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第 30 回 UJNR 水産増養殖専門部会日米合同会議議事要録

第 30 回 UJNR 水産増養殖専門部会日米合同会議は、平成 13 年（2001 年）12 月 1 ～ 8 日に米国フロリダ州サラソタ及び同州中部周辺地域において開催された。

事務会議及びシンポジウムはフロリダ州サラソタに所在する Mote 海洋研究所において開催された。本年度シンポジウムの主題は「増養殖対象種の生態と資源増殖」であった。

事務会議において、はじめに Mote 海洋研究所水産増殖センター長 Ken Leber 博士と米国側部会長 James P. McVey 博士（NOAA/National Sea Grant College Program）より開会が宣言された後、中村保昭部会長をはじめとする全ての日本側参加者に対し歓迎の意が述べられた。

McVey 部会長より、本会議の開会に際し以下のように挨拶が述べられた。

第 30 回 UJNR 水産増養殖専門部会日米合同会議への、中村部会長並びに日本側参加者を歓迎する。また、本会議を主催した Mote 海洋研究所に感謝する。今回は、初めて私設研究機関が主催する UJNR 合同会議である。また、今回は第 5 次 5 カ年計画の最後の年にあたり、特に本会議中に次期 5 カ年計画について論議することが大変重要であり、全日程を通じて話し合いを持ちたい。

過去 5 年間は UJNR にとって大変活動的な時期であった。会議も大変盛況で、その多くは 100 名以上の参加者があった。また、インターネットを用いたコミュニケーションの増進は、UJNR 共同体制に真の利益をもたらし始めた。学生や研究者を交えたヒラメ増養殖共同研究は、UJNR の堅牢な協力体制を強く示すものである。プロシーディングも迅速に出版され（いくつかは現在インターネット上で公開中）、昨年の米国貝類研究者訪問団のように、専門使節の訪問は研究情報交流を深化させた。これら全ての共同研究体制は増養殖研究の急速な発展とともに発生し、環境関連研究もこの分野の新たな方向性として加わってきた。

今日、両国は大きな変革の時を迎えており、それぞれ増養殖研究体制の再編が行われている。米国は、今後 5 年間で増養殖のとらえ方を変えようと試みており、環境にやさしい増養殖の施行に関する研究を日本とともに行いたいと求めている。米国側では、増養殖研究における国家予算の競争的配分が行われてきており、政府及び外部の研究勢力を統合しようとする試みの中で、国家海洋漁業局と大学の研究者のどちらもこの競争に参加している現状にある。

現在、米国側は、増養殖と漁業のための生態系の総合的管理を目指しており、陸上循環養殖システム、沖合養殖、海洋水産資源増殖が 3 つの主要領域となっている。増養殖の管理と研究は益々複雑化しており、複合的教育、複合的人材、複合的組織によるアプローチが求められている。加えて、企業との提携もさらに必要となってくる。

米国側には日本と共通して関心を持っている分野が多くあり、UJNR が率先して増養殖分野における日米の共通問題を明らかにするよう、これからの日程の中で課題を精査することを試みたい。そして、これらの共同作業と同時に、UJNR と社会との関係に関しても行政機関を通じて改善の努力を行うべきである。

今後、養殖をも含めた沿岸生態系モデリングの分野で共同事業・研究を強力に推進する予定であり、これはまさに増養殖と漁業が融合するための一つの方策である。米国と日本は、両国の水産物の市場、輸出、価格を改善するため、ともに漁業と増養殖

を統合するよい機会にあるといえる。
最後に、本会議のテーマの一つである水産資源増殖は、引き続き日米共同研究の焦点となるだろう。両国ではそれぞれ行政機関の大きな変革期を迎えており、今は相互が関心を持つ重要課題に焦点を絞ることによって今後の共同研究の課題を確定するよい機会である。

中村保昭部会長（水産総合研究センター理事、養殖研究所長）から McVey 部会長並びに米国側参加者に対し、本会議の開催にかかる努力への感謝の意が述べられるとともに、以下のように挨拶が述べられた。
予想もしなかった 9 月 11 日の同時多発テロにより米国民が受けた衝撃に、我が国でも多くの人が心を痛め、テロの撲滅を願っている。心よりお見舞い申し上げる。このような状況を乗り越え、会議の開催にご努力いただいた関係者に篤く御礼申し上げる。
2001 年は米国でのイチローの活躍が象徴的であり、日米の協力が多方面に渡って野球のように発展することを望んでいる。残念ながらテロにより様々な活動に影響が生じたが、日本では、小泉純イチロー首相が登場し、日米の協力推進に活躍が期待されている。昨年の UJNR 水産増養殖専門部会合同会議以来、米国大統領の交代など双方に変化があり、21 世紀に入って初めての本会議が極めて重要であると認識している。
承知のとおり、日本では、2001 年 4 月 1 日より政府所管の研究機関のほとんどが独立行政法人となり、新しい組織で研究を推進する運びとなっている。水産総合研究センターでは、農林水産大臣の定めた中期目標を達成するため、中期計画をもとに新たなスタートを切っている。
日本における水産増養殖生産は、ほとんどの漁業生産量が減少する中で生産量の 20 %を維持する重要な役割を持っており、21 世紀の安定食料供給を担う期待が寄せられている。このため、中期計画により水産生物の機能の解明及び積極的な資源造成と養殖技術の高度化をはかる。
本事務会議では昨年度の合意に基づき、両国の目標に至る共通部分の確認、活動の PR 方策、これまでの活動に関するフォローアップ、共同研究の構築について十分な協議を行い有意義な成果を得たい。
本年度のシンポジウムは「増養殖対象種の生態学と資源増殖」を主題としており、第 5 次 5 カ年計画の最終年度に相応しい活発な討議を期待する。
米国フロリダ州における増養殖の現場を視察する機会を与えていただき感謝する。日本側参加者の理解が一層深まるものと期待している。
最後に大変な時局にもかかわらず本会議の開催に尽力された日米両国の UJNR 関係者に厚く御礼申し上げる。次年度の日本での開催に熱烈歓迎を申し上げたい。

McVey 部会長は中村部会長の挨拶に謝意を述べ、如何なるテロリズムも UJNR の協力関係を妨げることはできないと付け加えた。また、昨年の第 29 回 UJNR 水産増養殖専門部会合同会議開催に際しての日本側の歓待に謝意を述べた。

引き続き、中村部会長より日本側参加者の、養殖研究所　關哲夫（事務局長補佐）、同　山崎誠（事務局員）、　同日光支所　生田和正（事務局員）、同日光支所　長澤和也、東北区水産研究所　関野正志、中央水産研究所　堀井豊充、日本海区水産研究所　藤井徹生、水産大学校　村井武四、福井県立大学　富永修、瀬戸内海区水産研究所　重田利拓が紹介された。

McVey 部会長より米国側参加者の Dr. Kenneth Leber（主催者）：Mote Marine Laboratory、Dr. Conrad Mahnken（副部会長）：NOAA/National Marine Fisheries Service (NMFS)、Dr. William Heard（事務局長）：NOAA/NMFS、Mr. Dominic Preiswerk（副事務局長）：NOAA Research International Activities Office、Dr. Paul Kilho Park（顧問）、Dr. James Sullivan（研究交流担当）：Hawaii Sea Grant、Dr. Charles Helsley：Hawaii Sea Grant College Program、Dr. Robert Iwamoto：NMFS Northwest Fisheries Science Center、Ms. Eileen McVey（文献交換担当）：NOAA Central Library、Mr. Kunikazu Shimamoto：NOAA Research International Activities Office、Dr. Robert Stickney：Texas Sea Grant、Dr. Anthony Calabrese：NOAA/NMFS、Ms. Linda Chaves：NMFS、Dr. Ronald Goldberg：NMFS Northwest Fisheries Science Center、Dr. Thomas Mcllwain：NMFS、Dr. Tomas Jamir：University of Massachusetts at Dartmouth が紹介された。

この後書記の人選に移り、McVey 部会長と中村部会長より、米国側は Preiswerk 副事務局長が、日本側は生田事務局員が推薦され、了承された。

協議事項

○第 5 次 5 カ年計画の総括

中村部会長より第 5 カ年計画期における合同会議の主題と共同事業をとりまとめた総括表が提示された。米国側より英文版の提出を求められ、日本側はそれを了承した。

○共通研究課題の確認

日本側より、日本政府が推進する増養殖研究・技術開発に関する下記の 8 つの主要課題が提示された。

１．水産資源の持続的利用
２．増養殖技術の高度化
　a. 遺伝・育種技術の開発
　b. 繁殖技術の開発
　c. 栄養・代謝要求に基づく餌料の開発
　d. 環境制御技術の開発
　e. 魚病と病原体の防除
３．水域生態系研究と漁場の環境の管理・保全技術の開発
４．水産業の持続的管理
５．消費者ニーズに対応した水産物供給
６．漁業地域の活性化
７．水圏生物の機能解明と高度利用技術の開発
８．国際的視野に立った研究推進

米国側は、日本側の提示した主要課題に対し、その多くは米国側の主要課題を含んでいると合意し、水産資源増殖、水域汚染の軽減、優良品種作出、魚病の防除と軽減、増養殖管理を、特に共同研究を続けるに価値のある課題として認識した。

○ UJNR 成果の社会への公表

UJNR 水産増養殖専門部会の活動を、将来的にさらに効率的に情報伝達する必要があることが総体的に合意された。このため、UJNR 事務局と行政指導者間の情報伝達の向上と現行の共同プログラムの追跡調査の推進を含む、改善方法の検討が提案された。

日本側は、UJNR の活動を確固たるものとし、その成果の行政指導者への情報伝達を促進するための下記の行動リストを提示した。

１．シンポジウムで論議された問題のその後の追跡調査とインターネットを通じた未解決問題の分析結果の公表。
２．UJNR 成果の行政施策への反映とこれらの貢献結果のインターネット上での記録。
３．シンポジウムに先立ち次回 UJNR 会合に関して深く検討・企画するための代表者をそれぞれの国から選定。企画代表者はあらかじめ会合予定地を訪れるべき。
４．UJNR 出版物に査読システムを取り入れる。

米国側は、これらの点について検討することに合意した。

○共同研究

日本側は将来的な共同研究として以下の 3 タイプを提案した。

１．標的分野における情報交換（予算措置なし）
２．個別研究者レベルでの共同研究（旅費支援）
３．共同研究プロジェクト（共同プロジェクト支援）

米国側はこの提案に合意した。日米双方とも、この 3 分野においてさらなる協力体制が必要であると合意した。また、両国とも共同研究相手を特定するための手段が必要であり、UJNR がその機能を満たすことができると合意した。

○ UJNR 検討委員会分科会の設置

以上の、情報化の促進、過去の成果のとりまとめ、及び将来的共同研究課題の精査によって UJNR 水産増養殖専門部会の活性化を図るとの合意を受け、米国側はそれぞれの問題に対応するための 3 つの検討委員会分科会を設置することを提案し、日本側は以下の 3 分科会の設置を合意した。

１．情報化検討分科会
　　米国側委員：Eileen McVey、Linda Chaves
　　日本側委員：山崎誠、堀井豊充
２．成果検討分科会
　　米国側委員：James Sullivan、Conrad Mahnken
　　日本側委員：生田和正、藤井徹生
３．将来検討分科会（第 6 次 5 カ年計画を含む）
　　米国側委員：Robert Iwamoto、Gordon Grau（代理で Charles Helsley）
　　日本側委員：關哲夫、長澤和也

それぞれの分科会は、本会議最終日までに各課題への対応戦略を準備することが求められた。各報告書を本議事録巻末に添付（添付書類 Ⅱ－５）。

○新規事業

米国側 Mahnken 博士より、Puget Sound 湾において絶滅に瀕しているメバル類及びアイナメ類の孵化技術の開発を米国側と共同研究できる日本側研究者を探していることが報告された。米国側は、神戸で開催予定の栽培漁業国際シンポジウムにおいてこのような日本側研究者との接触を希望しており、また候補者の一人である北海道大学桜井博士を訪ねたい旨を述べ、UJNR 事業の一環として支援を求め、日本側はこれを了承した。

關事務局長補佐より、養殖研究所には日本国政府より新規養殖産業の創出に関する研究が求められており、現在最新課題として海洋深層水利用及び機能化学物質の応用に焦点を当てていることが報告された。

また、關事務局長補佐より、現在日本では研究機関と研究課題の評価に大きな努力が払われており、様々な分野において評価者となり得る科学者のリストを必要としていることが報告された。米国側は、必要とされる分野のリストを求め、それに沿った米国側候補者名を提出することを了承した。

○来年度の日米合同会議について

中村部会長より、第 31 回 UJNR 水産増養殖専門部会日米合同会議は東京または伊勢において、またミニシンポジウムは仙台地域の塩釜において開催される予定であることが発表された。

