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Fisheries growth amid sustainability evidence gaps across West Africa

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Abstract

National fisheries production is often used to support food-security and blue-economy narratives, but aggregate output does not establish whether ecological condition, fishing-dependent livelihoods and monitoring capacity are adequately documented. We integrate a complete 1990–2023 production panel for 17 West African countries with a verified inland-fisheries evidence base and a non-compensatory four-domain diagnostic. Regional production increased by 173.1%, yet production prominence was unrelated to socioeconomic evidence coverage or monitoring capacity. Ecological evidence was available for only ten countries and was inversely associated with production prominence within that selected subset. Baseline rules identified ecological–social mismatches in Nigeria, Senegal and Guinea; visibility–information mismatches in Mauritania, Cameroon and Sierra Leone; and ecological concern among several lower-prominence countries. Four of six compound classifications were stable across all 81 threshold scenarios. The findings show that production growth and sustainability evidence are distinct policy objects and should be reported separately.

Introduction

Small-scale and inland fisheries support food security, micronutrient supply, employment, trade and social identity, yet their contributions remain incompletely represented in national statistics and policy accounts.[1–6] The problem is especially consequential in Africa, where small-scale fisheries supply a large share of aquatic foods and livelihoods while official data are frequently aggregated across production systems.[7,1,8]

Production is necessary information, but it is not a sustainability diagnosis. A national total may rise because of marine capture, inland capture, aquaculture expansion, changes in reporting or combinations of these processes. These pathways differ in ecological limits, tenure, labour relations and benefit distribution.[2,9–10] Treating production growth as evidence of ecological or social progress therefore risks substituting a readily available output statistic for the multidimensional observations required by sustainability governance.

Inland fisheries are coupled social–ecological systems in which hydrology, fish populations, fishing practices, markets, institutions and household wellbeing interact across scales.[11–14] Demonstrating temporal coupling or decoupling requires synchronised trajectories.[15] Where ecological and social observations are sparse, asynchronous or cross-sectional, a more defensible question is whether the evidence architecture supporting production-oriented policy is aligned across ecological, social and monitoring domains.

This distinction matters because missing evidence is not equivalent to favourable condition. Freshwater biodiversity is under severe global pressure, while monitoring frameworks still omit substantial dimensions of ecological change and remain geographically uneven.[16–20] The West African literature

contains valuable reservoir, river, lake and floodplain assessments, but it is concentrated in a limited set of countries and water bodies.[21–25]

Composite sustainability scores can compound this problem when favourable performance in one domain offsets a critical deficit in another. Such compensation is inappropriate when ecological evidence, social visibility and minimum monitoring capacity are non-substitutable conditions.[26–28] We therefore developed a four-domain, non-compensatory diagnostic for 17 West African countries. We asked whether fisheries-sector prominence aligns with verified inland ecological pressure, socioeconomic evidence coverage and monitoring capacity; which countries exhibit compound evidence deficits; and how strongly classifications depend on plausible threshold choices. The framework is a policy-screening instrument, not a ranking of national sustainability.

Methods

Study design and analytical scope

We integrated six cleaned tables: a 61-source research register (D0), a 279-record evidence catalogue (D1), a complete 578-row country-year production panel (D2), a 148-location spatial register (D3), a coding dictionary (D4) and a 285-row record-level spatial crosswalk (D5). The evidence synthesis followed structured-review principles, with source provenance retained through Study_ID and record provenance through Record_ID.[47–48] The analysis covered 17 West African countries represented in D2: Benin, Burkina Faso, Cabo Verde, Cameroon, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone and Togo.

Production-prominence domain

D2 contained World Development Indicators series ER.FSH.PROD.MT for 1990–2023.[29] For each country, recent production was the 2019–2023 mean and trend was the Theil–Sen slope across 1990–2023. Recent production and slope were converted to percentile ranks across the 17 countries. Production prominence was $P = 0.65R_{share} + 0.35R_{trend}$, giving greater weight to current sector scale while retaining direction. Kendall's τ tested monotonic trends; recent volatility was the 2019–2023 coefficient of variation. Concentration was summarised by top-three and top-five shares and the Herfindahl–Hirschman index.

Ecological-pressure domain

Ecological records were restricted to collapsed, underexploited, fully exploited and overexploited classifications. Record confidence combined indicator richness, study quality and the weaker of reverse-coded bias-risk and confidence-limitation scores using a geometric mean. Within each Study_ID–country cluster, record weights were normalised to one so that a publication contributing many species or water-

body records did not dominate. Country status shares were the mean of independent source-country profiles. Ecological pressure was E = C + 0.75O + 0.25F, where C, O and F are source-balanced collapsed, overexploited and fully exploited shares; underexploited contributed zero. E remained missing where no ecological classification was available. The score is an evidence-severity index, not an estimate of the national proportion of stocks in adverse condition.

Socioeconomic evidence-coverage domain

Within each Study_ID–country cluster, fishing income, livelihood dependence and fish-price components were coded present when at least one valid positive code occurred. Country coverage for each component was the proportion of independent clusters reporting it. Breadth was the arithmetic mean of the three components and was multiplied by Ds = min[1, ln(1 + N)/ln(5)], where N is the number of broader inland-fisheries sources. The resulting S domain measures reporting breadth and replication, not actual socioeconomic dependence.

Monitoring-capacity domain

Ecological source depth was min [1, ln(1 + Ne)/ln(5)], where Ne is the number of independent ecological sources. Other monitoring capacity was the geometric mean of mapped ecological-record coverage, mean record confidence normalised to the regional maximum, the proportion of linked records with original site coordinates, and water-body breadth min[1, ln(1 + W)/ln(6)], where W is the number of unique linked spatial locations. Final monitoring capacity was M = min(source depth, other capacity). The bottleneck rule prevents coordinates, detailed mapping or high confidence in a single study from compensating for absence of independent replication.

