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Intelligent fish recognition in fish pass facilities of water conservancy and hydropower projects

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XVIII WORLD WATER CONGRESS Water for All Harmony between Humans and Nature

第18届 世界水资源大会 水与万物：人与自然和谐共生

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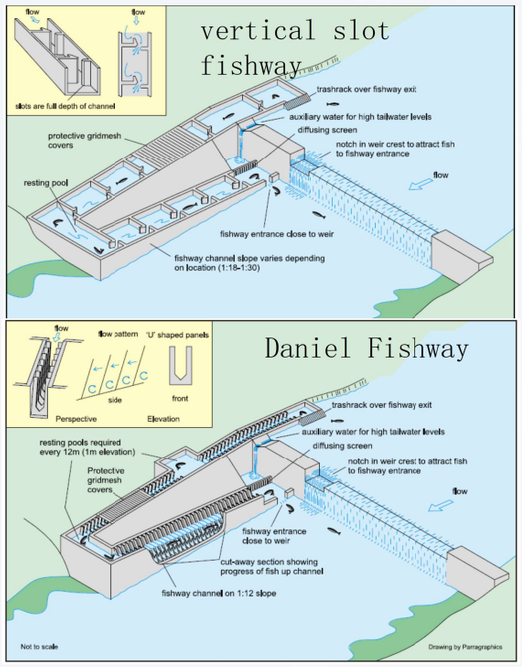
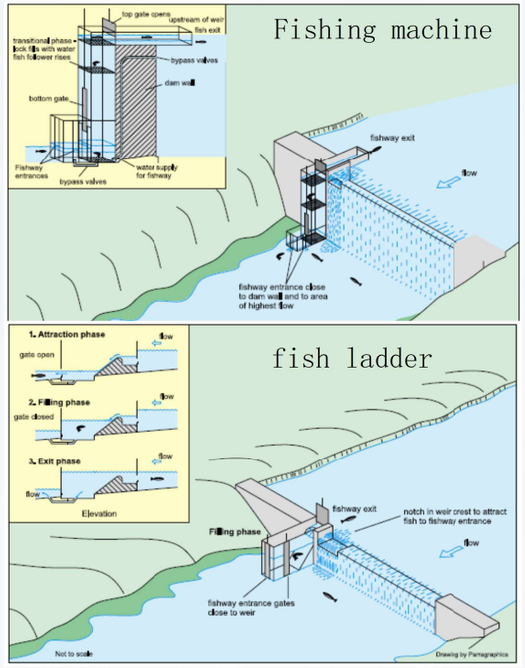
- Background and significance
- Research Methods and Ideas
- Research results and conclusions
- Applications and preliminary work

Background and significance of the study





- China possesses the largest amount of water resources globally, and the construction of medium and large-scale hydropower stations has become a crucial strategy for water resource development
- Dams can disrupt river connectivity and impede fish migration
- The construction of fish pass facilities has been identified as an important measure
- Fish passage monitoring is a key step in evaluating the effectiveness of fish pass facilities and serves as important evidence for optimizing operational methods

Background and significance of the study

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➢ Traditional fish passage monitoring methods

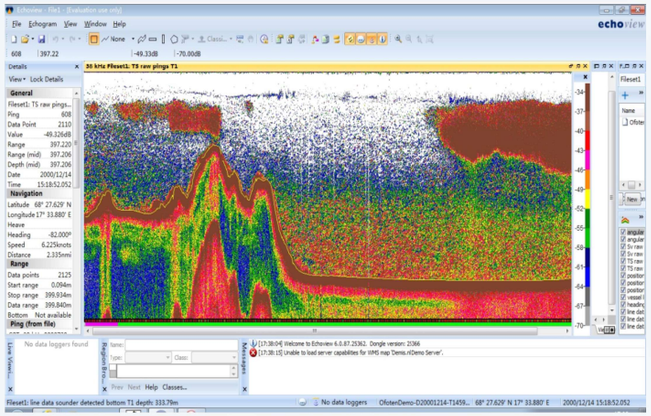
Traditional fish passage monitoring methods primarily rely on manual netting, acoustic surveys, and PIT tagging.

