ADVANCING SUSTAINABLE HYDROPOWER: BIODIVERSITY ASSESSMENT AND MANAGEMENT WEBINAR SERIES

DATA ANALYSIS FOR LONG-TERM MONITORING

February 18, 2021

International Finance Corporation
WORLD BANK GROUP

Creating Markets, Creating Opportunities

IN PARTNERSHIP WITH

Australian Aid

Norwegian Ministry of Foreign Affairs

Introduction and Housekeeping

Kate Lazarus
Senior Asia ESG Advisory Lead
IFC

HOUSEKEEPING

Today's webinar is scheduled to last 1.30 hrs including Q&A.

You will be automatically muted throughout the webinar. Please be informed that this webinar session will be recorded.

Please do not use raise hand option. You can use the chat box on your screen to drop in your questions/comments directed towards a specific speaker. We will collate your comments and present them before speakers at appropriate times.

If you require any administrative support during the webinar, please private message Upasana Pradhan in the ZOOM chat box. We will address your concerns as best we can.

All the materials and presentation of this event will be shared with the participants in a few days following the webinar.

Agenda

19:00 - 19:10	Welcome and Housekeeping	Kate Lazarus Senior Asia ESG Advisory Lead IFC
19:10 – 19:30	Data Analysis for Long-Term Monitoring	Leeanne Alonso Biodiversity Consultant, IFC
19:30-20:00	Data Analysis Excel Tool for monitoring fish abundance over time (video presentation)	Jonathan Levin PhD Candidate in Ecohydrology University of the Witwatersrand, South Africa
20:00 - 20:20	Q & A	Moderator: Kate Lazarus Senior Asia ESG Advisory Lead IFC
20:20-20:30	Closing Remarks	Babacar Faye Resident Representative, IFC, Nepal

Data Analysis
for Long-term Monitoring

Presenters:

Leeanne Alonso

Biodiversity Consultant, IFC

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Jonathan Levin

PhD Candidate in Ecohydrology

University of the Witwatersrand, South Africa

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Talk Outline

Why Biodiversity Monitoring

Sampling Design and Field Methods

Data Analysis and Metrics

Data Analysis Excel Tool for monitoring fish abundance over time

Why Biodiversity Monitoring

What is Biodiversity Monitoring?

- Biodiversity monitoring is the process of determining status and tracking changes in living organisms and the ecological complexes of which they are a part.
- **Biodiversity monitoring is important because it provides a basis for evaluating the integrity of ecosystems, their responses to disturbances, and the success of actions taken to conserve or recover biodiversity.**
- Research addresses questions and tests hypotheses about how these ecosystems function and change and how they interact with stressors.
- Ecological research provides the context for interpreting these monitoring results. Policy and management needs guide the development of monitoring.

https://biodivcanada.chm-cbd.net/ecosystem-status-trends-2010/biodiversity-monitoring-research-information-management-and-reporting#:~:text=Biodiversity%20monitoring%20is%20the%20process%20of%20determining%20status,of%20actions%20taken%20to%20conserve%20or%20recover%20biodiversity.

ESIA and IFC PS6 General Process for Hydropower Project

1. Hydropower Project is proposed
2. ESIA is required per EIA Manual for Hydropower (2018) for Government of Nepal and per GIIP for IFC
3. Baseline biodiversity data collection for ESIA
4. Impact Assessment using the baseline biodiversity data collected (literature and field)
5. Mitigation is developed per the Mitigation Hierarchy to avoid, minimize and, if needed, offset impacts
6. IFC's PS6 requires project to achieve and demonstrate No Net Loss of Biodiversity (NNL) for Natural Habitat Values and Net Gain (NG) for Critical Habitat Values
7. **Monitoring program is developed to demonstrate that the mitigation measures committed in the ESIA are successful and that NNL/NG is achieved for government and lender compliance**

ESIA Baseline

1. Provides the Baseline on biodiversity and ecosystem values used for:
    - Impact Assessment
    - Mitigation Actions

Thus Baseline sampling for an ESIA should utilize all possible field sampling methods, at as many sites, and as frequently as possible to **maximize the data available** to make these decisions.
The More Data the Better!

2. Often provides the Pre-construction Baseline for the Long-term Monitoring program
    - Extremely Important- Will be used to compare to all future years for Monitoring
    - Think Ahead- Need to include the sampling protocol for Monitoring because Monitoring requires standardized, repeated data collection in order to make valid comparisons over time- using same field methods, same sites, same dates, same researchers, same data collection and analysis
    - Baseline for Monitoring must be collected as early as possible - at least 1 year before construction and ideally for several years before construction
      *This is lacking in most monitoring programs

What is No Net Loss (NNL) and Net Gain (NG)?
How will we know when it is achieved?

IFC Performance Standard 6 (2012)

Paragraph 15, Footnote 9:
No net loss is defined as the point at which project-related impacts on biodiversity are balanced by measures taken to avoid and minimize the project's impacts, to undertake on-site restoration and finally to offset significant residual impacts, if any, on an appropriate geographic scale (e.g., local, landscape-level, national, regional).

Paragraph 18, Footnote 15:
Net gains are additional conservation outcomes that can be achieved for the biodiversity values for which the critical habitat was designated. Net gains may be achieved through the development of a biodiversity offset and/or, in instances where the client could meet the requirements of paragraph 17 of this Performance Standard without a biodiversity offset, the client should achieve net gains through the implementation of programs that could be implemented in situ (on-the-ground) to enhance habitat, and protect and conserve biodiversity.

https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/performance-standards/ps6

IFC PS6 Guidance Note (2012, Updated 2019)

GN43 **A defensible rationale for how no net loss will be achieved should be provided.** A variety of methods exist to calculate losses and gains of the quantity *and* quality of identified biodiversity values and to assess the likelihood of success of proposed mitigation and management actions. While appropriate methods and metrics will vary from site to site, these should be evidence-based, utilizing quantitative and semi-quantitative methods as inputs to an expert-led process. The level of confidence in the results of the analysis should be commensurate with the risks and impacts that the project poses to the natural habitat.

GN51. **Long-term biodiversity monitoring may be required to validate the accuracy of predicted impacts and risks to biodiversity values posed by the project, and the predicted effectiveness of biodiversity management actions.** The monitoring and evaluation program should include the following: (i) *baseline*, measures of the status of biodiversity values prior to the project's impacts; (ii) *process*, monitoring of the implementation of mitigation measures and management controls; and (iii) *outcomes*, monitoring of the status of biodiversity values during the life of the project, compared to the baseline. In addition, clients should consider *controls*, monitoring in comparable areas where project impacts are not occurring to detect effects unrelated to project impacts. **The client is expected to develop a practical set of indicators (metrics) for the biodiversity values requiring mitigation and management. Indicators and sampling design should be selected on the basis of *utility*, that is, their ability to inform decisions about mitigation and management, and *effectiveness*, their ability to measure effects with adequate statistical power given the estimated ranges of natural variability for each biodiversity value.** Proxy indicators for some biodiversity values may be necessary to satisfy these criteria.

GN52. **Specific thresholds should be set for monitoring results that will trigger a need to adapt the management plan(s)** to address any deficiencies in performance. The results of the monitoring program should be reviewed regularly. If they indicate that the actions specified in the management plan(s) are not being implemented as planned, the reasons for failure need to be identified (for example, insufficient staff, insufficient resources, unrealistic timeline, etc.) and rectified. If outcome monitoring results indicate that project impacts to biodiversity values were underestimated or that the benefits to biodiversity from management actions including offsets were overestimated, the impact assessment and management plans should be updated.

