ARIS Sonar Camera: Site Visit Findings and Feasibility Assessment

May 2026

IFI/2026/1-4808





Iascach Intíre Éireann
Inland Fisheries Ireland

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Contents

Executive Summary 3

Introduction 4

ARIS Deployment Framework 5

Initial Programme Setup – Wales 6

Site Visit Findings 7

Operational Considerations 9

Site selection – considerations 12

Required Development Phases 13

Appendix 1: 15

Executive Summary

This report summarises a site visit to Natural Resources Wales (NRW) to examine how ARIS sonar camera systems are used in operational fish-counting programmes and to assess the potential for applying the technology in Irish rivers. The visit combined discussions with NRW research staff and field inspections of active deployments on the Rivers Usk, Teifi and Towy. Overall, the visit confirmed that ARIS can provide valuable fish-counting data in suitable river systems for habitat directive species (e.g., salmon and sea lamprey), but only where site specific technical, operational and resourcing requirements are carefully addressed.

Key findings. Site selection is the single most important determinant of success and reliable counts. Suitable sites are typically 20-30m in width and ~1-2m deep where fish movement is directed and predictable; wider channels, pooling areas and locations with fish milling behaviour are less suitable. NRW experience indicates that one to two years of site-specific trials are generally required before operational confidence is achieved, and full implementation may take four to five years at some locations. The technology also brings substantial operational demands, including daily or near-daily maintenance, regular cleaning and adjustment, annual servicing, and robust supporting infrastructure such as power, communications, secure housing and custom mounting arrangements.

Resource implications. Data management and processing represent major constraints. NRW reported data volumes of approximately 550 GB per day and around 2.2 TB per month for a single deployment, creating significant requirements for storage, transfer, backup and archiving. Processing demands also vary seasonally, with peak migration periods requiring intensive manual review. Although motion-threshold filtering and developing AI-assisted tools can reduce workloads, these methods remain site-specific and do not remove the need for expert oversight. Indicative costs are approx. €120,000 for an ARIS Explorer 1800 unit, about €20,000 for auxiliary equipment (tilting arm), and a further €20,000 for mounting and installation infrastructure, in addition to staffing, servicing and recurring service costs. A two-year Research and Development project (at one pilot site) including; staff costs, operational expenses and ARIS equipment costs would be approx. €480,052. Where the river width exceeds the effective coverage of a single camera (approximately 20–30 m), two cameras would be required to achieve complete coverage and an accurate fish count. This would result in an additional equipment cost, with a second camera estimated at approximately €185,000 and a potential total project cost of €665,052.

Conclusion. ARIS is technically feasible for use at suitable sites in Irish rivers. A pilot project could be considered at a key monitoring site. It would need to be supported by dedicated staffing, site-specific validation, a formal data management plan, and clear procedures for calibration, quality assurance and long-term maintenance. This would allow the methodology, resource requirements and analytical confidence to be established.

Introduction

Fish Counters are used as a scientific and management tool to provide Inland Fisheries Ireland with indices of total stock of salmon or sea trout within selected Irish Rivers. This information acts as a representation of the status of fish (salmon/sea trout) stocks within a given river and informs national trends. Inland fisheries Ireland carries out assessments of developing technologies to enhance its existing fish counter programme.

In this context and with additional interest and emphasis generated by the Moy Action Group several site visits and presentations were organised with our counterparts in Natural Resources Wales (NRW). Meetings in Wales were arranged between 18th and 20th May 2026 to explore the use of Adaptive Resolution Imaging Sonar Camera (ARIS) for counting fish in larger rivers. Three members of IFI staff travelling were Inspectors Barry Kelly, Padraic O'Malley and Senior Research Officer James Barry. Three members of the Moy Action Group also attended at their own expense. A dedicated Risk Assessment was prepared for the trip and activities.

The agency facilitating the trip was Natural Resources Wales (NRW) and the contact for the trip was Mr. Peter Clabburn. The trip incorporated presentations and field visits. The presentations were from NRW staff and an online presentation from a Deveron fisheries trust in Scotland who are involved in a project to develop an AI tool for analysing the vast amount of data generated by the sonar camera. Discussions focused on the integration of ARIS technology into routine monitoring programmes, operational and maintenance requirements, data management processes, and lessons learned during system development. The visit also included field inspections of three rivers (Usk, Teifi Towy) where ARIS sonar cameras are actively deployed.

