

Assessing the Effects of Changing Demographic and Consumption Patterns on Sea Tenure Regimes in the Roviana Lagoon, Solomon Islands

This paper investigates how sea tenure institutions in the Roviana Lagoon, Solomon Islands, mediate among population, consumption, and the environment. The focus is on explaining how growth in population and consumption alter sea tenure regimes, and the factors that shape either their institutional robustness or vulnerability. The paper also addresses the regional differences among sea tenure institutional arrangements, the processes that are producing them, and the social and environmental outcomes of these institutions as they engage external forces and internal changes. A major question is how existing forms of sea tenure respond comparatively when faced with parallel demographic and economic transformations? Two villages representing different sea tenure arrangements within the Roviana Lagoon are compared. Results show that inhabitants in these villages perceive their systems of sea tenure governance similarly; yet their managerial responses to changes brought about by growth in population and consumption differ, and the responses produce contrasting environmental effects.

INTRODUCTION

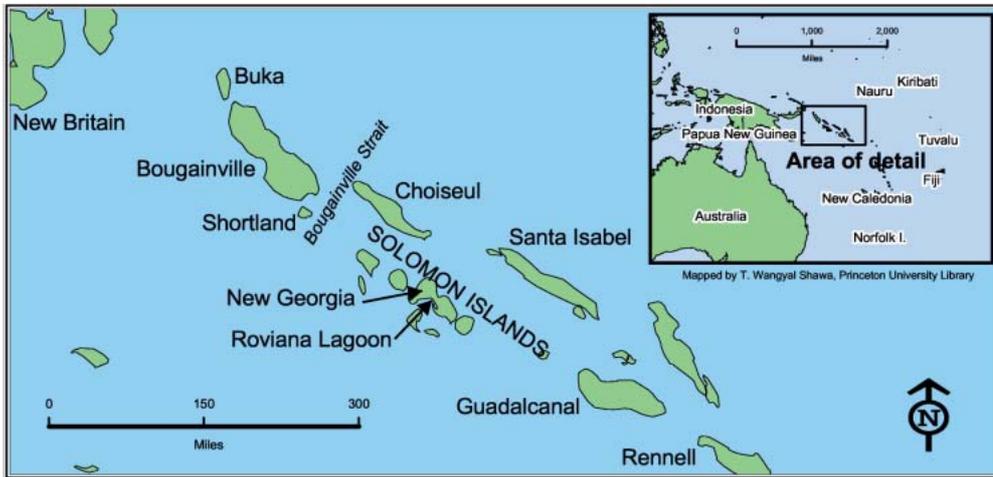
The relationship between growth in population and consumption and common-pool resources, particularly those that are governed under common-property institutions, has been the subject of lively academic debate. Researchers have long dwelled upon the global demographic transition and its effect on land-tenure and inheritance practices in different regions of the world. Boserup postulated in 1965 (1) that as population increases, and as peasants intensify agricultural production, land holdings are transformed from communal to private forms of tenure. Resource economists and demographers routinely argue that growth in population, and increases in migration and consumption, hasten the collapse of traditional common-property institutions and result in resource degradation (2–4).

This proposition has met with numerous critics who argue that, under certain conditions, common-property institutions can be robust enough to withstand demographic, economic, and political changes, and mitigate collective action problems (5–7). “Common property,” as understood by these authors, entails a bounded set of resources that are claimed, used, and/or owned by an identifiable community of resource users. Entitlement holders have either formal or informal rights to resources and maintain regulations that translate their property rights into practice (8). Of course, each common-property regime is historically situated and unique. These regimes contrast with the “open-access commons,” by which we mean property that no one owns, or situations in which people cannot be excluded from accessing and harvesting resources, even to the point of exhausting

them (9, 10). Although scholars have deemed many common-property regimes strong enough to withstand demographic, economic, and political transformations, they have offered few measurable variables to show the actual circumstances that allow actors to translate their governance into management, and prevent the “tragedy of the commons.”

In the Insular Pacific, common-property studies have focused on the dynamic responses of customary land-tenure to demographic, economic, ecological, and political permutations (11, 12). Land-tenure in this region displays an array of different property arrangements, and the majority of contemporary systems neither are truly communal nor truly private (13). This variety of arrangements is owing to two centuries of indigenous and colonial socioeconomic entanglements. Even so, the general consensus among researchers is that these institutional hybrids gradually are being transformed into private land holdings (either individually or corporately held), as population grows and consumption intensifies in the region (14). Interests in contemporary transformations of land-tenure recently have extended to sea-tenure (15–17). Sea-tenure is a situation in which particular groups of people have riparian entitlement to nearshore areas, and in which their entitlements to use and access resources are excludable, transferable, and enforceable, either conditionally or permanently. Stakeholders may preclude nonmembers from accessing resources, while enforcing some type of resource-use limitations on participants, although their rights may vary among systems and may change over time (10).

Local and global political and economic contests regarding natural resources seem to overwhelm sea-tenure institutions. The conventional wisdom is that sea-tenure is weakened by growth in population and consumption, or by situations in which the difficulties of exclusion and subtractability of benefits are intensified. The prediction that Pacific Island land-tenure systems will evolve into private holdings often is reversed for sea-tenure institutions. That is, many sea-tenure systems are thought to be fated to become *de facto* open-access commons unless protected by national or provincial legislation (17–19). This inversion is peculiar given that a number of authors have stressed the lack of indigenous dichotomization between land and sea spheres of ownership in the Insular Pacific. For many Pacific Islanders, land and sea space exist as a single property domain, not as the separate realms predominant in the West (20). This is so notwithstanding that indigenous ownership of sea space has weakened or disappeared in many areas. Demographic and economic changes, then, impinge differently upon each domain—land scarcity pushes people to subdivide their commons into private estates, while simultaneously impelling them to seek unfettered access to their waters, which cannot so easily be carved out from the greater commons. As more and more people exploit their sea commons for subsistence and for cash, a *de facto* open-access regime and concomitant marine resource degradation emerge.



This process has been exacerbated by a Western legal system, which simultaneously encourages the privatization of land and open access to the sea.

Yet, demographic and economic changes do not always linearly transform sea common property governance into systems of open access. The response of those in charge of sea-tenure governance to local and global changes is in fact more complex, resilient, and adaptive than previously thought (21), and different forms of sea-tenure governance and management can coexist within single cultural regions (22). By closely examining concrete actions and concomitant events (23) within each sea-tenure institution, we find that these are shaped by, and are embedded in, particular cultural and historical contexts. Indigenous practices, rooted as they are in local culture and history, coalesce with exogenous influences to generate varying forms of governance and management, or situations in which stakeholders are, and are not, able to solve collective action problems. The responses of those answerable for changes have raised a significant question among researchers (24, 25): how adaptive or vulnerable are various sea-tenure regimes to demographic changes and to encroachment by the market economy? This question largely has been left unanswered.

This paper investigates how sea-tenure institutions in the Roviana Lagoon, Solomon Islands, mediate among population, consumption, and the environment. The focus is on explaining how growth in population and consumption alter sea-tenure regimes, and the factors that shape either their institutional robustness or vulnerability. In this context, growth in population encompasses various factors, including high fertility rates, sharp decreases in mortality, increasing life expectancies, changing age structures, and negligible net migration in or out of the region. Growth in consumption pertains to the rising demand for resources at two levels: those that are vital for human survival and those that are not. Individuals and households increasingly exploit natural resources for subsistence and for cash to access goods and services that are perceived as improving human welfare and fulfilling culturally situated needs and wants. The concurrent transformation of population and consumption variables not only can result in unsustainable environmental practices, but such transformation also can create deep-seated asymmetries among sea-tenure institutions that were more homogeneous in the past. This paper addresses the differences among sea-tenure institutional arrangements, the processes that are producing them, and the social and environmental outcomes of these institutions as they engage external forces and internal transformations. The historical spatial patterns of settlement across the landscape and adjoining seascapes, and their concomitant effect on property relations, are crucial to understanding tenurial differences. The chief question is how do existing regional forms of sea-tenure respond comparatively when faced with parallel demographic and economic transformations?

The analysis is based on the comparison of two villages: Olive and Nusa Roviana, each representing a different sea-tenure regime within the Roviana Lagoon. To evaluate apparent effects on resources, the first-order events examined are *i*) how much effort among these villages is going into diving for marine products; and *ii*) what other uses are made of the lagoon environment. The second-order question examines the differences in institutional responses among the inhabitants of these villages, including attempts to exclude and regulate interlopers. Results show that inhabitants of Olive and Nusa Roviana perceive their systems of sea-tenure governance similarly. Yet their managerial responses to changes brought about by growth in population and consumption differ, and these differences produce contrasting environmental outcomes. The basis for managerial differences between these communities lies in the history of regional patterns of settlement and the way they have shaped the political economy and configuration of land- and sea-tenure rights. Settlement histories, therefore, are critical to understanding the contemporary choices and responses of actors. A combination of demographic, ethnographic, economic, and ecological data is presented to illustrate these processes. Ultimately, identifying institutional variation is not merely an academic exercise, since institutional differences of sea-tenure have significant managerial implications and environmental repercussions.