IFC PS6 Guidance Note (2012, Updated 2019)

GN90. In areas of critical habitat, the client will be expected to **demonstrate net gains in biodiversity values** for which the critical habitat was designated, as stated in paragraph 18 of Performance Standard 6. Net gains are defined in footnote 15 of Performance Standard 6 and could **be considered "no net loss *plus*;" therefore, the requirements defined for critical habitat build upon and expand those defined for natural habitat.** Net gains may be achieved through the biodiversity offset. As described in footnote 15 of Performance Standard 6, net gains of biodiversity values must involve measurable, additional conservation outcomes. Such gains must be demonstrated on an appropriate geographic scale (e.g., local, landscape-level, national, regional) as determined by external experts. In instances where a biodiversity offset is not part of the client's mitigation strategy (i.e., there are no significant residual impacts), net gains may be obtained by supporting additional opportunities to conserve the critical habitat values in question. In these cases, qualitative evidence and expert opinion may be sufficient to validate a net gain.

Pressure-State-Response Monitoring Approach

There are many approaches to long-term monitoring for biodiversity that can be used.

One good approach is the Pressure-State-Response Model in which the program monitors:

Pressure Indicators – Indicators of the stressors or impacts (e.g. minimum river flow rate in dry season, #days dry river, #illegal fishing nets, #sand mining operations)

State Indicators – Indicators of the current state/condition of the target biodiversity values (e.g. #fish individuals/hour, macroinvertebrate indices, area of riverine habitat)

Response Indicators – Indicators of the mitigation actions implemented to avoid or reduce impacts on biodiversity (e.g. release of EFlows, fish ladder operation, #patrols for illegal fishing, km of river enhanced)

Sampling Design and Field Methods

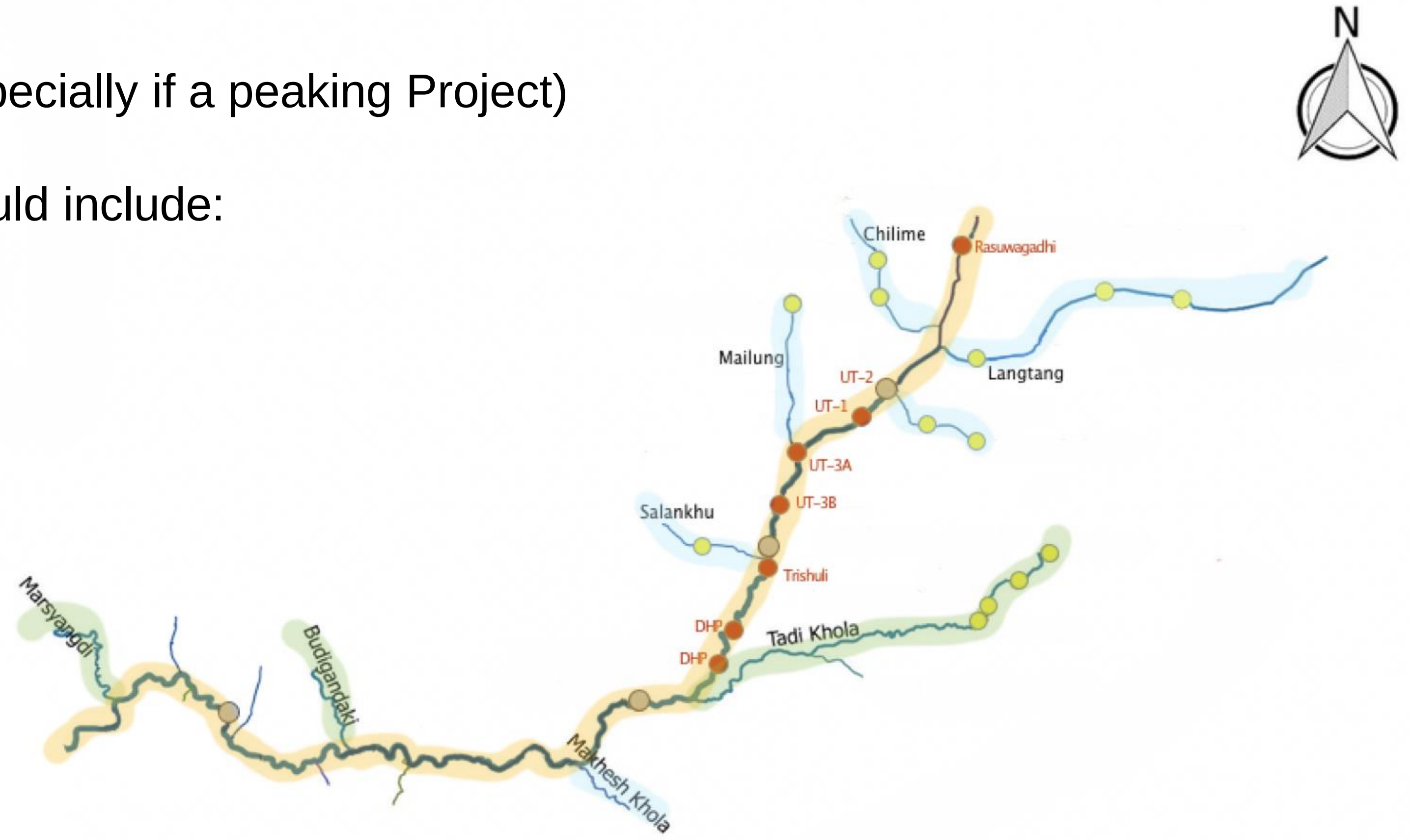
Sampling Design for Hydropower Project

A Monitoring Program should include sampling in three River Units:

1. Upstream of Hydropower Project, including reservoir area
2. Diversion reach
3. Downstream of Power House (especially if a peaking Project)

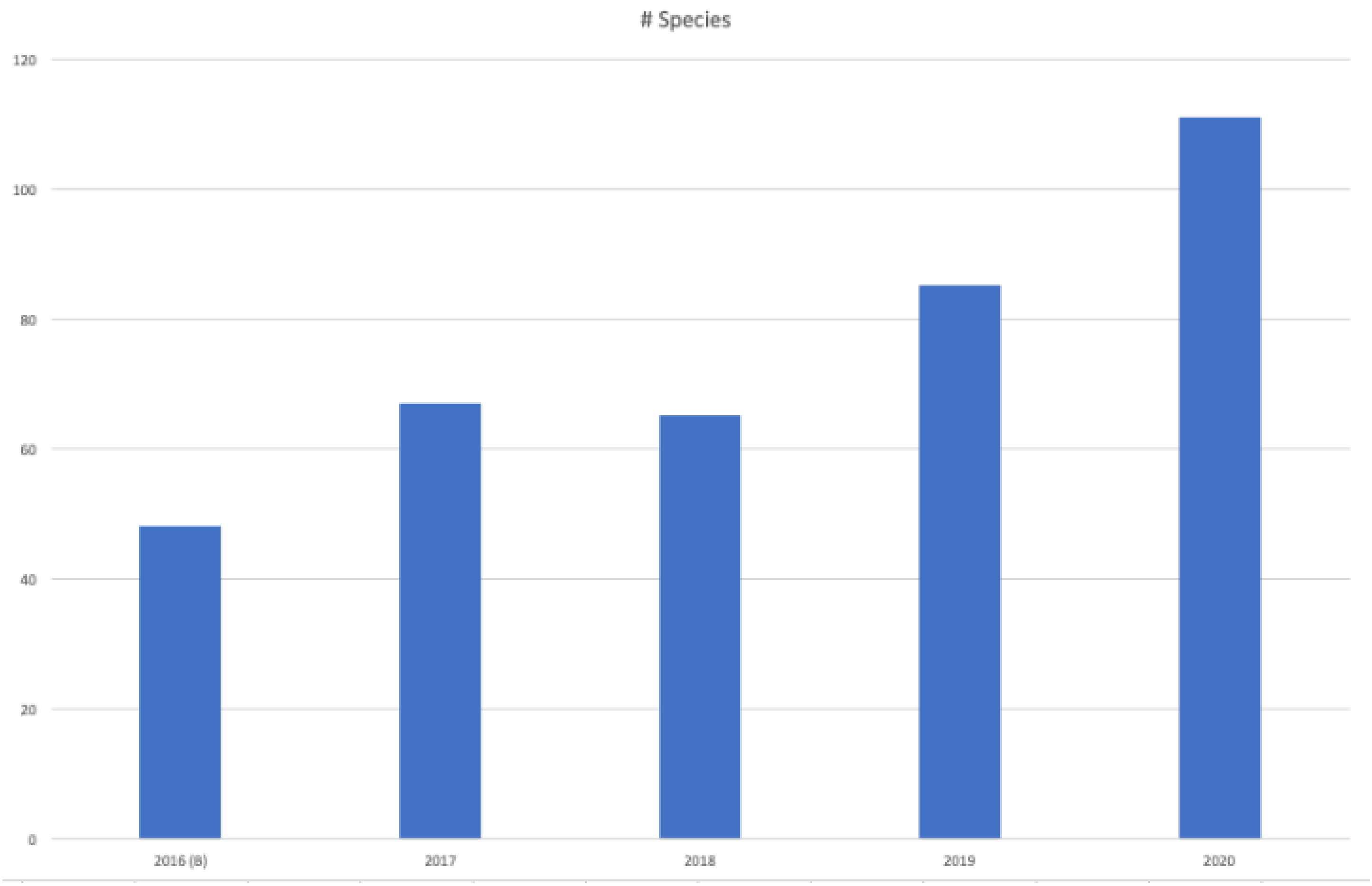
Within each River Unit, sampling sites should include:

