1 Adaptations and well-being: Gulf of Alaska fishing families in a changing

2 landscape

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4 Key words: fisheries management; fishing families; Alaska; well-being; adaptation

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7 Abstract

8 Over the last three decades, fishing families in the Gulf of Alaska have adapted to numerous multifaceted

9 conditions in response to near constant flux in stocks, markets, governance regimes, and broader

10 sociocultural and environmental changes. Based on an analysis of seven focus groups held across Gulf of

11 Alaska fishing communities, this study explores the variety of strategies that families across the Gulf have

employed to adapt to changing conditions from the 1980s to the present day. Furthermore, the study

examines how those strategies have evolved over time to accommodate cumulative effects and

14 synergisms. While families continue to employ long-standing adaptation strategies of fisheries portfolio

15 diversification and increasing effort, they are also integrating new adaptations into their framework as

16 changing management systems, demographics, and technologies shift how choices about adaptations are

17 made. This study also demonstrates how adaptations have implicit intra- and inter-personal well-being

tradeoffs within families that, while potentially allowing for sustained livelihoods, may undermine other

- 19 values that individuals and families derive from fishing.
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22 **1. Introduction**

Social systems and social change modulate human interactions with ecosystems and mediate ecological
impacts (Kittinger et al. 2012). People's capacity to adapt to social and ecological changes implies that
these systems need to be considered dynamic. In turn, the existence of diversity in adaptation strategies,
how that diversity is distributed or patterned, has implications for the ultimate resilience of socialecological systems and the well-being of individuals, families, and communities (Leslie et al. 2013).

28 Commercial fishing is a highly risky occupation subject to spatial and temporal variability across 29 multiple social and ecological dimensions (Kasperski and Holland 2013). Across the world, fisheries are 30 changing more rapidly than in the past in response to the increased pace of ecological, technological, 31 market, and other socioeconomic shifts, necessitating more rapid response and varied adaptations (Allison et al. 2009; Cheung et al. 2010; Hobday and Pecl 2014; Pecl et al. 2017). Researchers have shown that 32 33 understanding the importance of the family unit as responsive to changing conditions is central to 34 developing effective policies that facilitate adaptation (Neis 1999; Zvonkovic, McGraw, and Manoogian-O'Dell 2000: Zhao et al. 2013: Pettersen 2018). Yet the research on the role that the family unit has in 35 adaptive choices and how those choices in turn affect individual and family well-being is fragmented and 36 largely responsive to specific changes in fishery conditions, i.e. catch share implementation, stock and 37 price declines (Durrenberger 1997; Mederer 1999; Mederer and Barker 2000; Zvonkovic, McGraw, and 38 Manoogian-O'Dell 2000; Conway, Gilden, and Zvonkovic 2002; Marks 2012), with some notable 39 40 exceptions that focus on longer term family evolution (Endter-Wada and Keenan 2005; van Ginkel 2014) 41 and the central role of women in providing adaptive capacity (Munk-Madsen 1998; Binkley 2000; Britton

42 2012; Calhoun et al. 2016)

43 Unlike businesses or firms structured to maximize profits, commercial fishing families are often 44 organized around non-economic household concerns and family interests with shared work structures that 45 may allow them to more readily adjust to lean fishing times (Doeringer, Moss, and Terkla 1986; 46 Durrenberger 1994; Munk-Madsen 2000; Marks 2012). The reserve of labor coupled with pooled economic, cultural, and knowledge resources may allow fishing families a degree of adaptability that is 47 not readily replicated in other contexts (Durrenberger and Palsson 1985; Doeringer, Moss, and Terkla 48 49 1986; Marks 2012; van Ginkel 2014). Fishing families often operate in terms of expenses and income 50 rather than wages and profits, moving resources like labor and capital fluidly in response to expansions

and contractions, a versatility that can be critical for survival in lean times (Durrenberger 1997; Munk Madsen 2000; Marks 2012).

53 Although adaptations may mitigate adverse livelihood effects of fisheries downturns, they may 54 also be associated with implicit tradeoffs in other well-being components (e.g., family connection, 55 physical safety). A fisherman may go out further to sea to adjust to decreasing nearshore catches, which may attenuate diminishing earnings, but in turn increase safety risk and time away from family (Criddle 56 57 2012, Suckall et al 2014; Coulthard and Britton 2015). The balance of well-being components with adaptation strategies is going to be determined by the freedom and agency of individuals in terms of 58 59 choosing whether and how to adapt (Coulthard 2012). Yet, families are comprised of multiple individuals 60 and even within families making unified adaptation choices there are likely to be both intra-personal 61 tradeoffs on different components of well-being and inter-personal tradeoffs between the well-being of 62 various actors (McGregor, Coulthard, and Camfield 2015; Coulthard and Britton 2015).

63 The following study examines commercial fishing family characteristics and adaptation strategies 64 to changing fishery conditions in Gulf of Alaska fishing communities. The Gulf of Alaska has been 65 identified as one of the sentinels for ecosystem change in the world, where ocean warming is occurring 66 fastest and where temperature anomalies associated with marine heat waves have already greatly undermined some fisheries (Hobday and Pecl 2014; Barbeaux et al. 2019 Walsh et al. 2018). For 67 68 example, in response to unprecedented low numbers of Pacific cod the Gulf of Alaska federal directed 69 cod fishery will be closed in 2020 (NPFMC 2020) At the same time large-scale technological disasters 70 and price shocks, including the Exxon Valdez Oil Spill and the decline of salmon prices following the 71 introduction of farmed salmon, as well as the implementation of increasingly complex management regimes in the region have affected when, where, and how people participate in fisheries (Picou et al. 72 73 1992; Carothers 2010; Carothers and Chambers 2012; Knapp 2013; Hebert 2015). Thus fishing families 74 in the area have been grappling with multifaceted change for decades and the ways in which they have 75 applied and modified their adaptation strategies over that timeframe can inform a broader understanding 76 of how fishing communities may adapt to change elsewhere. Furthermore, this study illuminates factors that contribute to choices about adaptive strategies and the well-being tradeoffs associated with these 77 78 strategies, providing a context for understanding how adaptations and associated well-being may be

79 distributed within and across communities.

