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Research, part of a Special Feature on Resilience and Change in Arctic Alaska

Equality and equity in Arctic communities: how household-level social relations support community-level social resilience

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ABSTRACT. Social and economic inequality are increasingly linked with greater vulnerability and compromised resilience for communities navigating ecological and institutional change. We focused on social resilience; i.e., the ability of foundational social institutions of sharing and cooperation in three Arctic Indigenous communities to maintain key social processes and structures in response to contemporary challenges. We explored two propositions: first, sharing and cooperation are distributional processes that increase the equality of access to wild foods at the community level. Second, sharing and cooperation embody cultural mechanisms that express trust and build social cohesion. Our analyses were based on household-level harvest and social network data that represented social ties and magnitudes of wild foods flowing from crews and between households. Qualitative and quantitative results indicated that material, emotional, and cultural outcomes of sharing and cooperation act across social levels—households to communities—to increase equality and equity. For all three communities, Lorenz curves and Gini coefficients indicated that distributions of wild food were more equal when sharing, cooperative-provisioning, and self-provisioning were considered than household self-provisioning alone. Network regressions emphasized close kinship and total harvest as social mechanisms strongly predictive of sharing outflows across communities (i.e., people share with family, and the more you have, the more you give). Income effects were mixed. There was evidence of different forms of need-based sharing in all communities, which suggests that social relationships also act as mechanisms to improve equity. Qualitative results linked decisions to share and cooperate with outcomes of well-being, and cultural integrity at household and community levels. While production of wild foods occurs at greater-than-household scales, the State manages wild food production at individual and household scales, which sets up conflicts between Indigenous communities and the State. Sharing and cooperative networks embedded in Arctic mixed economies are culturally derived and place-based institutions. Redistribution of resources through these networks, and the maintenance of social relationships to activate networks in times of need, increase the equality of outcomes —and therefore social resilience—at the community level in the face of rapid change.

Key Words: *Alaska Native; cooperation; equality; equity; resilience; sharing; social networks; social resilience; subsistence; well-being*

INTRODUCTION

A substantial body of literature links social inequality in social-ecological systems to increased vulnerability and compromised resilience (Adger 2000, Adger et al. 2005, Thomas and Twyman 2005). Leach et al. (2018) highlighted differences between equality (equal access to resources) and equity (distribution of resources based on the needs of recipients). Donkersloot et al. (2020) explored issues of equality, equity, and sustainability in Alaska's salmon fisheries, noting that the Alaska Constitution mandates equality—not equity—in the allocation of Alaska's renewable resources, and arguing that resource policies based on equality are "often at odds with the principle of equity."

We explore equality and equity as valued principles in the culturally embedded sharing and cooperative practices of two Iñupiaq communities and one Gwich'in community in Alaska, focusing on implications for household- and community-level social resilience. Our approach acknowledges the Arctic as a landscape of resilience and immense environmental variability, one in which diverse human communities have developed cultural and social adaptations organized around principles of redistribution through sharing and cooperation. We use quantitative social network methods to describe the activation of these principles through natural resource redistributions—"wild food flows"—among households and crews. We examine the extent to which resource redistributions reduce—though not eliminate—inevitable inequalities in household-level wild food production. We also explore how local residents themselves perceive the effects of redistribution through sharing on household and community well-being, a concept allied to resilience but with stronger local relevance.

The contribution of individual- and household-level social relations to higher levels of community equality and equity in the Arctic is hardly a surprise (Bodenhorn 1990, Collings et al. 1998, Bodenhorn 2000, Wenzel et al. 2000, Kishigami 2004, Natcher et al. 2012, Kishigami 2013, Collings et al. 2016). However, we investigate these contributions with a grounded approach to the characterization, quantification, and categorization of wild food flows for a large, culturally diverse sample of Indigenous Alaskans (Charmaz 2006). This approach allows analyses of redistribution structures, factors that influence redistribution, and—perhaps most important—the contributions that culturally embedded sharing and cooperative practices make to community equality and equity, and therefore social resilience.

Background and theoretical framing

The three Arctic communities we studied have strong, place-based, social-ecological relationships that link people with each other, and people to the land and animals that sustain them. The focus here is on social resilience, defined as "the way in which individuals, communities, and societies adapt, transform, and potentially become stronger when faced with environmental, social, economic, or political challenges" (Cuthill et al. 2008:146). For Adger (2000), the term is analogous to ecological resilience but focuses on the ability of social institutions—in our case, sharing and cooperative networks—to maintain key elements of social function and structure in response to exposures (Brown

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2014, Berman et al. 2017). These institutions are theorized here as forms of social capital, which are embedded in networks of social relationships, and act to provide access to resources, build trust, and facilitate cooperation in communities for mutual benefit (Lin 1999, Putnam 2000, Woolcock and Narayan 2000). Community resilience is defined as the ability of co-located groups of people to respond to changes without losing the critical structures, processes, and dynamics that are the basis for livelihoods and well-being (Berkes and Ross 2013).

The Arctic today is experiencing rapid and profound change, not only climate change but also the continuing impacts of two centuries of exploration, colonial expansion, assimilation pressures, and economic disruptions. Nonetheless, Arctic Indigenous peoples have persisted and continue to advocate for ways of life based on core values and practices deeply embedded in their cultures (Wilson 2014, Gadamus and Raymond-Yakoubian 2015, Thorton and Mamontova 2016). A predicted wholesale transition from subsistence-based livelihoods to market-based wage employment has not materialized. Instead, we see widespread and persistent mixed subsistence–cash economies grounded in cultural values around human–human and human–animal sharing relationships (Langdon 1991, BurnSilver et al. 2016, Magdanz et al. 2016). In recent decades, Arctic peoples have negotiated new institutional and governance arrangements to improve political, land, and mineral sovereignty, and to protect cultural integrity (Mitchell 2001, Burwell 2005). Yet, as Arctic mixed economies become more diverse, people are continuously pushed and pulled to adjust livelihoods to respond to regional opportunities and challenges (Reedy-Maschner 2009, BurnSilver and Magdanz 2019).

Contemporary Arctic livelihoods—mixed subsistence–cash economies—are built on three fundamental and integrated pillars: (1) households harvesting wild foods, (2) households generating cash through salaries, wage work, or the making of art, and (3) households and groups redistributing food and non-food resources through social relationships (Langdon and Worl 1981, Wolfe and Walker 1987, BurnSilver and Magdanz 2019). Scholars have described wild food sharing patterns in contemporary Arctic mixed economies for the Copper, Netsilik, and Iglulik Inuit of Canada and Greenland (Damas 1972, Hovelsrud-Broda 1999, 2000, Wenzel 2000, Harder and Wenzel 2012), for the Yupik of St. Lawrence Island, Alaska (Jolles and Oozeva 2002), for the Iñupiat of Alaska's Arctic coast (Bodenhorn 2000, SRB&A 2018, Erickson 2020), and for Yup'ik of southwest Alaska (Langdon 1991). Sharing and cooperation create and maintain social relationships over time, with positive effects on the nutritional, social, emotional, and economic security of the larger group as high-harvesting households provision others (Smith and Wright 1989, Usher et al. 2003). Household-level actions (e.g., harvesting, working, sharing) scale up to community-level outcomes (BurnSilver et al. 2017). Viewed in this way, sharing and cooperative relationships are a set of social structures and processes that (1) materially affect equality of access to wild foods and other resources, and (2) contribute to well-being and social cohesion within communities and beyond. Outcomes of sharing and cooperation—material, emotional, and cultural—act across social levels—individuals to households to communities—to affect social resilience.

Early scholarship by explorers created an image of Yupik, Central Yup'ik, and Iñupiaq societies as egalitarian and non-hierarchical. However, ethnohistorian Burch (1980) presented a more nuanced view of Indigenous life in northwest Alaska before 1850. According to Burch (1980), people lived in semi-migratory groups made up of one or a few extended "local" families in which a productive hunting household or a productive individual—an *umialik*—held influence over and responsibility for the well-being of others, most of whom were kin (Burch 1975). In the North Slope dialect of the *Iñupiaq* language, *umialik* (*umialgit*) means "boat captain(s)," but also "boss," "rich man," or "church elder" (Webster and Zibell 1970, Seiler 2012). In Central Yup'ik, the equivalent terms are *alularta* or *angyalek* (Jacobson 2012). In Yupigestun (spoken on St. Lawrence Island), the equivalent terms are *angyalek*, *angyalegtaq*, and *angyallighta*. These terms reflect the unique roles and relationships linked to the bowhead whaling complex in the Alaskan and Russian Arctic, and imply that perfect equality was not the norm historically in Arctic societies. Patterns of sharing and cooperation were attenuated by interactions between climate and food availability. When food was plentiful, it was assumed that households could provide for themselves, and so household access to harvests was not equal. When food was scarce, it was shared from the *umialik* and his wife with those in need, and created greater equity among extended family groups (Burch 1980). But when famine threatened, all households were on equally bad footing, and groups dispersed.

Eleven Yupik and Iñupiaq communities in Alaska continue to hunt bowhead whales (*Balaena mysticetus*). In these communities, *umialgit* organize whaling crews that link individuals from multiple households together under the leadership of the *umialgit* and their spouses or partners. Preparing crews for the hunt requires provisioning by captains, their partners, crew members, and many other local and non-local households and entities; for example, local businesses or industry. When a crew is successful, it is a cause for celebration, but the sheer size of a bowhead whale creates a distribution challenge. To provide access to the harvest, successful *umialgit* distribute significant shares to crew members, other whaling crews, and households who initially provisioned them. Usually, these large crew or helper shares are then further divided and redistributed to others inside and outside communities (SRB&A 2018). Successive feasts and "household share" traditions also ensure that every individual and household in communities receives whale from successful crews (Alaska Eskimo Whaling Commission, personal communication). These general patterns hold true across whaling communities, but there are significant community-to-community differences grounded in cultural histories of place and environment.

Linked structural inequalities and distribution processes like those characterizing whaling complexes are an everyday feature of subsistence economies, regardless of the resources being harvested. Contemporary empirical evidence for these relationships comes from a program of comprehensive community harvest surveys initiated in rural Alaska around 1980, which quantified subsistence harvests at household and community levels. As data from this program accumulated, Alaska researchers found a pattern so consistent—about 30% of households in a given community accounted for about 70% of the community's total wild harvest, by weight—that Wolfe (1987) termed it the "30:70 rule". Wolfe et al. (2009) advanced several explanations for the skewed harvest distributions, including the differential capabilities of households, household developmental cycles, and household-level challenges. The credible assumption was that highly productive households—"super households"—were redistributing wild foods to households with lower harvests in the community, usually characterized simply as "sharing." But the State program did not collect information about which households were sources or consumers ("sinks") of the redistributed foods, nor did it attempt to quantify the amounts of wild foods being shared.

A methodological advance occurred in the mid-1990s when scholars began applying social network methods to subsistence food production in the Arctic. Initial work was limited to the identification of source and sink households and associated counts of ties (Magdanz et al. 2002, Dombrowski et al. 2013a, Ziker 2014, Natcher 2015, Collings et al. 2016, Ready and Power 2018, Ready 2018). Network approaches were also applied by subsistence researchers working in Indonesia (Nolin 2010), Fiji (Dacks et al. 2020), and elsewhere. These studies revealed similarities and differences in the structure of sharing networks. They highlighted a range of causes and motivations for sharing across large geographic and cultural distances, including kinship (Nolin 2011, Dombrowski et al. 2013b), prestige/leadership (i.e., costly signaling) (Ready and Power 2018), and reciprocal altruism (Nolin 2012).

Researchers subsequently expanded their protocols to ask community members to describe the quantities of wild foods they received. This documented the wild foods and other resources flowing from sources to sinks, a time-intensive data collection task infrequently attempted at community scales. Working with a sample of 35 Indigenous households in two adjacent communities in Nicaragua, Koster (2011) may have been the first to quantify subsistence food flows at a community scale. Working with a sample of 300 households in three widely dispersed communities in Arctic Alaska, "The Sharing Project" (Kofinas et al. 2016) documented wild foods flows into households across 20 social relations. The Sharing Project found that only about one-quarter of community-level wild food inflows by weight resulted from households' own production for themselves, while three-quarters occurred through social relations (Kofinas et al. 2016). Project results were disseminated widely within communities and to regional collaborators. Ensuing comments by community partners emphasized that the method adhered strongly to points communities had been making about sharing and cooperation as integral to northern ways of life for decades. Data from The Sharing Project formed the basis of our analyses.

