IN THE SUPREME COURT OF THE STATE OF ALASKA

SITKA TRIBE OF ALASKA, Appellant, v. **STATE OF ALASKA DEPARTMENT OF FISH AND GAME, and SOUTHEAST HERRING CONSERVATION ALLIANCE,** Appellees.	Supreme Court No. S-18114

Trial Court Case No. 1SI-18-00212 CI

On Appeal from the Superior Court
First Judicial District at Sitka
The Honorable Daniel Schally, Superior Court Judge

AMICUS CURIAE **BRIEF OF SEALASKA CORPORATION**
Filed in Support of the Appellant

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STATUTES

AS 16.05.258. Subsistence Use and Allocation of Fish and Game.

(a) Except in nonsubsistence areas, the Board of Fisheries and the Board of Game shall identify the fish stocks and game populations, or portions of stocks or populations, that are customarily and traditionally taken or used for subsistence. The commissioner shall provide recommendations to the boards concerning the stock and population identifications. The boards shall make identifications required under this subsection after receipt of the commissioner's recommendations.

(b) The appropriate board shall determine whether a portion of a fish stock or game population identified under (a) of this section can be harvested consistent with sustained yield. If a portion of a stock or population can be harvested consistent with sustained yield, the board shall determine the amount of the harvestable portion that is reasonably necessary for subsistence uses and

(1) if the harvestable portion of the stock or population is sufficient to provide for all consumptive uses, the appropriate board

(A) shall adopt regulations that provide a reasonable opportunity for subsistence uses of those stocks or populations;

(B) shall adopt regulations that provide for other uses of those stocks or populations, subject to preferences among beneficial uses; and

(C) may adopt regulations to differentiate among uses;

(2) if the harvestable portion of the stock or population is sufficient to provide for subsistence uses and some, but not all, other consumptive uses, the appropriate board

(A) shall adopt regulations that provide a reasonable opportunity for subsistence uses of those stocks or populations;

(B) may adopt regulations that provide for other consumptive uses of those stocks or populations; and

(C) shall adopt regulations to differentiate among consumptive uses that provide for a preference for the subsistence uses, if regulations are adopted under (B) of this paragraph;

(3) if the harvestable portion of the stock or population is sufficient to provide for subsistence uses, but no other consumptive uses, the appropriate board shall

(A) determine the portion of the stocks or populations that can be harvested consistent with sustained yield; and

(B) adopt regulations that eliminate other consumptive uses in order to provide a reasonable opportunity for subsistence uses; and

(4) if the harvestable portion of the stock or population is not sufficient to provide a reasonable opportunity for subsistence uses, the appropriate board shall

(A) adopt regulations eliminating consumptive uses, other than subsistence uses;

(B) distinguish among subsistence users, through limitations based on

(i) the customary and direct dependence on the fish stock or game population by the subsistence user for human consumption as a mainstay of livelihood;

(ii) the proximity of the domicile of the subsistence user to the stock or population; and

(iii) the ability of the subsistence user to obtain food if subsistence use is restricted or eliminated.

(c) The boards may not permit subsistence hunting or fishing in a nonsubsistence area. The boards, acting jointly, shall identify by regulation the boundaries of nonsubsistence areas. A nonsubsistence area is an area or community where dependence upon subsistence is not a principal characteristic of the economy, culture, and way of life of the area or community. In determining whether dependence upon subsistence is a principal characteristic of the economy, culture, and way of life of an area or community under this subsection, the boards shall jointly consider the relative importance of subsistence in the context of the totality of the following socio-economic characteristics of the area or community:

(1) the social and economic structure;

(2) the stability of the economy;

(3) the extent and the kinds of employment for wages, including full-time, part-time, temporary, and seasonal employment;

(4) the amount and distribution of cash income among those domiciled in the area or community;

(5) the cost and availability of goods and services to those domiciled in the area or community;

(6) the variety of fish and game species used by those domiciled in the area or community;

(7) the seasonal cycle of economic activity;

(8) the percentage of those domiciled in the area or community participating in hunting and fishing activities or using wild fish and game;

(9) the harvest levels of fish and game by those domiciled in the area or community;

(10) the cultural, social, and economic values associated with the taking and use of fish and game;

(11) the geographic locations where those domiciled in the area or community hunt and fish;

(12) the extent of sharing and exchange of fish and game by those domiciled in the area or community;

(13) additional similar factors the boards establish by regulation to be relevant to their determinations under this subsection.

(d) Fish stocks and game populations, or portions of fish stocks and game populations not identified under (a) of this section may be taken only under nonsubsistence regulations.

(e) Takings and uses of fish and game authorized under this section are subject to regulations regarding open and closed areas, seasons, methods and means, marking and identification requirements, quotas, bag limits, harvest levels, and sex, age, and size limitations. Takings and uses of resources authorized under this section are subject to AS 16.05.831 and AS 16.30.

(f) For purposes of this section, "reasonable opportunity" means an opportunity, as determined by the appropriate board, that allows a subsistence user to participate in a subsistence hunt or fishery that provides a normally diligent participant with a reasonable expectation of success of taking of fish or game.

REGULATIONS

5 AAC 27.195. Sitka Sound commercial sac roe herring fishery

(a) In managing the commercial sac roe herring fishery in section 13-B north of the latitude of Aspid Cape (Sitka Sound), the department shall

(1) manage the fishery consistent with the applicable provisions of 5 AAC 27.160 (G) and 5 AAC 27.190;

(2) distribute the commercial harvest by fishing time and area if the department determines that it is necessary to ensure that subsistence users have a reasonable opportunity to harvest the amount of herring spawn necessary for subsistence uses specified in 5 AAC 01.716(b).

(b) In addition to the provisions of (a) of this section, the department shall consider the quality and quantity of herring spawn on branches, kelp, and seaweed, and herring sac roe when making management decisions regarding the subsistence herring spawn and commercial sac roe fisheries in Section 13-B north of the latitude of Aspid Cape.

STATEMENT OF INTEREST

The portion of this appeal to which this brief is addressed concerns one of the principal legal thresholds that a subsistence user must overcome in order to obtain interlocutory relief from harm that is being caused to the subsistence fishery. As such, it touches the heart of one of Sealaska's core corporate concerns.

Sealaska Corporation is the regional corporation for Southeast Alaska under the Alaska Native Claims Settlement Act. Sealaska has just over 23,000 Tlingit, Haida and Tsimshian Indian shareholders. As this brief will show, our shareholders' culture, values and well-being hinge in no small part on the enduring tradition of sharing the herring roe from the Sitka subsistence harvest at stake here.

Sealaska stands at the forefront of the effort to protect traditional Native culture, including protecting our shareholders' subsistence fishing rights. This mission is perhaps best exemplified by the creation of Sealaska Heritage Institute, a Sealaska subsidiary that is nationally prominent as a guardian and advocate for Northwest Native art and culture. [1]/

Moreover, Sealaska plays a direct role in the traditional annual distribution of subsistence-harvested herring roe from Sitka Sound:

> *Between 2002 and 2018, herring eggs were shared with 41 other communities in Southeast Alaska and beyond…Herring eggs are distributed to institutions in Juneau as well through Sealaska Corporation…*

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[1] / *See:* https://www.sealaskaheritage.org/

> *The distribution of subsistence herring eggs harvested from Sitka Sound is prodigious, with 87% of the overall harvest volume given away….*

S. Langdon, *The Significance of Sharing Resources in Sustaining Indigenous Alaskan Communities and Cultures* (2021) at 30 ("*Langdon Study*"). [2]/

For these reasons, Sealaska has been an active *amicus* participant in this litigation from the outset. Sealaska joined with a number of Indian Tribes in an *amicus* memorandum at the preliminary injunction stage, [3]/ and likewise in the earlier petition for review before this court. [4]/

Sealaska is submitting this brief on only one issue in this appeal: the trial court's ruling that, in order to obtain interlocutory relief, subsistence users must show that a sudden-onset crisis is causing harm dissimilar from any previously-occurring harm. [5]/ The decay of subsistence fisheries is often (if indeed not invariably) the product of years of mismanagement causing a measured but inexorable bleed—not a sudden-onset crisis. The trial court's hurdle, which is now precedent in the First Judicial District, creates a serious barrier to any Native effort to

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[2] / Available at https://www.sealaskaheritage.org/sites/default/files/Significance%20of%20Sharing%20final%20with%20cover.pdf

[3] / R. 369 *et seq.*

[4] / *Amicus Memorandum in Support of Petition for Review, Sitka Tribe of Alaska v. State of Alaska*, S-17384 (Feb. 28, 2019).

[5] / Point on Appeal No. 2, *Amended Statement of Points on Appeal* (Oct. 19, 2021).

timely protect their fishery. That consequence of that ruling is what motivates this *amicus* submission. [6]

STATEMENT OF ISSUES

In order to demonstrate irreparable harm for purpose of preliminary relief, is the movant required to prove the existence of a crisis that produces harm different in kind from any previously-suffered harm?

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[6] / Section I of this brief's Statement of the Case ("Statement of Facts") makes extensive use of two 2021 studies: (i) the *Langdon Study*; and (ii) T. Thornton and M. Moss, *Herring and People of the North Pacific: Sustaining a Keystone Species,"* Univ. of Wash. Press (2021) ("*Thornton Study"*). Obviously, neither study existed when the trial court decided the preliminary injunction motion in 2019. These studies, however, are not cited as adjudicative facts. Rather, they are cited to illustrate the unreasonableness of the trial court's rule of law that irreparable harm does not exist if the loss is similar to losses previously suffered. They are, in a nutshell, offered as an aid to this court "in its determination …that a particular change in the law would probably do more harm than good." *Commentary, Alaska Rule of Evidence 201.* As such, they represent "legislative facts" that may be freely considered by the court. *State v. Erickson*, 574 P.2d 1, 5-6 (Alaska 1978) ("Legislative facts come into play when the court is faced with the task of deciding …the extension or restriction of a common law rule upon grounds of policy. These policy decisions…often hinge on social, political, economic, or scientific facts, most of which no longer fall within the classification of irrefutable. Cases involving such decisions cannot be decided adequately without some view by the court of the policy considerations and background upon which the validity of a particular statute or rule is grounded.").
In preliminary injunction proceedings below, the Sitka Tribe of Alaska (the "Tribe") and *amici* presented substantial evidence on the principal points made in the Statement of Facts—*i.e.,* the value and vulnerability of our regional tradition of sharing Sitka herring roe. In addition to the record evidence referenced in the Statement of Facts, additional evidence offered below by the Tribe and *amici* on these issues is discussed in Section II of the Statement of the Case ("Proceedings Below.")

STATEMENT OF THE CASE

I. Statement of Facts

a. Genesis of the Sitka roe-on-hemlock fishery

Each spring, and since time immemorial, Sitka Natives of the Kiks.ádi clan have laid hemlock branches in the shoreline waters of Sitka Sound to collect the roe of returning herring. [7]/ That tradition is prominent in Tlingit, Haida and Tsimshian legend. Most conspicuous is the Kiks.ádi clan woman who immersed her hair in the waters below Sitka's Herring Rock. Herring began spawning on her hair, leading to today's practice to collecting roe on hemlock branches. *Thornton Study*, *op. cit. n 6* at 119.

Parenthetically, Herring Rock remained hallowed ground for Sitka Tlingits until real estate developers blew it up. *Id.*. *Thornton Aff.,* p. 6 (R. 1060). Even so, the herring season still begins with a blessing ceremony at the site of Herring Rock. *Id.*

The abundance of the Sitka fishery is as legendary as its origin. As Kiks.ádi elder Harvey Kitka described to the trial court:

> *Historically in my lifetime, the herring spawned all over Sitka Sound…When you were down by the ocean it sounded like it was pouring rain; the herring would be flipping in the water as far as the eye could see…[The] whole beach would be covered in spawn.*

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[7] / *Thornton Study* at 119-120; Lauren A. Sill and Margaret Cunningham, *The Subsistence Harvest of Pacific Herring Spawn in Sitka Sound, Alaska, 2016*, ADFG Technical Paper No. 435 (2017) at 1 ("*Sill and Cunningham")* (available at http://www.adfg.alaska.gov/techpap/TP435.pdf). The *Sill and Cunningham* report was repeatedly cited to the trial court at the preliminary injunction stage. R. 4, 8, 14, 338.

Kitka Aff., ¶6 (R. 187); *Sill and Cunningham*, *op cit. n. 7* at 1 ("In the 19th century, Sitka was a center for Tlingit culture all over Southeast Alaska to harvest herring and herring spawn…In the 1860's, herring were so numerous around Sitka in February and March that the water became milky from eggs and milt and it was easy to catch herring with rake…[*internal cites omitted*]").

b. The essential role of the Sitka subsistence roe fishery in Tlingit, Haida and Tsimshian culture

(i) The system of sharing

The quintessential trait of this fishery is the extent to which the harvested roe is shared. One study found that 87% of the harvest is shared throughout the region and beyond, while only 13% is consumed by the harvester and his/her household, [8]/ while another found that, in 2016, 97% was shared, while the harvesters' households kept 3%. [9]/ The sharing is neither casual nor informal; rather, it is the product of a structured cultural tradition in which each harvester and community plays its appointed role. For example, and in addition to the Sealaska distribution role noted *ante*:

> *In Sitka, individual harvesters and designated harvesters deliver fish eggs to the Sitka Senior Center, Sitka Salvation Army, SEARHC hospital, and the Sitka Pioneer Home… The Hoonah Indian Association provides financial assistance to a Hoonah harvester who travels to Sitka Sound every year to obtain herring eggs that are brought back to the community and shared without cost to up to 200 individuals.*

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8 / *Langdon Study* at 30.

9 / *Sill and Cunningham*, *op. cit.* n 7 at 8.

Langdon Study at 30. It is an "amazing distribution and sharing system," anthropologist Dr. Thomas Thornton noted, "represent[ing] the triumph of communalism and conviviality." [10]/

(ii) The cultural significance of sharing the fishery's harvest

(A) The role of sharing in Alaska Native culture

Sharing of the subsistence harvest is an underpinning of Alaska Native culture. It is sinew that holds the culture together. To begin with, sharing is an efficient food distribution system. As an ADF&G technical paper observed:

> *In specialized harvests, such as of herring eggs, where specific knowledge and skills are required for a successful harvest, sharing is even more profound. The pattern of a small number of households ('superhouseholds") harvesting and then distributing a unique resource is common since these super-households' have the time, ability, knowledge, and equipment necessary to successfully harvest.*

Sill and Cunningham, op.cit. n. 7 at 18. Sharing "is not random: it operates according to complex codes of participation, partnership and obligation." *Langdon Study* at 2. For village elders, the tradition is existential:

> *The sharing of traditional foods with Elders is especially important as they are a necessity for feeling healthy and staying active and are believed to contribute to longevity. It is believed by many Indigenous Alaskans that Elders … have developed physiological and possibly psychological dependence on such foods.*

[10] / *Thornton Study, op. cit.* n. 6 at 176, 202.

Id. at 13. Sharing, however, is "more than a means of production." *Id.* at 2. "As a central value and practice characteristic of all Indigenous Alaskan societies, sharing of subsistence resources was and is a foundation of Indigenous life and livelihood. Sharing is both glue in binding extended families together and lubricant promoting expansion of social ties." *Id.* at 1. Sharing guides Alaska Natives' ethical compass: it reflects a "deeply embedded cultural value" that "translates into moral and ethical obligations for producers and those with resources to give to others particularly if they are in need and without expecting a return." *Id.* at 8, 10.

Sharing is also "at the center of a spiritual belief system recognizing the joint nature of existence and necessary interdependence of humans, fish, birds and animals to continuity." *Langdon Study* at 44.

(B) The cultural role of sharing Sitka herring roe

Regionwide (and indeed statewide) sharing of Sitka herring roe is of singular importance to the Alaska Native community for "complex cultural, nutritional, culinary, and social reasons." *Id.* at 30. "[T]he distribution, trade and exchange of herring eggs has an importance in its own right. Both with and between communities, this movement of herring eggs appears to provide an opportunity to fulfill social obligations and maintain cultural values" and is hence often used in "potlatches, payoff parties, mortuary feasts, and other cultural occasions." [11]/

[11] / R. Schroder and M. Kookesh, *The Subsistence Harvest of Herring Eggs in Sitka Sound,* ADF&G Technical Paper 173 (1990) at 52-53. The Schroder and Kookesh

Herring and herring roe, in fact, sit at top of Southeast Alaska's subsistence pantheon, for a number of reasons:

- For Alaska Natives that have left the village for urban centers, sharing herring eggs provides a continuing lifeline to their heritage. As one Juneau Tlingit told Dr. Langdon: "For the Tlingits who've moved away from home, it's our soul food, keeping us connected to one another and to place." *Langdon Study* at 31;
- "Herring eggs are special…[T]hey are the first 'fruit' of the season, heralding a new year of fishing and gathering." *Thornton Study, op. cit. n. 6 at 202; see also Thornton Aff.,* ¶6 (R. 1059). As a Sitka elder recounted to Dr. Thornton:

  > *It would just be amazing when we'd arrive at [my aunt's house each spring] because people came from a lot of different places…to have a feast. We'd arrive, and her table would be covered with layers of newspaper [upon which to lay out herring eggs]…Then all the stories would come out.*

  Id.; and
- The herring itself is Southeast Alaska's seminal species. As Sitka elder Henry Kitka Sr. put it, over the millenia:

  > *Herring come—whale come—sea lion—seal—king salmon—everything eat herring, come—big time.*

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report was cited to the trial court both by the Tribe and *amici*. R. 4, 370; *see also Thornton Aff.* ¶ 5 (R. 1058-59).

Id. at 118. Or, as one fisherman succinctly stated, herring are "the key to the ocean…It's our buffalo." [12]/

c. The loss of other regional subsistence herring fisheries

The Sitka subsistence fishery assumes preeminent importance because, with one minor exception, it is the only meaningful subsistence herring fishery remaining in Southeast Alaska. The others have been lost through commercial overfishing. Indeed, Alaska Native concern over ADF&G management of the Sitka fishery is predicated in no small part on the agency's checkered past in protecting similar fisheries elsewhere.

Since the early 1970's, ADF&G has opened all of the region's once-productive herring roe harvest areas to commercial gillnet and purse seine fisheries. [13]/ Within a decade those fisheries began to fail, taking the subsistence fisheries with them. As ADF&G frankly acknowledges, and as the trial court was informed, these other regional herring and herring roe fisheries simply don't exist anymore. According to

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[12] / T. Thornton and J. Hebert, *Neoliberal and neo-communal herring fisheries in Southeast Alaska: Reframing sustainability in marine ecosystems,* Marine Pol. 2014 at 5. This Thornton study was cited to the trial court by *amici.* R. 371, 375.

[13] / Hebert, *2018 Report to the Alaska Board of Fisheries: Southeast Alaska—Southeast Alaska-Yakutat Herring Fisheries* (Fishery Management Rpt. 17-58) (Dec. 2017) at 2 (available at https://www.arlis.org/docs/vol1/N/1029204556.pdf). The report was cited to the trial court at R. 377.

ADF&G's 2018 *Herring Fishery Management Plan*, the status of those fisheries was as follows: [14]/

> Revilla Channel. "From 2000 through 2017, the minimum threshold level was not reached in state managed waters and no fishery was permitted."
>
> West Behm Canal. "In 2004, a fishery was announced but due to inseason concerns over the lack of herring in West Behm Canal, the fishery was not opened and no herring were harvested. From 2005 to 2010, the threshold was not met and no fishery occurred. … A fishery was announced in 2012, but due to inseason concern over lack of herring in West Behm Canal, no fishery was prosecuted and no herring were harvested…From 2013 to 2017, the threshold was not met and no fishery occurred."
>
> Seymour Canal. "[T]he current model structure was unable to reproduce the extremely low egg depositions observed in 2014 and 2016 while also matching the observed cast net age composition… The Seymour Canal set gillnet herring fishery will not be opened in 2018. ADF&G plans to monitor and document the Seymour Canal spawn event in spring 2018 but is not planning further stock assessments at this time."
>
> Hobart/Houghton. "Herring biomass estimates were not large enough to allow fisheries in 2001–2004, 2006, 2007, and 2011–2016. Herring spawn was not documented in 2016."
>
> Lynn Canal. "The spawning biomass estimate of 351 tons is a record low and well below the 5,000 ton threshold for a commercial fishery. The long time series of observed production has been consistently below threshold." [15]/

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[14] / Thynes et al., Alaska Department of Fish and Game, *2018 Southeast Alaska Sac Roe Fishery Management Plan,* (Reg. Info. Rep. No. 1J18-02) (Mar. 2018) (available at: http://www.adfg.alaska.gov/FedAidPDFs/RIR.1J.2018.02.pdf) at 5-6. That report and the fisheries' status described above were cited to the trial court at: R. 9, 378-9.
[15] / *Id*. at 5–6.

> In 2021, ADF&G offered this update to Lynn Canal: 2021 surveying produced "the smallest total cumulative spawn mileage…since regular observations began in 1972…" [16]/
>
> <u>Hoonah Sound</u>. "No spawn has been documented since 2015 …A commercial fishery last took place in 2012. " *Id.*

Two case studies underscore a more general point: that Southeast's other herring fisheries disappeared as a result of commercial overfishing over a period of time:

Auke Bay/Lynn Canal. Auke Bay, at the south end of Lynn Canal, once supported a herring and roe fishery so abundant that the Aak'w <u>K</u>wáan people moved their village to avoid disturbing the extraordinary concentration of herring spawn. [17]/ The fishery was once considered the third most important spawning area in Southeast Alaska, but:

> The fishery was closed after 1982 and very little spawning has been observed in this historically important area since then.… Just as with the reduction fishery closure of 1940, political pressure from the fishing industry over-rode biological considerations, and the final harvest of 551 tons in 1982 marked the last significant observation of herring in the area. [18]/

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[16] / ADF&G, *2021 Southeast Herring Summary* (May 28, 2021) (available at https://www.adfg.alaska.gov/static/applications/dcfnewsrelease/1265317815.pdf) at 2.

[17] / *Thornton Study, op. cit. n. 6* at 151

[18]/ Thornton *et al., Herring Synthesis: Documenting and Modeling Herring Spawning Areas Within Socio-Ecological Systems over Time in the Southeastern Gulf of Alaska,* (North Pacific Research Board Project #728) 87 (JUNE, 2010) (available at: http://herringsynthesis.research.pdx.edu/final_docs/HerringSynthesisFINAL102710.pdf) at 284. This Thornton report was quoted by to the trial court at: R. 5, 371, 374.

In his above-referenced study (*op. cit. n. 18*), anthropologist Dr. Thornton interviewed nearly 100 Southeast fishermen on the history of the region's subsistence fisheries. Among those interviews, a Tlingit man recounted that: "At that time [1949] you could go to Indian Point, Auke Bay or the harbor and jig all the herring you could use …1992, 1996, 2000 were the last time I saw herring spawn in Auke Bay … I've seen the Auke Bay herring decline from the 1980s. I haven't seen the big schools in 5 years." [19]/ In his 2021 study, Thornton concluded: "Scientific and historical accounts of Auke Bay agree that Auke Bay was overfished during the [commercial] sac roe era, leading to its collapse as a spawning area in the early 1980's." [20]/

<u>Kah Shakes (Revilla Channel)</u>

According to Tlingit elder Martin Perez, Sr., "[p]eople won't believe you when you tell them how much herring used to be around [at Kah Shakes…You could] go up in any harbor where you anchor and you…[could] jig herring with treble hooks and you'll get 'em for eating, just jigging them." [21]/

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[19] / *Id*. at 520-21.
[20] / *Thornton Study, op. cit. n.* 6 at 155.
[21] / Jamie Sue Hebert, *Event Ecology: An Analysis of Discourses Surrounding the Disappearance of the Kah Shakes Cove Herring* (2011) at 37-38 (available at https://pdxscholar.library.pdx.edu/open_access_etds/5/) (*Hebert Study*). This study was quoted to the court by *amici* at R. 380.

