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भारत सरकार /Government of India

मत्स्यपालन, पशुपालन और डेयरी मंत्रालय/

Ministry of Fisheries, Animal Husbandry and Dairying

मत्स्यपालनविभाग / Department of Fisheries

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चंद्रलोक बिल्डिंग, नई दिल्ली /

Chanderlok Building, New Delhi-110001

दिनांक /Dated 3rd November, 2026

Notice for Stakeholders Consultation

Subject: Inviting comments/suggestions on the Draft Standard Operating Procedure (SoP) for Application of Drone Technology in Fisheries and Aquaculture - regarding

1. The Department of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India, is promoting adoption of innovative and emerging technologies for the sustainable development and modernization of the fisheries and aquaculture sector. Among such technologies, drone-based solutions have emerged as a promising tool with significant potential to enhance operational efficiency, monitoring, resource management, surveillance, and live fish transport ertc.

2. Drone technology, encompassing both aerial Unmanned Aerial Vehicles (UAVs) and underwater Remotely Operated Vehicles (ROVs), can support a wide range of applications, including water quality monitoring, fish stock assessment, feed dispensing, disease surveillance, transportation of fish & fish seed, mapping and monitoring of aquatic ecosystems, environmental assessment, and disaster response and management.

3. With a view to facilitating the safe, efficient, and lawful deployment of drone technology in the fisheries and aquaculture sector, the Department of Fisheries has prepared a Draft **Standard Operating Procedure (SoP) for Application of Drone Technology in Fisheries and Aquaculture in India**.

4. The SoP provides a comprehensive framework governing the use of drone technology in fisheries and aquaculture operations. It covers operational procedures, regulatory compliances, safety requirements, permissions and approvals, operator competency and certification, as well as protocols relating to data collection, management, storage, and security.

5. The proposed framework is intended to support the adoption of drone technology across inland, reservoir, coastal, and marine fisheries and aquaculture activities, while ensuring compliance with applicable laws and regulations, including the Drone Rules, 2021, and guidelines issued by the Directorate General of Civil Aviation (DGCA) and other competent authorities from time to time.

6. In order to ensure wider stakeholder participation and to incorporate diverse perspectives, the **Draft Standard Operating Procedure (SoP) for Application of Drone Technology in Fisheries and Aquaculture in India** is hereby placed for comments and suggestions from State Governments/ Union Territories (UT) Administrations, research and academic institutions, industry associations, technology providers, fisheries and aquaculture and other related stakeholders.

7. Comments and suggestions on the draft document may be submitted within **15 days from the date of issue of this Notice**.

8. Comments and suggestions may be forwarded through e-mail in MS Word format to js-inland@dof.gov.in . Alternatively, responses may be sent by post or email to the following address:

Shri Subhash Chandra
Director,
Department of Fisheries
Ministry of Fisheries, Animal Husbandry and Dairying,
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Ground Floor, Chanderlok Building, Janpath Road,
New Delhi – 110001.
Email: subhashchandra1@ord.gov.in ; it-director@dof.gov.in

E-mail/envelope may kindly be superscribed as "Comments/Suggestions on the Draft SoP for Application of Drone Technology in Fisheries and Aquaculture in India".

Encl.: As above.



(Subhash Chandra)
Director (Fisheries)
Tel: 011-23710005



Draft Standard Operating Procedure (SoP) for Application of Drone Technology in Fisheries and Aquaculture in India

Department of Fisheries

Ministry of Fisheries, Animal Husbandry and Dairying

Government of India

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2. Abbreviations

AAI	Airport Authority of India
AI	Artificial Intelligence
AGL	Above Ground Level
AIS	Automatic Identification System
BIS	Bureau of Indian Standards
BMP	Best Management Practices
CIBA	Central Institute of Brackishwater Aquaculture
CMFRI	Central Marine Fisheries Research Institute
CIFA	Central Institute of Freshwater Aquaculture
CIFE	Central Institute of Fisheries Education
CIFRI	Central Inland fisheries Research Institute
CIFNET	Central Institute of Fisheries Nautical and Engineering Training
CRZ	Coastal Regulation Zone
DAHD	Department of Animal Husbandry and Dairying
DGCA	Directorate General of Civil Aviation
DO	Dissolved Oxygen
DoF	Department of Fisheries
DPIIT	Department for Promotion of Industry and Internal Trade
Digital Sky	Online drone registration and flight permission platform developed by DGCA
eGCA	e-Governance of Civil Aviation
EO	Electro-Optical (camera sensors)
FAA	Federal Aviation Administration
FBO	Fishery-Based Organization

FFPO	Fish Farmers Producer Organization
FSSAI	Food Safety and Standards Authority of India
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GVA	Gross Value Added
ICAR	Indian Council of Agricultural Research
IMU	Inertial Measurement Unit
INCOIS	Indian National Centre for Ocean Information Services
IoT	Internet of Things
IP67	Ingress Protection Rating (waterproofing standard)
IIT	Indian Institute of Technology
ITI	Industrial Training Institute
KCC	Kisan Credit Card
LiDAR	Light Detection and Ranging
LMO	Lithium Metal Oxide (battery type)
MIS	Management Information System
MoA&FW	Ministry of Agriculture and Farmers Welfare
MoFAH&D	Ministry of Fisheries, Animal Husbandry and Dairying
MoEFCC	Ministry of Environment, Forest, and Climate Change
MoES	Ministry of Earth Sciences
MoPSW	Ministry of Ports, Shipping and Waterways
MoU	Memorandum of Understanding
NDMA	National Disaster Management Authority

NFDB	National Fisheries Development Board
NGO	Non-Governmental Organization
NPNT	No Permission – No Take-off
OEM	Original Equipment Manufacturer
PMFME	Pradhan Mantri Formalisation of Micro Food Processing Enterprises
PMMSY	Pradhan Mantri Matsya Sampada Yojana
PPE	Personal Protective Equipment
PPP	Public–Private Partnership
QA/QC	Quality Assurance / Quality Control
R&D	Research and Development
RF	Radio Frequency
ROV	Remotely Operated Vehicle (Underwater Drone)
RPAS	Remotely Piloted Aircraft System
RTH	Return to Home
SHG	Self Help Group
SOP	Standard Operating Procedure
UAS	Unmanned Aircraft System
UAV	Unmanned Aerial Vehicle
UAOP	Unmanned Aircraft Operator Permit
UIN	Unique Identification Number
VHF	Very High Frequency
VLOS	Visual Line of Sight
VLO	Village-Level Organization
VTOL	Vertical Take-Off and Landing

3. Introduction

India's fisheries and aquaculture sector has evolved into one of the world's largest and most diverse food production systems, contributing significantly to food security, employment generation, exports, and rural livelihoods. The sector provides direct livelihood support to more than three crore fishers and fish farmers and sustains millions of people across the fisheries value chain. Despite its rapid growth, the sector continues to face several operational challenges, including inefficient resource utilization, labour dependency, limited real-time monitoring, environmental stress, and the increasing need for transparency and traceability across the value chain.

Drone technologies have rapidly emerged as cost-effective and efficient tools to address these challenges and modernize fisheries and aquaculture practices. Aerial drones, i.e. Unmanned Aerial Vehicle (UAV) and underwater Remotely Operated Vehicles (ROVs) can significantly improve operational efficiency through advanced data collection, real-time monitoring, and automation in aquaculture management.

Under Pradhan Mantri Matsya Sampada Yojana (PMMSY) Phase-II, drone technologies will be promoted for diverse applications across inland, coastal, and marine fisheries sectors. In aquaculture, drones will be used for monitoring pond conditions, assessing water quality, tracking feeding practices, managing input delivery, and identifying early signs of disease outbreaks or algal blooms to facilitate timely interventions and improve farm management. In marine and coastal areas, drones will support surveillance against illegal fishing activities, monitoring of ecologically sensitive ecosystems such as mangroves and coral reefs, marine litter mapping, and fisheries resource assessment.

By leveraging drone technology, PMMSY Phase-II aims to enhance productivity, strengthen governance and monitoring systems, improve sustainable fisheries management, and create new opportunities for employment, entrepreneurship, and technology-driven growth in the sector.

This Standard Operating Procedure (SOP) has been developed to ensure the safe, effective, and compliant use of drone technologies in the Indian fisheries and aquaculture sector. The SOP is aligned with the guidelines of the Directorate General of Civil Aviation (DGCA) for aerial drones, and followed available SOPs developed by the Ministry of Agriculture and Farmers Welfare, and sector-specific operational requirements for inland, reservoir, and marine fisheries applications and also best practices of drone by different institutes such as IARI, ICAR – CIFRI, ICAR-CMFRI, ICAR-CIBA, ICAR- CIFA, IIT- Kanpur and IIT- - Hyderabad

4. Objective

The Drone Standard Operating Procedure (SOP) aims to provide guidelines for the safe, efficient, and lawful operation of aerial and underwater drones in aquaculture, in line with the *Drone Rules, 2021* [1].

i. **Improve Resource and Environmental Management:** Enable precision monitoring in dissolved oxygen, turbidity, pH, quicker applications of liquid medications or fertilizers or other aquaculture inputs and optimize feed use to reduce wastage and environmental impact.

ii. **Enable Real-Time Surveillance and Response:** Facilitate early detection of disease, mortality, and water quality issues through continuous monitoring and timely corrective action.

iii. **Enhance Productivity:** Automate critical processes like feeding, and stock assessment to reduce manual labour, minimize downtime, and improve operational precision, long-term financial and ecological sustainability.

Facilitate Live Fish Transport: Promote the use of drones for rapid, safe, and efficient transport of live fish, particularly in remote or hard-to-access aquaculture areas, to minimize mortality and handling stress.

iv. **Remote sampling of water for quality monitoring:** To strengthen aquaculture management through the use of aerial and underwater drones for remote water sampling, water quality monitoring, disease detection, feed management, fish transportation, and real-time surveillance of fish health and behaviour, enabling efficient monitoring of large-scale aquatic environments and underwater infrastructure.

v. **Rescue and Relief Operations :** To enhance the speed, safety, and efficiency of emergency response in fisheries and aquaculture by deploying drones for rapid disaster assessment, marine search and rescue, infrastructure damage monitoring, and delivery of life-saving support in areas where traditional ground access is blocked, hazardous, or inaccessible during natural disasters and maritime emergencies.

vi. **Technology Upgrades:** Research focuses on integrating AI with drone imaging for fish behaviour analysis and automatic real time tracking of vessels in the Exclusive Economic Zone (EEZ)

vii. **Integration with IoT:** To integrate with underwater cameras and sonar sensors to provide comprehensive real-time data.