SEA-TENURE AS COMMON PROPERTY: THEORETICAL ISSUES

Sea-tenure governance and management are responses to problems emerging from allocation, distribution, and competition over common-pool resources in coastal marine environments. Like other forms of property governance (e.g. private or state property), sea-tenure institutions (i.e. the actors within) can effectively regulate resource use and access in some circumstances, but may fail in others (7, 8). Two main parameters affect resource sustainability or depletion in common-property institutions: the difficulty of exclusion and the subtractability of benefits (6). Various authors have identified design principles of governance in common-property institutions, including the demarcation of boundaries, the capacity to monitor, and the existence of conflict resolution mechanisms, that when present can mitigate free-riding, subtractability, and self-enforcing problems (6–8). Their occurrence also distinguishes robust and enduring regimes from those that are not. However, simply describing the parameters that define a long-lasting and robust system is not sufficient. Neighboring tenure systems often appear to have uniform use and access rules of governance, but the feasibility of development and implementation of regulatory mechanisms will depend on the historical, socioeconomic, political, and environmental conditions within which each common-property institution is situated. The key is to identify these conditions, or the

circumstances that determine if individuals can translate governance into effective management regimes. That is, how people's "cognition" of their rights to access and to exclude others from using a commonly held resource (i.e. what is claimed or property rights) translate into an "effective" activation of those rights through the control of participating members and the exclusion of others (i.e. actual behavior or operational rules) (15).

An effective response to collective action problems requires cooperation among stakeholders and enforcement measures to punish potential interlopers (7). Cooperation is especially important for regulating use and access to tropical mosaic marine ecosystems because their defense costs tend to be high and their subtractability benefits low compared to land ecosystems. Another problem is that stakeholders may exclude interlopers from accessing and using a resource, but may themselves overexploit resources if no means of monitoring harvests and enforcing limits are imposed. Game theorists have shown that this is true even if all would benefit from harvest restraint, as explained with models such as the "prisoner's dilemma" (26). The dilemma suggests that in a one-shot or finite-play game each self-interested individual will act to the detriment of the collective benefit. Runge has argued that the dilemma's outcome is not inevitable in village-level, common-property regimes when decision interdependence and a set of specified engagement rules can "assure" members of the group that others will cooperate rather than defect (27). Yet, rapid population growth and economic transformation can undermine common-property institutions by scrambling assurances of cooperation among stakeholders.

Multiple reasons exist why people make strategic choices when dealing with resource allocation and distribution rules or, as noted by McCay and Jentoft (28), rules are embedded within "discrete and changing historical moments, social and political relations, and environmental conditions." In this paper, however, only one major process is addressed: the historical spatial patterns of settlement across the landscape and adjoining seascapes, and their concomitant effect on property relations. In many Pacific islands, divergent settlement patterns have resulted from historical processes such as inter-island trade, disease, intermarriage, warfare, labor, and missionization, and these processes have determined whether entitlement holders to an indigenous estate are geographically *nucleated* or *dispersed*. These processes have taken new forms in recent decades as increasing numbers of people migrate to urban centers. In rural contexts, if a majority of stakeholders live adjacent to their marine estates, then the jurisdictional tendency is for territorial boundaries to be circumscribed, local political powers over estates to be centralized, and sea entitlements to be regionally recognized and uncontested. If entitlement holders are dispersed and live away from their marine holdings then the jurisdictional tendency is for territorial boundaries to be porous, jurisdictional controls over estates to be decentralized, and sea-tenure entitlements to be contested by different groups (29). The latter are expected to increase their jurisdictional demands and interloping activities in waters that they consider to be theirs. The importance for management of resource owners' location in relation to their resources has been recorded for other regions of the world (30, 31).

Two general settlement processes are assumed to be crucial in determining the capacity to institute cooperation and enforcement mechanisms when growth in population and consumption are pervasive insofar as sea-tenure is concerned. Specifically, I predict that:

- i*) If a large proportion of entitlement holders to a sea estate are geographically nucleated and live adjacent to their marine holdings, growth in population and consumption will promote, among the resource owners, the development of excludability and subtractability rules and result in a strengthened corporate sea estate.
- ii*) If a large proportion of entitlement holders to a sea estate are

geographically scattered and live away from their marine holdings, growth in population and consumption will prevent, among the resource owners, the development of excludability and subtractability rules and result in a *de facto* open-access sea estate.

The expectation is that the less even the spatial distribution of entitlement holders across the seascape, the higher the *transaction costs*, or costs of making and keeping agreements. This idea will be developed further in the discussion section. The first step in testing predictions (*i*) and (*ii*) is to ascertain the spatial distribution of those who hold entitlement to the major sea estates of the Roviana Lagoon. The next step is to identify the environmental, demographic, and economic processes operating within each group to gauge whether contextual similarities or differences affect people's resource use and access decisions. Finally, to accurately evaluate these predictions the following need to be measured: *i*) the actual enforcement of access; and *ii*) harvest limitations among the identified groups. Quantitative data on neither is presented here. Instead, I measure cultural attitudes concerning interloping as a proxy for "enforcement of access" because under certain institutional conditions these attitudes can translate into actual territorial behavior. What is more, cultural attitudes can be a form of "social boundary defense" (32) and public condemnation can serve as a deterrent for interloping. Next, I use relative resource abundance as a proxy for "harvest limitations," as it is plausible that differences in fishing yields between communities—all else being equal—indicate that those with higher overall returns can control harvesting or at a minimum be able to keep nonmembers from harvesting resources. Indeed, a number of other factors can affect resource abundance besides harvest controls (e.g. environmental conditions), and there is not a necessary one-to-one relationship between resource abundance and harvest yields (E.A. Smith pers. comm.). To tighten the relation between these two variables, I also present data on fishing effort among Olive and Nusa Roviana fishers. The regional context is summarized before presenting the results.

THE REGIONAL CONTEXT

The Solomons are a double-chained island archipelago lying east of Papua New Guinea and stretching some 900 miles across the southwestern Pacific (Fig. 1). The land area covers approximately 29 000 km², while the marine territory encompasses several times that size, much of it rich in marine resources. Approximately 85% of the country's population is rural and subsists primarily on local staples and imported foods like rice, while marine resources provide the bulk of animal protein in their diet. In recent years, rapid economic development has eroded local subsistence activities, particularly in urban areas. Wage income, through direct employment or through remittances sent by relatives employed in the capital city or in the provinces, accounts for about one quarter of the country's household income. Growth in employment, however, has stagnated due to recent ethnic conflicts that have pushed many urban people back to the provinces. Rural people acquire cash through various activities, including shell diving, marketing of local produce, handicrafts, copra production, and operating small stores. The country's main economic activities include fisheries, timber, mining, copra, palm oil, and cocoa production. Fertility rates in the Solomon Islands and net population growth are among the highest in the world, with women bearing an average of six children and the population increasing by 3.4% per year (33). Increasing land clearing and dwindling resources across the Solomons indicate that this net growth is having negative effects on marine and terrestrial ecosystems. Further, rural people are increasingly demanding outboard motors, corrugated roofing, iron water tanks, and chainsaws, all of which require considerable cash that is attained from the exploitation of natural resources.