80 2. Methods

81 Information about commercial fishing family characteristics, dynamics, and responses to changing conditions was garnered from discussions held during focus groups from June 2017 to September 2018 82 83 across the seven largest fishing communities in the Gulf of Alaska in terms of revenues and number of 84 vessels: Anchorage, Cordova, Homer, Juneau, Kodiak, Petersburg, and Sitka. This research is specific to 85 commercial fishing families in the harvesting sector, and similar dynamics could be explored separately for processing families. The focus groups were intended to provide a venue for a facilitated discussion of 86 three key topic areas: (1) fishing family roles and gender divisions of labor; (2) impacts of management, 87 88 environmental, economic, and social conditions on fishing family dynamics; and (3) the future of fishing 89 families and women in Alaska fisheries. These focus groups also illuminated patterns in women's 90 participation in fishing families and Alaska fisheries more broadly, which are presented in Szymkowiak 91 (2020).

92 The first discussion topic focused on perceptions of family roles and responsibilities in Alaska 93 fisheries, wherein participants were asked to define a fishing family and the inherent characteristics of those families. The intent of discussing the characteristics of fishing families as the initial discourse of the 94 95 focus groups was two-fold. First, it contextualized the remainder of the focus group discussion within a 96 broader framework of various components of well-being (Breslow et al. 2016) because the 97 characterization of fishing families enveloped numerous components -- livelihood, identity, family 98 connection, sense of community, etc.. Secondly, by initiating the conversation with a simple question 99 about "what is a fishing family", it empowered participants with wholly providing the language for 100 defining those characteristics and reduced researcher bias in informing that process. In addition, allowing 101 participants the autonomy to fully frame their own fishing family attenuates academic pursuits of "central tendencies", which have been noted by others (Ellis 1984). In utilizing focus group methods, this research 102 103 provides that participants inherently speak to their own experiences and identities in ways that encompass 104 variability not as divergence from the mean but as variations of themes that are largely discussed with respect to their congruence. This was further ensured within this research through emphasis on a diversity 105 of perspectives, wherein participants were asked to not repeat themes unless they disagreed with 106 107 something that was said, but to speak to their individual experiences of thematic areas.

108 The second discussion topic focused on fishing family dynamics and adaptation strategies to 109 regulatory, environmental, social, and economic changes. The intent of this topic was to examine the 110 changing conditions that Alaska fishing families have responded to and the strategies they have employed to adapt to those conditions. Participants were given a memory aid -- a timeline of major events in 111 Alaska's fisheries from 1900 to the present day (see supplementary materials) -- which was conducted as 112 an individual exercise prior to group discussion. This exercise helped to facilitate the discussion and tap 113 into social memory and cultural heritage (Nadel-Klein 2003; Coulthard 2005; Britton 2012), while 114 115 providing participants with a way of framing their experiences that is less subject to group dynamics and 116 censoring (Kidd and Parshall 2000; Carey 2016). These responses were also analyzed and incorporated into the overall results on fishing family dynamics and changing conditions. 117

118 The third discussion topic focused on expectations about future shifts in the relevant socio-119 ecological system and how participants envisioned adapting to those circumstances, given their 120 experiences in the past. This discussion was often highly integrated with that of the second discussion 121 topic and elucidated how adaptation strategies may need to evolve to accommodate rapidly changing 122 conditions and how fishing families are responding to increased uncertainty about the landscape within 123 which they operate.

124 A maximum variation sampling design was implemented, which targeted study sites and 125 participants across specified criteria to understand fishing family dynamics and adaptations across a broad spectrum of experiences (Creswell and Poth 2018). The seven fishing communities were selected on the 126 127 basis of their high fisheries engagement and participation across a variety of fisheries, with differing 128 historical contexts of changing fishery conditions and participation. Key informants were identified for 129 the focus groups across a number of criteria, including gender, age, years of fishing experience, family contexts, and target fisheries (Tremblay 1957; Krueger and Casey 20014). The focus groups were also 130 advertised with local fishing associations and organizations, which helped to identify and solicit potential 131 132 participants. However, because these were effectively public meetings, the sample was not fully under the 133 control of the researcher. A total of 102 participants attended the focus groups, participating across at 134 least 20 distinct fisheries (although the actual total is likely to be much greater due to gear and area 135 distinctions that are not readily demarcated from the discussions), with an estimated age range of 15 to 70

and an average of 45 (as ages were not directly solicited), with a total of 59 women across the focus

137 groups. Figure 1 provides the geographic, demographic, and fishery distribution of the focus group

participants. Many focus group participants participate in multiple fisheries and some were fishery

139 representatives or managers that did not indicate activity in any fishery.



140

141 Figure 1. Map of focus group communities each listing the fisheries that each group indicated some

142 degree of participation

The focus groups lasted two hours each, with process agendas and interview guides based on open 143 144 ended topics to elicit spontaneous and multi-layered responses (Kidd and Parshall 2000; Krueger and Casey 2014). In addition to the timeline exercise described above, participants were provided with 145 handouts for additional feedback for each topic. Major themes for each topic were summarized on flip 146 charts posted at the front of the room, which allowed participants to reflect on the full discourse of each 147 148 topic area while the conversation continued and for the researcher to track data saturation points on each 149 topic. The major themes and related discussions were summarized for each focus group and provided to participants via email for further feedback allowing them the opportunity to challenge any interpretations 150 151 by the researcher and to provide further explanations. The focus group discussions were recorded with the 152 informed consent of the participants and transcribed verbatim. Transcribed discussions were entered into MAXQDA, a qualitative data analysis program, and thematically coded using grounded theory (Strauss 153 154 and Corbin 1990). Focus groups provide a means of conducting robust research across multiple, geographically isolated 155

communities (as in the Gulf of Alaska) when resources such as time and capital for travel are limited

157 (Szymkowiak and Rhodes-Reese 2020). Furthermore, in facilitating a wider geographic scope for

research, focus groups can also provide for inter-community comparisons and examining conceptual

reliability in thematic areas across the group discourse (Szymkowiak and Rhodes-Reese 2020). In this

