Determinants of Anglers Willingness to Pay to Support the Recreational Quota Entity Program

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Abstract

This study applies data from a web-based survey administered to Alaska sport fish license holders in 2017 to examine the newly introduced Recreational Quota Entity (RQE) program in Alaska's guided halibut sport fishery and the possibility of increasing halibut available to sport anglers by funding this program through a state-endorsed halibut stamp. Two valuation questions were randomized amongst the survey sample. The questions were designed to elicit willingness to pay (WTP) for a halibut stamp in support of the RQE program under (1) status quo halibut fishing regulations and (2) more relaxed charter halibut fishing regulations made possible through revenues from halibut stamp sales. The need for two valuation questions is in response to the many factors that would ultimately determine the degree to which charter fishing regulations could be relaxed and the time needed for regulatory change made possible through revenues from halibut stamp sales. The findings indicate that non-resident anglers and resident anglers have a very similar WTP for a state-endorsed halibut stamp and that anglers are willing to pay for a halibut stamp despite having little or no history of participation in the halibut fishery. The pairwise comparison among mean WTP estimates from both valuation questions indicates that differences in anglers' WTP are inconsequential. Findings suggest that the WTP for a state-endorsed halibut stamp reflects an interest in preserving access to the fishery or the value of reserving an option to participate in the halibut fishery. Respondent education level and employment status were found to be statistically significant determinants of anglers' willingness to pay for a state-endorsed halibut stamp to support the RQE program.

1. Introduction

A recently adopted management program in Alaska's charter halibut sport fishery aims to provide a market-based mechanism to facilitate the compensated reallocation of commercial halibut quota to the sport fishing sector (82 FR 46016). The reallocation could allow catch regulations to be liberalized for charter halibut anglers (82 FR 46016). The following analysis is based on responses to a web-based survey that was administered in Fall 2018 to 10,021 holders of a 2017 Alaska sport fish license (5,017 residents and 5,004 non-residents). Respondents were asked to provide information about their fishing experience in Alaska and about some of their social and demographic characteristics. In addition, respondents were asked to respond to contingent valuation (CV) questions designed to elicit the maximum value they would be willing to pay (WTP) for a state-endorsed halibut stamp if it were required to fish for halibut in Alaska. Respondents were given one of two valuation questions to evaluate WTP for a state-endorsed halibut stamp. In one version of the CV question, respondents were queried about their WTP for a state-endorsed halibut stamp under status quo charter-fishing regulations. In the second version of the CV question, respondents were asked about their WTP for a state-endorsed halibut stamp under charter halibut fishing regulations relaxed to the more liberal levels that currently apply to unguided anglers; two fish of any size in Area 3A. While the RQE program is intended to collect funds in support of enough halibut purchases to relax charter halibut fishing regulations, the actual extent of regulatory change will also depend on other factors and is unlikely to be implemented in the same year that anglers' purchase a halibut stamp. All respondents were informed that revenues generated from halibut stamp sales would be dedicated to the RQE program to relax fishing regulations for charter halibut anglers. The WTP bids were elicited through the payment card method introduced by Mitchell and Carson (1981), (e.g., $0 to $100 in $10 increments) (Boyle 2003). The range of values included in the survey was selected based on the results of a pilot survey. The indicated WTP was assumed to represent the respondent's upper threshold; the next lowest bid option was treated as an estimate of the lower bound of their WTP. The empirical analysis applies an Interval Regression model (Stewart 1983) and maximum likelihood methods to investigate the determinants of WTP.

The next section briefly describes the policy and regulatory background for the halibut commercial and sport fisheries in Alaska and the development of the RQE program. The third section explores the need for an RQE-type program in various limited entry fisheries given the challenges faced in allocating catch between commercial and sport fishing sectors. Section 4 describes the empirical model used for data analysis of the survey responses. Data collection methods and an overview of the data are reported in Section 5. The results are presented in Section 6. Section 7 includes conclusions and discussion.

2. Background

Halibut fishing is permitted throughout marine waters off the United States and Canada from California to Alaska. The International Pacific Halibut Commission (IPHC) is mandated to manage the halibut stock to maximize sustainable yield in ten regulatory Areas, eight (Areas 2C-4E) off Alaska, one (Area 2B) off British Columbia, and one (Area 2A) off the U.S. Pacific Northwest. The IPHC does so by setting overall catch limits on retained and discarded catch and apportioning those limits among the ten regulatory Areas. Within Alaska, the North Pacific Fishery Management Council (NPFMC) is responsible for developing and amending Fishery Management Plans (FMPs), including catch allocations of the overall catch limits set by the IPHC among the various fishing sectors. The principal sectors are commercial harvests in the halibut fishery, incidental catch in other commercial fisheries, non-guided sport fisheries, guided (charter) sport fisheries, and subsistence fisheries. The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) of 1976 is the primary law governing marine fisheries management in U.S. federal waters. The Act includes National Standards that must be followed in any FMP set forth by the NPFMC to ensure sustainable and responsible fishery management. Importantly,

national standard 1 requires an end to overfishing. The NPFMC is advisory to the Secretary of Commerce who delegates authority to the National Marine Fisheries Service (NMFS) to review and implement regulatory amendments proposed by the NPFMC. The National Marine Fisheries Service (NMFS), the U.S. Coast Guard, and the State of Alaska provide enforcement of catch limits and fishing regulations (83 FR 47819).

Historically, charter and unguided sport fisheries for halibut in Alaska were subject to uniform regulations. In IPHC regulatory areas 2C, 3A, 3B, and 4A-E (Figure 1), halibut fishing was closed in the winter and opened typically, from March 1- October 31. During the open season, anglers were subject to a 2-fish daily bag limit, a 4-fish possession limit, but no annual limit on total retained catch (Mecum and Muse 2007). However, there was significant growth[1] in Alaska's halibut sport fishery in the late 1990s and 2000s. During this time, there were no restrictions on the number of boats allowed to offer halibut sport fishing charters. Consequently, the number of charter boats and the amount of halibut caught aboard charter boats increased greatly. The sportfishing sector regularly exceeded the amount of catch that had been set aside for its use. Halibut catch within the commercial sector also exceeded allowed levels in the 1980s and 1990s[2]. The outcome was that together with bycatch (which was monitored and held below its allocation), the overall catch and discard mortality off Alaska threatened to exceed the limit set by the IPHC. The NPFMC was impelled to guard against this possibility to avoid non-compliance with the MSFCMA and national standard 1 requirement to end overfishing. Conservation and management efforts taken to end overfishing in sport and commercial fisheries around the world set precedents for regulatory actions adopted to end overfishing and allocations disputes in Alaska's halibut fishery.

