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Explaining Inequality in Northwest Coast and Native California Societies: A Critical Assessment

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Abstract

Indigenous societies of the Pacific Coast region of North America developed a range of subsistence ecologies and associated political economies, from plant-focused relatively egalitarian communities in much of California to fish-focused systems composed of hereditary elites, commoners, and slaves on the Northwest Coast. This variation provides an ideal opportunity to explore the causes of variation in the degree of institutionalized inequality in wealth and power in small-scale societies. After summarizing key features of ecology, social organization, and political economy across this region, we provide a critical review of various leading explanations for variation in institutionalized inequality in small-scale societies, qualitatively and quantitatively evaluating their success in explaining the observed patterns in contact-period California and Northwest Coast. We focus on six prominent explanations for this variation: food surplus and storage, population pressure, population size (scalar dynamics), warfare, management of collective action, and differential resource control. Although some explanations exhibit mixed results, only subgroup control of dense, predictable, and clumped resources, with resulting patron-client dynamics, gains robust support. We briefly consider whether other coastal foraging societies scattered around the globe match this explanatory scenario.

Keywords Hunter-gatherers · Institutionalized inequality · Pacific coast societies · Patron-client systems · Political economy · Resource control

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Introduction

Institutionalized inequality in wealth and power is ubiquitous in modern societies, but appears to have been absent or present only sporadically for upwards of 200 millennia—that is, most of our species' existence. We define institutionalized inequality as "codified differences in power and wealth that are ascribed to individuals via inheritance (e.g., hereditary slavery, aristocracy) or some other institutional procedure (e.g., priesthood)" (Smith et al. 2023a, b, p. 3). Given the relatively egalitarian systems that seem to have characterized most human societies until recent millennia, explaining how inequality can become institutionalized is of great interest, as has long been recognized and debated (e.g., Hobbes 1909 [1651]; Marx and Engels 1977 [1848]; Rousseau 1992 [1754]). Although many scenarios assume that this transition only occurred once agriculture arose (e.g., Powers and Lehmann 2014; Seabright 2013), institutionalized inequality has been documented for several widely dispersed foraging societies (review in Arnold et al. 2016). In addition, many societies reliant on domesticated resources other than intensive grain production do not display institutionalized inequality (Gurven et al. 2010; Scott 2017). One could suppose that institutionalized inequality could be formed through direct coercion of subordinates by dominants. While this is certainly the case for stratified societies engaging in conquest or colonialism, there are a number of reasons to doubt its role in this transition within small-scale societies, and various analyses demonstrate how institutionalized inequality could emerge without it (Dow and Reed 2023b; Hooper et al. 2010, 2018; Powers et al. 2016; Mattison et al. 2016; Smith and Choi 2007).

Prior to European colonization, the continent of North America was inhabited by a diverse set of societies that appear to have descended (culturally and genetically) from a few waves of immigration from Siberia or Beringia (Willerslev and Meltzer 2021). Over millennia, Indigenous societies in the Western Hemisphere developed a remarkable range of sociopolitical inequality and complexity. One striking feature of this sociopolitical variation is that it often occurred over a quite narrow geographic range. For example, systems characterized by hereditary nobility, large differences in wealth, and in many cases slavery, such as in the Northwest Coast or lowland Southeast (Cobb 2003), shared boundaries with systems based on consensus governance and almost no formal political offices—e.g., Columbia Plateau (Brown and Hackenberger 2024; chapters in Walker 1998) and upland Southeast societies (see various chapters in Fogelson 2004; Thompson 2023). What might account for this variation?

This is a complex matter, usefully approached by limiting the temporal and spatial scope. Accordingly, in this paper, we focus on variation in political-economic inequality in two adjacent culture areas of the Pacific coast of North America: California and Northwest Coast. For expository convenience, we often compare differences between these two regions, but our analyses examine continuous variation in inequality and other proposed causal factors across both regions, without presupposing discrete regional differences. We also examine important variation within each culture area in detail. Insofar as possible, we

focus on the situation at, or shortly following, initial contact with Europeans or Euro-Americans, relying on available ethnographic and historical information, as well as environmental data, to describe and analyze the patterns of variation. To a limited extent, we include information derived from archaeological research in this broad region.

Northwest Coast societies have frequently been portrayed as exceptional due to being sedentary populations with foraging economies featuring durable wealth, monumental architecture, elaborate ceremonial life, and inherited status distinctions. Similarly, archaeologists and ethnographers often portray Native California societies as outliers from the stereotype of hunter-gatherers as mobile egalitarian bands (Arnold et al. 2016; Bean and King 1974; King 1978). There is growing interest in challenging the conventional view of hunter-gatherers as small-scale and egalitarian (Bird et al 2019; Boyd and Richerson 2022; Singh and Glowacki 2022) and giving due attention to "complex hunter-gatherers" (Arnold 1996; Arnold et al. 2016; Price and Brown 1985). However, lumping all Northwest Coast and Native California societies as "complex hunter-gatherers" masks some critical differences in ecology and political economy both across and within these culture areas, as we discuss below. It is increasingly apparent that the *diversity* found across this set of societies is deserving of careful analysis (Bettinger 2015; Prentiss 2023; Smith and Codding 2021).

Below we briefly summarize key ethnographic features of the two culture areas, emphasizing relevant aspects of ecology, social organization, and political economy. We then critically review proposed explanations for variation in institutionalized inequality in small-scale societies, examining their success in explaining the observed patterns in this study region. A concluding section summarizes our findings, and points toward future research goals, including better measures of key variables, greater integration with the archaeological record, and comparison with coastal hunter-gatherer societies outside our study region. We build on our previous research (Smith and Codding 2021) by presenting a much deeper and more nuanced discussion of regional variation, alternative analyses, and additional evidence, including new quantitative tests. Our broader goal is to advance understanding of the ways in which ecological factors might shape variation in institutionalized inequality among small-scale societies. By "ecological factors," we mean relationships between people as active agents and their environments, particularly key resources (in the present case, wild plants and animals). Ecology is thus interactive and not to be confused with simplistic environmental determinism, a point we expand on in our concluding section.

Ethnographic Patterns Across the Region

In this section, we provide an overview comparing ecological and sociocultural patterns among contact-period North American Pacific region Indigenous societies, focusing on features most relevant to describing and/or explaining inequality in wealth and power. We include both qualitative descriptions drawn from the ethnographic literature and corresponding descriptive statistics, based primarily on the

Western North American Indian (WNAI) database (Gray 2006; Jorgensen 1980, 1999). The WNAI database contains information on 441 variables coded for 172 geographically and culturally distinct groups in 5 culture areas. Our study includes all 34 Northwest Coast (NWC) groups (WNAI cases 1–34), from the Southeastern Alaska panhandle to what is now southern Oregon, plus all 55 WNAI groups in the California (CAL) culture area (cases 35–78 and 80–90) stretching south to approximately the current US–Mexico border. These cases are listed in the Supplementary Information (hereafter, SI), Tables S1 and S10.

For convenience, many qualitative statements are organized by culture area, but important variation within the two culture areas is noted, and most quantitative analyses consider the full set of 89 cases. The boundary between the two culture areas has been drawn in various locations by different researchers, with some including northwestern California groups within the Northwest Coast (e.g., Drucker 1965), while others consider the same groups as exhibiting values and practices antithetical to NWC (Wengrow and Graeber 2018). In our view, the boundary is somewhat arbitrary, being more of a continuum culturally and ecologically (Smith and Codding n.d.), as is true of many other culture area boundaries. In the end, our goal is to determine what best accounts for variation in political-economic inequality across the full set of societies analyzed herein, irrespective of culture area.

Although the WNAI has its limitations, it does greatly facilitate the description and statistical analysis of variation at multiple levels: region, culture area, language group, and at the finest scale ethnolinguistic group—generally, a small set of contiguous societies sharing a common language or dialect and a host of cultural features (labeled "tribes" in the WNAI). The data compiled in the WNAI were mostly collected in the first half of the 20th century, from informants who were asked to describe cultural patterns as they were at the time their grandparents lived. While allowances were made for the dramatic and often destructive changes that occurred with European contact, including diseases, trade goods, and firearms, the goal was to approach a detailed description of Indigenous societies at or shortly after contact. The extent to which this was successful, or can ever be achieved, is of course subject to debate. However, with amendment from further ethnographic, historic, and archaeological research, it remains a highly useful source. We have consulted sources outside the WNAI extensively, in particular to generate estimates on demographic, geographic, and environmental variables, and have dichotomized a number of WNAI variables to capture broad trends without implying dubious precision (as detailed below and especially in the SI).

The societies of native California (CAL) occupied diverse habitats, from savannah-like grasslands to marshes, rivers and lakeshores, and from forested mountains to rocky coasts. Like most foragers elsewhere, Californians managed their landscape through regular burning, coppicing, and other practices (Anderson 2005). For some groups, considerable environmental diversity was present within the territories they occupied, whereas others relied heavily on trade with neighboring groups or reciprocal access rights. In most areas, plant resources dominated the diet, and pre-eminent among these were acorns of various oak species. Other plant foods such as grass seeds were also important, especially in areas where oaks were scarce, as were deer and small game (particularly waterfowl in the wetter areas) and various species of

fish and shellfish. Following harvest, many plant resources were stored in granaries or baskets (e.g., Gayton 1948; Harrington 1942). Most food production, storage, and distribution in native California was carried out at the household level, generally a small extended family unit, a point we return to below.

NWC subsistence had a strong marine (or in some cases riverine) focus, reflecting both the productivity of the North Pacific coastal ecosystem and a forested terrestrial habitat that was increasingly poor in food resources as one moved north (Schalk 1981). For all the NWC cases in WNAI, the single most important resource consisted of the various Pacific salmon species and, along with other aquatic resources, provided an estimated half or more of the diet (see SI, Table S.2). Salmon runs were also harvested in several parts of California, but with the exception of the northwestern subarea and groups on the Sacramento and San Joaquin Rivers and their main tributaries, they did not feature nearly so prominently in the subsistence economy; only 4 of the 55 CAL cases, all of them in the northwestern subarea, are coded in the WNAI as basing the majority of their diet on aquatic resources (SI, Table S9; see SI, section D.3 for further analysis). One reason for this is certainly the much greater productivity of terrestrial resources (both faunal and floral) in most of California, as discussed below. The importance of terrestrial resources, especially acorns and small seeds, appears consistent for CAL societies not included in the WNAI, such as Coast Miwok and Ohlone societies (e.g., Milliken 1995, pp. 16–19).

In sum, most NWC groups had a strong marine focus, with highly productive salmon fisheries, whereas most CAL groups depended more heavily on gathering (especially various acorn varieties) and terrestrial hunting, as confirmed by WNAI data (see SI, Table S2 for details). This is reflected in the WNAI list of edible species for the two areas, with about twice as many plant species tabulated for the average CAL group, and three times as many fish among NWC peoples (Figure 1), with virtually no difference in the tabulation of terrestrial mammals.

Sustained contact with Europeans began circa 1770 in both areas, and resulted in devastating population decline from disease (Boyd 1990; Cook 1976; Jones et al. 2021), as well as forced labor, displacement, and in many cases outright genocide. Although detailed demographic measures such as fertility and mortality rates under aboriginal conditions are elusive, ethnohistoric and archaeological data have allowed increasingly refined estimates of population densities in the two areas. While even these are best seen as rough approximations, evidence in the sources cited above confirms that little population decline occurred before direct contact (i.e., 1770s and later). Boyd (1990) used detailed information on various waves of introduced epidemic disease to estimate NWC precontact density as 40.5 people/100 km^2, close to the density estimate of 44 by Ubelaker (2006). The latter estimates overall CAL density at 73/100 km^2, his highest estimate for the 10 culture areas in Native North America. We examined additional sources for both areas, focusing on local-level estimates for both population size and area. As tabulated in the SI (Section B), this yields a substantially lower density for NWC (35 people/100 km^2) than for CAL (62 people/100 km^2), a difference primarily driven by the lower density along the northern NWC (above 50° latitude).