Traditional fish passage monitoring methods fail to meet the long-term dynamic monitoring requirements of fish pass facilities!

Manual netting

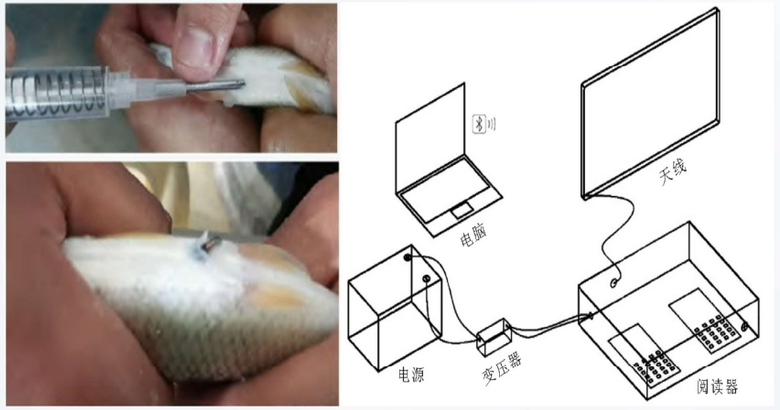
- ✓ Manual operations
- ✓ Low efficiency and accuracy
- ✓ Significant disruption to fish
- ✓ High cost

Acoustic surveys



- ✓ Calculating Fish by Echo Intensity
- ✓ Small monitoring range
- ✓ High threshold for data processing
- ✓ Weak anti-interference ability

PIT tagging



- ✓ Sampling monitoring
- ✓ Fish damage is significant
- ✓ Suitable for single evaluation
- ✓ Difficulty in continuous observation

Background and significance of the study

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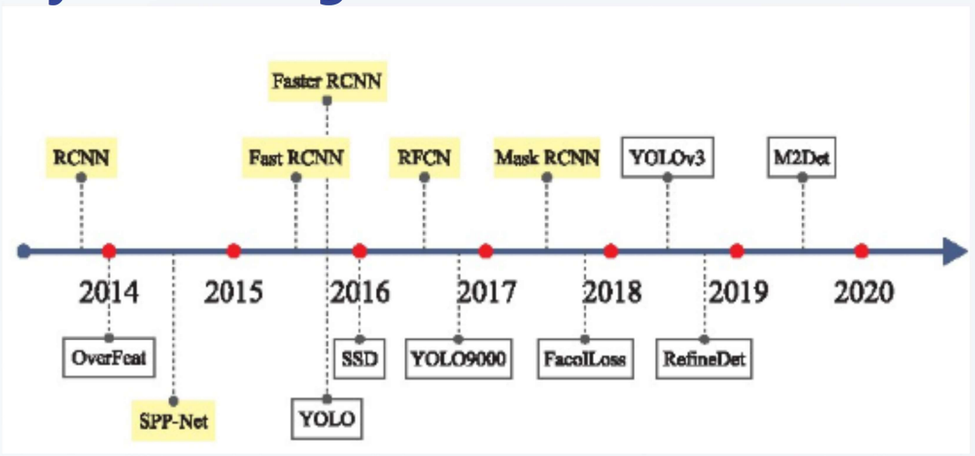
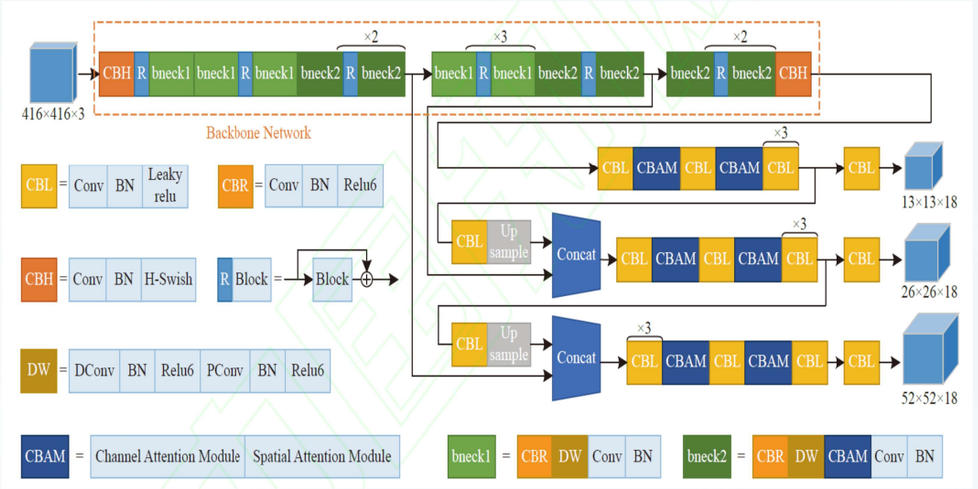
➢ Key Technologies and Practical Difficulties