[1] https://www.dgca.gov.in/digigov-portal/jsp/dgca/homePage/viewPDF.jsp?page=InventoryList/headerblock/drones/Drone%20Rules%202021.pdf

5. Scope and Applicability

This SOP establishes a uniform and practical framework for the use of drone technology across inland, coastal, marine, and reservoir-based fisheries and aquaculture systems. Applications are broadly classified into the following categories:

i. Monitoring, Mapping and Surveillance

ii. Precision Management

iii. Live Fish Transportation

This SOP is applicable to drone-based operations within the aquaculture and fisheries sector in India. It covers a wide range of critical functions including water quality monitoring, feed broadcasting, disease surveillance, fish stock assessment, transport and emergency response. The integration of drone technology in these operations is expected to improve efficiency, support better resource management, and advance sustainable practices across aquaculture systems.

The drone operators to be certified by DGCA authorized Remote Pilot Training Organisation (RPTO).

The SOP ensures consistency, safety, and legal compliance across all drone applications in the fisheries and aquaculture value chain.

4.1. Monitoring, Mapping and Surveillance Applications

a) Inland Aquaculture (Reservoir, Wetland and River, Ponds, Tanks, and Open water cages)

1. Surveillance using aerial video and imaging (thermal/ RGB/ multispectral/hyperspectral)
2. Mapping for layout planning and water tracking / Geo-referenced mapping for farm layout planning design and water, tracking-resource monitoring and picking up dead fish.
3. Support inland aquaculture census activities through accurate resource mapping and real-time data collection.
4. Monitoring water quality parameters (levels, DO, pH, turbidity, macrophyte coverage area), pollutions and seasonal environment changes
5. Assessing biomass in an aquaculture system
6. Inspecting cage integrity, sediment buildup below cages and anchoring systems
7. Observing fish behaviour using underwater drones

b) Marine Fisheries and Coastal Resource Mapping

1. Tracking fishing vessel/boat movement

2. Monitoring illegal fishing in restricted zones through Medium Altitude Long Endurance (MALE) Drones
3. Monitoring marine litter and ecologically sensitive ecosystems such as mangroves and coral reefs.
4. Assisting in rescue operations with lifesaving kits, real-time video and coordinates
5. Supporting nighttime operations with infrared imaging
6. Mapping mangroves, estuaries, and coastal habitats
7. Supporting marine spatial planning and aquaculture zoning
8. Creating baseline environmental datasets

c) Pollution Monitoring and Enforcement

1. Detecting oil spills, effluent discharge, and debris
2. Collecting evidence for incident reporting
3. Supporting coastal security, disaster/rescue response coordination and management
4. Using drones as mobile platforms for water quality monitoring.

d) Disease Surveillance and Health Monitoring

1. Identifying early signs of stress or illness in fish
2. Mapping and estimating fish mortalities.
3. Enabling remote diagnostics in bio secure zones

4.1.1. SOP for Aerial Application of Drones

This section outlines the standard operating steps for drone deployment in aquaculture environments—both inland and coastal. Aerial drones are well suited for surface-level monitoring, mapping, surveillance, and infrastructure assessment in inland and coastal aquaculture settings. These procedures are intended to ensure safe, efficient, and compliant operations while minimizing disruptions to farm activities or aquatic ecosystems.

4.1.1.1 Pre-Flight Procedures

Before conducting any drone operation, the objective of the flight—whether for feed distribution, perimeter surveillance, or pond mapping—should be clearly defined. The designated flight area must be verified on the Digital Sky airspace map to determine its classification (Green, Yellow, or Red Zone). A thorough pre-flight check of the drone's camera, sensors, inertial measurement unit (IMU), and battery must be conducted, with calibrations performed as per the manufacturer's guidelines if required. For large-scale mapping or surveillance tasks, it is recommended to pre-program automated flight paths using type certified software and complaint as an integrated part of a specific drone model to ensure consistent and comprehensive coverage.

Prior to initiating any drone operation over a fishpond, reservoir, or coastal aquaculture site, the following preparatory steps are recommended:

1. Select the Right Drone:
    i. Fish Transport: Payload-capable drones.
    ii. Feed Application: Spreader/sprayer drones.
    iii. Monitoring: Camera-equipped drones
2. The selected drone shall be operated in accordance with the manufacturer's operating manual
3. Drone must be type certified unless exempted under the Drone Rules 2021. Verify that then drone is type certified for the intended use case.
4. Verify the drone's Unique Identification Number (UIN) and confirm that the remote pilot holds a valid certificate.
5. Verify that the drone has valid third-party insurance coverage
6. Ensure that the drone is fully charged, and routine maintenance checks have been completed, covering:
    i. Propellers and motors
    ii. Camera lens clarity
    iii. GPS module and compass status
7. Calibrate the drone's IMU, compass, and GPS systems in accordance with manufacturer instructions.
8. Check weather conditions using reliable sources. Operations should be typically avoided in:
    i. High winds (typically > as per the limitations mentioned in the operation manual of the type of certified drone)
    ii. Rain or excessive humidity
    iii. Poor visibility or foggy conditions
    iv. However operational limitations mentioned in DGCA issued type certificate and associated manuals
9. Plan the flight route or pond boundary using mapping software., geofencing features should be enabled.
10. Flight route should in in adherence to Airports Authority of India (AAI)
11. Survey the operation area for obstacles such as trees, power lines, cage nets, aerators, or poles, and reposition as needed.
12. Notify ground staff in advance and advise them to restrict human movement near take-off and landing zones.

13. Verify the airspace classification of the drone operation site on the Digital Sky airspace map. For Red and Yellow Zone areas, ensure that required permissions have been obtained.
14. Confirm that geo-fencing boundaries are properly configured and test the Return-to-Home (RTH) functionality.
15. Perform a brief test flight to validate overall system readiness and sensor accuracy.
16. Ensure the drone operator: - Has not consumed alcohol within the last 12 hours- Is medically fit to operate the drone- Is familiar with applicable safety procedures.

4.1.1.2. In-Flight Procedure

i. Drones should be launched from a flat, dry, and obstacle-free area, preferably at an elevated location, to ensure safe take-off and landing. Maintaining **Visual Line of Sight (VLOS)** throughout the operation is recommended to enhance safe and effective control, of the drone. Flight altitude should be determined based on the operational requirements and intended application and applicable regulatory limitations.
ii. Continuous monitoring of the live feed is essential to detect indicators such as abnormal fish behaviour, water discoloration, algal blooms, fish mortality, and infrastructure damage or breaches in i bunds and. To minimize stress on fish and avoid disruption to farm operations, drone flights should be avoided during sensitive activities such as stocking, harvesting, or chemical treatments.
iii. To ensure safe and uninterrupted operations the following precautions shall be observed while operating drones over water bodies, near live fish, and in public or shared spaces.
iv. For critical operations, communication redundancy mechanism, such as 4G/5G networks, radio frequency (RF) backup systems, or satellite communication links (for marine operations) should be incorporated wherever feasible. Operator Safety:

1. Always wear Personal Protective Equipment (PPE) such as reflective vests, safety gloves, and eye protection when operating or assisting with drone flight.
2. The drone operator must be mentally and physically fit, with no alcohol or intoxicants consumed within the previous 12 hours.
3. Ensure that at least one trained visual observer is present to assist with spotting obstacles and hazards, especially when operating near populated or forested areas.

v. Equipment Operation

1. Always Maintain Visual Line of Sight (VLOS) to ensure full situational awareness.
2. Fly at a specified altitude in accordance with the manufacturer's specification and applicable regulatory requirements.

3. Monitor battery levels in real-time and maintain sufficient power to safely return and land the drone.

vi. Environmental Conditions

1. Continuously monitor weather conditions during flight operations. Immediately abort flight if winds pick up, or if visibility is lost due to fog or rain.
2. Avoid flying near wildlife, domestic animals, or people as drones can cause stress to animals or pose safety risks to bystanders.

vii. Operational Discipline

1. Use only authorized radio frequencies and communication channels for drone operations.
2. Avoid distractions—no mobile phone usage or multitasking during drone operation.
3. Do not alter pre-programmed flight paths required to address safety concerns or avoid an obstacle
4. Avoid sudden movements, such as sharp turns, low hovers, or fast descents that may impact fish, birds, or operational equipment.
5. Maintain a safe distance from aerators, bird deterrents, high-voltage poles, and other moving or mechanical installations.
6. When using pre-programmed flight paths, validate all waypoints, elevation settings, and emergency landing zones beforehand.
7. Remain alert for aerial threats, particularly birds of prey such as kites and eagles, which may exhibit territorial behavior around drones.
8. Do not fly directly over:
    i. Feed application zones.
    ii. Areas where farm workers are actively engaged in operations.
9. Chemical storage areas and net storage facilities. When surveying multiple farms, the landing gear and other exposed surfaces should be disinfected between operations to minimize the risk of cross-contamination and disease transmission.

4.1.1.3. Post-Flight Procedure

i. After landing, the drone should be carefully inspected for any signs of damage and cleaned if required to maintain its functionality. All captured data, including images and videos, should be promptly backed up and systematically organized with clear labels indicating the date, location, and purpose of the flight. Additionally, maintaining a brief flight log is recommended, documenting details such as flight duration, weather conditions, key observations, and any technical issues encountered during the operation.

ii. After every drone flight, it's important to complete a series of actions to ensure equipment integrity, data security, and future readiness. After safely landing the drone, operators should carry out the following steps to wrap up the operation and maintain proper documentation.

iii. Drone Recovery

1. Land the drone slowly and carefully in a designated, obstacle-free area.
2. Power down the drone and disconnect the battery safely.
3. Detach all payloads and auxiliary equipment, if installed.
4. Power off both the drone and its ground control system/controller

iv. Equipment Inspection

1. Conduct a quick physical inspection to identify any damage accumulation, or signs of overheating.
2. Examine:
    i. Propellers for cracks or wear
    ii. Motors and arms for signs of stress or overheating
    iii. Check the battery for swelling, leakage, or physical damage.
    iv. Sensors/cameras for cleanliness and lens integrity
3. Clean the drone, peripherals and landing gear using soft cloth/ dry microfiber cloth and manufacturer-recommended cleaning solutions.

v. Data Management

1. Transfer all collected data (including images, videos, maps, GIS datasets, and sensor readings) to a secure storage system.
2. Record the flight details in the Drone Logbook, including:
    i. Date, time, and GPS location.
    ii. Name of the pilot and drone ID
    iii. Purpose of operation (e.g. feed monitoring, disease surveillance, or infrastructure inspection)
    iv. Any anomalies, safety events, or unusual observations
    v. Any unusual observations must be reported to the manufacturer.
3. Back up all data to a cloud drive or MIS (Management Information System), if available, to support traceability and reporting.

vi. Recharge and Repack

Recharge batteries and update the Battery Cycle Register to track usage history and battery life.