- Main Stem
- Large Tributaries
- Small Tributaries
- River Tributaries

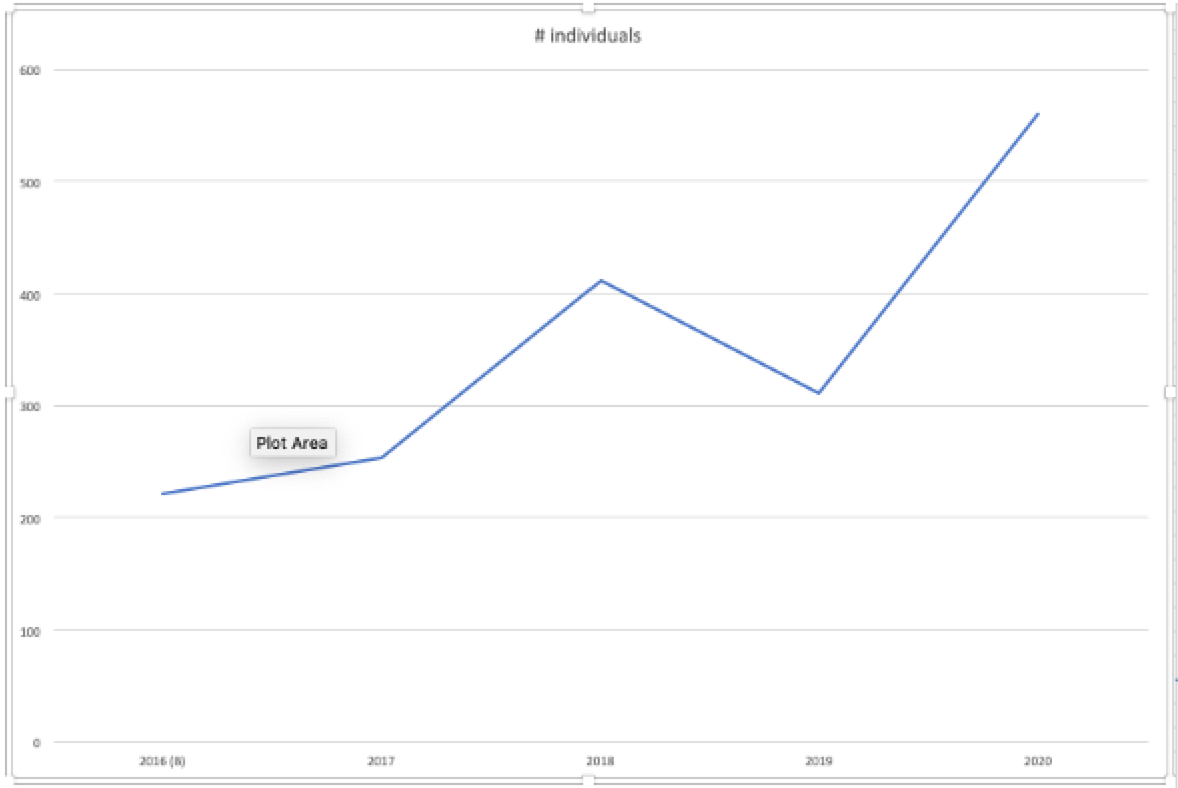


Common sampling design and data presentation for project monitoring Not Adequate

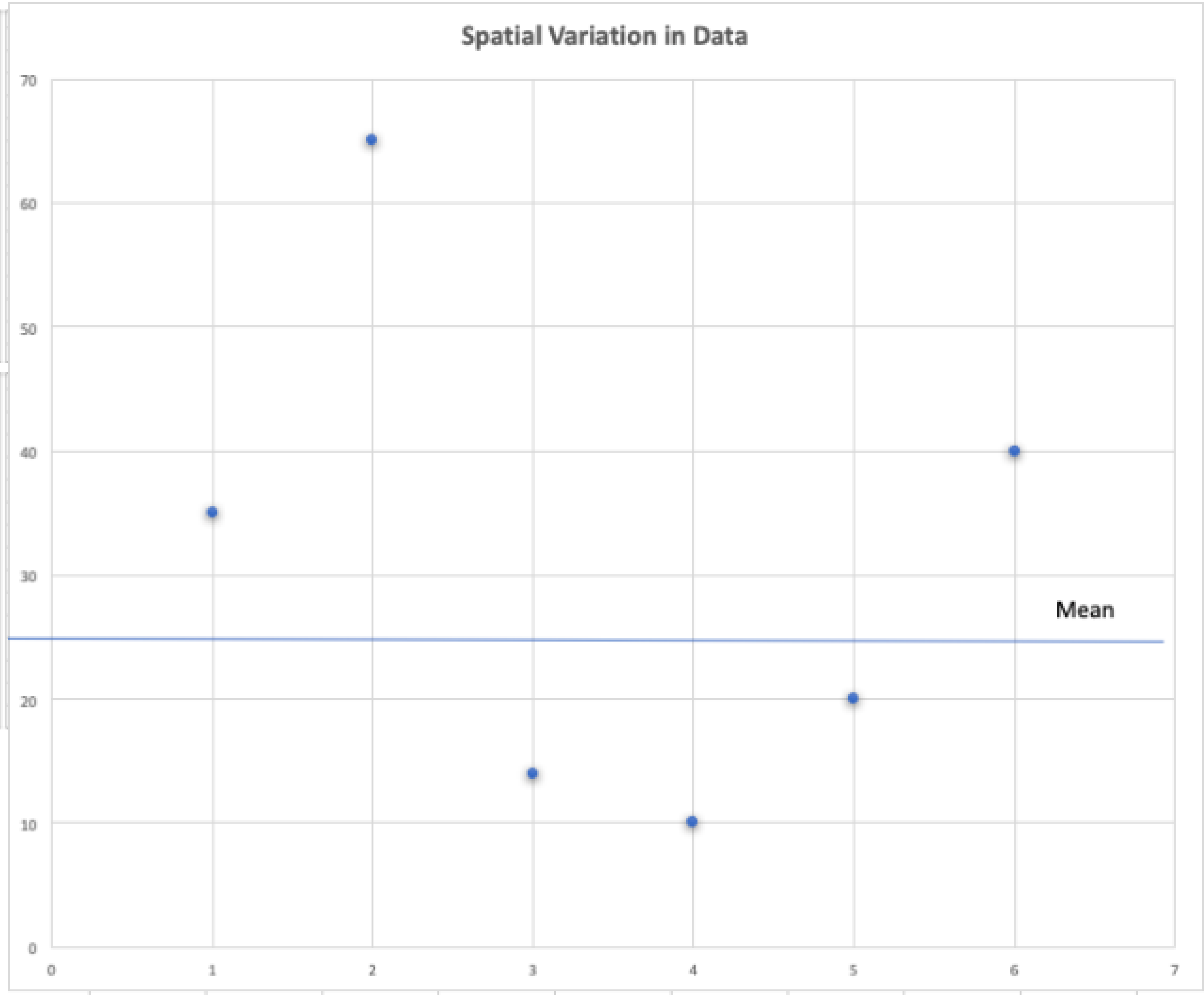
- Set of sampling sites across the entire project area, rather than in the 3 target River Units
- Small number of sampling sites (<5)
- Combining the data for total # of species, or total # individuals across all sites (and all methods)



