

ALASKA LEGISLATURE SPECIAL COMMITTEE/SUBJECT FILE 8672
1804 SCOMM 74: SEN. SPEC. COMM. ON DOMESTIC & INTL. FISH., 1991-92. *24*

manage fisheries to provide broodstock to hatcheries. In the same way that the Alaska Constitution directs the Board of Fisheries to manage for the return of broodstock, we believe that the law also directs the department to manage for the same result.

2. Department's authority to manage for cost recovery fish

The law is not clear on the question of whether the department, through the commissioner's emergency order power, is authorized to independently manage fisheries for cost recovery fish. It is also not clear whether it is required to do so.

On one hand, it can be argued that the commissioner's statutory charge in AS 16.05.020(2) to "maintain and improve" the resource authorizes actions that will enable private, nonprofit hatcheries to survive. Unless they are able to meet financial obligations, hatcheries will not be able to raise broodstock, and thereby not be able to contribute to the "maintenance and improvement" of the resource. It can also be argued that it is unlikely that the legislature would have created a program for financing the hatcheries and yet not intended for fisheries to be managed so that these hatcheries could pay back their loans and contribute to the fishery resource.

On the other hand, cost recovery fish, unlike broodstock fish, do not directly contribute to the perpetuation of the resource. They are sold to meet economic needs of a user subgroup. Thus, they can be likened to fish that exceed the amount needed for sustained yield and are thus available for allocation among various users.

In the past, we have opined that the commissioner probably cannot allocate fish through his or her emergency order power. Only the board can allocate fish among competing fisheries or user groups. 1990 Inf. Op. Att'y Gen. (Jan. 12; 663-90-0227); 1989 Inf. Op. Att'y Gen. (Apr. 7; 663-89-0465). According to this argument, the department could not independently manage fish for cost recovery because it is not authorized to allocate fish among users. 5/

5/ Although it is not clear whether the department, independent of the board, is authorized or required to allocate fish for cost recovery, we note that there are several ways that the department, in conjunction with the board, could manage for this purpose. First, under AS 16.05.270 the board could delegate to the department its own authority to allocate for certain fisheries. Next,
(continued...)

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The arguments on both sides of this question depend upon implication and analogy. The law does not clearly point to one answer or the other. Although we believe we could defend an emergency order that was issued to provide cost recovery fish, we hesitate to predict the outcome of any challenge. Accordingly, if the department wishes to independently manage for cost recovery fish, we recommend that it seek clear authority from the legislature to do so.

II. CONCLUSION

The Board of Fisheries and the Department of Fish and Game are authorized, and in fact are directed, to manage fisheries so that broodstock returns to hatcheries. The board can manage through its power to adopt regulations and the commissioner, when he or she acts independently of the board, can manage through the power to issue emergency orders. The authority of both is based upon statutory provisions for managing for conservation and on constitutional mandates for managing for sustained yield.

The board has the statutory authority to manage fisheries so that cost recovery fish return to a private, nonprofit hatchery. However, it is not clear that the present allocation criteria recognize the special attributes of hatcheries. If the board adopts such criteria, the board's regulatory authority to manage for cost recovery would be clear as well. On the other hand, there is no basis to conclude that the board is required to allocate fish for this purpose.

Absent the board's delegation of allocation authority to the department, it is not clear that the latter is authorized or required to independently manage for cost recovery, even by emergency order. Although we believe we could defend such an action, we could not predict the outcome of such suit. Therefore, we recommend that the department seek legislation that more clearly establishes this power.

We hope this answers your questions. Please do not hesitate to contact us if we can be of further help.

SMW:tg

5/ (...continued)

the board could by regulation direct the department to manage a particular fishery for this purpose. Examples of this are in 5 AAC 24.365 and 5 AAC 24.366. Finally, the board could by regulation establish an allocation framework that the department could implement through emergency orders.

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cc: Bonnie Harris, Assistant Attorney General
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DATE: February 28, 1991

TO: Kate Troll, Executive Director
Southeast Alaska Seiners

FROM: Michael A. D. Stanley *MS*

SUBJ: Department of Law Opinion Re Management Of Fisheries
For Hatchery Broodstock And Cost Recovery

You have asked me to review an opinion authored by Assistant Attorney General Stephen White, dated August 1, 1990, concerning the legal authority of the Board of Fisheries ("Board") and the Alaska Department of Fish and Game ("ADF&G") to manage fisheries for return of hatchery broodstock and cost recovery.

This memo is not intended as a lengthy analysis of Mr. White's conclusions or the issues presented, but is instead meant to identify questions raised by his opinion.

Briefly stated, White's conclusions are as follows:

1. The Board has the authority and, under article VIII, section 4 of the Alaska Constitution (the sustained yield clause), the obligation to manage fisheries to provide broodstock to hatcheries.
2. The Board has the authority to allocate fish to nonprofit hatcheries for cost recovery, as a subgroup of commercial users.
3. Like the Board, ADF&G has the authority and the obligation to use its management powers -- i.e., its emergency order authority -- to assure return of broodstock to hatcheries.
4. ADF&G does not have clear authority to use its emergency order authority to manage for cost recovery, which is a form of allocation among competing users, but could achieve such result
 - a. by working in conjunction with the Board (e.g., receiving a delegation of the Board's authority or implementing a Board regulation requiring such allocation), or
 - b. by seeking legislation that clearly establishes such power.

DISCUSSION

The difficulty I have with Mr. White's opinion is not so much what he says, but what he doesn't say; that is, assumptions or legal inferences that are implicitly made but not discussed. Once these are understood, it can be seen that his conclusions regarding the Board's and ADF&G's authority to manage for broodstock and cost recovery are subject to some question.

1. Are Hatchery Stocks Subject To Article VIII?

White's memo is premised on the assumption that hatchery fish are necessarily subject to the provisions of article VIII of the Alaska Constitution. This leads him, among other things, to conclude that the Board and ADF&G are required to manage fisheries for return of hatchery broodstock, just the same as they are required to manage for escapement of wild stocks. I believe there is reason to question this assumption.

Article VIII does not use a single term for what it covers, but all seem to have a similar meaning: "natural" resources, resources in their "natural state," and "replenishable resources belonging to the state." The question is, do these terms encompass man-made hatchery fish? Put another way, does the state "own" hatchery fish in the same way as it "owns" wild fish and game. If the answer to that question is no, then it may well be that hatchery fish are not subject to the requirements of article VIII at all.

I have not studied this "ownership" question for hatchery stocks at length, but I have run across items that suggest they might be different from wild stocks. For instance, in the commentary on what became section 3 of article VIII (the common use clause), the framers indicate that it "does not apply to the domestication of fur-bearing animals or other animals subject to intensive culture, to fish in private ponds, or to registered trap lines if authorized by law." Commentary on Article on State Lands and Natural Resources, January 16, 1956, Alaska Constitutional Convention Proceedings, Part 6, Appendix V, p. 98 (emphasis mine). Although the examples mentioned do not include hatchery fish, a common thread is creatures which man plays a substantial role in propagating.

Further, it could be argued that the legislature itself, when it passed the statutes authorizing private nonprofit hatcheries, did not view hatchery fish as subject to article VIII. As White points out, AS 16.10.440(a) provides that hatchery fish are "available for common use and are subject to regulation under applicable law in the same way as fish occurring in their natural state." However, this legislation would not have been necessary if hatchery fish were already believed to be subject to article VIII. The very fact that

AS 16.10.440 was enacted suggests that, in a constitutional sense, hatchery fish may be different from wild stocks.

Similarly, the sustained yield clause surely prohibits the Board or ADF&G from extinguishing a wild run. Yet, under certain circumstances hatchery permits may be revoked and production stopped. AS 16.10.430. Assuming hatchery fish were subject to section 4's command to sustain production, wouldn't terminating operation of a hatchery likewise be a constitutional violation? The answer may be that section 4 does not apply to hatchery fish.

The point simply is, White's conclusion that the Board and ADF&G are constitutionally mandated to manage for broodstock, just as they are required to manage for escapement of wild stocks, is subject to some question or, at the least, further analysis.

2. Are Nonprofit Hatcheries Engaged In Commercial Fishing?

In concluding that the Board can allocate fish to private nonprofit hatcheries for cost recovery, White states that "we know of no reason why they could not be considered a subgroup of commercial users and thus be targeted for allocations like any other distinct subgroup of commercial users." He conspicuously fails to refer to the definition of "commercial fishing" in articulating this premise. "Commercial fishing" is defined in AS 16.05.940(5) as

the taking, fishing for, or possession of fish, shellfish, or other fishery resources with the intent of disposing of them for profit, or by sale, barter, trade, or in commercial channels...

Nonprofit hatcheries do not take cost recovery fish "for profit." Are such fish nonetheless taken "with the intent" of disposing of them "by sale...or in commercial channels?" Although it could be argued that they are, that leads to a fairly expansive definition of commercial fishing. Salmon derbies possess fish with the intent of selling them; are they engaged in commercial fishing, too? Could the Board make an allocation to a fishing derby as subgroup of commercial users? At some point such an interpretation of "commercial fishing" becomes rather strained.

The definition of "commercial fisherman" in AS 16.10.940(4) may also provide guidance. That term is defined in terms of an "individual" -- i.e., a natural person -- and would not appear to include a nonprofit corporation.

Thus, there is a question whether nonprofit hatcheries are indeed engaged in "commercial fishing." If not, then White's conclusion that they may be the recipients of an allocation is undermined.

3. May Nonprofit Hatcheries Receive An Allocation?

The conclusion that the Board can allocate hatchery fish to a hatchery for cost recovery is, as White's memo states, "based upon characterizing private, nonprofit hatcheries as another type of commercial subgroup." I discussed above my doubts that hatcheries can really be said to be engaged in "commercial fishing."

There is another basis for questioning whether hatchery fish can be the subject of a specific allocation to a hatchery. AS 16.10.440(a) provides that hatchery fish are subject to regulation in the same manner as wild stocks "until they return to the specific location designated by the department for harvest by the hatchery operator." This suggests two things: (1) it is the department, not the Board, which is responsible for "allocating" hatchery fish to a hatchery through designation of special harvest areas, and (2) such allocation occurs only after those fish have traversed the common property fisheries and returned to the specific location designated for hatchery harvest. This statutory scheme is circumvented if the Board takes it upon itself to make an allocation to a hatchery prior to those fish returning to the designated area, while they are still in the common property fisheries.

Similarly, the statute which governs allocation of fisheries resources -- AS 16.05.251(e) -- does not really square with the idea of an allocation to a hatchery. The various factors which may be considered as allocation criteria are all tied to the term "fishery." But the definition of "fishery" in AS 16.05.940(12) does not include a hatchery. This suggests that a hatchery was never intended as the recipient of an allocation by the Board under AS 16.05.251(e).

Thus, the structure of applicable legislation suggests that hatchery operators may receive an allocation only through the procedures set forth in AS 16.10.440 (after leaving the common property fishery and in an area designated by ADF&G) and not from the Board pursuant to AS 16.05.251(e).

I must emphasize that the foregoing -- especially the discussion of the constitutional issue -- are not intended as definitive legal advice on whether the Board or ADF&G have the authority and/or the obligation to manage fisheries in order to assure the return of broodstock to nonprofit hatcheries or to provide for cost recovery. More analysis remains to be done. But I do think that this points up some significant problems with the Department of Law's opinion.

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MEMORANDUM

April 8, 1991

SUBJECT: Sustained Yield Management of Salmon Produced by Private Nonprofit Hatcheries (Work Order 7LS0990)

TO: Senator Dick Eliason

FROM: George Utermohle *GU*
Legislative Counsel

You have asked whether the state must manage salmon produced by private nonprofit hatcheries according to principles of sustained yield.

The Department of Law in its consideration of this issue has concluded that the sustained yield section of the Alaska Constitution (art. VIII, sec. 4) is applicable to private hatchery stocks of salmon and that the Board of Fisheries is required to manage private hatchery stocks of salmon according to sustained yield principles in order to provide broodstock to the hatcheries. Memorandum to Don W. Collinsworth file no. 663-90-0327, August 1, 1990. The Department of Law reached this conclusion by finding that the return of hatchery-bred salmon to the hatchery for use as broodstock, like the escapement of wild salmon to the spawning grounds, is necessary to achieve sustained yield of the salmon resource.

The sustained yield section can be reasonably construed as supporting the conclusion reached by the Department of Law, however the section is also open to other interpretations which would support different conclusions. Article VIII, sec. 4 states:

SUSTAINED YIELD. Fish, forests, wildlife, grasslands, and all other replenishable resources belonging to the State shall be utilized, developed, and maintained on the sustained yield principle, subject to preferences among beneficial uses.

Of particular significance is the fact that this section applies to fish "belonging to the State" and that utilization, development, and maintenance of fish on the sustained yield principle is "subject to preferences among beneficial uses."

Fish belonging to the state are clearly to be managed according to sustained yield principles. The general rule is that salmon while in state water are property of the state and are held in trust for the benefit of all people of the state. Metlakatla Indian Community, Annette Island Reserve v. Egan, 362 P.2d 901, 914-915 (Alaska 1961). Part of the state's trust responsibility includes the management of salmon according to sustained yield principles. However it is unclear whether the sustained yield requirement applies to salmon raised by a private nonprofit hatchery, because the ownership of hatchery salmon is uncertain.

Private nonprofit salmon hatcheries are authorized under AS 16.10.375 - 16.10.470. AS 16.10.375 - 16.10.470 that does not answer the question of who owns hatchery stocks of salmon, though a number of provisions do suggest that some property interest in hatchery salmon stocks may pass to the hatchery under the terms of the hatchery permit. There are at least four references to salmon eggs or fry being sold to or by a hatchery. AS 16.10.420(3), (7), and (8); 16.10.450. The ability to sell salmon eggs and fry implies an ability to transfer property rights in the eggs and fry.

AS 16.10.440, which provides for the common use of hatchery fish while the fish are in the natural water of the state, is silent as to whether hatchery fish belong to the state. AS 16.10.440(a) provides

Fish released into the natural waters of the state by a hatchery operated under AS 16.10.400 - 16.10.470 are available to the people for common use and are subject to regulation under applicable law in the same way as fish occurring in their natural state until they return to the specific location designated by the department for harvest by the hatchery operator.

The phrase "occurring in their natural state" used in AS 16.10.440(a) mirrors the language of the common use section of the state constitution (art. VIII, sec. 3) in order to assure that while in the water of the state hatchery fish are to be subject to common use. However providing that hatchery fish are available for common use neither implies state ownership of the hatchery fish nor entails a concomitant responsibility to manage hatchery fish for sustained yield, because the requirements for common use and sustained yield are separate provisions of the constitution.

AS 16.10.440(a) does not use the important phrase "belonging to the state" which would invoke the sustained yield section. According to AS 16.10.440(a), hatchery fish are to be treated "in the same way as fish occurring in their natural state until they return to the specific location. . ."; this language does not say that hatchery fish are a common property resource belonging to the state, but only that they are to be treated as though they were a common property resource until they return to the designated location, at which time the fish become subject to private use by the hatchery. This language suggests some form of lingering private property interest in

hatchery fish by the hatchery even after the hatchery releases the fish into the wild. If there is a latent private property interest in hatchery fish while they are in the wild, then those fish may not necessarily be fish belonging to the state. If the fish do not belong to the state then they are not subject to the requirements for sustained yield management under the state constitution. This could permit the state through the Board of Fisheries and the Department of Fish and Game to manage fisheries through which hatchery fish pass without regard to assuring a sustained yield escapement to the hatchery.

Even if the hatchery fish do belong to the state for the purposes of the sustained yield section, the requirement of the sustained yield section of the state constitution is not absolute, because the management of fish and other replenishable resources belonging to the state shall be utilized, developed, and maintained on the sustained yield principle, subject to preferences among beneficial uses. The delegates to the Alaska Constitutional Convention considered this qualifying language to be necessary because they found that the sustained yield principle becomes meaningless and ineffective, if it is not qualified by the concept of beneficial use. Alaska Constitutional Convention Proceedings, Delegate Riley, p. 3054-55. The delegates to the convention did not discuss in detail how they felt the concept of preferences among beneficial uses would be applied in the context of sustained yield management of replenishable resources, except to say that certain kinds of resources (e.g. predators and parasites) should not be maintained on a sustained yield basis. Alaska Constitutional Convention Proceedings, Delegate Riley, p. 2451; Commentary on Article on State Lands and Natural Resources, 6 Proceedings of the Alaska Constitutional Convention at 98. However the delegates did discuss the concept of beneficial uses in regard to water rights. Section 13 of article VIII, relating to water rights, contains the same "subject to preferences among beneficial uses" language that is contained in the sustained yield section. The delegates understood preference among beneficial uses to allow the state to choose among competing beneficial uses of water in order to achieve the greatest public good, even if it meant eliminating other existing, vested beneficial uses of water, provided that the owner of those rights are compensated for the loss of the rights. Commentary on Article on State Lands and Natural Resources, 6 Proceedings of the Alaska Constitutional Convention at 102. Thus the delegates understood that the concept of preferences among beneficial uses would also allow the state to make reasoned decisions to prefer certain renewable resources over other renewable resources to achieve a more beneficial public purpose. The authority to establish preferences among beneficial uses may permit the state to harvest hatchery fish without providing for a sustained yield from the hatchery, provided that those who have vested rights in hatchery fish are compensated for those rights that are taken by the state.

The ability of the state to establish preferences among beneficial uses is reflected in AS 16.10.430(b) which allows the commissioner of fish and game to terminate the

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operation of a hatchery in the best interests of the public, if the adverse effects of the operation of the hatchery are irreversible and cannot be mitigated.

If I can provide further assistance, please advise.