1. Store drones, batteries, and accessories in dry, cool, and dust-free environments, preferably in their original cases.
2. Drones with degraded battery performance shall not be used for operational missions
3. Logbook maintenance - Record all required information in the pilot logbook, drone logbook, and battery charging register immediately after completion of each flight

4.1.2. SOP for Underwater Application of Drone

i. Underwater drones or Remotely Operated Vehicle (ROVs) play a valuable role in submerged inspections—such as observing fish behaviour, checking cage conditions, or monitoring underwater structures. The usage may cover a wide range of applications such as inspection of ponds and cages, monitoring fish health and behaviour, assessing water quality and sediment conditions, underwater environmental monitoring (temperature, DO, pH, turbidity),infrastructure and net inspection, detecting biofouling, surveying habitats, artificial reefs and breeding grounds, fish seed monitoring and ensuring structural integrity of aquaculture infrastructure. This may be relevant for both routine farm management and research-driven activities aimed at improving efficiency, sustainability, and data-driven decision-making in the sector.

ii. The following subsections detail the recommended procedures to ensure safe, effective, and consistent operations of underwater drones in inland, coastal, and cage-based aquaculture systems.

4.1.2.1. Pre-Dive Procedures

i. Before deploying the ROV, water conditions—including clarity, current, and temperature—should be assessed to ensure safe and effective operation. A thorough check of the equipment, including the drone body, tether cable, camera dome, and propellers, must be conducted to detect any damage or debris. Calibration of key sensors such as depth, compass, and temperature should be performed in accordance with manufacturer guidelines. It is also essential to verify full battery charge and stable software connectivity with the control device, whether a tablet or controller. The objective of the dive—whether for net inspection, fish monitoring, or sediment observation—should be clearly communicated with the support team, and the operator must be certified and trained in underwater drone navigation and data interpretation to ensure accurate and safe deployment.

Prior to deployment, the operator should conduct a comprehensive pre-dive assessment to ensure safe, efficient, and reliable operation of the underwater drone. All systems should be inspected, tested, and verified in accordance with the manufacturer’s guidelines and mission-specific requirements.

a) Site Assessment and Operational Clearance

i. Assess site conditions, including water depth, currents, tides, visibility, temperature, wave action (where applicable), and weather conditions.

ii. Identify underwater and surface hazards such as cages, nets, mooring lines, fishing gear, vegetation, and vessel traffic that may affect navigation or recovery.

iii. Ensure that the designated launch and recovery area is safe, unobstructed, and accessible for personnel and support equipment.

iv. Confirm that drone operations do not interfere with aquaculture activities, fish welfare, navigation routes, or environmentally sensitive zones.

v. Notify on-site personnel and obtain clearance of operational zones such as feeding, stocking, harvesting, or inspection areas.

b) Equipment Inspection and Functional Checks

i. Inspect the drone body, thrusters, propellers, tether system, cameras, lights, sensors, and manipulators for any damage, wear, corrosion, or debris.

ii. Verify battery charge status and ensure sufficient endurance for the planned mission.

iii. Check and calibrate key instruments, including depth sensors, compass, sonar, cameras, lighting systems, and water quality modules, as applicable.

iv. Confirm functionality of communication links between the surface control unit and the underwater drone.

v. Test onboard recording systems and data storage devices.
vi. Perform a short functional test in air (dry run) to verify motor response, camera feed, and signal transmission.

c) Mission Planning and Operational Parameters

i. Define mission objectives such as inspection, surveillance, biomass observation, water quality assessment, or infrastructure monitoring.

ii. Establish operational parameters including depth limits, dive duration, survey path, tether length, and obstacle clearance.

iii.Identify recovery points and emergency retrieval procedures.
iv. Define communication protocols among operators, vessel crew, and support personnel.

v. Establish abort criteria for adverse environmental conditions, equipment malfunction, loss of communication, or safety risks.

d) Navigation in GPS-Denied Environments

In case, Global Navigation Satellite System/ Global Positioning System (GNSS/GPS) signals are unavailable underwater, operators should implement alternative navigation and positioning systems to ensure safe and reliable operations.

The underwater drone operator should adhere to manufacturers' recommendation for the navigation methods.

e) Failsafe Mechanisms

The underwater drone should be equipped with appropriate failsafe mechanisms to ensure operational safety and recovery in the event of system failure or navigation uncertainty. These may include:

i. Automatic station-holding or stabilisation mode using inertial and optical systems.

ii. Controlled ascent to a safe depth or surface in case of critical sensor failure or loss of navigation reference.

iii. Automatic surfacing in the event of prolonged communication loss or low battery conditions (for untethered systems).

iv. Emergency tether-based retrieval for ROV operations.

v. Redundant navigation and sensor systems to minimise drift and positional error.

vi. Real-time alerts for communication loss, excessive drift, obstacle proximity, or system malfunction.

f) Recovery Planning and Emergency Preparedness

i. Define normal recovery procedures at designated recovery points.

ii. Establish emergency retrieval protocols for entanglement in nets, cages, moorings, or underwater structures.

iii. Prepare contingency procedures for propulsion failure, power loss, or sensor malfunction.

iv. Ensure availability of recovery tools such as retrieval lines, hooks, and support vessels, where required.

v. Maintain updated emergency contact details and escalation protocols.

Note: No underwater drone mission shall commence unless all pre-dive checks are completed, all critical systems are verified to be operational, and emergency recovery procedures are clearly established and communicated to all personnel involved.

4.1.2.2. In-Dive Guidelines

i. Underwater drones should be gently lowered into the water from a secure and stable platform or dock at a pre-assessed deployment location to ensure safe

deployment. Navigation must be slow and deliberate to minimize disturbance to fish and avoid stirring up sediment, which can reduce visibility. Camera angles and lighting settings should be adjusted during the dive as needed to optimize underwater visibility. Continuous monitoring of the live video feed and sensor data is essential, particularly in complex environments such as cage farms or reservoirs. Operators should regularly check battery levels, signal strength, and the position of the tether to prevent entanglement or loss of connection. It is important to avoid any direct contact with fish, nets, or underwater structures and to operate strictly within the drone's recommended depth and range limits to ensure safety and equipment integrity.

ii. Once the ROV is submerged, the operator should adhere to the following operational protocols:

1. Maintain constant visual monitoring of the ROV's position via real-time video feed and telemetry data.
2. Operate the ROV at a controlled and steady pace to minimize sediment disturbance and avoid stressing aquatic organisms.
3. Avoid contact with:
    a. Cage nets or mooring lines.
    b. Underwater structures or anchors
    c. Aeration or pumping systems
4. Adjust buoyancy and trim settings for optimal stability and maneuverability.
5. Monitor environmental parameters such as turbidity, dissolved oxygen, or temperature, where applicable.
6. If fish behavior appears stressed or erratic, consider ascending and adjusting position or lighting.
7. Track tether movement to avoid entanglement or overextension, especially in cage culture systems.
8. Refrain from capturing or manipulating aquatic organisms unless approved and trained for such activities.

4.1.2.3. Post-Dive Documentation

i. After retrieval, the underwater drone should be thoroughly rinsed with freshwater to remove any salt, debris, or contaminants, and then dried using clean cloth or compressed air to prevent corrosion or damage. Any unusual observations during the dive—such as net tears, abnormal fish behavior, or excessive sediment accumulation—should be documented and reported to farm supervisors, if relevant. All video footage and sensor data must be backed up, properly labelled with details such as date, location, and purpose, and securely archived. Maintaining a simple dive log is also recommended, capturing key information such as depth reached,

duration of the dive, notable observations, and any technical performance issues for future reference.

ii. Upon retrieval of the underwater drone, the following steps are suggested:

1. Power down the ROV and surface control station.
2. Rinse the drone thoroughly with freshwater to remove salt, sediment, or biological residues.
3. Inspect all components for wear or damage particularly the propellers, camera housing, and tether cable.
4. Clean the camera lens and sensor surfaces using soft, dry cloth or lens wipe.
5. Transfer all captured images, videos, and sensor data to a secure storage system.
6. Enter dive details into the ROV Logbook, including:
    i. Date, time, and site location.
    ii. Dive purpose and observations.
    iii. Maximum depth, water clarity, and temperature (if recorded)
    iv. Operator name and ROV ID
    v. Notes on performance issues or environmental anomalies
    vi. Communicate to the farm manager/CA in case of any anomalies, if detected.
7. Recharge the battery and update the battery maintenance record.
8. Back up data to a centralized MIS, GIS platform, or cloud-based archive, if applicable.

4.1.3. Monitoring, Mapping & Surveillance

Purpose: To collect real-time visual and sensor-based data from aquaculture ponds, cages, or coastal areas for health assessment, water quality, and site surveillance.

Step	Activity	Description
1	Sensor/Camera Setup	Equip the drone with appropriate sensors such as HD camera, thermal camera, multispectral, hyperspectral, fluorescence, or any other imaging sensors as per operational requirements
2	Define Monitoring Goals	Select monitoring parameters such as macrophytes, algal blooms, plankton, water quality parameters, fish behaviour, fish health, biomass estimation, aquatic flora and fauna assessment, coral bleaching, or any other relevant indicators.

3	Flight Planning	Define flight path, altitude, coverage area, and geofencing boundaries based on the monitoring objectives.
4	Data Collection	Conduct the flight and record images, videos, thermal, or multispectral data as required
5	Real-time Observation	Stream live video/data feed to the ground station to enable real-time monitoring and issue detection
6	Return and Data Storage	Safely land the drone and store all data in secure local or cloud storage systems. Back up critical recordings
7	Data Processing and Analysis	Use GIS and image-processing tools to analyze fish health, stocking density, algal blooms, and other relevant parameters
8	Reporting	Generate a summary report for decision-making, including feed adjustment, harvesting schedules, pond maintenance, and other management actions

Cautions:

1. Ensure privacy is respected; do not capture data outside designated aquaculture zones or without authorization
2. Do not rely solely on -based observations; validate key findings through ground truthing and field inspection.