Plotting one number per site is not representative



Need to understand the natural variation



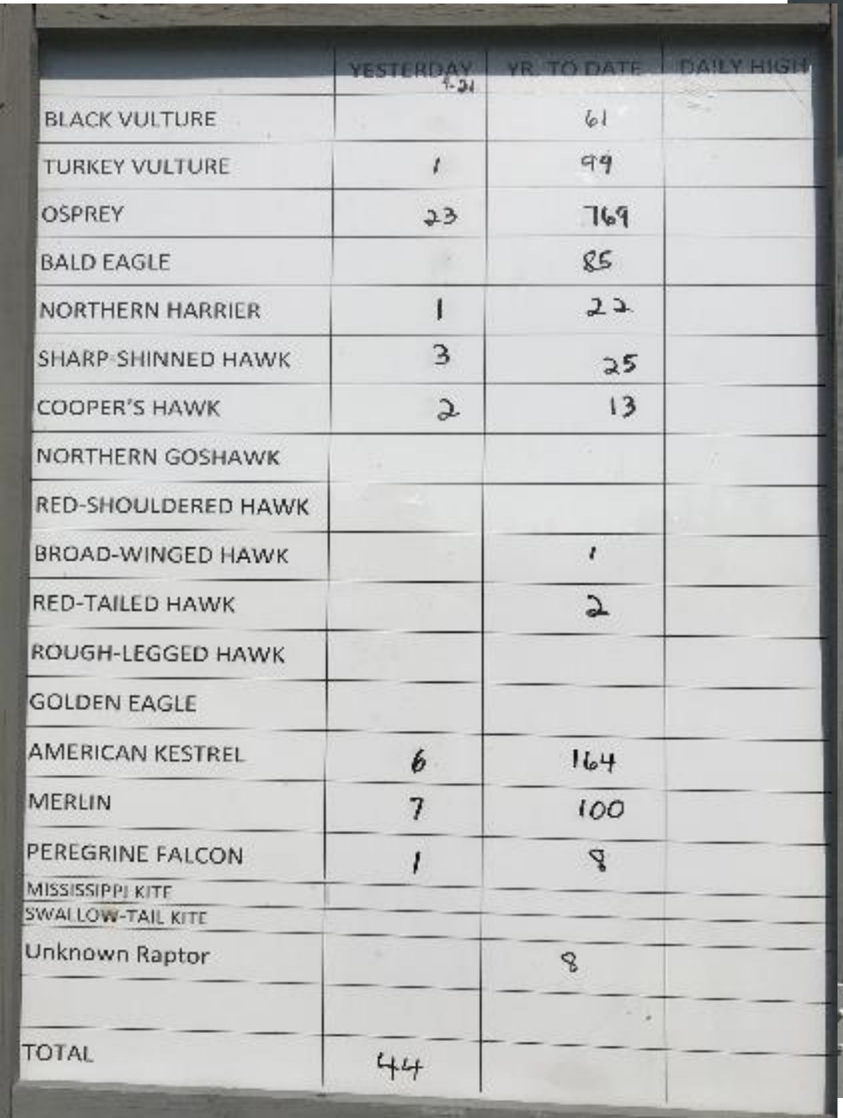
Need Multiple Samples (Replicates) to capture Natural Variation

Due to the high variation in natural ecosystems, it is important to have Multiple Replicates per River Unit (Upstream, Diversion Reach, Downstream of Power House)

- Replicates can be Spatial – multiple sites
- Replicates can be Temporal – multiple dates
- Due to time and cost constraints, replicates are usually done spatially
- Statistical analyses to compare data over time require at least 5 replicates per sampling period (e.g. season) (Again, the more sampling sites the better!)

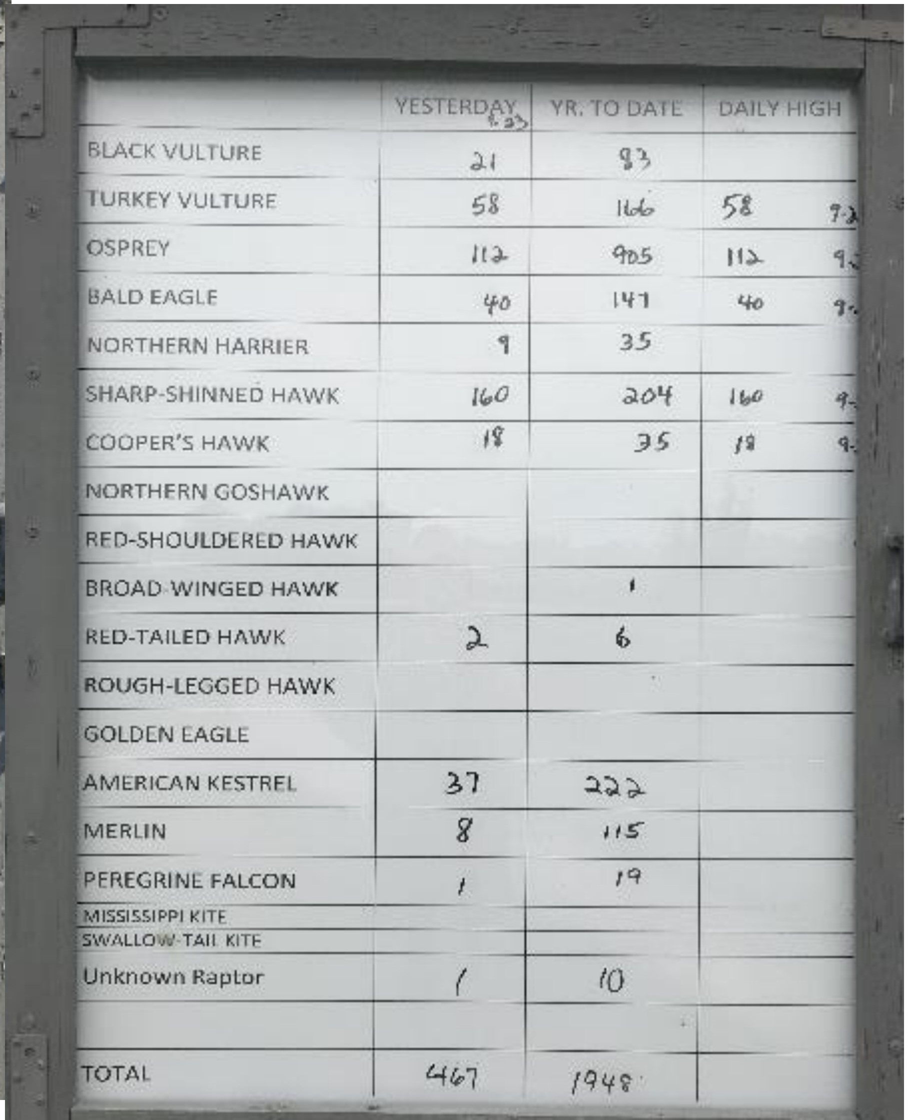
Trishuli Assessment Tool recommends 6 sampling sites in each of the 3 River Units (18 sampling sites)