研究者交流

Sullivan 博士より、2000 年 11 月より 2 度にわたって計 14 名の研究者からなる米国訪問団が、UJNR 水産増養殖専門部会関連の業務の一環として日本を訪れたことが報告された。（添付資料 Ⅱ－６）

關事務局長補佐より、日本側研究者 1 名が UJNR 関連の活動における共同研究のために米国を訪れたことを報告した。（添付資料 Ⅱ－７）

文献交換

Ms. McVey より、1998 年より出版された 103 の論文別刷りが様々な研究所及び大学から収集されたことが報告され、そのリストが日本側に手交された。（添付資料 Ⅱ－８）

生田事務局員より、4 つの研究所から 11 の文献と論文別刷りが収集されたことが報告され、それらが米国側に手交された。（添付資料 Ⅱ－９）

共同研究

日本側より、共同研究としてヒラメ増養殖研究が継続しており、このような共同研究を今後も続けるべきであることが報告された。また、養殖研究所矢田氏の研究がこ

の共同研究プログラムのもとに米国で行われていることが報告された。
　米国側も、ヒラメ共同研究を継続することが重要であることに合意し、このような共同研究を沿岸域生態系モデリング研究に発展させるべきであると提案した。（添付資料　Ⅱ－１０）

出版物
　日本側より、第 29 回 UJNR 水産増養殖専門部会日米合同会議シンポジウムプロシーディングのコピーが提出された。米国側は、本第 30 回 UJNR シンポジウムプロシーディングを次回会合までに出版することを約束した。

現地検討会
　Leber 博士より、現地検討会は 12 月 5 日（水）午前 8 時より開始することが告知され、その予定表のコピーが配布された。（添付資料 Ⅱ－１２）

閉会の辞
　中村部会長は米国側参加者に対し、第 30 回 UJNR 合同会議の開催への感謝の意を表すとともに、特に日米の共通関心課題とそれらに対してとるべき適切な行動が明らかになったことに対し強く謝意を表した。

　McVey 部会長と中村部会長は、事務会議のために予定されていた全ての議事が終了したことを確認し、第 30 回 UJNR 水産増養殖専門部会日米合同会議事務会議の閉会を宣言した。

米国フロリダ州サラソタ市にて

2001 年 12 月 2 日

ジェームス　P.　マクベイ　　中村保昭
米国側部会長　　日本側部会長

Ⅰ　2．議 事 要 録　英 文

Statement of the 30th Joint Meeting of the United States-Japan Cooperative Program in Natural Resources (UJNR) Aquaculture Panel Meeting

The 30th Joint Meeting of the UJNR Aquaculture Panel Meeting was held from December 1-8, 2001 in Sarasota and Central Florida. The business meeting and symposium were held on December 2-4 in Sarasota, Florida at the Mote Marine Laboratory. The theme of the symposium was "Ecology of Aquaculture Species and Enhancement of Stocks".

Dr. Ken Leber, Director of the Center for Fisheries Enhancement at Mote Marine Laboratory and Dr. James P. McVey, Chair of the U.S. delegation, NOAA/National Sea Grant College Program, opened the joint meeting by welcoming Dr. Yasuaki Nakamura, Chair, and the entire Japan delegation.

Opening Remarks

Dr. McVey then addressed the delegations with his opening remarks.
Dr. McVey welcomed Dr. Nakamura and the Japanese delegation to the 30th UJNR Aquaculture Panel Meeting. He also thanked Mote Marine Laboratory for hosting the meeting. This is the first UJNR Aquaculture Panel meeting in which a private institution has hosted. Dr. McVey emphasized that this is the final year of the Fifth 5-Year Plan, and that discussions of the next 5-Year plan will be very important during this meeting. He added that this entire UJNR meeting should be used wisely to discuss this plan.
Dr. McVey said that the last five years have been a very active period in UJNR. The meetings have been well attended, with many meetings attracting over 100 participants. He mentioned that using the web to increase communication has just begun to bring real benefits to UJNR collaboration. He said that a strong collaboration in flounder research, including both students and scientists, has been a strong aspect of UJNR cooperation. Proceedings have been published quicker (with some available now on the web) and specialized delegations, such as last year's shellfish delegation, have nurtured information exchange. All of this collaboration has occurred while aquaculture science has been developing quickly and environmental concerns have added an extra dimension to the field.
Dr. McVey noted that today is a time of great change in both countries for aquaculture. Both sides are reorganizing their structure of aquaculture research. The U.S. is attempting to change the perception of aquaculture in the U.S. during the next five years. The U.S. is looking to work with Japan on environmentally sound aquaculture practices. The U.S. side has had national competitions for aquaculture, and, in an attempt to include both federal and external science communities, the National Marine Fisheries Service and university scientists have both participated in this competition.
The U.S. side is looking toward the holistic management of ecosystems for

aquaculture and fisheries. On-shore recirculation systems, offshore aquaculture, and marine stock enhancement are three priority areas. Aquaculture management and research is increasingly complex, requiring a multi-disciplinary, multi-person, multi-institution approach. In addition, industry partners need to become more involved.
Dr. McVey continued by saying that he sees many common areas of interest with the Japanese. The challenge in the subsequent days will be to refine the issues, with UJNR being a guide for expressing joint U.S-Japan interests in aquaculture. Included in this cooperation should be a unified effort to improve UJNR's public relations with government agencies.
Dr. McVey added that strong research and collaboration will be encouraged in the area of coastal ecosystem modeling, with aquaculture included in the modeling studies. This is just one example of how aquaculture and fisheries can work together. The U.S. and Japan share an opportunity to combine fisheries and aquaculture to improve the marketing, exports, and pricing of fishery products in both countries. Dr. McVey concluded that fisheries enhancement (one of the theme's for this year's meeting) will continue to be a focus of U.S.-Japan collaboration. Since both countries are experiencing great change in their administrations, now is a good time to define the areas of collaboration, with the challenge being to focus on key areas of mutual interest.

Dr. Yasuaki Nakamura, Chair of the Japan delegation and Director of the Japan Fisheries Research Agency and Director General of the National Research Institute of Aquaculture (NRIA), thanked Dr. McVey and the U.S. delegation for their extensive efforts in organizing the meeting. He then began his opening remarks.
The unpredictable terrorism on September 11 not only came upon American citizens with a tremendous shock, but also made Japanese people feel very sorry for them.
Please accept our sincere condolences and we are hoping for the complete eradication of terrorism. We thank all of those who worked very hard to hold this meeting despite this difficult time.
In 2001 "Ichiro", a Japanese baseball player did a very good job in the field of baseball. Following this, I hope that collaboration between the U.S. and Japan in other various fields will expand. Unfortunately, a number of activities have been affected by terrorism. However, I also hope "KOIZUMI, Jun-ichiro" the prime minister of Japan, will be able to bring us a bright future for U.S.-Japan collaboration.
As the first meeting of this century, this meeting is very important because many things have been happening since the last meeting, such as the inauguration of the new president of the United States.
As many of you already know, in Japan, almost all governmental research institutes became "independent self-supporting governmental institutions" and they started their research under new organization management on April 1, 2001. Since then, the Fisheries Research Agency has been making progress toward the middle-term strategic plan, which is provided by the Minister of Agriculture, Forestry, and Fisheries.
While almost all kinds of fisheries productions are decreasing in Japan, aquaculture

has continued to produce 20% of all fisheries products and it has been playing a very important role, which will hopefully help stabilize food supply in the 21st century.
Therefore, the middle term strategic plan is focusing on the analysis of the function of aquatic life, active stock enhancement and technology for aquaculture.
Based on last year's agreement, I hope we will be able to have substantial discussions and obtain fulfilling results about the following topics: common profits in the process to accomplish each country's goal; methods to disseminate our activities; follow-up for the past activities; and cooperative research mechanisms.
I hope that this year's symposium topic, "Ecology of Aquaculture Species and Enhancement of Stocks" will lead to active discussions that bring us to a successful conclusion of the fifth 5-Year plan.
We appreciate this opportunity to visit the sites of aquaculture in the state of Florida in order to further our understanding of American aquaculture.
I thank both countries' people for working very hard to prepare this meeting, even though it has been very tough time due to the national tragedy. We will give you an enthusiastic welcome to the next meeting in Japan.

Dr. McVey thanked Dr. Nakamura for his remarks and added that we cannot let terrorism stop U.S.-Japan aquaculture collaboration. Dr. McVey also thanked the Japanese for their hospitality at the 29th UJNR Aquaculture Panel Meeting.

Introduction of Panel Members, Participants, and Observers

Dr. Nakamura then introduced the members of the Japan delegation: Dr. Tetsuo Seki, Deputy Secretary General, National Research Institute of Aquaculture (NRIA); Dr. Makoto Yamasaki, secretary, NRIA, Dr. Kazumasa Ikuta, secretary, NRIA Nikko Branch; Dr. Kazuya Nasagawa, NRIA Nikko Branch; Dr. Masashi Sekino, Tohoku National Fisheries Research Institute; Dr. Toyomitsu Horii, National Research Institute of Fisheries Science; Dr. Tesuo Fujii, Japan Sea National Fisheries Research Institute; Dr. Takeshi Murai, National Fisheries University; Dr. Osamu Tominaga, Fukui Prefectural University; and Dr. Toshihiro Shigeta, National Research Institute of Fisheries and Environment of Inland Sea.

Dr. McVey introduced the members of the U.S. delegation: Dr. Kenneth Leber, Meeting Coordinator, Mote Marine Laboratory; Dr. Conrad Mahnken, Vice Chair, NOAA/National Marine Fisheries Service (NMFS); Dr. William Heard, Secretary General, NOAA/NMFS; Mr. Dominic Preiswerk, Deputy Secretary General, NOAA Research International Activities Office, Dr. Paul Kilho Park, Advisor; Dr. James Sullivan, Hawaii Sea Grant, Science Exchange Official; Dr. Charles Helsley, Hawaii Sea Grant College Program; Dr. Robert Iwamoto, NMFS Northwest Fisheries Science Center; Ms. Eileen McVey, NOAA Central Library, Literature Exchange Official; Mr. Kunikazu Shimamoto, NOAA Research International Activities Office; Dr. Robert Stickney, Texas Sea Grant, Dr. Anthony Calabrese, NOAA/NMFS; Ms. Linda Chaves, NMFS; Dr. Ronald Goldberg, NMFS Northwest Fisheries Science Center; Dr. Thomas Mcllwain, NMFS; and Dr. Tomas Jamir, University of

Massachusetts at Dartmouth.

Procedural Matters

Dr. McVey and Dr. Nakamura introduced the rapporteurs, Mr. Preiswerk of the U.S. side and Dr. Ikuta of the Japan side.

General Discussion

Evaluation of Fifth 5-Year Plan

Dr. Nakamura presented an achievements paper describing the themes of joint meetings and cooperative projects during the fifth 5-Year Plan. The U.S. side asked for an English translation, and the Japanese side agreed to do so.

Identification of Common Areas

The Japanese side presented a list of eight areas that have been identified by their government as priority areas for aquaculture research and technology. They are:

1. Sustainable use of fisheries resources
2. Improvement of aquaculture technology
   a. development of genetic controls
   b. development of reproduction technology
   c. development of feed based on nutrition and metabolism requirements
   d. development of environmental controls
   e. prevention of fish disease and pests
3. Ecosystem studies for improved management and restoration
4. Sustainable fisheries management
5. Improvement of fisheries supply to meet demands of consumer
6. Establishment of "brisk aquaculture region"
7. Functional analysis of aquatic life and utilization technology upgrades
8. Research promotion for international aspects

The U.S. side agreed that many of the Japanese priority areas are consistent with those of the U.S. The U.S. side recognized stock enhancement, pollution abatement, superior strain production, disease prevention and mitigation, and aquaculture management as areas of special value for continued collaboration.

UJNR Public Relations

There was general agreement that the activities of UJNR Aquaculture need to be communicated more effectively in the future. Proposed remedies for this situation include better communication between UJNR officials and agency leaders and improved follow-up of current collaborative programs.

The Japanese side presented a list of possible actions to solidify UJNR activities and enhance the communication of UJNR successes to agency leaders:

1. Follow up on issues discussed at the symposium and publicize the analysis of unsolved issues via the internet.
2. Promote the benefits of UJNR to government policy makers and record these contributions on the internet.
3. Select a representative from each country to discuss and coordinate the upcoming UJNR meeting in depth prior to the symposium. The representative coordinator should visit the meeting site in advance.
4. Include a referee system for UJNR publications.

The U.S. side agreed to take these points into consideration.

Research Cooperation

The Japanese side proposed three types of collaborative research for the future. They include:

1. Information exchange in targeted areas (no budget support)
2. Research cooperation at the individual scientist level (support for travel)
3. Collaborative projects (joint project support)

The U.S. side was agreeable to this recommendation. The U.S. and Japanese sides agreed that more collaboration in each of the three areas was needed. Both sides also agreed that a means for identifying research partners was necessary, and that UJNR could fill this role.