Not today. In 1976, ADF&G opened a herring gillnet fishery in the Kah Shakes management area. By the late 1980's, there was trouble. In 1989, the commercial roe harvest was a mere 595 tons, and in 1990 there was no harvest at all. [22]/

At the outset of the 1991 season, there was no appreciable spawning at Kah Shakes. *Hebert Study, op. cit. n. 21,* at 41-42. Undaunted, ADF&G found a large spawning group 12 miles away at Cat Island. *Id.* at 43. Assuming that these were the errant Kah Shakes herring, ADF&G issued an emergency order expanding the Kah Shakes' management area boundaries to include Cat Island. *Id.* at 44. This although managers from the Metlakatla Indian Reservation on nearby Annette Island, a geography on the opposite side of Cat Island, insisted that these were the Reservation's herring. *Id.* at 46; *See also Thornton Study, op. cit. n. 6* at 170. The Board of Fisheries subsequently made the boundary change permanent anyway and changed the management area's name to "Revilla Channel."

History teaches that inflating the Kah Shakes' numbers by capturing the Cat Island herring, thereby enabling the agency to ignore the warning signs, was a bad idea. By 1999, there was insufficient spawn at either Kah Shakes or Cat Island to support any fishery at all, and there has never been a fishery since. [23]/

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[22] / Dupuis, *2021 Southeast Alaska Herring Sac Roe Fishery Management Plan,* Reg. Info.Rpt. No 1J21-04 (Feb., 2021) at Table 1 (available at https://www.adfg.alaska.gov/FedAidPDFs/RIR.1J.2021.04.pdf)
[23] / *Thynes, op. cit.* n. 14 at 5-6.

As this brief proceeds towards Argument, one should keep in mind that there is no evidence—none—that the ultimate disappearance of any of these fisheries was due to some sudden-onset crisis, or that the denouement was occasioned by some harm different from the damage that had been inflicted in prior years. To the contrary, it is clear from ADF&G's own narrative that these fisheries died slowly and inexorably, until it was simply too late.

d. Erosion of the Sitka subsistence fishery

Pursuant to AS 16.05.258, the Alaska Board of Fisheries has determined that between 136,000 and 227,000 pounds of Sitka herring roe are needed to meet subsistence needs. 5 AAC 01.716(b). As the trial court was advised, the Sitka herring subsistence harvest fell short (and often well short) of even the minimum subsistence target in 10 of the 14 years between 2005 and 2018. [24]/ More recent data demonstrates that, in fact, 2018-2020 were the worst years this century for the subsistence harvest, with 2020 being the nadir, barely topping 20,000 pounds. [25]/

For 2021, ADF&G forecasted an extraordinary return of 175,731 tons of mature, 5-year-old herring to Sitka Sound. [26]/ One year, however, does not a trend

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[24] / *Affidavit of Gregory Ruggerone* at ¶4; R. 61.

[25] / ADF&G, *Subsistence Harvest of Herring Eggs in Sitka Sound, 2021 Herring preseason meeting,* March 12, 2021 at 8, available at: (https://www.adfg.alaska.gov/static/fishing/PDFs/commercial/southeast/meetings/herring/2019_2020_herring_harvest_results.pdf).

[26] / Dressel, *2021 herring forecast for Sitka,* Feb. 12, 2021 at 13 (*Appendix A* herein). The 5-year-old cohort represents the first year of fully mature, fecund herring. ADF&G research has shown that only 19% of 3-year-old Sitka Sound herring are

reverse. Looking even at the commercial purse seine fishery, the 2021 bounce does not suggest any long-term upturn in the fishery's health:

- The 2018 commercial fishery yielded only 2,926 tons—well short of the 11,128 ton harvest target level (the "guideline harvest level") set by ADF&G; [27]/
- Due to the absence of mature, fecund herring, there was no commercial fishery at all in 2019 or 2020; and [28]/
- Looking forward, ADF&G forecasts a near-complete collapse of mature, fecund 5-year old herring recruitment in 2022, with a negligible 47 tons projected to return that year. *Appendix A* at 13. 2023 appears nearly as bleak, with only 3876 tons of what will then be 5-year-old fish predicted to return. *Id.*

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considered mature, while even 4-year-olds are only "partially mature." *Id.* at 6; Hebert, *Southeast Alaska 2019 Herring Stock Assessment, Fishery Data Series 20-23* (Dec., 2020) (available at https://www.adfg.alaska.gov/FedAidPDFs/FDS20-23.pdf) at 75.

[27]/ *2021 Herring Plan*, *op. cit. n. 22* at Table 3.

[28] / ADF&G press release, *Sitka Sound Sac Roe Fishery Announcement,* May 17, 2019 (available at: https://www.adfg.alaska.gov/static/applications/dcfnewsrelease/1032212824.pdf) at 1; ADF&G press release, *Sitka Sound Herring Fishery Announcement,* April 30, 2020 (available at https://www.adfg.alaska.gov/static/applications/dcfnewsrelease/1150580168.pdf). While the failure of the 2020 fishery was also plainly influenced by COVID-19, ADF&G concluded that the fishery failed because "[p]rocessors indicated that herring of [this] small size would be below market requirements..." *Id.*

II. Proceedings Below

Under AS 16.05.258, the Board of Fisheries and ADF&G are obliged to provide subsistence users a reasonable opportunity to meet their subsistence needs. Under that statute, subsistence harvests are the state's priority use—if a conflict emerges with any other use, that other use must yield.

Sitka-specific restrictions on the commercial purse seine fishery at 5 AAC 27.195 represent a key asset in the Board's effort to meet that statutory requirement. That section requires ADF&G to: (i) distribute the commercial fishery when needed to assure a reasonable opportunity for subsistence; and (ii) keep the quality and quantity of subsistence-harvested herring roe in mind when managing the commercial fishery.

On January 14, 2019, the Tribe moved for a preliminary injunction aimed at forcing ADF&G to comply with §195 in the course of managing the 2019 commercial sac roe fishery. In support of that motion, the Tribe and *amici* submitted substantial evidence on the importance of the Sitka subsistence fishery; ADF&G's doubtful past in protecting other regional subsistence herring fisheries; the decade-long decline in the quality of the Sitka subsistence harvest; the harm that the decline had caused, and continued to cause, Tlingit, Haida and Tsimshian culture; and the 2018 events that amplified the need for interlocutory relief. [29]/

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[29] / The Tribes' irreparable harm argument can be found at: R. 15 *et seq.*, R. 1047-48. *Amici*'s memorandum, which was devoted entirely to the irreparable harm issue, is found at R. 369 *et seq.*

That evidence included:

- The pre-2021 scholarly works cited in the Statement of Facts, *ante*, regarding the role that the Sitka subsistence fishery plays in regional Native culture and the vulnerability of that culture if that fishery is not adequately protected. *See notes 7, 11, 12, 18 and 21, ante;* and
- 22 affidavits from experts, tribal elders and fishery participants detailing the range of harm that their fishery, and their culture, have endured (and continued to endure) because of the intercepting commercial fishery, including:
  - the persistent erosion of the quality and productivity of the fishery over the past decade; [30]/
  - the 2018 harvest catastrophe—"the worst that we have experienced" and a "disaster"; [31]/
  - the damage to Native culture when, as in 2018, there was an insufficient harvest to support the ceremonial and religious occasions for which sharing the roe is a culture necessity. [32]/ Those ceremonies range from funereal protocol to potlatches, dances, and naming ceremonies. *Id.* Each December, for example, the Sitka clans gather to celebrate the new

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[30] / *See, e.g.,* Bennett Aff., ¶3 (R. 180); Kitka Aff ¶¶ 16-17 (R. 191); Bean Aff. ¶¶8-9 (R. 207-08).
[31] / Kitka Aff. ¶14 (R.190); Bennett Aff. ¶2 R. 180).
[32] / Kitka Aff. ¶¶27-29 (R. 184-95); Brady Aff. ¶5 (R. 217); Bennett Aff. ¶5 (R. 180-81).

year. In 2018, "[t]here were no herring eggs at this coo.éex [ceremony] because nobody had eggs to bring." Kitka Aff. ¶29 (R.194-95);

- The irretrievable loss of educational opportunity when an insufficient herring return prevents robust young Native apprenticeship in the skilled art of harvesting roe from hemlock branches. [33]/ Without the opportunity to teach that tradition, the tradition itself risks being lost, as has already occurred in the village of Yakutat. *Kitka Aff. ¶*25 (R. 193-94); and
- The severe disruption to the culture of sharing—about which much of the Statement of Facts, *ante,* was devoted. [34]/

Additionally, the trial court was told that the purse seine fleet cherry picks larger, mature and more fecund herring. Those older fish seem instrumental in herding younger herring to prime spawning sites. They are also, not surprisingly, the same herring that lay the highest quality of roe on the Natives' hemlock branches. [35]/

And, the purse seine nets are frequently laid just seaward of prime subsistence fishing areas. This intense industrial activity scatters and disorients the school, while herring that manage to escape the nets are subject to injury that can cause premature spawning. *Id.*

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33 / Kitka Aff. ¶¶5-6 (R. 186-87); Bennett Aff. ¶6 (R. 181); Bean Aff. ¶13 (R. 209).
34 / Hill Aff. ¶¶2-6, 12 (R. 224-25, 227); M. Johnson Aff., *passim* (R. 230 *et seq.*).
35 / Kitka Aff. ¶¶ 15-18 (R. 190-91); Littlefield Aff. ¶¶3-4 (R. 213); Rosendale Aff. ¶4 (R. 52-3); Baines Aff. ¶5 (R. 222-23).

On February 20,2019, the trial court denied the Tribe's motion. R. 959-60. The court did not question the veracity, or the accuracy, of any of the Tribe's evidence. Rather, it ruled, as a matter of law, that the Tribe had failed its "threshold burden" of demonstrating irreparable harm. It did not offer a rationale of its own, but rather adopted, by reference, a legal theory advanced by the Southeast Alaska Conservation Alliance (the Intervenor purse seine trade group). The court's holding on the irreparable harm issue consisted, in its entirety, of this statement:

> *As most succinctly described in the Alliance's opening brief, the Tribe has not been its threshold burden of demonstrating irreparable harm.*

R. 960. A footnote then referred the reader to page 25 of the Alliance's memorandum. That page was equally brief in explaining why the Tribe had not (and would not) suffer irreparable harm:

> *What they* [the Tribe] *fail[s] to demonstrate, however, is an urgent problem that demands immediate remedy of an injunction against the 2019 commercial fishery. The trends in the subsistence fishery described by the tribe have been underway for many years; there is no new crisis that warrants an emergency response.*

R. 313. "Irreparable harm," according to the trial court (via its incorporation of the Alliance's theory), thus involves a two part test: *First,* there must be a "new crisis"; and, *second*, the "crisis" must be producing harm that is materially different from anything that has "been underway for many years."

On February 28, 2019, the Tribe filed a petition for review of the trial court's denial. [36]/ The petition was denied in a one-sentence order on March 27, 2019.

STANDARD OF REVIEW

Sealaska is challenging only the trial court's conclusion of law that, in order to demonstrate irreparable harm, the plaintiff must demonstrate the existence of a new crisis causing harm that is different in kind from any damage previously suffered. While preliminary injunction decisions are reviewed under an "abuse of discretion" standard, rulings on issues of law in a preliminary injunction decision are reviewed *de novo* by this court. *Alsworth v. Seybert,* 323 P.3d 47, 54 (Alaska 2014).

ARGUMENT

I. A showing of crisis-driven atypical loss is not a prerequisite of finding irreparable harm

The lower court ruled that "irreparable harm" does not exist unless there is a "new crisis" that is causing a specie of harm that has not "been underway for many years."

That is not the law. This court has repeatedly turned to *Blacks Law Dictionary* to define "irreparable harm" as:

> *[i]nclud[ing] an injury, whether great or small, which ought not to be submitted to, on the one hand, or inflicted, on the other; and which, because it is so large or so small, or is of such constant and frequent occurrence, or because no certain pecuniary standard exists for the measurement of damages, cannot receive reasonable redress in a court of law.*

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[36] / *Sitka Tribe of Alaska v. State of Alaska,* S-17384.

*State v. Kluti Kaah Native Vill*age, 831 P.2d 1270, 1273 n.5. (Alaska 1992); *State v. Galvin*, 491 P.3d 325, 333 (Alaska 2021). Nothing in that definition imparts either of the trial court's prerequisites. To the contrary, the definition speaks of the "constant and frequent occurrence" of the harm. Moreover, the ultimate test looks to whether the harm "cannot receive reasonable redress in a court of law." And that has long been the touchstone of Alaska's definition—whether the harm can be rectified later by a money judgment. *State v. Galvin,* 491 P.3d at 333 ("The harm to her candidacy cannot be quantified with certainty, and so is not susceptible to monetary compensation."): *A.J. Industries v. Alaska Public Services Commission,* 470 P.2d 537, 541 (Alaska 1970) ("[T]he harm suffered by the petition will be irreparable, since is appears well settled that a public utility cannot recoup past losses.").

There are few species of loss less capable of being "quantified with certainty" than losses to Native subsistence culture. Such was the point of *Native Village of Quinhagak v. United States*, 35 F.3d 388 (9th Cir. 1994), a case remarkably like this one. In that case: the operation of state and federal had, for years, prohibited villagers from undertaking a subsistence harvest of rainbow trout in the area's navigable waters. To borrow our trial court's words, the harm "had been underway for many years." [37]/

[37] / If anything, the villages' situation had marginally improved by the time the preliminary injunction motion was filed, as the villages had recently been allowed to keep rainbow trout when caught incidentally in the course of fishing for permissible species.

The trial court in *Quinhagak* denied the villagers' preliminary injunction motion to open such a fishery, but the court of appeals reversed, holding that:

> *The [trial] court focused on the absence of a showing by the Villages that people are going hungry, and by doing so, accorded insufficient weight to the Villages' evidence of harm to their culture and way of life. We agree with the Villages that, rather than focusing on whether anybody currently is starving, the court should have focused on the evidence of the threatened loss of an important subsistence food source and destruction of their culture and way of life.*

Id. at 394, n. 5. "The Villages," the court added, "presented evidence that the federal and state regulations interfere with their way of life and culture identity" (*id.* at 394), adding:

> ***They needed to prove nothing more*** *in light of the clear congressional directive to protect the cultural aspects of subsistence living**.** 16 U.S.C. § 3111(1).*

Id.; emphasis added. Just like Congress declared in Title VIII of the Alaska National Interest Lands Act, [38]/ the Alaska Legislature has articulated a clear policy of protecting subsistence culture. In its findings accompanying the establishment of a subsistence priority in AS 16.05.258, the legislature stated:

> *[C]ustomary and traditional uses of Alaska's fish and game originated with Alaska Natives, and have been adopted and supplemented by many non-Native Alaskans as well; these uses, among others, are culturally, socially, spiritually, and nutritionally important and provide a sense of identity for many subsistence users.*

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[38] / P.L. 96-487, §801 *et seq.*

Ch. 1, §1(a)(3), SLA 1992. This court relief on that policy in *State v. United Cook Inlet Drift Association*, 815 P.2d 378 (Alaska 1991), in which this court ruled that the lower court had improperly granted a temporary restraining order to a commercial fishing group, the effect of which was to harm subsistence fishing. The court held:

> *The trial court in this case failed to consider the injury to subsistence users which would result as a consequence of the issuance of the temporary restraining order. Subsistence users are given statutory priority over commercial users, AS 16.05.258(c), and the injury which they would suffer as a result of the injunctive relief is as irreparable as the injury which commercial fishermen might suffer if injunctive relief were not granted.*

Id.

This brief's Statement of Facts showed (and the trial court below did not dispute) that ADF&G's management of the purse seine fishery resulted in almost-yearly inadequacy of the subsistence harvest. The resultant injury was not simply to the harvest itself, but to the unique, intricate and existential system of sharing that has developed over the centuries with respect to that harvest. Dismissal of that damage because it had been "underway for many years" was wrong.

A delay in seeking a preliminary injunction "is but a single factor to consider in evaluating irreparable injury…" *Arc of California v. Douglas*, 757 F.3d 975, 990-91 (9th Cir. 2014), and courts are "'loathe to withhold relief solely on that ground.'" *Id.*

(internal cites omitted). [39]/ Moreover, the passage of time is even less "probative in the context of ongoing, worsening injuries." *Id.*

Before the trial court, the Tribe laid out its decade-long effort to work with the Board of Fisheries, and ADF&G, to better protect the subsistence fishery. R. 5-9. The Tribe then explained the three events that triggered the need for its January 14, 2019 preliminary injunction motion:

- the 2018 refusal of the Board of Fisheries to modify its rules for the purse seine fishery to better protect subsistence, and the failure of negotiations with ADF&G to improve fishery management. R. 9, 42-43;
- a November 16, 2018 ADF&G email indicating that ADF&G's management priority was an adequate commercial harvest, and not a sufficient subsistence harvest. R. 12; [40]/ and
- the singularly disastrous 2018 subsistence harvest. *Statement of Facts, §(d), ante*.

As the Tribe summarized in its petition for review:

> *The 2018 subsistence harvest was the worst year in a decade of bad years. In October 2018, STA attempted to negotiate a management plan with ADFG to improve the opportunity for a successful subsistence harvest. It became clear during the negotiations that ADFG interpreted its duty under the regulations very narrowly, and was in fact managing the commercial fishery to ensure the*

[39] / *In accord, Wildearth Guardians v. Bail*, No. 2:20-CV-440-RMP, 2021 U.S. Dist. LEXIS 75940, at *11-13 (E.D. Wash. Apr. 20, 2021); *Turo Inc. v. City of L.A.,* No. 2:18-CV-06055-CAS-GJSx, 2020 U.S. Dist. LEXIS 108884, at *46-47 (C.D. Cal. June 19, 2020).
[40] / That email can be found at R. 201.

> *commercial fishery achieves the maximum allowable harvest, i.e., full guideline harvest level ("GHL"). After receiving this interpretation of law from ADFG, STA filed its motion for a preliminary injunction.*

Petition for Review, S. 17384 (Feb. 28, 2019) at 4. Where, as here, the injured party pursues other avenues before restoring to a preliminary injunction, "[t]he significance of such a prudent delay in determining irreparable harm may become so small as to disappear." *Arc of California v. Douglas*, 757 F.3d at 990-91.

The trial court considered none of this. The passage of time between the first damage to our subsistence culture, and the filing of the Tribe's motion, was not "but a single factor to consider," but, rather the only and determinative factor. And that is not the law.

II. The preliminary injunction motion is moot, but exceptions to Alaska's mootness doctrine apply, and the court should address the merits of Point on Appeal 2

The Tribe's preliminary motion is moot. The 2019 season for which the injunction was sought has come and gone. *State v. United Cook Inlet Drift Association,* 815 P.2d at 379; *Sprucewood Investment Corp. v. Alaska Housing Finance Corp.,* 33 P.3d 1156, 1161 (Alaska 2001). However, Alaska's mootness doctrine is not constitutional; it is judicial policy to which this court has grafted a public interest exception that considers three factors:

> *… 1) whether the disputed issues are capable of repetition, 2) whether the mootness doctrine, if applied, may repeatedly circumvent review of the issues and, 3) whether the issues presented are so important to the public interest as to justify*

overriding the mootness doctrine.

Hayes v. Charney, 693 P.2d 831, 834 (Alaska 1985); *in accord, Peninsula Marketing Association v. State*, 817 P.2d 917, 920 (Alaska 1991); *Anchorage v. Anchorage Daily News*, 794 P.2d 584, 588 (Alaska 1990).

All three of those factors are present here:

First, the issues raised will certainly recur. Disputes between subsistence users, the Board of Fisheries and ADF&G are endemic to Alaska, and regularly result in efforts, manifested by preliminary injunction motions, to open, close or modify particular hunts and fisheries. Articulating the legal "threshold" (in our trial court's words) for subsistence groups' obtaining interlocutory relief will be central to virtually all of these controversies-to-come. In *Peninsula Marketing Association v. State,* 817 P.2d 917 at 920, this court, while declining to review a specific Board of Fisheries' regulation that was no longer in effect, did review a principal legal issue in the case (one involving the statutory limitations on Board regulations), because "the authority of the board to make allocative regulations is continually at issue." The same considerations apply here.

Second, the issue will otherwise "repeatedly circumvent review." A petition review is, or should be, an extraordinary remedy. Absent the court's interest in expanding its use of the petition for review, at least in cases involving subsistence harvest conflicts, it serves the interest of judicial economy to address basic questions, once and for all, as to when (if ever) courts will recognize harm to subsistence harvests as "irreparable." *State v. United Cook Inlet Drift Association*, 815 P.2d at 379 (requiring courts take harm to subsistence culture into account in rulings on interlocutory relief that may "may otherwise evade review" unless addressed in an appeal of a then-expired temporary restraining order); *Peninsula Marketing Association v. State,* 817 P.2d at 920 (the "evading review" test requires consideration of the practicalities of otherwise obtaining judicial review).

Finally, with respect to the public interest involved, this case presents a question of "considerable public importance" because it "impacts upon the allocation of fishery resources." *Peninsula Marketing Association v. State*, 817 P.2d at 920. The lower court's decision sets a "threshold burden" for subsistence plaintiffs to even compete in the *A.J. Industries'* "balance of hardships" test. [41]/ That burden requires subsistence users to prove that the harm they may be suffering was caused by a "new crisis" and is distinct in kind from any pre-existing damage to their harvest and culture. When a subsistence harvest is being damaged by a longstanding commercial interception fishery like the purse seine fishery here, that will be a near-impossible standard to meet. As a result, the trial's decision is very much a "fishery allocation" decision, because it undermines Alaska's supposed subsistence priority by subordinating subsistence users to other fishing interests in any interlocutory proceeding. And that rule is now precedent in at least the First Judicial District, and ADF&G, as well as their commercial co-defendants, will invariably invoke it whenever

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[41] / *A.J. Industries, Inc. v. Alaska Public Services Commission,* 470 P.2d 537 at 540 .

any Native group, or for that matter, any other subsistence user, seeks a court's aide in protecting its fishery through interlocutory relief.

CONCLUSION

For the foregoing reasons, Sealaska respectfully urges this court to reverse the trial court's ruling that a subsistence user seeking a preliminary injunction affecting a competing commercial fishery must demonstrate that, absent the injunction, the user is likely to suffer loss that is: (i) caused by a "new crisis"; and (ii) is different in kind from any pre-existing harm that the subsistence user has suffered.