Example of Temporal Replicates
Migrating Raptors counts, September 2020 USA



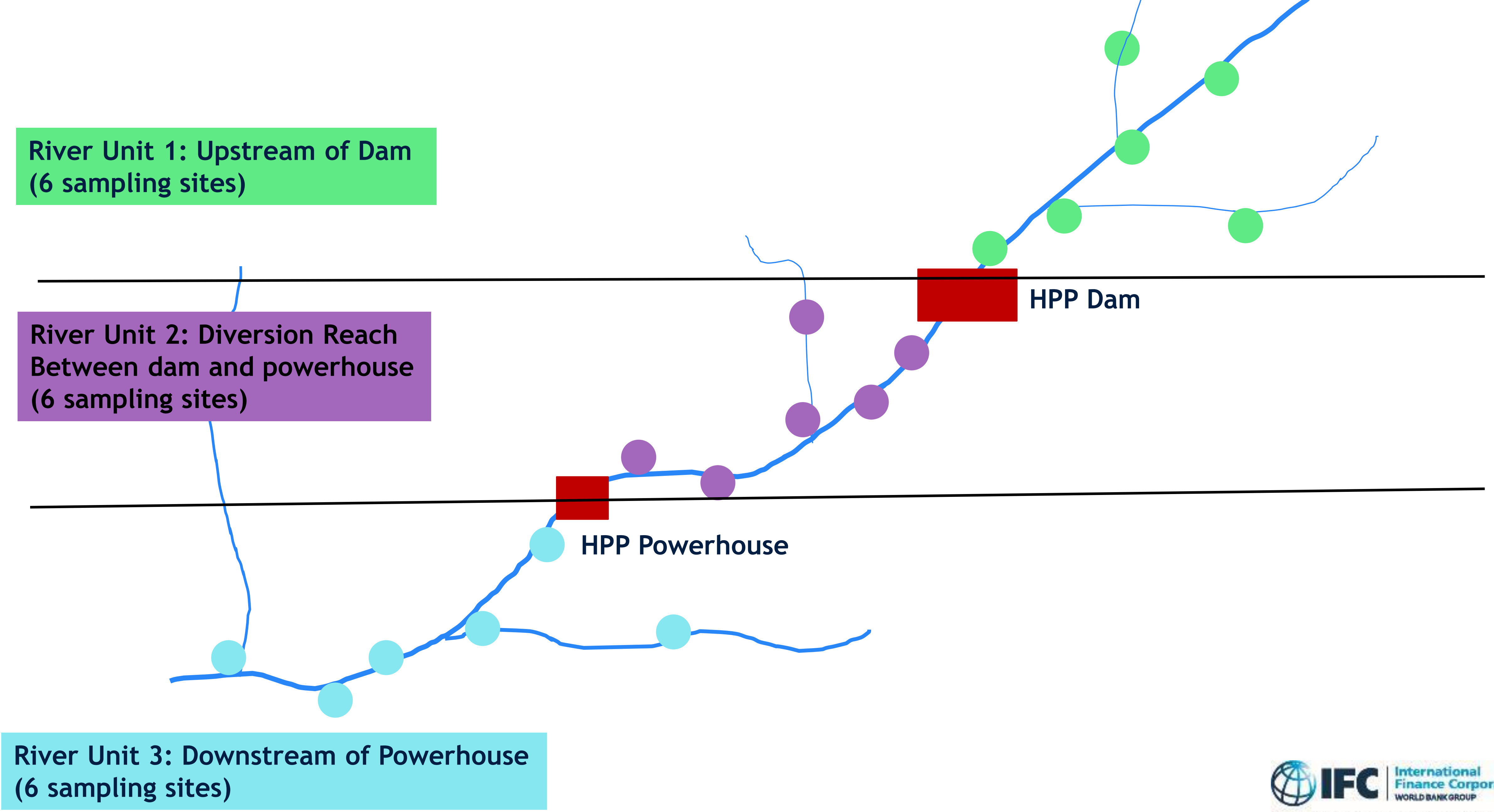
	YESTERDAY 9-21	YR. TO DATE	DAILY HIGH
BLACK VULTURE		61	
TURKEY VULTURE	1	99	
OSPREY	23	769	
BALD EAGLE		85	
NORTHERN HARRIER	1	22	
SHARP-SHINNED HAWK	3	25	
COOPER'S HAWK	2	13	
NORTHERN GOSHAWK			
RED-SHOULDERED HAWK			
BROAD-WINGED HAWK		1	
RED-TAILED HAWK		2	
ROUGH-LEGGED HAWK			
GOLDEN EAGLE			
AMERICAN KESTREL	6	164	
MERLIN	7	100	
PEREGRINE FALCON	1	8	
MISSISSIPPI KITE			
SWALLOW-TAIL KITE			
Unknown Raptor		8	
TOTAL	44		

	YESTERDAY 9-23	YR. TO DATE	DAILY HIGH
BLACK VULTURE	1	62	
TURKEY VULTURE	9	108	
OSPREY	24	793	
BALD EAGLE	22	107	
NORTHERN HARRIER	4	26	
SHARP-SHINNED HAWK	19	44	
COOPER'S HAWK	4	17	
NORTHERN GOSHAWK			
RED-SHOULDERED HAWK			
BROAD-WINGED HAWK		1	
RED-TAILED HAWK	2	4	
ROUGH-LEGGED HAWK			
GOLDEN EAGLE			
AMERICAN KESTREL	21	185	
MERLIN	7	107	
PEREGRINE FALCON		18	
MISSISSIPPI KITE			
SWALLOW-TAIL KITE			
Unknown Raptor	1	9	
TOTAL	114	1481	



	YESTERDAY 9-23	YR. TO DATE	DAILY HIGH
BLACK VULTURE	21	83	
TURKEY VULTURE	58	166	58 9-2
OSPREY	112	905	112 9.
BALD EAGLE	40	147	40 9-
NORTHERN HARRIER	9	35	
SHARP-SHINNED HAWK	160	204	160 9-
COOPER'S HAWK	18	35	18 9-
NORTHERN GOSHAWK			
RED-SHOULDERED HAWK			
BROAD-WINGED HAWK		1	
RED-TAILED HAWK	2	6	
ROUGH-LEGGED HAWK			
GOLDEN EAGLE			
AMERICAN KESTREL	37	222	
MERLIN	8	115	
PEREGRINE FALCON	1	19	
MISSISSIPPI KITE			
SWALLOW-TAIL KITE			
Unknown Raptor	1	10	
TOTAL	467	1948	

Example Monitoring Sampling Design



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At each sampling site, apply the Trishuli Assessment Tool Field Methods

