ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT071

# From Fish-Landing Inventories to Microplastic Monitoring:Development of a Proposed Surveillance Protocol for Pasacao, Philippines

Rowelyn Jaudian Paz Oliver
Mariners Polytechnic Colleges Foundation of Canaman, Camarines Sur, Philippines

Corresponding author

**Abstract**

**Background: Fish-landing inventories may provide an entry point for local microplastic monitoring, but their suitability depends on traceable sampling and analytical quality assurance. Objective: To assess the documentation readiness of a Pasacao, Camarines Sur fish-landing study and specify a prospective microplastic surveillance protocol. Methods: A revision-stage documentary appraisal of a 2026 graduate thesis examined its species inventory, landing-site sampling description, laboratory procedures and supporting appendices. Source statements were classified by documentary status and mapped to requirements for repeatability, biological replication, contamination control, polymer confirmation and reporting. No new field or laboratory observations were generated. Results: The source reported 17 landed taxa, provisional feeding-guild labels and chemical analysis involving three selected taxa. Although composite preparation was specified, the accessible records did not establish the numbers of independently processed samples. Fish-capture provenance, sampling denominators and particle-level confirmation remained incompletely reported. The proposed architecture differentiates Tier A landing registration and biological sampling, Tier B1 laboratory screening and quality control, and Tier B2 spectroscopic confirmation. A prospective pilot-evaluation matrix specifies coverage, workload, cost, recovery, reproducibility and reporting performance. Conclusion: The inventory can inform protocol design but cannot establish monitoring feasibility, geographic contamination levels or feeding-guild differences. Prospective assessment is required before routine adoption.**

**Keywords:** *Fish Landing; Microplastics; Surveillance Readiness; Protocol Development; Biological Replication; Coastal Fisheries.*

## I. INTRODUCTION

Marine microplastics constitute an established environmental contamination concern [1]. Microplastic monitoring in fish requires more than a record of suspected particles: study design must connect a defined sampling population to documented collection, contamination control, chemical identification and interpretable denominators. Published quality criteria for microplastics in biota stress sampling strategy, sample size, laboratory preparation, controls and polymer identification [2]. For environmental decision-making, the U.S. Environmental Protection Agency also recommends specifying the intended decision and required data quality before a monitoring design is deployed [3].

Plastic leakage into marine systems is documented at international scale through studies of land-based waste inputs, riverine transport and projected global leakage [4], [5], [6]. Those models motivate local observation but cannot identify the origin, abundance or distribution of contamination within Pasacao. Accordingly, the present paper does not convert modeled pathways into site-specific exposure claims.

At Caranan in Pasacao, Camarines Sur, a 2026 master's thesis catalogued 17 fish taxa from landings and reported FTIR-related observations in three selected taxa [7]. Those observations are useful for evaluating an existing sampling workflow, but catch availability and landing-site access do not imply unbiased marine population coverage. This article therefore examines what the source documentation can support and how gaps can be translated into a reproducible future protocol. It is distinct from a companion manuscript on particle characteristics: no reanalysis of polymer spectra or comparative particle counts is presented as an outcome here.

Published fish studies from the English Channel, North Sea, Portuguese coast and Ghana demonstrate that species selection, individual specimen denominators and feeding-environment classifications are central to interpretation [8], [9], [10], [11]. They also show why apparent differences among species or feeding groups should not be inferred from isolated composites. Studies of anthropogenic debris in marketed seafood provide evidence that fish-landing access is useful for collection, but market or landing observations are not geographically representative without catch-provenance information [12].

ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT071

The objectives were to (i) transcribe the available species-level inventory, preserving its unverified classifications; (ii) audit documentary completeness and analytical units; (iii) map traceable limitations to operational protocol requirements; and (iv) specify outcomes for a prospective pilot without representing proposed operations as completed research.