GU:pl
91-235.plm

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October 17, 1991

PRINCE WILLIAM
SOUND AQUACULTURE

OCT 21 1991

Mr. John McMullen, President
Prince William Sound Aquaculture Corporation
Box 1110
Cordova, AK 99574

RE: Proposed Hatchery Regulations
Our File No. 91-7618

Dear John:

Enclosed is the long memorandum that I promised on the cost recovery and production limitations issues that you raised. I would be happy to discuss these matters with PWSAC at any time that is convenient for you.

In addition to the questions addressed in the enclosed memorandum, you also asked whether the Board of Fisheries could change the Prince William Sound Allocation Policy this year, out of its normal sequence. My understanding is that the policy has been implemented in the form of regulations, which are codified at 5AAC 24.370. To my knowledge, there is no absolute bar that would prevent the Board from amending or repealing its regulations at any time, so long as it fulfills the statutory requirements for promulgating regulations. Those detailed requirements are included in the Administrative Procedures Act.

However, any new regulations must be consistent with existing statutes, within the scope of the authorizing statute, and reasonably necessary to carry out the purpose of the statute. As with any law or regulation, any amending regulations must also be "reasonable and not arbitrary." Kelly v. Zamarello, 486 P.2d 906 (Alaska 1971).

Given the substantial public testimony in favor of the allocation policy, and the exhaustive back-up documentation that supported the allocation regulations adopted last year, it seems highly unlikely that the Board could make significant amendments that would be "reasonable and not arbitrary." An extensive record would have to be developed showing a dramatic change in circumstances and public support in order to support a change in the policy.

Mr. John McMullen

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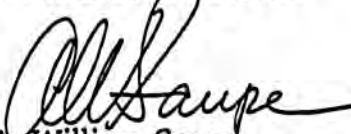
October 17, 1991

Even if such a record were to be made, any new regulations would have to preserve PWSAC's ability to continue a reasonable level of broodstock and cost recovery, for all of the reasons stated in my memorandum. For the same reasons, any new policy that attempted to limit PWSAC's salmon production would be vulnerable to legal challenge.

If you have further questions, please give us a call.

Very truly yours,

ASHBURN & MASON



A. William Saupe

AWS/nk

ASHBURN AND MASON

LAWYERS

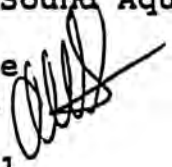
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MEMORANDUM

TO: John McMullen, President
Prince William Sound Aquaculture Corporation

FROM: A. William Saupe
Ashburn & Mason 

DATE: October 16, 1991

RE: Regulation of Private Hatcheries

I. Issues Presented

You have asked us to research several legal issues that go to heart of PWSAC's ability to conduct its business as it has for the past 14 years. First, you asked for the legal basis for of PWSAC's right to conduct broodstock and cost recovery harvests, and an analysis of the degree to which the Department of Fish and Game (the "Department") and the Board of Fisheries (the "Board") can regulate broodstock recovery and cost recovery by private non-profit hatcheries. In that connection, you requested an analysis of an Attorney General's Opinion by Stephen White (Op. No. 663-90-0327, August 1, 1990) and two other opinions on the same topic. One is a memorandum written to Senator Eliason by George Utermohle, Legislative Counsel, dated April 8, 1991, and the other is a

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February 28, 1991 memorandum from Michael A. D. Stanley to Kate Troll, Executive Director of the Southeast Alaska Seiners.

You also asked for an evaluation of the extent of the Board's authority to regulate hatchery production levels on a regional or individual hatchery basis, with specific reference to AS 16.05.440(b), regarding salmon egg take.

The analysis and arguments that we would make follow.

II. Brief Conclusion

Based upon the relevant provisions of the Alaska Constitution, applicable statutes, and related legislative history, we would argue that PWSAC has a constitutional and statutory right to continue a reasonable level of broodstock and cost recovery harvest. Any regulation by the Board or Department that significantly restricted PWSAC's ability to continue its present broodstock and cost recovery practices would be inconsistent with an extensive statutory scheme that explicitly authorizes broodstock and cost recovery by private non-profit hatcheries and regional aquaculture associations. Any such restriction would also conflict with Article VIII, Section 4, of the Alaska Constitution (requiring fish resources belonging to the State to be "utilized,

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developed, and maintained on the sustained yield principle"), Article VIII, Section 15 of the Alaska Constitution (prohibiting any exclusive right or special privilege of fishery, except insofar as limited entry may be imposed by the State "to promote the efficient development of aquaculture in the State").

On the related question of the Board's authority to restrict hatchery production (as distinct from its authority to regulate harvests), the Board is statutorily authorized to regulate such things as the "propagation and stocking of fish" (AS 16.05.251(7)), and the "source and number of salmon eggs" taken by a hatchery (AS 16.10.440(b)), which suggests that it might have some measure of control over individual hatchery output. However, the available legislative history strongly suggests that the legislature never intended to give the Board the power to limit hatchery production on either a local, regional or statewide basis. Nothing in the current law would permit regional production ceilings designed to restore historical market share percentages, which we understand to have been proposed.

If the Board does have power to regulate production, at some point it would come into conflict with the constitutional provisions mentioned above and the numerous other statutes, such as

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the statutes creating the FRED Division, the Limited Entry Act, and the State Hatchery Loan Program, which together evidence a strong policy in favor of hatchery development as well as enhancement and extension of the State's fisheries. Because there are no court decisions interpreting the Board's power to regulate propagation or egg take, and because the Alaska Supreme Court has not elucidated either the meaning of the constitutional reference to "efficient development of aquaculture," or the meaning and application of the sustained yield concept, there is no sure way to know precisely where the collision might occur until a specific restriction is imposed and challenged in court.

It would seem reasonable to conclude, however, that in the absence of a strong factual showing that hatchery production posed a serious genetic or disease threat to wild salmon stocks or perhaps was causing severe economic distress, neither the Department nor the Board could legally restrict PWSAC's output below a level necessary to sustain hatchery yields, to efficiently develop aquaculture, to repay state loans and to recover its costs.

III. Discussion

A. The Board And The Department Are Required By The

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Alaska Constitution And Numerous Statutes To Manage
For Broodstock Recovery

In its August 1990 opinion, the Attorney General's Office advanced the argument that the Board is obligated to manage Alaska's fisheries to provide for broodstock recovery by hatcheries. Analogizing broodstock fish to wild stock escapement, the Assistant Attorney General Stephen White reasoned that Article VIII, Section 4 of the Alaska Constitution mandates that conclusion. That section provides as follows:

Sustained Yield. Fish, forests, wildlife, grasslands, and all other replenishable resources belonging to the State shall be utilized, developed, and maintained on the sustained yield principle, subject to preferences among beneficial uses.

Alaska Const. Art. VIII, §4. White implicitly assumes that hatchery fish "belong to the State" and argues that without broodstock harvests, hatchery stocks obviously could not be sustained.

In an opinion on this subject requested by Senator Eliason, Legislative Counsel George Utermohle questioned White's conclusion that the sustained yield principle applies to hatchery

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fish, on the grounds that they may not "belong to the State." He bases his argument entirely on AS 16.10.440(a), which provides:

Fish released into the natural waters of the state by a hatchery operated under AS 16.10.400 - 16.10.470 are available to the people for common use and are subject to regulation under applicable law in the same way as fish occurring in their natural state until they return to the specific location designated by the department for harvest by the hatchery operator.

AS 16.10.440(a).

Utermohle points out that the phrase "occurring in their natural state" used in this section mirrors the language of the common use clause of the constitution (Art. VIII, Sec. 3).¹ He then argues that merely providing that hatchery fish are available for common use "neither implies state ownership of the hatchery fish nor entails a concomitant responsibility to manage hatchery fish for sustained yield, because the requirements for common use and sustained yield are separate provisions of the constitution." Next, Utermohle asserts that AS 16.10.440(a) does not use the phrase "belonging to the state," which would invoke the sustained

¹Article VIII, Sec. 3 provides: "Common Use. Wherever occurring in their natural state, fish, wildlife, and waters are reserved to the people for common use."

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yield clause. Instead, he argues that the statute requires only that hatchery fish be treated in the same way as fish occurring in their natural state until they return to the specific hatchery location. Utermohle Memo. p. 2.

From this phrasing in AS 16.10.440(a), Utermohle reasons that there may be "some form of lingering private property interest in the hatchery fish even after the hatchery releases the fish into the wild." Id. at 3. If the fish do not "belong to the State," Utermohle concludes that they are not subject to the sustained yield requirement and neither the Board nor the Department is required to manage hatchery fish to assure a sustained yield escapement to the hatcheries.

Utermohle's ownership argument does not stand up to closer analysis and is contradicted by the available legislative and constitutional history. Certainly PWSAC has understood since its creation in 1975 that once it releases its fish, it no longer owns or controls them. From the point of release forward, they are "fish occurring in their natural state" and, as Utermohle acknowledges, Article VIII, Section 3 of the constitution reserves them to the people for common use. This is consistent with the general rule, which he also cites, that salmon while in state water

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are property of the state and held in trust for the benefit of all people of the state. Metlakatla Indian Community v. Egan, 362 P.2d 901, 914-915 (Alaska 1961).

That hatchery fish belong to the State is also consistent with the views of the legislature that created the nonprofit hatchery program. In her July 31, 1991 memorandum to Senator Eliason, Linda J. Snow, a Legislative Analyst, wrote as follows:

Consensus is that the legislature had always intended that the fish from PNP hatcheries belong to the common property fishery until such time as they return to the hatchery, and then they belong to the hatchery for broodstock and cost recovery. Testimony by Senator Dick Eliason at a 1975 Senate Resources Committee hearing on SB 180 indicates that the initial concept private hatchery system considered making corporate ownership. How profit-making corporation might claim to exclusive ownership of every produced. Thus, it was felt that nonprofit ownership of hatcheries was more consistent with the concept of publicly owned hatchery fish. This opinion is echoed by former Representative Terry Gardiner.

At a March 7, 1977 House Resources Committee hearing, Jack Milnes, executive director of Southern Southeast Regional Aquaculture Association testified: "I wish to recognize the fact that these are common property fish, that they belong to the state of Alaska and to the people of Alaska and therefore they should be protected by the representatives of the

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people of the state of Alaska." At a 1979 Senate Resources Committee hearing on HB 48, Don Clockson, an attorney with Alaska Legal Services discussed the question of ownership of hatchery fish. In his testimony, he asked "When are fish no longer common property fish?" He felt that constitutionally, they were considered to be common property at all times. Consequently, it appears there was never any question that hatchery fish were common property of the people of the state while in Alaska waters, and they may or may not be the property of the PNP hatchery operator at the hatchery, but that he is allowed to harvest a sufficient number for broodstock and cost recovery.

Snow Memo. p. 14 (attached as Attachment A) (emphasis added). These statements effectively answer the "ownership" issue. When the legislature created private hatcheries, it intended that the fish would belong to the State, contrary to Utermohle's supposition.

The commentary of the Committee on Resources of the Alaska Constitutional Convention is also significant on this point. Referring specifically to the "common use" clause, which Utermohle seeks to distinguish from the sustained yield clause, the commentary states in relevant part as follows:

Game fish, wildlife, fisheries, and water are recognized as belonging to the state so long as in a natural state. These resources are subject to a private right only when they have been acquired or utilized as provided by law.

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Alaska Constitutional Convention Proceedings, Part 6, p. 98 (emphasis added). Thus, the framers of the common use clause thought that the fish being reserved for common use "belonged" to the State. Hatchery fish are reserved for common use by AS 16.10.440(a) and the common use clause itself. Therefore, they must belong to the State and be subject to the sustained yield principle.

Also significant is the commentary to the sustained yield clause, which states in relevant part:

Sustained yield is recognized as a principle applicable to the administration of plant and animal life subject to the immediate authority of the state.

Id. (emphasis added). Because hatchery fish are subjected to the authority of the State by AS 16.10.440(a), among other provisions, it follows that they are subject to the sustained yield clause.

This conclusion also comports with common sense. If they did not belong to the State, it could not reserve hatchery fish for use by others without paying for them. Moreover, if the mere expectation that a hatchery will later be allowed to harvest some unidentified fraction of the returning fish constitutes an ownership interest in all of its fish, then every other limited entry permit holder could be said to have the same "lingering

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property interest," leading to the false conclusion that none of the fish in Alaska's waters ever belong to the State or are subject to the sustained yield principle of management.

A more reasonable interpretation of these related statutory and constitutional provisions is that, once released, hatchery fish become like wild stocks in every legal respect. They belong to the State, are reserved to the people for common use and must be managed for sustained yield. Therefore, broodstock recovery must be permitted by the Board and the Department at a level sufficient to produce a sustained yield of hatchery stocks.

Even if this is true, Utermohle goes on to argue that the sustained yield principle in Article VIII, Section 4 is not absolute and is "subject to preferences among beneficial uses." He suggests that this phrase implies the power on the part of State regulators to deny hatchery harvests altogether, in order to achieve a "more beneficial public purpose." According to Utermohle, the ability of the State to establish preferences among beneficial uses is reflected in AS 16.10.430(b), which allows the Commissioner of Fish and Game to terminate the operation of a

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hatchery if its adverse effects are irreversible and cannot be mitigated. Utermohle Memo., p. 4.²

A more plausible interpretation of AS 16.10.430(b) is that the listed conditions under which a hatchery operation may be terminated are the only bases upon which termination is permitted. In other words, unless there are irreversible adverse effects that cannot be mitigated, a licensed hatchery operation cannot be terminated, directly through a termination order, or indirectly through a denial of broodstock or cost recovery funds.

Utermohle's argument also overlooks, among other things, Article VIII, Section 15 of the constitution, which provides:

²AS 16.10.430(b) provides as follows: "If the commissioner finds that the operation of the hatchery is not in the best interests of the public, the commissioner may alter the conditions of the permit to mitigate the adverse effects of the operation, or, if the adverse effects are irreversible and cannot be mitigated sufficiently, initiate a termination of the operation under the permit over a reasonable period of time under the circumstances, not to exceed four years. During the period of time that the operation is being terminated, the permit holder may harvest salmon under the terms of the permit but may not release additional fish."

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No exclusive right or special privilege of fishery shall be created or authorized in the natural waters of the State. This section does not restrict the power of the State to limit entry into any fishery for purposes of resource conservation, to prevent economic distress among fishermen and those dependent upon them for a livelihood and to promote the efficient development of aquaculture in the State.

This provision strongly suggests that the framers of our constitution considered the efficient development of aquaculture to be an important value to be protected. It also indicates read to mean that the efficient development of aquaculture is one of the purposes of limited entry, a principle that is central to fisheries management in Alaska.

Hatchery harvests for broodstock (and cost recovery) are absolutely essential to conservation of the resource and to the efficient development of aquaculture. If deprived of broodstock (or the funds generated by cost recovery), PWSAC could not continue in existence, much less develop efficiently. Furthermore, other beneficial uses, such as the harvest of PWSAC produced fish by commercial, sport and subsistence users, would be seriously harmed, not helped by a restriction on broodstock harvest. Over the past 14 years, PWSAC has harvested an average of less than 30% of the

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salmon returning to its hatcheries. During the period from 1986 through 1990, PWSAC fish constituted 50 percent of the total commercial harvest. During that period PWSAC contributed an average of approximately \$15.4 million annually in value to the common property fishery, while costing the State little or nothing. PWSAC harvests have consistently sustained other user groups throughout the region, while causing no demonstrable harm to wild stocks. Short of the extreme situation envisioned by AS 16.10.430(b), it is hard to conceive how denial of a reasonable hatchery harvest in favor of other beneficial uses could achieve a greater public purpose.

Any regulation that severely limited or denied PWSAC's right to harvest a reasonable number of fish would violate both Section 4 (sustained yield) and infringe on the values reflected in Section 15 (limited entry and efficient development of aquaculture) of Article VIII and the Limited Entry Act, of which hatchery harvests are an integral part.

Utermohle's argument also overlooks an extensive web of statutory provisions that evidence an unwavering legislative intent to sustain and expand hatchery operations through hatchery harvests. A good example is the very provision that Utermohle

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cites, AS 16.10.440(a), which provides that hatchery fish are available for common use "until they return to the specific location designated by the department for harvest by the hatchery operator." This indicates a legislative expectation and intent that hatchery harvests are necessary.

The obligation of the Department to affirmatively assist with broodstock recovery is embodied in AS 16.10.443, which states:

Department assistance and cooperative. (a)
Before and after permit issuance under AS 16.10.440 - 16.10.470, the department shall make every effort, within the limits of time and resources, to advise and assist applicants or permit holders, as appropriate, in the planning, construction, or operation of salmon hatcheries.

As explained above, broodstock recovery is essential to hatchery operations. Without it, they could not exist. The Department is obligated under AS 16.10.443 to assist in the operation of hatcheries. Any departmental regulation, action or order that denied broodstock recovery would be inconsistent with this obligation and would be invalid.

Other relevant statutory provisions that establish the obligation of the Department and the Board to manage for hatchery harvests are discussed below, in relation to cost recovery.

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B. The Board And The Department Must Also
Manage For Cost Recovery Harvests

Assistant Attorney General White concluded that the Board and the Department "are authorized, and in fact directed, to manage fisheries so that broodstock returns to hatcheries." Both the reasons given by White and the additional reasons set forth above support this conclusion. On the related issue of whether the Board and the Department must manage for cost recovery, White is less certain. He believes that the arguments on both sides of the question "depend upon implication and analogy" and concludes that "the law does not clearly point to one answer or the other." White Memo., p. 7. However, we would argue that the Alaska Constitution and an extensive statutory scheme require the Board and the Department to manage for hatchery cost recovery.