Establishment of Sub-committees

With the agreement that UJNR Aquaculture would benefit from increased communication, cataloging of past achievements, and rigorous examination of future collaborative topics, the U.S. side proposed establishing three sub-committees to address these issues. With agreement from the Japanese side, the following sub-committees were established:

1. Communication
   U.S. : Eileen McVey, Linda Chaves
   Japan : Makoto Yamasaki, Toyomitsu Horii
2. Achievements
   U.S. : James Sullivan, Conrad Mahnken
   Japan : Kazumasa Ikuta, Tetsuo Fujii
3. Future (including Sixth 5-Year Plan)
   U.S. : Robert Iwamoto, Gordon Grau (via Charles Helsley)
   Japan : Tetsuo Seki, Kazuya Nagasawa

Each group was asked to prepare a strategy for addressing their issue before the end of the 30th Meeting. Their reports are attached at the end of this document (Appendix Ⅱ－５).

New Business

Dr. Mahnken of the U.S. side reported that he is looking for a Japanese researcher to work with the U.S. side to develop culture methods for rockfish and ling cod, which is nearly extinct in Puget Sound. The U.S. side would like to establish contact with such a Japanese researcher at the Kobe conference, and is willing to travel to Hokkaido to visit Dr. Sakurai, a possible collaborator. Dr. Mahnken asked for such an effort to be sanctioned under UJNR. The Japanese side agreed to assist.

Dr. Seki reported that the Japanese National Research Institute of Aquaculture (NRIA) has been tasked by the Japanese government to create new aquaculture industries. Presently they are focusing on deep sea water use and the application of function chemicals as hot topics.

Dr. Seki also reported that in Japan there is currently a large effort to evaluate Japanese organizations and research management. The Japanese would like to assemble a list of scientists as possible evaluators in various fields. The U.S. side requested a list of fields covered, and will provide names of U.S. candidates upon receipt of this list.

Plans for Next Joint Meeting

Dr. Nakamura announced that the 31st UJNR Aquaculture Meeting will be held in Tokyo or Ise with a mini symposium scheduled for Shiogama in the Sendai region.

Scientist Exchange Program

Dr. Sullivan presented a list of the two U.S. delegations comprising 14 scientists who visited Japan since November, 2000 to carry out work under the UJNR Aquaculture Panel (Appendix Ⅱ－6).

Dr. Seki reported that one Japanese scientist visited the U.S. to cooperate in activities pertinent to the UJNR (Appendix Ⅱ－7).

Literature Exchange Report

Ms. McVey reported that 103 reprints published since 1998 were collected from various research institutes and universities. She handed over the list to the Japanese delegation (Appendix Ⅱ－8).

Dr. Ikuta reported that 11 articles and reprints were collected, and they were handed over to the U.S. delegation (Appendix Ⅱ－9).

Cooperative Studies Program

The Japanese side reported that cooperation continues with flounder research and

feels that such cooperation should continue. It was also reported that Dr. Yada continues to study in the U.S. under such cooperative programs.

The U.S. agreed that continuing flounder research is important and suggested that such cooperation be extended to coastal ecosystem modeling. The Japanese side agreed (Appendix Ⅱ－10).

Publications

The Japanese side distributed copies of the 29th UJNR Aquaculture Panel Meeting proceedings. In return, the U.S. side promised to publish the 30th UJNR Aquaculture Panel Meeting proceedings before the next meeting.

Field Trips

Dr. Leber announced that the field trips would begin at 8 am on Wednesday, December 5. A copy of the field trip agenda is attached (Appendix Ⅱ－12).

Conclusion

Dr. Nakamura thanked the U.S. delegation for hosting the 30th UJNR Meeting, and particularly emphasized that areas of joint interest have emerged, and appropriate action should be taken.

Dr. McVey and Dr. Nakamura announced that all business had been concluded. The 30th joint business meeting of the UJNR Aquaculture Panel Meeting was then adjourned.

December 2, 2001

Dr. James P. McVey
U.S. Chairman

Dr. Yasuaki Nakamura
Japanese Chairman

Ⅱ　1．合同会議行事日程

30th UJNR Aquaculture Panel Meeting

Schedule of Events

December 1-8, 2001

December 1 (Sat.)		
		Travel to Sarasota
December 2 (Sun.)		
	PM	UJNR Business Meeting
December 3 (Mon.)		
	AM	Symposium: "Ecology of Aquaculture Species and Enhancement of Stocks"
	PM	Continuation of Symposium
		Tour of Mote Marine Laboratory
	Evening	Reception Dinner
December 4 (Tue.)		
		Continuation of Symposium
December 5 (Wed.)		
		Site Visits
	AM	Red Drum Hatchery at the State of Florida's Stock Enhancement Research Facility, Port Manatee, Florida
	PM	University of Florida's Institute of Food and Agricultural Sciences laboratory in Ruskin, Florida (overview of ornamental fish farm industry)
December 6 (Thu.)		
	AM	Mini-symposium on fish aquaculture at the University of Florida at Gainesville
	PM	Tour of Institute of Food and Agricultural Sciences
December 7 (Fri.)		
		Site Visits
	AM	Harbor Branch Oceanographic Institution, Fort Pierce, Florida
	PM	Living Seas Exhibit, Epcot Center Orlando, Florida
December 8 (Sat.)		
		Return home

Ⅱ　2．事 務 会 議 議 事 次 第

30th UJNR Aquaculture Panel Meeting

Mote Marine Laboratory, Sarasota, Florida
December 2, 2001
15:00 - 17:00

Business Meeting Agenda

1. Opening of Meeting
   Ken Leber, James McVey

2. Opening Remarks
   U.S. Panel Chair: James McVey
      Review of past 5 years
      Comments on next 5 year plan
      Call for more collaboration
   Japanese Panel Chair: Yasuaki Nakamura

3. Introduction of Panel Members, Participants and Observers
   James McVey, Yasuaki Nakamura

4. Procedural Matters
   James McVey

5. General Discussion
   1) Pending Questions
      -Evaluation of the 5th 5 year plan
      -Identification of common areas
      -PR plan of UJNR
      -Research cooperation
   2) New Business
   3) Five Year Plan
   4) Other
      -Plans for Next Joint Meeting
      Yasuaki Nakamura

6. Confirmation Matters
   1) Scientist Exchange Report
      James Sullivan, Tetsuo Seki
   2) Literature Exchange
      Eileen McVey, Kazumasa Ikuta
   3) Cooperative Studies
      James McVey, Yasuaki Nakamura
   4) Publications
      James McVey, Kazumasa Ikuta

7. Information
   1) Field Trip Guidance
      Ken Leber

8. Closing Remarks

Ⅱ　３．日本側部会構成者及び参加者リスト

平成１３年度ＵＪＮＲ水産増養殖専門部会
日本側委員名簿

部会長	中村　保昭	養殖研究所所長
副部会長	浮　永久	水産庁増殖推進部参事官
	松里　寿彦	水産総合研究センター研究推進部長
運営委員	小林　正裕	水産庁増殖推進部研究指導課研究企画官
	中添　純一	水産総合研究センター研究推進部次長
	藤井　武人	水産総合研究センター研究推進部研究交流科長
事務局長	反町　稔	養殖研究所企画連絡室長
事務局長補佐	關　哲夫	養殖研究所遺伝育種部長
事務局員	山崎　誠	養殖研究所企画連絡室企画連絡科長
	生田　和正	養殖研究所日光支所繁殖研究室主任研究官
	鈴木　徹	養殖研究所栄養代謝部代謝研究室長
	良永　知義	養殖研究所病理部病原生物研究室長

Japanese Member of UJNR Aquaculture Panel, 2001

Chair	Yasuaki Nakamura	Executive Director, Director General National Research Institute of Aquaculture Fisheries Research Agency
Vice Chair	Nagahisa Uki	Counselor Fisheries Agency
Vice Chair	Toshihiko Matsusato	Director Research Coordination and Planning Division, Headquarters Fisheries Research Agency
Panel Member	Junichi Nakazoe	Senior Research Coordinator Research Planning and Coordination Division, Headquarters, Fisheries Research Agency
Panel Member	Masahiro Kobayashi	Research Planner Resource Promotion Division Fisheries Agency
Panel Member	Taketo Fujii	Chief Research Cooperation Section, Research Planning and Coordination Division, Headquarters, Fisheries Research Agency
Secretary General	Minoru Sorimachi	Director Research Coordination and Planning Division, National Research Institute of Aquaculture Fisheries Research Agency
Deputy Secretary General	Tetsuo Seki	Director Genetics Division, National Research Institute of Aquaculture
Secretary Staff	Makoto Yamasaki	Chief Research Planning and Coordination Section, Research Planning and Coordination Division, National Research Institute of Aquaculture

Secretary Staff	Toru Suzuki	Chief Metabolism Section Nutrition Division, National Research Institute of Aquaculture
Secretary Staff	Tomoyoshi Yoshinaga	Chief Parasitology and Bacteriology Section, Pathology Division, National Research Institute of Aquaculture
Secretary Staff	Kazumasa Ikuta	Senior Researcher Reproduction Section, Nikko Branch, National Research Institute of Aquaculture

第 30 回 UJNR 水産増養殖専門部会日米合同会議
日 本 側 参 加 者

部会長：養殖研究所所長	中村　保昭
事務局長補佐：養殖研究所遺伝育種部長	關　哲夫
事務局員：養殖研究所企画連絡室企画連絡科長	山崎　誠
養殖研究所日光支所繁殖研究室主任研究官	生田　和正
養殖研究所日光支所長	長澤　和也
東北区水産研究所海区水産業研究部資源培養研究室研究員	關野　正志
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オブザーバー：独立行政法人水産大学校教授	村井　武四
福井県立大学生物資源学部助教授	富永　修

30th UJNR Aquaculture Panel

December 1-8, 2001
Florida, U.S.A.

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U.S.A. Member of UJNR Aquaculture Panel, 2001

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Vice Chair	Conrad Mahnken	Director National Oceanic and Atmospheric Administration National Marine Fisheries Service Manchester Laboratory
Secretary General	William Heard	Program Manager National Oceanic and Atmospheric Administration National Marine Fisheries Service Auke Bay Laboratory
Deputy Secretary General	Dominic Preiswerk	Program Manager International Activities Office Oceanic and Atmospheric Research National Oceanic and Atmospheric Administration
Meeting Coordinator	Kenneth M. Leber	Director Center for Fisheries Enhancement Mote Marine Laboratory
Scientific Exchange Official	James Sullivan	Science Advisor for Hawaii Sea Grant
Literature Exchange Official	Eileen McVey	National Oceanic and Atmospheric Administration
Program Intern	Kunikazu Shimamoto	International Activities Office Oceanic and Atmospheric Research National Oceanic and Atmospheric Administration
Panel Member	Robert Stickney	Director Texas Sea Grant College Program

Panel Member	Anthony Calabrese	Chief Aquaculture & Enhancement Division Northeast Fisheries Science Center National Marine Fisheries Service Milford Laboratory
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30th UJNR Aquaculture Panel

December 1-8, 2001
Florida, U.S.A.

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Ⅱ　5．分 科 会 報 告

Subcommittees Report

Program Planning Committee

Committee Members

Japanese Delegation: Tetsuo Seki, Kazuya Nagasawa

U.S. Delegation: Robert Iwamoto, Charles Helsley

Ⅰ. 5-Year Plan

The Program Planning Committee considered the appropriateness of the 5-year plan as proposed. Since the symposia topics for the first two years (2002 and 2003) have already been the subject of considerable discussion, the topics are timely, appropriately defined, and adequately specific with some minor adjustments (below). On the other hand, the Program Planning Committee recommends that the topics for the 3 remaining years be left fairly general to accommodate possible changes in direction and to be broad enough to cover both Japanese and U.S. goals.

2002:

a. Carrying capacity should be an underlying theme.
b. Disease element should focus on *algal* diseases.

2003:

Expand title to ---Aquaculture and pathobiology of crustaceans and other invertebrates (including bivalves).

It will be held in California, San Diego.

The following points were also recommended for the succeeding symposium plan.

・ At the next meeting in Japan, some of the scientists on fisheries economy should be invited.

Ⅱ. Symposium Coordinators

The Program Planning Committee recommends that the Japanese and United States delegations each designate a coordinator to help plan and co-chair the symposium for the following year. The symposium coordinators will also be charged with inviting key experts for the symposium topic to provide plenary talks. The plenary talks might address state of the science as well as future issues. U.S. will send lists of candidates of coordinator and topic presenter to Japan.

Ⅲ. Proceedings

The Program Planning Committee recommends the following:

1. All presentations to UJNR should be written as very short papers or extended abstracts for the annual proceedings. This will ensure continued timely publishing of the proceedings. The Program Planning Committee feels that

requiring peer review for the Symposium proceedings will result in delays.

