



Substituting for the State: Informal Institutions, Retrospective Regularization, and the Limits of Formal Supervision in Indonesian Seaweed Aquaculture

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Abstract

The social-ecological systems (SES) framework treats boundary clarity, formal rules, monitoring, sanctions, and institutional capacity as interdependent attributes of durable commons governance and generally assumes that informal institutions complement or nest within formal ones. This article examines a case in which informal institutions instead substitute for formal provision across all five attributes at once. Seaweed cultivation in Nunukan Regency, on Indonesia's maritime border with Malaysia, expanded from 2,652 to 13,050 ha between 2018 and 2023. Drawing on 71 semi-structured interviews with 62 informants across three coastal sub-districts and four administrative tiers, together with document review, we find every formal attribute weak: no legally enacted zoning, seven of nine regulatory domains without specific rules, no licence held by any of nineteen cultivators interviewed, none of eight water-quality parameters monitored on a schedule, and no formal sanction ever imposed for zoning breach. Informal institutions fill each gap, but unevenly. Substitution is dense in one sub-district, concentrated in a single village in a second, and has collapsed in a third. Two conceptual contributions follow. First, substitution is not a stable equilibrium: it depends on individual leadership and enforceable social sanction, and where either is absent no governance operates at all. Second, we identify retrospective regularization boundaries in practice follow where cultivators place their frames, and the state subsequently ratifies the result which converts spatial planning from a preventive instrument into a legitimating one. Aggregate claims that informal institutions compensate for weak states therefore obscure sharply divergent local outcomes.

Introduction

Nearshore sea space is a classic common-pool resource: exclusion is costly, use is subtractive, and the benefits of restraint accrue collectively while its costs fall on individuals. Where a commercially valuable activity expands quickly across such space, the institutional framework governing it is placed under acute strain. Seaweed cultivation in Nunukan Regency, on Indonesia's maritime border with the Malaysian states of Sabah and Sarawak, offers an unusually sharp instance. Between 2018 and 2023 the cultivated area grew from 2,652 to

13,050 ha and the number of participating fishing households from 2,551 to 4,770. Within five years a dispersed livelihood became a dense industry occupying navigation lanes, capture-fishing grounds, and mangrove margins.

Elinor Ostrom's work on the commons supplies the standard analytical response. The social-ecological systems (SES) framework as elaborated by (McGinnis & Ostrom, 2014a) identifies the institutional attributes on which durable governance of shared resources depends, and the design principles set out in (Ostrom, 2015) specify their content: clearly defined boundaries, rules congruent with local conditions, participation of users in rule-making, effective monitoring, graduated sanctions, conflict-resolution mechanisms, recognition of local authority by external government, and nested enterprises for larger systems. Subsequent work has confirmed the principles empirically (Cox et al., 2010) and mapped the framework's applications and limits (Partelow, 2018).

Running through this literature is an assumption about the relationship between formal and informal institutions. Whether framed as nesting, congruence, or co-management, the expectation is that local rule systems and state provision are complementary: each supply what the other lacks, and the design task is to align them. Three gaps follow from taking that assumption less for granted.

First, applications of the SES framework remain concentrated in forests, inland and capture fisheries, protected areas, and increasingly urban infrastructure (Delgado-Serrano & Ramos, 2015; Dressel et al., 2018; Flynn & Davidson, 2016; Partelow, 2018). Marine aquaculture frontiers are under-represented, and border regencies where multi-level coordination is complicated by geopolitical sensitivity more so.

Second, and more consequentially, the case in which informal institutions substitute for formal provision across every attribute simultaneously has received little conceptual attention. Complementarity presumes that formal institutions supply something. Where they supply almost nothing, informal arrangements are not filling gaps in a system; they are the system. Whether that condition is a stable equilibrium or a fragile one, and what determines the difference, is an empirical question with direct design implications.

Third, the boundary attribute is normally analysed as a question of whether boundaries exist and are known. Less examined is the case in which boundaries exist in reverse: where the practical demarcation of space is set by users and subsequently ratified by the state. Planning theory treats zoning as anticipatory. The inverse case converts it into a legitimating instrument, with consequences for the preventive function that the boundary attribute is supposed to perform.