Two propositions

We considered two propositions: (1) sharing and cooperation are distributional processes that increase equality of access to wild foods at the community level, and (2) sharing and cooperation embody cultural mechanisms that express trust and build social cohesion. The first proposition emphasizes material benefits of sharing; the second highlights non-material benefits. Both propositions describe institutions that improve social resilience (Adger 2000).

Just as a household works together to provision its members with needed resources—children and elders have access to food and resources they would not have without more productive household members—sharing and cooperation among households and crews acts to increase equality of wild food access at the community level. Access to high-quality (i.e., nutrient- and protein-dense) wild foods has significant nutritional benefits for northern households (Johnson et al. 2009). To the extent that active hunters and their households have greater ability to distribute wild foods to those with less, equity within communities is also improved.

Community narratives about sharing commonly prioritize elders and single parents with children as those "in need"; i.e., elders who have done their part for the community over time, and particular families that require additional help (Okada 2010). Need might stem from low direct access to wild food due to age or choice, or lack of time, hunting ability, or equipment. For example, Collings et al. (2016) found that high-income households that are fully able to purchase store-bought food may still be perceived as "in need" of wild food if they hunt or fish only occasionally. The interaction between ability and need sets the stage for an exploration of the effects of sharing and cooperation on equality, equity, and social resilience in communities.

Subsistence goes beyond the means, methods, and outcomes of producing wild food: it includes enactment of cultural practices, values, and ways of knowing, while supporting spiritual and social relations (Active 1998, Raymond-Yakoubian and Angnaboogok 2017). Bodenhorn (1990:28) described sharing among the Iñupiat of Alaska's North Slope as "a complex set of social actions, all of which create and maintain morally valued relationships that extend well beyond hunting itself." Similarly, Alexie (2015:1) stated that Indigeneity and governance among her people, Teetł'it Gwich'in, "is premised on traditional principles of respect, sharing, and reciprocity."

Sharing relationships also demonstrate care for others, including non-human persons. Such practices serve a fundamental social purpose in maintaining human connections and creating social cohesion, and in contributing to a sense of well-being, thriving, or happiness for individuals and communities (Kral et al. 2011). According to Adger (2000:351), it is this "cultural context of institutional adaptation…within different knowledge systems [that is] central to the resilience of institutions." Capacity to deal with change is activated when people exercise agency (Brown and Westaway 2011, Berkes and Ross 2013) and when they perceive they have the self-efficacy to do so (Kruse et al. 2009). For Alaska's Indigenous peoples, a foundational way their agency is expressed is through active engagement in hunting, fishing, gathering, and cooperative relationships. This suggests that social institutions like sharing and cooperation—which are of a place and of the people—are by their nature adaptive and critical for resilience.

In the following sections, we explore these propositions. Using measures of inequality, we examine the extent to which sharing and cooperative practices at the household and crew levels scale up to affect distributional equality of material food flows in communities and highlight the directionality of flows between households based on characteristics that may differentiate ability versus need. We do so based on livelihood, harvesting, and social network data that represent both existing ties and the magnitude of wild food flows between households within communities through social relationships. We use a network regression model to explore possible influences of household factors on the flows of wild foods among households.

We then integrate cultural narratives that describe sharing effects on household and community well-being. We use well-being as a proxy for social resilience because "resilience" is not a term in common use in the North, and outcomes associated with well-being overlap with social resilience constructs; e.g., social cohesion, trust, health, and connectedness (Duhaime et al. 2004, Healey Akearok et al. 2019).

THE SETTING

Alaska's North Slope is a broad coastal plain stretching north and west from the foothills of the Brooks Range to the Beaufort and Chukchi Seas. It is home to the Iñupiat, a cultural subgroup of Iñuit circumpolar peoples who have access to a diverse array of marine, riverine, and terrestrial subsistence species. The Upper Yukon is a watershed that drains the southern slopes of the Brooks Range and flows ultimately into the Bering Sea. It is home to the Gwich'in, a subgroup of the Dene peoples, who are dependent primarily on the resources of interior rivers and boreal forests.

On the North Slope, Wainwright (Ulġuniq) and Kaktovik (Qaaktuġvik) are coastal Iñupiaq whaling communities (Fig. 1). In 2010, Wainwright had a total population of 556 people, of whom 92% were Alaska Native. Similarly, 90% of Kaktovik's 239 residents were Alaska Native (US Census Bureau 2012). Wainwright and Kaktovik residents hunted, fished, and gathered 52 and 53 different species, respectively, during the study period.

Fig. 1. Alaska and the study communities.

Hunting of bowhead whales in particular is a critical part of being Iñupiaq. Both communities are represented on the Alaska Eskimo Whaling Commission, and the Indigenous right to whale for subsistence has been successfully negotiated and defended by the Alaska Eskimo Whaling Commission and US delegation to the International Whaling Commission since the late 1970s (Huntington 1989). Wainwright crews historically hunted the bowhead in spring in boats launched from the shorefast ice. Kaktovik crews hunt only in the fall in the open water. In 2009, Wainwright also began fall hunting due to increasingly uncertain spring ice conditions. Social relationships specific to whaling include those that coordinate hunting and harvesting labor through crew membership, and access to supplies and equipment (e.g., crew shares, towing shares, captains' shares, helper shares), as well as processing and distribution of landed whales (e.g., household-to-household sharing and trade, helper shares, whaling captain's feasts, and the annual *Nalukataq* whaling feasts).

Wainwright and Kaktovik are both part of the North Slope Borough and the Arctic Slope Regional Corporation (one of 13 regional corporations created by the Alaska Native Claims Settlement Act). Taxable oil infrastructure funds fire and health services in communities, as well as centralized water/sewer and natural gas systems. Wainwright and Kaktovik are accessible only by summer barge and daily bush air services.

On the northeast bank of the Chandalar River, 200 miles (322 km) south of Kaktovik, lies the Gwich'in Dene community of Venetie (Vááhtàáá). Cultural groups represented in this area include Neets'ai, Gwichyaa, and Dihaii Gwich'in (State of Alaska 2020). In 2010, Venetie's population was 166, of whom 99% were Alaska Native. Venetie is not connected to Alaska's road system but is accessible by bush aircraft and by small boat via the Chandalar River. Venetie homes are wood heated and unconnected to a central water system. Residents harvest, fish, and gather terrestrial and riverine species (39 species in 2009–2010).

Kaktovik and Venetie both depend on the Porcupine caribou herd (*Rangifer tarandus granti*): Kaktovik in spring and fall at the herd's northern migration point on the coastal plain, and Venetie during the herd's winter migration south. While lacking direct access to marine environments, Venetie residents receive bowhead whale, bearded seal (*Erignathus barbatus*), and beluga whale (*Delphinapterus leucas*) based on sharing and trading relationships with coastal residents (Kofinas et al. 2016).

Having opted out of the Alaska Native Claims Settlement Act in 1971, the two Native villages of Venetie and Arctic Village jointly own 1.8 million acres (728,434 ha) of their traditional lands in Alaska's eastern interior, giving them a higher degree of territorial sovereignty than most other Indigenous Alaska communities but reducing their access to some Native corporation benefits under the Alaska Native Claims Settlement Act. Both Venetie and Arctic Village are members of the Council of Athabascan Tribal Governments, which provides health care and other services.

The study communities are similar in their dependence on wild foods but vary in the nature and extent of their agency over wild food access. Wainwright and Kaktovik depend primarily on marine mammals harvested in a marine commons managed by the federal government, and face limited direct hunting competition from others, even as the Beaufort and Chukchi Seas are increasingly congested with shipping, oil and gas operations, fishing, and other interests that are potentially in conflict with subsistence goals. In contrast, Venetie depends primarily on caribou, moose, and salmon harvested from tribal lands and waters where renewable wild resources are managed by the State of Alaska for the "common use" of all Alaska residents. The people of Venetie also face significant harvest competition from users beyond the boundaries of their lands, and expose themselves to legal jeopardy when they fail to conform to the State-mandated individual harvest reporting systems.

METHODS

Data collection

Data collection was conducted as part of the 3-year Sharing Project funded by the US Department of the Interior, Minerals Management Service (later Bureau of Ocean Energy Management). The project sought to understand the role of social relationships within mixed subsistence–cash economies in offsetting household vulnerability and building resilience to changes associated with potential offshore oil and gas development. Social relationships were a specific focus of the research, based on social capital (Putnam 2000) and network theories (Borgatti et al. 2009), which highlight that in addition to other household-level attributes, patterns of social ties between entities are predictive of social, health, and economic outcomes.

The Sharing Project was approved by the University of Alaska Fairbanks Institutional Review Board. All three communities formally consented to, actively participated in, and reviewed results of the research. All respondents were paid an hourly rate for their time, and interviews lasted an average of 90 minutes (minimum 30 min; maximum 3 h). Response rates were high: 146 households in Wainwright (96%), 70 in Kaktovik (82%), and 84 in Venetie (94%). For the analyses, non-local teacher households were removed, which resulted in samples of 133, 64, and 80 households for Wainwright, Kaktovik, and Venetie, respectively.

Fieldwork began in 2008–2009, when researchers conducted semi-directed interviews with key respondents (Bernard 2006) to identify key species and culturally resonant sharing and distribution patterns that were specific to each community. A process of open-coding, literature review, and iterative discussion with community members identified 20 unique social relationships through which 7–10 core fish and wildlife species flowed from households and crews into respondent households (see Kofinas et al. 2016:19-22). These relationships—including multiple types of shares resulting from cooperative harvest or processing efforts, and sharing resulting from household-to-household exchanges, among others—structured how network data were collected. In late 2010 and early 2011, researchers worked in teams (one academic researcher paired with one local interviewer) to carry out a household survey that collected demographic, employment, harvest, and social network data in Wainwright, Kaktovik, and Venetie. Using the 20 social relationships, the survey asked respondents to describe flows of food into their households (inflows) in local terms (e.g., a large cooler, half of one caribou, three ducks) during the preceding 12 months. All quantities were then converted to estimated pounds using the State's standard wild food conversion factors (Alaska Department of Fish & Game 2020; see Appendix 1). Open-ended questions about reasons and processes for sharing were also asked during the Kaktovik and Wainwright surveys.

Many key sharing and cooperative relationships were captured in the study period covering 2009–2010, but not all. Individual meal sharing and flows of wild food into households from communal Thanksgiving and Christmas feasts were not documented. In Wainwright, captains and crew members from all three bowhead whales landed that year were interviewed. In Kaktovik, crew members from all successful crews were interviewed, but only one of three successful whaling captains was interviewed. This resulted in substantial under-documentation of crew contributions to crew whaling efforts in Kaktovik and *umialik* (captain's) shares from those whales, as well as household-level social flows to households that were not interviewed (see Chapter 3 in Kofinas et al. 2016 for details on sampling methodology).