Spatial validation and mapping

D5 was restricted to evidence-to-spatial rows for analytical linkage. Linked records required a valid Record_ID, Spatial_ID and site-level usability flag. D3 coordinates were retained after range checks and documented longitude-sign correction; unresolved sites were excluded from site-level analysis. All 148 validated D3 locations were shown in the spatial inventory, whereas linked ecological sites were distinguished by larger, outlined symbols. Water-body types were classified reproducibly from standardised names into river, reservoir or dam, lake, lagoon or estuary or coastal water, wetland or floodplain or delta, stream or creek or inlet, basin or regional context and other inland water.[43–44]

Non-compensatory pathways and policy classes

Baseline thresholds were P ≥ 0.60, E ≥ 0.50, S < 0.40 and M < 0.50. The ecological pathway required high P and high E; the social pathway required high P and low S; and the information pathway required either high P or high E together with low M. Mutually interpretable classes were assigned in hierarchical order:

ecological–social mismatch, visibility–information mismatch, information deficit, ecological concern without high prominence, low-prominence evidence gap and no compound high-prominence mismatch. The classes diagnose evidence priorities and are not rankings of sustainability.

Uncertainty and sensitivity analysis

Sensitivity analysis crossed production thresholds of 0.55, 0.60 and 0.65; ecological thresholds of 0.45, 0.50 and 0.55; socioeconomic thresholds of 0.35, 0.40 and 0.45; and monitoring thresholds of 0.40, 0.50 and 0.60, yielding 81 scenarios. For each country, we calculated the frequency of ecological, social and information pathways and of at least two simultaneous pathways. Frequencies quantify dependence on analytical choices and are not probabilities that a country is unsustainable. Pairwise Spearman correlations used complete country pairs and were interpreted cautiously because the sample comprised 17 countries and ecological pressure was observed for only ten.

Software and reproducibility

Analyses were performed in Python 3 using pandas, NumPy, SciPy, Matplotlib and GeoPandas. The supplied script recreates country profiles, all four figures, source-data tables and the 81-scenario sensitivity analysis from the cleaned D0–D5 files. Randomness was not used in the main country classifications.

Operational definition of the analytical domains

Domain	Primary input	Calculation	Threshold	Interpretation
Production prominence	Recent production and Theil–Sen slope	0.65 rank(recent) + 0.35 rank(slope)	High ≥ 0.60	National total-sector scale and direction
Ecological pressure	Source-balanced stock-status profiles	Collapsed + 0.75 overexploited + 0.25 fully exploited	High ≥ 0.50	Severity of documented inland ecological classifications
Socioeconomic coverage	Income, livelihood and price reporting	Source-depth adjusted mean coverage	Low < 0.40	Breadth and replication of social evidence, not dependence magnitude
Monitoring capacity	Source depth, mapping, confidence, coordinate provenance and water-body breadth	Minimum of source depth and geometric monitoring components	Low < 0.50	Minimum capacity to interpret ecological evidence

Results

Fisheries production expanded strongly and remained concentrated

Regional total fisheries production increased from a mean of 1.524 million tonnes in 1990–1994 to 4.160 million tonnes in 2019–2023, an increase of 173.1% (Fig. 1a). The regional Theil–Sen slope was 88,283 tonnes yr − 1 (95% interval 78,965–99,665), and Kendall's τ was 0.907 ($P < 0.001$). Fifteen of 17 countries had significant positive monotonic trends (Fig. 1c).

Recent production was concentrated in Nigeria (25.7%), Mauritania (18.0%), Senegal (12.1%), Ghana (11.0%) and Guinea (9.6%) (Fig. 1b). The three largest producers accounted for 55.8% and the five largest for 76.4% of the regional mean; the Herfindahl–Hirschman index was 0.142 (Fig. 1d). Because the World Development Indicators series combines marine capture, inland capture and aquaculture, these values describe national sector scale rather than inland-fishery production.[29,2]

Figure 1 | Total fisheries production across West Africa, 1990–2023. a, Regional annual production with the 1990–1994 and 2019–2023 comparison windows and Theil–Sen trend. b, Country means for 2019–2023; labels show regional shares. c, Country Theil–Sen slopes; orange bars indicate significant positive Kendall trends and grey bars indicate non-significant trends. d, Cumulative concentration of recent production. Production combines capture and aquaculture across marine and freshwater environments.

Sustainability evidence did not track production prominence

The four-domain profile showed pronounced cross-country asymmetry (Fig. 2a). Production prominence was unrelated to socioeconomic evidence coverage (Spearman's $\rho = 0.001$, $P = 0.996$) and monitoring capacity ($\rho = 0.180$, $P = 0.488$). Recent production magnitude was similarly unrelated to socioeconomic evidence coverage ($\rho = 0.010$, $P = 0.970$) and monitoring capacity ($\rho = 0.268$, $P = 0.298$).

Socioeconomic evidence coverage was highest in Benin (0.533), Liberia (0.431), Ghana (0.421) and Nigeria (0.397), but was zero in Mauritania, Guinea-Bissau, Cabo Verde and Sierra Leone. The domain measures whether fishing income, livelihood dependence and fish-price information were documented across independent sources; it does not estimate the magnitude of household dependence. This distinction is essential because social indicators are often absent even where fisheries are economically prominent.[30,1]

High-prominence countries occupied both sides of the social-evidence threshold (Fig. 2b). Nigeria combined the highest production prominence with a borderline socioeconomic score, while Mauritania, Cameroon and Sierra Leone had high prominence and very low coverage. Conversely, Liberia had low production prominence but comparatively broad social reporting.