2. Papers from the proceedings will be chosen, at the author's discretion, for subsequent publication in peer-reviewed publications or in a peer-reviewed volume edited by the symposium coordinators.

3. The coordinator will identify referees to review and comment on papers. Once adjustments were made after coordinator, papers will be turned to UJNR technical administrators.

Communications Subcommittee

Committee Members

Japanese Delegation: Makoto Yamasaki, Toyomitsu Horii

U.S. Delegation: Linda Chaves, Eileen McVey

Communications subcommittee has identified several areas for providing information about UJNR past, current and future activities. These include the Internet using the United States and Japanese UJNR websites; commercial and government publications; handouts at various professional and scientific meetings; and use of government newsletters and "hot" items reports.

Possible actions for further promotion of UJNR activities.

- Greater cooperation between the U.S. and Japan websites so that they are more visibly related
- Inclusion of broader explanatory material about UJNR goals, history and achievements on the websites
- Higher visibility on the U.S. side with the UJNR site within the NOAA hierarchy
- Brief oral and/or written reports at significant international and national meetings. The first meeting identified is the Japan/U.S. bilateral fisheries trade negotiations in Tokyo in January, 2002
- Information provided to relevant staff at U.S. Embassy in Tokyo and Japanese Embassy in Washington, D.C.
- Promotional articles covering the significance of the 30th Annual Meeting using such publications as World Aquaculture Magazine, Business Commerce Daily, and fisheries press in both countries
- Continued communication via email between subcommittee members to identify further opportunities for publicity and to exchange information for release

Ⅱ　6．米国側研究者交流リスト

U.S. UJNR Aquaculture Panel Science Exchanges 2001

Summary: 14 U.S. professional scientists visited Japan from November 2000 through November 2001 under the auspices of the UJNR Aquaculture Panel.

1. Name: Ms. Dorothy L. Leonard
   retired, formerly with National Ocean Service
   Project: Shellfish delegation study tour in Japan
   Location: Hiroshima and Mie Prefecture
   Duration: November 2000

2. Name: Dr. Carolyn S. Friedman
   California Fish and Game
   Project: Shellfish delegation study tour in Japan
   Location: Hiroshima and Mie Prefecture
   Duration: November 2000

3. Name: Ms. Lori A. Howell
   Lawyer for Molluscan Shellfish Industry
   Project: Shellfish delegation study tour in Japan
   Location: Hiroshima and Mie Prefecture
   Duration: November 2000

4. Name: Dr. Daniel P. Cheney
   Pacific Coast Shellfish Foundation
   Project: Shellfish delegation study tour in Japan
   Location: Hiroshima and Mie Prefecture
   Duration: November 2000

5. Name: Mr. Bill Dewey
   Taylor Shellfish
   Project: Shellfish delegation study tour in Japan
   Location: Hiroshima and Mie Prefecture
   Duration: November 2000

6. Name: Dr. Ralph A. Elston
   Pacific Shellfish Institute / Aqua Technology
   Project: Shellfish delegation study tour in Japan
   Location: Hiroshima and Mie Prefecture
   Duration: November 2000

7. Name: Mr. Frederick G. Kern
Oxford Laboratory, National Ocean Service
Project: Shellfish delegation study tour in Japan
Location: Hiroshima and Mie Prefecture
Duration: November 2000

8. Name: Mr. Ken B. Moore
Massachusetts Fish and Game
Project: Shellfish delegation study tour in Japan
Location: Hiroshima and Mie Prefecture
Duration: November 2000

9. Name: Dr. John Supan
Gulf Coast Oyster Industry and LSU
Project: Shellfish delegation study tour in Japan
Location: Hiroshima and Mie Prefecture
Duration: November 2000

10. Name: Dr. William Seama
Project: To discuss ongoing research projects on artificial reefs. To visit engineering facility that does research using scale models of artificial reefs.
Location: Tokyo University of Fisheries
Duration: November 2000

11. Name: Dr. Gordon Grau
Hawaii Sea Grant, Director
Dr. Tetsuya Hirano
Hawaii Sea Grant
Dr. James Sullivan
Hawaii Sea Grant, Counselor
Project: Attend meetings with various university and national institute staff to discuss possible arrangements for future collaborations.
Location: Tokyo University, Tokyo Fisheries University
Duration: October 1-12, 2001

Ⅱ　7．日本側研究者交流リスト

List of Japanese Scientist Exchange Concerned with UJNR Aquaculture Panel (Sep. 1, 2000 - Aug. 31, 2001)

Name: Takashi KAMAISHI

Affiliation: National Research Institute of Aquaculture, Fisheries Research Agency

Place: Virginia Institute of Marine Science (VIMS)

Contents: Technical study of in situ hybridization method for haplosporidium disease of bivalves

Date: March 12, 2001 - March 15, 2001

Ⅱ　８．交 換 文 献 リ ス ト（米国側部会作成）

2001 Literature Exchange
from United States Aquaculture Panel, UJNR
to Japanese Aquaculture Panel, UJNR

Selected Titles
Compiled by Eileen M. McVey
Aquaculture Information Center
Library and Information Services Division
National Oceanic and Atmospheric Administration Department of Commerce

December 2001

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Ⅱ　１０．共 同 研 究 報 告

The UJNR Cooperative Research on Juvenile Flounder

Mass-release experiment of Japanese flounder *Paralichthys olivaceus*
at Wada Beach, Wakasa Bay Japan

Japan Sea Farming Association, Kyoto University and Fukui Prefectural University

Objective

To estimate carrying capacity and assess an affect of mass-release on fish community in the release area

Approach

Mass-release experiment was initiated at Wada beach in 1997.

1997: Impact of release time on survival, growth of stocked juveniles. Release was conducted at different two periods: mysids rich (late May) and poor (early July).

1998: Impact of release size on survival of stocked juveniles. Large and small fish.

1999: No release. Enclosure experiment in the field. Field research on wild Japanese flounder juvenile using Wada beach as a nursery area.

2000: Comparison of release area. Two places were selected, Wada beach and Yura beach. Study on food-relation between released fish and other fishes was added.

2001: Release at two places: Wada beach and Yura beach.
Wada: wide size-range juveniles were released.
Yura: Extensive mass-release.

Methods

Movement of juveniles after release by fishing survey

Growth analysis by daily increments on the otoliths

Food habit analysis: Both qualitative and quantitative study

Results

Mysids abundance is a key factor affecting on feeding, growth, movement after release.

When flounder juveniles smaller than 40mmTL were released, strong

size-dependent mortality occurred, and moreover only fish showing rapid growth after release can survive (growth dependent mortality also occurred after release).

When flounder larger than 50mm were released, movement, growth, feeding was dependent on mysids abundance.

In case of mysids rich conditions

Emigration from release area was little and feeding condition was good. Daily ration was much and growth rate was high.

In case of mysids poor conditions

Fast-growing fish (not always large size) emigrated from release area immediately after release and slow-growing fish stayed in the release area. The fish remaining in the release area were divided into two groups. One was extremely slow-growing fish which would die, and the other group grew in the release area (especially surf zone and near rock-shore and bank) and, afterward moved out of the shallow area.

This event mentioned above is thought to be associated with seedling quality (including genetic problem).

Daily ration of a fry after release reflects the abundance of mysids, and it seems to be a useful tool to evaluate the release place, time and fry quality. The detail will be introduced at UJNR symposium.

We will continue this research and plan to use new technique, molecular tool and stable isotope etc., to evaluate seedling quality and release tactics.

Ⅱ　１１．第６次５ヶ年計画

UJNR 水産増養殖専門部会日米合同会議
第６次５ヶ年計画(2002 － 2006)

優秀な系統の作出、資源の増大・管理、病害の防除と緩和、汚染の除去といった分野で進行中あるいは将来推進すべき課題に焦点をあてることに加え、沿岸域や排他的経済水域（EEZ）の資源がもたらす価値を持続的に最大限に利用するため、増養殖と漁業技術の統合化に関して、国家的・国際的に継続する対話が引き続き必要である。我々はまた、空間的にも時間的にも限られた海域を共有するために、国防や商船、海洋での採鉱など海での他の主要な活動と共存する必要がある。我々は、本第６次５カ年計画において、初期生活史や実用的な技術を包含する基礎科学、および増養殖と漁業を豊かにするための管理基盤に関する包括的な情報の交換に引き続き努力しなければならない。

（１）藻類およびろ過食者の増養殖（日本，２００２）

栄養塩の動態、特に窒素、優良株の作出、餌飼料、物質循環、初期生態、持続可能な環境収容力の見積もり、疾病被害の緩和、二酸化炭素の吸収

（２）甲殻類の増殖と病原生物学（米国，２００３）

エビ養殖における病原生物学(ウイルス、細菌、原虫、その他病原体全て)、アルテミアの最適生産システム、ロブスターおよびカニ養殖の最適化、病気が少ないエビ養殖池の造成、天然資源に影響を与える可能性のあるエビ養殖池で発生する疾病の防除

（３）魚類の増養殖（日本，２００４）

新しい高価格魚を養殖するための技術的な妥当性、個体群動態、環境収容力と資源培養の間の関係、好適漁場造成のための最適化、遺伝的な手法による個体群の改変及び管理の継続

（４）増養殖漁場の生態系と環境収容力（米国，２００５）

県／州管轄地と国管轄地の間の沿岸・沖合養殖のインフラ整備、各種産業の共存のための法的整備・体系化、増養殖漁場の環境収容力の推定のための陸上－沿岸－沖合生態系の解明、有害藻類の増殖と二酸化炭素の吸収、船舶の自由航行と共存するための沈降型・沖合生け簀システム、排他的経済海域における沖合養殖漁場、生態学的および経済学的モデルへの増養殖の統合、養殖生態系におけるエネルギーと窒素の流れ

（５）養殖、野生集団の補充および生息域の管理を介した農業的、持続的水産業の構築（日本，２００６）

沿岸資源の最大利活用を目指した増養殖および漁業の総合化、増養殖場の適地設定、増養殖へのバイオテクノロジーの応用と天然資源への影響、一般市民の認知への努力、汚染の緩和と低減を目的とした沖合および循環型養殖技術

The UJNR Aquaculture Panel
The Sixth Five-Year Plan（2002-2006）

Areas of Future Cooperation Between the U.S. and Japan in Aquaculture

With the rapid expansion of the global aquaculture industry, building sustainable, cost effective, and healthy fish stocks has become a dynamic and interdisciplinary task. Stock enhancement, pollution abatement, superior strain production, disease prevention and mitigation, and aquaculture management are issues common to both the U.S. and Japan and thus are given high priority as topics for future UJNR Aquaculture Panel meetings.

The current successful collaborative activities between the U.S. and Japan in scallop and flounder stock enhancement should be expanded to include other maritime species. Since stock enhancement capitalizes on the existing oceanic foodweb, the biophysical processes inherent in stock enhancement must be modeled to ensure maximum benefits to the health of the fish and the local environment.

New techniques for aquaculture management must be explored. Offshore cage aquaculture is a new field whose principles and implementation minimize both pollution and diseases. At present, the U.S. and Japan work closely together on this endeavor and should continue to do so in the future.

Aquaculture can be stressful to captive fish. Crowded conditions have resulted in increased levels of water pollution and diseased fish. Economic advantage must be balanced with the maintenance of sound environmental integrity. Thus estimations of the aquaculture carrying capacity for the aquaculture ground（inland, coastal, and offshore）must be continually updated, and the UJNR Aquaculture Panel can play a role in sharing improved carrying capacity estimations.

The 200 mile Exclusive Economic Zone（EEZ）is an important asset for both countries. The marriage of physical oceanography and fisheries management within the EEZ is a needed prerequisite for the sustainable harvest of living marine resources. Both the U.S. and Japan are placing greater emphasis on using their EEZs to increase both natural and aquaculture fishery yields. Thus the possibilities for U.S.-Japan collaboration in developing sound EEZ management strategies are excellent.

The UJNR Aquaculture Panel Five-Year Plan（2002-2006）

The UJNR Aquaculture Panel strategically addresses the issues of modern aquaculture through its Five-Year Plan. This plan, while allowing for flexibility, provides a concrete strategy for discussing and acting upon the most current and pressing aquaculture issues. The Five-Year Plan sets the topics for future UJNR Aquaculture symposia which in turn attract highly qualified scientists from both countries to present their current research. These presentations are compiled into the

UJNR Aquaculture Panel Proceedings and distributed to all the participants, appropriate field offices, and interested professionals.

Preparations for the Sixth Five-Year Plan, for the period 2002-2006, are nearing completion. This plan has been developed jointly by the U.S. and Japan to focus on the common issues listed previously. The topics for the next five UJNR Aquaculture Panel Meetings are as follows:

2002 Aquaculture and stock enhancement of algae and filter feeders (To be held in Japan).
Focus issues: Nutrient dynamics (nitrogen in particular); superior strain production; diets; material cycling; early life history; estimating sustainable carrying capacity; disease mitigation; carbon dioxide sequestration.