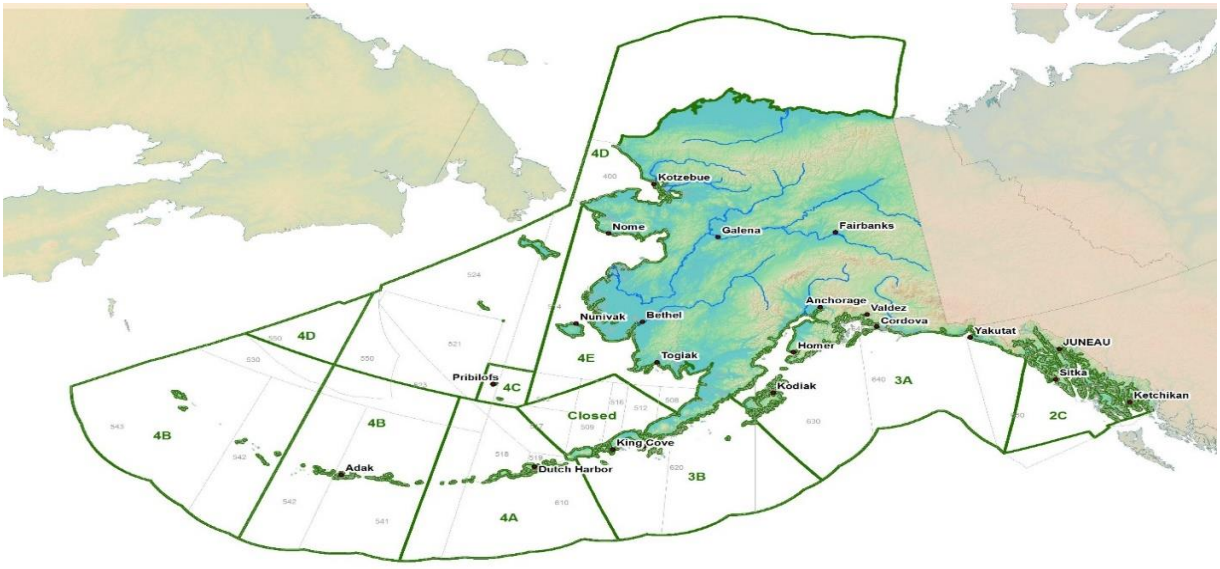

Figure 1. International Pacific Halibut Commission (IPHC) regulatory areas off Alaska (retrieved from https://alaskafisheries.noaa.gov/maps)

Beginning in the early 1970s, limited entry programs were introduced in world fisheries as a means to slow the race-for-fish, to reduce the chance of overharvesting fish stocks, and to preserve economic value for fishermen (Bishop 1973). However, by the late 1970s, it was increasingly apparent that limited entry often failed to deliver on those management, biological, and economic objectives

[1] Between 1970 and the end of the 1990s the number of resident sport fish licenses sold increased 41% per year and the number of non-resident sport fish licenses sales increased by 480% (Criddle, Herrmann, Lee and Hamel 2003).

[2] Catch within the commercial sector has stayed under its limits ever since IFQs were implemented in 1995.

(Wilen 1988). Economic theory supported the need to stint the use of common-pool resources (Demsetz 1967, Anderson and Hill 1975, Castle 1978). The application of exclusive-use rights to shares of natural resource surplus production or share of recreation services based on public resources became increasingly common in the late 1970s and early 1980s (Moloney and Pearse 1979, Atkinson and Tietenberg 1982, Livengood 1983, Lueck 1989). The economic consequences of not controlling overcapacity in fisheries could be observed as fishery managers were unable to control fishing effort and harvests.

An assessment of limited entry programs showed that while managers could bind some of the elements of the fisheries production function, e.g., boat numbers and size, gear dimensions, etc., fishermen can modify other elements of their production function, including the intensity of their labor, their mobility, and knowledge, or through gear and vessel modifications unconstrained by regulation (Pearse and Wilen 1979, Rettig 1984, Stollery 1986, Wilen 1988). The extent to which fishery managers could combat fishing effort by controlling a single input through limited entry programs did nothing to alter the incentives among fishermen who then substituted unrestricted inputs to maintain a race for fish and further dissipation of resource rents (Wilen 1988, Dupont 1991, Criddle 2004). The economic shortcomings of limited entry programs soon led to the development of quota allocation systems in commercial fisheries (Moloney and Pearce 1979, Dewees 1989, Terry 1993, Gauvin et al. 1994, Wang 1995, Squires et al. 1995). Abundant evidence suggests that individual quotas (Casey et al. 1995, Herrmann 1996, Weninger 1998, Herrmann 2000, Herrmann and Criddle 2006, Costello et al. 2008, Brinson and Thunberg 2016, Melnychuk et al. 2016, Warpinski et al. 2016) and divisible sector allocations (Felthoven 2002, Morrison-Paul et al. 2009, Strong and Criddle 2014) in commercial fisheries have reduced costs and increased revenue to fishermen. Alaska's commercial fishery for halibut transitioned to individual fishing quota (IFQ) management in 1995 (NPFMC 1992, NPFMC 2016). This process has been observed in Alaska's halibut fishery, where limited entry into the charter halibut fishery was implemented and followed by further regulatory measures to control output. Isolated management measures have generally been unsuccessful, and the idea of complementing the various types of management measures with other measures, i.e., input, output, and rights-based, may prove to be more effective (OECD 1997).

Like commercial fisheries, sport fisheries are subject to congestion externalities and the potential to exceed sustainable harvest levels. Traditional management measures for sport fisheries include season closures, gear restrictions, size limits, daily bag and possession limits, and annual catch limits. In addition, sport fisheries may be controlled through indirect measures such as access restrictions or fees charged by those who own land that abuts prime sport fishing habitat. Regulations for non-resident anglers are often more restrictive than regulations for resident anglers, and regulations for charter anglers are generally more restrictive than regulations for unguided anglers. Recently there has been theoretical and practical interest in the application of limited entry (Cox et al. 2002, Johnston et al. 2007) and individual quota (Abbott et al. 2009, Abbott and Wilen 2009, Borch 2010) or group quota (Sutinen and Johnston 2003) programs to sport fisheries. Efforts to design market-based solutions for sport fisheries draw on parallels with markets for hunting permits (Livengood 1983, Little and Berrens 2008).

To contend with the previously open-ended allocation of commercial halibut fishing quotas to the recreational fishery, Guideline Harvest Levels (GHLs) were assigned to the recreational halibut fishery in 2003, reflecting halibut abundance at this time, for areas 2C and 3A (67 FR 3867) where the largest commercial and recreational halibut harvests occur[3]. Together, Areas 2C and 3A encompass the entire southcentral and southeast coastlines of Alaska (Figure 1).

[3] In 2012, Areas 2C and 3A accounted for 65% of total commercial landings and 99% of the recreational catch of halibut (Gilroy 2016).

> By weight, the GHLs would equate to 13.05 percent of the combined guided recreational and commercial quota in area 2C or 1,432,000 lb (649.5 mt) net weight; and 14.11 percent of the combined guided recreational and commercial quota in area 3A or 3,650,000 lb (1,655.6 mt) net weight (67 FR 3867).

The GHLs identified the target harvest limits for the charter fishery (67 FR 3867). The assigned poundages fluctuate in response to fluctuation in halibut abundances. In addition to these management measures, the Alaska Department of Fish and Game (ADF&G) Sport Fish Division implemented a Saltwater Charter Vessel Logbook requirement in 1998. Logbooks collect information on:

> …the number of fish landed and/or released, the date and primary location of fishing, the hours and number of lines fished, the number of clients and crew fishing, the ownership of the vessel, and the identity of the vessel operator (67 FR 3867).

This information contributes to the determination of total annual halibut harvests by the charter fishing sector, stock abundances in given regulatory areas, fishing pressures in regulatory areas, and lends itself to the determination of GHLs and allocations to the various fishing sectors.

While the GHLs were intended to control halibut harvests by the recreational fishery, in area 2C actual harvests exceeded the GHL every year from 2004-2010, and in Area 3A, halibut harvest met or exceeded its GHL in 2004-2007 and 2007-2009. To cut down on these overages in Area 3A, NMFS used emergency orders to restrict halibut harvests by charter vessel skippers and crew (78 FR 75843). The GHL was therefore not effective at controlling the halibut harvest/output levels in the charter fishery. Its major disadvantages are understood as having been "not responsive or adaptable to changes in halibut abundance and fishing effort" (78 FR 75843).

Beginning in 2011, the NPFMC implemented a limited entry program for commercial businesses that offer halibut sport fishing trips, the Charter Halibut Limited Access Program (CHLAP; 82 FR 12730). Under this program, vessels offering halibut sport fishing charter services must have a Charter Halibut Permit (CHP) (Yamada 2014; 82 FR 12730). The number of CHPs was limited to reflect historical participation. However, additional permits can be issued to non-profit Community Quota Entities incorporated to promote the economic development of small communities in Southeast Alaska and along the Gulf Coast of Alaska. CHPs are revocable use rights for a specific regulatory area. They are infinitely durable and transferable but include limits on the number of anglers allowed aboard to fish for and retain halibut. Commercial provisioning of recreation services involving public resources is common; consider guide-use permits, guide permits for white-water rafting, guide permits for hiking and horseback trips on public lands, etc. In a sense, CHPs, along with permitting processes observed for other public resources, act as an assigned property right characterized by exclusivity, transferability, and enforceability. However, rights-based management, as it pertains to fisheries, is costly to create, monitor, and enforce when there are numerous rights-holders (Criddle 2004).