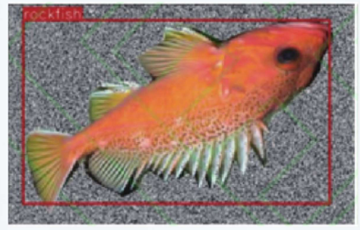


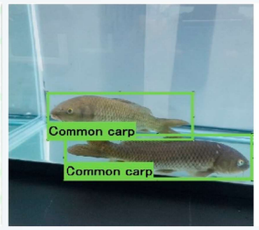


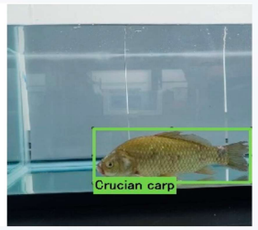
✓Research based on controlled environment

✓ Single backgrounds object detection

✓ Static scenes object detection







The conclusion is not convincing enough

Not applicable for fish passage monitoring

Background and significance of the study

➢ Key Technologies and Practical Difficulties

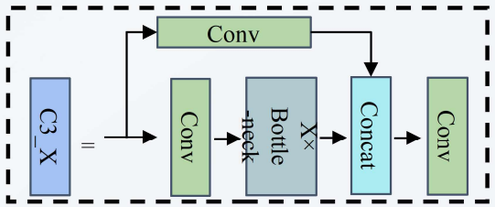
① Complex underwater imaging environment in fish passes

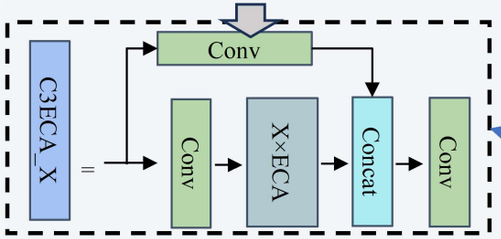
② High-speed upstream fish migration

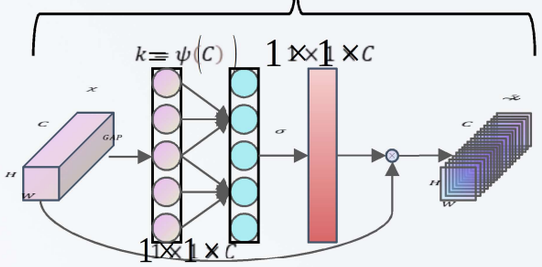
③ Dense fish schools obstructing passage