Quantitative data analyses

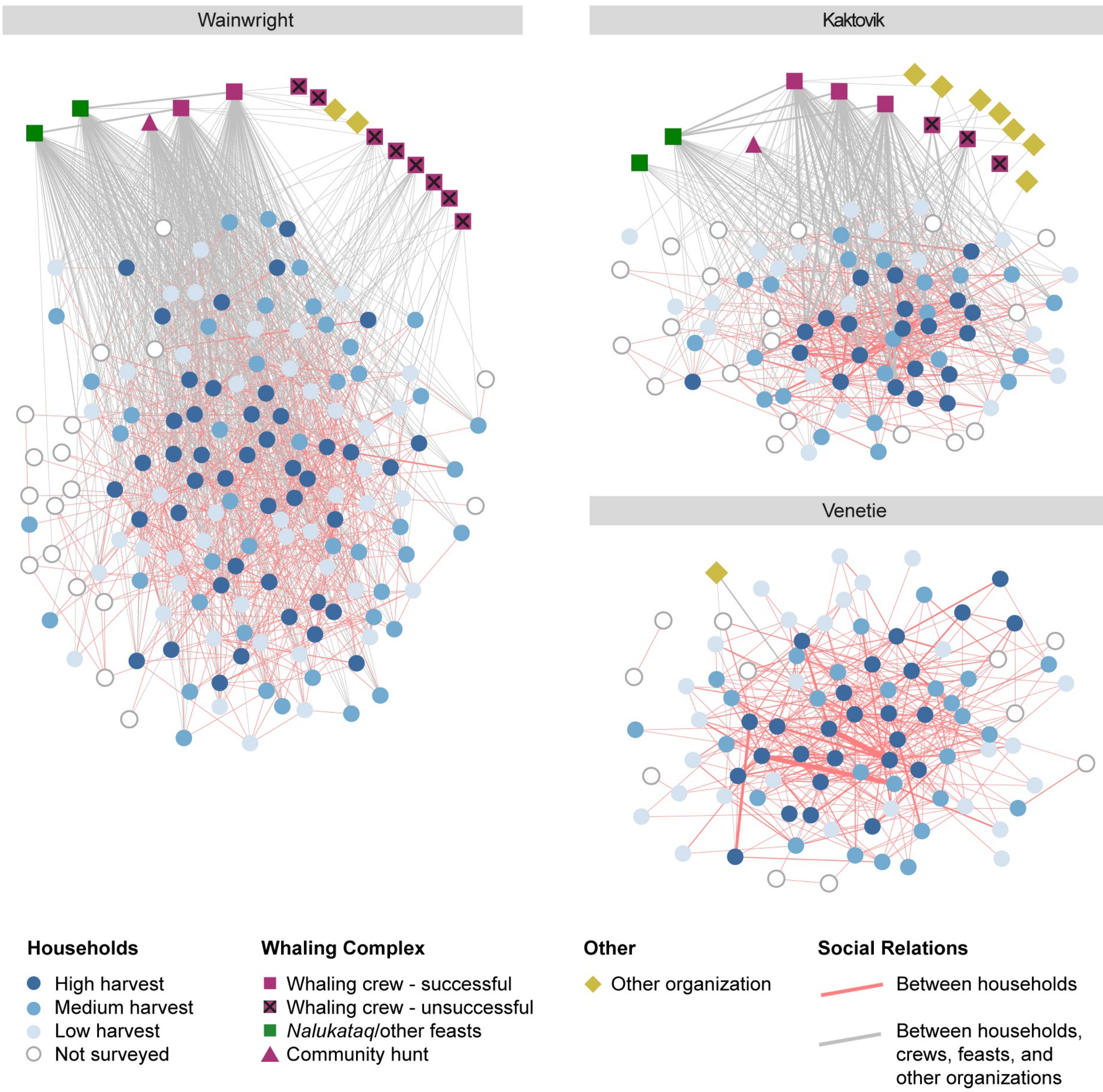
While the Sharing Project was fundamentally a social network project and network data were essential to our analyses, this analysis does not include network-specific statistics. We relied on Lorenz curves and Gini coefficients for estimates of the effect of social relations on equality, and on a network regression model for estimates of the influence of household attributes on flow patterns. For detailed descriptions of the network methods and for foundational network analyses and summary statistics, see Kofinas et al. (2016).

Conceptually, a social network consists of nodes and edges stored in an *n* x *n* socio-matrix, where each cell contains a value representing the presence/absence or, in a valued network, the strength of the relationships (edges) between each pair of nodes (i, j). In a directed network, the entry y_{ij} represents the value of the relationship from i to j, while the entry y_{ji} represents the value of the (reciprocal) relationship from j to i. In this study, network edges were both valued and directed. When, as here, multiple relations are collected, each relationship is stored in a separate matrix (e.g., moose sharing). Multiple matrices can be aggregated into a new matrix (e.g., all sharing). Networks often are represented graphically, as in Fig. 2, which illustrates the aggregation of all wild foods redistributed through social networks in Wainwright, Kaktovik, and Venetie. Sampling rates were high enough that most dyads (two households connected by an edge) were represented by two surveys, one from each household, and both reporting social and/or cooperative inflows from the other. Since only inflows were collected, flow data were not duplicated; outflows from one household were inflows to the other, thus providing a nearly complete set of network data.

A complex subsistence food distribution system can become analytically overwhelming, so the collected data were aggregated and simplified in several ways. The 20 social relationships were categorized into three groups for these analyses: self-provisioning, cooperative-provisioning, and social-provisioning (Fig. 3). Food could flow into households through any of the provisioning processes—own, cooperative, or social—but when food was redistributed to other households, it became—from the perspective of the receiving household—social-provisioning.

To further simplify and visualize flows of wild foods among households for some analyses, households were categorized into high-, medium-, and low-harvest terciles, and individual households' harvests were aggregated to each tercile. In the aggregated data set, nodes represent groups of households, while the edges between nodes represent the aggregate sharing and cooperative wild flows moving between groups of households. For Wainwright and Kaktovik, whaling crews were categorized

Fig. 2. Complete network graphs for Wainwright, Kaktovik, and Venetie, illustrating wild food flows between surveyed households (red ties). Flows to/from whaling crews (successful and unsuccessful), other organizations (businesses, oil companies, etc.), community hunts (primarily beluga whale), and *Nalukataq* feasts (all gray ties) are additional critical layers within community networks in Wainwright and Kaktovik. Successful whaling crews (open purple squares) are sources for whaling captains' feast shares and other types of cooperative and helper shares.

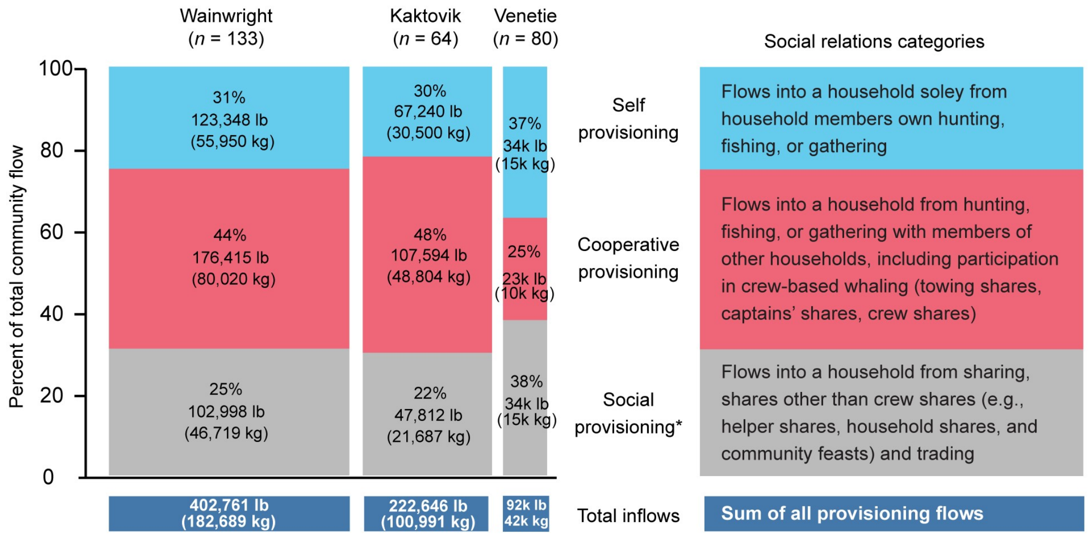


as a fourth type of node group (labeled "Crews"). The total harvests from successful crews (in pounds) across all social relationships were aggregated and then represented as flowing outward from a crew node to the three household-harvest terciles. Social and cooperative flows between harvest terciles (as well the crew nodes in Wainwright and Kaktovik) are presented as weighted, directed network diagrams, where edges reflect proportions of total flows in each community. Within-group flows —those that stay within a harvest tercile—were calculated as a proportion of total flows.

Representing equality

To visually represent and mathematically characterize the equalities of each community's wild food system, we relied on Gini coefficients calculated from Lorenz curves. A Gini coefficient of zero represents perfect equality, where the resource of interest (income, wild food) is distributed equally among all households. A Gini coefficient of 1 represents perfect inequality, where the resource of interest rests entirely with one household. After calculating estimates of each household's wild food inflows from each of the three types of provisioning relations, we drew Lorenz

Fig. 3. Social relations concepts and provisioning flows, by community and flow type.



* Wild foods often are redistributed several times from household to household. No matter how food flows into a household (via self-, cooperative-, or social-provisioning), when food flows out, it becomes social-provisoing from the perspective of a receiving household. Thus, the sum of wild food flows will always be somewhat more than the amount of food originally harvested.

curves and calculated Gini coefficients using the "ineq" package in R (version 0.2-13) (Zeileis and Kleiber 2015, R Core Team 2021). We used these metrics to compare the cumulative distributions of households' food inflows from each of the three categories of social relations redistribution (self-provisioning, cooperative-provisioning, social-provisioning). Note that equality at a community scale—objectively determined from quantitative observations or estimates of a variable—is not the same as equity.

Estimating influential flow factors
Based on northern ethnography and the work of Wolfe et al. (1987), we expected that wild food would flow from households with higher harvests and incomes to households with lower harvests and incomes, and from households with lower wild food needs to households with higher wild food needs. In addition, higher flows were expected between households with strong kin relationships than between households with extended or no kin relationships. To explore these ideas, we relied on a social relations regression model (Kenny and La Voie 1984) robust to zero inflation (Hoff et al. 2013, Hoff 2018). The social relations regression model regresses a dyadic outcome variable (directed, weighted flows of food between the nodes in the dyad) on a set of attributes of the source and the sink nodes of each dyad, as well as attributes shared by both nodes in each dyad.

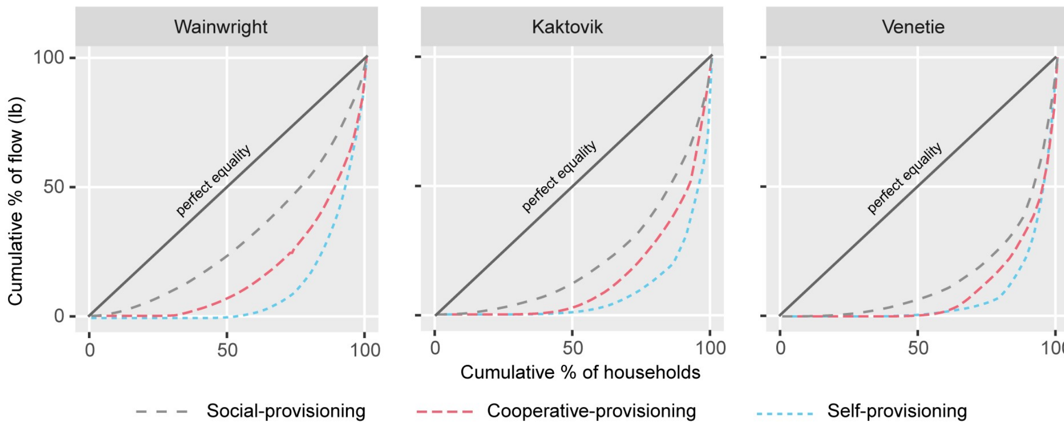
In the regression models, the response variable was total social flows or total cooperative flows between pairs of households. A separate model was constructed for each community and each flow type (social or cooperative), for a total of six models. Predictor variables included node attributes total household harvest (in thousands of pounds), total household income (in tens of thousands of dollars), and a dichotomous "elder/single parent" household variable indicative of need. The "in-need" variable was set to 1 if a household consisted of a single parent (male or female) with children, or of elders living alone, elders raising children (one or two elders), or elders (one or two) with one adult and children (a variation on single parent), and zero otherwise (44 households across three communities had a value of 1). Elders were defined as those 60 years or older. Two dyadic variables were included to describe kin relationships between households. The "close kin" variable was set to 1 if a parent–child, sibling, and/or grandparent–grandchild relationship existed between a household pair, while the "extended kin" variable was set to 1 if a nepotic (aunt/uncle–niece/nephew), cousin, or in-law relationship existed. When both variables were zero, no kin relationship existed.

The *ame* function in the R package "amen" (version 1.3) (Hoff et al. 2017, R Core Team 2021) explicitly models dyadic relationships between row/source-specific and column/sink-specific node-level covariates and edge-level response variables (e.g., social relations regression models, as well as network models with higher order dependencies such as clustering and transitivity). The function uses a multivariate Gibbs sampling algorithm—a type of Markov chain Monte-Carlo sampler—to estimate model parameters. Details of the sampling algorithm and its implementation in *ame* can be found in Hoff (2015, 2018). Each community network was specified as a separate model, with dyadic and node-level predictors described in the preceding paragraphs. In total, 10,000 samples were drawn from the target (Tobit) distribution with a burn-in period of 500 samples. Default starting values were used, and model convergence was achieved. Posterior mean parameter estimates located in the tails of the distribution (i.e., less than 0.025 or greater than 0.975) were considered non-significant.

Qualitative data analysis
To explore the effect of sharing on well-being and, indirectly, on communities' own perceptions of community equity, we relied on qualitative data from two survey questions posed only in Wainwright and Kaktovik, which differentiated between the effects

Fig. 4. (A): Lorenz curves for social-, cooperative-, and self-provisioning in Wainwright, Kaktovik, and Venetie. For each type of provisioning in each community, households are ranked in ascending order of inflows. The X-axis shows the cumulative percentage of households (each household's percentage is the same), while the Y-axis shows the cumulative percentage of inflows for the accumulated households. Perfect equality would occur if every household had exactly the same inflows. (B): Gini coefficients for household inflows, by provisioning category and community. A Gini is calculated as a ratio of the area below the Lorenz curve and the area below the diagonal in (A). Gini coefficients provide a unitary measure of the equality of a distribution.