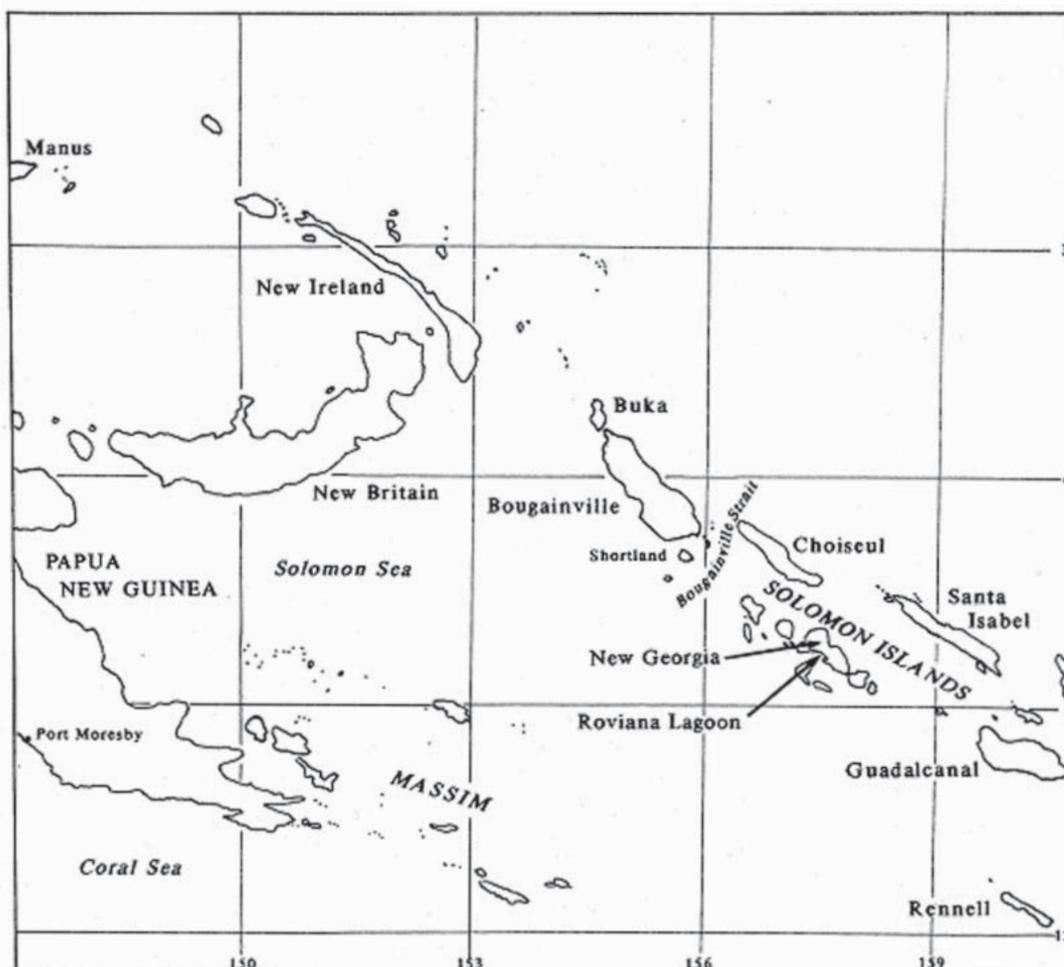
The Roviana Lagoon in the Island of New Georgia extends from Munda, New Georgia's largest settlement, to Kalena Bay near Viru Harbor. Human settlements of various sizes are found both in the islets and the New Georgia mainland. The lagoon is divided into the political districts of Saikile and Kalikoqu, each a composite of various villages, and the independent hamlets of Nusa Roviana, Dundee, Kekehe, Lodu Maho, and Kindu in the Munda area (Fig. 2). Roviana customary chiefs and elders control each district and exercise control of resource use and access-entitlements that are upheld by customary law and sanctioned by national statutory law (34). Hence, both property composed primarily of natural resources and property governed as part of management systems are subject to local controls. The government plays a nominal role in dictating fisheries regulations because it cannot enforce them. Tribal territories (*pepeso*) extend from the interior of New Georgia to the barrier islands that form the lagoon and beyond to the open sea between the channel separating South New Georgia and Rendova Island. Ownership of these estates often is shared with neighboring communities as a result of widespread intermarriage among the tribal groups that originally occupied the interior of southwestern New Georgia and the groups that inhabited the coastal fringes of the adjacent lagoons (35). These kinship ties not only shape the sociocultural identity of contemporary Roviana people, but they also create overlapping political and jurisdictional claims and counterclaims that continue to intensify as economic and demographic circumstances change. As this paper will show, Olive and Nusa Roviana respectively fit the two ends of this resource

contestation spectrum and have different systems of management.

SETTLEMENT PATTERNS AND FORMS OF SEA-TENURE

To illustrate the spatial distribution of entitlement holders two approaches are used: *i*) a qualitative review of historical settlement patterns and *ii*) a quantitative measure of the geographical distribution of households having members with tribal affiliations to the major estates of Roviana. According to oral history, all Roviana people can trace their immediate membership to various tribal groups, but two, which are associated with key land and sea estates, are most relevant here: the Kazukuru-Roviana tribe, which owns an estate in the New Georgia mainland and adjacent waters (Munda area), and particularly the Vuragare tribe, which holds all the barrier and outer reefs extending from Nusa Roviana Island to Patu Parao past Rarumana Village. Around the 16th and 17th centuries members of these tribes, jointly with members of other groups, converged in what today is Nusa Roviana Village (Fig. 2). Through intermarriage and political coercion these tribes amalgamated to become the Roviana confederate polity. During the following 200 years, various Nusa Roviana groups abandoned their home as a consequence of political friction among ruling elites and moved to neighboring territories east and west of Nusa Roviana Island. The groups that moved west to the New Georgia mainland founded various independent chiefly settlements, which are presently known as Dundee, Kekehe, and Lodu Maho, and were able to re-

Figure 1. The Western Solomon Islands.



locate because they retained their original Roviana-Kazukuru tribal entitlements to the mainland estate. In turn, those who moved east were able to migrate because during the preceding two centuries they had intermarried with lagoon coastal Koloï and inland Taghosaghe tribes (among others) and had acquired rights to the barrier island and mainland estates of eastern Roviana (Fig. 2). These groups became consolidated into the major chiefly districts of Kalikoqu and Saikile, with each being a composite of various villages (36).

Of key importance is that people who moved to eastern Roviana took with them powerful land and sea rights to the Roviana-Kazukuru and Vuragare tribal estates that they had left behind. This was possible because in Roviana descent is traced bilaterally and is cumulative. That is, people can trace their descent through maternal and paternal ancestors and can accumulate access rights to various estates held by either parent (15). Meanwhile, factions remaining at Nusa Roviana had not intermarried as readily with eastern groups (i.e. Koloï and Taghosaghe) and, therefore, did not have rights to eastern territorial possessions. Their rights had remained localized within the Roviana-Kazukuru and Vuragare land and sea estates. Kalikoqu and Saikile inhabitants, therefore, have exclusive rights over their respective estates, while simultaneously sharing Vuragare and Kazukuru rights with Nusa Roviana and Munda area villages. Today, the territorial outcomes of these settlement histories have allowed members of Kalikoqu and Saikile to claim entitlement to Nusa Roviana waters (as well as those of other Munda area and Vonavona villages), while concurrently maintaining their own political and territorial integrity. Conversely, Nusa Roviana inhabitants, who lack pivotal kin ties to Kalikoqu and Saikile estates, cannot claim rights there and have to safeguard their boundaries from Kalikoqu and Saikile territorial demands.

The distribution of households with at least one member belonging to the major estates shows that the observed association between contemporary villages and existing tribal affiliations is significantly nonrandom. This is shown by a chi-square test ($\chi^2 = 94.03$, $df = 18$, $p < 0.001$) of regional tribal distribution as documented in Table 1. This spatial distribution results from the historical indigenous processes summarized above. Table 1 also shows that the majority of households in Kalikoqu and Saikile villages have tribal affiliations to the estates that they occupy and hold a high proportion of entitlements to Munda area territories (i.e. Kazukuru and Vuragare). Households in Dundee and Nusa Roviana have a large number of Kazukuru members, but only half of households have rights to Vuragare, and only a few have entitlements to the property of Kalikoqu and Saikile. This is true also for other Munda area hamlets. For instance, in Olive 100% of households have at least one spouse belonging to the Saikile tribe, which owns all waters adjacent to Olive, and 53% of them have rights to Vuragare waters (i.e. Nusa Roviana). This pattern is repeated across neighboring Saikile villages. In Nusa Roviana only 50% of households have at least one spouse belonging to the Vuragare tribe, which owns all adjacent waters to Nusa Roviana, and only 23% of them have rights to Saikile waters. Thus, a large number of Olive and other Saikile households (as well as those in Kalikoqu) potentially could enter Nusa Roviana waters, but only few of the latter could enter the waters of the former without permission. Settlement histories and their associated political processes have determined whether entitlement holders are geographically nucleated or dispersed, and are crucial in determining the structure of governance and management in contemporary Roviana sea-tenure regimes (37).

Today, most Roviana stakeholders similarly recognize heredi-

Figure 2. The Roviana Lagoon.

