STATEWIDE FISH/SHELLFISH HEALTH PROGRAM IN ALASKA: Mitigating Disease Risks to Wild and Cultured Stocks

Alaska Department of Fish & Game

ADF&G Fish Pathology Section
Ted Meyers, Principal Pathologist

Purpose/Function as Required by Statute

- Provide pathology/diagnostic services to fisheries managers, state and private salmon hatcheries, shellfish growers, other aquatic farmers and sport fishers.
- Protect the health of wild and cultured fisheries resources through regulatory oversight of finfish/shellfish pathogens, development of disease policies and application of technical expertise to prevent, detect and treat diseases in cultured or wild fish and shellfish in Alaska.

Products and Services

- Diagnostic Services- wild and cultured fish/shellfish
- Hatchery Support and Oversight
- Regulatory Authority
- Statewide Fish and Shellfish Disease Policy
- Applied Research - Publications
- Public Education
- Continuing surveillance for existing, emerging and exotic disease agents

PATHOLOGY LABS AND STAFF

- Anchorage – Fish Pathologist (Ph.D.), Microbiologist II, Laboratory Technician
- Juneau – Principal Fish Pathologist/Fishery Scientist I (Ph.D.)., Microbiologist II
- Staff experienced and trained in microbiology, fish and shellfish health and aquatic veterinary pathology
- Certifications by the FHS/AFS held by 2 staff as Fish Pathologist
- Two labs located to service both hatchery hubs in SE and SC

LAB CAPABILITIES

- Virology and cell culture
- Bacteriology
- Histopathology
- ELISA-for Rs antigen detection
- PCR and qPCR for several pathogens
- FAT
- Wet lab studies
- Development of a 30-year database for comparisons/evaluations of disease histories for fish stocks in different watersheds
- Nationwide contacts with several fish health laboratories for additional specialized testing

Diagnostic Testing

a) Fish health oversight for 30 fish rearing facilities, 70 aquatic farming operations (58 farms, 4 hatcheries, 8 nurseries) statewide

b) Wild fish/shellfish health – investigate reports of mortality, parasites, abnormalities, commercial product quality concerns

c) Instate finfish/shellfish Transport Permits (FTPs) requiring evaluation of disease histories prior to transport

d) Requests by other agencies or laboratories for fish/shellfish diagnostic services

Hatchery Oversight/Support

- Advise good culture practices to maintain fish and shellfish health
- Conduct periodic hatchery inspections with written reports
- Provide preventative measures and therapy to control fish and shellfish diseases
- Collect diagnostic samples and conduct surveillance
- Conduct fish health workshops to train hatchery personnel in basic disease recognition
- Advise regarding use of aquaculture drugs and INAD permits
- Review FTPs/AMPs for permitted hatcheries and farms

Number of Cases and Tests by Category

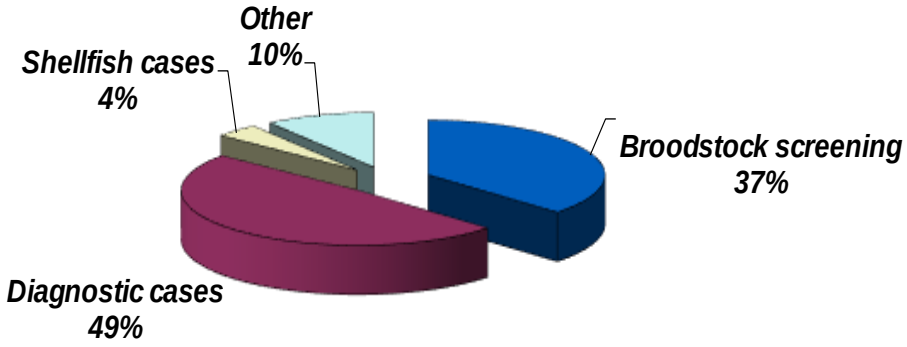
Fiscal Year 2021

Category	Number of Tests:	Number of QC Tests:	% of Total Tests:	Number of Cases:	% of Total Cases:
ADF&G Sport Fish	3,492	463	14.1%	10	13.2%
Other State Projects	2,239	0	8.0%	6	7.9%
Federal	394	116	1.8%	5	6.6%
PNP	17846	2555	72.8%	52	68.4%
Sci-Ed	712	49	2.7%	2	2.6%
Other	174	0	0.6%	1	1.3%
Total Tests:	**24857**	**3183**	**100.0%**	**76**	**100.0%**

