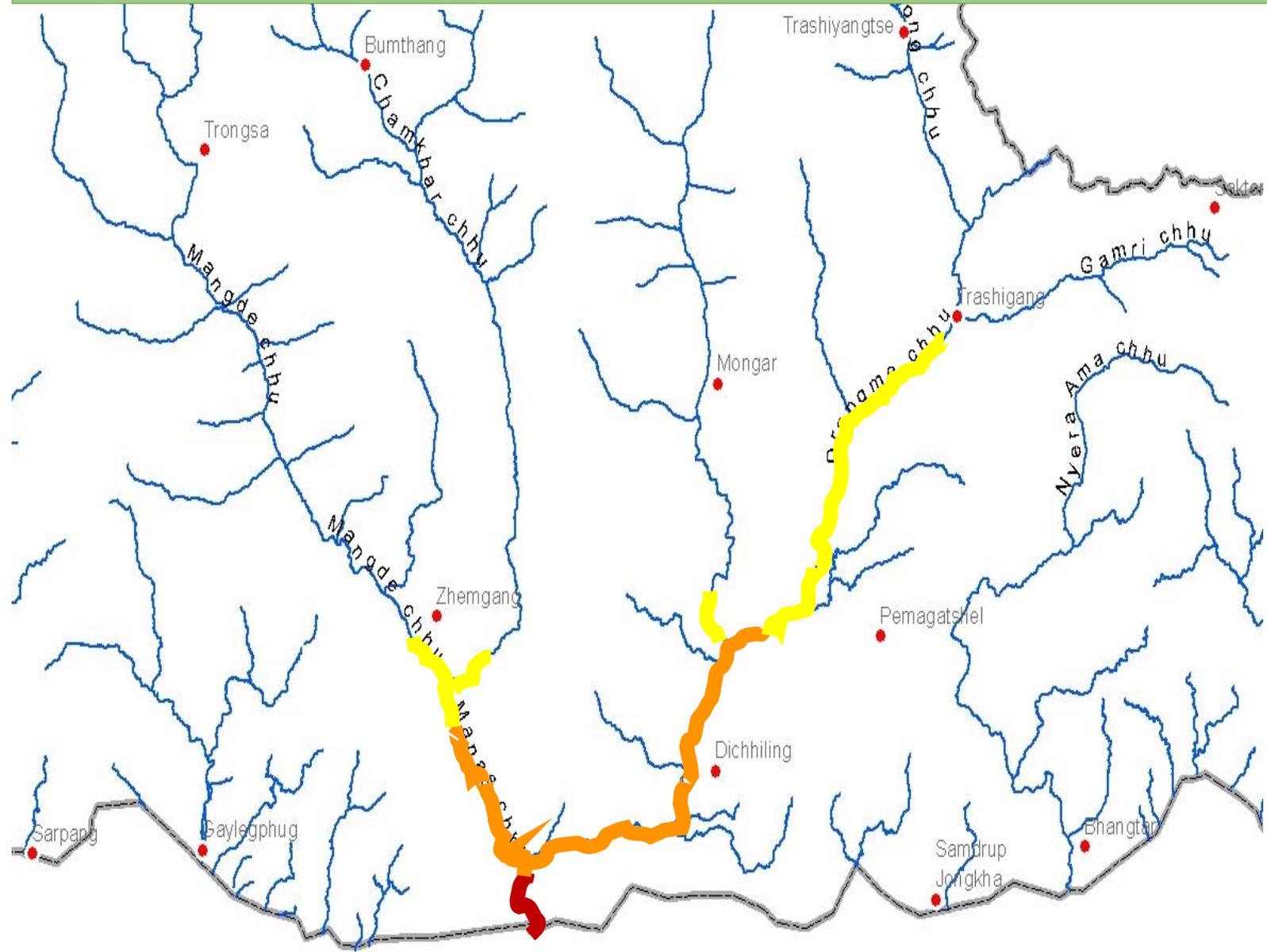
MAHSEER LOCATIONS – MANAS WATERSHED



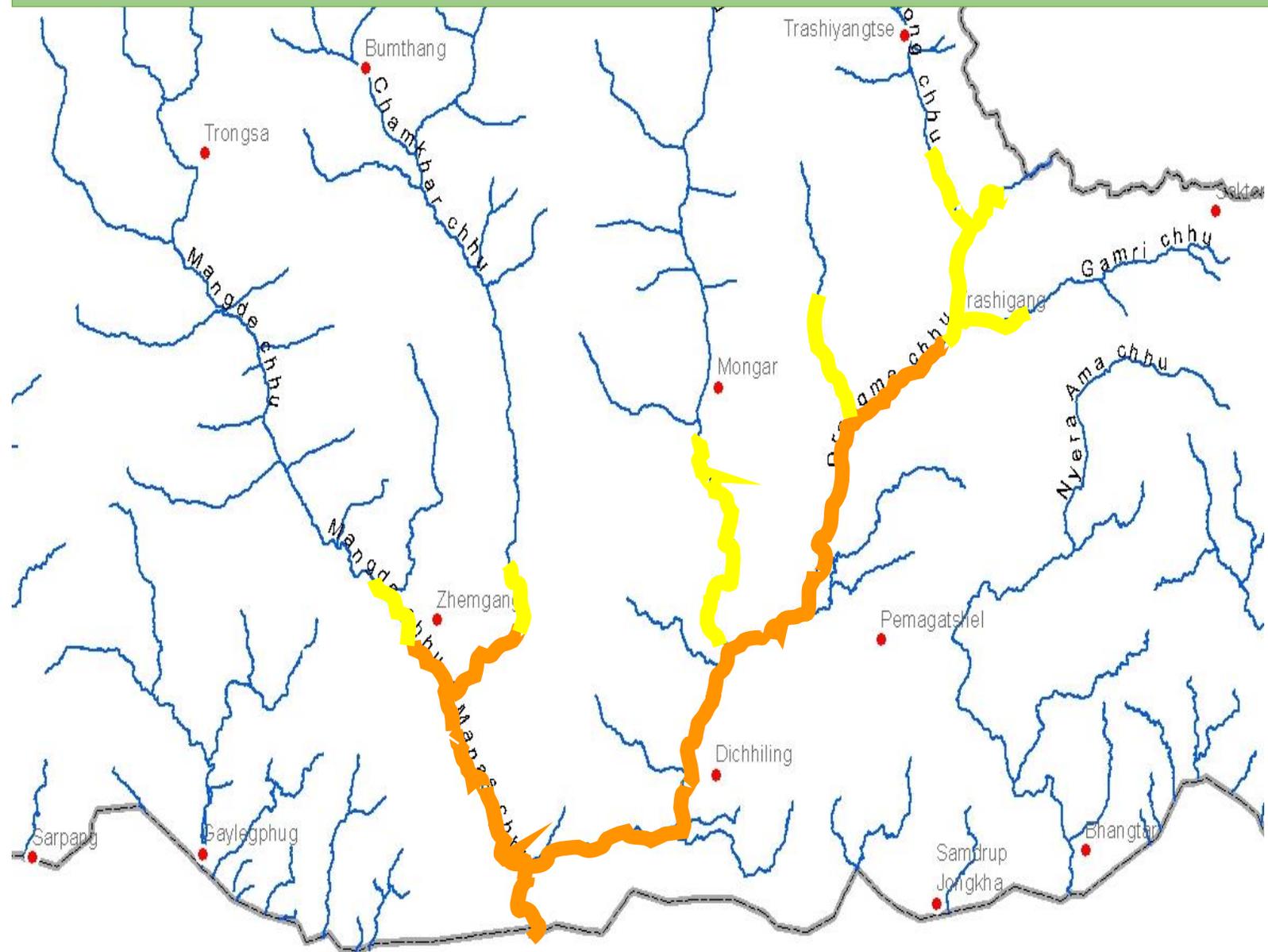
MAHSEER LOCATIONS DECEMBER – FEBRUARY



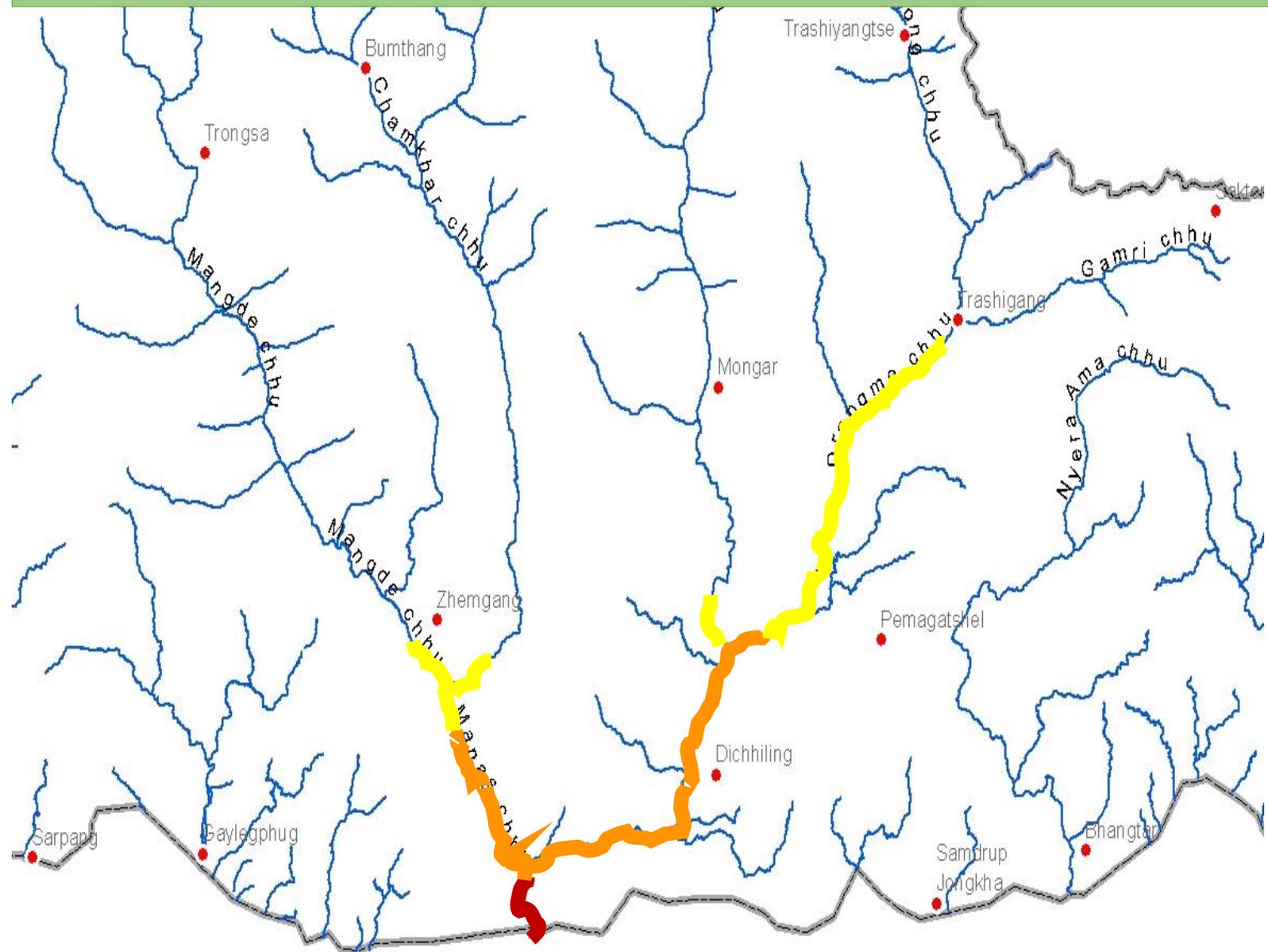