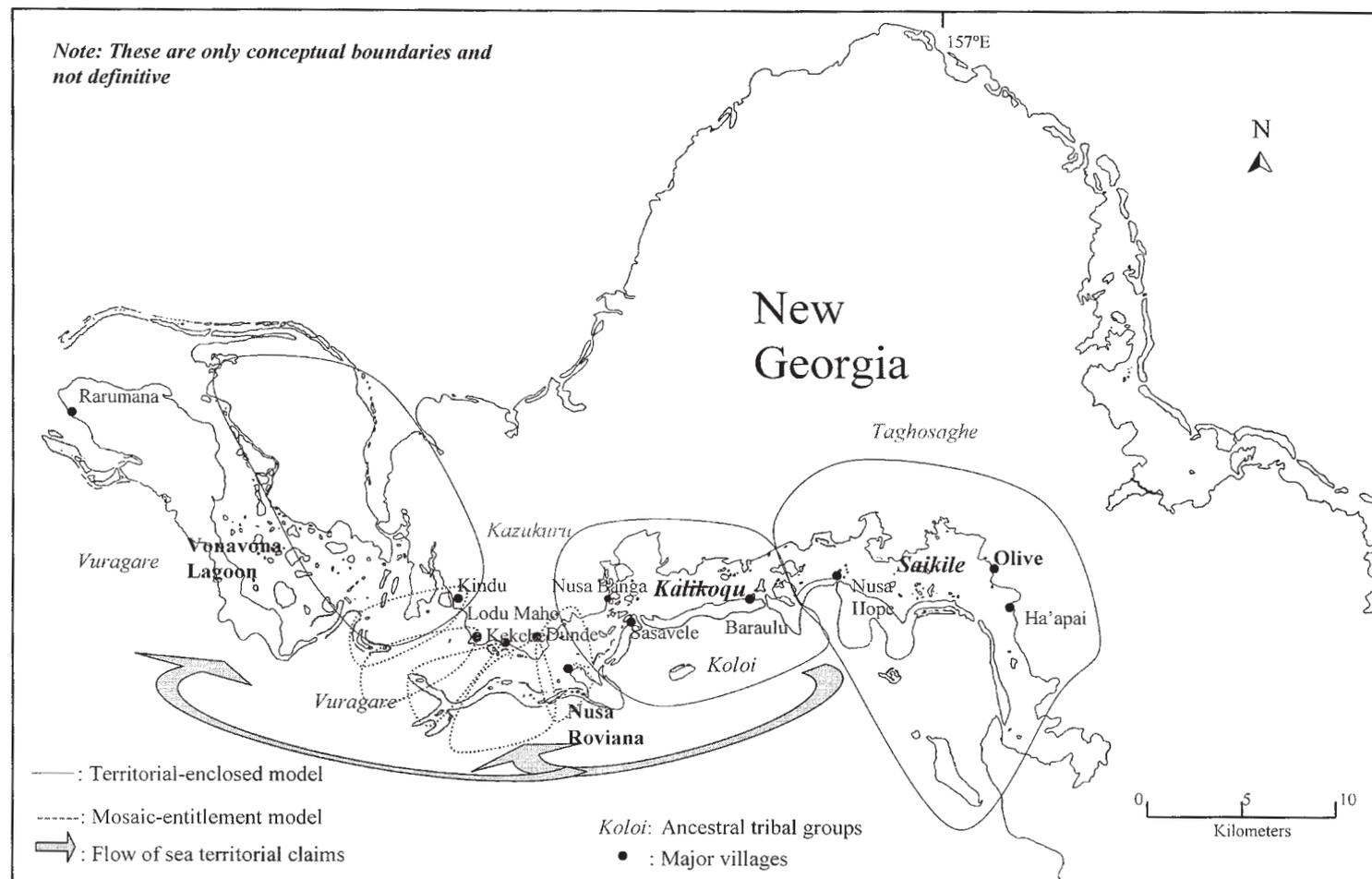


Table 1. Percentage of households in principal villages with at least one member (either spouse) with affiliation to the major tribal groups in Roviana (villages in geographical order from West to East).

Major tribes	Dunde (n = 35)	Nusa-Roviana (n = 22)	Sasavele (Kalikoqu) (n = 22)	Baraulu (Kalikoqu/ Saikile) (n = 38)	Nusa Hope (Saikile) (n = 49)	Olive (Saikile) (n = 15)	Ha'apai (Saikile) (n = 14)
Kazukuru	100	95	73	76	39	33	83
Vuragare	46	50	77	95	71	53	83
Kalikoqu*	14	32	100	100	43	13	14
Saikile*	23	23	14	84	98	100	79

* Each of these is an amalgam of tribes. Household members tend to have several sub-affiliations to the composite tribes in each major polity (e.g., Saikile includes the Taghosaghe, Koqu Kalena, and Hoava tribes among others).

tary property rights to their respective sea territories, making differences between regimes indistinguishable on the surface. Upon closer inspection, however, operational rules of management markedly differ across the region as a result of the processes, outlined above, of regional mobility. Roviana sea-tenure regimes can be classified into two major conceptual models. *i) the territorial-enclosed entitlement* regime, found in the Saikile and Kalikoqu chiefly districts, is a situation in which entitlement holders are spatially nucleated, territorial boundaries are circumscribed, a centralized chiefly authority controls waters, and sea entitlements are recognized regionally; *ii) the mosaic-entitlement* regime, found in the independent Munda area hamlets of Nusa Roviana, Dunde, Kekehe, Lodu Maho, and Kindu (38) is a situation in which entitlement holders are scattered geographically, territorial boundaries are porous, control over waters is decentralized among competing stakeholders, and various regional groups contest sea-tenure entitlements (Fig. 2). A third model, the *transitory-estate*, is an amalgam of the other two conceptual models and occurs in neighboring Vonavona Lagoon. This model illustrates the dynamism and hybridity of regional forms of sea-tenure, but further discussion of this regime will not be pursued here (15).

Sea-tenure in Olive

Olive fits the territorial-enclosed entitlement model because a majority of stakeholders reside adjacent to their waters (Table 1). People in Olive generally do not want neighboring groups to access their marine resources unless granted permission by their chief. The villages of Olive, Ha'apai, Nusa Hope, and Baraulu share all Saikile marine resources owing to the intermarriage of constituent tribal groups and the pooling of land and sea entitlements. Overall, power over the ocean commons is vested in the chief (*bangara*) and everyday authority is delegated to local leaders (*palabatu*) who supervise waters proximate to each of the inclusive villages. The Saikile chief and elders periodically close shell-beds before important religious festivities, although regulatory measures to restrict resource use and access are uncommon in this region. Olive members exploit resources without restraint, and nonmembers normally are allowed access to resources for subsistence purposes. Nonresidents entering these waters usually will ask local authorities for permission to fish to avoid unnecessary embarrassment unless they possess clearly recognized customary rights to enter these areas. Resource commercialization, however, encourages resource owners to verbally impose access- and use restrictions on nonmembers. A similar situation occurs in the neighboring Kalikoqu chiefly district.

Sea-tenure in Nusa Roviana

Nusa Roviana fits the mosaic-entitlement conceptual model because stakeholders (Vuragare reef owners) are dispersed across all Roviana hamlets (Table 1). Attitudes here are more permissive when dealing with the interloping activities of neighboring

groups. Nusa Roviana is an independent village whose inhabitants unambiguously demarcate their marine holdings, which are controlled by a chief and committee of local elders. Members of neighboring Kalikoqu and Saikile, as well as other regional groups, however, claim jurisdictional control over these waters, particularly those associated with the ancestral Vuragare reef-owning tribe. Nusa Roviana stakeholders accept other regional claimants' subsistence rights of usage, but assert exclusive custodianship over their waters and reject other groups' claims. As mentioned, Nusa Roviana inhabitants neither can claim exclusive jurisdictional rights to their own adjoining reefs, nor can they claim overlapping rights to counter the territorial demands of neighboring tribes. Nusa Roviana leaders' incapacity to enclose their commons does not result in Kalikoqu and Saikile fishers encroaching on Nusa Roviana waters either for subsistence or for small-scale commercial activities. They do, however, claim political and economic control over present and future fisheries and tourist development in the area. Another problem is that divers from Munda-area villages and Rendova Island who have rights or association (e.g. through marriage) to the Vuragare reef-owning tribe often enter Nusa Roviana waters for commercial diving and fishing, thus ignoring contemporary inter-village customary boundaries and claims that do not directly recognize the association to Vuragare as a rationale for interloping for commercial resources. Nusa Roviana leaders allow their members to exploit resources without restraint, while nonmembers generally are permitted to use resources for subsistence purposes only. Fishery commercialization has led Nusa Roviana leaders to formulate in village meetings regulatory measures to protect their marine territory. These measures, however, have been difficult to implement because the power of Nusa Roviana traditional authorities has eroded as a result of sustained economic and political disputes.

ENVIRONMENTAL, DEMOGRAPHIC, AND ECONOMIC PARAMETERS

To answer the questions of how sea-tenure issues in Olive and Nusa Roviana are responded to comparatively when faced with demographic and economic transformations, we first need to identify how contextual similarities and differences affect people's resource use and access decisions. Both communities: *i)* occupy like environments; *ii)* experience similar demographic processes; *iii)* allocate a significant portion of their time to the collection of marine products; and *iv)* depend on similar marine products for the generation of household income. Following the description of these parameters, each village's cultural attitudes with its concomitant consequences and its strategies for using its resources are compared to distinguish between institutional success and failure. Data obtained through a combination of research methods, including a regional census, open-ended and structured interviews, time-allocation spot-check schedules, income/expenditure surveys, mapped ecological inventories for

coastal habitats and fishing grounds, and catch-per-unit-effort (CPUE) measurements of fishing forays across all identified areas are presented (39–41).

Environmental Context

Olive and Nusa Roviana share similar, but not identical, ecosystems. The Roviana Lagoon is protected by a series of offshore, raised coral islands that developed during the Pleistocene from sea-level changes and accretion of coral limestone, organic debris, and volcanic detritus. The outer lagoon shoreline is characterized by rugged notched limestone with numerous inlets, bays, carbonate-sand beaches, and moats (42). Within the lagoon there are small islets, coral reefs, and intertidal reef flats. The lagoon is characterized by a variety of ecosystems, including grass beds, mangroves, freshwater swamps, shallow reefs, outer reef-drops, and river estuaries. Unhindered water exchange occurs in various wide passages allowing for the movement of numerous species into and out of the lagoon for purposes of feeding and spawning, and this makes such passages highly productive ecosystems. In general, Olive has a more estuarine and closed-lagoon environment than Nusa Roviana does.

People in Olive can access all marine habitats in the Saikile polity, or an equivalent area of 133 km². Olive shares the Saikile marine ecosystems with various neighboring villages, or a population of more than 2000 people (43). Nusa Roviana inhabitants hold governance over 14 km² of reef, sea grass, and mangrove habitats, and if overlapping rights with Munda area hamlets are counted, they have rights of access to over 96 km² of marine ecosystems. More than 4000 people potentially share all Nusa Roviana and Munda area habitats (excluding Kindu marine holdings). The population density of Nusa Roviana and neighboring communities is 41.7 people km² of marine habitat, while the population density of Olive jointly with other Saikile hamlets is of 15.0 people km² of marine habitat, or nearly one-third of that of Nusa Roviana and neighboring communities. The higher population densities in Nusa Roviana and the Munda area are more likely to contribute to the degradation of marine ecosystems than the lower density of Olive. However, if we consider Nusa Roviana separately and that fishers have access to a marine section of neighboring Kalikoqu—for which they have only subsistence usufruct rights as agreed by the chief of Kalikoqu—the population density decreases to 23 people km² of accessible marine habitat. Olive fishers, in turn, generally fish in waters near their village (it being too costly to go elsewhere, unless for shell diving commercially), or an area of roughly 48 km², and they directly share these resources with their close neighbors at Ha'apai and various smaller settlements. This circumstance thus slightly increases the population density to 17. If we consider the actual territory accessed by both communities, the population density differences narrows considerably.