4.2. SOP for Precision Management

Application of drone technology in fisheries and aquaculture are as mentioned below:

i. Distribution of Feed to improve Feed Conversion Ratios (FCR)

ii. Spraying of medicines, immunostimulants, and other aquaculture inputs

iii. Deployment of drones, smart aquaculture systems, automation tools, and AI-enabled applications to improve productivity, monitoring, surveillance, and resource efficiency.

iv. Use of drone-based systems for disease surveillance, environmental monitoring, precision feeding, and automated farm operations to enhance sustainability and operational efficiency.

4.2.1. Operational Procedures of Drone Technology in Application of Feed Using Drone

To automate and standardize the process of feeding fish and spraying chemicals, in ponds, tanks, or cages using drones equipped with feed spreaders or sprayers.

Step	Activity	Description
1	Drone Selection	Use a certified drone fitted with a feed tank and spreader module with adjustable flow rate. Verify that the drone is type certified for the intended use case.
2	Calibrate Dosage	Set feed quantity as per stocking density, biomass, and feeding schedule.
3	Configure Spread Settings	Adjust distribution range, spread angle, application rate, and flight speed.
4	Plan the Flight Path	Prepare route using ground-survey data and farm maps covering ponds, tanks, or cages
5	Feed Dispersion	Begin flight and ensure uniform feed/chemical distribution at stable altitude as per manufacturer specifications
6	Monitor Distribution	Use live camera or take help of observer to ensure even coverage.
7	End Flight & Maintenance	Stop feed flow before landing. Clean feed spreader after each use.
8	Record Feed Data	Document quantity dispensed, flight time, and operational observations.

Cautions:

1. Avoid flying in windy conditions to prevent feed drift.
2. Ensure payload is within manufacturer-specified limits.
3. Maintain proper calibration before every operation.

5. SOP for Fish Transportation

Drone-based fish transportation enables the quick and safe movement of live fish, fish seed, and essential fisheries inputs over short distances, especially in remote, inaccessible, flood-prone, hilly, island and other difficult-to-reach areas. With certified drones, secure payload systems, and oxygenated, insulated or leak-proof containers, drone-based transport can reduce transit time, minimize fish stress, and support timely stocking, market linkage, emergency response and movement of high-value fish species in fisheries and aquaculture operations.

5.1. Uses of drone technology in fisheries and aquaculture are mentioned below:

i. Transport of live fish and fish seeds from hatcheries to ponds, cages, and markets in remote or difficult-to-access areas.

ii. Strengthening of fisheries supply chains, post-harvest logistics, and emergency response systems using drone-enabled technologies.

iii. Use of drones in fish marketing, aquaculture operations, and aquatic resource management to improve efficiency and reduce transport time.

5.2. Scope of Drone-Based Live Fish and input Transport

This SOP applies to the transportation of live fish, fish seed and fisheries-related inputs over short distances using drones equipped with suitable payload mechanisms. The movement may be undertaken from:

i. Hatcheries to ponds

ii. Hatcheries to cages

iii. Hatcheries to remote stocking sites

iv. Hatcheries or landing points to nearby markets

v. Remote catch areas to collection points

vi. Emergency locations to culture or holding facilities.

Drone-based fish transportation shall be used only where the selected drone is suitable for the intended payload, route, distance, terrain, and environmental conditions.

5.2.1. Operational Requirements

Before undertaking drone-based fish transportation, the following requirements shall be ensured:

1. **Use of Certified Drone:** Only certified drone suitable for the intended use shall be deployed. The drone shall be capable of safely lifting and carrying the fish container without exceeding the payload limits specified in the type certificate, technical specifications, or manufacturer’s manual.

2. **Payload Suitability:** The payload mechanism shall securely hold the fish container and prevent swinging, leakage, detachment, or imbalance during flight.
3. **Use of Proper Containers:** Lightweight, sealed, leak-proof, insulated, and oxygenated containers shall be used to reduce fish stress and prevent spillage during flight.
4. **Route Suitability:** The route shall be planned based on mapped data and ground survey, avoiding obstacles, dense habitations, restricted airspace, power lines, tall trees, and bird congregation areas.
5. **Environmental Conditions:** Drone flights shall be undertaken only within the operating temperature and wind-speed limits specified in the drone's type certificate, technical specifications, and manufacturer's manual. Flights shall be avoided during extreme heat, rain, poor visibility, strong winds or gusty conditions.

5.2.2. Pre-Flight Procedure

The following steps shall be followed before take-off:

Step	Activity	Description
1	Select Drone Type	Use certified drone capable of lifting and securely carrying live fish or fish seed. Ensure that the total payload does not exceed the permissible limit specified in the type certificate or technical specifications.
2	Check Drone Condition	Inspect battery level, propellers, motors, payload attachment, communication system, GPS, return-to-home function, and emergency controls.
3	Select Proper Container	Use lightweight, sealed, insulated, leak-proof and oxygenated containers designed to reduce fish stress and prevent spillage.
4	Prepare Fish for Transport	Select healthy fish or fish seed. Avoid transporting weak, diseased, or highly stressed fish. Maintain suitable water quality and oxygen level in the container.
5	Avoid Overloading	Ensure that fish density, water volume and oxygen requirement are appropriate for the transport duration. Do not exceed the safe carrying capacity of the container or drone.
6	Route Planning	Plan the permissible route between origin and destination through ground survey and mapped data. Avoid obstacles, restricted areas, human settlements, power lines, and unsafe landing points.
7	Check Weather Conditions	Confirm that wind speed, temperature, visibility, and rainfall conditions are within safe operational limits prescribed for the drone.
8	Identify Landing Zone	Mark a clear, flat, and obstacle-free landing area at the destination for safe landing and offloading.
9	Secure Payload	Attach the container firmly to the drone payload mechanism. Check balance and ensure that there is no leakage, loose fitting, or risk of detachment.
10	Brief Operating Team	Ensure coordination between drone pilot, loading team and receiving team. Communication shall be maintained throughout the operation.

5.2.3 During Flight Procedure

The following precautions shall be observed during flight:

Step	Activity	Description
1	Take-off	Take off slowly from a clear and obstacle-free area. Ensure that the payload remains stable after lift-off.
2	Maintain Stable Flight	Maintain low and stable flight altitude as per manufacturer's specifications and applicable regulations. Avoid sudden acceleration, rapid movements, or sharp turns.
3	Monitor Payload Stability	Continuously observe the movement of the container during flight. If abnormal swinging, leakage, or instability is noticed, the drone shall be safely landed.
4	Follow Planned Route	Operate the drone only along the pre-decided route. Avoid deviation unless required for safety or emergency reasons.
5	Maintain Visual/Operational Control	The drone pilot shall maintain required operational control and monitor telemetry, battery, signal strength, and weather changes during flight.
6	Avoid Stress Conditions	Avoid hovering for long periods, sudden altitude changes, jerky movement, or prolonged exposure to heat, as these may increase stress on live fish.
7	Emergency Response	In case of low battery, high wind, signal loss, payload instability or adverse weather, activate safe landing or return-to-home procedure as per the drone manual.

5.2.4. Landing and Offloading Procedure

The following procedure shall be followed at the destination:

Step	Activity	Description
1	Prepare Landing Zone	Ensure that the receiving team is present and the landing zone is clear of people, animals, vehicles, trees, electric poles, and other obstacles.
2	Land Safely	Land the drone slowly in the marked obstacle-free zone. Avoid hard landing to prevent stress or injury to fish.
3	Detach Container	Carefully detach the fish container from the payload mechanism after the drone motors are stopped.
4	Check Fish Condition	Immediately inspect fish movement, water quality, oxygen condition, and mortality, if any.
5	Acclimatize Fish	Before releasing fish into ponds, cages or holding tanks, acclimatize them gradually to the receiving water temperature and quality.
6	Release or Transfer	Gently release the fish into the pond, cage, tank or holding facility. Avoid sudden pouring or rough handling.

5.2.5. Post-Flight Procedure

After completion of the transportation operation, the following shall be undertaken:

Step	Activity	Description
1	Record Transport Data	Record date, time, origin, destination, distance covered, flight duration, fish species, quantity transported and purpose of transport.
2	Record Fish Health	Record survival, mortality, abnormal behaviour, stress symptoms, or any injury observed after transport.
3	Record Drone Data	Record battery usage, flight path, payload weight, weather condition, and any technical issue encountered during flight.
4	Clean Containers	Clean and disinfect containers after use to avoid disease transmission between batches or sites.
5	Inspect Drone and Payload System	Check drone body, propellers, motors, battery, payload hook, container attachment and other components for damage or wear.
6	Report Incidents	Any incident such as fish mortality, payload detachment, leakage, emergency landing, drone malfunction, or route deviation shall be documented and reported to the concerned authority/operator.
7	Maintain Logbook	Maintain a drone fish transportation logbook for future reference, monitoring, and evaluation.

Cautions:

i. Avoid flying in extreme temperatures or strong winds.
ii. Use insulated or oxygen-packed boxes for longer distances.
iii. Do not overload the drone beyond certified payload capacity.
iv. Do not transport fish without adequate water volume and oxygen support.
v. Avoid rapid drone movement, sharp turns, or sudden altitude changes.
vi. Avoid flights over crowds, schools, hospitals, sensitive installations, or restricted areas.
vii. High-value fishes such as trout, ornamental fishes and other sensitive species may be transported only under controlled conditions with proper oxygenation, temperature management, and reduced handling stress.
viii. Emergency landing sites should be identified along the route wherever feasible.
ix. Drone operations shall comply with applicable civil aviation rules, local permissions, safety requirements, and manufacturer's operating limitations.