Figure 2 | Country sustainability-evidence domains. a, Production prominence, source-balanced ecological pressure, socioeconomic evidence coverage and monitoring capacity; grey NA cells indicate missing

ecological evidence rather than zero pressure. b, Production prominence versus socioeconomic evidence coverage; marker area scales with recent production and colour indicates whether monitoring capacity is below 0.50. c, Production prominence versus ecological pressure for the ten countries with classifications; marker area and labels show independent ecological-source depth. Dashed lines are baseline thresholds.

Ecological concern and monitoring capacity occupied different geographies

Ecological pressure could be estimated for only ten countries. It was highest in Niger and Togo (1.000), Côte d'Ivoire (0.875), Burkina Faso (0.750), Benin (0.667), and Nigeria, Senegal and Guinea (0.625 each) (Fig. 2a,c). These scores are source-balanced summaries of reported classifications and must not be interpreted as proportions of all national stocks.

Within the ten-country observed subset, ecological pressure was negatively associated with production prominence ($\rho = -0.726$, $P = 0.017$). This relationship is descriptive and vulnerable to selection effects because countries without ecological classifications are excluded, and several observed countries are represented by only one or two independent sources. It nevertheless demonstrates that production-based prioritisation alone would overlook ecological concern in lower-prominence contexts such as Niger, Togo, Côte d'Ivoire, Burkina Faso and Benin.

Monitoring capacity was highest in Ghana (0.886), Mali (0.861), Benin (0.831) and Nigeria (0.722), reflecting deeper source replication, mapped ecological records and broader water-body coverage (Fig. 3c). Senegal had ecological classifications but zero monitoring capacity under the bottleneck rule because its linked evidence did not satisfy all minimum components. Cabo Verde and Sierra Leone contained validated spatial-inventory locations but no D0/D1 ecological evidence links; their locations were retained as spatial-only inventory rather than counted as monitoring evidence.

The map reveals that validated spatial locations are much more geographically extensive than independently replicated ecological evidence (Fig. 3a,b). Rivers and reservoirs dominate the inventory, but lagoons, estuaries, lakes, wetlands and regional basin contexts are also represented. Filled country classes and water-body symbols therefore answer different questions: country colour indicates the baseline evidence-deficit class, whereas symbols show the spatial inventory and whether a location is linked to ecological evidence.

Figure 3 | Spatial distribution of sustainability evidence and monitoring capacity. a, Africa locator and West Africa zoom. Country fill indicates the baseline policy class. Water-body type is encoded by unique colour and marker shape; larger black-edged symbols are linked to ecological classifications, whereas smaller pale symbols are validated inventory locations without linked ecological evidence. b, Composition of the validated D3 inventory by country and water-body type. c, Monitoring capacity; the dashed line is the 0.50 baseline threshold. Cabo Verde and Sierra Leone spatial-only inventory records are retained without creating unsupported D1 evidence links.

Non-compensatory rules separated distinct evidence-deficit pathways

At baseline thresholds, Nigeria, Senegal and Guinea met the ecological–social mismatch class: high production prominence coincided with ecological pressure at or above 0.50 and socioeconomic coverage below 0.40 (Fig. 4a). Mauritania, Cameroon and Sierra Leone met the visibility–information mismatch class because high production prominence coincided with low socioeconomic evidence and monitoring deficits, while ecological pressure was unavailable.

Niger and Togo were classified as information deficits because ecological concern occurred where monitoring capacity was below 0.50. Benin, Burkina Faso and Côte d'Ivoire were classified as ecological concern without high production prominence. Cabo Verde, Gambia, Guinea-Bissau and Liberia were low-prominence evidence gaps because ecological pressure was indeterminate and monitoring capacity was zero. Ghana and Mali showed no compound high-prominence mismatch, although this category is not a certification of sustainability.

The non-compensatory structure prevents a high score in one domain from cancelling a critical deficit in another. A country with high production but missing ecological evidence cannot be treated as environmentally secure, and a country with detailed coordinates but no independent ecological sources cannot be treated as monitoring-ready.[26–27]

Sensitivity analysis distinguished stable deficits from boundary cases

Across 81 combinations of production, ecological, socioeconomic and monitoring thresholds, Senegal met all three pathways and at least two pathways in every scenario (Fig. 4b). Mauritania, Cameroon and Sierra Leone met the social and information pathways in every scenario. Guinea met the ecological and social pathways in every scenario, while Nigeria met the ecological pathway in all scenarios and the social pathway in 66.7%.

Ghana was a boundary case: the ecological pathway occurred in 66.7% of scenarios, the social pathway in 22.2%, and at least two pathways in 22.2%. Niger triggered the information pathway in 66.7% of scenarios, Côte d'Ivoire in 33.3%, and Togo in all scenarios. The stable classes therefore identify robust evidence deficits, whereas intermediate frequencies identify countries whose interpretation depends on threshold choices rather than providing probabilities of unsustainability.

Domain correlations were weak except for a moderate positive association between socioeconomic evidence and monitoring capacity ($\rho = 0.476$, $P = 0.054$) and the negative production–ecological association within the selected ten-country subset (Fig. 4d). This limited alignment supports retaining the domains separately rather than collapsing them into a compensatory sustainability index.

