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Memorandum
Agenda Changes/Supplemental Packet

TO: MAYOR ZAK AND HOMER CITY COUNCIL
FROM: MELISSA JACOBSEN, MMC, CITY CLERK
DATE: JULY 2, 2018
SUBJECT: AGENDA CHANGES AND SUPPLEMENTAL PACKET

NEW BUSINESS **Resolution 18-059,** A Resolution of the City Council of Homer, Alaska Requesting the Alaska Board of Fish to Consider the Topic of Salmon Enhancement in Prince William Sound at the Regularly Scheduled Fall Meeting Instead of the July 17, 2018 Special Meeting. Erickson/Smith.

Written Public Comments

From: Nina Faust
To: Department Clerk
Cc: Mayor Email; Donna Aderhold; Caroline Venuti; rachelforcouncil2017@gmail.com; Tom Stroozas; Heath Smith; Shelly Erickson
Subject: Resolution 18-059
Date: Monday, July 02, 2018 11:01:12 AM

P.O. Box 2994
Homer AK 99603

July 2, 2018

Homer City Council
Homer, AK 99603

Dear Council Members:

Regarding Resolution 18-059, I urge you not to support this resolution.

Last fall there were numerous articles regarding pink salmon showing up in streams all over Cook Inlet and Prince William Sound, including even Beluga Slough. This glut of pinks seems to me to indicate that something is out of kilter with the pink salmon runs. We don't need more pink salmon. It is important to approach management of hatchery fisheries with a cautious mind. Too many pink, which are voracious, affects other species that we also depend on. Too many salmon overrunning our streams can create dead zones where systems do not flush well. There have been numerous articles in the Homer Tribune by people knowledgeable on this issue.

Let's let the emergency hearing happen because it is important to have a discussion on issues surrounding the over abundance of pinks before we dump more fish into the system.

Thank you,
Nina Faust

Nancy Hillstrand
Coal Point Trading Company
4306 Homer Spit
Homer Alaska 99603

6/29/18

I am finding it very distressing that the city council would "hold a special meeting with such short notice when stakeholders are busy fishing and cannot provide input."
This lacks the very transparency as specified in resolution 18-059.

At issue is very complex and dangerous subject requiring in-depth understanding, of the unexpected, unheard of, massive inter-regional straying from PWS hatchery fish into Lower Cook Inlet wild salmon river systems. Inter-regional straying is prohibited under the ADFG Policies, State Statutes and regulations all that mandate **wild fish priority.**

The entire crowning jewel of State of Alaska salmon management strategy is the SEG or Sustainable Escapement Goals. The SEG is designed to ensure wild fish are escaping to spawn into wild salmon streams without contamination from hatchery fish. Straying distorts and nullifies SEG's.
This is against state law.

At issue is 20,000,000 additional pink salmon eggs added to the Solomon Gulch hatchery.
This, amount, added to an already burgeoning 800,000,000 egg capacity spewed from all PWS hatcheries released into wild fish pastures each year. Solomon Gulch hatchery is already permitted at 250,000,000. Wouldn't you think that was enough?

ADFG otolith (earbone) sampling in Kachemak Bay, has documented straying of hatchery fish with proportions of up to 93% in Barabara Creek, a significant salmon stock. **This means only 7% were wild fish** in that stream on days of sampling. This is completely unacceptable in the State Genetics Policy:

> **Interaction with or impact on significant stocks:** ***Priority is given to protection of significant wild stocks from harmful interactions with interaction with introduced stocks. Stocks cannot be introduced to sites where they may impact significant or unique wild stocks.***
>
> **Use of Indigenous stocks in watersheds with significant wild stocks:** *A watershed with a significant wild stock can only be stocked with progeny from the indigenous stocks. The policy also specifies that no more than one generation of separation from the donor system to stocking of the progeny will be allowed. This means that only progeny from eggs taken from natural broodstock from the watershed may be used, and not progeny of broodstock returning to a hatchery or release site.*

In 2014, 2015, 2016, Solomon Gulch hatchery made up over 30% of this inter-regional straying. These fish were not harvested. They lined the beaches and streams as wanton decomposing putrefied waste. To ask for any more fish to be released is criminal. Straying of this magnitude is invasive and needs to be quarantined to PWS, away from Kachemak Bay, Cook Inlet and Gulf of Alaska wild salmon streams.

Pink salmon eat 2-4% of their body weight per day growing 500% in the last 4 months of life.

They are gape limited, meaning they will eat anything their mouths can fit around. Pinks have been documented to eat crab, shrimp, herring, sockeye, sand lance, caplin and squid. This outcompetes or eats high valued fisheries: king, coho, sockeye salmon and Dungeness crab. Which fish do you prefer?

I watched a tourist off the cruise ship last September holding a handkerchief over his nose due to the incredible stench of these invasive PWS rotting fish lying all over in Beluga slough. I wonder what he will remember about Homer Alaska?

Do we really want to glut Kachemak Bay with these low valued eating machines of inferior genetic diversity that just die on our beaches and in our streams making it impossible to get out of boats without ice cleats on for all the wanton waste of carcasses?

The emergency petition was submitted due to the responsibility of the law. The mechanics of the BOF statutory process have been in play with ample notice to the public on the ADFG web site, listing all background documents to fully involve the public in this process.

The BOF often receives petitions for emergency changes during times of years when it is not meeting and no meeting is scheduled within the next 30 days. Pursuant to AS 16.05.310, if two or more Board members vote in favor of a special meeting to consider the emergency petition, then the executive director will, after consultation with the Board chair and members, schedule a public Board meeting.

This is what has been done under the law. This resolution 18-059 is moot because the law must and will be followed and this issue cannot wait as the emergency is now…not in October.

Fisheries issues are very complex deserving more than a knee jerk reaction. To attempt to bring an additional complexity of the completely different industry of the sea ranching hatchery production of PWS to the Homer council spurs nothing but confusion to the public and I am sure the council itself.

98% of all fisheries revenue for the City of Homer is coming from **wild fish** not hatchery fish. This resolution is a slap in the face to our wild sockeye fisherman.

Adding billions of low valued hatchery pinks to compete in the wild fish pastures is removing poundage from wild fish making them smaller. This interception is taking money right out of wild fisherman's pockets from poundage loss and has lowered wild fish prices by glutting the markets.

It becomes evident that we had all best begin to learn more about these issues before we do any more damage to our wild fish resource that over 96% of the fisherman of the state of Alaska rely on.

We need wise concerned decision making to uphold wild fish priority. The hatchery issue in its gluttonous form today is very concerning.

With Kind regards

Nancy Hillstrand

From:	Ann & Ron Keffer
To:	Donna Aderhold; Tom Stroozas; Rachel Lord; Heath Smith; Caroline Venuti; Shelly Erickson; Mayor Email; Department Clerk
Subject:	RESOLUTION 18-059/Board of Fish
Date:	Friday, June 29, 2018 3:34:39 PM

Mayor Zak and Councilpersons,

I am writing in opposition to Resolution 18-059. I also oppose the calling of a special meeting on very short notice during one of the busiest times of the year when some interested parties cannot attend.