## II. MATERIALS AND METHODS

### 2.1 Study design, documentary source and boundaries

This was a document-based methodological case study followed by a revision-stage, retrospective documentation appraisal. The primary source was the 2026 master's thesis attributed on its title pages to Rowelyn Jaudian Paz, "Microplastic Accumulation in Fish Species with Varying Feeding Habits in Pasacao, Camarines Sur," prepared at Central Bicol State University of Agriculture [7]. Material examined included the methodology (thesis pp. 11–22), species inventory (Table 1, p. 24; Appendix 3, pp. 71–72), analytical summary (Table 2, p. 35) and described spectral appendices. A separate thesis-front-matter file was used to confirm the listed title and institutional presentation. The documentary appraisal was undertaken for this manuscript revision; it was not an activity reported by the original thesis.

The review used published tables and descriptions, not independent field forms, instrument raw files, specimen-level data or catch logs. A procedure classified as "not reported" may have occurred without appearing in the available reporting. The appraisal cannot independently confirm species identities, original permissions, individual sample histories or spectroscopy match decisions.

### 2.2 Evidence extraction and classification

For each evidence item, a record was made of its thesis location, source-reported statement, documentation status, interpretive consequence and proposed remedy. Four documentation labels were used: D, described in the thesis; P, partially described or internally inconsistent; NR, not reported in the assessed documents; and NA, not assessable from the supplied material. This is a transparency classification, not a validated quality score. A documented method is not equivalent to proof that every stated procedure was implemented for every specimen.

Terminology and analytical comparability were assessed with reference to definitions of plastic debris [13] and reviews of environmental microplastic sampling and identification [14], [15]. A separate systematic data-quality assessment in fish emphasizes that laboratory confirmation, clean-air conditions, positive controls and sample-size reporting remain frequent methodological weaknesses [16]. These publications are external benchmarks for appraisal, not evidence that any additional fieldwork or testing occurred in the parent thesis.

The appraisal considered ten biota-analysis quality domains summarized by Hermsen et al. [2]: sampling strategy, sample size, processing/storage, laboratory preparation, clean-air conditions, negative controls, positive controls, target tissue/component, pretreatment and polymer identification. The evidence-to-protocol mapping was additionally organized around traceability, independent replication, operational measurability and fit to an explicit surveillance question [3]. Table 2 gives the resulting completed appraisal, not an unperformed proposed extraction exercise.

### 2.3 Analytical units and treatment of uncertainty

The thesis states that 17 taxa were inventoried and identifies three taxa selected for GI-tract analysis. It also describes a compositing rule of three fish per species with a target tissue mass of 50 g (methodology, p. 19); another results passage states that three specimens were collected for each species. These passages are protocol or aggregate descriptions, not independently auditable records showing the actual number of fish contributing to each submitted preparation. Accordingly, three taxa are documented, but exact numbers of successful pools, independently processed laboratory preparations, and fish-level observations for inference remain unverified. No prevalence estimate, feeding-guild comparison, trend or confidence interval was calculated.

### 2.4 Derivation of the proposed protocol

A four-step requirement-mapping approach was applied: (1) extract source-reported inventory and sampling facts; (2) classify documentation and inferential gaps; (3) formulate a requirement and verifiable checkpoint for each gap; and (4) arrange requirements in a staged operational architecture. The framework is an author-developed synthesis using the thesis and external methodological guidance [2], [3], [17]. It is neither a Delphi-consensus product nor a validated implementation framework. Proposed eligibility rules and quality checkpoints must be tested in a future pilot.

A cross-disciplinary methodological precedent for context-sensitive measurement-framework construction is provided by Osma [18]. Its subject is ASEAN digital-trade measurement, not marine plastic pollution; it is cited solely to illustrate the need to define measurable constructs and context-specific criteria before application. Biota-specific technical requirements in this study instead come from microplastic sampling and analytical guidance [2], [17], [19], [20].

ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT071

## III. RESULTS

### 3.1 Traceable fish inventory and ecological-label uncertainty

Table 1 reproduces the 17 landing-inventory records as reported; taxon names and guild assignments have not been independently verified. The source narrative lists eight piscivorous, five planktivorous and four benthivorous species. These are inventory labels, not findings of species abundance or tested trophic classification. The thesis' ordering and some taxonomic spellings vary among its tables, narrative and appendices; original entries were retained where possible rather than silently reconciled.

**Table 1. Source-Reported Species Inventory (Thesis Table 1 and Appendix 3)**

| | | | | | |
|---|---|---|---|---|---|
| Tulingan / Bullet tuna | Auxis rochei | Piscivorous | Pelagic | 24.5 | 157 |
| Titso / Obtuse barracuda | Sphyraena obtusata | Piscivorous | Coastal/pelagic | 34.0 | 155 |
| Adgawon / Bigeye snapper | Lutjanus lutjanus | Piscivorous | Reef-associated | 16.5 | 51 |
| Timon-timon / Moonfish | Mene maculata | Benthivorous | Coastal/reef | 15.3 | 53 |
| Galungong / Redtail scad | Decapterus kurroides | Piscivorous | Pelagic | 17.9 | 53 |
| Talimago / Slender scad | Decapterus macrosoma | Piscivorous | Pelagic | 8.9 | 10 |
| Kuwaw / Red bigeye | Priacanthus hamrur | Piscivorous | Reef-associated | 20.0 | 99 |
| Aswang/mumu / Roudi escolar | Promethichthys prometheus | Piscivorous | Deep pelagic | 36.2 | 250 |
| Dalagang bukid / Redbelly yellowtail fusilier | Caesio cuning | Planktivorous | Reef-associated | 26.5 | 255 |
| Saramulyete / Goatfish | Parupeneus heptacanthus | Benthivorous | Benthic | 19.13* | 100 |
| Matang baka / Bigeye scad | Selar crumenophthalmus | Planktivorous | Coastal pelagic | 18.6 | 102 |
| Talinyasi/tamban / Indian oil sardine | Sardinella longiceps | Planktivorous | Coastal pelagic | 11.5 | 15 |
| Salay-salay / Yellowstripe scad | Selaroides leptolepis | Planktivorous | Coastal pelagic | 9.5 | 15 |
| Sibubog / Mackerel scad | Decapterus macarellus | Benthivorous | Pelagic | 20.0 | 57 |
| Kabalyas / Chub mackerel | Scomber japonicas† | Piscivorous | Pelagic | 16.6 | 50 |
| Pakan / Torpedo scad | Megalaspis cordyla | Benthivorous | Coastal/pelagic | 16.0 | 50 |
| Tonsoy / Goldstripe sardinella | Sardinella gibbosa | Planktivorous | Coastal pelagic | 17.5 | 48 |

[1] Source-reported labels remain provisional pending taxon-specific diet verification. [2] Source Table 1 total length; * goatfish length differs between Table 1 (19.13 cm) and Appendix 3 (19.3 cm). † "Scomber japonicas" follows the Appendix 3 spelling and requires nomenclatural reconciliation; it is not presented as independently validated. The source also varies in the spelling of Auxis rochei across sections. Species availability over repeated visits and trip-level capture origin were not established by this one-time inventory.

### 3.2 Completed documentation appraisal

**Table 2. Retrospective Documentation Appraisal (D = Described; P = Partial; NR = Not Reported)**

| | | | |
|---|---|---|---|
| Sampling strategy | P | Caranan landing; 10% boat statement (pp. 14–16) | Boat denominator, probabilistic selection and capture origin not documented |
| Sample size / units | P | 17 taxa; three selected taxa; three-fish compositing rule (pp. 16,19,35) | Realized independent analytical units unverified |
| Processing / storage | P | Foil, cooling and freezing instructions (pp. 16–19) | Per-specimen storage logs not reported |
| Lab preparation | D | GI separation, KOH, $H_2O_2$ and filtration (pp. 18–22) | Implementation by batch not independently verified |
| Clean-air conditions | NR | No explicit clean-air log in reviewed pages | Potential airborne contamination cannot be evaluated |
| Negative controls | NR | No blank results in reviewed tables | Background contamination cannot be evaluated |
| Positive controls | NR | No recovery data in reviewed tables | Extraction efficiency unknown |
| Target component | D | GI tract specified (pp. 6,18–19) | Not an edible-muscle exposure estimate |
| Pretreatment | D | KOH digestion and peroxide oxidation (pp. 20–21) | Reagent/batch recovery unknown |
| Polymer identification | P | FTIR described; selected spectra appendices (pp. 22,35) | Fraction of individual particles confirmed unclear |

ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT071

An NR designation is not evidence that the original investigator omitted a control. It identifies that the available report does not document information needed to evaluate that aspect of analytical reliability. The analytical counts and the polymer assignments are not reused as results of this protocol-development article.

### 3.3. Evidence-to-protocol traceability

**Table 3. Extracted Evidence, Requirement Mapping and Verification Checkpoints**

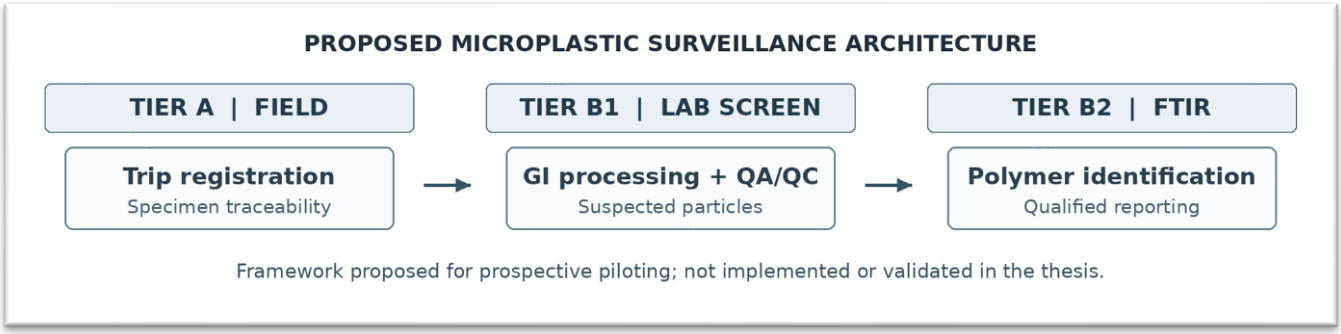
| | | | | |
|---|---|---|---|---|
| Capture provenance | Thesis p. 16; landing purchase; trip origin not mapped | P | Link specimen to verified/uncertain catch zone and gear | Trip-to-specimen link completeness |
| Selection denominator | Thesis pp. 14–16; “10%” without eligible-boat roster | P | Register eligible, approached, accepted and refused trips | Coverage fraction and refusals |
| Taxonomy and guild | Table 1 / Appendix 3; source labels not rechecked | P | Taxonomic record; explicit diet-source review | Resolved/unresolved taxa register |
| Biological units | Method p. 19; compositing rule; no batch-level roster | P | Unique fish ID and pool membership IDs | Independent n and pooling audit |
| Analytical QA | Method pp. 18–22; control outputs not in table | NR/P | Matched blanks, recovery and batch review | Qualified/excluded batches |
| FTIR identity | Table 2 and spectral appendices; unknown confirmation fraction | P | Per-particle spectrum or predeclared selection | Verified proportion by class |

### 3.4 Three-tier monitoring and laboratory architecture

Tier A is landing-site registration and biological sampling, not microplastic detection. Tier B1 is GI processing and morphological screening of suspected particles under documented contamination-control and recovery assessment. Tier B2 uses FTIR or another validated spectroscopic method to identify analyzed particles, with qualified reporting of the fraction confirmed. If fewer than all suspected particles are examined, a predefined subsampling scheme and class-specific denominator are mandatory [2], [17]. The workflow in Figure 1 is proposed and has not been field-tested.