In CAL, the polity (politically autonomous unit) usually consisted of several hundred people (Bean 1978; Kroeber 1954). The typical polity had a main village,

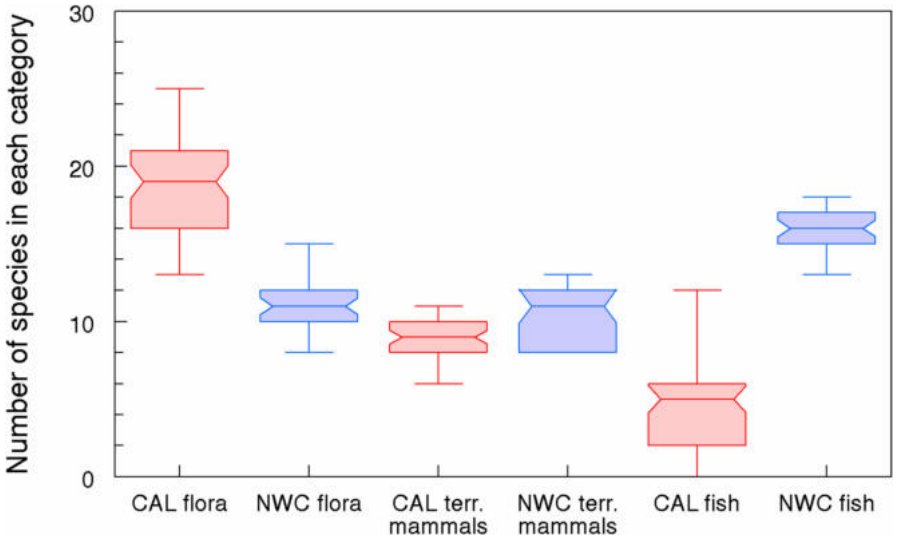

Fig. 1 Number of main edible flora and fauna (species richness) present in CAL and NWC territories (WNAI variables 12–64, 96–114, and 116–134). Central lines indicate median values, shaded areas indicate the 95% confidence interval around each median, and whiskers indicate the outlying points.

usually characterized by a larger population (often over half the polity total), the chief's residence, and a large meeting house used for community gatherings (secular and sacred) and hosting visitors from other groups (Bean 1978). Over much of the NWC, the politically autonomous group was smaller and more circumscribed by kinship. This corporate group (hereafter, "house group") was organized around a core membership of close kin, plus additional related and unrelated individuals (Ames 2003). For reasons of mutual defense and because suitable sites were rare, many winter villages (the "local community" in Jorgensen (1980)) included multiple house groups, but each house group remained politically autonomous and self-sufficient (Drucker 1983). Winter village size increased markedly from south to north over the NWC (Schalk 1981, Table 2). Our detailed estimates of NWC polity size average just over 250, ranging from a mean of around 160 among Salish and more southerly groups to about 400 in the northern subarea (SI, Table S1). By comparison, our CAL sample has an average polity size of about 450, though there was substantial variation (Bean 1978) ranging from two cases less than 100 to ten polities over 700.

Compared to other areas of Native North America, as well as global data, both NWC and CAL had extraordinarily high levels of linguistic diversity. In CAL, an estimated 80 distinct languages were spoken at contact (Golla 2011; Shipley 1978), and NWC boasted upwards of 45 languages (Thompson and Kincade 1990). The WNAI (v441) groups the languages of CAL into at least 12 families, and those of the NWC into 6 families, plus a few isolates (languages that cannot be related to any other language) in each area. This high linguistic diversity has important implications for evaluating explanations of cultural diversity (SI, section D.5).

Rules governing property rights to resources are key variables in several explanations of institutionalized inequality. Territorial exclusion of outsiders (WNAI variable o260) was equally developed in the two areas, with over half of societies in each area coded 1 (the highest level of exclusivity) (see SI, Table S4). In contrast, internal property rights over resource sites (o254) were much more developed among NWC societies, with 76% of cases coded for some division of ownership within the polity or settlement, whereas 81% of CAL cases are coded as having open access within the group. Given the central focus of this paper—internal inequality in resource access—the question is not whether groups (polities) were territorial, but rather the degree to which resource access varied *within polities*. The former is equally characteristic of both areas, whereas the latter marks most NWC societies as much more unequal.

NWC societies are characterized by varying levels of institutionalized inequality in status, wealth, and power within each local group. NWC chiefs were the ceremonial, political, and economic leaders of their respective house groups, and exercised their prerogatives by virtue of inherited titles granting their descent group ownership of various productive resource sites, ceremonial rights and duties, and many other privileges and responsibilities. NWC chiefs coordinated the harvest and distribution of key resources; they also financed the conversion of food stores into wealth production by employing skilled craftsmen, and channeled both food surpluses and wealth goods into exchanges with other house groups (via potlatching, marriage alliances, and other interactions).

In a typical CAL polity, the chief presided over a polity of several hundred people residing in a few dozen households across several settlements sharing a defined territory. The typical CAL chief "helped settle community disputes, organized major ritual and social functions, and coordinated preparations for war and defense" (Bettinger 2015, p. 130), but by most accounts had quite limited authority, and little or no coercive power (cf. Bean 1978 for a divergent view). In most CAL societies, households enjoyed much greater economic and political autonomy than did comparably sized NWC units. Some CAL chiefs received shares of household production, which they used to finance ceremonial and diplomatic feasts and to assist any household in their polity that suffered a severe shortfall due to illness or localized resource failure (Bean 1978). But the share of the group harvest controlled by CAL chiefs, and their role in managing production, was quite limited compared to NWC societies (but see SI, section D.3). As summarized by Bettinger (2015, pp. 139f), "chiefs had only limited ability to appropriate and redistribute resources from the private stores of families who owned their own critical resource plots, and then almost always only in connection with ritual celebrations." These patterns hold among several coastal CAL societies not included in the WNAI, such as Coast Miwok and Ohlone communities. Randall Milliken, one of the foremost scholars of the Indigenous history of the region, summarizes that communities were dispersed into small, temporary villages, and "[m]embers of the local groups hosted dances, pooled their labor during specific short harvest period, defended their territory, and resolved internal disputes under the leadership of a headman. There were no higher levels of government" (1995, p. 21). The Chumash to the south were an important exception; however, as we address later in the paper, their subsistence and political economy actually provide support

for the main arguments developed herein and in our prior work (Smith and Codding 2021).

NWC house chiefs and their closest relatives formed a hereditary aristocracy. Most other members of the house group were commoners (whether or not genealogically related to the chief), while some individuals (ranging from a few up to 20% in a few cases) were slaves owned by the elite, who had complete control over their labor and indeed their lives (Donald 1997). To be sure, there was variation across NWC societies in the degree and form of power and wealth inequalities. In particular, many of the Coast Salish as well as Oregon Athapaskan-language groups had less emphasis on chiefly powers, hereditary rank, and wealth displays (see SI, section D.1 for extended discussion). In contrast with NWC, CAL chieftainship was only nominally hereditary, and chiefs did not belong to any formally defined, title-inheriting subset of their local group. Although there were distinctions between extended family groups in terms of status and wealth, particularly in Northwestern CAL and along the south coast, these were primarily due to achieved differences in wealth accumulation. In sum, roles glossed as "chief" were present in both culture areas, but their statuses, powers, and methods of assignment differed greatly.

Table 1 summarizes our description of the two culture areas at contact. With this background, we now present several prominent explanations of the emergence of institutionalized inequality in small-scale societies, and critically evaluate these in light of the evidence from WNAI data, as well as additional information on CAL and NWC societies.

Evaluating Alternative Explanations

The scholarly literature on political economy and social evolution in small-scale and mid-range societies is extensive. There is little consensus on how to measure inequality, and even less on the key factors favoring the emergence of institutionalized inequality in wealth and power in such societies. Measures include hereditary social class systems (Haynie et al. 2021), number of administrative levels (Ember et al. 1997; Feinman et al. 2025), and Gini coefficients of wealth (Bowles et al. 2010), grave goods (Schulting 1994), house size (Kohler and Smith 2018; Kohler et al. 2025a, b), or storage area (Bogaard et al. 2019, 2025). Proposed causes include population pressure, risk buffering through economic redistribution, trade monopolies, control of spatially concentrated resources, intergroup conflict, food storage, control of production technology, managing collective action, transmissible wealth, scalar effects of increasing population density or community size, competitive feasting and gift-giving, land-limited production, network structure, ritual integration, and manipulation of esoteric knowledge or ideology (reviews in Feinman 2023; Flannery and Marcus 2012; Hayden 2001; Mattison et al. 2016; Summers 2005). Possible causes thus range from environmental to demographic to economic to social to ideological. However, most current scenarios focus on food surplus and storage, population pressure, polity size (scalar dynamics), warfare, managing collective action, and differential resource control (Bogaard et al. 2019; Carballo and Feinman 2016; Glowacki and von Rueden 2015; Hayden 2001; Hooper et al. 2010; Mattison

Table 1 Summary of key features of NWC and CAL societies.[a]

Feature	CAL cases (n≤55)	NWC cases (n≤34)	Comment[b]
Population density	0.62 people/km^2	0.36 people/km^2	Regional averages (see SI, Table S1)
Settlement pattern	Main village plus hamlets	Nucleated (winter village), seasonally dispersed	
Polity size	453 (median = 375)	256 (median = 204)	Multiple polities in each WNAI "tribe"
Annual fish harvest	65 kg/km^2 115 kg/person	158 kg/km^2 392 kg/person	p135 (point estimates of v135)
Quercus habitat	29% of habitat	7% of habitat	Species producing edible acorns only
Dietary composition	23% aquatic; 27% hunted; 49% gathered plants	80% aquatic; 9% hunted; 12% gathered plants	Point estimates of v199/204/211
Resource index	−0.54 (median = −0.71)	0.59 (median = 0.52)	% aquatic minus (% gathered + % hunted)
Food storage	Well developed, but varies by degree of seasonality	Same	v216 (maximum storage duration)
Redistribution of food	Mostly equal (76% cases, mean = 0.24)	All cases unequal (1.0)	d252 (0=equal access, 1=unequal)
Ownership of resource sites	Gathering = 72%, Hunting = 41%, Fishing = 50%	Gathering = 82%, Hunting = 65%, Fishing = 100%	Dichotomous recodes of v269-271
Inheritance of resource sites	Gathering = 67%, Hunting = 38%, Fishing = 41%	Gathering = 50%, Hunting = 53%, Fishing = 78%	Dichotomous recodes of v277-279
Hierarchical ranking within kin group	9% of cases	85% of cases	d318 (Dichotomous recode of v318)
Raiding frequency	Median = rare or never	Median = >4 times/year	v361 (offensive raiding incidence)
Raiding for plunder, for slaves	Plunder = 24% of cases, slaves = 2%	Plunder = 81% of cases, slaves = 91%	Dichotomous recodes of v354, v356
Hereditary elites	Absent in all cases	Present in all cases	Controlled material & ritual property
Slavery presence	18% of cases (in the form of debt peonage)	82% of cases (all = chattel slavery)	D436 (Dichotomous recode of v436
Hierarchy index	Mean = 0.5; median = 0	Mean = 2.7; median = 3	Sum of d252 + d318 + d436

[a]Values are means unless otherwise noted.

[b]See Supplementary Information for details on each variable; vNNN indicates a variable from the WNAI database, dNNN a dichotomous recode of same done for this study (as documented in SI, section A).

et al. 2016), and we focus on these. Whenever possible, we link each to specific predictor variables in the WNAI database and other sources, and evaluate their logical and empirical strength in accounting for variation in inequality in wealth and power. First, we present and explicate the Hierarchy Index, the measure we use to calibrate institutionalized inequality in our study societies.

Measuring Inequality

Our primary measure of institutionalized inequality is a composite of the three WNAI variables (recoded dichotomously) that we feel best capture inequality in wealth and power in the societies in our sample. This "Hierarchy Index" (HI) is formed by summing d252 (distribution of goods), d318 (kin group ranking), and d436 (presence of slavery), with a resulting range from 0 to 3 (Smith and Codding 2021).

The first variable (WNAI v252) codes the mode of redistribution of "food and chattels" as ranging from balanced (egalitarian) to unbalanced—either from poorer to wealthier or the (much rarer) converse. We have recoded it as a dichotomous measure of egalitarian vs. nonegalitarian distribution patterns (see SI, Section A for details). By this admittedly narrow measure, all NWC cases have nonegalitarian resource distribution, while the CAL ones are mostly (76%) egalitarian (Table 1 and Table S10).

Given our focus on inequality within polities or local groups, WNAI variable 318 is of particular relevance, as it codes the form and degree of formal ranking within "demonstrated" (genealogically defined) kinship units. WNAI codes nearly all (91%) CAL societies as lacking internal kin ranking (many even lacking demonstrated kin groups), whereas nearly all (85%) NWC ones are coded as having this feature (Table 1).