The CHALP suffered from the familiar limitations observed in commercial limited entry programs: the presence of latent capacity on vessels issued CHPs allowed continued increases in the number of angler days offered by halibut charter operators. Those increases resulted in ongoing overharvest of the GHL despite additional restrictions onboard halibut charters.

In 2014 the GHL was replaced by the Catch Sharing Plan (CSP; 78 FR 75844). The CSP outlined a total allowable halibut catch (TAC) and separately assigned fixed percentages of this TAC to the charter fishery and the commercial fishery. These percentages are designated as quota shares (QS). The TAC and the fixed percentages assigned to each fishing sector would vary according to the IPHC annual halibut abundances estimate. Allocation of harvest quotas are determined annually taking into account halibut abundance and the historical halibut catch in each fishery. Ideally, these allocations would result in the equitable distribution of catch across sectors. Commercial catch limits are directly monitored and

enforced as annual poundage limits applied at the individual vessel level. This is possible because the commercial fishery has, since, 1995, operated under a system of IFQs with monitoring of all landings and a sample of fishing trips. The individual quotas are derived as shares of the commercial fishing allocation. Fishery managers strive to control the total poundage of retained sport fishing catches through various combinations of daily bag and possession limits (e.g., 1 or 2 per day, 4 in possession), annual bag limits (e.g., a 4-fish annual limit for charter angler's in Area 3A), gear restrictions (e.g., single rod with a single hook); minimum size limits, maximum size limits, or slot size limits, etc. Regulations on charter anglers, have become more stringent as halibut abundance has dropped, and charter catch limits have been reduced (83 FR 47819).

Current regulations (84 FR 3403) on halibut charter anglers are:

- In Area 2C (Southeast Alaska): Sport fishers aboard sport fishing charter vessels are subject to a one-fish daily bag limit, with a reverse slot limit that allows retention of halibut less than 38 inches, or greater than 80 inches; there is no annual limit for halibut in Area 2C.

- In Area 3A (Central Gulf of Alaska): Sport fishers aboard sport fishing charter vessels are subject to a two-fish daily bag limit, with a maximum size limit of less than or equal to 28 inches on one of those halibut, and a four fish annual limit. Also, sport fishing charter operators in Area 3A are not allowed to fish for halibut on Wednesdays throughout the season, or on six Tuesdays (four in July and two in August). In addition, sport fishing charter vessels and charter permit holders are limited to no more than one trip per day.

Competition for a fixed number of halibut shares creates conflict between user groups. Further reductions or restrictions applied to either user group or TAC places an increasingly burdensome challenge on fishery managers to provide for the needs of the users and the resource. A developing economic approach to fisheries management suggests shifting the responsibility from the fishery managers to the market (Sutinen and Johnston 2003, Criddle 2004, Abbott et al. 2009, Borch 2010, Abbott and Willerd 2017). Perhaps the market is better equipped to self-correct from the multitude of biological or economic changes that can render an optimal allocation sub-optimal at any moment in time. The sheer variability in the proposed optimal allocation as well as the number of variables influencing optimality, prompted a more market-based mechanism of transferable shares between the contesting users.

The charter halibut fishery currently has one way to provide additional harvest opportunities to its clients through participation in the Guided Angler Fish (GAF) program (78 FR 75843). GAF offers CHP holders in IPHC Areas 2C or 3A the opportunity to lease a limited amount of IFQ from commercial quota shareholders to allow charter clients to harvest halibut in addition to, or instead of, the halibut harvested under the daily bag limit for charter anglers (Iverson, 2018, Kroetz et al. 2019).

Charter operators have expressed an interest in finding a market-based mechanism to help increase or supplement the amount of halibut allocated to the charter sector under the existing Catch Share Plan. The NPFMC responded by proposing a Recreational Quota Entity (RQE) program 82 FR 46016. The RQE's are similar to the Angling Management Organizations suggested in Sutinen and Johnston (2003). The RQE program is intended to provide additional harvest opportunities and less restrictive annual harvest measures for charter anglers in times of low halibut abundance (82 FR 46016). The final rule for the RQE program was published in the Federal Register on 21 September 2018 (83 FR 47819). This final rule allows the formation of an RQE, a 501(c)(3) non-profit corporation, to purchase commercial halibut QS. The harvest pounds associated with the purchased QS would yield annual Recreational Fishing Quota, supplementing the amount of halibut allocated to the charter sector under the existing CSP. If the RQE were to acquire enough QS, the halibut size and bag limits for charter anglers could be relaxed to the current daily bag limit for unguided halibut anglers; the retention of two fish of any size as a daily bag limit (82 FR 46016.) Attempts to increase the supply of recreational goods are frequently undertaken by

private and public entities. For example, there are private, state, and federal sport fish hatcheries programs to supplement sportfish stocks.

The mechanisms for funding the RQE acquisition of commercial halibut QS have not yet been determined. One possible funding mechanism is to require that anglers purchase a state-endorsed halibut stamp. Other potential funding mechanisms include a federal halibut stamp, a tax on charter halibut trips, an annual fee on CHP's, public or private funds, government or non-government grants, or a surcharge of sport fishing licenses (Yamada and Flumerfelt 2014). The Dingell-Johnson Sport Fish Restoration Act, which authorizes federal financial assistance for state fish restoration and management plans and projects, such as stock enhancement, habitat improvement, and public access, might be another source of funding for RQE purchases of halibut QS. While there is some private provision of sport fishing opportunities, e.g., private fishing ponds, most sport fishing opportunities are reliant on natural aquatic systems. Similar public goods, such as parks, preserves, and refuges are typically financed with public funds or through contributions from private organizations (e.g., Safari Club International, Ducks' unlimited, The Nature Conservancy). Where commercial activities compete with recreation activities, increases in resources allocated to recreation can also be increased through the attenuation of commercial use rights (e.g., revocation of timber and water rights, reallocation of fishing rights, reductions or restrictions in Exclusive Guide Areas (EGA's), or hunting concession permits). While there are many possible funding mechanisms to fund QS purchases to support the RQE program, this paper focuses on one mechanism, angler WTP for a state-endorsed halibut stamp.

3. Literature Review

The commercial and recreational fishing sectors satisfy two distinct but competing market demands. While recreational fishermen may, in part, demand fish for consumptive purposes, the overwhelming demand observed in the sport fishery is recreation (Green 1991). In contrast, while the commercial fishermen speak of the importance of lifestyle, the principal role of the commercial fishery is to supply fish for consumption. In the presence of competing demands for scarce goods and services, economic benefits are maximized when resources are reallocated among sectors until the marginal net benefit of the resource is equal across sectors (Bishop and Samples 1980). Within each fishing sector, competition arises for the use of limited fish resources and intensifies when the total harvest must be decreased, or the rate of increase must be reduced. Inevitably, sustainability by "ensuring the expected flows of use, option, and nonuse benefits provided by the fishery are not degraded through time" (Criddle 2004), becomes a principal concern in fisheries management. Achieving an optimum sustainable outcome requires a thorough understanding of the economic composition of the utility functions associated with commercial and sport fishing as well as a comprehensive understanding of the biological and ecological systems that govern the production of the goods and services valued by society. Because the demand for and supply of fishery-related goods and services shifts in response to changes in input and output factor prices, shifts in tastes and preferences, changes in technology, and changes in the productivity and carrying capacity of the natural system, the fortuitous circumstances under which an optimal allocation is achieved will not last. Consequently, without a mechanism to reallocate the resource in response to those changes, every optimal allocation will soon become suboptimal. A central planner would be hard-pressed to keep up with the myriad of changes in demand and supply of fishery-dependent commercial and recreation goods and services, and central planning often leads to economically wasteful rent-seeking. Under well-known conditions, market-based allocations are self-correcting and, consequently, outperform allocations through central planning. However, markets for public goods can fail in the presence of externalities, market concentration, and information asymmetry, conditions that are often present in fisheries. To what degree and for the appropriate way to manage such resources, we look to decades of economic study and historical outcomes resulting from management strategies or lack thereof.