Figure 4 | Non-compensatory pathways and threshold sensitivity. a, Baseline ecological, social-visibility and information pathways. b, Frequency with which each pathway and at least two simultaneous pathways occurred across 81 threshold scenarios. c, Number of countries assigned to each baseline policy class. d, Pairwise Spearman correlations among domains; ecological correlations use the ten countries with observed ecological pressure. Frequencies describe model dependence, not probabilities of unsustainability.

Discussion

The central finding is that fisheries growth and sustainability evidence are not aligned. Regional production more than doubled, but production prominence did not predict whether inland ecological condition, fishing-dependent livelihoods or monitoring capacity were documented. This does not imply that production growth caused ecological pressure or social vulnerability. It shows that aggregate production is being used in a policy space that requires evidence it cannot provide.

This distinction is important for blue-economy and food-system strategies. Total production combines marine capture, inland capture and aquaculture, each with different ecological constraints and social institutions.[2,9–10] National reporting should therefore disaggregate production by subsector and connect each subsector to indicators of stock condition, ecosystem state, labour, income, prices, nutrition and distributional outcomes. Without this structure, growth can be celebrated while the evidence needed to evaluate who benefits and whether ecological limits are respected remains absent.[1,8]

The evidence geography also complicates production-led prioritisation. Lower-prominence countries such as Niger, Togo, Côte d'Ivoire, Burkina Faso and Benin contained high ecological-pressure scores, while several high-prominence countries had no ecological estimate. The country scores reflect reported evidence, not representative national stock assessments. They are best interpreted as triage signals for monitoring investment. Recent and historical studies from reservoirs, rivers and lakes illustrate both the value and heterogeneity of the available evidence.[31–39]

The social domain reveals a different deficit. Fishing-income, livelihood and price information was often recorded inconsistently or not at all, even though small-scale fisheries make multidimensional contributions that cannot be inferred from catches.[1,4–5] Social monitoring should be designed as a core management function rather than an optional research add-on. Repeated household panels, gender- and age-disaggregated labour data, market-price series and measures of food access would permit actual dependence and distributional change to be estimated, rather than merely whether variables were mentioned.[30,40–42]

The monitoring-capacity results demonstrate why spatial extent and evidence depth must be separated. The database contains 148 spatial records across 18 countries, but only a subset is linked to ecological classifications and many locations are supported by one source. Georeferencing standards can improve reproducibility, but coordinates do not substitute for repeated biological and social observations.[43–44]

Coordinated long-term programmes, interoperable metadata, open data publication and institutional incentives are needed to transform scattered studies into monitoring systems.[17–20]

Our non-compensatory framework is deliberately conservative. It treats missing ecological evidence as indeterminate, caps source-depth contributions, and prevents strong performance in one domain from offsetting a critical deficit in another. These choices reduce the risk of false reassurance but do not eliminate subjectivity. Thresholds are policy parameters, domain weights reflect explicit assumptions, and country estimates are constrained by literature coverage. Sensitivity analysis makes this dependence visible and should accompany any application of the framework.[26–28]

Several limitations define the appropriate use of the results. First, D2 is total fisheries production, not inland capture production. Second, D1 is a structured evidence catalogue rather than a probability sample of fisheries or households. Third, ecological classifications differ in method and time period, although source balancing limits domination by prolific studies.[45–46] Fourth, the socioeconomic domain measures reporting coverage rather than dependence magnitude. Fifth, spatial-only inventory rows for Cabo Verde and Sierra Leone must not be interpreted as ecological evidence. Finally, cross-sectional associations cannot establish temporal decoupling or causation.[15]

The framework nonetheless offers a practical governance sequence. Countries can first disaggregate production, then identify which ecological, social and monitoring domains are missing, and finally direct investment toward the bottleneck that prevents defensible sustainability assessment. Stable mismatch classes indicate immediate priorities; boundary cases indicate where modest improvements in data depth or threshold agreement could change interpretation. Production growth should remain an economic and food-system indicator, but it should no longer stand in for sustainability evidence.

The central insight emerging from this analysis is that fisheries production growth and sustainability evidence are fundamentally misaligned across West Africa. Although *regional production increased by 173.1%*, the diagnostic framework shows that production prominence does not predict whether countries document inland ecological conditions, fishing-dependent livelihoods, or minimum monitoring capacity. This disconnect underscores a structural problem in how fisheries performance is interpreted: production statistics are being used as proxies for sustainability in policy arenas where they cannot substitute for ecological or social evidence.

Production Growth Is Not a Sustainability Signal

The widespread use of national production totals in blue-economy and food-system narratives obscures the fact that these totals combine marine capture, inland capture, and aquaculture — sectors with distinct ecological limits, governance systems, and social institutions. Treating aggregate production as a sustainability indicator risks conflating economic output with ecological condition and livelihood wellbeing. As the manuscript states, *“production growth and sustainability evidence are distinct policy objects and should be reported separately.”* This distinction is essential: without disaggregation and

domain-specific indicators, production increases can be celebrated even when the evidence needed to evaluate ecological pressure, social vulnerability, or monitoring readiness remains absent.

Evidence Geography Challenges Production-Led Prioritization

The spatial and domain-specific evidence patterns complicate any assumption that high-production countries are the most urgent sustainability priorities. Several lower-prominence countries — including Niger, Togo, Côte d'Ivoire, Burkina Faso, and Benin — exhibited high ecological-pressure scores, while some high-prominence countries had no ecological classifications at all. Because ecological pressure scores reflect *reported* evidence rather than representative national stock assessments, they should be interpreted as triage signals rather than definitive ecological diagnoses. Nonetheless, the pattern demonstrates that production-based prioritization alone would overlook ecological concern in multiple inland systems.