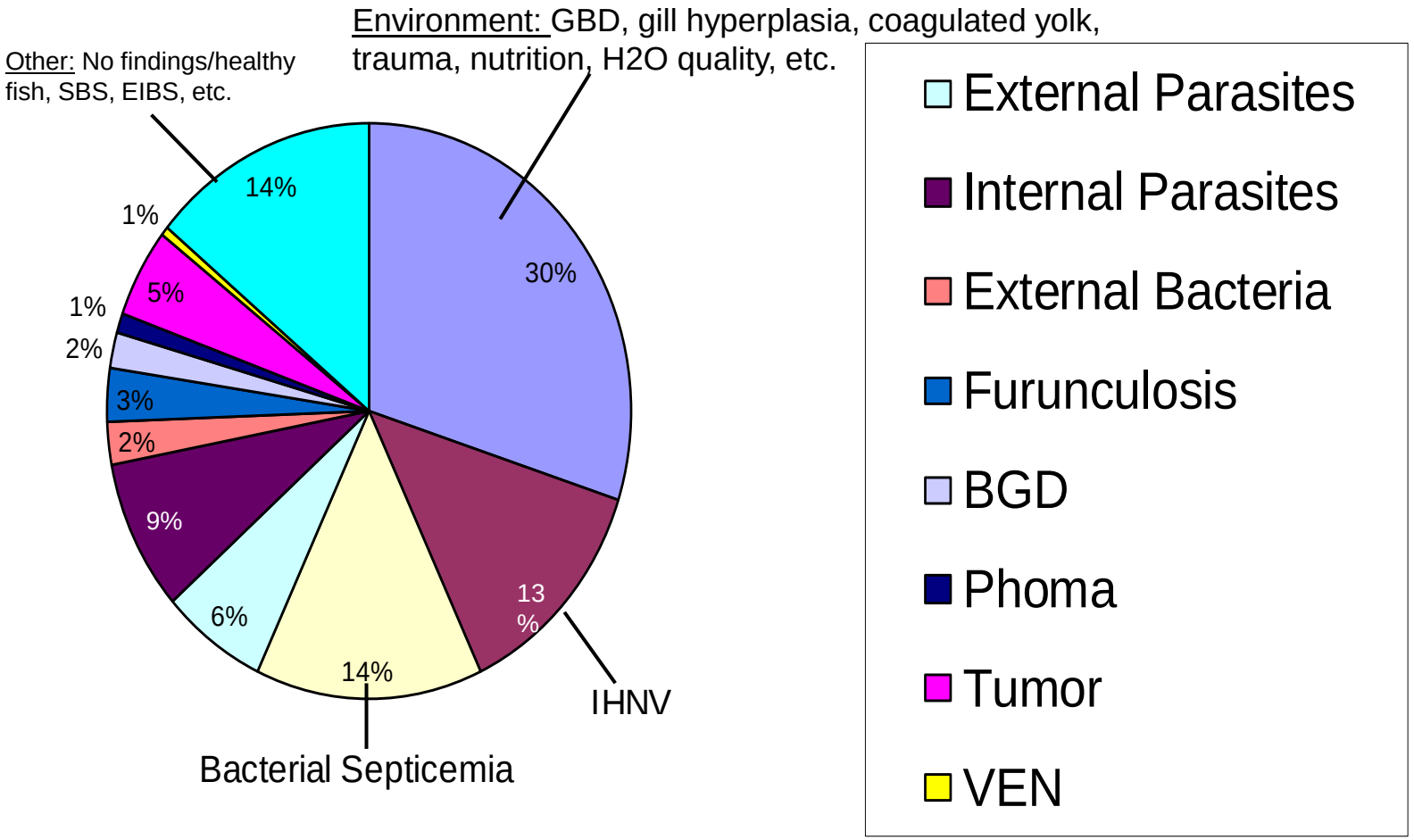
Total Tests + QC **28,040**

Number of fish/shellfish tested **10,816**

ADF&G Fish Pathology Lab Cases
FY 2004-2014



Diagnostic Findings FY 2004-2014



Regulatory Authority

- Signatory on permits (5AAC 41.005, 41.030, 41.050, 41.290, 41.300) for fish and shellfish
- Inspection, reporting, control of fish diseases (AS 16.40.150, 5AAC 41.020, 41.080, 41.310) – Fish/shellfish disease policy, Sockeye Culture Policy
- Inspection of hatcheries (5AAC 41.080); maintain AFS/FHS health specialist certification (AS 16.05.733)
- Imported Pacific oyster seed (5AAC 41.070) $\leq$ 20 mm from disease certified facilities on west coast for seed from brood-stock cultured for at least 3 generations
- Destruction of diseased fish (5AAC 41.080)
- Categories of fish and shellfish pathogens and associated administrative actions (5AAC 41.075)

Applied Research

- Characterization of new/poorly described pathogens (crab *Hematodinium*, VHSV IVa, *Phoma*, *Ichthyophonus*, aquabirna and reoviruses, scallop weak meat, BES in *Chionoecetes)*
- Disease transmission studies
- Evaluation of new detection technology (ELISA, DNA probe, PCR, qPCR)
- Distribution of specific disease agents (disease history database) within fish/shellfish stocks
- Review literature, attend meetings/workshops to maintain a relevant aquatic health program

Public Education

- Inform user groups through public media including web page with links to policies and documents
- Laboratory tours