As an initial matter, it is important to remember that the Board and the Department manage the fisheries primarily through regulations and orders. In order to be valid, a regulation must be within the scope of the authorizing statute and it must be "consistent with standards prescribed by other provisions of law." Beran v. State, 705 P.2d 1280 (Alaska App. 1985), citing AS 44.62.020. In Beran, the court struck down a Board regulation on

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the basis that it was inconsistent with other provisions of law and therefore invalid. Id. at 1289. If the Board or the Department were to issue regulations that curtailed PWSAC's ability to conduct a cost recovery harvest, the regulations would be inconsistent with numerous provisions of law and could be successfully challenged in court.

The first section of this memorandum focused on the requirements of Article VIII of our constitution. The same constitutional provisions that protect broodstock recovery also protect cost recovery, because cost recovery is also absolutely essential to sustain hatchery yields (Section 4) and to promote the efficient development of aquaculture (Section 15). This discussion will not repeat those arguments, but will focus instead on the legislative mandate for cost recovery. Numerous statutes express the legislative intent that hatcheries must be permitted to conduct cost recovery harvests in order to generate funds for operation, debt retirement, and expansion.

The most obvious such provision is AS 16.10.450(a), which could hardly be clearer on this point. It states:

Sale of salmon and salmon eggs by hatchery.
(a) Except as otherwise provided in a contract for the operation of a hatchery under

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AS 16.10.480, a hatchery operator who sells salmon returning from the natural waters of the state, or sells salmon eggs to another hatchery operating under AS 16.10.400 - 16.10.470, after utilizing the funds for reasonable operating costs, including debt retirement, expanding its facilities, salmon rehabilitation projects, fisheries research, or costs of operating the qualified regional association for the area in which the hatchery is located, shall expend the remaining funds on other fisheries activities of the qualified regional association.

AS 16.10.450(a).³

The Limited Entry Act, AS 16.43.400, et. seq., permits the Commercial Fisheries Entry Commission to issue "special harvest area entry permits" to holders of private, nonprofit hatchery permits issued by the Department. Section 420 of the Act, noted above in connection with the ownership issue, specifically authorizes cost recovery harvest by permit holders, such as PWSAC:

Disposition of fish. Fish caught under the authority of a special harvest area entry

³The intent of this provision is reiterated in AS 16.40.210, the recently enacted statute that bans mariculture. It provides in section (b)(2) that "this section does not restrict the ability of a nonprofit corporation that holds a salmon hatchery permit under 16.10.400 to sell salmon returning from the natural waters of the state, as authorized under 16.10.450, or surplus salmon eggs, as authorized under 16.10.420 and .450."

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permit are the property of the permit holder.
The permit holder may sell the fish if the
proceeds are used in the manner described in
AS 16.10.450.

AS 16.43.420. PWSAC, of course, holds a special harvest area entry permit under AS 16.43.400, and its cost recovery funds are used for the purposes listed in AS 16.10.450. It thus has a statutory right to cost recovery that cannot be curtailed through regulation.⁴

PWSAC also conducts cost recovery harvests at Main Bay and Cannery Creek under authority of contracts entered pursuant to AS 16.10.480, enacted by the legislature in 1988. That section authorizes the Department to enter into hatchery management contracts for certain state-owned hatcheries, which allow harvest of adult salmon "in a quantity sufficient to allow the contractor to recover all or part of the contractor's costs of operating the hatchery." While this provision is permissive, rather than

⁴It could also be argued that cost recovery is guaranteed to permit holders such as PWSAC by the Limited Entry Act itself. In Johns v. CFEC, 758 P.2d 1256, 1263 (Alaska 1988) the court stated: "The Limited Entry Act has two purposes - enabling fishermen to receive adequate remuneration and conserving the fishery," citing, Art. VIII, Sec. 15, Alaska Const., AS 16.43.010; CFEC v. Apokedak, 606 P.2d 1255, 1265 (Alaska 1980). Without cost recovery, PWSAC would not receive adequate remuneration or be able to help conserve the fishery.

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mandatory, it is further evidence of the legislature's expectation and intent to permit cost recovery harvests at state-owned but privately operated hatcheries.⁵

Another statutory provision that is quite clear on this point is AS 16.10.430(b), discussed above. This provision permits the Commissioner of Fish and Game to terminate a hatchery permit if he finds that continued operation is no longer in the public interest. Presumably, termination could be ordered if a hatchery failed to sustain itself economically, or more likely, if it produced diseased or genetically damaged fish that might threaten other stocks. See Snow Memo., pp. 12-13, 16. In any case, the relevant point is that termination is to be phased over time.

During the period of time that the operation is being terminated, the permit holder may harvest salmon under the terms of the permit but may not release additional fish.

AS 16.10.430(b). Logically, this provision can only contemplate cost recovery harvest. In the context of hatchery termination,

⁵Both the Main Bay and the Cannery Creek contracts provide that PWSAC shall have the right to conduct cost recovery harvests during the terms of the contracts.

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broodstock harvest would not be necessary since no new fish could be released.

Under AS 16.05.020, the Commissioner of Fish and Game is required to "manage, protect, maintain, improve, and extend the fish, game... of the state in the interest of the economy and general well-being of the State." The FRED Division has been charged with the duty, "through rehabilitation, enhancement and development programs" to do everything "necessary to insure perpetual and increasing production and use of the food resources of Alaska's waters and continental shelf areas." AS 16.05.092. Also significant is AS 16.10.443, cited above, which requires the Department to do everything possible to assist with hatchery operations. Any regulation or order that prevented a reasonable level of cost recovery would hardly be consistent with these duties on the part of the Commissioner or with the myriad of other statutes that authorize cost recovery harvests by hatcheries. Under Beran v. State, supra, and numerous other cases, regulations are invalid if they are inconsistent with other provisions of law.

The statutory provisions discussed above lead to the conclusion that the legislature intended cost recovery harvest to be the primary method of funding private nonprofit hatcheries. The

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Snow Memorandum on the legislative history of the hatchery program supports this conclusion:

At this time [1973-974], legislators were coming to the view that the private sector would be more efficient than the government in the operation of hatcheries. Also, nongovernmental hatcheries had much to recommend them from the perspective of public finance issues: the operation of private hatcheries could be funded from the harvest of returning fish and from tax assessments on the fishermen who had access to hatchery production, thus shifting the cost of the facilities from the shoulders of the general public to the people who derived benefits directly from them.

Snow Memo., p. 5. (emphasis added). Snow goes on to point out that in 1974 "there was great enthusiasm about the prospect of PNP hatcheries from fishermen's groups, education centers, Native corporations, and the legislature itself." Id.

An attorney for the Southeast Alaska Seiners, Michael D. Stanley, seems less enthusiastic about cost recovery. He has approached the issue from a different direction, acknowledging the Department's primary responsibility for control of hatchery harvests, but questioning whether the Board has the statutory authority to allocate fish to private hatcheries. See Memorandum from Michael Stanley to Kate Troll, Executive Director Southeast

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Alaska Sealers, dated February 28, 1991. Stanley bases his argument on AS 16.05.440(a), cited above at page 5. He focuses on the statutory language subjecting hatchery fish to regulation in the same manner as wild stocks, "until they return to the specific location designated by the department for harvest by the hatchery operator." From this he concludes (1) it is the Department, not the Board, which is responsible for "allocating" hatchery fish to a hatchery through designation of special harvest areas, and (2) such allocation occurs only after those fish have traversed the common property fisheries and returned to the specific location designated for hatchery harvest. Stanley Memo., p. 4.

One flaw in this reasoning is that it confuses allocation of fish to be harvested with designation of a special harvest area and harvest timing. There is no logical reason that the Board cannot allocate a portion of the return to a hatchery and the Department designate the specific time and place for the harvest of that allocation. In fact, my understanding is that that is how the system has always worked.

This scheme also appears to be in harmony with subsection (b) of AS 16.10.440, which gives the Board the authority "to amend by regulation... the terms of the permit relating to the harvest of

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fish by hatchery operators, and the specific locations designated by the department for harvest." This provision gives the Department primary responsibility to regulate cost recovery harvests, but also confers sufficient statutory authority on the Board to allocate fish to be harvested. The legislative history of AS 16.10.440, quoted at length below, indicates that the role of the Board extends to regulating the harvest of "those fish which are returning as a result of releases from natural systems and also from hatchery releases." House Journal, March 15, 1979, pp. 601-602.

Another difficulty with Stanley's theory that the Board does not have the power to allocate fish for hatchery harvest is that it seems to be inconsistent with two specific provisions of the Limited Entry Act, under which hatcheries are granted limited entry permits. AS 16.43.440 provides that: "use privileges granted under AS 16.43.400 - .440 are subject to the regulations of the Board of Fisheries." Also, AS 16.43.950 states that "... Holders of ... entry permits issued under this chapter are subject to all regulations adopted by the Board of Fisheries." These provisions

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also could be read to authorize the Board to allocate fish to hatcheries.⁶

As a final point in response to the Stanley Memorandum, the Board's primary authorizing statute, AS 16.05.251(a), is quite broad and seems to give the Board ample authority to allocate fish for cost recovery and broodstock harvest. Examples of the types of regulations the Board may adopt are found in Section 251(a)(6) (classifying as commercial fish, sport fish, personal use fish, subsistence fish, or predators or other categories essential for regulatory purposes); Section 251(a)(12) (regulating commercial, sport, subsistence, and personal use fishing as needed for the conservation, development, and utilization of fisheries); Section 251 (a)(14) (establishing nonexclusive, exclusive, and superexclusive registration and use areas for regulating commercial fishing.) See also, AS 16.05.251(e) (Board shall establish criteria for allocation of fishery resources among personal use,

⁶As we have argued elsewhere, the power of the Board to allocate to hatcheries does not include the power to deny a reasonable allocation altogether.

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sport and commercial fishing). These provisions are broad enough to allow the Board to allocate to hatcheries.

The idea that hatchery harvests do not qualify as "commercial fishing", and therefore not covered by these statutory sections, is directly contrary to the plain meaning of the definition found in the statute.

"Commercial fishing" means the taking, fishing for, or possession of fish... with the intent of disposing of them for profit, or by sale, barter, trade, or in commercial channels;

As 16.05.940(4). There can be no doubt that PWSAC takes and possesses fish with the intent of disposing of them by sale in commercial channels, and is thus engaged in commercial fishing within the meaning of AS 16.05.251. Commercial fishing is precisely what a cost recovery harvest is. PWSAC's conduct in this regard is indistinguishable from that of any other commercial fisherman. (Ironically, one of the objections that is raised by hatchery opponents is that it is inappropriate, for some reason, for hatcheries to "compete" in the commercial market with other fishermen trying to sell their fish to the same customers).

If PWSAC is engaged in commercial fishing, AS 16.05.251 and the case law cited in the White Memorandum (e.g., Meier v.

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State Bd. of Fisheries, 739 P.2d 172 (Alaska App. 1987)) support the conclusion that the Board has ample power to make allocations for hatchery harvests. The Board not only has the authority, but it also has an obligation to do so. See, AS 16.05.251(d) (requiring the Board to provide a fair and reasonable opportunity for the taking of fishery resources by personal use, sport and commercial fishermen).

C. The Board's Power To Restrict Hatchery Output Is Unclear, But Must Be Limited By The Same Constitutional And Statutory Restrictions That Apply To Cost Recovery

Your second question concerns the extent of the Board's authority to regulate hatchery output, as opposed to allocation of harvests. The Snow Memorandum (Attachment A) addresses this issue. It directly responds to a question posed by Senator Eliason as to whether the legislature ever considered limiting hatchery production because of: (1) adverse impacts on wild stocks; or (2) adverse impacts on salmon market prices. Snow's answer is revealing. Her memorandum states as follows:

We found no discussion in the legislative record that hatchery production should be restrained to a predetermined level for either biological or economic reasons. While the legislature was presumably prepared to take whatever corrective measures were necessary in the face of persuasive evidence that the hatchery program

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was causing serious biological problems, there appears to have been no discussion of establishing a ceiling on the production of fish from hatcheries.

There also appears to have been no contemplation of imposing a ceiling on the production of hatchery fish to support market prices. According to Terry Gardiner, salmon stocks were so depressed in the 1970's that there was no thought given to the possibility of oversupply.

* * * * *
Clem Tillion told us that the legislature did not anticipate dependence on hatchery salmon by Alaska's commercial fishermen, and if adverse impacts on salmon market price were suspected by any legislators, it was not a widespread feeling, for they did not take steps to be able to limit production if that occurred.

Snow Memo., pp. 13-14 (emphasis added).

Consistent with Snow's conclusions, a review of the Board's authorizing statute as well as the other statutes relating to hatcheries finds little or no basis for regulation of hatchery output by the Board.

You specifically asked whether AS 16.10.440(b), which provides, among other things, that the Board has the authority to regulate "the terms of [a hatchery] permit relating to the source and number of salmon eggs...",⁷ authorizes the Board to limit

⁷Section 440(b) goes on to say that the Board may not "adopt regulations or take any action regarding the issuance or denial of any permits required in AS 16.10.400 - 16.10.470." This suggests that the Board does not have the power to completely deny a cost

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hatchery production levels. The legislative history of this provision indicates that it does not. The Resources Committee's letter of intent on HB 359, which included the language in question, states as follows:

There are three other major changes made by the bill:

(1) Section 2 of the bill amends AS 16.10.440(a)(b). The amendment clarifies the role of the Board of Fisheries. The role of the Board of Fisheries as envisioned by the original legislation was to regulate the harvest of salmon returning to the waters of the state. That role extends to regulating those fish which are returning as a result of releases from natural systems and also from hatchery releases. There are provisions in other portions of the non-profit hatchery Act which allow the designation of specific locations for the harvest of salmon by the hatchery operator for sale, and use of the money from that sale, for the specific purposes as stated in AS 16.10.450. The added language clarifies that the Board of Fisheries may adopt regulations relating to the harvest of the fish by hatchery operators at the specifically designated locations. The Board of Fisheries in the past year or two has enacted regulations relating to those harvests for several of the private non-profit hatcheries in the state.

recovery harvest permit.

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House Journal, March 15, 1979, pp. 601-602 (emphasis added). The exclusive reference to regulation of harvest, and the absence of any mention of production controls, corroborates the conclusion reached by the Snow Memorandum that the legislature never intended to authorize the Board to limit hatchery production. The Board's traditional function has always been to allocate harvests.

The only other statutory provision that suggests otherwise is found at AS 16.05.251(7), which authorizes the Board to regulate the "propagation and stocking of fish," which tends to suggest the power to regulate production, not just harvest levels and allocations. The most plausible explanation of this language is that it was included to permit regulation of such activities as stocking lakes with trout or perhaps even raising fish in ponds. There is regrettably no legislative history available to aid in the interpretation of this language. Because it runs counter to the Board's traditional role and is inconsistent with the conclusions in the Snow Memorandum, it would be wrong to assign much importance to this provision.

Apart from the issue of whether the Board could regulate hatchery output on a local basis, you have asked also whether the Board has the authority to set regional production limits for the

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purpose of adjusting relative market shares between different regions of the State. Can the Board, for example, legally cap hatchery sockeye output in Prince William Sound to keep it at the historical position it has held in relation to Bristol Bay sockeye production?

There is no short and simple legal answer to this question. The authority to regulate propagation and stocking is a very slender thread from which to hang an unprecedented, statewide regulatory program of production allocation, which has not been specifically authorized or even contemplated by the legislature. Certainly any such regulatory regime would raise serious questions as to its consistency with the Board's statutory duty to "conserve and develop" the State's fisheries. Such a policy might further conflict with a number of the other statutory provisions already discussed. It would also run up against the sustained yield concept (Section 4) and the maximum use (Section 1) and maximum benefit (Section 2) policies at the heart of Article VIII of our constitution.

Perhaps more significant than the legal impediments, which are considerable, there would be serious practical and policy problems with any attempt by the Board to allocate production

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between regions of the State. For example, which historical moment would serve as the reference point for assignment of regional quotas? Would it be before or after establishment of the hatchery program? Would new hatchery programs (such as the Main Bay sockeye facility) be automatically precluded if they would alter the historical balance of harvest levels between regions? How could hatcheries plan their budgets and production levels from year to year, given the inherent unpredictability of natural returns? Would a direct consequence of such a policy be to reward stagnant regions and to stifle initiative on the part of any region that is efficient, well-organized and capable of growth? Would the anticompetitive aspects of regional limits outweigh the asserted benefits? What are the asserted benefits? Do they go beyond mere regional jealousy and have some statewide economic rationale? While the answers to these questions are unknown, it may be very difficult for the Board to identify a defensible, rational basis for any such plan.

Chapter VI. PLANNING AND PERMITTING

A major element of the statewide salmon enhancement program is the planning and permitting process.

CURRENT PLANNING AND PERMITTING PROCESS

Legislation in 1976 authorized the commissioner of the Alaska Department of Fish and Game (ADF&G) to designate regions of the state for the purpose of enhancing salmon production. This statutory responsibility is implemented through Regional Planning Teams (RPTs), composed of department personnel from the fisheries divisions and representatives from the regional aquaculture associations. The RPTs also have ex-officio members from other agencies (e.g. U.S. Forest Service, U.S. Fish & Wildlife Service). See attached charts for an illustration of the planning and permitting process.

In regions where no regional aquaculture association has been formed, planning core groups representing ADF&G fisheries divisions, fishermen and other agencies and interest groups are established for the purpose of developing comprehensive salmon plans.

The mission of the RPTs is to plan for the long-term utilization of the salmon resource using an orderly process that examines the full potential of the region's salmon production capacity. Regional comprehensive salmon planning progresses in stages. Phase I sets the goals, objectives and strategies for the region by developing a 20 year, long-range plan. Phase II identifies potential projects and establishes criteria for evaluating the enhancement and rehabilitation potential of the salmon resource in that region through the development of 5-year action plans. Upon completion of these phases, the RPT annually reviews the status of the program and prepares updates to the Phase II plans. In Prince William Sound, the RPT has initiated development of a Phase III plan that incorporates Board of Fisheries-approved allocation and fisheries management plans with hatchery production plans. All plans are reviewed and approved by the ADF&G commissioner.