Observing operational systems provided valuable insight into equipment setup, site selection criteria, infrastructure requirements, and logistical considerations associated with long-term deployment. Factors influencing system performance under varying river conditions, including flow characteristics, channel morphology, accessibility, installation constraints and upkeep of units once deployed.

Overall, the visit provided important technical and operational information regarding the feasibility, effectiveness, and practical application of ARIS sonar technology for fish counting purposes. This report outlines the main topics covered during the site visit including:

-ARIS development phases

-Site Visits

-Operational Considerations

-Initial Programme Set up and Cost

ARIS Deployment Framework

Implementation of an ARIS-based fish monitoring station follows a phased approach, progressing from initial catchment-scale assessments and site screening through to hydraulic surveys (ADCP), fish behaviour studies, and riverbed stability monitoring before permanent infrastructure is installed. This staged process is essential to ensure site suitability, optimise system performance, and validate fish counting accuracy under local environmental conditions. Experience from existing deployments demonstrates that achieving operational confidence typically requires one to two years of site-specific trials, while the full journey from initial assessment to a fully operational monitoring station can take four to five years at some locations.

The ARIS programme follows a phased approach to site development and implementation:

Table 1: Example phased approach to ARIS deployment, from NRW presentation Day 1.

Phase	**Description**
Phase 1	Macro-scale assessment to determine river suitability, channel width constraints, and whether full or partial counts are achievable
Phase 2	Site screening and preliminary suitability assessment
Phase 3	Acoustic Doppler Current Profiler (ADCP) surveys and hydraulic profiling
Phase 4	Assessment of fish behaviour and evaluation of non-target species interactions
Phase 5	Riverbed stability monitoring and assessment of channel changes
Phase 6	Installation of permanent infrastructure and transition to operational monitoring

Experience from NRWs existing deployments indicates that Phases 1–5 may require between one and two years of site-specific trials before operational confidence is achieved. At some locations, the overall process from initial assessment to a fully operational monitoring station required approximately four to five years.

Initial Programme Setup – Wales

Discussions with programme staff highlighted several recurring themes including Site selection and an establishment or trial period.

Site selection was consistently identified as the most critical factor influencing success.

Ideal locations include:

- Natural migration bottlenecks.
- Narrow sections of river channels.
- Areas where fish movement is directed and predictable.
- Fast runs and constricted reaches.

Less suitable locations include:

- Pools.
- Areas where fish exhibit milling behaviour (e.g., downstream movements)
- Wide channels where complete coverage becomes difficult.
- Obstruction on river bed (e.g., large boulders which cause acoustic shadow).

The technology performs most effectively in channels up to approximately 20-30 metres wide, beyond which readings can become problematic.

Site scoring using the above input factors has been used by existing companies to select appropriate sites. The maximum range of the equipment is also key, and this was estimated at approximately 34 meters at the Welsh sites visited. The effective range of the camera is dependent on the profile of the river, configurations of the camera, water height and turbidity of the river at any particular time. These variables also affect resistivity and optical counters; however automatic counters have a self-calibration function operating every twenty minutes to minimise the effect of these changing variables.

The ARIS 1800, currently in operation in Wales, is recommended at locations with a channel width of approximately 20–30 m, subject to site-specific conditions and the effective detection range of the camera. Where the river width exceeds the coverage achievable with a single camera, two cameras could be deployed to achieve a complete count. This would require careful configuration to minimise overlapping acoustic beams and avoid double-counting, potentially through alternating camera operation or monitoring different sections of the river at specified intervals. However, a dual-camera configuration would introduce additional complexity in terms of installation, synchronisation, data processing and validation, particularly when reconciling detections from both cameras to produce a reliable total count. It would also increase equipment, maintenance and operational costs.

Consequently, the preferred approach is to identify a suitable monitoring location where a single ARIS 1800 camera can provide adequate channel coverage. This would minimise capital and operational costs, simplify data processing and quality assurance, and provide a more straightforward and consistent approach.

Establishment Period

Two to three years may be required before sufficient data are available to generate robust biological estimates. Significant effort is required during the initial setup and troubleshooting period. Long-term datasets are essential for calibration and validation.

Site Visit Findings

River Usk Site Visit

The first site visited was located in a remote area with limited physical access.