- Mentoring students for school projects
- Publish research results in peer-reviewed journals
- Fish/Shellfish Pathology Procedures Manual requested by other laboratories - template for the US FWS National Wild Fish Health Survey manual
- Fish and shellfish diseases field guides
- Fishery Scientist serves as technical representative for ADF&G (PNFHPC and others)

Website links

- Fish diseases field guide

http://www.adfg.alaska.gov/static/species/disease/pdfs/fish_disease_book.pdf

- Shellfish diseases field guide

http://www.adfg.alaska.gov/static/species/disease/pdfs/shellfish_disease_book.pdf

- Pathology labs and other document links

http://www.adfg.alaska.gov/index.cfm?adfg=fishingpathologylab.main

Considerations: Fewer Pathogens and Diseases in Alaskan Salmonids Compared To Other Parts of North America

- Geographic isolation
- Colder water temperatures
- Protective legislation preventing importation except Pacific oysters (& Kumamoto) from certified sources

Surveillance for Aquatic Disease Agents in Alaska

- Indigenous pathogens- native in wild fish and shellfish stocks used for hatchery brood stocks and are present in hatchery water supplies having resident fish
- Emergent pathogens – native in wild stocks but cryptic/undetectable until environmental change or more sensitive tests developed
- Exotic pathogens- introduction from outside Alaska – less likely due to geographic isolation and import restrictions (changing due to marine range extensions from global warming).