Fisheries issues can become complicated, especially when they involve the on-going dispute regarding hatchery fish, in this case pink salmon. The Alaska Board of Fisheries (BOF) received a petition that was supported by eight different groups representing a large number of people who make a living fishing, as well as by eleven separate signatories from the Lower Cook Inlet, including Homer. Those groups and individuals requested that the BOF declare an emergency relating to the recent granting of an additional allowance of twenty million pink salmon eggs for hatching in Prince William Sound (PWS) hatcheries.

When two BOF members officially recognize a petition as representing a genuine emergency, a hearing must be scheduled and held. There are two main reasons the hearing on the petition in question was scheduled for 17 July 2018. First, if the emergency were to be addressed, the hearing had to be held before pinks began to return and the eggs were harvested and processed for hatching. Second, the selected date had to accommodate the schedules of the members of the BOF. The petition was submitted in May. In early June notice of the comment period went out, and public comment will continue to be heard until 9 July 2018. All the pertinent documents, including the petition itself, are available on-line at the Alaska Department of Fish and Game website at http://www.adfg.alaska.gov/index.cfm?adfg=fisheriesboard.meetinginfo&date=07-17-2018&meeting=anchorage.

With regard to the petition in question, there is no issue about notification and time to comment. Also, since this matter was recognized as an emergency, it must be heard at the 17 July meeting as scheduled. Any efforts to ask for a change are rendered invalid at the outset.

To ask for a delay in this hearing is disingenuous. A superficial look at the issue tells us that a delay would permit the harvest of eggs and their hatching to go ahead. By the time of the fall meeting the issue relating to 2018 no longer would exist, and a thorough discussion of the merits of the contending viewpoints would not have occurred. Adding twenty million fish to an environment that last year saw huge numbers of PWS hatchery pinks moving into Cook Inlet and streams near Homer would seem on the face of it to be a problem needing calm consideration and resolution. Regardless of one's attitudes toward hatchery fish and preservation of wild fish, it is inappropriate to ask that the discussion be squelched. The fresh air of scientific data and professional management is needed here.

One might add that this is a divisive issue that is not strictly a matter for the Homer City Council. Considerable consternation arises when councilpersons avoid a regularly scheduled meeting but then call for a special meeting in this manner. To claim that there hasn't been sufficient notice or time to comment regarding the petition in question - and clearly both elements have taken place appropriately - while simultaneously avoiding the customary process of ample public notice and time for comment with regard to the special meeting of 2

July itself seems a bit fishy.

I urge all councilpersons to vote against this resolution and to allow a well-considered process to play out as intended.

Thanks for reading my e-mail.

Ron Keffer

Ann and Ron Keffer
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From:	Lani Raymond
To:	Department Clerk
Subject:	Opposition to Resolution 18-059
Date:	Monday, July 02, 2018 11:36:42 AM

July 2, 2018

Mayor Zak and the Homer City Council,
I am writing to oppose Resolution 18-059. This is a matter for the BOF who have complied with the July 17th meeting notifications ahead of time. This is not an issue that can be delayed because it concerns the hatching of the fish which cannot be controlled by a postponement.

This issue has been presented as an emergency to the BOF, and therefore the science of it is what is critically important. There are population limits for everything and many complex factors involved also.

Vote NO on this resolution. It seemed to me like there were too many pinks in Beluga Slough and some other areas also last year. I admit I not a scientist but I trust the scientists who have studied this to make the best decision within the time table they currently have set.

Lani Raymond
41640 Gladys Ct
Homer, AK

From:	Francie Roberts
To:	Donna Aderhold; Tom Stroozas; Caroline Venuti; Heath Smith; Mayor Email; Rachel Lord; Shelly Erickson; Department Clerk
Subject:	Fisheries Resolution
Date:	Monday, July 02, 2018 10:14:39 AM

Dear Council members,

I urge you not to support the fisheries resolution on your agenda this evening. Though it is true that many of the residents of the City of Homer are involved in the fishing industry, it is my thought that there are many viewpoints regarding a specific issue in the fishing industry. If you wish to avoid contention, perhaps not weighing in on one side of a fishing issue would be wise. Though several of the members of the council may have a biology background, I do not believe any member is a fisheries biologist.

I am not sure the purpose of encouraging a postponement of the Board of Fish deliberations, as it is my understanding that this issue must be heard at the July meeting.

This council meeting was quickly conceived and allows minimal public input, particularly to the people who have the most knowledge and interest in this issue. I looked online and neither local paper had any notice that I could find this past weekend. The only way I found out about this meeting was word of mouth.

Francie Roberts

From:	Bob Shavelson
To:	Donna Aderhold; Tom Stroozas; Rachel Lord; Heath Smith; Caroline Venuti; Shelly Erickson; Mayor Email
Cc:	Department Clerk; Katie Koester
Subject:	Ordinance 18-059
Date:	Monday, July 02, 2018 12:47:56 PM
Attachments:	Inletkeeper - Annotated Biblio 20180702 - DRAFT.pdf

Dear Mayor & City Council -

I'm writing to oppose Ordinance 18-059.

The issue of salmon hatcheries and their effects on our natural systems is highly complex. To help illustrate the myriad complexities surrounding this issue, attached please find a draft annotated bibliography of scientific literature discussing hatcheries, predator/prey relationships, genetic impacts, straying and related issues.

The Board of Fish has established policies and procedures to address the emergency petition it is considering, and the City of Homer should let that process play out under current law. While the City of Homer certainly has an interest in the matter of fish hatcheries, the Board of Fish has the specialized expertise needed to deal fairly with these issues.

I'm especially concerned with the abbreviated timeline for this resolution, particularly when the City Council could not convene recently due to a lack of quorum over a manufactured controversy.

At a public listening session last December in Homer sponsored by state agencies, one fisherman proclaimed that opposition to more hatchery fish is opposition to commercial fishing. However, nothing could be further from the truth. In fact, we believe we must get a handle on hatchery science and the appropriate management response to it if we hope to retain the viability of the wild fish stocks which make Alaska the last great wild salmon stronghold in the United States.

Our oceans and fisheries are under enormous stress. From the "warm blob" in the Gulf of Alaska to elevated temperatures in our salmon streams, climate change is having a real and demonstrable effect on our salmon. Adding to the problem, we have outrageous by-catch numbers flowing from factory and other trawlers in the Gulf of Alaska and the Bering Sea, inadequate fish habitat protections statewide, and large inputs of point and nonpoint source pollution in the Cook Inlet watershed.

If we want our salmon runs to go the way of Europe, New England and the Pacific Northwest, all we have to do is one simple thing: nothing.

Thank you for your work, and for your attention to this comment. I hope you agree this issue is best left to the expertise and the processes of the Board of Fish.

Yours for Cook Inlet,

Bob Shavelson
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Agler, B.A., G.T. Ruggerone, L.I. Wilson, & F.J. Mueter. 2013. Historical growth of Bristol Bay and Yukon River, Alaska chum salmon (Oncorhynchus keta) in relation to climate and inter-and intraspecific competition. Deep-Sea Res II 94, 165-177.

This study of Bristol Bay and Yukon River adult chum salmon scales from 1965 through 2006 showed that increased growth was associated with higher regional ocean temperatures but slower growth associated with wind mixing and ice cover. Lower third-year growth was associated with high abundance of Asian chum and warmer sea surface temperatures in the Gulf of Alaska. High abundances of Russian pink salmon was also associated with lower third-year growth but the effects were smaller than those shown for high abundance of Asian chum and warmer GOA SST.