Demographic Processes

In 1999, 62 739 people lived in the Western Province, about 15.3% of the total Solomon Island population. The Roviana and Vonavona Lagoons had 12 235 inhabitants, or 19.5% of Western Province's population; Nusa Roviana had about 600 inhabitants, or 4.9%; and Olive had about 380, or 3.1%. The 1970, 1986, and 1999 national censuses roughly show a steady increase in population in Roviana and Vonavona of about 3.5% per year, with almost identical localized growth rates for Nusa Roviana and for Olive. This mirrors the growth rate of 3.5% in the nearby Marovo Lagoon and approximates the Western Province's annual increase rate of 3.2%. The reasons for this increase are a sharp decrease in mortality rates, a slower decrease in fertility, and negligible net population movements out of the region. During the next decade child mortality is expected to decline by another 50%, while life expectancy is projected to lengthen by six years for both males and females. Although generational length



Shallow inner-lagoon reefs in the Roviana Lagoon. Photo: S. Aswani.

and population age distribution suggest that total fertility rates (TFR) are declining slowly, population still is expected to increase during the next 25 years (33, 43–44). Rural-to-urban drift, further, does not alleviate population pressures because migration is predominantly circular, with people moving back and forth from villages to urban centers. In fact, the flow of migration has reversed in recent years, a result of ethnic conflict in the urban centers. Roviana age distribution shows that more than half the population is in the 0–19 years age group, and more than 60% is in the 0–24 bracket. The aggregated sex ratio of 110 shows a larger number of males than females in this region, slightly higher than the national average of 107 males to 100 females (43). Olive and Nusa Roviana age pyramids illustrate young populations with high male ratios, especially in Nusa Roviana (Figs 3 and 4). This result is consistent with past censuses that show higher male sex ratios in Roviana than for other regions in the Solomons (45). A growing young population is making increasing demands on the environment.

Economic Activities

To measure how much effort among villagers is going into various economic activities, two economic indicators are used: *i*) time allocation, and *ii*) household income. Olive and neighboring Ha'apai have undergone several infrastructure developments from royalties derived from logging operations during the 1980s, 1990s, and into the present. Olive has a basic water supply system, a clinic, and a school. Logging has brought about profound changes in the social economy of this community. Royalty payments, employment opportunities, and secondary economic opportunities, such as marketing food to Malaysian logging crews, have brought wealth to the village. However, not all funds disbursed by the Kalena Timber Company (presently a subsidiary of Earthmovers-Malaysia) have been employed for community

development—substantial funds have been spent on imported foods, luxuries, and financial mismanagement. Reliance on imported goods has grown significantly during the last decade, although the majority of households still relies on horticulture and fishing for subsistence. This growing dependency has created an insatiable need for cash that cannot be sustained by royalty pay-

Figure 3. Age pyramid for Olive Village, 1994.

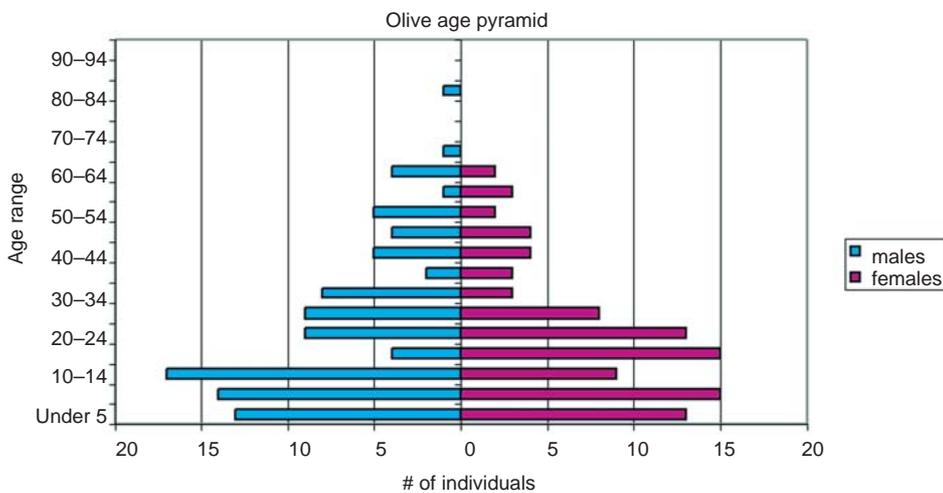


Figure 4. Age pyramid for Nusa Roviana Village, 1994.

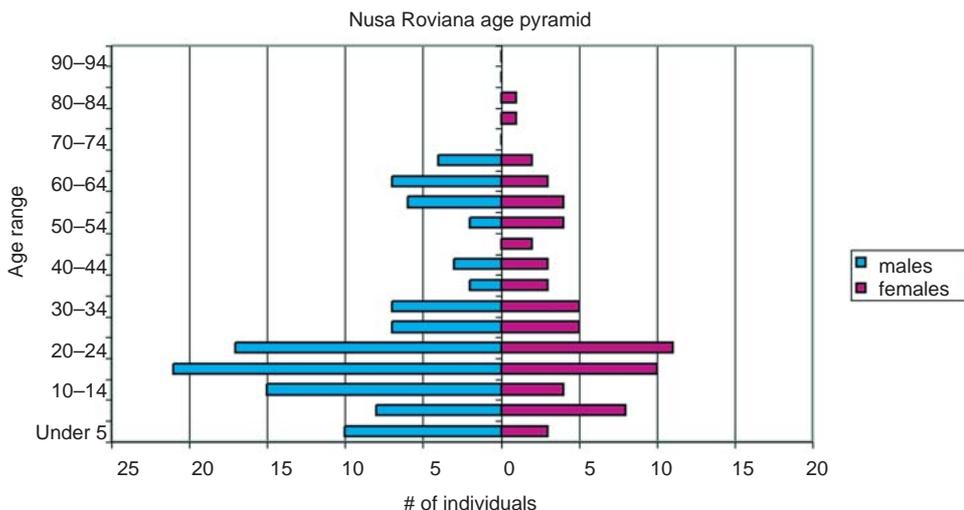
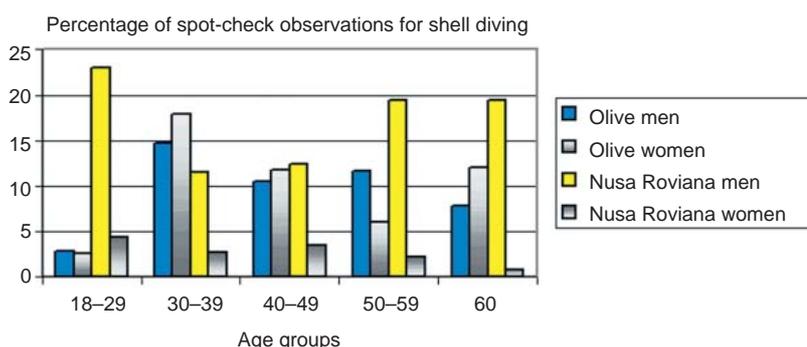


Figure 5. Participation of individuals in shell-diving in Olive and Nusa Roviana villages.



ments and wage labor in logging operations alone. In fact, an important proportion of most households' daily cash flow comes from harvesting a shell called *Nassarius camelus* and, to some extent, from bêche-de-mer (sea cucumber). The former are abundant and harvested from nearby reefs to be sold to local and Honiara buyers. The Tolai people of New Britain buy these shells to make a currency (*tabu*) for traditional exchange.

Marine resources provide a more stable source of income than do wages and royalties derived from transient resource extraction industries. Household questionnaires and spot-check schedules conducted in 1994–1995 show that most adult members (between 17–65 years of age) dive 4 to 5 times a week, with a weekly average of 12 hours labor for men and 14 hours for women. This amounts to a substantive frequency for spot-check observations *vis-à-vis* other economic activities of 4.2% for men and 4.6% for women (Table 2). Results also show that Olive adult women dive more often than men (Fig. 5). The greater effort toward this activity has resulted in neglected gardens and coconut plantations and a greater reliance on imported foodstuffs. Income survey schedule results show that 86% of households participate in diving and that for 75% of them diving is their most important economic activity, providing a mean proportion of 29.8% for each household's total cash inflow (Table 3). Behind shell diving is wage labor in logging operations, which also constitutes an important economic element in the local economy.