- 160 case this was exemplified through examining the utilization of similar adaptation strategies across
- 161 communities. Focus groups are a method for conducting participatory research that benefit from group
- discourse yielding results that could not be generated from individual interviews alone (Kidd and
- 163 Parshall, 2000; Krueger and Casey, 2014), which have been employed in other contexts examining
- 164 fishing families (Zvonkovic et al., 2000; Bene et al., 2007). In this study the group discussion allowed
- participants to identify both the commonality and divergence in the adaptation strategies that they
- 166 employed in response to various conditions and the factors that may have contributed to any differences.
- 167 Despite substantial variation in community sample sizes the overall sample is considered representative 168 since the focus of this study is to understand the diversity of adaptation strategies that have been
- 169 employed to a mixture of conditions that have differentially affected these communities.
- 170 171

3. Results and Discussion

172 3.1 Exploring the characteristics of Alaska commercial fishing families

173 For exploratory purposes in initial data analysis, a word cloud was created of the top 100 words used by 174 focus group participants to characterize fishing families that denote the frequency of usage by word size, 175 (Fig. 2). (The colors in the figure are only an artistic rendering and do not represent any statistical aspects 176 of the data). The foremost feature of a fishing family that emerged from this exercise was the social 177 relationships, exemplied with the prominence of various words including kids, women, families, 178 daughters, people, guys, role, dad, mom, wife, sons, husband, skipper, community, and men. The 179 employment and physical dimensions that characterize families with respect to the fishing occupation are 180 also notable in the world cloud, with boat, things, home, work, operation, and job all appearing with various frequency. The importance of the temporal landscape for fishing families is also conveyed with 181 182 the time-related words (years, time, day). Although income and money both appear in the word cloud these words were used less frequently than most of the words that comprise the other dimensions noted 183 184 above, which is aligned with previous findings that income may be less relevant for fishing identities and maintaining participation than other facets of the occupation (Durrenberger 1997; Garcia-Quijano 2009; 185 Urguhart and Acott 2014; Pascoe et al. 2015). 186



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Figure 2. Word cloud of top 100 words used to characterize fishing families by focus group participants.Word cloud created in R

192 The overarching dimensions of fishing family characteristics that appear in the world cloud were consistent with thematic areas that emerged during the coding process for the focus group transcripts. The 193 discussion of fishing families across the focus groups revealed four general areas that, according to 194 195 participants, characterize fishing families - culture and identity, livelihood, social relationships, 196 independence and resilience. Figure 3 shows these overarching characteristics as well as specific 197 components of those characteristics (each of which are described in more detail below). The 198 characteristics denoted were homogenous across focus group participants, irrespective of their target 199 fisheries and communities. 200



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Figure 3. Defining characteristics of Gulf of Alaska fishing families as described by focus groupparticipants. Note: Graphic made with the help of NOAA-NMFS-AFSC.

According to focus group participants, fishing families are characterized by a number of salient features: (1) economic dependence on fishing (to various degrees); (2) independence and resilience in the face of high variability and risk; (3) a sense of self (individual and family) and community tied to fisheries that is propagated through generations and that permeates everyday life, and (4) social relationships built upon the common experience of fishing and its associated risks.

The characteristics of fishing families highlighted by focus group participants are implicitly 210 211 intertwined and inherently synergistic. Fishing families, as described by focus group participants, are 212 structured around the unpredictability and seasonality of fisheries, which necessitate both a flexible reserve labor pool and near constant scheduling accommodations (Endter-Wada and Keenan 2005). The 213 214 ways in which fishing families manage their operations, with fluidity and adaptability implies that all 215 family members have a role in the operation (Durrenberger 1997; Endter-Wada and Keenan 2005; Marks 216 2012). This structure helps to in turn build a family value system that affects everything from daily 217 activities to child rearing philosophies (Conway, Gilden, and Zvonkovic 2002; Endter-Wada and Keenan 218 2005; Marks 2012). These dynamics contribute to personal and family identities that are structured 219 around fishing as a way of life rather than an occupation and include a sense of pride associated with 220 demonstrable family resilience, especially in the face of high risk and variability (Ellis 1984; Davis 1986; 221 Palsson 1989; Smith and Jepson 1993; Mederer 1999; Nadel-Klein 2000; Britton 2012; Calhoun, Conway 222 and Russell 2016). In turn, families build deep connections internally and with other fishing families in 223 their community upon which they rely for support in the face of financial and emotional adversity (Davis 224 1986; Smith and Jepson 1993; Conway, Gilden, and Zvonkovic 2002; Garcia-Quijano 2009). 225 Participants described fishing as a way of life providing a rhythm around which families are 226 structured, from daily life to seasonal transitions. Even for those in the family that do not actively 227 participate in fishing, their lives are often deeply embedded in it, from providing logistical support to

228 planning family life around the fishing seasons. A focus group participant described how deeply this