2003 Aquaculture and pathobiology of crustaceans (To be held in U.S.).
Focus issues: Comprehensive shrimp culture pathobiology; optimal brine shrimp feed production system; lobster and crab aquaculture optimization; healthy aquaculture pond preparation; prevention of pond-generated diseases.

2004 Aquaculture and stock enhancement of finfish (To be held in Japan).
Focus issues: Technological adaptability of emerging high-value finfish to aquaculture; population dynamics; relationship between carrying capacity and stock enhancement; optimization of favorable ground creation; continuing genetic population improvement and management.

2005 Ecosystem and carrying capacity of aquaculture ground (To be held in U.S.).
Focus issues: Non-intrusive offshore cage systems; nearshore and offshore aquaculture coordination between local and national governments; code of cooperative conduct for industry; estimation of holistic land-nearshore-offshore ecosystem carrying capacity of aquaculture ground; harmful algal blooms and carbon dioxide sequestration; EEZ offshore aquaculture sites; integration of aquaculture into ecological and economic models; energy and nitrogen flow in the aquacultural ecosystem.

2006 Building agricultural and sustainable fisheries through aquaculture, wild stock enhancement, and habitat management (To be held in Japan).
Focus issues: Integrating aquaculture and fisheries technologies to optimize value from coastal resources; zoning for aquaculture; use of biotechnology in aquaculture and effects on natural population; public perception improvement.

Ⅱ　１２．現地検討会等スケジュール

30th UJNR Aquaculture Panel Meeting

Field Trip and Mini-Symposium Schedules

December 5-8, 2001

December 5 (Wed.)

08:00 Pick-up from Helmsley Sandcastle Hotel, Travel to Port Manatee

09:30 Red Drum Hatchery at the State of Florida's Stock Enhancement Research Facility Tour, Port Manatee

Agenda

- Introduction
- Acquisition and Conditioning & Spawning Broodstock
- Egg and Larvae Incubation
- Pond Stocking and Fingerling Rearing
- Health Management
- Identification of Hatchery-reared Fish
- Hatchery Effluent Treatment & Disposal

11:30 Travel to Ruskin

12:30 Lunch

13:30 University of Florida's Institute of Food and Agricultural Sciences Laboratory Tour - Overview of ornamental fish farm industry

15:45 Travel to Gainesville

December 6 (Thu.)

08:30 Pick-up Participants at Bed and Breakfast

10:00 Fish Aquaculture Mini-Symposium, University of Florida, Department of Fisheries and Aquatic Sciences

Agenda

10:00-10:15 William Lindberg - Welcome and Introductory Comments

10:15-10:45 Shirley Baker - Shellfish Aquaculture Program

10:45-11:15 Ruth Francis-Floyd and Roy Yanong - Aquatic Animal Health Program

11:15-11:45 Frank Chapman - Sturgeon Aquaculture and Conservation Program

11:45-12:00 Randall Stocker - Aquatic Plant Information Resources

12:00 Lunch

13:15 Institute of Food and Agricultural Sciences, Department of Fisheries and Aquatic Sciences Tour

14:30 Travel to Ft. Pierce

December 7（Fri.）

08:30 Pick-up at Dockside-Harborlight Hotel

09:00 Harbor Branch Oceanographic Institution Tour

Aquaculture Development Park tour will cover

- Gastropod conch culture
- Southern flounder culture
- Tilapia culture
- Clam culture

Participants will see

- Recirculating systems
- Pre-treatment water systems
- Effluent management ponds

11:30 Lunch

12:30 Travel to Orlando

14:30 The Living Seas Behind-the-Scenes Tour, EPCOT Center

17:15 Ceremonial Dinner, Norway Club

December 8（Sat.）

Return Home

Ⅱ　１３．シンポジウムプログラムと講演要旨

30th UJNR Aquaculture Panel Meeting

Ecology of Aquaculture Species and Enhancement of Stocks

Mote Marine Laboratory, Sarasota, Florida
December 3-4, 2001

TECHNICAL SESSION PROGRAM

Monday, December 3, 2001

09:00-09:15 Opening Remarks

Session 1 U.S.-Japan Cooperation in Stock Enhancement

09:15-09:40 Charles Helsley, "Open Ocean Aquaculture- A Venue for Cooperative Research Between the United States and Japan"

09:40-10:05 Mark Drawbridge, "Enhancement of Southern California Marine Species with an Emphasis on U.S.A.-Japan Collaborative Projects in Fish Health"

10:05-10:30 John Miller, "UJNR Student and Scientific Exchange"

10:30-10:45 Break

Session 2 Flounder Stock Enhancement: Growth and Nutrition

10:45-11:10 Osamu Tominaga, "Daily Ration of Hatchery-reared Japanese Flounder *Paralichthys olivaceus* as an Indicator of Release Place, Time and Fry Quality; *In situ* Direct Estimation and Possibility of New Methods by Stable Isotope"

11:10-11:35 Woo-Seok Gwak, "RNA/DNA Ratio as a Measure to Evaluate the Nutritional Condition of Japanese Flounder (*Paralichthys olivaceus*) Larvae and Juveniles"

11:35-12: 00 Discussion

12: 00-13:00 Lunch Break

Session 3 Flounder Stock Enhancement: Genetic Diversity

13:00-13:25 Masashi Sekino, "Genetic Diversity Within and Between Hatchery Populations of Japanese Flounder Assessed by Means of Microsatellite and Mitochondrial DNA Sequencing Analysis"

13:25-13:50 Tetsuo Fujii, "Tracking Released Japanese Flounder *Paralichthys olivaceus* by Mitochondrial DNA Sequencing"

Session 4 Pacific Threadfin Stock Enhancement

13:50-14:15 Michael Tringali, "Preliminary Aspects of Genetic Management for Pacific Threadfin (*Polydactylus sexfilis*) Stock Enhancement Research in Hawaii"

14:15-14:40 David Ziemann, "Stock Enhancement of Pacific Threadfin (*Polydactylus sexfilis*) in Hawaii: Progress and Current Status"

14:40-15:00 Discussion

15:00-17:00 Tour of Mote Marine Laboratory

17:30-19:00 Reception, Mote Aquarium Courtyard

Tuesday, December 4, 2001

Session 5 Pacific Salmon Stock Enhancement

09:00-09:25 Kazumasa Ikuta, "Historical Analysis and Recent Status of Salmon Stock Enhancement Activities in Japan"

09:25-09:50 William Heard, "Alaska Salmon Enhancement; A Successful Program for Hatchery and Wild Stocks"

09:50-10:15 Kazuya Nagasawa, "Predation on Chum Salmon Juveniles by Fishes and Birds in Rivers and Coastal Oceanic Waters of Japan"

10:15-10:30 Discussion

10:30-10:45 Break

Session 6 Physiological and Ecological Applications to Stock Enhancement

10:45-11:10 Allen Place (on behalf of Yonathan Zohar), "Manipulation of Spawning in Finfish: Application to Aquaculture and Restoration Programs"

11:10-11:35 Toshihiro Shigeta, "Cleaning Behavior of the Juvenile Sharpnose Tigerfish, *Rhyncopelates oxyrhynchus* in the Seto Inland Sea, Japan: Possibility of the Application to Aquaculture"

11:35-12:00 Discussion

12:00-13:00 Lunch Break

Session 7 Stock Enhancement Case Studies

13:00-13:25 Thomas Mcllwain, "NMFS Involvement with Stock Enhancement as a Management Tool"

13:25-13:50 Theodore Smith, "Stock Enhancement Research with Anadromous and Marine Fishes in South Carolina"

13:50-14:15 Robert Chapman, "Genetic Determination of Effective Population Size in Red Drum and Its Implications for Stock Enhancement Issues"

14:15-14:40 John Ransier, "The Stock Enhancement of Red Drum (*Sciaenops ocellatus*) in Tampa Bay, Florida"

14:40-15:00 Break

15:00-15:25 Carl Walters, "Steps in Evaluation of Marine Enhancement Programs"

15:25-15:50 John Tucker, "Comparison of Some Developmental, Nutritional, Behavioral, and Health Factors Relevant to Stocking of Striped Mullet (Mugilidae), Sheepshead (Sparidae), Common Snook (Centropomidae), and Nassau Groupers (Serranidae)"

15:50-16:15 Brett Blackburn, "Assessment of Pilot Releases of Red Snapper, *Lutjanus campechanus,* in the Gulf of Mexico"

16:15-16:40 Nathan Brennan, "Effects of Release Strategies on Growth and Survival of Juvenile Snook, *Centropomus undecimalus,* in a Florida Estuary"

16:40-17:05 Toyomitsu Horii, "Evaluation of the Increment of Sustainable Yield by Stocking with Juvenile of the Red Seabream, *Pagrus major*"

17:05-17:30 Discussion

OPEN OCEAN AQUACULTURE - A VENUE FOR COOPERATIVE RESEARCH BETWEEN THE UNITED STATES AND JAPAN

Charles E. Helsley
University of Hawaii Sea Grant College Program
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During the past decade, aquaculture in the United States has begun to assume a more significant role both in U.S. policy and in the U.S. economy. In 1999 the U.S. Department of Commerce (DOC) enunciated a policy to encourage aquaculture development in the United States. This plan envisages the growth of the aquaculture industry to $5 billion industry in the U.S. by 2025 vs. the current value of $900 million. This will involve the production of about 5 times the current production in 2000. This increase is necessary to reduce the seafood import deficit and to stabilize world seafood supplies. But its success will depend upon rapid removal of administrative and scientific impediments.

Cooperation between researchers in the U.S. and Japan is highly desirable to accomplish these goals. The cooperative international scientific information exchange program fostered by the UJNR Aquaculture program has assisted many U.S. scientists to become more aware of Japan extensive experience and research base in marine aquaculture. The development of an active marine aquaculture research program in the U.S. presents an opportunity to expand upon these ties and to provide information useful to both countries as we attempt to make more utilization of the sea. Some possible areas of expanded scientific research and information exchange could include: 1) establishment of culture protocol for additional species including additional cold water species, tropical and subtropical species, and deepwater species; 2) establishing guidelines for the assessment of carrying capacity of coastal and offshore waters; 3) identification of additional sources of high protein fish food and development of additional additives and nutrition enhancers; and 4) the development of technologies that would assist in the growth of the aquaculture industry in more exposed locations.

ENHANCEMENT OF SOUTHERN CALIFORNIA MARINE SPECIES WITH AN EMPHASIS ON U.S.A.-JAPAN COLLABORATIVE PROJECTS ON FISH HEALTH

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Successful marine stocking programs require a multidisciplinary, scientific approach that is complimented by close cooperation with user groups and governmental agencies. Stock enhancement activities in Japan serve as an excellent model for this type of cooperation. In southern California, scientists at the Hubbs-SeaWorld Research Institute (HSWRI) have teamed up with a strong user base of recreational fishermen and the California Department of Fish and Game to help evaluate the efficacy of marine enhancement. Twelve volunteer-based growout facilities have been constructed in an area encompassing more than 200 miles of coastline and one coastal island. Fishermen at these facilities receive 8 cm fingerlings that are tagged with coded wire and grow the fish to 20-30 cm before release. The high profile nature of this program, combined with the logistical difficulties in treating diseases in open cage systems, has made the need for fish of the highest quality paramount. Effective health management procedures must be developed through improved nutrition, and by using traditional and advanced means to diagnose and control disease.

A collaborative project with researchers at the Kagoshima University has been initiated to improve our understanding of the nutritional requirements of white seabass, with the goal of improving fish health, survival and quality. Increased mortality and incidence of deformity occurs routinely at several specific developmental stages under current rearing protocols. Early larval mortality at 2-14 days post hatch (dph) is being addressed through refinements in the broodstock diet and brine shrimp enrichment. Two metamorphic phases (25-35 and 70-90 dph) have been identified as critical periods where stress tolerance is reduced and fish are more vulnerable to disease. Preliminary results using experimental weaning diets have demonstrated improved robustness and a reduction in the incidence of spinal deformities when compared to commercial marine fish and salmonid diets.

Among the pathogens recently found to infect white seabass, viral nervous necrosis virus (VNNV) is being recognized globally as an "emerging disease". VNNV was definitively identified in white seabass by researchers from Hiroshima

University using indirect fluorescent antibody test (IFAT), and represents the first reported case in North America. Our collaboration with Hiroshima University has been expanded to include the University of California, Davis and is currently focused on determining the mode of transmission and prevalence of VNNV in the wild.

UJNR STUDENT AND SCIENTIFIC EXCHANGE

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The exchange of U.S. and Japanese scientists and students under the auspices of UJNR over the past 10 years has resulted in a number of scientific papers and proposals. Results from a few key papers are summarized, particularly with regard to how they illustrate emergent values of collaborative research. A key belief and motivator, shared by researchers in both countries, is the importance of investing in future generations through student exchange.