Social Evidence Deficits Are Systemic, Not Sporadic

The socioeconomic domain reveals a different but equally consequential gap. Fishing income, livelihood dependence, and fish-price information were often inconsistently recorded or entirely absent, even in countries where fisheries are economically prominent. This absence does not imply low dependence; rather, it reflects a chronic underinvestment in social monitoring. Small-scale fisheries contribute to nutrition, gendered labour, informal trade, and household resilience in ways that cannot be inferred from catch statistics. Without repeated household panels, market-price series, and labour-force data, policymakers cannot evaluate who benefits from fisheries growth or how vulnerability evolves.

Monitoring Capacity Requires Depth, Not Just Spatial Breadth

The monitoring-capacity domain highlights why spatial extent and evidence depth must be treated separately. Although the spatial inventory contains 148 validated locations, only a subset is linked to ecological classifications, and many of those links originate from single studies. The bottleneck rule — which prevents coordinates or detailed mapping from compensating for lack of independent ecological sources — reveals that monitoring systems remain shallow even where spatial coverage appears broad. Long-term ecological programmes, interoperable metadata standards, and open data publication are necessary to convert scattered studies into functional monitoring architectures.

Non-Compensatory Logic Prevents False Reassurance

The non-compensatory framework is intentionally conservative. It ensures that strong performance in one domain cannot offset critical deficits in another. A country with high production but missing ecological evidence cannot be treated as environmentally secure; similarly, a country with detailed coordinates but no independent ecological replication cannot be considered monitoring-ready. This logic

reduces the risk of false reassurance and aligns with governance principles that treat ecological integrity, social wellbeing, and monitoring capacity as non-substitutable conditions for sustainability.

Sensitivity Analysis Identifies Robust Priorities

The 81-scenario sensitivity analysis distinguishes stable evidence-deficit patterns from threshold-dependent cases. Countries such as Senegal, Mauritania, Cameroon, Sierra Leone, Guinea, and Nigeria consistently triggered ecological, social, or information pathways across all or most scenarios, indicating robust evidence deficits that warrant immediate policy attention. Boundary cases such as Ghana, Niger, and Côte d'Ivoire — demonstrate where modest improvements in data depth or threshold agreement could shift interpretation. These results reinforce the need for transparent threshold selection and routine sensitivity analysis in sustainability diagnostics.

Policy Implications for West African Fisheries Governance

The findings support a practical governance sequence:

1. Disaggregate production into marine capture, inland capture, and aquaculture.
2. Identify missing domains — ecological, social, or monitoring — for each subsector.
3. Direct investment toward the bottleneck that prevents defensible sustainability assessment.
4. Prioritize stable mismatch classes (e.g., ecological–social mismatches and visibility–information mismatches) for immediate intervention.
5. Develop long-term monitoring systems that integrate ecological surveys, socioeconomic panels, and spatial metadata.

This sequence shifts the policy focus from production-led narratives to evidence-led governance.

Conclusion

Taken together, the results demonstrate that production growth should remain an economic and food-system indicator, but it should no longer stand in for sustainability evidence. The diagnostic framework provides a structured way to identify evidence gaps, triage monitoring priorities, and prevent policy decisions from being guided by incomplete or misleading signals. Strengthening ecological, social, and monitoring domains — and ensuring they evolve alongside production — is essential for building a defensible, equitable, and ecologically grounded fisheries governance system across West Africa.

Declarations

Data Availability

Versioned Python code used to normalize text, synchronize D0 and D1 metadata, reconcile relational keys, validate controlled values, test the production panel, validate coordinates, construct D5 and reproduce all figures will be deposited at [https://doi.org/10.5281/zenodo.22153716]. The archived

release should include a software-environment file, checksums and the exact script commit used for the submitted tables and figures.[48]

Code Availability

Versioned Python code used to normalize text, synchronize D0 and D1 metadata, reconcile relational keys, validate controlled values, test the production panel, validate coordinates, construct D5 and reproduce all figures are deposited at [https://doi.org/10.5281/zenodo.22153716].

Author Contributions

J. O. E.: conceptualization, data curation, investigation, methodology, visualization and writing original draft.

T. S.: supervision, project administration, methodology, review, and correspondence.

R.K.: methodology, supervision, validation, and review.

G.I.: validation and review.

Competing Interests

The authors declare no competing interests.