- rhythm may sometimes be internalized by family members in relation to her son's understanding of
- 230 seasons:
- "He was five years old, been fishing since he was two, like I said, and he came home with
 homework from school and it was a picture of the seasons: summer, winter, fall, you know,
 spring. And, he was looking at that piece of paper, and he's five, and he says, 'mom I don't get
 it.' It said write down what season it is. And I said, 'you know what the seasons are', and he said
 'you mean crab, halibut, salmon and herring?'" (Kodiak participant)
- 236 Participants described how fishing is often at the center of family organization and provides the setting for interactions through which identities are created and meanings are constructed (Mederer 1999). 237 According to participants, fishing families are defined by their work and how it shapes each generation 238 239 within their family, instilling values early in children that are deeply ingrained in the occupation, 240 including building a work ethic, a sense of responsibility in helping the family, and discipline. Children are given tasks to perform early on in life that are tied to the success of the fishing operation and thus 241 learn the value of their contribution and how the family unit relies and benefits from each member. 242 243 Because of the extensive time and isolation that are often associated with fishing, families are afforded
- the opportunity to build deep connections through learning about each other and how to work together.
- 245
- 246 "Everyone, no matter how old you are, you have some role to play and that role is important to
 247 the success to the operation and I think that is what is so important when you are thinking about
 248 what a fishing family does." (Kodiak participant)
- 249 Participants discussed a deep sense of pride in their family fishing identity, which is rooted in the 250 independence and agency with which they make a living that researchers note may be difficult to replicate 251 in other occupations (Pollnac and Poggie 2008; Bavinck et al 2012; Coulthard and Britton 2015). A key dimension of this sensibility is the perceived lack of a social safety net to buffer against hard times in 252 253 terms of government income insurance programs, which in turn necessitates inherent resilience in the family structure. In contrast, the importance of intra-community buffers was discussed in several 254 255 communities with respect to the presence of social capital or networks of fishermen and fishing families 256 that, as elsewhere, serve to facilitate life for each other (Dasgupta 2005; Bodin and Crona 2009; Ramirez-257 Sanchez and Pinkerton 2009; Holland et al. 2019).
- 258 Fishing families may be defined by a set of characteristics that are exceptional to households 259 where occupational responsibilities may be shared, which provide for unique opportunities to shape 260 identities, children, and bonds. However, focus group participants also described how these families are subject to exceptional risks, constant adjustments, and often prolonged periods of separation which may 261 both define them as different from non-fishing families (Endter-Wada and Keenan 2005) as well as stress 262 263 these bonds and identities. A fishing family's reliance on a resource subject to variability in abundance 264 and value puts it inherently at risk of income fluctuations, with an associated sense of uncertainty that is 265 inherently stressful. Fishing families are also in frequent transitions imposed by the departure and arrival of the predominant fishing participant in the household. Both periods are marked by a certain upheaval 266 and necessitate renegotiation of roles and responsibilities, power dynamics and decision making, and 267 268 family membership more broadly (Mederer and Barker 2000). The family's capacity to fluidly respond to different situations over the course of a day, fishing season, or year seem to build a sense of functionality 269 270 that underlies its comradery.
- The deeply rooted personal identity of fishermen and fishing families coupled with a sense of resilience that, as discussed above, may be integral to that identity can make fishing families reluctant to exit fishing even in the face of diminishing returns and multifaceted adverse conditions (Bavinck 2001;

- 274 Nadel-Klein 2003; Pollnac and Poggie 2008; Marks 2012; van Ginkel 2014). Rather, families seem to
- adopt a variety of often synergistic strategies intended to mitigate financial loss, provide stability for
- household incomes and family dynamics, and ensure the viability of their fishing operations and family
- 277 fishing identities in the long-run.
- "fishing is a lifestyle and you have to decide that's the lifestyle that you want to do...the price of
 getting into a fishery has always fluctuated over history, whether it's quotas or salmon permits or
 whatever...if you want the lifestyle, you're going to have to pay attention to where you put your
 money and what you are going to get for a return." (Homer participant)
- 282

283 3.2 Changing Conditions and Evolving Adaptation Strategies

284 This section focuses on adaptations to conditions that were perceived as adverse by focus group

- participants, which dominated the discourse during the discussions. Nevertheless, it should be noted that
- some participants also discussed the benefits of certain changes in Alaska's fisheries, including catch
- share programs and hatchery fish production, in terms of providing stability, predictability in business
- 288 planning, and safety improvements that allowed for *inter alia* product quality improvements, operational
- expansion, and integrating broader family participation onboard fishing vessels. The discussion of
- changing conditions begins with the late 1970s, aligned with the representativeness of the majority of the
- collective memory at the focus groups.

292 3.2.1 Changing Conditions in Alaska's Fisheries

293 Over the last three decades, focus group participants noted that fishing families in Alaska have evolved their adaptation strategies in response to a multitude of novel, increasingly complex and synergistic 294 fishery conditions (Table 1). The descriptions of the conditions and strategies in Table 1 are provided in 295 296 terms of the primary ways in which they were discussed by focus group participants. Most conditions affected participants throughout the study period to varying degrees. For example, changes in prices were 297 298 discussed in terms of large declines (e.g., price shocks in the 1990s following the introduction of farmed 299 salmon into the global fish market) as well as continued year-over-year variability and uncertainty. Because most of these conditions reoccur over time they are not associated with a specific timeframe. 300 301 However, some events like the Exxon Valdez oil spill in 1989 and the institution of specific limited access privilege programs (LAPPs) – limited entry and catch share programs - with distinct timestamps 302 303 were discussed effectively as regime shifts in how people participate in Alaska fisheries. The 304 implementation of LAPPs in Alaska began in the 1970s with limited entry permit programs in State salmon fisheries and has continued over the decades to include catch share programs in federal fisheries, 305 306 beginning with the Pacific halibut and sablefish Individual Fishing Quota (IFQ) Program in 1995. The 307 institution of a variety of Limited Access Privilege Programs (LAPPs) has limited fishery diversification 308 opportunities and increased entry costs while other management regimes have curtailed when, where, and 309 how families can fish. The volume of management actions that affect fishing families, inclusive not just of fishery-specific regulations like LAPPs but those dealing with safety requirements, insurance, and 310 child labor provisions has also increased according to focus group participants. Furthermore, intricate 311 312 management systems are coupled with increasingly complex scientific models underpinning stock 313 assessments and perceived ecosystem changes from marine heat waves and climate change more broadly, 314 leaving fishing families feeling heightened uncertainty and anxiety about their futures.

Table 1. Changing conditions in Alaska fisheries and adaptation strategies discussed by focus groupparticipants

Conditions	Description	Conditions	Description
<i>Exxon Valdez</i> Oil Spill (EVOS) (1989)	•Associated effects on stocks and prices	Fish prices	•Variability/uncertainty •Decreases

Management	•Regulations - instability, season lengths, area closures, insurance/safety/child labor regulations, reallocations, complexity •Science - models/stock assessments, complexity, mistrusts	Fishing costs	•Boats, gear, operating
Fish Stocks	•Variability/uncertainty •Decreases	Sociocultural Factors	•Drugs, work ethic, technology, demographics, cultural norms
Limited Access Privilege Programs (LAPPs)	 Entry costs (permits and quota shares) Catch share and limited entry programs, in particular limited entry in State salmon fisheries (beginning in 1973) and the Pacific halibut and sablefish IFQ Program (1995) 		
Strategies	Description	Strategies	Description
Fisheries Diversification (Portfolio or employment diversification within fisheries)	 Area, gear, species Position (crew, skipper, vessel owner) Leasing 	Increase effort/Reduce Costs	 Fish harder, longer, further Invest in larger vessels Replace paid crew with family members
Exit	•Geographic or occupational •Temporary or permanent •Fishery specific or general	Altered succession	 Delayed retirement Changed modes of entry or entry patterns into fishing Changed intra-family transfer patterns Loan restructuring
Pluriactivity (income diversification)	•Individual or household income diversification outside of fishing	Political participation	•Participation in fisheries policies at the individual, household, or association level
Specialization within a fishery or group of fisheries	•Species, permit or QS investment	Increase value of harvests	 Direct/niche marketing, custom processing Branding Product quality improvement

