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Making Landfall: Linkages between Fishing Communities and Support Services

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ABSTRACT
The relationship between the fishing industry and the fisheries-related support service sector creates economic benefits for communities through the strong linkages between fishermen and their land-based suppliers and the induced or multiplier effects from fisheries revenue. The support service sector is embedded within fishing communities where the impacts of fisheries management changes are perpetuated. This article examines the potential for such impacts by evaluating the diversity of fishing gear use, ex-vessel revenue, presence of processing plants, public moorage, and haul-out or tidal grids, and the number of vessels in a community, in relation to the availability of support services in communities in Alaska. The results show that the presence of a processor and haul-out facilities in a community significantly affects the number of support service businesses; however, there is not a strong association with the number of vessels or ex-vessel revenue. One hypothesis is that fishermen often travel to other communities to obtain services. We evaluate this hypothesis using social network analysis to evaluate transfers of revenue for fishery-related goods and services. Ultimately, this informs the exploration of the importance of support service businesses and fishery-support infrastructure to the continued well-being of fishing communities.

KEYWORDS
Alaska; fishing communities; fishing industry; support services; well-being

Introduction

As fisheries become increasingly regulated, the fishermen and communities that depend on them are affected in varying ways. Many studies have shown that changes in fisheries management create different socioeconomic impacts for different communities (e.g., Clay, Pinto da Silva, and Kitts 2010; Clay and Olson 2008; Hall-Arber 2007; Tuler et al. 2008). Some communities may benefit through increased access to fisheries resources through receipt of quota or other catch allocations, or protection of historical harvesting participation through a limited entry permit system. Others may be negatively affected and not receive such allocations or permits depending on how the management system is designed. Community resilience to such changes will also vary based on the overall dependence of each community on

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the affected fishery(ies) and their engagement in fisheries overall, as well as their social characteristics that may affect their adaptive capacity (Himes-Cornell and Hoelting 2015; Himes-Cornell and Kasperski 2015).

In the United States, the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) requires the eight regional fishery management councils to develop management plans consistent with 10 National Standards for fishery conservation and management. National Standard 8 dictates that conservation and management measures must take into account the importance of fishery resources to fishing communities to both provide for their sustained participation and to minimize adverse economic impacts. Furthermore, the term "fishing community" is defined in the implementing regulations for National Standard 8 to encompass communities that are dependent on "directly related fisheries-dependent services and industries (e.g., boatyards, ice suppliers, tackle shops)" (50 C.F.R. Sec. 600.345).

Many management actions, such as limited entry systems, large-scale changes in total allowable catch, and the implementation of catch share programs, can have significant effects on the overall level of fisheries activity or participation in specific areas. As Knapp and Lowe (2007) observed, the rationalization of the Bering Sea and Aleutian Island crab fishery led to a significant reduction in vessel spending and infrastructure use in communities in the Aleutians East Borough that contributed to the overall economic impact of the program. McClintock, Baines, and Taylor (2000) found that communities with businesses closely linked to the fishing industry experienced boom and bust cycles mirroring the local fish abundance. The existence and condition of various support service businesses and infrastructure has been recognized as an important indicator of community fishery dependence (Himes-Cornell and Hoelting 2015; Jacob et al. 2001, 2010). Likewise, the individuals that maintain community infrastructure and provide fishing support services are dependent on the health and persistence of fisheries for their own well-being (Himes-Cornell and Hoelting 2015). Given the implicit connection between fishing communities and the related support sector, it is imperative that fisheries managers and researchers understand the interconnectedness of fishermen, communities, and the services and infrastructure that support them. This understanding will allow managers to adequately weigh the economic impacts of management alternatives on a community-specific basis.

The incrementalism theory of community reliance on natural resources argues that the formation of a community economy is activated by natural resource extraction, which then encourages the growth of the economy with backward linkages to businesses that support the resource extraction (Richardson 1979; Jacob et al. 2001). Seung and Waters (2009) define backward linkages as the connection between a particular sector and its upstream suppliers through goods or services that are used as intermediate inputs. Backward linked industries in fishing include shipyards, skilled tradesmen like welders and machinists, hydraulics manufacturers, marine electronics providers, and providers of refrigeration systems, nets, and fuel. When fishermen spend the revenue they earn from fishing at local businesses such as hardware stores, they create induced or multiplier effects in a community because the fishing revenue is then generating revenue for the support service sector (Chen, Hunt and Ditton 2003; Jacob et al. 2001).