Respectfully submitted,

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2021 herring forecast for Sitka

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Executive Summary

The 2021 forecast of mature herring biomass from the Sitka Sound integrated statistical catch-at-age model (also called the age structured assessment (ASA) model) is 210,453 tons, and the GHL, if a maximum harvest rate of 20% is applied, would be 42,091 tons (Figures 1–4). The 2021 forecast is very similar to the 2020 forecast (212,330 tons; Figure 2). The 2021 mature biomass forecast is a 16% decrease from the model estimate of 2020 mature biomass (250,468 tons). The 2020 model hindcast of mature biomass is 18% greater than the 2020 forecast. Since there was no commercial harvest in 2020, the mature (pre-fishery) biomass and spawning (post-fishery) biomass are nearly identical (there were 20 tons of personal-use-by-permit harvest). The 2020 hindcast of mature biomass (250,468 tons) was 71% greater than the estimate (hindcast) of the 2019 mature biomass (146,771 tons) due to the large increase in maturity between the age-3 cohort in 2019 and the age-4 cohort in 2020 (Figures 1–4). The 2019 recruitment estimate (3,161 million immature and mature age-3 individuals) is the largest in the times series (1976–2020) and is over three times larger than the next largest recruitment estimate (2003; Figure 5). The 2020 recruitment estimate is the fourth smallest in the time series and is the lowest recruitment since 1993. Cast net age compositions (Figures 6, 7, 8) indicate that the mature biomass in 2019 and 2020 were dominated by the 2016-year class (age-3 and age-4 fish, respectively). Combined with the 2019 and 2020 egg deposition estimates (8.19 and 23.06 trillion eggs, respectively; Figure 9), the age compositions reflect an unprecedentedly high recruitment event corresponding to the 2016-year class. This large year class has been documented in age composition and survey estimates in multiple Gulf of Alaska herring stocks (Table 1). The forecast age composition is composed of mostly age-5 fish by mature numbers at age (86%; Table 2) and by mature biomass at age (84%; Table 2). The biomass of this one age class (age 5) is forecast to be 175,731 tons (Table 2, Figure 10). Due to the large percent of age-5 fish in the 2021-forecasted population, the mean population weight at age (across all ages) is forecasted to be 112 grams. There is likely greater uncertainty in the 2021 forecast for Sitka than in most years due to (1) the large recruitment of age-3 fish in 2019, (2) the likelihood that age-4 fish in 2020 are still not fully mature and more of the cohort will mature in 2021, (3) the confounding of maturity, natural mortality, and recruitment parameters in the model, and (4) the large impact that uncertainty in, and confounding of, parameters has when an exceptional recruit class occurs. While the uncertainty in the 2021 forecast is likely less than that in the 2020 forecast, the uncertainty in the 2021 forecast is likely considerably larger than most years due to the exceptional size of the partially mature age-4 cohort in 2020. Model structure (or parameterization) refers to the number of time periods (in order) for survival, maturity, and gear selectivity. The recommended model has the same structure as the 2020-forecast model with three survival periods (1976–2007, 2008–2014, and 2015–2020), one maturity period (1976–2020), and one gear selectivity period (1976–2020; *i.e.,* "311" structure; Table 3).

Model Summary

Statistical catch-at-age model

The integrated statistical catch-at-age forecast model used for Sitka is a standard implementation of an age-structured assessment model (Quinn and Deriso 1999, chapter 8). The observed data that are fit by the model include an egg deposition index (from hydroacoustic estimates of biomass converted to eggs for 1976–1982, and egg estimates from spawn deposition dive surveys from 1983–2020), commercial fishery age composition data (from samples of the purse seine sac roe harvest of pre-spawning herring), and fishery-independent spawning age composition data (from cast net sampling of spawning herring). The egg deposition index is fit by assuming log-normally distributed observation uncertainty. The fishery and spawning age composition are fit using the normal distribution with variance (*i.e.,* sum of squares, SSQ) fixed at 1.0. The objective function also includes the model fit to a Ricker spawner-recruit function. The Ricker spawner-recruit function is weighted low in the objective function so has virtually no influence on the model fit but keeps estimates of recruitment positive and is used for forecasting recruitment in the upcoming year. Parameters are estimated within the model to maximize the objective function (*i.e.,* to produce a model that best describes the data that is collected).

Data

Harvest

Harvest in the model is comprised of all sources of mortality, including the harvest from the commercial herring sac roe, bait, test fishery bait, bait-pound, personal use by permit, and any additional estimated mortality. Personal use one-ton allowances are not included because they are not tracked by permits or fish tickets and are generally expected to be very low. No commercial herring sac roe harvest occurred in 2020, but 20 tons of personal-use-by-permit herring were harvested. Although herring were available to the commercial fishery, fish were not of sufficient size for the market, therefore, no openings were announced. Historical harvest values for 1976–1984 were double-checked and updated based on historical management memos, published research reports, and historical tables.

Egg estimates

For the 2021-forecast model, the time series of egg estimates was extended back to 1976. Egg estimates used in the model for 1976 – 1981 were based on hydroacoustics estimates of herring biomass (1976–1980 estimates from Blankenbeckler and Larson (1982); 1981 estimate from Blankenbeckler and Larson (1987)). Hydroacoustic biomass estimates were converted to eggs assuming 100 million eggs per ton of spawners (Blankenbeckler and Larson 1987). Egg estimates used in the model for 1982–2020 were based on two-stage surveys of aerial surveys followed by scuba dive surveys to estimate spawn deposition.

The Alaska Department of Fish and Game mapped 58.5 cumulative nautical miles (nmi) of herring spawn in 2020 from March 25 through April 20 (Figure 11 and 12). The start date of spawning (March 25) was similar to 2018 and 2019 (both March 24). Like 2019, herring spawn in 2020 occurred along the shorelines of Kruzof Island, Hayward Strait, the Magoun Islands, Promisla Bay, and Eastern Bay (Figure 11). However, in 2020 spawning also occurred in Katlian Bay, along the Sitka road system, around the islands near Sitka, Eastern Channel, Povorotni Point, and the entrance to West Crawfish Inlet. There was more spawn around the islands near Sitka and along the road system than occurred in 2018 and 2019. The estimate of 58.5 nmi of herring spawn in 2020 is approximately the same as the long-term (1976–2020) average spawn mileage of 59.0 nmi (Table 4). The mean transect length of surveyed areas was nearly twice the average and is the second longest in the time series, resulting in a total spawn area that is the largest on record. The egg density (eggs/m^2) in 2020 was 2.5 times the long-term average and the second highest in the time series. The density of eggs was especially high in the spawn on the Kruzof Island shoreline, where extensive heavy egg deposition was often observed directly on rocks during the surveys. In 2005, 2008, 2018 and 2019, a similar situation occurred where the spawn extended far offshore on Kruzof Island due to the very wide shelf of herring spawning habitat. However, in 2020, substantial egg deposition was observed on the western shore of Kruzof Island, which has been a rare occurrence in recent decades. The survey estimated total egg deposition was the highest recorded and 4.5 times the average since the start of spawn deposition dive surveys in Sitka. While the egg estimate for 2008 (20.148 trillion eggs; Table 4) was similar in magnitude to the 2020 estimate (23.065 trillion eggs; Table 4), the estimated standard deviation relative to the mean (CV) of the 2008 survey estimate (0.60) was extremely large whereas that of 2020 was similar or lower (0.16) than other years. While the confidence interval for 2020 is larger than all years except 2008, the CV is slightly lower than most years. This means that, while the confidence interval around the 2020 estimate is large, it is smaller than would be expected for an estimate of egg abundance as large as that estimated in 2020.

Spawn deposition surveys were conducted during April 4-6 on Kruzof Island (west stratum, also called "Survey 1"; Figure 13) and during April 8-9 in north, east and south Sitka Sound (east stratum, also called "Survey 2"; Figure 14). The first spawn survey had 15 transects on 13.5 nmi of spawn (Figure 13) and the second spawn survey had 23 transects on 21.1 nmi of spawn (Figure 14). There were 2.6 nmi of post-survey spawn in the west stratum, approximately 1 nmi of which overlapped the west stratum survey mileage (for a total of 16.1 nmi used for spawn calculations and 15.1 cumulative nmi). There were 25.3 nmi of post-survey spawn in the east stratum, approximately 3 nmi of which overlapped the east stratum survey mileage (for a total of 46.4 nmi used for spawn calculations and 43.4 cumulative nmi). The total mileage used for calculating biomass (sum of west stratum survey mileage, west stratum post-survey mileage, east stratum survey mileage and east stratum post-survey mileage) was 62.5 nmi. For the west stratum post-survey spawn (2.6 nmi), 50% density and 50% transect length of the west stratum survey was used to estimate post-survey egg abundance. For the east stratum post-survey spawn (25.3 nmi), 100% density and 100% transect length of the east stratum survey was used to estimate the east stratum post-survey egg abundance, because there were several days of spawn that appeared to be of relatively high density based on aerial surveys. The nearly three-fold increase in the estimate of 2020 herring egg deposition from that of 2019 was due to an increase in spawn area (greater number of miles of spawn than 2019 and greater average transect length) and a doubling of egg density.

<u>Population catch-age composition</u>

Annual population age composition in the 2021-forecast model is based on cast net samples (Figure 6). The spring survey cast net samples are collected during the spawn in late March and early April by management staff. Samples are distributed over space and time, and the goal is for the number of sampling buckets to roughly approximate the number of fish that spawn over space and time. The buckets are later sampled evenly in the lab unless management staff directs them to do otherwise. This year, the lab sampled approximately double the number of fish (n = 1023) from buckets than usually sampled to decrease the variability in estimates of age composition from the buckets sampled, particularly for age classes with a small percent of fish (all age classes except age 4). Age composition across space and time for Sitka herring in 2020 was consistent across samples (Figure 7). Observed cast net age compositions by sample for 2020 are shown in Figure 7, observed cast net age compositions are shown in Figure 8, observed and estimated population age compositions for all model years are shown in Figure 6, and residuals for all years are shown in Figure 15.

Fishery catch-age composition

Annual catch-age composition in the 2021-forecast model is based on commercial purse seine samples. In 2020 there was no commercial sac roe fishery, as available fish on the spawning grounds were not large enough to satisfy market demand. In 2020 there were 20 tons of personal-use-by-permit herring harvested. In the absence of purse seine age composition and weight at age, 2020 cast net age composition and an average 2017–2018 weight at age was used to estimate number of fish by age class of the personal-use-by-permit harvest in the model. Observed purse seine age compositions are shown in Figure 8, observed and estimated age compositions for the seine fishery are shown in Figures 16 and residuals are shown in Figure 15.

Weight-at-age

Average weight at age for mature and harvested Sitka herring is estimated using primarily the spring commercial seine samples (Figure 17, top plot). Cast net average weights are shown in Figure 17, bottom plot, for trend comparison. Purse seine average weights (dashed lines in Figure 17, top plot) are greater for each age than cast net average weights (dashed lines in Figure 17, bottom plot). Commercial purse seine samples are used in the model to represent both mature and harvested herring because, despite the likelihood that commercial samples are biased slightly high due to the tendency for the purse seine fishery to select for larger fish at age, that bias is expected to be smaller than the tendency of cast net samples to be biased low due to capture of spawned out fish. Spring purse seine and cast net weight at age follow similar trends, increasing in the mid-1990s, holding steady for approximately 20 years and then declining between 2010 and 2015 (Figure 17). Cast net samples indicate that weight at age has remained approximately constant since 2015 (Figure 17, bottom plot). Growth appears slower for cohorts in the 1980s and after 2010, than before 1980, and during the 1990s and 2000s (Figure 18).

Forecast weight-at-age

Since trends in cast net weight at age indicate that weight at age has been approximately stable since 2015, the average weight at age from the two most recent years of spring purse seine fishery samples (2017 and 2018) was used in the model to hindcast biomass for 2019 and 2020 and forecast biomass for 2021 (Table 2). An average of two years was used to provide sufficient sample size for each age class (sample size for ages 4, 6, 7, and 8+ were low in 2017 and sample size for ages 5, 7 and 8+ were low in 2018). The mean population weight at age (across all ages) is forecasted to be 112 grams.

Within and between dataset weighting

Between-dataset weighting has been set at 1.0 for the egg index, 1.0 for the commercial fishery age composition data, and 1.0 for the fishery-independent spawning age composition, so that no one dataset is unduly influential. The Ricker spawner-recruit function is weighted extremely low in the objective function (0.000001) so has virtually no influence on the model fit (Figure 5). However, it is included in the model to keep recruitment estimates from going negative and to forecast recruitment in the upcoming year.

For within-dataset weighting, there is equal weighting among years for both age composition data sets (each year is set to 1.0). For the egg index, individual years were weighted with an inverse of the estimated variance. For 1991–2020 (years for which spawn deposition dive survey raw data were available), the variance was estimated with a bootstrap procedure of the egg deposition observations in each year according to the two-stage survey sampling design. For 1983–1990 (years in which spawn deposition dive surveys were the basis for the egg estimate, but raw data were not available), variance (standard deviation squared) was estimated using the egg estimate for each year and a linear regression of log-transformed egg estimates and associated standard deviations from 1991–2020. For 1976–1982 (years for which hydroacoustic biomass estimates were used for setting the GHL), a CV of 0.29 (measurement error estimated from Prince William Sound herring acoustic surveys; Muradian et al. 2017) was used to calculate the variance, where: $variance = (egg\, estimate * CV)^2$.

Model Selection

Like previous years, the recommended 2021-forecast model was compared to a suite of models with different time-dependent parameterizations (*i.e.,* change in model structure). Due to the importance of temperature to the population dynamics of herring, an annual index based on temperature anomalies (mean monthly Pacific Decadal Oscillation (PDO) values) was used from 1900 to 2020 (see *Appendix A: Description of the Pacific Decadal Oscillation (PDO) and the STARS Method*), and the "Sequential *t*-Test Analysis of Regime Shifts (STARS)" method (Rodionov and Overland 2005) was used to determine the time-blocks in the 2021-forecast model based on breaks in the mean PDO index. Based on the STARS method, four potential time blocks were considered in the 2021–forecast model (1944–1976, 1977–2007, 2008–2014, and 2015–2020, corresponding to splits in 1976/1977, 2007/2008 and 2014/2015; Figure 19; see *Appendix A: Description of the Pacific Decadal Oscillation (PDO) and the STARS Method*). Since 1976 was the sole year in the 1944–1976 time block, 1976 was added to the 1977–2007 time block for the 2021-forecast model, resulting in three potential time blocks (1976–2007, 2008–2014, and 2015–2020) for the Sitka 2021-forecast model. The years in which model-estimated survival, maturity, and gear selectivity (defined as availability plus fishing selectivity, *i.e.*, both gear and fisher's behavior) were allowed to change corresponded with these splits in the mean PDO index. As in the previous forecast models, a change in gear selectivity was only investigated as an alternative model if maturity time periods changed or if there were known and obvious changes in selectivity/fishing. In this write-up, gear selectivity is defined as availability plus fishing selectivity (both gear and fishers' behavior). Also, like previous years, the recommended model was selected by considering Akaike Information Criterion corrected for small sample sizes (AICc values; Burnham and Anderson 1998), biologically realistic estimation of parameters, inspection of residuals, and consistency with prior structures (similar time periods of change for survival, maturity, and selectivity as prior years). The difference (Δ_i) between a given model and the model with the lowest AICc value is the primary statistic for choosing appropriate models. For biologically realistic models, those with $\Delta_i \leq 2$ have substantial support, those in which $4 \leq \Delta_i \leq 7$ have considerably less support, and models with $\Delta_i > 10$ have essentially no support (Burnham and Anderson 2004).

The 2021-forecast model structure that had the lowest AICc (Model 49; *Appendix B: The 2021-forecast models including structure and AICc*) had three survival blocks (1976–2007, 2008–2014, 2015–2020; Figure 20), one maturity block (1976–2020; Figure 21), and one selectivity block (1976–2020; Figure 21) and was the same model structure as selected for the 2020 forecast. Of the stepwise models compared (Table 3), estimates of survival, maturity, and gear selectivity were similar across the Sitka 2021-forecast models and the Sitka 2020-forecast model. In addition, the range of forecasts from the suite of all 32 models with different parameterizations (188,305 to 248,899 tons; *Appendix B: The 2021-forecast models including structure and AICc*, Table B1) was not unusually large. These results indicate stability of estimation across different parameterizations and stability of estimation compared to previous years. The increase in the 2020-hindcast (250,468 tons) over the 2020 forecast (212,330 tons) was due almost entirely to the addition of the updated data (2020 egg estimate and 2020 cast net age composition), rather than slight corrections to the 1980-1984 data or the extension of the time series back to 1976 (Table 3).

Uncertainty in the 2021 forecast

The absolute size of the 2019 age-3 cohort is still considerably uncertain, despite the corroboration of a large proportion of age-3 fish across the Gulf of Alaska in 2019, the accompanying large increase in the number of eggs observed in Sitka in 2019 and 2020, and the increases in the survey estimates of other herring populations in the Gulf of Alaska. The uncertainty in the estimated abundance, survival, and increased maturity of the 2020 age-4 cohort is justification for taking conservative management action, if chosen by management. For the 2020 fishery, a precautionary approach was taken when setting the GHL to account for the higher than usual uncertainty in the forecast due to the unprecedented size of the age-3 year class in 2019 and the uncertainty around mortality and maturity. ADF&G reduced the GHL by 39%, which approximated the harvest level available if the number of age-4 fish was half that projected (*Appendix C: Sitka Sound Herring Fishery Announcement, Alaska Department of Fish and Game Commercial Fisheries Advisory Announcement 23 December 2019)*. While the uncertainty in the 2021 Sitka forecast is likely less than that in the 2020 forecast, the uncertainty in the 2021 forecast is likely still considerably larger than most years due to the exceptional size of the partially-mature 2020 age-4 age class. There is likely greater uncertainty in the 2021 forecast for Sitka than in most Sitka forecasts due to (1) large recruitment of age-3 fish in 2019, (2) age-4 fish in 2020 are still not fully mature and more of the cohort will mature in 2021, (3) the confounding of maturity, mortality, and recruitment parameters, (4) and the large impact that uncertainty and confounding of parameters has when an exceptional recruit class occurs. If a decrement to the GHL is chosen by management, one that is a portion (say, half) of that taken for 2020 could be used to account for uncertainty with the 2021-forecast.

The Scientific and Statistical Committee (SSC) for the North Pacific Fisheries Management Council has set precedent for reducing maximum allowable harvest from that specified in a harvest control rule in one or multiple consecutive years for both crab and finfish species that are expected to have substantial unquantified risk due to considerable uncertainty when forecasting when there are exceptionally large recruit classes (*e.g.,* Eastern Bering Sea snow crab (*Chionoecetes opilio*) 2021 forecast (SSC Report October 2020), sablefish (*Anoplopoma fimbria*) 2019 (SSC Report December 2018), 2020 (SSC Report December 2019), and 2021 forecasts (SSC draft Report December 2020). Stock assessments for populations with exceptionally large recruit classes which are not yet fully mature or recruited into the fished population, often have unusually large uncertainty in the forecast. Reductions from the maximum acceptable biological catch (ABC_{max}), such as that made for Alaska sablefish, are an infrequent action by the SSC prompted by extraordinary circumstances or considerable uncertainty and are a response to substantial unquantified risk. The SSC adjustments from the maximum ABC are based on the uncertainty and risk not already accounted for in the tier-system approach (*i.e.*, harvest rate strategy).

Similar to actions taken by the SSC for species that are expected to have substantial unquantified risk when there are exceptionally large recruit classes, management action was taken for both Sitka and Craig (*Appendix D: 2019/2020 Southeast Alaska Winter Food and Bait Herring Fishery, Alaska Department of Fish and Game Commercial Fisheries News Release 11 October, 2019*) in 2020. According to the Sitka and Craig 2021-forecast models, the 2019 age-3 class is three times larger than any other since 1976 for Sitka, and about five times larger than any other year since 1988 for Craig. Additional precedent for reducing the GHL from that calculated by the regulatory formula was made by ADF&G in 2007 and 2012 when setting the 2008 and 2013 GHLs for Sitka Sound (*Appendix E: Sitka Sound Herring Fishery Announcement, Alaska Department of Fish and Game Commercial Fisheries News Release 4 December 2007* and *Appendix F: Sitka Sound Herring Fishery Announcement, Alaska Department of Fish and Game Commercial Fisheries News Release 12 December 2012*). Similarly, precedent for reducing the harvest rate below the 20% maximum named in regulation due to elevated uncertainty in the forecast was made by ADF&G when setting the 2019 harvest rate for Togiak (*Appendix G: 2019 Togiak Herring Forecast, Alaska Department of Fish and Game Commercial Fisheries News Release 13 December 2018*).

Final Model Description

Similar to the 2020-forecast model, the recommended 2021-forecast model:

1) was implemented in the statistical application AD Model Builder (ADMB; Fournier et al. 2012)
2) used inverse-variance weighting of the egg estimates (variance estimated with a bootstrap resampling procedure according to the two-stage survey design; Thompson 2002) for within-dataset weighting of 1991–2020 estimates (years for which raw data were available)
3) approximated inverse-variance weighting of egg estimates for 1982–1990 egg estimates using a linear regression of log-transformed mean and standard deviations of 1991–2020 egg data
4) applied within dataset weighting of 1.0 for all years of age compositions
5) applied between dataset weighting of 1.0 for egg deposition and age composition datasets
6) incorporated a Ricker spawner-recruit function that was weighted low in the objective function (same weighting as previous models), so had virtually no influence on model fit (Figure 5)

7) considered three potential time blocks over the Sitka model time series, corresponding to shifts in the PDO, in which model-estimated survival, maturity, and gear selectivity were allowed to change (Figure 19)

8) had three survival estimates (63% survival for 1976–2007, 78% for 2008–2014, and 68% for 2015–2020; Figure 20)

9) had a single maturity schedule (34% maturity for age-3 fish and 96% maturity for age-4 fish in 1976–2020; Figure 21)

10) had a single gear selectivity schedule (19% of age-3 fish and 58% of age-4 fish selected by the gear in 1976–2020; Figure 21)

11) used the most recent survival and maturity for the 2021 forecast

12) used the Ricker spawner-recruit function to forecast age-3 recruitment in 2021

13) used the average weight-at-age from the 2017 and 2018 spring purse seine fisheries samples as the forecast weight-at-age since there was no commercial sac roe fishery in 2019 or 2020 (Table 2)

14) applied the STARS method to determine the breaks in the mean PDO index from 1900–2020 in the R Project for Statistical computing version 3.6.3 (R Core Team 2020) using a script written by Seddon et al. (2011) instead of a Microsoft Excel add-in (Figure 19)

Unlike the 2020-forecast model, the recommended 2021-forecast model:

1) was based on a time series of data starting from 1976, instead of 1980

2) used hydroacoustic biomass estimates for 1976–1981 and converted to egg estimates assuming 100 million eggs per ton of spawners (Blankenbeckler and Larson 1987)

3) weighted hydroacoustic-derived estimates of eggs with a hydroacoustic survey coefficient of variation (CV; standard deviation/mean) of 0.29 (measurement error), as estimated from Prince William Sound herring acoustic surveys (Muradian et al. 2017)

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TABLES AND FIGURES

Table 1: Spawning age composition (by number) for 2020 by Gulf of Alaska stock and gear. Sample size (number of fish sampled) is shown for each stock. Sitka Sound herring age composition is shown in bold. Proportions shown may not add to one due to rounding.