"Markets are going to go up and down; stocks are going to go up and down. Those are risks that
we know and understand. I learned them since I was old enough to understand English. That I can
handle. What I can't... is when somebody comes up with a brand-new model that doesn't let you
access the resource. Or if it is like we are going to reallocate, that would be a problem."
(Petersburg participant)

"you have uncertainty about the price of fish, uncertainty about the stocks you are dependent on
whether it's going to be high or low. But I also think we have the added uncertainty about climate
change and what how's that going to affect things. Typically we're on a little bit of variability up
and down, but then we have cod go down by 80% in one year and they blamed it on the Blob...
there is going to be more of those types of events in the future which means as a fishing family
you are going to have more uncertainty about the revenue you are going to generate." (Kodiak
participant)

333 The ways in which changing conditions manifest themselves, as described by focus group 334 participants, have different temporal and spatial dimensions necessitating both a variety and the coupling 335 of adaptation strategies. For conditions that have defined timestamps, such as the Exxon Valdez Oil Spill 336 337 (EVOS), some of the resultant changes like fishery closures were immediate and required instantaneous response. Other conditions are somewhat bounded spatially, like the crash of the red king crab fishery 338 339 around Kodiak and EVOS, where the effects were described similarly to that of an earthquake with a 340 distinct epicenter and lessening intensity as one moves towards the periphery. Some conditions have 341 substantial inter-annual variation (like stocks and prices) and/or an evolutionary component (LAPPs, 342 management effects, costs, sociocultural factors) necessitating strategies that respond to different 343 temporal dimensions. Ultimately, some conditions have effects that may transpire over the course of multiple years (e.g., the rising costs of entry associated with LAPPs) and many conditions have coupled 344 345 synergistic or multiplicative effects (e.g., the decline of salmon prices occurred immediately following 346 EVOS, leaving many families with few opportunities to generate fishing income).

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348 3.2.2 Adaptation Strategies Utilized by Focus Group Participants

The strategies employed by focus group participants in response to the diversity of aforementioned 349 350 changing conditions in Alaska fisheries are demonstrated in the chord diagram (Fig. 4). The thickness of 351 the lines denotes the frequency with which the strategies were noted in the context of a specific condition. 352 The colors are intended to facilitate interpretation of the figure with respect to which adaptations were 353 employed in response to each condition, with each condition having its own designated color. The focus group discourse was not intended to provide an exhaustive list of strategies that each family employed to 354 355 address each type of condition. Rather, it points to the diversity of strategies employed and potentially the 356 ones participants believed were most critical in addressing any potential adversities. 357



359 360 Figure 4. Coupled adaptations to changing conditions derived from focus group discussions. The 361 thickness of the lines represents the extent to which the adaptation strategy was employed in response to each condition. The coloration is intended to facilitate interpretation with each condition having its own 362 associated color. Chord diagram created using the R package "Circlize" (Gu 2014). 363

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365 Modification of fishing behavior with increased effort, fisheries diversification, and decreasing operating costs were noted as the most well-established strategies that were employed by fishing families 366 367 throughout Gulf of Alaska communities to address changing conditions. Participants noted that increasing 368 effort by fishing harder, going out further to sea, staying out longer, and investing in larger vessels are common responses to fishing revenue declines, as elsewhere (Binkley 1996; Durrenberger 1997; Marks 369 2012; Costello 2017). These strategies are particularly applicable in response to inter-annual variation in 370 spatial distributions of fish and localized depletion and to decreases in dockside prices when harvests are 371 372 not constrained by individualized quotas. As such, the strategies were indicated by focus group 373 participants to be within the standard portfolio of responses that fishermen have historically utilized to adapt to conventional shifts in conditions - that is, stock and price variability. 374

375 Fisheries diversification, in terms of for example targeting various species, in multiple areas, has also been widely utilized by Alaska fishing families to mitigate income variability in response to inter-376 377 annual variation in stock abundance and prices. This is a commonly employed strategy by fisheries participants around the world and has had demonstrable efficacy in decreasing variation in revenues and 378 increasing economic resilience (Binkley 1996; Hilborn et al. 2001; Endter-Wada and Keenan 2005; 379 380 Kasperski and Holland 2013). However, focus group participants and researchers alike note the decreasing opportunities for diversification in Alaska fisheries over time due to the implementation of 381

LAPPs and associated increases in the costs of entering a fishery (Kasperki and Holland 2013; Beudreau
et al. 2019). Other dimensions of diversification strategies noted by focus group participants included
leasing fishing access or harvest privileges and working as crewmembers or skippers on someone else's
vessel (Szymkowiak and Himes-Cornell 2015).

Fishing families also address inter-annual revenue variation by decreasing operating costs. Focus group participants largely discussed replacing paid crewmembers with household family members who do not ostensibly require payment as a way of mitigating costs. Family fishing operations have been noted in other contexts to be fluid and flexible, pooling resources and adjusting to expansions and contractions with a reserve labor pool that may be used to replace a paid crewmember in response to decreasing revenues (Durrenberger and Palsson 1985; Doeringer, Moss, and Terkla 1986; Binkley 1996; Grzetic 2004; Munk-Madsen 2000; Power 2005; Marks 2012).

393 The focus group discussions indicated that other strategies including increasing value, 394 pluriactivity (diversifying household income), and exit, which have been used to adapt to inter-annual 395 revenue variation from stocks or prices in the past in the region, have grown in frequency of application 396 over time. The increasing utilization of these alternative strategies has been both in response to traditional 397 changing conditions (stocks and prices) and new conditions emerging from broader sociocultural and management transformations (including LAPPs) as the other, more traditional, strategies like 398 399 diversification have become increasingly constrained by management systems. In turn, focus group 400 participants noted an increasing reliance on value-added strategies as technological developments have 401 facilitated both fish quality improvements and marketing strategies that utilize improved Internet connectivity and the advent of social media to capitalize on shifts in consumer preferences towards 402 403 products that demonstrate socio-ecological sustainability.