The value of the support service sector in terms of jobs and revenue in Alaska has been documented in reports such as *The Seafood Industry in Alaska's Economy* (Northern Economics 2009) and the *Economic Value of the Alaska Seafood Industry* (McDowell Group 2013). The McDowell Group (2013) estimated that in 2011 the support service sector employed 8,000 people in Alaska and produced $1.5 billion in economic output. The value of the support service sector that is created as a result of the multiplier effects of harvesting revenue accumulates at the local community level. Furthermore, communities provide the geographic basis for giving context to backward linkages in fisheries (Jacob et al. 2001; St. Martin 2006). However, Bohnsack et al. (2002) note that studies of how changes in fisheries management affect these linkages and influence a community's sustained participation in fisheries through the support service sector are sparse. For example, a decrease in the catch or profit of a group of fishermen could impact support service businesses if there is a reduction in their demand for products or services from those businesses (Seung and Waters 2009). A cascade of effects could then occur as the support service businesses decrease their business expenditures (e.g., reduced supply purchases and staff positions), which would reduce the overall flow of money coming into the support sector that ultimately gets spent in the local community or other communities to which the businesses are connected.

The existence of support service businesses and fishery-support infrastructure within a community is hypothesized to contribute to a community's capital for sustained participation in fisheries. This community capital of support services would help communities attract and maintain active fishermen in their communities and therefore foster the inflow of harvesting revenue that then induces further economic activity in the community. Existing work on this topic has often been fishery or sector specific (e.g., Knapp 2006; Bohnsack et al. 2002; Chen, Hunt, and Ditton 2003; Seung and Waters 2009; Portman 2008). However, a fishery-specific focus may miss the compounding impacts on an individual community from impacts in different fisheries in which its residents participate.

Focusing on communities in Alaska that participate in a wide range of North Pacific fisheries, this article aims to inform this gap by examining the critical link between fisheries management impacts on the support service sector and the communities where the impacts are felt. Regional impact models quantify economic impacts but do not necessarily describe in detail which communities are affected. Existing literature suggests that the economic impacts on communities from a specific perturbation vary (e.g., Clay et al. 2010; Clay and Olson 2008; Hall-Arber 2007; Tuler et al. 2008). Through the use of community-level survey data, the relationship between characteristics of the fisheries-related economy in a community and the presence and network of fisheries support services and infrastructure is explored. This research includes a wide variety of commercial fishing-related support service businesses, from haul-out facilities to fishing gear repair and storage. The article is structured as follows: an overview of the data sources, the structure of the regression model and social network analysis, the regression and network results, and finally, insight into what can be gained by better understanding the relationship between fishing activity and the support service sector.

Methods

Survey development and implementation

For the analyses presented here, data that were collected through the *Alaska Community Survey* in 2011 and 2012 were used (for a complete explanation see Himes-Cornell and Kent 2014a, 2014b). The survey instrument was developed through consultation with experts in survey design as well as representatives of communities that were part of the overall respondent population. Cognitive interviews (in-depth one-on-one interviews) were conducted in

2010 with a small number of community representatives to refine the survey instrument. The questionnaire collected information related to the capacity of individual Alaskan fishing communities to host fishing activities, the level and types of fishing occurring in each community, and how communities are being differentially affected by fisheries management. The questionnaire was sent to the municipal office of each community, and if applicable, the tribal office. A single survey was designed to be completed by multiple individuals depending on area of expertise. The sampling frame for the population of interest included 193 fishing communities, composed of the 136 communities that were profiled in the 2005 *Community Profiles for North Pacific Fisheries—Alaska* (Sepez et al. 2005) and an additional 57 communities that were profiled for the 2013 update (Himes-Cornell et al. 2013). The additional 57 communities were selected due to their involvement in commercial, recreational and subsistence fishing in Alaska, as determined using a data envelopment analysis (DEA) that focused on scoring communities based on their overall dependence and reliance on fishing to support their well-being (Himes-Cornell et al. 2013). For community selection, 2009 fishing data for each community were used in the DEA, which then assigned a score to each community based on multiple indicators of participation in various fisheries. As a nonparametric approach, DEA may more effectively capture fisheries participation across multiple indicators without giving a pre-determined weight or importance to each indicator. The communities selected through the DEA model demonstrated strong participation in any unique combination of commercial, recreational, and subsistence fisheries. Communities were framed according to the definition used in the Magnuson-Stevens Act (P.L. 109–479).