The RPTs not only develop the comprehensive salmon plans, but also review and comment to the ADF&G on:

- private nonprofit (PNP) hatchery permit applications;
- proposed alterations to PNP hatchery permits;
- PNP and ADF&G annual hatchery management plans; and
- annual reports by PNP hatchery operators.

Each hatchery enhancement project is reviewed, based on some relatively consistent criteria:

- Will the hatchery make a significant contribution to the common property fishery?
- Does the proposed project allow for continued protection of natural stocks?
- Is the proposed project compatible with the comprehensive plan?
- Does the proposed project make the most appropriate use of the site's potential?

Comprehensive salmon plans have been developed and approved for northern Southeast Alaska, southern Southeast Alaska, Yakutat, Prince William Sound/Copper River, Cook Inlet, Kodiak, and Bristol Bay. The comprehensive salmon planning process has recently

been initiated for the Alaska Peninsula/Aleutian Island/Area M region, the Chignik region, and for the Kotzebue Sound area in relation to the Sikusuilaq Springs Hatchery.

Regional Aquaculture Associations

In addition to regional planning, ADF&G was also directed to assist and encourage the formation of qualified regional associations for the purpose of planning and implementing fisheries enhancement and rehabilitation projects. An association must be representative of commercial fishermen and other user groups in the region. Once formed, an association typically receives a planning and organizational grant from the Department of Commerce and Economic Development.

Private Nonprofit Permit Application Process

The commissioner of ADF&G may issue a nontransferable permit to a nonprofit corporation for the construction and operation of a salmon hatchery after the permit application has been reviewed by the regional planning team.

The permit application process is rigorous and includes: 1) pre-application assistance from ADF&G, 2) a management feasibility analysis, 3) the permit application and fees, 4) determination of acceptance by the department for formal review, 5) regional planning team review, 6) a provision for requesting additional information, 7) completeness determination by the department, 8) the public hearing process, 9) review and determination by the commissioner (this includes six major criteria), and 10) a provision for reconsideration. The departmental review of all PNP hatchery permit applications includes review and comment by all fisheries divisions, the Habitat Division, the principal geneticist, and the principal pathologist. A public hearing and full review by state and federal agencies through the coastal zone review process is also required.

Conditions may be placed on a PNP permit, including a provision that donor stock eggs must be from the department or a source approved by the department. Other permit conditions include restrictions on placement of salmon eggs or resulting fry into the waters of the state; restrictions on the sale of eggs or resulting fry; the timing and conditions of releasing salmon; destruction of diseased salmon; departmental control over where salmon are harvested by hatchery operators; and siting requirements so that reasonable segregation from natural stocks occurs while still allowing, to the extent feasible, returning hatchery fish to pass through traditional salmon fisheries.

The commissioner may alter, suspend, or revoke a PNP permit if the operator fails to comply with the terms and conditions of the permit within a reasonable period after notification of noncompliance. The commissioner may also alter the permit or terminate the operation, if it is found that the hatchery is not in the best interest of the public.

Fish released by hatchery operators are available for common use as natural stocks, until they return to the location established by the department for hatchery harvest. The Board of Fisheries may, after a permit has been issued, amend by regulation the terms of the permit relating to the source and number of eggs, the harvest by hatchery operators, and the locations of hatchery special harvest areas [AS 16.10.440(b)]. This is the basis for the Board-regulated Fish Transport Permit process (see Biological Issues chapter), establishment of hatchery special harvest areas, and board-

approved terminal harvest area plans. *The statutes also appear to give the Board the authority to limit or control production at individual hatcheries based on egg-take for broodstock.* This authority has never been used, and there is a strong difference in opinion as to whether or not the Legislature actually intended the Board of Fisheries to regulate hatchery production, or instead, to regulate the take of eggs from wild stocks for hatchery production.

A hatchery operator must file an annual report with ADF&G by December 15 of each year. The report contains information on hatchery returns, numbers of eggs taken, and numbers of fry or smolt released.

A *Basic Management Plan* (BMP) is developed as part of the actual permit. The BMP includes a complete description of the facility and special harvest area, broodstock development schedules, and descriptions of broodstock and hatchery stock management. Marking programs for hatchery-produced fish can be required in the hatchery permit and BMP. Tagging is usually considered optional, unless during the permit or permit alteration process, fisheries managers specify the need for special in-season management capability.

When a permit is approved and operational, an *Annual Management Plan* (AMP) is developed for each year of operation. Specific plans for egg-takes, cost-recovery harvest, fry and smolt releases, and marking and recovery are included. AMPs are developed by the department in conjunction with the operator and are reviewed by all the fisheries divisions and the RPT before being approved by the commissioner.

Alaska Statutes 16.10.400-16.10.475 address this process, as well as regulations in 5 AAC 40.100-40.990.

Fish Transport Permits

The possession, transportation or release of live fish and their reproductive products (eggs) into the waters of the state requires a *Fish Transport Permit* (FTP) from ADF&G. The FTP permit application covers only one specific operation and is quite detailed, including:

- effective period,
- transport dates,
- maximum number of fish or eggs to be taken,
- incubation and rearing location,
- release location,
- purpose and benefits,
- evaluation methods,
- native stocks present,
- history of known transport of this stock,
- disease history,
- description of proposed egg-take methods,
- planned disease control measures, and
- water source for rearing and effluent discharge location.

The FTP application is intensively reviewed by the regional supervisors of the FRED, Commercial Fish and Sport Fish Divisions, the FRED pathologist and principal geneticist, as well as the FRED chief of technology and development and the FRED director. A signature page is attached to the actual permit which includes recommendations and comments. The permit is then approved or disapproved by the commissioner of ADF&G.

The potential for disease and genetic impacts are the primary considerations in the FTP review process.

Fish Resource Permits

ADF&G is currently developing a policy on *Fish Resource Permits* (FRP). The FRP was previously called a scientific/educational (sci/ed) permit. This policy is being developed as a result of a previous lack of standards for the scientific and educational projects. Alaska statutes have only brief references to these activities, but it is clear that the Legislature intended them to be allowed.

Under the proposed policy, Fish Resource Permits will be issued with the stipulations of no commercial activities, no human consumption, and no sale of the species. These permits are classified into collecting permits for scientific or educational purposes, holding permits for either exhibition or scientific research, and limited propagation permits for various scientific or educational purposes.

ADF&G's proposed policy clearly indicates what reviews and permits are required for each kind of project and should alleviate the prior problems caused by a lack of such standards.

PROBLEMS AND ISSUES

1. Lack of statewide goals and objectives for enhancement program.

The 1974 authorizing legislation provides the legislature's intent that private nonprofit corporations (PNPs) contribute to the rehabilitation of the state's depleted and depressed salmon fisheries. Except for some specific regions of the state and gear groups in those regions, this goal has been met. The numbers of Alaska's wild and hatchery fish are at an all time high. Other than the problems of marketing and price, most of the state's salmon fisheries are no longer depressed. Few people dreamed the state's enhancement program would be so successful in terms of quantity of fish. Large enhanced production, in combination with improved management of wild runs and favorable environmental conditions, have resulted in Alaska once again producing record amounts of salmon.

The state does not have a clearly defined policy for future management and development goals for hatcheries and other enhancement efforts that goes beyond increased production. It has been proved it is possible to grow large numbers of fish. Where should we go from here? For example, should our goal be to cap salmon production at a certain level, or cap production of specific species at a set level? Should the focus be on enhancement efforts in other areas of the state that have very small or depressed fisheries with a goal of economic development? Should the focus be shifted to other species such as crab enhancement or sheefish or arctic char? These are the kinds of policies and goals that are yet to be made on a statewide basis.

ADF&G's FRED Division is currently developing a strategic plan for the next decade. However, this plan needs to be developed in conjunction with a statewide planning effort so that FRED's goals and objectives are coordinated with the other elements of the state's enhancement program, including the PNPs. Additionally, adequate financial support is essential to meeting those goals and objectives.

2. Regional v. Statewide Planning.

State law directs salmon production planning to be done on a regional basis. Although the commissioner of ADF&G has overall authority for both PNP and department enhancement efforts, little comprehensive statewide planning is done, with only minimal interaction between regions of the state. Most planning focuses on *production* in a region and not whether the production is *desirable* relative to other regions. Additionally, within each region, state hatcheries have varying interaction with the private enhancement efforts.

Today, however, hatchery produced fish comprise a growing proportion of the statewide harvest. There are concerns that Alaska's production-oriented enhancement program may result in one region's program affecting markets, prices and management in other regions.

Fisheries managers argue that the state needs a statewide planning policy that will take into account the potential impacts of one region on another, as well as closely scrutinizing potential management problems and marketing feasibility.

Others agree with the idea in principle, but maintain that such an effort is impossible in a state where competing interests would find it difficult to agree on a system that diminishes local control over hatchery development and production goals. Shifting to a statewide review could create enormous tensions between the user groups of different regions.

The Board of Directors of the United Fishermen of Alaska (UFA) in January 1992, requested the FRED Division to involve all RPTs in a statewide review process of hatchery production. The request was based on the premise that "[s]ince hatchery production is now at a level that the impacts are no longer confined to one region, UFA believes that such a review is warranted now more than ever."

3. Funding and support for planning.

Fishermen, hatchery operators, and state fisheries managers agree that the RPT planning process provides an important forum for discussing and resolving difficult issues on an ongoing basis.

However, *state support for planning has declined since the early 1980s* when FRED had a budget of over \$500,000 for grants to aquaculture associations. Grants were gradually reduced and eliminated in 1987. Meanwhile, the number of regions requiring plans increased from six in 1987, to ten by the end of 1991. Initial, one-time-only planning grants of up to \$100,000 are still available for regional aquaculture associations from the Department of Commerce and Economic Development.

Despite the need for more rigorous planning because of increased enhanced production, FRED planning staff has declined from two to one and a half positions. These positions coordinate all enhancement efforts statewide, including state facilities, provide technical assistance to the PNPs, and plan new ventures.

Budget reductions have forced state planners to shift priorities from plan development and implementation to plan maintenance. As a result of decreased state support, Prince William Sound and Cook Inlet Aquaculture Associations have hired full time planners. Although hired by the regional associations, these planners consider

themselves staff to the local RPT. However, they are also involved in internal corporate planning, and arguably, this could be considered a conflict.

As a result of budget cuts, new planning efforts are minimal. New ventures are at a distinct disadvantage when compared to those started ten years ago. In the past, there was money for new hatchery projects, either through state general bond initiatives, grants or loans. More recently however, new hatchery initiatives have received little financial support.

FRED managers, gear group representatives and several aquaculture association managers strongly believe that present funding levels for planning are inadequate for FRED to properly oversee the functions of the 37 hatcheries in operation in Alaska. As a result, they believe that many more conflicts and issues will develop that should have been resolved early in the process. Perhaps just as importantly, FRED managers indicate that they are unable to consider the "big picture" issues such as long-term analyses and guidance for future developments.

RPT members also complain that the cutback in funds for planning has limited their contribution to a cursory discussion and approval of permit changes. If a hatchery requests a change in permit, they often have to wait six months or longer to be considered because funds are not available for some RPTs to meet more than twice a year.

4. Composition of Regional Planning Teams

*Although many people believe the regional planning team (RPT) process is a good one if adequately staffed and funded, there are others who believe that the entire structure of the RPT should be changed. A frequent complaint is that the composition of the RPT is heavily weighted towards the commercial sector of the fishing industry, without sufficient representation of subsistence and sport fishing users, community and regional governments, environmentalists, and the general public. These critics argue that in order to have a truly **balanced** decision, all the varied interests of the region need to be adequately represented. Some RPTs have tried to address this complaint by broadening the composition of the team to include all interested groups.*

Another, more fundamental concern is that ADF&G managers are usually out-numbered on the RPTs. As a result, the group can pressure department managers into approving projects that should probably be denied. Department personnel who raise future management concerns are under considerable pressure to be a *positive* presence in the RPT process, which in some cases, translates into withdrawing or modifying their objections without these concerns being adequately addressed. On the other hand, concern has also been expressed that department managers sometimes have a strong, anti-hatchery bias that can influence their management recommendations.

There is also the concern that the non-Fish and Game members of the RPT may not be sufficiently capable of evaluating and making decisions on issues that are increasingly technical in nature.

5. Allocation issues.

While issues such as location, harvest timing and cost recovery projections are scrutinized, the question of allocation is not considered by any of the parties involved with the RPT review process; AS 16.05.251 delegates that responsibility to the Board of Fisheries.

Without the ability to consider allocation issues as part of the permit review process, ADF&G may approve a hatchery permit that could create future allocation problems. By the time the Board of Fisheries begins to consider allocation problems resulting from hatchery production, millions of dollars may have been invested through state loans. The state may well feel a financial obligation to ensure the success of the facility.

In addition, allocation conflicts over hatchery-produced fish may eventually require tagging programs as part of their resolution. The question of tagging -- and who should pay for it -- is one that is more easily addressed early in the planning and permitting process.

Recent developments seem to indicate a change for the future. ***In 1988, the Board of Fisheries charged the Prince William Sound Aquaculture Corporation (PWSAC) with development of an allocation plan for enhanced stocks in Prince William Sound.*** After an intense planning effort and several drafts, PWSAC was able to come up with an allocation scheme that all user groups and the department could support. The allocation plan was approved by the Board of Fisheries in 1991 and was in effect this past fishing season. The regional planning team incorporated the allocation plan with its production and management plans into a comprehensive Phase III maintenance plan.

Using the success of PWSAC as a model, the Board of Fisheries has also directed the two Southeast regional aquaculture associations (NSRAA and SSRAA) to develop an allocation plan for hatchery stocks by March 1993. There is considerable debate among participants and observers as to whether this can be done. Unlike the Prince William Sound plan, which deals primarily with one species and a single user group, Southeast must address deep-seated conflicts between two aquaculture associations, three commercial user groups and several species of salmon, as well as factoring in the complexities of the U.S./Canada salmon treaty.

6. Management issues.

Another complaint is that regional comprehensive salmon plans often focus exclusively on production goals for a hatchery, but provide little specific information on fishery management. Statements such as "management agencies and fishermen should work together to find the best solutions currently available to reverse declines" are common.

Initially, hatchery permitting was a two-stage process. The preliminary application included identification of such things as site, species, and run-timing. It contained little detail, and was given a relatively cursory review by ADF&G to notify the permittee if there were any significant potential problems before the applicant went to the expense of a full permit application. In 1985, however, hatchery permits were placed under the Coastal Zone Management process. As part of permit reform, FRED planners were told that only a single application could be required.

To replace the preliminary application, FRED now requires an initial ***Management Feasibility Analysis (MFA)*** be completed before a final application is submitted. The MFA covers the basics of siting, species, timing, and magnitude of production, and is developed by the Commercial Fisheries and Sport Fisheries Divisions to avoid potential

management problems. Quite often, if red flags are raised during this review process, the original proposal ends up being modified.

Additionally, once an application is deemed acceptable by the department, the department's divisions are again given further opportunity to comment.

FRED planners believe that they have never permitted a hatchery or enhancement project that fisheries managers did not initially approve.

7. Uniform review.

State hatcheries and projects are not subject to the same permitting requirements as PNPs. Some fishermen believe that state projects cause the most allocation, management, and potential biological problems because of the lack of this additional layer of scrutiny. They would like to see permits required for state hatcheries and projects, as well as for PNP projects.

FRED Division believes adding this requirement is unnecessary. Although PNP-type permits are not required, state projects are reviewed through the Coastal Zone Management review process. In addition, the annual management plans for state facilities are submitted to the Regional Planning Teams for review. Some people believe these projects often receive more critical review than the PNP projects. Both state and PNP operations also require Fish Transport Permits (FTPs).

8. Criteria to show public benefit.

Four criteria must be considered by the RPT to determine if a permit application is in compliance with the regional comprehensive salmon plan:

- the contribution the proposed hatchery would make to the common property fishery;
- the provisions for protecting wild stocks from any adverse effects which may originate from the proposed hatchery;
- the compatibility of the proposed hatchery with the goals and objectives of the comprehensive salmon plan for the region; and
- whether the proposed hatchery would make the best use of the site's potential to benefit the common property fishery.

Critics say these criteria should be expanded to consider other public benefits and costs. Possible additions include marketability, a detailed cost-benefit analysis, and ongoing genetic and biological monitoring.

9. Operation performance reviews and permit revocation.

State managers and RPT gear group representatives are also concerned about ADF&G's authority over hatcheries that are out of compliance with state laws, regulations, and permit requirements.

Present regulations allow RPTs, at the direction of the ADF&G commissioner, to review a hatchery's compliance with statutes and regulations, and to recommend the suspension, alteration or revocation of a permit if certain performance standards are not met such as survival rates and contribution to the common property fishery. However, a recent attorney general's opinion required that one hatchery facing revocation of a permit must be given a hearing before an administrative officer under the Administrative Procedures Act. This can be a relatively lengthy process.

With the potential risk of impacts on the state's common property fisheries, managers and some RPT members believe a mechanism to allow for the timely revocation of a permit is necessary. They advocate for a change in the statute to allow the ADF&G commissioner to revoke, suspend or alter a permit for any violation of Title 16 without going through APA requirements.

10. Hatchery Siting Privileges

If a region has an organized aquaculture association, that association, under state statutes, has the preference rights to all potential hatchery sites in that region. Non-association PNPs (Mom and Pops) have expressed concern that giving priority use of potential sites to an association is not good public policy. The Mom and Pop operations believe that any unused hatchery sites should be available to both associations and non-association PNPs.