A. Lorenz curves



B. Gini coefficients

Wainwright		Kaktovik		Venetie	
Self	0.79	Self	0.84	Self	0.84
Cooperative	0.66	Cooperative	0.75	Cooperative	0.79
Social	0.42	Social	0.60	Social	0.69
Total inflows	0.49	Total inflows	0.65	Total inflows	0.67

of sharing at household and community levels. The questions were "How does sharing contribute to the well-being of your household?", and "How does sharing contribute to the well-being of your community?" Qualitative data from open-ended responses were coded inductively to identify themes related to cultural narratives about sharing and cooperation and well-being in the context of subsistence (Charmaz 2006). A content analysis was used to summarize the frequency of themes mentioned by respondents. Some respondents provided multiple answers, so frequencies outnumbered respondents in some cases. For the household question, there were 152 responses in Wainwright and 60 responses in Kaktovik. For the community question, there were 142 responses in Wainwright and 65 responses in Kaktovik.

RESULTS

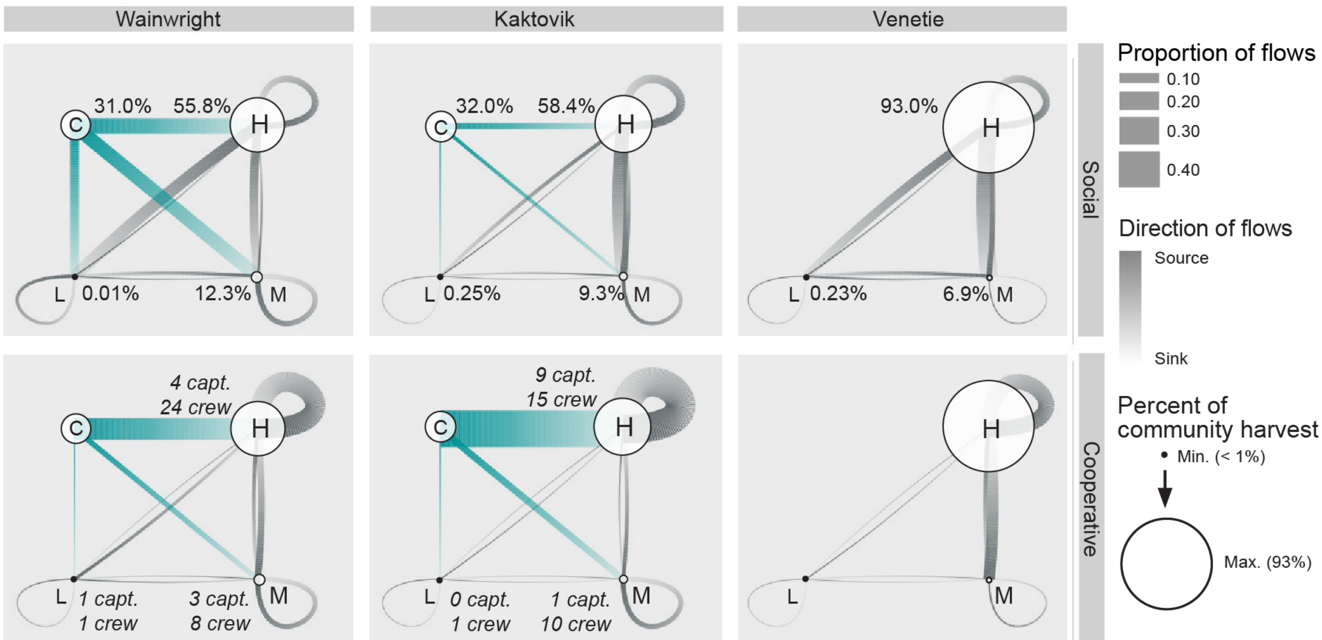
In the quantitative analyses section, we explore the community-level effects of cooperative-provisioning and social-provisioning on the equality of households' access to wild food. Then we explore the magnitude of wild food flows among household harvest terciles in all three communities, and from whaling crews to terciles in Wainwright and Kaktovik. Finally, we model wild food flows on household- and dyad-level attributes contributing to equality and equity. In the qualitative analyses section, we summarize households' responses about the perceived effects of sharing on household- and community-level well-being.

Quantitative analyses

Lorenz curves showed that self-provisioning was the least equally distributed type of inflow (curve farthest from the equality diagonal), meaning that many households provided very little wild food for themselves, while a few households provided a great deal (Fig. 4). For self-provisioning, the median household inflow as a percentage of total household inflows was very low—Wainwright: 1.8%; Kaktovik: 4.5%; Venetie: 11.5%. Cooperative-provisioning was slightly more equally distributed than self-provisioning, while social-provisioning was the most equally distributed (closest to the equality diagonal).

Gini coefficients in Fig. 4 were derived from the Lorenz curves and provide a unitary measure of the levels of equality for each of the three types of household inflows, as well as for all household inflows combined. The relatively high inequality of self-provisioning is reflected in Gini coefficients approaching 1.00, ranging from 0.79 to 0.84. Cooperative-provisioning inflows pushed wild food access toward equality among households, as reflected in reductions in the Gini coefficients over self-provisioning alone of 0.13, 0.09, and 0.05 for Wainwright, Kaktovik, and Venetie, respectively. The effects of social-provisioning inflows on equality were even stronger, as reflected in reductions over self-provisioning alone of 0.47, 0.28, and 0.18 in Wainwright, Kaktovik, and Venetie, respectively. The cumulative effect of social relationships reduced the Gini coefficient (i.e., increased equality) in all communities. The effect

Fig. 5. Social (top) and cooperative (bottom) flows between high (H), medium (M), and low (L) harvest terciles and whaling crews (C) by community. Nodes are sized by the percentage of total harvest represented by households in each tercile. Edges represent social and cooperative flows between crews (green) and households grouped into harvest terciles, and are weighted by the percentage of total flows of each type (social or cooperative) in each community, excluding within-tercile flows. Reflexive loops represent flows between households of the same harvest tercile and are weighted by the ratio of within-tercile flows to total community flows. Numbers in black text represent the percentage of harvest accounted for by each harvest tercile. Number of whaling captains and crew households within each harvest tercile are noted in italic text as captain, crew. Flows from captain/crewmembers' whaling efforts originate from crew nodes; their non-whaling flows (e.g., from a group caribou hunt) originate from their household's harvest-income tercile node.



was strongest in Wainwright, where the Gini coefficient decreased from 0.79 for self-provisioning alone to 0.49 for all inflows (a 0.30 decrease), but was also evident in Kaktovik (0.19 decrease) and Venetie (0.17 decrease).

Visualizing wild food flows

By aggregating households and crews shown in Fig. 2 into harvest terciles and whaling crews, Fig. 5 provides a succinct summary of wild food flows in the three study communities. Cooperative and social flows among households in the same group are termed "within-group" flows, and are represented by looping edges.

The flows in Fig. 5 include three bowhead whales landed by Wainwright crews, accounting for 120,465 lb (54,642 kg), and three whales taken by Kaktovik crews, accounting for 84,616 lb (38,381 kg) across social- and cooperative-provisioning categories. Venetie does not hunt whales because of its inland location. Fig. 5 also includes the flows of other kinds of wild foods: 283,617 lb (128,647 kg) in Wainwright, 138,999 lb (63,049 kg) in Kaktovik, and 92,034 lb (41,746 kg) in Venetie. We discuss social-provisioning first, then cooperative-provisioning.

Social-provisioning

For whales, some social relationships are based on ideals of equal distribution across members of a community. This is expressed in community feasts (Captain's feast and *Nalukataq*) and additionally household shares in Wainwright. In both communities, members of a household receive whaling feast shares if they choose, with a household of one receiving one share, and a household of 10 receiving 10 shares, etc. On average, Wainwright community members received 56.0 lb (25.4 kg) and Kaktovik received 48.3 lb (21.9 kg) per capita from both feasts. In contrast, sharing and the distribution of helper shares are culturally defined social flows that occur based on household-level relationships with others and specific contributions that households make to the whaling efforts of crews.

The effect of this mix of equality-based shares and household-specific roles and relationships on flows is apparent in Fig. 5. In Wainwright, 61,075 lb (27,703 kg) of social flows from crews were distributed across high-, medium-, and low-harvest groups (41%, 27%, and 22%, respectively). In Kaktovik, 7019 lb (3184 kg) of social flows from crews were distributed (60%, 34%, and 6%, respectively).

Social flows in Wainwright were much higher than social-provisioning in Kaktovik. There is an important caveat here, which emphasizes the flexibility of whaling efforts and social relationships overall. This was a result of a different pattern of distribution for the 2009 fall whale taken by one Wainwright crew. Rather than social-provisioning of whale occurring through feasts and some household-to-household ties—as occurred for all bowhead whales taken in Kaktovik—Wainwright's fall whale was distributed as household shares immediately after landing. Since household shares are defined as social-provisioning, the proportion of whale flowing through social-provisioning relationships was higher in Wainwright than in prior years.

For species other than whales, social flows occurred between all harvest groups, and patterns differed across communities. In Wainwright, most social flows went to low-harvest households (45%) compared to 22% and 33% to high- and medium-harvest households. In Kaktovik and Venetie, most social flow went to high-harvest households (54% and 51%, respectively). Medium-harvest households received 39% and 30%, respectively, and low-harvest households received 8% and 19%, respectively. Households in all terciles were givers and receivers of social flows, but higher harvests correlated positively with inflow in Kaktovik and Venetie.

Within-group social-provisioning flows (social-provisioning of any resource among households in the same group) tracked groups' harvest levels. Within-group social flows were highest for high-harvest groups in all communities, comprising 8% of all social-provisioning flows in Wainwright, 12% in Kaktovik, and 9% in Venetie. Within-group social flows were lowest for low-harvest groups, comprising 4.0% in Wainwright, 0.3% in Kaktovik, 0.6% in Venetie.

Cooperative-provisioning

For whales, cooperative flow patterns were determined by the shares allotted to *umialgit* and crew households. Households with captains and crew members fell almost entirely within high-harvest and medium-harvest groups (Fig. 5). In Wainwright, by far the largest portion of 64,302 lb (29,167 kg) of cooperative flows from whaling crews went to the high-harvest group (79%); much smaller portions went to the medium-harvest (18%) and low-harvest (3%) groups. A stronger pattern was evident for 65,321 lb (29,629 kg) of cooperative whale flows in Kaktovik, where the high-harvest group received 84%, the medium-harvest group 15%, and the low-harvest group 1%.

For species other than whales, cooperative-provisioning was also concentrated in high-harvest and medium-harvest groups. Cooperative-provisioning between high-harvest and medium-harvest households was particularly evident in Venetie, where medium-harvest households were a significant source of flows to the high-harvest group (Fig. 5). In all communities, low-harvest households had hunting relationships with high-harvest households, but the results emphasize productive hunting relationships between high-harvest households.

Compared with within-group social flows, within-group cooperative flows for high-harvest households were large. As a proportion of total community inflows, within-group cooperative flows totaled 28% in Wainwright, 41% in Kaktovik, and 21% in Venetie, again illustrating that highly productive households tended to hunt together. But medium- and low-harvest households also cooperated with other households in their harvest groups.

Modeling flow predictors

Across the three communities, social-provisioning accounted for 31% of all household inflows, while cooperative-provisioning (households working with members of other households and with crews) accounted for 43% of all household inflows. In this section, an additive multiplicative effects network regression model (Hoff 2018) is used to explore potentially influential predictors of wild food flows in social- and cooperative-provisioning. Unlike the previous section, which explored flows from crews and between aggregated groups of households, this section explores flows between household pairs (dyads) (see *Methods* and Fig. 2). We discuss social-provisioning first, and then cooperative-provisioning. Regression results, including posterior mean estimates and standard deviations, are shown in Fig. 6.

Modeling social-provisioning

The average social-provisioning inflow per household was 927 lb (420 kg) (25% of total inflow) in Wainwright, 1051 lb (477 kg) (22%) in Kaktovik, and 432 lb (196 kg) (37%) in Venetie. The difference between Wainwright and Kaktovik, on the one hand, and Venetie on the other, was a function of much larger cooperative-provisioning associated with the whaling complex. Close kin relationships and source household harvests were influential in all three communities. The significance and strength of other social-provisioning predictors varied by community.

The existence of a close kin relationship (parent–child, sibling, and grandparent–grandchild) between a source and sink household was the most influential predictor of social-provisioning flows across all three communities. A close kin relationship between a pair of households was associated with an average increase in social-provisioning flows of 89 lb (40 kg) in Wainwright, 322 lb (146 kg) in Kaktovik, and 175 lb (79 kg) in Venetie.