Amoroso, R. O., M. D. Tillotson, and R. Hilborn. 2017. Measuring the net biological impact of fisheries enhancement: Pink Salmon hatcheries can increase yield, but with apparent costs to wild populations. Canadian Journal of Fisheries and Aquatic Sciences 74:1233–1242.

The subject of this research is estimating the net effect of the largest hatchery program in North America, the Prince William Sound pink salmon. Using other Alaska regions as reference sites (Kodiak, SE Alaska, and southern Alaska Peninsula), the authors used catch data from before establishment of hatchery programs (1960-1976) and after (1988-2011). The reference sites all had smaller programs than PWS (with no southern Alaska Peninsula pink hatchery program). Post late-1970s climate regime shift, all regions had higher catches, with PWS having the greatest increase. Changes in wild salmon abundance were estimated for each region. Hatchery releases did not appear to decrease year-to-year variability in catches. No net positive effects (that is, taking into account the cost of the hatchery programs and reduced wild abundance) from the hatchery programs were detected for in Kodiak or SEAK. In PWS, the net effect was an increase in catch by 28%, lower than that estimated by other studies. This does not take into account other negative effects (e.g., other ecosystem effects, smaller size of returning fish), so any increases in hatchery programs should be done with a full accounting of risks and benefits.

Atcheson, M. E., K. W. Myers, N. D. Davis, and N. J. Mantua. 2012 (abs). Potential trophodynamic and environmental drivers of steelhead (Oncorhynchus mykiss) productivity in the North Pacific Ocean. Fisheries Oceanography 21:321–335.

“Information on prey availability, diets, and trophic levels of fish predators and their prey provides a link between physical and biological changes in the ecosystem and subsequent productivity (growth and survival) of fish populations. In this study two long- term data sets on summer diets of steelhead (Oncorhynchus mykiss) in international waters of the central North Pacific Ocean (CNP; 1991–2009) and Gulf of Alaska (GOA; 1993–2002) were evaluated to identify potential drivers of steelhead productivity in the North Pacific. Stable isotopes of steelhead muscle tissue were assessed to corroborate the results of stomach content analysis. We found the composition of steelhead diets varied by ocean age group, region, and year. In both the GOA and CNP, gonatid squid (Berryteuthis anonychus) were the most influential component of steelhead diets, leading to higher prey energy densities and stomach fullness. Stomach contents during an exceptionally warm year in the GOA and CNP (1997) were characterized by high diversity of prey with low energy density, few squid, and a large amount of potentially toxic debris (e.g., plastic). Indicators of good diets (high proportions of squid and high prey energy density) were negatively correlated with abundance of wild populations of eastern Kamchatka pink salmon (O. gorbuscha) in the CNP. In conclusion, interannual variations in climate, abundance of squid, and density- dependent interactions with highly- abundant stocks of pink salmon were identified as potential key drivers of steelhead productivity in these ecosystems. Additional research in genetic stock identification is needed to link these potential drivers of productivity to individual populations."

Azumaya, T., and Y. Ishida. 2000. Density interactions between Pink Salmon (*Oncorhynchus gorbuscha*) and Chum Salmon (*O. keta*) and their possible effects on distribution and growth in the North Pacific Ocean and Bering Sea. North Pacific Anadromous Fish Commission Bulletin 2:165–174.

Data from Japanese salmon research vessels from 1972-1998 were analyzed to evaluate the long-term spatial and temporal distribution of chum and pink salmon. Chum salmon distribution varied out-of-phase with the odd-even differences in pink salmon abundance (pinks having higher abundance in odd years). Chum salmon growth was not directly affected by pink salmon abundance but was affected by chum salmon abundance (higher abundance = slower growth), indicating that intra-species competition was more important than inter-species competition. Dietary (stomach content) research would shed more light onto the importance of inter-specific competition.

Batten, S. D., G. T. Ruggerone, and I. Ortiz. In press. Pink Salmon induce a trophic cascade in plankton populations in the southern Bering Sea and around the Aleutian Islands. Fisheries Oceanography. DOI: 10.1111/fog.12276.

This study examined time-series (2000-2014) of phytoplankton and copepod abundances around the Aleutian Islands and the southern Bering Sea and compared those numbers with pink salmon abundances, which were eight times higher in odd years than in even (2000-2012). In 2013 (odd year), the abundance was 73% lower than previous odd years and the next year, pink abundance was relatively high (although lower than the average odd year abundance). There are opposing biennial patterns in abundances of large phytoplankters and copepods relative to pink salmon abundances: in odd years, pink salmon abundance and large diatom abundance is high, while copepod (prey of pink salmon and grazer of diatoms) abundance is low. These associations were stronger than comparisons to “stanzas”, the 4-6 year cycle of warm or cold temperatures found in the Bering Sea.

Beamish, R. J., R.M. Sweeting, T.D. Beacham, K.L. Lange, and C.M. Neville. 2010. A late ocean entry life history strategy improves the marine survival of chinook salmon in the Strait of Georgia. NPAFC Doc. 1282. 14 pp. (Available at www.npafc.org).

One aggregated population of Georgia Strait Chinook salmon (South Thompson drainage of the Fraser River) has increased in recent years while most other Georgia Strait Chinook populations have declined. The South Thompson Chinook juveniles are not abundant in Georgia Strait in July but are by September, and by November are moving to sea, probably through the Strait of Juan de Fuca. Harrison River sockeye salmon are also a “late-entry” juvenile and doing better than others. It is theorized that high populations of pink and chum salmon present in Georgia Strait at the same time as earlier-entry populations of Chinook and sockeye are the reason why these populations of Chinook and sockeye are not doing as well as late-entry populations. Focused research is needed.

Brenner, R. E., S. D. Moffitt, and W. S. Grant. 2012. Straying of hatchery salmon in Prince William Sound, Alaska. Environmental Biology of Fishes 94:179–195.

The authors (all ADFG employees) sampled streams in PWS to determine stray rates using data gathered in two time periods,1997-1999 and 2008-2010. Percentages of hatchery pink salmon in spawning areas varied from 0 to 98%. Most (77%) of spawning locations had pink salmon from three or more hatcheries, and the escapement at 51% of locations consisted of more than 10% hatchery pink salmon during at least one year surveyed. Application of an exponential decay model indicates that many streams would have over 10% hatchery pinks, even if distant from a hatchery. Besides the implication of genetic effects on wild populations, the authors express concern that estimates of wild escapement may be inflated by the assumption that all fish seen in weirs or in aerial surveys are assumed to be wild.

Debertin, D. J., J. R. Irvine, C. A. Holt, G. Oka, and M. Trudel. 2017. Marine growth patterns of southern British Columbia Chum Salmon explained by interactions between density-dependent competition and changing climate. Canadian Journal of Fisheries and Aquatic Sciences 74:1077–1087.