This article addresses the three gaps through an embedded case study of seaweed aquaculture supervision in Nunukan. We ask: (1) What is the condition of each of the five SES attributes? (2) Does informal institutional substitution occur across attributes, and is it spatially even? (3) What does the observed inversion of planning logic imply for the boundary attribute? Because the three study sub-districts share one regency administration, one provincial authority, and one regulatory framework, formal provision is effectively constant and variation in substitution can be attributed to local institutional context.

The contribution is threefold. Empirically, the article maps all five SES attributes in an Indonesian border aquaculture frontier. Conceptually, it distinguishes institutional substitution from complementarity and shows that substitution is attribute-specific and spatially concentrated rather than general, so that aggregate claims about informal institutions compensating for weak states conceal divergent local outcomes. And it proposes retrospective regularization to name the pattern in which spatial planning ratifies rather than anticipates use.

Analytical framework

The analysis follows the five institutional attributes identified in McGinnis & Ostrom, (2014b) and operationalises each for the supervision of marine aquaculture. Boundary clarity concerns who hold access rights and over which space. It is operationalised through the availability of legally binding zoning, physical demarcation in the water, dissemination of boundaries to users, and mechanisms for settling boundary disputes. Formal rules concern the written regulation of use, allocation, and protection: sector-specific by-laws, environmental carrying capacity, licensing procedure, and rules governing the allocation of cultivation space. Monitoring concerns routine observation of resource condition and user conduct: patrol frequency and coverage, scheduled water-quality sampling, integrated inter-agency reporting, and the availability of current ecological data. Sanctions concern whether breaches are addressed consistently and proportionately, examined here across zoning violation, appropriation of drifting stock, illegal mangrove cutting, and the consistency of enforcement overall. Institutional capacity concerns the ability of designated bodies to act: the presence and activity of community surveillance groups, the operational capacity of state supervisory units, technical training, and inter-agency coordination.

Two further ideas frame the interpretation. Ostrom's fifth design principle, graduated sanctions, matters because the case turns on the contrast between a formal sanction regime that never operates and a graduated informal one that does. And the concept of order without law (Ellickson, 2017) supplies the vocabulary for social orders sustained by norm rather than statute, though the evidence here suggests a boundary condition on that argument which we develop in Section 5.

Materials and methods

Study site and design

Nunukan Regency lies on Indonesia's northern maritime border. Three coastal sub-districts account for the bulk of cultivation and serve as embedded units: Sebatik Barat on the Indonesian half of Sebatik Island; Nunukan, containing the regency seat and the busiest navigation channels; and Nunukan Selatan. All three fall under a single regency administration, a single provincial marine and fisheries authority, and a single regulatory framework. The study uses a qualitative embedded single-case design with within-case comparison across the three units, chosen so that formal institutional provision is held constant and variation in informal substitution can be isolated.

Informants and data collection

Sixty-two informants were interviewed purposively with snowball expansion, generating 71 interview records. The composition supports vertical triangulation across administrative tiers, horizontal triangulation across categories of field actor, and spatial triangulation across sub-districts. Table 1 reports the distribution.

Table 1. Composition of informants by category and sub-district (62 informants; 71 interview records).

Informant category	Sebatik Barat	Nunukan	Nunukan Selatan	District/Province	Total
Sub-district heads	1	1	1	—	3
Village and ward officials	3	4	2	—	9
Customary institution	—	1	—	—	1

Community surveillance groups	1	1	—	—	2
Seaweed cultivators	7	6	6	—	19
Seaweed scavengers (pemukat)	5	5	4	—	14
Capture fishers	4	4	5	—	13
Technical agencies	—	—	—	9	9
Regional parliament	—	—	—	1	1
Total interview records	21	22	18	10	71

Note: pemukat harvest drifting or detached seaweed from the water column and seabed; they are distinct from cultivators and from capture fishers. Field actors (cultivators, scavengers, fishers) total 46. Source: authors' interview data, 2026.

Data were generated between 1st and 3rd 2026. Semi-structured interviews followed a protocol organised in five blocks corresponding to the five attributes. Participant observation covered patrols, inter-agency meetings, and the handling of reported breaches. Focus group discussions with multi-actor representation validated emerging findings. Document review covered the draft provincial coastal zoning plan 2014–2034, Governor Regulation 26/2024 on seaweed management, Regent Regulation 28/2021 on technical cultivation guidelines, national statutes on coastal and small-island management, agency budget and planning documents, and local press coverage of breaches and enforcement.