11. Canadian evaluation model

The Canadian government is considered to have a model evaluation program of its national salmon enhancement program. Under the auspices of the Internal Audit and Program Evaluation Branch of the Department of Fisheries and Oceans, this program is intended to provide a thorough and comprehensive review of the program, by facility.

The first evaluation project began in 1985 and concluded that there was not enough production and biological data available to carry out a proper program evaluation. The program audit branch then designed the optimum evaluation framework and determined what kind of data would be needed. These data included biological and production information, as well as an analysis of economic costs and benefits. With that data in hand, program auditors are now preparing to spend a year reviewing the entire program, with a final report due in March 1993. Federal funds are being used for this project, although university staff and consulting firms are conducting the actual evaluation.

OPTIONS FOR POSSIBLE CONSIDERATION:

- Working with the public and user groups to develop statewide goals and objectives for the state's entire fisheries enhancement program.
- Directing FRED Division to develop a program to implement these goals and objectives.
- Declaring a moratorium on further hatchery development or increased production until the Legislature's economic cost-benefit studies are complete and a full assessment of the state's program can be made.

- Development of a statewide planning process.
- Development of a statewide production plan.
- Requiring FRED to develop a comprehensive annual report that not only compiles production figures from state and PNP facilities, projects, and current management regimes, but also includes future production and management plans.
- Evaluation of the composition and procedures of the RPT to determine if changes in the RPT structure are necessary.
- Expansion of state statutes to require all hatcheries, including state facilities, to comply with a single planning and permitting process, with the same requirements for monitoring and review.
- Widening the scope of RPT review, including recommendations for allocation of enhancement production.
- Providing adequate funding for planning.
- Reviewing the required Management Feasibility Analysis to determine if it needs to be a more comprehensive review.
- As part of permit review and solicitation of state loans, consideration of adding new criteria to show public benefit, including marketability, a detailed cost/benefit analysis instead of a financial feasibility analysis, a more specific indication of the "significant contribution" to be made to the common property fishery, and some kind of environmental assessment.
- Providing concrete direction for the timely performance review of PNP hatcheries and a more workable mechanism for closing or converting hatcheries not making a "significant" contribution to the common property fishery.
- Exempting the alteration, suspension or revocation of an enhancement permit for violations from the Administrative Procedures Act.
- Instituting a regular review process similar to the Canadian model.
- Clarifying Board of Fisheries authority to regulate hatchery production levels.
- Re-evaluation of the policy of giving regional aquaculture associations the preference rights to develop future hatchery sites in the region.

Planning Process

Regional Planning Team

Regional Comprehensive Plans

Historic harvests,
production/harvest
goals by area, species

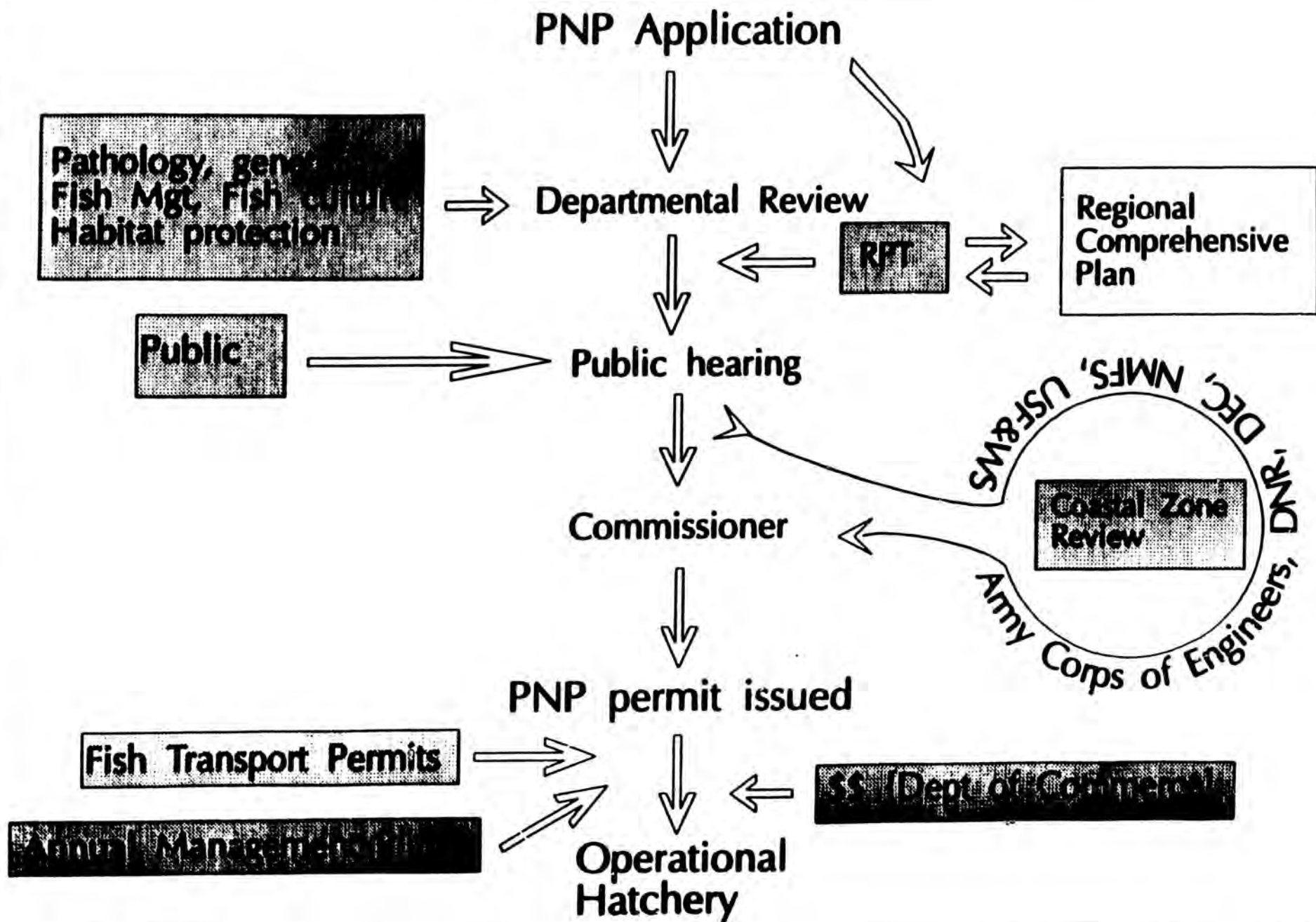
Project
opportunities
to fill gaps

Plan Update

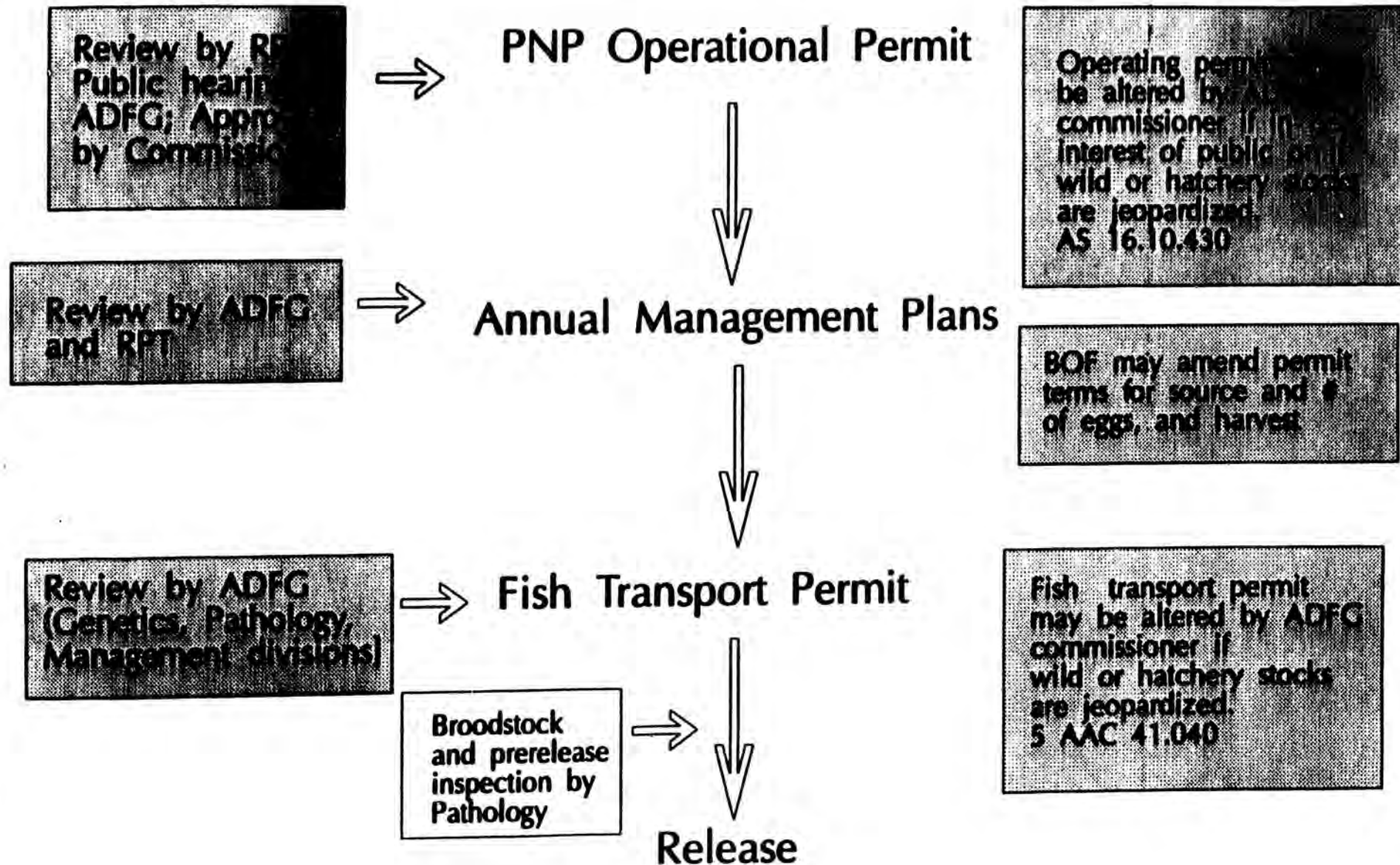
Phase I --> Phase II
Annual Update

Attachment to
Chapter VI.

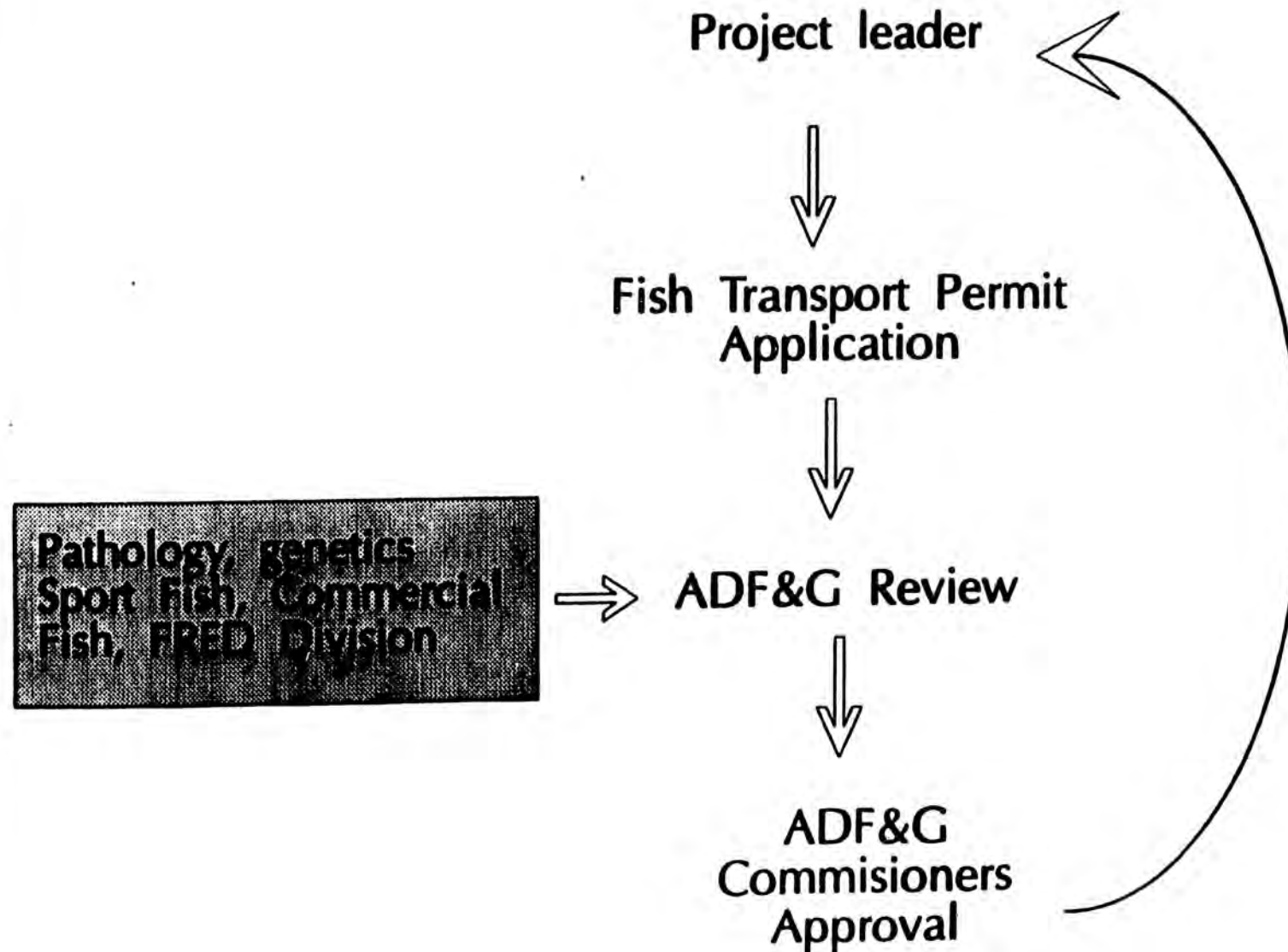
PNP Application Process



Regulation of PNP Hatcheries



Fish Transport Permit Process



CHAPTER VII. BIOLOGICAL/GENETIC ISSUES

In November 1991, in Cordova, Alaska, the Prince William Sound Science Center (PWSSC) and the School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, convened a group of world-renowned experts to examine "The Biological Basis for Maintaining Strong Co-existing Stocks of Natural and Enhanced Salmon Populations in Alaska." This workshop followed a series of international symposiums on this topic during the past two years. Top fisheries biologists, ecologists and geneticists from the United States, Norway, Sweden, the Soviet Union and Japan were present at the Cordova workshop. As a follow-up to the workshop, the group intends to produce a summary report and list of recommended policies and procedures to be considered by the state of Alaska in managing its wild and enhanced salmon stocks. That report is expected in late February.

The cumulative effect of hydroelectric dams, habitat destruction, overfishing, and large-scale hatcheries has led to the decimation of many wild salmon stocks in Pacific Northwest states. Biologists in states with a long history of hatchery programs are generally less enthusiastic about these programs than biologists in areas such as Alaska and British Columbia with comparatively recent programs. *Although poor hatchery practices can clearly endanger wild salmon populations, scientists do not agree on the extent to which hatcheries with sound practices can co-exist with sustained healthy runs of wild salmon.*

The lack of consensus among scientists largely results from insufficient data and research, and at times, professional bias. Even where information exists, however, it is often subject to conflicting interpretations. To complicate matters, results of specific studies may not be transferable to other areas or salmon species, and year-to-year environmental changes may affect the results of these studies.

THE GENETIC EFFECTS OF HATCHERIES

Most scientists agree that it is essential to have healthy wild stocks to maintain the health and genetic diversity of both wild and hatchery stocks; genetic diversity must be preserved. Scientific knowledge about the genetic impact on wild stocks of hatchery fish, however, is still incomplete. Reduction in the fitness of salmon stocks, to the extent it has been documented, may involve numerous factors. Most scientists agree that hatcheries can complicate mixed-stock fisheries and affect the genetic composition of wild fish stocks. Scientists do not agree on the extent to which genetic changes affect the short- or long-run fitness of wild stocks.

Straying and intermingling of stocks is a major concern to scientists. The extent of straying, the variables involved in imprinting, and the effects of interbreeding are largely unknown. Large-scale ocean ranching appears to set the stage for straying of wild stocks in the harvest areas of enhanced stocks and also for hatchery fish to stray into the natural streams. What impact this has on the genetic diversity of salmon stocks in a given region is a question that remains to be answered. However, the concern is that intermingling may reduce the fitness of the locally adapted populations.

It is known that the greater the distance between the donor stream or hatchery and the release site, the greater the amount of straying. Many scientists are concerned about the extensive releases at remote sites practiced by many hatchery operations today, with many more planned for the future. They fear that such

straying could potentially, in time, destroy genetic diversity -- resulting in a permanent, irreversible loss. Some scientists believe remote releases should be banned altogether. Others believe they should be permitted with stringent controls and careful monitoring.

OCEAN CARRYING CAPACITY

Some scientists suspect that the carrying capacity of nearshore marine waters and the high seas for salmon may be exceeded by large-scale releases of hatchery salmon. A reduction in the average size of salmon was reported throughout the Pacific region in 1991, but various factors may be responsible. Since 95 percent of the growth of salmon occurs at sea, some researchers believe ocean conditions affect the size of salmon more than competition. Much evidence, however, supports the theory of density-dependent growth for some salmon species, although there is considerable debate regarding its occurrence. More information is needed on the effects of predation and competitors.