The survey was implemented as a mail survey and the protocol followed a modified Dillman et al. (2009) tailored design method that included an advance letter, an initial mailing of the survey instrument, a postcard follow-up, a telephone follow-up, and second full mailing. The survey was sent to the municipal and tribal office of each community if offices for both existed. If surveys were returned from both entities in a community, the data were combined into one dataset per community. A set of rules was developed based on the most common issues observed in comparing duplicate surveys that precluded basic merging of similar responses. For multiple response questions (i.e., check all that apply), responses were combined between the two surveys to report the widest spread possible.

For the 2011 implementation of the survey, surveys for 115 unique communities were returned (response rate of 59.6%). For the 2012 survey implementation, surveys for 114 unique communities were returned (59.1% response rate). Based on a comparison of responses between the two years of data for the variables used here, there was not a substantial difference in the reported data in the span of one year. Given this, a combination of the 2011 and 2012 survey data were used in an effort to broaden the communities represented in these analyses; no communities were duplicated through the use of two years of data. This resulted in a dataset representing a total of 154 unique communities or 79.8% of the survey population.

Data analysis

To explore the specific characteristics that may influence the size of the support service sector within an individual community, a regression model was developed to test the significance of a subset of data collected in the survey (the survey questions used for this analysis can be found in the Appendix). Using the assumption that fisheries-related support services arise in a community as a result of fishing activity, a negative binomial regression was run on several potential variables that characterize inputs from fisheries to support services. A negative binomial regression was appropriate because the dependent variable was a non-negative count variable and the mean and variance were not equal (i.e., the distribution of support service businesses was over-dispersed, thus a Poisson regression was unsuitable) (Kumar and Dansereau 2014). The dependent variable incorporated in the model was the number of different support service categories represented within a community (Question 16 of the *Alaska Community Survey*). It is important to note that the variable represents the type of services and not the overall number of businesses within a community. The six independent variables tested in the regression model were ex-vessel revenue based on vessel owner residency (ADF&G and CFEC 2011), the number of vessels in a community based on owner residency (CFEC 2011), the presence of a shoreside fish processor in town (ADF&G 2011), the number of fishing gear types used by community residents (Question 15 of the *Alaska Community Survey*), and the presence of haul-out facilities or a tidal grid and public moorage (Question 16 of the *Alaska Community Survey*).

Ex-vessel revenue was hypothesized to influence the nature of the support service sector in a particular community because it represents the potential monetary inputs to the support service sector. The presence of a shoreside processor may attract vessels to a particular community as it is operationally efficient for fishermen to be located near the services and infrastructure they need (Copes and Charles 2004); therefore, it was hypothesized that communities with processing capacity in town would also have more support service businesses. Different fleets may need different support service businesses; for example, live delivery fisheries, such as crab, do not have the marine refrigeration system needs of trawl vessels. Indeed, Seung and Waters (2009) found that there were differences in the strength of the backward linkages between different gear-types and sectors in Alaska when they ran a data simulation. This potential association was added to the model using the number of different gear types in use as reported by communities. Additionally, more vessels homeported in a community might create a greater demand for support services. Finally, the availability of haul-out facilities and public moorage was hypothesized to influence the presence of particular support services in a community because many services necessitate a vessel to be present and/or dry-docked to complete.

Variables

An average of data from the years 2000 to 2010 was used to represent vessel count and ex-vessel revenue for each community. The use of a range of years prior to the years used for the dependent variable (2010 and 2011) was due to the hypothesis that impacts of increased or decreased business or revenue would display a lagged relationship with the presence of support service business. An individual business may be able to weather a few bad seasons without shuttering, or conversely, new businesses would likely not appear immediately after an increase in revenue within a community. The 10-year range was chosen to account for this potential lag of unknown time.[1] The presence of a processor was represented as a binary variable created using 2010 data on the number of processors that operated within a community. These secondary data were provided by the Alaska Fisheries Information Network, which obtains data on revenue and vessel counts from Alaska Commercial Fisheries Entry Commission (CFEC) fish tickets. Data were connected to vessel owner residency based on vessel registration with the CFEC. Data on the presence of haul-out facilities or tidal grids and diversity of gear types were sourced from the *Alaska Community Survey*. These data were used to create a binary variable that indicated presence or absence of either haul-out or tidal grid facilities. Communities were asked to report the linear feet of public moorage they had available for permanent and transient vessels. These data were used to create a binary variable that indicated presence or absence of public moorage. Communities also reported which gear types were used by residents of the community during the fishing season. These data were converted to a count variable of the number of different gear types used in each community. Data analyses were completed using Stata, Excel, and Tableau software packages.[2]