The designation of suspected particles must remain separate from verified polymer assignments. Comparative method reviews describe limitations of visual identification [14], the need to report sample preparation and particle-recovery steps [15], and practical extraction considerations for seafood tissues [21]. Since the original study did not provide independently auditable particle-by-particle spectra in this secondary analysis, no chemical-identification success rate is estimated here.

**Figure 1. Proposed Landing-Site and Laboratory Surveillance Workflow (Unvalidated)**




For each laboratory batch, the prospective protocol requires blank IDs and results, matrix-spike or comparable recovery observations, sample tissue mass, reagents and digestion conditions, filter pore size, detection window, instrument mode, spectral matching rules and a documented accept/qualify/repeat/exclude decision. No universal spectral score or blank cutoff is assumed; acceptance criteria must be pre-specified for the chosen method and tested during piloting [2], [17].

Brander et al. [19] provide a cross-matrix QA/QC guide that supports documenting potential contamination sources throughout sample collection and handling. Dehaut et al. [21] evaluate tissue-processing effects on polymer preservation, while Nuelle et al. [22] demonstrate that recovery estimates are method- and matrix-specific. Neither study establishes a universal acceptance threshold for the untested Pasacao surveillance workflow.

ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT071

### 3.5 Sampling, endpoints and prospective pilot evaluation

The initial target population is eligible fishing trips landing at a defined site on scheduled visits; trips, fish, pools and analytical batches are separate units. A future prevalence endpoint requires individually traceable and independently analyzed fish, with a defined laboratory detection window. A reporting numerator could be fish with at least one spectroscopically confirmed GI particle and the denominator all eligible fish with qualified results. Since fish from one trip share exposure and handling, clustering by trip should be considered. A pilot should quantify visit-to-visit variability, detection frequency and intratrip dependence before any sample-size or precision target is selected. The present source lacks those parameters, so an arbitrary sample size is not recommended.

Prior monitoring investigations show markedly different sampling frames: Lusher et al. examined multiple fish taxa from the English Channel [8], Foekema et al. analyzed North Sea fish [11], Neves et al. assessed commercial fish from Portugal [9], and Adika et al. examined pelagic and demersal catches off Ghana [10]. Their numerators and denominators cannot be transferred directly to an unpiloted municipal sampling frame. A Pasacao-specific study would need its own precision targets and estimates of between-trip variability.

**Table 4. Proposed Pilot Evaluation Plan (Not Outcomes of This Study)**

| | | |
|---|---|---|
| Recruitment | Eligible, approached and sampled trips; refusals | Sampling access and denominators |
| Candidate availability | Scheduled visits with prespecified taxa/size classes | Repeatable eligibility |
| Provenance | Fish linked to usable trip/zone/gear record | Geographic interpretability |
| Workload | Minutes per visit, specimen and laboratory batch | Staffing requirement |
| Cost | Field, preparation, QC and FTIR costs per qualified result | Operational affordability |
| Analytical quality | Blanks, recovery, identification success, rejected batches | Measurement reliability |
| Reproducibility | Independent taxon / morphology classifications | Observer agreement |
| Reporting utility | User interpretation of uncertainty-qualified bulletin | Management relevance |

## IV. DISCUSSION

### 4.1 Contribution relative to established guidance

The proposed contribution is not a new chemical extraction or particle-identification technique. Hermsen et al. [2] already establish biota-specific quality criteria, and the Mekong River Commission provides a fish-monitoring protocol [17]. EPA data-quality planning guidance addresses defining a decision and the data needed to support it [3]. The contribution here is an ex plicit landing-site implementation architecture combining trip provenance, unresolved fish taxonomy, sentinel-candidate eligibility, specimen genealogy, qualified laboratory evidence and uncertainty-sensitive municipal reporting. These connected implementation steps respond to constraints found in the Pasacao documents but have not been tested for novelty or effectiven ess in other settings.