Nusa Roviana lies at a socioeconomic crossroads between the orthodox inner lagoon settlements and the more "progressive" Munda area communities. The tuna cannery at Noro employs a large number of young men and an even larger number of women. Recently, many of these workers have been laid off owing to the partial shutdown of the Noro cannery. The continued deterioration of the Solomon Island economy triggered by ethnic conflict has left many of these young people scrambling to find means to get cash, and this drives them to intensify the harvest of marine resources. Among the most significant economic activity in Nusa Roviana is diving for Trochus (*Trochus niloticus*), Cardita clams (*Begonia semi-orbiculata*), and bêche-de-mer. These resources are common in the area, but are not as abundant as *Nassarius camelus* shells are in Olive. Adult men dive an average of 12 hours per week, and women 3 hours. The frequency for spot-check observations *vis-à-vis* other economic activities is 4.6% for men (for combined fishing and diving trips) and 0.2% for women (Table 2). Women's participation in commercial diving is

negligible because many young women work in the cannery, thus making wage labor a major source of income. Household surveys, however, suggest that although women's salaries are included within total household income as shown by Table 3, most of these young women spend their money independently and only a fraction enters the household as household income. The harvesting of marine resources, therefore, still constitutes the most important income-generating activity for most households. Fully 88% of households participate in diving and this activity is important for 76% of households, providing a mean proportion of 22.4% for each household's total cash inflow (Table 3). Data also show that at Nusa Roviana men in the 18–29 and 50-and-above age categories dive more often than men in the 30–49 age group, and more than women of all ages (Fig. 5).

Table 2 shows that there are some differences between Nusa Roviana and Olive in the total amount of time allocated to all activities ($\chi^2 = 1185.4$, $df = 31$, $p < 0.001$). If cash-earning activities are analyzed as a separate subset, the difference is significant for only 5 activities ($\chi^2 = 663.5$, $df = 11$, $p < 0.001$), including commercial shell diving (see Table 2). If subsistence fishing at Nusa Roviana is factored with diving, however, then there is no significant difference in men's shell-diving activities between both villages. This is possible because diving for Trochus or Cardita clams in Nusa Roviana usually is combined with day-fishing trips and, therefore, most spot-check observations coded for subsistence fishing also encompass diving for marine products. Nonetheless, there remains a significant differ-

ence between women's diving activities in both villages, primarily because women at Nusa Roviana work in the Noro tuna cannery. Overall, differences in time allocation for wage labor remain significant for both villages, with a higher proportion of wage labor spot-check observations for Nusa Roviana inhabitants. Note that differences could result from underreporting (46) people's participation in wage labor at Olive, as income data shows that wages are relatively important as a source of household operating income in this village. Household surveys also suggest that most of the men working in logging operations spend their money individually, and that only a fraction of their incomes enters the household. In fact, the suggestion that marine economic resources are important to both villages is supported by the income data in Table 3. The income data show that marine products are an important component of both economies, with the mean household income from marine products being chief sources of income in both villages. A t-test shows that there is no significant difference ($\alpha = 0.05$) in mean household income between the two villages, and that there is no significant difference ($\alpha = 0.05$) between the mean household income from marine produce between the two villages. Preliminary research results for fieldwork conducted during 2000 and 2001 at Olive and Nusa Roviana villages suggest very similar time allocation and household income patterns.

DIVERGENT CULTURAL ATTITUDES

The ecological, demographic, and economic similarities among these communities indicate that their governance and management strategies should be akin. In particular, the economic dependency on marine resources of Olive and Nusa Roviana should make them both reluctant to allow outsiders (i.e. non-Roviana people living in other areas) and neighboring communities to exploit their natural resources for cash. Indeed, there are other factors that pattern peoples' economic choices and their opportunity costs, including seasonal economic and ecological changes, which affect the cost-benefit ratio of territorial behavior. But considering that the exploited resources in both villages are available throughout the year, abundant, and predictable in space and time (47), we would expect that both would implement regulations to control use and access to their marine resources. This is particularly true for Nusa Roviana, which periodically experiences commercial marine resource shortages and is highly dependent on these resources for household income. Instead, there exists a clear asymmetry between each village's territorial strat-

Table 2. Time-allocation to different activities in Olive and Nusa Roviana villages.

Activity	Olive Village			Nusa Roviana Village		
	Males	Females	Total	Males	Females	Total
Household activities						
Leisure/sitting	10.8	8.5	19.3	14.0	9.5	23.5
Sleeping	3.2	2.8	6.0	2.3	1.4	3.7
Eating	2.7	3.2	5.9	3.0	3.0	6.0
Personal hygiene	0.6	0.4	1.0	0.3	0.5	0.8
Sick	0.3	0.4	0.7	0.8	0.2	1
Sweeping	0.1	0.9	1.0	0.2	1.3	1.5
Washing clothing	0.5	3.4	3.9	0.2	1.2	1.4
Sewing	0.0	0.6	0.6	0.1	0.1	0.2
Attending children	1.2	2.5	3.7	0.7	2.9	3.6
Collecting water	0.5	0.6	1.1	0.1	0.1	0.2
Cooking	1.6	5.0	6.6	1.2	5.6	6.8
Collecting firewood	1.7	0.1	1.8	1.0	0.3	1.3
Subsistence activities						
Fishing	6.2	1.3	7.5	3.6†	0.4	4.0
Gardening	3.5	3.8	7.3	3.2	5.4	8.6
Picking nuts	0.1	0.1	0.2	—	—	—
Husbandry	0.1	0.1	0.2	—	—	—
Shell/crab collection	0.2	1.2	1.4	0.6	0.2	0.8
House materials	0.7	0.1	0.8	0.8	0.0	0.8
Cash-earning activities						
Shell-diving (cash)*	4.2	4.6	8.8	1.0	0.2	1.2
Commercial netting	0.1	0.0	0.1	0.3	0.1	0.4
Cutting copra	0.7	0.2	0.9	0.5	.2	0.7
Carpentry*	0.7	0.1	0.8	0.1	0.0	0.1
Canoe making*	1.1	0.1	1.2	—	—	—
House building*	2.2	0.2	2.4	0.9	0.0	0.9
Tool making	0.1	0.0	0.1	0.2	0.0	.2
Buying goods	0.1	0.0	0.1	0.1	0.0	0.1
Sawing timber	0.1	0.0	0.1	0.4	0.1	0.5
Mat weaving	0.1	1.6	1.7	0.5	0.7	1.2
Employment*	0.1	0.2	0.3	2.6	8.2	10.8
Marketing produce	0.5	0.3	0.8	0.1	0.0	0.1
Baking buns	0.1	0.1	0.2	0.1	0.0	0.1
Other activities						
Traveling away	3.5	2.6	6.1	9.9	4.5	14.4
Visiting friends	0.5	0.5	1.0	3.0	1.5	4.5
School	2.3	0.5	2.8	0.1	0.7	0.8
Attending church	2.3	1.9	4.2	0.2	1.0	1.2
Totals	52.7	47.9	100.6	52.1	47.8	99.9

Observations for Olive adults 17–65: 6931 spot-check observations.

Observations for Nusa Roviana adults 17–65: 2035 spot-check observations.

* There is a significant difference between the two villages in terms of the amount of time engaged in this activity.

† Fishing is combined with shell diving trips.

Table 3. Cash-earning activities in Olive and Nusa Roviana villages (household cash-flow proportions).

Income	Olive		Nusa Roviana	
	Proportion	s.d.	Proportion	s.d.
Bakery	2.3	0.5	4.1	0.8
Canoe hire	1.5	0.2	2.5	0.4
Canoes	0.2	0.1	0.0	0.0
Chickens	0.0	0.0	0.1	0.0
Copra	0.5	0.1	6.3	0.5
Crafts	1.1	0.1	0.5	0.1
Fish	1.9	0.3	1.9	0.1
Fruits	0.1	0.0	0.1	0.0
Garden produce	1.7	0.3	0.6	0.1
Betel nut	1.5	0.2	0.2	0.0
House building	0.4	0.1	3.3	0.7
Marine products	29.8	1.7	22.4	1.6
Canarium nuts	0.1	0.0	0.0	0.0
Pigs	0.0	0.0	0.1	0.0
Remittances	4.4	0.5	5.4	0.5
Royalty	5.5	0.3	0.8	0.1
Store/Petrol	26.6	4.4	10.8	1.4
Timber	1.3	0.3	0.0	0.0
Video	0.0	0.0	0.0	0.0
Wage labor	15.8	1.2	40.4	2.4
Other	5.4	1.0	0.4	0.1

egies, and the villagers' cultural attitudes regarding use and access to marine resources. To accurately evaluate the predictions presented in this paper, differences in enforcement of access strategies between Olive and Nusa Roviana need to be measured. Instead, cultural attitudes concerning interloping are employed because public opinion in Roviana serves as an effective deterrent under conditions of territorial certainty. Data in Table 4 show that both communities differ in their attitudes toward the interloping activities of neighboring communities. Olive and Nusa Roviana both are bordered by the Kalikoqu chiefly polity (Fig. 2). Although both communities have identical views regarding the interloping activities of outsiders, they have opposite attitudes toward the commercial activities of neighboring Kalikoqu residents.

Table 4. Cultural attitudes of household heads in Olive (n = 22) and Nusa Roviana (n = 22) regarding other communities potential access to their commercial marine resources.

	Kalikoqu for income		Outsider for income	
	Not ask	Ask	Not ask	Ask
Olive	2	20	1	21
Nusa Roviana	19	3	1	21

Table 5. Cultural attitudes of household heads regarding best venue for local resource management in Olive (n = 22) and Nusa Roviana (n = 22) villages.