5.3. Sensor Payloads (Cameras, Thermal Imaging, Water Testing Sensors)

To support fisheries operations, drones should be capable of carrying and integrating the following payloads:

1. RGB Cameras (High-resolution): General surveillance, pond boundary monitoring, macrophyte coverage area monitoring

2. Multispectral Cameras: Algal bloom detection, water colour analysis, Hyperspectral cameras: Water quality parameter (Turbidity, Chl-a, algal bloom, pollutions etc.) identification)
3. Thermal Sensors (FLIR-based): Mortality identification, oxygen stress zones, cage monitoring.
4. LiDAR (optional): Topographic analysis around ponds or bunds
5. Water Quality Sensors (experimental integration): pH, turbidity, temperature via lowered tethered probes (mostly under research)

Other Emerging Payloads: Any additional sensors approved for fisheries applications

5.4. Drone Types and Technical Specifications

Drones used in fisheries and aquaculture must meet specific technical and functional criteria to ensure safe, reliable, and efficient operations. Drone Manufacturers shall ensure that rigorous safety checks have been conducted at lab and ground level for drones that are being used in fisheries and aquaculture. The choice of drone depends on the environment (inland, marine), purpose (monitoring, mapping, surveillance, feeding), and payload requirements.

5.4.1. Drone Classification Based on DGCA Guidelines

As per the DGCA's Drone Rules, 2021, drones are classified based on maximum all-up weight (including payload):

Category	Weight	Usage in Fisheries
Nano	≤250 grams	Training and limited near-shore monitoring (non-commercial use)
Micro	>250 g and ≤2 kg	Pond surveillance, feed monitoring
Small	>2 kg and ≤25 kg	Pond mapping, waterbody surveillance, thermal imaging
Medium	>25 kg and ≤150 kg	Large-scale marine surveys, feed applications, and liquid/solid payload delivery in cages and ponds
Large	>150 kg	Future large-scale fisheries and aquaculture operations

For most fisheries applications, **Micro to Medium drones** is sufficient and widely used due to ease of handling

5.4.2. Data Storage and Processing Systems

i. Drones should have removable storage to ensure lossless data capture.

ii. Ground stations or base tablets should support real-time data sync.

iii. Data processing software may include:

   a. Drone Deploy / Pix4D / Agisoft Metashape (for pond and cage mapping)

   b. QGIS/ArcGIS (for spatial integration)

   c. Thermal analysis software (for mortality/stress detection)

   d. For critical operations, communication redundancy systems such as 4G/5G, RF backup, or satellite communication (for marine environments) shall be used wherever required.

6. Activity Specific Procedure for Drone Application

This section provides practical use of drones in fisheries and aquaculture operations. These SOPs are designed to ensure efficiency, safety, and sustainability in drone-assisted activities across inland and coastal farming systems.

6.1. Drone for heavy payload transport drone:

Step	Activity	Description
1	Drone Selection	• Use a drone capable of lifting and securely carrying live fish/fish seed/ harvested fish. • Ensure that the total weight of the drone including payload should not exceed the maximum take-off weight (MTOW) limit specified by manufacturer.
2	Container Selection	• Use lightweight, sealed, oxygenated containers designed for live fish transportation to reduce stress and prevent spillage during flight. • Do not fly without inspecting the CG (centre of gravity) of the attached container after loading.
3	Route Planning	• Route planning between origin and destination through on ground survey based on mapped data. • Confirm that drone is not flying in a restricted area. Check the planning zone on DigitalSky platform.
4	Loading Fish	• Load the fish in the container with care. Avoid overloading. • Ensure containers are tightly sealed and mounted on

		payload bay
5	Pre-flight check	• Inspect the drone body, blades, landing gear for any visual damage or loosely attached parts. • Ensure all batteries are adequately charged. • Check software and mission planning with correct way points. • Verify the planned home position is correctly set in GCS.
6	Take-off and Flight	• Ensure an open space free of people, trees, buildings, signal transmitting towers, or jammers. • Ensure that the take-off area is a flat and level surface.
7	In-flight Monitoring	• Maintain stable flight altitude as per manufacturer's specification. • Avoid rapid movements or sharp turns unless absolutely required. • GPS heath, Telemetry health, Vibration levels, Battery health should be at optimal levels. • Compass heading, Altitude level, and Waypoint execution status should be consistent with planned mission.
8	BVLOS operation	• Ensure proper approval from DGCA for BVLOS flying. • Notify local authority for the flying. • Maintain optimum flying height in the pathway for avoiding obstacles like tall building, tress, electric tower etc. • Ensure full communication range from source to destination.
9	Landing & Offloading	• Landing should be in a clear, marked, stable and obstacle-free zone. • Before removing the container ensure that the drone is disarmed and disconnected from power source.
10	Post flight check	• Conduct a physical inspection of the drone body, blades, landing gear, and batteries. • Save and back up the flight data from the GCS. • Review the mission data and flight log for any discrepancies, irregularities, or problems during the

		mission. • Record time, distance, battery levels, fish condition, mortality (if any).
Emergency Feature		
S.No	**Failure**	**Solution**
1.	**Loss of communication**	
	Pre-Programmed Return-to-Home (RTH)	Drone should be equipped with Pre-Programmed RTH function that automatically directs the drone to return to the take-off position when communication is lost.
2.	**System Malfunction**	
	Failsafe Notification	Fail-safe alerts shall be monitored in the GCS, including communication, battery, and GPS failsafe triggers

Caution:

i. Ensure weather conditions are suitable for flying (no snow, extreme heat, rain, drizzle, gusts, fog, thunder, or strong winds)

ii. Ensure the wind speed is within manufacturer-specified limits.

iii. Use insulated or oxygenated containers for long-distance transport

iv. Ensure DGCA approval for BVLOS operations prior to flight.

7. Do's and Don'ts

Regulatory Compliance

Before using drones for any fisheries or aquaculture-related activities in India, it is mandatory to follow all the legal and regulatory requirements laid out by the Ministry of Civil Aviation (MoCA) and the Directorate General of Civil Aviation (DGCA). These ensure safe, legal, and responsible drone operations across the country.

7.1. Key Regulatory Requirements:

S. No	Requirements	Details
1.	Drone Registration	• All drones must be registered on the official eGCA platform. • Each registered drone receives a Unique Identification Number (UIN) and must display it clearly

S. No	Requirements	Details
		on the body.
2.	Pilot Certification	• Drone pilot must obtain a Remote Pilot Certificate from a DGCA-authorized Remote Pilot Training Organisation (RPTO).
3.	Operational Zones	• Drones can only be flown in permitted zones. These are: o Green Zones – no prior permission required. o Yellow Zones – require prior approval from the Air Traffic Control (ATC). o Red Zones – strictly prohibited (e.g., near airports, defence installations). without prior permission from the Central Government
4.	Altitude Limit	• Operations must be carried out below 400 feet (120 meters) and strictly within Visual Line of Sight (VLOS) in green zone.
5.	Flight Insurance	• Operators are encouraged to have liability insurance for drone operations to cover accidental damage to third parties.
6.	Safety /Mandatory Compliance	• Follow all safety rules mentioned in all Drone Rules • Equip the drone with essential safety features like geo-fencing, return-to-home (RTH), collision avoidance, and emergency landing mechanisms where applicable.
7.	Local Permissions	• Apart from DGCA permissions, drone operators should take necessary applicable approvals from regulatory bodies as per requirement of the operations
8.	Risk assessment	• Payload safety and redundancy features such as dual battery, parachute system, fail safe landing, and flotation attachment may be recommended for over-water operations.

Regulatory and Compliance Guidelines – Underwater Application of Drone

i. Comply with Indian telecommunication and import laws for underwater equipment.

ii. Follow environmental regulations under the Environment Protection Act, 1986

iii. Adhere to guidelines issued by the Department of Fisheries and Coastal Regulation Zone (CRZ) norms where applicable.

iv. Seek approval from State Fisheries Departments for specific operational areas.

v. Comply with Wildlife Protection Act if operating near protected habitats.

Emergency Protocols and Incident Reporting

7.1.1.1. Environmental Impact

i. Do not operate drones during fish breeding cycles or mass stocking to prevent stress to aquatic fauna.

ii. Avoid flying over bird nesting zones, mangrove patches, or protected wetland areas.

iii. Minimize noise and light pollution caused by drone propellers and LED lighting—especially at night.

iv. In coastal zones, maintain safe distance from turtle nesting beaches and coral reef zones.

v. Drones must not discharge waste or fuel into waterbodies under any circumstance.

7.1.1.2. During Aerial Application of Drone

During drone operations, unforeseen incidents may occur such as weather changes, technical failures, or crashes may occur. Being prepared for emergencies is essential for safety, equipment recovery, and regulatory compliance. Operators are advised to remain calm and follow the corresponding responses to ensure safety and minimize equipment or data loss.

i. Since the operations are mainly over water regions, a detailed drone recovery and retrieval SOP during water crash/failure may be added, including flotation systems, emergency beacon, and retrieval responsibility.

ii. Monitoring and battery management, including multispectral/hyperspectral sensors for fishpond health assessment and strict battery operation within specified cycle and voltage limits.

7.1.1.3. Immediate Response Actions

i. In the event of loss of GPS or signal, the drone should or automatically return to home (RTH) or manually land the drone at a nearby safe location without delay. The operator may also move closer to the drone’s location to re-establish signal connectivity

ii. If a low battery warning is triggered during the flight, the operator should either activate the RTH function or manually land the drone at a nearby safe location without delay.

iii. In case of a bird attack, it is advisable to immediately ascend vertically to a higher altitude and divert the drone laterally away from the threat to avoid collision or damage.

iv. If the drone crashes or falls into water, the operator should immediately cut power (if accessible) and initiate a safe retrieval process. Under no circumstances should the drone be restarted until it has been thoroughly inspected and dried.

v. In the event of equipment malfunction, the mission should be aborted immediately. The nature of the malfunction should be recorded in the maintenance log for follow-up repair or diagnostics.

vi. If the drone enters a restricted or unauthorized airspace (zone violation), it should be landed immediately. If required, the operator should notify the relevant authority or airspace regulator depending on the zone's classification.

vii. In all cases involving safety hazards, technical failure, or airspace breaches, the operator should complete a Drone Incident/accident Report and promptly inform the district fisheries authority by the user. No later than 48hrs after an accident involving an unmanned aircraft system takes place, the remote pilot of such unmanned aircraft system shall report the accident to the DGCA through the eGCA portal. If the situation warrants regulatory attention, State Fisheries Department should also be notified following standard reporting protocols.