MAHSEER LOCATIONS MARCH – MAY



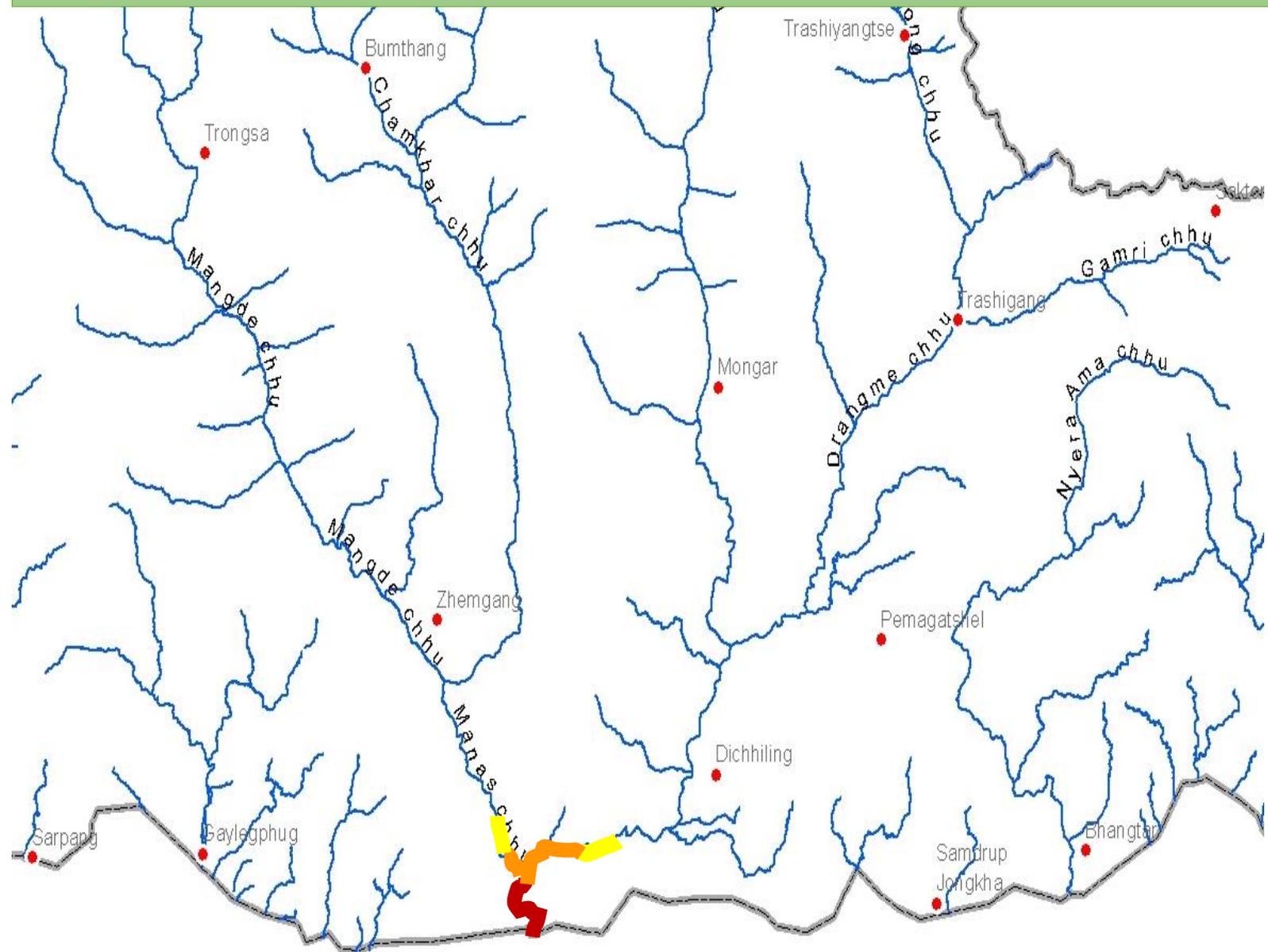
MAHSEER LOCATIONS JUNE – AUGUST



MAHSEER LOCATIONS SEPTEMBER – NOVEMBER