Key observations included:

- System status and obstruction monitoring were primarily conducted remotely.
- Solar panels and mobile network connectivity were used to support operation (Fig.1).
- Solar-powered systems can be vulnerable during winter periods.
- Overheating represents a significant risk if equipment becomes exposed or runs dry (Fig.1).





Fig.1: Top - Housing unit on riverbank – fully remote site. Bottom - Solar panels used to charge batteries operating the ARIS unit on the Usk site.

River Teifi and Towy Site Visits

The second and third sites demonstrated alternative deployment approaches.

Key observations included:

- Systems could be accessed remotely.
- Camera angles could be adjusted to accommodate changing flow conditions.
- A subsampling approach was employed to reduce processing requirements – camera tilt options were explained at this site.



Fig 2: ARIS counter and mount on River Usk.



Fig. 3: NRW and IFI staff viewing ARIS beam display in real time inside the Teifi ARIS storage facility (hydrometric station hut on riverbank); the Teifi site can be accessed remotely via 4g connectivity which allows status check from office – tilt change in higher flows – checks for debris.

Operational Considerations

Equipment Maintenance

Routine maintenance requirements are substantial.

Observations included:

- Daily inspections are generally required.
- Cameras must be cleaned regularly to remove debris and fouling.
- Camera positioning may need adjustment during changing flow conditions.

- Annual servicing is considered essential, typically undertaken between November and March. ARIS units are returned to the manufacturer in the United States approximately every two years for servicing and calibration, resulting in additional costs and downtime.

Infrastructure Requirements

Successful deployment requires supporting infrastructure beyond the sonar unit itself.

Requirements include:

- Mains power supply where possible.
- Solar power only where mains supply is unavailable.
- Secure housing or container units for computers and data storage equipment.
- Reliable communications systems (4g connection preferable).
- Purpose-built mounting structures.

A custom-fabricated mounting arm or frame capable of adjusting camera angle is considered highly desirable. Estimated fabrication costs are approximately €15,000–€20,000 per installation and are often overlooked during project budgeting.

Data Management and Processing

Data Volume

Data management and data volume were identified as two of the most significant operational challenges (outlined in Table 2.)

Table 2: Data Volume from ARIS fish counters

Parameter	**Volume**
Daily storage	~550 GB
Monthly storage	~2.2 TB
File structure	Half-hour recording files

The storage, backup, transfer, and archiving requirements associated with these data volumes are substantial and require dedicated planning.

Processing Requirements

Processing effort varies considerably throughout the migration season.

Reported averages indicate:

- Four days of data typically require approximately one day of processing time.

- During peak migration periods, one day of collected data may require one full day of processing.

Consequently, personnel requirements can increase substantially during peak fish movements.

Subsampling approach

NRW adopt a subsampling approach that allows data to be processed within reporting timelines but introduces additional uncertainty into abundance estimates.

To compensate for incomplete counts, a logistical modelling framework is used that incorporates:

- Day of year (DOY).
- Fish size.
- Net capture data collected downstream.

The resulting logistic models assign probabilities to detections and support species apportionment. During Day 2 presentations in the office, NRW staff explained how raw files are processed using a motion-threshold filter. This removes large volumes of footage in which no movement is detected, helping to reduce the amount of material requiring manual review.

The use of motion detection software (NRW developed software) can be employed to filter out periods where no activity is detected, minimising the time required to view and process data. The motion detected by this filter will be required to be measured to record them in a digital format and thus have verifiable count for the first two or three years.

Thresholds can be set to filter out certain size ranges, for example movements below or above a certain size can be filtered out to minimise data capturing. This is similar to existing counters and acts to eliminate debris coming down the river from spoiling a good set of data. However, this will limit any counting of smolts or smaller finnock travelling through the beams.