7.1.1.4. During Under water application of Drone

While underwater drones are typically stable in operation, certain contingencies should be planned for. Suggested emergency response actions include:

1. In the event of loss of video or sensor feed, pause the operation and attempt to reset the control connection. If unresolved, initiate retrieval.
2. If the ROV becomes entangled in cage nets or underwater structures, attempt gentle reverse maneuvers or tether tensioning. Avoid aggressive force.
3. In case of leak detection or motor failure, terminate the dive immediately and bring the drone to the surface.
4. If a battery warning or signal loss is triggered, initiate manual return using tether guidance and reduce dive depth progressively.
5. Any incident involving equipment malfunction, property damage, or safety risk should be documented in an Incident Report Form, including:
    I. Time and location of the event
    II. Equipment involved.
    III. Actions taken during recovery.
    IV. Lessons learned or mitigation measures.

6. Review and file incident reports with the concerned officials and retain them as part of the drone operation records.

8. Policy and Regulatory Framework

8.1. Overview of Drone Rules, 2021

The Ministry of Civil Aviation vide gazette notification CG-DL-E-26082021-229221 dated August 25, 2021, published the Drone Rules 2021.

These Rules shall apply to-

i. all persons owning or possessing, or engaged in leasing, operating, transferring or maintaining an unmanned aircraft system in India;

ii. all unmanned aircraft systems that are registered in India; and

iii. all unmanned aircraft systems that are being operated for the time being, in or over India.

iv. The provisions of the Aircraft Rules 1937 shall not apply to unmanned aircraft systems except in case of an unmanned aircraft system with maximum all-up-weight of more than 500 kilograms.

v. These rules shall not apply to an unmanned aircraft system belonging to, or used by, the naval, military or air forces of the Union of India.

8.2. Categorisation Of Unmanned Aircraft System

i. The unmanned aircraft system shall be categorized into the following three categories, namely: -

   a) aeroplane

   b) rotorcraft

   c) hybrid unmanned aircraft system.

ii. The aeroplane, rotorcraft and hybrid unmanned aircraft system shall be further sub-categorised as follows: -

   a) remotely piloted aircraft system;

   b) model remotely piloted aircraft system; and

   c) autonomous unmanned aircraft system

8.3. Classification of unmanned aircraft systems

The unmanned aircraft system shall, based on the maximum all-up weight including payload, be classified as follows:

a) Nano unmanned aircraft system: weighing less than or equal to 250 grams;

b) Micro unmanned aircraft system: weighing more than 250 grams, but less than or equal to 2 kilograms;

c) Small unmanned aircraft system: weighing more than 2 kilograms, but less than or equal to 25 kilograms;

d) Medium unmanned aircraft system: weighing more than 25 kilograms, but less than or equal to 150 kilograms; and

e) Large unmanned aircraft system: weighing more than 150 kilograms.

8.4. Certification of Unmanned Aircraft System

i. "Type certificate" a certificate issued by the Director General certifying that the unmanned aircraft system of a specific type meets with the requirements specified as mentioned in CSUAS 2022.

ii. No type certificate is required for the following categories as mentioned in Drone Rules, 2021: –

a. UAS for research, development & testing

b. Model RPAS

c. Nano UAS

iii. No person shall operate an unmanned aircraft system without first registering it on the eGCA and obtaining a unique identification number (UIN)

iv. Transfer of unmanned aircraft systems. A person may transfer an unmanned aircraft system to another person by way of sale, lease, gift or any other mode or any other mode, after providing requisite details of the transferor, transferee and unique identification number of the unmanned aircraft system on eGCA portal.

v. Research, development and testing entity are exempted from obtaining UIN

8.5. Remote Pilot Certificate

i. No individual other than a holder of a valid remote pilot certificate shall operate an unmanned aircraft system.

ii. A remote pilot certificate mentions • Category, • Sub-category and • classification of the unmanned aircraft system

iii. Age: Not less than eighteen years of age and not more than sixty-five years of age;

iv. Issued by - Remote pilot training organization (RPTO) authorized by DGCA

v. Exemption from obtaining RPC.

vi. Operating a Nano UAS (250 gms); Operating a Micro UAS (2Kgs) for non-commercial purposes.

8.6. Unmanned aircraft system operations for research, development and testing

As per Rule 42 of Drone Rules, 2021 The following persons shall not require a type certificate, unique identification number, prior permission and remote pilot licence for operating unmanned aircraft systems for research, development and testing purposes, namely:

i. any research and development entity under the administrative control of, or recognised by, the Central Government or State Government or Union Territory Administration;
ii. any educational institution under the administrative control of, or recognised by, the Central Government or State Government or Union Territory Administration;
iii. any Startup recognised by the Department for Promotion of Industry and Internal Trade;
iv. any authorised testing entity; and
v. any unmanned aircraft system manufacturer having a Goods and Service Tax Identification Number:
vi. Provided that such unmanned aircraft system operations takes place within a green zone and within the premises of the person where such research, development and testing is being carried out or within an open area in a green zone under person's control.

8.7. Remote Pilot Training Organisation

i. Conduct training for candidates aspiring to become remote pilot & remote pilot instructors in specified categories and classes of drones.

ii. Issue Remote Pilot Certificates (RPCs) to successful candidates digitally through the eGCA platform.

8.8. Zoning and Airspace Map Usage

i. For any drone operation over aquaculture or fish farm sites, it is essential to verify the airspace classification of the location using the interactive airspace map provided on the Digital Sky Platform (https://digitalsky.dgca.gov.in). India's airspace is categorized into Green, Yellow, and Red Zones, each representing different levels of regulatory control and required permissions for drone activity.

Green Zone:

1. Airspace up to 400 ft (120 m) not designated as a Red/Yellow zone, and up to 200 ft (60 m) in areas 8–12 km from an operational airport..
2. No prior permission is required to operate drones in the Green Zone.
3. Most inland, coastal, and rural aquaculture farms are typically situated within Green Zones, making them suitable for routine drone-based monitoring and operations.

Yellow Zone:

i. Restricted airspace requiring ATC permission:
   a. Above 400 ft (120 m) in a Green zone, or
   b. Above 200 ft (60 m) in the 8–12 km airport belt.

ii. Fish farms located near urban environments or airport peripheries may fall under Yellow Zone restrictions. In such cases, it is advisable to apply for drone flight

clearance to AAI through email drone.asmchq@AAI.AERO , with relevant details such as:

a. Drone model and Specification Nodal Officer details
b. Details of Operations
c. Remote Pilot and Operator ID

Red Zone:

i. The Red Zone includes no-fly areas, such as those near defense establishments, international borders, nuclear plants, and other sensitive installations.
ii. Drone operations in Red Zones are prohibited unless specifically authorized by the Central Government through a formal exemption process. (MoCA email sdit.div-moca@gov.in).
iii. It is recommended that operators avoid planning any activity in or around Red Zone areas unless officially approved.

Temporary Red Zone:

i. A restricted airspace designated by State/UT authorities or law enforcement to temporarily prohibit UAS operations in a specific area

8.8.1. Procedure for Zoning Verification

i. Operators should log in to the Digital Sky Platform, navigate to the Airspace Map section, and enter either the GPS coordinates or physical address of the fish farm location.
ii. The map will display a color-coded classification indicating the applicable zone. It is recommended to capture a screenshot or export the zoning status for recordkeeping.
iii. This step should be completed prior to each flight to account for any temporary or situational airspace changes.

8.8.2. Compliance and Safety Considerations

i. Any drone operation conducted without verifying zoning status, or without securing required permissions, is treated as a violation of the Drone Rules, 2021.
ii. It is further advised to recheck zoning classification before every operation, especially in cases where airspace restrictions may be temporarily applied due to VIP movement, emergency responses, or security alerts.
iii. Operators should also avoid flying drones:

a. Over people
b. Near religious structures, highways, or public gatherings
c. Over residential areas adjacent to farm sites

d. In any area where privacy or crowd safety may be at risk

iv. Regular zoning checks, along with proper documentation and adherence to permitted airspace classifications, are encouraged as part of responsible and compliant drone operations in aquaculture environments.

v. There is currently no formal Zoning or Airspace Mapping framework for underwater drones (ROVs) in India. However, underwater drone operations may be subject to:

a. Site-specific permissions from fisheries departments (especially in public reservoirs, marine protected areas, or coastal zones)

b. Local port, navy, or coastal police authorities, if operating near strategic or security-sensitive coastal waters

c. Environmental regulations (e.g., CRZ notifications, wildlife sanctuary boundaries)

d. Internal farm policies for private ponds or cage culture systems

vi. While underwater drones are not subject to national zoning frameworks like aerial drones, it is advisable to:

a. Coordinate with the local fisheries office or farm manager before any ROV deployment.

b. Avoid restricted or ecologically sensitive marine areas.

c. Maintain navigational records and coordinates, especially when working in shared waterbodies, harbours, or estuaries.

9. Risk Management

9.1. Health, Safety and Environmental Considerations

Drones used in fisheries and aquaculture must be operated in a manner that ensures the safety of operators, on-ground personnel, aquatic life, and the surrounding environment. Proper handling, maintenance, and awareness of risks are essential to sustainable drone operations.

9.2. Battery Handling and Drone Maintenance

1. Battery safety for marine/coastal humid environments may be elaborated further, especially corrosion protection and waterproof battery compartments.

i. Use only manufacturer-approved batteries and chargers.

ii. Ensure batteries are fully charged and free of swelling, leakage, or corrosion before each flight.

iii. Never store or transport batteries in extreme heat or direct sunlight.

iv. Keep fire extinguishers (Class D or Lithium-based) nearby during charging or flight operations.

v. Store batteries in fireproof containers if kept on-site.

vi. Conduct routine drone maintenance including:

    a. Cleaning of propellers and motors
    b. Inspection of joints and seals
    c. Software and firmware updates
    d. Camera lens and sensor calibration

9.3. Risk Mitigation and First Aid

i. Conduct a risk assessment prior to each drone operation identifying possible hazards (e.g., obstacles, birds, weather).

ii. Maintain a safety radius of at least 10 meters around the drone take-off and landing zone.

iii. Train all drone pilots and support staff in basic first aid and handling of:

    a. Minor injuries (cuts, burns)
    b. Electrical faults
    c. Eye protection against sun glare or debris

iv. Keep a First Aid Kit at all drone operation sites.

v. Record and report any accidents, injuries, or near-miss incidents to supervisors and relevant authorities.

9.4. Guidelines for Use Near Sensitive Coastal and Marine Ecosystems

i. Consult State Coastal Zone Management Authorities (SCZMAs) for sensitive zone demarcations.

ii. Fly at higher altitudes (≥40 meters) when operating near:

    a. Estuaries
    b. Mangrove forests
    c. Marine protected areas (MPAs)

iii. Do not collect or disseminate imagery of sensitive marine sites without prior environmental clearance.

iv. Drones should be sanitized when moved across different marine zones to prevent cross-contamination of aquatic pathogens.