Detection of a pathogen DOES NOT mean there will be disease

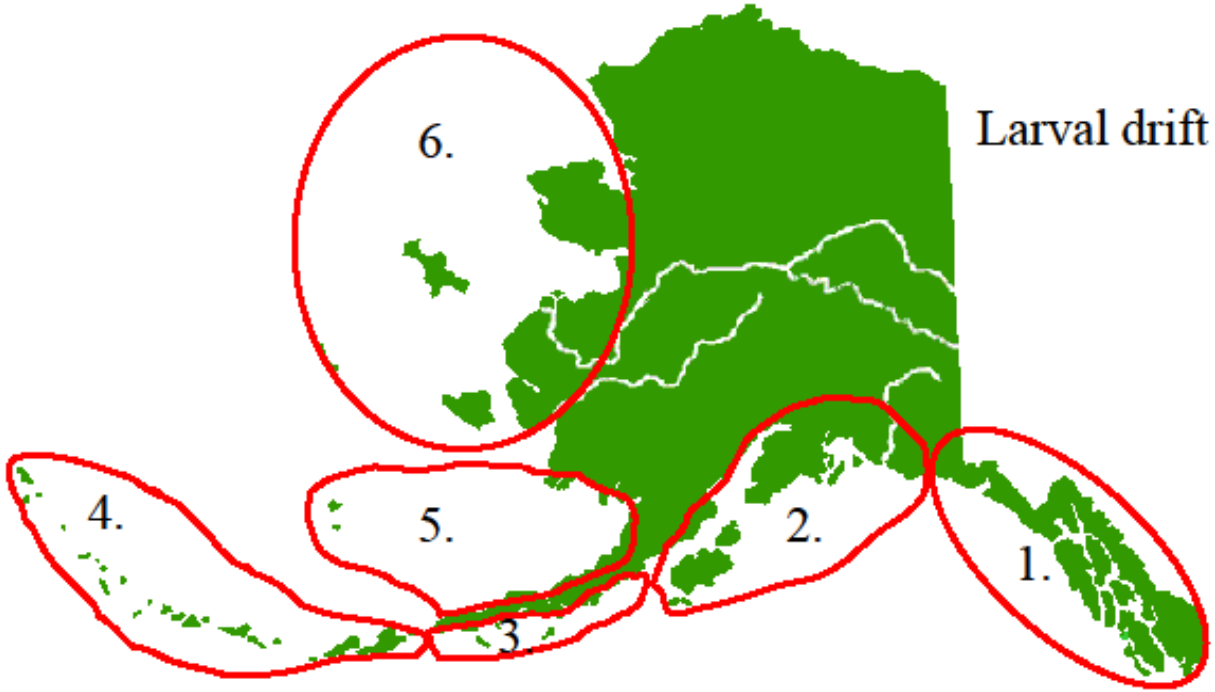
Statewide Fish/Shellfish Disease Policy (Meyers 2014)

- Controls indigenous pathogens and their diseases in the hatchery/marine farm environment
- Diseased animals cannot be released where the pathogen does occur - Reduces amplification
- Healthy animals with history of pathogen cannot be released where the pathogen does not occur - Reduces new introductions. Larval drift zones (RaLonde 1993) used for shellfish and 50 Km zoning restriction based on brood-stock source for marine plants
- Imported oysters must be ≤20 mm from disease certified sources on the US west coast derived from brood-stock through 3 or more generations
- Policy manages both pathogens and diseases

Meyers TR. 2014. Policies and Guidelines for Alaska Fish and Shellfish Health and Disease Control, 3rd edition. Alaska Department of Fish and Game, Regional Information Report No.

RaLonde, R. 1993. Shellfish aquaculture in Alaska and the potential of interaction with wild species. Proceeding of the twenty-second U.S.- Japan aquaculture panel symposium. Homer, Alaska, August 21-22, 1993. 27-39.

Larval Drift Zones in Alaska



(1) Southeastern Alaska, from the Canadian border north to Cape St. Elias.

(2) Prince William Sound and Cook Inlet, from Cape St. Elias west and south to Cape Igvak, including Kodiak Island.

(3) Chignik and the Alaska Peninsula-Aleutian Islands, from Cape Igvak west to the tip of Unimak Island.

(4) The Aleutian Islands, including all islands west of Unimak Pass.

(5) The southeast Bering Sea and north Alaska Peninsula, from the westernmost tip of Unimak Island north to the Kuskokwim River, including the Pribilof Islands.

(6) The northeast Bering Sea, including all coastal islands north of the Kuskokwim River.

Hatchery Release Sites

- Established for minimal interactions with wild fish stocks or no interaction at all
- Pathogen transmission likely occurs when fish densities are high in freshwater
- Pathogen transmission less likely to occur after fish disperse into marine environment
- Larval drift zones (6) are used for marine shellfish transfers and within 50 Km restrictive distance of brood-stock collection for marine plants

Mixing of Hatchery Fish/Shellfish Stocks with Wild Stocks Is Minimized by :

1. disease policy
2. genetics policy
3. hatchery site selection/management criteria

Managed Pathogens Used as Indicators of Fish Hatchery Practices in Alaska

1. *R. salmoninarum* (Rs) causes BKD in salmonids- chinook and coho salmon

- External egg disinfection with 100 ppm iodophor solution
- Culling of eggs from Rs-positive parent fish tested by ELISA
- Erythromycin therapy

  - Prophylactic injection of brood-stock
  - Prophylactic medicated diet for fry
  - Medicated diet for clinical disease
- Destruction of fish if necessary