Stock	Gear(s)	3	4	5	6	7	8+	Sample size
Craig	Cast net	0.01	0.93	0.03	0.02	0.00	0.00	1180
Craig	Spring purse seine	0.02	0.92	0.03	0.02	0.00	0.01	522
Craig	Winter purse seine	0.05	0.81	0.04	0.07	0.01	0.02	524
Kah Shakes/Cat Island	Cast net	0.01	0.78	0.15	0.03	0.01	0.02	508
North Stephen's Passage	Cast net	0.00	0.91	0.03	0.01	0.01	0.03	519
Seymour Canal	Cast net	0.01	0.73	0.11	0.03	0.06	0.08	525
Sitka Sound	Cast net	**0.01**	**0.91**	**0.03**	**0.03**	**0.00**	**0.02**	**1023**
Prince William Sound	Cast net weighted by aerial survey biomass and district	0.11	0.79	0.04	0.03	0.02	0.00	1328
Kodiak Island	Trawl and purse seine	0.00	0.95	0.01	0.02	0.00	0.01	6328

Table 2: Forecasted mature biomass at age (tons) for forecast year 2021 for Sitka Sound, forecasted weight at age (grams) based on the average spring purse seine fishery data from 2017 and 2018 (no commercial fishery in 2019 or 2020), and forecasted percentage of mature numbers at age for 2021. Proportions shown may not add to one due to rounding. The percent of age-3 fish was estimated with a Ricker spawner-recruit function. The total forecasted mature biomass is 210,453 tons.

Age	Mature biomass (tons)	Proportion mature (based on biomass at age)	Weight at age (g)	Proportion mature (based on numbers at age)
3	3,876	0.02	78.8	0.03
4	47	0.00	92	0.00
5	175,731	0.84	109	0.86
6	11,025	0.05	125.8	0.05
7	8,337	0.04	144.2	0.03
8+	11,437	0.05	164.9	0.04

Table 3: Comparison of model outputs for the 2020-forecast model, the 2021-forecast model that used the selected parameterization (time block) from the 2020-forecast model, and the 2021-forecast model that allowed different year breaks between time blocks. The mature biomass is in short tons. Model structure refers to the number of time-periods for survival, maturity, and gear selectivity, respectively.

	2020-forecast model	**2020-forecast model updated with 2020 data**	**2020-forecast model updated with 1980-1984 and 2020 data**	**2021-forecast model (2020-forecast model updated with 1976-1984 and 2020 data)**
Model structure	311	311	311	311
Time series	1980-2019	1980-2020	1980-2020	1976-2020
Potential time-block splits	2007/2008; 2014/2015	2007/2008; 2014/2015	2007/2008; 2014/2015	2007/2008; 2014/2015
Survival time blocks	1980-2007; 2008-2014; 2015-2019	1980-2007; 2008-2014; 2015-2020	1980-2007; 2008-2014; 2015-2020	1976-2007; 2008-2014; 2015-2020
Survival values	0.65, 0.77, 0.67	0.64, 0.77, 0.67	0.66, 0.78, 0.68	0.63, 0.78, 0.68
Maturity time block	1980-2019	1980-2020	1980-2020	1976-2020
Maturity for ages-3 and -4	0.32, 0.89	0.32, 0.90	0.35, 0.96	0.34, 0.96
Gear selectivity time block	1980-2019	1980-2020	1980-2020	1976-2020
Gear selectivity for ages-3 and -4	0.18, 0.58	0.18, 0.58	0.19, 0.62	0.19, 0.58
Mature biomass forecast (2021)	---	214,168	209,623	210,453
Mature biomass forecast (2020)	212,330	---	---	---
Mature biomass (2020)	---	247,642	250,307	250,468
Mature biomass (2019)	130,738	146,682	146,335	146,771

Table 4: Spawn deposition survey metrics for Sitka Sound including annual cumulative spawn mileage (nm), mean transect length (m), spawn area (m^2), egg density ($eggs/m^2$), and total egg deposition (trillions of eggs), and average values over the time-series. Mean transect length is calculated over surveyed areas only (not extrapolated to post survey spawn), whereas spawn area, egg density, and total egg deposition represent the full area of spawn (surveyed and post-survey spawns). Cumulative spawn mileage is the total nmi of shoreline that received spawn and can be less than that used for calculating the total egg deposition if a portion of shoreline received spawn during two distinct time periods. For instance, if herring spawn on a section of shoreline, that section is surveyed, and then afterwards there is post-survey spawn on that same shoreline, then shoreline for each spawning event is used separately and eggs for the two spawning events are summed. Dashes denote values missing from data files and reports. Each column is shaded with larger values having darker shading.

Year	Cumulative spawn mileage (nm)	Mean transect length (m)	Spawn area (m^2)	Egg density ($eggs/m^2$)	Total egg deposition (trillions)
1976	13.0	--	--	--	--
1977	10.7	--	--	--	--
1978	12.5	--	--	--	--
1979	41.0	--	--	--	--
1980	63.0	--	--	--	--
1981	60.0	--	--	--	--
1982	40.8	40.0	3,022,464	884,870	3.566
1983	68.0	33.6	4,227,746	485,359	2.732
1984	65.0	--	--	--	3.850
1985	60.5	--	--	--	3.025
1986	51.6	--	--	--	2.580
1987	86.0	46.0	--	516,000	4.201
1988	104.0	32.2	--	852,000	5.871
1989	65.5	33.0	--	607,000	2.700
1990	39.1	49.3	--	573,000	2.273
1991	44.5	64.0	--	399,126	2.347
1992	72.5	87.6	11,867,099	331,534	4.335
1993	55.3	90.6	8,718,522	360,363	3.715
1994	58.1	54.0	5,805,141	234,540	1.494
1995	37.3	95.4	6,272,956	507,357	3.499
1996	45.6	106.0	9,189,783	356,559	3.593
1997	32.8	97.1	5,897,983	345,850	2.888
1998	64.6	91.9	9,526,225	325,980	3.584
1999	59.5	89.8	9,898,461	408,766	4.496
2000	54.5	82.4	8,318,354	633,083	5.851
2001	61.0	92.3	10,429,736	520,031	6.026
2002	42.6	99.9	7,361,746	497,961	4.073
2003	47.1	116.7	10,179,483	497,539	5.627
2004	79.8	75.8	11,207,378	575,702	7.169
2005	39.5	168.8	11,595,965	606,123	8.139
2006	57.4	79.5	8,451,232	564,494	5.301
2007	50.2	89.0	8,273,353	746,000	6.858
2008	55.3	93.8	9,487,431	1,911,323	20.148
2009	65.5	98.4	11,322,017	715,851	9.005
2010	87.7	70.6	11,470,941	784,557	10.000
2011	78.3	79.4	11,513,921	1,021,360	13.067
2012	55.9	61.1	6,325,487	708,533	4.980
2013	61.3	76.0	8,629,698	852,680	8.330
2014	50.0	62.5	5,784,311	616,221	3.960
2015	87.9	43.9	7,142,409	578,850	4.594
2016	63.3	80.4	9,428,167	592,993	5.979
2017	62.3	48.0	5,715,091	531,042	3.714
2018	33.1	94.4	5,540,258	692,405	4.262
2019	55.8	90.4	9,339,573	789,657	8.195
2020	58.5	145.5	12,984,592	1,598,671	23.065
Average	**59.0**	**79.4**	**8,546,049**	**645,094**	**5.874**

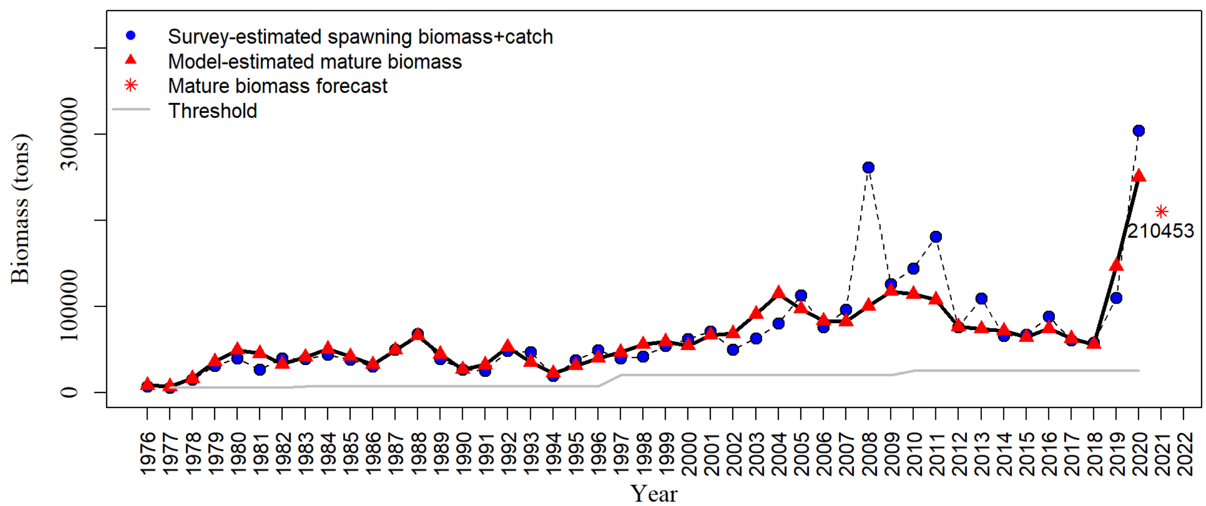


Figure 1: Current survey-estimated mature biomass (survey-estimated spawning biomass plus harvest), model-estimated mature biomass, and model-estimated mature biomass forecasts (tons).

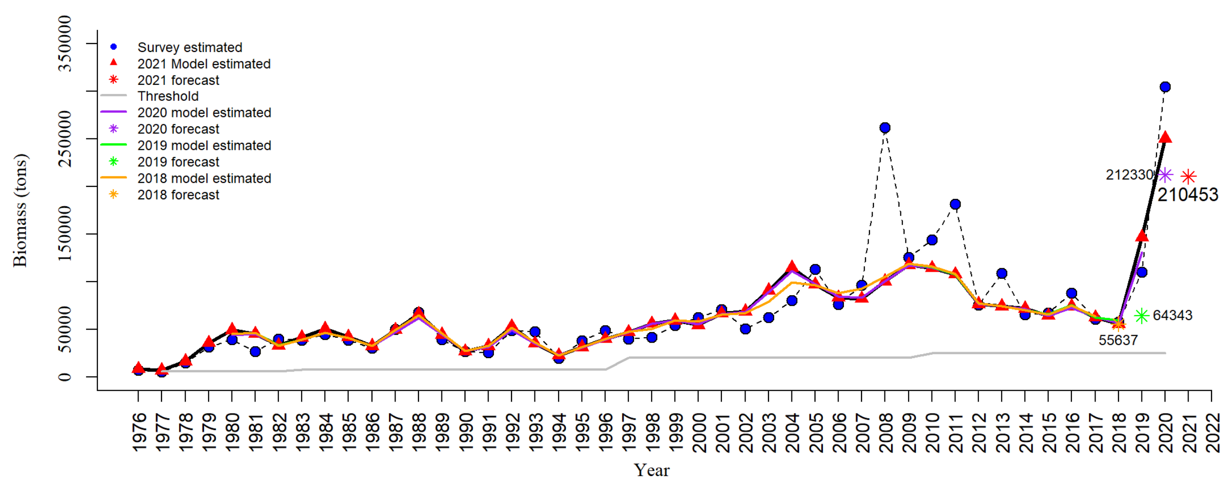


Figure 2: Comparison of survey-estimated mature biomass (survey-estimated spawning biomass plus harvest), model-estimated mature biomass, and model-estimated mature biomass forecasts (tons) from the 2017-forecast model through the 2021-forecast model.

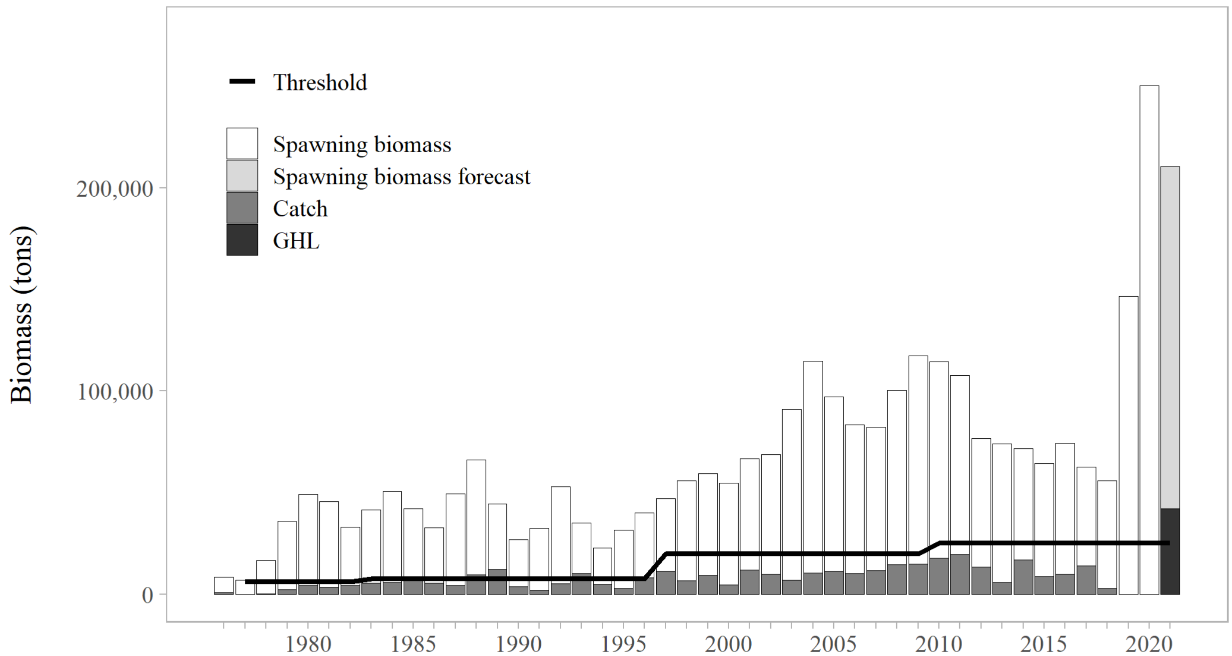


Figure 3: Stacked bar graph of harvest, spawning biomass, GHL, and the spawning biomass forecast. The harvest (or GHL under a 20% harvest rate) plus the spawning biomass (or spawning biomass forecast) equals the mature biomass. The horizontal line is the threshold.

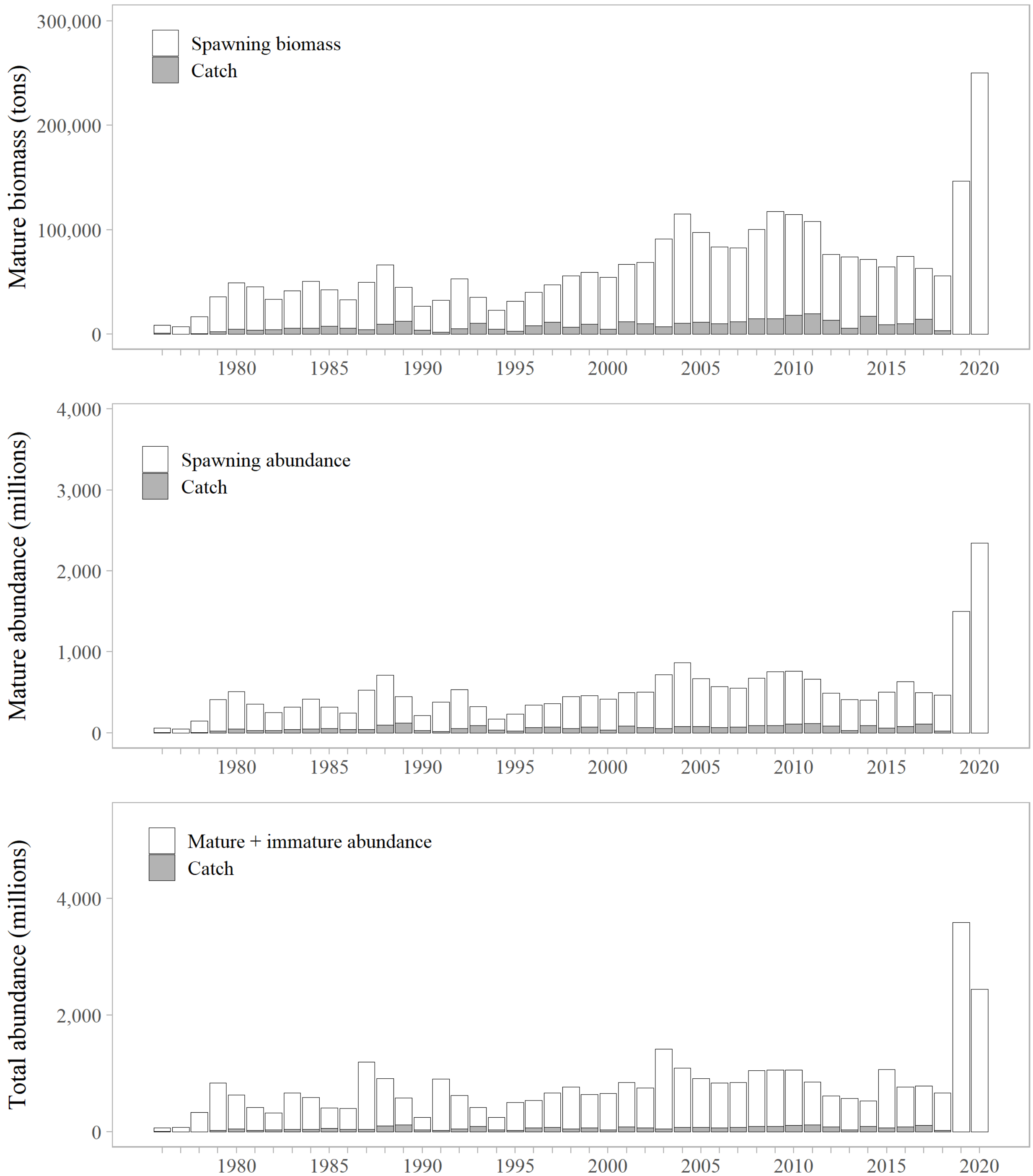


Figure 4: Spawning population biomass and catch (top figure), spawning population abundance and catch (middle figure), and total population abundance (immature and spawning abundance) and catch (bottom figure). The total height of each bar is the mature biomass, mature population abundance, or total population abundance (immature and mature abundance) for the three figures, respectively.

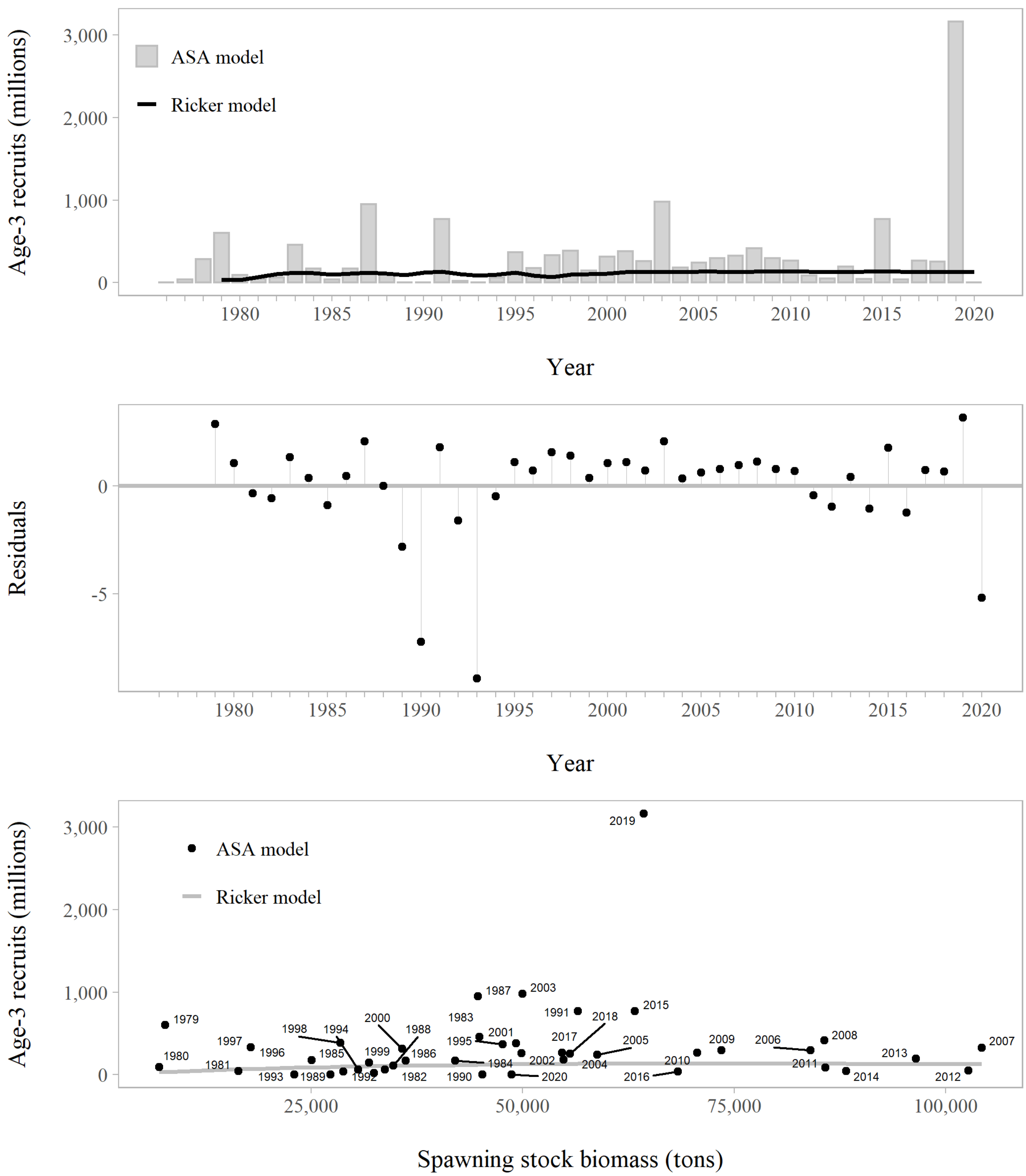


Figure 5: Model estimates (bars) of age-3 recruitment strength (numbers of age-3 mature and immature fish) (top figure). The Ricker spawner-recruit function (line) is weighted low in the objective function so has virtually no influence on model fit and explains the poor fit. The middle figure shows the residuals from the model fits to the Ricker spawner-recruit function, and the bottom figure shows the spawning biomass (tons) versus age-3 abundance (millions of mature and immature fish) with Ricker-estimated age-3 abundance from 1979–2020.