9.5. To maintain a safe and controlled flight environment, operators are advised to observe the following weather and safety considerations:

i. Avoid flight operations during adverse conditions, including:
    a. Strong winds, fog, or rain
    b. Lightning risk or low cloud cover

i. Flights should be postponed if visibility drops below 1 kilometer.

ii. Prefer operating during early morning or late afternoon when wind is calm, glare is minimal, and fish are less active near the surface.

iii. Maintain a minimum safe distance (10 meters) between the drone operation site and any bystanders or farm workers.

iv. Drone usage should be strictly avoided during:
    a. Any human activities going on in the pond or farm
    b. Fish harvests or net lifting activities, due to high operational sensitivity.

9.6. During Underwater Application of Drone

To ensure safe underwater operations and minimal environmental disruption, the following guidelines are recommended:

i. Avoid deployment during periods of:
    a. Excessive wave action or strong currents
    b. Low underwater visibility (<1 meter)
    c. Chemical treatment or mass feeding events

i. Do not operate ROVs alone; always have a second person present as surface observer.

ii. Keep all equipment and cables away from walkways, boat edges, and mechanical zones to prevent tripping hazards.

iii. Use personal protective equipment (PPE) such as gloves and life jackets while deploying or retrieving the drone.

iv. Place clear markers around the dive zone to restrict access during operation.

v. Ensure tether spools and connectors are handled with care to prevent injury or cable fatigue.

10. Permissions and Approvals

1. Drone operations in fisheries and aquaculture must be carried out in compliance with regulatory requirements laid down by DGCA/MoCA and coordinated with local and coastal authorities. Proper permissions and clearances ensure safety, accountability, and legal compliance.

10.1. Digital Sky/eGCA Platform Usage

i. All drones, must be registered on the eGCA portal.

ii. Prior to every operation (except in Green Zones), the pilot must:

   a. Log in to Digital Sky

   b. File flight plan including date, time, GPS coordinates, and purpose.

   c. Obtain a Permission Artefact for the drone to be able to take-off.

iii. The airspace map must be checked before each flight to determine if the location falls under Green, Yellow, or Red Zone.

10.2. Permissions from State and Local Authorities: For drone operations over aquaculture ponds, reservoirs, coastal and reservoir cages, permission may be required from.

State Fisheries Department

a. If the operation involves government waterbodies, prior approval must be sought from the Department of Water Resources or concerned government authority.

b. In tribal or forest buffer zones, Forest Department clearance may also be necessary.

c. A letter of intent or purpose of drone use should be kept on record for field verification.

d. If the operations are over Red Zone, permission from Ministry of Civil Aviation must be obtained.

e. If the operations are over Yellow Zone, permission from AAI must be obtained.

f. The operations must be carried out within the scope mentioned in the type certificate of the drone.

Local Administration

Facilitating the activities wherever applicable as and when required by respective authorities as mentioned below:

   a. District Administration

   b. State/District Police and coastal/maritime police

   c. State Pollution Control Board

   d. State Forest Departments

10.3. Coordination with Coastal Security Agencies and Fisheries Departments

i. For marine and coastal drone operations (e.g., cage culture, marine surveillance), prior intimation must be sent to Coastal Security Agencies such as:

   a. Indian Coast Guard (ICG)

   b. State Marine Police

c. Navy, where applicable

ii. Intimations should include:

a. Pilot credentials

b. Drone registration number (UIN)

c. Flight time and coordinates

d. Area of operation

iii. Coordination with the District Fisheries Officer is mandatory for any government-linked fisheries initiative.

iv. In border states, drones should not be flown near international maritime boundaries without security clearance.

11. Drone Operator Training and Certification

i. The safe and effective use of drones in fisheries and aquaculture requires trained and certified personnel who are not only skilled in piloting but also understand fisheries-specific applications. This section outlines the qualifications, training institutions, and conduct requirements for drone operators.

ii. Comprehensive training, certification, and capacity-building programmes will be undertaken to develop skilled drone operators, technicians, and data analysts in the fisheries and aquaculture sector, thereby promoting digital integration, real-time monitoring, and data-driven decision-making.

iii. Further, specialized training initiatives for deep-sea fishing operations will be supported, wherever required, in collaboration with leading maritime nations to strengthen technical expertise and develop human resources capable of carrying out sustainable offshore fishing activities.

iv. Drone operators are trained and certified individuals tasked with executing drone flights/dives safely and effectively. It is recommended that operators:

a. Handle equipment setup, sensor calibration, and pre-flight/dive checks.

b. Follow operational protocols tailored to the mission—whether for feed dispensing, water quality assessment, or disease detection.

c. Maintain real-time awareness of environmental conditions and drone status during operations.

d. Report any technical or safety-related issues to the concerned authority.

e. Ensure compliance with applicable flight and safety standards at all times.

v. Operators play a vital role in the collection of accurate data that directly informs management decisions.

11.1. Required Qualifications and Licensing

i. Required Qualifications and Licensing - Suggested to mention that the course requirement for getting a drone pilot licence varies based on the type of drones (medium, large) and their application
ii. The drone must be operated by a person holding a valid Remote Pilot Certificate (RPC) issued by a DGCA-authorized Remote Pilot Training Organization (RPTO).
iii. The minimum eligibility to obtain an RPC includes:
    a. Not less than eighteen years of age and not more than sixty five years of age;
    b. Successful completion of theoretical and practical drone training from any DGCA Authorized RPTO
iv. Drone requirement as per fisheries and aquaculture requirements.
v. Each drone operation must be logged with details of the Remote, including their RPC number.

11.2. Approved Training Institutes

i. The Remote Pilot Training Organizations (RPTOs) authorised by DGCA, shall issue remote Pilot Certificate (RPC) through eGCA.

11.3. Standard Code of Conduct for Operators

i. All drone pilots engaged in fisheries-related work must adhere to the following code of conduct:

a. Always operate drones within Visual Line of Sight (VLOS) unless otherwise approved.

b. Ensure every flight is pre-approved and conducted in compliance with DGCA regulations.

c. Maintain logbooks, battery records, and maintenance checklists up to date.

d. Avoid reckless flying, stunts, or photography in restricted zones.

e. Respect data privacy norms — no capturing of neighbouring properties or individuals without consent.

f. Immediately report any accident, crash, or airspace violation to the farm manager and relevant authorities.

g. Ensure drones are sanitized when moving between multiple ponds or farms to prevent bio-contamination.

h. Continuously upgrade knowledge through refresher training, especially on drone software, GIS tools, and safety regulations.

12. Data Management and Security

1. Drone operations in fisheries generate large volumes of sensitive spatial, visual, and operational data. It is essential to manage this data responsibly, ensuring accuracy,

privacy, secure storage, and integration with digital systems for effective planning and decision-making.

12.1. Data Collection Guidelines (Surveillance)

i. All data collected using aerial or underwater drones should be:
   a. Geo-tagged and time-stamped
   b. Captured at appropriate resolution (e.g., 4K for videos, ≥20MP for still images)
   c. Stored in standardized formats (e.g., JPEG, MP4, TIFF, CSV, GeoTIFF)

ii. Data collection must align with the intended use case — e.g., feed dispersion, cage inspection, or pond mapping.

iii. Operators should avoid collecting non-essential or personally identifiable data (PII).

iv. Use of automated flight and capture software is encouraged for consistency and reduced human error.

12.2. Privacy, Ownership and Storage Norms

i. National geo spatial data guidelines

ii. The ownership of data rests with the farm owner, cooperative, or agency commissioning the drone service.

iii. Data collected over private farms or water bodies cannot be shared or published without consent.

iv. Drone operators must sign a data confidentiality agreement, especially in contract service models.

v. All data should be:
   a. Stored in secure, access-controlled devices.
   b. Backed up on encrypted storage drives or verified cloud platforms.
   c. Retained for at least 2 years (or as mandated by project/scheme guidelines)

13. Review and Updates

i. Periodic review and update of the SOP for the application of drone technology in fisheries and aquaculture in India is essential to maintain its relevance, effectiveness, and alignment with rapidly evolving technologies, regulatory developments, and on-ground implementation experiences. As drone usage expands into areas such as surveillance, resource mapping, aquaculture pond monitoring, and delivery of inputs, the SOP must remain flexible and responsive—incorporating emerging best practices, safety protocols, innovations, and stakeholder inputs. To ensure consistency and accountability, the SOP should be

reviewed periodically by the Department of Fisheries, Government of India, or any designated authority, with active involvement from institutions such as the NFDB, ICAR institutes, and State Fisheries Departments. Updated versions of the SOP should be formally circulated to all relevant stakeholders to facilitate uniform adoption and promote safe, efficient, and sustainable use of drone technology in the sector.

14. Annexures

Annexure-I- Sample Drone Application Checklist

Since the operations are mainly over water regions, a detailed drone recovery and retrieval SOP during water crash/failure may be added, including flotation systems, emergency beacon, and retrieval responsibility.