Analysis

Interview material was analysed following Miles et al., (2020), through data condensation, display, and conclusion drawing. Coding proceeded from open coding of meaning units, through axial coding into the five attributes and their twenty sub-indicators, to selective coding of the cross-attribute pattern. Coded responses were quantitized where every relevant informant gave an assessable answer (Sandelowski, 2000); denominators vary across tables and are stated individually. Quantitizing serves transparency, not statistical inference. Trustworthiness was addressed through source and method triangulation, member checking, and an audit trail of recordings, transcripts, coding memos, and document extracts.

Ethics and limitations

he studies covers three sub-districts of one regency. Its design is cross-sectional, so the durability of the substitution patterns described cannot be observed directly. And because formal provision is held constant by design, the analysis cannot speak to the effect of statutory variation, which would require cross-jurisdictional comparison.

Results

Boundary clarity

Zoning instruments exist on paper and are almost unknown in practice. Table 2 reports their status alongside informant awareness.

Table 2. Status of regulatory instruments governing seaweed cultivation and informant awareness (n = 60).

Instrument	Legal status	Aware (%)	Internalisation
Provincial coastal zoning plan 2014–2034	Not enacted as by-law	13.3	Very low
Governor Regulation 26/2024, seaweed management	Enacted	1.7	Not internalised
Regent Regulation 28/2021, technical guidelines	Enacted	1.7	Not internalised
National statutes on coastal and small-island management	In force nationally	8.3	Very low
Ministerial regulation on capture and cultivation	In force nationally	5.0	Very low
Oral village prohibition on cultivation in fast-boat channel	No legal basis	Local only	Locally effective

Source: authors' interview and document data, 2026.

The two instruments written specifically for this sector were known to one informant in sixty. The single sub-district head aware of both identified the cause as a lack of synchronisation among central, provincial, and regency authorities in coastal policy. Against this, one village secretary had issued an oral prohibition on cultivation in the fast-boat channel and near the jetty unenforceable in law, locally observed, and the only rule in the study area that responds directly to a mapped navigational hazard. Physical demarcation is almost entirely absent, and boundaries are set instead by practice. Table 3 reports the position by locality.

Table 3. Physical demarcation and de facto basis of boundary setting, by locality.

Locality	Official physical marker	De facto basis of boundary	Setting actor
Sebatik Barat, Liang Bunyu	None	Historical frame claim	Senior cultivators
Sebatik Barat, elsewhere	None	Coordinator agreement	Area coordinators
Nunukan, Tinabasan	None	Tidal timing rule (guris to slack water)	Scavenger coordinator
Nunukan, Tanjung Cantik	None	Agreement among users	Area coordinators
Nunukan, Pampang	None	Frames follow cultivators	Cultivators
Nunukan, Binusan	None	Oral village rule and customary institution	Village secretary; customary body
Nunukan Selatan, Mamelok	Boundary buoys	Provincial agency marker	Provincial fisheries agency
Nunukan Selatan, Selisun	None	Informal claim	Cultivators
Nunukan Selatan, Mansapa	None	Historical fisher claim	Capture fishers

Source: authors' interview data, 2026.

A ward head stated the position plainly: in practice the boundary of the cultivation area follows wherever cultivators have placed their frames, rather than the frames following the boundary. We term this retrospective regularization and return to it in Section 5. Its consequences were reported as recurrent overlap: cultivation frames in the ferry lane (16 mentions, concentrated in Liang Bunyu), frames in fast-boat channels (11), contraction of fishing grounds (14), frames in mangrove conservation margins (8), conflict with port and jetty areas (6), and overlap between cultivators (5). The pattern is consistent with an earlier technical assessment identifying thirteen cultivation sites in active shipping lanes (Wickliffe et al., 2024; Yoo & Jeong, 2020).