The magnitude of a household's wild food harvest was the other influential, cross-community predictor of social-provisioning flows. As would be expected, households with higher harvests had higher social outflows. For each 1000-lb (454-kg) increase in the total harvest of a source household, social outflows would be expected to increase on average by 24 lb (11 kg) in Wainwright, 29 lb (13 kg) in Kaktovik, and 25 lb (11 kg) in Venetie. In Wainwright, household harvests were influential in another way: a 1000-lb (454-kg) increase in the total harvest of a sink household was associated with a 13-lb (6-kg) decrease in social inflows to that household. In Kaktovik and Venetie, sink household harvests were not significant influences on sink household inflows.

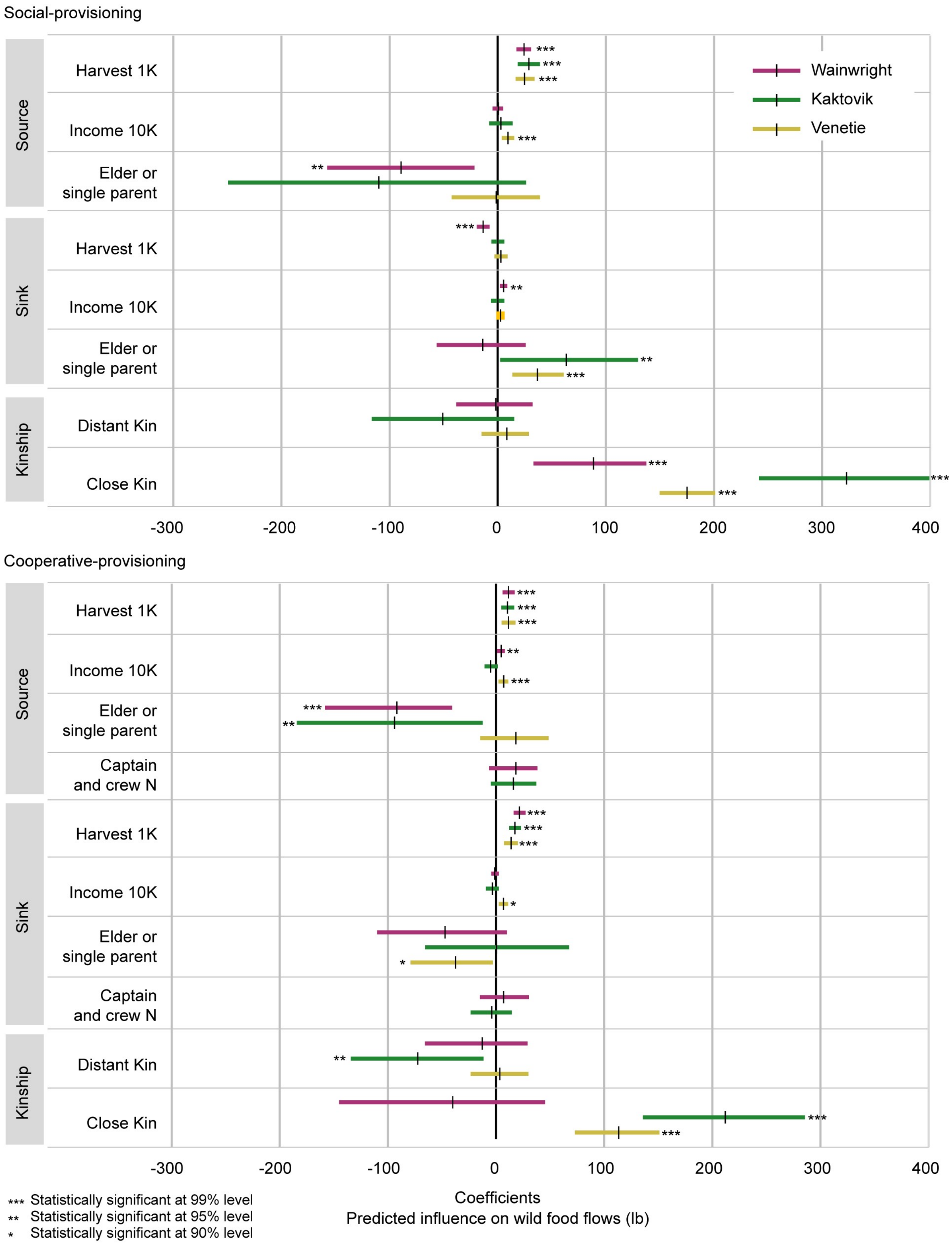
In Wainwright, elder or single-parent households were expected to give less than average to other households, a decrease of 89 lb (40 kg) in social outflows. In Venetie, elder and single-parent households were expected to receive more than average from other households, an increase of 37 lb (17 kg) in social inflows.

In summary, there was evidence of (1) a strong effect of close kinship on flows of shared wild food, (2) ability-based flows of food through social relationships (i.e., the more you have, the more you give) in Wainwright and Venetie, (3) need-based sharing related to harvest (i.e., the less you harvest, the more you receive) in Wainwright, and (4) need-based sharing related to single parent/elder status in Venetie.

Modeling cooperative-provisioning

The average cooperative-provisioning inflow was 1326 lb (604 kg) per household (44% of total inflow) in Wainwright,1681 lb (762 kg) (48%) in Kaktovik, and 291 lb (132 kg) (25%) in Venetie. As with social-provisioning, the higher flow magnitudes in the two

Fig. 6. Predicted influence of harvest, income, household type, crew membership, and kinship, showing coefficients and confidence intervals. Separate models were fit for each community, combined here to facilitate comparisons across communities.



Iñupiaq communities reflected the whaling complex. Because of the cooperative nature of the whaling complex, an additional household attribute—the number of captains or crew members in the household—was added to the cooperative model. The general pattern of influence for cooperative flows resembled the pattern for social-provisioning—source household harvests were again influential—but there were differences.

Compared to unrelated or extended kin households, cooperative flows (pounds) were on average 214 lb (97 kg) and 115 lb (52 kg) higher between closely related households in Kaktovik and Venetie, respectively. Close kinship was not a significant predictor of cooperative flows in Wainwright.

Households' wild food harvests were a highly significant predictor of cooperative flows but were only modestly influential. For each 1000-lb (454-kg) increase in total harvest by the source household, the average amount of cooperative inflow would be expected to increase by 13 lb (6 kg) in Wainwright, 12 lb (5 kg) in Kaktovik, and 13 lb (6 kg) in Venetie. For a 1000-lb (454-kg) increase in total harvest of the sink household, the average amount of cooperative inflow would be expected to increase by 23 lb (10 kg), 19 lb (9 kg), and 15 lb (7 kg) in Wainwright, Kaktovik, and Venetie, respectively.

Compared with other household types, sink households headed by an elder/single parent received on average 91 and 93 fewer pounds of cooperative inflow in Wainwright and Kaktovik, respectively. This result suggests that elder and single parent households may be less likely to engage in cooperative hunting activities due to age and time constraints. Elder/single parent household type was not a significant predictor of cooperative flows in Venetie.

The number of whaling captains and/or crew members in a household was not a significant predictor of cooperative flows for source or sink households in Wainwright or Kaktovik. Finally, an increase of US$10,000 in total income of the source household in Wainwright and Venetie would be expected to increase cooperative inflows by 4 lb (2 kg) and 9 lb (4 kg), respectively. In Venetie, the same increase in income of the sink household would be expected to increase cooperative inflows by 5 lb (2 kg).

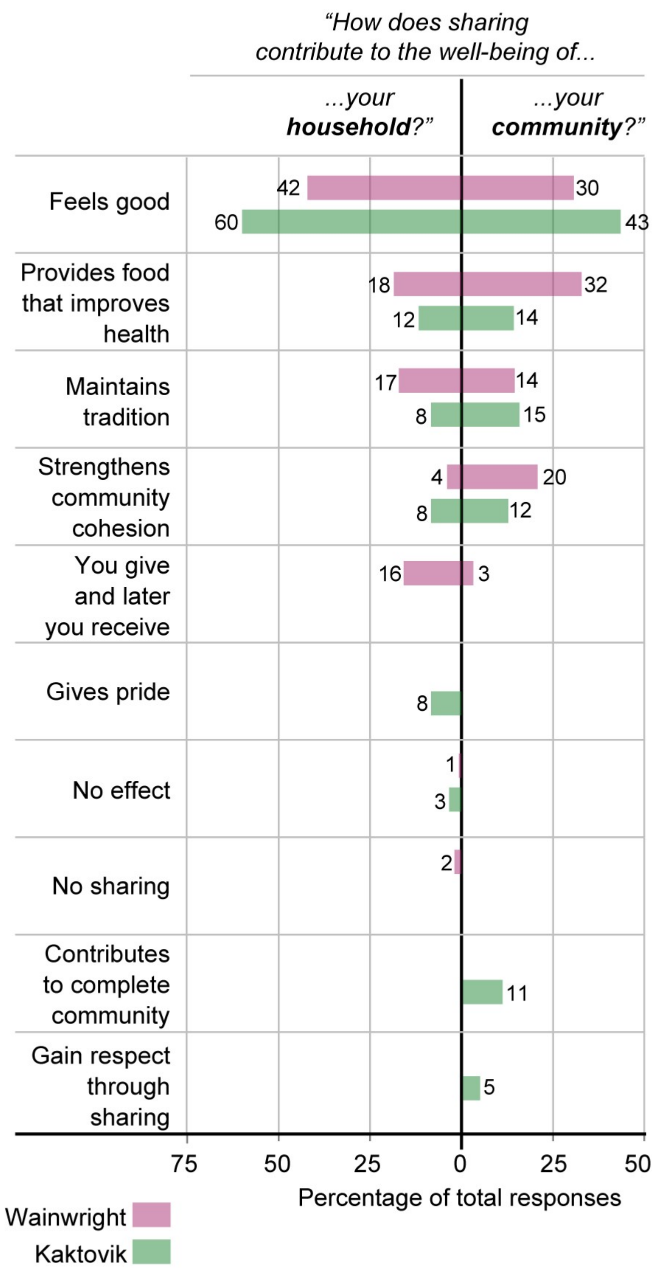
Qualitative analyses

In response to open-ended questions, respondents expanded on contributions of sharing to the well-being of communities and households (Fig. 7).

Four themes were expressed at household and community levels in both communities. By far, the most frequent theme for household-level effects of sharing on well-being was that sharing "feels good". The reasons underlying these positive feelings were diverse. One elder described it this way: "I don't know, I just…some say it's respect and some say it just makes you feel good because you are helping others." This idea also strongly resonated at the community level, signaling that sharing translates into broader feelings of good will.

Two other common themes—sharing provides food that improves health, and sharing maintains tradition—expressed that sharing improved well-being at both household and community levels. Community-level effects on "health" (respondents mentioned nutritional, physical, and psychological benefits) were more frequently mentioned in both communities, and Kaktovik respondents emphasized the role of sharing in maintaining tradition at the community rather than household level.

Fig. 7. Perceived effects of sharing on household and community well-being for Wainwright and Kaktovik. Responses are percentages of total responses across all respondents. Questions were not asked in Venetie.



A fourth theme in common emphasized community cohesion. Some respondents described sharing as contributing to household well-being by strengthening community cohesion. Less surprisingly, sharing was more frequently described as a community-level mechanism that increased social cohesion, and therefore well-being. Responses to this question also highlighted a link between social cohesion and cultural integrity, as expressed by a woman in Wainwright: "sharing makes us stronger because it says who we are as Iñupiaq."

There were differences in perceptions of sharing effects by community and level. Two infrequent themes expressed negative effects. A few respondents in both communities stated that sharing had no effect on their well-being because it did not occur frequently or at high enough magnitudes. A few Wainwright respondents similarly expressed the view that "no sharing" at the household level occurs.

Almost 16% of Wainwright responses highlighted the reciprocal nature of sharing as benefiting household well-being because "you give and later you receive." Approximately 3% of Wainwright households described similar positive effects at the community level.

Three themes specific to Kaktovik emerged. At the household level, 8% of Kaktovik respondents said that sharing gives them a sense of pride. The reciprocal of this sentiment was expressed at the community level by 5% of Kaktovik respondents as they "gain respect in the community through sharing" with others. Finally, 11% of Kaktovik respondents described sharing as contributing to a complete community. "Sharing defines us as a household and a member of the community," one Kaktovik respondent said. "It is very spiritual. It contributes both to economic aspects of the community, but also the spiritual."