④ Difficulty in fish passage detection

Research Methods and Ideas

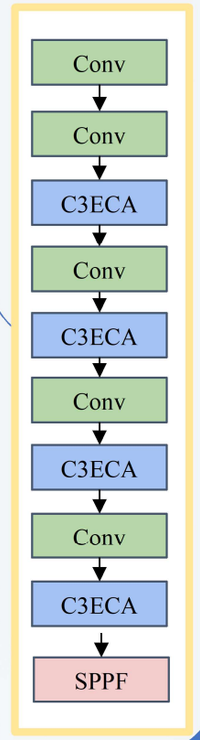


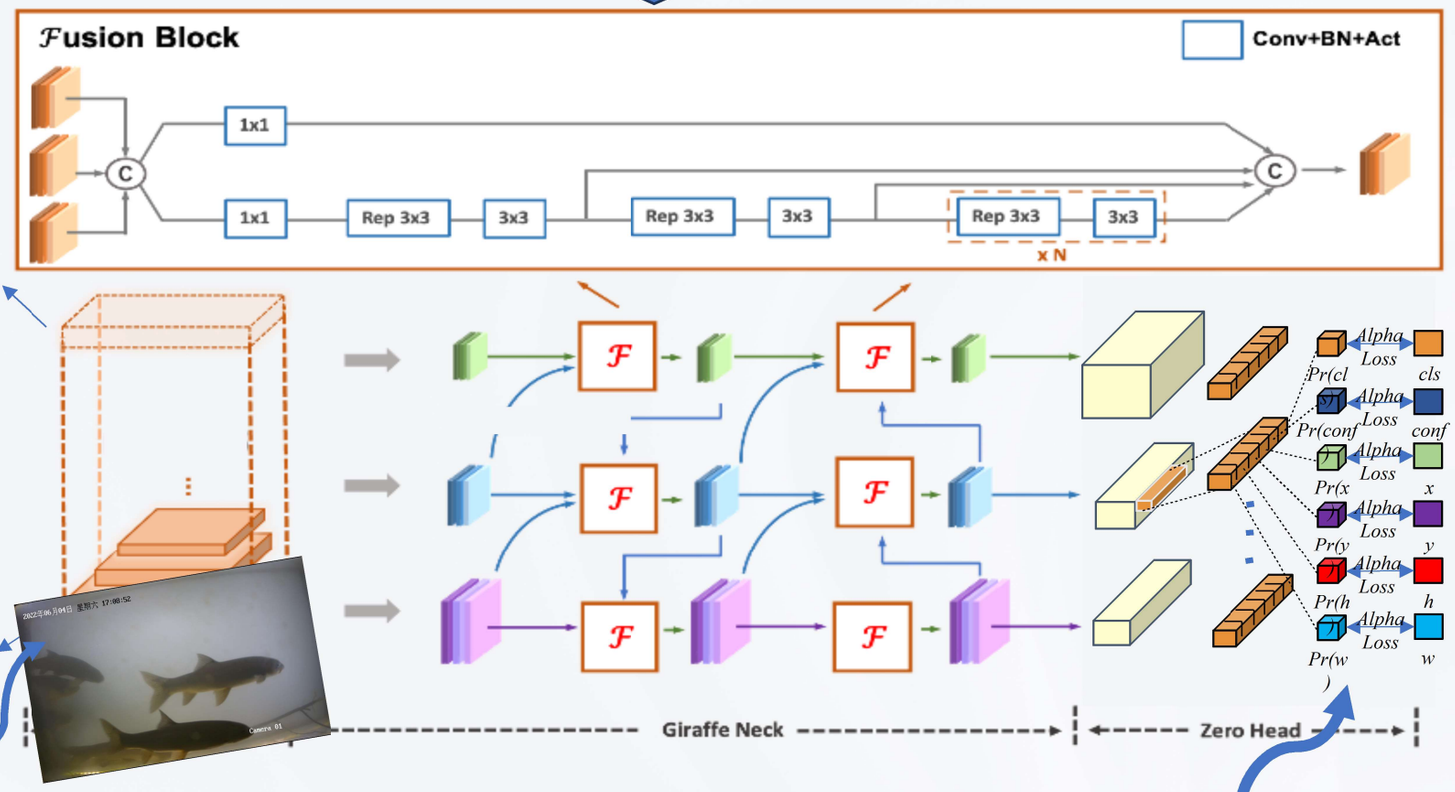




- The Efficient Channel Attention is used as the Bottleneck to reduce computational parameters and enhance detection accuracy