Dissemination of boundaries reaches a minority of users and does so unevenly. Of 57 stakeholders assessed, 26.3% had ever received formal dissemination: 50.0% of organisationally active cultivators and of surveillance group officers, against 23.1% of capture fishers, 22.2% of unaffiliated cultivators, 22.2% of ward and village heads, and 14.3% of scavengers. The figure forward and village heads is the most consequential, because they occupy the vertical link between regency policy and coastal communities. One ward head described receiving no copies of the regulations he was expected to disseminate; several requested a formal instrument specifying their supervisory role.

Dispute settlement is the one boundary sub-indicator that functions, and it functions informally. Direct negotiation between parties operates everywhere, mediation by area coordinators is structured in Nunukan and limited elsewhere, and mediation by community figures the head of the fishers' association, the scavengers' organisation in Tinabasan, the customary institution in Binusan is recognised and generally honoured. Escalation to the marine police or navy occurs incidentally. No formal multi-actor mediation forum with binding authority exists in any sub-district.

Formal rules

Of nine regulatory domains bearing directly on cultivation, seven lack specific provision. Sector-specific regency zoning by-law: absent. Seed quality standards: absent. Management of plastic float waste: absent. Biosecurity: absent. Minimum price or price protection: absent. Rules governing agreements between categories of sea-space user: absent in formal law, present informally in one locality. Prohibition of mangrove cutting for stakes: covered only by general environmental statute, not specific, and not enforced. The two domains with specific provision the provincial and regency regulations of 2024 and 2021 are complete as documents and, as Table 2 shows, unknown in practice.

The absence of a carrying-capacity rule is the most consequential gap, because expansion is proceeding without any ecological ceiling. Informants reported the symptoms without possessing the metric: widening cultivation area (18 mentions), contracting fishing grounds (14), frames placed without control (9), declining yield per frame (11), rising incidence of ice-ice disease (9), localised shallowing (7), and accumulating plastic float waste (23). A sub-district head acknowledged that management instruments were incomplete and that no licensing mechanism existed. Cultivators themselves observed that frames had become too dense and were closing channels. Setting a carrying-capacity rule would require an ecological baseline, which as Section 4.3 shows does not exist the first of several dependencies among attributes.

Licensing is absent in the strict sense. Of nineteen cultivators interviewed, none held a written licence; one had begun an application and not completed it; eighteen had never applied or did not know that a procedure existed. An activity supporting an estimated 14,310 workers, with reported monthly capital turnover of IDR 3–4.5 billion, operates without any formal

authorisation. The regulatory instrument through which a state ordinarily observes, conditions, and where necessary restricts an economic activity is simply not in use. Allocation of cultivation space therefore proceeds on other bases: historical priority, dominant in Sebatik Barat; agreement among area coordinators, dominant in Nunukan; and, in Tinabasan specifically, a set of arrangements between scavengers and cultivators that includes a working-time rule and a fine schedule. The timing rule permits scavenging only while the tide is running locally, guris and requires it to stop at slack water, when detached seaweed would otherwise be taken from cultivation lines. It was agreed between coordinators and is enforced by informal fine. No objective criterion set by formal policy operates in any locality.

Monitoring

Monitoring is the attribute where formal provision is thinnest and community substitution most visible. Table 4 summarises patrol capacity and water-quality surveillance.

Table 4. Patrol capacity and water-quality surveillance.

Body or parameter	Frequency	Coverage	Means
PATROL			
District fisheries agency	Annual or incidental	Not comprehensive	Inadequate
Provincial surveillance unit	Limited monthly	Critical sites not covered	Limited vessel
Provincial resource surveillance	Incidental	Report-driven	Provincial assets
Port authority and navigation office	Shipping-based	Navigation lanes	Navigation vessel
Marine police and navy	Incidental	Report-driven	Patrol vessel
Surveillance group, Nunukan (two units)	Daily, during work	Own operating area	Members' private assets
Surveillance group, Liang Bunyu	Nightly rotation	Liang Bunyu	Community watch hut
WATER QUALITY (8 parameters)			
Salinity, pH, temperature, turbidity	Not monitored	—	—
Nutrients, heavy metals, microplastics	Not monitored	—	—
Ice-ice pathogen density	Not monitored	—	—

Source: authors' interview and document data, 2026.