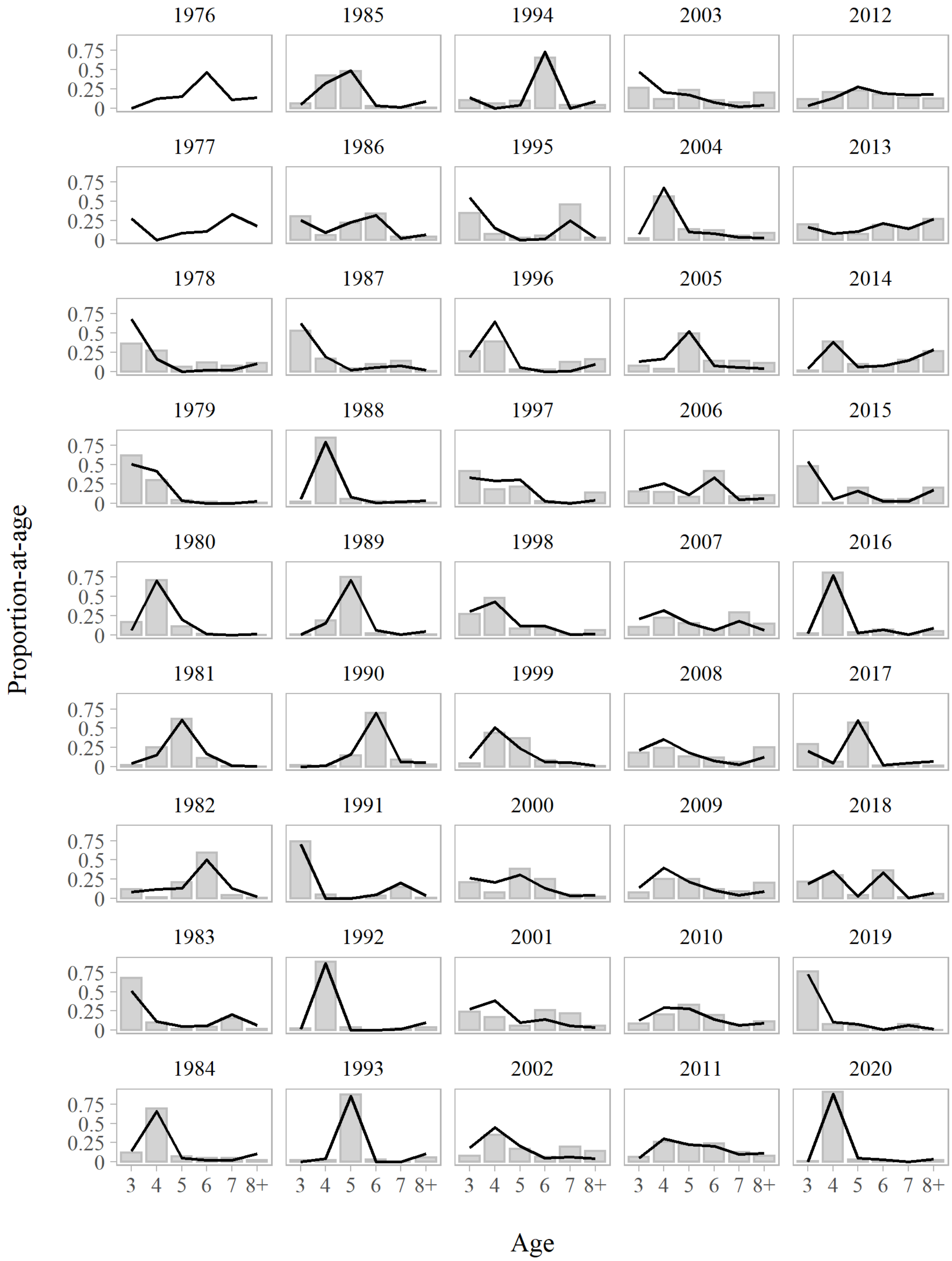


Figure 6: Observed spring survey cast net (bars) and model-estimated (line) spawning age compositions by year.

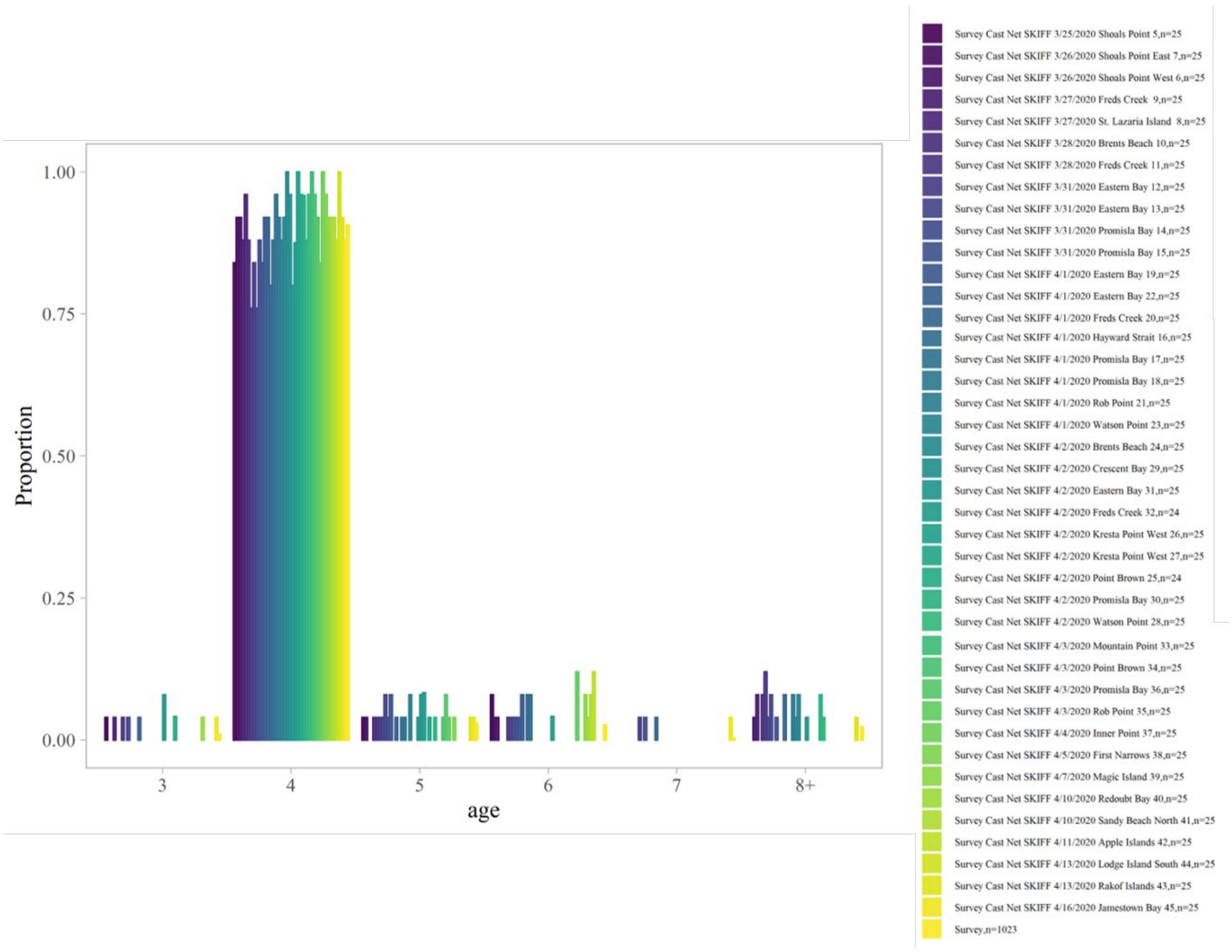


Figure 7: Cast net age composition by sample and date (n=1,023). This age composition was used in the recommended model to represent the population age composition and the 2020 age composition of the personal-use-by-permit bait harvest.

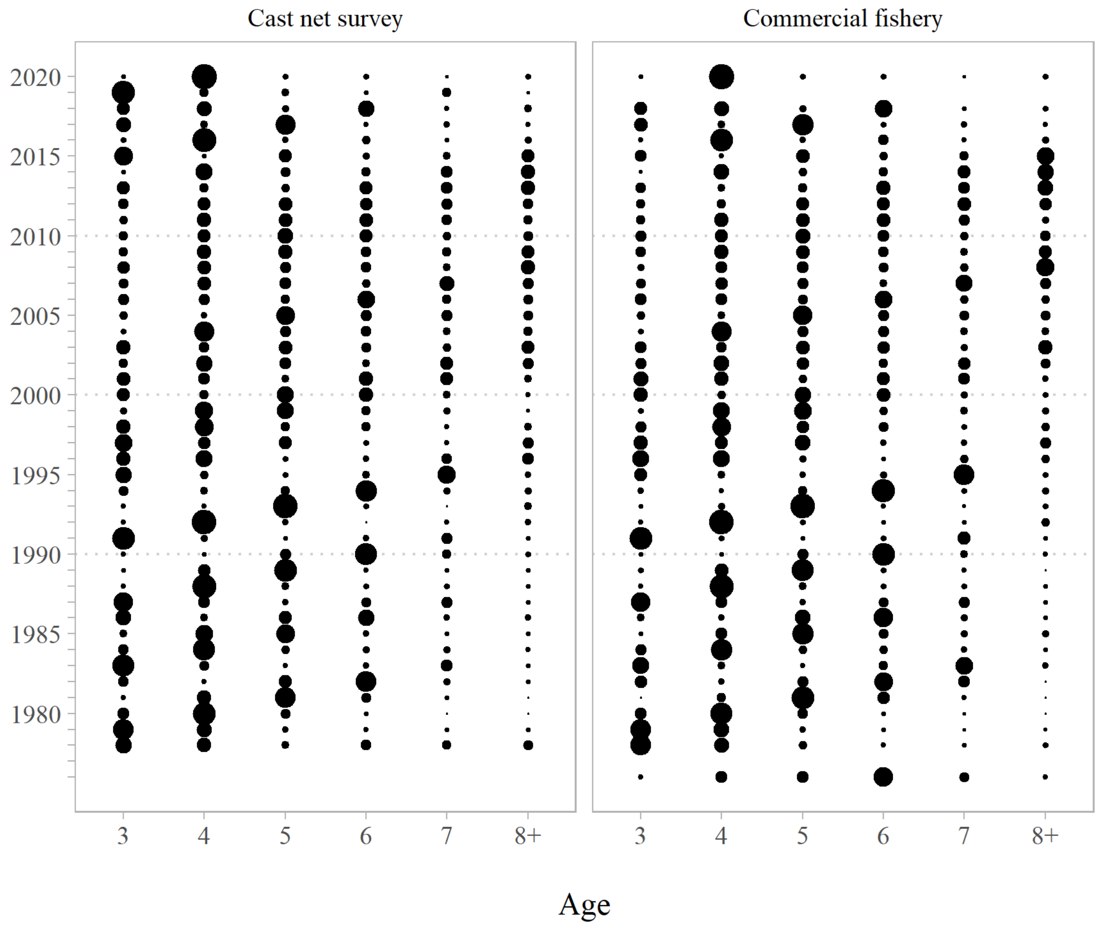


Figure 8: Spawning and commercial catch age compositions by year. There were no commercial fisheries in 1977, 2019 and 2020. Cast net age composition was used as the spawning and the catch age composition in 2020 to represent the age composition of the spawning population and the personal-use-by-permit harvest (20 tons).

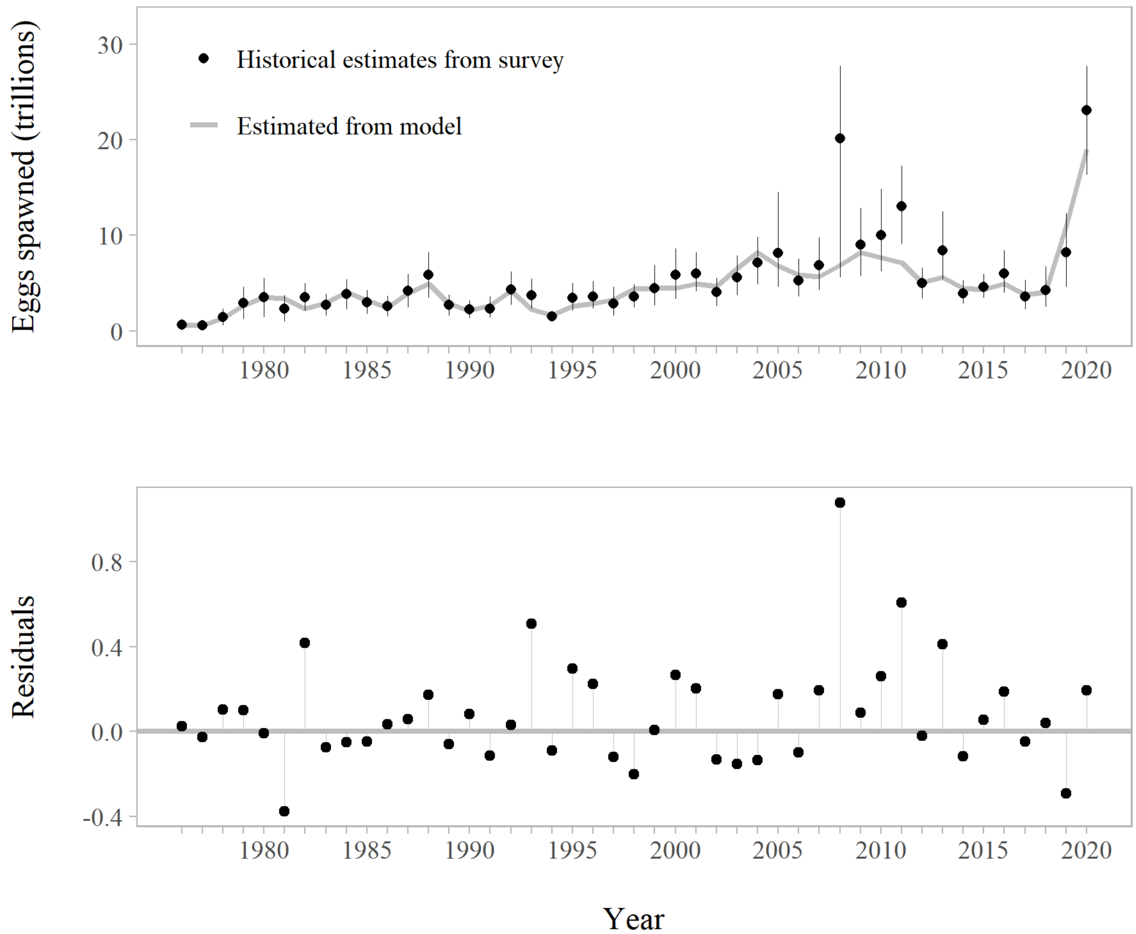


Figure 9: Survey- and model-estimated egg deposition (top figure). Bootstrapped methods were used to calculate 95% confidence intervals for annual egg deposition estimates (top figure). The upper 95% confidence interval for the 2008 egg deposition has been cut off to aid in visualization. Residuals from model fit to survey egg deposition (bottom figure).

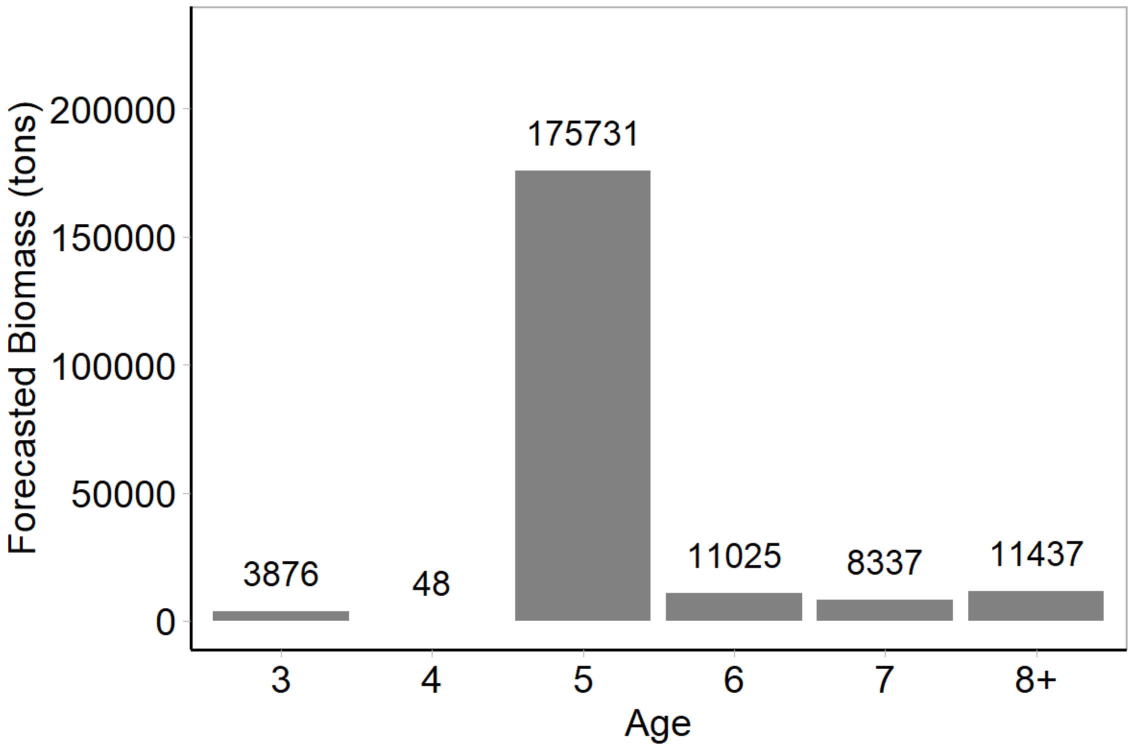


Figure 10: Forecast biomass at age for 2021.

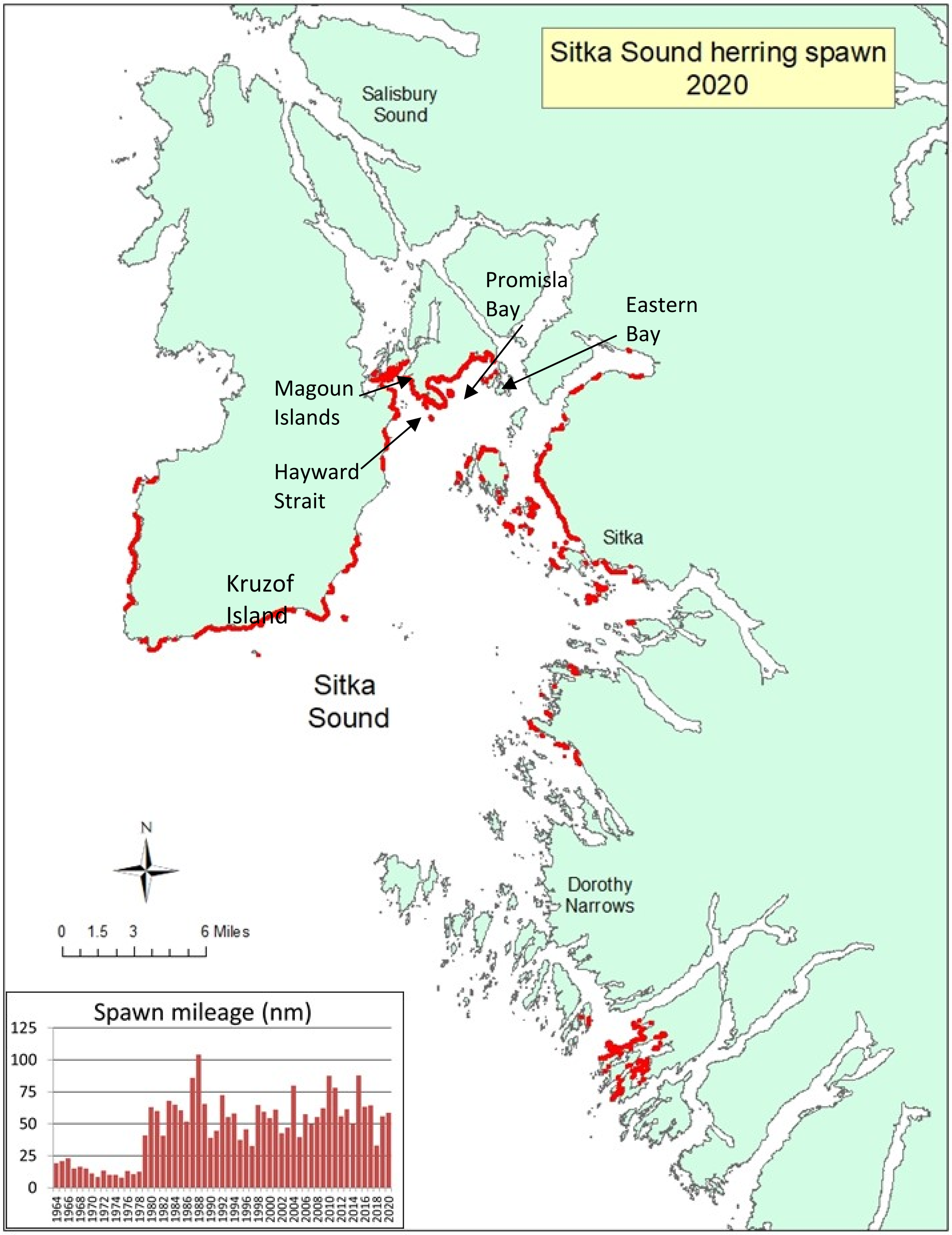


Figure 11: Distribution of 2020 Sitka herring spawn by area and spawn mileage by date. There were 58.5 cumulative nautical miles (nmi) of spawn for 2020 and 62.5 nmi were used for estimating egg abundance due to spatial overlap of surveyed spawn and post-survey spawn that were separated in time (13.5 nmi surveyed in the west stratum; 2.6 miles of post-survey spawn in the west stratum, with approximately 1 nmi overlapping the west stratum surveyed area; 21.1 nmi surveyed in the east stratum; and 25.3 nm of post-survey spawn in the east stratum, with approximately 3 nmi overlapping the east stratum surveyed area).