The design is also consistent with broader work on comparability: Stock et al. [15] describe the dependence of interpretation on consistent preparation methods, Koelmans et al. [23] document how inconsistent quality criteria can obstruct synthesis across environmental matrices, and Lin et al. [16] identify persistent limitations in fish microplastic research. These studies support developing auditable reporting fields; they do not establish that the proposed local protocol is effective.

**Table 5. Existing Guidance Compared With the Proposed Landing-Site Adaptation**

| | | |
|---|---|---|
| [1] Hermsen et al. (2018) | Biota analysis quality domains and controls | Document-status audit and future batch qualification |
| [4] MRC (2024) | Fish-specific microplastic monitoring guidance | Integration with trip and catch-origin records |
| [2] US EPA (2006) | Decision-led environmental data planning | Checkpoints and pilot endpoints tied to municipal decisions |
| Present protocol | Not a new chemical method | Trip-to-fish traceability + 3-tier reporting architecture |

### 4.2 Decision boundaries, transferability and limitations

A municipal bulletin could report completeness of sampling records, eligible taxa by visit, blanks and confirmation fractions before summarizing qualified GI observations. It should not equate a visually suspected particle with a confirmed polymer, in fer food-safety hazards from GI samples or attribute plastics to specific land-based activities without source-tracing. Transfer to other landing centers requires reassessment of trip provenance, seasonality, species availability, costs and laboratory access. Source-reported external fish anomalies are outside the evidentiary basis of a microplastic exposure mechanism.

ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT071

Literature on plastic-associated debris in marketed seafood [12], systematic evidence from seafood contamination research [24], and findings from cultured bivalves [25] concern different analytical matrices and exposure pathways. Consequently, GI screening of landed fish alone cannot support estimates of human dietary dose, edible-tissue concentrations or seafood safety for Pasacao consumers.

The retrospective assessment relied on a single thesis, with incomplete original specimen genealogy, no independent catch-area verification, no full laboratory QA logs and inconsistent source names. A documented protocol is not proof of execution. The proposed criteria have not undergone expert consensus, implementation assessment, inter-rater reliability testing or validation against known outcomes. The companion laboratory-characterization article should be disclosed to editors when submitted, and the common thesis origin cited; overlapping particle results are intentionally not reproduced here.

## V. CONCLUSION

The Pasacao fish-landing inventory provides a preliminary basis for developing a microplastic-monitoring protocol, but its documented sampling and analytical limitations prevent population-level, feeding-guild or geographic inference. This methodological case study maps recorded evidence and reporting gaps to a proposed three-tier architecture encompassing landing-site registration, independent biological sampling, laboratory screening and quality assurance, spectroscopic confirmation, and uncertainty-qualified reporting. The framework remains unvalidated. Prospective piloting should evaluate species availability, provenance, workload, cost, analytical performance and reproducibility before routine monitoring or temporal comparisons are attempted.

## ACKNOWLEDGEMENT

The author acknowledges the support of the Pasacao local government, municipal fisheries personnel, and participating fisherf olk as recorded in the original graduate thesis. This secondary methodological article did not involve new interviews or stakeholder fieldwork.

### Conflict of Interest
The author declares no conflict of interest.

### Funding
This research received no external funding.

### Data Availability and Ethics
The species-level observations reproduced here are transcribed from the author's 2026 graduate-thesis tables [7]. No independent specimen-level dataset, raw spectroscopy files, individual trip logs or new measurements were available for this documentary appraisal. Access to additional thesis materials is subject to the university's applicable archival and intellectual-property policies. This manuscript reports secondary examination of existing research records and no new animal sampling or human-participant interaction. No claim is made about institutional ethics review or permit determinations for the original thesis beyond the permits referenced in its appendices.