No state body conducts scheduled patrol; three community surveillance groups do, using members' own boats and a community watch hut. A group officer identified operating cost and equipment as the binding constraint and confirmed that assets are largely personal. The thirteen sites identified as overlapping shipping lanes are not covered by any scheduled patrol.

Not one of eight relevant water-quality parameters is monitored on a schedule. Sampling occurs incidentally through student fieldwork, official visits, or individual research projects, and results do not enter any cumulative series or reach the public. The recurrent ice-ice outbreaks are consequently classified by the technical authority as a natural phenomenon, a designation that cannot be tested because no pathogen or water-quality data exist to test it against.

Nor is reporting integrated. No electronic system links the fisheries, environment, port, police, and community surveillance channels; each body maintains its own internal record. The most telling channel is informal: the Nunukan surveillance group reports by instant message directly to the provincial surveillance unit, bypassing the regency entirely. Written reports that could enter a formal database are not produced. Field observation of ecological change is nonetheless substantial and convergent across categories plastic float accumulation (23 mentions across all three field-actor categories), declining coastal water quality (9), disease frequency (9), changes in catch composition (8), mangrove cutting sites (8), localised shallowing (7), shifting current patterns (6), and altered planting seasons (5) and none of it is recorded anywhere official.

Sanctions and enforcement

Enforcement operates on two tracks that barely intersect. Table 5 reports their status and perceived effect.

Table 5. Dual-track enforcement of cultivation rules and perceived deterrence.

Sanction	Status	Deterrent effect	Where
FORMAL TRACK			
Written warning	Never issued	—	—
Cutting of frame lines in breach	Incidental	Low	Nunukan; Nunukan Selatan
Administrative fine	Never imposed	—	—
Compulsory relocation	Never imposed	—	—
INFORMAL TRACK			
Graduated fine between scavengers and cultivators	Active	High	Tinabasan
Verbal reprimand by coordinator	Active	Moderate	All sub-districts
Community social sanction	Incidental	Low	All sub-districts
Customary mediation	Active	Moderate	Binusan

Source: authors' interview data, 2026.

A sub-district head stated that no sanction for a cultivation breach had ever been carried out, attributing this to the incompleteness of the supervisory instruments. Where lines were cut for obstructing a navigation channel, cultivators reported simply reinstalling them. Perceptions among field actors follow: 58.7% reported that formal enforcement produces no deterrent effect, 41.3% that enforcement is inconsistent and depends on who complains, 30.4% those offenders disregard verbal warnings, and 19.6% that those sanctioned reoffend. A further 17.4% concentrated among capture fishers reported that the enforcement that does occur disadvantages them rather than protecting them.

Against this, 23.9% reported that informal sanction is more effective than formal sanction, and the same proportion that tiered mediation produces compliance. The contrast is sharpest in Tinabasan, where scavengers and cultivators reported that the agreed fine schedule generates real deterrence because the amount is known and the coordinators impose it. This is a graduated sanction in Ostrom's sense, operating in the absence of any state sanction whatever.

Two enforcement domains fall outside both tracks. Appropriation of drifting seaweed is contested in principle cultivators regard it as theft of an asset, capture fishers as free catch — and no regulation establishes the legal status of detached stock. Cases are settled by coordinator or customary mediation with informal compensation, and none is recorded as a formal matter in any sub-district, so no data on frequency or pattern exist. Mangrove cutting for cultivation stakes was reported by both cultivators and fishers, yet no inventory of cleared areas has been made, no dedicated environmental patrol operates, no inter-agency case has been brought, and no alternative stake material has been supplied. Officials interviewed treated plastic waste as the environmental priority; mangrove loss sits in an enforcement blind spot despite consequences for coastal erosion, water quality, and fish habitat.

Institutional capacity

State supervisory capacity is minimal, and unevenly distributed community capacity partially offsets it. Across the district fisheries agency, the provincial surveillance unit, and the district environment agency, dedicated supervisory staff are limited, dedicated budget lines for cultivation supervision were not identified at district level, and the standard equipment of contemporary marine supervision patrol vessels, water-testing kits, aerial survey equipment, integrated information systems, and field posts at critical sites is almost entirely absent. Technical training is absent across the board: none was identified in biosecurity, laboratory sampling, data-based zoning, aquatic plastic waste, electronic reporting, conflict resolution, or community institutional management, for state supervisors, surveillance group members, or cultivators. The single exception is adaptive cultivation technique, available informally through extension officers. The absence of biosecurity training is a direct paradox: ice-ice is the most frequently reported technical problem in the sector and no training addresses it.