The authors report the results of a study of 39 years of scale growth measurements of chum salmon from Big Qualicum River (BC) in regard to climate variation and competition with other North American salmon (chum, sockeye, and pink). When the North Pacific Gyre Oscillation was positive, growth increased (attributed to higher primary production). Growth at all ages was negative when the combined biomass of NA salmon was high. Competition effects increased when the NPGO was more positive and the Pacific Decadal Oscillation was more negative. The authors recommend the use of biomass estimates over abundance estimates to take into account inter-species variations and the observed trend of smaller returning salmon. The authors believe this study is the first to use a longitudinal model to examine growth versus the interactions of climate and density dependent competition. If their results are typical of wild salmon populations, reductions in hatchery releases should be considered.

Grant, W.S., 2012. Understanding the adaptive consequences of hatchery-wild interactions in Alaska salmon. *Environmental biology of fishes*, *94*(1), pp.325-342.

This is a review of hatchery-wild interactions with an emphasis on genetic effects to wild populations. While the author acknowledges that some may argue that studies conducted elsewhere may not be applicable to Alaskan salmon populations for a variety of reasons, the near-universal result that introgression between hatchery fish and wild fish leads to reduced fitness in wild populations is a fact that must be considered when evaluating hatchery programs. The adaptive potential of wild populations must be preserved as a buffer against climate change and diseases.

Gritsenko A.V. and E.N. Kharenko. 2015 (abs). Relation between biological parameters of Pacific salmons of the genus Oncorhynchus and their population dynamics off the northeastern Kamchatka Peninsula. J Ichthyol 55:430–441.

“Results are provided of a 7-year study of biological parameters in females of three Pacific salmons of the genus Oncorhynchus (pink salmon O. gorbuscha, chum salmon O. keta, and sockeye salmon O. nerka) in the Olyutorsky and Karaginsky gulfs, Bering Sea. Abundance of the pink salmon is identified as the main determining factor of the interannual dynamics of maturity index in female Pacific salmon in coastal waters. Maturity index rises at high levels of abundance as a result of differently directed changes in two parameters: decreasing body weight and increasing ovary weight. In female chum salmon, maturity index depends on the age structure of the population and body weight dynamics of different age groups, factors influenced by high abundance of some pink salmon generations, and does not depend on the abundance of spawning chum salmon. The revealed association between pink salmon and sockeye salmon in dynamics of their biological parameters may result from the similarity of their diets; during the last year of fattening in the sea, the sockeye salmon is affected by the pink salmon, the most abundant of the three species. The interannual variation of biological parameters in pink salmon and chum salmon is more pronounced in Olyutorsky Gulf than in Karaginsky Gulf.”

Heard, W.R., 2012. Overview of salmon stock enhancement in southeast Alaska and compatibility with maintenance of hatchery and wild stocks. Environmental biology of fishes, 94(1), 273-283.

This review of primarily the hatchery programs of SEAK, as well as some relevant studies of wild-hatchery interactions, acknowledges that some interactions between hatchery salmon and of wild salmon are unavoidable, but concludes that “obvious adverse impacts from the current levels of hatchery releases and population trends in Alaska’s wild salmon populations are not readily evident.” The author believes that SEAK hatchery chum programs have been successful in increasing numbers for fisheries, but says that additional increases (which have been requested) should be limited to “gradual incremental steps” given concern over straying in some streams, until better information is generated on the possible impacts of hatchery programs on wild populations.

Hilborn, R. and D. Eggers. 2000. A review of the hatchery programs for pink salmon in Prince William Sound and Kodiak Island, Alaska. *Transactions of the American Fisheries Society* 129:333-350.

Wertheimer, A. C., W. W. Smoker, T. L. Joyce, and W. R. Heard. 2001. Comment: A review of the hatchery programs for pink salmon in Prince William Sound and Kodiak Island, Alaska. *Transactions of the American Fisheries Society* 130:712–720.

Hilborn, R. and D. Eggers, 2001. A review of the hatchery programs for pink salmon in Prince William Sound and Kodiak Island, Alaska: Response to Comment. *Transactions of the American Fisheries Society* 130:130:720–724.

Hilborn and Eggers used ADF&G catch data from four Alaska regions. The initial paper concluded that while the PWS hatchery program was successful in producing fish to be harvested, the increase in harvest wasn't necessarily due to the PWS pink salmon hatchery programs, because other AK regions saw (with no, or geographically separated hatchery programs) an increase in wild pink production. In fact, increases in pink salmon harvest in PWS occurred before large-scale hatchery programs there. Therefore, the hatchery-produced pink salmon replaced rather than augmented the wild fish. A decline in wild production in PWS was attributed to lower wild escapements and hatchery releases (the authors claim no evidence has been produced to show that the Exxon Valdez oil spill was detrimental to long-term pink salmon production.

Wertheimer et al. (2001) published a comment asserting that Hilborn and Eggers vastly over-estimated wild pink production and therefore underestimated the proportion of the PWS pink harvest that could be attributed to hatchery production. They also used a longer time-series of catch data, among other different approaches to the data. Hilborn and Eggers (2001) stand by their conclusions and point out why, in this case, a longer time-series is not appropriate (positive changes in pink salmon habitat after the 1964 earthquake). They maintain that an increase in PWS pink production was evident before large-scale hatchery releases took place, and that hatchery releases replaced rather than augmented wild production.

Holt, C.A., Rutherford, M.B, & Peterman, R.M. 2008 (abs). International cooperation among nation-states of the North Pacific Ocean on the problem of competition among salmon for a common pool of prey resources. Marine Policy 32, 607–617.

"A common-pool problem in the North Pacific Ocean that remains largely ignored in international policy is competition for prey resources among salmon populations (*Oncorhynchus* spp.) from different countries. Hatcheries release large abundances of juvenile salmon into the North Pacific and the resulting decrease in mean body size of adult wild and hatchery salmon may lead to reductions in benefits. We examine incentives and disincentives for cooperation among nation-states on this issue. We recommend that either a new international organization be created or that amendments be made to the mandate and powers of an existing organization. The resulting organization could encourage collective action to reduce competition among salmon from different nations by using side-payments to change the incentive structure, by establishing a multi-national scientific assessment team to create a common frame of reference for the problem, and by implementing policy prescriptions."

Irvine, J. R., and M. Fukuwaka. 2011. Pacific salmon abundance trends and climate change. ICES Journal of Marine Science 68:1122–1130.

This study compared abundance of five species of salmon (represented by commercial catch data) in both Asia and North America with five climate "regimes" (1925-1946, 1946-1976, 1977-1988, 1989-1998, and 1999-2009). Higher catches in the western north Pacific are attributed to hatchery programs (both releases and better hatchery technology resulting in healthier fry). The results confirm earlier studies indicating regime "shifts" in 1947, 1977, and 1989. Higher catches of pink and chum since 1990 in all regions have occurred and can only be attributed to hatchery releases in the western north Pacific region because only Russia has significantly increased releases.

Jeffrey, K. M., I. M. Coté, J. R. Irvine, and J. D. Reynolds. 2016. Changes in body size of Canadian Pacific salmon over six decades. Canadian Journal of Fisheries and Aquatic Sciences 74:191–201.