DAILY RATION OF HATCHERY-REARED JAPANESE FLOUNDER *PARALICHTHYS OLIVACEUS* AS AN INDICATOR OF RELEASE PLACE, TIME AND FRY QUALITY; IN SITU DIRECT ESTIMATION AND POSSIBILITY OF NEW METHODS BY STABLE ISOTOPE

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Feeding intensity is affected by not only the health of fish (vitality and nutritional status) but also the physical and biological conditions in the release area. Therefore, the daily ration of a fry after release becomes a useful tool to evaluate the release place, time and fry quality. Mass releases of hatchery-reared Japanese flounder under various experimental conditions were conducted in Wakasa Bay, the Sea of Japan, from 1997 to 2000. The daily ration was estimated in terms of percent of body weight (BW) by Elliotto and Persson's method in the field. Daily ration was between 1.5% BW/day and 22.2% BW/day and well related with the biomass of mysids. The relative growth rate of stocked flounder was high when the daily ration was high.

The daily ration estimated in the field shows a food consumption of a limited day. It is more important to know the accumulated food consumption after release. We tried to estimate the accumulated food consumption from the temporal change in the stable isotope ratio of δ 13C in dorsal muscles when the diet of juveniles was switched from the artificial pellets to live mysids (different δ 13C from pellets). The δ 13C of fish fed mysids of 4.4% BW/day changed more quickly than that of 2.2% BW/day. There is a significant positive relationship between the change of δ 13C of 14 days after switching of diet and relative otolith growth rate. Our results suggested that the stable isotope could be a useful tool to estimate feeding condition after release.

RNA/DNA RATIO AS A MEASURE TO EVALUATE THE NUTRITIONAL CONDITION OF JAPANESE FLOUNDER (*PARALICHTHYS OLIVACEUS*) LARVAE AND JUVENILES

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Recently developed fluorescence techniques were used to quantify RNA/DNA ratios in the whole body of fed and starved laboratory-reared larval and juvenile Japanese flounder. RNA/DNA ratios in wild larvae and juveniles, and released juveniles were concurrently measured to evaluate their nutritional condition. Significant differences in the RNA/DNA ratios were found between fed and starved fish, and appeared to expand drastically as starvation proceeded. Even in the fed fish marked fluctuations in its ratios during metamorphosis were observed, evident by decreasing from late-metamorphic to post-metamorphic stages. Using the criteria established from these laboratory experiments, the nutritional conditions of wild Japanese flounder larvae and juveniles collected in Wakasa Bay in 1994 and 1995 were determined by measuring RNA and DNA. Starved fish were mainly found at the I stage (settling stage) fish during the late season of settlement in 1995. Hatchery-reared juveniles were released twice in an experimental field, Wada beach, Wakasa Bay, to find the optimal release season; prey mysid abundant (late May) and scarce (early July) seasons. RNA/DNA ratios in the early-released juveniles, which were under higher availability of food were significantly higher than those of the late-released fish at every sampling. RNA/DNA ratios found in the early-released juveniles were consistently higher than those of the wild juveniles simultaneously collected. The present study demonstrates the usefulness of RNA/DNA ratios for assessment of the nutritional condition of wild and released Japanese flounder larvae and juveniles.

GENETIC DIVERSITY WITHIN AND BETWEEN HATCHERY POPULATIONS OF JAPANESE FLOUNDER ASSESSED BY MEANS OF MICROSATELLITE AND MITOCHONDRIAL DNA SEQUENCING ANALYSIS

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The Japanese flounder is a flatfish species widely distributed throughout coastal areas of Japan, and forms an important fishery resource, which is heavily exploited. Market landings of this species have not increased greatly over the last decade in spite of extensive fishery management efforts, and recent interest thus has been directed toward exploitable resource enhancement by means of stocking of hatchery-reared fish into natural sea areas. As a consequence of the increase of artificial fry production, the potential genetic impact of the release of hatchery-reared fish on the wild fish stocks is a growing concern. This is because most hatchery stocks typically show a reduced genetic variability, which may possibly result in the loss of disease resistance or in the reduction of the population's capability to adapt to new environments.

Here, we present an assessment of genetic divergence within and between hatchery and wild populations of Japanese flounder by means of microsatellite and mitochondrial DNA (mtDNA) sequencing analysis. Three hundred individuals derived from three hatchery populations and 190 individuals from three wild populations were examined. All 11 microsatellites screened were polymorphic in all populations, and the levels of genetic variability varied depending on the locus and population. Sequences of the mtDNA control region of Japanese flounder were highly variable; of approximately 443 base pairs sequenced, 132 sites were variable among 490 individuals. The number of microsatellite alleles and mtDNA haplotypes, and mtDNA haplotype diversity showed marked reductions in the hatchery populations compared with the wild populations. Both molecular markers yielded high values of F-statistics between the hatchery populations, and between the hatchery and wild populations. According to phylogenetic tree topology on the basis of inter-individual genetic relatedness as estimated from microsatellite data, distinct clusters consisting of individuals from each hatchery population were formed,

possibly resulting from the effects of random genetic drift. The DNA techniques employed in this study will be useful for the genetic monitoring of Japanese flounder hatchery populations and in furthering our understanding of the genetic conditions of hatchery populations.

TRACKING RELEASED JAPANESE FLOUNDER, *PARALICHTHYS OLIVACEUS*, BY MITOCHONDRIAL DNA SEQUENCING

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The Japanese flounder, *Paralichthys olivaceus*, is one of the most important fish for the coastal fisheries in Japan, and more than 20 million hatchery-produced juveniles have been released annually for the enhancement of stocks. Clarifying the migration of the released flounders is necessary for genetic management as well as the evaluation of stocking effectiveness. In this study, a method of tracking released flounder was developed. The mitochondrial DNA of the Japanese flounder is characterized by the extremely high sequence variability especially in the control region. The determination of the mother of a released flounder is possible by sequencing the mitochondrial DNA control region because of its variability and maternal inheritance. In this method, sequences of hatchery-produced juveniles should be analyzed first. The sequence data are then registered in a database, so that when the flounder is caught, the hatchery where they were produced can be determined. We can get the information about the genetic variability of hatchery-produced stocks in the sea as well as the migration of the released flounder. Although other methods have been used to track the released flounder, mitochondrial DNA sequencing appears to be less harmful for juveniles and potentially less expensive.

PRELIMINARY ASPECTS OF GENETIC MANAGEMENT FOR PACIFIC THREADFIN (*POLYDACTYLUS SEXFILIS*) STOCK ENHANCEMENT RESEARCH IN HAWAII

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Preliminary aspects of genetic management for Pacific threadfin stock enhancement research at the Oceanic Institute (OI) are focusing on genetic stock identification and broodstock management. To investigate genetic structure in wild threadfin, samples from four locations in Hawaii (n = 41) and from three locations in Oahu (n = 32) were examined by DNA sequencing. For each specimen, data were obtained for 1,045 base pairs of the mitochondrial DNA (mtDNA) control region. Overall, haplotype diversity was high (99.3%); a total of 61 unique haplotypes were observed among the 73 individuals assayed. However, nucleotide diversity was low (0.34%) in comparison to that observed for other marine/estuarine percoids. The data are suggestive of an unusually low substitution rate for the threadfin mtDNA control region or of an evolutionarily recent origin (15,000 to 30,000 yrs ago) for the species in the Hawaiian islands. The female effective population size, estimated using the Maximum Likelihood Metropolis-Hastings sampling method, ranged approximately 200,000-300,000. No phylogeographic structure was evident from clustered haplotypes. Genetic variance was partitioned predominantly among individuals within populations (98%); only 1% of the genetic variance occurred between threadfin from the islands of Oahu and Hawaii. Haplotype distributions did not differ significantly among these two locations. These data, which are preliminary, are suggestive of high gene flow on a regional basis.

Preliminary studies for broodstock management are focusing on levels of relatedness among female broodstock and on quantifying female contributions to OI progeny groups. Using mtDNA sequencing, a maternity survey was performed on a cultured progeny group containing normal individuals and individuals exhibiting a specific morpho-anatomical deformity. No maternity/deformity relationship was observed; the condition appeared to be randomly distributed among the offspring of 23 contributing females. This suggests that inbreeding depression and maternal effects are unlikely to be causative factors.

STOCK ENHANCEMENT OF PACIFIC THREADFIN (*POLYDACTYLUS SEXFILIS*) IN HAWAII: PROGRESS AND CURRENT STATUS

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Many coastal fisheries in the Hawaiian Islands show evidence of depletion through overfishing or loss of critical habitat. While conventional stock management (imposition of harvest controls) may aid some overfished stocks to recovery, generally such recovery is slow and subject to variability of natural recruitment. Research into the feasibility of stock enhancement (release of hatchery-reared fish to supplement stocks and reproductive success) in Hawaii on Pacific threadfin (moi, *Polydactylus sexfilis*) has established the information necessary to design and implement a responsible enhancement program, and has demonstrated the potential contribution released fish can have on localized fisheries. Current research is examining threadfin behavior and conditioning, fisheries demographics and ecology, genetics and the ecological basis of fisheries production.

HISTORICAL ANALYSIS AND RECENT STATUS OF SALMON STOCK ENHANCEMENT ACTIVITIES IN JAPAN

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Salmon has been valued as an important food among the Japanese people since the ancient ages. In the Edo era in the 18th century, local governments recognized the instinctive homing behavior of salmon, and took measures to preserve and improve the environment of the rivers serving as spawning and nursery areas. With the implementation of these policies, the volume of salmon catch in Japanese rivers was seen to expand significantly. Following the Meiji Revolution in 1868, modern salmon hatchery techniques were introduced from the United States in 1876, and a number of salmon hatcheries were established mainly in Hokkaido. However, salmon stocks did not improve as expected, perhaps due to over-fishing and deterioration of river environments.

After World War II under Japan's occupation by the United States, the GHQ reformed Japan's fishery systems, and the "Law for the Preservation of Fishery Resources" was enacted. The Hokkaido National Salmon Hatchery was established shortly thereafter under this new legislation. With the development of new hatchery technology, stock populations of chum salmon, *Oncorhynchus keta*, increased rapidly since 1970. However, it has recently become clear that this kind of large-scale artificial manipulation of resources impacts the natural ecosystem. The average body size of adult salmon has been decreasing on a yearly basis, and the release of artificial fish is also considered to disrupt the genetic diversity of natural populations. In contrast to the situation of chum salmon, resource levels of masu salmon, *O. masou*, remain extremely low despite stock enhancement efforts. Since a great part of the life cycle of this species occurs in a river habitat, it is thought that the deterioration of river environments due to development and construction has been affecting the propagation of masu salmon in a negative manner. These facts suggest that it is of fundamental importance to research the ecosystem and environment of target species in order to promote appropriate stock enhancement activities.

ALASKA SALMON ENHANCEMENT: A SUCCESSFUL PROGRAM FOR HATCHERY AND WILD STOCKS

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Alaska salmon have been the focus of major commercial harvest since the latter part of the 1800s. Since then, cyclic fluctuations of salmon abundance in various regions of the state, sometimes synchronous statewide, have caused periods of high or low run strength associated with comparable harvest levels. Low harvest levels from weak wild stocks produce important socio-economic disruptions throughout the state. Modern salmon hatcheries in Alaska grew out of record low wild-stock runs in the 1960s and 1970s and now provide an important component to fisheries utilizing these resources. Initially conceived as a state-run system, salmon hatcheries in Alaska have evolved in the private sector, focused on nonprofit regional aquaculture associations run by fishermen and other stakeholders. Alaska now has 33 production hatcheries, many release more than 100 million juvenile salmon annually (more then 1.4 billion total in 2000) in a balanced program designed to protect and maintain healthy wild stocks. Representing a major turnaround from record low levels two decades earlier, commercial harvest of Alaska salmon in the 1990s were at or near record levels. During this period when wild stocks made impressive recoveries from earlier low levels, hatcheries produced 27-63 million adults annually, accounting for 14-37% of common-property harvest. As the Alaska salmon enhancement program has matured, 13 hatcheries have been closed for various reasons. Protecting wild stock fitness and other unique stock characteristics through careful evaluation of hatchery contributions to fisheries along with strict regulations by geneticists, pathologists, and managers for siting and capacity of hatcheries and restricted use of hatchery broodstocks have been emphasized throughout the program. New mass-marking technologies now enable harvest managers to protect wild stocks better in mixed-stock fisheries. A cornerstone of the successful Alaska program has been the application of escapement-based adaptative management for wild stocks along with the judicious use of appropriate enhancement technologies designed to supplement common property fisheries, not to supplement wild spawning populations or attempt to rebuild depressed wild stocks with hatchery-origin fish.