Backpack Electrofishing

Cast Net

Dip Net

Visual Asessment with Underwater Camera

Environmental DNA

Macroinvertebrate and Periphyton Sampling

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Sampling Effort for each Field Method - Standardized

Method	Effort Units	Number of units	Approx. Sampling/ Total Time *RECORD THE TIME SPENT SAMPLING	Personnel
Electrofishing	Time sampling with current on (minutes)	20 min US/20 min DS (40 minutes total/site)	40 min/120 min	3 people
Cast Net	Cast Net Throws Time for 25 throws (mins)	12 US/1 MP/12 DS (25 total/site)	60 min/120 min	2 people
Dip Net	Dip Net Emersions	10 samples/site	30 min/60 min	1 person
Underwater Video	Camera sets	5 minute recording/set 6 sets US / 6 sets DS (12 sets/site)	60 min/90 min	1 person
eDNA	2 L water samples	5 samples+1 control/site (6 samples/site)	60 min/180 min	2-4 people
Macroinvertebrate sampling	Net subsamples	20 total over different substrate types	60 min/150 min	2-3 people
Periphyton sampling	Rock Scraped	5 per site	15 min/30 min	2-3 people

Metrics and Data Analysis

Long-term Monitoring Questions and Metrics

Questions

1. How has the number of individuals of target species changed over time?
2. How has the number of species changed over time?
3. How has the distribution of species changed over time?
4. How has the composition of species changed over time?

Monitoring analysis requires specific Metrics to quantitatively compare over time

1. CPUE = Catch (# individuals) Per Unit Effort (hours) per site per season per year
2. SPUE = Species (# species) Per Unit Effort (hours)
3. Habitat area (m^2) (e.g. riffle habitat)
4. #juvenile fish/10 dip nets
5. Macroinvertebrate analysis has specific indices and metrics (see Macroinvertebrate webinar)

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Quantitative Metrics for Long-term Monitoring with the Trishuli Assessment Tool

Target	Indicator	Metric
Overall Aquatic Biodiversity	Composition	Species names
	Species Richness (# species)	# species / hour (SPUE)
	Abundance of target species	# individuals / hour (CPUE)
Snow Trout adults and juveniles (*Schizothorax richardsonii*)	Abundance	# individuals / hour (CPUE)
Golden Mahaseer adults and juveniles (*Tor putitora*)	Abundance	# individuals / hour (CPUE)
Macroinvertebrates/Periphyton	Richness and abundance of key taxa	EPT Index
	Functional Feeding Groups	Ratio of groups

Common Snow Trout, *Schizothorax richardsonii*

Data Collection
Sample Data from the Tadi Khola, February 2020

Metric	Electrofishing	Cast Nets	Dip Nets
Total # fish individuals (N)	106	20	30
Total Effort (minutes)	32	57	20
Total Effort (hours)	0.53	0.95	0.33
CPUE (# individuals/hour)	199	21.1	90
Species Richness - Total # fish species (S)	15	4	1
SPUE (# species/hour)	28	4.2	3

Monitoring Comparisons: Compare Like with Like

- Control for other variables that may cause differences/changes such as season, location, time of day, researcher, climatic events, other disturbances, etc.

- Comparisons made for each River Unit separately (6 sampling points/unit)
  - Upstream Baseline compared to Upstream Monitoring Year 1, Year 2, etc.
  - Diversion Reach Baseline compared to Diversion Reach Monitoring Year 1, Year 2, etc.
  - Downstream of Powerhouse Baseline compared to Downstream Monitoring Year 1, Year 2, etc.

- Baseline Year (pre-construction) compared to Monitoring Years (during and post-construction)

- Same Season compared to Same Season
  - February compared to February
  - October compared to October

Data Analysis Excel Tool
for monitoring fish abundance over time

Tool is based in Excel for ease of use, linked with statistical program 'R'

Tool was developed by:

- Jonathan Levin, University of Witswatersrand, Johannesburg, South Africa
- Gina Walsh, Aquatic Biologist, Consultant and The Biodiversity Consultancy
- Claire Fletcher, The Biodiversity Consultancy
- Emma Hume, The Biodiversity Consultancy

Objective of the Tool:

To provide a simple user-friendly data analysis tool to compare monitoring data over time to:

- Track changes in indicator/metric
- Assess mitigation success
- Demonstrate NNL or NG to meet lender's requirements
- This version was designed for snow trout in Trishuli River, but can be modified for other species and locations, as well as other metrics

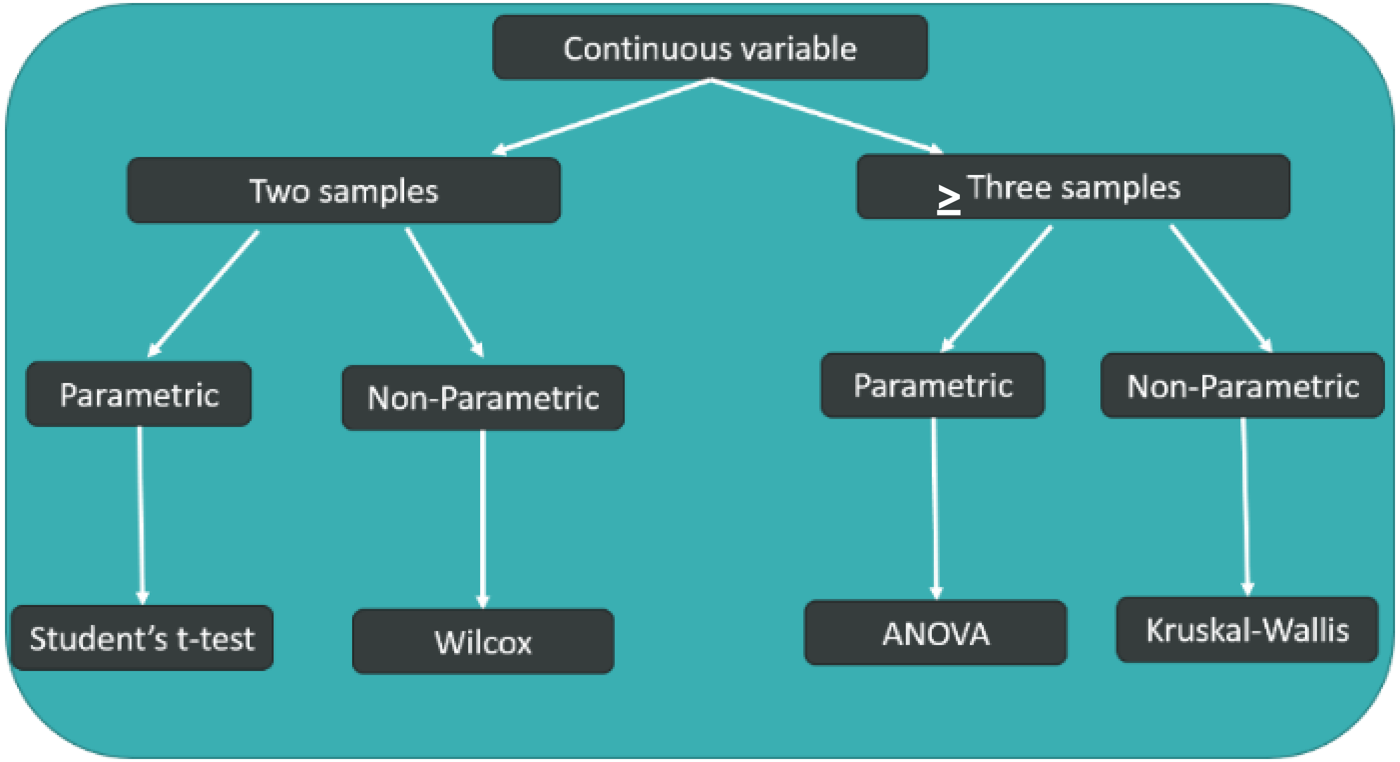
The Tool is still in development/refinement. We welcome comments and suggestions. We can schedule another session to discuss the details if people are interested.