Commercial catch data for five salmonid species from 1951-2012 were analyzed along with climatic variables (four Pacific Ocean indices), latitude of catch, and total salmonid biomass to determine if size of caught fish has changed, and if so, what variables are associated with the changes. Catch data from the least-selective method were used to minimize any size-selective gear bias. Analyses from the earlier part of the catch dataset agree with the results of previous research. The results from this study indicate changes in body size over time from oceanic changes as well as density-dependent effects. Pink salmon size declined initially but has changed relatively little over the last 20 years. Body size of Chinook, chum, and coho was most influenced by the total biomass of sockeye, chum, and pink salmon in the Gulf of Alaska. Inclusion of Asian chum salmon did not improve model performance. Pink salmon size was reduced as total biomass increased, with odd-years (higher abundances of pinks) showing a more pronounced effect. Chinook and coho body size increased with total salmon biomass, possibly reflecting better overall environmental conditions, given the lack of overlap in diet preferences between Chinook and coho vs. the other three species.

Kaev, A. M. 2012 (abs). Wild and hatchery reproduction of Pink and Chum salmon and their catches in the Sakhalin-Kuril region, Russia. Environmental Biology of Fishes 94:207–218.

"In the Sakhalin-Kuril region hatchery culture of pink and chum salmon is of great importance compared to other regions of the Russian Far East. During the last 30 years the number of hatcheries increased two-fold, and significant advances were made in hatchery technologies. As a result, chum salmon capture in regions where hatcheries operate (southwestern and eastern Sakhalin coasts, and Iturup Island) was 9 times as high during 2006–2010 than during 1986–

1990, whereas wild chum salmon harvest markedly declined. Recent dynamics in pink salmon catch appear to track trends in natural spawning in monitored index rivers, suggesting natural-origin pink salmon play a dominant role in supporting the commercial fishery. It remains uncertain as to whether hatcheries have substantially supplemented commercial catch of pink salmon in this region, and I recommend continued research (including implementing mass marking and recovery programs) before decisions are made regarding increasing pink salmon hatchery production. Location of hatcheries in spawning river basins poses problems for structuring a management system that treats hatchery and wild populations separately. Debate continues regarding the existence and importance of density-dependent processes operating in the ocean environment and the role hatcheries play in these processes. Loss of critical spawning habitat for chum salmon in the Sakhalin-Kuril region has lead to significant declines in their abundance. I conclude by recommending increases in releases of hatchery chum salmon numbers in the region to help recover depressed wild populations and provide greater commercial fishing benefits in the region."

Kaev, A. M., and J. R. Irvine. 2016. Population dynamics of Pink Salmon in the Sakhalin-Kuril region, Russia. North Pacific Anadromous Fish Commission Bulletin 6:297–305.

Catch plus escapement (run size) data and numbers of hatchery and wild fry were estimated for eight areas around Sakhalin Island and the southern Kuril islands over the 1975-2015 period. Marine survival was also indexed by dividing run size by the number of fry for each area. Odd-year runs are greater than even-year runs, with the difference increasing over time. The recent increase in pink salmon catch do not appear to be the result of hatchery releases (greater numbers of fry) but instead is the result of environmental conditions in early life stages. Increasing size of adults is attributed to conditions in the common area where pinks from a number of investigated areas mingle later in life.

Kaga T., Sato S., Azumaya T., Davis N.D., and M-a. Fukuwaka. 2013. (abs) Lipid content of chum salmon Oncorhynchus keta affected by pink salmon *O. gorbuscha* abundance in the central Bering Sea. Mar Ecol Prog Ser 478:211–221.

"To assess effects of intra- and inter-specific interactions on chum salmon in the central Bering Sea, chum salmon lipid content was analyzed as a proxy for body condition. We measured the lipid contents of 466 immature individuals collected during summer from 2002 to 2007. Individual variation in log-transformed lipid content was tested using multiple regression analysis with biological and environmental variables. A regression model that included chum salmon fork length and pink salmon CPUE (number of fish caught per 1500 m of gillnet) was the most effective in describing variation in lipid content. Path analysis showed that the negative effect of pink salmon CPUE was stronger than the effect of chum salmon CPUE on chum salmon lipid content. Stomach content analysis of 283 chum salmon indicated non-crustacean zooplankton (appendicularian, chaetognath, cnidarian, ctenophore, polychaete, and pteropod) was higher under conditions of high pink salmon CPUE. Increased consumption of non-crustacean zooplankton containing a low lipid level could lower the lipid content of chum salmon. Thus, chum salmon lipid content could be affected directly by their shift in prey items and indirectly by interspecific competition with pink salmon."

Malick, M.J. and Cox, S.P., 2016. Regional-scale declines in productivity of pink and chum salmon stocks in western North America. PloS one, 11(1), p.e0146009.

Historical population data from 99 wild chum and pink stocks in WA, BC, and AK were assessed, and trends in productivity noted. While productivity of some pink stocks in Alaska declined over time, others increased. The authors believe that the productivity of pink and chum stocks in western North America is driven by common processes "operating at the regional or multi-regional spatial scales." The effects are not constant but can change over time. While some environmental factors operating at the regional scale (and thus, are potential drivers of productivity) were identified, they were not investigated. "Mechanisms that operate over these spatial scales may include freshwater or marine processes such as disease or pathogens, changes in stream flow and stream temperature, competition with abundant hatchery salmon, or shifts in oceanographic condition such as the timing of the spring phytoplankton bloom or sea surface temperature." They found that most chum and some pink salmon stocks declined, in contrast to Stachura et al. (2014) and Ruggerone and et al. (2010).

Malick, M.J. 2017. Multi-scale environmental forcing of Pacific salmon population dynamics. PhD thesis, Simon Fraser University, School of Resource and Environmental Management, Burnaby, BC.
http://summit.sfu.ca/system/files/iritems1/17425/etd10171_MMalick.pdf

This researcher considered variable environmental factors (e.g., phytoplankton phenology, horizontal and vertical transport patterns) and their influence on salmon productivity (*see* Malick and Cox 2016). The thesis also contains a section on policy analysis where the author outlines the problems that arise from management of migratory anadromous fish species, e.g., multiple national and sub-national polities, the fact that management decisions of one entity can impact the resources of another, and incomplete use of real-time data to make management decisions. The author believes that an "international ecosystem synthesis group" could integrated information from various managers and provide "strategic management advice" based on their synthesis of the various information they receive. Because of the complexity of the problem of management of Pacific salmon, a multi-faceted approach is warranted.

Manhard, C.V., Joyce, J.E., Smoker, W.W. and Gharrett, A.J., 2017. Ecological factors influencing lifetime productivity of pink salmon (Oncorhynchus gorbuscha) in an Alaskan stream. Can. J. Fish. Aquatic Sci. 74(9), 1325-1336.

A study of the pink salmon populations (both even- and odd-years) of a short (323 m) lake-outlet stream indicated that early marine survival was the primary determinant of overall productivity. An overall downward trend in productivity was associated with an observed decline in freshwater spawning habitat quality. A nearby hatchery released large numbers of pink fry 1988-2002 but no difference in marine survival was noted between that time period and afterwards (with no hatchery releases). "[W]hile commercial harvest and hatchery straying do occur, the effects of these processes on adult recruitment are more likely to be stochastic than deterministic."

Morita, K. 2014. Japanese wild salmon research: toward a reconciliation between hatchery and wild salmon management. North Pacific Anadromous Fish Commission Newsletter 35:4–14.