2. IHNV- Sockeye Salmon Culture Policy (McDaniel et al. 1994) minimizes losses in juvenile sockeye due to the virus

- Virus-free water supply- limits horizontal transmission
- Compartmentalization- containment when vertical or horizontal transmission occurs
- Rigorous disinfection of hatchery, utensils and eggs
- Destruction of infected juvenile fish
- Isolation of sockeye culture from other production of susceptible fish species

McDaniel, T.R., K.M. Pratt, T.R. Meyers, T.D. Ellison, J.E. Follett, J.A. Burke. 1994. Alaska Sockeye Culture Manual. Spec. Fish. Rpt. No. 6, AD F&G, Juneau, 39 pp. http://www.adfg.alaska.gov/fedaidpdfs/cfsp.06.pdf

Have Fish Hatchery Practices in Alaska Affected These Indicator Pathogens?

1. NO increasing trend in prevalence or changes in clinical disease of the indicator pathogen Rs (Meyers 2005). This could change with global warming.
2. Modest increase of IHNV (31% vs 38%) and high titers (30% vs 48%) during 20 years in both wild and cultured sockeye examined- NO correlation with hatchery practices based on the SSCP further supported by:
   a. Low genetic diversity (42 isolates) of U-clade IHNV with stasis over time (Emmenegger et al. 2000) based on genome finger-prints and nucleotide sequences- No selective pressure.
   b. U-clade IHNV remains restricted to sockeye salmon as a host species and is evolutionarily constrained in Alaska.

Meyers, T. R. 2005. Disease transmission from cultured salmonids to wild fish stocks: perspectives on the Alaskan hatchery program. *In* R. C. Cipriano and I.S. Shchelkunov (eds) Health and Diseases of Aquatic Organisms: Bilateral Perspectives. Michigan University Press.

Emmenegger, E.J., T.R. Meyers, T. Burton, G. Kurath. 2000. Genetic diversity and epidemiology of infectious hematopoietic necrosis virus in Alaska. Diseases of Aquatic Organisms 40: 163-176.