	Marine resource management		
	Chiefs	Tribe	Government
Olive	11	7	4
Nusa Roviana	6	2	14

Olive residents would like everyone, including Kalikoqu neighboring communities with overlapping rights, to ask chiefly permission for access to commercial resources because they have secure tenure over their territory. Nusa Roviana residents, on the other hand, only require outsiders to ask for permission because they lack enough tenurial security to prevent neighboring stakeholders access to their marine resources. This permissiveness has been extended to all types of fishing, including night diving, netting, and traditional mass harvesting methods for commercial purposes. Cultural attitudes are crucial because they are a type of defense mechanism utilizing social boundaries (32). Fishers crossing over to Olive waters for commercial resource exploitation purposes are less likely to trespass without prior chiefly consent because they know that resource owners are more likely to publicly condemn such behavior than in Nusa Roviana. Further, Olive residents believe that local authorities can best manage marine resources, whereas most Nusa Roviana respondents believe that the provincial government can do better (Table 5). Note that this does not mean that Olive residents are actively conserving resources. It simply means that they are using socially sanctioned territorial controls to keep interlopers out and cultural consensus to lower transaction costs of keeping resource-management agreements. In Nusa Roviana, such controls are less effective because different regional groups have rights to these waters and are less deterred by the opinions of elders. The latter, in fact, acknowledge their incapacity to do anything.

DIVERGENT ENVIRONMENTAL OUTCOMES

These contrasting cultural attitudes have visible environmental effects. A data set encompassing more than 4000 fishing events and extending for more than 5300 hrs of fishing activity for the entire Roviana Lagoon was collected over a 2-year period (1994–1995) (48) to explore the effect of village and habitat type on mean net return rates and fishing event duration (39). The analysis shows that there is a significant difference between Olive and Nusa Roviana in both of these variables for most habitat types

Table 6. Mean return rate per fishing event for each habitat type (in kcal min⁻¹).

Habitats	Nusa Roviana			Olive			Lagoon Totals		
	Mean	s.e.	n	Mean	s.e.	n	Mean	s.e.	n
Mangroves	0.32	—	1	—	—	—	38.47	71.62	37
Grass beds	16.82	—	1	64.63	41.27	12	86.52	191.94	216
Inner lagoon shallow reefs	-1.68	18.99	110	49.57	37.63	122	29.13	50.15	1473
Inner deep lagoon reefs	10.05	15.33	13	58.68	43.64	13	22.21	40.22	408
Lagoon passages	—	—	—	41.88	51.88	51	32.24	69.70	1002
Outer lagoon reef drop	18.55	27.10	55	29.35	39.39	62	27.25	60.22	429
Outer lagoon reef flat	19.77	203.27	98	36.55	22.15	9	12.39	141.66	203
Sand banks	-1.18	—	1	—	—	—	31.19	51.80	10
Open sea	23.01	40.84	15	160.65	163.34	3	80.06	137.62	167
River mouth	—	—	—	53.08	104.13	5	26.33	55.47	18
Outer lagoon intertidal pool	—	—	—	77.81	—	1	75.00	82.17	9
Outer lagoon island	12.89	—	1	88.92	34.07	3	45.39	45.19	49
Total	11.11	118.72	295	46.13	46.98	281	33.73	82.69	4021

Table 7. Mean time allocation per fishing event for each habitat type (in min.).

Habitats	Nusa Roviana			Olive			Lagoon Totals		
	Mean	s.e.	n	Mean	s.e.	n	Mean	s.e.	n
Mangroves	126.00	—	1	—	—	—	67.24	45.84	37
Grass beds	26.00	—	1	60.08	59.02	12	58.99	53.08	216
Inner lagoon reefs	96.95	73.17	110	42.79	35.85	122	67.69	57.90	1473
Deep lagoon reefs	109.85	104.94	13	77.77	58.70	13	71.40	65.72	408
Lagoon passages	—	—	—	92.86	100.68	51	95.17	81.47	1002
Outer lagoon reef drop	180.36	140.74	55	104.92	74.69	62	103.53	88.43	429
Outer lagoon flat reef	120.06	62.73	98	47.89	27.85	9	101.17	61.60	203
Sand banks	51.00	—	1	—	—	—	62.40	40.77	10
Open sea	59.53	36.89	15	28.33	1.15	3	44.46	36.57	167
River mouth	—	—	—	71.80	46.61	5	96.89	105.10	18
Outer lagoon intertidal pool	—	—	—	273.00	—	1	85.11	75.57	9
Outer lagoon island	377.00	—	1	72.00	67.62	3	88.86	73.40	49
Total	119.49	93.69	295	69.60	69.48	281	79.41	70.53	4021

($\alpha = 0.05$) (summaries in Tables 6 and 7). Overall, Olive and Nusa Roviana's net return rate per bout markedly differ. Olive has an average aggregated net return rate in kcal per minute of 415% greater than Nusa Roviana (a statistically significant difference at a 99.9% confidence interval). A number of different factors could explain this difference besides the existence of harvest controls. However, if we account for fishing effort in both communities, the relation between resource abundance and harvest control (i.e. through social boundary defense) tightens. Nusa Roviana has an overall mean bout time 172% greater than Olive (also significant at a 99.9% C. I.). In other words, there is a significant difference in the environmental returns to the inhabitants of Olive and Nusa Roviana. Nusa Roviana inhabitants receive a significantly lower net return rate per fishing event and spend significantly longer fishing time per bout. To state the situation simply, fishing returns are low and effort high in this part of the lagoon owing to widespread intrusion by neighboring Munda area and Rendova Island villages on each other's territories for subsistence and commercial fishing. Also contributing to these low fishing returns is the resultant environmental degradation that this situation produces. Variance in fishing return rates and effort data for different habitats not only show differences in territorial size, population density, and environmental variation, but also hint at the effectiveness of each community's resource use and access controls (49).

DISCUSSION

The data presented here support predictions (i) and (ii) and also suggest: i) that cultural attitudes serve as monitoring and sanctioning mechanisms (e.g. social boundary defense); ii) that cultural consensus probably lowers transaction costs; iii) that diverging cultural attitudes have measurable environmental effects; and iv) that disparities in resource abundance and fishing effort among communities can be indicative of institutional efficiency in terms of resource sustainability. The question remains: why do the attitudes and environmental actions of Olive and Nusa Roviana inhabitants so markedly differ, particularly when ecological, demographic, and economic parameters are so similar? The answer as shown here lies in the settlement histories of their constituent members and the cultural, sociopolitical, and economic conditions that these movements have created. The spatial distribution of entitlement holders establishes whether transaction costs can be reduced and whether collective action problems can be solved endogenously or require outside intervention. Taylor and Singleton (50) have argued that transaction costs can be lowered when communities have i) "stability of relations," or enduring social relations; ii) "multiplex relations," or repeated interactions across various social spheres; iii) "direct relations," or unmediated interactions (e.g. without state intervention); and most importantly iv) "shared beliefs and preferences," as social and cultural homogeneity advances common goals (6, 27). These parameters are likely to be enhanced when social actors having rights to use, to access, and to allocate the same resources reside in proximity to their property. Close-knit communities of entitlement holders who share linguistic, cultural, social, and consanguine affinities can reduce negotiation, monitoring, and enforcement costs more effectively than communities whose entitlement holders are geographically dispersed from their holdings. The latter often are expected to integrate with other communities and their entitlement ties to the source population are likely to become increasingly diffuse, thus increasing transaction costs.

Cultural homogeneity can be measured in terms of ethnicity and religion, as these parameters influence people's daily resource use and management decisions. Olive inhabitants have a lower proportion of outside consanguine ties than do those of Nusa Roviana (Fig. 6). Olive inhabitants have intermarried with

other New Georgia populations, including people from Marovo, Viru, Hoava, and north New Georgia as well as with some eastern Solomon groups in recent times (e.g. Malaita). This pattern of intermarriage has kept most of their bilateral kinship ties within New Georgia Island. Conversely, Nusa Roviana inhabitants and other Munda area populations have more often, and for a longer time, intermarried with Europeans and other western and eastern Solomon Islanders (Fig. 7). The reason for this is that European traders and missionaries settled the area first and opened the region for other Solomon Islanders (35). Intermarriage with non-Roviana groups has diluted their bilateral links to regional tribal groups and increased tenurial differences across the region. Table 1 also illustrates differences in ethnicity. Frequency of affiliations to the constituent land- and sea-owning tribes within each village can be used as a proxy to measure Roviana ethnic homogeneity.

In addition to ethnic differences, distinct religions predominate in the two communities (Figs 8 and 9). Most Olive inhabitants belong to the Christian Fellowship Church (CFC), as do most people in Saikile and Kalikoqu. This church blends Methodist doctrine with indigenous beliefs. The significant point is that CFC adherents are institutionally and communally unified and, therefore, control over CFC members in matters of resource management is accomplishable through local and church authorities. This cultural factor does translate into behavior, as Saikile and Kalikoqu authorities have occasionally closed shell beds (22) and night diving spots, and have asked neighboring communities not belonging to CFC to avoid boundary interloping, although Kalikoqu allows Nusa Roviana fishers access for sub-

Figure 6. Ethnic composition of Olive Village (representing affiliation to Western and Eastern Solomon Island ethnic groups. Mixed European descent is not disaggregated and is present in some categories).