Social network analysis

In the *Alaska Community Survey*, communities provided information on where fishermen from their communities go for services that are not available in their community. A total of 128 communities provided a response to this question. These data were converted into a binary matrix that represents the social network connections between communities and the directionality of the relationship. This type of social network analysis can be used to map the flow of goods and services between communities. The network was then analyzed using UCINet (Borgatti, Everett, and Freeman 2002) and measured degree centrality, which evaluates activity in a network through the number of direct links each node or community has with all other nodes in the network (Hanneman and Riddle 2005; Ernoul and Warden-Johnson 2013). Specifically, in-degree centrality was measured, which represents how many times a particular community (node) was nominated by other communities (nodes). A visual representation of the social network was created using the path shelf function in Tableau for From-To Pattern Analysis.

For infrastructure or support service businesses that are not available in their home community, fishermen may have to travel elsewhere and therefore divert a portion of their ex-vessel revenue to businesses in other communities. Additionally, fishermen may obtain goods and services in areas more proximate to where they fish rather than where they live. To understand how communities in the state may be interrelated based on the patterns of movement of fishery-related goods and services, a social network analysis was completed on responses by community leaders to the survey question about where their residents go for services not available within their own community. The degree centrality of the network as a whole lends itself to a discussion of the existence of hub communities in Alaska that smaller, perhaps more remote, communities depend on for goods and services specific to fishing activity.

Results

Community availability of fishery-support services

The first component of this analysis was to determine where fishery-related support services were located across the state. Communities were presented with 21 services to consider. There were relatively few communities which reported to have certain types of support service businesses or infrastructure, while other services were more prevalent. For example, businesses such as boat fuel sales were reported by many communities ($n = 108$), but only 6 communities reported having a fishing gear manufacturer in town and 19 reported having a marine refrigeration business (Table 1). Additionally, a total of 12 communities reported that they had a tidal grid for vessels larger than 60 tons and 16 reported having a haul-out facility for over 60 ton vessels. The presence of these businesses across the state in individual communities is shown in Table 1. There were 14 communities that indicated that they did not have any of the support service businesses in question. Figure 1 provides a representation of the number of different support service business types by community. A total of 129 unique communities provided a response to the question on support service businesses, out of the 154 that responded to the survey across both years of data collection. From those 129, data for all variables in the model existed for 127 communities. Therefore, the sample size for the regression is 127 communities.

Clustering of services in individual communities using the self-reported presence of specific types of fishery-related support services was explored. Communities that reported having many of the services shown in Table 1 are considered to be hubs of fishing activity. The number of different support service businesses per communities ranged from 0 to 21. Petersburg, Kodiak, and Homer were each self-reported hubs of commercial fishing-related support services with all of the 21 support services. Five communities reported having 19 of the support services from the list: Wrangell, Sitka, Sand Point, Ketchikan, and Cordova. On the other end of the spectrum, 22 communities reported having only one support service from the list. The average number of different businesses across communities was 6.4 while the sample variance was 34.0; thus supporting the use of the negative binomial regression as opposed to a Poisson regression, which relies on the assumption that the variable is not over-distributed.

Regression results

The quantity of different types of support service businesses within individual communities was used as the dependent variable in a negative binomial regression with six independent

Table 1. Count of fishery support service businesses and infrastructure in respondent communities.

Business type	Number of communities	Percentage of responding communities
Fishing gear sales	66	51.97
Fishing gear manufacturer	6	4.72
Boat repair	54	42.52
Electrical	40	31.50
Welding	67	52.76
Mechanical services	58	45.67
Machine shop	44	34.65
Hydraulics	35	27.56
Haulout facilities for small boats (less than 60 tons)	58	45.67
Haulout facilities for large boats (more than 60 tons)	16	12.60
Tidal grid for small boats (less than 60 tons)	35	27.56
Tidal grid for large boats (more than 60 tons)	12	9.45
Commercial fishing vessel moorage	57	44.88
Drydock storage	39	30.71
Marine refrigeration	19	14.96
Fishing business attorneys	11	8.66
Fishing related bookkeeping	32	25.20
Boat fuel sales	105	82.68
Fishing gear repair	41	32.28
Fishing gear storage	53	41.73
Ice sales	52	40.94
Community does not have any of the above businesses or infrastructure	14	11.02
Number of unique communities that responded	127	