- The Efficient-RepGFPN is used as the Neck network in the model to enhance feature information decoding and improve the model's detection ability





- The AlphaIOU Loss is used as the model's loss function to enhance target localization and optimize the overall performance of the model.

Research results and conclusions

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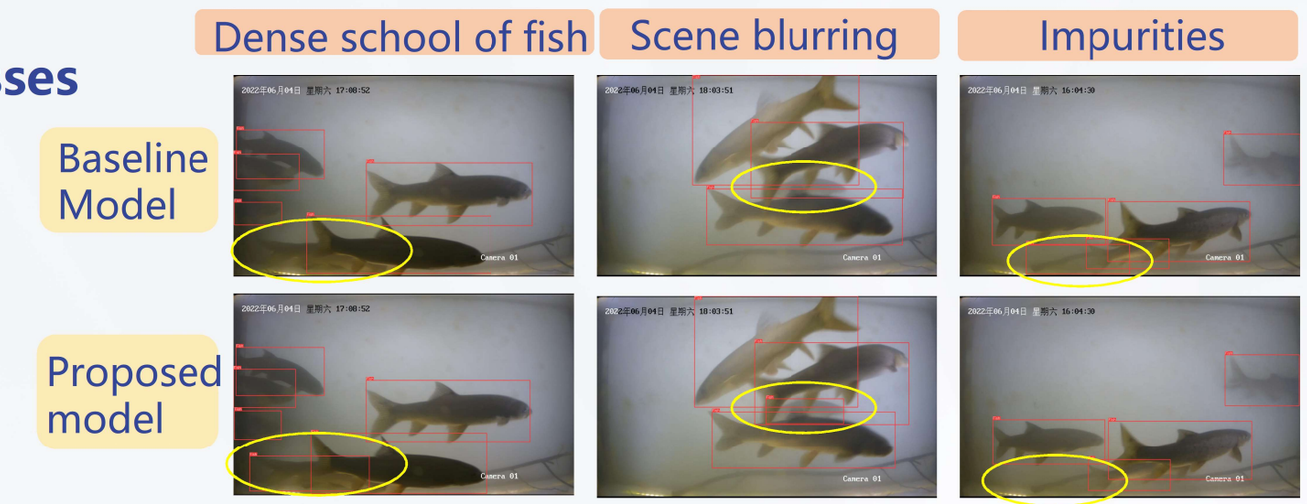
Analysis of ablation experiments

- ✓ Improved method provides various enhancements in accuracy, recall and precision of the model
- ✓ mAP@0.5 91.9%, our model achieved a 4.8% increase in accuracy compared to the Baseline model
- ✓ Effectively improving the detection ability of object in turbid water without affecting the processing speed

Model	C3ECA	EfficientRepGFPN	Alpha-IoU	Precision (%)	Recall (%)	mAP@0.5 (%)	Speed (ms/ img)
Baseline	-	-	-	84.6	78.2	87.1	10.8
B	√	-	-	90.0	77.3	89.4	8.1
C	-	√	-	86.3	84.6	90.4	11.0
D	-	-	√	80.6	81.3	87.1	6.7
E	√	√	-	89.1	82.9	91.4	12.2
F	-	√	√	87.4	81.2	90.3	9.3
G	√	-	√	86.3	82.7	89.4	7.2
Our	√	√	√	90.3	83.2	91.9	10.4