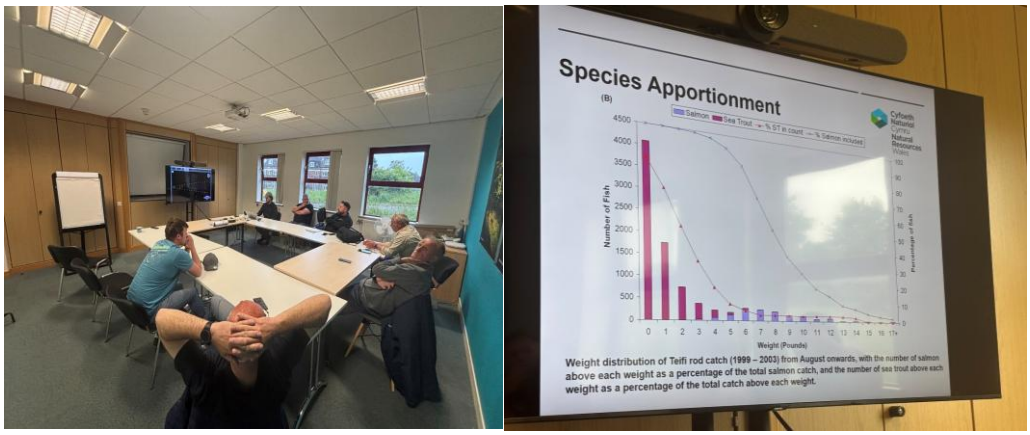


Fig 4. Presentations at NRW base where staff outlined species apportionment and threshold settings on the ARIS fish counters.

Artificial Intelligence and Machine Learning

Researchers using ARIS equipment are developing machine learning and artificial intelligence tools to assist with fish detection and classification.

AI-assisted processing remains under active development but for now manual annotation remains necessary when setting up a new site. At least two to three years of manually counted data may be required to adequately train site-specific machine learning models.

Therefore, AI should currently be viewed as a developing support tool rather than speeding up the counting process or as a replacement for expert review

Site selection – considerations

The site visits demonstrated that ARIS sonar technology can provide valuable fish-counting data under suitable river conditions. However, successful implementation depends heavily on-site selection, dedicated staffing (for at least 2 seasons while kit is being trialled at a site-specific level), long-term commitment, and robust data management infrastructure (e.g., Data Management Plan).

Key findings include:

- Site selection is the primary determinant of success.
- Significant setup and validation periods should be anticipated.
- Data processing and management represent major resource commitments.
- Dedicated personnel are required during establishment and operation.
- Infrastructure and maintenance costs extend well beyond the purchase price of the sonar unit.
- NRWs in-house motion detection screening, developed through MS Access, significantly reduces file sizes by retaining data only when predefined motion thresholds are triggered, such as by fish movement. However, threshold performance is site- and flow-specific and must be calibrated and validated at each location.
- AI-assisted processing has potential but currently remains insufficient to eliminate manual review.
- A phased implementation approach with trial deployments over several years would likely be required before operational monitoring could be established in Irish rivers.

Overall, ARIS technology is technically feasible for deployment in suitable Irish river systems, particularly where natural migration bottlenecks exist. However,

implementation would require substantial investment in equipment, staffing, infrastructure, and long-term programme development before reliable operational outputs could be achieved.

Required Development Phases

Phase 1 (R &D)

Sites should be screened and a preliminary suitability assessment carried out. Hydraulic profiling and river profile would need to be evaluated at identified potential sites using an Acoustic Doppler Current Profiler (ADCP). To facilitate this and ensure the effective use of IFI equipment and staff resources the sites proposed would be shortlisted using a checklist from existing information and knowledge.

For a single pilot river system, an initial two-year R&D phase is likely to be required before standard operating procedures (SOPs) can be developed and confidence established in the resulting data which could be used for reporting and management purposes.

Suggested initial steps for a pilot IFI study (resource dependant):

- Site suitability assessment would need to be undertaken (e.g. hydraulic profiling - ADCP cross sections, ARIS camera view e.g. shadow assessments)
- Liaise with ARIS distributors, specialist and other researchers on site selection.
- Equipment deployment and maintenance (operations)
- Development of monitoring protocols.
- Fish detection and behaviour.
- Counting validation.
- Data management and storage solutions.
- Development of species apportionment methods (e.g. grilse, MSWs, sea lamprey)
- Calibration against alternative monitoring techniques (e.g. downstream rod catch, counters).
- Development of quality assurance and quality control procedures.
- Evaluation of machine learning and automated processing tools.
- Production of operational guidance documents and SOPs.

The primary objective of this phase would be to transition from an experimental deployment to a repeatable and defensible monitoring programme capable of producing data sufficient for management use. The estimated costs for the initial two-year R&D phase can be seen in Table 3.

Table 3: Indicative costs for R&D phase (2 years).