PREDATION ON CHUM SALMON JUVENILES BY FISHES AND BIRDS IN RIVERS AND COASTAL OCEANIC WATERS OF JAPAN

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The present paper compiles information on predation by fishes and birds on juveniles of chum salmon (*Oncorhynchus keta*) in rivers and coastal oceanic waters of Japan. In this country, nearly 100% of chum salmon juveniles are reared at hatcheries and released into rivers. Various freshwater fishes, such as salmonids, gobiids and cyprinids, are known to feed on such released juveniles and in this paper, information on predation by sculpin (*Cottus nozawae*) and juvenile masu salmon (*O. masou*) is introduced. In river-mouth areas, birds and Japanese dace (*Tribolodon hakonensis*) are significant predators of juveniles. Gulls and some other birds aggregate in the areas during a season of the release and feed heavily on juveniles. Results from a recent survey on the impact of bird predation on a juvenile population in a river of Hokkaido are shown. Little information is available on predators in coastal oceanic waters, but the impact of predation by seabirds, such as rhinoceros aulklets (*Cerorhinca monocerata*), may be significant.

MANIPULATION OF SPAWNING IN FINFISH: APPLICATION TO AQUACULTURE AND RESTORATION PROGRAMS

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As captive broodstock, hatchery and restoration programs have intensified during the last three decades, it has become increasingly obvious that modern seed production facilities must gain complete control over the reproductive cycle of the target fish and produce fertilized eggs on demand. The early spawning induction technologies used pituitary extracts or mammalian gonadotropins. With the determination that most fish held in captivity fail to spawn due to a lack of gonadotropin (LH) release from the pituitary, research and development efforts focused on the use of gonadotropin-releasing hormones (GnRHs). Analogs of GnRH were designed which are resistant to enzymatic degradation, have a higher affinity to the GnRH receptor and are potent stimulators of LH release and ovulation. These analogs were incorporated into a range of sustained-release delivery systems that have been optimized for the induction and synchronization of final oocyte maturation (FOM), ovulation, spermiation and spawning in multiple fish species. The GnRH-based technology is being used in aquaculture and restoration programs. The discovery that the brains of most fish species contain three forms of GnRH, and information about their relative roles in the regulation of reproduction, is now being used to tailor more physiologically-compatible GnRH spawning induction therapies. The cloning of the genes and cDNAs coding the multiple GnRH forms and their receptors, and our current understanding of the regulation of GnRH synthesis and release, is shedding new light on the nature of the hormonal failure responsible for the absence of FOM, ovulation and spawning in many farmed fish, and will lead to the development of novel biotechnological strategies for their induction.

CLEANING BEHAVIOR OF THE JUVENILE SHARPNOSE TIGERFISH, *RHYNCOPELATES OXYRHYNCHUS* IN THE SETO INLAND SEA, JAPAN: POSSIBILITY OF THE APPLICATION TO AQUACULTURE

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Cleaning symbiosis is a well-known phenomenon among marine fishes. The cleaners feed on ectoparasites and other material from the body surface of cooperating hosts which display a stationary pose. In northern Europe, some temperate labrid fishes living there are used in the farming of Atlantic salmon to control sea lice. Although it is assumed that cleaning behavior exists in almost all aquatic environments, there has been little study on cleaning behavior of the fishes in the temperate sea around Japan.

For the first time, we observed cleaning behavior of a juvenile sharpnose tigerfish *Rhyncopelates oxyrhynchus* (Terapontidae), which is found in coastal waters common around inlets and estuaries, toward black porgies *Acanthopagrus schlegeli* (Sparidae) in the fishing port of Hiroshima Bay in the Seto Inland Sea. The diet of the tigerfish included not only small benthic invertebrates such as copepods, ostracods and gammarids in the substrate, but also parasitic copepods which usually inhabited the body surface of the fish. The cleaning behavior consisted of the three parts as follows. First, a host approached the cleaner. Then the host solicited the cleaner for cleaning with the pose. Finally, the cleaner picked on the body surface of the host. The cleaning station of the sharpnose tigerfish was formed in the shallow water of approximately 0.5-1m in depth on their foraging migration route. Actually, the cleaner showed the behavior to pick on the surface of four fishery and aquaculture species among five those which requested cleaning.

In Japan, ectoparasites cause substantial damage in aquaculture industry. For the extermination of those, two methods of a medicated bath and a fresh water bath have been adopted. However, the former has the problem such as environmental pollution around aquaculture pens. On the other hand, the latter needs much handling. The utilization of this cleaning symbiotic relationship may resolve those problems and attain to an environmentally benign aquaculture system in Japan.

NMFS INVOLVEMENT WITH STOCK ENHANCEMENT AS A MANAGEMENT TOOL

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During the last of the 19th century and the first half of the 20th century, the United States marine fishery management agency attempted to recover depleted fish stocks by propagating and releasing hatchery produced eggs and larvae. However, after more than fifty years of effort, there was no evidence that this technique was successful. This was partly a result of the early approach to assessment, in which success of hatchery programs was judged by numbers of fry produced rather than by numbers of adults surviving to enter the fishery. This early stock enhancement program was subsequently abandoned in favor of other techniques for recovering depleted fish stocks such as restoring degraded nursery and spawning habitats and regulating fishing effort. In the 1960s the United States Congress passed the Anadromous Fish Act, which provided funds primarily to the States, with Federal oversight, to culture and stock anadromous fish in an effort to rebuild depleted stocks of anadromous fish across the nation. The anadromous fish program continues today. The National Marine Fisheries Service, created in 1976, has traditionally used techniques other than stock enhancement as a management tool to recover depleted stocks. However, over the past several years the United States Department of Commerce, the National Oceanic and Atmospheric Administration, and the National Marine Fisheries Service have each adopted aquaculture policies that include stock enhancement.

STOCK ENHANCEMENT RESEARCH WITH ANADROMOUS AND MARINE FISHES IN SOUTH CAROLINA

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In 1985, the Marine Resources Research Institute, South Carolina Department of Natural Resources initiated a program focused on examining the feasibility of stock enhancement of an endangered, native anadromous sturgeon species. Since then, research has been broadened to include two marine fish species with estuarine dependent life histories.

Stocking efforts with the shortnose sturgeon, *Acipenser brevirostrum*, ceased in 1992 after a total of 97,483 fish (18.7% tagged) had been released in the Savannah River. These fish originated from broodstock collected from this river over a seven-year period. Fish were stocked at various riverine sites, different seasons, and at a variety of sizes to develop efficient stocking protocols. Tagged fish continue to be captured with the majority of fish remaining in the Savannah River where it is estimated that stocked fish provide at least 38.7% of the current adult population. However, some fish have also supplemented the population in the Ogeechee River, Georgia while others appear to have colonized a more northerly river (Edisto River) and are now reproducing there. This colonization hypothesis is supported by observation of commercial fishermen, tagging data, and recent genetic studies.

The red drum, *Sciaenops ocellatus*, is a popular recreational species along the south Atlantic coast and throughout the Gulf of Mexico. This species has been over-harvested and present populations are still considered depressed. Stock enhancement research has been conducted since 1988. Protocols have been developed for production, marking and stocking fish and for evaluating impacts to local populations. Currently, approximately 1.5 million small juveniles (25-35 mm TL) are stocked annually for research purposes. Results to date indicate that stocked fish can provide a substantial impact. In a study conducted from 1995-1999 in Port Royal Sound in Beaufort County, hatchery fish were captured at age 3 up to 30 km from the release site and sex distribution was not significantly different than the 50:50 ratio recorded among wild fish. At a stocking density of 600 fish/ha^2, hatchery fish provided 58.8% of the age 0-3 year old fish near the release site. Hatchery contribution increased to 77.3% at a stocking density of ~2,300/ha^2. During the four-year study, 19-20% of all red drum captured within 15 km of the release site was of

hatchery origin. In 2000, a new study was initiated to focus on addressing the critical issue of whether stocking supplements or displaces wild fish. Annual CPUE data based on stratified random trammel net sampling for YOY red drum are being used to examine this issue. One year post-stocking (2000), the CPUE from the Ashley River has increased from historically the lowest value of all sampled sites in the state to the highest value recorded of all sites in 2000. Thus, results to date of this continuing study suggest that stocking has supplemented and not displaced fish in the wild population.

During fall 2001, a new program was initiated with cobia, *Rachycentron canadum*. A total of 1,523 fish were tagged and released in four locations in Port Royal Sound through the combined efforts of a local sport fishing club and project staff. The fish were stocked on October 9 and 23 at which time they were 130-144 days old. Overall, fish had a mean size of 348 mm TL and weighed 332 g. These pond-reared juveniles were produced during the normal spawning season and were similar in size to wild juveniles. Stocking occurred in believed coastal nursery systems. These fish, byproducts of aquaculture studies, represent the first socking of cobia on the Atlantic coast. This program is expected to provide information on movements and growth of this highly important recreational and commercial species.

GENETIC DETERMINATION OF EFFECTIVE POPULATION SIZE IN RED DRUM AND ITS IMPLICATIONS FOR STOCK ENHANCEMENT ISSUES

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The red drum, *Sciaenops ocellatus*, is one of a number of species that occupies estuarine waters as a juvenile and migrates to open ocean waters as an adult. This species has experienced dramatic declines in population numbers over the past two decades, which has prompted increasing fishery restriction. In addition, hatchery augmentation has been initiated by several states to increase the abundance of juveniles in local areas. In South Carolina, hatchery reared fish have made significant (20%) contributions to the juvenile population on very local scales. As hatchery-reared fish are typically produced by a small number of individuals, the genetic consequences of augmentation programs are of some concern. In this paper, we assess genetic variation at five microsatellite loci in *S. ocellatus*. The data indicate little geographic differentiation among samples collected along the Atlantic Coast of the U.S., while substantial differences were noted among year classes taken from South Carolina. The gene frequency differences among year classes were used to estimate the effective population size (Ne) of *S. ocellatus* in South Carolina and suggested that Ne was very small (< 300) from 1990 to 1993 and increased to about 1,000 in 1994 and 1995. Whether this increase reflects the effectiveness of management regulations or is simply a random fluctuation in *S. ocellatus* populations is not clear. The data suggest that a limited number of individuals produce the bulk of a given year class and support the sweepstakes hypothesis. Given the small Ne and estimates of the contribution of hatchery reared fish to the wild stock, it is suggested that the current augmentation program in South Carolina has the potential to increase, rather than decrease, Ne in the wild.

THE STOCK ENHANCEMENT OF RED DRUM, *SCIAENOPS OCELLATUS*, IN TAMPA BAY, FLORIDA

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In March 2000, we initiated a study to test the efficacy of stock enhancement by releasing hatchery-raised red drum into Tampa Bay on the west coast of Florida. Our experimental design incorporates the responsible approach to stock enhancement outlined by Blankenship and Leber in 1995. The object of this study is to determine if hatchery-produced red drum released into the wild could ultimately increase recreational angler catch of harvest sized red drum (slot size - 457.2 to 685.8mm TL) by 25%. To achieve this level of effect at a minimal cost, factors including the optimal size-at-release, release habitat, and season-of-release are being evaluated.

The Alafia and Little Manatee Rivers are two of the most significant nursery grounds utilized by wild red drum in Tampa Bay. Hatchery fingerlings are being stocked into both river systems, however, the Alafia is the focus of this experiment. Three size classes of fingerlings are being stocked throughout four one-mile zones in the Alafia River. Each river zone is subdivided into north and south bank sites. Phase I fish (<35mm SL) are stocked in mid-fall (Oct. - Nov.), phase II fish (>70mm SL) in spring (April - May), and phase III fish (>135mm SL) in the summer (June - July). All of these fish were released at a size and age that was similar to fish in the wild, i.e. released fish were in-sync with wild fish. Only phase I fish are being stocked into the Little Manatee River. These fish are being stocked in-sync and six months out-of-sync with wild fish recruitment.

Stocked fish are recovered using intensive fisheries-independent and fisheries-dependent monitoring. Hatchery fish that have been captured are differentiated from wild stocks using mitochondrial and micro-satellite DNA analysis (phase I) and sequential decimal coded wire tags (phases II and III). To date, approximately 1.1M fingerlings have been stocked into the Alafia and Little Manatee Rivers. Fisheries independent monitoring recovered 566 hatchery-reared red drum in 2000 and 606 hatchery-reared red drum in 2001. The majority of these fish were caught soon after stocking. When sufficient data have been collected, we will adapt stocking strategies to emphasize the size of fish, preferred release habitat, and season-of-release that increases the recreational catch in the most cost-effective manner.

STEPS IN EVALUATION OF MARINE ENHANCEMENT PROGRAMS

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Marine enhancement programs are likely to spread dramatically in the near future. There is much potential for these programs to do more harm than good, through mechanisms ranging from post-release survival failure to competition between hatchery and wild fish and increased fishing mortality due to effort attracted by the enhanced fish. We need to develop clear guidelines and priorities for enhancement programs as adaptive management experiments, to insure that successes are recognized and that failures are shortlived. I would recommend that at least the following six scientific evaluation steps be followed in the design of such experiments:

1) Make certain that management priorities and acceptable tradeoffs are absolutely clear
2) Do careful stock assessments to show that the target stock is in fact recruitment overfished or can no longer rear successfully in the wild
3) Show that enhanced fish can recruit successfully in the wild
4) Show that total abundance is at least initially increased by the hatchery fish contribution
5) Show that fishery regulations are adequate to prevent continued overfishing of the wild population, unless there has been an explicit decision to "write off" the wild population
6) Show that the hatchery production system is actually sustainable over the long run, in cases where it is to be a permanent component of the production system.