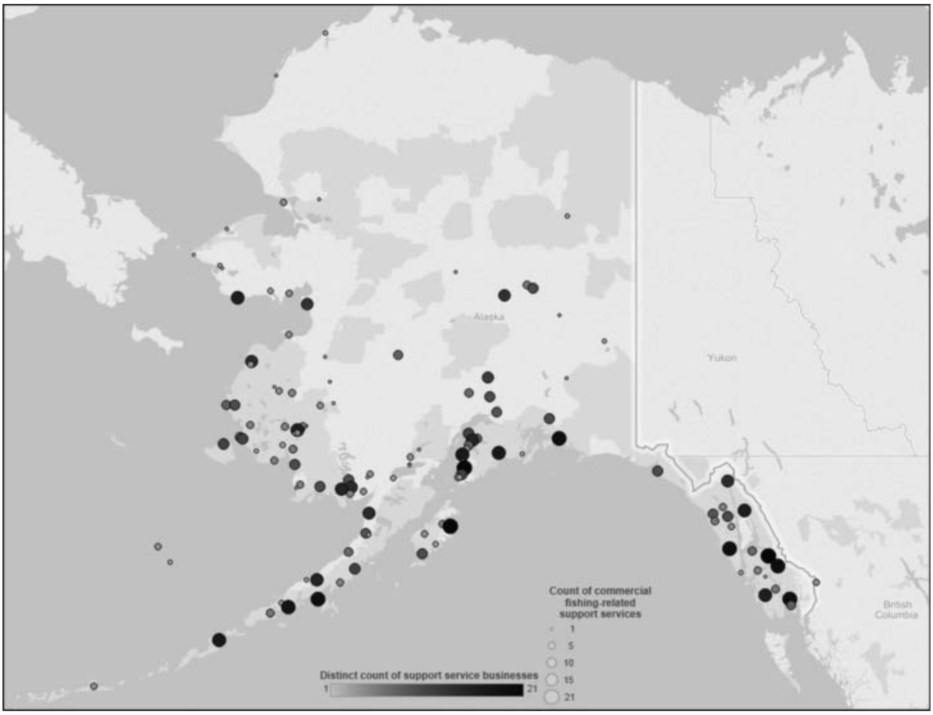

Figure 1. Number of fishing-related support services by community.

variables: ex-vessel revenue, presence of public moorage, count of vessels, presence of a processor, number of commercial gear types based out of the community, and the presence of haul-out facilities or tidal grids. The presence of a processing plant in the community had a positive and statistically significant relationship with the number of types of support service businesses, at a significance level of $p = .001$ (Table 2). The presence of haul-out facilities or a tidal grid also displayed a statistically significant and positive association with the number of different support service businesses ($p = .001$). There was a significant relationship between the number of vessels in a community based on vessel owner residency at a p-value of.10. The ex-vessel revenue, presence of public moorage, and diversity of gear type variables did not return significant associations with the response variable.

Table 2. Negative binomial regression.

Independent variable	Coef. (SE)
Ex-vessel revenue based on vessel owner residency	−0.003 (0.008)
Presence of public moorage	0.069 (0.148)
Count of vessels based on vessel owner residency	0.001 (0.001)*
Presence of processor in community	0.590 (0.141)***
Number of gear types in community	0.031 (0.044)
Presence of haul-out facilities or tidal grid	0.785 (0.150)***
Constant	0.830 (0.108)***
McFadden's Pseudo-R^2	0.131
N	127

*$p < .10$, ***$p < .001$

The ex-vessel revenue variable did not return a significant relationship with support service businesses in a community. It was hypothesized that this relationship is complicated by an existing web of support service supply across communities that may act as endogeneity in the model. To test for endogeneity, a Hausman test was run using weighted average price as an instrument for ex-vessel value. The test returned a p-value of 0.7047, therefore, it was concluded that there is not significant endogeneity in the model due to the ex-vessel value variable. Another possibility of the lack of significance of the ex-vessel revenue variable was multi-collinearity in the model, that at least two of the independent variables in the regression model demonstrate a high amount of correlation with each other. Pair-wise correlation tests of the independent variables revealed that there was collinearity between the count of vessels based on vessel owner residency and the ex-vessel revenue (0.85). The multi-collinearity may be affecting why ex-vessel revenue did not return a significant coefficient in the negative binomial regression. However, the results of a post-estimation test of linear hypotheses demonstrated that the coefficients of ex-vessel revenue and count of vessels variables are not equal to zero at a significance level of 0.10. This result offers some support of keeping these two variables in the model, despite the collinearity.