DISEASE

Few studies document the transmittal of diseases between hatchery and wild salmon, and there is no documentation of such transmittal in Alaska. Where transmittal of a disease by hatchery salmon has been documented, it occurred after fish were transplanted long distances. Hatchery fish appear to be more vulnerable to disease than wild fish because of the stress of hatchery conditions and large concentrations of eggs and fry. Norway has had considerable problems with disease transmitted by farmed salmon that have escaped and mixed with wild stocks.

Active fish pathology laboratories are maintained by the FRED Division in both Juneau and Anchorage. Their basic function is to implement policies and procedures that guard against the spread of fish and shellfish diseases in Alaska. Reviewing fish transport permits in order to reduce the occurrence of disease is a major task of the labs, as is examining each broodstock for disease prior to its use in a hatchery.

STATE GENETICS PROGRAM AND POLICY

The state genetics program is intended to implement policies and procedures that protect and maintain the genetic uniqueness of Alaska's wild salmon stocks in the face of North America's largest salmon enhancement program. The state's fish genetics policy, considered to be one of the most stringent in the world, was last revised in 1985, and will be reexamined and updated this year.

Alaska's genetic policy contains guidelines and restrictions intended to protect the genetic integrity of wild stocks. The *goal* is to maintain adequate genetic variability, ensuring that the enhanced stock will be able to adapt to changing environmental conditions.

Geneticists have two primary concerns in protecting wild stocks and implementing a successful enhancement program. The first is possible genetic impacts due to gene flow between wild or enhanced stocks; the primary concern being, of course, for wild stocks. The second concern is the loss of genetic variation within or among stocks. Both impacts

can potentially cause the reduction of total fitness in wild stocks and hatchery broodstocks. These problems are addressed in the policy's three main topic areas: stock transport, protection of wild stocks, and the maintenance of genetic variation.

Since specific knowledge of salmon population genetics and the genetic impacts of salmon enhancement on wild stocks was limited, the 1985 genetic policy was based primarily on information from agricultural genetics and research on other species. As a result, the policy contains guidelines that are rather flexible. The policy suggests that because scientific knowledge is limited, fish transport should be evaluated conservatively. For example, if genetic similarity decreases with distance, arbitrary limits must be set on the distance a stock can be transported. For that reason, the Fish Transport Permit process is the prime regulatory tool in the genetic policy. *ADF&G is attempting to clarify some of the flexible guidelines in the revised policy by incorporating knowledge gained from recent studies of the population genetics of salmonids.*

The genetic policy also acknowledges that all salmon runs are not of equal importance. The effect of a salmon enhancement project depends to some degree on the relative value of the stock that might be impacted. However, the policy says that the concept of "significant stock" only relates to the size of a fish population in the context of local importance and use. A population that would be considered insignificant in size in one region, may be of vital importance in another region.

OPTIONS FOR POSSIBLE CONSIDERATION:

Although a report of recommended management actions resulting from the Cordova workshop is expected in late February, some preliminary options for consideration include:

- Evaluation of how well the current hatchery program protects wild salmon from possible negative effects of hatchery salmon. Such a review would help policy makers determine the risk of various alternatives for the future of Alaska's hatchery program.
- Increasing the amount of genetic monitoring required of hatchery operators, and directing ADF&G to continuously review and analyze resulting data statewide.
- Obtaining consensus about research priorities concerning the interaction of hatchery and wild fish in Alaska, coordinating future studies, and deciding how and when to apply the results of those studies to current management practices.
- Conducting research to define the minimum conditions for imprinting for remote release programs.
- Review of current and future programs for their compliance with the state genetics policy.
- Placing greater emphasis on management concerns in the permitting process in order to protect wild stocks.
- Re-examination of escapement goals in order to maximize wild productivity.

- Increased use of marking and tagging programs to monitor interactions between hatchery and wild populations.
- Policy development to minimize inbreeding and straying, including an evaluation of remote releases.
- Treating a remote release site as a de facto hatchery site in terms of broodstock and hatchery site guidelines, even if all fish are expected to be harvested.
- Identification of genetic population structures to determine what populations are genetically distinct.
- Survey of populations prior to any enhancement activity to provide a baseline for subsequent genetic monitoring. Evaluation of genetic consequences of hatchery production on adjacent populations during phased-in expansion, with production increases halted if adverse impacts are noted.
- Monitoring wild and hatchery stocks to determine extent of straying and intermingling.

Alaska State Legislature

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September 11, 1991

MEMORANDUM

TO: Senator Lloyd Jones
FROM: Glenn T. Gray ^{GT6}
Legislative Analyst
RE: Effect of Hatchery Salmon on Wild Salmon
Research Request 91.303

You requested information about how hatchery-produced salmon affect wild stocks. You asked us to address five specific questions relating to this issue:

- 1) Do hatchery-produced fish cause genetic dilution of natural stocks?
- 2) Does the harvest of hatchery salmon result in unintended harvest of wild stocks?
- 3) Do hatchery salmon compete with wild stocks for food?
- 4) Is predation by hatchery salmon on wild salmon a significant threat to wild stocks?
- 5) Are wild stocks vulnerable to diseases that originate with hatchery-produced fish?

For this memorandum we reviewed studies by scientists from Alaska, other states, Canada, Japan, the Soviet Far East and Europe. We also reviewed abstracts of papers presented at recent conferences concerning the genetic implications of interaction between enhanced and wild fish. We then discussed these studies and related topics with several scientists and personnel from the Alaska Department of Fish and Game (ADF&G).

This memorandum begins by defining some important terms which are commonly used in discussions of salmon biology. Next, an introduction provides an overview of current knowledge of the effects of hatchery salmon on wild fish. Then each of the five questions you posed are addressed. We also identify other possible biological effects of hatchery salmon on wild stocks. This is followed by a discussion of how management can minimize possible negative effects of hatcheries. The memorandum ends with a summary of concerns voiced by biologists about hatcheries and research needs for the future.

DEFINITIONS

Biologists have traditionally recognized six species of Pacific salmon: coho (*Oncorhynchus kisutch*), chum (*Oncorhynchus keta*), chinook (*Oncorhynchus tshawytscha*), pink (*Oncorhynchus gorbuscha*), sockeye (*Oncorhynchus nerka*), and masu (*Oncorhynchus masu*). All but masu salmon may be found in Alaska waters. Recently, cutthroat trout (*Oncorhynchus clarki*) and steelhead (*Oncorhynchus mykiss*) have been reclassified as Pacific salmon. Atlantic salmon (*Salmo salar*) are not native to the Pacific, but some of them have escaped from fish farms in British Columbia.¹ Salmonids are a biological grouping which includes salmon species as well as related fish such as trout, char and whitefish. Most salmon are anadromous, that is they have both freshwater and saltwater residencies during different periods of their life. Some Pacific salmon spend their whole life in fresh water: Kokanee salmon are sockeye salmon that remain in lakes, rainbow trout are steelhead that live in lakes or streams, and cutthroat trout may also spend their life in fresh water.

We use the term stock to refer to groups of fish of the same species with a similar genetic background that return to spawn in the same locality, and do not generally interbreed with other groups of fish.² Some watersheds may have two or more salmon stocks, but these stocks usually spawn at different times or at different parts of the watershed.³ Fish of a particular stock have a unique genetic make-up because wild salmon generally do not interbreed with other stocks. (As a result of natural straying, stocks spawning near each other would be expected to have more similar traits than stocks located further apart.) Some fishery experts prefer the term population because the term stock is often used in many different contexts. Alaska statutes, for example, define fish stocks less precisely.⁴

A wild stock, as used in this memorandum, is a distinct group of fish descended from a population of fish historically found in a particular area that have not bred to a significant degree with fish from another area.⁵ A natural run is a self-sustaining group of "wild" fish in a natural environment that may or may not have genetic influence from hatchery or farmed fish.

¹Although Atlantic salmon have been caught in Alaska waters, there have been no reports of naturally reproducing populations.

²The term stock generally refers to wild fish because hatchery fish may have originated from several different stocks.

³Larkin (1981) notes that in some instances the "differences among the tributaries of a single river are greater than those among comparable tributaries of different rivers" p. 1460.

⁴Alaska Statute 16.05.940(15) defines a fish stock as "a species, subspecies, geographic grouping or other category of fish manageable as a unit."

⁵The Oregon Wild Fish Management Policy defines a wild fish as one that is descended from a population present in the same area since 1800.

A mixed stock fishery occurs when fish of different wild stocks or hatchery and wild stocks intermingle during commercial harvest. Many of the fisheries in Alaska are mixed stock fisheries. Fisheries that occur after stocks separate are known as terminal fisheries. In watersheds where several stocks spawn, individual stocks may not completely separate until they reach up-water spawning grounds. While terminal fisheries are desirable from a management perspective because stocks may be harvested selectively, they may not be economically desirable because the quality of the flesh deteriorates as the fish approach fresh water.

Genetic variability is measured by the "number, frequency, and diversity of alleles present. Alleles are the variant forms of the gene" (Kelly et al. 1989, p. 60). A procedure known as protein electrophoresis measures allele frequencies and can be used to identify different stocks as well as genetic changes these fish may experience.⁶ Electrophoresis may also be used to measure heterozygosity (an indication of the variation of genes) to determine whether hatchery fish have lost genetic variability. Although electrophoresis is useful to determine a difference between some salmon stocks, the test does not reveal differences between all salmon stocks. Salmon stocks that cannot be differentiated by electrophoresis may be marked through a process known as genetic tagging.

Fisheries enhancement includes a variety of methods to augment natural runs. Hatcheries, construction of spawning channels, and lake fertilization are several examples of enhancement. Hatchery-produced fish are released to open water and are known as ranched fish; while fish raised in net pens and never released are known as farmed fish.

Fitness is the ability of fish to survive competition, predation and disease and return to native spawning streams. Some scientists suspect that wild fish are more fit than hatchery fish because wild fish have evolved through thousands of years of natural selection.

Brood stock are the fish used to start or maintain a hatchery. After salmon eggs hatch and their yolk sacs are consumed, the young fish are known as fry. When immature salmon migrate to the sea they are called smolts.

INTRODUCTION

Hatcheries have become a major contributor to commercial fisheries in the Pacific during the past two decades. As the numbers of wild salmon have decreased, Pacific Northwest states have become increasingly dependent on salmon produced by hatcheries. Except for masu and kokanee salmon, Japan depends almost entirely on hatchery stocks to supply its commercial fisheries

⁶Electrophoresis works better with chinook and chum salmon than with sockeye, pink, or coho salmon (Seeb, personal communication).

(Kelly et al. 1989).⁷ Although the Soviet Far East and Alaska still have many wild stocks, both have ambitious hatchery programs. For example, in recent years hatchery fish have comprised up to 98 percent of the total pink salmon harvest in Prince William Sound (Geiger et al. 1991). Despite the increasing contribution of salmon hatcheries, much is still unknown about the effect hatchery fish have on wild stocks. Additionally, some fear that the long-term productivity of hatcheries cannot be sustained (Hilborn 1990).

Each of the questions addressed in this memorandum are discussed separately, but they may actually be related, and addressing them separately may overlook cumulative impacts. For example, the genetic impact of straying salmon may be greater for a stock that has been reduced by over-fishing than for a healthy stock. Likewise, other influences of hatchery fish may have a detrimental cumulative effect when combined with practices destructive to wild fish (e.g., over-fishing and habitat destruction).

Most of the issues addressed in this memorandum ultimately relate to a concern about a reduction of genetic variability in wild salmon stocks. Genetic variability of a specific stock may be reduced when the size of that stock is significantly diminished. The numbers of a specific stock may be reduced by habitat loss, over-fishing, predation, disease, competition, and possibly by disturbance of wild fish nests (redds) by later-spawning salmon. Some geneticists believe that genetic integrity of a stock could also be at risk because of "genetic pollution" which occurs when hatchery fish breed with wild fish and introduce traits that may not be suited to a particular stream. Genetics most likely determine such traits as the timing of smolting, disease resistance, temperature tolerance, size of eggs, size of fish, timing of return, and possibly the ability of a salmon to find its natal stream. Because the brood stock for hatcheries are often obtained from distant watersheds, hatchery salmon may not be genetically suited for rivers near the hatchery. Hatchery fish which stray to local streams and spawn with wild stocks might introduce traits that would reduce the ability of wild salmon fry to survive in their natal stream.

During the 1970's, when Alaska's current hatchery program began, some biologists expressed concern about the risk to wild salmon of large numbers of hatchery salmon.⁸ These concerns have been amplified in recent years. Several scientific conferences have convened to discuss the interactions of wild and hatchery salmon. A recent article by the American Fisheries Society's Endangered Species Committee identifies 159 West Coast salmon stocks at risk of extinction and 54 additional stocks of special concern (Nehlsen et al.

⁷Attempts to develop natural runs of coho, chinook, and sockeye salmon in Japan have been unsuccessful.

⁸The Alaska District of the American Institute of Fishery Research Biologists issued a position paper concerned with genetic implications of hatcheries in 1975 (Attachment A). This organization was concerned that legislation creating private, nonprofit hatcheries did not address genetic issues.

1991).⁹ Habitat loss, over-fishing, and negative interactions with hatchery fish were cited as the major threats to the wild stocks. The article notes that there is a high probability that 104 of these wild stocks have suffered genetic changes from the presence of hatchery fish.

Although researchers have recently placed more emphasis on studying the possible impacts of hatchery salmon on wild salmon, scientists debate the results of these studies. Many factors could be responsible for the decline of a salmon stock. Weak runs may result from habitat disturbance, over-fishing, disease, competition with other fish, or unsatisfactory environmental conditions, as well as a reduction in fitness from the influence of hatchery fish.

Even when evidence suggests that hatchery fish may have adversely affected a specific wild stock, it is difficult to generalize from that evidence about other stocks. First, each species of salmon has a different life history, different lengths of time in freshwater and marine environments, and different preferences for habitat and feeding.¹⁰ Second, a study in one area may produce different results than if it was conducted in another environment or using different research methods. Third, the same study completed during separate years could have different results because of changing environmental conditions from year-to-year. Fourth, the location of a hatchery and its operating procedures will influence the effects of hatchery fish on wild populations. Fifth, the source of hatchery brood stock may determine the effect on local wild salmon. Sixth, different researchers may reach different conclusions from the same data. Lastly, there is often a shortage of baseline data on wild stocks (many significant stocks may not yet be identified), so it is difficult to measure changes that may occur.

Despite the gaps in scientific knowledge, there is consensus on at least two major points. First, fishery experts agree that in mixed stock fisheries where there are strong hatchery returns and weak wild stocks, wild stocks are likely to be over-harvested. Second, fishery geneticists generally agree that hatchery salmon have the potential to alter the genetics of wild fish. Researchers do not agree, however, if interbreeding between hatchery and wild fish will reduce the long-term fitness of wild salmon stocks. Likewise, there is not a consensus about how hatchery fish affect wild fish through competition, transmission of disease, and predation. Large-scale releases of hatchery salmon, however, are more likely to result in more profound effects on wild salmon than are releases of smaller numbers of fish.

⁹Salmon stocks in California, Oregon, Idaho and Washington were examined in this study.

¹⁰Reimers (1979) reports that life histories of juvenile chinook salmon vary both within and among stocks although many managers fail to recognize such variation.

GENETIC DILUTION OF NATURAL FISH STOCKS BY HATCHERY-PRODUCED FISH

The genetic diversity of wild salmon populations in Alaska is the result of ten thousand years of natural selection.¹¹ Biologists assume that specific salmon stocks are best suited to their immediate native environment and that wide genetic diversity permits the stock to withstand extreme changes in environmental conditions. Wild stocks are "adapted to their local habitats, yet flexible enough to respond to future changes in these habitats" (Oregon 1990). The consensus among geneticists is that "fitness (reproductive potential) is enhanced by heterozygosity (genetic variability)" (ADF&G 1985, p. 14).

The subject of genetic dilution is further addressed under several subheadings: the lack of scientific consensus, evidence of reduced genetic variability, causes of reduced variability, interbreeding of hatchery and wild salmon, and evidence of a loss of fitness.

Lack of Scientific Consensus

While there is a general consensus among biologists that hatchery strays can affect the genetic make-up of wild fish, it is difficult to prove that such changes will reduce the fitness of a naturally spawning salmon stock. Kelly et al. (1989) surveyed salmon experts and found no "solid data base which could support a documented position (either pro or con) regarding the effects of interbreeding among wild and hatchery fish" (p. 83). Waples et al. (1990) state that compared to other management problems, there has been little effort to address the genetic aspects of salmon management. The current state of scientific knowledge is unable to bridge the gap between the ardent proponents of aquaculture and those who recommend a more cautious approach. Chettleburgh (1991) states that genetic pollution

has become a rallying point for the opponents of aquaculture, particularly commercial fishermen and environmentalists who use the issue with impunity since it is almost impossible to prove or disprove. The effects, if any, may take centuries to occur. (p. 3)

Many scientists agree that literature on genetic impacts is not conclusive and "is largely speculative in nature and without much hard evidence" (Smoker 1985, p. 3). Poor returns can be blamed on over-fishing or bad environmental conditions (Helle 1981). Yet the increased attention given to the topic during the past few years reflects a growing concern by fisheries managers and

¹¹Two levels of genetic variation occur: differences between fish of the same stock and differences between different stocks (Oregon 1990).

scientists.¹² Those who encourage a conservative approach point out that loss of genetic variability that has evolved for thousands of years may be irreplaceable.

While some scientists are critical of hatcheries because of a fear that they may reduce fitness by altering genetic diversity, others are willing to accept some risks as long as production is increased (Mathisen 1991). As a result, different jurisdictions approach salmon enhancement from different perspectives. For example, while the Alaska Department of Fish and Game (ADF&G) Genetic Policy gives priority to wild stocks, Japan gives priority to enhanced fish.