More often than not, we have observed the allocation of fish resources by user groups under the consideration of their "values;" the gross benefits observed from the recreational fishery and the dockside value of commercial landings. The derivation of these values has relied on various economic methodologies such as input-output analysis and cost-benefit analysis, and investigation into the use of each method suggests that neither is equipped at determining the optimal allocation of a fishery resource (Edwards 1990). For example, input-output analysis assumes that prices are fixed and does not allow for substitution between factors (Lew and Seung 2010), of which recreational fishing and consumption of fish resources have many substitutes. Bishop and Samples (1980) identify several issues stemming from this method of allocation such as the inadequate calculation of costs, a measurement of average benefits as opposed to marginal benefits, the assignment of total allowable catch (TAC) based on the inability to model the relationship between sport and commercial catches given changes in stock abundances (Bishop and Samples 1980). The problem of adequately accounting for costs in determining the socially optimal allocation between the two fishing sectors has been explored, and problems arise in comparing and contrasting the most economical or optimal allocation of a fish resource across these two very heterogeneous user groups based on the costs they incur. This is true in comparing the value of recreational fishing with commercial fishing, where the currency value is over-emphasized because recreational fishing is motivated mainly by non-catch utility (McPhee and Hundloe 2004). When comparing benefits or costs, it is important to consider not only primary markets, such as ex-vessel sales of commercial catch but also secondary markets such as processors, charter operators, lodges, etc., that depend on primary markets and generate additional consumer and producer surpluses (Edwards 1990, Easley 1992). Sutinen (1993) models allocations between commercial and recreational fishing sectors under the assumptions that enforcement costs differ between user groups and that compliance is imperfect. Models show an increased bag limit in the sport fishery can have the unintended consequence of creating the perception of improved benefits to both violators and complying anglers to the regulations placed on the resource. Improving the allocation to this user group in Sutinen's (1993) model would be expected to increase the number of anglers participating in this fishery as well as potentially increasing the number of trips by both regulation violators and compliers; consequently, an increase in the bag limit could increase the aggregate catch. This notion is supported again when fishery managers regulate fishing sectors independent of one another but with the common goal of improving or sustaining fish stocks. The successful management of fishing efforts in one sector results in benefits attainable by the other sector which often further encourages fishing efforts by both sectors (McConnell and Sutinen 1979). Several models are presented and provide that enforcement costs and imperfect regulatory compliance are important factors in determining the optimal catch allocations as well as suggest that the optimal allocation assignment may be to the fishing sector having the higher marginal enforcement costs (Sutinen 1993).

Attainable net benefits in any fishery depend on fish population levels, the mix of commercial and recreational goods and services associated with the fish population level, choices of how to divide product capacity of the fishery among competing sectors, harvest control rules and allocation mechanisms within each sector, and the costs of management and enforcement . For the most part, fisheries around the world are fully allocated. Consequently, allocations between fishing sectors generally entail amending existing allocations and their associated regulations rather than developing an optimal allocation of a hitherto unexploited resource. For example, in implementing a new policy, such as the RQE program, managers must contend with the failures of the status quo. Amending the status quo in favor of one sector will adversely affect its rival and thereby create resistance to changes even if that change will result in an overall welfare improvement (Easley 1992). It should also be noted that a review of case studies on the allocation of access into Australia's fisheries to improve overall net benefits failed to consider that the change in allocation could result in merely a regional redistribution of economic benefits (McPhee and Hundloe 2004).

In situations where biological and economic demands require harvest to be reduced or for allocations to be reassigned, economic welfare is maximized when the marginal net benefits are equated across the user groups (Bishop and Samples 1980). This notion of maximizing welfare through an allocation decision that equates marginal net benefits across user groups is strongly supported in economic theory (Mcphee and Hundloe 2004, Easley and Prochaska 1987). The rippling effects of initial catch allocations, reduced, improved, or reassigned allocations can be significant. The dynamic factors that influence the marginal net benefits of a commercial and sport fishery make it nearly impossible for central planning to capture the optimal allocation based on the highest gain in marginal net benefits by user group. Nearly every possible allocation assignment would be sub-optimal because the ability to capture and to model the effects and implications of one allocation only holds optimal with the assumption of ceteris paribus. The possible interaction effects of any fisheries management decisions are without limit and not constrained to the user groups but the resource as well. Fisheries are complex ecological systems with a unique and self-supported food chain. Fisheries management decisions for one species will inevitably affect that species prey and or predator as well (Bishop and Samples 1980).

Fisheries managers face many constraints under which they are required to make decisions to sustain fish resources and the industries they support. They are restricted by available data, stock assessments, research methodologies, funding for further analysis or enforcement of regulation, etc. (Edwards 1990). As discussed previously, fishery managers are almost certain to fail at optimally allocating fish resources; the question is whether a market structure can be developed to more optimally allocate fish resources. Markets respond to relative changes in values and, in theory, under particular management design providing users the ability to reallocate resources to the use that generates the greatest economic value, and can self-correct under the influence of its many dynamic factors.

4. Empirical Model

A payment card method was applied in our survey and used to collect WTP interval data. Procedures for maximum likelihood estimation of the "payment card" regression model are followed (Cameron and Huppert 1989). Respondent WTP, Equation (1), is assumed to be non-negative and to follow a linear function where WTP_i is the WTP of respondent i. The intercept of this equation, α is an unknown constant to be estimated. The disturbance, ε_i, is assumed to be normally distributed with mean zero and standard deviation σ. The coefficient, β, is an unknown value to be estimated. The matrix consists of explanatory variables acting as determinants of each respondent's WTP for a state-endorsed halibut stamp:

$$WTP_i = \alpha + x_i'\beta + \varepsilon_i. \quad (1)$$

The respondent's true WTP_i is known to lie within an interval. Equation (2) accounts for this by standardizing the lower and upper bounds of this interval with t_{li} and t_{ui}, where z_i is distributed as a standard normal variable:

$$Pr\{WTP_i \subseteq [t_{li}t_{ui})\} = Pr\left\{\frac{t_{li}-\alpha-x_i'\beta}{\sigma} \leq z_i < \frac{t_{ui}-\alpha-x_i'\beta}{\sigma}\right\}. \quad (2)$$

The probability function expressed in Equation (2) can be rewritten as the difference between two standard normal cumulative distribution functions. In Equation (3), z_{ui} and z_{li} represent the lower and upper bounds in Equation (2), and for, any given observation, this can be written as $\Phi(z_{ui}) - \Phi(z_{li})$, where Φ is the cumulative standard normal density function:

$$Pr\{WTP_i \subseteq [t_{li}, t_{ui})\} = \Phi(z_{ui}) - \Phi(z_{li}). \quad (3)$$

The joint probability density function for n individual observations can be expressed as a log-likelihood function defined over the unknown parameters α, β, and σ. The log-likelihood function is given as:

$$logL = \sum_{i=1}^{n} log\,[\Phi(z_{ui}) - \Phi(z_{li})]. \quad (4)$$

Applying the maximum likelihood method when estimating Equation (4) allows for the examination of how explanatory variables influence in determining WTP.