Patterns of movement of fishery-related goods and services

The survey asked respondents to name the top three communities that residents of their community go to for fishery-support businesses that are not available within their own community. The survey was administered to Alaskan communities; however, the nominations were not limited to communities in Alaska. Figure 2 shows the social network analysis of the connections between communities based on the exchange of fisheries-related goods and services. Table 3 then details the in-degree centrality present for all communities in Figure 2. Communities that received the most nominations have the thickest connecting lines and largest dots marking their location. The total number of nominated communities was 128. A total of 100 of those communities were survey respondents and the other 28 were communities that did not complete the survey, but were nominated by respondents. A total of 257 connections link the communities; a connection between two communities was created when a respondent community nominated another community for this question. Anchorage was nominated the most frequently (i.e. had the highest in-degree centrality), with 35 different communities naming it as where residents go for businesses or services not available within their own community. The second most nominated community was Homer, which had an in-degree centrality measure of 22. Seattle ranked third with 16 nominations and Bethel had 12 nominations. Kodiak, Dillingham, and Naknek tied with 11 nominations each.

Discussion

The cause and effect processes that link the fishing industry and support service industry take place within individual communities. The regression results presented here suggest that there is an association between the presence of a processor in a community and the variety of support service businesses or infrastructure that exists within a community. The number of vessels that may need support service businesses and the presence of haul-outs or tidal grid facilities also affect the presence of support service businesses. These results suggest support service businesses co-locate with processing plants, possibly because the vessels already

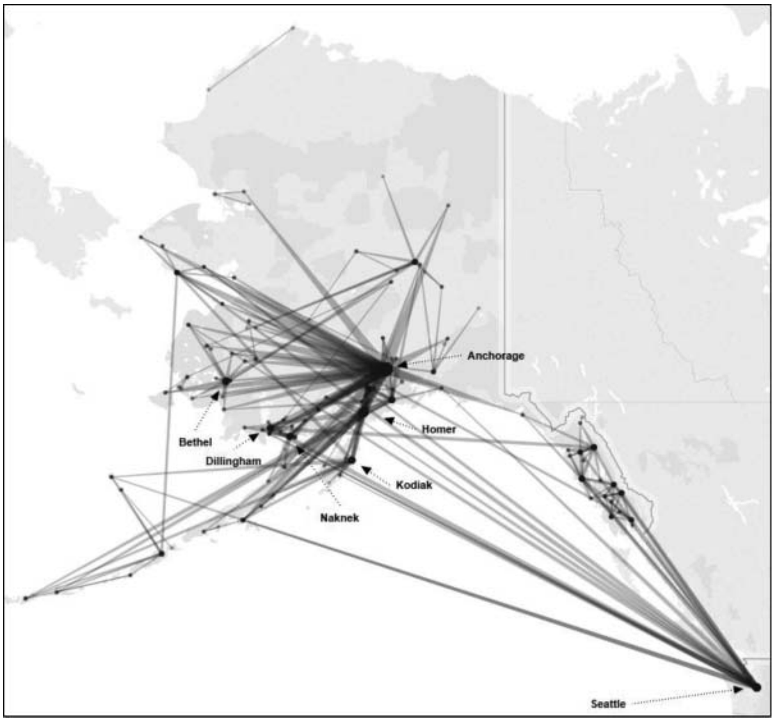

Figure 2. Linkages between communities based on the movement of fishery-related goods and services.

visit the community to land fish, so it is efficient for them to seek support services in that same community. Given this, the presence of a processor may serve to anchor support services in a community. Especially in a time of rising fuel prices, it is operationally efficient for fishermen to obtain services in the community where they land fish (Copes and Charles 2004). Additionally, processors in remote locations may serve as support service providers themselves, as is the case in King Cove and Sand Point (Knapp and Lowe 2007). The presence of a processor may help ensure a customer base for local support service businesses, which would help shield businesses from geographic dislocation from their customers due to a mobile fleet. Revenue obtained through taxes on shore-side processors are another lifeline for communities in Alaska (Lowe 2008). Each of these contributes to the weighty role a processor may play in a small community.