Our third HI element is slavery, surely one of the starkest forms of political and economic inequality. Slaves can be considered an "external resource" (Blanton and Fargher 2009), not requiring acquiescence for participating in collective action and therefore less of a constraint on elites who control them. In addition, slave labor is "a form of privately owned material wealth that could both be very unequally held and transmitted across generations" (Bowles and Fochesato 2024, p. 1526). The ethnographic record indicates slavery was pervasive over most of the NWC, but rare in CAL. WNAI codes slavery (WNAI v436, dichotomized as present/absent for use in HI) as present in 82% of NWC societies, but in only 18% of CAL ones (SI, Table S5). Fully 50% of NWC cases are coded as having "many slaves," whereas no CAL cases are so coded. In addition, the nature of slavery in the two areas is markedly different. NWC slaves were chattel property who could be sold or given away, used as concubines, or even executed. The CAL societies coded as having slavery include four groups in northwestern California, who clearly had what is referred to as "debt peonage" or "penal servitude," a final recourse if an individual could not repay debts or fines, and reversible by purchase of freedom, as noted by Kroeber (1922, p. 287) and various chapters in Heizer (1978). (See SI, section A for further discussion.)

A recent comment criticizes the Hierarchy Index as logically flawed:

> …the hypothesis that unequal distribution of food is a causal factor in the emergence of social inequality can only be tested by separating these two variables for spatial and temporal analysis. Combining them in a single index of hierarchy introduces circularity into the argument and weakens it. (Wengrow 2024, p. 627)

This criticism derives from Wengrow's misunderstanding of the variable on food distribution (WNAI v252) included in HI, as in the same paragraph he refers to it as "unequal food distribution in the landscape." In fact, this variable codes unequal *postharvest* food distribution *within the polity*. As detailed below, we employ the spatial and temporal distribution of resources (e.g., resource clumping) as a candidate causal or predictor variable that might explain variation in HI, *not* as a component of HI; hence there is no circularity.

Recent analyses have demonstrated that inequality in wealth or income (typically measured with Gini coefficients) can be driven by both economic factors, such as heritable wealth and political structure, conceived as a continuum from collective or consensus governance to autocratic rule (Blanton and Fargher 2008; Bowles and Fochesato 2024; Feinman et al. 2025). Indeed, the best predictor of household-level inequality (Gini coefficients of house size) in a large worldwide sample of archaeological sites is an index titled "hierarchical clout," which combines polity scale (number of hierarchical levels in a polity or region) and the degree to which decision-making power is centralized (Feinman et al. 2025).

While we find these arguments persuasive, they are somewhat orthogonal to our analysis, for two reasons. First, polity scale exhibits very little variation across NWC and CAL societies, with WNAI v337 (coding number of levels in polity territories) ranging from one to two levels for most cases in both culture areas. Second, since we are interested in explaining variation in political-economic inequality—that is, inequality in wealth *and power*–it will not work to include centralization of decision-making or the like as a predictor; for our purposes, power inequality must be part of the explanandum rather than the explanans. We read the ethnographic record (summarized above) as clearly indicating that decision-making is less concentrated in most CAL societies than in NWC ones. But this does not mean that NWC governance is markedly autocratic. Although slaves had minimal agency, commoners who had relatives in a different house group were usually free in principle able to change residence, and this "outside option" could limit the power of the elite, who needed to attract and retain co-residents to compete with other house groups in production and defense (Ames 2006; Coupland et al. 2009).

As can be seen in Table 1, the HI average is five times higher in NWC societies than in CAL societies, though there is substantial variation among the latter, with 40% of CAL cases coded >0. Irrespective of culture area boundaries, HI exhibits a marked increase as one moves north within the study region (Figure 2, Table 2).

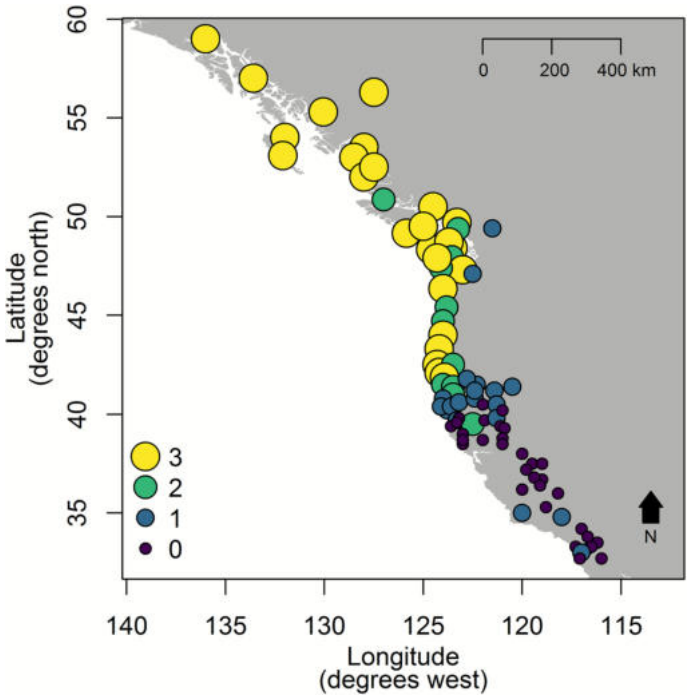

Fig. 2 Map of the study area showing Hierarchy index (HI) values of the 89 WNAI societies in this study (after Smith and Codding 2021; see text for definition of HI).

Table 2 Bivariate correlations between Hierarchy Index and other variables.

Variable (source)[a]	Variable type	Sample size	Kendall's tau[b]
Latitude (d-place)	Continuous	89	.721*
Fishing site ownership (d271)	Dichotomous	88	.564*
Raiding for plunder (d354)	Dichotomous	70	.393*
Fishing site inheritance (o279)	Ordinal	89	.389*
Fish harvest per capita (p135/pop)	Continuous	83	.350*
Raiding frequency (v361)	Ordinal	76	.273
Polity size (Table S1)	Continuous	73	−.234
Population density (Table S1)	Continuous	83	.007

[a]Variables are listed in descending order of absolute value of correlation coefficients. Further information on each variable can be found in the Supplemental Material, section A.

[b]Statistical significance levels: * indicates p<.001, otherwise p>.05

Surplus and Storage

Scenarios for the emergence of stratification based on surplus production and storage have a long history in anthropology and cognate fields, going back at least to Adam Smith. Some scholars (Keeley 1988; Testart 1982; Wesson 1999) have argued that reliance on food storage predisposed small-scale societies, including hunter-gatherers, to develop inequalities in wealth and power. In one formulation, storage has been seen as a means of generating surplus to manipulate social alliances and create power differentials (Hayden 2001; Woodburn 1980), which in turn might lay the groundwork for institutionalized inequality.

Reliance on food storage is clearly a correlate of political-economic inequality in hunter-gatherer societies (Arnold et al. 2016; Keeley 1988; Kelly 2013; Stutz 2020). The more difficult questions are whether that correlation is causal, and if so, in which direction the causality flows and if there are crucial mediating variables. Recent work by economic historians suggests that the emergence of stratified state societies is associated with cereal grain crops, but not with root crops (Mayshar et al. 2022; Scott 2017). While both crop types increase agricultural productivity, only grains can be effectively appropriated (through taxation, etc.) to support state elites. Of course, the development of stratified states is a different question than our concern here with the initial emergence of institutionalized inequality in societies lacking it (such as most hunter-gatherers, and all societies prior to the Late Pleistocene or Early Holocene). The more general point that Mayshar et al. (2022) and others have pointed out is that demographic dynamics will generally convert increased productivity into population growth, with any surplus used to insure against shortfalls rather than to support aggrandizer or elite interests (Kuijt 2009). This dynamic is only likely to be interrupted if a subset of the group (bandits, emergent elites) can profitably appropriate surplus. Thus, the causal impetus falls on mechanisms that can allow such appropriation, rather than surplus production per se (Bowles and Fochesato 2024).

Turning to our empirical cases, we note that food storage was universal throughout the study region. The stability of acorns allowed many CAL groups to keep stores longer than a year (24% of the CAL cases in our sample), something rarely found among NWC groups (Table S2). A limitation is that the WNAI storage variable only codes the maximum duration of storage, not the quantity or importance of stored foods. Keeley (1988) draws on Ethnographic Atlas data to code for these variables, and finds storage importance among hunger-gatherers is strongly correlated with what he terms "class distinctions." But he also notes that storage intensity is a correlate of latitude and various environmental measures. Given that latitude is strongly correlated with Hierarchy Index (Table 2), and that latitude serves as a proxy for ecological and economic variables, it is difficult to directly test the causal role of storage in favoring institutionalized inequality.

Population Pressure

Population pressure explanations for the emergence of sociopolitical complexity and inequality have a long and contentious history (Hayden 2001; Keeley 1988;

Mattison et al. 2016). The particular arguments vary, but typically per capita resource scarcity is seen as driving competition within or between polities. In the case of internal competition, the argument is that those with greater competitive ability might emerge as elites, imposing a hierarchical political-economic structure (Bell and Winterhalder 2014; Kennett et al. 2009). Alternatively, if population pressure drives competition between groups, those with hierarchical organization may be more successful at acquiring or retaining contested resources, or may establish political and economic control over defeated entities (Carneiro 1970; Dow and Reed 2023a, 2023b, and many others).

The only WNAI variable directly assessing risk of food shortfalls (v214, "General availability of local subsistence resources") codes all 89 societies the same (2 = "constant but much daily variation"), and thus is of no use here. Many studies of hunter-gatherers have employed terrestrial net primary productivity (NPP) as a proxy or assay of resource availability, and some have correlated NPP with population density (e.g., Kelly 2013; Tallavaara et al. 2018). While we have reservations about this, particularly for marine-focused populations, it is worth noting that mean monthly NPP values for the two areas are almost identical (Table S3), although NPP does decline markedly at higher latitudes. In any case, NPP could only be a possible measure of population pressure if it varied per capita. The same is true of population density; there is no firm basis for assuming that denser populations have fewer food resources per capita (i.e., greater population pressure).

Elsewhere we evaluated the relationship of population pressure to HI using three measures of local resource availability: annual fish harvest (WNAI, p135), proportion of territory occupied by oak (*Quercus* spp.) woodlands, and annual net primary productivity, in each case divided by local population size to generate per capita values. In simple nonparametric bivariate tests (Table 2), per capita fish production was positively correlated with HI (contrary to the population pressure hypothesis), while per capita oak availability was negatively correlated; we interpret these results as reflecting the fact that institutionalized inequality was well established in the fish-dependent groups (primarily NWC) and mostly absent among acorn-dependent groups (mostly CAL). NPP per capita has a low and nonsignificant correlation with HI.

In a more elaborate multivariate test, per capita NPP exhibited the weakest effect on HI of the six variables with some association, and a statistical model including the above per capita resource measures and controlling for the effects of shared cultural (linguistic) descent and spatial proximity turned in the weakest performance of any models we examined (Smith and Codding 2021). Thus, to the extent that we are able to measure population pressure, it does not appear to have a major, or perhaps even a minor, role in driving inequality in the study region. Of course, this is a synchronic analysis, and some diachronic analyses indicate that resource crises may spark the emergence of institutionalized inequality (Kennett et al. 2009; Prentiss et al. 2014, 2023), though these dynamics may just set the necessary but not sufficient conditions for its emergence. We will return to this issue in the Discussion section.

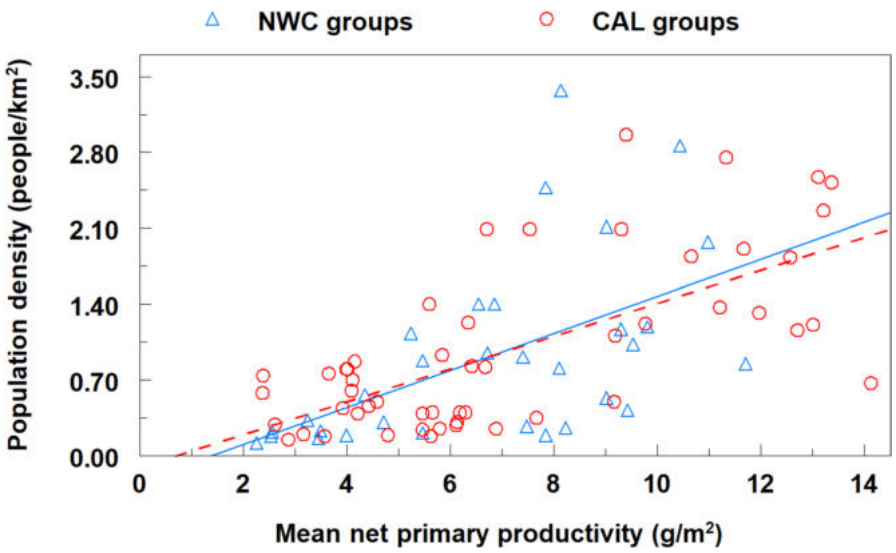

Fig. 3 Local population density in relation to terrestrial mean annual net primary production (grams of sequestered carbon per square meter per month). Lines indicate linear regression for each culture area.