5. Data

A web-based survey was conducted over two months, December 2018, and January 2019. The survey presented information about the newly adopted RQE program in Alaska's charter halibut fishery and inquired about anglers WTP to support the RQE program under current and liberalized catch regulations for charter anglers. The survey was designed and implemented using Qualtrics professional survey software. Respondents were initially solicited for their voluntary participation via a postcard mailing, which provided a QR code and URL link for access to the online survey. A pilot survey was administered in November 2018 to 200 individuals who held an Alaska sport fish license in 2017. Based on comments and suggestions received on the pilot survey, adjustments were made to the survey instrument version to improve clarity.

The survey sample was randomly drawn from a publicly available database of individuals who held an Alaska sport fishing license in 2017. Because the database did not include information about the license holder's fishing history, it was not possible to screen for individuals who had participated in Alaska's halibut sport fishery. Consequently, the survey sample included many license holders who had not participated in the halibut sport fishery[4]. The survey was mailed in December 2018 and delivered to a stratified random sample of 10,021 individuals who held an Alaska sport fishing license in 2017; the sample was stratified to include 5,017 resident anglers and 5,004 non-resident anglers. A 'Survey Reminder' postcard was mailed to a stratified random sample of 2,000 non-respondents in January 2019. Responses were received from 503 license holders. Survey responses with significant item non-response (i.e., failed to include responses to the CVM question or were missing responses to all the socio-demographics questions) were omitted from the data to be used to estimate model parameters; this left 414 responses. Some of these 414 responses were incomplete for some of the socio-demographic questions. A mean imputation method was used to replace those missing values[5], and the final data set was cross-validated with statistics reported in the NOAA report on Demographics of Recreational Fishing in Alaska (Little and Sepez 2003, Patrician 2002, Samnaliev et al. 2003). We feel confident that imputed values closely reflect the demographics of anglers who sport fish in Alaska. A majority of the respondents (310 of 414) indicated that they had participated in Alaska's halibut sport fishery in 2017.

The survey captured a broad cross-section of anglers in that responses were obtained from residents of 36 states besides Alaska. A total of 150 responses were from Alaska residents. Variables used in the empirical models directly relate to the responses elicited in the survey based on fishing avidity and socio-demographics. Table 1 provides these variable definitions and statistical descriptions while summarizing the sociodemographic characteristics of the sample as a whole. As shown in Table 1, 70.77% of the respondents were male, the average age of respondents was 53, and 344 (83%) of the respondents indicated that they were responsible for planning their household's fishing trips.

[4] Evaluation of the pilot survey yielded a total angler response rate of 6.5%. Of this 6.5%, 92% of respondents indicated a history of participating in Alaska's halibut sport fishery in either 2017 or 2018.

[5] A total of 29 values were imputed for missing data on respondents Age, 17 values were imputed for Household Income, 3 values were imputed for Household size, 3 values were imputed for Employment status, 1 value was imputed for Gender, 1 value was imputed for Trip Planner, and 1 value was imputed for Education level

Table 1. Variable Definition and Statistical Summary (n=414)

Variable	Description	Mean	S.D.
Total_daysfish_1718	Respondents total days fishing for any species in Alaska during 2017 and 2018, combined	20.08	43.27
Halibutfish	Dummy variable: 0 if the respondent did not fish for halibut in 2017 or 2018, 1 if the respondent did fish for halibut in 2017 or 2018	0.73	0.44
Area2C_2017	Respondents total days halibut fishing in Alaska in area 2C, 2017	1.82	10.20
Area3A_2017	Respondents total days halibut fishing in Alaska in area 3A, 2017	1.73	5.74
Area2C_2018	Respondents total days halibut fishing in Alaska in area 2C, 2018	1.79	12.25
Area3A_2018	Respondents total days halibut fishing in Alaska in area 3A, 2018	1.35	6.84
Charterfish	Dummy variable: 1 if the respondent charter halibut fished in Alaska in 2017 or 2018, 0 if the respondent did not charter halibut fish in Alaska in 2017 or 2018	0.47	0.50
Gender	Dummy variable: 0 for male, 1 for female	0.29	0.46
Age	Respondent's age	53.51	13.53
Residency	Dummy variable: 0 for State of Alaska resident, 1 for non-resident of Alaska	0.64	0.48
Education	The highest level of education completed by the respondents: 1 = some high school, 2 = high school diploma, 3 = some college, 4 = Associates degree, 5 = Bachelor's degree, 6 = Master's degree, 7 = Ph.D.	4.44	1.44
Employment	Respondents employment status: 1 = Unemployed, 2 = Part-time, 3 = Full-time, 4 = Retired	3.17	0.71
HHincome	Household's annual income level of respondents: 1 = $0-24,999, 2 = $25,000-49,999, 3 = $50,000-74,999, 4 = $75,000-99,999, 5 ≥ 100,000	4.03	1.14
HHsize	Size of respondents household: 1 if the respondent lives alone.	2.60	1.31
Trip Planner	Dummy Variable: 0 if the respondent is responsible for planning the fishing trips in their household, 1 if the respondent is not responsible for planning the fishing trips in their household.	0.17	0.38
Version A	Dummy Variable: 0 if the respondent completed survey Version A, 1 if the respondent completed survey Version B	0.51	0.50

The mean annual household income was reported to be between $75,000 and $99,999, and 90.34% of respondents had varying levels of college education, with the largest concentration (35.75%) holding four-year bachelor degrees. In addition, the average household size coefficient was 2.59, indicating a household size of 2-3 persons, and 64.49 % of respondents were employed while 31.16% were retired. Table 2 provides summary statistics and socio-demographic characteristics by survey version.

Table 2. Summary Statistics by Survey Version

	Version A			Version B		
Angler Characteristic	Mean	Median	SD	Mean	Median	SD
Average days fished in 2017	13.81	5	28.35	8.99	5	17.05
Average days fished in 2018	11.09	3	25.61	5.98	2	13.30
Proportion having halibut fished	0.79	1	0.41	0.68	1	0.47
Proportion having charter halibut fished	0.41	0	0.49	0.54	1	.050
Proportion female	0.31	0	0.47	0.27	0	0.44
Age (years)	53	53	13.52	54	56	13.54
Proportion non-resident	0.61	1	0.49	0.67	1	0.47
Education	4.39	5	1.50	4.50	5	1.36
Employment	3.15	3	0.73	3.19	3	0.70
Household income	3.95	4	1.19	4.1	4	1.07
Household size (by number of persons)	2.66	2	1.29	2.53	2	1.33

Version A (n=213) Version B (n=201) *Categorical variables not indicated as proportions correspond to statistical descriptions outlined in Table 1.

At the beginning of the survey, respondents were provided with a brief description of how Alaska's halibut fishery is managed (Section 1) followed by background information on the RQE program- what it is and what it is intended to do (Section 2). In section 3, respondents were prompted to provide information concerning their angling activity in Alaska over two years, 2017 and 2018. Section 4 of the survey contained the valuation question. The valuation question asked anglers WTP for an annual state-endorsed halibut stamp if it were required for halibut fishing in Alaska. Respondents were asked to assume that revenues from stamp sales would be dedicated to purchasing commercial QS for the RQE program to help relax the regulations for charter halibut anglers. Both versions of the CV question were framed with an initial question asking respondents the strength of their agreement with the following statement, "I am willing to pay for less restrictive charter halibut fishing regulations in Alaska." This question was followed by a note outlying the current price of a sport fishing license in Alaska and a statement that stamp fees would be paid in addition to the sport fishing license fee and that receipts from stamp purchases would be dedicated to the RQE program. Both versions of the survey asked respondents to:

> Please check the box corresponding to the greatest amount you would be willing to pay for an annual halibut stamp so that you would be able to halibut fish on your next fishing trip in Alaska (see supplemental file for survey instrument).