Evidence of a Reduction in Genetic Variability

Several methods are used to determine the difference between hatchery and wild fish, including scale pattern analyses and starch gel electrophoresis of tissue proteins. Periodic genetic monitoring using electrophoresis can determine if there has been a change in allelic frequencies and therefore a reduction in genetic variability. These studies can reveal if there has been gene flow between a hatchery and wild population and if the genetic variability has been reduced. This process, however, does not reveal if hatchery-wild hybrids are more or less fit than the wild fish. In other words, geneticists can use electrophoresis to determine if a fish is a hatchery fish or a wild fish or if salmon stocks, such as hatchery fish, have lost genetic variability (assuming that the test recognizes a genetic difference between hatchery and wild fish and that electrophoresis data is available for the stocks before hatchery fish entered the gene pool).¹³ With salmon stocks that do not show a discernable difference using electrophoresis, it may be necessary to use a marking program such as coded wire tagging to determine if hatchery fish are spawning with native fish.

Researchers from around the world have found a reduction of genetic variability in enhanced salmon. In Ireland, Whelan and McGinnity (1991) found that a rare allele has been lost in hatchery fish. Japanese researchers found that concerns about a reduction of genetic variability are supported by a decrease in the number of late run chums and odd-year pinks, reduction of variations in

¹²The 1980 FAO-UNEP Expert Consultation on the Conservation of Genetic Resources of Fish, sponsored by the United Nations, was one of the first major conferences to deal with this topic. Several recent conferences include the April 1990 conference in Loen, Norway; the June 1990 NATO-sponsored Genetic Conservation of Salmonid Fishes in Moscow, Idaho; and the International Symposium on Biological Interactions of Enhanced and Wild Salmonids in Nanaimo, British Columbia. Dr. Ole Mathisen is planning a workshop on this topic to be held in Alaska this fall, and Dr. Tony Gharrett is organizing a panel discussion at the November 1991 meeting of the Alaska Chapter of the American Fisheries Society.

¹³According to Steer et al. (1991), there is a scarcity of data for wild stocks compared to enhanced fish.

the timing and duration of maturation of individual fish, and a reduction in the proportion of the effective number of breeding to total number of returning fish (Kaeriyama 1991). A Soviet Far East study of the Ochepukha watershed found that although selected breeding practices reduce the genetic potential of the hatchery salmon, researchers have not been able to detect any significant differences in abundance, size, weight or fertility of males between streams with only natural runs and those with both wild and enhanced stock (Shubin and Kaevo 1991). Ryman and Stahl (1981) report strong evidence suggesting that hatchery fish in Scandinavia have drastically changed the genetic composition of wild brown trout.

Causes of Reductions in Genetic Variability

Hatchery practices can lead to a reduction of genetic variability. For example, poor hatchery management could reduce the genetic variability through inbreeding or as a result of inadvertent or purposeful selection.

Inbreeding

Crossing salmon that are directly related to one another can result in a loss of genetic variability known as inbreeding. According to Smoker (1985),¹⁴ studies have shown that inbreeding is a distinct possibility in a hatchery. Practices such as the use of a low male to female ratio or too few fish for brood stock may increase the possibility of inbred fish in future generations. The use of local wild stocks to periodically refresh hatchery populations is one way to avoid inbreeding. Studies have not yet documented inbreeding for Pacific salmon hatchery stocks. Riddell et al. (1991), however, speculate that inbreeding could account for reductions in body size of cohos. Waples et al. (1990) note that there have been no comprehensive attempts to determine if hatcheries have been successful in their attempts to prevent inbreeding. Inbreeding depression (loss of vigor) has been documented for some hatchery-raised trout species and Atlantic salmon (Kelly et al. 1989). This may be the result of using a small number of fish to start these hatcheries.

Additionally, studies have not documented a reduction in the average heterozygosity of a Pacific salmon hatchery stock when compared to the whole species (Kelly et al. 1989, Smoker 1985).¹⁵ A lower value of heterozygosity

¹⁴Smoker (1985) reports that a study has shown that with 50 spawners, a hatchery would lose 10 percent variability after ten generations and 25 percent after 20 to 30 generations.

¹⁵Unless studies have been completed for wild fish before genetic interaction with hatchery fish, comparing average heterozygosity of hatchery fish to that of "wild" fish may not be valid.

in Japanese chum salmon when compared with U.S.¹⁶ chum salmon suggests a loss of genetic variability for chum salmon in Japan.

Selection

The rate of genetic change may increase dramatically in hatcheries through selection, which may be either deliberate or unintentional. Selection of large males and earlier-run salmon for hatchery brood stock has resulted in earlier runs of Sakhalin Island chum salmon. The fish are bigger but the rate of reproduction has decreased (Khorevin 1991). Larkin (1981) suggests that a change in traits of hatchery salmon is likely and selection over generations may explain a perceived decline in the fitness of hatchery stocks.

Some scientists recommend against intentional selection for hatchery fish for specific characteristics such as size, growth, and color (Krueger et al. 1981). The ADF&G's Genetic Policy recommends that brood stock represent a broad cross section of the genetic diversity of a run. However, Larkin (1981) suggests that selected hatchery stocks could improve wild stocks and that the "truth may well be that wild stocks improve hatchery strains rather than that hatchery strains dilute wild stocks" (p. 1473). He suggests that deliberate selection could also offset selection by the fishery, perfect transplanting techniques, and determine the timing of hatchery runs. Smoker (1985) also suggests that hatchery salmon could increase genetic diversity in stocks that have been decimated through over-fishing or as a result of natural population crashes. This is because a small escapement of such a stock could lead to inbreeding.

Actions of hatchery personnel or hatchery conditions may result in inadvertent selection. Hatchery-produced salmon may adapt to hatchery conditions which differ from conditions in the wild. To avoid selection of fish tolerant of hatchery conditions Krueger et al. (1981) recommend release of fish at an early age.

Spawning behavior in the wild involves an elaborate courtship ritual and an establishment of a hierarchy of males. Pink salmon tend to mate with similar sized mates and these progeny tend to be more viable than matings between fish of different sizes, as often occurs in hatcheries (Chebanov 1991). Thus, even random pairing of hatchery fish are likely to produce different pairings than what would occur naturally (Helle 1981).

Natural selection in hatcheries produce fish adapted to hatchery conditions which may not have survived in freshwater conditions (for those salmon that do not migrate immediately). If these salmon survive ocean conditions, they could stray to local streams and if successful at reproduction they could reduce fitness.

¹⁶Japanese fisheries are almost completely dependent on hatchery production.

Interbreeding of Hatchery and Wild Fish

The increased straying of hatchery salmon, especially transplanted fish, can result in the transfer of ill-adapted genes. Large-scale hatcheries can be expected to have more strays than small-scale hatcheries (Smoker 1985).

Although it is known that salmon will stray to some degree, scientists do not agree about the degree straying occurs. We were unable to find many studies that predict a specific percentage of strays for either wild, hatchery or farmed salmon.¹⁷ Gritsenko (1991) found that there is a significant increase in spawners due to straying from large rivers in the Okhotsk Sea coast of Sakhalin Island, but that there is poor survival of their progeny. Using a mathematical model, Zhivotovsky et al. (1991) found that straying between stocks had a significant influence on the dynamics of pink salmon populations. On the other hand, an Alaska study at Auke Creek suggests that pink salmon do not ordinarily stray in large numbers to nearby streams, and that there may be some degree of genetic isolation between runs that spawn at different times in the same stream (Gharrett and McGregor 1991). Other studies may not consider that pink salmon are known to test various streams before ultimately spawning in their natal stream (Gharrett, personal communication). Therefore, the extent of straying suggested by some researchers may be exaggerated.

Many authors report that transplanted and hatchery salmon stray more often than wild salmon. Helle (1981) reports that transplanted salmon have a reduced homing ability. Waples et al. (1990) think that straying rates may be higher for hatchery fish. Gausen and Moen (1991) found that greater numbers of escaped farm salmon spawn in rivers within twenty kilometers of a net pen facility. Bams (1976) conducted an experiment in British Columbia using transplanted pink salmon, hybrids of transplanted males and wild females, and wild salmon. He found that for a stream in British Columbia, transplanted salmon were the least likely to return to spawn. The hybrids were more likely to return, but the wild salmon had the best chances of returning. In a similar experiment, Smoker (1985) found that transplanted salmon may be more fit than transplanted-wild hybrids. The propensity of transplants to stray may mean that genetics play a role in the ability of pink salmon to return to their natal streams. Larkin (1981) suggests that the straying of hatchery fish may be due to rearing conditions instead of or in addition to genetics.

Although hatchery salmon may stray more than wild salmon, Soviet scientists Gritsenko and Kovtun (1991) think that locating a hatchery away from natural spawning areas can reduce straying and the impact of straying on the gene pool of wild stocks. The authors maintain that wild and enhanced fish can co-exist as two reproductively isolated groups.

¹⁷A 1991 study by Hard and Heard that studied chinook returns from a fish hatchery in Little Port Walter that used transplanted salmon. Of the 1.1 percent of the fish that strayed, approximately 1/3 of them strayed within 7 kilometers, almost 2/3 strayed less than 25 kilometers, and the most distant stray was 500 kilometers away. Curiously, none of them strayed to their original rivers which were 250 kilometers from the hatchery.

The ADF&G Genetic Policy acknowledges the potential of straying hatchery fish to reduce the fitness of the naturally spawning fish, but it also suggests that hatchery strays may have little impact on wild stocks.

The degree of interbreeding between hatchery and wild fish can only be detected if there is a significant genetic difference between the two. Studies have revealed little contributions by hatchery steelhead fish to wild fish in the Skagit River after twenty years of stocking. On the Yakima River, considerable introgression (introduction of genetic material from one gene pool to another) between hatchery and nonanadromous wild steelhead occurred, yet anadromous steelhead have shown little introgression with hatchery fish (Campton 1991). Hindar et al. (1991) cite several other studies that reveal introgression between hatchery or farmed salmonids and wild stocks.

Evidence of a Loss of Fitness

Some studies have shown that hybrids of wild and nonlocal salmon are less fit than their wild counterparts (Waples et al. 1990). Because many traits are thought to be inherited, biologists fear that hybrids will be less able to compete, less resistant to disease, and more vulnerable to predation. Allendorf (1991) points to the growing evidence of a loss of local adaptations. Larkin (1981) reports that some people suspect that declining success of hatcheries after a decade or so may be due to genetic changes. Hindar et al. (1991) state that a "considerable body of relevant indirect evidence" points to adaptive changes resulting from interbreeding (p. 950).

On the other hand, according to Kelly et al. (1989), some fishery specialists do not think that hatchery-wild hybrids will detrimentally affect wild stocks. Additionally, there is speculation that in some cases of over-fished wild salmon stocks, hatchery fish may actually increase the fitness of the wild stocks (Kelly et al. 1989; Larkin 1981). However, according to Davis and Burkett (1989), "[a]ny loss of genetic variation results in a loss of fitness, but any gain in genetic variation may or may not improve fitness" (p. 4).

Some researchers have found that wild smolts are more likely to survive than hatchery smolts (Hilborn et al. 1991; Whelan and McGinnity 1991). Swain and Riddell (1991) suggest that if hatchery fish mate with wild stocks, the offspring may be less fit than the wild fish, but that throughout time, wild fish stocks would likely regain fitness.

A study in Norway found that farmed brown trout males do not survive well in wild streams and that only a limited amount of spawning occurred between wild males and farmed females (Skaala et al. 1991). Flemming and Gross (1991) found similar results with hatchery-reared coho salmon in Vancouver Island, British Columbia. Hatchery salmon, especially males, did not reproduce well unless there were no fish in the stream. As the density of spawners increased, the reproductive success of the hatchery fish decreased. Hatchery fish that do breed in the wild could produce a genetically inferior fish. Reisenbichler and McIntyre (1977) revealed that hatchery steelhead were genetically different from wild steelhead and that they did not survive as well as wild fish.

Some studies using hatchery and wild fish from the same parents have found that the hatchery fish do not survive as well as wild fish in natural conditions. These results suggest that a reduction in fitness is a response to hatchery conditions rather than caused by genetics. A study using progeny of the same parents reared one group naturally and the other in the hatchery found that the hatchery group had a reduced osmoregulatory ability (i.e., diffusion of water through cell walls). Because both came from same stock, the difference was probably a response to the rearing environment (Shrimpton et al. 1991). Ward et al. (1991) found that pen-reared steelhead from wild parents survived at lower rates than wild steelhead.

Transplants

Hatchery salmon bred from salmon transplanted from long distances have a greater chance of being less fit than those bred from a local stock. The ADF&G Genetic Policy assumes that hatchery stock from a different geographic area could reduce fitness of a salmon stock, but it is not known if this reduction is critical (Davis and Burkett 1989). The policy suggests that it may be safe to transfer stocks from within the same region for brood stock (ADF&G 1985).

Many states, including Alaska, restrict the transport of live fish or gametes (eggs or sperm) to decrease the chance of spreading disease and to be sure fish used in hatchery operations are similar to local stocks. Recently, however, an increase of fish smuggling by aquacultural operators was reported in California (CAA 1990).

INCREASED FISHING PRESSURE ON WILD STOCKS

In a survey of fishery professionals about the effect of hatchery fish on wild fish, Kelly et al. (1989) found that the greatest consensus was that large-scale releases of hatchery fish can be detrimental to wild fish stocks if there is no feasible way to separate the fish before harvest. "Almost all hatchery-produced salmon in Alaska have the potential for engendering mixed-stock fishery management problems" (Smoker 1985, 14). Mixed stock fisheries are difficult to manage because there is a danger that the smaller stocks will be over-harvested. The state's mixed stock policy encourages terminal fisheries whenever possible (fisheries that occur after the stocks separate). It is not economically feasible to fish at many terminal fisheries because once salmon near their spawning area, the quality of their flesh declines as they adopt spawning characteristics.

While there is danger of over-exploitation of a weak stock in mixed stock fisheries, the problem is compounded with the addition of hatchery stocks (Smoker 1985). Hatchery stocks need less brood stock than wild fish, so it is

possible to have a higher harvest rate for hatchery fish than for wild fish.¹⁸ Especially with large-scale hatcheries, it is difficult to estimate the numbers of wild fish returning (unless they are separated physically or at the time of return). A certain number of wild fish are needed to sustain a stock's genetic variability.

The director of ADF&G's Division of Commercial Fisheries in 1982 explained that with fisheries enhancement, "[w]e may not be able to fully develop some sites and stocks without declines in natural stocks or foregoing harvests of enhanced stock unless we modify our current way of managing" (Pennoyer 1982, p. 113). Under mixed stock fisheries "stocks which are of consistently lower productivity will probably have consistently lower escapements and sooner or later will decline, often drastically, even with 'good management'" (Pennoyer 1982, p. 112).

Many examples document that optimum harvest of hatchery fish in mixed stock fisheries has occurred at the expense of wild fish. Because hatchery fish can withstand a higher exploitation rate than wild fish, wild stocks will be over-harvested unless the entire fishery is limited (Waples et al. 1990). An Oregon study found that the decline in abundance of wild coho salmon in the Columbia river coincided with a sharp increase in harvest rates. The study suggests that current harvest rates will result in the extinction of wild coho (Cramer 1991).

In the Baltic Sea, the number of natural Atlantic salmon drastically declined as a result of an off-shore fishery on mixed stocks (Eriksson and Eriksson 1991). Hilborn (1990) reports that high harvest rates of hatchery fish in the waters between British Columbia's Vancouver Island and the mainland has resulted in an increase in hatchery production, a decline in wild stocks "and the Canadians have no more coho now than they did fifteen years ago" (p. 3). Enhancement activities (new spawning channels) in Babine Lake of British Columbia's Skeena River basin significantly increased production at the expense of other basin stocks (Smoker 1985).

The risks inherent in mixed-stock fishing may be reduced if hatchery and wild fish spawn at different times. Although original hatchery stocks in Prince William Sound were selected to be later or earlier than the wild runs, there is some overlap. Wild stocks can be easily over-harvested at the entrance to the sound in areas where stocks are mixed, such as happened during 1990 (Geiger et al. 1991). According to Eggers et al. (1991), the recent decline in wild pink salmon in Prince William Sound is believed to be a result of low escapement due to over-fishing of wild stocks. Hatchery and wild stocks are harvested together "in the near-terminal mixed-stocks fishing areas and as cost

¹⁸Optimum harvest rates for hatchery fish are 90 to 95 percent while optimum rates of harvest for wild fish are between 60 to 75 percent (Kelly et al. 1989). Hatchery production results in fewer mortalities than wild production because wild fish are subject to changing environmental conditions, competition and disturbance of redds by other fish.

recovery in the hatchery terminal harvest areas" (p. 4). The authors ascribe the low escapement of wild fish to "a weak implementation of the fixed escapement goal policy" (p. 27). In other words, in order to harvest the high numbers of hatchery-reared salmon before they lose quality, harvest rates of wild salmon in these fisheries have reduced the number of wild salmon escapement to levels lower than before the hatcheries were built.

To assess the pressure exerted upon wild fish, some method of identifying the numbers of wild and hatchery salmon must be used. Coded wire tags are sometimes inserted in juvenile fish. The coded wire tag program in Prince William Sound, however, doubled the cost of managing that fishery. A recently introduced marking method, known as thermo-marking, relies on distinctive markings on the fish's otolith (ear bone) as a result of different water temperatures in the hatchery. Each hatchery using this method uses a different sequence of water temperatures. Electrophoresis is another technique that can be used to separate stocks, although it has limitations. The lack of a marking program for hatchery fish from the Gastineau hatchery in Juneau made it impossible to determine if poor returns in 1989 were due to over-harvesting (Geiger et al. 1991).