This English-language article summarizes some Japanese-language literature on wild and hatchery salmon management in Japan. The author believes that wild salmon productivity is higher and more important than many people believe. Most large rivers in Japan have hatchery programs, and protecting wild populations is a way to guarantee continued success of the hatchery programs (e.g., genetic reserve, source of broodstock in integrated programs). Integrated hatchery programs are probably the best management option in highly-developed, hatchery-dominated Japanese watersheds.

Morita, K., S. H. Morita, and M. Fukuwaka. 2006. (abs) Population dynamics of Japanese Pink Salmon (*Oncorhynchus gorbuscha*): are recent increases explained by hatchery programs or climatic variations? Canadian Journal of Fisheries and Aquatic Sciences 63:55–62.

"Hatchery programs involving the mass release of artificially propagated fishes have been implemented worldwide. However, few studies have assessed whether hatchery programs actually increase the net population growth of the target species after accounting for the effects of density dependence and climatic variation. We examined the combined effects of density dependence, climatic variation, and hatchery release on the population dynamics of Japanese pink salmon (*Oncorhynchus gorbuscha*) from 1969 to 2003. The population trends were more closely linked to climatic factors than to the intensity of the hatchery programs. The estimated contributions of hatchery-released fry to catches during the past decade are small. We concluded that the recent catch increases of Japanese pink salmon could be largely explained by climate change, with increased hatchery releases having little effect."

Ohnuki, T., K. Morita, H. Tokuda, Y. Oksutaka, and K. Ohkuma. 2015. (abs). Numerical and economic contributions of wild and hatchery Pink Salmon to commercial catches in Japan estimated from mass otolith markings. North American Journal of Fisheries Management 35:598–604.

"Evaluating the contribution of wild and hatchery fish to a fishery is essential to understand economic feasibility as well as the impact of hatchery fish on the ecosystem. However, a precise estimate of this contribution is often difficult to obtain, particularly when hatchery and wild fish are mixed in the catch. In this study, we quantified the contribution of hatchery and wild Pink Salmon *Oncorhynchus gorbuscha* to the mixed- stock commercial fishery in Japan by identifying the ratio of otolith- marked hatchery fish to unmarked and presumably wild fish. The contribution of hatchery fish to the total coastal catch of Pink Salmon in Japan was estimated to be 16.6% and 26.4% in 2011 and 2012, respectively. Thus, the majority of the commercial salmon catch originated from naturally spawned wild fish. Economic yield per release by Japanese hatcheries was 2.2 yen (¥2.2) (≈US$0.022) and ¥1.5 in 2011 and 2012."

Pearson, W.H., Deriso, R.B., Elston, R.A., Hook, S.E., Parker, K.R. and J.W. Anderson. 2012. Hypotheses concerning the decline and poor recovery of Pacific herring in Prince William Sound, Alaska. *Reviews in Fish Biology and Fisheries*, *22*(1), pp.95-135.

In 1993, the Pacific herring stock of Prince William Sound dramatically declined: the stock was about 20% of the predicted record-breaking biomass. The authors examine a number of studies advancing a number of different hypotheses on the reason(s) for the observed decline, and could find no evidence that: oil exposure from the *Exxon Valdez* oil spill: harvest effects; spawning habitat loss: the spawn-on-kelp fishery:, or disease have led to either the decline or poor recovery of PWS herring. Instead, the authors attribute the decline to poor nutrition that began in the mid-1980s and reached a low in 1993. Disease was a secondary response. The fact that the recovery of PWS Pacific herring has been poor despite fishery restrictions is attributed to oceanic conditions outside of PWS, juvenile pink salmon releases (pink salmon predation on age-0 herring and food competition between pink salmon and age-1 herring). Multi-species or ecosystem-based management, rather than single-species management is recommended.

Peterman, R. M., C. A. Holt, and M. R. Rutherford. 2012. The need for international cooperation to reduce competition among salmon for a common pool of prey resources in the North Pacific Ocean. North Pacific Anadromous Fish Commission Technical Report 8:99–101.

These researchers accept that density-dependent competition is occurring in the north Pacific and is caused by hatchery programs. Increasing hatchery releases may result in a diminishing return on the costs of hatchery programs, but if competition becomes so severe wild populations will also be affected as well. The situation is that the "common-pool" resource that is the north Pacific is subject to the classic "Tragedy of the Commons". The North Pacific Anadromous Fish Commission, after amendments to its mandate, is the body best equipped to deal with the situation. The NPAFC should "identify and implement collective actions to prevent further increases in competition among salmon from different nations or even reduce it" as [a]ction on this problem of multi-national grazing of salmon food is long overdue." Action needs to be taken before a crisis occurs, such as climatic changes that may limit overall salmon productivity, and will likely lead to a knee-jerk call for more (counter-productive) hatchery releases.

Prince William Sound Science Center studies on hatchery-wild interaction:

Gorman, K., McMahon, J., Rand, P., Knudsen, E., and Bernard, D.R., 2016. Interactions of wild and hatchery pink salmon and chum salmon in Prince William Sound and Southeast Alaska. Progress Report for 2016. Prince William Sound Science Center, Cordova, AK.

Gorman, K., McMahon, J., Rand, P., Knudsen, E., and Bernard, D.R., 2018. Interactions of wild and hatchery pink salmon and chum salmon in Prince William Sound and Southeast Alaska. Final report for 2017. Prince William Sound Science Center, Cordova, AK.

Knudsen, E., Buckhorn, M., Gorman, K., Crowther, D., Froning, K., Roberts, M., Marcello, L., Adams, B., O'Connell, V. and Bernard, D.R., 2015. Interactions of wild and hatchery pink salmon and chum salmon in Prince William Sound and Southeast Alaska. Final Progress Report for 2013. Prince William Sound Science Center, Cordova, AK; Sitka Sound Science Center, Sitka, AK.

Knudsen, E., Buckhorn, M., Gorman, K., Rand, P., Roberts, M., Adams, B., O'Connell, V. and Bernard, D.R., 2015. Interactions of wild and hatchery pink salmon and chum salmon in Prince William Sound and Southeast Alaska. Final Progress Report for 2014. Prince William Sound Science Center, Cordova, AK; Sitka Sound Science Center, Sitka, AK.

Knudsen, E., Rand, P., Gorman, K., McMahon, J., Adams, B., O'Connell, V. and Bernard, D.R., 2016. Interactions of wild and hatchery pink salmon and chum salmon in Prince William Sound and Southeast Alaska. Progress Report for 2015. Volume 1. Prince William Sound Science Center, Cordova, AK; Sitka Sound Science Center, Sitka, AK.

Prince William Sound Science Center. 2013. Interactions of Wild and Hatchery Pink and Chum Salmon in Prince William Sound and Southeast Alaska. Annual Report 2012. For Alaska Department of Fish and Game Contract IHP-13-013

These reports were generated as part of a research effort sponsored by ADF&G. The purposes are to: "1) further document the degree to which hatchery pink and chum salmon straying is occurring; 2) assess the range of interannual variability in the straying rates; and, 3) determine the effects of hatchery fish spawning with wild populations on the fitness of wild populations." Ocean sampling was conducted in 2013-2015 in nine locations near the entrances to PWS to determine wild or hatchery origins of pink and chum in PWS (via examination of otoliths). Stream studies were also conducted to determine the proportion of hatchery-origin fish on the spawning grounds and an investigation into the relative survival of the offspring of naturally spawned fish (wild and hatchery-origin). These reports have reported basic data with no statistical or biological analyses. Proportions of hatchery-origin pink salmon on spawning grounds range from zero to over 80% in some PWS streams.