Accomplishments Significant to Program Efficacy in Disease Management

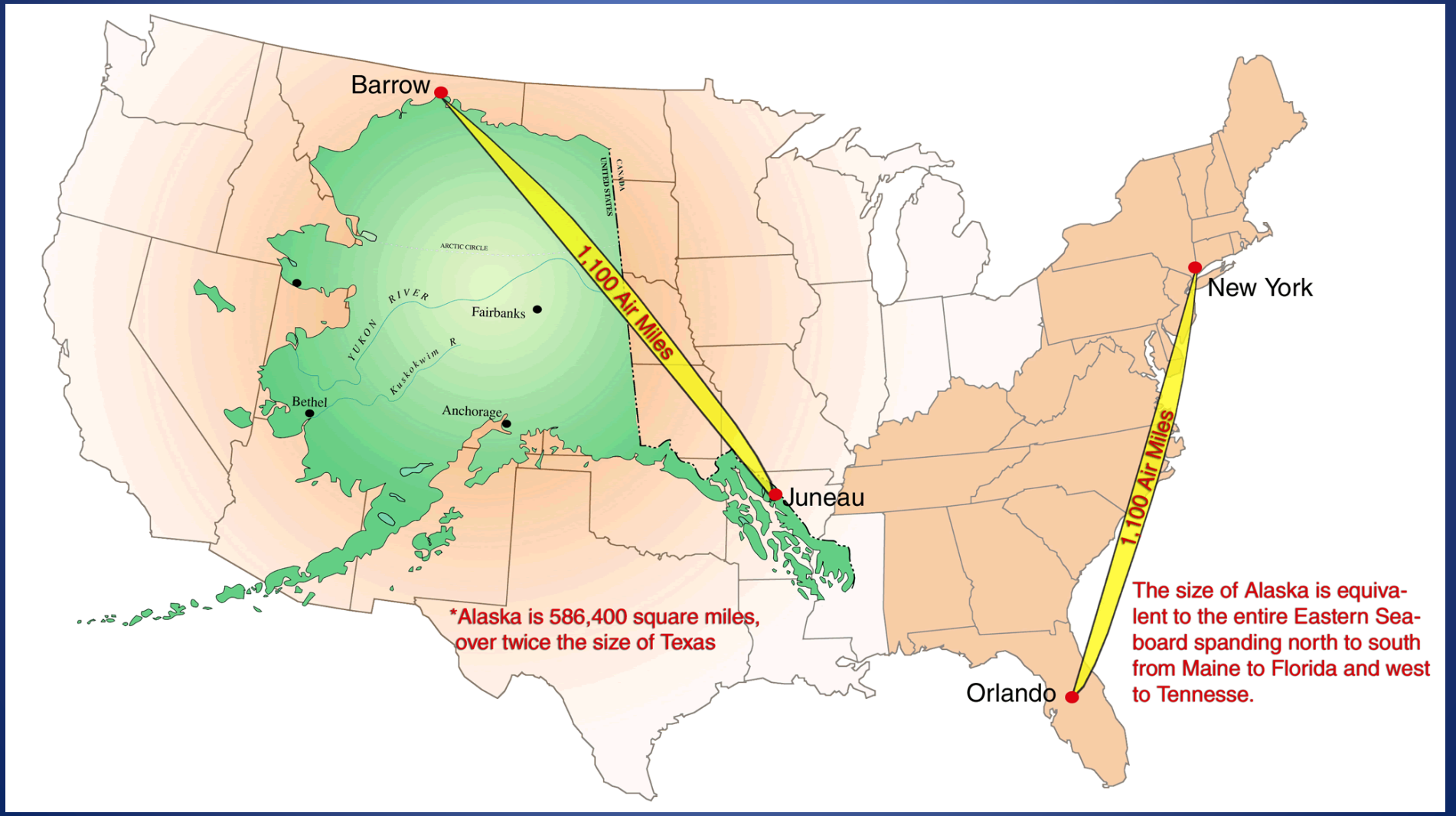
- IHNV is managed and remains confined to one species-sockeye salmon.
- Rs is successfully managed in coho and chinook salmon by statewide culling of eggs from infected brood-stocks by ELISA (9,162 kidney tissues examined for FY 2022).
- Active surveillance for emerging and exotic pathogens. Previous cooperation with the USDA/APHIS and USGS indicateed ISAV (also SAV and PMCV) does not occur in the PNW or Alaska (Gustafson et al. 2017); PRV-1a was discovered and has been endemic in Alaska and the PNW but is benign to Pacific salmon (Purcell et al. 2017).
- Under the current fish health program management there has NOT been a disease that has negatively affected the sustainability of finfish or shellfish in Alaska (BCS is not actively managed but perhaps should be with global warming).

Gustafson LL, Creekmore LH, Snekvik KR, Ferguson JA, Warg JV, Blair M, Meyers TR, Stewart B, Warheit KI, Kerwin J, Goodwin AE, Rhodes LD, Whaley JE, Purcell MK, Bentz C, Shasa D, Bader J, Winton JR. 2017. A systematic surveillance programme for infectious salmon anaemia virus supports its absence in the Pacific Northwest of the United States. J Fish Dis.:1–10. https://doi.org/10.1111/jfd.12733

Purcell MK, Powers RL, Evered J, Kerwin J, Meyers TR, Stewart B, Winton JR. 2017. Molecular testing of adult Pacific salmon and trout (Oncorhynchus spp.) for several RNA viruses demonstrates widespread distribution of piscine orthoreovirus in Alaska and Washington. J Fish Dis. 41: 347-355. https://doi.org/10.1111/jfd.12740

What Does 9,162 ELISA Samples Look Like?

The Size of Alaska Compared to the Contiguous United States- depending on source- 570,374 to 663,268 sq miles



Cost comparison fish/shellfish health programs in Alaska[1], Washington, Oregon, California, British Columbia, Canada; includes numbers of hatcheries, fish released and revenues from commercial (exvessel)/recreational fishing. Figures for 2014-2018 except where noted. [1] Other federal/university fish health laboratories are present in BC and states listed except Alaska and cooperate with existing state fish health programs.