Scalar Stress

Because larger and denser populations entail exponential increases in social ties, this may pose problems of information management, social coordination, and/or interpersonal conflict, irrespective of any resource scarcity. In many small-scale societies, such "scalar stress" can be alleviated via group fissioning, but increased regional density ("packing") can make this difficult. Theorists posit that an alternate solution involves the emergence of higher-level integrative institutions, which by definition entail some form of sociopolitical hierarchy (Alberti 2014; Bandy 2004; Johnson 1982). To evaluate this argument, we use estimates of local population density and polity size (see Table S1), hypothesizing that increases in either measure will be associated with increased inequality (HI values).

Population density scales positively with NPP, regardless of culture area (Figure 3). More importantly, density exhibits no relationship to HI in a nonparametric rank-order test (Table 2). Polity size exhibits a moderate correlation with HI, but this correlation is *negative*, contrary to the scalar stress hypothesis. Although this negative correlation holds for the full sample (N=89), the pattern differs markedly between the two areas; for NWC, there is a weak positive correlation (r =.147, p=.33), but for CAL, there is a negative relationship (r = −.159, p=.198). On balance, it appears this result just indicates that polity size tends to be larger at the lowest and highest latitudes of the study region, with little overall relationship to inequality as measured by our index (HI). More robust analyses presented elsewhere that include all predictors as well as controls (spatial and linguistic) put these two population-scale variables near the bottom of the list, with essentially no effect on HI (Smith and Codding 2021).

Analysis of the large set of archaeological sites in the Gini Project found only a modest correlation between house-size inequality and polity population, with considerable variation in Ginis, especially at larger polity sizes (Feinman et al. 2025). Very few of the sites in this sample are small-scale societies comparable to those in our study region, and the inequality measure is narrower than the one we are using here, so it is hard to directly compare the two sets of results.

Intergroup Conflict

Many researchers have stressed the importance of warfare in the emergence or maintenance of inequality in prestate societies, though they differ on whether warfare is primarily a driver of inequality, or a consequence (Ferguson 1983; Gavrilets and Fortunato 2014; Roscoe 2017). Others have argued that warfare can act to level internal social divisions and thus reduce inequality (Angelbeck and Grier 2012; Bowles 2012). The first view posits that centralized leadership might better coordinate and enforce effective defense against enemy attacks, and have similar advantages in the conduct of offensive raids (Gavrilets and Fortunato 2014; Hooper et al. 2010). In addition, hereditary inequality might develop if leaders of raiding parties can regularly assert control over plunder or slaves taken (Maschner 1991; Mitchell 1984).

Although organized conflict between CAL groups certainly occurred, ethnographic accounts indicate that raiding was considerably more pervasive and chronic among NWC societies (SI, Table S5), and archaeological evidence for fortified sites is also widespread along the central and northern NWC (Bocinsky 2014; Moss and Erlandson 1992; Schaepe 2006). Motivations for raiding were complex in both areas, often including revenge for deaths due to past attacks. However, raiding for plunder characterized almost all NWC societies, whereas only a quarter of CAL societies are coded in WNAI (v354) as having engaged in it (Table 1). In addition, raiding for slaves was pervasive among NWC societies, whereas only one CAL society (Yana) is coded as doing so (SI, Table S5), and that one case is undoubtedly miscoded, as Yana lacked slavery.

Clearly, dense, predictable, and clumped resources such as good salmon runs may attract greater efforts to seize control from current owners. Such cases do occur in the ethnohistorical record (Ferguson 1984; Swadesh 1948), but appear relatively rare; whether this means they were unimportant in the long run is unclear. What we can glean from the ethnographic evidence is that in the immediate postcontact period, most NWC raiding was aimed at seizing plunder and capturing people, usually from groups at some distance from the raiding village (Donald 1997; Mitchell 1984). These captives were primarily women and children, who were easier to control; their fate was to become slaves under the control of the elite members of the raiding polity. The emphasis on distance discouraged both revenge counterattacks and the escape of captives.

A different dynamic is posited by Ferguson (1983), who argues that endemic warfare on the NWC "made redistributive exchange between neighboring groups necessary…(as) a means of preventing attacks and building alliances in an atmosphere

charged with potential violence" (p. 133). In this view, various features of NWC political economy are driven by "a social environment of intense warfare. Exchanges of food, property, and women between neighbors were means of defusing potential conflicts over resources, and simultaneously building alliances needed in conflicts with more distant groups" (p. 141). Thus, feasting, potlatches, and even wealth production and display serve to cement alliances, as well as grow the local group size by attracting commoners. In Ferguson's words, NWC war is "a selective mechanism capable of eliminating groups that did not redistribute surpluses" (p. 141). We do not dispute elements of this account, as maintaining alliances and attracting new members was clearly important in NWC society, including for military purposes, as detailed for Kwakiutl polities (Mitchell and Donald 1975). But Ferguson's argument fails to explain why alliance formation and feasting would drive the emergence of institutionalized (ascribed) inequality; despite their presence in many CAL societies, these institutions do not seem to have done so there.

Ethnographic evidence indicates that raiding was particularly frequent and intense in the central and northern parts of the NWC (Maschner 1997). This variation has recently been discussed by Tushingham and Bettinger (2019), who characterize societies in that subarea as "expansive," contrasting them with other NWC groups (and Northwestern CAL ones) that they classify as "intensive." They argue that an expansive system "incentivizes greater physical risk tied to territorial expansion and defense, whereas intensive territorialism involves inward turned interests that incentivize drudgery" (p. 21). In turn, they link this dichotomy to subsistence ecology, specifically to the contrast between resources that are what they term "front-loaded" (extensive processing required before storage) and those that are "back-loaded" (processing deferred).

The logic here is that front-loaded (preprocessed) food stores are more valuable, thus more prone to seizure by outsiders and more in need of defense, than are back-loaded resources. Salmon, which were laboriously dried or smoked for storage, are key examples of front-loaded resources. Acorns, which were often stored in the shell, are quintessentially back-loaded ones. Tushingham and Bettinger (2019) tie the extensive/intensive typology to a broad range of sociocultural features, arguing that extensive territoriality entails a larger sociopolitical group, group ownership, hereditary leadership, relatively low population density, and intergroup raiding focused on displacing neighbors or plundering their stores, whereas the intensive form involves high degrees of household autonomy ("orderly anarchy"), increasing population density without increased polity size, and private property rather than group territories.

Although Tushingham and Bettinger's argument is consistent with some of our findings and interpretations (as discussed below), we see some significant problems with it. We present and analyze these in detail in the SI (section D.2). Briefly, we argue that their argument conflates polity (the relevant unit for raiding) with ethnolinguistic divisions, misattributes the motivation for raids (seizure of slaves and wealth goods, not primarily food stores), and is inconsistent regarding the definition of back-loaded resources (which do not vary so greatly over their cases). On balance, then, we consider the extensive/intensive distinction to be of limited value. While it does highlight the variation among NWC societies in several dimensions, it

collapses the north-south clinal variation among NWC and north-coast CAL societies into a dichotomy. As we discuss below, we interpret this variation as reflecting differences in clumping of resources and competition for fishing sites, and are unpersuaded that it has much to do with whether food stores are ready to consume (front-loaded) or not (back-loaded).

To evaluate the possible effect of intergroup conflict on inequality (HI scores), we employ WNAI variables on the frequency of offensive raiding (v361) and raiding for plunder (d354), the latter framed as dichotomous (present/absent). We do not include raiding for slaves (v356) as a predictor; doing so would be circular, since the presence of slavery is included in our outcome measure (HI). In simple bivariate correlations, both predictors exhibit a moderate relationship with HI, although we cannot reject the null hypothesis for raiding frequency (Table 2). Results of more robust tests that include additional predictors and controls indicate that raiding frequency is only weakly associated with HI, while raiding for plunder is not (Smith and Codding 2021).

How do these ethnographic analyses compare to archaeological data for Northwest Coast? Maschner and Reedy-Maschner (1998, p. 43) summarize archaeological patterns in the eastern North Pacific (which extends beyond NWC) as revealing "a strong relationship between the increase in household size, increase in village size, population movements, culture change, the development of rank, and an investment in defensive fortifications and other evidence for warfare." That appears consistent with our findings; polity size correlates with raiding frequency for NWC societies (r=.503, p=.003) though not for CAL (r=.242, p=.175).

Summarizing archaeological and ethnographic evidence from the northern NWC, Lambert (2002, p. 216) concludes that "absolute food shortage was not paramount" among the causes of warfare, but "status clearly was, at least during the historic period." She goes on to note that raids were "often launched by the most powerful groups with resources to support slaving and other activities that had more to do with power and prestige than with the acquisition of food and other essential resources" (see also Maschner 1997, pp. 292f). Moving beyond correlations, at many Northwest Coast sites evidence for strong status distinctions (in burial goods, etc.) appears centuries earlier than high levels of intergroup violence as measured via skeletal trauma, defensive fortifications, and weaponry (Bocinsky 2014; Cybulski 2013; Martindale and Supernant 2009; Moss and Erlandson 1992; see Fitzhugh 2003 for a contrary case). This further weakens the case for warfare as a primary determinant of institutionalized inequality, though it does not rule out some degree of mutual causation.

In contrast, Angelbeck and Grier (2012) have interpreted temporal shifts in archaeological markers of status inequality and raiding intensity at Coast Salish sites to argue that warfare served as a "key element of resistance and decentralization…a strategy for breaking the increasing concentration of power in the hands of Marpole elites" (p. 564). While we are not convinced by this last argument, including for reasons detailed by Helbling's (2012) commentary, it does offer an interesting inversion of Ferguson's (1983) view of the role of warfare in fostering institutionalized inequality. Indeed, Helbling (2012) offers reasons why intensive warfare would favor achieved rather than ascribed bases for hierarchy; given high war-related mortality

and the pressure for competent leadership, "local groups could not afford hereditary recruitment of chiefs but instead had to rely on a more competitive system. Each local group needed one or more political leaders to organize war campaigns, recruit allies, and pursue diplomatic negotiations" (p. 573). If chiefs failed to perform these roles successfully, Helbling speculates that group members might "switch to a rival and depose the current leader."

Labor Control and Collective Action

Patterns of labor organization and postharvest resource distribution, and how these articulate with systems of property rights and inheritance, are key foci in several models of the dynamics of inequality. A common scenario proposes that inequality develops from mutualistic interactions between agents (e.g., households) who buffer subsistence risk through resource redistribution, with the coordination of this process handled by one or more leaders who thus attain some degree of differential power and possibly wealth. A modern reworking labeled "managerial mutualism" (Diehl 2000; Smith and Choi 2007) portrays the leader's role as coordinating collective action, particularly group labor in producing resources and facilities (e.g., fish harvested at weirs, irrigation networks for agriculture) in exchange for a fee and/or deference (Carballo and Feinman 2016; Glowacki and von Rueden 2015; Hooper et al 2010). Some even go so far as to portray resource tenure as collective management of a commons, albeit with nominal title invested in chiefs (Trosper 2002). A less collectivist version of this line of argument posits that the emergence of institutionalized inequality in small-scale societies turns on control over extra-familial labor (Arnold 1996; Hayden 2001).

Ethnographic information on both NWC and CAL leaders leaves no doubt that they exercised some managerial functions, with nonkin included in the labor force to varying degrees. Unfortunately, there are no WNAI variables that suitably capture variation in labor control or management of collective action, frustrating a direct evaluation of such explanations. We are left with drawing inferences from qualitative accounts from the ethnographic literature.

NWC "house chiefs" had considerable control over the allocation of labor in collective subsistence tasks, particularly anadromous fish harvest and processing, as well as the distribution of both consumables and durable goods. They also directed the construction and maintenance of structures and facilities (fish weirs, plank houses, totem poles, etc.). Most NWC subsistence activities were undertaken by cooperative task groups (Donald 1997, p. 122), with much of the product being stored for later consumption in the winter-village longhouse. In sum, the house group was the primary unit for both production and consumption, but actual resource procurement was usually carried out by subsets of the house group.