Community institutional capacity varies sharply. Nunukan sub-district hosts two active surveillance groups, a fishers' association, a scavengers' organisation, and a customary institution. Sebatik Barat has one active surveillance group, concentrated in a single village. Nunukan Selatan has no surveillance group at all and a cultivators' association that was formally constituted and then ceased to meet. This last case is instructive: organisational form was created without operating resources, defined working arrangements, or provision for leadership succession, and did not survive.

Coordination among agencies is fragmentary. No pairing among the fisheries, environment, port, navigation, police, investment-licensing, and sub-district authorities operates within a consistent formal arrangement, and no multi-actor coordination forum exists at regency level. The one relatively active channel runs from a community surveillance group to the provincial agency by instant message. At ward level the asymmetry is stark: a ward head was unaware of the surveillance group operating in his own jurisdiction.

Cross-attribute pattern

Reading the five attributes together produces the article's central observation. Every attribute is weak in its formal provision, and in every attribute an informal arrangement performs some part of the function instead. But the informal arrangements are not distributed evenly. Table 6 sets out the substitution matrix.

Table 6. Institutional substitution across the five SES attributes, by sub-district.

Attribute	Informal substitute observed	Sebatik Barat	Nunukan	Nunukan Selatan
Boundary clarity	Historical frame claims; coordinator agreements; oral village rule	Partial	Strong	Weak
Formal rules	Reciprocal user agreements; tidal timing rule	Absent	Strong (Tinabasan)	Absent
Monitoring	Community surveillance groups; everyday observation	Moderate	Strong	Absent
Sanctions	Graduated informal fines; coordinator reprimand; customary mediation	Weak	Strong (Tinabasan)	Weak
Institutional capacity	Fishers' and scavengers' organisations; customary institution; coordinators	Concentrated in one village	Dense	Collapsed
Dominant conflict	—	Frames against ferry lane	Expansion against fishers	Native against settler
Overall character	—	Concentrated substitution	Dense substitution	Substitution failure

Source: authors' interview and document data, 2026.

Where substitution is dense, governance of a recognisable kind operates boundaries are agreed, a timing rule allocates access, breaches are fined, and disputes are mediated in tiers. Where substitution has failed, nothing operates in its place, because formal provision was never functioning either. Nunukan Selatan is not a case of weak collaborative governance; it is a case of the absence of governance across all five attributes simultaneously.

The attributes are also interdependent in ways that compound the weakness. Without an ecological baseline, no carrying-capacity rule can be drafted. Without a licensing procedure, there is no register of who is authorised and therefore no basis on which to sanction anyone. Without operational capacity, no patrol can be scheduled, so no monitoring data accumulate. Each dependency runs from an attribute that is empty to an attribute that therefore cannot be filled.

Discussion

Substitution rather than complementarity

The commons literature ordinarily frames the relationship between local rule systems and state provision as complementary or nested: each supply what the other cannot, and design consists in aligning the two (Andersson & Ostrom, 2008; Cox et al., 2010; Ostrom, 2010). The Nunukan evidence describes a different relationship. Formal provision is not weak in some attributes and adequate in others; it is close to empty in all five. What operates is substitution: informal arrangements performing the function outright rather than supplementing a partial state effort.

This distinction matters because substitution and complementarity have different failure modes. Complementary arrangements degrade gracefully; if the informal component weakens, the formal component still performs part of the function. Substitution has no such floor. The

three sub-districts make the point precisely: under identical formal provision, one has dense substitution and functioning governance, one has substitution concentrated in a single village, and one has none. Aggregate statements that informal institutions compensate for weak states are therefore misleading when applied to a jurisdiction rather than a locality the compensation is real where it occurs and entirely absent a few kilometres away.