404 Pluriactivity, manifested through the generation of household income from multiple sources 405 inclusive of fishing, was also noted as an increasingly employed strategy to provide financial security and 406 buffer against uncertainties in fishing incomes (Salmi 2005; Endter-Wada and Keenan 2005; Marks 2012; Blythe et al. 2014). Engaging in alternative forms of income generation can be undertaken by the member 407 408 of the household who is the predominant fisherman, but was most frequently mentioned in the context of 409 the other partner. As noted in other parts of the world, this means that pluriactivity in Alaska fishing 410 families often manifests itself as the woman in the household engaging in shoreside employment, which in turn often necessitates renegotiations of traditional gender roles (Mederer 1999; Binkley 2000; Davis 411 412 2000; Bates 2006; Britton 2012; Zhao et al. 2013).

413 The focus group discourse also revealed how exit strategies herein referring to a mixture of 414 strategies that include geographic or occupational, temporary or permanent, fishery specific or general 415 exit, have high degrees of fluidity and connectivity with other adaptations (Binkley 1996; Marks 2012). For example, temporary exit was regularly contextualized with pluriactivity, as in the case of responses to 416 417 EVOS wherein some fishing families took a hiatus from fishing and engaged in other employment associated with the cleanup effort, in an attempt to remain in their geographic communities while 418 419 awaiting the restoration of local fisheries (Picou et al. 2009). On the other hand, permanent exit from 420 fisheries in response to other changing conditions (especially LAPPs) seemed often associated with 421 concurrent geographic exit, as documented by researchers (Carothers 2010; Donkersloot and Carothers 422 2017; Ringer et al. 2018). This may reflect how identities and sense of place may be intrinsically linked to the fishing occupation for some Alaska communities, so that ceasing to participate in fisheries would 423 424 imply the loss of a connection to the place itself and thus potentially necessitate geographic exit as well 425 (Carothers 2010; Holen 2014; Himes-Cornell and Hoelting 2015).

426 Other adaptation strategies seem to be more directly tied to conditions that have largely emerged 427 from changing management regimes and associated complexities, inclusive of but not limited to LAPPs. 428 Focus group participants noted increasing participation in the political process, as individuals, families, or 429 through larger fishing associations, in response to a need to both understand and try to advocate for the 430 family fishing operation within a constantly changing management system. One participant in Homer 431 noted their increased political participation in terms of the adage "'if you're not at the table, you're on the 432 table" particularly in reference to LAPPs. Participation in policymaking by attending meetings, providing testimony, and serving on management councils may be an important strategy for fishing families to feel
some control of the management process in response to changing conditions, although it is not always
coupled with a sense of efficacy in affecting policy (Smith and Jepson 1993; Mederer 1999).

436 Specialization, in terms of concentrating fishing effort in one fishery, area, or species, can manifest itself as investing in more specialized equipment or quota shares and/or divesting of other 437 fishing access or harvest privileges. Focus group discourse revealed that this strategy was heavily 438 439 associated with LAPPs in particular (Hentati-Sundberg 2015; Holland et al. 2017). The institution of the 440 Pacific halibut and sablefish IFO Program (IFO Program) in 1995 was associated by many focus group participants with a loss of harvesting opportunities due to the allocation of very small amounts of quota 441 442 shares that were not economically worthwhile to fish (Knapp 1997; Carothers 2013). In the salmon 443 fisheries, the institution of limited access permits included a constraint on the total number of commercial 444 limited entry salmon permits that can be owned and utilized by an individual, effectively necessitating 445 specialization in one type of salmon permit (which are generally area- and gear-specific) (AS 16.43.140). Interestingly, some participants noted that the implementation of the IFQ Program actually provided for 446 447 greater diversification opportunities for them as the prolonged fishing season no longer conflicted with 448 the season for their primary target fishery (e.g., salmon), affording them the opportunity to participate in 449 the federal halibut and sablefish fisheries as well.

450 Altered succession dominated the discourse across the focus groups, especially with respect to changes in management, the implementation of LAPPs, sociocultural factors, and costs. For the purposes 451 452 of coding these focus group results, altered succession encompassed a number of interrelated and co-453 occurring themes including: changes to entry paths or patterns, no entry, intra-family transfers of harvest 454 or access privileges, and loan structures and restructuring schemes. For example, participants noted that 455 sociocultural factors such as shifting values around work, increasing drug usage, and perceived stigmas 456 surrounding the fishing industry coupled with regulations that in part prevent youth from working onboard fishing vessels (e.g. child labor laws and insurance liability issues) have stymied the growth of 457 the next generation of fishermen. This has been exacerbated by increasing capital and operating costs of 458 459 fishing along with perceived instability in management regimes including the possibility of reallocations 460 and increasingly complicated scientific models underpinning harvest targets.

Relative to other changing conditions, the effects of LAPPs on altering and limiting succession in 461 Alaska fisheries are perhaps the most well documented amongst the changes impacting entry and exit in 462 463 Alaska fisheries (Carothers 2010; Carothers 2013; Donkersloot and Carothers 2017; Ringer et al. 2018). With permits and harvest privileges that have generally appreciated in value concurrent with losses in 464 crew employment, coupled with delayed retirement due to increased safety and leasing of privileges, 465 466 LAPPs have limited diversification opportunities and inhibited or altered entry for new participants around the world (Power 2012; Neis and Power 2013; van Ginkel 2014; Szymkowiak and Himes-Cornell 467 468 2015; White 2015). Thus, traditional succession patterns of young family members and new participants gaining sufficient experience and capital to become vested in fisheries have changed with the new access 469 470 structure, potentially impeding the capacity of the next generation of participants to be able to enter and 471 expand their investment in fisheries (Donkersloot 2005; Lowe 2015; Donkersloot and Carothers 2016; 472 Ringer et al. 2018). Similar disconnects and intergenerational strife have been noted in other fisheries where Individual Transferable Quotas (ITQs) have disrupted multi-generational family fishing firms and 473 adversely affected family and broader community relationships because of equity concerns (McCay 1995; 474 475 Olson 2011; van Ginkel 2014).