DISCUSSION

We integrated quantitative and qualitative observations from three Arctic communities to explore social resilience through the lens of cooperative production and distribution processes for wild foods at household and community levels. Our analyses are unusual in the Arctic subsistence literature in that we relied on households' own reports of the amounts of wild food flowing through households' social networks. We explored two propositions. First, sharing and cooperation are distributional processes that increase the equality of access to wild foods at the community level. Second, sharing and cooperation embody cultural mechanisms that express trust and build social cohesion.

The links between sharing and cooperative institutions, on the one hand, and social resilience in northern communities, on the other, hinge on the premise that equality, equity, and social cohesion are critical components of social resilience. A recent National Academies of Sciences, Engineering, and Medicine (2021:8) report emphasized this connection: "Social capital and connectedness are among the most important factors in determining the resilience of a community". Similarly, *Michi Saagiig Nishnaabeg* scholar Leanne Betasamosake Simpson (2017:77) invoked the resilience of her ancestors, who:

> *…didn't accumulate capital, they accumulated networks of meaningful, deep, fluid, intimate collective and individual relationships of trust. In times of hardship, we did not rely to any great degree on accumulated capital or individualism but on the strength of our relationships with others."*

Simpson (2017) highlights both the material role of social networks in resilience, where resources physically move between people to potentially increase equality and equity, and the cultural role of social relationships, where the lived integration of human–animal relationships and processes of cooperation and sharing translate into greater shared capacity to respond to change. "Without a doubt," Mishler and Frank (2019:239) wrote, "sharing and togetherness are what have made the Gwich'in so resilient over the centuries." We described the roles of sharing and cooperation in social resilience in both contexts: material and cultural.

Quantitative analyses identified the material flows of wild foods among households through culturally resonant social relations, whih made it possible to assess the equality of households' food access at the community scale. We illustrated quantitative patterns of social and cooperative flows between harvest groups, paying particular attention to the unique role of whaling crews in providing food and distributing it widely. We explored mechanisms of ability- and need-based household-to-household sharing that gave rise to increased equality of wild food distribution in the community. Qualitative analyses (Fig. 7) highlighted cultural and emotional effects of social ties on household and community well-being, which we applied as a meaningful proxy for social resilience (Healey Akearok et al. 2019). Our results emphasized that sharing and cooperation are social mechanisms that both increase equality and generate positive feelings and community cohesion in communities.

One important caveat in framing our results is that the climatic, social, and economic conditions that contributed to harvests and social ties for 2009–2010 describe only 1 year in a long continuum of social and subsistence time. These complexities are important to consider as communities in the Arctic and elsewhere adapt to an Arctic that is moving "faster now" than in the past (Krupnik and Jolly 2002).

Lorenz curves (Fig. 4) showed that wild foods flowing through social relations increased the equality of access at the community level in all three communities. Successive shifts toward equality in the social- and cooperative-provisioning curves reflect the cumulative positive effect of social relationships on wild food access. Gini coefficients (Fig. 4) quantified the magnitudes of these changes, showing substantial and positive shifts toward equality at the community level. Social relations did not achieve parity, nor does history suggest that they ever have (Burch 1980, Buela 2020). However, household-level sharing did result in greater equality at the community level, a point often assumed but rarely quantified. In all communities, social-provisioning resulted in the largest shift toward equality of wild food access, followed by cooperative-provisioning. The sizes of effects differed among communities. Total inflows were distributed most equally in Wainwright, followed by Venetie and Kaktovik (bottom row, Fig. 4).

High-harvest households were important mechanisms for wild food redistribution based on aggregated flows among three household-harvest groups and from whaling crews (Fig. 5). In the two Iñupiaq whaling communities, flows from whaling crews exemplified cultural premises of distribution throughout communities. High-harvest households typically included one or more crew members, and thus became sources to redistribute parts of crew and/or captain's shares. High-harvest households (the top one-third) harvested most of the wild food in every community and (notably) engaged in cooperative harvests with other high-harvest households. They were less likely to engage in cooperative harvests with medium- and low-harvest households, but high-harvest households did contribute a large portion of the social flows to medium- and low-harvest households. Beyond simple distribution, the cultural patterns that provision and sustain crews and bring together hundreds of people onshore to bless, divide, cook, and share a landed bowhead whale also enact processes of social cohesion, well-being, and goodwill that characterize social resilience. One young whaling captain from Wainwright characterized the connections this way:

> *"My house and my cellar are open…ask me, tell me [you've taken some], just so I know it's not there anymore, and I know I need to get more. I expect just a smile on their face. It meant life and death in the day. Now that's not true, but it's still really important…A community wouldn't be a community without sharing. We wouldn't be Wainwright."*

High-harvest households, then, were the foundational providers in the study communities through whaling, non-whaling cooperative hunting, and self-provisioning, production that is later shared through social-provisioning. Qualitative responses emphasize these feel-good, pride, and cultural strength effects of sharing at both household and community scales. Wolfe (1987) and Wolfe et al. (2009) showed that household harvests tended to be highly skewed toward a small number of "super households." Using the corpus of comprehensive subsistence household survey data for Alaska at the time, Wolfe et al. (2009) modeled influential factors for household harvest levels and made the reasonable assumption that foods tended to flow out of high-harvest households and into low- and middle-harvest households. But in both studies (Wolfe 1987, Wolfe et al. 2009), the sources or destinations of wild foods given and received, and the quantities involved were unknown. In our study, the sources, destinations, and flow amounts were known. In the next section, we summarize our models of factors that influenced food flows among households rather than harvests by individual households as in Wolfe (1987).

Modeling food flows

Network regression provided quantitative evidence that supported existing narratives of wild food distribution between households on the basis of kinship, ability, need, and inclusivity (Fig. 7). We discuss these key factors and attributes that signal both distributional equity and equality—institutional patterns that are important for social resilience.

Kinship was a significant predictor of social-provisioning between households in all communities. Households shared more wild food with close kin than with extended family or non-kin. Knowing relatives and family lineages—*iḷisimaliq iḷagiiḷiġmik*—along with maintaining relationships with and caring for close family, are important values in Iñupiaq (Topkok 2015) and Dene cultures (Alaska Native Knowledge Network 2006). Previous studies highlighted the importance of kinship in the distribution of wild food for Canadian communities (e.g., Dombrowski et al. 2013a, b, Harder and Wenzel 2012, Natcher 2015) and the Nganasan and Dolgan of northern Siberia (Ziker 2007). Whether close or extended kin, our findings were in strong agreement with the narratives of sharing with relatives.

Total household harvest was a significant predictor of social outflows ("the more you have, the more you give"). Household harvest was also a significant predictor of cooperative flows, as high-harvest households tended to harvest wild food with each other. Sharing based on ability is part of being a good provider, which is a strong value in Iñupiaq (Bodenhorn 2000, Topkok and Green 2014, Hervé 2015), Dene cultures (Barnaby et al. 1977), and other northern Indigenous communities (Hovelsrud-Broda 1999, Usher et al. 2003, Natcher et al. 2021). High-harvest households in our study exemplified this pattern. Distribution patterns supported the idea that "the more you give, the more you receive," which also indicated that generalized reciprocity (Sahlins 1972)—with humans and other non-human relations—is an important dimension of harvesting and sharing wild food. In Wainwright and Venetie, households with higher incomes tended to have slightly higher cooperative outflows, possibly a result of their ability to provision fuel or food for harvesting activities.

The model suggested that other households' needs for wild foods was less influential than kinship and harvest factors but was still statistically significant. In Wainwright, households with lower total harvests and higher incomes received more in social inflows, while in Venetie and Kaktovik, elder/single parent households received more in social inflows. Households with these characteristics are often cited as those with whom wild food is shared first and frequently (Ziker 2002). Evidence of sharing to reduce inequities in access to traditional foods for elders and single mothers exists for Iñuit, as well as for Dene communities across the North (e.g., Kishigami 2000, Gombay 2010, McMillan and Parlee 2013). In Wainwright, higher household income predicted slightly higher social inflows. High-income household heads may have jobs that conflict with hunting or gathering (Collings et al. 1998), and high-income households may be able to purchase fuel or food for other households' harvesting activities and receive wild food shares in return (Wenzel et al. 2000, Ready and Power 2018).

The strength and significance of elder/single parent status and income as predictors of receiving wild food varied, which may reflect variation in individual households or the changing nature of "need" itself. For example, some elders and single parents remain active providers and are not "in need" despite their elder/single parent status. Additionally, what "in need" means may be changing in modern mixed economies where income can mitigate against lack of wild food (Ready 2016, Willson 2016). However, we did find evidence that wild foods flowed to those households that were not able to provision enough wild food, whatever the reason.

An unexpected finding—given whaling's substantial contributions to equality and equity in the two Iñupiaq communities—was that household members' participation in whaling crews (as captains or crew members) was not a significant predictor of households' wild food flows, either as sources or as sinks. For that, the whaling complex itself may be partly responsible. In the two whaling communities, every household receives whale shares irrespective of economic or social factors, which contributes to inclusivity and social connectedness. In essence it says, "It doesn't matter who you are or who you know, the whale harvest benefits everyone." Social connectedness is enhanced by feasts like *Nalukataq* and captain's feasts, which both honor those who provide food for the community and enact the social ideal of provisioning others (MacLean, *unpublished manuscript*). While Venetie did not participate in whaling, studies in other Dene communities have reported similarly positive outcomes from cooperative caribou and moose hunting; e.g., social connectedness, public appreciation for hunters, and increased access to wild food (McMillan and Parlee 2013).

Social resilience and longitudinal heterogeneity

By definition, social resilience is a longitudinal process characterized by diversity and disruption. Over time, groups of individuals, households, and communities encounter and grapple with diverse challenges, and outcomes vary. In periods of uncertainty and transition, cooperative institutions of wild food production and distribution act as cultural and emotional "muscle" memories. They support and guide people as they cohere around a set of problems.

A recent high-profile Arctic example is the watershed 2018 ruling at the International Whaling Commission in support of a "limited automatic renewal" for the Indigenous hunting quota for bowhead whale, which removed the need for the Alaska Eskimo Whaling Commission to defend their hunting quota every 4 years (Koenig 2018, Scruggs 2018). The success reflected the strength of collaborative social relationships built over 40 years between whaling captains and their crews, the Alaska Eskimo Whaling Commission, leadership and scientific expertise from the North Slope Borough, and US representatives from the National Oceanic and Atmospheric Administration, a co-management alliance that was grounded at every step in foundational Iñupiat values of sharing, cooperation, spirituality, and hard work (Topkok 2015, US Department of Commerce 2018).

On a smaller scale, communities with high levels of social capital across a range of contexts have been shown to experience less severe negative impacts from exposures. In an urban context, Klinenberg (1999) documented fewer deaths from record-setting heat in Chicago in neighborhoods with stronger social capital, and Lins et al. (2017) found higher corporate returns for socially responsible companies in the wake of the 2008 financial crisis. Further, MacLean et al. (2014:149) observed that "in times of change, [community-based social] networks provide essential support, operationalize community capacity, identify opportunities, and provide a focus for renewed optimism and hope". Our results and those of previous studies suggest that people who repeatedly exercise relationships of cooperation, distribution, and sharing can address challenges more effectively and equitably than those who lack such a tradition of cooperation.

These results align with Aldrich and Meyer's (2015) assertion that social infrastructure, not just physical infrastructure, is critical for community resilience. Berkes' (2007) work in the Canadian Arctic identified a mechanism for this effect, wherein sharing networks contribute to community adaptive capacity in the face of shocks because they are storehouses for knowledge and experience of past generations' responses to uncertainty. Day-to-day actions in social networks express these values under typical circumstances but can be leveraged into broader responses under more severe or novel conditions.

As households in northern communities engage with cash-generating opportunities, one would expect equality and equity outcomes across communities to change as well. Erickson (2021) points out that while communities across the North may be dealing with similar climatic or economic challenges, household diversity within and between communities is significant, so experiences and outcomes of change will be similarly diverse. Household heterogeneity across a range of socioeconomic and subsistence attributes theoretically indicative of sensitivity and adaptive capacity is being increasingly emphasized by northern scholars (Natcher 2009, Haalboom and Natcher 2012, Ready and Power 2018, BurnSilver and Magdanz 2019, Scaggs et al. 2021). Counter to this recognition of growing diversity is a tendency to universally categorize all northern communities as "vulnerable". This assumption is problematic because it homogenizes agency (Haalboom and Natcher 2012) and erases important inter- and intra-community differences—such as the ability to respond to challenges by drawing on unique social networks—that set the stage for social resilience over time. Our results suggest that the loss of high-harvest households in the community could threaten community social resilience. However, this ebb and flow of highly active individuals and crews in communities due to employment, age, and health is also foundational to mixed economies and subsistence livelihoods.