The two versions of the survey differed from one another in that, Version A of the WTP question explicitly stated and graphically showed no change in the current guided halibut fishing regulations and stated no change in the unguided halibut fishing regulations; that is, the status quo was maintained for halibut fishing, but the proceeds from the purchase of the halibut stamp would be dedicated to the RQE program to help loosen the regulations for charter halibut anglers in the future. Version B explicitly stated and graphically showed less restrictive guided halibut fishing regulations allowing charter fishermen to catch their daily bag limit with fish of any size and also stated no change in the unguided halibut fishing regulations; that is, the RQE program is presented as having already relaxed management measures and

that proceeds from stamp purchases would continue to be dedicated to the RQE program. The ranges of halibut stamp prices respondents were asked to select from were: $0, $10, $20, $30, $40, $50, $60, $70, $80, $90, and >$100. The indicated response was presumed to represent the upper bound of their WTP, the next lowest bid option was presumed to represent the lower bound of their WTP, and it was assumed that their true WTP exists within the intervals between the upper and lower bounds[6]. The payment card interval choice frequencies for both Version A and Version B are provided in Table 3 and Table 4. Figure 2 provides a histogram of bid values by survey version.

The certainty calibration method was applied to overcome issues of hypothetical bias. The WTP question was followed by a question asking respondents how confident they are with the value they indicated in the valuation question (Gate 2010). The responses to the confidence question were recorded on a 4-point scale ranging from "extremely confident" to "not at all confident."

Table 3. Version A (no change in charter halibut regulations) Interval Selection Frequencies (n=190)

Interval	Raw Frequency (%)	Cum.
$0-10	63 (33.16)	40.53
$10-20	65 (34.21)	67.37
$20-30	20 (10.53)	77.89
$30-40	14 (7.37)	85.26
$40-50	16 (8.42)	93.68
$50-60	2 (1.05)	94.74
$60-70	2 (1.05)	95.79
$70-80	0	0
$80-90	0	0
$90-100	8 (4.21)	100.00

All respondents were also asked: "How confident are you that this value reflects the maximum amount you would be willing to pay for a halibut stamp allowing you to fish for halibut under the current halibut fishing regulations?" If a respondent indicated a $0 bid as well as replied "Extremely confident," we consider their true WTP to be $0. True $0 bids are not included in Table 3.

Table 4. Version B (relaxation of charter halibut regulations) Interval Selection Frequencies (n=175)

Interval	Raw Frequency (%)	Cum.
$0-10	56 (32.00)	38.86
$10-20	52 (29.71)	61.71
$20-30	19 (10.86)	72.57
$30-40	12 (6.86)	79.43
$40-50	21 (12.00)	91.43
$50-60	3 (1.71)	93.14
$60-70	2 (1.14)	94.29
$70-80	1 (.57)	94.86
$80-90	1 (.57)	95.43
$90-100	8 (4.57)	100.00

[6] Models were estimated using the upper interval as well and statistical significance of estimates remained unchanged.

As in Table 3, bid intervals for payment card responses reported on Table 4 excludes true $0 bids. True "zeros" were detected and omitted from WTP analysis. Finally, in the last section of the survey, respondents were asked to answer questions about their socio-demographic characteristics. This information was used to ensure that the survey reached a broad cross-section of society and in investigating various determinants in WTP.

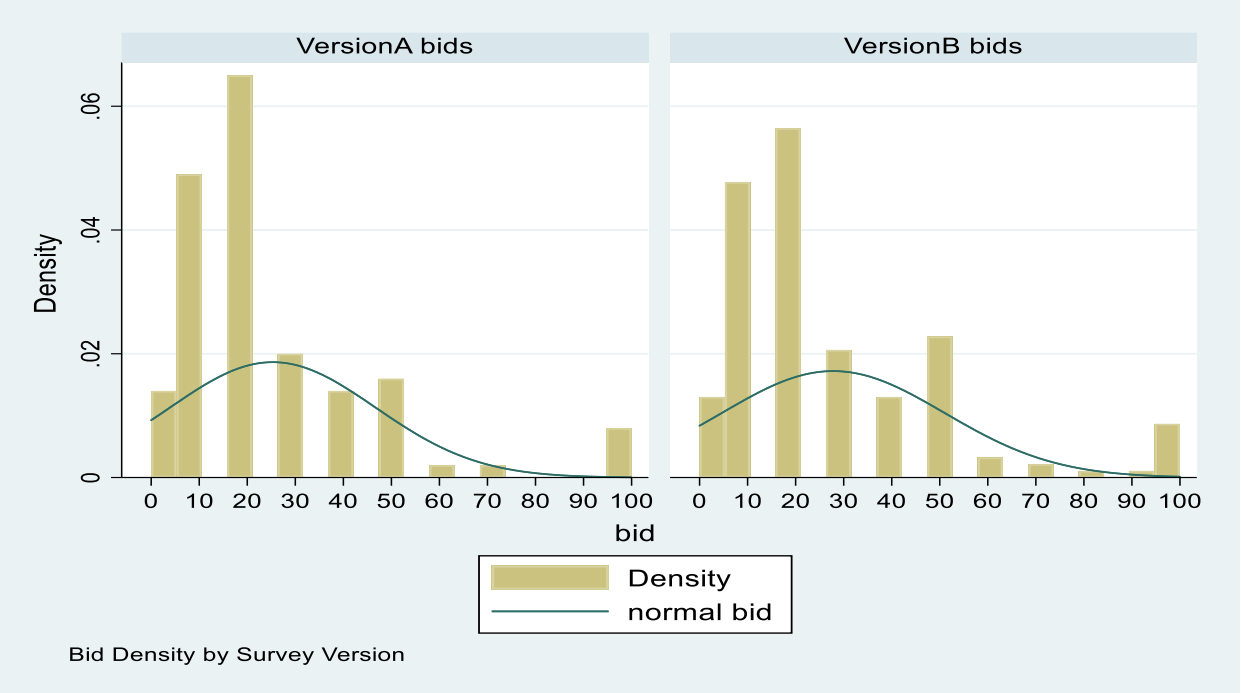

Figure 2. Histogram of bid densities by survey version

6. Results

6.1 Descriptive Analysis

As expected, both versions of the model results found a statistically significant inverse relationship between WTP and the percentage of bids. As the bid interval increases, bid frequencies decrease. Estimates of WTP based on the two CV versions are similar. For both survey versions, the median WTP is $20. Mean WTP for Version A was $25.32, while mean WTP for Version B was $27.83. A Wilcoxen rank-sum test shows that differences across WTP distributions by survey version are not statistically significant.

6.2 Determinants of WTP Amounts

Coefficient estimates for variables affecting WTP are presented in Table 5. The coefficients can be interpreted as changes in the marginal WTP for incremental changes in the value of the corresponding variable. Model results presented in Table 5 include estimates of coefficients associated with variables related to fishing experience for six combinations of CV question version and model specification. Candidate models were selected based on post-estimation results of best fit and to show that inference of the data has minimal variance under various model specifications to support findings presented in the

conclusion. Models 1A and 1B include the variable of total days fished in 2017 and 2018 for survey Version A and survey Version B. In contrast, while models 2A and 2B also estimate alternative specifications for survey Version A and Version B, they differ from models 1A and 1B by including a variable representing the respondent's participation in the charter halibut fishery. Models 3A and 3B differentiate by these same variables, however they do so over the pooled data set. That is, responses from both Version A and Version B, and include the variable *VersionA* to assess the marginal differences between survey versions across the entire sample. The variable *VersionA* is not statistically significant, which supports other findings that WTP for a state-endorsed halibut stamp is not contingent upon a regulation change; the true value is in preserving the option to halibut fish. With respect to the variable referring to anglers history of participating in Alaska's halibut sport fishery (represented by *Halibutfish*), it is not statistically significant in any of the estimated models; implying that anglers with a history of participating in Alaska's halibut sport fishery are no more willing to pay for a halibut stamp than all other anglers. Similarly, no statistical significance is found to affect WTP with anglers who indicated having charter fished for halibut in 2017 or 2018 (represented by *Charterfish)*. Also, the total days fished in Alaska in 2017 and 2018 are significant for respondents to the Version A question (Model 1A). The variable *totaldaysfish_1718* represents respondents' fishing avidity by days spent sport fishing, whereas, the variable *Charterfish* and *Halibutfish* are dummy variables representing participation in the respective fishing sectors. Statistical significance for WTP for a halibut sport fishing stamp observed for the variable *totaldaysfish_1718* (representing days fished in Alaska without species specification) in Model 1A and not for the variable *Charterfish* (representing charter halibut fishing) suggests that WTP is weighted more heavily towards the option to fish than to fish for specific species in the guided sector.