Riddell, B., M. Bradford, R. Carmichael, D. Hankin, R. Peterman, and A. Wertheimer. 2013. Assessment of Status and Factors for Decline of Southern BC Chinook Salmon: Independent Panel's Report. Prepared with the assistance of D.R. Marmorek and A.W. Hall, ESSA Technologies Ltd., Vancouver, B.C. for Fisheries and Oceans Canada

(Vancouver. BC) and Fraser River Aboriginal Fisheries Secretariat (Merritt, BC). xxix + 165 pp. + Appendices. Available at www.psc.org/publications/ workshop-reports/southern-bc-chinook-expert-panel-workshop. Accessed June 5, 2018

Evidence presented at a workshop discussing the decline of southern BC chinook did not support the hypothesis that pink salmon abundance had a role in the decline. There was no apparent odd- and even-year pattern in Chinook survival (which would thought to be present if pinks were having an effect), although some recent literature (referenced in this report) indicated that there may be an effect.

Ruggerone, G.T., & Irvine, J.R. 2018. Number and biomass of natural- and hatchery-origin pink, chum, and sockeye salmon in the North Pacific Ocean, 1925-2015. Mar Coast Fish:10:152-168.

Abundance and biomass data are presented for pink, chum, and sockeye for the time period 1925-2015; this is the most comprehensive tally to date. These species are at an all time high, as the late 1970s regime shift benefited these species. If immature salmon are included, the north Pacific contains 5 x 10^6 metric tons of these species. Pink salmon were the most abundant adult fish of the three (67%) and were 48% of the total biomass (chum 20%, 35%; sockeye 13%, 17%). Alaska produced 39% of the pink salmon with Japan and Russia producing most of the remainder. Hatcheries accounted for 15% of the pink salmon production (Alaska produced 68% of hatchery pink salmon) although hatchery fish dominated in some regions, such as PWS and SEAK. In the period 1990-2015, hatchery fish composed 40% of the total biomass in the north Pacific, which may be at its carrying capacity. Density-dependent effects are occurring although hatchery-wild interaction effects are difficult to quantify. Management agencies should mark hatchery fish and estimate hatchery- and natural-origin fish in their catch and escapement data.

Ruggerone, G.T., Agler, B.A., Connors, B.M., Farley Jr., E.V., Irvine, J.R., Wilson, L.I. & Yasumiishi, E.M. 2016. Pink and sockeye salmon interactions at sea and their influence on forecast error of Bristol Bay sockeye salmon. N Pac Anadr Fish Comm Bull 6, 349–361. doi:10.23849/npafcb6/349.361 (Available at http://www.npafc.org).

Ruggerone et al. (2010) showed that abundance of sockeye salmon in western and central Alaska tended to be positively correlated with pink salmon abundance, in contrast to more southern regions where sockeye abundance was negatively correlated with pink salmon abundance. Ocean conditions may be an overriding factor, so this research was focused on evaluation of the evidence of competition between Bristol Bay sockeye and pink salmon from Russia and central Alaska. Sockeye scales from 1965 through 2009 were evaluated for growth patterns; abundance of adult pink salmon was available in previously published literature. Growth patterns from all five BB sockeye stocks indicated a strong alternating-year growth pattern, consistent with the hypothesis that sockeye and pinks compete for food on the high seas. Sockeye growth at sea during odd-years was low; other referenced research indicated that pink and sockeye have a high diet overlap and in odd-years was sockeye stomach fullness was reduced. Examination of the ADF&G's sockeye salmon abundance forecasts from 1968-2010 indicated systemic errors in an alternating-year pattern; a tendency for a too-high forecast in even-years, and too low in odd-years, consistent with a hypothesis that competition at sea between sockeye and pink was a factor but not considered in the forecasts.

Ruggerone, G.T. & Connors, B.M. 2015. Productivity and life history of sockeye salmon in relation to competition with pink and sockeye salmon in the North Pacific Ocean. Can. J. Fish. Aquat. Sci. 72, 818–833.

Ruggerone, G. T., B. A. Agler, and J. L. Nielsen. 2012. Evidence for competition at sea between Norton Sound Chum Salmon and Asian hatchery Chum Salmon. Environmental Biology of Fishes 94:149–163.

Ruggerone, G.T., Myers, K.W., Agler, B.A. and J.L. Nielsen. 2012. Evidence for bottom-up effects on pink and chum salmon abundance and the consequences for other salmon species. *N Pac Anadr Fish Comm Tech Rep*, *8*, pp.94-98.

The authors review a number of papers offered as evidence of density-dependent relationships (while respecting changes in oceanographic conditions) as well as stand by their conclusions in Ruggerone et al (2003) and later manuscripts (linking declines in Bristol Bay sockeye growth and survival to increased Asian pink salmon abundance), thus offering a rebuttal to Wertheimer and Farley (2012). They list a number of reasons why the use of correlation analyses by Wertheimer and Farley (2012) is incorrect, while acknowledging that use of correlation would lead to a conclusion that there is not a significant relationship between Asian pink abundance and BB sockeye survival.

Ruggerone, G.T., Peterman, R.M., Dorner, B. & Myers, K.W. 2010. Magnitude and trends in abundance of hatchery and wild pink, chum, and sockeye salmon in the North Pacific Ocean. Mar Coast Fish 2, 306–328.

Ruggerone, G.T. & Nielsen, J.L. 2004. Evidence for competitive dominance of pink salmon (*Oncorhynchus gorbuscha*) over other salmonids in the North Pacific Ocean. Rev Fish Bio. Fish 14, 371–390.

Ruggerone, G.T., Zimmermann, M., Myers, K.W., Nielsen, J.L. & Rogers, D.E. 2003. Competition between Asian pink salmon (*Oncorhynchus gorbuscha*) and Alaskan sockeye salmon (*O. nerka*) in the North Pacific Ocean. Fish Oceanogr 12, 209–219.

Saito, T., Hirabayashi, Y., Suzuki, K., Watanabe, K. and Saito, H., 2016. Recent decline of pink salmon (O*ncorhynchus gorbuscha*) abundance in Japan. *N. Pac. Anadr. Fish Comm. Bull*, *6*, pp.279-296.

In-river catch data from twenty-two pink stocks from the coast of the Sea of Okhotsk were analyzed (separated into five regional groups) along with sea surface temperatures (SST). The long-term decline in pink salmon abundance is related to higher coastal SSTs which can cause decreased juvenile survival, preliminary adult mortality and increased straying. The higher coastal SSTs can also cause a shift in migration timing, although pink salmon hatchery programs have been consciously selecting for earlier migration. No data were available to determine the proportion of wild fish in the escapement.

Sakai O., O. Yamamura, Y. Sakurai, and T. Azumaya 2012 (abs). Temporal variation in chum salmon, *Oncorhynchus keta*, diets in the central Bering Sea in summer and early autumn. Environ Biol Fishes 93:319–331.