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Figures

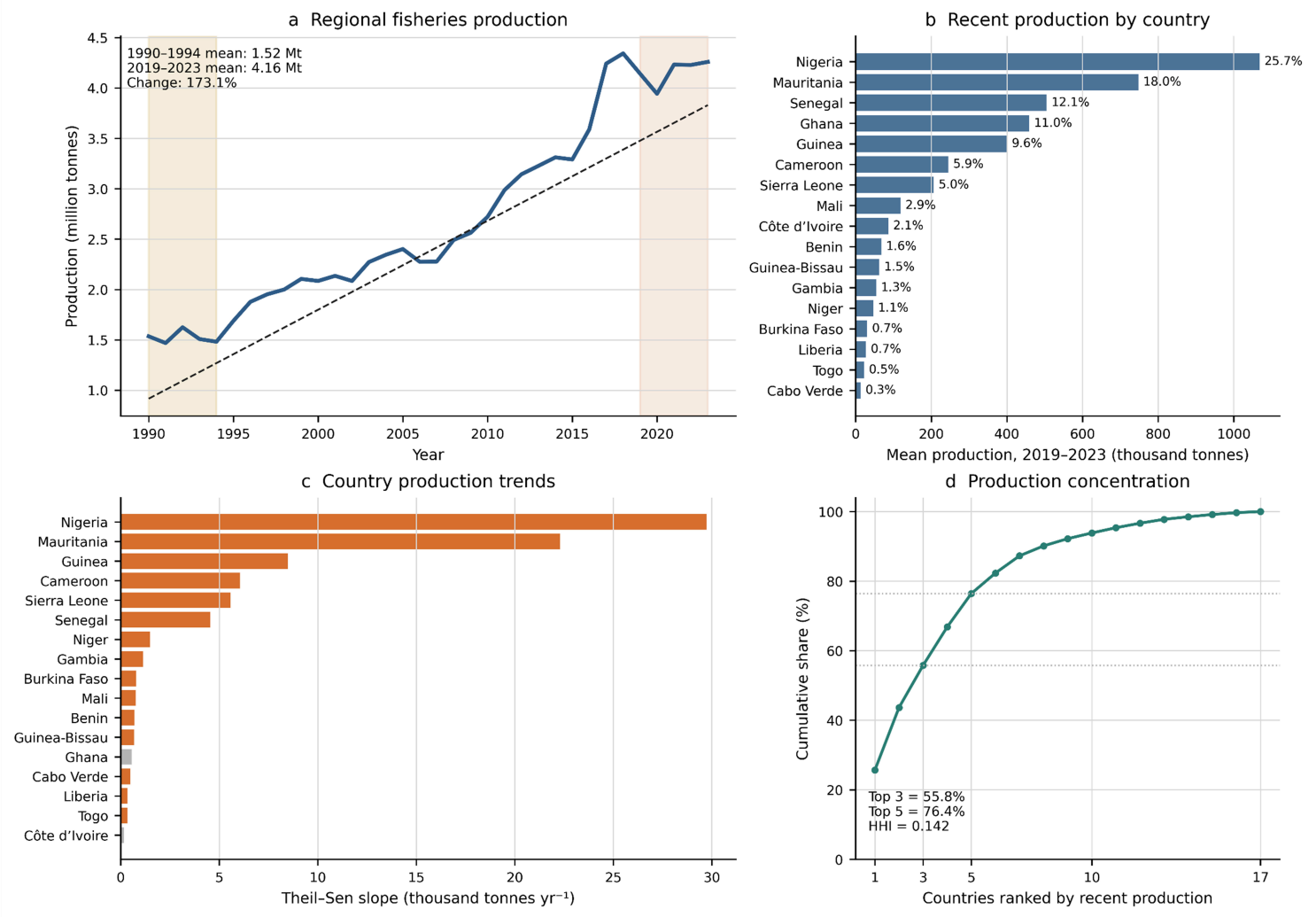


Figure 1

Total fisheries production across West Africa, 1990–2023. a, Regional annual production with the 1990–1994 and 2019–2023 comparison windows and Theil–Sen trend. b, Country means for 2019–2023; labels show regional shares. c, Country Theil–Sen slopes; orange bars indicate significant positive Kendall trends and grey bars indicate non-significant trends. d, Cumulative concentration of recent production. Production combines capture and aquaculture across marine and freshwater environments.