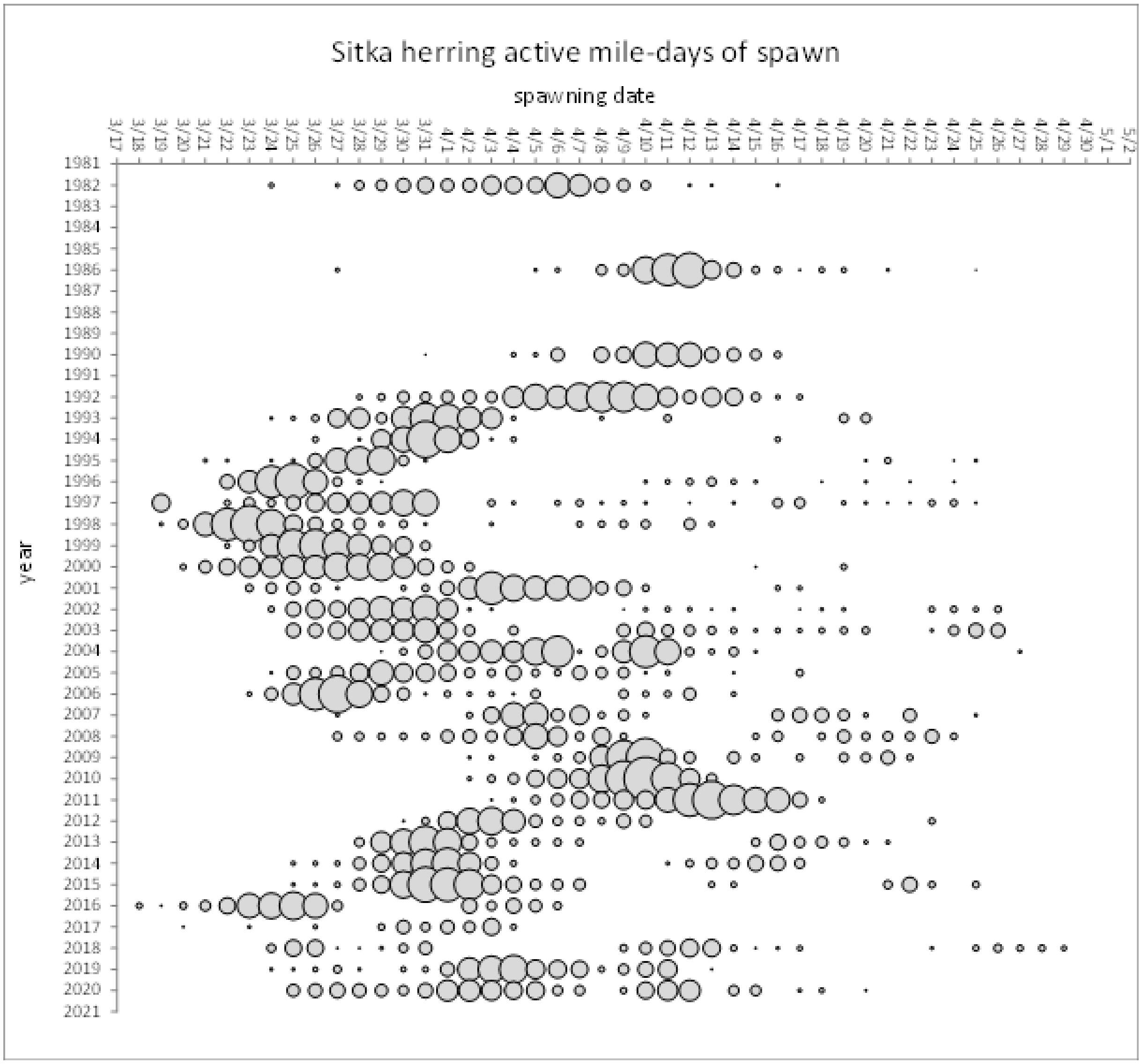


Figure 12: Spawn timing by year and date. The size of the circle within each year is proportional to the nautical miles of spawn.

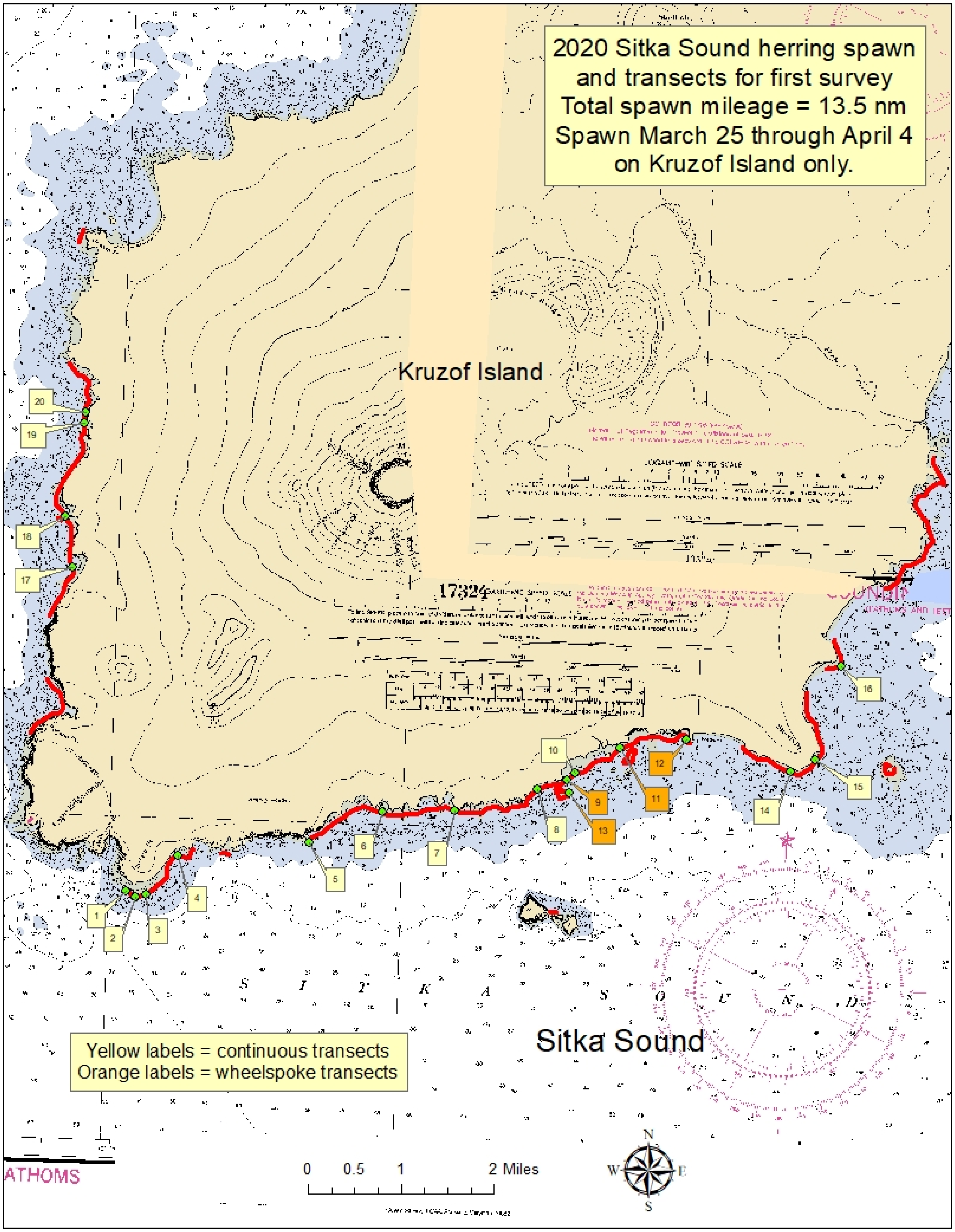


Figure 13: Spawn (13.5 nmi) and transect distribution for the west stratum, also called the first spawn survey. "Continuous transects" are those that ended when there were no more eggs at depth. "Wheelspoke transects" are those that were terminated when the transect crossed another potential transect to avoid double-sampling. Transects 1-3, 5 and 19 were not sampled due to time and weather constraints.

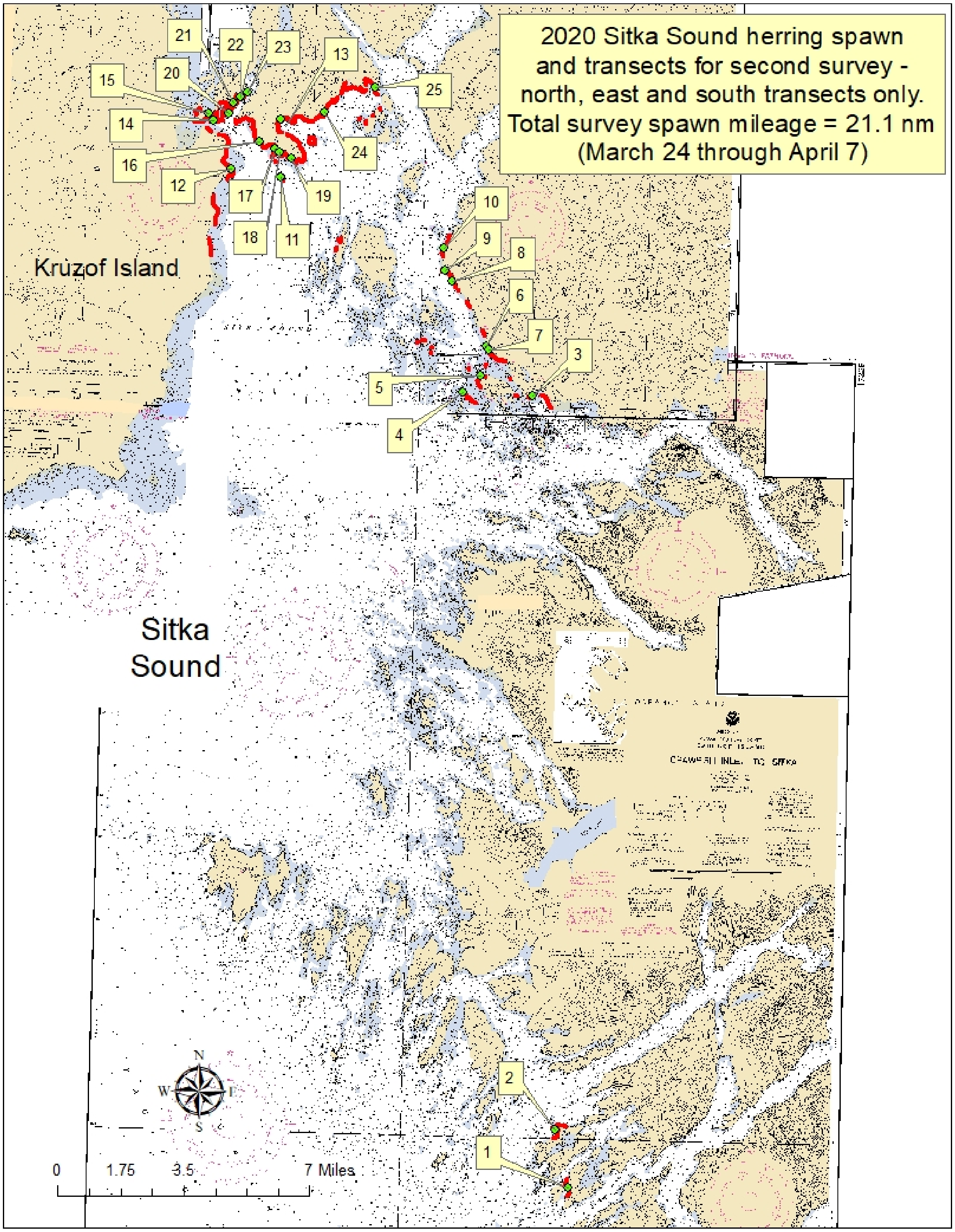


Figure 14: Spawn (21.1 nmi) and transect distribution for the east stratum (included north, east, and south areas of Sitka Sound), also called the second spawn survey. Transects 1 and 2 were not sampled due to time and weather constraints.

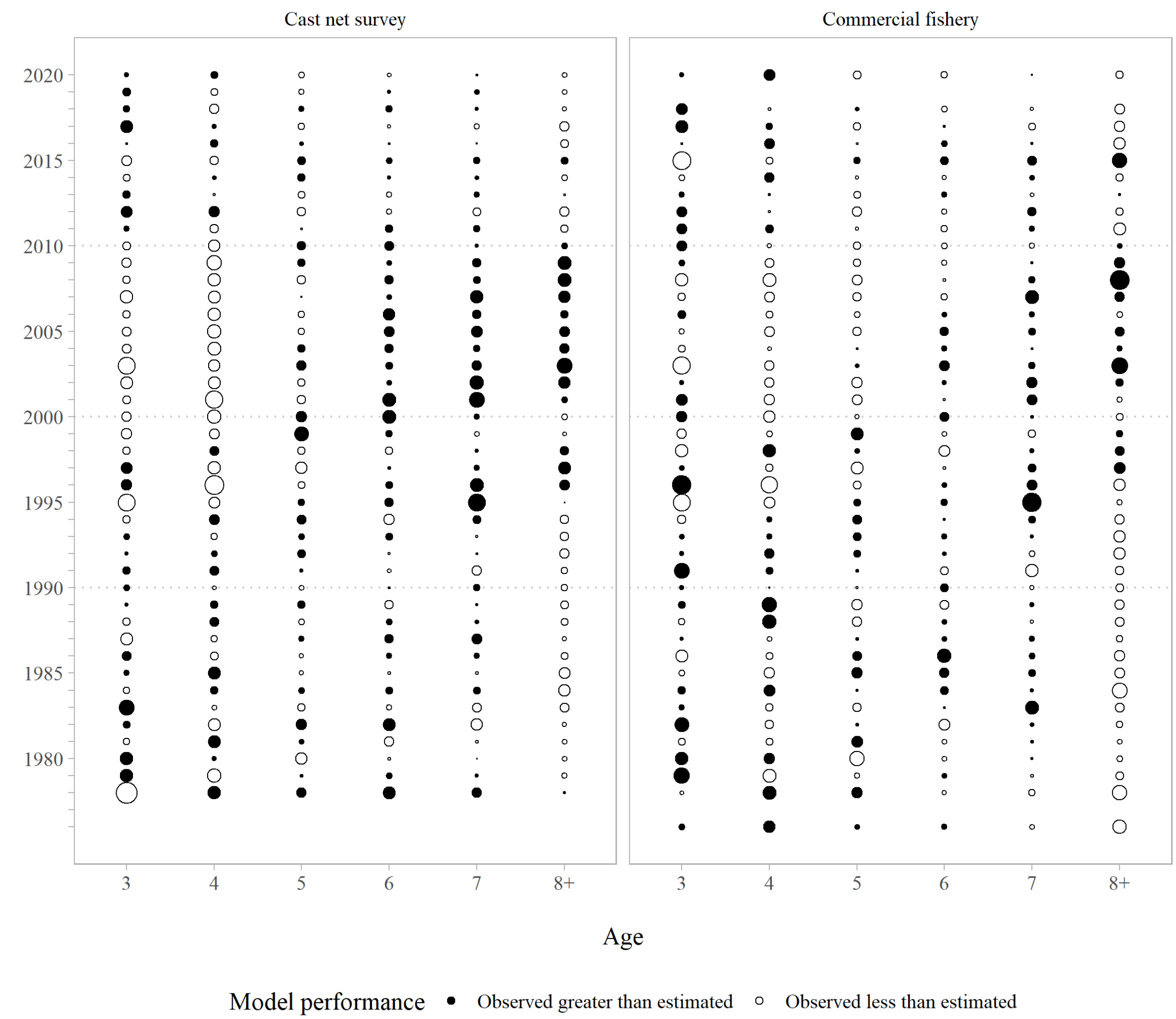


Figure 15: Spawning age composition and commercial catch age composition residuals.

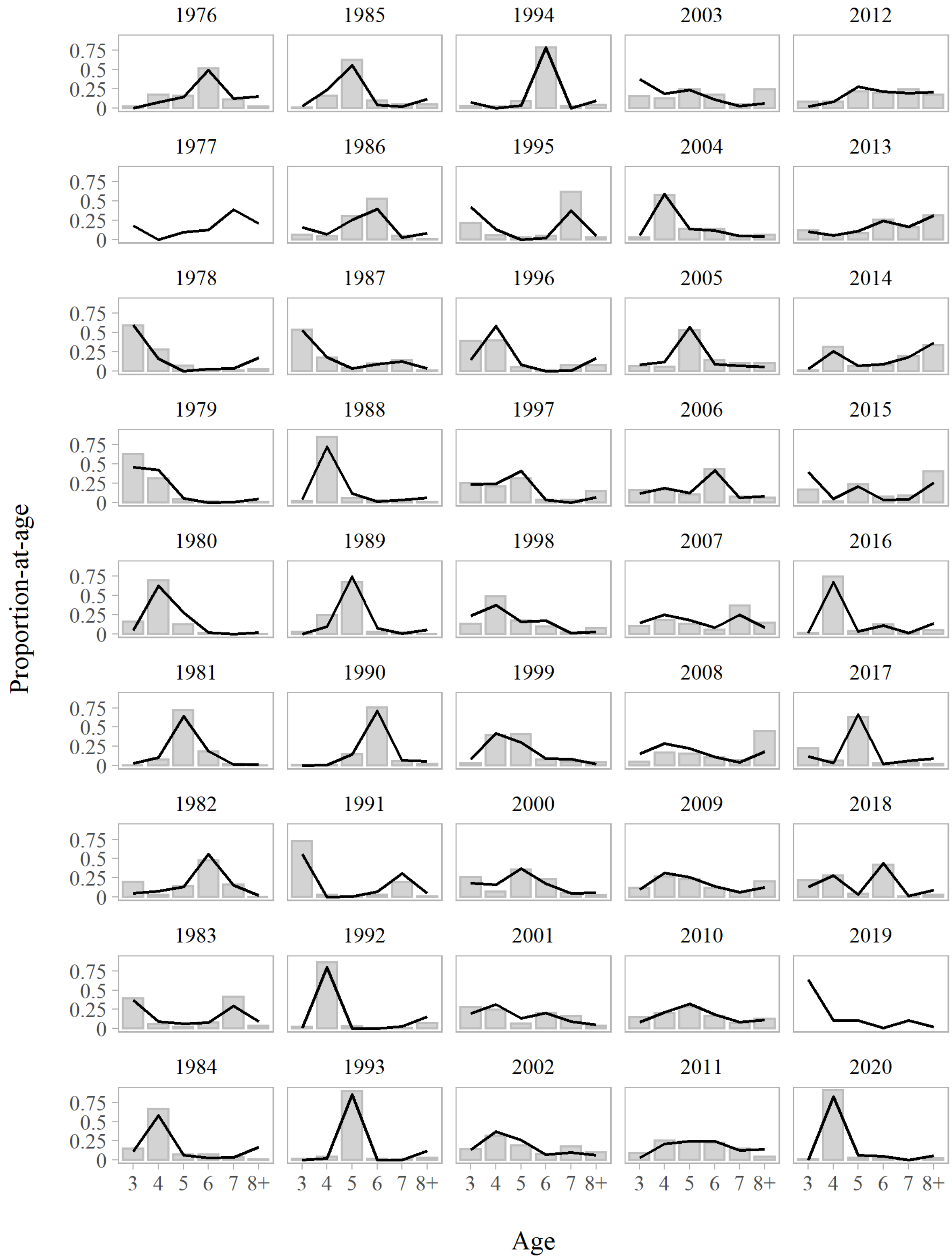


Figure 16: Observed commercial (bars) and model-estimated (line) catch-age compositions from the spring purse seine fishery by year. No commercial herring sac roe fishing occurred in 2019. In 2020, the only harvest was 20 tons of personal-use bait by permit and cast net age composition was used as the "observed commercial" age composition since there was no commercial fishery.

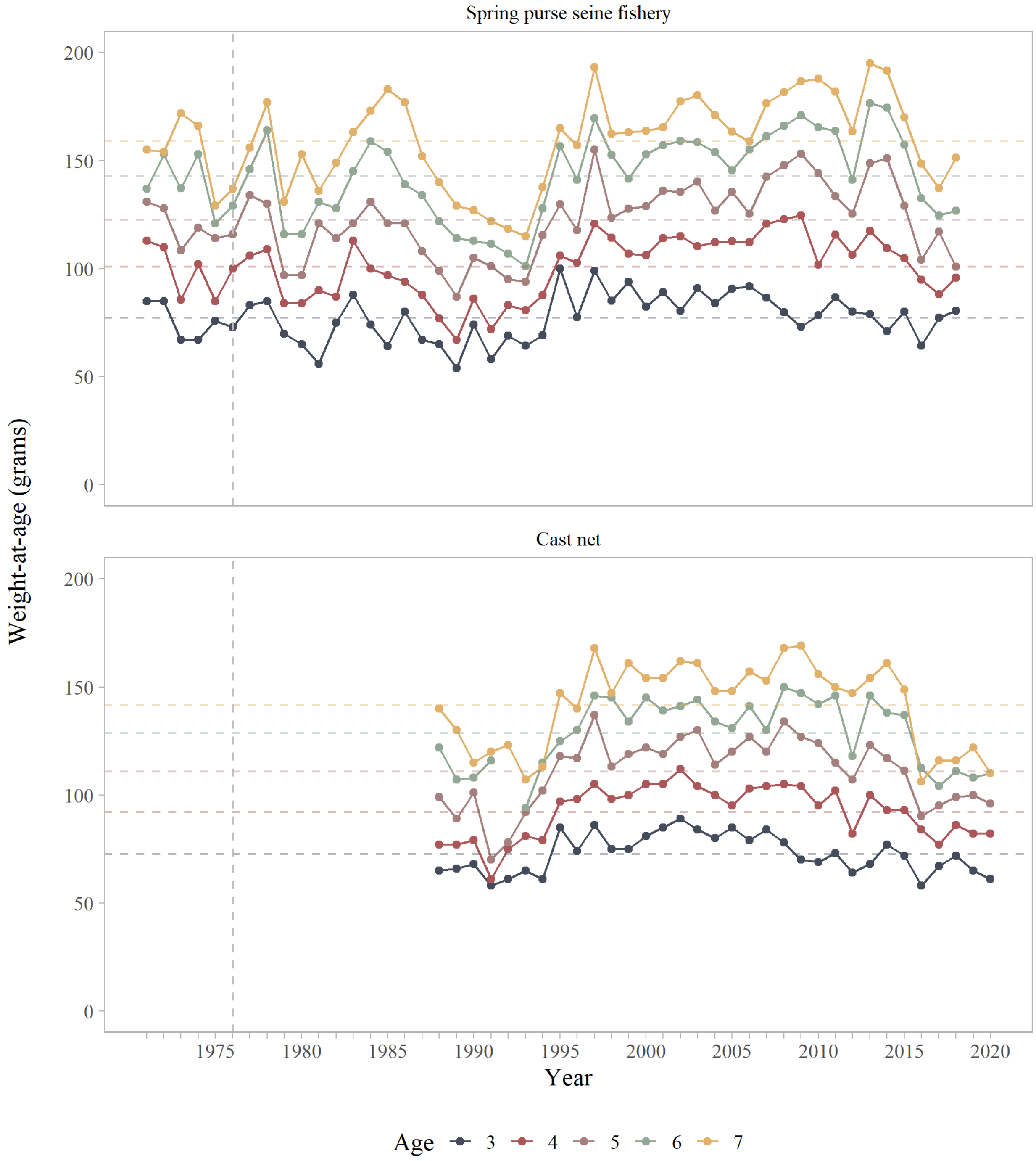


Figure 17: Weight-at-age trends (grams) by year from cast net and spring purse seine fishery samples. Horizontal dashed lines indicate average weight for each age. The vertical dashed line indicates that model start year. Cast net age compositions start in 1988 because prior-year values were not compiled in time for this assessment. Since there was no spring purse seine fishery in 2019 or 2020, the average weight at age from 2017 and 2018 spring purse seine fishery samples were used in the model to estimate the hindcasted biomass for 2019 and 2020, as well as the forecasted biomass for 2021. Cast net weights at age are not used in the model (they are expected to be negatively biased due to spent fish in samples) but are presented for comparison and for general trends for 2019 and 2020 when there were no spring purse seine samples.