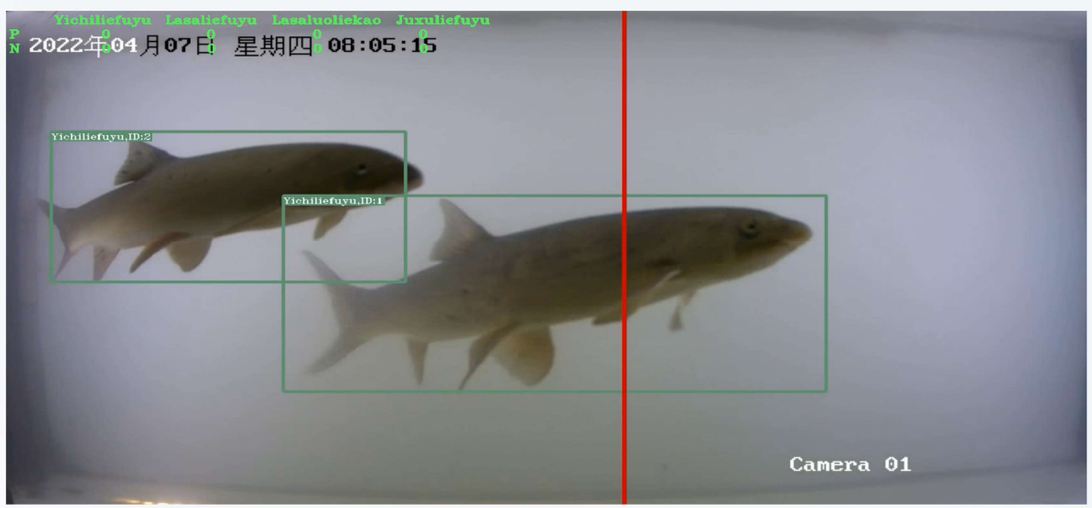
Monitoring of fish passage in fish passes

- ✓ Fish obscuration and low valid information
- ✓ Reduction of missed and false detections
- ✓ More robust and suitable for monitoring fish passes in complex water bodies



➢ Underwater fish species counts

- ✓ Record information on the category and quantity of fish currently passing through
- ✓ High accuracy based on guaranteed rapid detection, with over 90.1 per cent accuracy in different scenarios
- ✓ Improved efficiency of fish passage monitoring, saving labour costs and providing better alternatives or complements to fish passage monitoring



scenes	low density	medium density	high density
Number of fish	≤ 2	3~5	> 5

scenes	unit	Fish A	Fish B	Fish C	Fish D	Fish E	Average
low density	%	97.5	97.4	98.3	97.2	96.9	97.46
medium density	%	93.9	94.3	95.4	93.4	93.3	94.06
high density	%	91.2	91.8	92.6	90.5	90.1	91.24

Applications and preliminary work

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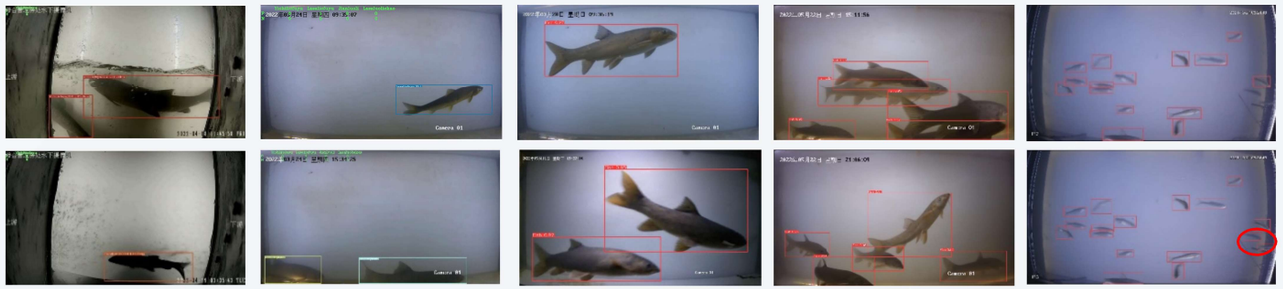
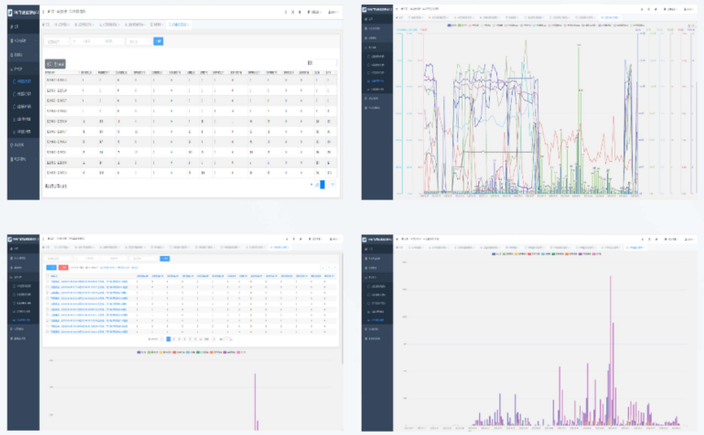
Intelligent monitoring of the effects of fish passage at a number of hydropower stations