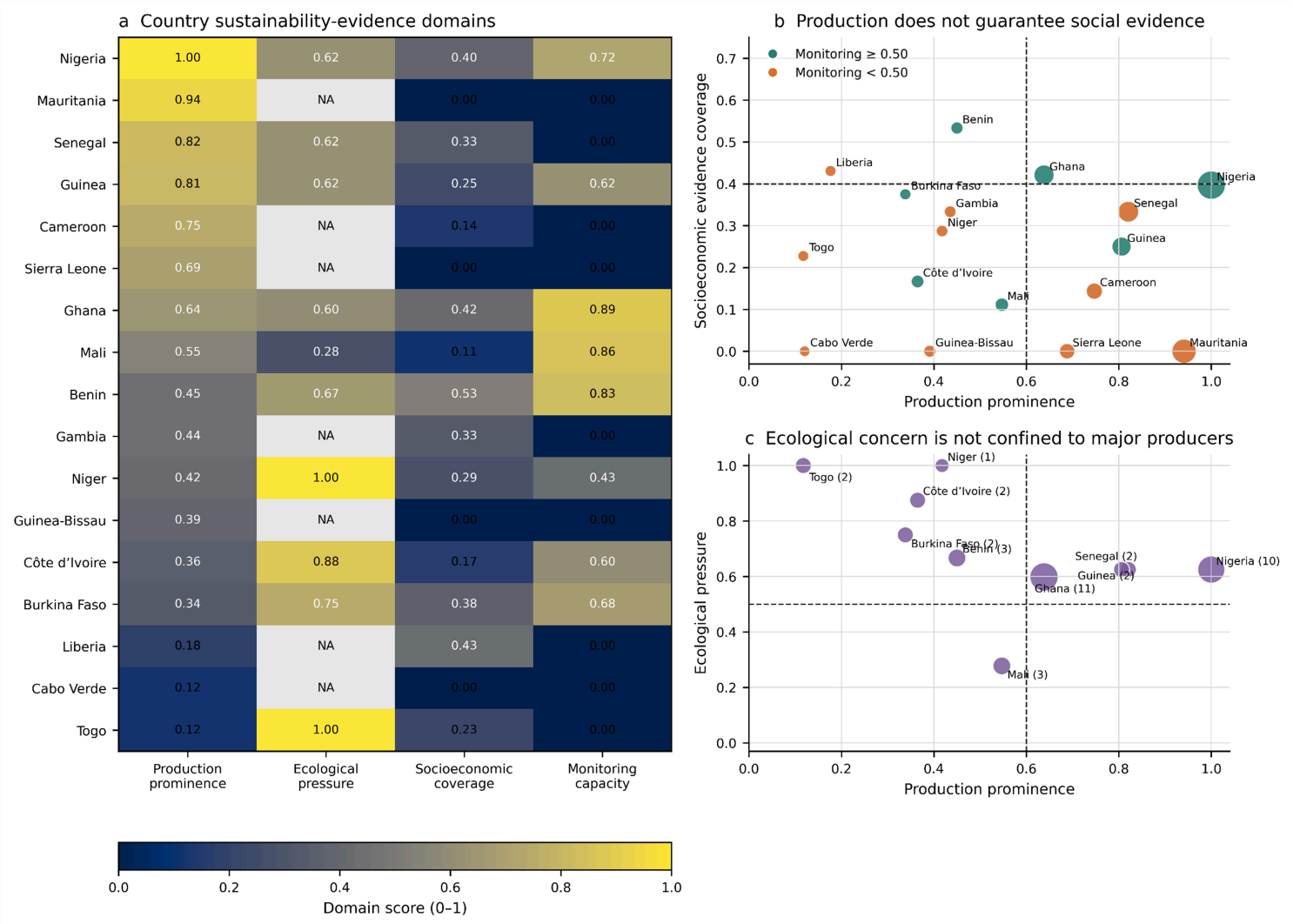


Figure 2

Country sustainability-evidence domains. a, Production prominence, source-balanced ecological pressure, socioeconomic evidence coverage and monitoring capacity; grey NA cells indicate missing ecological evidence rather than zero pressure. b, Production prominence versus socioeconomic evidence coverage; marker area scales with recent production and colour indicates whether monitoring capacity is below 0.50. c, Production prominence versus ecological pressure for the ten countries with classifications; marker area and labels show independent ecological-source depth. Dashed lines are baseline thresholds.

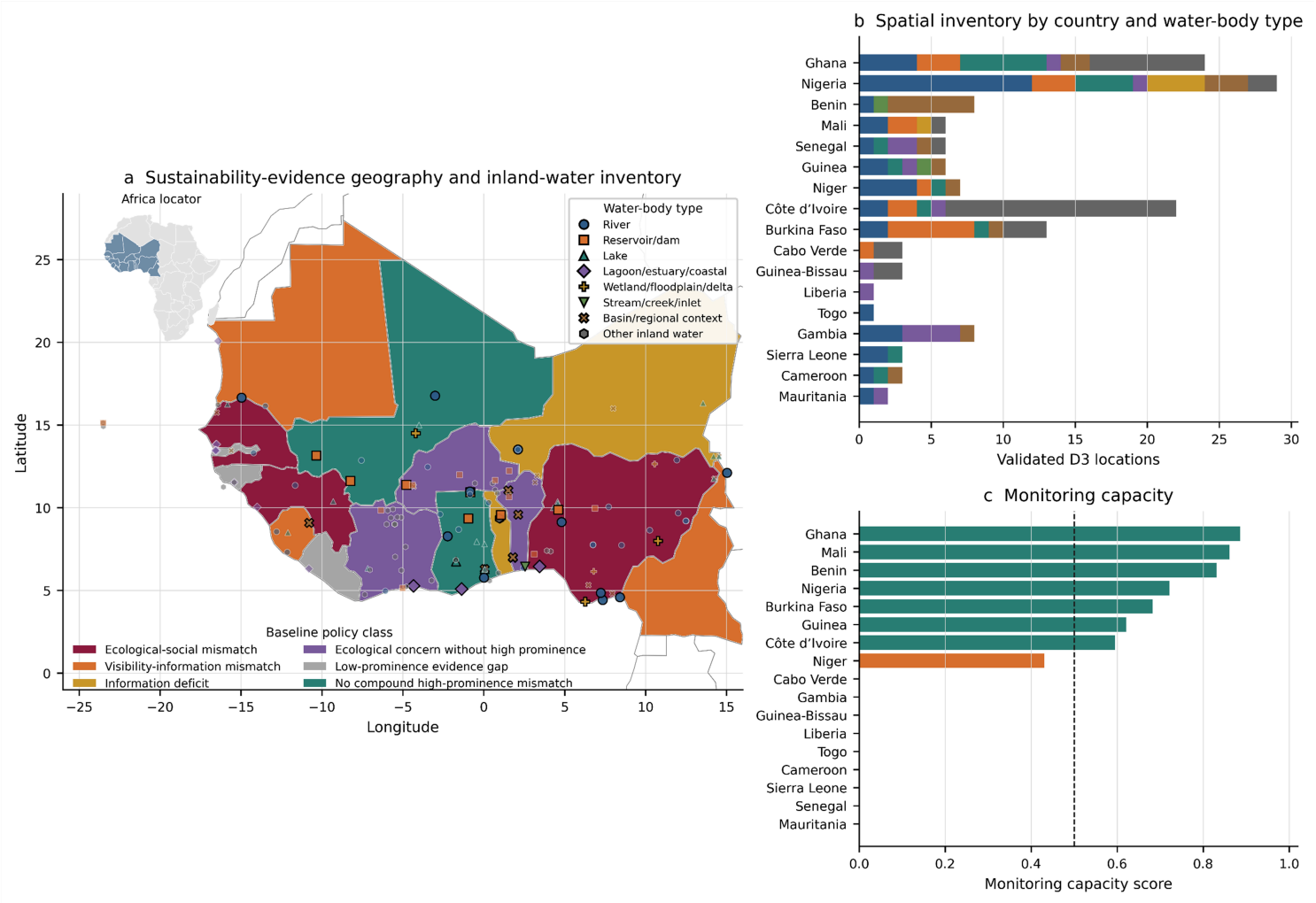


Figure 3

Spatial distribution of sustainability evidence and monitoring capacity. a, Africa locator and West Africa zoom. Country fill indicates the baseline policy class. Water-body type is encoded by unique colour and marker shape; larger black-edged symbols are linked to ecological classifications, whereas smaller pale symbols are validated inventory locations without linked ecological evidence. b, Composition of the validated D3 inventory by country and water-body type. c, Monitoring capacity; the dashed line is the 0.50 baseline threshold. Cabo Verde and Sierra Leone spatial-only inventory records are retained without creating unsupported D1 evidence links.