The significance of the association between support service businesses and the presence of a haul-out represents a basic infrastructural need relative to specific services. A community that has a haul-out facility or tidal grid can then also support services that require drydock work on a vessel. The weakly significant relationship of support service businesses and the number of vessels in a community demonstrates that while the number of vessels may be associated with the services offered within a community, there may be other factors at play that contribute to the make-up of the local support services industry. Additionally, the significance of the coefficient of the vessel count variable from the regression is likely affected by the collinearity found with the ex-vessel revenue variable.

The social network analysis presented in Figure 2 suggests a pattern of revenue movement between communities for fisheries-related support services. It is clear that there is a large

Table 3. In-degree centrality of communities that were nominated as support service providers.

Community	In-degree centrality	Community	In-degree centrality	Community	In-degree centrality	Community	In-degree centrality
Adak	1	Glennallen	1	Newtok	1		
Akiak	0	Grayling	0	Nikiski	0	Selawik	0
Akiattuk	1	Haines	0	Nikolski	0	Seldovia	0
Akutan	1	Homer	22	Ninilchik	0	Seward	10
Aleknagik	0	Hoonah	5	Nome	5	Shageluk	0
Alitak Bay	0	Igiugig	0	North Pole	0	Shaktoolik	0
Anchorage	35	Iliamna	0	Nunapitchuk	0	Sitka	8
Aniak	3	Juneau	8	Old Harbor	0	Skagway	1
Anvik	1	Kake	0	Olgoonik	1	Soldotna	6
Atka	1	Karluk	0	Palmer	0	Sterling	0
Barrow	1	Kasigluk	0	Pelican	0	Taksok	1
Bethel	12	Kasilof	1	Perryville	0	Talkeetna	0
Brevig Mission	0	Kenai	6	Petersburg	6	Tanana	1
Chefornak	0	Ketchikan	6	Pilot Point	1	Tenakee Springs	0
Chignik	1	Kiana	0	Pilot Station	0	Thorne Bay	1
Chignik (Bay)	0	King Cove	1	Pitkas Point	1	Togiak	0
Clam Gulch	0	King Salmon	4	Point Baker	0	Tok	0
Clarks Point	0	Kodiak	12	Point Lay	0	Toksook Bay	1
Cordova	0	Koliganek	1	Port Alexander	0	Tununak	1
Craig	3	Kotzebue	2	Port Alsworth	0	Ugashik	0
Delta Junction	0	Kwethluk	1	Port Heiden	0	Unalakleet	3
Dillingham	11	Levelock	0	Port Lions	0	Valdez	5
Dutch Harbor	6	Lower Kalskag	0	Port Protection	0	Wainwright	0
Eagle River	1	Manokotak	0	Port Townsend	1	Wales	0
Eek	0	McGrath	0	Portage Creek	0	Wasilla	2
Egegik	1	Mekoryuk	1	Quinhagak	0	Whale Pass	0
Ekuk	0	Metlakatla	0	Russian Mission	0	White Mountain	0
Ekwok	0	Moose Pass	0	Saint George	0	Whittier	2
Elfin Cove	0	Naknek	11	Saint Mary's	0	Willow	1
Emmonak	1	Nanwalek	0	Saint Michael	0	Wiseman	0
Fairbanks	8	Napaskiak	1	Saint Paul	1	Wrangell	7
False Pass	0	Nenana	1	Salcha	1	Yakutat	0
Fort Yukon	0	New Stuyahok	1	Sand Point	3		
Gakona	0	Newhalen	0	Seattle	16		

amount of non-resident activity in certain communities for services not available in their home community. This contributes to a diverted flow of fisheries revenue from a vessel owner's home community to other communities to obtain fishery-related goods and services. This sheds light on a potential reason for why the regression model did not show a significant association between ex-vessel revenue and the number of support service businesses, in addition to the multi-collinearity within the model. Despite the collinearity, a post-estimation test of the variables did not suggest that the two variables should be removed from the model. However, it suggests opportunities to further explore how these characteristics interact within communities.