Indicative checklist for Drone Application in Fisheries and Aquaculture for aerial drone application like fish transport, Feed application and monitoring and surveillance are given below:

S. No	Activities	Checklist
1	Pre-Operation Legal Compliance	Drone must be type-certified by DGCA (unless otherwise exempted) for the intended use case.
		Ensure drone is registered as per DGCA norms on the eGCA Platform and obtain UIN
		Verify pilot has a valid Remote Pilot Certificate for the drone category and weight class.
		Confirm operations follow Drone Rules 2021 and Amendment Rules 2022 by MoCA.
		Do not operate in restricted/no-fly zones (e.g., airports, electronic stations). Flying permission Yellow Zone → concern ATC Permission Red Zone → MoCA
		Ensure that the operations are carried out within the scope mentioned in the type certificate of the drone
		Obtain all local permissions from fisheries departments or relevant authorities.
		Valid Third Party Insurance
2	Pre-Application Preparation	Do not consume alcohol within 12 hours before drone operation.
		Choose a type certified drone model suitable for the

S. No	Activities	Checklist
		activity: transport, feeding, or monitoring.
		Select appropriate software and technology based on activity type.
		Attach necessary peripherals (e.g., containers, sensors, cameras).
		Set drone altitude and speed settings based on operation requirements.
		Check GPS functionality and mapping accuracy to ensure proper area coverage and safe boundaries.
		Plan and map safe flight routes, avoiding obstacles (trees, poles, wires).
		Mark and confirm safe take-off and landing zones.
		Perform equipment checks – battery, propellers, payload, sensors.
		Carry out pre-start calibration and safety checks.
3	Precautionary Measures – During Operation	Follow health and safety guidelines strictly.
		Wear Personal Protective Equipment (PPE) while handling drones.
		Ensure proper flying height as per guidelines.
		Confirm weather suitability – check wind speed, temperature, and humidity.
		Avoid unnecessary turns – confirm route to minimize turnaround time.
4	Specific Activities	Fish Transport: Use drones capable of carrying live loads safely.
		Fish Transport: Ensure oxygenated or water-tight compartments if applicable.
		Feed Application: Use drones with

S. No	Activities	Checklist
		spreaders/sprayers.
		Feed Application: Calibrate for dosage and uniform coverage.
		Monitoring & Surveillance: Use cameras/multispectral/thermal sensors.
		Monitoring & Surveillance: Ensure real-time video or data collection.
5	Data Collection & Processing	Use real-time operation protocols to process data from cameras/sensors.
		Prepare reports using ICT tools for timely and accurate decisions.
6	Post-Operation Maintenance	Examine drone and all peripherals for wear, damage, or malfunction.
		Perform maintenance using manufacturer-recommended tools and methods.
		Contact manufacturer for any technical support or issue resolution.
		Schedule regular maintenance as per drone/peripheral manual.
7	Post-Application Precautions	Clean and inspect drone after operation.
		Store equipment in safe, dry, and secure location.
		Maintain flight logs and maintenance records.
8	Emergency Preparedness	Be trained in handling accidents, fire, or emergency landings.
		Keep emergency first aid kit and tools available.
		Provide first aid and report details as per workplace norms.
		Use emergency equipment as per instructions.

Annexure-II - Relevant Government Notifications and Guidelines

List of **applicable rules and regulations** relevant to the **application of drone technology in fisheries and aquaculture in India**, along with their **corresponding sources of information** are mentioned below:

1. Drone Rules 2021 (and amendments thereof)
2. Certification Scheme for Unmanned Aircraft Systems, 2022
3. Drone Training & Drone Manufacturing Circulars
4. Drone related Public notices & other guidelines available on DGCA website.
5. UAS Traffic Management (UTM) Policy Framework, 2021
6. Digital Sky/eGCA Platform Guidelines
7. Remotely Piloted Aircraft Systems (RPAS) Guidance Manual
8. Environment Protection Act, 1986
9. Wildlife Protection Act, 1972
10. Guidelines for PMMSY Implementation

Annexure-III- Implementing Agencies

The Stakeholder Engagement Framework outlines the key target groups, institutional partnerships, and collaborative mechanisms essential for the effective deployment of drone technology in fisheries and aquaculture. It defines the roles and responsibilities of various stakeholders—including farmers, government bodies, research institutions, and technology providers—to ensure coordinated action. This framework fosters inclusive participation and shared accountability across all levels of implementation

PMMSY Phase-II will further promote innovation by encouraging start-ups and MSMEs to develop customized drone solutions tailored to the specific needs of Indian fishers and fish farmers.

Stakeholders Engaged

Institutional support and collaboration:

The following Institutional support shall be leveraged for promotion of drone technology in fisheries and aquaculture in India.

S. No.	Institution Name	Areas of Collaboration
1	Department of Fisheries, Ministry of Fisheries, GoI	• Provide overall policy direction and national-level coordination for the adoption of drones in fisheries and aquaculture and also regulatory facilitation. • Facilitate the inclusion of drone-based activities, along with support and funding, under PMMSY -Phase II and Blue Economy programmes. • Issue advisories, model SOPs, and operational frameworks for drone deployment across various fisheries segments. • Support inter-ministerial and Inter-Departmental convergence, especially with MoCA, MoEFCC, AAI, DGCA and MoA&FW for regulatory and funding alignment.
2	National Fisheries Development Board (NFDB)	• Act as a technical and implementation support agency for promoting drone technology across States and UTs as per PMMSY - Phase II guidelines. • Develop and disseminate training modules, awareness materials, IEC material, and

S. No.	Institution Name	Areas of Collaboration
		operational handbooks for the use of drones in the fisheries sector. • Facilitate capacity-building programmes and exposure visits for fisheries officials, fishers, and FFPOs on drone applications. • Support data integration and monitoring frameworks using drone-generated outputs such as GIS, MIS, and PMMSY - Phase II monitoring systems. • Promote pilot project demonstrations, innovation challenges, and research collaborations to test scalable drone solutions in inland, marine, and reservoir fisheries. • Maintain a central knowledge repository and dashboard on drone deployments, use cases, and impact metrics.
3	State/UTs Fisheries Departments	• Serve as the nodal authority for field-level implementation of drone-enabled activities under schemes such as PMMSY Phase II and designate a dedicated nodal officer for the same. • Identify priority areas and clusters for drone applications, including cage culture sites in reservoirs, open seas, and coastal zones. • Provide administrative approvals and necessary local permissions, particularly for shared or protected water bodies. • Coordinate with State drone cells, maritime boards, and security agencies, wherever applicable. • Oversee training programmes and beneficiary selection, particularly for fishers, SHGs, and FFPOs adopting drone-based solutions. • Identify permissible routes and operational corridors for drone applications within their

S. No.	Institution Name	Areas of Collaboration
		respective jurisdictions. • Facilitate the identification of test sites and prepare action plans for convergence with relevant State schemes.
4	Ministry of Civil Aviation (MoCA)	• Issuance of Drone rules, Airspace ,Red Zone permissions • Issue and Amendment of Drone Rules 2021 • Issue of Certification scheme of Unmanned Aircraft Systems. (CSUAS 2022) • Granting approval for Nodal officers (Creator and approver) nominated by States/UTs towards creation of Temporary RED zone. • Notifying specified airspace as RED Zone on Digital Sky Platform • Granting permission for drone operations in Red Zones.
5	Directorate General of Civil Aviation (DGCA)	• Regulatory approvals such as, Type certification, RPTO authorisation, , guidance on Drone Rules 2021. • Issue of Type Certification (TC) • Authorization of Remote Pilot Training Organizations (RPTOs). • Registration of Drone in the form of Unique Identification Number (UIN), safety oversight, and compliance monitoring. Issue of Drone Circulars • Safety Oversight of TC holders and RPTOs.
6	Airports Authority of India (AAI)	• Granting permissions for drone operations in air space- Yellow Zones declared on the Digital Sky platform. • Defining Standard Operating Procedures (SOPs) for drone flights within Yellow Zones • Air Space Maps

S. No.	Institution Name	Areas of Collaboration
7	ICAR-Central institute of Brackishwater Aquaculture (CIBA)	CIBA will facilitate as R&D partner in demonstrating pilot projects with the technology available in the areas of marine sector. Precise topographic analysis for planning and identifying the potential areas for aquaculture. Surveillance of the farming operations with real-time alert mechanisms.
8	ICAR-Central Institute of Fisheries Technology (CIFT)	CIFT will facilitate as R&D partner in the areas of post-harvest practices, training modules, environmental impact assessments, payload calibration.
9	ICAR- Central Inland Fisheries Research Institute (CIFRI)	CIFRI will facilitate as R&D partner in designing and demonstration of drone use in natural water bodies & water quality mapping.
10	ICAR-Central Marine Fisheries Research Institute (CMFRI)	CMFRI will facilitate as R&D partner in coastal and marine surveillance, fish shoal detection, marine biodiversity monitoring & feed distribution in marine cages using drones.
11	IIT Hyderabad	TiHAN, IIT Hyderabad will facilitate as R&D partner for support for autonomous aerial technologies, payload integration, AI-based monitoring, field validation, and technology development for fisheries and aquaculture applications
12	ICAR-Central Institute of Freshwater Aquaculture (CIFA)	CIFA will facilitate as R&D partner in designing and demonstration of drone use in pond-based aquaculture, feed application trials, water quality mapping.
13	ICAR-Indian Agricultural Research Institute (IARI)	IARI will facilitate as R&D partner in Drone Remote Sensing (with varying sensors) for surveillance, mapping and monitoring and Drone Robotics for variable rate technology based efficient input management for precision aquaculture (in collaboration with Fisheries Institutes) and capacity building

S. No.	Institution Name	Areas of Collaboration
14	Remote Pilot Training organisation (RPTO) authorized by the Director General of Civil Aviation (DGCA)	Issuance of remote pilot certificate
15	Indian Institute of Technology, Kanpur (IIT-K)	IIT-K will facilitate as R&D partner for designing indigenous drones with varying endurance and payload for different application in Fisheries and aquaculture and capacity building
16	Coastal Zone Management Authorities / MoEFCC	1. Oversee compliance with CRZ norms and environmental safeguards, especially for drone use in marine protected areas, estuaries, and sensitive coastal zones. 2. May issue permissions or clearance protocols for drone operations involving underwater ecosystems. 3. Ensure security oversight and risk assessment for underwater drone use in strategic or sensitive areas, including ports, naval bases, and international maritime boundaries. 4. Coordinate with fisheries departments and drone operators to prevent unauthorized or accidental intrusions into restricted waters. May require intimation or coordination for deep-sea ROV deployments near shipping lanes or defence zones
17	Indian National Centre for Ocean Information Services (INCOIS)	Coastal zone mapping, ocean data integration, drone-data interoperability for fishery forecasting.
18	National Remote Sensing Centre (NRSC), ISRO	Bringing synergy and complimenting drone and satellite technologies for large scale applications in fisheries
19	Agricultural Skill Council of	Certification and skilling of drone pilots specific

S. No.	Institution Name	Areas of Collaboration
	India (ASCI)	to fisheries and aquaculture sector needs.
20	Drone Federation of India (DFI)	Industry collaboration, drone manufacturers engagement, innovation incubation, start-up support.
21	Krishi Vigyan Kendras (KVKs)/ICAR Fisheries Institutes/DoF Field Institutes	On-ground training, farmer awareness, field demonstrations, feedback collection.
22	National disaster Management Authority (NDMA)	NDMA issues the rules and regulations to be followed during the disaster as listed in their SOPs
23	Local Administration	Facilitating the activities wherever applicable as and when required by respective authorities as mentioned below. • District Administration • State/District Police and coastal/maritime police. • State Pollution Control Board • State Forest Departments