It is plausible that resources with high spatiotemporal concentration not only reward concentrated and coordinated labor, but also facilitate differential control, as posited in the labor-control argument. This should particularly be the case where resources offer returns to scale (Codding et al. 2019) and those who manage labor coordination reap differential benefits (Hooper et al. 2010). As noted above, salmon

runs on the NWC are characterized by strong spatial and temporal compression, with runs of a given species in a given locale of relatively short duration, but often of high volume. This is also the case for Pacific herring, the second most ubiquitous species in the late prehistoric archaeological record for the area (McKechnie and Moss 2016), as well as for the more localized but highly valued eulachon (Mitchell and Donald 2001). For spawning marine fish to be the staple resources that they were for virtually all NWC groups, the labor force had to coordinate effectively and work efficiently to harvest them, and even more crucially to process them for storage (Ames 2003; Donald 1997; Schalk 1981).

Coordinating this subsistence effort was a complex endeavor, and "required considerable skill at managing available labor power, organizing the preservation and storage of food, and managing its distribution and redistribution" (Donald 1997, p. 134). This managerial role was filled by the house chief, the head of the highest ranked descent group. Besides allocating labor to ensure successful harvests, the house chief (and other titleholders, generally close relatives) attempted to amass durable goods and surplus foodstuffs to distribute at feasts and potlatches. The regional standing of these leaders depended on their success in doing so and in turn depended on their success in attracting and retaining (commoner) followers, as well as slaves (Ames 2006).

Although resource sites and some other property (e.g., the cedar longhouse itself) were owned communally by the house group or by corporate kin groups that formed the core of such groups, in most cases effective control over these resources (including the stored foods) was in the hands of the elite subset of the group—the hereditary titleholders—with the chief exercising pre-eminent control. In sum, NWC chiefs controlled not only the resource harvesting of salmon and many other resources, but also the distribution of the pooled resources, as well as their partial conversion into durable forms of wealth through the support of craft specialists as well as various forms of intergroup exchange (Ames 2003; Arnold et al. 2016; Donald 1997).

Among CAL societies, few resources rewarded labor coordination on a scale above the household—that is, a nuclear or minimally extended family (Bettinger 2015; Tushingham and Bettinger 2013). Importantly, most resources required little or no labor coordination beyond the household level to harvest and store (Bettinger 2015; Gould 1975). Managerial roles for harvesting, processing, and storing key CAL resources could be filled by household members in most cases. As a result, management functions were less centralized, and primarily concerned with ceremonial and diplomatic relations with other polities. However, as noted earlier, there was some central flow of subsistence goods and wealth objects to stores controlled by leaders. Chiefs and their assistants played some role in redistributing resources to assist households that suffered temporary shortfalls and in financing feasts for polity members as well as important visitors. However, most accounts portray these institutions as ancillary to the subsistence economy (Bettinger 2015, pp. 139f). Nevertheless, hierarchical management of the salmon fishery did occur in some northwestern CAL societies (e.g., Swezey and Heizer 1977; Waterman and Kroeber 1938). There were several other CAL groups where salmon were key resources; the degree to which these cases are similar to NWC groups is an interesting issue, addressed in detail in the SI (section D.3).

The patterns just summarized would seem to support the view that control of nonkin (or distant-kin) labor could explain variation in institutionalized inequality. However, periodic labor coordination is widely reported from many small-scale societies, but in most cases, it does not involve persistent inequality. Instead, leadership roles rotate among different individuals, or go to those considered currently most skilled or knowledgeable (Arnold 1996, p. 90; Garfield et al. 2019). Well-known examples from Native American foragers include deer and caribou drives, and the "rabbit bosses" and "antelope shamans" among Great Basin Indians (Steward 1938). This strongly suggests that labor coordination or management is not sufficient to drive the emergence of institutionalized inequality.

Resource Control and Patron-Client Dynamics

When a valuable resource is sufficiently dense as well as predictable in time and space, it becomes economically defensible—that is, the costs in time, energy, and risk for claiming exclusive use rights are more than repaid by the benefits of doing so (Brown 1964; Dyson-Hudson and Smith 1978). If such resource patches are also clumped enough to provision a local group while economically defensible by a subset of this group (a lineage or other coalition), the stage is set for a patron-client system to develop (Boone 1992; Smith and Choi 2007). In such systems, a dominant minority (patrons) controls access to concentrated resources, and allows subordinate group members (clients) access to them in exchange for their labor, tribute, or military support.

The patron-client model assumes that those controlling richer patches can decide, within limits, how much to share with subordinates—that the population has shifted from an "ideal-free distribution" where individuals or groups will locate so as to match population density to resource availability (Fretwell and Lucas 1969) to a system where some control rich resource patches and others poor ones or none. Such an "ideal-despotic distribution" (Codding and Jones 2013; Winterhalder et al. 2010) requires (a) large differences in patch quality and (b) asymmetry in competitive ability. As just noted, condition (a) holds if key resources are sufficiently dense, predictable, and clumped. Condition (b) may be due to control over relevant technology (weaponry, transport technology), network size or structure, and perhaps information. In small-scale societies such as the ones considered here, factors such as kin group size or solidarity may create variation in competitive ability. Arrival priority (place-based ancestry) might be a sufficient initial asymmetry to differentiate owners from others, thus setting the stage for a patron-client system to arise (Bowles and Choi 2025; Prufer et al. 2017; Smith and Choi 2007).

Regardless of initial conditions, once the richest resource patches are successfully controlled by a subset of the social group—a lineage, for example—this subgroup can enforce claims of ownership, and bargain with nonowners to exchange access for goods and services. If nonowners acquiesce, this establishes a system of patron-client relations. Acceptance by subordinates need not require active coercion, if subordinates experience higher net rewards by cooperating with resource "owners" than fighting with them. Cooperation here can include allowing patrons to decide how

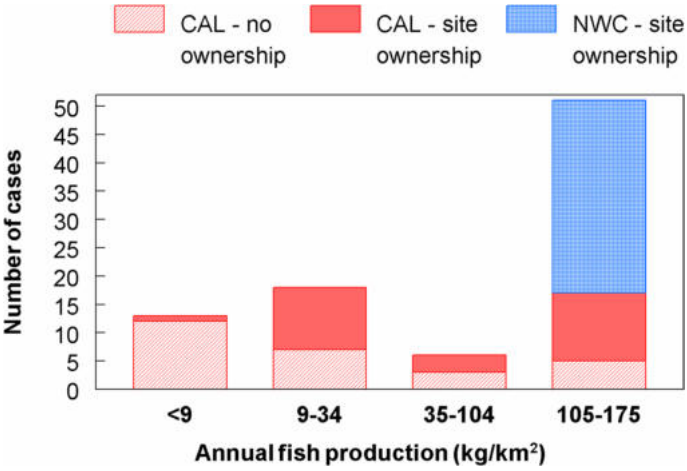

Fig. 4 Fishing production (p135) in relation to fishing site ownership (d271).

group production is organized, and how the products of group labor are allocated. If patrons are overly exploitative, such that the clients' outside options—moving to another locale, joining another group, or fighting to usurp the patrons—provide a higher expected payoff, then the system will destabilize. Accordingly, in successful systems, one can expect dominants (patrons) to yield sufficient benefits to subordinates (clients) to maintain their loyalty, or at least acquiescence (Bell and Winterhalder 2014; Boone 1992; Wilson et al. 2023). Such a system will be far from despotic, and may well appear to be a fairly harmonious unit, but with some (patrons/owners) more equal than others. This is similar to Coupland et al.'s (2009) portrayal of NWC house groups as balancing, or even integrating, hierarchical and communal elements in a negotiated compromise between elite and commoner interests.

To summarize, the patron-client model posits that a coalition controlling highly clumped, productive resource patches can exchange access to these resources for labor contributions and surplus production by subordinate members of their group. How does this argument match the broader patterns in our region, where NWC groups exhibit greater political-economic inequality than most CAL groups? Above we have discussed the dense and highly clumped staple NWC resources such as salmon, herring, and eulachon. In contrast, most staple resources in CAL, including acorns (Tushingham and Bettinger 2013, p. 533, n1), were more evenly dispersed across space and/or through the seasons, and many were available for long periods each year. This is true even for most CAL salmon fisheries, as runs extended over longer periods of the year, being available nearly year-round and at multiple locations in larger rivers, thereby posing fewer logistical constraints for scheduling harvest and processing (Schalk 1977; Tushingham and Bettinger 2013, p. 528) (see SI, section D.3 for further discussion). Empirically testing the resource-control explanation of institutionalized inequality can take a number of directions. Variation in property rights, coded in WNAI as ownership and inheritance of specific gathering, hunting, and fishing sites, is instructive. Ownership of gathering sites was nearly as

frequent among CAL groups as among NWC ones, while ownership of hunting sites was somewhat more common among NWC groups (SI, Table S4). Of greatest interest, fishing site ownership was universal among NWC cases, but occurred in just half of CAL groups (Figure 4 and Table S4), though some of this can be attributed to the paucity of fishing opportunities in more arid parts of California.

The intergenerational transmission (inheritance) of property is a key variable in some theories of institutional inequality (Borgerhoff Mulder et al. 2009; Mattison et al. 2016), including hunter-gatherers (Donald 1985; Kelly 2013; Smith et al. 2010). Such transmission in turn can be linked to the nature of the property or other wealth that is inherited (Borgerhoff Mulder et al. 2009; Bowles et al. 2010). Patterns of inheritance of property rights to resource sites in NWC and CAL are similar to but more nuanced than the access rights just discussed. In general, inheritance of gathering sites was more privatized among Californians, concomitant with the primacy of household production in this sector of the economy, whereas hunting and particularly fishing site inheritance was more circumscribed in the NWC (SI, Table S4).

The patron-client model posits that control over clumped resources is key to establishing inequality in wealth and power. To evaluate whether inequality covaries with resource concentration, we quantify resource clumping with two proxies: the spatial dispersion of net primary productivity (NPP-SD), with more clumped resources having lower values of NPP-SD; and a Resource Index (RI), defined as the dietary percentage contributed by aquatic animals (p199) minus the summed dietary percentages of terrestrial hunted resources (p204) and gathered resources (p211)—roots, seeds, berries, nuts. leaves, tubers, and other wild plants). The RI measure is designed to capture the relative reliance on more clumped (fish) resources versus more evenly dispersed (plant and terrestrial game) resources (see SI, section A for details).

The NPP-SD measure varies markedly across the region, but the range of values across the NWC is similar to the CAL range, and the CAL mean is only 7% lower than for the NWC (SI, Table S.4). RI also varies substantially across the region, but with a clearer geographical signature, ranging from a high of 0.78 among most NWC groups to negative values (indicating plant-biased food resources) in almost all CAL groups, falling as low as −1.02 (Figure 5). A bivariate correlation test shows that the Resource Index (RI) is strongly related to the Hierarchy Index (HI)—indeed, more strongly correlated than any other variable examined (Table 2). This association between RI and HI is particularly marked for higher HI values (2 and 3), as detailed in Figure 6. Multivariate analyses presented elsewhere (Smith and Codding 2021) indicate that RI has the largest effect size of any HI correlate, even when including spatial and linguistic controls. On the other hand, NPP-SD is only weakly related to HI in a bivariate test (Table 2). The multivariate analysis indicated that the best model includes both the Resource Index *and* fishing site ownership, plus spatial and linguistic controls, although the model with just RI has nearly as good a fit (Smith and Codding 2021). Whether these results indicate that fishing site ownership and inheritance are independent determinants of inequality, or merely correlates of subsistence relying heavily on aquatic resources, they are consistent with the patron-client scenario for the emergence of institutionalized inequality.

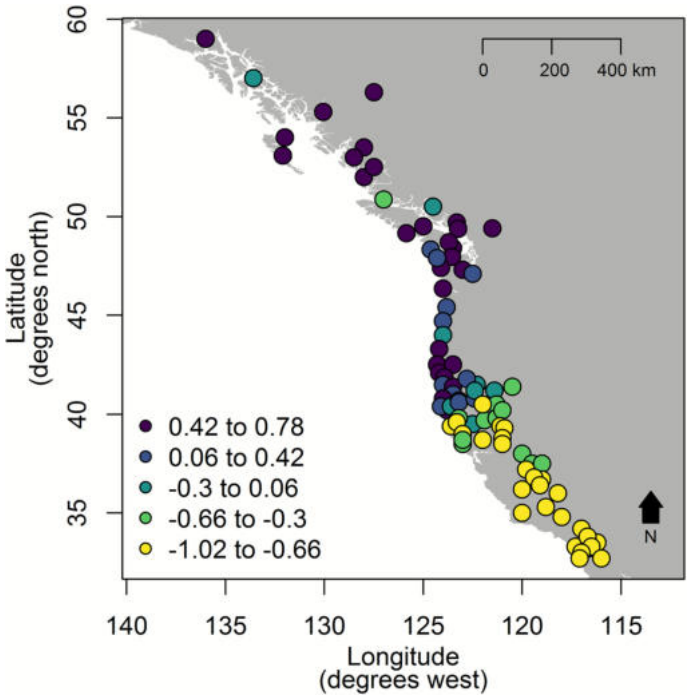

Fig. 5 Map of the study region showing the location and Resource Index (RI) for each of the 89 societies in this study. RI values <0 (coded yellow or green) indicate greater reliance on terrestrial resources, whereas values >0 (coded blue or black) indicate more reliance on aquatic resources (after Smith and Codding 2021) (Color figure online).