	Year 1	Year 2
Salary		
Research Officer	€47,983.00	€50,107.00
Data Analyst (HEO)	€58,912.00	€60,656.00
SUBTOTAL	€106,895.00	€110,763.00
IFI Operational expenses (e.g., T&S, Vehicle hire, ICT, PPE).	€35,550.00	€26,050.00
External expertise (Site visit)	€10,000	-
SUBTOTAL	€45,550.00	€26,050.00
*Sonar camera costs (capital)***	€185,794.00	€5,000.00
Subtotal	**€338,239.00**	**€141,813.00**
TOTAL		**€480,052.00**

***Note: if sonar camera site is over 30m width two cameras would need to be deployed to achieve a complete fish count which would be an additional cost of €185,794.*

Phase 2

Transition to Operational Monitoring

Following R&D phase, the programme if successful could transition to operational monitoring.

At this stage:

- SOPs would be established.
- Site-specific operational procedures would be documented.
- Data workflows established.
- Subsampling and analytical approaches could be implemented to improve efficiency while maintaining acceptable levels of uncertainty.

Ongoing requirements would remain for, equipment maintenance, data processing, and quality assurance. Annual servicing would need to be planned for along with infrastructure maintenance. A dedicated staff resource would likely remain necessary to ensure continuity and data quality.

Appendix 1:

Resource – indicative staff requirements

Successful implementation requires dedicated personnel, particularly during the establishment phase:

- A dedicated ARIS team is essential during initial deployment. Approximately 2–3 staff members may be required during the first two years while operational procedures are developed and validated.
- Existing programmes typically utilise at least one dedicated staff member responsible for equipment management, data processing, maintenance, and quality assurance.
- Once standard operating procedures (SOPs), calibration methods, and subsampling protocols are established, staffing requirements could potentially be reduced.

Table A1: Indicative staff requirements during this phase

Role and indicative requirement	**Indicative cost / time contribution**
New Project Staff	
1 x Research Officer	1.0 FTE (€47,983.07)
1 x Data Analyst / senor/data Specialist (HEO)	1.0 FTE (€58,912.34)
Internal Staff	
RBD Support (Operations) (As required per river)	0.2 FTE
Project Lead (SRO / RBD Director)	0.1 FTE
Catchment manager / Inspector	0.1 FTE
IT / Data Management Support (Data Manager)	0.1 FTE

Indicative equipment costs

Indicative costs of ARIS unit and auxiliary kit (Researchers currently operating ARIS kit recommended having a replacement unit to avoid down time).

Item	Indicative Cost (inc. VAT)
Capital costs	
ARIS Explorer 1800 sonar unit	€122,704.80
Auxiliary equipment (ARS rotator package, Lens, Cable Assembly)	€43,089.36
Mounting frame / installation structure / riverbank storage	€20,000
Site visit - Maintenance - Operational costs	
Site visit – assessment (external)	€6,000
Data Storage cost (cloud storage 25TB)	€3,000
Annual Service maintenance cost	€5,000
Shipping	Additional recurring cost

Considerations for ARIS in a national monitoring programme

The resource requirements outlined above relate to the deployment of ARIS technology at a single river (pilot study).

Scaling the approach to a national monitoring programme would introduce significant additional challenges and costs.

Firstly, identified river systems would require individual assessment and validation. Site suitability cannot be assumed, as ARIS performance is highly dependent on local channel morphology, flow characteristics, fish behaviour, and infrastructure constraints. Consequently, the development work undertaken at one river may not be directly transferable to another.

A national programme would therefore require:

- Multiple site assessments and feasibility studies.
- Site-specific trial deployments.
- Additional infrastructure development.

- Expanded data management capacity.
- Additional staffing for operations and analysis.
- Consistent quality assurance procedures across all locations.

Data management requirements would also increase substantially. Given that a single ARIS deployment can generate several terabytes of data per month, a multi-site programme would require enterprise-level storage, backup, processing, and archiving infrastructure. Long-term data retention policies would also need to be established.

From an organisational perspective, a national programme would likely require the establishment of a dedicated ARIS monitoring unit responsible for:

- Programme coordination.
- Equipment procurement and maintenance.
- Technical support.
- Data processing and analysis.
- Site specific SOP development.
- Staff training.
- Quality assurance and reporting.

Machine learning and automated processing tools are being developed. While this technology does not eliminate the need for manual review, future efficiencies may be realised through the accumulation of large, annotated datasets across multiple rivers. Such datasets could support the development of more robust automated detection and classification models, potentially reducing long-term processing requirements.

Overall, while deployment at a single river represents a significant investment in equipment, personnel, and infrastructure, a national roll-out would require a substantially larger resource commitment.