Agency	# FH Labs	Perm Staff #	Budget (1000s)	# Hatch	Fish released	Fish Revenue	Shellfish Revenue	Total Rev
ADFG	2 (fish and shellfish)	5 (2 pathol, 2 micro, 1 lab tech)	$683.8* (GF, Fed RSA) * $718.5	30	1.66 Bil (mostly salmon, some rbt, char)	Hatch = $124 Mil Wild = $465 Mil Sport = $ 500 Mil Grndfish = $ 855 Mil Total = $1.9 Bil	$456 Mil- (ex-vessel for shrimp, crab, bivalves, cucumbers)	$5.6 Bil ($4.9 Bil 1st wholesale for seafood) (1.7 Bil wages)
IDFG	1	6 (1 super, 2 pathol, 3 micro)	$858.3 (license, Fed, private)	20	33.5 Mil (Rbt, steel, chin, kokanee, walleye, catfish, tiger musky)	$300 Mil (2004)	NA	$333.5 Mil
WDFW (WA)	1	10 (1 super, 3 pathol, 3 Vets, 2 micro, 1 tech)	$1,000.0 (GF, Fed, tribal PUD)	68 (+ 15 ponds) 12-federal	149 Mil (salmon, steelhead, trout)	$1 Bil (includes state, tribal and federal)	$185 Mil – (farmed bivalves- 2013) $40 Mil (comm crab, shrimp (2014) $40 Mil- wild harvest bivalves (2012) Total = $265 Mil	$1.27 Bil
NWIFC (WA)	1	6 (3 pathol, 1 Vet, 2 Micro)	$645.0 (Fed)	35	40 Mil (salmon)	See above	Inclusive	Inclusive
ODFW	3	11 (6 pathol, 5 micro +1 seasonal)	$1,138.3 (21 funding sources include GF, Fed; supply budgets with different FYs)	32	46.5 Mil (trout, salmon, steelhead)	$904 Mil (70-75% of state produced fish harvested in sport & commercial salmon fishery)	$23 Mil (farmed bivalves) $81 Mil (commercial crab, shrimp) $38 Mil (rec clams, crabs; 2008) Total = $142 Mil	$1.05 Bil
CFG	2 (1 fish, 1 shellfish)	10 (7 fish- 2 pathol, 3 Vets, 2 sci; 3 shellfish-1 pathol, 2 sci)	$1,100.0 (GF, SFRA)	22	46-50 Mil (trout, salmon)	$183.3 Mil-ex-vessel recreational and commercial salmon only	$122.6 Mil (commercial crab, shrimp, lobster, squid urchin roe) $23 Mil (farmed bivalves- 2013) Total = $145.6 Mil	$329 Mil
B.C. Dept Fish & Oceans	1 (Pac Biol Stn Fish Health Section)	17 (additional part-time staff grant-supported)	$1,550.0 (Fed)	15 (+ 6 spawning channels)	258.4 Mil (salmon, rbt/cutthroat)	$51.9 Mil (wild commercial harvest) $463.6 Mil (farmed salmon) Total = $515.5 Mil	$24.6 Mil (farmed oysters, clams) $149.0 Mil (wild crabs, shrimp, other) Total = 173.6 Mil	$689 Mil

Indications – Future Concerns

- Alaska fishery resources are enormous, many having unknown disease histories regarding fish/shellfish pathogens due to geographic remoteness.
- Alaska produces more hatchery and wild salmon/shellfish than other comparable states in the PNW or BC Canada.
- The value of fisheries in Alaska is significantly greater than similar revenues from other PNW states including the commercial fishery and farmed salmon industry in BC Canada.
- Despite the vast size of Alaska fishery resources, less is spent on the fish health program to protect these resources than expended for other comparable state fish health programs in the PNW.
- Global warming will lead to emerging pathogens and range extension of southern fish and shellfish species bringing exotic pathogens to threaten the sustainability of wild and cultured fish and shellfish species in Alaska. State ownership of an adequate fish pathology program to provide real-time surveillance and detection will be a crucial pro-active defense for future protection of Alaska fishery resources. There are NO other in-state agency or private fish/shellfish health laboratories in Alaska to provide similar services.

Note: Public Perception is that Alaskans love their salmon. A 2013 survey by The Salmon Project found: 90% think wild salmon are important; 75% felt connected to salmon in some way.