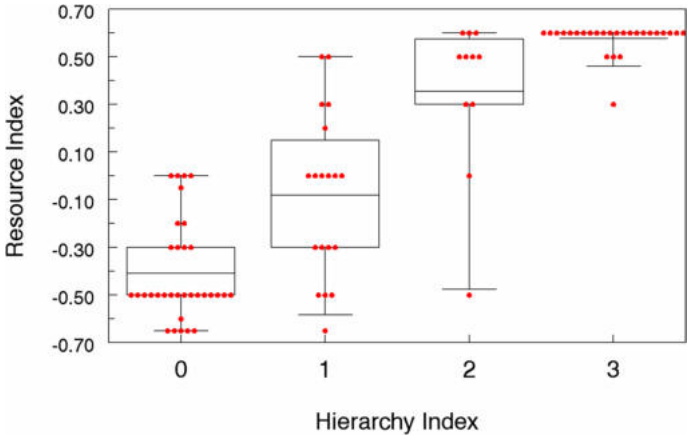

Fig. 6 Relationship between Resource Index and Hierarchy Index values of the 89 societies in this study (central line = mean; box = 25th to 75th percentile; whiskers = 95% confidence interval).

Comparison and Synthesis

Having outlined salient aspects of ecology and political economy among contact-period NWC and CAL societies, as well as several prominent explanations for these patterns and evaluations of the evidence pertaining to each, we now turn to a more conceptual approach to what drives variation in institutionalized inequality in the study region. We begin by outlining a framework for describing the logical structure of explanations of sociocultural variation and apply this framework to the explanations presented earlier. We draw on that discussion and prior syntheses to sketch a plausible account of how and why inequality varies across our study region. We conclude with a brief consideration of the degree to which our account might apply to similar societies not included in our sample.

Causes, Conditions, and Correlates

Arnold (1996), following Price and Brown (1985), offers a useful distinction between causes and their associated conditions and consequences or correlates (see also Smith et al. (2023a, b), Table 1). Causes include the hypothesized determinants we have named for each of the explanations for variation in institutionalized inequality examined in this paper. Conditions, which some term prerequisites, are any "environmental or historical circumstances, or context" (Arnold 1996, p. 94) that are necessary but not sufficient for the explanans (in this case, institutionalized inequality) to emerge or persist. Consequences are those features that result from the explanans but are causally downstream. Thus, in principle, there is a temporal sequence in which conditions → causes → consequences, though often reality is not so simply parsed.

Note that the cause or causes of any one explanatory scenario might be consequences or perhaps even conditions in another scenario. For example, scalar effects of population density are seen as causes in one scenario, whereas in some other scenarios increases in population density may be viewed as consequences.

For reasons detailed above, we find the patron-client explanation best supported empirically for our study region. It can be outlined in terms of the conditions/causes/correlates framework as follows:

(a) Conditions/prerequisites: Key resources are clumped into dense, predictable patches such that benefits to individuals of controlling them outweigh costs; effective technology for mass harvest, processing, and storage of these resources exists; potential subordinates have limited outside options.
(b) Causes: A small, cohesive group (e.g., a set of close kin) controls access to such patches and exchanges access to them for acquiescence to leadership, labor control, property claims, and differential status.
(c) Consequences: These may include intensified extraction, processing, and storage of controlled resources; increased population density; institutionalized inequality

as reflected in status hierarchies, differential wealth, and power; and increased intergroup conflict over resource patches and/or plunder.

The above outline, though schematic, should help clarify how we view the resource control/patron-client scenario in relation to other explanations for the emergence of institutionalized inequality in small-scale societies. Thus, storage could be considered a condition, cause, or a correlate of inequality, depending on the focal scenario or mechanism. As suggested by one of our reviewers, since storage involves wealth carried over from one time period to the next, it can foster inequality if households vary in their successful accumulation over time. This variation could be due to random shocks, as in the dynamic modeled in Borgerhoff Mulder et al. (2009), or to differences in skill or labor supply. However, in most cases food stores are likely to be minor sources of wealth compared to sources of renewable resources, such as salmon streams or even oak groves.

But if accumulated stores that are true surplus beyond the annual consumption needs of the household, they might be converted into durable wealth (through trade, manufacture of crafts or valuables) or forms of social capital (e.g., alliance formation through gifts in strategic marital arrangements, hosting feasts, etc.). This does seem germane to processes in both NWC societies (feasts and potlatches, elite intermarriage) and CAL societies (hosting intergroup ceremonies and trade feasts, debt peonage, freeing labor to create shell-bead money and other valuables). Yet for NWC societies, this surplus-to-wealth avenue involves within-household (elite) control of surplus, hence pre-existing institutionalized inequality. And in CAL, it may have helped drive wealth and status inequality between households, but did not lead to a class of hereditary elites (with the possible exception of Chumash, as discussed below). In sum, we view capability for mass harvest and storage of resources as a prerequisite, but not sufficient in themselves to generate sustained inequality; the near-absence of institutionalized inequality yet universal importance of storage in most CAL cases (see above) reinforces that conclusion.

Similarly, we would argue that status competition through feasting and other displays of wealth and power are more consequences than causes, at least in the Pacific Coast cases examined herein. As for population pressure, although our evaluation failed to support it as a determinant of inequality among Pacific Coast foragers, it is a notoriously tricky explanation to test, something we discuss further below.

To the extent that labor control by elites (e.g., a house chief) enhances the efficiency of resource harvest and distribution, increased population density is a possible consequence. However, the data from our study region, showing the lack of correspondence between population density and inequality, argue against a causal role. In addition, polity size is generally higher in CAL than NWC, the opposite pattern we would expect if scalar stress was driving inequality across the region. However, polity sizes are mostly in the few hundreds (averaging ~250 for NWC, ~450 for CAL), and only exceed 800 in six cases (SI, Table S1). Assuming that scalar effects are primarily felt at the polity level or lower, one could argue that this size range is too low to produce sufficient pressure to drive the emergence of inequality. A counter to that argument can be found in the much larger, worldwide sample of the Gini

Project which revealed only a modest correlation between house-size inequality and polity population, even at very large polity sizes (Feinman et al. 2025).

Is warfare a cause or a consequence of hierarchy development? For societies at the scale of NWC polities (as distinct from large-scale societies—complex chiefdoms, states and proto-states), the balance of the evidence favors the warfare-as-consequence answer, though we cannot rule out a causal role (McCoy et al. 2025). Comparatively, there are many examples of foraging and horticultural societies with endemic warfare that lacked institutionalized inequality (Falk and Hildebolt 2017; Walker and Bailey 2013; Glowacki et al. 2020; and various authors in Allen and Jones 2014). In our study area, raiding is coded as present in over 60% of the CAL societies coded in WNAI (SI, Table S5) and appears to have been relatively common in precontact times (review in Jones and Allen 2014), though less frequent than in NWC societies.

Although certain forms of control over nonkin labor may be a key feature of institutionalized inequality (and indeed were prominent in NWC societies), we view this as a consequence or correlate rather than a cause. For such control to be institutionalized beyond the usual domains of skill or seniority, and persist beyond short-term situations, elite actors must gain sufficient leverage over nonkin. Barring direct coercion, which (with the exception of slavery) appears to be a minor factor in the societies examined here, what could provide such leverage? Again, we conclude that the evidence discussed herein indicates that controlling access to clumped, defensible resource patches provided such leverage among many societies along the North American Pacific Coast. This control, we argue, allowed some individuals or factions (e.g., kin groups) to exchange access to them for labor and other services. In turn, this control could be transmitted in the form of hereditary property rights to descendants (Bowles et al. 2010), cementing a system of institutionalized inequality.

As noted above, slavery is a special form of nonkin labor control found in most NWC groups, while a minority of CAL groups had debt peonage but no chattel slavery (Table 1). Wengrow and Graeber (2018) argued that this difference is due to a conscious rejection of slaveholding on the part of Native Californians, whereas its presence in NWC societies derived from aristocratic abhorrence of physical labor. We find this argument completely without merit on both empirical and logical grounds, as detailed elsewhere (Smith and Codding n.d.; see also Lindisfarne and Neale 2021; Wiessner 2022). Instead, we link NWC slavery to the high labor demands of harvesting and processing salmon and other mass-capture fish, particularly when harvest windows are relatively narrow as they were in the central and northern reaches of the NWC—precisely where slavery (and raiding for slaves) was most intense.

Analyses of the full set of WNAI societies (n=172) have found strong associations between linguistic affiliation, spatial location, and behavioral variables (Mathew & Perreault 2015; Towner et al. 2012). Although our focus is more restricted in both geographical scope and topic, our previous multivariate analysis found that latitude and language family exhibit the second and third largest effect sizes, respectively, with RI having the strongest effect (Smith & Codding 2021). Does this mean that cultural ancestry (as proxied by linguistic phylogeny) and borrowing from neighbors was as important as ecology in shaping political economy in these societies? We

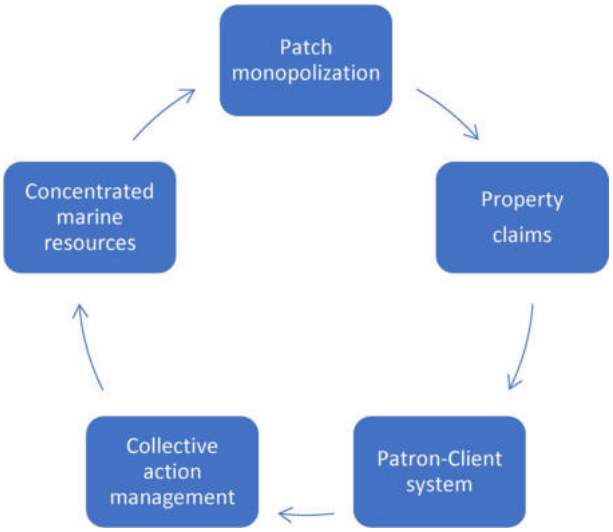

Fig. 7 Proposed synthesis of causal relationships governing the emergence of institutionalized inequality in small-scale societies.

question this interpretation, for several reasons. Briefly, phylogenetic signals can be due to multiple factors, including ecological ones such as niche conservation and habitat selection (Hansen 2014). In addition, partitioning causes into "culture" versus "ecology" is a tricky business, and attempts to do so can be quite misleading. We provide a detailed discussion of these issues in the SI, section D.5.

Toward a Synthesis

The downstream consequences of the productive base undoubtedly involve complex causal dynamics in multiple domains—demographic, political, economic, and ideological, to list a few crude glosses. Those who favor a labor-control explanation for the emergence of inequality (e.g., Arnold 1996) can certainly find support for their views in our results, as can those emphasizing wealth transmission (e.g., Borgerhoff Mulder et al. 2009), property rights (e.g., Bogaard et al. 2019), spatial population dynamics (e.g., Bell and Winterhalder 2014) or patron-client systems (e.g., Mattison et al. 2016). Although we have focused on the last of these, we believe all of them have plausible explanatory value in our study region, and beyond. On the other hand, our negative results for tests of the population pressure, scalar stress, and warfare-driven explanations for variation in inequality across our study region, as detailed above, also raise issues, which we consider below.

Our central conclusions can be diagrammed in a simplified form (Figure 7). Concentrated resources clumped into defensible patches are best viewed as a (pre) condition for subgroup control (differential ownership). Another precondition in this scenario (not diagrammed) is a dearth of better "outside options" whether due

to population packing or to steep resource gradients (the latter being a feature of resource clumping). Patch monopolization could be enforced by aggressive behavior, but in stable political-economic systems, these will usually be minimized through culturally codified property rights. These cultural norms reduce conflict and other transaction costs and are thus "best moves" in a game-theoretical sense as long as nonowners lack better alternatives. However, such systems benefit some individuals (patrons/owners) more than others (clients/commoners). They accordingly may be challenged from time to time, especially when labor or resource dynamics alter the relative bargaining power of patrons versus clients (Dow and Reed 2023a).