Schindler D., et al. (2013) Arctic-Yukon-Kuskokwim Chinook salmon research action plan: Evidence of decline of Chinook salmon populations and recommendations for future research. Available at www.aykssi.org/wp-content/uploads/AYK-SSI-Chinook-Salmon-Action-Plan-83013.pdf. Accessed June 5, 2018

Shiomoto, A., Tadokoro, K., Nagasawa, K., & Ishida, Y. (1997). Trophic relations in the subarctic North Pacific ecosystem: possible feeding effect from pink salmon. Marine Ecology Progress Series, 150, 75-85.

Shaul, L.D. & Geiger, H.J. (2016). Effects of climate and competition for offshore prey on growth, survival, and reproductive potential of coho salmon in Southeast Alaska. N Pac Anadr Fish Comm Bull 6, 329–347. doi:10.23849/npafcb6/329.347. (Available at http://www.npafc.org).

Spencer, P., & Ianelli, J. (2016). Assessment of the Pacific Ocean Perch stock in the Bering Sea/Aleutian Islands. In: Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions, pp. 1391-1464. North Pacific Fishery Management Council, 605 W. 4th Ave, suite 306. Anchorage, AK 99501

Springer, A. ,van Vliet, G.B., Bool, N., Crowley, M , Fullagar, P., Lea, M.A., Monash, R., Price, C., Vertigan, C., and Woehler, E.J. 2018. Transhemispheric ecosystem disservices of pink salmon in a Pacific Ocean macrosystem, PNAS 2018 115 (22) 5038-5045.

Springer, A.M. & van Vliet, G.B. (2014). Climate change, pink salmon, and the nexus between bottom-up and top-down control in the subarctic Pacific Ocean and Bering Sea. PNAS 2014 111 (18) E1880-E1888.

Stachura, M. M., Mantua N. J., and M.D. Scheuerell. (2014. Oceanographic influences on patterns in North Pacific salmon abundance. Can. J. Fish. Aquatic Sci. 71(2), 226-235.

Authors took the 34 time series of regional salmon (wild North American and Asian, pink, chum, and sockeye) abundance used by Ruggerone et al (2010) and applied three separate ordination techniques to identify patterns of abundance (as represented by the salmon time-series) vs atmospheric and oceanographic variability (data from 10 environmental indices/datasets previously identified in the literature). Three dominant patterns were identified, accounting for 47% of the variability seen. Asian and North American populations had opposite trends for one pattern, indicating that large-scale climatic events may have different regional effects (e.g., NW Pacific vs. NE Pacific), or that density-dependent relationships become more important during these particular climatic events. Other factors "[f]or example, changes in harvest, hatchery practices, or freshwater habitat may contribute to abundance trends unrelated to climate and ocean variability" were not investigated.

Sydeman, W.J., Thompson, S.A., Piatt, J.F., Garcia-Reyes, M., Zador, S., Williams, J.C., Romano, M. & Renner, H.M. 2017. Regionalizing indicators for marine ecosystems: Bering Sea - Aleutian Island seabirds, climate, and competitors. Ecological Indicators 78, 458-469.

The Research Group. 2009. North Pacific Salmon Fisheries Economic Measurement Estimates (The Research Group, Corvallis, OR), Version 1.2. Available at https://mbstp.org/wp-content/uploads/2013/10/Salmon_Economic_Valuation.pdf. Accessed June 5, 2018.

Toge, K., R. Yamashita, K. Kazama, M. Fukuwaka, O. Yamamura, and Y. Watanuki. 2011. The relationship between Pink Salmon biomass and the body condition of short-tailed shearwaters in the Bering Sea: can fish compete with seabirds? Proceedings of the Royal Society B: Biological Sciences 278:2584–2590.

Urawa, S., J. R. Irvine, J. K. Kim, E. C. Volk, A. V. Zavolokin, T. Azumaya, T. D. Beacham, A. V. Bugaev, E. V. Farley Jr., J. R. Guyon, S. G. Kim, M. J. Kishi, N. V. Klovach, M. V. Koval, D. H. Lee, S. V. Naydenko, D. S. Oxman, T. Saito, S. Sato, M. W. Saunders, O. S. Temnykh, A. M. Tompkins, M. Trudel, V. V. Volobuev, K. I. Warheit, and N. D. Davis. 2016. Forecasting Pacific salmon production in a changing climate: a review of the 2011–2015 NPAFC science plan. North Pacific Anadromous Fish Commission Bulletin 6:501–534.

Ward, E. J., M. Adkison, J. Couture, S. C. Dressel, M. A. Litzow, S. Moffitt, T. Hoem-Neher, J. T. Trochta, and R. Brenner. 2017. Evaluating signals of oil spill impacts, climate, and species interactions in Pacific Herring and Pacific salmon populations in Prince William Sound and Copper River, Alaska. PLoS ONE [online serial] 12(3): e0172898.

Wertheimer, A. and E.V. Farley Jr. 2012. Do Asian Pink Salmon Affect the Survival of Bristol Bay Sockeye Salmon? North Pacific Anadromous Fish Commission Technical Report No. 8: 102-107.

http://www.npafc.org/new/publications/Technical%20Report/TR8/Wertheimer%20and%20Farley.pdf

Using the data analyzed by Ruggerone et al. (2003), the authors conclude there is no evident effect on Asian pink salmon numbers on Bristol Bay sockeye. Using correlation analyses, they found no consistent response in the three BB sockeye stocks with pink numbers (separated into odd-even years). They reject the contentions of Ruggerone et al (2012) that correlation analyses are not sufficiently robust to detect effects and stand by their conclusion that Asian pinks did not have a detrimental effect on BB sockeye.

Yamamoto, T., Hoshina, K., Nishizawa, B., Meathrel, C.E., Phillips, R.A. and Y. Watanuki. 2015. Annual and seasonal movements of migrating short-tailed shearwaters reflect environmental variation in sub-Arctic and Arctic waters. *Marine biology*, *162*(2): pp.413-424.

Zador, S., Hunt Jr., G.L., TenBrink, T. & K. Aydin. 2013. Combined seabird indices show lagged relationships between environmental conditions and breeding activity. Mar Ecol Prog Ser (485), 245-258.

Zavolokin, A. V., V. V. Kulik, and L. O. Zavarina. 2014. The food supply of the Pacific salmon of the genus Oncorhynchus in the Northwestern Pacific Ocean 2: comparative characterization and general state. Russian Journal of Marine Biology 40:199–207.

From:	Lynn Spence
To:	Shelly Erickson; Donna Aderhold; Heath Smith; Caroline Venuti; Rachel Lord; Tom Stroozas; Mayor Email; Department Clerk
Subject:	Special Meeting 7/2/18
Date:	Monday, July 02, 2018 11:45:23 AM

I am writing to comment on the special meeting scheduled for tonight. I am a not sure why this issue was not handled at the last regular meeting but since it wasn't and I won't be able to attend tonight, I just want you to think about the science behind decisions made about hatchery fish releases. I believe the people who do fish research have the best interest of fish survival and healthy fish stocks for fisheries in mind. Sometimes the over release of hatchery fish can reduce the returns. It is hard to say what is going on with the food supply, water quality, and temperature for the released fish. Hatchery fish can cause a failure of return if too many fish have to compete for too little food. I hope the City will go with the science of how to protect fish stocks. More is not always better.

Thank you.

Lynn Spence
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