The evidence also suggests what substitution requires. In Tinabasan the working arrangement combines a rule congruent with the ecology it governs (scavenging permitted only while the tide runs), an agreed fine, and coordinators withstanding to impose it. These are Ostrom's design principles operating without the state: congruent rules, graduated sanctions, and recognised local authority. Where any element is missing, substitution does not occur. Nunukan Selatan has coordinators but no agreed rule and no fine; its association collapsed; its dominant cleavage is a native-versus-settler narrative that no mediator has authority across. The failure is not one of community capacity in general but of the specific institutional ingredients (Kuran et al., 2025; Levin et al., 2013).

This qualifies the order-without-law argument (Ellickson, 2017). Ellickson's ranchers formed a single dense community with repeated interaction and shared norms. The Nunukan case suggests a boundary condition: order without law obtains only where a social sanction can be imposed, which requires both a recognised imposer and a population within reach of the sanction. Where the disputing parties belong to groups with no common authority, no order emerges, and the absence of law is simply absence.

Retrospective regularization

The boundary attribute in Nunukan does not merely lack clarity; its logic is inverted. Boundaries in practice follow where cultivators place frames, and the state's subsequent activity the buoys at Mamolok, the acknowledgment by officials of the resulting configuration ratifies that outcome. We call this retrospective regularization: spatial planning operating not as an anticipatory instrument that channels use, but as a legitimating instrument that records use already established.

Two features distinguish it from the more familiar observation that informal claims precede formal recognition. First, it is not confined to allocation among users; it extends to the interface with other public purposes. Frames occupy ferry lanes and fast-boat channels because they were placed there, and the planning instrument accommodates rather than removes them. The safety function of zoning is surrendered along with its allocative function. Second, the state is an active participant. Retrospective regularization is not the state failing to plan; it is the state planning backwards, which produces documents that appear to constitute a zoning regime while performing none of its preventive work.

The concept has a diagnostic use. It predicts that adding planning documents will not restore the preventive function, because the documents are already being produced. What is missing is the temporal ordering, and restoring that requires the demarcation and enforcement capacity examined in Sections 4.3 and 4.4 not further planning. It also predicts path dependence: each round of ratification raises the cost of the next correction, since more capital is embedded in the ratified configuration. Thirteen overlap sites identified in 2018 remained in place through the study period, and the cultivated area quintupled around them.

Where informal sanctions work, and what that implies

The dual-track pattern in Section 4.4 is theoretically informative because the two tracks are observable side by side under identical statutory conditions. Formal sanction is not merely weak; on the account of the responsible official, it has never been applied. Informal sanction in one locality is not merely present; participants describe it as producing real deterrence. The

variable distinguishing them is not severity an informal fine is far lighter than any statutory penalty but certainty. This is consistent with the procedural-justice finding that compliance responds to the perceived consistency and fairness of process more than to the magnitude of sanction (Tyler, 2006, 2021), and (Ostrom, 2010, 2015) fifth design principle.

It also indicates that the reflex response to weak enforcement expanding the statutory sanction menu is misdirected. The menu is not the constraint; four formal sanction types are already available, and none has been used. What is missing is a procedure that reliably converts an observed breach into a consequence, which in turn requires the register that licensing would create, the patrol that operational capacity would fund, and the ecological data that would make a breach demonstrable. Enforcement is the attribute whose failure most visibly depends on the others (Di Cintio et al., 2023).

A hybrid design follows. Rather than replacing the Tinabasan arrangement with a statutory one, the regency could recognise it: give legal standing to coordinators, codify the escalation path from coordinator to organisational head to state agency, and confine formal sanction to the cases informal sanction cannot reach breaches involving navigation safety, mangrove clearance, and disputes between groups with no common authority. That division of labour plays to the observed strengths of each track. It carries a risk, however, that Section 5.4 makes explicit.

Third-party government without a contract

Community surveillance groups conduct the only scheduled patrol in the study area, using members' own boats and a watch hut they built. In (Salamon, 1981) account of third-party government (Lynn, Jr., 2003; McGregor, 2004), public functions delivered by non-state actors are underwritten by contract: the state supplies resources, sets standards, and retains accountability. Here the delivery occurs without the contract. Responsibility has been assigned by expectation and practice; resources have not followed. The result is a public function financed privately by the people it is meant to protect.