Since clients typically exchange their labor for access to resources controlled by patrons, the stage is set for the latter to manage collective action in resource acquisition, processing, and distribution. In many cases, this collective action will include constructing and maintaining facilities (e.g., fish weirs) to increase output. This creates a feedback loop (as diagrammed in Figure 7), where labor management is key to enhancing the productivity of the resource base, as well as coordinating defense and offense in competition over resource sites. The allocation of this increased output is negotiated to varying degrees, but in nondespotic systems, it will generally include both increased benefits to most or all members of the collective and an above-average share for the patron (Hooper et al. 2010).

We can compare this schematic causal argument to some other syntheses that have been proposed as explanations of the emergence of institutionalized inequality in small-scale societies. Arnold (1996) argues that control of nonkin labor is the key determinant of emergent inequality in foraging societies. We have discussed this argument and its limitations above so will not repeat that here, simply noting that the resource-control model specifies a *mechanism* for how elites can begin to control subordinate labor, something lacking in the labor-control account. However, it is clear that NWC elites did more than control access to key resources (such as salmon streams); they also managed production (resource harvest, storage, and distribution). Ethnographic accounts indicate that maximizing the storable harvest from NWC salmon runs required well-coordinated labor inputs, implying some form of leadership (Ames 2003; Donald 1997). This was especially the case at the northern end of the NWC, where salmon runs have a shorter duration but often a greater temporal concentration (Schalk 1977, 1981). Thus, we find it plausible that both differential control of dense and clumped resource patches *and* management of concentrated and coordinated labor (glossed as "collective action management" in Figure 7) favored inequality in the form of patron/client systems as well as slavery in NWC societies.

Keeley (1988) argues that population pressure (defined in various ways, but essentially as a ratio of population density to some measure of terrestrial environmental productivity) produces diminishing returns and increased subsistence risk in relatively stable environments, which lack periodic famines to keep population below carrying capacity. He proposes that social complexity (defined as storage, wealth/status distinctions, and formal exchange systems) develops to ameliorate this risk. Setting aside questions about the validity of how population pressure is operationalized, we argue that the correlations Keeley finds can readily be explained by our synthesis. In other words, dense and clumped resources encourage both patron control and management of collective action to enhance total harvest (to attract

clients as well as increase patron wealth). If elite management of collective action is successful in enhancing resource accrual, increased population density will likely result.

It may also be the case that denser populations present barriers to movement (i.e., "population packing"), thus reducing outside options. As argued by Prentiss (2023 and elsewhere):

> …groups settled into geographically constrained contexts lacked mobility options as alternatives during subsistence crises [which] favored the development of elaborate cultural traditions (feasts and potlatches, for example) designed to ensure favorable political relationships with neighbors and to attract and retain group members… In contrast, groups lacking such landscape-level constraints substituted residential mobility and subsistence extensification for competitive economic and demographic signaling. (2023, p. 6)

In contrast to Keeley, Prentiss posits acute resource crises (rather than chronic pressure) as driving inequality through intergroup competition. A somewhat indirect role for population pressure can be found in recent archaeological research showing that land-limited (as contrasted with labor-limited) economies develop higher levels of house-size inequality (Bogaard et al. 2025). To the extent that "under population growth good farming land eventually becomes scarce relative to labor" (Kohler et al. 2025a, b, p. 2), one could argue for a form of population-pressure driven inequality. Since "land" in this formulation is a form of material wealth that can be accumulated and inherited, it includes unfree labor such as slaves or coerced workers (Bowles and Fochesato 2024; Bogaard et al. 2025).

Hayden (2001) argues that aggrandizing strategies arise where highly productive resources allow surplus production, feasting, and storage. These resource manipulations facilitate inequalities as "some individuals exert extended political and economic power over other members of their community" (p. 253), and subordinates become indebted to aggrandizers. "Social complexity and inequality...among hunter-gatherers occurs only where resources are abundant or where there are very special circumstances" (p. 241). Thus, contra both Keeley and Prentiss, Hayden argues that resource abundance is a necessary condition for the emergence of hierarchical systems. There is some definite overlap between Hayden's scenario and the clumped-resource-control argument we favor. However, we view overall abundance as insufficient; key resources must be clumped into defensible patches that can be monopolized by a subgroup. In addition to the logic of this argument, we point to the evidence presented above: overall resource abundance (and resulting population density) was clearly greater in aboriginal CAL than in most NWC locales, but resource clumping was higher in the NWC.

In addition, we view the *manner* in which surpluses are generated as a key variable. In some cases, household-level production can produce a reliable surplus for storage, as in the acorn-complex of many CAL groups, or smelt fishing among Tolowa (Gould 1975). In other ecologies, generating a storable surplus is enhanced by collective labor to harvest and process the resources. But it is not clear why individuals participating in such cases of collective action would allow an incipient elite to claim rights to this surplus, unless there were enforceable

property rights over relatively scarce resource patches (e.g., prime fishing sites) or over the requisite technology (e.g., reef-net fishing gear). Thus, we argue that control over resource patches or productive technology logically precedes control over surplus stores. Furthermore, such control must involve a degree of monopolization, for if productive patches or technology are widely available, ownership of them will not provide leverage over others. Note that control (private ownership) of resource sites also occurred in various CAL and Plateau groups, but generally without monopolization by elites. That is why we posit clumping (relative scarcity) of such sites as a necessary condition for institutionalized inequality in these societies.

Our argument is by no means original. Indeed, the essential features of the resource-control explanation of NWC institutionalized inequality were delineated four decades ago:

> Along the coast we find ownership of most important resources and even stretches of beaches. Ownership arises when a resource is important, reliable, and localized and when the society is relatively sedentary… If a resource is not reliable and fluctuates, control will not usually be important. Since such a resource is not predictable, it is not efficient for the local group to exercise control over it, since much or most of the time sufficient return would not occur... Therefore efforts at controlling access would be expected if the resource is abundant, reliable and localized, but not otherwise (Matson 1983, p. 138).

Matson further argued that the concentration of resources (such as localized salmon runs) and resulting opportunity for subgroup monopolization is key to the development of institutionalized inequality:

> A resource location such as a reef net site is too small to be shared by a large group, and too few existed to allow free access, so ownership by a smaller group (household?) was inevitable. In contrast with the interior, where almost all other resources beside salmon are widely scattered, other resources along the coast are typically located at specific places along the shore. With the higher population density and shorter seasonal rounds allowed by the salmon intensification, control of these resources by members of local groups was both possible and feasible. Once the most important resource locations are "owned" it is easy to see how all localized resource locations would soon be controlled (Matson 1983, p. 141).

We view the results of our analysis as providing detailed support for Matson's argument. They are also in agreement with the broader review of theory and cases provided by Feinman and Neitzel (2023).

There is some skepticism in the recent literature about the centrality of salmon for NWC subsistence, and by extension as a key factor in the emergence of inequality. This is a complex issue that invokes information from ethnography, archaeology, and nutritional physiology, as discussed in SI section D.4. Clearly, there was significant variation across the NWC in the particular mix of species

harvested and logistical methods thereby employed. However, the question of concern here is how this variation impacted factors such as group production, economic distribution, and the degree to which resource access could be controlled or monopolized. Like Matson and others, we have emphasized control of salmon harvest sites as a key determinant. While several critiques of "salmon-centric" accounts of NWC societies have some validity, we do not see them as seriously challenging the resource-control explanation for NWC inequality, nor even the primary importance of salmon for NWC subsistence (see SI section D.4). In any case, accounts that give salmon a central role in NWC political economy do not require that salmonids constitute half or more of the diet, only that they be a key resource for a good part of the year.

Comparative Evidence

Our findings are restricted to a limited time and place: contact-era Indigenous societies in what is now California, Washington, British Columbia, and southeast Alaska. Clearly, further refinement and empirical testing are warranted to determine how broadly the patron-client explanation for the emergence of institutionalized inequality might apply. There is no space here to undertake a systematic evaluation of this question, but we do want to present brief qualitative accounts of additional coastal foraging societies.

The Calusa society, located on the Gulf Coast of what is now southern Florida, provides an independent North American case of fisher-foragers with institutionalized inequality. As described in 16th-century accounts of Spanish explorers, the Calusa polity was much larger and more stratified than anything on the North American Pacific Coast. The ruling elite extracted resources from an estimated 20,000 subjects in 50 to 60 Calusa communities, adjured subsistence labor, supported a specialized military force, and claimed secret religious knowledge. Given the scale of the Calusa polity, its elite was necessarily larger and more subdivided than in NWC societies; yet evidence indicates the core membership was a corporate kin group (lineage) headed by a single "king" at the time of sustained contact with Spaniards. This system was supported by intensive aquaculture, including intertidal "water-courts" constructed and managed to capture and store live fish, which were then processed and distributed in ways that enhanced elite power and control (Fitzpatrick 2020; Thompson et al. 2018, 2020). These facilities, like the stone fish traps, weirs, and clam gardens constructed by NWC societies, are engineering feats designed to enhance and concentrate aquatic resources.

The Calusa case thus contains the essential elements of a resource-control patron-client system, but with greater elite power at a larger social scale. The presence of adjacent stratified agricultural societies in lowland river valleys of the Southeast culture area may have served as models or otherwise stimulated this political-economic intensification. Marquardt et al. (2022) employ archaeological and paleoenvironmental evidence to track temporal oscillations between "cooperative, heterarchical relations," and "coercive hierarchical" ones, linking these to lower versus higher levels of aquatic and other resources driving "overall prosperity." This linkage can

be seen as evidence for an inverse relationship between population pressure and inequality (contra the usual formulation). It can also be viewed as support for the idea that controlling concentrated subsistence resources to exchange for labor and political support fosters inequality.

On the opposite side of the globe, Roscoe's (2020) survey of contact-era New Guinea foragers shows that those dependent on terrestrial sources for noncarbohydrate nutrients had lower levels of power and status inequalities than ones reliant on aquatic ones, a pattern that has been documented in a worldwide survey of hunter-gatherers (Kelly 2013). Roscoe's explanation for this pattern is that the denser aquatic resources allow higher population density, larger residential communities, and sedentism, which in turn reduce the costs of establishing and maintaining the social networks employed to establish power differentials. Roscoe also notes that food storage was absent among New Guinea foragers, thus eliminating that oft-invoked explanation for inequality variation. He argues that even valuable resources are "politically worthless unless an agent can also *command* or *monopolize* it, excluding others in at least some degree from access" (p. 23; emphasis in original). Roscoe holds that differential power in these New Guinea foraging societies accrues to "gifted agents" who possess greater "political talent and ambition" (p. 25). Although we find Roscoe's arguments cogent and plausible, they are based on a limited sample of 30 societies, with no quantitative tests. A greater limitation for purposes of the present study is that the power differentials in question are primarily achieved, not ascribed; while the roles are institutionalized, the intergenerational transmission is not, or only weakly so (Roscoe 2020, p. 26).

Ben Fitzhugh has published extensively on the archaeology of the Kodiak Archipelago in Southeast Alaska inhabited by Yup'ik-speaking Sugpiaq, and more recently on the Kuril Islands in the Northeastern Pacific. Here we summarize his recent comparison of the varying patterns of inequality in these two places (Fitzhugh 2020). On Kodiak, inequality gradually developed into institutionalized structures in the form of patron-client relations at the community level (but not island-wide). In contrast, Kuril Islanders maintained relatively egalitarian relations within communities, but there was some differential wealth across communities depending on differential resource endowments and outside trade access. Fitzhugh frames his explanation of these patterns in terms of the ideal-free and ideal-despotic distributions (Fretwell and Lucas 1969), pointing out that despotic (hierarchical) systems are most likely to develop when key resources are concentrated in "hot-spots" or defensible patches that can be monopolized by certain actors or subgroups, and outside options for subordinates are limited or absent. In the Kodiak case, sedentary settlements with food storage develop gradually, but clear signs of institutionalized inequality do not appear for many centuries, until population densities are high enough to presumably restrict outside options. Concurrent with growing inequality, the archaeological record indicates intensification of warfare and trade in prestige goods, and inferred features of NWC type such as competitive feasting, alliances, and enslavement of war captives.

The archaeological record for the Kuril Islands is less developed, but indicates initial colonization from Hokkaido to the south circa 4 Kya, followed by the development of the Okhotsk tradition circa 1300 BP, which then declined and was replaced

by Hokkaido Ainu. In contrast to Kodiak (and NWC) settings, the Kurils contain few dense resource patches—Fitzhugh (2020, p. 246) characterizes the setting as being "notable for lower overall resource productivity and undefendable patches" with most resources "more evenly distributed throughout the islands." Thus, the Kurils offered "little on which to leverage patron-client relations because the most important resources for food security in most parts of the chain were also the least controllable" (p. 246). In sum, Fitzhugh shows that the Kodiak/Kuril comparison fits the resource-clumping, patron-client model of institutionalized inequality quite neatly.