Angler employment is statistically significant at varying levels of significance,1%, 5%, and 10%, in each model given that the respondent indicated being full-time employed or retired from employment. Respondents indicating an education level of an associate's degree or a bachelor's degree is statistically significant at the 5% level in Model 3A and the 1% level in Model 3B.

The coefficients representing each respondent's confidence level in their stated WTP are grouped by those indicating being 'somewhat', 'not very', or 'not at all' confident. The base group is comprised of respondents who indicated that they were extremely confident in their indicated WTP bid. Eight respondents indicated a 'not at all' confidence level with their bid so this group was combined with the group of individuals indicating a 'not very' confidence level. However, coefficients for confidence levels are not found to be statistically significant in any of the models however, coefficients are negative for respondents indicating a 'not very' or 'not at all' confidence level in their bid selection. Similarly, positive coefficients are observed for 'somewhat' confident respondents in Models 1B, 2B, 3A, and 3B. Results suggest that the detection of hypothetical bias is coordinated across survey versions and among the estimated Models. It is expected that confidence levels in support of respondent's bid estimates would bias their WTP upward and vice versa; the direct relationship observed here supports the use of the indicated WTP as the upper threshold of bid intervals used in estimating the models. Negative coefficients for 'somewhat' confident respondents in their bid selection are observed in Models 1A and 2A, which suggest that survey version, i.e., regulation change, has some influence in respondents WTP but not at a statistically significant level. Confidence levels were run as interaction terms with the variable *Halibutfish*, a binary variable indicating participation in the halibut fishery, to support the null-hypothesis that a respondent's confidence level along with their bid estimate is supported by their fishing practices. We fail to reject the null hypothesis and conclude that confidence levels and bid estimates are indicative of a reiteration of respondent's preferences either to or not to sport fish for halibut. The statistically small number of true zero bids (8 total) indicates that the data presented here is not subject to any serious protest behavior.

Table 5. Coefficient Estimates and P Values for Models of WTP

VARIABLES	(Model 1A) Version A	(Model 1B) Version B	(Model2A) Version A	(Model 2B) Version B	(Model 3A) Pooled	(Model3B) Pooled
Total_daysfish_1718	0.109**	-0.00557			0.0696	
	(0.006)	(0.909)			(0.095)	
Halibutfish			2.453	-2.928		-1.092
			(0.591)	(0.446)		(0.708)
Version A					-1.030	-1.097
					(0.643)	(0.619)
Charterfish	2.345	4.766	0.611	4.527	3.076	1.983
	(0.393)	(0.179)	(0.825)	(0.215)	(0.183)	(0.385)
Gender	-2.350	1.494	-3.691	1.611	-0.660	-1.168
	(0.491)	(0.690)	(0.297)	(0.664)	(0.784)	(0.634)
Age	-0.217	0.322	-0.232	0.320	0.0230	-0.00223
	(0.114)	(0.081)	(0.109)	(0.079)	(0.842)	(0.985)
Non-resident	-0.0899	2.572	-0.111	3.075	2.290	2.793
	(0.976)	(0.443)	(0.974)	(0.360)	(0.320)	(0.253)
Education						
High School Diploma	0.0222	11.89	0.278	12.94	11.02	8.692
	(0.998)	(0.395)	(0.978)	(0.361)	(0.110)	(0.205)
Some College	2.453	9.565	5.114	10.25	12.37*	10.36
	(0.776)	(0.448)	(0.546)	(0.415)	(0.041)	(0.086)
Associates Degree	6.658	20.56	10.53	21.44	19.04**	17.50*
	(0.464)	(0.136)	(0.272)	(0.120)	(0.006)	(0.013)
Bachelor's Degree	6.201	16.08	7.369	16.77	16.89**	14.12*
	(0.470)	(0.194)	(0.376)	(0.172)	(0.006)	(0.020)
Master's Degree	1.756	4.729	2.818	4.951	10.10	7.656
	(0.850)	(0.711)	(0.755)	(0.701)	(0.117)	(0.229)
Professional/ Ph.D.	9.182	6.178	10.24	7.699	14.81*	12.36
	(0.408)	(0.655)	(0.351)	(0.575)	(0.047)	(0.095)
Employment						
Part-time	3.360	6.383	4.234	5.675	5.451	6.829
	(0.555)	(0.439)	(0.365)	(0.481)	(0.300)	(0.175)
Full-time	8.194	14.21*	8.631*	13.89*	10.48**	10.98***
	(0.073)	(0.019)	(0.027)	(0.019)	(0.001)	(0.000)
Retired	17.21**	-0.199	17.53***	-0.261	9.121*	9.594*
	(0.002)	(0.974)	(0.001)	(0.965)	(0.027)	(0.017)
HHincome						
$25,000-49,999	-0.840	11.00	1.805	10.54	1.350	3.148
	(0.902)	(0.468)	(0.788)	(0.467)	(0.818)	(0.603)
$50,000-74,999	-1.826	-3.964	1.613	-3.635	-1.253	0.393
	(0.795)	(0.651)	(0.813)	(0.669)	(0.818)	(0.942)
$75,000-99,999	-2.837	-12.00	-1.024	-12.45	-6.392	-5.180
	(0.680)	(0.156)	(0.873)	(0.127)	(0.224)	(0.313)
$100,000 or more	1.271	-10.97	2.888	-11.23	-2.520	-1.368
	(0.856)	(0.219)	(0.655)	(0.190)	(0.629)	(0.788)
HHsize	-0.149	-0.0867	-0.163	-0.248	-0.361	-0.328
	(0.896)	(0.951)	(0.888)	(0.860)	(0.679)	(0.712)
Confidence						
Somewhat confident	-0.550	6.327	-2.177	6.332	3.031	2.170
	(0.875)	(0.074)	(0.528)	(0.069)	(0.232)	(0.388)
Not at all confident	-4.921	-1.780	-4.796	-1.791	-2.387	-2.484
	(0.400)	(0.712)	(0.415)	(0.710)	(0.534)	(0.514)
Constant	17.09	-14.81	15.98	-12.95	-4.046	0.748
	(0.276)	(0.220)	(0.324)	(0.302)	(0.670)	(0.939)
lnsigma	2.962***	3.026***	2.995***	3.024***	3.035***	3.044***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	190	175	190	175	365	365

P-values are in parenthesis. *significant at 10%, **significant at 5%, *** significant at 1%

6.3 Assessment of Policy Preferences

Additional questions were presented to respondents of both survey versions to provide a more thorough understanding of angler preferences at the individual level and insight into their response to the valuation questions. After the valuation section in each survey version, respondents were prompted to select from several options helping to describe their anticipated plans about future halibut sport fishing trips in Alaska under the assumption that there would be a requirement to purchase a halibut stamp. The survey questions and corresponding response selections are shown below. Quantities in parenthesis represent the total number of respondents who selected that option. Respondents were allowed to check every option that applied to them. "Which of the following best describes your future halibut fishing decisions in Alaska if you were required to purchase a halibut stamp to fish for halibut in Alaska?"