Step 1: Enter Field Data into Excel Spreadsheet

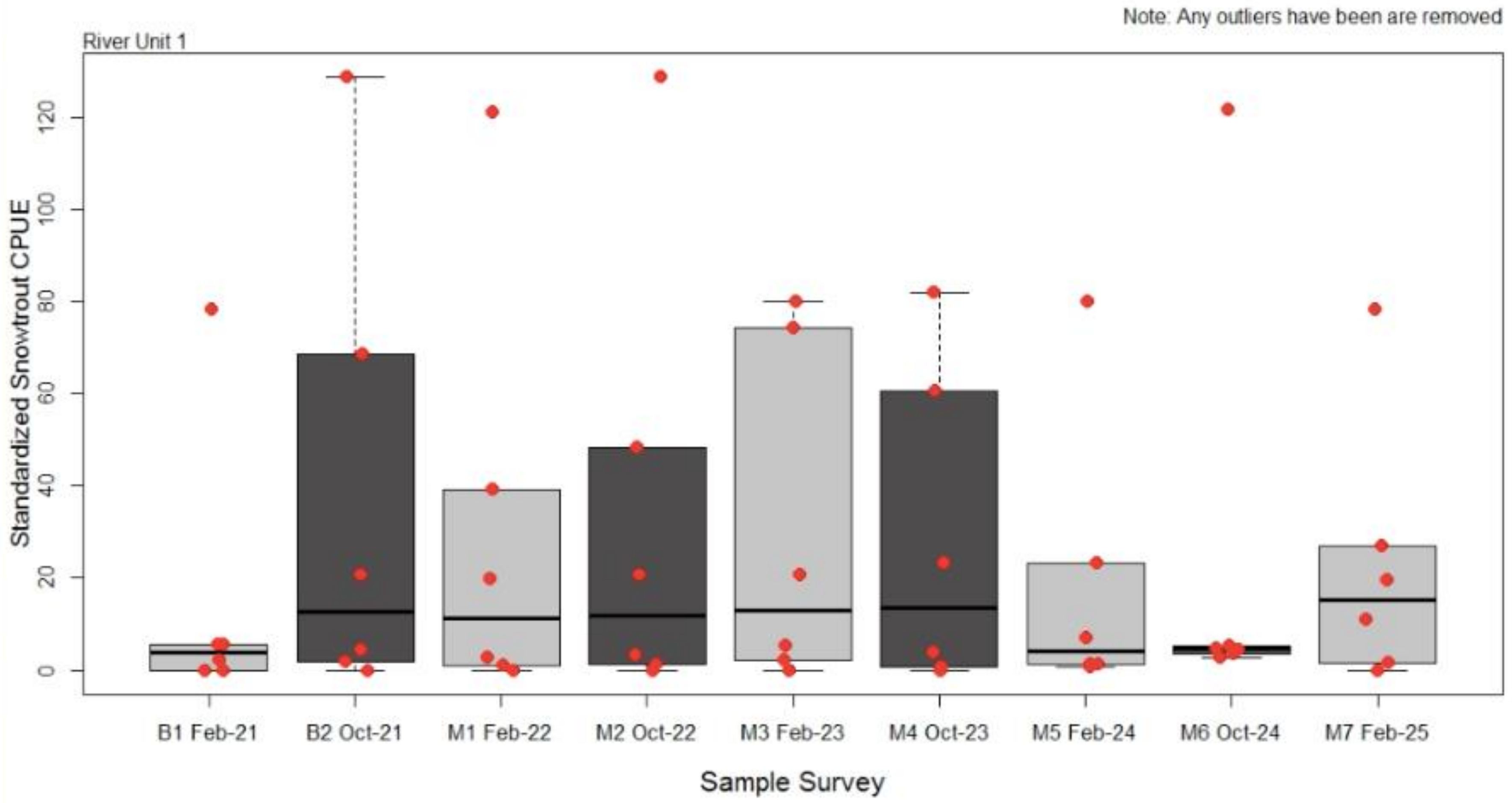
Sampling Site	Sampling Method	# fish	Time (Minutes)
Upstream 1	Electrofishing		
	Cast Nets		
	Dip Nets		
	Video (Camera)		
	Seine Nets		
Upstream 2	Electrofishing		
	Cast Nets		
	Dip Nets		
	Video (Camera)		
	Seine Nets		
…..			

Step 2: Excel Tool calculates standardized CPUE for all field methods combined

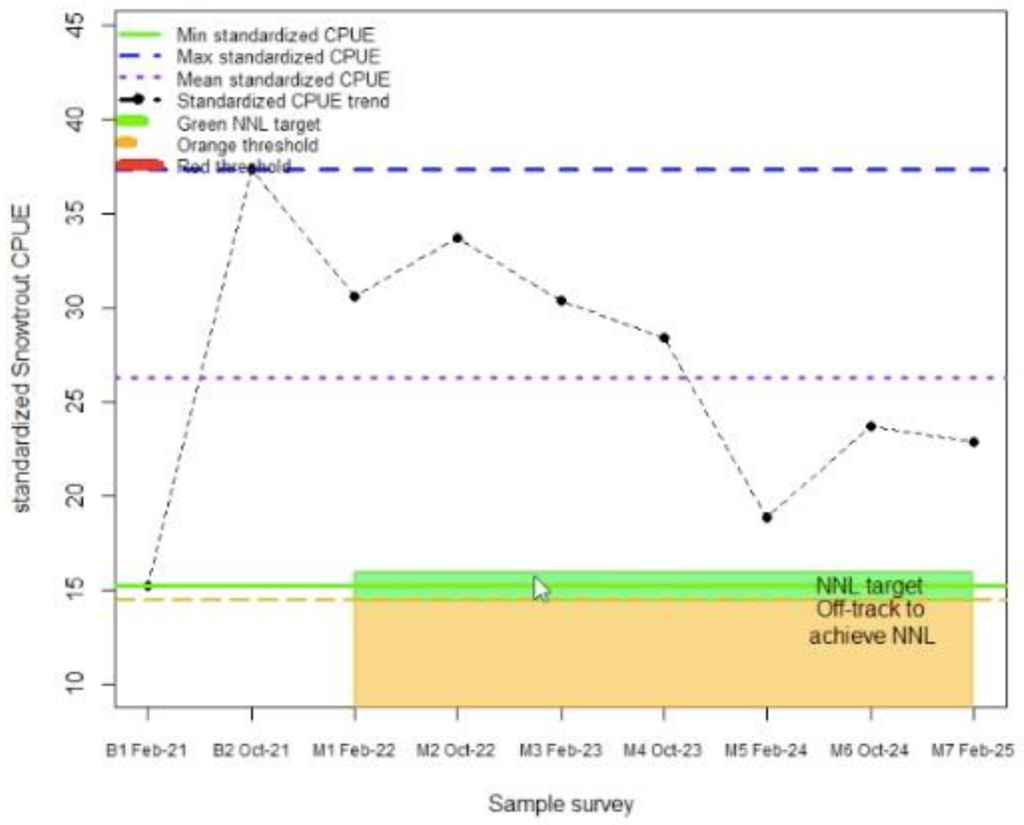
Step 3: Compare Mean Standardized CPUE between Baseline and Monitoring Year(s)