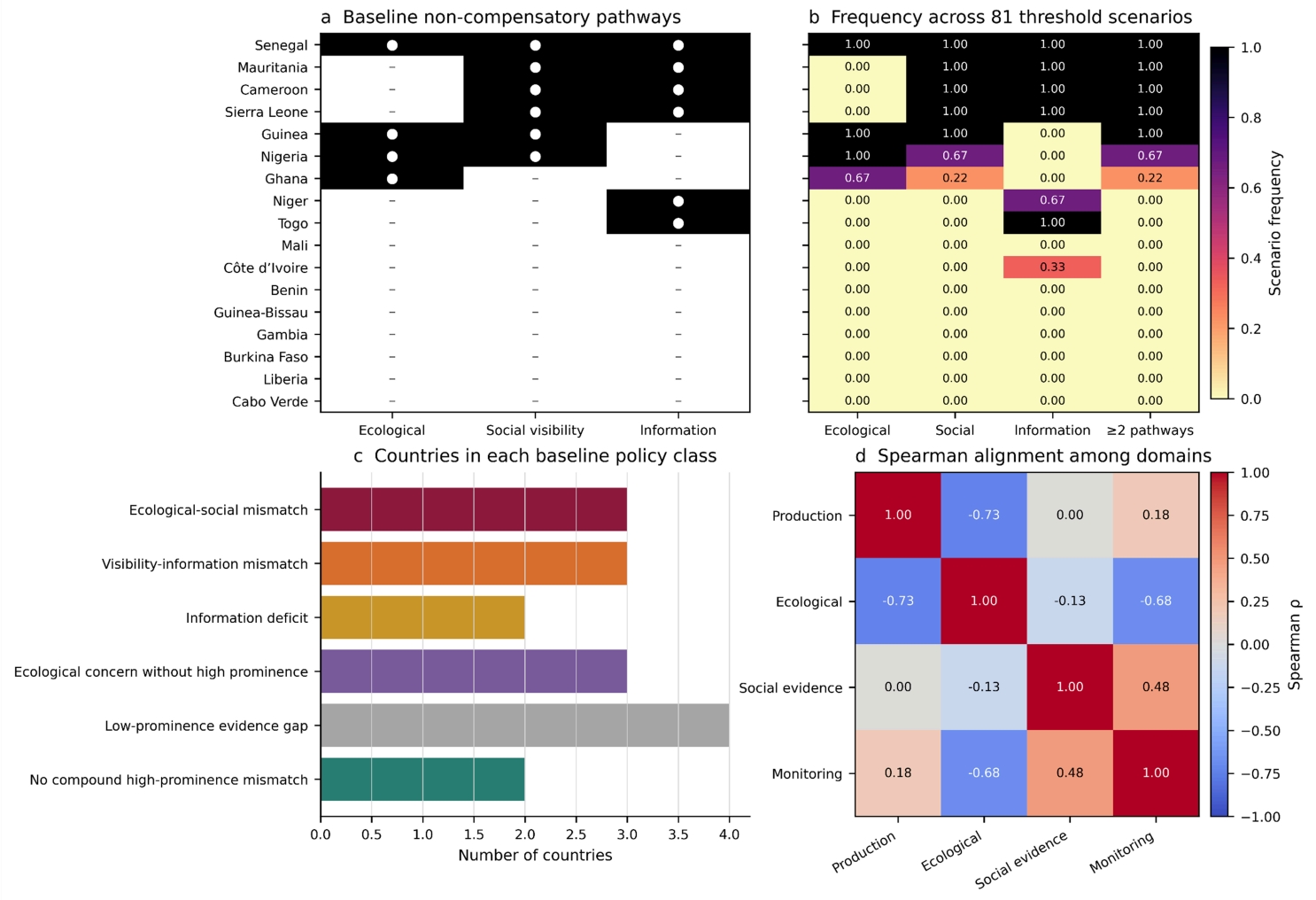


Figure 4

Non-compensatory pathways and threshold sensitivity. a, Baseline ecological, social-visibility and information pathways. b, Frequency with which each pathway and at least two simultaneous pathways occurred across 81 threshold scenarios. c, Number of countries assigned to each baseline policy class. d, Pairwise Spearman correlations among domains; ecological correlations use the ten countries with observed ecological pressure. Frequencies describe model dependence, not probabilities of unsustainability.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Countryproduction.xlsx
- SupplementaryInformation.docx
- Domaincorrelation.xlsx
- RegionalProduction.xlsx

- Threshholdsensitivity.xlsx
- D1ReferenceCatalogueCuratedv3.xlsx
- D0ResearchKnowledgeBaseAuditedv3.xlsx
- SensitivityFrequency.xlsx
- D3SpatialDataRECleaned.xlsx
- D5SpatialCrosswalkRECleanedv2.xlsx
- D2ProductionData.xlsx
- EcologicalsourceCountyclusters.xlsx
- SpatialInventory.xlsx
- Countrydomainprofile.xlsx
- Monitoringcapacitycomponents.xlsx
- SocioeconomicsourcecountrycapacityComp.xlsx