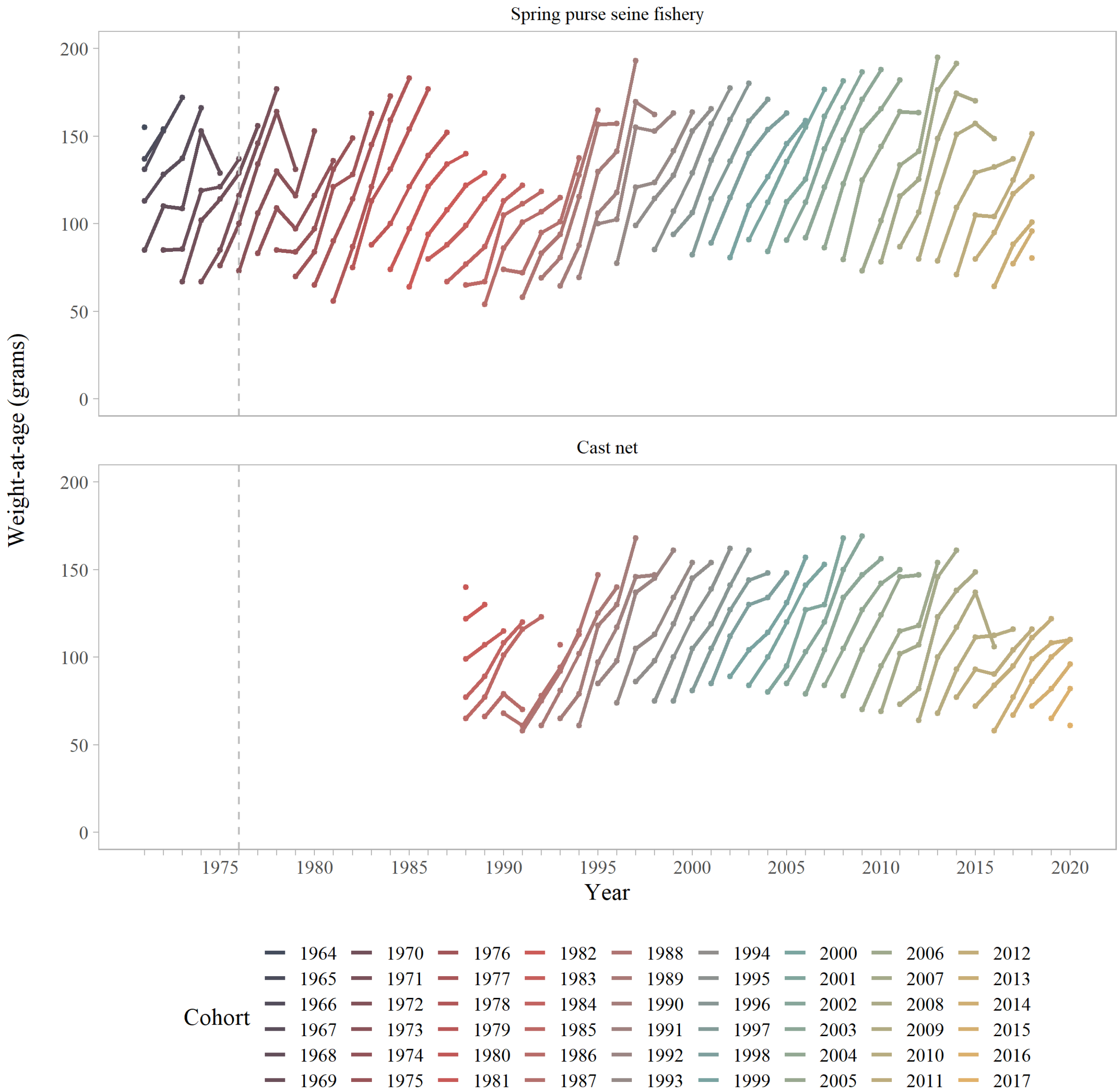


Figure 18: Weight at age (grams) by cohort from the spring purse seine fishery and cast net samples. The vertical dashed line indicates that model start year. Cast net age compositions start in 1988 because prior-year values were not compiled in time for this assessment.

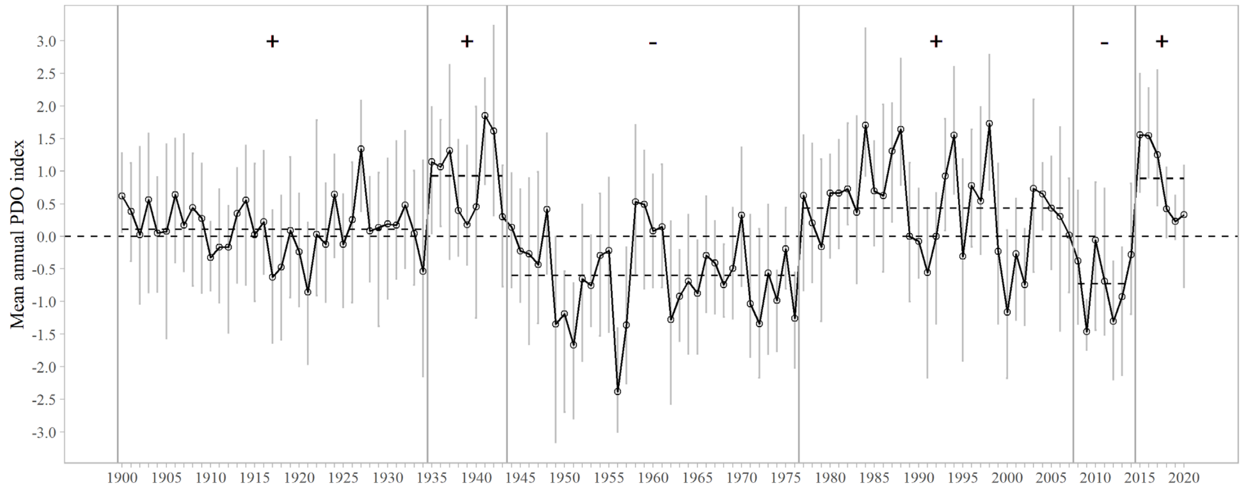


Figure 19: Mean Pacific Decadal Oscillation (PDO) index with 95% percentiles in monthly values. Time blocks are 1900–1934, 1935–1943, 1944–1976, 1977–2007, 2008–2014, and 2015–2020. The horizontal dotted lines are the mean PDO value within each time-block. Positive values indicate a positive, or warm phase of the cycle and negative values indicate a negative, or cool phase of the cycle. The forecast model for the Sitka stock is based on time series data starting in year 1976. Since 1976 was the sole year in the 1944–1976 time block, 1976 was added to the 1977–2007 time block for the 2021-forecast model.

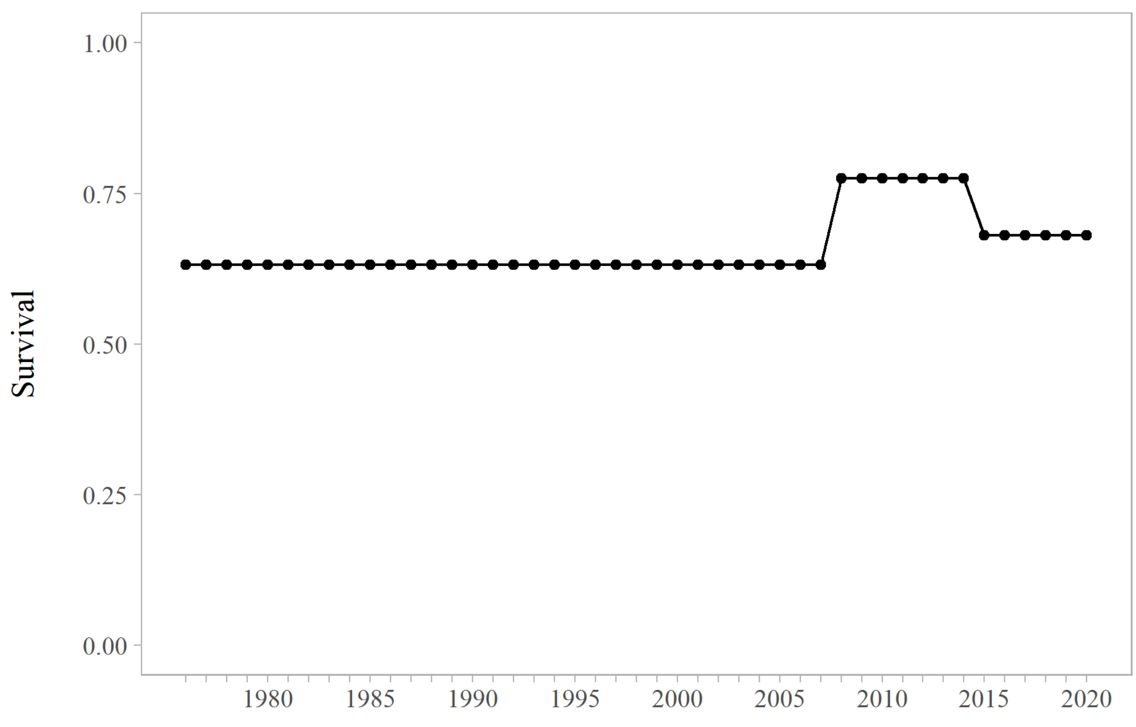


Figure 20: Model estimates of survival by time block (1976–2020).

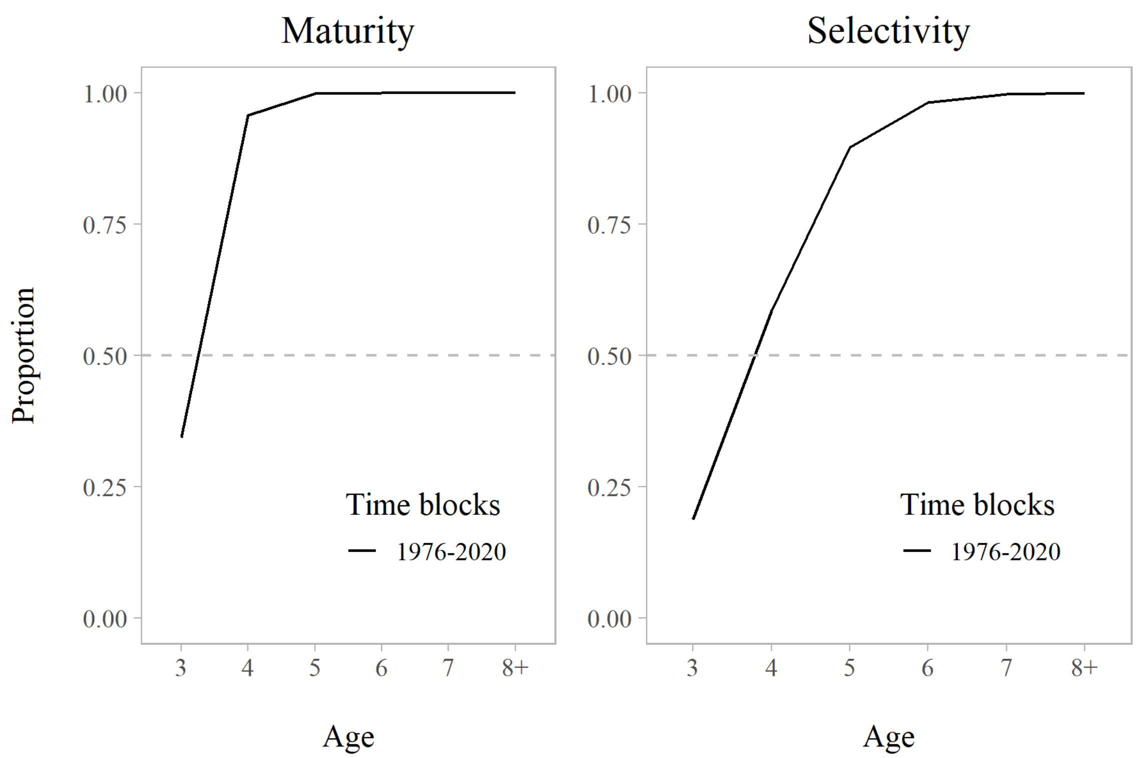


Figure 21: Model estimates of maturity and gear selectivity at age by time block.

Appendices

Appendix A: Description of the Pacific Decadal Oscillation (PDO) and the STARS Method

Pacific Decadal Oscillation

Sea-surface temperature anomalies are often leading indicators and important drivers of ecosystem fluctuations (Stock et al. 2015) and temperature indices have shown to be important for herring population dynamics (Stocker et al. 1985; Zebdi and Collie 1995; Williams and Quinn 2000). Temperature has been identified as affecting the recruitment (Stocker et al. 1985; Zebdi and Collie 1995; Williams and Quinn 2000), growth (Moores and Winters 1982; McGurk 1984; Haist and Stocker 1985), survival (McGurk 1984; Gregg et al. 2011), and maturity (Moores and Winters 1982) of herring species. The mechanism by which temperature affects herring may be direct (*e.g.,* changes in metabolism) or indirect, as temperature often does not drive ecosystem changes and processes through direct physiological effects but serves as a proxy for other physical (*e.g.,* mixed layer depth, stratification, horizontal transports; Stock et al. 2015) and biological factors (*e.g.,* prey quality and availability, predation, spawn timing; Benson and Trites 2002; Tojo et al. 2007; Andrews et al. 2015).

The Pacific Decadal Oscillation (PDO) is a basin-wide oceanographic index of sea surface temperatures that has been linked to productivity of lower trophic levels and Pacific salmon production in the North Pacific (Mantua et al. 1997; Mantua and Hare 2002). Models incorporating the mean PDO index as environmental information, whether through time-blocks or as a covariate, have shown to have better model fits to available data compared to the model in which these parameters were time-invariant (Hulson et al. 2018). Due to the importance of temperature to the population dynamics of herring, an annual index based on temperature anomalies (mean monthly PDO values from April of the previous year through March of the labelled year) was used as an annual PDO index from 1900 to 2020 to determine time-blocks in the 2021-forecast model. For example, the PDO index for 1990 was the average monthly PDO value from April 1989 through March 1990. Hereafter, we will refer to this index as the 'mean PDO index.'

Outer coast herring stocks in Southeast Alaska, including the Sitka stock, spawn primarily in late March, at which time most data for the model are collected. The chosen PDO index time period coincides with the model's annual time step. In other words, the natural mortality (or maturity or gear selectivity) time-dependent parameter that is estimated for 1990 is based on the natural mortality experienced by herring during the year from the previous spring spawning event, the last time data was collected. Break-points between years with predominantly positive PDO anomalies and years with predominantly negative PDO anomalies defined time blocks within which survival, maturity, and gear selectivity parameters were allowed to differ if the additional parameters resulted in improved model fit. A change in gear selectivity was only investigated as an alternative model if maturity time periods changed or if there were known and obvious changes in selectivity/fishing, which there were not for Sitka.

STARS Method

Because consistently defining meaningful shifts in the PDO is not necessarily obvious, the Sequential *t*-Test Analysis of Regime Shifts (STARS) method was used in this year's assessment to determine the breaks in the mean PDO index (Rodionov and Overland 2005). The STARS method identifies discontinuity in a time-series and allows for early detection of a regime shift and subsequent monitoring of changes in its magnitude over time (Rodionov 2004). Detection of discontinuity is accomplished by sequentially testing whether a new mean PDO value within a time-series represents a statistically significant deviation from the mean value of the current 'regime.' As data are added to the time-series, the hypothesis of a new 'regime' (*i.e.,* time block) is either confirmed or rejected based on the Student's *t*-test (Rodionov and Overland 2005). The STARS method is well documented in the literature and has been applied previously to physical and biological indices (Mueter et al. 2007; Howard et al. 2007; Marty 2008; Conversi et al. 2010; Lindegren et al. 2010; Blamey et al. 2012; Menberg et al. 2014; Reid et al. 2016). An R script (STARS.R; Seddon et al. 2011; http://esapubs.org/archive/ecol/E095/262/suppl-1.php) that is equivalent to the v3-2 Excel add-in tool (http://www. beringclimate.noaa.gov/regimes), and references the methods from Rodionov (2004, 2006) was used to run the STARS method in 2018–2020.

Several parameters within the STARS method need specification prior to application to determine the breaks in the mean PDO index. Two parameters, the *p*-value (the probability level for significance between 'regime' means) and the cutoff length (the *approximate* minimum number of years within a regime) control the magnitude and scale of the regimes to be detected, or how strong a change in the mean PDO index needs to be detected. If regimes are longer than the cutoff length, they will be detected. There is a reduced probability of detection for regimes shorter than the cutoff length, but the regimes may still be detected if the shift is of sufficient magnitude (Rodionov 2004). In addition, Huber's weight parameter determines the weight assigned to outliers and thus the magnitude of the average values of each regime (Huber 1964). Finally, the user determines whether to account for autocorrelation and specifies the associated subsample size needed. For this study, a *p*-value of 0.10 was chosen, which is well within the range of other studies that have applied the STARS method. Regime shifts are known to be associated with relatively rapid changes in climate, oceanic conditions, or the ecosystem from one decadal-scale period of a persistent state to another (King 2005) and the most important scale of variability for fisheries management is decadal-scale (King and McFarlane 2006). Therefore, a cutoff value of ten years was specified within the STARS method. The default value of one for Huber's weight parameter, and autocorrelation were included (Newman et al. 2003). Two frameworks are available within the STARS method to estimate autocorrelation (Rodionov 2004): the MPK (Marriott-Pope and Kendall) and the IPN4 (Inverse Proportionality with 4 corrections). The two frameworks break the time series into subsamples, estimate bias-corrected first-order autocorrelation for each subsample and then use the median value of all estimates. The two frameworks produce very similar results and only in certain instances (small subsample size) does the IPN4 method significantly outperform the MPK method (Rodionov 2004). Therefore, the IPN4 method was used in this analysis with the suggested subsample size of $m=(l+1)/3$, where l is the cutoff length. This resulted in four potential time blocks for the Sitka data time series: 1976, 1977–2007, 2008–2014, and 2015–2020 (corresponding to splits in 1976/1977, 2007/2008 and 2014/2015). Since 1976 was the sole year in the 1944–1976 time block, 1976 was added to the 1977–2007 time block for the 2021-forecast model, resulting in three potential time blocks (1976–2007, 2008–2014, and 2015–2020) for the Sitka 2021-forecast model.

Appendix B: The 2021-forecast models including structure and AICc

Table B1: Model structure (or parameterization) refers to the number of time-periods (in order) for survival, maturity, and gear selectivity. For the columns 'Survival', 'Maturity', and 'Gear selectivity', the year ranges represent the time blocks for that parameter. The models are ordered from lowest ΔAICc to highest. The recommended model for the 2021-forecast (in bold) has a structure with three survival periods (splits at 2007/2008 and 2014/2015), one maturity period, and one gear selectivity period (*i.e.,* "311" structure; Model 49). Some of the 64 models that were run for the assessment are not shown because a change in gear selectivity was only considered as an alternative model if maturity time periods changed as well or if there were known and obvious changes in selectivity/fishing. For example, Model 2 had a 112 structure (one survival time period, one maturity time period, and two time periods for gear selectivity), and therefore was not considered a plausible model for the 2021 forecast.

Model number	Model structure	Survival	Maturity	Gear selectivity	AICc	ΔAICc
49	**311**	**1976 - 2007; 2008 - 2014; 2015 - 2020**	**1976 - 2020**	**1976 - 2020**	**-519.4**	**0.0**
57	321	1976 - 2007; 2008 - 2014; 2015 - 2020	1976 - 2014; 2015 - 2020	1976 - 2020	-516.5	2.9
17	211	1976 - 2007; 2008 - 2020	1976 - 2020	1976 - 2020	-515.8	3.5
59	322	1976 - 2007; 2008 - 2014; 2015 - 2020	1976 - 2014; 2015 - 2020	1976 - 2014; 2015 - 2020	-515.5	3.9
61	331	1976 - 2007; 2008 - 2014; 2015 - 2020	1976 - 2007; 2008 - 2014; 2015 - 2020	1976 - 2020	-514.5	4.8
27	222	1976 - 2007; 2008 - 2020	1976 - 2014; 2015 - 2020	1976 - 2014; 2015 - 2020	-514.3	5.1
63	332	1976 - 2007; 2008 - 2014; 2015 - 2020	1976 - 2007; 2008 - 2014; 2015 - 2020	1976 - 2014; 2015 - 2020	-513.3	6.1
21	221	1976 - 2007; 2008 - 2020	1976 - 2007; 2008 - 2020	1976 - 2020	-513.0	6.3
29	231	1976 - 2007; 2008 - 2020	1976 - 2007; 2008 - 2014; 2015 - 2020	1976 - 2020	-511.7	7.7
31	232	1976 - 2007; 2008 - 2020	1976 - 2007; 2008 - 2014; 2015 - 2020	1976 - 2014; 2015 - 2020	-511.5	7.9
62	332	1976 - 2007; 2008 - 2014; 2015 - 2020	1976 - 2007; 2008 - 2014; 2015 - 2020	1976 - 2007; 2008 - 2020	-511.1	8.3
64	333	1976 - 2007; 2008 - 2014; 2015 - 2020	1976 - 2007; 2008 - 2014; 2015 - 2020	1976 - 2007; 2008 - 2014; 2015 - 2020	-510.0	9.4
32	233	1976 - 2007; 2008 - 2020	1976 - 2007; 2008 - 2014; 2015 - 2020	1976 - 2007; 2008 - 2014; 2015 - 2020	-508.4	11.0
30	232	1976 - 2007; 2008 - 2020	1976 - 2007; 2008 - 2014; 2015 - 2020	1976 - 2007; 2008 - 2020	-507.0	12.4
16	133	1976 - 2020	1976 - 2007; 2008 - 2014; 2015 - 2020	1976 - 2007; 2008 - 2014; 2015 - 2020	-496.4	23.0
48	233	1976 - 2014; 2015 - 2020	1976 - 2007; 2008 - 2014; 2015 - 2020	1976 - 2007; 2008 - 2014; 2015 - 2020	-494.5	24.8
46	232	1976 - 2014; 2015 - 2020	1976 - 2007; 2008 - 2014; 2015 - 2020	1976 - 2007; 2008 - 2020	-493.8	25.6
14	132	1976 - 2020	1976 - 2007; 2008 - 2014; 2015 - 2020	1976 - 2007; 2008 - 2020	-493.4	26.0
13	131	1976 - 2020	1976 - 2007; 2008 - 2014; 2015 - 2020	1976 - 2020	-492.6	26.8
15	132	1976 - 2020	1976 - 2007; 2008 - 2014; 2015 - 2020	1976 - 2014; 2015 - 2020	-491.0	28.3
45	231	1976 - 2014; 2015 - 2020	1976 - 2007; 2008 - 2014; 2015 - 2020	1976 - 2020	-490.1	29.3
47	232	1976 - 2014; 2015 - 2020	1976 - 2007; 2008 - 2014; 2015 - 2020	1976 - 2014; 2015 - 2020	-488.7	30.7
38	222	1976 - 2014; 2015 - 2020	1976 - 2007; 2008 - 2020	1976 - 2007; 2008 - 2020	-486.9	32.5
1	111	1976 - 2020	1976 - 2020	1976 - 2020	-486.8	32.6
6	112	1976 - 2020	1976 - 2007; 2008 - 2020	1976 - 2007; 2008 - 2020	-486.2	33.1
33	211	1976 - 2014; 2015 - 2020	1976 - 2020	1976 - 2020	-484.9	34.4
5	121	1976 - 2020	1976 - 2007; 2008 - 2020	1976 - 2020	-484.8	34.6
37	221	1976 - 2014; 2015 - 2020	1976 - 2007; 2008 - 2020	1976 - 2020	-482.3	37.1
9	121	1976 - 2020	1976 - 2014; 2015 - 2020	1976 - 2020	-482.1	37.3
11	122	1976 - 2020	1976 - 2014; 2015 - 2020	1976 - 2014; 2015 - 2020	-481.6	37.7
41	221	1976 - 2014; 2015 - 2020	1976 - 2014; 2015 - 2020	1976 - 2020	-480.3	39.0
43	222	1976 - 2014; 2015 - 2020	1976 - 2014; 2015 - 2020	1976 - 2014; 2015 - 2020	-479.4	40.0

Appendix C: Sitka Sound Herring Fishery Announcement, Alaska Department of Fish and Game Commercial Fisheries Advisory Announcement 23 December 2019

Division of Commercial Fisheries
Sam Rabung, Director

Sitka Area Office
304 Lake Street, Room 103
Sitka, AK 99835

Alaska Department of Fish and Game
Doug Vincent-Lang, Commissioner

PO Box 115526
Juneau, AK 99811-5526
www.adfg.alaska.gov

Advisory Announcement
For Immediate Release: **December 23, 2019**

CONTACT: Eric Coonradt
Sitka Area Management Biologist
(907) 747-6688

SITKA SOUND HERRING FISHERY ANNOUNCEMENT

Sitka. . . The Alaska Department of Fish and Game announced today the guideline harvest level (GHL) for the 2020 Sitka Sound sac roe herring fishery is **25,824 tons** of mature herring. The 2020 GHL was calculated by reducing the Age Structure Analysis (ASA) derived GHL by 39%, which approximates the harvest level available if the number of age-4 fish is half of that projected. This precautionary approach takes into account the higher than usual uncertainty in the size of the return of the age-4 herring.