### Appendix A. Proposed Data Dictionary for a Future Surveillance Pilot

The following fields are protocol specifications, not additional observations collected during the parent thesis.

| | | |
|---|---|---|
| Visit ID, date, site | Scheduled survey instance | Counts completed vs planned visits |
| Trip ID and eligibility | Eligible, approached, accepted, refused | Sampling denominator and nonresponse |
| Catch-origin status | Verified area / fisher report / unknown | Limit geographic inference |
| Gear and fishing effort | Gear class, hours or sets where recorded | Document catch selection |
| Fish ID and taxon ID | Individual specimen; source + checked taxon | Separate biological units and resolve names |
| Species availability | Presence among eligible trips per visit | Sentinel-candidate repeatability |
| Pool ID, fish membership | Any combination of individuals, with tissue mass | Prevent pseudoreplication |
| Preparation and blank batch IDs | Laboratory run, field and process controls | Link contamination and recovery |
| Particle and FTIR IDs | Suspected class and confirmed spectral decision | Retain chemical verification fraction |
| Data qualification | Valid, qualified, repeated or excluded, with reason | Prevent unqualified prevalence reports |

ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT071

## REFERENCE


[1]. A. L. Andrady, "Microplastics in the marine environment," Marine Pollution Bulletin, vol. 62, no. 8, pp. 1596–1605, 2011. https://doi.org/10.1016/j.marpolbul.2011.05.030

[2]. E. Hermsen, S. M. Mintenig, E. Besseling, and A. A. Koelmans, "Quality criteria for the analysis of microplastic in biota samples: A critical review," Environmental Science & Technology, vol. 52, no. 18, pp. 10230–10240, 2018. https://doi.org/10.1021/acs.est.8b01611

[3]. U.S. Environmental Protection Agency, Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G-4, EPA/240/B-06/001. Washington, DC: U.S. EPA, 2006. https://www.epa.gov/quality/guidance-systematic-planning-using-data-quality-objectives-process-epa-qag-4 (agency report; no DOI assigned)

[4]. J. R. Jambeck et al., "Plastic waste inputs from land into the ocean," Science, vol. 347, no. 6223, pp. 768–771, 2015. https://doi.org/10.1126/science.1260352

[5]. L. J. J. Meijer, T. van Emmerik, R. van der Ent, C. Schmidt, and L. Lebreton, "More than 1000 rivers account for 80% of global riverine plastic emissions into the ocean," Science Advances, vol. 7, no. 18, art. eaaz5803, 2021. https://doi.org/10.1126/sciadv.aaz5803

[6]. S. B. Borrelle et al., "Predicted growth in plastic waste exceeds efforts to mitigate plastic pollution," Science, vol. 369, no. 6510, pp. 1515–1518, 2020. https://doi.org/10.1126/science.aba3656

[7]. R. J. Paz, Microplastic Accumulation in Fish Species with Varying Feeding Habits in Pasacao, Camarines Sur. Master's thesis, Central Bicol State University of Agriculture, Pili, Camarines Sur, Philippines, 2026. (Original thesis; no verified DOI, archival citation to be confirmed.)

[8]. A. L. Lusher, M. McHugh, and R. C. Thompson, "Occurrence of microplastics in the gastrointestinal tract of pelagic and demersal fish from the English Channel," Marine Pollution Bulletin, vol. 67, nos. 1–2, pp. 94–99, 2013. https://doi.org/10.1016/j.marpolbul.2012.11.028

[9]. D. Neves, P. Sobral, J. L. Ferreira, and T. Pereira, "Ingestion of microplastics by commercial fish off the Portuguese coast," Marine Pollution Bulletin, vol. 101, no. 1, pp. 119–126, 2015. https://doi.org/10.1016/j.marpolbul.2015.11.008

[10]. S. A. Adika et al., "Microplastic ingestion by pelagic and demersal fish species from the Eastern Central Atlantic Ocean, off the coast of Ghana," Marine Pollution Bulletin, vol. 153, art. 110998, 2020. https://doi.org/10.1016/j.marpolbul.2020.110998

[11]. E. M. Foekema et al., "Plastic in North Sea fish," Environmental Science & Technology, vol. 47, no. 15, pp. 8818–8824, 2013. https://doi.org/10.1021/es400931b