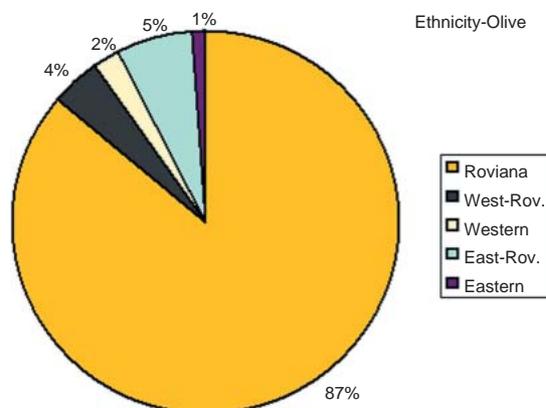


Figure 7. Ethnic composition of Nusa Roviana Village (representing affiliation to Western and Eastern Solomon Island ethnic groups. Mixed European descent is not disaggregated and is present in most categories).

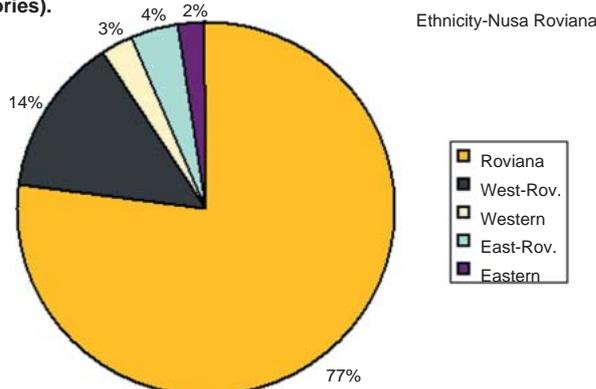


Figure 8. Religion adherence in Olive Village.

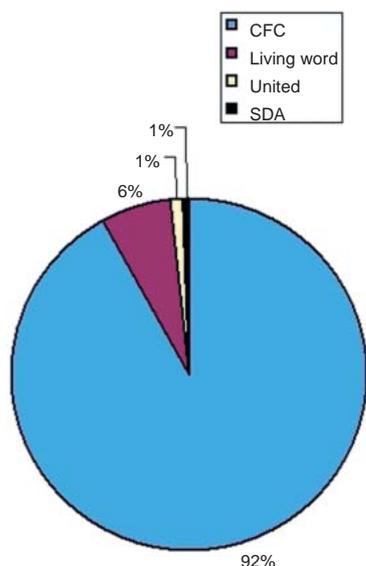
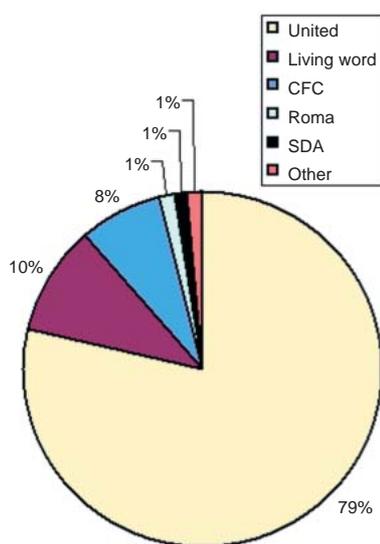


Figure 9. Religion adherence in Nusa Roviana Village.



sistence purposes. Nusa Roviana is composed mainly of United Church adherents (former Methodists). Throughout the 1990s, however, a number of households have converted to evangelical churches. Conversions often have been aligned along ethnic lines, particularly among those families with eastern Solomon ties. These groups also have been involved in contests over natural resources and have utilized their new religion as vehicles for political dissension. This discord contributes to the inability of Nusa Roviana authorities to establish regulatory measures effectively.

In sum, kinship and reciprocity relations clearly affect economic resource-use patterns in other cultures (51, 52). It is very probable that these two variables also significantly affect sea-use patterns in Roviana. If sea co-owners are relatives and live in close spatial proximity, then they likely will compete less. Conversely, the fewer the co-owners who are related and the farther apart they reside, the more likely it is that they will compete with one another in using the sea's resources for immediate benefit (53). Note that consanguine ties are not a prerequisite for cooperation, as unrelated individuals still can cooperate if interacting repeatedly (54). The strength of reciprocal relationships (mutually beneficial exchange relationships) and their frequency in a village or villages, however, may have a significant effect on cooperation and resource-use patterns. It is very plausible that the higher the density of reciprocal ties among close kin or neighbors in a village or neighboring villages, the more likely it is that their land- and sea-use patterns will be conservative, particularly if they hold secure tenure over their seas (55). Note that intentional biological conservation by participating actors is not a necessary aim, as fishers are expected to conduct fishing forays as optimally as possible within the context of spatio-temporal resource variability (39). Resource regulation can nonetheless occur because kin-based reciprocal ties and repeated interactions should lower competition (i.e. the better others do, the better one does oneself), therefore lowering free-riding and concomitant resource degradation, and encouraging cooperation to exclude interlopers with controls such as social boundary defense. Olive's nucleation of stakeholders as has been shown in Table 1 fit these situations. Conversely, the lower the density of reciprocal kin-based ties and the less the frequency of interactions in a village or neighboring villages, the lower the likelihood that land- and sea-use patterns will be conservative. The probability of failure under these circumstances increases because entitlement owners interact less frequently and hold less-

certain authority over their territories. As a consequence, stakeholders will overexploit the ocean for subsistence and for cash in the short-term, and allow interlopers to do the same because they are less likely to benefit in the long-term from sustainable resource-management practices. Nusa Roviana's dispersion of reef owners as illustrated in Table 1 matches these circumstances.

CONCLUSION

This paper formulates a basic question: How adaptive or vulnerable are sea-tenure regimes to demographic changes and to encroachment by the market economy? Sea-tenure's robustness or vulnerability is measured by historical spatial patterns of settlement across the landscape and adjoining seascapes, and their attendant influence on property relations. Settlement patterns of inclusive stakeholders, even at a small geographical scale, are crucial as they determine the capacity to institute cooperation and enforcement mechanisms. It is likely that entitlement holders living in close proximity hold a higher degree of linguistic, cultural, social, and kinship affinities than those who do not. Thus, communities with nucleated entitlement holders more effectively can reduce transaction costs, including negotiation, monitoring, and enforcement costs than communities whose entitlement holders are geographically dispersed away from their holdings and who, as a result, may be more socioculturally heterogeneous. The key factor in this investigation has been to illustrate how the identified conceptual regimes respond comparatively when faced with similar demographic and economic changes. When actors in Olive are faced with demographic, economic, and social transformations, they do not fall necessarily into collective action problems driving their institutions into open-access systems. In fact, these changes strengthen common property regimes. The example also suggests that in Nusa Roviana, the *de facto* open access commons not only results from institutional breakdown caused by population growth, the market economy, and globalization processes, but also from historically embedded practices that undermine the institutional viability of sea-tenure regimes.

The case study challenges the notion that sea-tenure always is weakened by growth in population and consumption, or by situations in which the difficulties of exclusion and subtractability of benefits are intensified, and that these linearly transform sea common-property governance into systems of open access. Results also caution us from treating "sea-tenure" institutions as functional ecological "community-based" systems designed to conserve and/or manage marine resources (39). Closer attention has to be paid to the actual social, economic, and political behaviors of the actors whose institutions we seek to understand—action and events that result from diverse historical paths and which shape sea-tenure into diverse, wide-ranging, and dynamic institutions. Historical processes matter and their outcomes must be identified and measured before we can fully understand the effects of changing demographic and consumption patterns on sea-tenure regimes. Indeed, we can formulate an empirically based and generalizing theory of the commons (56), but first we need to ask: what are the historical, socioeconomic, political, and environmental conditions that encourage social actors to develop cooperation and enforcement strategies to avoid their resources from becoming public goods, particularly when faced with growth in population and consumption? In addition, what are the outcomes of such strategies? Theoretical approaches such as game theory provide us with some answers. These questions, however, cannot be fully answered without careful and systematic attention to particular case studies. From such efforts,

measurable, comparative, and generalizing causal variables ultimately will be drawn that will contribute to developing a theory of the commons.

The identification of institutional asymmetries has significant policy implications. Policy-makers need to ask which institutional arrangements are most appropriate for creating management initiatives like marine protected areas (MPA). This paper suggests that the territorial-enclosed model of sea-tenure (e.g. Olive) is most suitable because it is not as adversely affected by fishery commercialization and demographic shifts as the mosaic-entitlement sea-tenure regime (e.g. Nusa Roviana). The institutional power centralization, nucleated stakeholders, and un-contested boundaries facilitate co-managerial schemes between conservation practitioners and local people. Managerial success

in these areas is likely to encourage villagers living in other areas that are more vulnerable to resource overexploitation to negotiate with neighboring groups toward natural-resource management (57). In conclusion, understanding how different forms of sea-tenure governance contribute to or perhaps hinder marine environmental protection is essential to establishing any form of effective management in the Insular Pacific. Research results such as those offered in this paper only can provide a road map to identify the processes that generate systems of sea governance that are most and least vulnerable to contemporary growth in population and consumption. Ultimately, it will be up to local communities with their inherent capacity to cooperate that will determine what regulatory measures, if any, are instituted to protect their marine environments and livelihoods.

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