This bears directly on the recognition strategy proposed above. Formalising informal coordinators without transferring resources would not correct the asymmetry; it would deepen it, converting a voluntary arrangement into an obligation while leaving the cost where it falls. The collapse of the Nunukan Selatan association is the relevant warning. It was constituted formally and given nothing else, and it did not survive form without operating budget, defined function, or leadership succession. Recognition must therefore be paired with an operating budget, equipment, and training, or it will reproduce that outcome at larger scale. The point generalises: institutional bridging is an attractive policy prescription precisely because it appears cheap, and it fails for the same reason.

Interdependence and the sequencing problem

The dependencies traced in Section 4.6 imply that the five attributes cannot be addressed in arbitrary order. A baseline monitoring programme is a precondition for a carrying-capacity rule; a licensing register is a precondition for enforceable sanction; operational capacity is a precondition for scheduled patrol. Interventions that begin at the wrong end of these chains drafting a by-law before the data exist to specify it, or adding sanction types before a register exists to identify offenders will produce further instruments of the kind already accumulating unread. This is consistent with the framework's treatment of social-ecological systems as integrated rather than decomposable (Levin et al., 2013; McGinnis & Ostrom, 2014b; Ostrom, 2010; Partelow, 2018).

It also implies a specific ordering. The foundational interventions are those on which others depend: a scheduled water-quality monitoring programme with public reporting; a licensing

register, initially registration rather than restriction, to establish who is operating where; operational resourcing of the bodies expected to patrol; and physical demarcation at the sites where cultivation meets navigation. Rulemaking on carrying capacity, seed quality, biosecurity, and waste can then be specified against evidence rather than in the abstract. Dissemination is a cross-cutting requirement throughout, given that two existing instruments are known to one informant in sixty.

Limitations and further research

The findings derive from three sub-districts of one border regency, and their transferability should be assessed accordingly. The cross-sectional design means that the durability of the substitution arrangements cannot be observed, and the causal direction between institutional density and substitution capacity cannot be settled: dense local institutions may enable substitution, or a history of successful substitution may have produced the institutions. Three lines of work follow. First, longitudinal observation of whether substitution arrangements survive leadership turnover, which the collapsed association suggests is the critical test. Second, examination of whether retrospective regularization is general to rapidly expanding aquaculture frontiers or particular to contexts where planning authority is split across administrative tiers. Third, evaluation of hybrid recognition where it has been attempted, to establish whether formal standing strengthens informal coordinators or erodes the social basis of their authority.

Conclusion

Seaweed cultivation in Nunukan expanded almost fivefold in five years, and the institutional framework governing it did not expand at all. All five SES attributes are weak in their formal provision: zoning that is not enacted and not known, seven of nine regulatory domains without specific rules, no licence held by any cultivator interviewed, none of eight water-quality parameters monitored on a schedule, no formal sanction ever imposed for a cultivation breach, and supervisory bodies without vessels, test kits, or training.

What operates instead is institutional substitution, and it operates across every attribute: historical claims and coordinator agreements in place of demarcation, reciprocal user agreements and a tidal timing rule in place of allocation rules, community surveillance in place of state patrol, graduated informal fines in place of administrative sanction, and community organisations in place of institutional capacity. The substitution is real, and in one sub-district it constitutes a functioning governance system built from Ostrom's design principles without the state's participation.

But substitution is not evenly distributed, and it is not a stable equilibrium. It requires a rule congruent with local ecology, an enforceable sanction, and an authority recognised by all parties to the dispute. Where these are present it works; where any is missing it does not occur, and because formal provision is empty, nothing operates in its place. The three sub-districts, governed by identical rules, span the full range from dense substitution to complete absence. Claims that informal institutions compensate for weak states are therefore true only locally and cannot be aggregated to the jurisdiction.

Two implications follow for practice. Recognition of informal arrangements is the most promising available strategy, but only if paired with resources: the community bodies currently performing public functions do so at their own expense and formalising that arrangement without funding it would deepen rather than relieve the asymmetry. And sequencing matters, because the attributes depend on one another in a fixed order. Monitoring data, a registration system, operational capacity, and physical demarcation at navigation interfaces are foundational; rule-making that precedes them will produce further documents of the kind that

two existing regulations already exemplify complete, enacted, and known to one person in sixty.

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