476

477 "I know lots of young people who would do just about anything to be successful...And there's not
478 an opportunity to buy a boat and go fishing right now, unless you have to go and buy a permit of
479 some sort. You guys were talking about the salmon fishery and it's not a corporate fishery but
480 most people can't live an entire year, a family on a salmon season. When you can't have access to
481 any other fisheries, then what are you going to do?" (Kodiak participant)

483 *3.2.3 Adaptations and their effects on well-being*

One of the critical links between the impacts of adaptations on well-being is the extent to which a person 484 485 has the freedom and agency to choose whether and how to adapt (Brown and Westway 2011; Wolf 2011; Coulthard 2012). The focus group discourse revealed a number of factors that can constrain the adaptation 486 487 strategies available to and thus employed by Alaska fishing families (Table 2) (which, similarly to 488 conditions and adaptations, is not an exhaustive list but those that were noted in the discussions). 489 Demographic variables coupled with well-being priorities (e.g., maintaining a fishing identity) were of 490 paramount importance to the chosen strategy. For example, fisheries diversification was an adaptation most often noted by older participants who have both the historical context of relying on that strategy and 491 492 (ostensibly) access to capital to buy additional permits. Pluriactivity and increasing value strategies were 493 also associated with demographics in the discourse. Whereas older fishing participants revealed feeling 494 largely constrained to continuing in fisheries, younger participants denoted a sense of greater occupational mobility (Marks 2012). Similarly focus group discourse revealed that direct marketing is often a strategy 495 employed by women, so that gender or marital/family status could also be included to explain adaptation 496 497 choices. In part this may be borne out of competitive advantage, but focus group participants also 498 discussed how autonomy related to access to capital and sociocultural factors coupled with a sense of 499 fishing identity and well-being priorities (which may also be associated with demographics) affect

- 500 adaptation choices.
- 501

502	Table 2. I	Factors	affecting	the choice	of adaptation	strategy	and the	associated	dimensions	of those	e factors
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Factor	Dimensions
Demographics	age, gender, marital status, education, children
Capital investment in fisheries	size of boat, loans, type of boat
Sociocultural factors	macroeconomic trends, cultural norms
Well-being dimensions	fishing identity (years of experience and heritage), subjective well-being, prioritization of well-being components
Community factors	transportation and technology access, fishing identity
Access to capital	family financing, loan availability

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"So, you're either in it or you're not. And a lot of kids choose not to be in it anymore because they kinda see the writing on the wall...but for those of us who are older and don't have an education in anything but the fisheries. Where are you going to go when you are 50-60 years old? You stay, so you just move around." (Juneau participant)

The ultimate impacts of changing conditions on individual and family well-being were implied in the focus group discourse to be associated with not just the success of the adaptation in addressing the adverse impacts of the condition but the effects of the adaptation itself on other dimensions of individual and family life. Although the intent of adaptations is presumably to mitigate adverse livelihood effects from changing fishing conditions that are reducing fishing income, there are other dimensions that may be heterogeneously affected depending on the adaptation strategy and other underlying family dynamics. For example, increasing effort may imply going out further to sea, fishing longer and harder, which can result 517 in heightened safety risks from fishing in unknown grounds with different hazards (strange tides, 518 navigational obstacles, different sea bottoms), farther offshore in small vessels, and with insufficient rest 519 periods (Binkley 1996). A few focus group participants noted that these kinds of adaptations usually 520 result in family members other than the primary fisherman staying onshore due to safety concerns. In turn, increased risk can cause stress and anxiety for fishermen and their families while lengthened periods 521 522 of separation and resultant greater responsibilities for the onshore spouse can strain interpersonal familial 523 relationships (Binkley 1996; Zvonkovic, McGraw, and Manoogian-O'Dell 2000; Coulthard and Britton 524 2015). Although the extent of this stress is highly dependent on the structure of the family and how it 525 normally operates (Mederer and Barker 2000; Zvonkovic, McGraw, and Manoogian-O'Dell 2000).

Understanding the nuances of adaptation effects across the components of well-being (Breslow et 526 527 al. 2016) would necessitate a targeted inquiry at how those impacts may unfold across the family unit. 528 What emerged from the focus group discussions, however, was the increasing necessity for families to 529 adapt to changing conditions with a fundamental renegotiation of identities, relationships, and 530 perspectives. According to participants, the increasing reliance on pluriactivity to buffer against 531 variability in fishing income has largely resulted in women in fishing families engaging in shoreside 532 employment and those wages often becoming the primary source of income and in turn sometimes subsidizing the fishing operation (Danowski 1980; Maril 1995; Binkley 1996; Endter-Wada and Keenan 533 534 2005). These sorts of shifts can be detrimental for men whose identity is tied to securing livelihood for 535 their families and participation in the fishing industry (Lampl 1986; Davis 2000; Mederer 1999; Smith et 536 al. 2003; Sherman 2009), and for women it can mean a tradeoff with other uses of their time and energy, including working on the family boat, child care, building social capital, etc. (Smith et al., 2003; Marks 537 538 2012). However, focus group participants noted that often even as women in fishing families become the 539 primary breadwinner, their other family responsibilities are not diminished and, as other researchers have 540 noted, the net effect may be a subjugation of their personal well-being in exchange for that of their fishing family (Davis and Nadel-Klein 1992; Binkley 2002; Britton 2012; Britton and Coulthard 2013). In 541 addition, women's engagement in shoreside employment becomes critical in terms of not just maintaining 542 543 household income but providing for the family's welfare more broadly by ensuring health insurance – a 544 responsibility that is internalized and often exchanged for the personal enjoyment of participating directly in fisheries. 545 546

547 "Well I call my husband a highliner because I have a federal job. As much as I want to be a
548 fishing family where we all fish, I really don't think I could abandon my steady paycheck with
549 insurance job in order to do that. There is just too much risk for me personally." (Sitka female
550 participant)

551 In cases wherein pluriactivity is coupled with the exit of the fishing partner from fishing, whether 552 temporary or permanent, focus group participants noted that renegotiation of relationships and identities can also be difficult. In effect the adjustment is the opposite of what it is with increased effort because 553 554 now the family has to adapt to the increased presence of that person within the household (Mederer 1999; 555 Mederer and Barker 2000). Similarly to prolonged absences caused by increased effort, the upheaval is in the normal patterns and duration of entry and exit to which families are adapted and which are often 556 557 internalized and manifested in their sense of identity. It is the fluctuation beyond the conventional norms that can be destabilizing to fishing families that have created lifestyles, identities, and dynamics based on 558 intermittent presence (Binkley 1996; Mederer 1999; Mederer and Barker 2000). At times, the concurrence 559 560 of substantial income reductions from fishing and changes in established entry and exit patterns for the fishing partner within the household can be the most difficult dynamic faced by fishing families in 561 transition (Mederer and Barker 2000). 562

Even for families that may be able to remain within fisheries through various adaptations,
numerous participants noted a shift in their perceptions of that participation and implicitly the value they
derive from it. In effect there is an implied tradeoff in the adaptation strategies that they have employed to
be able to remain within fisheries and their overall well-being.