Smoker (1985) recommends several possible solutions to reduce over-fishing of mixed hatchery-wild stocks: 1) identify the percentage of wild fish in the mixed-stock fishery and reduce catch levels to permit sufficient escapement of the wild stocks, 2) establish annual catch quotas for the fishery, 3) use hatchery stock that return at a different time than wild fish, and 4) restrict the numbers of hatchery fish produced. Smoker acknowledges the problems with each of these solutions.

COMPETITION FOR FOOD BETWEEN WILD AND HATCHERY-PRODUCED FISH

The issue of carrying capacity (the number of fish that can be supported in a given area) of salmon is still contentious. Inhibited growth of salmon due to competition with other fish is known as density-dependent growth. It is difficult to determine if density dependency is the cause of a reduced average size of salmon or if this reduction is a result of poor environmental conditions (e.g., less food sources due to colder water temperatures), or a combination of factors. It should be noted that even if density dependency is found to be an important factor in one area, it may not be as important in another area or at another time. Environmental conditions may be different during different years and in different places. Also, salmon of the same species may have different migration patterns in different areas.¹⁹ Different

¹⁹In the Soviet Far East, salmon from East and West Kamchatka spend about three months in coastal waters while those in southwestern Sakhalin Island spend up to five months in coastal waters (Karpenko 1991).

life histories of Pacific salmon species makes it difficult to generalize about density-dependency factors for all salmon.²⁰

According to Peterman (1984), "[d]ensity-dependent growth or survival has been well documented for the freshwater life phase of Pacific salmon," but less is known about such limitations in marine waters. Given the lack of knowledge of density-dependent growth among wild fish, it is even more difficult to determine how important competition between hatchery and wild fish is. Many scientists suspect, however, that hatchery and wild salmon may compete for food in freshwater, in estuaries, in saltwater nearshore areas, and in the open ocean. Hatchery fish may also displace wild fish from their habitat during juvenile freshwater residence and during spawning (Hindar et al. 1991). Additionally, Kelly et al. (1989) report that some scientists believe that hatchery-wild hybrids may be less able to compete with other fish for food. The density-dependency dispute will only be answered by studies that span many years and consider a variety of factors including fluctuations in environmental conditions and the numbers of hatchery fish released. The discussion below centers on existing studies on this subject.

Competition in Freshwater

A Washington study in two rivers suggests that hatchery coho fry were better able to compete than wild fry. The production of hatchery fry increased, but the total number of fry living to smolts stayed the same. While the number of hatchery smolts increased, the number of wild smolts decreased (Seiler et al. 1991). Reisenbichler and McIntyre (1977) also found that hatchery fish released into stream systems may affect wild fish through competition for food and space. Lichatowich and McIntyre (1987) report that hatchery coho smolts displaced wild fry. Another Washington study, however, found that neither wild nor hatchery coho (from native stock) fry were affected by the presence of the other when released into four streams (Wampler et al. 1991). A study in France showed that if prey density is low, coho salmon escaped from farms could affect the density and growth rate of native Atlantic salmon (Beall and Heland 1991).

Competition in Estuaries

Some evidence points to density dependence in estuaries. Larkin (1981) notes that the unnaturally high numbers of hatchery salmon released at one time may displace wild fish at the site of release as well as in the estuaries and offshore rearing areas. Preliminary research in British Columbia estuaries reveals that migration of large numbers of hatchery-raised sockeye smolts may affect the growth and distribution of wild chinook fry in some estuaries. The researchers suspect that the limitations in the estuary may be due to space and food (McAllister and Levings 1991).

²⁰For example, pink and chum salmon immediately migrate to salt water and do not have competition pressures in freshwater. On the other hand, sockeye coho salmon may spend several years in freshwater and are therefore subject to different types of competition.

Competition in Nearshore Areas

Ocean survival may depend on nearshore competition. Bob Burkett, chief of technology and development for the FRED division places a high priority on studies concerning the nearshore carrying capacity (Gay 1991). Some salmon spend the early portion of their marine life in nearshore areas. Ivankov and Volkov (1991) found that competition for food is an important factor in early marine life survival for juvenile salmon. Karpenko (1991) found that the availability of food, determined in part by the numbers of juveniles, is a major factor determining survival of juveniles. An Oregon study that involved the review of demographic records of salmon stocks suggests that the carrying capacity of nearshore areas may be exceeded during some years. However, according to Smoker (1985), other authors have interpreted the same data and reached the opposite conclusion.

Eggers et al. (1991) acknowledge that it is possible that the nearshore carrying capacity of Prince William Sound may be nearly reached, but there "does not appear to be any competitive interaction between hatchery and wild stocks" (p. 23). Some people speculate, however, that the reduced size in salmon during the 1991 season was due to competition as a result of high hatchery production (Miller 1991).

Competition in the Ocean

Studies suggest that there may be density-dependent growth in the Gulf of Alaska. Peterman (1984) revealed that significant reductions in body sizes of adult sockeye salmon occurred during years of high numbers of sockeye salmon in the Gulf of Alaska. This study suggests that growth in the gulf is slowed during early ocean life and most likely results from "competition for food among similar-sized sockeye."²¹ Eggers et al. (1991) report that a trend in decreasing average weight suggests that pink salmon growth in the Gulf of Alaska may also be density dependent, affected in part to increasing hatchery returns.

Studies in other parts of the world also suggest a relationship between high numbers of salmon and reduced growth. A Japanese study found that during the last decade of increased chum salmon hatchery production, salmon have decreased in size along with a decrease of the mean age at maturity. Stunted growth during the first year in the ocean suggests that the rate of growth decreased because of increased numbers of fish competing for food (Hayashizaki and Hitoshi 1991). Kaeriyama (1991) also suggests that a reduction in size and average age of adult chum results from density-dependent growth, but found little evidence that survival has declined (Kaeriyama 1991).

²¹According to Peterman (1984) 80 percent of the sockeye in the Gulf of Alaska are from British Columbia and Bristol Bay. The density-dependent growth appears to be between fish of the same stocks as well as among sockeye from different origins.

Smoker (1985) modeled factors affecting ocean survival and found that large releases of hatchery salmon could not only result in a reduction of survival and growth but also could lead to increased variability of salmon abundance from generation to generation. While salmon may have more food available than they need in many areas, food may be patchy during their first summer at sea and "transitory limits to carrying capacity" may be important. Production of salmon has been more variable as hatchery production has increased in Hokkaido Island, Japan and in Oregon (Smoker 1985).

Ricker (1981) notes a decrease in the average size and age of Pacific salmon since the 1920s. He attributes this decrease to eight possible causes, including the possibility that some aspect of artificial propagation has caused slower growth.

Other studies suggest that density-dependent growth is unlikely. Smoker (1985) reports several studies that show no evidence that ocean growth is limited by density of the salmon. One of these studies simulated the growth and survival of salmon during the first six months of ocean life and found that more food is available to Pacific salmon than is consumed.

Should nearshore density-dependency growth be a threat, possible solutions include staggering the release of stocks and rearing salmon to a larger size before release. Future monitoring of growth, age and survival records will help determine where density-dependent growth appears to be a problem.

PREDATION ON WILD STOCKS BY HATCHERY PRODUCED FISH

Little is known about predation by hatchery fish. Generalities based on individual studies are problematic because of differences in the life histories of different salmon species (e.g., differences in freshwater residency, time spent in nearshore areas and ocean migration patterns). While there is evidence of predation by hatchery fish on wild salmon, wild salmon also target hatchery fry.

Ivankov and Volkov (1991) found that predation was an important factor in early marine life survival for juvenile salmon. Most knowledge of predation is in freshwater, estuaries and nearshore areas, and few studies quantify the loss of wild salmon by predation of hatchery fish (Smoker 1985). Hilborn (1990) states that hatchery fish pose a possible threat to wild fish by predation upon them. Smoker (1985) also suspects that enhanced fish may prey upon wild fish. Correlations between releases of hatchery salmon and declines in wild stocks have been observed. Hatchery releases of coho have been found to be coincident with decreases in pink and chum stocks in Washington. In another part of the state, delaying the release of hatchery coho until pink salmon migrated resulted in greater survival of pink salmon (Smoker 1985).

Coho salmon raised as smolts are known to feed on hatchery-produced pink salmon, and early predation in estuaries may be heavier than later predation. Additionally, large numbers of hatchery-released fry may attract coho salmon, which will feed on hatchery as well as wild salmon fry (Smoker 1985, Hindar et al. 1991).

Wood et al. (1991) found that declining sockeye returns to four lakes on Vancouver Island, British Columbia, were not a result of predation by hatchery smolts during the downstream migration. The researchers suspect that marine survival may be affected by predators attracted to nearshore areas because of the large numbers of juvenile salmon present there.

Karpenko (1991) reports that mortality of salmon due to predation varies from 1.5 to 52 percent in coastal waters of various regions. Fish, birds and marine mammals feed on juvenile salmon, but other species of fish (e.g., smelt, Arctic char and Siberian Char) are the most significant predators. Predation was found to be highest during the peak period of downstream out-migration for pink and chum salmon.

Some authors report predation upon hatchery fish as a reason for a reduction in hatchery fish. Beamish and Thomson (1991) report that in the Strait of Georgia, British Columbia, the average survival of hatchery coho and chinook were initially higher than that for wild fish, but after five years the survival rate decreased below historic levels for wild fish. The authors speculate that the cause of the decline in the survival rate may be due to a cyclic decrease in other food for predators so that they target hatchery fish. A Washington study suggests that hatchery fish may be more vulnerable than wild fish to predation by squawfish although the researchers concede that the higher predation may be because the hatchery fish were the most abundant prey (Fresh et al. 1991). One laboratory revealed that under pressure of predation hatchery chum had reduced feeding when compared to wild chum (Tompkins 1991).

THREAT OF DISEASE FROM HATCHERY-PRODUCED FISH ON WILD STOCKS

The threat of disease and parasites is twofold. First, a possible reduction of genetic diversity resulting from interbreeding with hatchery fish could make a natural population of salmon more susceptible to disease. Second, diseased hatchery stock could transmit the illness to wild stocks.

Few studies document the transmission of disease between hatchery and wild fish. However, Kitchell (1991) reports that hatchery-transmitted diseases may have led to the death of thousands of salmon in the Great Lakes. In a California hatchery, an unintentional cross between chinook and coho resulted in a hybrid that may have resulted in the first outbreak of IHN in coho (a viral disease lethal to hatchery chinook not normally found in coho salmon). None of these crossbreeds have been found returning to a hatchery, however (Bragg 1991). The ADF&G fisheries pathologist Ted Meyers knows of no instances in Alaska where hatchery fish have transmitted diseases to wild fish (personal communication). The ADF&G policy about the control of disease prescribes methods to reduce the transmittal of disease from hatchery-fish to wild fish (Attachment B).

The use of transplanted fish from one area to another can increase the chance of disease outbreak in the wild fish. For example, 23 wild stocks in Norway were decimated after the introduction of fish from the Baltic spread a parasite (Menke 1990). Smoker (1985) reports that researchers in Oregon speculate that transplanted coho may have weakened the ability of wild coho to resist the

pathogen *Ceratomyxa shasta* in Nehalem Bay. Although transplanting fish from outside of Alaska is prohibited now, during the 1970s out-of-state chinook stock were raised in Ketchikan's Crystal Lake hatchery and in the Dredge Lake area in Juneau. The ADF&G terminated this project after the IHN virus infested the transplanted chinook salmon (Burkett, personal communication).

Captive fish are more susceptible to disease because of stress caused by the hatchery environment (FFTF 1990). There is some speculation that hatchery-wild hybrids may be less resistant to disease than wild fish (Kelly et al. 1989).

OTHER EFFECTS

Hatchery salmon may affect wild salmon in other ways not addressed above. Some professionals theorize that wild fish may follow hatchery fish as a result of a chemical (pheromonal) attraction (Kelly et al. 1989). A detrimental effect of hatchery salmon may result when late-spawning hatchery strays dig up the redds of the wild fish (Menke 1990). Additionally, in Pacific Northwest states some hatcheries that fail to produce adults must use wild stocks for a source of eggs and thereby present a net drain to already dwindling numbers of wild stocks (Hilborn et al. 1991). Over-exploitation of wild brood stock for a hatchery on Sakhalin Island in the Soviet Far East also resulted in destroying chum salmon runs from small brooks of the Tym River (Gritsenko and Kovtun 1991).

Recent experiments with gene transfer techniques could someday be used in commercial salmon hatcheries to produce faster-growing fish or ones with greater environmental tolerance. The American Fisheries Society has recommended that such fish not be used in aquaculture facilities without completion of risk assessment studies (Kapuscinski and Hallerman 1990).

An additional consideration relates to the effect large unharvested returns of hatchery salmon may have on wild salmon. During the 1991 season, a significantly large return of hatchery pink salmon returned later than normal but matured earlier than normal. As a result of market saturation, millions of these fish were not harvested. The effect of this large unharvested return is unknown and a few questions remain unanswered. Did hatchery fish displace wild salmon in local streams? Will there be a subsequent reduction of wild salmon in future years? Will there be a larger number of hatchery-wild hybrids? Although there are no funds allocated to study these questions, tissue samples from Prince William Sound rivers are being preserved for possible study in the future.

HATCHERY MANAGEMENT IMPLICATIONS FOR WILD SALMON

Proper siting of a hatchery along with good hatchery management and effective management of the commercial fisheries will reduce the potential for adverse biological interaction between hatcheries and wild fish. Conversely, improper siting and poor management practices will increase the risks of adverse interaction. The following discussion considers the effects of management in

general and then provides an overview of management programs in Alaska and Pacific Northwest states.

Sound Hatchery Management Practices

According to Helle (1981), the location of a hatchery is the most important factor that will help maintain wild populations. Hatcheries must be able to separate wild and enhanced stocks either through time or space. General consensus among biologists is that large-scale hatcheries can potentially wield more damage to wild stocks than smaller facilities. Larkin (1981), however, notes that in some cases large centralized hatchery facilities may be practical.

Other potential problems resulting from hatcheries may be minimized by following specific procedures. The risk of losing genetic variability in hatchery salmon can be reduced by using a large founder population, random pairing representing a wide cross section of the local run, avoiding intentional selection, and crossing wild and hatchery fish every season (Kelly et al. 1989). Although there is no official policy for renewing hatchery stocks Menke (1990) claims that

Alaska fisheries officials agree that it may be a good idea to renew hatchery production with wild eggs and sperm on a frequent cyclic basis, perhaps every four years or so (p. 50).

Some scientists recommend that wild salmon mating behavior be emulated as much as possible (e.g., use as high a ratio of male to female fish as occurs in the wild). Hatchery and wild fish can be kept genetically similar by initially using local brood stock and by periodically renewing hatchery stock with local fish.

Maitland et al. (1981) recommend the establishment of a worldwide system to identify and monitor wild salmonids. They suggest that a group such as the International Union of Nature and Natural Resources (IUCN) undertake this project. Others advocate the creation of areas known as genetic sanctuaries to protect significant salmon stocks. Enhancement activities would be prohibited in these areas (FFTF 1990; Helle 1981, ADF&G 1985).²²

Waples et al. (1990) recommend that programs be expanded to identify different genetic stocks, monitor genetic changes in hatcheries, and evaluate the consequences of proposed large-scale enhancement programs. Kelly et al. (1989) recommend meticulous record keeping for hatcheries about such topics as breeding practices, disease resistance and average heterozygosity. Use of recently developed thermo-marking techniques may eventually make it feasible to mark all hatchery fish and determine the extent to which salmon stray.

²²No gene bank programs for salmon are officially recognized in the U.S. (Kelly et al. 1989).

Other management initiatives may become important in the future. Release of sterile hatchery salmon may be used to prevent hatchery fish from affecting the gene pools of wild stocks.²³ Sperm from fish can be stored (cryopreserved), but preservation of eggs or embryos has not yet been accomplished (Thorgaard and Cloud 1991).²⁴ Wildt and Rall (1991) warn that such techniques should not be used as a "quick-fix" but instead be used along with other conservation techniques. Norway's gene bank program involves the deep freeze of sperm and establishment of living gene banks in brook stock-stations. The program began in an effort to preserve genetic material before the genetic make-up of wild fish were negatively affected by fish farm strays (Gausen 1991). Gene banks have also been established in the Soviet Union (Helle 1983).

A paper by the American Fisheries Society recommends federal regulation of salmon and steelhead hatchery programs to preserve existing genetic diversity (Nehlsen et al. 1991). The authors think that federal regulation now could reduce future listings of stocks as required by the Endangered Species Act.

Alaska Hatchery Management

Because management can minimize or exacerbate the negative impacts of hatcheries, some discussion of Alaska statutes, regulations and policies is appropriate. However, a critique Alaska's hatchery program is beyond the scope of this memorandum.

The intent language of the 1974 legislation authorizing private nonprofit hatcheries reflects a priority for wild stocks.

The program shall be operated without adversely affecting natural stocks of fish in the state and under a policy of management which allows reasonable segregation of returning hatchery-reared salmon from naturally occurring stocks (Chapter 111 SLA 1974).

Alaska Statute 16.10.400 states that the ADF&G commissioner will not issue a hatchery permit unless the hatchery "would result in substantial public benefits and would not jeopardize natural stocks." Other statutes do not show a clear preference for management of wild stocks over hatchery salmon (White, personal communication; Utermohle, personal communication).

Alaska statutes direct ADF&G's Division of Fisheries Rehabilitation, Enhancement and Development (FRED) to complete state and regional plans. Alaska Statute 16.05.090(1) requires the FRED division to "develop and

²³Sterile triploid brook trout are recommended by Corely-Smith et al. (1991) to protect their genetic material. Triploid fish can be created by using heat treatments or by crossing tetraploid females with diploid males. Seeb (1991) reports that the British Columbia government is considering the use of sterile net pen fish to prevent escapees from spawning with wild fish.

²⁴Alaska is using sperm cryopreservation for fish on the Chilcat River (Seeb 1991).