With future years of data collected on the presence of support service businesses, it will be possible to use time-series analysis to better understand the relationship between ex-vessel revenue and the presence of support service businesses. It is possible that there is complexity between the variables that is not captured in the negative binomial regression; for example, the mean value of ex-vessel revenue over a 10-year period may be less of an influence on the presence of support service businesses than the number of years individual businesses have net losses in profit, for example. Additionally, the presence of support service businesses may be too coarse of a variable to understand the sustainability or success of a business in a particular community over time. A community's proximity to a hub community may also influence the presence of support service businesses. This analysis provides an initial exploration into the question of what influences the presence of support service industries in individual communities, and raises more questions to be explored. Nevertheless, the results are clear that revenue from fishing is not being completely fed into a fishermen's home community, but instead likely streams, in part, into communities where necessary services and supplies are available. This analysis also shows that a hub community of support service businesses serves fishermen from a variety of different communities across the state.

Changes in the use of local support services and infrastructure constitute a significant part of the overall economic impact of management changes, such as the implementation of a catch share program (Knapp and Lowe 2007). Fishermen may be relatively mobile in their ability to follow the resource; however, support service businesses that need infrastructure such as store-fronts are more anchored to a specific community. If there is movement of the fleet away from the existing processing capacity, a community may feel reduced economic activity from both the processor and the collocated support service businesses (Goodwin 1988; Portman 2008). Reduced support service activity may then be compounded by community economic loss associated with reduced fishing activity by local residents (Copes and Charles 2004; Olson 2011). This could make the support service sector more susceptible to economic disruption if local fishermen lose or sell their rights to fish after a management change, which potentially negates a community's need for support services. A decline in a community's economic viability can lead to the loss of social capital and viability of a small community (Wingard 2000; Copes and Charles 2004; Olson 2011). Furthermore, undue impacts on small communities from fisheries management changes may contribute to the loss of working waterfront businesses and infrastructure (PFMC 2014).

Conclusion

This analysis provides insight into how fishing communities and the support service industries are influenced by fisheries activity. Highlighting this linkage is an important step in understanding the full extent of fishery social–ecological systems in any region, which is imperative to making sound fisheries management decisions (Himes-Cornell and Hoelting 2015). Through recognizing the role of support service businesses in helping to sustain community participation in a fishery, the U.S. regional fishery management councils have the latitude to address community sustainability through specific community protections in fisheries management. For example, landing requirements in management programs may have the added benefit of protecting the local support service businesses in addition to maintaining processing capacity as a result of the linkage between processor presence and diversity of support service businesses within a community. The NPFMC/NMFS (2004) hypothesized in its Regulatory Impact Review of the Bering Sea Crab Rationalization Program that landing requirements could help protect landings in individual communities and thereby bolster local economic activity and revenues.

The current availability of data on support service businesses offers only a snapshot in time; however, the *Alaska Community Survey* is intended to provide a time-series dataset that could eventually yield the necessary data to look at how the change in variables such as ex-vessel revenue and the number of vessels fluctuates in relation to changes in the support service businesses held in each community. This would allow a more nuanced analysis of a potential lag effect between revenue and vessels in a community with the presence of support service businesses. Further information on how the presence of support service businesses in communities changes over time will allow analysis of how changes in this sector precipitate as a result of changes in fisheries and in management. Ultimately, the link between fisheries, communities, and support service businesses is an important one that needs to be recognized as a component of community fisheries activity that may be impacted by changes in fisheries management. Furthermore, for communities, maintaining fisheries activity is more than an economic consideration; it is a matter of cultural identity (Hall-Arber 2007; Carothers 2010).

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Notes

1. The survey included questions about current conditions in each community. We tested a 5-year average and did not find a significant difference between that and the 1 year average. We ultimately selected the 10-year average for the analysis in order to be more conservative and smooth out any inter-annual variation that may not be reflective of more large-scale changes.
2. Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

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Appendix: Survey questions utilized from the 2011 and 2012 implementation of the *Alaska Community Survey*

Question 15. Which fishing gear types, if any, are used by commercial fishing boats that use [COMMUNITY NAME] as their base of operation <u>during</u> the fishing season? *Check all that apply.*

- ☐ Trawl
- ☐ Pots
- ☐ Longline
- ☐ Gillnet
- ☐ Purse seiner
- ☐ Troll
- ☐ Other: ______________________________
- ☐ None of the above

Question 16. What types of fishing support businesses are located in [COMMUNITY NAME])? *From the list below, check one box for each type of business to indicate if it is present in [COMMUNITY NAME].*

Question 17. For those businesses in Question 16 that are not available in [COMMUNITY NAME], please list the top three communities that people go to for these services.

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