The previous point highlights that longitudinal analyses of community networks are needed to explore levels of dynamism inherent in social institutions given cumulative patterns of change (Baggio et al. 2016, Ready and Power 2018). The connections drawn between social relationships, equity, equality, and social resilience for Wainwright, Kaktovik, and Venetie are based on data that describe patterns for one 12-month period, which masks expected variability (and flexibility) in social ties year-to-year. Longitudinal network research of this kind is rare (Janssen et al. 2006, Matous and Todo 2015, Ready and Power 2018), but it has the potential to resonate strongly with local narratives of good and bad years, response, change, and adjustment.

CONCLUSION

The Arctic social-ecological-systems literature is replete with conceptual papers positing linkages between community resilience and the social capital embedded in networks of relationships. Our goal was more focused: using both quantitative and qualitative data, we sought to empirically explore the effects of sharing and cooperation in three Arctic communities on equality and equity of wild food access, and through the repeated expression of social institutions that support these flows, greater trust and social cohesion. Our results strongly support the connection between equality, social resilience, and social institutions expressed as wild food flows and ties that connect Iñupiaq and Gwich'in to each other, to the animals they depend on, and to the places where they live. The question of social resilience of Arctic communities is much larger than just these attributes, inclusive of governance outcomes; political and economic trends; social, health, and employment challenges; and climate change—all of which change over time. However, community networks of sharing, cooperation, and trust continue to emerge as foundational in the broader efforts to navigate change.

These social institutions have evolved for tens of thousands of years, shaped subtly and sometimes aggressively by climate, conflicts, values, development initiatives, and politics. Sharing and cooperation networks—and the mix of skewed, equal, and equitable access to wild food they embody—persist today, and will continue to shape and support adaptation and community resilience into the future.

Responses to this article can be read online at:
https://www.ecologyandsociety.org/issues/responses.php/13479

Author Contributions:

Shauna BurnSilver and James Magdanz collected and analyzed data and wrote the manuscript. Jesse Coleman analyzed data and wrote the manuscript.

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Data Availability:

Data/code are openly available in a public repository that issues data sets with DOIs. The data/code that support the findings of this study are openly available in anonymized and aggregated form from the Arctic Data Center at Household sharing and cooperation network and kinship data: Kaktovik, Wainwright, and Venetie, Alaska; 2009-2010. Reference number urn:uuid:31b56982-a9b2-4350-956c-7cc6bb260e87. Ethical approval for this research study was granted by the University of Alaska Fairbanks Institutional Research Board, approval number 05-70.

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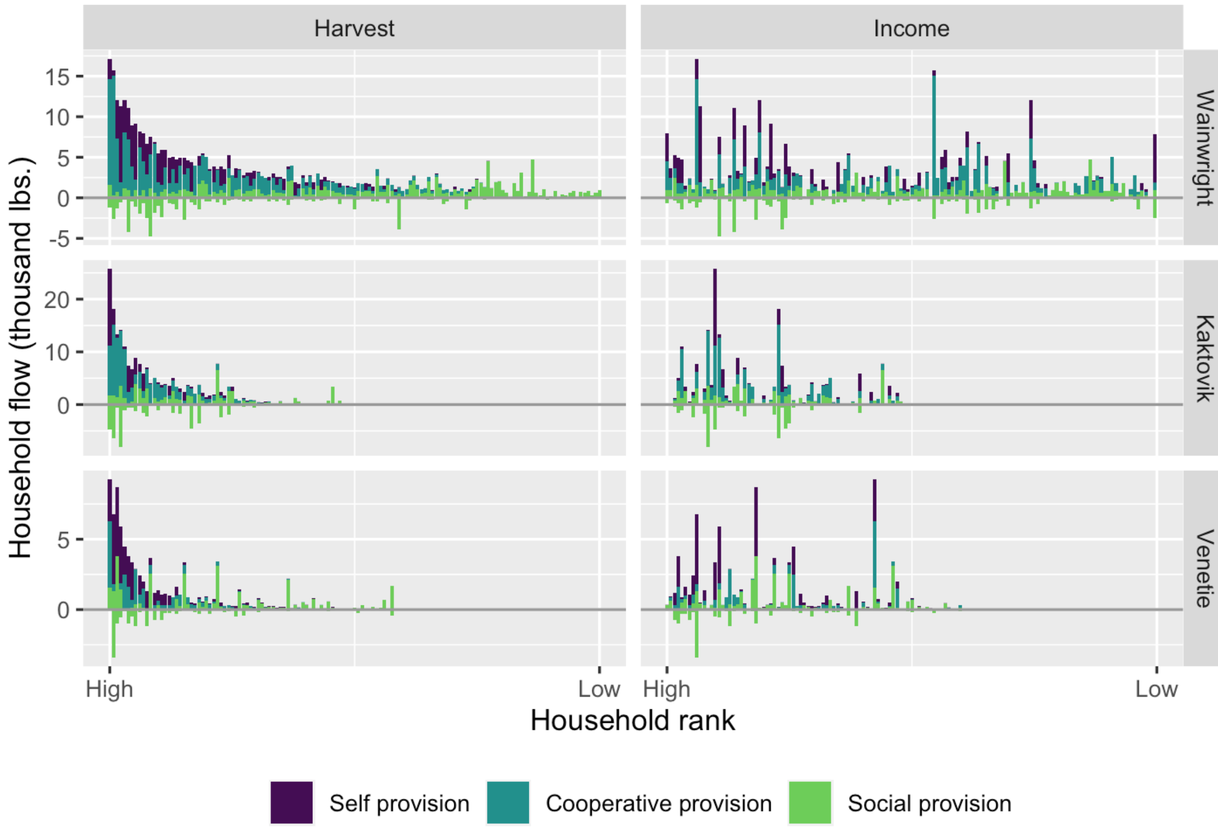
Appendix 1

1. Figure A1. Distribution of harvests by community



2. Conversion factors for calculating edible weights—ADF&G methods

   a. Respondents in this study reported the amounts of wild foods harvested and shared as individual animals ("25 salmon"), as animal parts (1 caribou shoulder), as volumes ("3 one-gallon Zip-Loc™ bags of blueberries"), and as weights (10 pounds of moose meat). Before analysis in this study, all harvests and flows of wild food by and among households were converted to estimated edible pounds, regardless of how they were reported to researchers. Weights were entered as reported, but other reports required conversion to edible pounds.

   b. The Alaska Department of Fish and Game Division of Subsistence has developed standard conversion factors to convert numbers and standard volumes of fish, wildlife, and plants to edible pounds. ADF&G's conversion factors vary by region and have been adjusted over time as new information is collected. A list of these conversion factors is publicly available at: https://www.adfg.alaska.gov/sb/CSIS/index.cfm?ADFG=main.conversionFactorSelRes

   c. Researchers in this study contracted with ADF&G data analysts to estimate total community harvests for the three study communities. From the community harvests, ADF&G used community population data from the study to estimate household and per capita harvests. Conversion factors used for this appear on ADF&G's list above, under Project ID 213.

d. ADF&G, however, did not estimate the edible pounds of food shared among households in this study. For that, researchers relied primarily on ADF&G's list of standard conversion factors, but when unorthodox units (e.g., 1 caribou shoulder) were reported, researchers relied on other sources. Binford (1978) provided weight estimates for component parts of caribou and wild sheep. Crapo et al (1993) provided weight estimates for fish and shellfish. Trites and Purdy (1998) and Ryg et al. (1990) provided weight estimates for marine mammals and their blubber mass. Bellrose and Kortright (1976) provided weight estimates for migratory birds.

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3. Info on error in calculating wild food flows (pounds) from survey data—ADF&G methods

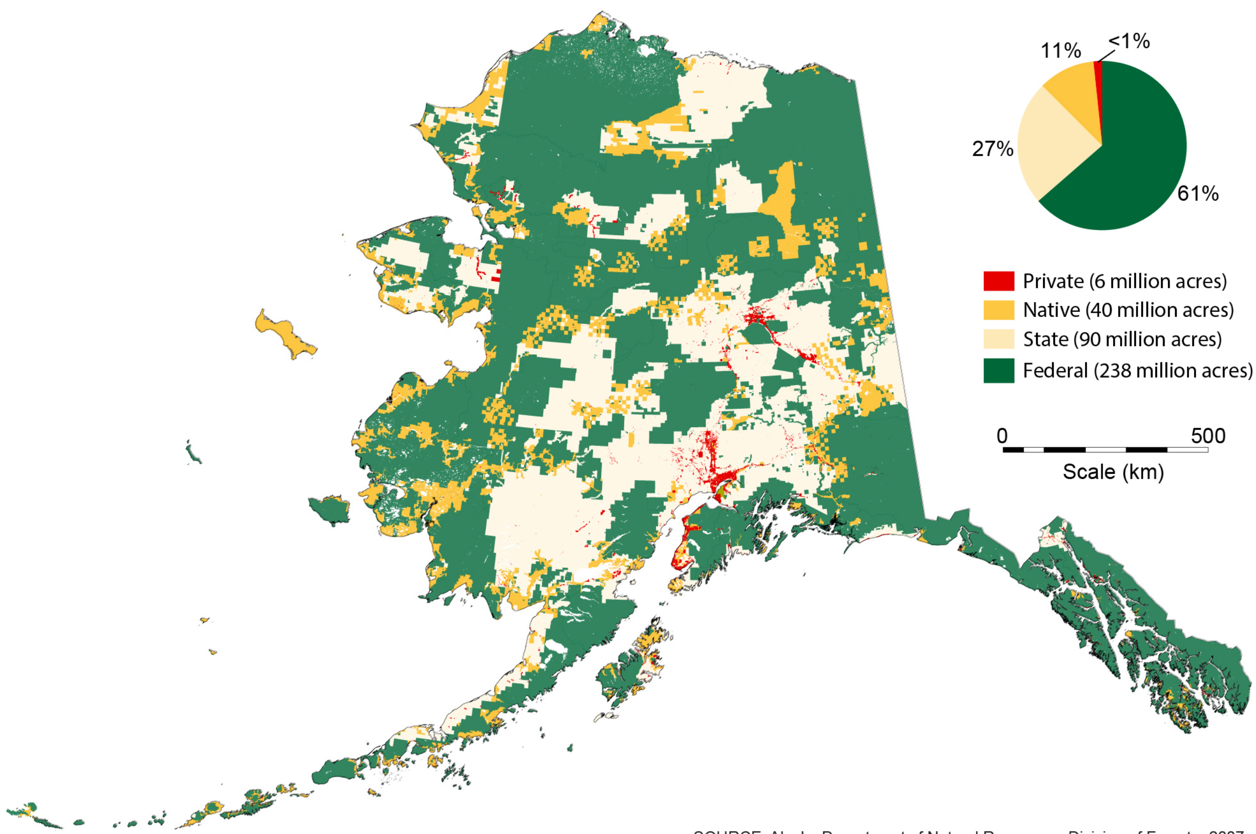
a. Harvest amounts and amounts received by households were reported in a variety of units: numbers of individual fish or wildlife harvested, gallons harvested (for berries), pounds received, boxes, coolers, bags, gunny sacks, etc. Standard conversion factors for individual species to pounds, gallons to pounds, and unorthodox units to edible pounds were completed using methods developed by ADFG (see Appendix II in Kofinas et al. 2016). These standard conversion factors applied in the study to estimate edible pounds for each harvest and type of social relationship.

b. "The project collected flows of subsistence foods coming into households, rather than simply harvests. As a consequence, respondents reported different parts they received as shares from hunts and gifts, such as caribou ribs, shoulder blades, hams, heads, tongues, even intestines. That method created unusual conversion challenges in calculated edible weights for a variety of (mostly) animal parts. Several archeologists have explored this problem. Binford (1978) proposed a measure called the "Modified Generalized Utility Index" (MGUI). Metcalf and Jones (1998) reevaluated Binford's work and concluded that simple weights were as reliable as the MGUI, and proposed a measure called the "Food Utility Index" (FUI). The FUI is the gross weight of a part minus the dry bone weight of a part, with a Binford averaging routine applied (Metcalf and Jones

1998:489–491). Wiklund et al. (2008) also have estimated Rangifer (caribou/reindeer) carcass weights. Buckland and Gérard (2002) provided estimates for component weights for domestic geese. These sources supported calculations and a conversion table for edible weights of individual parts of caribou and waterfowl" (Kofinas et al 2016:32).