Note that one of the most popular worries, genetic impact on wild stocks, is not even mentioned in this list. I consider the other risks much more immediate and likely to cause policy failure.

COMPARISON OF SOME DEVELOPMENTAL, NUTRITIONAL BAHAVIORAL, AND HEALTH FACTORS RELEVANT TO STOCKING OF STRIPED MULLLET (MUGILIDAE), SHEEPSHEAD (SPARIDAE), COMMON SNOOK (CENTROPOMIDAE), AND NASSAU GROUPERS (SERRANIDAE)

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Striped mullet (*Mugil cephalus*, family Mugilidae) are temperate to tropical, euryhaline, schooling very omnivorous, coastal fish that eat detritus and a wide range of other organic material. Sheepshead (*Archosargus probatocephalus*, family Sparidae) are temperate to tropical, euryhaline, territorial, omnivorous, coastal fish that are more specialized in feeding; crustaceans and mollusks are important in their diet. Common snook (*Centropomus undecimalis*, family Centropomidae) are tropical, euryhaline, schooling, carnivorous, coastal fish that eat mainly fish and crustaceans. Nassau groupers (*Epinephelus striatus*, family Serranidae) are tropical to temperate, moderately stenohaline, territorial, carnivorous, reef fish that eat mainly fish, crustaceans, and mollusks. Preconditioning can help released fish adapt more quickly; however, the swimming, feeding, social, and fright behaviors of these four species when reared are surprisingly similar to those of wild fish. In addition to providing biological needs and minimizing predation, good choice of release habitat can help limit stress and disease.

ASSESSMENT OF PILOT RELEASES OF RED SNAPPER, *LUTJANUS CAMPECHANUS*, IN THE GULF OF MEXICO

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Successful stock enhancement depends on the survival and reproduction of released fish. Much of the current research in stock enhancement centers on understanding the factors determining the effectiveness of stocking programs, particularly in the context of a balanced ecosystem. The U.S. Gulf of Mexico Marine Stock Enhancement Program is developing the techniques to enhance overfished marine fishes such as the red snapper, *Lutjanus campechanus*. Over the last three years we have conducted pilot releases of cultured red snapper in waters off Mississippi and Florida to investigate various aspects of their ecology.

In the first year, we released approximately 1,200 externally and internally tagged fish onto $1m^2$ artificial reefs off Mississippi to assess tagging techniques, survival, growth, and recapture rate. Sites were monitored periodically for approximately one year using diver observations and arbitrary sampling. Approximately 20 externally tagged fish were observed over a three-month period following release. Five internally tagged fish (out of approximately 500 recovered fish) were collected upon termination of the experiment and were essentially indistinguishable from wild fish. In the second year, we released approximately 3,000 externally and internally tagged fish in Mississippi and Florida onto oyster shell, concrete rubble and cinder block pyramid artificial reefs to assess the appropriateness of different artificial substrates for fingerling red snapper. Post-release assessments focused on survival, distribution, and growth of individual fish. Assessments in Mississippi were hampered by poor weather, but four internally-tagged fish (out of about 250 recovered fish) were recovered and were indistinguishable from wild fish. In Florida, observable red snapper populations on all substrate types stabilized at approximately 25% of the initial population size and remained constant for over four months.

EFFECTS OF RELEASE STRATEGIES ON GROWTH AND SURVIVAL OF JUVENILE SNOOK, *CENTROPOMUS UNDECIMALUS*, IN A FLORIDA ESTUARY

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In central and southern Florida, U.S.A., the common snook, *Centropomus undecimalis*, is rated among the top three near-shore sport fish species and supports a rapidly expanding recreational fishery. Populations of the warm water estuarine snook have suffered from shoreline development and pollution affecting post-larval and juvenile habitat, and from periodic natural freezes in central Florida. With these high pressures on the stock, Mote Marine Laboratory, in partnership with the Florida Fish and Wildlife Conservation Commission, is testing the potential of stock enhancement of snook as an additional fisheries management tool.

Since April 1997, approximately 40,000 hatchery-reared juvenile snook were released as a series of experiments into Sarasota Bay and its surrounding waters to identify optimal release strategies. Coded-wire tags were used to identify experimental treatments of the released snook. In one study, juvenile snook were released during winter and spring into four basic microhabitats of a stream system including: 1) upstream habitats, 2) midstream habitats, 3) stream mouths, and 4) across the bay from stream mouths along island shoreline habitat. Four replicate stream systems were stocked accordingly, with relatively equal numbers of the different size classes released within each treatment. Other studies have focused on the relative survival rates of snook temporarily acclimated *in situ* in predator-free enclosures in comparison to non-acclimated juvenile snook released directly into the wild. A field comparison of tag type on growth, diet, and survival rates was also performed with juvenile snook tagged with either visible implant elastomer tags or T-Bar tags.

A standardized sampling regime with seines and cast nets was developed to recover hatchery-released fish to determine growth rates, feeding habitats, movement patterns, and quantitatively compare relative survival among release groups using recapture rates (No. recaptured/ No. released x 100). Recapture rates from fish released among the release sites within the creeks were variable, however recapture rates of creek released snook were significantly higher than those released at the island habitats. Higher recapture rates from creek-released fish than island-released

fish were also seen in follow up sampling of adult snook habitat along beaches and island passes. Post-release sampling resulted in significantly higher recapture rates of snook acclimated in enclosures than those not acclimated. Recapture rates from snook tagged with VIE tags were also significantly higher than those tagged with T-Bar tags.

EVALUATION OF THE INCREMENT OF SUSTAINABLE YIELD BY STOCKING WITH JUVENILES OF THE RED SEABREAM, *PAGRUS MAJOR*

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Japanese red seabream, inhabiting the southeastern coastal area, is a major target of commercial and recreational fishing, and millions of juveniles have been released each year for stock enhancement since the early 1980s. Recovery rates and expected catches of released juvenile were estimated to be 5-17% and 20-80 tons per one million juveniles respectively. In this paper, the effect of juvenile releasing on the sustainable yield values is discussed.

Numbers of recruits and broodstock biomass during 1983-1993 were estimated with virtual population analysis (VPA) by the data of age composition of landed fish. When the relationships between broodstock biomass and recruits followed the Ricker model, number of recruits of 1-year old in *t* year (*Rt*) was

$$Rt = A*Et-1*exp(-B*Et-1)+St-1*K$$

here, *A* and *B* were the parameters of the Ricker model curve, and *Et* was broodstock biomass. *St* and *K* were numbers of released juvenile and the survival rate of released juvenile until becoming 1-year-olds, respectively. *A*, *B* and *K* were estimated to be 2.000, 0.000272 and 0.197 respectively by the method of least square. The increment of sustainable yield values by stocking was evaluated to be 20% under the current status of fishing mortality and number of released juveniles.

AQUACULTURE AND GENETIC STRUCTURE IN THE JAPANESE EEL (*ANGUILLA JAPONICA*)

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One hundred twenty to thirty thousand tons of eels have been consumed recently in Japan. In other words, every Japanese eats about five eels per year. Charcoal Grilled eel filet with sweet soy sauce is served on rice. It is called Unajuu or Unadon, which is an authentic Japanese food and as important as sushi. Eighteen percent of the total consumption have been produced in Japan (23,211 tons, aquaculture and 817 tons, wild in 1999) and the remaining has been imported from China, Taiwan, and Malaysia. Only 0.6 percent of the total is wild adult eels. Therefore, eel aquaculture is very important and successful for food industry. However, recent decline of glass eel catches in East Asia has caused serious problems in eel aquaculture in Japan and Taiwan. Still seeds for aquaculture depend totally on wild glass eels from East Asia and Europe. We need to start stock enhancement research for restoration of wild eel populations. The first obstacle to start is the lack of information in basic eel biology such as spawning migration and behavior, larval ecology, and population dynamics and structure in nature. We have to start collecting the basic information first. I compared frequency difference of each RAPD band to investigate genetic structure of the Japanese eel from Taiwan (n=10) and Japan (south to north, n=25 each: Kagoshima, Ibaraki and Miyagi). Nineteen 10-base random primers produced bands through PCR. Frequencies of most RAPD bands were similar among the four locations. The 1100 bp band amplified by the primer OPA-10 was absent in Miyagi samples and present in the remaining populations at different frequencies (0.11-0.24). This difference was nearly significant. Additional genetic studies with large sample size (ca. 100 individuals per location) are necessary to determine genetic structure of the Japanese eels. How much we know about life history and ecology of the target species is a key question for the success of resource management and stock enhancement efforts.

GENETIC POPULATION STRUCTURE OF JAPANESE TEMPERATE BASS, *LATEOLABRAX JAPONICUS*

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To assess genetic population structure in Japanese temperate bass *Lateolabrax japonicus*, we determined the DNA sequence variation in segments of the mitochondrial (mt) control region and transfer RNA proline gene for 120 individuals representing six populations. The number of mtDNA genotypes observed was 87. Restricted gene flow was indicated by significant pairwise Fst value in two populations, Sendai Bay and Ariake Bay.

Although phylogeographic structuring was weak in the gene tree, some individuals of Ariake Bay population had distinct genotypes. These were identified as the genotypes of Chinese temperate bass, *Lateolabrax* sp., and considered to be the legacy of past hybridization event between *L. japonicus and L.* sp.

EARLY LIFE HISTORY OF JAPANESE SPANISH MACKEREL *SCOMBEROMORUS NIPHONIUS* (SCOMBRIDAE): IMPLICATIONS FOR STOCK-ENHANCEMENT TRIAL

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Japanese Spanish mackerel, *Scomberomorus niphonius*, is commonly distributed in the eastern Asian coastal waters and is an important fisheries resource particularly in the Seto Inland Sea, Japan. Total catch in the sea exceeded 6,000t in the middle of the 1980s, but has drastically decreased to less than 500t in recent years. In order to re-stock the population, the Japan Sea-Farming Association started mass seed production of the species and releasing hatchery-raised juveniles in the sea. The mackerel larvae have a specialized feeding habit characterized by complete piscivory since the first feeding and behave a voracious feeder with a daily ration of about 100% of body weight. The larvae and juveniles exhibit markedly high growth potential: reaching 100 mm TL in maximum in the first month of life. It has been suggested that recruitment fluctuation of the mackerel is influenced by availability of prey fish larvae during the early life stages. In this paper, we calculate total number of anchovy larvae preyed by a single Japanese Spanish mackerel throughout the early life stages. Based on this calculated daily ration, we discuss the potential effect of mass release of the hatchery-raised juveniles on small pelagic fish comunity in the Seto Inland Sea.

CHANGES OF DIGESTIVE ENZYME ACTIVITIES AFTER FEEDING IN THE JUVENILE STAGE OF JAPANESE FLOUNDER, *PARALICHTHYS OLIVACEUS*

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Feeding behavior of fish is generally concerned to the inherent biorhythm of each species greatly. The strictness of the feeding behavior, however, might be flexible, because fish especially larval and juvenile stages, are not always guaranteed to encounter proper food organisms quantitatively and qualitatively. Therefore, it is important to clarify the effect of feeding frequency and time on the digestive enzyme activities in the early life stages of fish for the seed production. In this paper, Japanese flounder (*Paralichtys olivaceus*), mean body weight of 1,500mg and two months after hatching, were fed mysids once, twice a day or *ad libitum*. Proteolytic enzyme activities including peptic and tryptic ones were measured in the appropriate sampling interval.

In Japanese flounder fed *ad libitum*, total mysids weight (mg) in stomach was high during 15:00-20:00, and low at midnight (00:00~03:00). Stomach content increased again in the morning (06:00). Tryptic activity was high at 15:00, but the activity was almost constant in other time.

Fish fed mysids twice (10:00 and 17:00) a day for a week showed the maximum stomach content just after feeding and the content reached 150 mg/individual being the same level in *ad libitum* feeding group mentioned above. This indicates the satiated uptake of mysids to be 10% of each body weight of Japanese flounder. Tryptic activity was almost constant during sampling time, but the level of activity in body weight basis was lower compared to *ad libitum* feeding.

Fish fed mysids once a day at 07:35 showed the highest tryptic activity at 16:00 after about nine hours of feeding. In fish fed at 15:50, the highest activity was noticed during 04:00~10:00. On the other hand, peptic activity did not show the clear maximum peak, and the activity increased generally with the decrease of stomach content.

Thus, the aspect of activity was completely different between peptic and tryptic enzyme. Negative correlation was observed between tryptic activity and stomach content.

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