Routine video monitoring Manual technical monitoring ⟷ Automated and intelligent monitoring

Long-term dynamic monitoring and statistical analysis of fish species and quantities, as well as a scientific assessment of fish passage effectiveness, fish population dominance, and distribution.



Applications and preliminary work

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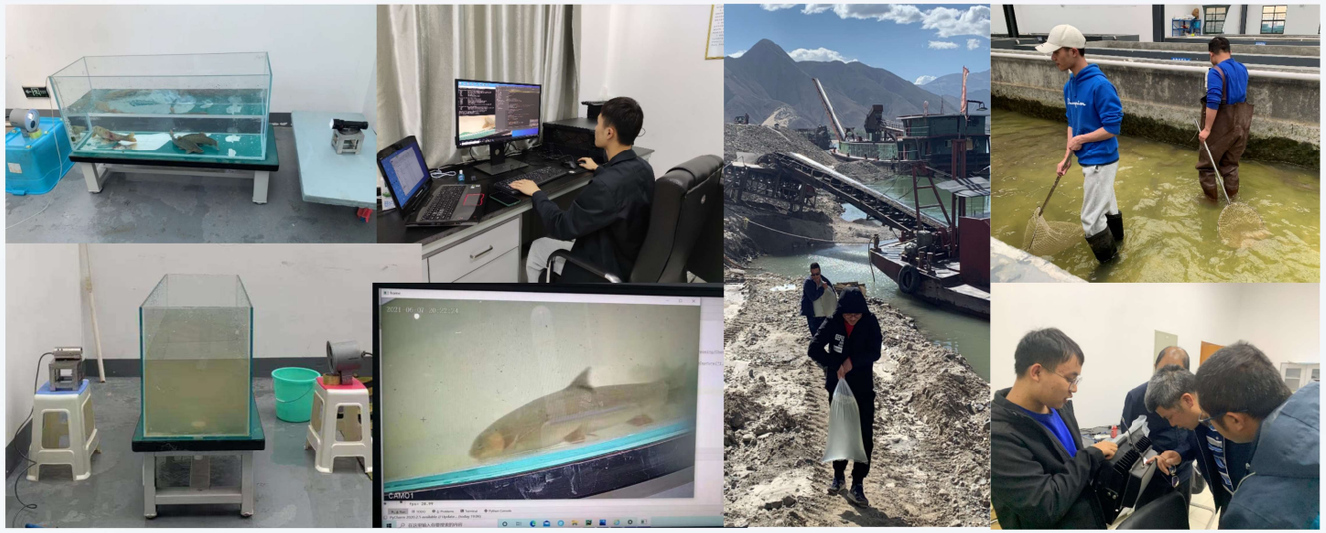

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Thank you!