MAHSEER LOCATIONS DECEMBER – FEBRUARY



POONCH RIVER IN PAKISTAN

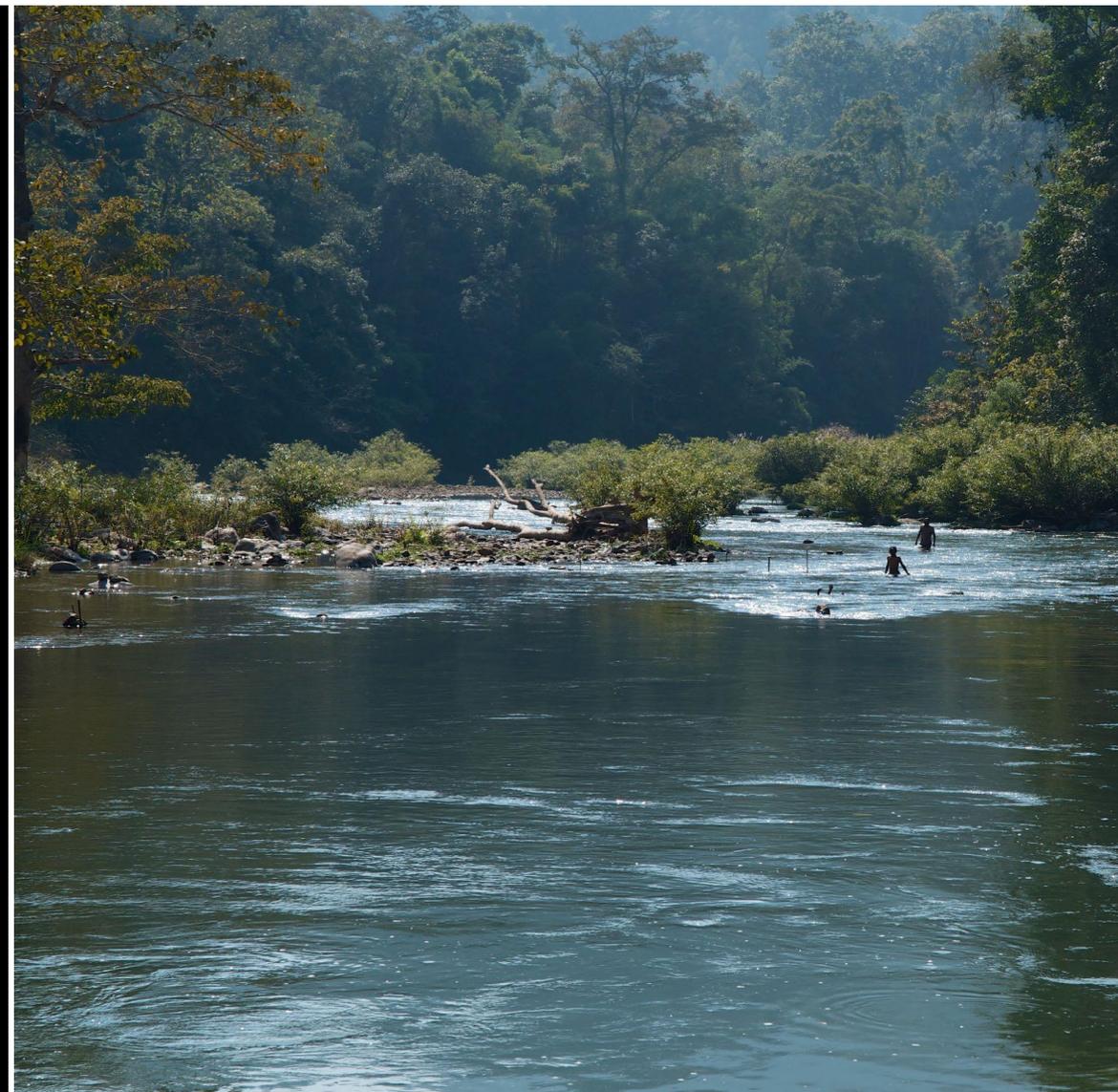
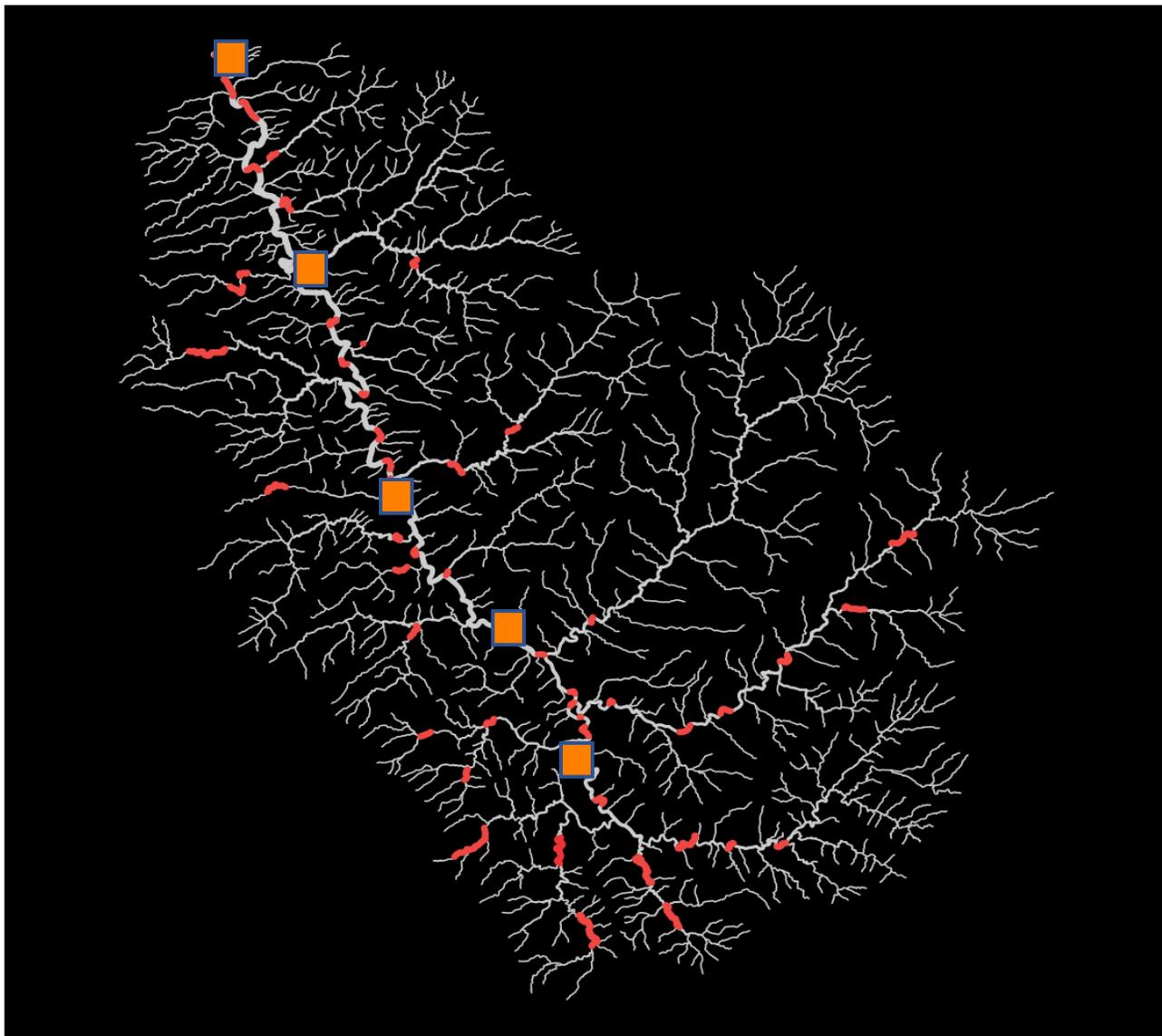
HOW DOES THE DAM IMPACT MOVEMENT?

12 Receiver Stations:
Lower River = 4
Upper River = 8



MAE NGAO IN THAILAND

HOW DO FISH MOVE AMONG RESERVES?



RADIO - TELEMETRY

ADVANTAGES

- Do not need a large number of fish tagged
- Daily, seasonal, and annual movements
- Long-range movements
- Long-term movement history
- Habitat use information
- Collects data continuously
- Needs only periodic data downloads
- Produces a TON of data.



DISADVANTAGES

- Costs can be high
- Labor Intensive during some periods
- Specific training needed



CONSIDERATIONS FOR A NEPAL RECEIVER STATION ARRAY