4. Summary of subsistence management in Alaska

Figure A2. Map shows generalized land status in Alaska. Federal subsistence regulations apply to most lands in the green areas. State subsistence regulations apply in the other areas. Federal regulations apply to marine mammals and migratory birds regardless of land status. Subsistence management in Alaska involves seven federal agencies within the departments of the Interior, Agriculture, and Commerce; five divisions and sections within the Alaska Department of Fish and Game; two federal management boards, two state management boards, several indigenous marine mammal commissions, and several cooperative management bodies. The federal management bodies are advised by 12 regional advisory councils. The state management bodies are advised by more than 50 local citizen advisory committees, some of which are inactive. See Supplemental Tables n-n.



SOURCE: Alaska Department of Natural Resources, Division of Forestry 2007

Table A1. Management of fish and wildlife on federal public lands and waters. “Federal Public Lands” include lands managed by the National Park Service, US Fish and Wildlife Service, and US Forest Service, as well as most lands managed by the Bureau of Land Management. Altogether about 60% of the total area of Alaska.

	Subsistence Uses	Other Uses[a]
Jurisdiction	Federal Government	State of Alaska
Subsistence Priority	Local rural residents with customary and traditional uses	n.a.
Management Bodies	Regional Advisory Councils (10) Federal Subsistence Board	Alaska Board of Fisheries Alaska Board of Game Fish & Game Advisory Committees
Areas Affected	National Parks, National Monuments, National Wildlife Preserves, National Forests, most Bureau of Land Management lands (~65% of Alaska).	
Comments	• In times of resource shortages, federal managers may close federal public lands to non-eligible users, that is, to anyone who is not a local rural resident with customary and traditional uses. • On federal public lands, at the exact same time and place, members of a family may be subject to different hunting and fishing regulations. A family member who lives in a local rural village may hunt and fish under federal subsistence regulations, while a family member who has moved to a city must hunt and fish under state regulations, which may be different from federal regulations. • The State of Alaska has contested federal claims of jurisdiction to manage subsistence fishing in navigable waters within federal public lands. The Alaska National Interest Lands Act created a subsistence priority on “federal public lands.” The State has taken the literal view that “lands” means lands and not waters. Federal courts have twice upheld federal jurisdiction over waters in John v. United States (720 Federal Reporter 1214) and Sturgeon v. Frost (139 S.Ct. 1066 (2019).	

[a] “Other Uses” may include commercial fishing, personal use fishing, sport fishing, guided hunting, and incidental take (when non-targeted species are taken in commercial fisheries).

Table A2. Management of fish and wildlife on other lands and waters in Alaska. "Other Lands" include lands owned by the State of Alaska, Alaska Native Corporations, private companies, and private individuals (including individual Native allotments). Altogether about 40% of the total area of Alaska.

	Subsistence Uses	Other Uses[a]
Jurisdiction	State of Alaska	State of Alaska
Subsistence Priority	All Alaska residents	n.a.
Management Bodies	Alaska Board of Fisheries Alaska Board of Game Fish & Game Advisory Committees	
Areas Affected	State of Alaska lands, ANCSA Native Corporation lands, Native allotments, private lands, some Bureau of Land Management lands (~35% of Alaska)	
Comments	• In times of resource shortages, the Boards of Fisheries or Game may establish "Tier II" fisheries or hunts that limit access to individuals with the longest histories of use and the fewest alternative resources. • The state manages fishing under several bodies of regulations: subsistence, personal use, sport, and commercial fishing. • The state manages hunting under a single body of "general" regulations, on the theory that all hunting by Alaska residents is for subsistence. • Native allotments and Native corporation lands are private lands managed by the state. Therefore, Alaska Natives do not have a priority over other non-Native Alaska residents for subsistence uses on Native-owned lands. • The State of Alaska has jurisdiction of fishing in waters within three miles of the coast. The State has contested federal claims of jurisdiction over submerged lands off the coast of Alaska.	

[a] "Other Uses" may include commercial fishing, personal use fishing, sport fishing, guided hunting, and incidental take (when non-targeted species are taken in commercial fisheries).

Table A3. Management of marine mammals in Alaska marine waters. The Marine Mammal Protection Act prohibited the taking of marine mammals generally, but Congress created an exception for subsistence uses by "coastal Alaska Natives." The law excludes other residents of Alaska, including Indigenous Alaskans who do not qualify as "coastal. Coastal Alaska Native taking of marine mammals in the lower reaches of rivers also has been allowed, but no fixed boundaries for such taking have been established.

	Subsistence Uses	Other Uses[a]
Jurisdiction	Federal Government	PROHIBITED
Subsistence Priority	Coastal Alaska Natives	
Management Bodies	Alaska Beluga Whale Committee Alaska Eskimo Whaling Commission Aleut Marine Mammal Commission Alaska Nanuq Commission Alaska Native Harbor Seal Commission Ice Seal Committee Indigenous People's Council for Marine Mammals Eskimo Walrus Commission Traditional Council of St. George Island Tribal Government of St. Paul	
Areas Affected	North Pacific Ocean, Bering Sea, Chukchi Sea, and Beaufort Sea.	
Comments	• Section 119 of the Marine Mammal Protection Act allows NOAA Fisheries or the U.S. Fish and Wildlife Service to establish agreements with Alaska Native Organizations, including tribes. Co-management involves close cooperation and communication between Federal agencies, Native organizations, hunters, and subsistence users. • The United States adheres to the 1946 International Convention for the Regulation of Whaling, which sets out measures that the International Whaling Commission collectively has decided are necessary to conserve whale stocks. The U.S. Delegation to the International Whaling Commission relies heavily on the Alaska Eskimo Whaling Commission for information on Bowhead whale harvests and population estimates, as well as for enforcement of possible infractions. In 2018, the IWC approved the automatic renewal of Bowhead whaling quotas for Indigenous Alaska whalers.	

[a] "Other Uses" may include general hunting, guided hunting, and incidental take (when marine mammals are taken in commercial fisheries).

Table A4. Management of migratory birds in Alaska. All taking of migratory birds in Alaska is subject to migratory board treaties between the United States, Canada, Mexico, and Russia. Until 1999, these treaties did not allow spring and summer taking of migratory birds, which is when Alaska Natives traditionally harvested most migratory birds. Protests by Alaska Natives resulted in new treaty protocols, adopted in 1999, to allow spring and summer hunting by rural residents.

	Subsistence Uses	Other Uses[a]
Jurisdiction	Federal Government	State of Alaska
Subsistence Priority	Permanent residents of communities within included harvest areas	n.a.
Management Bodies	Alaska Migratory Bird Co-Management Council (AMBCC)	US Fish & Wildlife Service Alaska Board of Game
Comments	• After the protocols were adopted, cooperating agencies and organizations established the Alaska Migratory Bird Co-Management Council. The council first met in October 2000, and the first legal subsistence seasons opened in July 2003. • Council members represent the U.S. Fish and Wildlife Service, the Alaska Department of Fish and Game, and Alaska Native representatives from ten subsistence regions. Members work collaboratively to co-manage spring and summer migratory bird subsistence hunting. • The Anchorage and Fairbanks areas, the Kenai Peninsula, road-connected areas between Anchorage and Fairbanks, and southeast Alaska are excluded from participation in subsistence migratory bird harvests.	

[a] "Other Uses" include general hunting.

5. Non-responding households: regression included only edges where both nodes were surveyed. Dropped 15, 23, and 15 households from Wainwright, Kaktovik, and Venetie networks, respectively. Total sample size of nodes included 133, 63, and 79 in Wainwright, Kaktovik, and Venetie networks, respectively.

6. Regression results tables

   a. Table A5. Social flows (row = source household, col = sink household).

COMMUNITY	VARIABLE	ESTIMATE	LOWER CI	UPPER CI	P-VALUE
WAINWRIGHT	intercept	-782.38	-862.13	-714.81	0.00
WAINWRIGHT	HarvestTotal1K.row	24.36	17.27	30.62	0.00
WAINWRIGHT	IncomeTotal10K.row	0.55	-4.69	5.05	0.82
WAINWRIGHT	InNeed.row	-89.41	-157.87	-21.54	0.01
WAINWRIGHT	HarvestTotal1K.col	-13.38	-19.39	-7.55	0.00
WAINWRIGHT	IncomeTotal10K.col	3.49	0.18	6.84	0.03
WAINWRIGHT	InNeed.col	-13.89	-56.51	25.74	0.52
WAINWRIGHT	close.dyad	88.56	33.13	137.32	0.00
WAINWRIGHT	dist.dyad	-1.75	-38.40	32.10	0.93
KAKTOVIK	intercept	-736.73	-868.20	-607.13	0.00
KAKTOVIK	HarvestTotal1K.row	28.89	18.14	38.91	0.00
KAKTOVIK	IncomeTotal10K.row	2.80	-8.13	13.71	0.63
KAKTOVIK	InNeed.row	-108.92	-250.13	24.12	0.12
KAKTOVIK	HarvestTotal1K.col	0.08	-5.93	6.06	0.98
KAKTOVIK	IncomeTotal10K.col	0.02	-6.27	5.98	0.99
KAKTOVIK	InNeed.col	63.36	-3.20	130.11	0.06
KAKTOVIK	close.dyad	322.20	241.42	398.82	0.00
KAKTOVIK	dist.dyad	-50.86	-116.95	14.27	0.13
VENETIE	intercept	-372.25	-410.13	-331.50	0.00
VENETIE	HarvestTotal1K.row	24.84	16.45	33.35	0.00
VENETIE	IncomeTotal10K.row	9.46	3.71	15.19	0.00
VENETIE	InNeed.row	-1.49	-42.75	39.11	0.95
VENETIE	HarvestTotal1K.col	2.83	-3.02	8.57	0.36
VENETIE	IncomeTotal10K.col	2.51	-1.37	6.20	0.20
VENETIE	InNeed.col	36.78	12.93	61.49	0.00
VENETIE	close.dyad	174.88	150.28	200.59	0.00
VENETIE	dist.dyad	8.28	-15.06	28.76	0.46

   b. Table A6. Cooperative flows (row = source household, col = sink household).

COMMUNITY	VARIABLE	ESTIMATE	LOWER CI	UPPER CI	P-VALUE
WAINWRIGHT	intercept	-998.27	-1092.44	-913.32	0.00

WAINWRIGHT	HarvestTotal1K.row	13.04	7.30	18.71	0.00
WAINWRIGHT	IncomeTotal10K.row	4.16	0.37	7.68	0.03
WAINWRIGHT	InNeed.row	-90.52	-157.03	-39.39	0.00
WAINWRIGHT	N_CaptCrew.row	19.65	-5.17	39.80	0.10
WAINWRIGHT	HarvestTotal1K.col	23.08	17.55	28.76	0.00
WAINWRIGHT	IncomeTotal10K.col	0.18	-3.14	3.84	0.92
WAINWRIGHT	InNeed.col	-45.87	-108.60	11.46	0.11
WAINWRIGHT	N_CaptCrew.col	8.48	-13.53	31.81	0.46
WAINWRIGHT	close.dyad	-38.72	-143.85	46.53	0.42
WAINWRIGHT	dist.dyad	-11.40	-64.44	30.61	0.64
KAKTOVIK	intercept	-597.36	-697.18	-506.97	0.00
KAKTOVIK	HarvestTotal1K.row	12.04	6.32	18.14	0.00
KAKTOVIK	IncomeTotal10K.row	-3.60	-9.42	2.90	0.27
KAKTOVIK	InNeed.row	-92.51	-182.97	-11.07	0.03
KAKTOVIK	N_CaptCrew.row	17.45	-3.47	38.72	0.10
KAKTOVIK	HarvestTotal1K.col	18.77	13.57	24.38	0.00
KAKTOVIK	IncomeTotal10K.col	-2.11	-8.01	3.86	0.50
KAKTOVIK	InNeed.col	1.69	-64.18	68.85	0.96
KAKTOVIK	N_CaptCrew.col	-2.54	-22.30	16.01	0.81
KAKTOVIK	close.dyad	213.49	137.42	286.34	0.00
KAKTOVIK	dist.dyad	-70.99	-133.04	-10.17	0.03
VENETIE	intercept	-411.50	-470.11	-361.42	0.00
VENETIE	HarvestTotal1K.row	13.06	6.52	19.34	0.00
VENETIE	IncomeTotal10K.row	8.81	3.98	13.05	0.00
VENETIE	InNeed.row	19.78	-13.33	50.07	0.27
VENETIE	HarvestTotal1K.col	15.30	8.70	21.55	0.00
VENETIE	IncomeTotal10K.col	5.03	0.75	9.46	0.03
VENETIE	InNeed.col	-36.34	-77.79	0.17	0.07
VENETIE	close.dyad	114.89	74.46	153.32	0.00
VENETIE	dist.dyad	4.92	-22.30	31.38	0.72