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568	"People used to be fishermen and now they have to also be businessmen. They have to
569	understand the regulatory cycle, they have to understand what potential regulations are out there
570	that might impact them." (Anchorage participant)
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572	"When I first started fishing was not too long after limited entry in the troll fishery andthe
573	trollers often took time off and had cook outs and picnics on the beach. And then as the price of
574	entry has gone up and salmon prices have gone down, relative to what people were making,
575	there's a lot less of that. People feel a lot more stressed to fish every day. Whether it's a family
576	fishery or not. So you see the families operating in a different way and when people are feeling
577	that they really have to make the most of every day, now I am seeing less kids on the boats
578	sometimes" (Juneau participant)
579	
580	The necessity of employing various adaptations that in many ways alter their fisheries
581	participation has changed the nature of fishing work for many families, as noted by focus group
582	participants. This has produced new subjectivities for those that have remained in fisheries by <i>inter alia</i>
583	decoupling fisheries participation from kinship networks, shifting skipper-crew dynamics, and redefining
584	family paradigms around fishing, breadwinning, and the household more broadly (Davis 1986;
585	Durrenberger 1997; Mederer 1999; Power 2005; Power, Norman, and Dupre 2014). Ultimately, although
586	some have been able to mitigate livelihood declines with adaptation strategies, the cost has been borne on
587	their way of life.
588	
589	"it's a lifestyle that has turned into corporate business and the lifestyle is what we are struggling
590	with now" (Kodiak participant)
591	
592	As conditions in fisheries continue to change and at an accelerating pace, managers should consider
595	now the policies that they employ may facilitate of impede adaptation and the well-being tradeons
594	addressing overconocity and overfishing in fisheries with excess conecity, they may also impede entry and
596	fisheries diversification opportunities, which have been a historically important mechanism for fisheries
597	narticinants to respond to flux. When fishermen are not able to mitigate revenue losses, exit from fishing
598	altogether becomes an adaptation strategy, but one that can also imply geographic migration and the loss
599	of a way of life for generations (Ringer et al. 2018). Similarly, pluriactivity may be effective at
600	attenuating household income declines but when that becomes the primary strategy of fishing families it
601	may in fact signal unsustainability especially in the face of wider economic instability. For example, the
602	COVID-19 pandemic has resulted in fishing revenue declines as well as an economic downturn that has
603	disproportionately affected the service sector and, therefore, women's employment in Alaska (Collins
604	2020). Given the reliance of many fishing families on women's labor to buffer household incomes, the
605	pandemic may have revealed the weaknesses of this adaptation strategy. Other participants are employing
606	value added strategies like direct marketing to address dockside price declines resulting from the
607	pandemic – a laborious task that is also frequently undertaken by women in fishing families and implies a
608	tradeoff in other potential uses of their time. In effect, managers may need to ensure that the tools that
609	tisheries participants have at their disposal to adapt to change are as diversified as the conditions that they
61U 611	race, not runneling them towards singular strategies that may have limited adaptive capacity in response
612	to varied conditions or unitaleral disproportionate well-being effects.
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- 614 4. Conclusions

615 Variability and adaptability are built into how fishing families define their underlying characteristics. Those uncertainties seem integral to how fishing families operate, and they have established strategies for 616 617 dealing with them. However, with the unprecedented pace of environmental change over the last three 618 decades and technological disasters, Gulf of Alaska fishing communities are responding to perceived shocks to a system beyond the established ranges of uncertainty, resulting in a variety of strategies from 619 620 normative behavior to long-term renegotiations of relationships and identities. This is in part because 621 strategies that were effective at adapting to changes within conventional bounds of risk may be 622 insufficient in the face of challenges that are inherently unpredictable, especially as the pace of change increases. In addition, strategies have implicit tradeoffs between various well-being components so that 623 an adaptation may be effective at mitigating adverse livelihood effects but at the cost of, for example, 624 625 increased safety risks and less time spent with family. Coupled together these factors are resulting in 626 fishing families throughout the Gulf of Alaska struggling to find new ways to maintain not just their

- 627 livelihood but their overall well-being.
- 628

629 While this study demonstrates the variation in adaptation strategies and their evolution in response to the 630 multiple facets of changing conditions, it also points to the necessity of understanding the underlying factors that inform adaptation choices. Changes in adaptations over time may be the result of not just 631 necessity borne out of new and more dynamic conditions but the underlying characteristics of fishing 632 633 individuals, families, communities, and the dynamics themselves. This may be manifest in a shift away from diversification of fishing portfolios, which is increasingly constrained by LAPPs, towards direct 634 635 marketing strategies that may foster agency by decoupling earnings (to some degree) from global seafood trends, prices, and stock conditions. While the former may be more available to those with access to 636 637 capital to invest in additional permits, the latter often necessitates comfort with technology and can be 638 facilitated by a shoreside partner, all of which have varied demographic dimensions. Thus some of the distribution in response diversity may be explained by heterogeneity in the fishing population, in addition 639 to the actual conditions. Especially in the context of Alaska, where communities are geographically 640 641 isolated and many fishing participants are bounded in their adaptation choices by that isolation, adaptation strategies have to be examined at a localized level. Future extensions of this research necessitate 642 systematic examinations of adaptations and their tradeoffs across multiple temporal and spatial scales, as 643 well as actors and social institutions. 644 645

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- 655 **6. References**
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