- I do not and I will not fish for halibut. (29)
- I would start charter halibut fishing. (24)
- I would continue charter halibut fishing. (207)
- I would stop charter halibut fishing. (36)
- I would start halibut fishing (non-guided). (28)
- I would continue halibut fishing (non-guided). (127)
- I would stop halibut fishing (non-guided). (18)
- Other (40)

Information provided from this question allowed for a more nuanced interpretation of WTP estimates as well as a comparison of future angling behavior by survey version. Table 6 presents the proportion of anglers by survey version who indicated each response. Notably, over 50% of the total respondents indicated that they would continue to take charter halibut sport fishing trips even if required to purchase a halibut stamp and nearly 31% indicated that they would continue to take non-guided halibut sport fishing trips.

A second question asked the respondents to rank, from their most preferred to their least preferred, alternatives for regulating sport fishing catch of halibut. The catch regulations to be ranked were the four catch regulation methods used to manage the sport fish industry in Alaska. Table 7 summarizes the responses. Daily bag limit, a restriction on the quantity of fish harvested daily, was most frequently selected as the most preferred catch regulation method. Restrictions on the days permitted to fish, either by season length or no-fishing days, was most frequently selected as respondents' least preferred catch regulation.

Table 6. Indicated Behavior Change, post valuation query

Response Option	Version A (current regulations) n=211	Version B (relaxed regulations) n=200
I do not and I will not fish for halibut	0.07	0.06
I would start charter halibut fishing	0.07	0.04
I would continue charter halibut fishing	0.44	0.57
I would stop charter halibut fishing	0.08	0.09
I would start halibut fishing (non-guided)	0.05	0.08
I would continue halibut fishing (non-guided)	0.33	0.28
I would stop halibut fishing (non-guided)	0.03	0.05
Other	0.11	0.08

Table 7. Preference Toward Various Catch Regulations

Catch Regulation	Version A (n=213) Most preferred	Least preferred	Version B (n=201) Most preferred	Least preferred	Total (N=414) Most preferred	Least preferred
Daily bag limit (restriction on the quantity of fish harvested daily)	104 (0.49)	23 (0.11)	103 (0.51)	23 (0.11)	207 (0.50)	46 (0.11)
Annual bag limit (restriction on the quantity of fish harvested annually)	66 (0.31)	47 (0.22)	51 (0.25)	41 (0.20)	117 (0.28)	88 (0.21)
Size of fish (minimum, maximum, or slot restrictions on fish length)	22 (0.10)	45 (0.21)	22 (0.11)	41 (0.20)	44 (0.11)	86 (0.21)
Days permitted to fish (length of season/ no-fishing days)	21 (0.10)	98 (0.46)	25 (0.12)	96 (0.48)	46 (0.11)	194 (0.47)

The frequency of catch regulation being most preferred is shown with proportions noted in parenthesis.

7. Conclusion

In this study, data collected from a web-based survey is used to estimate charter anglers' WTP to support the RQE program. A possible funding mechanism for the RQE is to require that anglers purchase a halibut stamp to participate in Alaska's halibut sport fishery. Revenues from stamp sales would be dedicated to the RQE to purchase commercial halibut QS and thereby increase the total allocation of halibut to the charter sector. The supplemental halibut to the charter allocation could help the charter sector accommodate continued increases in the demand for charter trips and might allow some relaxation of current charter halibut fishing regulations even in years of low halibut abundance, perhaps to a point where guided anglers could operate under the same limits applied to un-guided anglers: a 2-fish per day bag limit, a 4-fish possession limit, and no size limits. Two valuation questions were randomized across respondent samples to examine WTP under current charter halibut fishing regulations and under more relaxed charter halibut fishing regulations made possible through revenues generated by halibut stamp sales. The actual level of regulatory relief that may be afforded by the RQE program is unknown. It will depend on several factors, many of which are unrelated to the magnitude of revenues generated by halibut stamp sales. These exogenous factors include the effect of changes in the ocean environment and how those changes affect halibut size-at-age, abundance, and distribution, changes in the market price of commercial halibut QS, changes in the demand for charter halibut sport fishing trips, and whether the IPHC will continue the past practice of over-allocating Area 2 halibut to Area 2B (British Columbia). Moreover, the actual mechanisms for funding the RQE program have not yet been identified and might require additional regulatory action to be viable. If a regulatory change was made possible with the consideration of other factors as well as through the receipt of stamp purchases, it is likely that regulation changes would not be immediate and would instead be implemented for future fishing seasons. Great consideration was given to these challenges in the survey design process and ultimately resolved in the design and randomization of two different valuation questions. WTP estimates from both survey versions were very similar with no difference in median WTP and with mean WTP differing by only $2.51. Data collected on the socio-demographics and fishing experience were very similar across the two survey versions ruling out these factors as affecting the WTP values in each survey. The small variation observed in WTP estimates across survey versions and among resident and non-resident anglers as well as halibut and non-halibut anglers suggest that the anglers indicated value reflects their option value for halibut

sport fishing in Alaska. In other words, the value of the option to participate in Alaska's halibut sport fishery is ubiquitous and relatively concentrated in the lower bounds of the payment card values provided in the surveys. Non-resident anglers ultimately incur higher costs associated with fishing in Alaska compared with resident anglers. However, non-resident anglers indicated similar WTP in both survey versions as did resident anglers and residency was not statistically significant in any of the models for determining WTP. Results suggest that only a minimal portion of an anglers total WTP for fishing opportunities in Alaska is specific to halibut fishing. Alaska charter boat fishing trips in recent years have been estimated to range from $300 for a single day trip to about $1500 for a multi-day trip (Lew and Larson 2015). Travel costs, lodging, and other expenses are expected to be higher for non-resident anglers, and studies show that non-resident charter boat trips have a much higher total value for a single-day fishing trip (Lew and Larson 2012). Given the high costs associated with charter fishing in Alaska, the findings presented in this thesis could suggest that a $20 -$30 halibut stamp would likely be viewed as an insignificant additional cost relative to total charter fishing costs in Alaska. Bid estimates across both survey versions were heavily concentrated in the $10-$30 range. This high concentration of bid values was selected by anglers who have a history of charter halibut fishing, anglers who have a history of un-guided halibut fishing, and anglers who indicated that they had never fished for halibut in Alaska and have no future intention of fishing for halibut, implying that the bid values represent an option given the requirement to obtain a halibut stamp to participate in Alaska's recreational halibut fishery. The ability to charter halibut fish under less restrictive management measures is secondary and statistically insignificant in our findings.

Socio-demographic characteristics, except for employment and education in the pooled models, were not statistically significant in explaining WTP. These findings are not surprising because fishing is an expensive leisure activity. Fully employed respondents are more likely to have income that could support the financial demands of recreational fishing, and retired respondents would be expected to have the leisure time to participate in leisure activities. Education at varying college levels was found to be statistically significant in Model 3A and 3B, which include all responses from both survey versions. Statistically significant coefficients in these models indicate an increase in WTP that ranges from $12.37-$19.04. Education is understood as improving WTP, and the pooled models, Model 3A and 3B, are preferred in capturing angler response to the RQE program.

Finally, this study suggests two areas for continued research. First, these results and findings analyze WTP estimates from anglers who held a sport fishing license in Alaska in 2017 irrespective of whether they fished for halibut. Future studies could benefit from narrowing the sample frame to halibut anglers or, more specifically, charter halibut anglers. A tighter sample frame would have greater power to discern the likely response of anglers to a halibut stamp requirement for funding the RQE program. Second, attributes of charter fishing trips are likely to be important in determining the WTP amount for a stamp allowing an angler to halibut fish. The present study opted not to include charter fishing trip attributes such as day trips or lodge experiences, which often include multiple fishing days targeting multiple species as well as other activities such as bear viewing or whale watching due to the constraints from a broad sampling frame. This issue is left as a potential area for future research and continued analysis of Alaska's new charter halibut fishery management plan, the RQE.

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