[12]. C. M. Rochman et al., "Anthropogenic debris in seafood: Plastic debris and fibers from textiles in fish and bivalves sold for human consumption," Scientific Reports, vol. 5, art. 14340, 2015. https://doi.org/10.1038/srep14340

[13]. N. B. Hartmann et al., "Are we speaking the same language? Recommendations for a definition and categorization framework for plastic debris," Environmental Science & Technology, vol. 53, no. 3, pp. 1039–1047, 2019. https://doi.org/10.1021/acs.est.8b05297

[14]. V. Hidalgo-Ruz, L. Gutow, R. C. Thompson, and M. Thiel, "Microplastics in the marine environment: A review of the methods used for identification and quantification," Environmental Science & Technology, vol. 46, no. 6, pp. 3060–3075, 2012. https://doi.org/10.1021/es2031505

[15]. F. Stock, C. Kochleus, B. Bänsch-Baltruschat, N. Brennholt, and G. Reifferscheid, "Sampling techniques and preparation methods for microplastic analyses in the aquatic environment—A review," TrAC Trends in Analytical Chemistry, vol. 113, pp. 84–92, 2019. https://doi.org/10.1016/j.trac.2019.01.014

[16]. X.-H. Lin, A. A. Gowen, H. Pu, and J. Xu, "Microplastic contamination in fish: Critical review and assessment of data quality," Food Control, vol. 153, art. 109939, 2023. https://doi.org/10.1016/j.foodcont.2023.109939

[17]. Mekong River Commission, Protocol for Monitoring Microplastic in Fish: A Detailed Methodology for Long-Term and Cost-Effective Monitoring of Riverine Plastic Debris Pollution in the Lower Mekong River Basin. Vientiane: Mekong River Commission Secretariat, 2024. https://doi.org/10.52107/mrc.bhv7va

[18]. A. N. Osma, "Measuring digital trade development in ASEAN: A mixed-method framework," Electronic Journal of Business Research Methods, vol. 23, no. 1, pp. 35–52, 2025. https://doi.org/10.34190/ejbrm.23.1.3982

[19]. [19] S. M. Brander et al., "Sampling and quality assurance and quality control: A guide for scientists investigating the occurrence of microplastics across matrices," Applied Spectroscopy, vol. 74, no. 9, pp. 1099–1125, 2020. https://doi.org/10.1177/0003702820945713

[20]. A. L. Lusher, N. A. Welden, P. Sobral, and M. Cole, "Sampling, isolating and identifying microplastics ingested by fish and invertebrates," Analytical Methods, vol. 9, pp. 1346–1360, 2017. https://doi.org/10.1039/C6AY02415G

[21]. A. Dehaut et al., "Microplastics in seafood: Benchmark protocol for their extraction and characterization," Environmental Pollution, vol. 215, pp. 223–233, 2016. https://doi.org/10.1016/j.envpol.2016.05.018

[22]. M.-T. Nuelle, J. H. Dekiff, D. Remy, and E. Fries, "A new analytical approach for monitoring microplastics in marine sediments," Environmental Pollution, vol. 184, pp. 161–169, 2014. https://doi.org/10.1016/j.envpol.2013.07.027

[23]. A. A. Koelmans, N. H. Mohamed Nor, E. Hermsen, M. Kooi, S. M. Mintenig, and J. De France, "Microplastics in freshwaters and drinking water: Critical review and assessment of data quality," Water Research, vol. 155, pp. 410–422, 2019. https://doi.org/10.1016/j.watres.2019.02.054

[24]. E. Danopoulos, L. C. Jenner, M. Twiddy, and J. M. Rotchell, "Microplastic contamination of seafood intended for human consumption: A systematic review and meta-analysis," Environmental Health Perspectives, vol. 128, no. 12, art. 126002, 2020. https://doi.org/10.1289/EHP7171

ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT071

[25]. L. Van Cauwenberghe and C. R. Janssen, “Microplastics in bivalves cultured for human consumption,” Environmental Pollution, vol. 193, pp. 65–70, 2014. https://doi.org/10.1016/j.envpol.2014.06.010