Finally, one additional case within the study area but not included in the WNAI provides important evidence concerning institutionalized inequality in coastal foraging societies. Chumash polities in the Santa Barbara and Channel Island locale are exceptional among CAL cases in the degree of formal hierarchy. While there are some conflicting accounts about the degree of power and influence held by Chumash chiefs, Kroeber (1925, p. 556) states that "…everything goes to show that the Chumash chief enjoyed influence and honor to a rather unusual degree." Chumash chiefs received tribute in food and shell-bead money, and were wealthier than all others: "It is specifically said that he was head among the rich men" and that "…he alone had more than one wife" (Kroeber 1925, p. 556; see also Harrington 1942, p. 33). Juan Crespí reports a first-hand account of a Chumash village outside of what is today Ventura, California:

> They have their own style of government in these villages: as we have understood from this good chief here, all of these villages have three or four chiefs, one of whom is head, and gives orders to everyone and to the other chiefs, and these all have two wives while the rest of the men have only a single wife apiece (Crespí 1769, quoted in Brown 2021, p. 393).

There are multiple instances where chiefs held authority over multiple communities and commanded assistant chiefs below them who oversaw each village (Arnold 2004; Harrington 1942, pp. 32–33; Johnson 2000, p. 305; Kroeber 1925). Wealth, rank, and title were inherited, with the position of chief most often passed down to the first-born (Harrington 1942, pp. 33–34). Kroeber (1925, p. 834) suggests that Chumash may also have owned slaves, but Harrington (1942, p. 31) indicates they did not. Based on the above, we argue that Chumash society would have a Hierarchy Index score of at least 2, with an unequal distribution of goods and ranked kin groups.

In addition to their remarkable degree of formalized inequality, Chumash have long been recognized as heavily focused on marine resources; Kroeber (1925, p. 550) characterizes them as "more nearly maritime in their habits than any other Californian group," and goes on to note that

> Marine life along the Chumash shores is exceptionally rich, the climate far famed, and every condition favored the unusual concentration of population among a people living directly upon nature. The land, however, is dry; the watercourses, though long, are small and rarely run permanently, and each successive mountain chain increases the aridity. (Kroeber 1925, pp. 550–551)

Jorgensen states that "[f]ish, shellfish, and sea mammals in enormous amounts were exploited by the people of the Northwest Coast, somewhat less so by the coastal people of Southern California (Gabrielino and Chumash in particular), and less still by the inhabitants on the northern and central coast of California" (Jorgensen 1980, p. 124).

Following up on this, we can generate quantitative estimates for dietary reliance among contact-period Chumash communities on the mainland of the Santa Barbara Channel, following WNAI categories (Jorgensen 1980). Given the above quotation, we can assume that if Jorgensen had included Chumash in the WNAI database, he would have coded their dietary reliance on aquatic resources as falling between the NWC and other coastal CAL groups in the sample, which would numerically assign them to the 51–100% (class 5) category. For hunting, he notes a correlation between large game prevalence and overall reliance on hunted game, suggesting that "most animals were small" in southern California. This would place hunted game in the 1–10% category (class 2). This seems supported by Crespí's observations and Kroeber's synthesis noted above. Finally, as noted by Crespí and others, Chumash relied on various plant species, and especially acorns. We might expect mainland Chumash subsistence to fall in the 26–50% (class 4) category.

With these estimates, and using the method explicated above and in the Supplementary Information, we would calculate a resource index value of 0.24. (The point estimate of aquatic reliance (p199) is .65, hunting reliance (p204) is .05, and gathering reliance (p211) is .35, and since their sum exceeds 100% by 5%, reducing each by 5% brings the sum to .998, which rounds to 1.0, or 100%; with these adjusted point estimates, RI = .62 − [.05 + .33] = .24). This is higher than any CAL group except Wiyot (0.35), yet somewhat lower than any NWC case (the lowest ones are also 0.35). With a hierarchy index of 2 and a resource index of 0.24, mainland Chumash societies along the Santa Barbara channel would fit comfortably within the distributions of other CAL and NWC societies (cf. Figure 6).

In addition to the high reliance on marine resources relative to other CAL societies, the Channel Chumash also relied on specialized technology for resource acquisition. Throughout his northward journey, Crespí documented repeated scenes of Chumash coastal village life focused on fishing in sewn-plank canoes (the *tomol*, a sewn-plank and bitumen-caulked canoe unique in North America) producing abundant harvests of fish to accompany the staple acorn gruel (Crespí 1769, in Brown 2021, pp. 393–479). The reliance on the *tomol* for fishing and marine mammal hunting, as well as transport and trade with villages on the Channel Islands, presents a unique element of Chumash subsistence and technology. Indeed, ownership and control of these canoes, which were costly to construct, as well as of suitable landing sites in protected coves, may have been critical conditions that allowed powerful individuals to control access to dense, predictable marine resources (Arnold 2007).

Arnold (1992, p. 64) argues that chiefdoms emerged following a period of climate-induced marine resource deterioration to which elites responded by taking "…control over critical resources and over key technologies (e.g., chert, beads, and canoes)." There is some consensus among Chumash specialists that hierarchical political organization with elite control over resources, technology, and craft specialization likely emerged sometime in the Late Holocene following environmental

change that perturbed resource availability, especially among the poorest inhabitants, leading to territoriality and concentrated settlement at larger villages (Arnold 1992, 2000, 2001; Gamble 2008; Jazwa et al. 2019; Kennett 2005; Kennett et al. 2009; Raab 1996).

Variation within Chumash societies also supports this interpretation. North of Point Conception, Chumash did not rely on sewn-plank canoes and appear to have had less wealth and sociopolitical differentiation (Kroeber 1925, p. 551). Archaeological evidence suggests that Northern Chumash relied more heavily on shellfish, and less so on fish and marine mammals (Glassow and Wilcoxon 1988), and Crespí reports scenes of women and children harvesting grass seeds (1770, in Brown 2021, p. 715). While some large villages were still under the control of influential chiefs (Crespí 1769, in Brown 2021, pp. 477–479), these were adjacent to smaller, more mobile populations that did not seem to be under the control of hereditary chiefs but were instead more autonomous (Jones et al. 2023).

In sum, we would argue that the unusually developed inequality of most Chumash polities relative to neighboring CAL societies is plausibly related to Chumash reliance on dense, predictable, and clumped marine resources, as well as control over the technology required to exploit them (Arnold 1992; Kennett 2005). They are exceptional compared to other CAL societies, but arguably exceptions that "support the rule" of the resource-control explanation of institutionalized inequality.

In conclusion, the comparative evidence summarized above indicates that coastal HG societies reliant on marine resources are much more likely than interior ones to develop hierarchical political economies. Given sea-level rise following the terminal Pleistocene, the antiquity of this pattern is hard to determine, but data on cases in the Mid-Holocene and later suggest this pattern is only evident in the last few millennia. As reviewed above, this includes Calusa (subtropical), NWC (wet temperate), Chumash (dry temperate), Kodiak Alutiiq (subarctic), and even New Guinea (tropical), but perhaps not some other tropical/subtropical foragers (Jeffery and Lahr 2020). Thus, we believe the evidence on these cases supports the causal argument presented above and diagrammed in Figure 7.

Conclusions and Prospects

To summarize, our analyses demonstrate that key differences in the political economy of CAL versus NWC societies are strongly aligned with differences in subsistence ecology—the ways in which people organize themselves to harvest resources. In turn, those contrasts in subsistence can be seen as cultural responses to the differing characteristics of key resources, particularly their spatiotemporal distribution. Our evaluation of a range of explanations for the emergence of institutionalized inequality in Pacific Coast societies found robust support for only one of them: subgroup control of dense, predictable, and clumped resources, and resulting patron-client dynamics. In addition to empirical support documented herein and elsewhere, the patron-client scenario has well-developed theoretical underpinnings, including analytical and agent-based models (Hooper et al. 2018; Smith and Choi 2007). It also links to long-standing theory and empirical work in behavioral ecology

concerning resource defense (Dyson-Hudson and Smith 1978; Koster et al. 2024) and reproductive skew (Ross et al. 2023).

The Resource Index (RI) is a simple measure of the relative reliance on aquatic animals (primarily fish) versus gathered plant resources. Despite its simplicity and reductive appearance, across the 89 societies examined RI proved to be a robust predictor of inequality in wealth and power (as measured by the three variables that constitute the Hierarchy Index), this holds true even when controlling for linguistic affiliation and spatial proximity (Smith and Codding 2021). We argue that this is because RI captures the economic importance of salmon and certain other dense and localized (clumped) aquatic resources, compared to more dispersed or widely distributed terrestrial game and wild plant resources such as acorns. For foraging societies such as the ones in this study, this divergent resource distribution created very different political-economic opportunities and constraints: for resource ownership, for the organization of labor in harvesting and processing, and ultimately for bargaining over rights and privileges.

We stress that our argument is not simple environmental determinism. To the contrary, it is closer to classic historical materialism (Cohen 1978) which posits that "in acquiring new productive forces men change their mode of production; and in changing their mode of production, in changing the way of earning their living, they change all their social relations" (Marx 1920 [1847], p. 92). Our analysis provides ample roles for human agency, institutional dynamics, and nonlinear trajectories. Critiques that argue otherwise (e.g., Wengrow 2024) misconstrue it.

It is important to remember that the patron-client model requires that key resources be both economically defensible and clumped. When resources are relatively dense and predictable enough to reward defended property rights, but are relatively evenly dispersed across the landscape, the expectation is that ownership claims will tend to be more or less equally distributed among members of the social group (Smith and Choi 2007). In such cases, we expect little or no differentiation into resource owners and subordinates, as each family or household will control access to resources which meet their subsistence needs, either directly or via exchanges. Only when key resources are dense and predictable enough to make ownership claims profitable, yet also sufficiently clumped to allow monopolization, are conditions ripe for a subset of a local group to control these resources and exchange access to them for labor or other services. The first set of conditions and consequences (defensible but evenly dispersed resources, household control) is characteristic of most Native California societies, while the second (highly clumped and defensible resources, subgroup control) is the classic pattern for Northwest Coast societies.

The analyses in this paper focus on ethnographic—and therefore synchronic—evidence. Archaeological research indicates that key features of NWC society, including institutionalized inequality, were in place some three to four millennia ago, and thus show considerable antiquity and stability (Ames 2003; Coupland et al. 2016). However, salmon procurement has a much greater antiquity (Butler and O'Connor 2004; Sutton 2017), dating to the Pleistocene-Holocene boundary some 12,000 years ago, and possibly earlier. Duffield et al. (2021) document intensive reliance on marine fish (especially herring and salmon) extending over 6000 years

on the central coast. This temporal lag invites several possible explanations. One is that salmon productivity was limited until sea levels and river gradients stabilized in Mid-Holocene times (Fladmark 1974). Oceanographic evidence summarized in Fitzhugh (2016) suggests that the North Pacific was simply not productive enough until the Mid-Holocene to support population sizes that would make resource defense worthwhile.

A second view is that various technological and logistical innovations were required to support the mature NWC system of mass storage, winter villages, hereditary elites with property rights, and ancillary elements (Schalk 1981). The more of these and other variables requiring technological innovations and institution building are at play, the longer their development might entail. Additionally, as discussed above, a precondition required by patron-client systems is that the "outside options" clients face are less rewarding than the payoff from subordination to patrons. A number of factors besides resource clumping could affect outside options. These include habitat saturation due to population growth or resource depletion, economies of scale in resource acquisition and labor coordination, and constraints on movement due to endemic warfare. In order to adequately evaluate their causal roles in generating institutionalized inequality, detailed diachronic data will be required. Some instructive examples of the kind of research needed include Bogaard et al. 2019; Bowles and Fochesato 2024; Kennett et al. 2009; Kohler et al. 2018; Prentiss et al. 2014; Prufer et al. 2017; and the special feature on the Gini Project that recently appeared in *PNAS* (Kohler et al. 2025a, b).

However these questions are resolved, our findings clearly support the hypothesis that the ability to control dense, predictable, and highly clumped resource patches was a major factor in the emergence of institutionalized inequality in various Native American societies of the Pacific Coast region. Above, we briefly considered how other coastal foraging societies scattered around the globe might match this scenario. Further research will be needed to more fully evaluate how effectively this account explains variation in inequality among hunter-gatherers and perhaps other small-scale societies.

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