The size of the forecasted 2020 age-4 herring cohort is extremely high and has more uncertainty due to its dependence on the number of age-3 fish estimated by the model in 2019, maturity rate, and estimates of survival for this unprecedented large age class. Because the department has had only one opportunity to observe this year class as age-3 herring, precaution is being taken for setting the GHL for the 2020 season.

The 2020 forecast is larger than the estimated 2019 mature biomass of 130,738 tons and is greater than any forecast previously estimated for Sitka Sound herring. The 2020 ASA forecast of mature herring biomass is 212,330 tons of mature herring. Large proportions of age-3 fish were also observed throughout other herring populations in the Gulf of Alaska in 2019.

The forecast indicates that the mature population by number of herring in 2020 will consist of 2% age-3, 83% age-4, 7% age-5, 4% age-6, <1% age-7, and 4% age-8+. Because there was no commercial harvest in 2019, the 2020 forecast used an average of the spring commercial purse seine weights at age from the 2017 and 2018 fisheries harvest: age-3, 79 grams; age-4, 92 grams; age-5, 109 grams; age-6, 126 grams; age-7, 144 grams; and age-8+, 165 grams. The forecasted average weight across all age classes is 88 grams.

To forecast biomass, the department uses an ASA model with a long time series of egg abundance and age composition data from department surveys conducted during and following the spring fishery. Herring egg abundance is estimated using aerial surveys, designed to map the length of shoreline receiving spawn, and dive surveys, which are used to estimate the density of eggs and average width of the spawn. The department mapped 55.8 nautical miles (nmi) of herring spawn in the Sitka Sound area during the spring of 2019, compared to the recent 10-year average of 63.7 nmi. Egg deposition observed during dive surveys in 2019 was very high (6th highest recorded since 1976), particularly along the southern shore of Kruzof Island. Estimated age composition by number of spawning herring in 2019 was 76% age-3, 8% age-4, 6% age-5, 1% age-6, 8% age-7, and <1% age-8+.

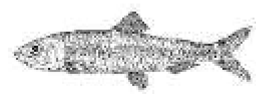
Advisory Announcement web site: http://www.adfg.alaska.gov/index.cfm?adfg=cfnews.main.

Office	*Ketchikan*	*Petersburg*	*Wrangell*	*Sitka*	*Juneau*	*Haines*	*Yakutat*
ADF&G	*225-5195*	*772-3801*	*874-3822*	*747-6688*	*465-4250*	*766-2830*	*784-3255*
AWT	*225-5111*	*772-3983*	*874-3215*	*747-3254*	*465-4000*	*766-2533*	*784-3220*

Appendix D: 2019/2020 Southeast Alaska Winter Food and Bait Herring Fishery, Alaska Department of Fish and Game Commercial Fisheries News Release 11 October, 2019

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF COMMERCIAL FISHERIES
NEWS RELEASE

Doug Vincent-Lang, Commissioner
Sam Rabung, Director



Contact:	Petersburg Area Office
Troy Thynes	P.O. Box 667
	Petersburg, AK 99833
Phone: (907) 772-3801	Date: October 11, 2019
Fax: (907) 772-9336	Time: 1:15 p.m.

2019/2020 SOUTHEAST ALASKA WINTER FOOD AND BAIT HERRING FISHERY

Petersburg. . . The Alaska Department of Fish and Game announced today the following information concerning the 2019/2020 Southeast Alaska winter food and bait herring fishery.

The 2019 egg spawn deposition for the Craig/Klawock herring stock was approximately 1.7 times higher than the maximum historical estimate from 1976-2018. Samples from both cast net and the commercial catch during the spawning event indicate that the mature biomass was dominated by age-3 fish, 81% of cast net and 85% of the commercial catch respectively. This large proportion of age-3 fish was observed throughout Southeast Alaska herring stocks, including Ernest Sound, Revilla Channel, Seymour Canal, and Sitka Sound. Because of the very large uncertainty associated with the 2019 age-3 abundance, the department will base the 2019/20 Craig/Klawock guideline harvest level (GHL) on the 2019 spawn deposition estimate of 55,072 tons. Given the proportion of age-3 herring in the mature biomass in 2019, it is anticipated that the population in 2019/20 will be comprised of predominately age-4 individuals.

The total GHL for the Craig/Klawock area will be set at 11,014 tons. Regulations state that 60% of this GHL goes to the winter food and bait fishery and 40% goes to the Section 3-B spawn-on-kelp pound fishery (5 AAC 27.185 (h)). Additionally, any portion not taken by the winter bait fishery is allocated to the spawn-on-kelp fishery and will be announced by March 5, 2020.

Section 3-B and District 4 (Craig/Klawock): **will open at 12:00 noon, Tuesday, October 15, 2019,** in those waters of Section 3-B west of a line from Blanquizal Point to Point Santa Rosalia to Tranquil Point and in those waters of District 4 north and east of a line from Lontana Point to Diver Point. The GHL is **6,608 tons**. This GHL is based on the spawn deposition estimate conducted in 2019 of 55,072 tons and a harvest rate of 20%.

District 7 (Ernest Sound): **will be closed**. Minimal herring spawn was observed, and a spawn deposition survey was not conducted in 2019. Therefore, a forecast for the 2019/20 season was not generated.

District 10 (Hobart Bay/Port Houghton): **will be closed**. Minimal herring spawn was observed, and a spawn deposition survey was not conducted in 2019. Therefore, a forecast for the 2019/20 season was not generated.

District 12 (Tenakee Inlet): **will be closed**. Minimal herring spawn was observed, and a spawn deposition survey was not conducted in 2019. Therefore, a forecast for the 2019/20 season was not generated.

Fishermen and operators of tendering vessels must obtain an ADF&G permit to participate in the Southeast Alaska Winter Food and Bait Herring Fishery (5 AAC 27.179). Permit applications are available at ADF&G area offices in Ketchikan, Sitka, Petersburg, Wrangell, and Douglas free of charge.

For the 2019/20 season, the department is requiring that permits be issued by ADF&G prior to fishing. Terms of the permit stipulate: 1) the amount of herring harvested and delivery location be reported to the Ketchikan office for Section 3-B and District 4 by 12:00 noon on the day after fish were harvested; 2) logbook forms must be completed and submitted with fish tickets; 3) one 5-gallon bucket of herring is to be provided to the department from each delivery for catch sampling purposes.

The Emergency Order corresponding with this announcement is EO 1H0319.

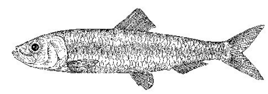
News releases web site: *http://www.adfg.alaska.gov/index.cfm?adfg=cfnews.main*.

Office	*Ketchikan*	*Petersburg*	*Wrangell*	*Sitka*	*Juneau*	*Haines*	*Yakutat*
ADF&G	*225-5195*	*772-3801*	*874-3822*	*747-6688*	*465-4250*	*766-2830*	*784-3255*
AWT	*225-5111*	*772-3983*	*874-3215*	*747-3254*	*465-4000*	*766-2533*	*784-3220*

Appendix E: Sitka Sound Herring Fishery Announcement, Alaska Department of Fish and Game Commercial Fisheries News Release 4 December 2007

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF COMMERCIAL FISHERIES
NEWS RELEASE

Denby S. Lloyd, Commissioner
John Hilsinger, Director



Contact:	Sitka Area Office
Dave Gordon	304 Lake Street, Room 103
	Sitka, Alaska 99835
Phone: (907) 747-6688	Date: December 4, 2007
Fax: (907) 747-6693	Time: 9:00 a.m.

SITKA SOUND HERRING FISHERY ANNOUNCEMENT

Sitka. . . The Alaska Department of Fish and Game announced today the preliminary guideline harvest level (GHL) for the 2008 Sitka Sound sac roe herring fishery is 13,796 tons.

This fall the department ran several ASA model runs exploring various biological parameters affecting the Sitka Sound herring stock and other model parameters to improve the fit of the model to the observed data. The ASA model uses a long time series of abundance and age composition data from department surveys conducted during the spring fishery. The best fitting ASA model run included splitting the maturity schedule estimates for the periods 1978-2001 and 2002-2007. The maturity schedule is the estimation of what age the herring are reaching maturity and capable of spawning. The model is showing that during the period 2002-2007 a smaller portion of age-3 through age-7 herring are recruiting as mature herring to the spawning grounds and the fishery. Maturation of herring is a function of growth and in recent years younger herring have been growing at a slower rate. The department has selected a more conservative GHL than that forecast using the ASA model because it is not fully understood how changes in the environment that are affecting herring growth, maturation and survival will affect the herring population in future years.

The forecast and quota for the 2008 fishery will be finalized in February, 2008 after a winter test fishery is completed. The preliminary forecast indicates that the spawning stock will consist of 4% age-3, 6% age-4, 9% age-5, 13% age-6, 12% age-7, and 57% age-8+.

News releases web site: http://documents.cf1.adfg.state.ak.us/TopicContents.po.

Office	*Ketchikan*	*Petersburg*	*Wrangell*	*Sitka*	*Juneau*	*Haines*	*Yakutat*
ADFG	*225-5195*	*772-3801*	*874-3822*	*747-6688*	*465-4250*	*766-2830*	*784-3255*
AWT	*225-5111*	*772-3983*	*874-3215*	*747-3254*	*465-4000*	*766-2533*	*784-3220*

Appendix F: Sitka Sound Herring Fishery Announcement, Alaska Department of Fish and Game Commercial Fisheries News Release 12 December 2012

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF COMMERCIAL FISHERIES
NEWS RELEASE

Cora Campbell, Commissioner
Jeff Regnart, Director

Contact:	Sitka Area Office
Dave Gordon	304 Lake Street, Room 103
	Sitka, Alaska 99835
Phone: (907) 747-6688	Date: December 12, 2012
Fax: (907) 747-6693	Time: 3:30 p.m.

SITKA SOUND HERRING FISHERY ANNOUNCEMENT

Sitka. . . The Alaska Department of Fish and Game announced today the preliminary guideline harvest level (GHL) for the 2013 Sitka Sound sac roe herring fishery is 11,055 tons. The age structured analysis (ASA) model forecast of 74,694 tons accounts for changes in the Sitka herring biomass through 2012. Due to substantial decreases in herring biomass observed in Sitka and at several other spawning locations in Southeast Alaska between 2011 and 2012, and because there may be factors affecting the herring population that cannot be incorporated into the model yet, the department has chosen to set a precautionary guideline harvest level for 2013. The 2013 GHL was calculated by reducing the ASA derived GHL by 25%, which approximates the harvest level that would be available if the survival between 2012 and 2013 is similar to a survival rate estimated by the ASA model for the period 1980-1998. This accounts for the possibility that survival rates have declined from higher survival rates estimated for the period 1999-2012.

The ASA model uses a long time series of abundance and age composition data from department surveys conducted during and following the spring fishery. Herring abundance is estimated using aerial surveys designed to map the length of shoreline receiving spawn, and dive surveys which estimate the density of eggs and the average width of the spawn. The department documented 55.9 nautical miles of herring spawn in the Sitka Sound area in the spring of 2012, slightly below the recent 10-year average of 60.4 nautical miles. Spawning herring sampled in the spring of 2012 showed an age composition of 12% age-3, 21% age-4, 23% age-5, 18% age-6, 13% age-7, and 13% age-8+. The ASA model estimates that 68,440 tons of herring spawned in the Sitka Sound area in the spring of 2012 and the commercial sac roe herring harvest was 13,231 tons, 16% of a total return of 81,671 tons. The forecast indicates that the spawning stock in 2013 will consist of 16% age-3, 18% age-4, 13% age-5, 17% age-6, 12% age-7, and 24% age-8 and older herring.

The forecast and GHL for the 2013 fishery will be finalized using average weight-at-age from sampling of the winter test fishery, to be conducted during late-January or early-February, 2013. The final forecast will be announced in late-February.

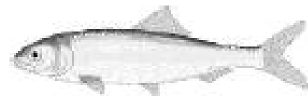
News releases web site: *http://www.adfg.alaska.gov/index.cfm?adfg=cfnews.main.*

Office	*Ketchikan*	*Petersburg*	*Wrangell*	*Sitka*	*Juneau*	*Haines*	*Yakutat*
ADF&G	*225-5195*	*772-3801*	*874-3822*	*747-6688*	*465-4250*	*766-2830*	*784-3255*
AWT	*225-5111*	*772-3983*	*874-3215*	*747-3254*	*465-4000*	*766-2533*	*784-3220*

Appendix G: 2019 Togiak Herring Forecast, Alaska Department of Fish and Game Commercial Fisheries News Release 13 December 2018

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF COMMERCIAL FISHERIES
NEWS RELEASE

Douglas Vincent-Lang, Acting Commissioner
Forrest Bowers, Acting Director



Contacts:
Greg Buck, Area Research Biologist
Sherri Dressel, Statewide Herring Fisheries Scientist
Phone: (907) 267-2355
Fax: (907) 267-2442

Anchorage Regional Office
333 Raspberry Road
Anchorage, AK 99518
Date: December 13, 2018

2019 TOGIAK HERRING FORECAST

The 2019 Togiak herring forecast and harvest allocations are listed below for the Togiak District sac roe and spawn-on-kelp fishery, and the Dutch Harbor food and bait fishery. At the 2018 Bristol Bay Board of Fish meeting, the gear group allocation found in the *Bristol Bay Herring Management Plan* 5AAC 27.865(b)(5) was changed from 70% purse seine and 30% gillnet to 80% purse seine and 20% gillnet. The following represents the allocations and quotas based on updated regulations and a 14% exploitation rate.

Table 1.–The 2019 Togiak District Pacific herring biomass and harvest forecast and allocation by fishery and gear.

	Biomass (Short Tons)	Harvest (Short Tons)
Biomass Estimate	217,548	
Total allowable Harvest (14% exploitation rate)		30,457
Togiak Spawn on Kelp Fishery (Fixed Allocation)		1,500
Remaining Allowable Harvest		28,957
Dutch Harbor Food/Bait Allocation (7% of remaining allocation)		2,027
Togiak District Sac Roe Fishery		26,930
Purse Seine Allocation (80%)		21,544
Gillnet Allocation (20%)		5,386

2019 TOGIAK HERRING FORECAST SUMMARY

The 2019 forecast uses a 14% exploitation rate because of three consecutive years of missing or poor aerial survey data. The Togiak mature herring population biomass has been estimated with aerial surveys since the late 1970s. Peak biomass estimates from these surveys, combined with population age data, are the basis for the model used to generate the annual forecast. No peak biomass estimates are available from 2016, 2017, and 2018 because of budget cuts and poor weather. No population age data was collected in 2016 as well. Without aerial survey biomass data from the last three years, model-estimated biomass and recruitment estimates from 2016 to 2018 were calculated from pre-2016 data. This data gap creates uncertainty in the 2019 forecast. There is precedent within the Alaska Department of Fish and Game and flexibility in the *Bristol Bay Herring Management Plan* (5AAC 27.865) to take a conservative approach to herring exploitation when data uncertainty exists. The department intends to implement a 2% reduction in the exploitation rate for each consecutive year in which there is poor or missing aerial survey biomass data. A 2% reduction per year over the last three years translates to a 14% exploitation rate of the forecasted 2019 mature herring biomass. A 14% exploitation rate is within the range of current exploitation rates used for herring around Alaska and British Columbia and provides a gradual approach for being more conservative with a multi-year absence of reliable survey biomass information. Fishery assessment funding has been restored and the department anticipates consistent collection of aerial survey and age class data in the future.

The 2019 mature herring biomass forecast is 217,548 tons (Table 1 and Figure 1). Under a 14% exploitation rate, the 2019 potential harvest is 30,457 tons in all fisheries and 26,930 tons in the Togiak sac roe fisheries (purse seine and gillnet). A harvest of this size would be ~131% of the recent 10-year average sac roe harvest. The increase in forecasted biomass for 2019 compared with previous years is due to the high percent of partially mature age classes (age-4 and age-5 fish) observed in 2018. These cohorts are projected to comprise an even larger portion of the population in 2019 due to increasing maturity (Figure 2). Age 4–6 herring are expected to comprise 50% of the biomass, age 7–10 herring are expected to comprise 32% while the remaining 18% are expected to be age 11+ of the run by weight. The projected average weight of a fish in 2019 harvest is 318g.

An age-structured assessment (ASA) model is used to forecast the Togiak herring population. The ASA model utilizes time series of catch, age composition of the purse seine harvest, age composition of the mature population, and aerial survey biomass estimates plus catch data from 1980 forward. Samples from the entire commercial purse seine harvest are used to estimate age composition of the seine harvest. Sample groups from the commercial purse seine harvest that include the peak-run survey and the post-fishery survey as well as harvest prior to the peak are used to estimate age composition of the mature population biomass. Aerial survey biomass estimates plus pre-survey harvest are used to estimate mature biomass. This model uses between-dataset weighting and variable weighting within the aerial survey dataset to reflect the confidence staff has in the respective datasets and the confidence staff has in the individual aerial survey estimates based on the number of surveys, timing of surveys, weather and water conditions. The forecasted average weight at age of herring for 2019 was calculated as the most recent two-year average.

Herring are detected in our sampling effort when they recruit into the fishery; a process that begins around age-4 and is fully complete by age-9. Large recruitments in this population generally occur every eight to ten years and typically last one or two years. The last large recruitment event experienced by the Togiak herring population was the 2005 year-class, which was detected in 2009 when the age-4 fish recruited to the fishery. Biological sampling in 2018 suggests both the age-4 and age-5 recruit classes may be larger than the past few years. It should be noted that measuring contributions of younger age classes is difficult because these fish are not fully recruited (available) in the harvest and often arrive on the spawning grounds near the end of the fishery.

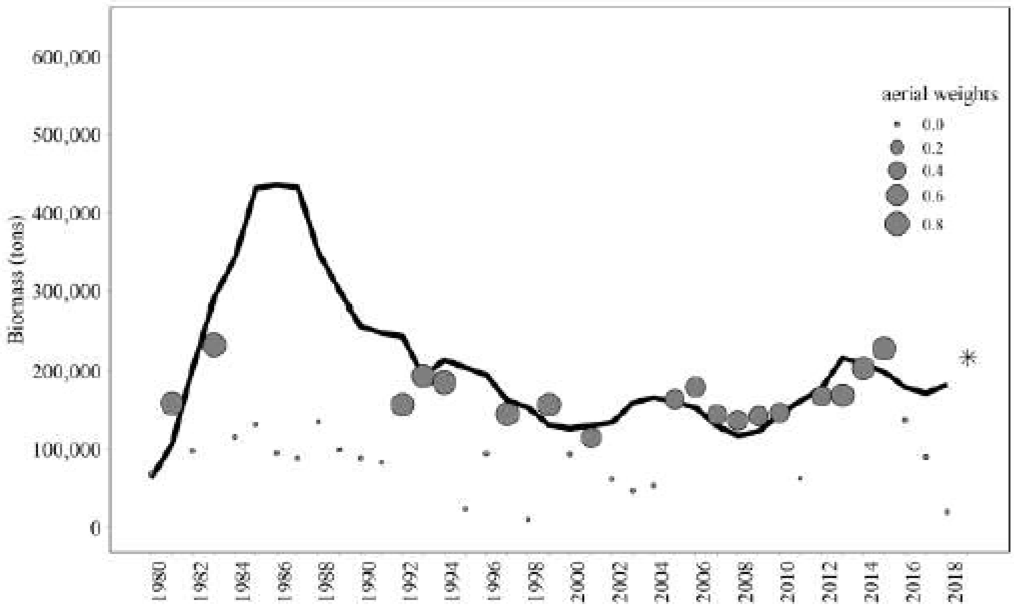


Figure 1.–Model-estimated mature biomass (black line). Annual abundance estimates with confidence weighting (black dots) ranging from 0 (very low confidence) to 1 (full confidence). Estimated mature biomass forecast for 2019 indicated by black star.

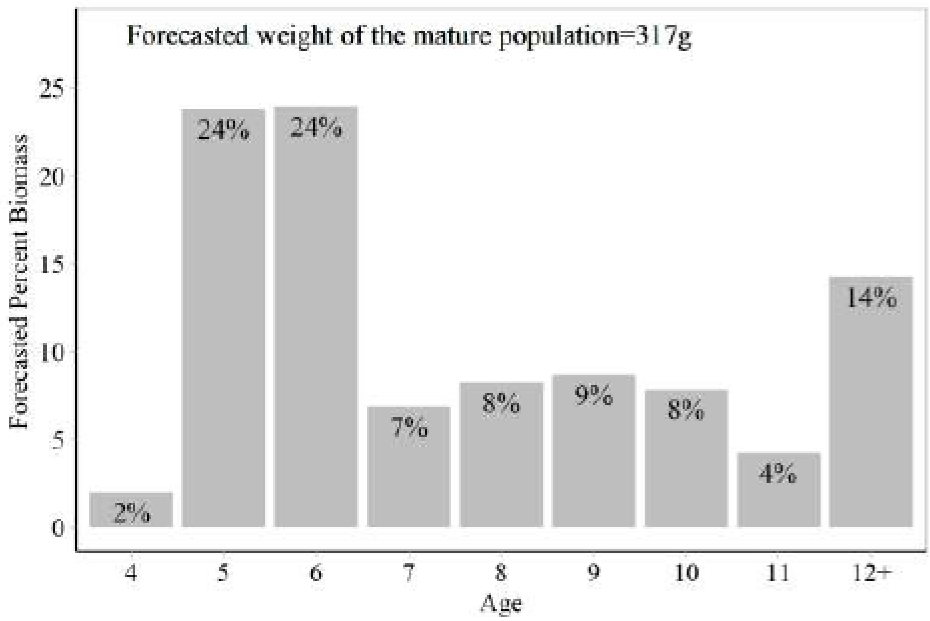


Figure 2.–Forecasted age composition and average weight (grams) for the 2019 Togiak mature biomass.