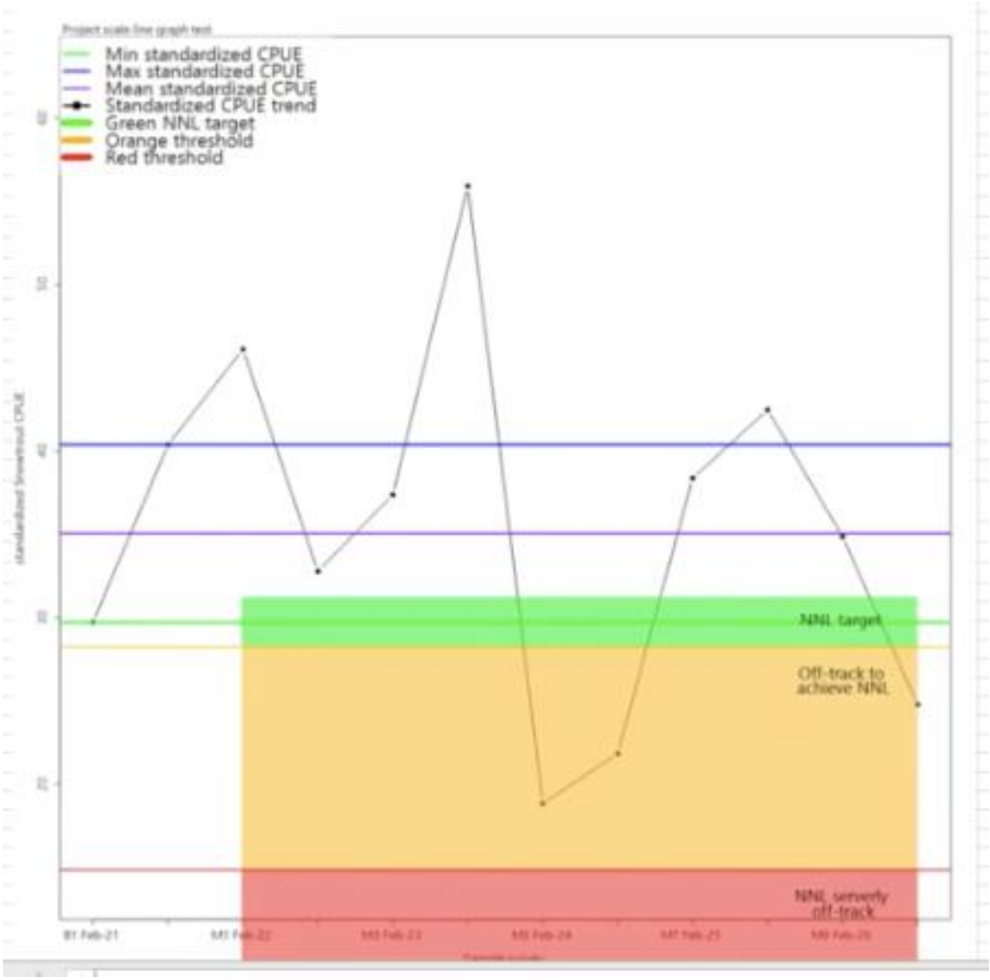


Step 4: Visualize the Data Comparison with BoxPlot



Step 5: Visual Trends Analysis and Thresholds for NNL and Net Gain Numerical Thresholds and Adaptive Management





Data Analysis Excel Tool for monitoring fish abundance over time (video presentation)

Presenter:

Jonathan Levin

PhD Candidate in Ecohydrology

University of the Witwatersrand, South Africa

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Q & A Session

Moderator:

Ms. Kate Lazarus

Senior Asia ESG Lead

IFC

Next Steps

Trishuli Assessment Tool Kit

- Manual
- Recordings of February Webinars
- Powerpoints from February Webinars
- In-person Training Courses

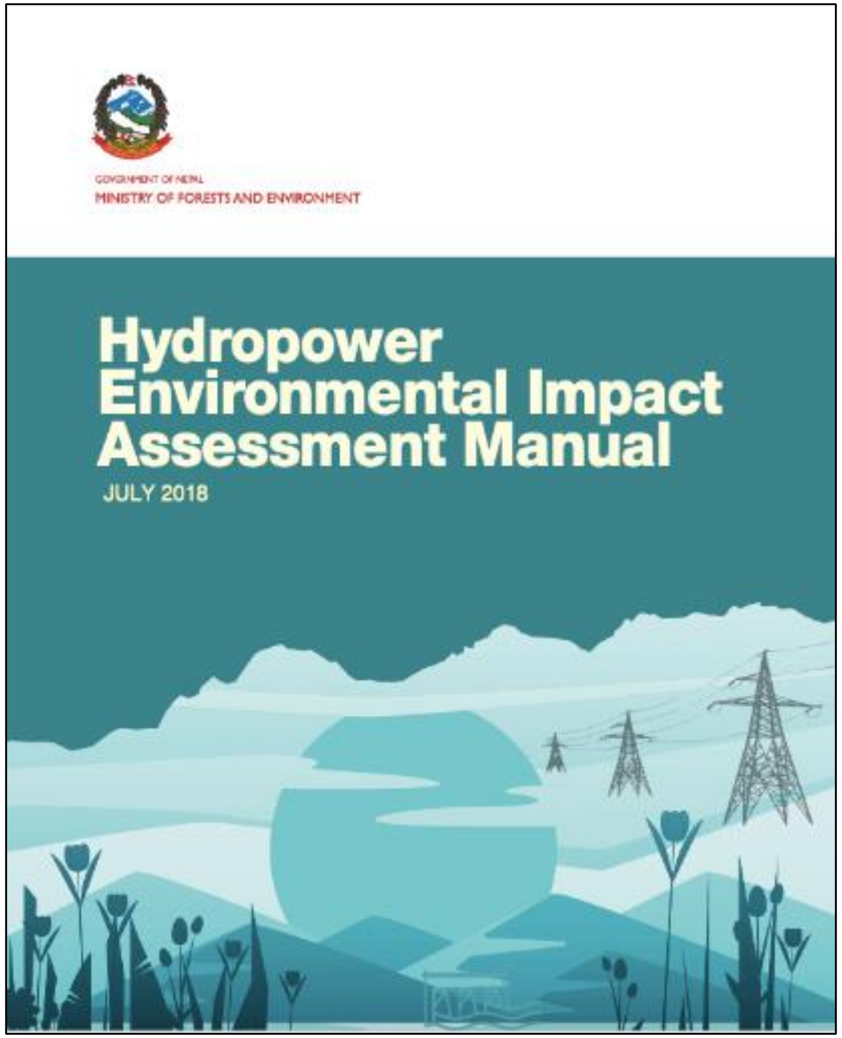
Develop local capacity for the Trishuli Assessment Tool

Promote use of the Trishuli Assessment Tool for ESIAs

- NEA
- Private Hydropower Developers
- Everyone!

Link with the Freshwater Ecosystem Assessment Handbook

- Companion handbook to the Hydropower Environmental Impact Assessment Manual (MoFE)
- Forthcoming from ICIMOD and Forest Research Training Centre (FRTC)
- Prepared by Deep Shah and Ram Devi Tachamo Shah
- Webinar on May 11



http://mofe.gov.np/downloadfile/Hydropower%20Environmental%20Impact%20Assessment%20Manual_1537854204.pdf

Next up in the IFC Webinar Series

Coming up in March:

- **March 16: Novel approaches to tracking fish movements**
- **March 23: Re-thinking Hatcheries: A Review of costs and benefits**

by Julie Claussen and David Phillip, Fisheries Conservation Foundation

Closing Remarks

Babacar Faye

Resident Representative

IFC, Nepal

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Thank you !